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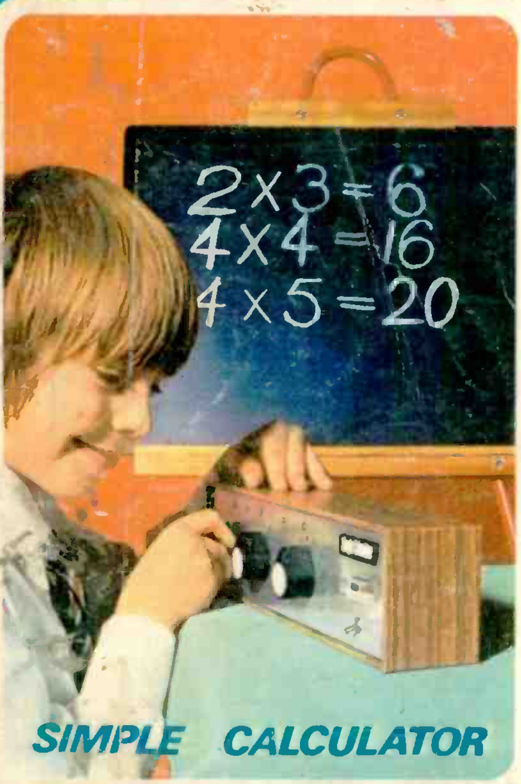

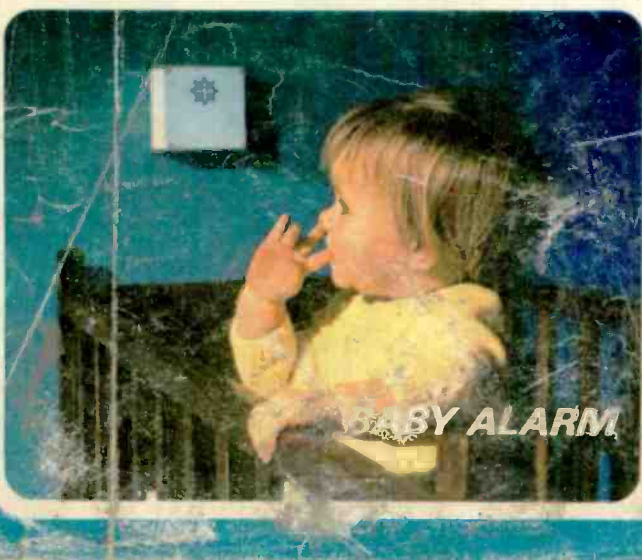

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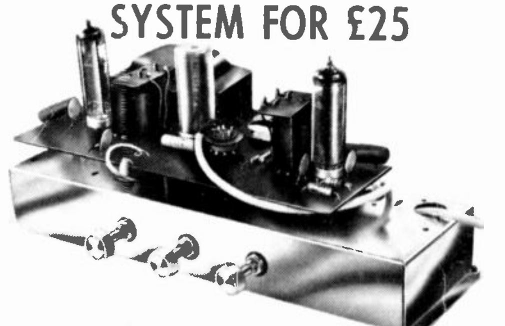

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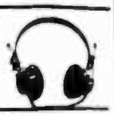

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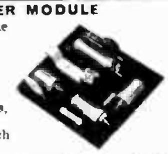

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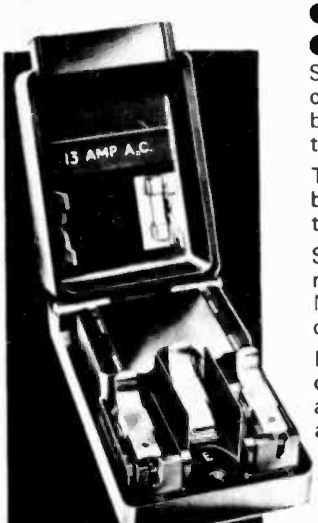

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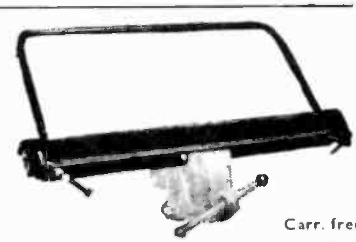

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OC41	0·13	AD149	0·30
OC44	0·13	AUY10	1·25
OC45	0·13	2S034	0·25
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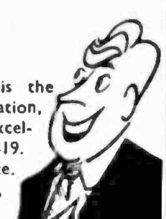

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Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00+£1·50 p&p
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SPECIFICATION R101
14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ±1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max) R101—P.U.1 and radio—65dB. P.U.2 −58dB. R100 same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx 13¾" x 9" x 3¾".

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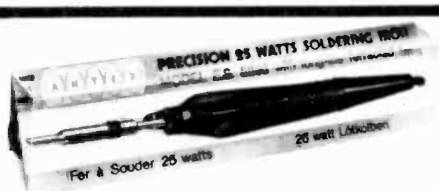

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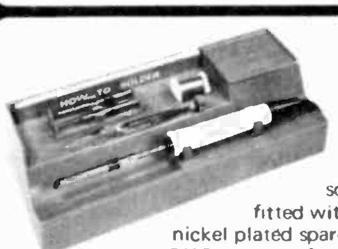

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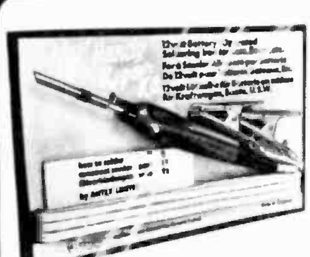

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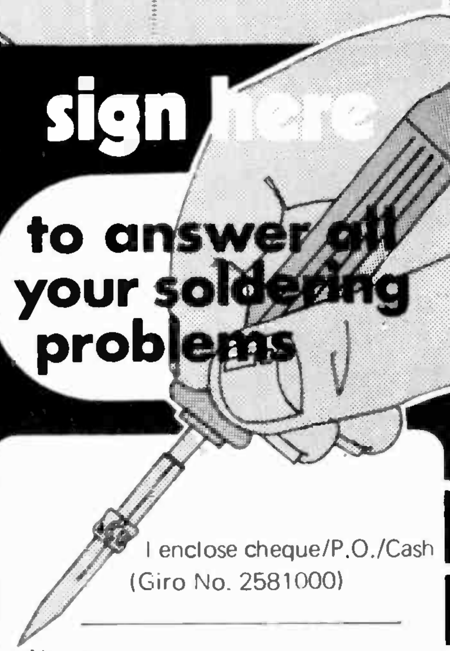

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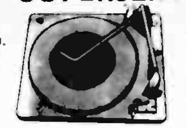

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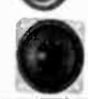

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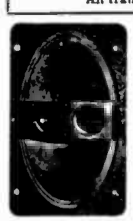

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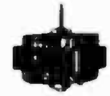

120v. or 240v. AC. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187 × 0·75in. Size 3½ × 2½ × 2¼in. (Illustrated). **£1·25**

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120v. or 240v. A.C. 1,200 r.p.m. 4 pole 50mA. Spindle ⅛ × 3/20. Size 2½ × 2½ × 1½in. Post 15p **85p**

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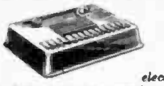
337 WHITEHORSE ROAD, CROYDON
Open 9–6 p.m. (Wednesdays 9–1 p.m., Saturdays 9–5 p.m.)

List 3p. Written guarantee with every purchase. (Export: Remit cash and extra postage.) Buses 50, 68, 159 pass door. Rail Selhurst Tel. 01-684-1665

ELECTRONIC ORGAN



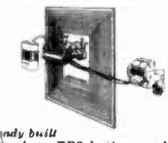
ONLY £2·75

Don't confuse with ordinary electronic organs that simply blow air over mouth-organ type reeds etc. Fully transistorised. **SELF CONTAINED LOUDSPEAKER.** *Fifteen separate keys span two full octaves—play the "Yellow Rose of Texas", play Silent Night", play "Auld Lang Syne" etc. etc.* You have the thrill and excitement of building it together with the pleasure of playing a real, live, portable electronic organ. **NO PREVIOUS KNOWLEDGE OF ELECTRONICS NEEDED.** No soldering necessary, Simple as ABC to make. *Anyone over nine years can build it easily in one short evening following the fully illustrated, step-by-step, simple instructions.* **ONLY £2·75** + 23p p. & p. for kit, including case, nuts, screws, simple instructions, etc. Uses standard battery (parts available separately). Have all the pleasure of making it yourself, finish with an exciting gift for someone.

Find buried treasure with this READY BUILT & TESTED

TREASURE LOCATOR MODULE

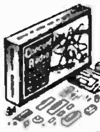
ONLY £4·95



FULLY TRANSISTORISED PRINTED CIRCUIT METAL DETECTOR MODULE. *Ready built and tested*—just plug in a PP3 battery and 'phones and it's working. Put it in a case, screw a handle on and **YOU HAVE A PORTABLE TREASURE LOCATOR EASILY WORTH ABOUT £20!** Extremely sensitive —penetrates through earth, sand, rock, water, etc.—**EASILY LOCATES COINS, GOLD, SILVER, JEWELLERY, HISTORICAL RELICS, BURIED PIPES, ETC.** Signals exact location by "beep" pitch increasing as you near buried metallic objects. *So sensitive it will detect certain objects buried* **SEVERAL FEET BELOW GROUND! GIVES CLEAR SIGNAL ON ONE COIN** £4·95 + 30p carr. etc. (High quality Danish Stethoscope headphones £2·75 extra if required.) **EXAMINE AT HOME FOR 7 DAYS. YOUR MONEY REFUNDED IN FULL IF NOT 100% DELIGHTED.**

BUILD 5 RADIO AND ELECTRONIC PROJECTS

only £1·97



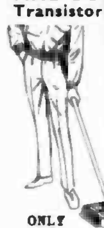
Amazing Radio Construction set! Become a radio expert for £1·97. A complete Home Radio Course. No experience needed. Parts including simple instructions for each design. Illustrated step-by-step plans, all transistors, loudspeaker, personal phone, knobs, screws, etc. all you need. Presentation box 37p extra as illus. (if required) (parts available separately) no soldering necessary. Send £1·97 + 23p p. & p.

SOOTHE YOUR NERVES, RELAX WITH THIS AMAZING RELAXATRON

Only £2·25

CUTS OUT NOISE POLLUTION—SOOTHES YOUR NERVES! Don't underestimate the uses of this fantastic new design — the **RELAXATRON** is basically a pink noise generator. Besides being able to mask out extraneous unwanted sounds, it has other very interesting properties. For instance, many people find a rainstorm mysteriously relaxing, a large part of this feeling of well-being can be directly traced to the sound of falling raindrops!—a well known type of pink noise. **IF YOU WORK IN NOISY OR DISTRACTING SURROUNDINGS, IF YOU HAVE TROUBLE CONCENTRATING, IF YOU FEEL TENSED, UNABLE TO RELAX**—then build this fantastic Relaxatron. Once used you will never want to be without it—**TAKE IT ANYWHERE.** Uses standard PP3 batteries (current used so small that battery life is almost shelf-life). **CAN BE EASILY BUILT BY ANYONE OVER 12 YEARS OF AGE** using our unique, step-by-step, fully illustrated plans. No soldering necessary. All parts including case, a pair of crystal phones. Components, nuts, screws, wire, etc. no soldering. £2·25+25p p. & p. *Parts available separately.*

FIND BURIED TREASURE? Transistorised Treasure Locator

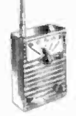


This fully portable transistorised metal locator detects and tracks down buried metal objects—it signals exact location with loud audible sound (no phones used)—uses any transistor radio which fits inside—no connections needed. **FINDS GOLD, SILVER, COINS, JEWELLERY, ARCHAEOLOGICAL PIECES ETC. ETC.** *Extremely sensitive, will signal presence of certain objects buried several feet below ground.* No knowledge of radio or electronics required. *Can be built with ease in one short evening by anybody from nine years of age upwards,* with the clear, easy to follow, step-by-step, fully illustrated instructions—Uses standard PP3 battery. No soldering necessary. Kit includes nuts, screws, wire, etc. **ONLY £2·37** + 27p p. & p. (Sectional handle as illustrated 75p extra). Parts available separately. Made up looks worth £15.

ONLY £2·37

Eavesdrop on the exciting world of Aircraft Communications V.H.F. AIRCRAFT BAND CONVERTOR

ONLY £2·37



Listen in to **AIRLINES, PRIVATE PLANES, JETPLANES.** *Eavesdrop on exciting cross talk between pilots, ground approach control, airport tower. Hear for yourself the disciplined voices hiding tenseness on talk downs.* Be with them when they have to take nerve ripping decisions in emergencies—Tune into the international distress frequency. Covers the aircraft frequency band including **HEATHROW, GATWICK, LUTON, RINGWAY, PRESTWICK, ETC. ETC. CLEAR AS A BELL.** This fantastic fully transistorised instrument *can be built by anyone over nine in under two hours.* No soldering necessary. Fully illustrated simple instructions take you step-by-step. Uses standard PP3 battery. All you do is extend rod aerial, place close to any ordinary medium wave radio (even tiny portables). **NO CONNECTIONS WHATEVER NEEDED. SEND ONLY £2·37** + 25p p. & p. for kit including case, nuts, screws, wire, etc. etc. (parts available separately).

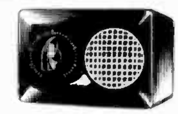
SHORTWAVE TRANSISTOR RADIO

only £2·25

Anyone from 9 years up can follow the step-by-step, easy as ABC fully illustrated instructions. No soldering necessary. 76 stations logged on rod aerial in 30 mins. — **Russia, Africa, USA, Switzerland, etc.** Experience thrills of world wide news, sport, music, etc. Eavesdrop on unusual broadcasts. Uses PP3 battery. Size only 3" x 4½" x 1¼" Only £2·25 + 17p p. & p. Kit includes cabinet, screws, instructions, etc. (Parts available separately).

INGENIOUS ELECTRONIC SLEEP INDUCER

ONLY £2·75



CAN'T SLEEP AT NIGHTS? DO YOU WAKE UP IN THE NIGHT AND CAN'T GET OFF TO SLEEP. AGAIN? WOULD YOU LIKE TO BE GENTLY SOOTHED OFF TO SATISFYING SLEEP EVERY NIGHT? Then build this ingenious electronic sleep inducer. *It even stops by itself so you don't have to worry about it being on all night!* The loudspeaker produces soothing audio-frequency sounds, continuously repeated—but as time goes on the sound gradually becomes less and less—until they eventually cease altogether, *the effect it has on people is amazingly very similar to hypnosis.* A control is provided for adjusting the length of times, etc., all transistor, can be built by anyone over 12 years of age in about two hours. No knowledge of electronics or radio needed. Extremely simple, easy-to-follow, step-by-step, fully illustrated instructions included. *No soldering necessary.* Works off standard batteries, extremely economical. Size only 3" x 4½" x 1¼"—take it anywhere. Kit includes case, nuts, wire, screws, etc. **SEND £2·75** + 25p p. & p. (parts available separately).

CONCORD ELECTRONICS LTD. (EE4X) 8 Westbourne Grove, London, W.2. *Callers welcome 9 a.m.—6 p.m. inc. Saturday*

The Unique

MULTI-MINI TWIN-VICE

An extra "Pair of hands" for those tricky jobs

ASSEMBLY—SOLDERING—GLUING—WIRING—DRILLING ETC.

- INDEPENDENT ADJUSTMENT OF THE TWO VICE HEADS TO ANY ANGLE WITH POSITIVE LOCKING.
- JAWS WILL FIRMLY GRIP, ROUND, FLAT, SQUARE, OR HEXAGONAL PARTS.

TWIN VICE: £5.90 (24p P & P)

ALSO AVAILABLE

SINGLE VICE: £3.37½ (20p P & P)

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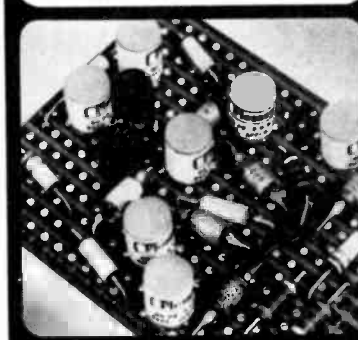
VEROBOARD



VEROBOARDS GIVE A PROFESSIONAL FINISH TO YOUR WORK

0.1" and 0.15" pitch, plain and copper clad universal circuit boards.

AVAILABLE FROM YOUR LOCAL RETAILER

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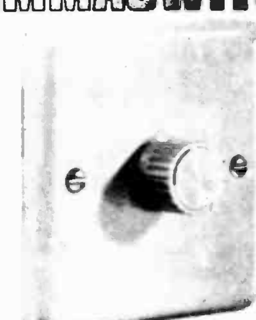
VERO ELECTRONICS LTD.
Industrial Estate, Chandler's Ford
SO5 3ZR Tel. Chandler's Ford 2921

Vary the strength of your lighting with a DIMMASWITCH



The DIMMASWITCH is an attractive and efficient dimmer unit which fits in place of the normal light switch and is connected up in exactly the same way. The ivory mounting plate of the DIMMASWITCH matches modern electric fittings. Two models are available, with the bright chrome knob controlling up to 300 w or 600 w of all lights except fluorescents at mains voltages from 200-250 v, 50Hz. The DIMMASWITCH has built-in radio interference suppression:

600 Watt £3·20. Kit Form £2·70
300 Watt—£2·70. Kit Form £2·20

All plus 10p post and packing.
Please send C.W.O. to:—

DEXTER & COMPANY
5 ULVER HOUSE, 19, KING STREET, CHESTER CH1 2AH Tel: 0244-25883,
As supplied to H.M. Government Departments.

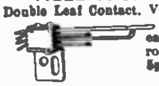
DRILL CONTROLLER
NEW 1KW MODEL

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. £1·50 plus 13p post and insurance. Made up model also available. £2·25 plus 13p post and p.

MAINS OPERATED CONTACTOR

220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2½ × 2 × 2in. £1 each.

NEED A SPECIAL SWITCH?



Double Leaf Contact. Very slight pressure closes both contacts. 6p each, 60p doz. Plastic push-rod suitable for operating, 5p each, 45p doz.

AUTO—ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in. or fully retractable. Suitable for 12v. positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £5·75 plus 25p post and ins.

TOGGLE SWITCH

3 amp. 250v. with fixing ring 7½p each, 75p doz.

MICRO SWITCH

5 amp changeover contacts, 9p each, £1 doz. 15 amp Model 10p each or £1·05 doz.

MINIATURE WAFER SWITCHES

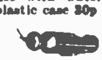
2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 20p each, £1·80 for ten, your assortment.

WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. 50p post free.

BLANKET SWITCH

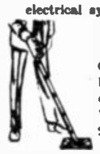
Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element, new plastic case 30p each. 3 heat model 40p.

CAR ELECTRIC PLUG



Fits in place of cigarette lighter. Useful method for making a quick connection into the car electrical system. 35p each or 10 for £3·42.

TREASURE TRACER



Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless August issue. £2·95 plus 20p post and insurance.

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 14p. 12v. car model also available same price. Jug heater £1·50 plus p. & p. 14p.

SNAP ACTION SLIDE SWITCH

Rated 5a. 240v. Made by Arrow. Type fitted in the handles of electric drills, vacuums, etc. 5p each, 10 for 45p.

NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-vac XN. 3, Price £1·45 each. 10 for £13.

12 WAY SUB-MINIATURE MULTI-CORE CABLE

7·0076 copper cores each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in. thick. Price 20p per yard.

LIGHT CELL

Almost zero resistant in sunlight increases to 10 K Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in. dia. by ½in. thick. Rated at 500 MW, wire ended. 43p with circuit. Also ORP 12 light cell 45p.

THE FULL-FI STEREO SIX

The amplifier sensation of the year

You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal chassis ready for mounting on plinth, this amplifier uses an integrated solid state circuit with an output power of 6 watt R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners. It has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. UNREPEATABLE PRICE is £6·50 plus 20p post and insurance. Simulated teak cabinet £1·95 (post free when ordered with chassis).

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. £2·25 plus 23p P. & I

Smiths 24 hour 2 on/2 off Time Switch. This is the popular model, as used in the Autoset and Morphy Richards time switches. Only needs a case and an output socket. 230v 50 cycle. Contacts switch up to 13 amps. Price £2·75p

TANGENTIAL HEATER UNITS

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW. element and 1kW. element allowing switching 1, 2 and 3kW. and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only need control switch. £3·50. 2kW. Model as above except 2 kilowatts £2·50. Don't miss this. Control Switch 25p. P. & P. 40p.

POCKET CIRCUIT TESTER

Test continuity for any low resistance circuit, house wiring, car electrics. Tests polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied). 30p or 2 for 50p post paid.

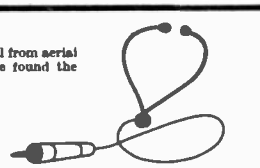
COMPUTER TAPE

2,400ft of the Best Magnetic Tape money can buy—users claim good results with Video and sound. 1in. wide £1·00 plus 33p post and insurance, with cassette. ¾ in wide £1·00 plus 30p post and insurance with cassette. ½in. wide 85p plus 25p post and insurance with cassette. Spare spools and cassettes—1in 75p, ½in. 75p each plus 20p post and insurance.

THIS MONTHS SNIP
MULLARD I.F. AMPLIFIER

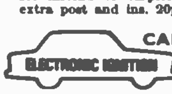
3 transistors, 10 tuned circuits, Mullard Ref. No. LP L65289. Frequency not known but believed to be around 465. Mounted on printed circuit board size approx. 3" × 1¼". Enclosed and sealed in a metal case with tin copper connecting leads. 75p each. 10 for £6·75. 100 for £62·50.

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—twin stethoset instead of earpiece 75p extra post and ins. 20p.

CAPACITOR DISCHARGE CAR IGNITION



This system which has proved to be amazingly efficient and reliable was first described in the *Wireless World* about a year ago. We can supply kit of parts for an improved and even more efficient version (*Practical Wireless*, June). Price £4·95 plus 30p post. When ordering please state whether for positive or negative systems. Also available, ready made ignition systems for 6v. vehicles. £5·25 plus 20p.

TYPE 25 RELAYS

These are miniature relays. Size approx. 1$\frac{1}{16}$th inch high × 1½" wide × ¾" deep. 4 change over silver/gold contacts. Contact rating lamp 100v D.C. Fitted with a plastic cover. Coil operates approx. 250 Mv D.C. available with the following coils :—

28 ohm for 1v–2·5v	45 ohm for 4v–7·5v	52 ohm for 4·9v–6v
90 ohm for 5.5v–11·5v	130 ohm for 10v–15v	530 ohm for 17v–36v
1250 ohm for 27v–44v	2500 ohm for 31v–65v	5800 ohm for 27v–44v

75p each. 10 for £6·75. Also one with 16,500 ohm coil but this has only 2 heavy duty change over gold contacts. Price £1·45.

MULLARD AUDIO AMPLIFIER MODULE

Uses 4 transistors, and has an output of 750mW into ohms speakers. Input suitable for crystal mic. or pick-up. 9 volt battery operated. Size 2" long × 1½" wide × 1" high. SPECIAL SNIP PRICE 60p each. 10 for £5.

0–8 AMMETER

2in. square full vision for flush mounting. Moving iron instrument. Ideal for charger. Price 43p each. 10 for £3·60.

BABY ALARM
SIMPLE CALCULATOR
POWER SUPPLY UNIT
To receive these and other featured kits promptly send approximate quoted price and we will refund any change.

Veroboard. We are now stocking this in various sizes. Prices as follows:

	0·1	0·15
2½ × 3¾	22p	16p
2½ × 5	24p	24p
3¾ × 5¾	24p	24p
3¾ × 5	27p	27p
17 × 2½	75p	57½p
17 × 3¾	100p	75p
17 × 5 (plain)	—	75p
17 × 3¾ (plain)	—	52½p
17 × 2½ (plain)	—	37½p
2½ × 5 (plain)	—	17½p
2½ × 3¾ (plain)	—	15p
Pin intersection tool	47½p	47½p
Spot face cutter	37½p	37½p
Pkt. 50 pins	20p	20p

REED SWITCHES

Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types:

Miniature. 1" long × approximately ⅛" diameter. Will make and break up to ½A up to 300V. Price 13p each, £1·20 dozen.

Standard. 2" long × $\frac{3}{16}$" diameter. This will break currents of up to 1A, voltage up to 250V. Price 10p each, 90p per dozen.

Flat. Flat type, 2" long, just over $\frac{1}{16}$" thick, flattened out, so that it can be fitted into a smaller space or a larger quantity may be packed into a square solenoid. Rating 1A 200V. Price 30p each, £3 per dozen.

Small ceramic magnets to operate these reed switches 9p each, 90p dozen.

Dry Reed Relays. Solenoids on moulded bobbins within magnetic shields—printed circuit or panel mounting.

