EVERYDAY ELECTRONICS

NOVEMBER 1989

INCORPORATING ELECTRONICS MONTHLY

£1.40

EEG BIOFEEDBACK MONITOR
IRON ON REMINDER
VARIABLE POWER SUPPLY UNIT

The Magazine for Electronic & Computer Projects

BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD7 4 In flex switches with neon on/off lights, saves leaving things switched on.
BD9 2 6V 1A mains transformers upright mounting with fixing clamps.
BD11 1 6½in speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
BD13 12 30 watt reed switches, it's surprising what you can make with these—burglar alarms, secret switches, relay, etc., etc.
BD22 2 25 watt loudspeaker two unit crossovers.
BD29 1 B.O.A.C. stereo unit is wonderful breakdown value.
BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day. original cost £40 each.
BD49 10 Neon valves, with series resistor, these make good night lights.
BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD59 2 Flat solenoids—you could make your multi-tester read AC amps with this.
BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD128 10 Very fine drills for pcb boards etc. Normal cost about 80p each.
BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
BD139 6 Microphone inserts—magnetic 400 ohm also act as speakers.
BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149 6 Safety cover for 13A sockets—prevent those inquisitive little fingers getting nasty shocks.
BD180 6 Neon indicators in panel mounting holders with lens.
BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD196 1 in flex simmerstat—keeps your soldering iron etc. always at the ready.
BD199 1 Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201 8 Keyboard switches—made for computers but have many other applications.
BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD242 2 6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
BD252 1 Panostat, controls output of boiling ring from simmer up boil.
BD259 50 Leads with push-on ¼in tags—a must for hook-ups—mains connections etc.
BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
BD283 3 Mild steel boxes approx 3in x 3in x 1in deep—standard electrical.
BD293 50 Mixed silicon diodes.
BD305 1 Tubular dynamic mic with optional table rest.
BD400 4 Books, useful for beginners, describes amplifiers equipment and kit sets.
BD653 2 Miniature driver transformers. Ref. LT44. 20k to 1k centre tapped.
BD553a 2 3.5V relays each with 2 pairs changeover contacts.
BD667 2 4.7 µf non-polarised block capacitors, pcb mounting.

There are over 1,000 items in our Bakers Dozen List. If you want a complete copy please request this when ordering.

EQUIPMENT WALL MOUNT It is a multi-adjustable metal bracket that could be used for mounting flood light, loudspeaker, TV camera, even a fan and on almost any sort of wall or ceiling even between wall and ceiling. The main fixing brackets rotate such that an inward or an outward corner can be accommodated. Front panel also tilts upward or downwards to a reasonable angle and can be easily removed separately for wiring. A very useful bracket. Regular price would be around £6 each. Our price only £3. Our ref 3P72. Or 2 for £5. Our ref 5P152.

SUB-MAN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome dolly fixing nuts. 3 for 1.00. Order ref BD649.

COPPER CLAD PANEL for making PCB. Size approx 12in long x 8½in wide. Double-sided on fibreglass middle which is quite thick (about 1/16in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD683.

POWERFUL IONISER

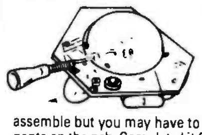
Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder—a complete mains operated kit, case included. **£12.50+£2 P&P.** Our ref 12P5/1.

REAL POWER AMPLIFIER for your car, it has 150 watts output. Frequency response 20hz to 20Khz and signal to noise ratio better than 60dB. Has built in short circuit protection and adjustable input level to suit your existing car stereo, so needs no pre-amp. Works into speakers ref. 30P7 described below. A real bargain at only £57.50. Order ref: 57P1.

REAL POWER CAR SPEAKERS. Stereo pair output 100W each. 4-Ohm impedence and consisting of 6½" woofer, 2" mid range and 1" tweeter. Each set in a compact purpose built shelf mounting unit. Ideal to work with the amplifier described above. Price per pair £29.96. Order ref: 30P7.

STEREO CAR SPEAKERS. Not quite so powerful—70w per channel. 3" woofer, 2" mid range and 1" tweeter. Again, in a super purpose built shelf mounting unit. Price per pair: £27.95. Order ref: 28P1.

VIDEO TAPES These are three hour tapes of superior quality, made under licence from the famous JVC Company. Offered at only £3 each. Our ref 3P63. Or 5 for £11. Our ref 11P3. Or for the really big user 10 for £20. Our ref 20P20.



ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with really detailed instructions. Ideal present for budding young electrician. A youngster should be able to assemble but you may have to help with the soldering of the components on the pcb. Complete kit £8. Our ref 8P30.

12" HIGH RESOLUTION MONITOR. Black and white screen, beautifully cased for free standing, needs only a 12v 1.5 amp supply. Technical data is on its way but we understand these are TTL input. Brand new in maker's cartons. Price: £25.00 plus £5 insured delivery. Order ref: 25P10.

14" COLOUR MONITOR made by the American Display Tek Company. Uses high resolution tube made by the famous Japanese Toshiba company. Beautifully made unit intended for console mounting, but top and sides adequately covered by plated metal panels. Full technical spec. on its way to us. We have a limited number of these. All brand new still in maker's cartons. Price: £89 each plus £6 insured carriage. Order ref: 89P/1.

BUSH RADIO MIDI SPEAKERS Stereo pair. BASS reflex system, using a full range 4in driver of 4ohms impedance. Mounted in very nicely made black fronted walnut finish cabinets. Cabinet size approx 8½in wide, 14in high and 3½in deep. Fitted with a good length of speaker flex and terminating with a normal audio plug. Price £5 the pair plus £1 post. Our ref 5P141.

3½in FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chinon. This is in the manufacturers metal case with leads and IDC connectors. Price £40, reference 40P1. Also a double sided, 80 track, by NEC. This is uncased. Price £59.50, reference 60P2. Both are brand new. Insured delivery £3 on each or both.

ATARI 65XE COMPUTER At 64K this is most powerful and suitable for home and business. Complete with PSU, TV lead, owner's manual and six games. Can be yours for only £45 plus £3 insured delivery.

REMOTE CONTROL FOR YOUR 65XE COMPUTER With this outfit you can be as much as 20 feet away as you wil have a joystick that can transmit and a receiver to plug into and operate your computer and TV. This is also just right if you want to use it with a big screen TV. The joystick has two fire buttons and is of a really superior quality, with four suction cups for additional control and one handed play. Price £15 for the radio controlled pair. Our ref 15P27.

ASTEC PSU. Mains operated switch mode, so very compact. Outputs +12v 2.5A, +5v 6A, ±5v .5A, ±12v 5A. Size: 7½in long x 4¾ in wide x 2¼in high. Cased ready for use. Brand new. Normal price £30+, our price only £12.95. Order ref 13P2.

VERY POWERFUL 12 VOLT MOTORS. ⅓rd Horsepower. Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £20 plus £2 postage. Our ref. 20P22.

PHILIPS LASER

This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £30 plus £3 insured delivery. Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15. As above for 12V battery. Also £15. Our ref 15P22.

ORGAN MASTER Is a three octave musical keyboard. It is beautifully made, has full size (piano size) keys, has gold plated contacts and is complete with ribbon cable and edge connector. Can be used with many computers, request information sheet. Brand new, only £15 plus £3 postage. Our ref 15P15.

FULL RANGE OF COMPONENTS at very keen prices are available from our associate company SCS COMPONENTS. You may already have their catalogue, if not request one and we will send it FOC with your goods.

HIGH RESOLUTION MONITOR. 9in black and white, used Philips tube M24/306W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. Brand new. £16 plus £5 post. Our ref 16P1.

12 VOLT BRUSHLESS FAN. Japanese made. The popular square shape (4½in x 4½in x 1¾in). The electronically run fans not only consume very little current but also they do not cause interference as the brush type motors do. Ideal for cooling computers, etc., or for a caravan. **£8 each.** Our ref 8P26.

MINI MONO AMP on p.c.b. size 4" x 2" (app.) Fitted Volume control and a hole for a tone control should yopu require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of **£1.15 each**, or **13 for £12.00.**

J & N BULL ELECTRICAL
Dept. EE 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT.

MAIL ORDER TERMS: Cash, PO or cheque with order. Orders under £20 add £2.00 service charge. Monthly account orders accepted from schools and public companies. Access and B/Card orders accepted—minimum £5. Phone (0273) 734648 or 203500.

POPULAR ITEMS — MANY NEW THIS MONTH

JOYSTICKS for BBC, Atari, Dragon, Commodore, etc. All £5 each. State which required.

TELEPHONE TYPE KEY PAD. Really first class rear mounting unit. White lettering on black buttons. Has conductive rubbers contacts with soft click operation. Circuit arranged in telephone type array. Requires 70mm by 55mm cut out and is connected by 10-pin IDC socket. Price: £2.00 each. Order ref: 2P251.

TELESCOPIC FM AERIAL. Stands up or folds over. Solidly constructed and heavily nickel plated. Supplied complete with fixing nut. Price £1 each. Order ref: BD741.

SUB-MIN PUSH SWITCHES Not much bigger than a plastic transistor but double pole. PCB mounting. Three for £1. Our ref BD688.

CARTRIDGES for the Double Microdrive. Price 4 for £5. Our ref 5P146.

NICAD CHARGER UNIT Metal pronged, plastic case contains mains transformer and rectifiers with output lead and plug—made to charge two cells but no doube adaptable or wonderful spares value. Only 50p each, two for £1. Our ref BD385.

EDGEWISE PANEL METER If you are short of panel space then this may be the answer. It has a FSD of 100µA and a nice full vision scale. It fits through a hole approx 1¼in x ½in. Another feature is that it has an indicator lamp behind the scale which you could light up, it would then serve as an on/off indicator. Price £1. Our ref BD700.

AA CELLS Probably the most popular of the rechargeable NICAD types. 4 for £4. Our ref 4P44.

COMPUTER SPECIAL The Perex 16meg Byte tape streamer. These are brand new and really an exceptional bargain. A few only so hurry. Only £15. Our ref 15P29.

20 WATT 4OHM SPEAKER With built in tweeter. Really well made unit which has the power and the quality for hi-fi reproduction. 6½in diameter. Price £5. Our ref 5P155. It is heavy so please add £1 to cover postage if not collecting.

MINI RADIO MODULE Only about 2in square with ferrite aerial and solid dia tuner with its own knob. It is a superhet and it operates from PP3 battery and would drive a crystal headphone direct but be better with our mini mono amp. Price £1. Our ref BD716.

BULGIN MAINS PLUG AND SOCKET The old faithful 3 pin with screw terminals. The socket mounts through a 1½in hole and the mains is brought in by the insulated plug. Used to be quite expensive but you can have 2 pairs for £1 or 4 of either plug or socket for £1. You could make yourself a neat and compact bench panel with these. Our ref BD715, BD715S or BD715P.

MICROPHONE If you want a low cost microphone then just arrived we have a very small hand-held dynamic mic with on/off switch in the handle, its lead terminates with one 3.5 plug and the other a 2.5 plug for remote control. Price only £1. Our ref BD711

EXTENSION CABLE WITH A DIFFERENCE It is flat on one side making it easy to fix and to look tidy. It is 4 core so suitable for telephone, bell, burgular alarms, etc. 50 yard coil for £5. Our ref 5P153.

MOSFETS FOR POWER AMPLIFIERS AND HIGH CURRENT DEVICES 140v 100w pair made by the famous Hitachi Company. Reference 25K413 and its component 25J118. Only £4 the pair. Our ref 4P42.

BATTERY OPERATED TRAVEL MECHANISM On a plastic panel measuring approx. 9in x 3½in. Is driven by a reversible 12v battery motor, fitted with a pulley and belt which rotates through a threaded rod and causes a platform to travel backwards and forwards through a distance of approx. 5in. Price £5. Our ref 5P140.

MAINS OPERATED WATER VALVE with hose connection for inlet and outlet suitable for low pressure. Auto plant watering, etc. Only £1 each. Our ref BD370.

20 VOLT 4 AMP MAINS TRANSFORMER Upright mounting with fixing feet. Price £3. 3P59.

16 OHM PM SPEAKERS Approx. 7in x 4in. 5 watts. Offered at a very low price so you can use two in parallel to give you 10 watts at 8 ohms. £1 for the two. Our ref BD684.

EHT TRANSFORMER 4kv 2mA Ex-unused equipment. £5. Our ref 5P139

4 CORE TINSEL COPPER LEAD As fittd to telephones, terminating with flat BT plug. 2 for £1. Our ref BD639.

EHT TRANSFORMER 8kv 3mA. £10. Our ref IOP56

VERY USEFUL MAGNETS Flat, about 1in long, ½in wide and ¼in thick. Very powerful. 6 for £1. Our ref BD274(a).

ACORN COMPUTER DATA RECORDER Ref ALF03. Made for the Electron or BBC computers but suitable for most others. Complete with mains adaptor, leads and handbook. £10.00. Ref 10P44. Add £2 special packing.

SOLAR CELLS Will give good current (depending on size) from sunlight or bright daylight. Module A gives 100mA. Price £1. Our ref BD631. Model C gives 400mA. Price £2. Our ref 2P199. Model D gives 700mA. Price £3. Our ref 3P42.

SOLAR POWERED NI-CAD CHARGER 4 Ni-CAD batteries AA (HP7) charged in eight hours or two in only 4 hours. It is complete, boxed ready to use unit. Price £6. Our ref 6P3.

METAL PROJECT BOX Ideal for battery charger, power supply etc., sprayed grey, size 8"x4¼"x4" high, ends are louvred for ventilation other sides are flat and undrilled. Price £3. Order ref 3P75.

CAPACITOR BARGAIN Axial ended — 4700µf at 25v. Jap made. Normally 50p each, but you will get 4 for £1. Ref 613.

SINGLE SCREENED FLEX 7.02 copper conductors, pvc insulated then with copper screen, finally outer insulation. In fact quite normal screened flex. 10m for £1. Our ref BD668.

3 CORE FLEX BARGAIN No. 1 Core size 5mm so ideal for long extension leads carrying up to 5 amps or short leads up to 10 amps. 15m £2. ref 2P189

3 CORE FLEX BARGAIN No. 2 Core size 1.25mm so ideal for long extension leads carrying up to 13 amps or short leads up to 25A. 10m for £2. Order ref 2P190

ALPHA-NUMERIC KEYBOARD This keyboard has 73 keys with contactless capacitance switches giving long trouble free life and no contact bounce. The keys are arranged in two groups, the main area field is a QWERTY array and on the right is a 15 key number pad, board size is approx. 13"x4" — brand new but offered at only a fraction of its cost namely £3 plus £1 post. Ref 3P27.

⅛ HORSEPOWER 12 VOLT MOTOR Made by Smiths, the body length of this is approximately 3in., the diameter 3in. and the spindle 5/16th of an inch diameter. It has a centre flange for fixing or can be fixed from the end by means of 2 nuts. A very powerful little motor which revs at 3,000rpm. We have a large quantity of them so if you have any projects in mind then you could rely on supplies for at least two years. Price £6. Our ref 6P1, discount for quantities of 10 or more.

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INCORPORATING ELECTRONICS MONTHLY

ABC

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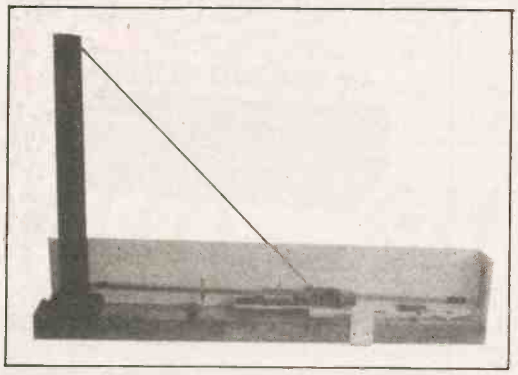
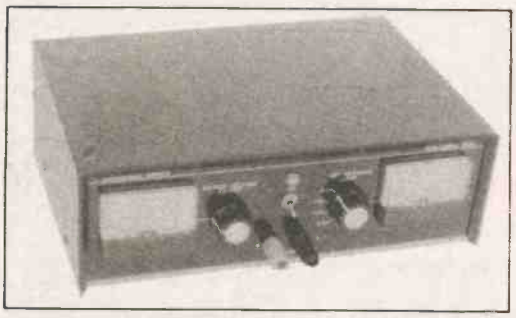
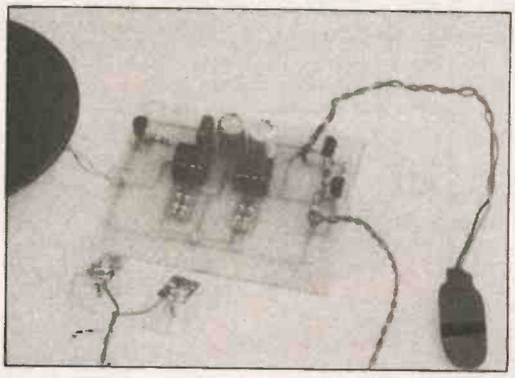
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







Our December '89 Issue will be published on Friday, 3 November 1989. See page 691 for details.