Ref.	*Coil Resistance*	*Reed Switches*	*Price*
71005	2 K	1 normally open	25p
81916	5 K	1 normally open 1 normally closed	75p
05003	4 K	1 normally open	25p
62040	1500 & 500 ohms	1 normally open	35p

Multiple Reed Relay. Ref. 58001. Contains 13 normally open reeds within a solenoid. Operates on 600 mW. Coil resistance 9K ohms. Price £1·95 each.

Multiple Reed Relay. Ref. 081. 2 normally open 1 normally closed coil resistance 30 ohms. Price 75p.

Fanostat. This is a thermostat with Sensor on the end of a long capillary tube. The temperature range is 50–120° C. approx. The setting is by spindle for pointer knob (knob not supplied). The Sensor can be immersed in the liquid or can be fixed to the container or as when used on an electric cooker, this can be fitted in the centre of a heating element. Price 65p each, £5·85 for ten. Many other thermostats available please request list.

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.

HOME SENTINEL INTRUDER ALARM
Electronic Components with case £3·75

SNAP INDICATOR .... 75p.

WINDSCREEN WIPER CONTROL
Components including metal for chassis £2

RECORD PLAYER
All components, but not case, loudspeaker, record deck or pick-up £5·50

DEMO DECK £6·75 POST PAID

FUZZ BOX .... £1·85

PHOTOGRAPHIC COLOUR TEMPERATURE METER .... £2·65

ASTRON RADIO £3

REMOTE TEMPERATURE COMPARATOR .... £4·25

ELECTRO LAUGH £2

TRANSISTOR MICROPHONE .... £1·70

AUTO ALERT
All electronic parts and metal bracket £2·50

RAIN WARNING ALARM
All electronic parts and chassis £1·80

WA-WA PEDAL .... £2·90

DARKROOM TIMER .... £4·50

SIGNAL INJECTOR 80p

SOIL MOISTURE METER .... £3·00

Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semi-conductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.) 7 Park Street, Croydon CRO IYD
Callers to: 102/3 Tamworth Road, CROYDON

BUDGET HIGH-FIDELITY STEREO SYSTEMS

FREE LEADS AND PLUGS SUPPLIED WITH ALL SYSTEMS

PREMIER STEREO SYSTEM "ONE" Consists of the new Premier 800 all transistor stereo amplifier, Garrard 2025 T/C auto manual record player unit fitted stereo mono ceramic cartridge with diamond stylus and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. 800 amplifier has an output of 5 watts per channel with inputs for ceramic and magnetic pick-up, tape and tuner also tape output socket and headphone socket. Controls: Bass, Treble, Volume, Balance, Selector, Power on/off. Mono/Stereo switch. Stereo Headphone socket. Black leatherette cabinet with aluminium front panel. Size: 12½" × 6¾" × 2¾". (Amplifier available separately if required £16·25. Carr. 40p).

ONLY £40·95 carr. £1·75

PREMIER STEREO SYSTEM "TWO", as above but with Garrard SP25 MK III and magnetic cartridge. ONLY £48. Carr. £1·75.

METER BARGAINS

MODEL GT-800 MULTIMETER A precision made pocket sized test meter, ideally suited for testing electronic circuits or electronic appliances. Supplied complete with test lead and batteries. RANGES—DC Voltages: 10, 50, 250, 1,000V (1,000 opV). AC Voltage: 10, 50, 250, 1,000V (1,000opV). DC Current: 1mA, 100mA. Resistance: 0-150K ohms. Decibel: −10 +22db (at AC 10V range) £2·47. P. & P. 17p.

MULTIMETER 20,000 O.P.V. Features large easy-to-read meter, wide choice of ranges. With test leads, batteries and manual. Size 4½" × 3½" x 1". RANGES D.C. Voltages 0–5–25–50–250–500–2500v. A.C. Voltages 0–15–50–100–500–1000v. D.C. Current: 0–50μA 2·5mA–250mA. Resistance: 0–6000 ohms 0–6 megohms (300 ohms and 30 Kohms, at centre scale). Capacity: 10μμf to ·001μf, ·001μf to ·1μf. Decibels −20 to +22dB. £4·90. P. & P. 17p.

MODEL CT-62 MULTITESTER RANGES—DC Voltages: 0, 5, 25, 100, 500/1,000V (20,000 ohms/V). AC Voltages: 0, 5, 25, 100, 500, 1,000V (10,000 ohms/V). DC Current: 0, 50μA, 0, 5, 50, 500mA. Resistance: 0, 6k, 600k, 6M, 60M ohms. Decibels: −20 db to +62 db in 5 ranges. £5·62. P. & P. 17p

WELLER "EXPERT" SOLDER GUN. Saves time and simplifies soldering in the home and service dept. Two position trigger gives instant dual heat. 100/140 watt. 240 volt A.C. **£3·95** P. & P. 30p

"Marksman" Soldering Iron. Lightweight 3/16" pencil bit. Ideal for regular bench use and around the home. 25 watts. 240 volt A.C. £1·50 P. & P. 15p

VERITAS V-313 TAPE HEAD DEFLUXER

A must for all tape users! Tape heads become permanently magnetized with constant use; this leads to background noise that prevents perfect recordings. Simply applied to recording head the V313 leaves head free of magnetism. Cleans any tape head in seconds. **£1·72** P. & P. 10p.

PREMIER HI-FI OFFERS

Rogers Ravensbrook II Stereo Amplifier in teak case (List £52·50)	£38·50
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Metrosound ST20E Stereo Amplifier in teak case (List £39·50)	£28·50
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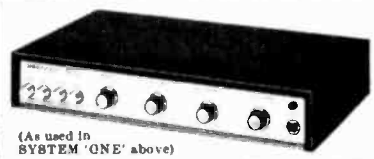
Garrard 2025 T/C with Stereo Ceramic Cartridge ready wired in teak plinth with cover	£12·45

Carriage and Insurance 50p extra any item.

PREMIER 800 STEREO AMPLIFIER



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A truly high quality stereo amplifier—compare the specification, compare the price. Output: 5 watts per channel. Frequency response: 30-20,000 Hz = 2 db. Distortion: 1% Output Impedance 8 ohms nom. Inputs equalised to R.I.A.A. Magnetic 4mV. Ceramic 100mV. Tuner 100mV. Tape 100mV. Tape out 150mV. Din sockets for inputs and outputs. Controls: Bass, Treble, Volume, Balance, Selector. Mono/Stereo switch. Stereo headphone socket. Attractive slim line design black leatherette cabinet with aluminium front panel. Size 12½" x 6¾" x 2¾".

ONLY **£16·25** Carr. 40p.

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Designed to the highest possible standard. Fitted 2½in. speaker units with soft padded ear muffs. Adjustable headband. 8 ohms impedance. Complete with 6ft lead and stereo jack plug. **£2·47** P. & P. 25p.

STEREO STETHOSCOPE SET Low imp. £1·25 P.&P. 10p
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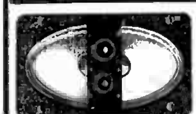
E.M.I. 13×8in. HI-FI SPEAKERS



Fitted two 2½in tweeters and crossover network. Impedance 8 or 15 ohm. Handling capacity 10W. Brand new. **£3·47** P. & P. 40p

VERITAS V-149 MIXER

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

MONO MODEL **£3** STEREO MODEL **£3.47** P. & P. 12p

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SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED. TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped-attractively boxed.

LP3	3"	250'	P.V.C.	28p	LP6	5¾"	1200'	P.V.C.	75p
TT3	3"	450'	POLYESTER	37p	DT6	5¾"	1800'	POLYESTER	£1·12
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SP5	5"	600'	P.V.C.	42p	SP7	7"	1200'	P.V.C.	62p
LP5	5"	900'	P.V.C.	50p	LP7	7"	1800'	P.V.C.	75p
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TAPE SPOOLS 3" 5p, 5", 5¾", 7" 9p.
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C60 (60 min.)	37p	3 for £1·05
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FREE Cassette Head Cleaner with every 10 cassettes
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everyday electronics

PROJECTS....
THEORY......

SELF SERVICE

The enthusiast who has more than a passing or casual interest in electronics will require a few items of test and measuring equipment. These will aid him when building projects, carrying out experiments, and fault finding. Such requirements are not lavish, and can be limited to about four or five items. Furthermore these can be reasonably simple in design, and can be built by the constructor himself, with real saving to his pocket.

EVERYDAY ELECTRONICS will be publishing designs for such items of equipment, from time to time. And this month we make a start by including full details of a mains operated power supply unit.

ON TAP

As we have already declared, many useful electronic devices and gadgets can be battery operated and if proof of this is required, look over the projects we have published to date.

Dry batteries have obvious advantages, but if a fair amount of practical work is intended, it will be found very convenient to have permanently on hand a d.c. supply that can be easily varied to give any output between zero and 16 volts. In other words, a "stand-in" for any of the commonly used batteries. So we recommend this power unit as an important acquisition for every constructor's workshop.

PLUNGE IN

We hope some of the enthusiasm shown by our *Memory Store* writers has been infectious and that many others have, as a result, been encouraged to take the plunge for the first time.

The wife of one reminiscing scribe has indeed taken the plunge—with pen, not soldering iron though—and her cautionary tale is published for the benefit of other wives!

WOMEN'S LIB

But in this enlightened age—equality of the sexes and all that—why should we assume electronics to be an exclusively male hobby?

In industry, the fair sex plays a prominent part in the manufacture of minute devices like transistors and other components; also in the wiring up and assembly of complete electronic equipments. Feminine touch and dexterity (and patience!) are assets in such operations.

There seems no logical reason why these attributes should not be channelled into a recreational activity as well. So perhaps the wife could be recruited as an assistant—or does the thought provoke cries of horror from hubby!

Seriously, there must be quite a number of women who are interested in electronics and who actively participate in this hobby of their own accord. We would like to hear from you, ladies.

Fred Bennett

Our May issue will be published on Friday, April 21

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.....EASY TO CONSTRUCT
.....SIMPLY EXPLAINED

VOL. I NO. 6

APRIL 1972

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

SOMETHING SPECIAL

Bound to suit your pocket

The Everyday Electronics Constructors Companion booklet we are giving away next month is aimed at all constructors and will, we are sure, be of value to all our readers. This booklet can only be obtained by buying next month's issue so make sure you do not miss out. For more details on the Constructors Companion and next month's issue see page 325

Simple CALCULATOR

By MIKE HUGHES

An interesting, simple to build, instructional aid.

THIS calculator is very simple to make and can be undertaken without too much worry by all beginners. The principle of operation is easy to understand and, although it seems elementary, it is the same principle as used in complex modern analogue computers. The instrument enables one to carry out multiplication with a fair degree of accuracy—regrettably the answers cannot be more accurate than one can read a dial, so do not embark on the project if you want something that is going to be as good as, or better than, your slide rule. The best way of viewing it is as an interesting instructional aid.

There is very little wiring in the unit and most work will be found to be in the preparation of the knob dials—these control the ultimate accuracy. Before explaining the constructional details let us see how it works.

Components....

Resistor
R1 1·2kΩ ±10%, ¼W carbon

Variable Resistors
VR1 300Ω
VR2 5kΩ
VR3 5kΩ
All linear wirewound

SEE
SHOP TALK

Diodes
D1–4 OA81 or equivalent germanium diode
D5 IN4148 or equivalent silicon diode

Miscellaneous
ME1 100μA to 1mA edgwise level meter (see text)
S1 single pole single throw toggle switch
B1 9V Battery. PP3 type
Small Terry clip to hold battery, battery connector, pointer knobs, materials for case, connecting wire.

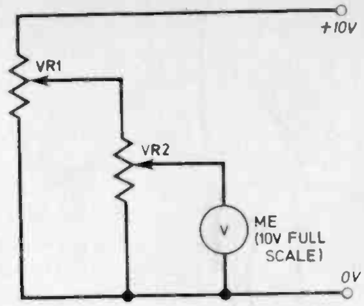


Fig. 2. Theoretical circuit to show the basic operation of the Simple Calculator.

CIRCUIT THEORY

The complete circuit diagram is shown in Fig. 1. Potentiometers VR1, 2 and 3 are all working in their true mode—as potential dividers. Let us assume that we will be running off a 10 volt supply line (in actual fact it does not matter what this voltage is in the final unit). The potential at the wiper of VR1 can be set between zero and 10 volts the value being in direct proportion to the degree of rotation of the wiper. By calibrating the knob of this potentiometer with numbers from 0 to 10 we were able to accurately set a voltage to represent the number in question (we call this voltage the "analogue" of the number).

Potentiometer VR2 takes the potential at the wiper of VR1 and in turn we can tap off any proportion of this potential depending on how far we turn the control of VR2. If we connected a voltmeter between the wiper of VR2 and the common rail (Fig. 2) we could read the voltage that was left. Let us also calibrate the scale of VR2 with numbers 0 to 1·0 in 0·1 divisions. Set VR1 to five (the potential at its wiper would be 5 volts). Now set VR2 to 0·5 (i.e. half way)—the potential read on the meter would be 2·5 volts. The circuit is actually multiplying 5 by 0·5 to give an answer 2·5 but of course the answer is shown as an analogue voltage. You could work out a similar state of affairs by setting the number 8 on VR1 with 0·4 on VR2; the answer would be shown as 3·2V.

FINAL DESIGN

Obviously for the system to be accurate th battery voltage must be stable and also at sight it would appear that the supply e ought to be 10V. The latter point is not sarily true because we could make a volt which was arbitrarily calibrated in "numbe as opposed to real voltage levels. In practic however we need not worry about the battery voltage at all if we use a potentiometer (VR3 Fig. 1) to convert from the analogue voltage back to a number. This is done by having VR3 as a potential divider across the supply voltage. It is possible to set the wiper so that the potential produced by it exactly equals the potential at the wiper of VR2 and the answer is read off on the dial of VR3.

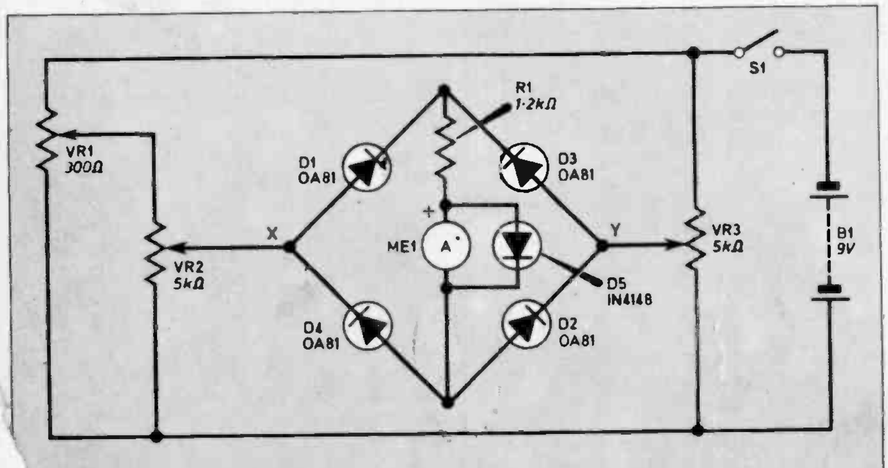


Fig. 1. Complete circuit diagram of the Simple Calculator.

We detect that the potentials at the two wipers are the same by detecting current flow. When there is no potential difference (i.e. potentials at X and Y are the same) no current will flow through the meter and diode circuitry. If that at VR2 is more positive then current will flow through D1, into the positive terminal of the meter and out through D2 (R1 is only there to protect the diodes from excessive current and D5 protects the meter movement). On the other hand if the wiper of VR3 was the more positive, current would flow the other way through D3 again into the positive terminal of the meter but out through D4.

Note that the meter will always read a positive current irrespective of the direction of current flow by virtue of the diode bridge. To find the answer to a multiplication all we have to do is adjust VR3 until the meter shows zero current flow and then read the proportion of rotation of VR3 off its dial.

OPERATION

As with a slide rule you can use the instrument to multiply any magnitude of numbers but you must decide for yourself where the decimal place will occur in the answer. In practice you should always attempt to set the number whose first digit is closest to 10 on VR1, otherwise you might find that the potential of the answer may be less than one unit of calibration and hence difficult to read on the dial.

Because of the independence of the meter to direction of current flow the polarity of the supply is unimportant and because everything is measured in terms of degree of shaft rotation of potentiometers and VR3 is run off exactly the same voltage as VR1 the actual value of the supply is unimportant. In practice it ought to be at least 4·5 volts to ensure sufficient current through the meter to enable one to identify an obvious zero, hence 9 volts will do. The prototype used a small PP3 type battery. Current drain is very small and if an on/off switch is provided the life of the battery ought not to be much less than its shelf life.

CONSTRUCTION

The potentiometers should be wirewound types and **must be linear law.** Note that VR1 has a value of resistance very much less than VR2 or VR3 although the actual values do not have to be the same as the prototype you should keep this ratio of values about the same or greater i.e., VR1 can be anything in the range 100 to 300 ohms while VR2 and VR3 can be 2 kilohms to 5 kilohms.

Diodes D1, 2, 3 and 4 **must** be germanium types to avoid a wide "dead band" on the meter and D5 **must** be a silicon type because it must not pass forward current until 500mV is placed across it. Most edgewise level meters may be used for the meter; the sensitivity should be between 100μA and 1mA; actual sensitivity controls the ease of detecting small variations from zero current. Resistor R1 can be in the range 500 ohm to 1·5 kilohm.

The layout and wiring of the unit is shown in Fig. 3. All wiring is self supporting and layout is not important; the only important things to watch for are the polarities of the diodes and the meter, and to which ends of the potentiometers wires are connected—this is vital otherwise calibration will be reversed! As previously stated the battery polarity is not important in this circuit.

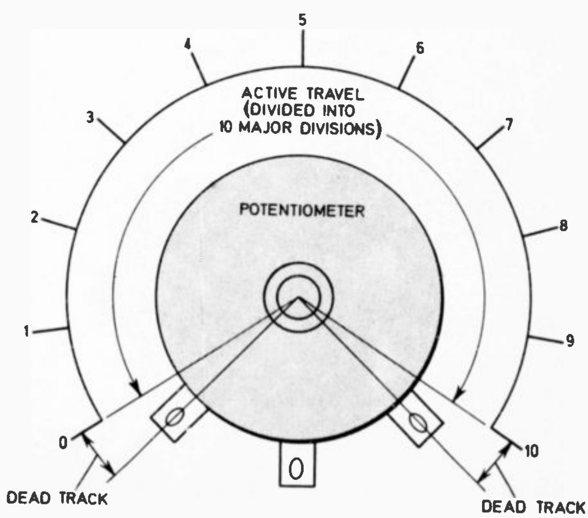
SCALE MARKING

Different types of potentiometer have different overall degrees of rotation and this must be determined for the types you have. Remember that there may be a dead portion of a few degrees at either end of the track. Use an ohm meter to determine the active degree of rotation you have and measure this using a pointer knob moving over a protractor. Once you have found this value (it should be between 260 degrees and 300 degrees, depending on the type of manufacture) divide it by 10 and then use a protractor to exactly mark off ten equal divisions round each potentiometer fixing (Fig. 4). These can be drawn in as radial lines over which a large pointer knob can move.

It cannot be over emphasised that this is the most critical part of the job if the instrument is to be at all accurate. Further subdivisions can be placed inbetween the major divisions if required.

The prototype used a piece of 14 gauge aluminium for the front panel (Fig. 5). Careful scrubbing with dry wire wool in a horizontal direction will produce a satin finish which can be

Fig. 4. Potentiometer control marking. This should be carried out as accurately as possible.



Simple Calculator

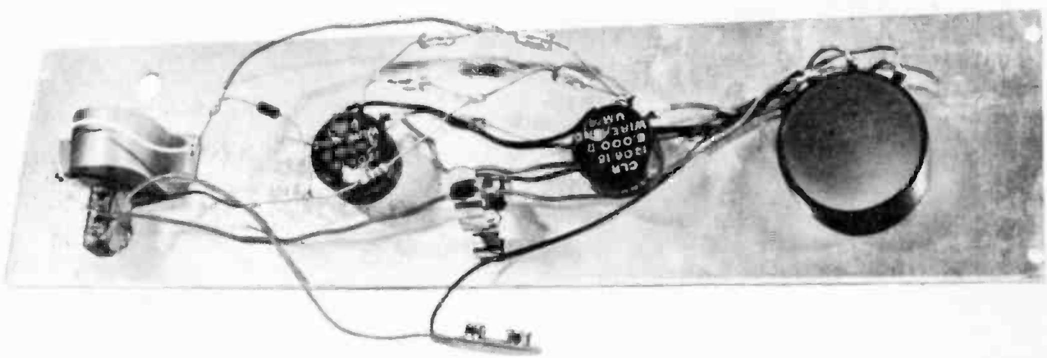


Fig. 3. Layout and wiring of the Simple Calculator. Battery BI is mounted in a Terry clip fixed to the front panel.

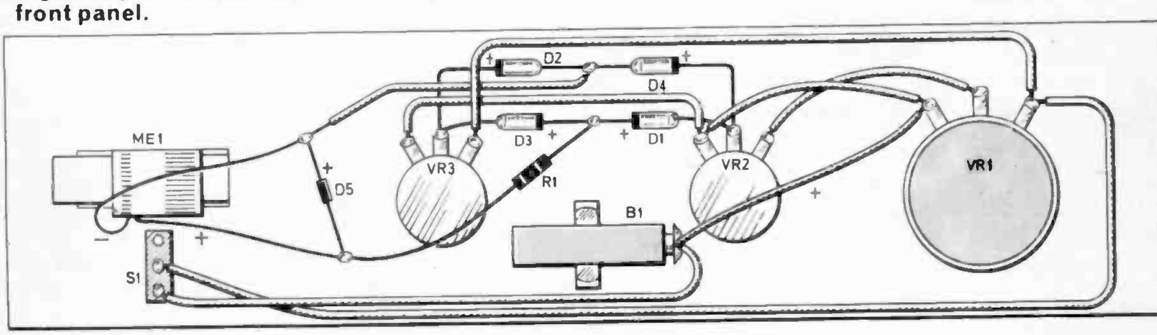
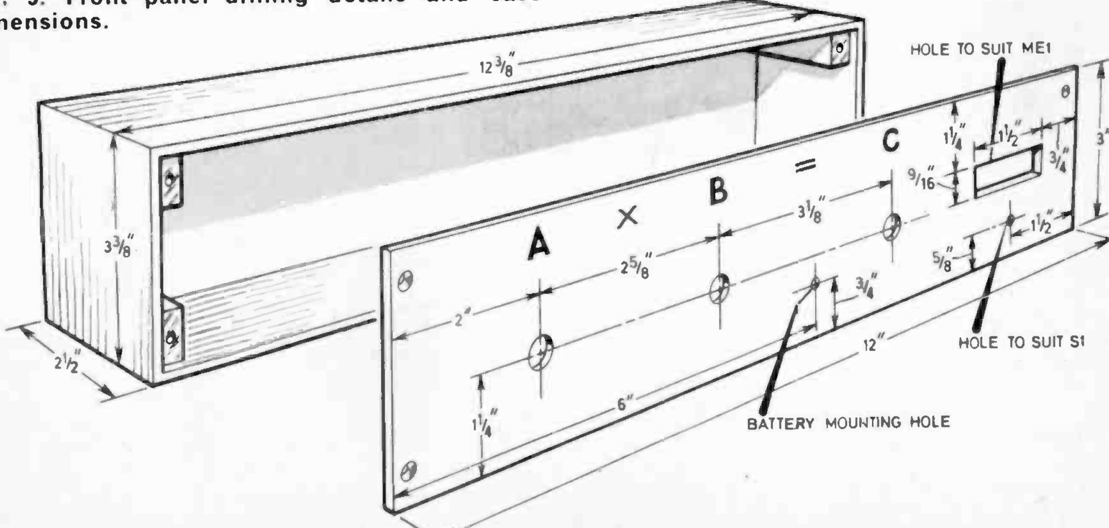
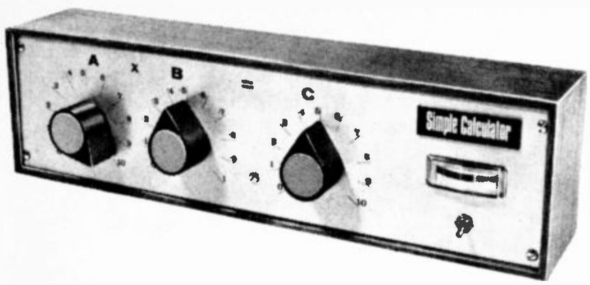


Fig. 5. Front panel drilling details and case dimensions.





View of the completed Simple Calculator showing the designations affixed to the front panel using Letraset.

immediately lacquered with aerosol polyurethane varnish. This provides a good finished surface which can be marked using Letraset. The surface can then be given a final coat of varnish to protect the lettering. A practical tip to ensure reasonable accuracy is to adjust the zero set of the meter (in simple level meters this may be inside the case) so that the needle is some way up the scale in its neutral position; this makes it easier to determine a zero current position.

A simple wooden case can be made to house the completed unit as shown in Fig. 5. The hole for the meter may differ according to the type of meter used.

APPLICATION

The knobs of the prototype were labelled A, B and C as shown in Fig. 5. This way it is easy to give instructions on how to use the calculator. Set the two numbers to be multiplied together on A and B and then turn C until minimum current is seen to flow through the meter; the answer can be read off dial C.

Reciprocals can be found by setting C at 1, next set the number whose reciprocal is required on B and turn A for zero current—the answer is shown on dial A. An extension of this enables one to carry out divisions where the answer must always be a decimal fraction less than unity. For example 2 divided by 3. Set 2 on C and 3 on B and turn A for zero current. The number displayed on A will be approximately 6·6 this means that the answer is 0·66.

If you wish you may subdivide the main divisions of the scale into ten finer units thus enabling better accuracy with two digit numbers. Obviously the larger the diameter of the scales the easier it is to work accurately, but there is a limit to the ultimate accuracy of the calculator. This is due to the linearity of the potentiometers and the ability of the meter to detect very small current near zero—the latter could be improved by using a more expensive 50μA meter. ▣

Cover picture: Blackboard and easel kindly loaned by A. W. Gamage Ltd., Holborn

Ruminations

By Sensor

Time to Stare

So restrictions on TV broadcasting hours are to be removed. I'm all for freedom and removal of restrictions but I am very suspicious of this move. There is, already, much more than enough TV for me, I don't want to pay for any more, and if programme time is increased someone has to pay. We all know who foots the bill, like it or not, in the end. As I see it, commercial television companies will sieze the opportunity to sell more advertising time and will need to make programmes to fill in the slots between the advertisements. Inevitably, many of these new programmes must be in the "popular appeal" i.e. lowest common denominator class in order to capture the largest audience for the advertisements. So we are unlikely to see anything different on our screens—just the mixture as before—but more of it.

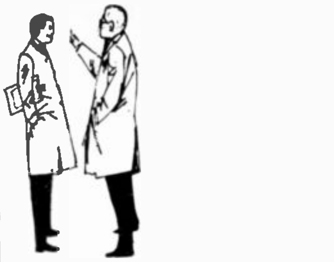
The B.B.C. will want to compete with the commercial companies for the mass audience and must, therefore, increase its output of "popular" programmes; consequently, there will be a call for an increase in the licence fee. The cost of additional advertising on I.T.V. will be passed on to the consumer, by way of higher prices, resulting in a further increase in the cost of living. What will the viewer get out of it, more mush for morons?

Unnatural Breaks

The other evening I felt in need of some relaxation and I tuned in to I.T.V. to watch *Appointment with Fear*. The Hammer Films spine-chiller looked quite promising but didn't stand a chance; three breaks for advertisements made sure that any feelings of terror that might have been aroused were quickly dispelled. Rhapsodies about beans, margarine and pet food are unlikely to chill the marrow—at least, not in their currently presented form, and but for the advertisements I could have been in bed ten minutes earlier.

I can switch off, I can choose my programmes but I cannot choose the advertisements that will interrupt my viewing and, perhaps, spoil my carefully selected entertainment. The B.B.C. has recently stepped up the advertising of its own programmes. The programmes have not been interrupted, as yet, for the advertisements but I find them irritating, nevertheless.

What does it all add up to? In my opinion, the entertainment value of television viewing is declining. I may be getting old and crotchety and a bit neurotic, but I look back with nostalgia to the days when full length plays and documentary films were regular features of evening viewing. We complained, from time to time when old films were shown too frequently, but those were surely the great days of television. Somewhere along the way, standards have slipped; it seems such a shame—electronics deserves better than this.



SHOP TALK

By Mike Kenward

A NUMBER of readers have written to us asking for advice when buying a test meter. Firstly let us say that we will be publishing a design for such a meter at some time—it will be a simple device, easy to construct and providing ranges that would be used most for testing our designs. For those who still want to buy a meter the following advice may be of some assistance.

Firstly most meters are only as good as the price tag, by this we mean that it is probably best to buy the best you can afford. A good meter properly used and carefully treated will last a lifetime and if you buy a good one to start with you will never regret it. How do you know the good ones from the bad? The ranges available and the ohms per volt are the best way to tell (20,000 ohms per volt or more is good).

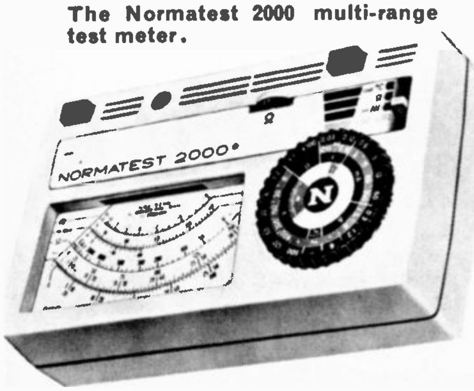
You can ignore the dB range and the capacitance range, unless you really know what you are doing these are useless so do not buy a meter just because it has these two extra ranges. We would not advise anyone to buy a meter costing less than about £3—you could probably make one as good for less.

If you can find a 20,000 ohms per volt (on d.c. ranges) meter with the following ranges it will satisfy most requirements for transistorised equipment testing and servicing:

D.C. Volts 0-500 volts in about 4 ranges
A.C. Volts 0-500 volts in about 3 ranges
D.C. Current 0-500mA in about 3 ranges
Resistance 0-5MΩ in 2 or 3 ranges

You may find it difficult to obtain a 500mA d.c. range on the less expensive meters, you could settle for a maximum of 250 mA.

The Normatest 2000 multi-range test meter.



If you want something really professional for £17·50 the Normatest 2000 multi-range test meter, that has recently been announced in this country, has 41 ranges, is 20,000 ohms per volt d.c. and 4,000 ohms per volt a.c. It covers the range 0-6A d.c., 0-600V d.c., 0-6A a.c., 0-600V a.c., 0-5MΩ in 6 ranges and has a maximum error of ±2·5 per cent for the d.c. ranges. The meter can also be used to measure temperature (with the addition of a separate thermocouple) and gain −20 to +46dB. The price includes a carrying case and test leads.

We hope this information will be of some assistance, now let's look at possible problems arising from this issue.

Simple Calculator

You can hardly go wrong with the *Simple Calculator* construction, it will even work with the battery reversed! One point to watch is that you use germanium diodes for the bridge and a silicon diode for meter protection. The reasons for this are stated in the text. Almost any small meter will do and there are a number of 1mA range ones available from many suppliers.

Incidentally a centre zero meter could have been used without the bridge but this could have added to the cost. Also the article explains the bridge principle so you can learn something from it, we try to be educational as well as practical!

The wirewound potentiometers can be any rating—you will see from the photo's that one used in the prototype was much larger than the other two—this does not matter. Incidentally you will find it difficult to buy log wirewound pots as they are not available, so the ones you do buy may not be marked linear, if you see what we mean.

The knobs used on the prototype are home made and are not available, however there are plenty of fairly large pointer knobs that are available.

Baby Alarm

The Newmarket PC2 amplifier module for the *Baby Alarm* is available from Home Radio and LST Components Ltd., incidentally L.S.T. are the distributors; prices may vary slightly its best to check first. Other than the module there should be very few buying problems.

As stated in the text the case used for the microphone does not have to be as large as it is and any small crystal microphone could be used. There are some available from suppliers for 60p or less—both the miniature types and the plastic encased types; this is probably cheaper than buying an insert and a case. If you do buy a complete microphone you will need a line socket to connect the microphone lead to the screened lead that feeds the amplifier.

Power Supply

The transformer used in the *Power Supply Unit* should be of reasonable size to fit the case design and a suitable 13·5V secondary type is available from Henry's Radio Ltd. The meter used in the prototype is a 1mA meter that has been calibrated 0-20V by the author. This meter can be replaced by a 20V f.s.d. meter that is available from G. W. Smith Ltd. Three things to note if you use the 20V meter; it costs the same as the 1mA meter, the two multiplier resistors R4 and R5 (10kΩ each) are replaced by a wire link and, the only point against, the meter is not so versatile if you want to use it in any other equipment at a later date.

Almost any 50 p.i.v. (or greater) bridge rectifier that can pass about 200mA will be suitable for the power supply or, as stated in the text it can be replaced by four individual rectifiers wired up in a bridge; this may be cheaper.

How it Works: The Tape Recorder

By John Howcroft

ONE of the most important developments in modern communications is the magnetic tape recorder. Now capable of recording, preserving and reproducing high fidelity sound. Besides being a valuable instrument in many scientific projects and daily communication media, tape recorders have become part of the everyday domestic sound system. Modern developments, such as cassettes and more compact battery powered recorders have made taped material very simple to handle, use and store.

HISTORY

The "magnetic sound recorder," as it was originally known was first expounded in theory by Oberlin Smith in 1888. Smith devised a machine which would apply metallic dust to a cotton cord on which sound could then be recorded by a magnetic induction process. The machine did not, however see the light of day.

It was not until 1898 that the first practical magnetic recorder was built, it used a steel wire as the recording media. This "wire" recorder was produced by a Dane named Valdema Poulson. The recorder used a mechanical/electrical means of recording and reproducing sound since, at that time, no electronic means were available; the valve had not been invented.

Sound was recorded through a carbon microphone connected into an electric circuit powered by a large dry battery. To replay the recorded sound a set of headphones was substituted for the carbon microphone.

Little more was heard about tape or magnetic recorders until the 1930s when Dr. Karl Stille developed an electronic magnetic recorder. Dr. Stille used steel tape in his machine and similar machines were developed and used for a number of years by the British Broadcasting Corporation.

During the second World War the Allies made use of steel wire recorders while the Germans developed a plastic-based, metallic oxide coated tape; this was the forerunner of today's magnetic tapes. The steel wire medium is now virtually extinct, but was used until quite recently in dictating machines.

MAGNETIC TAPES

The modern recording tape consists of a special plastic base normally acetate or polyester with a coating of ferrous oxide or similar metallic oxide. The particles of metallic oxide can be induced by a magnetic field so that they possess a similar magnetic field. The magnetic impression in these particles can represent a certain sound and, until the tape is disturbed by additional magnetic forces the recorded magnetic impression will remain on the tape.

To apply the necessary force to magnetise the

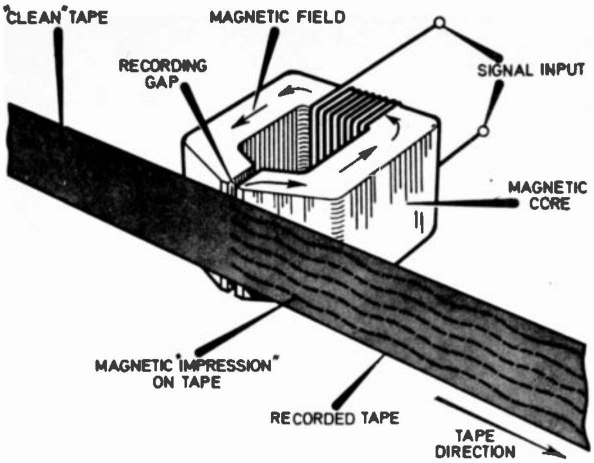


Fig. 1. The basic method of creating a magnetic field on a recording tape.

oxide particles on the tape so that these represent a piece of music or speech we apply the theory of electromagnetism. Magnetism can be created by passing an electric current through a coil of wire, preferably wound around a soft iron core. In the case of a recording head for a tape recorder this core usually consists of a number of soft iron laminates. The amount of magnetism can be varied by the amount of current flowing through the coil. To change the sound waves into an electric current a microphone and an amplifier are used. Sound waves acting upon a microphone mechanism produce a very small electric current. The amplifier magnifies the current produced by the microphone and, in turn, passes it on to the recording head of the tape recorder. The recording head transforms the electric current into a magnetic force. As the sound source varies in frequency and volume so also does the current and the strength and frequency of the magnetic signal at the recording head, and hence on the tape (Fig. 1).

RECORDING HEAD

The metal core of the recording head forms almost a complete circle, with the exception of a very small gap at the point where the tape will pass by it. The space created by the gap is closed by the ferrous oxide coating on the tape resting against the recording head, making a complete 360 degree magnetic field.

Thus the particles on the tape will acquire a magnetic impression or field similar to the signal being created by the current flowing through the coil. As the current varies, so does the magnetic field and, in turn, so does the magnetic impression on the ferrous oxide particles on the tape. During a recording the tape is passing the recording head at a constant speed. The impression of the magnetic particles on the tape is, therefore, a constant process.

BIAS

Unfortunately although the above description is true, in transforming sound waves into magnetic patterns on a tape, a problem which is fundamental to magnetic recording was encountered. This problem had to be solved before magnetic recording could be considered really satisfactory.

It was found that, when a magnetising force is applied to ferrous material the degree of magnetisation produced and retained is not proportional to the applied magnetising force. Beginning from zero, the amount of magnetisation first tends to rise very slowly, then rises more rapidly, then tapers off again as the ferrous material becomes magnetically saturated.

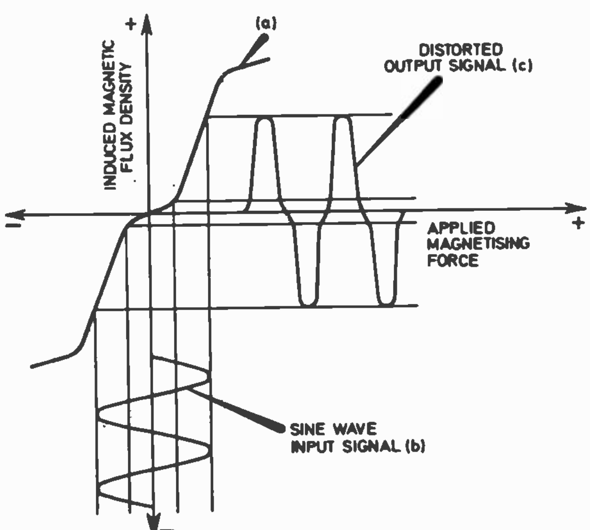
This occurs for magnetisation in either direction, so that the overall curve of induced magnetic flux plotted against magnetising force is as shown in Fig. 2 (curve (a)). The diagram also illustrates what happens to a sine wave signal which is passed through such a recording system.

For clarity, the input is shown as a pure sine wave (curve (b)). When transformed into a magnetic pattern, then recovered for subsequent amplification, the kink in the centre of the magnetisation curve is found to have produced a kink in the signal waveform (curve (c)). The end result is very severe distortion in the reproduced sound.

To overcome this effect, it is necessary to apply a magnetic "bias" to the tape so that the signal does not, as it were, centre on the kinked part of the magnetism curve.

The earliest system of magnetic bias involves placing a magnet near the recording gap, or passing a direct current through the recording head, together with the signal to be recorded, which causes the signal to centre on one of the straight portions of the curve.

Fig. 2. Illustrating the distortion produced by recording without bias.



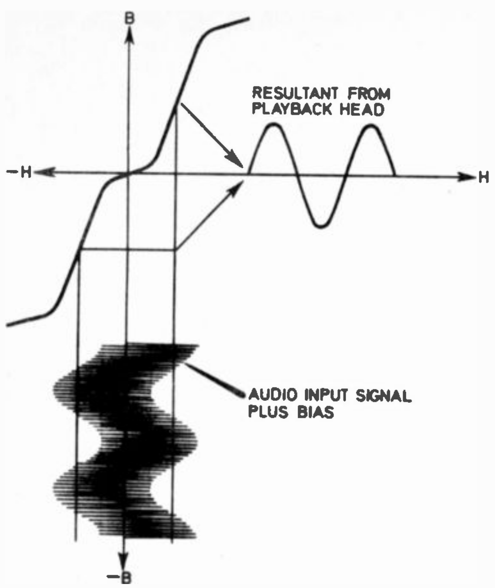


Fig. 3. High frequency bias recording system.

While a relatively simple method "d.c." or "permanent magnet" bias (as this system is called) tends to produce a recording with undue background noise. This is due largely to the fact that each discrete particle on the tape is magnetised in the same direction, so that the tiny pulses they produced are all additive and are heard as noise on playback.

HIGH FREQUENCY BIAS

Nowadays, all but the most elementary recorder's use a system of high frequency bias. A special oscillator in the recorder produces a high frequency signal well above the limit of hearing. During recording, this high frequency bias signal is fed into the recording head, along with the input signal.

Because the bias signal is at a very much higher frequency than the sound signal, the head is responding to a powerful magnetising force, even during instants when the sound signal waveform is passing through zero. This modifies fundamentally the way in which the particles on the tape respond to the sound signal.

In fact, as far as the recording head is concerned, the input signal is a composite waveform as illustrated in Fig. 3. As the tape passes across the gap in the record head, each particle is subject to one or more complete cycles of high frequency energy and is displaced bodily somewhere along its magnetising curve by the simultaneous presence of the audio waveform.

What each particle retains in the way of remanent flux would take far more space to explain than is available here. The end result, when the tape is played back, is an output waveform which is substantially free from non linear distortion, as in Fig. 3.

Because the particles are not all uniformly magnetised in one direction as with d.c. bias, they do not tend to generate additive noise pulses as they pass across the replay head. The background noise with high frequency bias is therefore much lower than with d.c. bias.

ERASE SYSTEM

In most tape recorders, the high frequency oscillator incorporated to provide the bias is actually made to serve double duty. In a normal tape recorder the threading is arranged so that the tape passes over an "erase" head just before it reaches the record/play head. During replay the erase head is not in use. When a recording is being made, however, a strong signal from the high frequency oscillator is fed into the erase head, creating an intense high frequency magnetic field across the gap in its exposed surface.

The amplitude of this erase signal is made such that it magnetically saturates the particles on the tape in both directions as they pass across the erase gap. As they move out of the gap the magnetic cycling diminishes to zero and the particles are left with zero magnetisation. In other words erasure eliminates any previous recording so that the tape passes to the record head magnetically "clean".

REPLAY

To reproduce sound from a recorded tape is basically a reversal of the procedure and techniques used in recording it without the need for the bias. Where a current flowing through a coil can create a magnetic field, so too can a magnetic field passed through a coil create a current.

The tape is played back by passing it across the playback head in the same direction and at the same speed as when the recording process took place. (It might be noted that many tape recorders use a single head for both recording and playback functions.)

As the tape passes the gap in the playback head the magnetic impression carried by the ferrous oxide particles is induced into the play-

A modern stereo tape recorder.

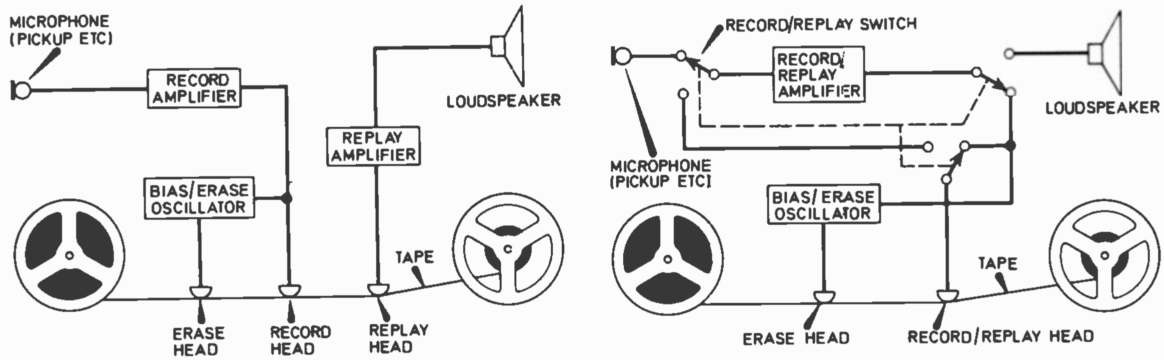


Fig. 4. Block diagrams of two basic tape recorder systems. Left—the system using separate record and replay heads. Right—the system using a single record/replay head.

back head. This magnetic field creates a current within the head and this current is fed into an amplifier and then to a loudspeaker.

The amplifier normally has a special frequency response to compensate for any changes in amplitude of the audio signal due to the record and replay process. Just as one head can be used for record and playback function. Block diagrams of two basic systems are shown in Fig. 4.

TAPE TRANSPORT

The transport mechanism used in a tape recorder is an interesting and essential device. It moves the tape across the recording, playback and erase heads.

On very cheap machines tape movement is achieved merely by motorising the take-up spool, simple though this method may be, it is not very effective. The actual speed of the tape across the heads will vary according to the amount of the tape on the take-up reel. For this reason any tape recorded on a machine of this nature must be played back on the same machine. On another machine the sound would be distorted because of variation in the original tape speed across the heads.

The more usual method of transporting tape, is to have a driving shaft or capstan close to the heads. The tape is held in contact with the capstan by a pressurised idler (or pinch) wheel. The capstan is directly connected to a flywheel (to ensure a constant speed) which is usually belt driven from a central motor.

This motor, through the use of additional belts, also keeps the take-up spool functioning so tape does not spill once it leaves the driving capstan. There is normally a slipping clutch arrangement on the take-up spool. This allows the speed of the spool to vary according to the amount of tape on it so that it keeps pace with the capstan and does not apply too much tension to the tape as it leaves the capstan (Fig 5).

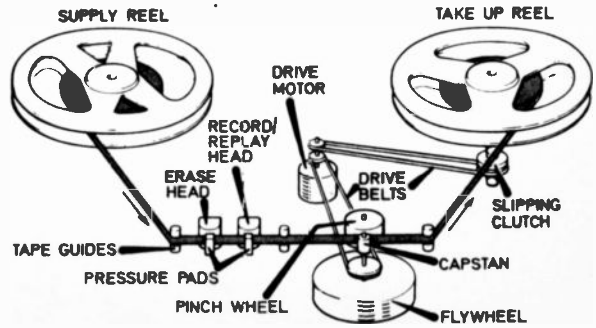
The supply spool is usually more or less free-wheeling with just a little pressure on it to prevent it from unspooling tape when the driving capstan and take-up spool are stopped. Some tape recorders have two driving capstans —one at each end of the erase and record/playback heads. This ensures a very high degree of accuracy in tape speed, which means more faithful reproduction of material recorded and played back.

Many modern tape recorders use three motors, one drives the capstan and is usually a synchronous motor which maintains a true speed constant to the mains frequency. The other two motors drive the take-up and supply reels. The operation of these two motors is governed by electro-magnetic switchgear to ensure the proper amount of tension on the reels so tape mishandling is eliminated.

FAST WIND

Almost all modern tape recorders are able to wind on and rewind the tape at a fast speed. In either of these modes the tape transport is concerned with but one purpose—that of getting tape onto one reel or the other as quickly as possible. The tape is not required to perform any electronic duty and is therefore lifted free and clear of the heads and released from the driving capstan mechanism. This allows the un-

Fig. 5. Basic mechanical arrangement of a modern tape recorder.



hindered passage of tape in either direction at fast speed. The mechanism lifting the tape clear of the heads also serves to protect the heads. The rate of wear under rewind conditions would soon render the heads useless.

In the fast forward mode, power is applied to the take-up reel. In the rewind mode the supply reel is powered. There is usually a slight braking effect on the opposite reel to prevent tape spillage should the operator decide to stop the tape.

Additional to the transport mechanism are tape guides which ensure proper alignment of the tape as it passes across the heads. Pressure pads are used to make sure the tape is held against the heads during recording and playback so there is no air gap between them. Both of these items help to ensure good reproduction of sound.

MULTI TRACK

Alignment of the tape across the heads is quite important particularly with the multi-track machines (two and four track). Originally tape recorders used just a single track, recorded across the full width of the tape. After playing such a tape it had to be rewound before it could be played again. The single track (which is confined to monaural recording) is used today for high fidelity requirements in professional and broadcast work.

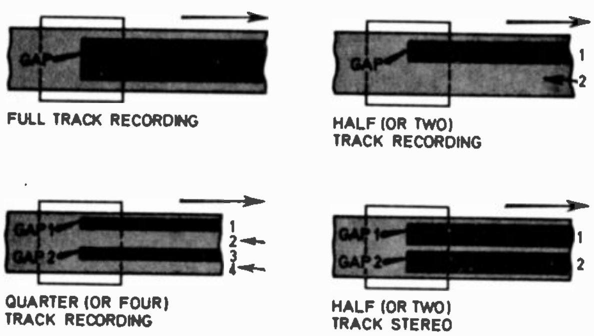
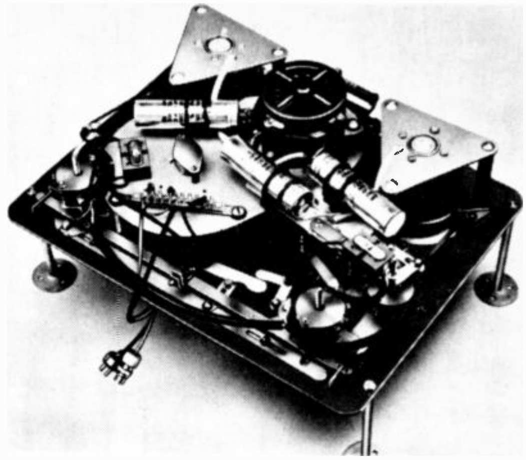


Fig. 6. Various track arrangements. In the four track system gap 1 records tracks 1 and 4, and gap 2 records tracks 2 and 3.