Projects

Series

Features

THE RTC MONITOR II

100 WATT SPEAKER KIT £60.00 +£3.50 P&P (pair)

RESPONSE: 55Hz–20kHz
BASS POLYMER CONE D: 22cm
DOME TWEETER: 14mm
OVERALL SIZE
(HWD): 382,252,204mm
RECOMMENDED AMP POWER:
10-100 watts per channel

The performance standard achieved in this compact design is distinctively superior to anything else available at the price. The drive units used are of sophisticated design and have been carefully integrated with a Complex Crossover. Stereo performance is exceptionally good with a well focussed sound stage and sharp resolution of detail. Distortion throughout the frequency range is low even at quite high power input and this gives a great sense of dynamic range and openness especially when used in bi-wired mode.

Supplied with:— 2 READY CUT BAFFLES, ALL CROSSOVER COMPONENTS, 2 BASS MID-RANGE, 2 DOME TWEETERS, HOOK UP WIRE, GRILLE CLOTH, SCREW TERMINALS AND SCREWS.

CROSSOVER KIT. To build 2 sets of crossovers **£11+£1.75** post. (Featured in *Everyday Electronics*—May 1989 issue). Reprint Free with Kits

AMPHONIC 125+125 POWER AMPLIFIER

125 watt per channel stereo power amplifier with independent volume controls, professional 19" rack mount and silent running cooling fan for extra reliability.

Output power .... 125W RMS max. per channel
Output impedance .... 4 to 16 ohms (max. power into 4 ohms)
Sensitivity .... 450V at 22K ohms
Protection .... Electronic short-circuit and fuses
Power .... 220-240V a.c. 50Hz
Chassis dim .... 435×125×280mm
Weight .... 10kg approx

£124.99 + £7.00 p&p

SPECIAL OFFER

J.B.L. BOLIVAR COMPONENT SPEAKERS

10" HI-FI BASS UNIT ... VOICE COIL, HIGH COMPLIANT, RE-INFORCED MOULDED PAPER CONE, ROLLED FOAM EDGE WITH A BIG 4½" MAGNET 6Ω IMPEDANCE **£18.73**

4½" 100W ... MID RANGE 1" VOICE COIL, PAPER CONED AND ... CAMBRIC EDGE FITTED WITH A 3½" MAGNET. 6Ω IMPEDANCE **£5.33**

4½" ... TWEETER ¾" VOICE COIL, 1¾" CONE WITH FOAM EDGE, ... MAGNET, 6Ω IMPEDENCE **£6.33**

POSTAGE £4.70 PER ORDER

52W 2-WAY COMPONENT SPEAKER SYSTEM £3.95

Comprises 8in rolled surround bass unit and 2¼in tweeter for In-Car or Hi-Fi use. 4 ohm. *Made by Sanyo.*

8 OHM HI-FI COMPONENT SPEAKER £4.95
6½in. Audax 60w. Res freq. 45Hz bass-mid
8in SOUND LAB 60W £12.95
Res freq. 38Hz full range
12in DANTEX 100W £21.75
Res freq. 23Hz bass unit
Postage **£3.20** each order

★ SPECIAL PURCHASE
Batteries C size NiCad 2.2 Ah EVERY-READY AN220
£1.98 each

£1 BARGAIN PACKS
BUY 10 GET 1 FREE

Please state pack(s) required
No = Order No. Qty = Quantity per pack

No	Qty	
BP010	2	6½" Speaker 8Ω 10 watt
BP012	2	6½" Speaker 4Ω 10 watt
BP013	3	8"×5" Speaker 4Ω 6 watt *made by E.M.I.*
BP015A	1	5½" full range 12 watt 4Ω speaker with matching grill. For small p.a. or in car use.
BP015B	1	30 watt, dome tweeter. Size 90×66mil *JAPAN made*
BP016	6	2200µf can type Electrolytic 25V d.c computer grade *made in UK by PHILIPS*
BP017	3	33000µf 16V d.c. electrolytic high quality computer grade *UK made*
BP018	3	2000µf 50V d.c. electrolytic high quality computer grade *made in USA*
BP019	20	20 ceramic trimmers
BP020	4	Tuning capacitors, 2 gang dielectric a.m. type
BP021	10	3 position, 8 tag slide switch 3 amp rated 125V a.c. *made in USA*
BP022	5	Push-button switches, push on push off, 2 pole change over. PC mount *JAPAN made*
BP023	6	2 pole 2 way rotary switch
BP024	2	Right angle, PCB mounting rotary switch 4 pole, 3 way rotary switch *UK made by LORLIN*
BP025	4	3 pole, 3 way miniature rotary switch with one extra position off (open frame YAXLEY type)
BP026	4	4 pole, 2 way rotary switch *UK made by LORLIN*
BP027	30	Mixed control knobs
BP028	10	Slide potentiometers (popular values)
BP029	6	Stereo rotary potentiometers
BP030	2	100k wire wound double precision potentiometers *UK made*
BP031	6	Single 100k multitune pots, ideal for varicap tuners *UK made by PHILIPS*
BP032	4	UHF varicap tuner heads, unboxed and untested *UK made by PHILIPS*
BP033	2	FM stereo decoder modules with diagram *UK made by PHILIPS*
BP034	3	AM IF modules with diagram UK made by PHILIPS
BP034A	2	AM-FM tuner head modules. *UK made by MULLARD*
BP034B	1	Hi-Fi stereo pre-amp module inputs for CD, tuner tape, magnetic cartridge with diagram. *UK made by MULLARD*
BP035	6	All metal co-axial aerial plugs
BP036	6	Fuse holders, panel mounting 20mm type *JAPAN made*
BP037	6	In line fuse holders 20mm type *UK made by BULGIN*
BP038	20	5 pin din, 180° chassis socket
BP039	6	Double phono sockets, Paxolin mounted
BP041	3	2.8m lengths of 3 core 5 amp mains flex
BP042	2	Large VU meters *JAPAN made*
BP043	30	4V miniature bulbs, wire ended, new untested
BP044	2	Sonotone stereo crystal cartridge with 78 and LP styli *JAPAN made*
BP045	2	Stereo cassette record and play heads *JAPAN made*
BP046	4	6-0-6 4VA mains transformers, P.C. mount *UK made*
BP047	1	24V 750mA mains power supply. Brand new boxed *UK made by MULLARD*
BP049	10	OC44 transistors. Remove paint from top and it becomes a photo-electric cell (or P12) *UK made by MULLARD*
BP050	30	Low signal transistors n.p.n., p.n.p. types
BP051	6	14 watt output transistors. 3 complimentary pairs in T066 case *(Ideal replacement for AD161 and 162s)*
BP052A	1	Tape deck pre-amp IC with record/replay switching No LM1818 with diagram
BP053	5	5 watt audio ICs. No TBA800 *(ATEZ)*
BP054	10	Motor speed control ICs, as used with most cassette and record player motors
BP055	1	Digital DVM meter I.C. *made by PLESSEY* as used by *THANDAR* with diagram
BP056	4	7 segment 0.3 LED display (R.E.D.)
BP057	8	Bridge rectifiers, 1 amp, 24V
BP058	200	Assorted carbon resistors
BP059	1	Power supply PCB with 30V 4V/A transformer. MC7818CT IC & bridge rectifier: Size 4"×2¾"
BP060	1	Transcription record player motor 1500rpm 240V a.c.
BP061	5	6.35mm Mono jack plugs
BP063	5	6.35mm stereo switched jack sockets
BP064	12	Coax chassis mount sockets
BP065	1	3mtr Euro-mains lead with a matching chassis socket

MULTIBAND RADIO
VHF 54-176 MHz + AM CB BANDS 1-80
Listen to: AIR TRAFFIC CONTROL, AIRCRAFT, RADAR PUBLIC UTILITIES RADIO AMATEURS AND MANY MANY MORE

£15.95
POSTAGE £2.85

SQUELCH CONTROL
"RUBBER DUCK AERIAL"

RADIO and TV COMPONENTS ACTON LTD
21 HIGH STREET, ACTON LONDON W3 6NG
MAIL ORDER TERMS. POSTAL ORDERS and or CHEQUES with orders. Orders under £20 add £3.00 service charge. Nett monthly accounts to Schools, Colleges and P.L.C. only. ACCESS + VISA. *Phone orders between 9.30 & 12pm please*
Phone: 01-723 8432 or 01-992 8430
Callers 323 Edgware Road, London W2

30+30 WATT AMPLIFIER KIT

An easy to build amplifier with a good specification. All the components are mounted on the single P.C.B. which is already punched and backprinted.

- 30W×2 (DIN 4 ohm)
- CD/Aux, tape I, tape II, tuner and phono inputs.
- Separate treble and bass
- Headphone jack

Size (H.W.D.) 75×400×195mm
Kit enclosed: case, P.C.B., all components, scale and knobs **£36.80**. post £3.50
(Featured project in *Everyday Electronics* April 1989 issue). Reprint Free with kit.

TV SOUND TUNER

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are quite common and that really is quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact independent TV tuner that connects direct to your Hi-FI is a must for quality reproduction. The unit is mains operated. This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder.

£29.50 +£2,50 p&p

As above but with built-in stereo headphone amplifier for the hard of hearing
You can tune into the TV channel you want while still receiving the picture on your TV set. In fact it is rather like a second television, but without the screen. So that the ordinary TV can be placed for everyone to see, and the volume on it can be comfortable for others, while the sound tuner can be placed where you can control it. You will need to plug in one of your own listening aids such as headphones or an induction loop to hear the sound. The tuner is mains operated, has 5 pre-selected tuning controls and can be used in conjunction with a video recorder.

Size: 270×192×65mm. **£35.90** +£2.50 p&p

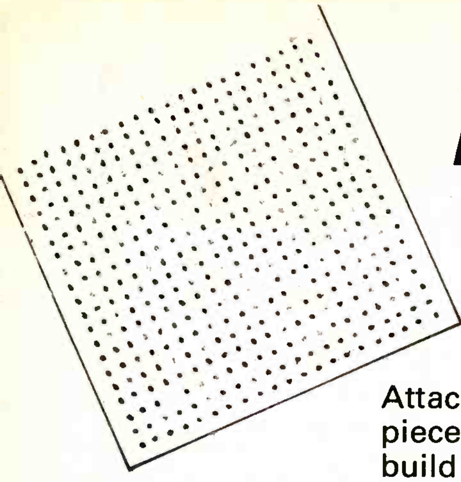
A.M. F.M. STEREO TUNER KIT

SPECIAL OFFER!
£8.95 *Plus £2.50 p&p*
This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics
For ease of construction and alignment it incorporates three Mullard modules and an I.C. I.F. System.
FEATURES: *VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM-Ferrite rod, FM-75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to strict P.E. specification. Front scale size: 10½"×2½" approx. Complete with diagram and instructions.*

Hi-Fi stereo cassette deck transport mechanism, complete with 3 digit rev counter and tape heads, 12V d.c. operation. Unused manufacturers surplus *JAPAN made*
£6.20 +£1.50 P&P 2 for **£10** +£2.50 P&P

EXTRACTABLE HOUSING FOR YOUR CAR STEREO ★ SIZE DIN E ★ HANDLE INCLUDED ★ SPACE FOR MEMORY BATTERY ★ 4 OR 2 SPEAKER SYSTEM.
ENABLES YOU TO REMOVE YOUR VALUED STEREO FROM YOUR CAR (WITHOUT THE AID OF A HAMMER AND CHISEL, CHAINSAW ETC).
£9.95 postage £2.50

NEXT MONTH



FREE!
VERO EASIWIRE CIRCUIT BOARD

Attached to the front of every copy next month will be a piece of plastic Vero Easiwire wiring board. On it you can build just about any small project you wish to.

However to give you some ideas we have designed the two items below just for this board.

AUTOLIGHT

This project is designed to switch on a small, low voltage lamp automatically when the light falls below a set level. This is an interesting circuit in its own right and has a number of useful applications. These include an automatic night light for use with a child or an emergency lighting system to take over illuminating a strategic area in the event of failure of a mains driven system.

IMPULSE WIPER

A very useful facility incorporated in some, but not all cars is the ability to have the windscreen wiper operate every now and again. This facility is known as the Impulse Wipe facility. This project describes how a very simple circuit can be constructed to provide this mode of operation.

New Series
MICRO IN CONTROL

Interest in electronic control, especially using the flexibility of the microprocessor, continues to grow. The dialogue in this series is based closely upon that which has taken place regularly during a series of courses on the topic, directed to enthusiastic beginners.

It is hoped that those who are starting up in this field will find it helpful, revealing perhaps some slight but deadly misconceptions which can bedevil the learner's progress. More experienced readers may find the approach of interest.

The series builds quickly from basic circuit principles through logic to simple microprocessor control.

SPECIAL OFFER —
CROTECH OSCILLOSCOPES

DON'T MISS IT

EVERYDAY ELECTRONICS

DECEMBER ISSUE ON SALE NOVEMBER 3 1989

POWER CONDITIONER

FEATURED IN ETI JANUARY 1988

The ultimate mains purifier. Intended mainly for lowering the noise floor and improving the analytical qualities of top-flight audio equipment.

The massive filter section contains thirteen capacitors and two current balanced inductors, together with a bank of six VDRs, to remove every last trace of impulsive and RF interference. A ten LED logarithmic display gives a second by second indication of the amount of interference removed.

Our approved parts set consists of case, PCB, all components (including high permeability toroidal cores, ICs, transistors, class X and Y suppression capacitors, VDRs, etc.) and full instructions.

PARTS SET £29.80 + VAT

A low cost (but high performance) mains conditioner is also available.
MAINS CONDITIONER PARTS SET £5.40 + VAT
RUGGED PLASTIC CASE £1.80 + VAT

KNIGHT RAIDER

FEATURED IN ETI JULY 1987

The ultimate in lighting effects for your Lamborghini, Maserati, BMW (or any other car, for that matter). Picture this: eight powerful lights in line along the front and eight along the rear. You flick a switch on the dashboard control box and a point of light moves lazily from left to right leaving a comet's tail behind it. Flip the switch again and the point of light becomes a bar, bouncing backwards and forwards along the row. Press again and try one of the other six patterns . . . An LED display on the control box let's you see what the main lights are doing.

The Knight Raider can be fitted to any car (it makes an excellent fog light!) or with low powered bulbs it can turn any child's pedal car or bicycle into a spectacular TV-age toy!

The parts set consists of box, PCB and components for control, PCB and components for sequence board, and full instructions. Lamps not included.

PARTS SET £24.80 + VAT

RAINY DAY PROJECTS

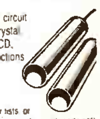
All can be built in an afternoon!

JUMPIN' JACK FLASH (ETI March 1988) Spectacular rock, stage and disco lighting effect!	£6.90 + VAT
CREDIT CARD CASINO (ETI March 1987) The wicked pocket gambling machine	£5.90 + VAT
MAINS CONTROLLER (ETI January 1987) Isolated logic to mains interface	£6.20 + VAT
MATCHBOX AMPLIFIERS (ETI April 1986) Listen: 50W of Hi-Fi power from an amp small enough to fit in a matchbox!	
Matchbox Amplifier (20W)	£6.50 + VAT
Matchbox Bridge Amplifier (50w)	£8.90 + VAT
L165V Power Amplifier IC, with data and circuits	£3.90 + VAT
TACHO/DWELL METER (ETI January 1987) Turn your Metro into a Porsche!	£16.40 + VAT
HI-FI POWER METER (ETI May 1987) Measures Hi-Fi output power up to 100W – includes PCB, components, meters	
Mono power meter	£3.90 + VAT
Stereo power meter	£7.20 + VAT

FEATURED IN ETI AUGUST 1988

There's nothing quite so encouraging as having a quantifiable result to show for your training efforts. If you are not particularly fit, your resting heart rate will be around 80 beats per minute. As your jogging, aerobics or sport strengthens your heart, the rate will drop dramatically – possibly to 60bpm or less. With the S101, you can watch your progress day by day.