The next advance was the half or two-track system. This means the recording and playback heads are only as wide as half the width of the tape (actually slightly less than half to allow for separation of the two tracks).

With the two-track system a tape could be played through one way, then turned over and played through again using the material on the second track. The two-track machine also opened the way for stereo tape recording using one track for each channel but only (as in the one-track monaural system) capable of being played in one direction.



The underside view of a Brenell tape deck. This deck used three separate motors, one synchronous type for the capstan and the other two to drive each spool.

The four-track system solved the matter of letting one run a tape back and forth using stereo material. It also allows one to put a considerable amount of monaural material on a single reel of tape. This is done by ignoring the stereo mode completely and recording different monaural material on each of the four tracks (Fig. 6).

TAPE SPEED

The amount of material which can be recorded on a given length of tape can also be varied by the speed of the tape past the heads. Standard speeds in common use today are $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ inches per second (in/sec). Other speeds are also used, such as 15 and 30 in/sec for sound studios and broadcast use. The faster speed is used where the utmost in fidelity of sound is required. The slower speed is only practical for voice reproduction and is used on some dictation machines or for recording lectures where fidelity is less important than extended playing time.

However, more advanced electronics and higher precision heads—at greater cost, of course—can offset the loss of fidelity at low tape speeds. Most modern domestic tape recorders offer high fidelity at $7\frac{1}{2}$ in/sec however, and this means reasonable tape costs for those building up their own libraries.

It should be realised, however, that the quality of the recorded material will not always match the quality of the original when taping from discs. And, of course, there is a variation in the ability of different tape recorders to duplicate the original fidelity of the sound.

As can be seen the modern recorder is a long way from the Poulson machine of the 1890s and with the introduction of electronic noise reduction systems and advances in the mechanical and tape aspects the tape recorder will go on advancing for some time. ■

Wifely Woes

A few hints and tips for constructors' wives, passed on by the wife of last month's Memory Store author

By JUNE BURN

. . . but it most certainly is NOT decorative.

SINCE the main purpose of this magazine is to encourage and instruct our men-folk in a new hobby, I have prevailed upon the Editor to allow me a little space to present the other side of the coin—a wife's-eye-view of amateur electronics.

As the wife of a keen electronics man myself, it seems only fair to pass on to other wives a few hints and tips picked up over the years. His new hobby does cause some slight (?) disruption of the domestic scene. Of course, some of the lads may have workshops, or rooms set aside for their hobby. This is fine, girls, but do persuade him to fix up an intercom, otherwise you'll never speak to him.

My husband works on the dining-room table in our all-purpose living-room. This way, we do occasionally manage to exchange the odd word, but this arrangement can lead to domestic friction. Electronic equipment may be functional but it most certainly is *not* decorative, and all those trailing wires do have a nasty habit of getting entangled with the cleaner!

If he is messy with the soldering-iron, try to get some newspaper between the carpet and the flying solder—it's hell trying to get blobs of the stuff out of the Axminster/Wilton. I have yet to solve the problem of getting it off of the wallpaper, although this can usefully provide an excuse for demanding a change of decor.

Of course, your husband's new hobby will have its fringe benefits. As he becomes more proficient, he will be able to make all sorts of useful gadgets for the home and car—or so I am told! Let's face it though, these marvels of science seldom seem to materialise. In my experience, electronic test equipment breeds only more electronic test equipment. Still, I don't really want an electrically heated loo seat, do you?

This can be an irritating hobby, but bear with it. Ask him what he's making (even if you don't understand one word of the answer), sympathise when it doesn't work (it never does at first), don't use his soldering iron as a tin opener, and your marriage will probably survive this new interest. After all, while he's immersed in his transistors and integrated circuits, he's not got his mind on other birds, neither is he in the local with the boys. Mind you, there have been times when I would have liked to get my hands on that chap with the boat (see last month). Well, how would you like solder all over your cooker?

. . . I have yet to solve the problem of getting it off the wallpaper

. . . don't use his soldering iron as a tin opener

. . . he's not got his mind on other birds

ELECTRONIC CIRCUITS— .....IN THEORY and PRACTICE

TEACH-IN ...FOR BEGINNERS

By Mike Hughes M.A.

6 SEMICONDUCTORS: Diodes

THIS month we introduce a very important family of components called "semiconductors." Much has been written describing these devices and many people might wince if they looked at the background theory in detail. Nevertheless, in the practical sense they are fairly easy to understand and once you get the hang of their basic functions they are not so formidable.

In this series we shall limit ourselves to two types of semiconductor—the "diode" already mentioned in *Teach-In* Part 2, and the "transistor."

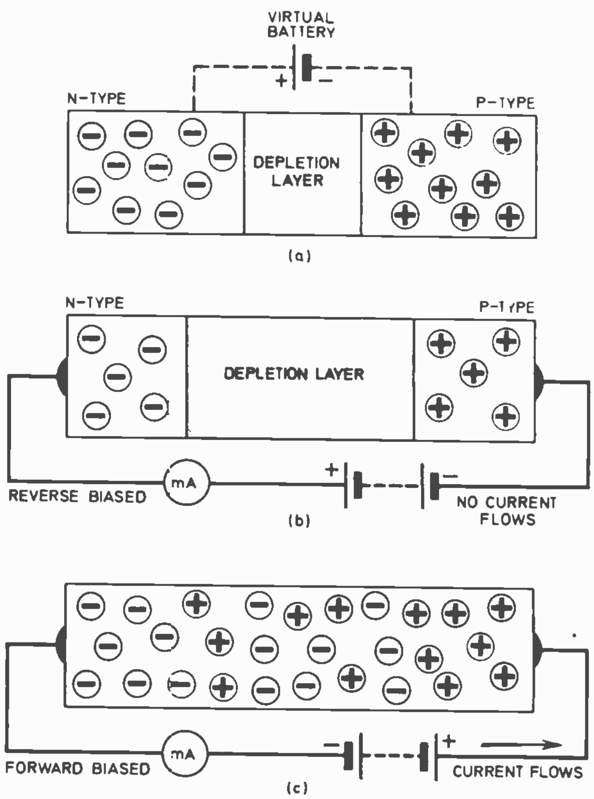
N- AND P-TYPE DOPING

First of all a few words about semiconductors in general; if you have difficulty understanding the reasons why they work, do not worry—it is useful if you can, but not disastrous if you cannot.

They are usually made from the metals, germanium or silicon, which have the unusual property (for metals) of having very poor electrical conductivity in their pure states at room temperature. This is because the atoms are bonded together in a very precise manner and there are no "spare" electrons "floating about" as is the case of copper for example.

If we heat up the pure material we can "dislodge" a number of electrons and it will start to conduct electricity in the usual way. Alternatively, if we introduce an impurity into the metal (e.g., arsenic or phosphorus) we can distort the precise equilibrium so that an extra electron is available for conduction for every

Fig. 1. Schematic diagrams of a p-n junction (a) no voltage applied—not biased (b) reverse biased (c) forward biased.

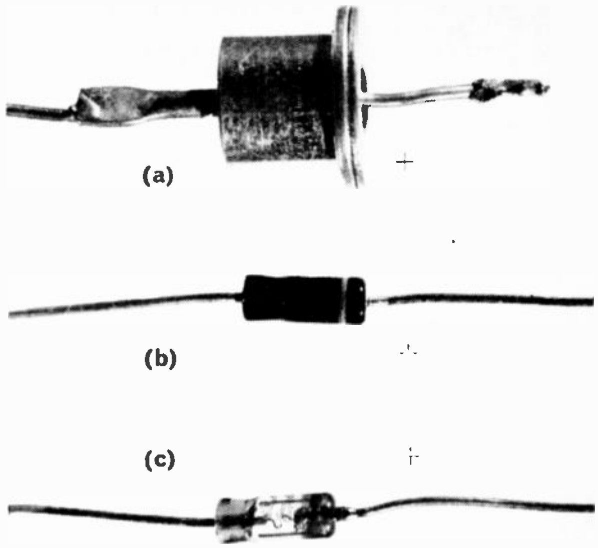


impurity atom added—this is known as "doping." These extra electrons will be free to move about thus increasing the electrical conductivity. By "adding" electrons in this manner we say we are introducing "negative carriers" (of current) and the resultant material is called an "n-type" semiconductor.

We could have "doped" the material with boron which has the effect of absorbing an electron for every atom added. This leaves a "hole" where the electron should have been. As this also upsets the equilibrium an electric current can be made to pass, only this time because the holes move (from positive to negative). A material doped in this way is called "p type"; the p standing for "positive carriers."

In practice the level of doping is very low and typically is only a few parts per million.

Because we can artificially control the conductivity in this way the metals germanium and silicon are called semiconductors.



Three common diodes: (a) medium power rectifier, BY100 silicon (b) signal diode IN4148 silicon (c) signal diode OA91, glass encapsulated point-contact germanium (Magnified x 2½).

P–N JUNCTION

Using modern techniques it is possible to bring together n- and p-type materials so that they are in perfect contact. At the interface between the two, the spare electrons in the n-type will cancel out the spare holes in the p-type, and a band is built up that is devoid of either positive or negative carriers.

At first you might think that this cancellation process would go on until all possible opposite pairs of carriers had cancelled out—but this is not so.

As the electrons move from the n-type material they leave it with a small positive charge. Likewise the holes moving from the p-type material will leave behind a slight negative charge. Eventually the negative charge in the p-type will start to repel any more electrons attempting to move across the interface and the cancellation process will stop at this point. The band of cancelled carriers is normally called the "depletion layer."

THE DIODE

The semiconductor diode is simply a p-n junction. Let's see why it will only allow current to flow in one direction. The potential across the junction caused by the cancellation process is as if we had connected a battery between the p- and n-type materials with its negative terminal going to the p-type Fig. 1(a).

If we now connect a battery across the two materials (positive terminal to the n-type and negative terminal to the p-type), we will allow more cancellation to take place at the junction thus increasing its width Fig. 1(b); but because there are no free carriers in the depletion layer no current can flow across it.

In practice there are always a few carriers present (generated by other impurities or heat) and so there will be a minute current detectable —this we call "leakage current." If this leakage current is too great the junction becomes valueless. If, on the other hand, we had connected the battery in the opposite sense Fig. 1(c), the depletion layer would be destroyed when the voltage exceeded that of the "virtual" battery.

In the absence of the depletion layer (which was acting like an insulating barrier) current can flow virtually unlimited. When the battery was connected so no current flowed, the junction is said to be "reverse biased," but when current flows it is said to be "forward biased."

The voltage level of the virtual battery is rather important because it is quite noticeable in electronic circuits. For germanium it can be from 50 to 300mV and 300 to 600mV for silicon; variations are caused by changes of temperature.

BREAKDOWN AND POWER DISSIPATION

If we reverse bias the junction and apply larger and larger voltages, eventually we reach a level when the depletion layer breaks down and conduction suddenly occurs. This level is called the "reverse breakdown voltage" and can destroy the junction. This can vary from one or two volts to thousands of volts depending on the way the junction was made. Usually this sets the limit which we must never exceed but in some cases (Zener diodes) practical use is made of this parameter.

When conducting in a forward direction the material shows a degree of electrical resistance (even though it is usually small) and consequently some power is dissipated; this generates heat and a rise in temperature degrades the junction performance. We always have to set a maximum forward current to prevent this happening.

All diodes work on the same principle and the only variations are in the magnitudes of reverse voltage and forward current limits, while the quality is defined by the reverse leakage current.

Like all semiconductors, diodes are sensitive to heat and although they are reasonably tolerant you should avoid overheating them when soldering (see *Teach-In* Part 1). With glass encapsulations you should not bend the lead out wires too close to the seal otherwise you might crack the glass!

DIODE TYPES

Diodes are identified by type numbers which are usually printed on the case. Regrettably one cannot identify any particular characteristic from this number and the only way to become familiar with these is to look them up in manufacturers' data sheets.

As there are thousands of different types of diodes made it is impossible to cover all possibilities in this series but by and large you will find that you can deal with most eventualities with either one of the following or similar types. OA91—a low voltage current germanium diode encapsulated in glass; 1N4148—this is very similar to the OA91 except that it is made from silicon; 1N4004—a reasonably high voltage (400V) medium current (1A) device made from silicon.

Because they are low voltage and current devices the OA91 and 1N4148 are sometimes referred to as "signal diodes" while high voltage and medium to high current devices—such as the 1N4004 are called "rectifiers." The most important characteristics of these devices are given in Table 1.

POLARITY AND TEST

The two terminations of the diode have names. If you refer to Fig. 2, the end to which the arrow

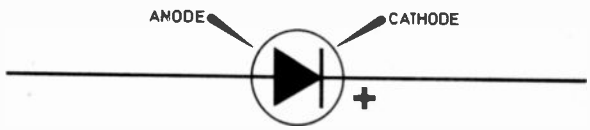
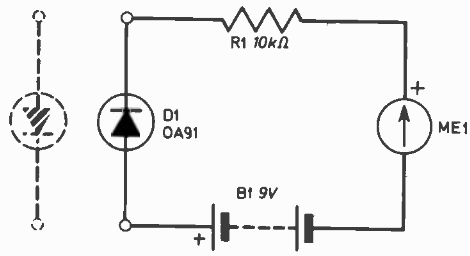


Fig. 2. The circuit symbol used for the diode showing the polarities. Current flow is out of the cathode.

head of its symbol is pointing is called the cathode and this is usually marked on the actual device with a band, spot, or a + sign. The other (unmarked) end is called the anode. If you



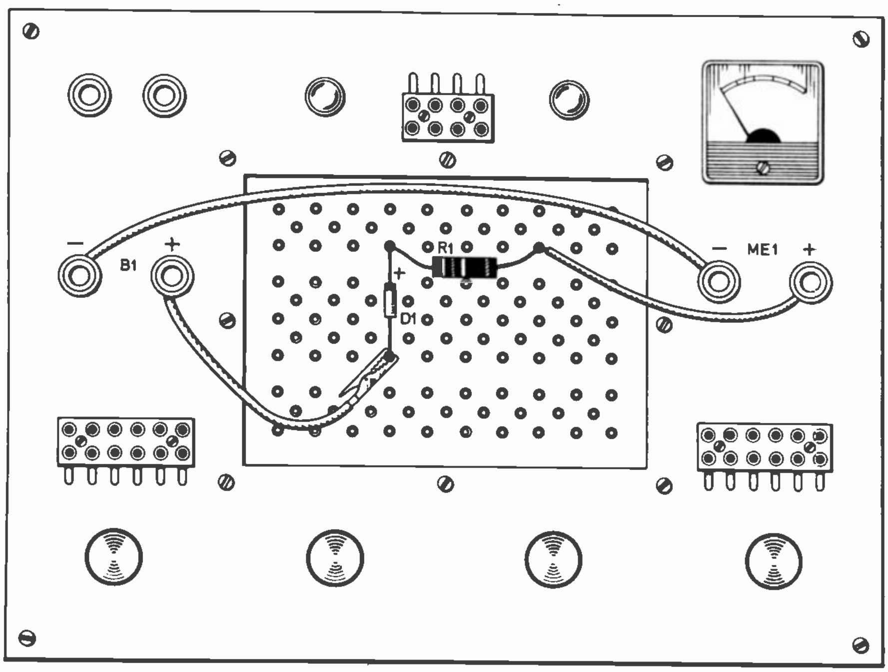


Fig. 3(a) (above). The circuit diagram for polarity test and demonstrating current flow in one direction only.

Fig. 3(b) (left). The circuit of Fig. 3(a) wired up on the Demo Deck.

Table 1: PARAMETERS OF SOME COMMON DIODES

Type No.	Description	Max. reverse voltage (V)	Max. leakage current (μA)	Max. forward current
OA91	Germanium point contact signal diode	115	275 at 100V	50mA
1N4148	Silicon planar diffused signal diode	75	0·025 at 20V	225mA
1N914	Silicon planar diffused signal diode,	75	0·025 at 20V	110mA
AA143	Germanium gold bonded signal diode	30	20 at 20V	60mA
OA200	Silicon alloy diffused signal diode	50	0·1 at 50V	160mA
ZS10A	Silicon alloy diffused signal diode	60	0·05 at 60V	100mA
1N4004	Silicon planar diffused rectifier	400	5 at 400V	1A

make the anode positive with respect to the cathode the diode is forward biased and will conduct. Try this for yourself using the Demo Deck (see Fig. 3), then reverse the diode to see that no current flows when it is reverse biased.

Use each of the three diodes to see that by and large they all exhibit the same effect. This is a simple test that can be used to see if a diode is working correctly.

CHARACTERISTICS—FORWARD BIASED

We will now try and plot what is called the diode "characteristic" curve. This is simply a curve or graph that shows the amount of current flowing through it for different applied voltages.

To prevent passing too much current through the diode we shall limit it with an external resistor R3 in series with the diode, see Fig. 3(a).

Use VR1 on the Demo Deck to make a potential divider to use as a variable voltage source, and a 10 kilohm resistor in series with the 1mA meter to make a 10V full-scale voltmeter.

Connect the diode D1 (OA91) as indicated in Figs. 4(a) and (b).

Prepare a table for recording the voltages at points A and B—V_A and V_B respectively.

Starting at zero volts and working up in small increments, measure V_A (crocodile clip at point A) and then V_B (clip at point B) for each increment. Repeat the experiment with the silicon diode, 1N4148.

It can be seen that the voltage across the diode is equal to $(V_A - V_B)$—multiply by 1000 to convert to mV.

Now the current flowing through the diode at each measurement is determined indirectly using the voltage seen across R3 and applying Ohm's law. In this case $I = V_B \div R3$. Since the

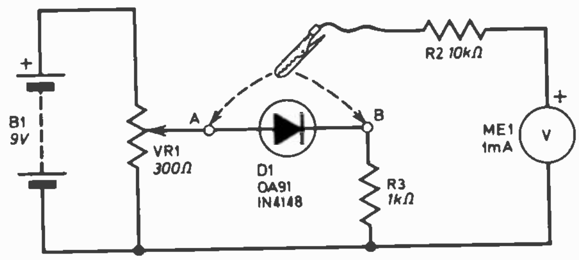


Fig. 4(a) (above). The circuit diagram for measuring the diode characteristics.

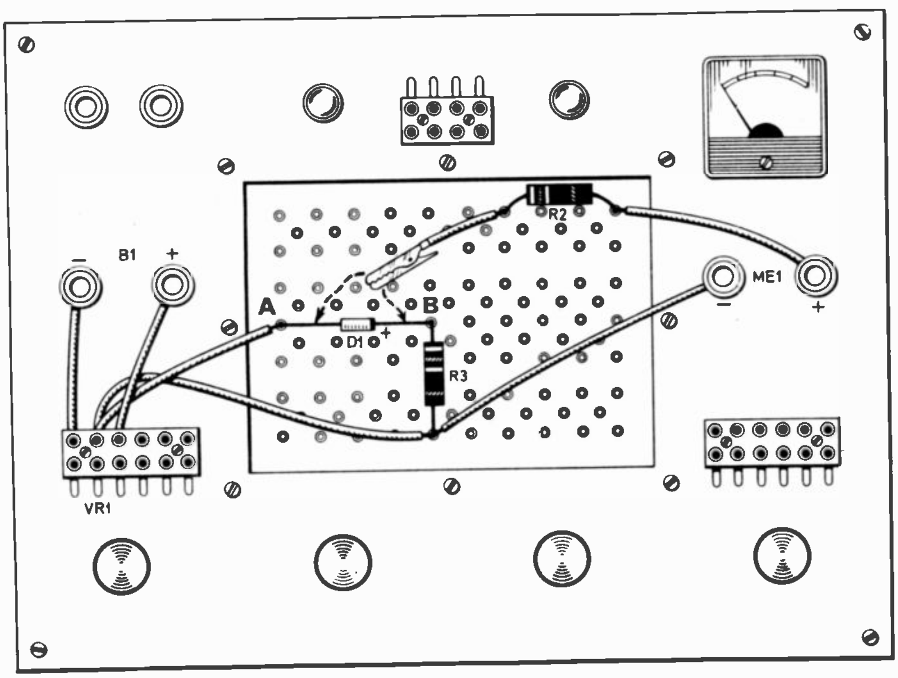


Fig. 4(b) (left). The circuit of Fig. 4(a) wired up on the Demo Deck.

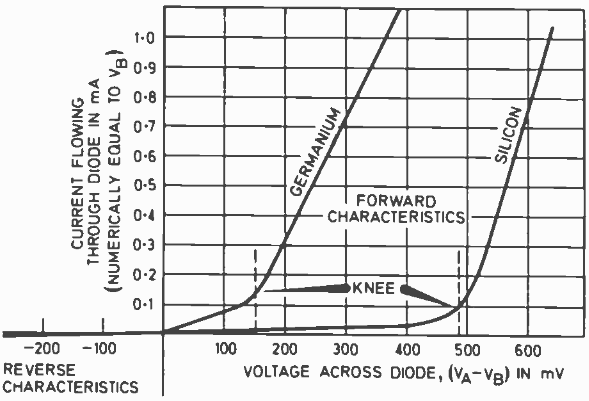


Fig. 5. Forward and reverse characteristics for the OA91 (germanium) and IN4148 (silicon) diodes obtained using circuit of Fig. 4(a). The two curves would eventually become parallel straight lines if we were able to plot the characteristics to a higher voltage.

value of R5 is 1 kilohm, the numerical value of V_B (in volts) gives the current flowing, in mA.

Plotting graphs of current flowing against the applied voltage will give curves similar to those in Fig. 5.

It can be seen that for the germanium diode, OA91, there is a sudden change from passing little current to complete forward biasing at about 150mV. For the silicon diode, 1N4148, this change occurs at a much higher voltage, 500mV.

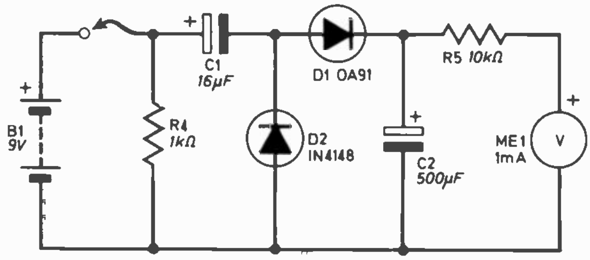
This abrupt change or "knee" of the graph occurs when the voltage we are applying just exceeds the virtual battery across the junction of the diode.

—REVERSE, BIASED

Although we do not have a high enough voltage available to cause reverse breakdown you can start to plot the reverse characteristics of these two diodes by reversing them in the circuit, i.e., cathode to the wiper of VR1 and measuring current for different voltages exactly as before. Of course you should read zero current at all voltages. Leakage current will be present but will not show up because our measuring system is not sufficiently sensitive.

TACHOMETER EXPERIMENT

We can demonstrate a very simple application of where two diodes can be used in a circuit. It is a very crude form of tachometer that will record on a meter the rate at which a contact is made to open and close. The circuit is shown in Fig. 6(a) and should be wired up on Demo Deck as shown in Fig. 6(b). You will only need one extra component—a 16μF capacitor with a minimum working voltage of 12V. D1 is the OA91 and D2 the 1N4148 (another OA91 would work equally as well for the latter).