Breathing is important too. How efficiently do you take up oxygen? How quickly do you recover from 'oxygen debt' after strenuous activity? The S101 will let you know.



The approved parts set consists of: case, 3 printed circuit boards, all components (including 17 ICs, quartz crystal, 75 transistors, resistors, diodes and capacitors), LCD, switches, plugs, sockets, electrodes, and full instructions for construction and use.

PARTS SET £33.80 + VAT

Some parts are available separately. Please send SAE for lists, or SAE + £2 for lists, circuits, construction details and training plan (free with parts set).

THE DREAM MACHINE

FEATURED IN ETI DECEMBER 1987

Adjust the controls to suit your mood and let the gentle, relaxing sound drift over you. At first you might hear soft rain, sea surf, or the wind through distant trees. Almost hypnotic, the sound draws you irresistably into a peaceful, refreshing sleep.

For many, the thought of waking refreshed and alert from perhaps the first truly restful sleep in years is exciting enough in itself. For more adventurous souls there are strange and mysterious dream experiences waiting. Take lucid dreams, for instance. Imagine being in control of your dreams and able to change them at will to act out your wishes and fantasies. With the Dream Machine it's easy!

The approved parts set consists of PCB, all components, controls, loudspeaker, knobs, lamp, fuseholders, fuse, mains power supply, prestige case and full instructions.

PARTS SET £19.80 + VAT

Ben Sweetland's best seller GROW RICH WHILE YOU SLEEP is now in stock. £2.95 (NO VAT)

THE MISTRAL AIR IONISER

The best ioniser design yet – this one has variable ion drive, built-in ion counter and enough power to drive five multi-point emitters. For the technically minded, it has nine main drive stages, five secondary drives, and a four section booster to give an output capability of almost fifteen billion (1.47×10^{10}) ions every minute, or 2.45×10^{8} ions per second. With extra emitters this can be increased still further!

PARTS SET £28.40 + VAT

The parts set includes case, printed circuit boards, 126 top grade components, all controls, lamps, hardware, a multi-point phospher-bronze emitter and full instructions.

Some parts are available separately – please send SAE for lists, or SAE + £1 for lists, circuit and construction details and further information (free with parts set).

READY-BUILT MISTRAL

The Mistral Ioniser (and most of our other projects) can now be supplied built, tested and ready to go. For details, please contact *Peter Leah at P.L. Electronics, 8 Woburn Road, Eastville, Bristol BS5 6TT. Tel: 0272 522703.* Evenings Only

INTERNAL EMITTER £2.80 + VAT

Can be used in place of the P-B external emitter, or both can be used together for the highest ion output. Parts set includes PCB, ion emitters, components and instructions.

IPA BOARD CLEANER £0.98 + VAT

Essential for removing grease and flux residues from the Mistral PCB to achieve peak performance. Applicator brush supplied.

ION FAN £9.80 + VAT

An almost silent piezo-electric fan, mains operated, to pump ions away from the emitter and into the room. Increases the effectiveness of any ioniser by five times!

ION DISPERSION METER

FEATURED IN ETI FEBRUARY 1989

The Q-ion is a hand-held meter which sniffs out ions in the air. It can tell the good ones from the duds if you're thinking of buying a commercial ioniser, check the efficiency and output of one you've made yourself, help you set up fans and position the ioniser for best effect, do an ion-survey of your house or office — in short, it will tell you anything you want to know about ions in the air.

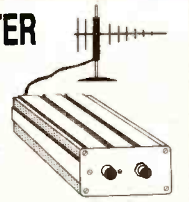
In direct mode the bar-graph readout will detect the presence of negative or positive ions and measure neg-ion strengths from 5×10^{7} to 10^{10} ions per second, which covers the levels you can expect when an air ioniser is in use. For the smaller concentrations of natural air ions, integrate mode will increase the sensitivity as far as you like.

Our approved parts set comprises: case, ion collector, printed circuit board, all components (including six ICs, schottky diode, cermets, VDR, zener, 37 resistors and capacitors, LEDs, plug, socket, earth lead, etc.) and full instructions.

PARTS SET £18.40 + VAT

Some parts are available separately — please send SAE for lists, or SAE + £1 for lists, circuit, construction details and further information (free with parts set).

TV BOOSTER



Good TV pictures from poor aerials is what this project is all about. Keith Brindley's Aerial Booster gives a massive 23dB gain to ensure good viewing for campers and caravanners, from indoor aerials, or wherever a properly positioned high-gain antenna is not practical.

Based on the OM335 hybrid amplifier, the booster has specifications to rival the best: wideband operation from 10MHz to 1.4 GHz, mid-band gain of up to 26dB and a wide supply range of 9V to 26V (it will run from car batteries for caravanners, dry batteries for campers, or a mains 'battery eliminator' in the home). No special UHF construction skills are needed — the project could be made by a careful beginner.

There are two parts sets for the project. AA1 contains the printed circuit board, OM335 hybrid amplifier, components and instructions. AA2 is the optional case set: rugged screened box, front and rear panels, waterproofing gaskets, feet, sockets and hardware.

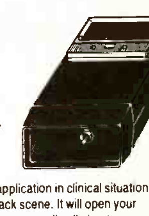
AA1 PARTS SET £12.80 + VAT

AA2 PARTS SET £4.80 + VAT

AA3 OPTIONAL MAINS POWER SUPPLY PARTS SET £6.80 + VAT.

BIO-FEEDBACK

FEATURED IN ETI DECEMBER 1986



Bio-feedback comes of age with this highly responsive, self-balancing skin response monitor! The powerful circuit has found application in clinical situations as well as on the bio-feedback scene. It will open your eyes to what GSR techniques are really all about.

The complete parts set includes case, PCB, all components, leads, electrodes, conductive gel, and full instructions.

PARTS SET £16.80 + VAT
BIO-FEEDBACK BOOK £4.50 (no VAT)

Please note: the book, by Stern and Ray, is an authorised guide to the potential of bio-feedback techniques. It is not a hobby book, and will only be of interest to intelligent adults.

POWERFUL AIR IONISER

FEATURED IN ETI JULY 1986

Ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer, and seems much more invigorating than 'dead' air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build . . . and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller tinned printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs 'about a third of the price of the individual components'. What more can we say?

Instructions are included

PARTS SET WITH BLACK CASE £12.60 + VAT
PARTS SET WITH WHITE CASE £12.80 + VAT

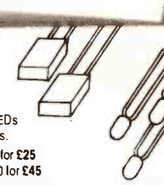
BURGLAR BUSTER

Be safe from intruders with our Burglar Buster alarm system! It has all the features you'd expect from a high-tech alarm: entry and exit delay, anti-tamper loop, delay warning and control-box protection.

The parts set includes *all four* PCBs and all components to go on them. Other parts (case, switches, etc.) are available separately, if you haven't got anything suitable in your spares box. Set contains 4 PCBs, ICs, transistors, relays, capacitors, resistors, diodes, regulator, piezo sounder and full instructions.

BB1 PARTS SET £12.80 + VAT

LEDs



Green rectangular LEDs for bar-graph displays.

50 for £3.50	500 for £25
100 for £6	1000 for £45

DIGITAL AND AUDIO EQUIPMENT LEDs
Assorted 3mm LEDs: red, green, yellow and orange.
25 of each (100 LEDs) for £6.80

BRAINWAVE MONITOR

FEATURED IN ETI AUGUST 1987

The most antonishing project ever to have appeared in an electronics magazine. Similar in principle to a medical EEG machine, this project allows you to **hear** the characteristic rhythms of your own mind! The alpha, beta and theta forms can be selected for study and the three articles give masses of information on their interpretation and powers.

In conjunction with Dr. Lewis's Alpha Plan, the monitor can be used to overcome shyness, to help you feel confident in stressful situations, and to train yourself to excel at things you're 'no good at'.

Our approved parts set contains case, two PCBs, screening can for bio-amplifier, all components (including three PMI precision amplifiers), leads, brass electrodes and full instructions.

PARTS SET £39.80 + VAT ALPHA PLAN BOOK £2.50
SILVER SOLUTION (for plating electrodes) £3.80 + VAT

Parts set available separately. We also have a range of accessories, professional electrodes, books, etc. Please send SAE for lists, or SAE + £2 for lists, construction details and further information (free with parts set).

U.K. orders: please add 80p post and packing and 15% VAT to total.
Eire and overseas: no VAT. Carriage and insurance £4.50.
Please allow up to 14 days for delivery.

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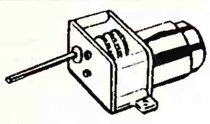
D.C. MOTOR GEARBOXES



Ideal for Robots and Buggies. A miniature plastic reduction gearbox coupled with a 1·5-4·5 Volt mini motor. Variable gearbox reduction ratios are obtained by fitting from 1 to 6 gearwheels (supplied). Two types available:

SMALL UNIT TYPE MGS
Speed range 3-2200 rpm. Size 37×43×25mm
£3.99

LARGE UNIT TYPE MGL
Speed range 2-1150 rpm. Size 57×43×29mm
£4.55

TOOTHED BELTS & PULLEYS

Glass fibre reinforced belts with nylon coating. Width ¼", Pitch ⅕". Available in a range of lengths from 6"—26" **£1.68-£2.60**

Matching pulleys 8 tooth, 12, 25 + 40 **£1.48, £1.70, £2.80, £2.99**

STEPPING MOTORS

A range of top quality stepping motors suitable for driving a wide range of mechanisms under computer control using simple interfacing techniques.

ID35 PERMANENT MAGNET MOTOR — 48 steps per rev. **£16.50**

MD200 HYBRID MOTOR — 200 steps per rev. **£16.80**

MD35 ¼ PERMANENT MAGNET MOTOR — 48 steps per rev. **£12.70**

MD38 PERMANENT MAGNET MOTOR — 48 steps per rev. **£8.95**

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Ref		Price
815	**EE TREASURE HUNTER** Aug 89	**Full Kit** £39.95
814	**BAT DETECTOR** Jun 89	£19.98
812	**ULTRASONIC PET SCARER** May 89	£13.80
807	**MINI PSU** Feb 89	£22.71
806	**CONTINUITY TESTER** Feb 89	£10.28
803	**REACTION TIMER** Dec 88	£31.93
801	**DOWNBEAT METRONOME** Dec 88	£18.71
800	**SPECTRUM EPROM PROGRAMMER** Dec 88	£28.72
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718	**3 BAND 1.6-300MHz RADIO** Aug 87	£28.25
719	**BUCCANEER I.B. METAL DETECTOR inc. coils and case, less handle and hardware** July 87	£28.17
720	**DIGITAL COUNTER/FREQ METER (10MHz) inc. case** July 87	£71.43
722	**FERMOSTAT** July 87	£12.93
715	**MINI DISCO LIGHT** Jun 87	£13.41
707	**EQUALIZER (IONISER)** May 87	£16.54
700	**ACTIVE I/R BURGULAR ALARM** Mar 87	£37.97
581	**VIDEO GUARD** Feb 87	£8.94
584	**SPECTRUM SPEECH SYNTH. (no case)** Feb 87	£22.28

Ref		Price
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263	**BUZZ OFF** Mar 83	£6.05
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108	**IN SITU TRANSISTOR TESTER** June 78	£10.03
106	**WEIRD SOUND EFFECTS GEN** Mar 78	£8.33
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EDUCATIONAL BOOKS & BOOK PROJECTS

INTRODUCTION TO ELECTRONICS

An introduction to the basic principles of electronics using a book and a set of components. Lots of simple experiments with full colour illustrations, diagrams and explanations. A lovely book, ideal for all ages. Based on Veroboard, requires soldering.

INTRODUCTION TO ELECTRONICS Book	**£3.50**
COMPONENT PACK (less book)	**£11.70**

ADVENTURES WITH ELECTRONICS

The classic Easy to Follow book suitable for all ages. Ideal for beginners. No soldering, uses an S-DEC breadboard. Gives clear instructions with lots of pictures. 16 projects — including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-DEC breadboard and all the components for the series.

ADVENTURES WITH ELECTRONICS	**£4.75**
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From the USBORNE Pocket Scientist series — An enjoyable introduction to electronics. Full of very clear full colour pictures accompanied by easy to follow text. Ideal for all beginners — children and adults. Only basic tools are needed. 64 full colour pages cover all aspects — soldering — fault finding — components (identification & how they work). Also full details of how to build 6 projects — burglar alarm, radio, game, etc. Requires soldering — 4 pages clearly show you how.
The components supplied in our pack allows all the projects to be built and kept. The book is available separately.

FUN WITH ELECTRONICS Book	**£2.25**
COMPONENT PACK (less book)	**£17.55**

30 SOLDERLESS BREADBOARD PROJECTS

A book of projects by R. A. Penfold covering a wide range of interests. All projects are built on a Verobloc breadboard. Full layout drawings and component identification diagrams enable the projects to be built by beginners. Each circuit can be dismantled and rebuilt several times using the same components. The component pack allows all projects in the book to be built one at a time.
Projects covered include amplifiers, light actuated switches, timers, metronome, touch switch, sound activated switch, moisture detector, M.W. Radio, Fuzz unit, etc.

30 SOLDERLESS BREADBOARD PROJECTS Book 1	**£2.95**
COMPONENT PACK	**£27.15**
VEROBLOC	**£7.49**

ENJOYING ELECTRONICS

A more advanced book which introduces some arithmetic and calculations to electronic circuits. 48 chapters covering elements of electronics such as current, transistor switches, flip-flops, oscillators, charge, pulses, etc. An excellent follow-up to Teach-in or any other of our series. Extremely well explained by Owen Bishop who has written many excellent beginners' articles in numerous electronics magazines.

ENJOYING ELECTRONICS Book	**£3.60**
COMPONENT PACK	**£14.31**
VEROBLOC	**£7.49**

Note – A simple multimeter is needed to fully follow this book. The M102 BZ is ideal. **£13.98**

A FIRST ELECTRONICS COURSE

A copiously illustrated book that explains the principles of electronics by relating them to everyday objects. At the end of each chapter a set of questions and word puzzles allow progress to be checked in an entertaining way. An S-DEC breadboard is used for this series – soldering is not required.

A FIRST ELECTRONIC COURSE BOOK	**£3.75**
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EE APRIL 85

A reliable electronic tester which checks insulation resistance of wiring appliances etc., at 500 volts. The unit is battery powered simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. One of our own designs and extremely popular.

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EE MAY 89

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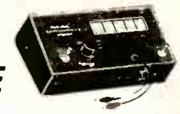
KIT REF 812
Mains Adaptor £1.98 **£13.80**

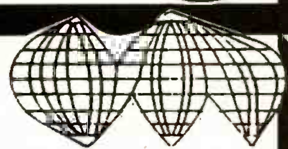
DIGITAL CAPACITANCE METER



EE DEC 85

Simple and accurate (1%) measurement of capacitors from a few pF up to 1,000 µF. Clear 5-digit LED display indicates exact value. Three ranges – pF, nF, and µF. Just connect the capacitor, press the button and read the value.

KIT REF 493 **£44.25**



3 BAND SHORT WAVE RADIO

EE AUG 87

Covers 1.6–30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

KIT REF 718 **£28.25**

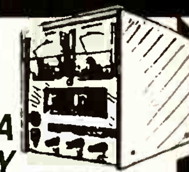
DIGITAL FREQUENCY 200 MHz METER

EE NOV 86

An 8 digit meter reading from AF up to 200 MHz in two ranges. Large 0.5" Red LED display. Ideal for AF and RF measurements. Amateur and C.B. frequencies.

KIT REF 563 **£62.98**

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY



EE FEB 88

A superb design giving 0.25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

KIT REF 769 **£52.96**

MINI STROBE

EE MAY '86

A hand held stroboscope which uses 6 "ultra bright" LEDs as the light source. Designed to demonstrate the principles of stroboscope examination, the unit is also suitable for measuring the speed of moving shafts etc. The flash rate control covers 170–20,000 RPM in two ranges.

KIT REF 529 **£14.76**

ACOUSTIC PROBE

EE NOV '87

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers and nosey parkers!

KIT REF 740 **£18.65**

MAINS TESTER & FUSE FINDER

EE MARCH '86

A handy unit which sounds an audible warning when the mains supply is disconnected and gives visual indication on three neon lamps of the connections to mains sockets. Designed for checking correct connections of mains wiring and for tracing which socket connects to which fuse in fusebox. Can detect no live, no neutral, no earth, L/N reversal, L/E reversal.