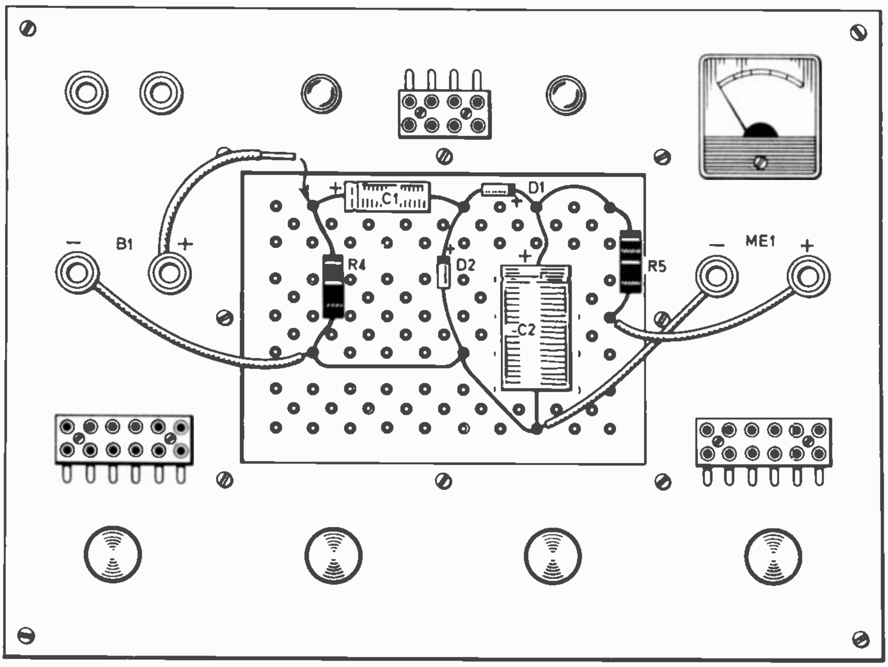
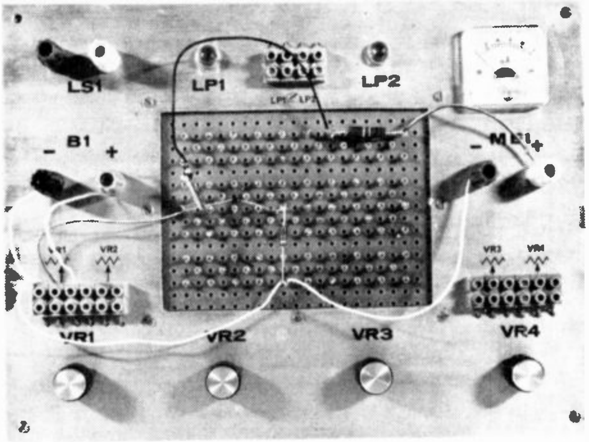


Fig. 6(a) (above). The circuit diagram for the Tachometer experiment.

Fig. 6(b) (left). The circuit of Fig. 6(a) wired up on the Demo Deck.



Photograph of the Demo Deck in use for measuring the characteristics of the IN4148 (silicon) diode.

METHOD

To operate the circuit, momentarily connect the positive end of C1 to the +9V supply and watch the meter, it will kick up a small amount and then slowly settle back towards zero. Now "dab" the wire on the +9V terminal at a regular rate—say once a second—and notice that the meter starts to read higher and although there is a slight waver in the reading you can see an average current level. Now speed up the rate of making the contacts—the meter reads higher. Note that this circuit will only work for rates up to a few a second.

THEORY

The circuit we are using is called a "diode pump" and works as follows: initially there is no charge on C2 so the meter reads zero. When you apply the positive lead to C1 a momentary charge current will flow through C1, D1 and C2 which are all in series.

Because C1 has a small capacitance, it will charge up quickly—C2 only attaining a small charge—and the charge current stops (even though the wire is still connected to the battery).

Capacitor C2 does, however, charge up by a small finite amount and this causes the "kick" you see on the meter, but C2 will then start to discharge slowly through the 10 kilohm resistance of the meter circuit.

When you disconnect the battery, C1 will discharge through R5 and D2.

During the charging part of the cycle, D2 was reverse biased because the potential at its cathode was predominantly more positive than the anode, but now the positive charge at the positive end of C1 is applied, through R5, to the anode and so it conducts this charge away at a rate limited by the value of R5.

The potential at the cathode of D2 thus falls to zero. Because C2 has a slight positive charge on it D1 now becomes reverse biased and prevents C2 discharging back through the circuit. If you re-apply the +9V to C1 the charge part of the cycle starts again and the potential at C2 will either rise back to its previous level or go higher, depending on time between pulses.

The circuit gets its name "pump" because the two diodes work rather like the leather flap valve of an old-fashioned water pump that is pumping squirts of water into a bucket with a hole in the bottom.

The circuit given here is purely for demonstration purposes and cannot be used for many practical applications due to its inability to work at pulse rates greater than about three per sec (i.e., frequency of about 3Hz) but the principle is used very frequently particularly in equipment such as electronic car rev-counters.

Next month we shall deal with the principles of the transistor and armed with that information we shall be able to move on to make some simple circuits. ◼

Now try the Test on page 333.

TEACH-IN PART 5—ERRATA

We apologise for a technical error with regards to the capacitor colour coding system given in last month's *Teach-In.*

There are numerous capacitor colour coding systems in use and the one given last month refers to the very popular Mullard C280 series and should be amended as follows: the first three bands are correctly labelled, i.e., 1st and 2nd digits and the multiplier. The fourth band gives the tolerance and is either black or white indicating ±20 and ±10 per cent respectively.

The fifth band indicates the working voltage, red 250V, yellow 400V.

Next Month: Transistors

THOSE who contemplate carrying out much experimental and constructional work with transistorised electronics will find that the use of batteries as a power supply can prove rather expensive.

A simple variable voltage power supply of the kind illustrated in this article will more than pay for itself in quite a short time and unlike batteries it doesn't run down. It will supply any voltage up to 16V at a nominal maximum current of 100mA and is fully protected against overload even to the extent of a direct short circuit across the output.

At very low current drain i.e. in the region of 10 to 20mA, the maximum voltage is about 17V which is suitable for many *npn* silicon transistor audio pre-amplifiers for example, requiring between 16 and 18V for operation.

POSITIVE OR NEGATIVE EARTH

Either the positive or negative rails can be "earthed" according to the requirements of the circuit being supplied. It is only necessary to move switch S2 to the appropriate position.

The meter always indicates the voltage at the output terminals i.e. the operating voltage being used. The a.c. ripple at any operating voltage and up to maximum nominal current drain is less than 0·5mV.

At any steady continuous current drain the voltage variation at any setting is negligible.

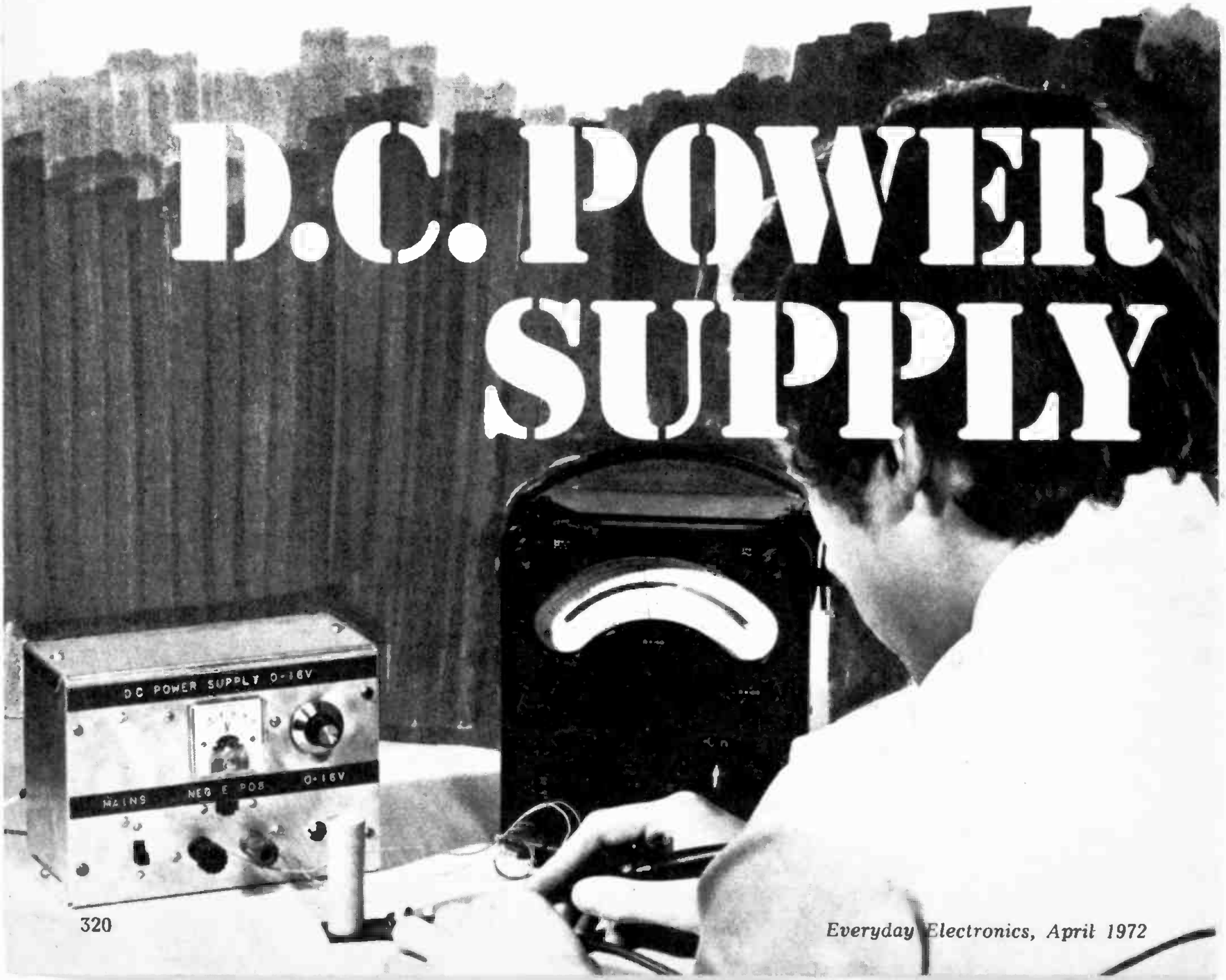
CIRCUIT DESCRIPTION

The complete circuit diagram is shown in Fig. 1 and is a fairly simple arrangement employing a small power transistor, TR1, to control the output voltage.

The transformer T1 steps down the mains voltage to 14V a.c. (r.m.s.) and applies this to points X and Y on the "diode bridge" network. This arrangement of the diodes gives full-wave rectification across points A and B.

The reservoir capacitor C1 connected across the bridge "smoothes" the pulsating d.c. from the bridge producing a mean d.c. level of about 20V with a small amount of "ripple" voltage. This is applied to the series combination of R1 and the Zener diode, D5. Capacitor C2 across

D.C. POWER SUPPLY



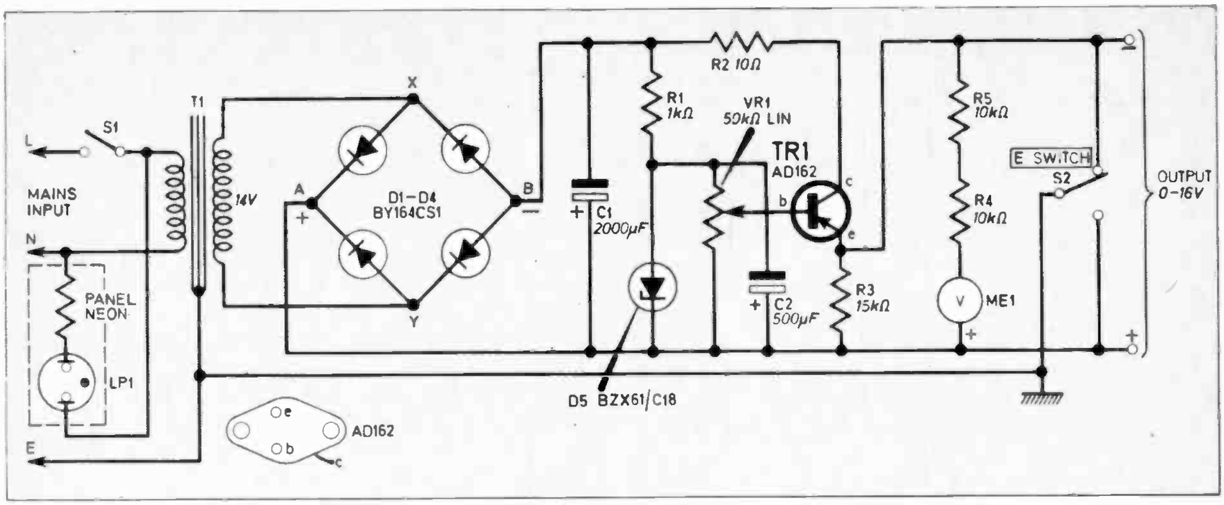


Fig. 1. The complete circuit diagram of the D.C. Power Supply Unit.

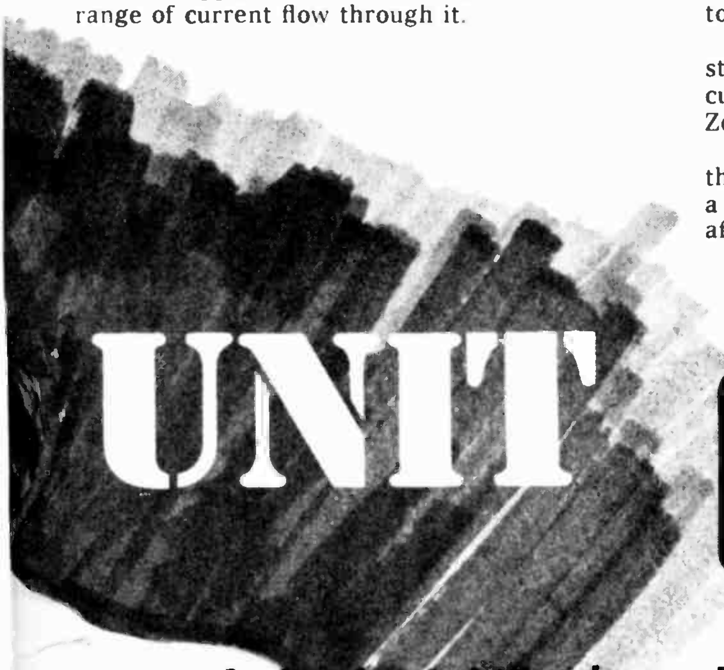
D5 helps to eliminate ripple voltage that may be present.

The Zener diode has the property of being able to supply a constant voltage over a wide range of current flow through it.

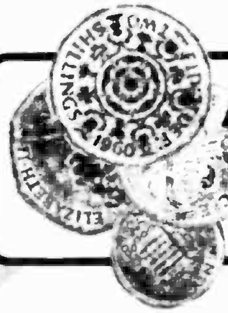
A small amount of voltage is dropped across R1 (Zener current limiting resistor) while D5 supplies a constant voltage of 18V to the potentiometer VR1 which controls the voltage applied to the base of TR1.

The inclusion of TR1 in the circuit affords stabilisation since without it, loads drawing large current would cause the voltage across the Zener to vary.

The voltage output from TR1 is a function of the potential drop across the transistor and also a function of the base-emitter voltage and affords stabilisation as follows.



UNIT



Approximate cost of components... £5·00 plus case

A simple stabilised supply providing 0-16 volts d.c. continuously variable output.

by F. C. Judd

Components....

Resistors

R1 1kΩ ±1% ¼W hi-stab.
R2 10Ω 10W wirewound
R3 15kΩ ±10% ¼W carbon
R4 10kΩ ±1% ¼W hi-stab.
R5 10kΩ ±1% ¼W hi-stab.

SEE SHOP TALK

Capacitors

C1 2000μF 25V elect.
C2 500μF 25V elect.

Diodes

D1–D4 BY164CS1 Bridge type rectifier (1 off) or if desired 1N4002 (4 off)
D5 BZX61/C18 18V 1W Zener or any 18V 400mW Zener

Transistors

TR1 AD162 germanium *pnp*

Potentiometers

VR1 50kΩ linear carbon

Miscellaneous

T1 240V primary 12 to 14V 200mA secondary transformer.
ME1 0–1mA 75Ω internal resistance meter
S1 Mains switch slide type, D.P.S.T.
S2 Slide type switch, D.P.D.T.
LP1 Mains panel neon with built in resistor
2 insulated terminals (1 red, 1 black); 0·15in matrix perforated s.r.b.p. size 3¾ x 2¾in.; 16 s.w.g. aluminium 3½ x 2½in. for heatsink; control knob to suit VR1; aluminium angle ⅜ x ⅜in.; various B.A. nuts and bolts for fixing of panel components; aluminium for building housing case or Universal chassis parts—CU168 (7 x 5in.) 2 off, CU147 (7 x 3in.) 2 off, CU145 (5 x 3in.) 2 off.

The base-emitter voltage is the difference between the output voltage and the voltage supplied to the base of TR1 via VR1 from the Zener diode (which is constant for any setting of VR1).

If the output voltage decreases (due to heavy load for example) so the base-emitter voltage increases, causing the output voltage to increase and in doing so causes the base-emitter voltage to decrease thereby decreasing the output voltage. Thus the circuit is self-compensating and the output voltage remains substantially constant for a wide range of output loads.

The supply rails can only be earthed by the switch S2 which connects either the positive or negative rail to common earth.

No part of the circuit, except the frame and core of the mains transformer, is directly connected to the panel and case, which is earthed.

CONSTRUCTION

The prototype was constructed in a box made from Universal chassis parts with everything mounted on the front panel, but any size case will do. The layout is not critical and may be modified to suit individual requirements. However it is essential that a heatsink be used to mount TR1 otherwise damage will occur to TR1.

Most of the components are mounted on a piece of 0·15in matrix perforated s.r.b.p. size $4\times2\frac{1}{4}$in. The layout of these components on the board is shown in Fig. 2.

Begin by wiring up the board as indicated, attaching all the flying leads and remembering to use a heat shunt when soldering the Zener diode, D5, in position.

The next thing to do is to make the mounting bracket for the component board and the heatsink, and cut and drill the front panel to the sizes given in Figs. 3 and 4.

When this is done, attach the remaining components including the transformer T1, to the front panel in the positions indicated.

It is best next to attach TR1 to its heatsink making sure that TR1 is completely insulated from the heatsink by using the appropriate size mica washer and insulating bushes. Connection to the collector (which is the body of the transistor) is made via a solder tag under one of the securing bolts.

Now connect the transistor to the component board via the flying leads and then attach it to the front panel in the positions indicated.

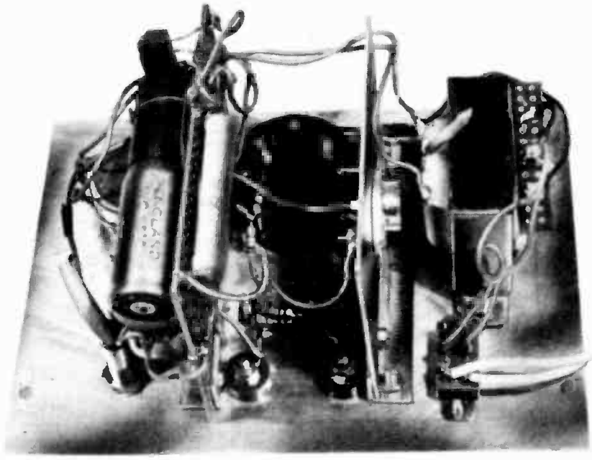
Connect all the flying leads from the component board and the transformer to the panel mounted components and wire an R3, R4 and R5 as shown in Fig. 5. Connect a suitable length of mains lead to S1 as shown.

THE METER

The resistors R4 and R5 are hi-stability types, and in series with the 1mA full scale deflection meter convert it to a 20V voltmeter.

Although the prototype was built with this kind of meter arrangement, it may be better to use one of the readily available 20V voltmeters which costs the same as the 1mA meter and need no calibration. The 20V meter would

D.C. POWER SUPPLY UNIT



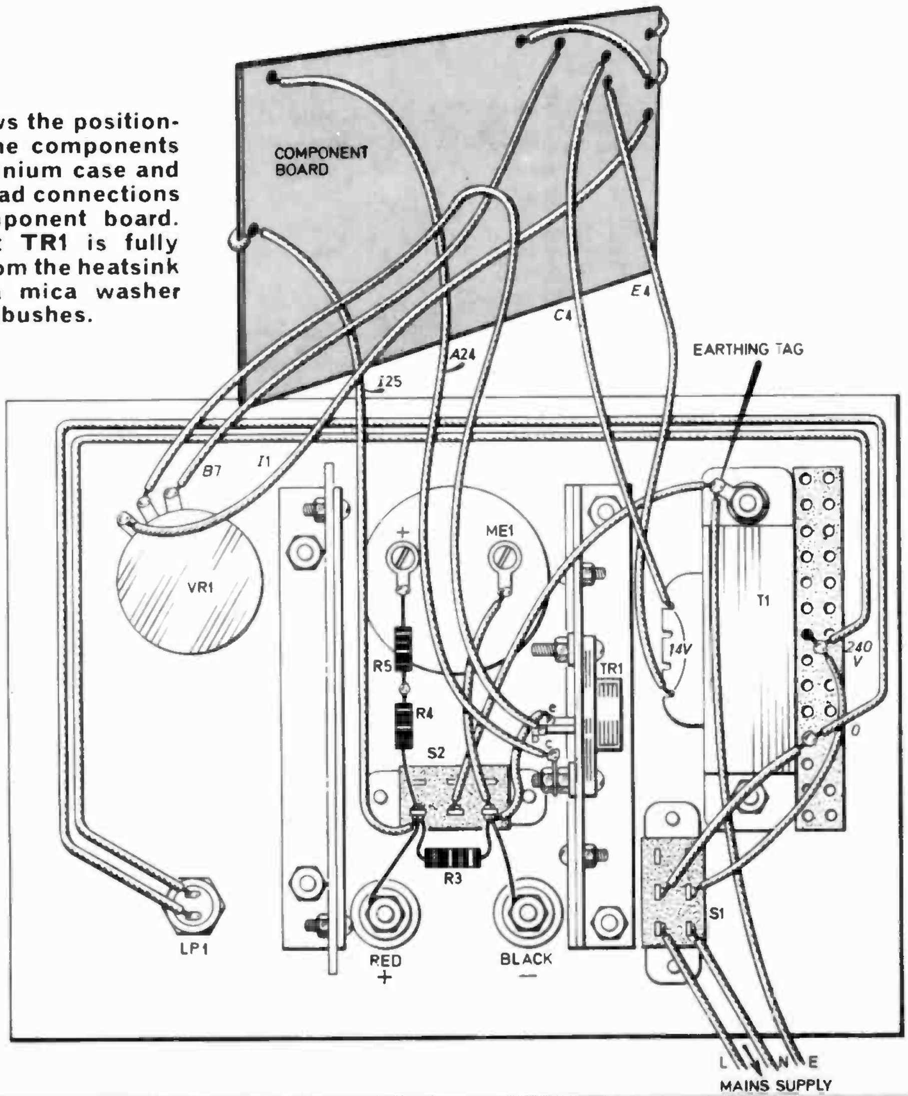


Fig. 5. Shows the positioning of all the components in the aluminium case and the flying lead connections to the component board. Ensure that TR1 is fully insulated from the heatsink by using a mica washer and plastic bushes.

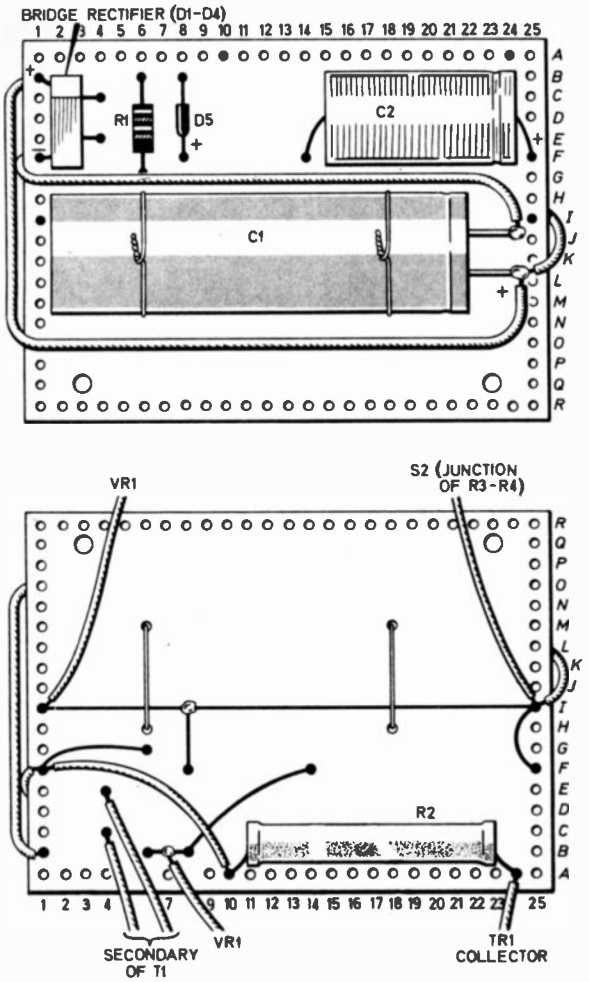


Fig. 2. The layout of the components on both sides of the board.

replace the 1mA meter and the series resistors R4 and R5.

If however, a 1mA f.s.d. meter is used as the voltmeter, it will be necessary to remove the meter scale and recalibrate it to read 0 to 20 volts.

This is done as follows: take off the meter cover and remove the meter scale by undoing the two retaining screws; gently slide the scale away from the meter. The original figures can be erased and new figures 0-20 inscribed.

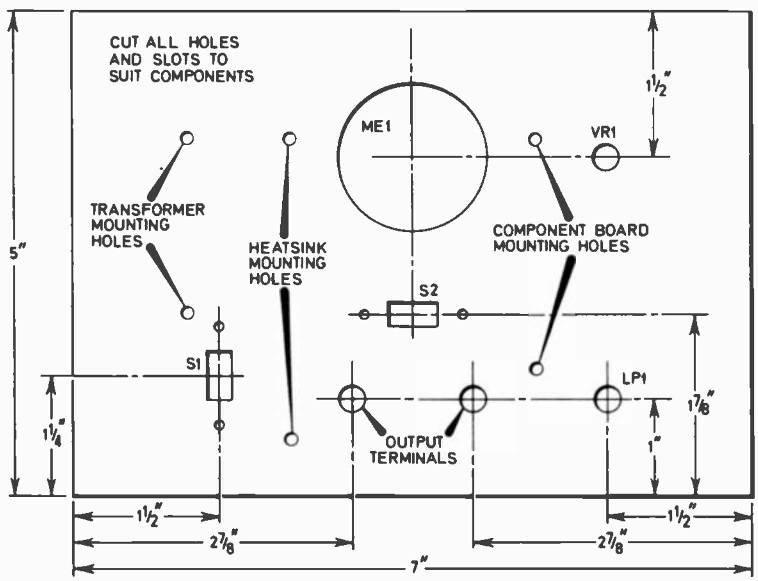
USING THE UNIT

It is a simple matter setting up the power supply unit for a specific job and should be carried out as follows: attach the battery leads from the test project to the negative and positive insulated terminals on the unit panel, decide which lead is the earth lead and switch S2 (marked E on front panel) to the correct position.

Turn VR1 fully anticlockwise (zero volts) and then plug in to the mains and turn on switch S1. Rotate VR1 to give desired voltage level—this is indicated on the meter.

The completed power supply unit is protected against temporary short circuits by the inclusion of the high wattage resistor R2 which will dissipate any power due to overload. However do not leave the unit running with a short circuited output, but switch it off until the overload is removed.

A direct short circuit will instantly reduce the output volts to zero and this will be shown on the meter. The unit will comfortably supply up to 100mA continuous at any voltage below 16V and between 150 and 200mA intermittent at 16V. ■



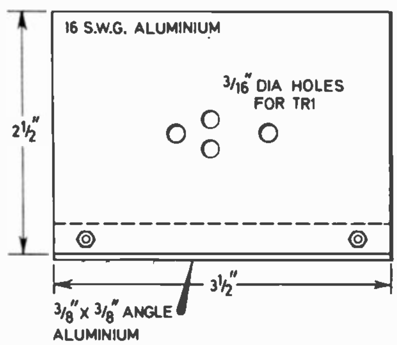
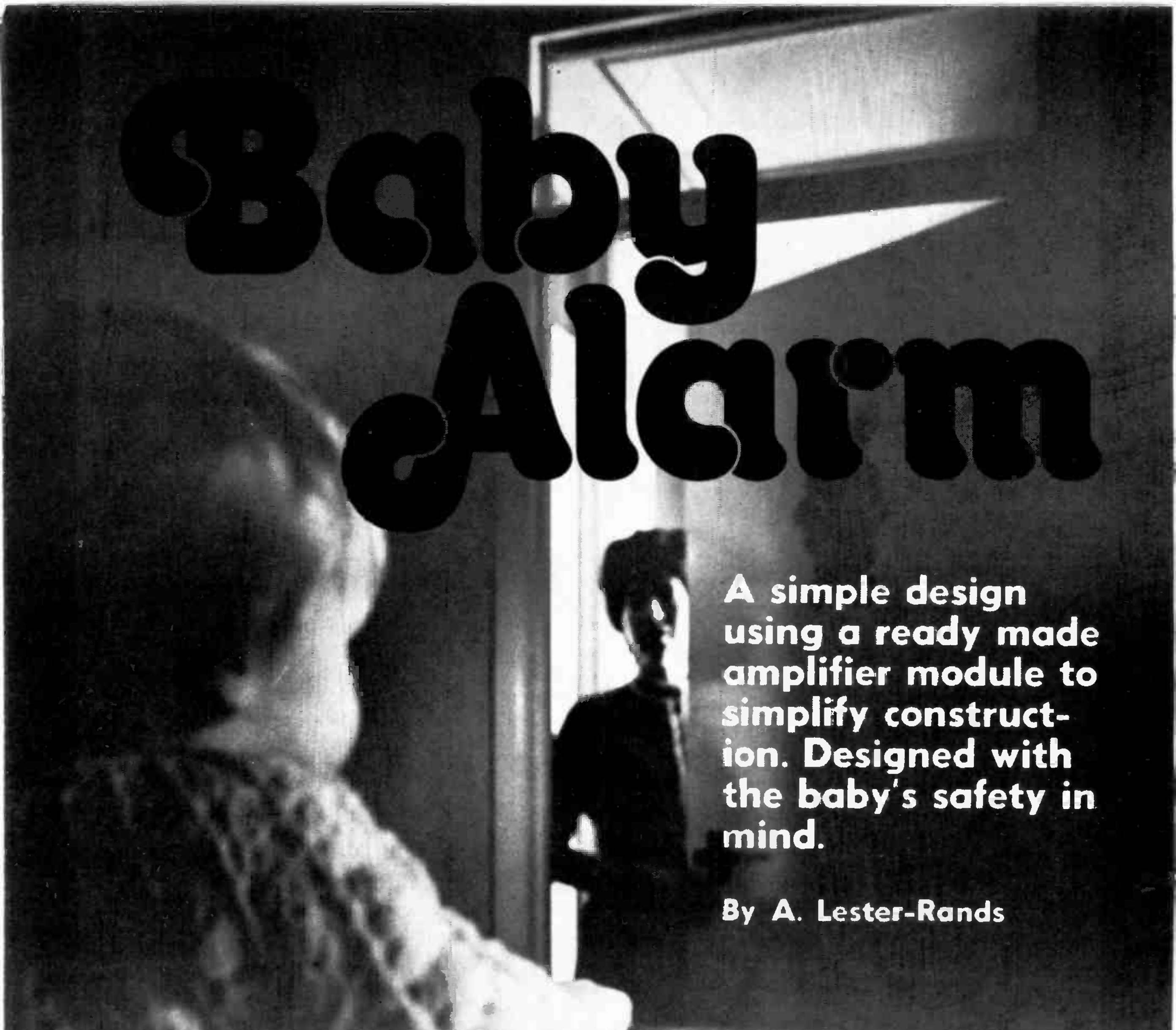


Fig. 3. (above) The dimensions of the heatsink for TR1.

Fig. 4. (left) The dimensions of the front panel showing positions of holes and cut-outs for mounting the components.



Baby Alarm

A simple design using a ready made amplifier module to simplify construction. Designed with the baby's safety in mind.

By A. Lester-Rands

No need to have the hi-fi or TV sound turned right down, or conversation reduced to whisper level, just in case the baby should awake and voice its discomfort. The baby alarm described in this article will solve the problem of being able to hear cries of protest.

The circuit has been simplified to a great extent by using a ready built main amplifier, but some constructional exercise can be obtained from building the microphone pre-amplifier and of course assembling the units within their respective boxes. The photographs show the original boxes that were used to house the amplifier and speaker, and the microphone. These are plastic electrical connecting boxes obtainable from electrical fittings retailers and are available in a variety of sizes. Choose a pair approximately the same dimensions as the originals which were about 4½ inches by 4½ inches by 3½ inches deep. These boxes are generally white and do not look out of place in most homes. The crystal microphone could be put into a much smaller box or a standard crystal microphone in a plastic case could be used if desired.

THE CIRCUIT

The circuit is given in Fig. 1 and consists of a one transistor pre-amplifier consisting of TR1 which raises the signal level from the microphone to a sufficient level to supply the amplifier. No attempt has been made to match the high impedance of the crystal microphone to the amplifier input impedance as this would only complicate the circuit; loss due to mismatch is made up by the amplifier gain anyway. The pre-amplifier is connected to the Newmarket PC2 amplifier, the circuit diagram of which is shown in Fig. 1, via the volume control VR1. The output from the PC2 module goes direct to the loudspeaker which may be any miniature (2½ to 3½ inch), 15 or 25 ohm impedance type. A brief specification of the amplifier is given in Table 1.

Table 1: NEWMARKET PC2 AMPLIFIER CHARACTERISTICS

Operating voltage	9V
Output	up to 400mW into 15Ω load
Input resistance	1kΩ
Input sensitivity	1mV for 50mW output
Quiescent (no signal) current	10mA

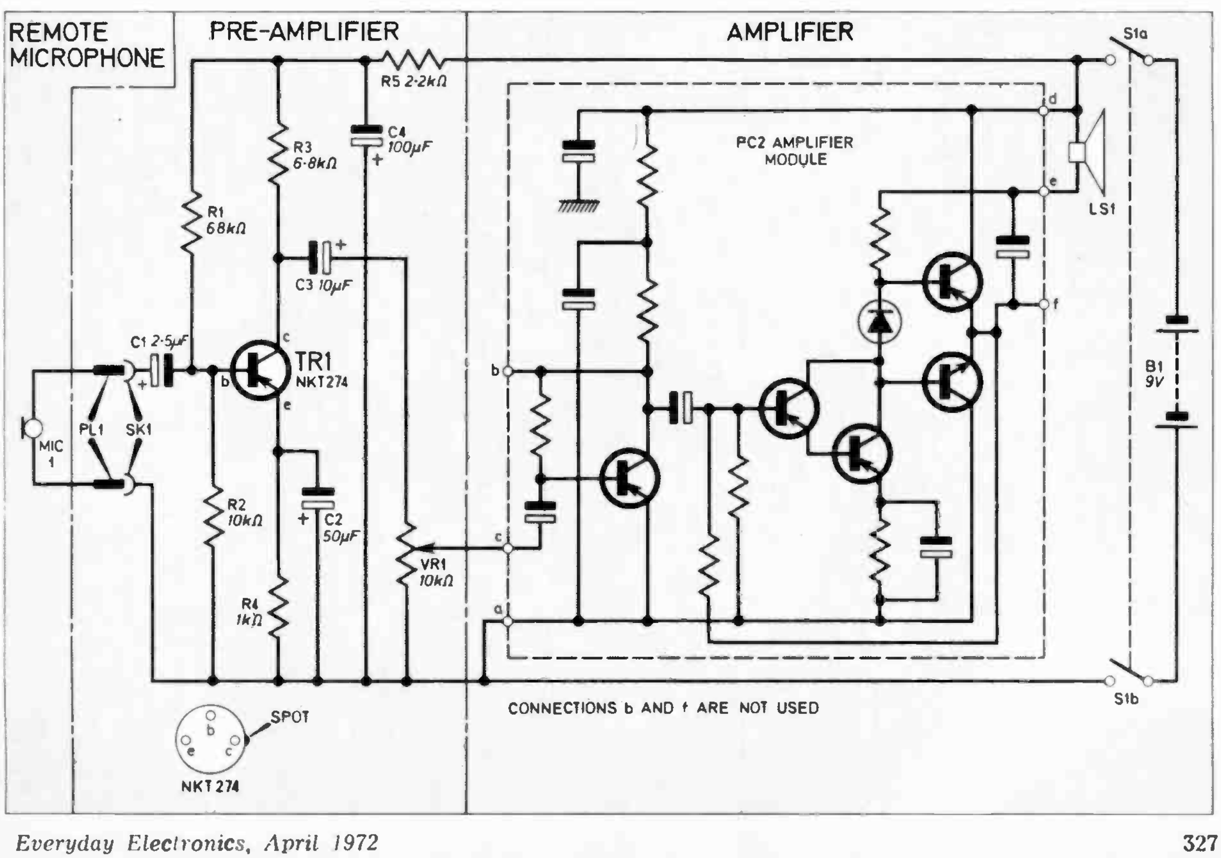
CONSTRUCTION

The pre-amplifier is constructed on a small piece of plain circuit board as shown in Fig. 2 and this and the PC2 amplifier are bolted on one side of the amplifier case. The capacitors used in the prototype are printed circuit types with both wires at one end. This simplifies construction and provides a neater finished job, however, this type of capacitor does not have to be used. If the capacitors available are larger than those specified this will not matter as there is plenty of room for larger types on the component board. The finished board is a similar size to the PC2 amplifier and the two units are mounted together on one side of the case.

With a box the same size as the original, or larger, there should be ample space for a PP9 battery as well as the loudspeaker. The layout of the components on the front panel of the amplifier box is shown in Fig. 3 and the photographs but again this may be varied to suit the size of the box used. Note that two wander plug type sockets (SK1) for the microphone lead are mounted on the side of the case. A miniature jack or similar two-pin connection could be used instead but the earthed connection must be from the screening braid of the microphone cable (black socket to screen). The wiring between the various components mounted in the case is shown in Fig. 3.

All that remains is to mount the crystal microphone in its box (Fig. 4) and connect it to the sockets on the side. (A jack or two-pin connection could also be used here instead of wander

Fig. 1. Circuit diagram of the Baby Alarm. The part of the circuit enclosed by the dotted line box is the Newmarket PC2 amplifier module.



Baby Alarm

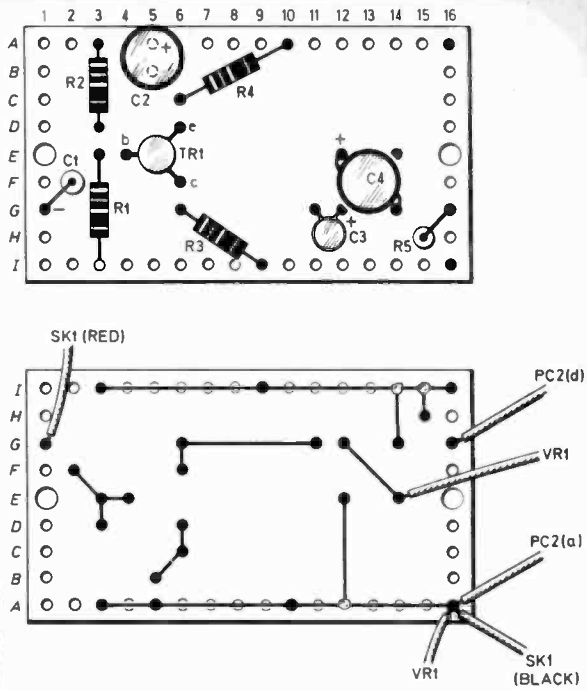


Fig. 2. (Above) Layout and wiring of the component mounting board.

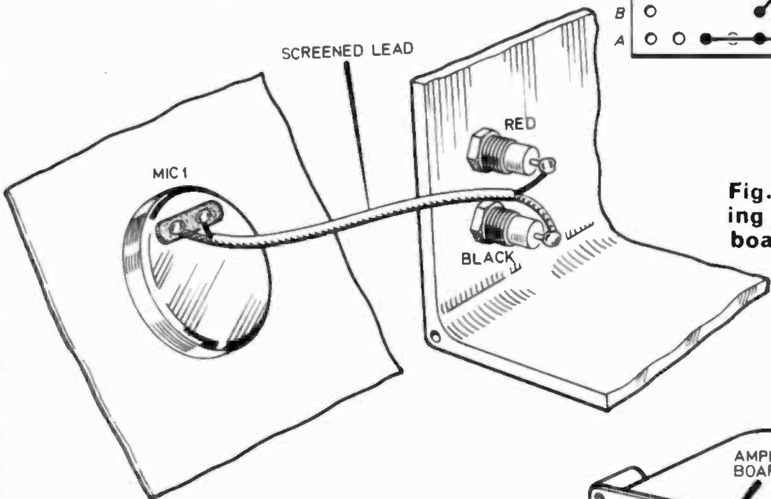
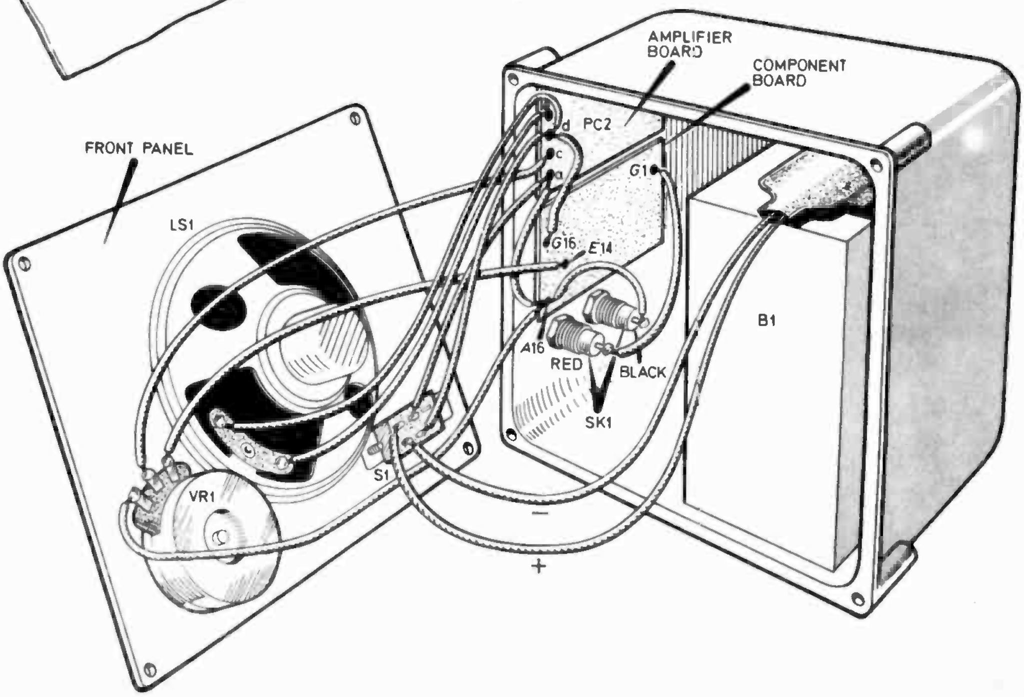


Fig. 4. Microphone wiring for box mounting.

Fig. 3. (Below) Interwiring of the amplifier box of the Baby Alarm.



Components....

Resistors
R1 68kΩ
R2 10kΩ
R3 6·8kΩ
R4 1kΩ
R5 2·2kΩ
¼W ± 10% carbon

SEE SHOP TALK

Capacitors
C1 2·5μF elect. 12V
C2 50μF elect. 12V
C3 10μF elect. 12V
C4 100μF elect. 12V

Potentiometer
VR1 10kΩ log. carbon

Transistor
TR1 NKT 274 germanium *pnp*

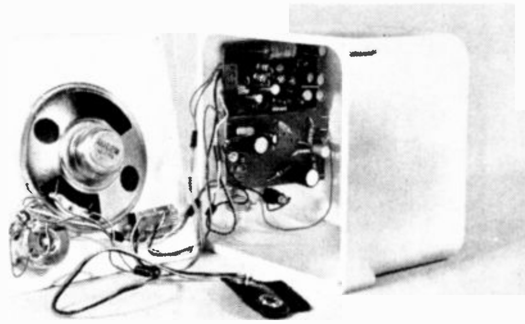
Miscellaneous
S1 Double-pole single-throw slide or toggle switch
B1 9V PP9 battery
PC2 Newmarket amplifier module
MIC1 Crystal microphone insert (any small type or complete microphone)
SKI, PLI wander plugs and sockets (2 red, 2 black of each)
LS1 Miniature 2½in. to 3½in. 15 or 25Ω loudspeaker
Screened lead (length as required), plain perforated 0·15 inch matrix Veroboard 2½in. × 1½in. 6 BA fixings, connecting wire, plastic cases (see text), control knob.

plug sockets.) It does not matter which way round the leads to the microphone insert are connected. The screening cable should preferably be screened light-weight microphone cable. The baby alarm units may be permanently mounted if required or, the microphone may simply be placed a few feet away from the cot, the cable led to the living room and the amplifier connected up. The whole can be quickly gathered up and put away when it is not in use.

In operation the unit is quite sensitive and with the microphone even 6 feet away from a crying baby the sound from the loudspeaker at half to full volume setting will be as loud as if the baby were in the same room.

SAFETY

The alarm is inherently safe due to its being battery operated. There is no d.c. present at the microphone end and hence even if the baby removes the leads and puts them in its mouth no harm can come of it, provided the plugs are securely fixed. The box used to house the microphone is also harmless to a baby and quite tough; if a complete microphone is used this should be taken into account when purchasing.

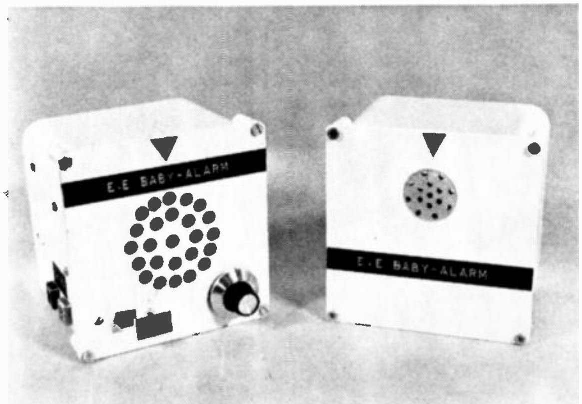


Due to the high impedance of the microphone the length of lead used to connect the two units should be kept as short as possible to avoid unnecessary noise or oscillation. The prototype was tested with a 15 yard length of screened lead and gave satisfactory results, suggesting that a reasonable increase on this length could be used without any major problems. To keep lead length within reason the wire could be fed from an upstairs room to a ground floor room via the windows instead of running it down a staircase. Routing the connecting wire parallel with mains wiring should also be avoided as this will induce hum in the circuit.

CHECKING THE UNIT

The standing current consumed by the amplifier with no signals is approximately 10mA so do not leave the unit running longer than is necessary. To test for operation, short circuit the microphone sockets and turn the volume control full on. A soft hiss should be heard from the loudspeaker. Place the microphone in another room to prevent feedback, which will occur if the microphone is near the speaker, and check by getting someone to speak quietly into the microphone. A good signal should be obtained from the speaker.

The unit is now ready for use and can either be permanently installed or placed in position as necessary. ■



Fifty years of British Broadcasting

FIFTY years ago British broadcasting was born in an ex-army hut near Chelmsford in Essex, when on February 14, 1922 a group of Marconi engineers began a series of regular experimental transmissions. Every Tuesday evening from a rigged-up transmitter, call sign 2MT Writtle, or more affectionately to its listeners, Two Emma Tock. They transmitted programmes whose original purpose was entirely technical. Shortly afterwards, in May, another transmitter, later to be even better known, was opened up by the company at Marconi House in the Strand in London. This was the famous 2LO station that provided the foundation from which the British Broadcasting Company grew after its formation on November 14 of the same year.

Two Emma Tock provided the first regular broadcast service in this country, and incidentally broadcasting's first audience, an audience which in its enthusiasm for the pioneering programmes, generated the original demand for public service broadcasting. The 2MT transmitter was set up for use in a series of experiments designed to establish the effective range of a wireless telephony transmitter. At the same time a number of radio amateurs were appearing, largely young ex-servicemen who had learnt about radio during the 1914-18 war, who had put together their own receiving sets, and who wanted transmissions to receive. Earlier experiments with entertainment had shown that there was a potential for wireless telephony outside official communication and navigation usage, but the official attitude had been discouraging.

2MT opened regular broadcasts officially on behalf of the amateurs who needed a source against which they could calibrate their receivers, and to begin with its programmes were not very much more interesting than early 1920 transmissions made before the government clamp-down, when W. T. Ditcham read from Bradshaw's railway timetable, but the enthusiasm and gaiety of the young Marconi engineers who ran it very soon turned it into a half-hour's entertainment in its own right.

The names of those men read like a roll-call of some of the great names in Broadcasting. In charge of the project was Captain P. P. Eckersley, who later went to the new British Broadcasting Company as its first Chief Engineer. It was his infectious and spontaneous humour which gave 2MT its unique flavour; he had a gift for ad-libbing that constantly alarmed those of a less adventurous disposition who worked with him. Others in the team were Noel Ashbridge, later Sir Noel, who was the BBC's first technical director, R. T. B. Wynn, a later Chief Engineer of the BBC and B. N. MacLarty, who became Head of the BBC's Design and Installation team.

By contrast, Marconi's 2LO station, granted its licence in May, began a rather staid existence, a happy coincidence for the pioneers of 2MT, as it gave them an opportunity to provide skits and lampoons which were much appreciated by their listeners. 2LO operated on conditions of restricted timing, at first even no music, and low power, beginning with 100 watts, later raised to $1\frac{1}{2}$kW.