KIT REF 512 **£9.39**

EE EQUALISER

EE MAY '87

A mains powered Ioniser with an output of negative ions that give a refreshing feeling to the surrounding atmosphere. Negligible current consumption and all-insulated construction ensure that the unit is safe and economical in use. Easy to build on a simple PCB.

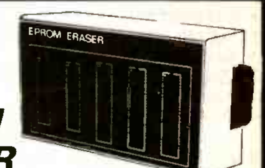
KIT REF 707 **£16.54**

MUSICAL DOORBELL

EE JAN '86

This project uses a special I.C. pre-programmed with 25 tunes and 3 chimes. A Magenta design, the circuit is battery powered and only draws current whilst producing sounds. Two rotary switches select the tune required. Provision is made for three bell pushes, each of which sounds a different tune, so that three points of entry can be identified.

KIT REF 497 **£19.95**



EPROM ERASER

EE OCT '88

Safe low-cost unit capable of erasing up to four EPROM's simultaneously in less than twenty minutes. Operates from a 12V supply. Safety interlock. Convenient and simple to build and use.

KIT REF 790 **£26.57**

LIGHT RIDERS

EE OCT '86

Thre projects under one title – all simulations of the Knight Rider lights from the TV series. The three are a lapel badge using six LEDs, a larger LED unit with 16 LEDs and a mains version capable of driving six main lamps totalling over 500 watts.

KIT REF 559 CHASER LIGHT	£14.52
KIT REF 560 DISCO LIGHTS	£20.89
KIT REF 561 LAPEL BADGE	£10.86

EE TREASURE HUNTER

EE AUG '89

A sensitive pulse induction Metal Detector. Picks up coins and rings etc., up to 20cms deep. Low "ground effect". Can be used with search-head underwater. Easy to use and build, kit includes search-head, handle, case, PCB and all parts as shown.

KIT REF 815 **£39.95**
Headphones **£1.99**

STEPPING MOTOR INTERFACE

EE JULY '85

This interface enables 4 phase unpolar stepping motors to be driven from four output lines of any computer user port. The circuit is especially suitable for the ID35 motor and our MD200 which are commonly used in buggies and robot arms. Supplied complete with ribbon cable and connector for the BBC user port.

KIT REF 464 **£8.95**

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

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TEACH-IN

Series in EE are always very popular and our recent City and Guilds *Introducing Digital Electronics* series is no exception. We can supply all the back numbers for this series (with the exception of Part 1 which is available in photostat form for the same price as a back number). We also now have three past series available in book form — all at very competitive prices. These are *Electronics Teach-In* books and you will find full details of the original *Teach-In* plus *Teach-In 88/89* on our book pages. The third book in the series, *Teach-In No. 3 Exploring Electronics*, is a reprint of a 28 part series by Owen Bishop that ran from the July 1986 issue of EE.

This new book, which is now available from newsagents, does not include masses of formulae or theory but gives straightforward explanations of circuitry and plenty of simple projects to build and experiment with. It should interest everyone who is studying electronics particularly those on GCSE, GCE "A" Level or BTEC courses.

Of course we will continue with the different series in EE — next month we start on *The Micro In Control*. Presented in a very different way, this course starts at a basic level and quickly builds to provide an understanding of microprocessor control. It is based on the author's experience in teaching just such a course and reflects the problems and misconceptions that many students have had over a number of years. I'm sure you will find it very informative.

FREE

No doubt you will have noticed that this issue carries a free copy of the 1990 Greenweld Catalogue. We believe this catalogue will once again prove to be of great interest to all EE readers. Next month we have another free gift for you — an Easiwire board from BICC-Vero Electronics. We will also be providing a couple of projects designed to go on this board, though you can of course build just about any small project on it.

It all adds up to the best value magazine around!

COMING SOON

Another publication will be available soon, this one is *Electronic Projects, Book 1*. The book is a joint venture from us at EE and Magenta Electronics — it will contain a wide range of projects each backed with a kit of components available from Magenta. Watch out for it at your newsagents from 20th October on.

Mike Kenward

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Annual subscriptions for delivery direct to any address in the UK: £15.70. Overseas: £19.00 (£36 airmail). Cheques or bank drafts **(in £ sterling only)** payable to Everyday Electronics and sent to EE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH.

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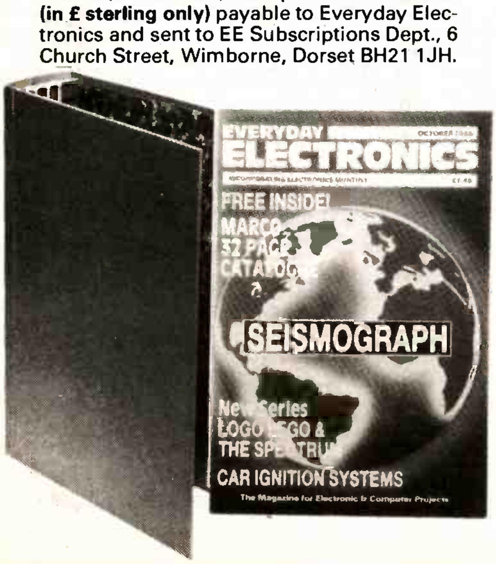

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Special Series

STABILIZED POWER SUPPLIES

STEVE KNIGHT **Part Five**

Apart from delving into the basic theory of p.s.u. design and potential problems, this short five part series will introduce three practical projects which are fairly simple to build and have reasonably good specifications.

The three stabilized units are: Variable 0V to 12V 1.5A; Variable 0V to 25V 1A; Variable 1.5V to 25V, with switched current limits of 0.5A, 1A, 1.5A and 2A.

A GREAT variety of integrated circuit power regulators and indeed complete power supply systems are available these days, and earlier on we looked at the 78/79 series and their applications as fixed voltage regulators. It sometimes happens that we have a voltage regulator which has a first class specification, but does not supply us with as much current as we would like.

The LM723 14-pin d.i.l. regulator is a case in point; it has a good ripple rejection with excellent load and line regulation, and an in-built current limiting facility. But its current output is restricted to a maximum 150mA.

This month we conclude the series by looking at a power unit design that makes use of the 723 as a driver unit for a beefier control system, one which will give us an output current of 2A while retaining the other desirable features of the 723 intact.

REGULATOR

The LM723 regulator, the pin connections of which are shown in Fig. 5.1, is a complete circuit system of the type already described, containing a series emitter-follower controller, a current limiting transistor, together with an error amplifier and reference voltage. Most parts of the circuit are made available at the pins and a variety of different connections can be made to provide a variety of stabilized output voltages.

The basic internal circuitry of the 723 is shown in Fig. 5.2 with the essential external connections shown in Fig. 5.3. By now, this should be a familiar system.

The reference voltage is derived from a constant current source and is available at pin 6. By connecting pin 6 to pin 5, the reference voltage can be applied to the non-inverting input of the error amplifier.

The inverting input is brought out to pin 4 and if this is controlled by a voltage derived from the output of the power supply, the difference will be detected by the amplifier and its output used to control the internal series regulator TR_A. This output is also brought out to pin 13 so that a compensating capacitor can be connected to the inverting input; this capacitor reduces the high frequency gain and maintains stability over the internal feedback system.

A current limiter, TR_B, is provided to take care of the effects of heavy load currents or short-circuits at the output, pin 10. This transistor senses the voltage developed across a resistor in series with the output (which in turn depends upon the current being drawn) and begins to conduct when the p.d. is about 0.65V. As TR_B conducts, it puts a low resistance bypass across the base-emitter junction of TR_A, so rendering it inoperative and shutting off the supply of current to the output.