By this time many wireless societies had been formed and more and more the demand for radio receivers was being felt. In the United States since 1919 "wireless" had become fashionable, but with no constitutional control of the use of wavelengths, chaos reigned in a commercially sponsored free-for-all. The British Government, seeking a way from the dilemma posed by popular demand on the one hand and a justifiable reluctance to allow free access to the air on the other, set up the Wireless Sub-Committee of the Imperial Communications Committee in April of 1922. After consideration, their recommendation to set up a single broadcasting company was accepted and in November 1922 the British Broadcasting Company was formed from six commercially interested companies with £100,000 share capital.

2MT Writtle continued to transmit until the following January, when it finally closed down.

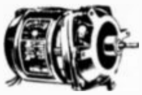
In-Store Watch-dog

ST MICHAEL now has an electronic watch-dog to help with quality control.

Marks & Spencer's St Michael brandname has long been a byword for dependability and has recently been developing in the foods market. As part of their quality control effort in this sensitive area, Marks are using a GEC-Elliott instrument in their shops, to check that chilled and frozen goods are maintained at the optimum temperatures for freshness and quality.

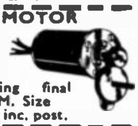
The equipment consists of a portable temperature measuring and recording system. It enables spot checks to be made at a moment's notice, or can operate continuously after the store has closed to record changes throughout the day, overnight or during the weekend. Although the company has supplied similar static equipment for cold stores, warehouses and refrigerated ships, this is the first portable system for the retail trade. The system is trolley mounted, so that it can be moved from counter to counter, or store to store.

BODINE TYPE N.C.I. GEARED MOTOR



(Type 1) 71 r.p.m. Torque 10lb. inch. Reversible. 1/70th h.p. 50 cycle, 0·38 amp (Type 2) 28 r.p.m. Torque 20lb inch. Reversible. 1/80th h.p., 50 cycle, 0·28 amp. "As new" condition. Input voltage of motor 115V a.c. Supplied complete with transformer for 230/240V a.c. input. Price, either type £3·15 plus 35p P. & P. or less transformer £2·13 plus 27p P. & P.

12 VOLT DC MOTOR



Powerful 1 amp. REVERSIBLE motor. Speed 3,750 RPM complete with external gear train (removable) giving final speed of approx. 125 RPM. Size 4½" × 2½" dia. Price 95p inc. post.

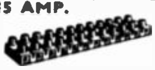
230V/240V COMPACT SYNCHRONOUS GEARED MOTORS

Manufactured by either Sangamo, Haydon or Smith. Built-in gearbox.

1 R.P.M. cw	1 R.P.H. A/cw	10 R.P.H. A/cw
	2 R.P.H. cw	15 R.P.H. A/cw
60 R.P.M. cw	3 R.P.H. A/cw	20 R.P.H. cw
	6 R.P.H. cw	30 R.P.H. cw

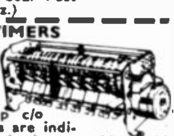
cw = Clockwise.
A/cw = Anti-clockwise rotation.
Fraction of makers' price. All at 75p incl. P.&P.

G.E.C. 12 WAY 15 AMP. CONNECTORS



NEW in maker's carton.
BAKELITE £1·25 per doz.
FLEXIBLE £1·50 per doz. Post paid (Minimum 1 doz.)

PROGRAMME TIMERS



(Mfr. by 'Magnetic Devices Ltd.') 240v A.C. 5 r.p.m. 'Crouzet' motor. Drives 15 cams, each operating a 10 amp c/o micro switch. Cams are individually variable, allowing innumerable combinations. Ideally suited for machinery control, automation, etc. Also in the field of entertainment, for chaser lights, animated displays, etc. NEW PRICE: £5·75. P. & P. 25p.

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200/250V Ex. GPO. Tested. Manually set 2 on, 2 off every 24h. Override switch: 10A £2·75, 15A £3·25, 20A £3·75. P. & P. 20p. Also available with solar dial ON dusk, OFF dawn. Price as above.

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5 amp c/o contacts. Fitted with removable push button assembly. Ex. P.O. 20 for £1 inc. post. (Min. order 20)

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INPUT 230/140V a.c. 50/60 OUTPUT VARIABLE 0-260V
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SHROUDED TYPE

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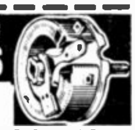
5 amp, £11·75
10 amp, £22·50   20 amp, £49·00
15 amp, £25·00   25 amp, £58·00
37·5 amp. £82·00   50 amp, £98·00
All plus £1·00 carr. where not specified.

OPEN TYPE (Panel Mounting) ½ amp. £4·75.
1 amp, £7.00 2½ amp. £8·05. Carr. 40p on open type.

Superior Quality Precision Made NEW POWER RHEOSTATS



100 WATT. 1 ohm, 10A; 5 ohm, 4·7A; 10 ohm, 3A; 25 ohm, 2A; 50 ohm, 1·4A; 100 ohm, 1A; 250 ohm, 0·7A; 500 ohm, 0·45A; 1 kΩ, 280 mA; 1·5 kΩ, 230mA; 2·5 kΩ, 2A; 5 kΩ, 140 mA. Diameter 3½in Shaft length ⅝in, dia. ¼in. All at £1·50 each. P. & P. 5p.

50 WATT. 1/5/10/25/50/100/250/500/1/1·5/2·5/5kΩ. All at £1·12 each. P. & P. 11p.

25 WATT. 10/25/50/100/250/500/1/1·5/2·5/3·5/5kΩ. All at 78p each. P. & P. 15p.

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Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation.

EXPERIMENTERS' ECONOMY KIT
Speed adjustable 1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions £6·30, plus 25p P. & P.

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This strobe has been designed and produced for use in large rooms, halls and the photographic field and utilises a silica plug-in tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. Speed adjustable 0-30 f.p.s. Light output approx. 4 joules. £12·00. P. & P. 50p.

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45	6–9	2 HD M	50p	700	15–35	2 c/o HD	73p*
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280	9–12	2 c/o	73p*	1,250	24–36	4 c/o	63p*
600	18–32	4 c/o	78p*	2,500	36–45	6M	63p*
700	16–24	4M 2B	63p*	2,400	30–48	4 c/o	50p
700	16–24	4 c/o	78p*	9,000	40–70	2 c/o	50p*
700	12–24	2 c/o	63p*	15k	85–110	6M	50p*

(1) Coil ohms; (2) Working d.c. volts; (3) Contracts; (4) Price (HD) Heavy Duty. All Post Paid. *Including Base.

12 VOLT D.C. RELAY
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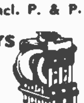

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PANELS with 2 power transistors similar to OC28 on each board—components 2 boards (4 × OC28) 50p, P. & P. 6p.

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8 lead I.C.   1 off 50p.   50 off 25p.
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250 MIXED RESISTORS 62p
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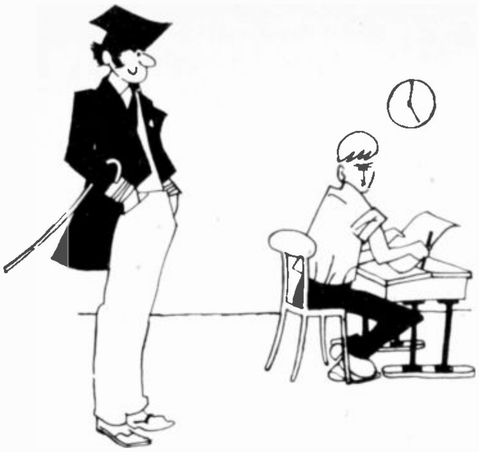


TEACH-IN
Half term test

It is always fun to prove to yourself how much you know, hence we have devised this test at the half way point of Teach-In. Do not worry if you are unable to answer all the questions, it simply means that you have not taken in all the information we have given. We will publish full answers next month so **do not write to us** with your answers or queries.

We have tried to set the sort of questions that will probably come up when you are actually involved in sorting out practical designs. Ultimately you ought to be able to answer them all from memory of the principles involved.

(1) In an electric circuit do **electrons** flow from the positive to the negative terminal of the battery or vice versa?

(2) Which of the following abbreviations are used to describe the magnitude of current:
(a) mV, (b) μA, (c) pF, (d) μF, (e) A, (f) nV, (g) kΩ.

(3) What would you expect the potential difference across a 2·2 kilohm resistor to be if 0·01 amperes were flowing through it.

(4) We can make a voltmeter by putting a resistor in series with a sensitive ammeter. Does it matter if the resistor is connected between the positive terminal of the meter and the battery's positive terminal or between the respective negative terminals?

(5) What current do you think would be flowing through R1 in Fig. 1? If you put another resistor in parallel with R2 would the current through R1 increase or decrease?

(6) What would be the minimum power rating of devices you would use for R1, R2 and R3 shown in Fig. 2?

(7) What would be the maximum power dissipation of the potentiometer shown in Fig. 3?

(8) The colour codes on resistors are as follows: what are the ohmic values and tolerances?
(a) Yellow, Violet, Red, Silver.
(b) Red, Red, Orange, Gold.
(c) Brown, Black, Yellow, Silver.

(9) Generally speaking if you wanted a 16μF electrolytic capacitor having a working voltage of 25V and the shopkeeper did not have one exactly as specified; which of the following alternatives would you choose as being the most suitable.
(a) 16μF 12V, (b) 20μF 40V, (c) 20μF 15V, (d) 12μF 25V.

(10) You ask the shopkeeper for a 0·15μF capacitor and he gives you one with no markings other than three coloured bands—reading from the top down to the black band, Brown, Red, Yellow. Would you (a) accept it as being correct, (b) reject it politely?

(11) In Fig. 4 which capacitor will charge up fastest when the switch is closed C1, C2 or C3?

(12) Again in Fig. 4 which capacitor will take the longest time to charge?

(13) Is D1 in Fig. 5 forward or reverse biased?

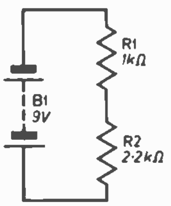
(14) In Fig. 6 S1 is a reversing switch that effectively changes the polarity of the supply voltage from the battery. Assuming it can be set in either position calculate the peak reverse breakdown voltage and forward current the diode D1 must be capable of withstanding.

(15) If a design called for a diode having a peak inverse voltage of 75V and a forward current of 0·1 amperes; which of the following specified devices could be used with safety?

	Reverse voltage	Forward current
(a)	100V	50 mA
(b)	50V	50 mA
(c)	50V	150 mA
(d)	100V	150 mA

(16) If D1 in Fig. 5 was a silicon device and you measured the voltage across it with a high resistance voltmeter; would you expect the voltmeter to read:
(a) 9V, (b) 0·6V, (c) zero volts?

1



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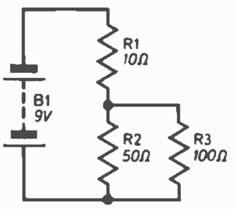

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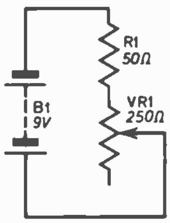

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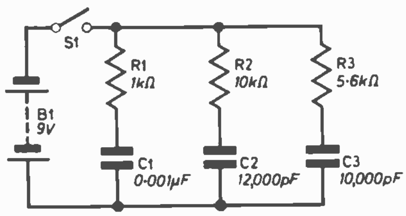

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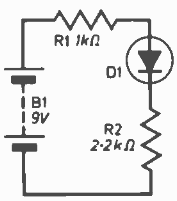

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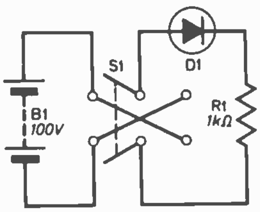
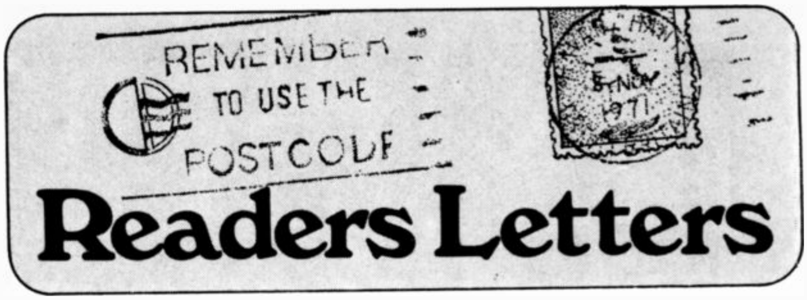




Readers Letters

From Abroad

I have now had the first three issues of your publication and find it very interesting. They are on sale here exactly a month after publication, which seems a long time. Also it is difficult to get the required components as we only have one stockist in town. Is it possible to have a parcel of all components for a project sent direct from England?

I have made the *Demo Deck* and tried the experiments on page 151, January EVERYDAY ELECTRONICS. According to your diagrams the positive terminal of the meter is connected to the positive terminal of the battery. By doing this I find the needle shooting across the dial of the meter. However, by connecting the positive battery terminal to the resistors then to the meter positive terminal I get the correct readings.

If the current goes from positive to negative then surely the resistors should come before the meter, and if this is the case, then the positive sign on the diagrams should be on the other side of the battery. Please explain.

D. A. Watson
South Africa.

It would seem that you have inadvertantly connected your Demo Deck *meter across the battery with no resistors in circuit. As the current flows around the whole circuit from positive to negative battery terminals and the resistors merely limit the flow it does not matter where in the circuit they are.*

Thanks for a great new magazine, will be making most of your projects shown. Envy your low low prices. OC71 costs £3 here!!!!

J. Koppard
Wellington, N. Zealand.

At those prices it may be cheaper to buy from one of the British suppliers. Unfortunately we are unable to show the beautiful grass-skirted Tahitian girl on the front of the postcard from this reader!

Constructive—Helpful!

As a regular subscriber to "big brother" *Practical Electronics*, permit me to add my quota of appreciation of particular features in the welcome appearance of the new member of the "practicals" family.

First, I note the very commendable provision of space for readers' letters. The growth of such a feature can provide a fraternal, club-like air. Both constructive and controversial writers therein can be respectively helpful or entertaining.

Myself an octogenarian who has followed the present hobby since the first days of the crystal detector and early usage of the now archaic term "wireless", which many qualified speakers and writers still use, I would like here to submit a small specially chosen item appropriate to the purpose of the *Teach-In* feature. It is with reference to the definition of alternating current as frequently seen in text books and other sources of instruction in basic electricity.

The virtually stereotype explanation says, "a current which flows this way and then that." To the uninformed, the nature of such expression at once conveys a relatively slow change without a precise frequency as required for practical use.

Still, with newcomers and beginners in mind, I would like here to repeat my comment, earlier published in *Practical Electronics*, which deplored the continued proliferation of semiconductors listed by retailers.

With every sympathy and understanding of the advertisers' problems in this matter, a list of over one thousand code markings for the identity of the devices being offered will serve only those readers who already know precisely that which they require. They may at the same time be aware of the many equivalents given in a list. It follows therefore that the ordinary active amateur constructor is saved frustration only by the authors of the constructional projects stipulating not only the preferred type of device, but also where possible, other alternatives, all of which point to the need for progressive enthusiasts to avail themselves of comprehensive data on solid-state products.

In good humour and intention, I now turn to the question of two essentially familiar components—variable resistors and capacitors. The more experienced followers of the electronics cult must have noticed that many suppliers who regardless of its specific use, persist in calling the former article a "volume control", while others continue to call the latter "condensors" or "condensers".

Lastly, for those who may not be aware, there is an excellently produced, colour illustrated, twenty-four page booklet issued by Joseph Lucas Ltd. under the title, "The Story of Semiconductors." Whether one knows it all or not, the lucid manner of presentation is a pleasure to read. To conclude, do I hear electronically simulated laughter at my laboured views?

P. Ashdown
Cheshire.

No laughter from us! We hope our booklet in the next issue will help with transistor data.

Commercial Equipment

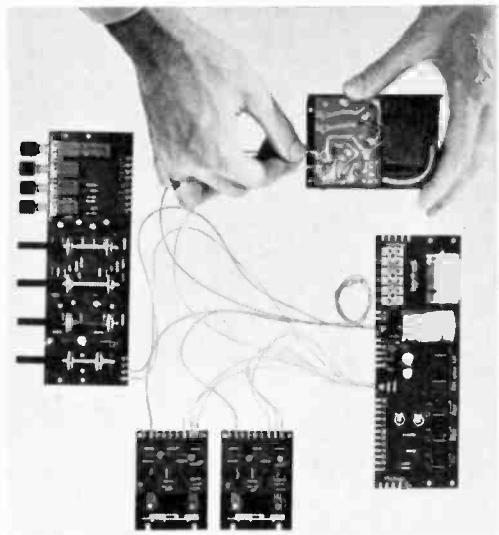
I have followed with interest your magazine since the first issue and have found it most helpful and informative. Your *Teach-In* articles are an excellent idea, and in particular I would commend the *Shop Talk* articles. These fulfil the purpose of providing the newcomer with what he needs to know about component buying, something that other magazines seem to think he knows already.

However, there is one "gap" I think you could yet fill. Your projects at present are all on the same theme—construction of simple self-contained electronic devices.

No doubt many readers are interested in these, in particular the devices for cars such as the *Auto Alert* I would consider most useful since it is not easy to obtain proprietary devices at reasonable cost to serve the same purpose. But I would be interested to see some articles about ordinary household apparatus, and simple repairs and modifications to them. For instance: What common faults can one expect to develop in a radio set and how can one deal with them?

How can one suppress electrical apparatus that is causing interference. How to fit a socket to a television set to make tape

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.,
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Specifications

Output – 30 watts music power (10 watts per channel R.M.S. into 3 Ω).
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

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for which I enclose £29.95 cheque/money order/cash. **E.E.6B**

recordings from the sound channel? How does one acquire circuit diagrams and service sheets for radio sets etc?

Another point in the diagrams accompanying the projects, the dimensions in inches, quarters and eighths strike me as a bit archaic, in view of the fact that most of the electronics industry works in metric units. If you must use inches, could you not use decimal fractions, e.g. 2·7in.

Finally, I would like to record my appreciation of the excellent drawings, photographs and general layout of the magazine.

Wishing your magazine every success,

M. D. McMahon
Middlesbrough.

The subject of servicing, repair and alteration of commercial equipment is a vast one and often individual items must be described separately. Thus we cannot and will not be able to cover such subjects.

Taking your point about metric measurement, we feel that most readers would prefer to use the conventional system, but we are always pleased to receive comment—so what do other readers feel?

When I saw the title of your magazine on the bookstall I—foolishly as it turned out—assumed that it would contain some reference to "electronic-flash" a piece of apparatus used by thousands of photographers both amateur and professional.

But nowhere in your pages—either editorial or advertisement—is there the slightest hint that such things as flash-guns exist. Of course your magazine is not the only offender. I wonder whether there is some conspiracy to keep circuit diagrams and maintenance of electronic flash systems out of reach of the public so that "repairers" can go on fleecing us.

As you undoubtedly know there is a tremendous sale on these relatively simple pieces of equipment. Consequently there must be many people like myself who use them and would welcome some details of construction and maintenance and the names of suppliers who could provide the necessary components.

I do not know whether my letter is useful as a contribution to your letters from readers page.

H. A. Williams
Swansea.

Designs for flash guns are within our scope but supply of the flash tubes is not so easy at present. We are not able to cover the design and maintenance of commercial flash guns.

Capacitors

I have just completed my first circuit—your *Snap Sequence Indicator*—and, guess what? It worked! Thanks mainly to your helpful *Teach-In* series.

As a complete beginner I have managed to understand what has been said so far, but then came Capacitors and there my enthusiasm cooled down a bit.

I am not mathematically-minded and think it would be helpful if you printed a few sums in full to show how to arrive at for example, 0·01μF., as I am not sure how to change pF's into μF's etc. Also I have not seen nF on a capacitor but in my catalogue a lot of capacitors are shown in mF. Please advise me what this stands for as I can find no mention of same in your *Teach-In* series.

Please could you advise me whether metallised polyester capacitors are suitable for all applications where electrolytic capacitors are not specified.

I hope you may be able to consider this letter for your letter page as I am sure there are a lot of home-constructors who, like me, find looking for the right capacitor in a catalogue extremely difficult owing to the wide range of types, voltages, etc. available.

B. Way
Isle of Wight.

Capacitors are usually designated in μF, nF and pF, these are millionths of Farads (÷1,000,000) thousandths of millionths of Farads (÷1,000,000,000) and billionths of Farads (÷1,000,000,000,000). Thus to change from pF to μF divide by 1,000,000; hence 10,000pF = 0·01μF. To change from μF to pF multiply by 1,000,000; hence 0·15μF = 150,000 pF. The use of nF is rather restricted and will probably be seldom encountered. If a manufacturer or supplier quotes mF he means μF.

Metallised polyester types are suitable for all our projects unless specific types are given and providing the specified value is available.

Q. and A.

As a follow up to D. Hill's letter in the February issue of EVERYDAY ELECTRONICS, I wish to endorse his suggestion of a Question and Answers section. *Readers' Letters* and *Shop Talk* are most helpful, but with a Question and Answer section short and to the point, more information could be conveyed, e.g. your abbreviations section is a perfect example as, to a beginner such as myself, a quotation such as s.r.b.p. is double dutch.

Belated congratulations on your magazine, which through the *Teach-In* series gives a welcome lead-in to electronics.

W. McLintock
Londonderry, N. Ireland.

It seems that a number of readers would like such a page and we will be looking into the possibility of including this item in future.

No Waa!

I am writing to you to see if you could possibly help me. In this month's edition of EVERYDAY ELECTRONICS, you featured a circuit for a *Waa-Waa Pedal*, which I have built, but unfortunately I cannot get it to function properly. Every time I press the pedal down, all that happens is that I get a very slight increase in volume, and when I bring the pedal back, I get a slight decrease in volume.

I have checked the circuit that many times now that I am beginning to give up hope.

R. Templeton
Melton Mowbray.

If you have checked out the circuit, paying special attention to transistor lead connections and capacitor polarities, and everything is correct, then we suggest that you experiment with the value of capacitor C2 (part of the filter network) as its value is critical.

If, for example, its value is too low due to a high tolerance figure, then the peak of the filter characteristic curve, Fig. 1 will be at too high a frequency—beyond or at the top end of the guitar upper scale.

Try increasing the value of C2 in small steps. This can be done by placing a capacitor across the one already in circuit. Capacitors in parallel are additive.

Astron

May I as a complete stranger to the world of electronics, congratulate you on your magazine EVERYDAY ELECTRONICS. I have followed with interest your magazine from its conception, especially your *Teach-In*. I dared not experiment with anything you published in case I made a hash of it But after following your instructions on how to build the *Astron* radio I was honestly surprised with the results I achieved.

James McFadden
Belfast.

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100µA	£3·20	300V. D.C.	£3·10
100-0-100µA	£3·45	1 amp. D.C.	£3·10
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1mA	£3·10	300V. A.C.	£3·10
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1mA	£2·60	VU Meter	£3·37
20V. D.C.	£2·60		

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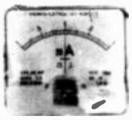

50µA	£3·60	50mA	£2·80
50-0-50µA	£3·10	100mA	£2·80
100µA	£3·10	500mA	£2·80
100-0-100µA	£3·00	1 amp.	£2·80
200µA	£3·00	5 amp.	£2·80
500µA	£2·90	15 amp.	£2·80
500-0-500µA	£2·80	30 amp.	£2·80
1mA	£2·80	20V. D.C.	£2·80
1-0-1mA	£2·80	50V. D.C.	£2·80
5mA	£2·80	150V. D.C.	£2·80
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100µA	£2·60	50V. D.C.	£2·00
100-0-100µA	£2·50	300V. D.C.	£2·00
500µA	£2·30	15V. A.C.*	£2·10
1mA	£2·00	300V. A.C.*	£2·10
5mA	£2·00	8 Meter 1mA	£2·10
10mA	£2·00	VU Meter	£2·30
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.65P. 3½in. × 3¼in. fronts.

50µA	£2·87	10V. D.C.	£2·20
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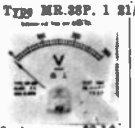
100µA	£2·75	50V. D.C.	£2·20
100-0-100µA	£2·65	150V. D.C.	£2·20
200µA	£2·65	300V. D.C.	£2·20
500µA	£2·40	15V. A.C.*	£2·30
500-0-500µA	£2·20	50V. A.C.*	£2·30
1mA	£2·20	150V. A.C.	£2·30
5mA	£2·20	300V. A.C.	£2·30
10mA	£2·20	500V. A.C.	£2·30
50mA	£2·20	8 Meter 1mA	£2·37
100mA	£2·20	VU Meter	£2·87
500mA	£2·20	50mA A.C.*	£2·20
1 amp.	£2·20	100mA A.C.*	£2·20
5 amp.	£2·20	200mA A.C.*	£2·20
10 amp.	£2·20	500mA A.C.*	£2·20
15 amp.	£2·20	1 amp. A.C.*	£2·20
20 amp.	£2·20	5 amp. A.C.*	£2·20
30 amp.	£2·30	10 amp. A.C.*	£2·20
50 amp.	£2·50	20 amp. A.C.*	£2·20
5V. D.C.	£2·20	30 amp. A.C.*	£2·20

Type MR.38P. 1 21/32in. square fronts.



50µA	£2·10	200mA	£1·60
50-0-50µA	£1·90	300mA	£1·60
100µA	£1·90	500mA	£1·60
100-0-100µA	£1·75	750mA	£1·60
200µA	£1·75	1 amp.	£1·60
500µA	£1·65	2 amp.	£1·60
500-0-500µA	£1·60	5 amp.	£1·60
1mA	£1·60	10 amp.	£1·60
1-0-1mA	£1·60	3V. D.C.	£1·60
2mA	£1·60	10V. D.C.	£1·60
5mA	£1·60	15V. D.C.	£1·60
10mA	£1·60	20V. D.C.	£1·60
20mA	£1·60	100V. D.C.	£1·60
50mA	£1·60	150V. D.C.	£1·60
100mA	£1·60	300V. D.C.	£1·60
150mA	£1·60	500V. D.C.	£1·60
		750V. D.C.	£1·60
		15V. A.C.	£1·70
		50V. A.C.	£1·70
		150V. A.C.	£1·70
		300V. A.C.	£1·70
		500V. A.C.	£1·70
		8 Meter 1mA	£1·70
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100µA	£2·10	20V. D.C.	£1·50
100-0-100µA	£1·87	50V. D.C.	£1·50
200µA	£1·87	300V. D.C.	£1·50
500µA	£1·75	15V. A.C.	£1·80
500-0-500µA	£1·70	300V. A.C.	£1·80
1mA	£1·70	8 Meter 1mA	£1·85
5mA	£1·70	VU Meter	£2·25
10mA	£1·70	1 amp. A.C.*	£1·70
50mA	£1·70	5 amp. A.C.*	£1·70
100mA	£1·70	10 amp. A.C.*	£1·70
500mA	£1·70	20 amp. A.C.*	£1·70
1 amp	£1·70	30 amp. A.C.*	£1·70

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50-0-50µA	£2·35	5 amp.	£1·95
100µA	£2·35	15 amp.	£1·95
100-0-100µA	£2·25	30 amp.	£1·95
500µA	£2·20	50 amp.	£1·95
1mA	£1·95	5V. D.C.	£1·95
1-0-1mA	£1·95	10V. D.C.	£1·95
5mA	£1·95	20V. D.C.	£1·95
10mA	£1·95	50V. D.C.	£1·95
50mA	£1·95	150V. D.C.	£1·95
100mA	£1·95	300V. D.C.	£1·95
500mA	£1·95	30V. A.C.*	£1·95
		50V. A.C.*	£1·95
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		300V. A.C.*	£1·95
		500mA A.C.*	£1·95
		1 amp. A.C.*	£1·95
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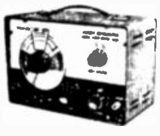

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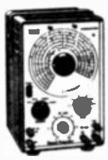

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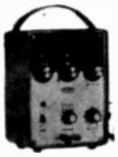

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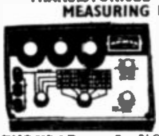

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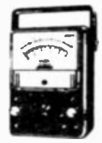

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2G301	20p	2N3417	37p	2S102	25p	BC116	15p	BFX12	22p	NKT224	22p
2G302	20p	2N3439	130p	2S103	25p	BC118	15p	BFX13	22p	NKT225	22p
2G303	20p	2N3440	97p	2S104	25p	BC119	30p	BFX29	25p	NKT229	30p
2G306	30p	2N3564	17p	2S301	50p	BC121	20p	BFX30	25p	NKT237	35p
2G308	30p	2N3565	15p	2S302	50p	BC122	20p	BFX37	30p	NKT238	25p
2G309	30p	2N3566	22p	2S303	60p	BC125	15p	BFX44	37p	NKT240	27p
2G371	15p	2N3568	25p	2S304	75p	BC126	25p	BFX68	67p	NKT241	27p
2G374	20p	2N3569	25p	2S501	32p	BC134	12p	BFX84	25p	NKT242	20p
2G381	22p	2N3570	125p	2S502	35p	BC135	12p	BFX85	30p	NKT243	62p
2N388A	49p	2N3572	97p	2S503	27p	BC136	15p	BFX86	25p	NKT244	17p
2N404	20p	2N3605	27p	3N83	40p	BC137	15p	BFX87	25p	NKT245	20p
2N696	15p	2N3606	27p	3N128	70p	BC138	20p	BFX88	20p	NKT261	20p
2N697	15p	2N3607	22p	3N140	77p	BC140	35p	BFX89	62p	NKT262	30p
2N698	25p	2N3638	18p	3N141	72p	BC141	35p	BFX93A	70p	NKT264	20p
2N699	30p	2N3638A	20p	3N142	55p	BC147	10p	BFY11	42p	NKT271	20p
2N706	10p	2N3641	18p	3N143	60p	BC148	10p	BFY18	25p	NKT262	20p
2N706A	12p	2N3642	18p	3N152	87p	BC149	12p	BFY19	25p	NKT274	20p
2N708	15p	2N3643	20p	40050	55p	BC152	17p	BFY21	42p	NKT275	20p
2N709	45p	2N3644	25p	40250	50p	BC153	20p	BFY24	45p	NKT278	25p
2N718	25p	2N3645	25p	40251	32p	BC154	20p	BFY29	40p	NKT281	27p
2N718A	30p	2N3691	15p	40309	32p	BC157	15p	BFY30	40p	NKT401	87p
2N726	25p	2N3692	18p	40310	45p	BC158	11p	BFY41	50p	NKT402	90p
2N727	25p	2N3693	15p	40311	35p	BC159	12p	BFY43	62p	MKT403	75p
2N914	17p	2N3694	18p	40312	47p	BC160	35p	BFY50	20p	NKT404	55p
2N916	17p	2N3702	10p	40314	37p	BC167	11p	BFY51	20p	NKT405	75p
2N918	30p	2N3703	10p	40315	37p	BC168B	12p	BFY52	20p	NKT406	62p
2N929	22p	2N3704	12p	40316	47p	BC168C	15p	BFY53	15p	NKT451	62p
2N930	20p	2N3705	10p	40317	37p	BC169B	14p	BFY56A	57p	NKT452	62p
2N987	52p	2N3706	10p	40319	55p	BC169C	15p	BFY76	42p	NKT453	47p
2N1090	22p	2N3707	12p	40320	47p	BC170	12p	BFY77	57p	NKT713	20p
2N1091	22p	2N3708	10p	40323	32p	BC171	15p	BFY90	65p	NKT717	42p
2N1131	25p	2N3709	10p	40324	47p	BC172	15p	BSX19	17p	NKT734	27p
2N1132	25p	2N3710	10p	40326	37p	BC175	22p	BSX20	15p	NKT736	35p
2N1302	17p	2N3711	10p	40329	30p	BC177	20p	BSX21	20p	NKT773	25p
2N1303	17p	2N3713	187p	40344	27p	BC178	20p	BSX26	45p	NKT781	30p
2N1304	22p	2N3714	200p	40347	57p	BC179	20p	BSX27	47p	OC16	50p
2N1305	22p	2N3715	220p	40348	52p	BC182	12p	BSX28	32p	OC19	37p
2N1306	25p	2N3716	265p	40360	40p	BC182L	10p	BSX60	82p	OC20	85p
2N1307	25p	2N3773	240p	40361	40p	BC183	9p	BSX61	62p	OC22	50p
2N1308	25p	2N3791	275p	40362	50p	BC183L	9p	BSX76	15p	OC23	60p
2N1309	25p	2N3819	34p	40370	32p	BC184	11p	BSX77	20p	OC24	60p
2N1507	17p	2N3820	55p	40406	57p	BC184L	11p	BSX78	25p	OC25	40p
2N1613	20p	2N3823	50p	40407	40p	BC186	25p	BSY24	15p	OC26	25p
2N1631	35p	2N3854	27p	40408	52p	BC187	27p	BSY25	15p	OC28	60p
2N1632	30p	2N3854A	27p	40409	55p	BC212L	12p	BSY26	17p	OC29	60p
2N1637	30p	2N3855	27p	40410	62p	BC213L	12p	BSY27	15p	OC35	50p
2N1638	27p	2N3855A	30p	40412	50p	BC214L	15p	BSY28	17p	OC36	60p
2N1639	27p	2N3856	30p	40467A	57p	BCY10	27p	BSY29	17p	OC41	22p
2N1701	165p	2N3856A	35p	40468A	35p	BCY30	30p	BSY32	25p	OC42	40p
2N1711	24p	2N3858	25p	40528	72p	BCY31	40p	BSY36	25p	OC44	15p
2N1889	32p	2N3858A	30p	40600	57p	BCY32	60p	BSY37	25p	OC45	12p
2N1893	37p	2N3859	27p	40603	50p	BCY33	30p	BSY38	20p	OC46	15p
2N2147	72p	2N3859A	32p	AC107	30p	BCY34	35p	BSY39	22p	OC70	15p
2N2160	57p	2N3860	30p	AC126	20p	BCY38	45p	BSY43	50p	OC71	12p
2N2193	40p	2N3866	150p	AC127	24p	BCY39	60p	BSY51	32p	OC72	12p
2N2193A	42p	2N3877	40p	AC128	20p	BCY40	50p	BSY52	32p	OC73	30p
2N2194	27p	2N3877A	40p	AC151	18p	BCY41	15p	BSY53	37p	OC74	30p
2N2194A	30p	2N3900	37p	AC152	22p	BCY42	15p	BSY54	40p	OC75	25p
2N2217	25p	2N3900A	40p	AC154	22p	BCY43	15p	BSY56	90p	OC76	25p
2N2218	20p	2N3901	97p	AC176	20p	BCY54	32p	BSY79	45p	OC77	40p
2N2219	20p	2N3903	20p	AC187	25p	BCY58	22p	BSY90	57p	OC78	20p
2N2220	25p	2N3904	25p	AC188	25p	BCY59	22p	BSY95A	12p	OC81	20p
2N2221	25p	2N3905	30p	ACY17	27p	BCY60	97p	C424	15p	OC81D	20p
2N2222	20p	2N3906	25p	ACY18	24p	BCY70	15p	C450	15p	OC82	25p
2N2222A	25p	2N4058	12p	ACY19	24p	BCY71	20p	GET102	35p	OC82D	15p
2N2297	30p	2N4059	10p	ACY20	20p	BCY72	15p	GET113	25p	OC83	25p
2N2368	15p	2N4060	12p	ACY21	20p	BCY78	30p	GET114	20p	OC84	25p
2N2369	15p	2N4061	12p	ACY22	10p	BCY79	30p	GET118	20p	OC139	25p
2N2369A	15p	2N4062	12p	ACY28	17p	BCZ10	27p	GET120	25p	OC140	40p
2N2410	42p	2N4244	47p	ACY39	47p	BCZ11	40p	GET873	12p	OC170	25p
2N2483	27p	2N4248	15p	ACY40	14p	BD112	50p	GET880	45p	OC171	30p
2N2484	32p	2N4249	15p	ACY41	15p	BD116	112p	GET887	15p	OC200	40p
2N2539	22p	2N4250	18p	ACY44	25p	BD121	65p	GET889	22p	OC201	75p
2N2540	22p	2N4254	42p	AD140	47p	BD123	80p	GET890	22p	OC202	80p
2N2613	35p	2N4255	42p	AD149	47p	BD124	75p	GET896	22p	OC203	40p
2N2614	30p	2M4284	17p	AD150	62p	BD131	75p	GET897	22p	OC204	40p
2N2646	47p	2N4285	17p	AD161	35p	BD132	80p	GET898	22p	OC205	75p
2N2711	25p	2N4286	17p	AD162	35p	BDY10	125p	MAT100	25p	OC206	95p
2N2712	25p	2N4287	17p	AF109	45p	BDY20	105p	MAT101	25p	OC207	75p
2N2713	27p	2N4288	15p	AF114	25p	BDY61	125p	MAT120	25p	OCP71	42p
2N2714	30p	2N4289	12p	AF115	25p	BDY62	100p	MAT121	25p	ORP12	50p
2N2904	20p	2N4290	12p	AF116	25p	BF115	25p	MJ400	107p	ORP60	40p
2N2904A	25p	2N4291	15p	AF117	20p	BF117	47p	MJ420	80p	ORP61	42p
2N2905	25p	2N4292	15p	AF118	44p	BF152	28p	MJ421	80p	P346A	22p
2N2905A	20p	2N4294	17p	AF121	30p	BF154	20p	MJ430	102p	ST140	15p
2N2906	20p	2N4303	47p	AF124	22p	BF158	15p	MJ440	95p	ST141	20p
2N2906A	25p	2N4964	15p	AF125	19p	BF159	35p	MJ480	97p	TI834	62p
2N2907	23p	2N4965	18p	AF126	16p	BF163	35p	MJ481	125p	TI843	40p
2N2923	15p	2N5027	52p	AF127	16p	BF167	25p	MJ490	100p	TI844	12p
2N2924	15p	2N5028	57p	AF139	28p	BF170	33p	MJ491	137p	TI845	12p
2N2925	15p	2N5029	47p	AF178	42p	BF173	30p	MJE340	50p	TI846	12p
2N2926G	12p	2N5030	42p	AF179	45p	BF177	30p	MJE370	80p	TI847	12p
2N2926O	12p	2N5172	12p	AF180	50p	BF178	25p	MJE371	80p	TI848	12p
2N2926Y	12p	2N5174	52p	AF181	40p	BF179	30p	MJE520	75p	TI849	12p
2N3011	20p	2N5175	52p	AF186	39p	BF180	35p	MJE521	70p	TI850	12p
2N3014	25p	2N5176	45p	AF239	30p	BF181	35p	MPF102	42p	TI851	10p
2N3053	20p	2N5232A	30p	AF279	47p	BF182	30p	MPF103	35p	TI852	11p
2N3054	49p	2N5245	45p	AF280	47p	BF184	20p	MPF104	37p	TI853	22p
2N3055	72p	2N5246	42p	AFZ11	32p	BF185	20p	MPF105	37p	XB112	22p
2N3133	25p	2N5249	67p	ASY26	25p	BF194	15p	MPS3638	32p	XC141	35p
2N3134	30p	2N5265	325p	ASY27	30p	BF195	15p	NKT124	42p	ZTX107	15p
2N3135	25p	2N5305	37p	ASY28	24p	BF196	15p	NKT125	27p	ZTX108	12p
2N3136	25p	2N5306	40p	ASY29	27p	BF197	15p	NKT126	27p	ZTX109	15p
2N3390	25p	2N5307	37p	ASY50	25p	BF198	15p	NKT128	27p	ZTX300	15p
2N3391	20p	2N5308	37p	ASY51	32p	BF200	35p	NKT135	27p	ZTX301	15p
2N3391A	30p	2N5309	62p	ASY54	25p	BF224	14p	NKT137	32p	ZTX302	20p
2N3392	17p	2N5310	42p	ASY67	45p	BF225	19p	NKT210	30p	ZTX303	20p
2N3393	15p	2N5354	27p	ASY86	32p	BF237	22p	NKT211	30p	ZTX304	25p
2N3394	15p	2N5355	27p	ASZ21	51p	BF238	22p	NKT212	30p	ZTX500	15p
2N3402	22p	2N5356	32p	AUY10	150p	BF244	32p	NKT213	30p	ZTX501	15p
2N3403	22p	2N5365	47p	BC107	10p	BFW61	47p	NKT214	20p	ZTX502	20p
2N3404	32p	2N5366	32p	BC108	10p	BFW87	25p	NKT215	22p	ZTX503	17p
2N3405	45p	2N5367	57p	BC109	10p	BFW88	23p	NKT216	35p	ZTX504	40p
2N3414	22p	2N5457	30p	BC113	10p	BFW89	20p	NKT217	40p	ZTX531	25p

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CA3020A		FJJ121	60p	SN7474	40p
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CA3021	156p	FJJ141	125p	SN7476	45p
CA3022	130p	FJJ181	75p	SN7483	87p
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CA3026	100p	FJJ211	125p	SN7490	87p
CA3028A	74p	FJJ251	125p	SN7492	87p
CA3028B		FJL101	125p	SN7493	87p
	105p	FJY101	25p	SN7495	87p
CA3029	87p	IC10	250p	SN7496	87p
CA3029A		IC12	250p	SN74107	52p
	165p	L900	40p	SN74153	
CA3030	137p	L914	40p		140p
CA3035	122p	L923	40p	SN74154	
CA3036	72p	MC724P	60p		220p
CA3039	82p	MC780P	247p	SN74160	
CA3041	109p	MC788P	146p		180p
CA3042	109p	MC790P	124p	SN74161	
CA3043	137p	MC792P	66p		260p
CA3044	120p	MC799P	66p	SN74164	
CA3045	122p	MC1303L			220p
CA3046	81p		200p	SN74165	
CA3047	137p	MC1304P			225p
CA3048	204p		225p	SN74192	
CA3049	160p	MC1305P			175p
CA3050	185p		386p	SN74193	
CA3051	134p	MC838P			175p
CA3052	165p		549p	TAA241	
CA3053	46p	MC1435P			162p
CA3054	109p		345p	TAA242	
CA3055	240p	MC1552G			425p
CA3059	165p		461p	TAA243	150p
CA3064	120p	MC1709CG		TAA263	75p
FCH101	85p		94p	TAA293	97p
FCH111	105p	MFC4000P		TAA300	175p
FCH121	105p		75p	TAA310	125p
FCH131	50p	PA222	260p	TAA320	72p
FCH141	105p	PA230	140p	TAA350	175p
FCH151	105p	PA234	92p	TAA435	147p
FCH161	50p	PA237	210p	TAA521	132p
FCH171	105p	PA246	160p	TAA522	360p
FCH181	105p	PA424	235p	TAA530	495p
FCH191	105p	PA264	190p	TAA811	445p
FCH201	130p	PA265	200p	TAB101	97p
FCH211	130p	SN7400	20p	TAD100	150p
FCH221	130p	SN7401	20p	TAD110	150p
FCH231	150p	SN7402	20p	SL403D	150p
FCJ101	160p	SN7403	20p	SL702C	147p
FCJ111	150p	SN7404	20p	UA702A	280p
FCJ121	275p	SN7405	20p	UA702C	77p
FCJ131	275p	SN7406	80p	UA703C	137p
FCJ141	525p	SN7408	20p	UA709C	125p
FCJ201	100p	SN7409	20p	UA710C	125p
FCJ211	275p	SN7410	20p	UA716	187p
FCK101	430p	SN7411	23p	UA723C	162p
FCL101	230p	SN7413	30p	UA730C	160p
FCY101	102p	SN7420	20p	UA741C	87p

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400 PIV 2A	75p	50 PIV 6A	62p
		100 PIV 6A	75p
		200 PIV 6A	75p
		400 PIV 6A	100p

SILICON RECTIFIERS MINIATURE WIRE ENDED PLASTIC

	IN SERIES 1 AMP	PL SERIES 1·5 AMP	CL SERIES 3 AMP
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4002 100PIV	7p	9p	20p
4003 200PIV	8p	10p	22p
4004 400PIV	8p	10p	25p
4005 600PIV	10p	12p	26p
4006 800PIV	12p	15p	27p
4007 1000PIV	15p	16p	30p

50 + less 15% 100 + less 20%

SILICON RECTIFIERS STUD MOUNTING

	6A	10A	17·5A	35A
100PIV	—	45p	50p	£1·22
200PIV	25p	50p	55p	£1·42
400PIV	30p	55p	62p	£1·77
600PIV	32p	60p	72p	£2·12
800PIV	35p	75p	87p	£2·47
1000PIV	40p	85p	£1·05	£2·77

50 + less 15% 100 + less 20%

ZENER DIODES

400MW	1·5 WATT	10 WATT
3·3-33 V	2·4—100	3·9—100V
10p each	25p each	40p each

25 + less 15% 100 + less 20%

TRANSISTOR DISCOUNTS:- 12 + 10%; 25 + 15%; 100 + 20% any one type. Postage on all Semi Conductors 7p extra. S.A.E. FOR FULL LISTS.

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6BR8	70p	DK92	55p	PCF806	70p
6BW6	85p	DK96	50p	PCF808	75p
6BW7	80p	DL92	35p	PCL82	35p
6BZ6	40p	DL94	48p	PCL83	65p
6C4	33p	DL96	45p	PCL84	45p
6CD6	125p	DM70	40p	PCL85	40p
6CL6	50p	DY86	32p	PCL86	45p
6CW4	65p	DY87	33p	PFL200	65p
6F1	62p	E88CC	100p	PL36	55p
6F6G	35p	E180F	100p	PL81	50p
6F13	45p	EABC80	35p	PL82	45p
6F14	70p	EAF42	35p	PL83	45p
6F15	65p	EB91	20p	PL84	40p
6F18	50p	EBC41	55p	PL500	75p
6F23	85p	EBC81	30p	PL504	80p
6H6	17p	EBF80	40p	PY32	55p
6J4	50p	EBF83	40p	PY33	63p
6J5	25p	EBF89	32p	PY80	40p
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10F1	75p	EF40	50p	UCC84	49p
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12AT6	30p	EF80	25p	UCH21	60p
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12AU7	30p	EF86	30p	UCH81	40p
12AX7	30p	EF89	28p	UCL82	35p
12AV6	40p	EF91	30p	UCL83	60p
12BA6	40p	EF92	35p	UF41	60p
12BE6	40p	EF183	35p	UF80	35p
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AAZ15	10p	BY103	22p	OA70	10p
BA100	15p	BY122	37p	OA73	10p
BA102	30p	BY124	15p	OA79	10p
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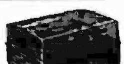

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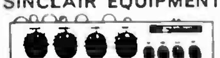

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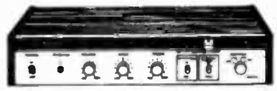

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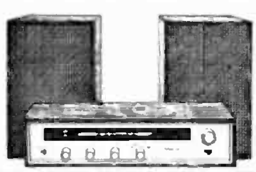

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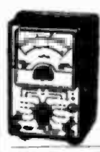

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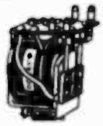

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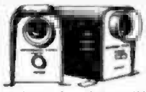

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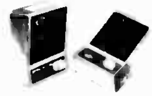

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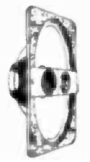

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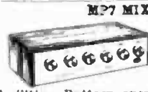

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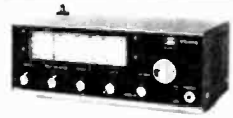

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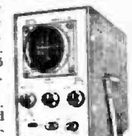

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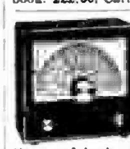

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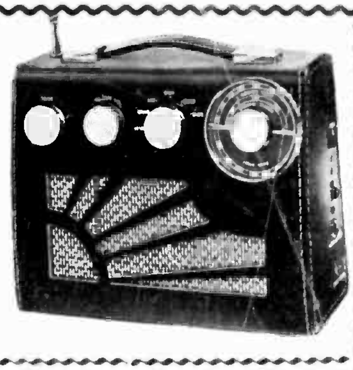

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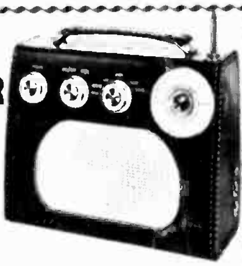

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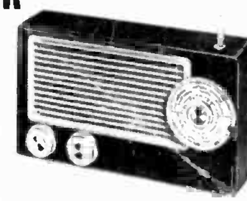

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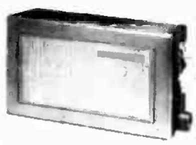

POCKET FIVE

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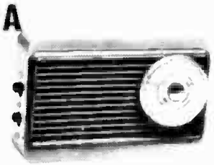

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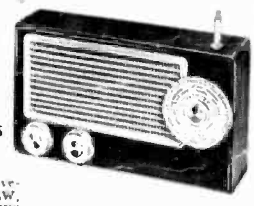

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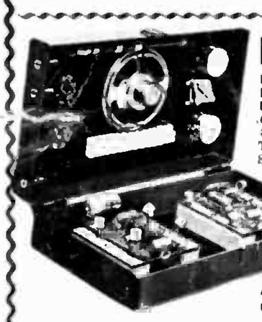

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