So we have here, with the addition of a few external components, a complete

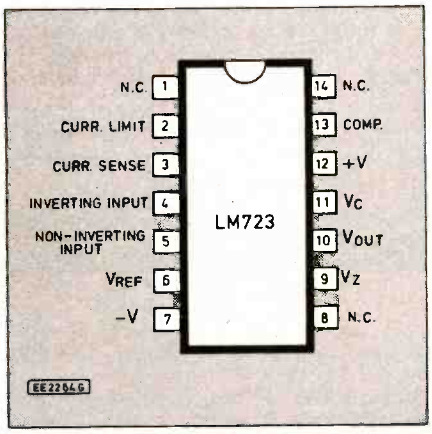
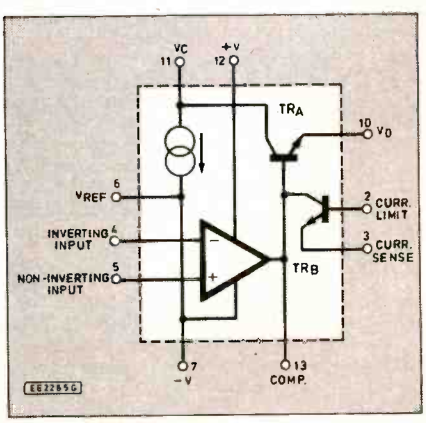


Fig. 5.1. Pinout details for the LM723.

Fig. 5.2. Internal circuitry for the LM723.



power unit which will, using the values indicated in Fig. 5.3, provide us with an output ranging from about 5V to 25V. However, there are problems of dissipation to think about — we cannot expect to be able to draw large currents from a small i.c. package.

As we have noted, the 723 has a maximum output current rating of 150mA and a maximum permissible power dissipation in TR_A of 660mW at an ambient temperature of 25°C. This derates by 5.6mW/°C so if we operate at the maximum temperature of 70°C allowed for by the manufacturers, we have lost about 250mW of our available power as internal heat. At 150mA output, we need have only 660/150 = 4.3V across TR_A before the power rating is exceeded.

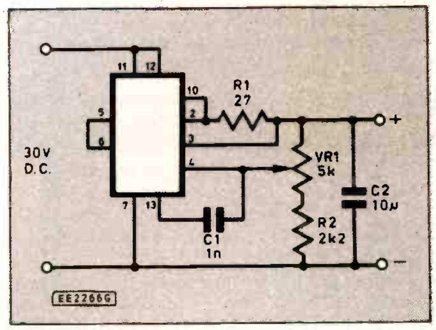


Fig. 5.3. Basic circuit using the 723 regulator to provide an adjustable low current output.

In the circuit of Fig. 5.3, if we set the output to 5V, then there will be 25V across the regulator and the maximum current will be restricted to 660/25 = 26mA. So on its own, the 723 is rather restricted in its capabilities. This does not mean that the 723 is not an effective regulator in its own right; it is, and for outputs requiring relatively small currents it is an excellent device.

Strictly speaking, circuits of the kind shown in Fig. 5.3 should be used to provide *fixed* outputs rather than variable. This then enables the maximum current to be calculated and so reduces the chances of it being inadvertently exceeded, as might well happen with a variable output

INCREASING OUTPUT CURRENT

We can boost the ouput current if we use the 723 to drive an external emitter-follower as a series regulator. The internal current limiting facility can be retained and from this we can arrange a series of discrete current limiting levels at the output.

This has an advantage over the previous designs in this series; while the earlier circuits had short-circuit protection, there was nothing to prevent the full output current flowing into the load when a fault condition appeared, whether accidental or not. So although the power unit was protected, the attached current was not. A heavy current could still be capable of doing some damage in whatever piece of equipment was attached to the power supply.

In this design, the current output in the event of a short-circuit or excessive load, can be limited to any level you care to choose within the total range of current available, that is, 0 to 2A. The actual levels are simply a matter of your own personal preference.

Three of the power supply models described in this series.

Constructional Project

VARIABLE STABILIZED POWER SUPPLY

Variable 1.5V-25V, with four switched current limits of 0.5A, 1A, 1.5A and 2A.

THE CIRCUIT he circuit diagram of the 2A power unit is shown in Fig. 5.4. Here a conventional bridge rectifier feeds the 723 (IC1) which in turn drives the power booster combination of transistors TR1 and TR2. Transistor TR1 (a 2N3055) is the conventional series emitter-follower controller which is itself driven by TR2, a small power transistor, type TIP31A. This is necessary as the output of IC1 (723) is insufficient to drive TR1 directly.

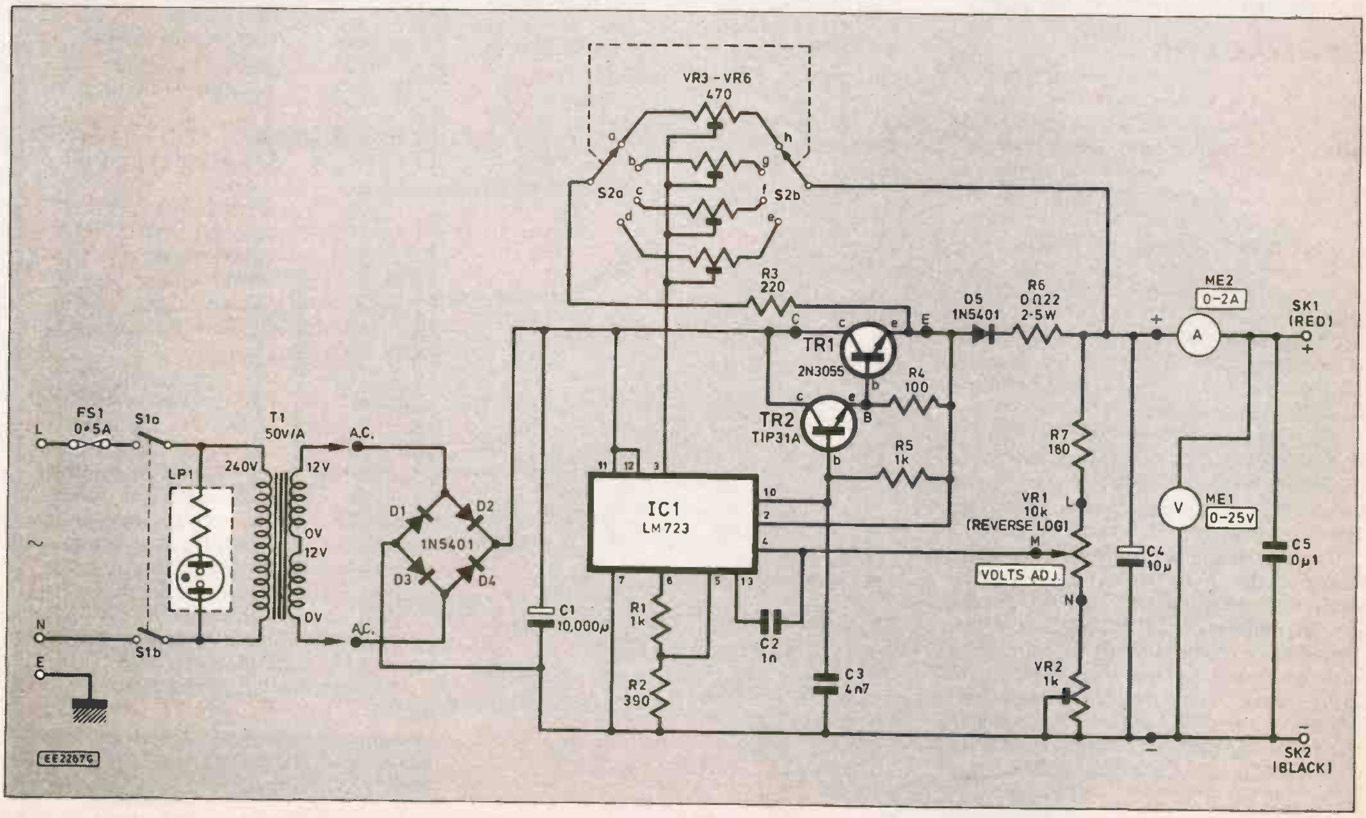
Resistor R6, in conjuction with diode D5, forms the current sensing resistor and a portion of the voltage developed across this arrangement is tapped off by one of the potentiometers VR3 to VR6 and applied to the current sensing input pin 3 of IC1. This determines the point at which the current output is limited.

The effect of diode D5 is that, being non-linear, the effective resistance of the sensing combination increases with lower current outputs and maintains a sufficient voltage across the potentiometers to ensure proper operation of the limiter in the 723 regulator. By selection of the potentiometers by the ganged switches S2a and S2b, four current levels can be preset.

The output voltage is adjusted between about 1.5V and 25V by VR1 which connects to the inverting input (pin 4) of the error amplifier. This compares output variations with the internal reference, selected by the divider chain made up of resistors R1 and R2, and adjusts the output at the base of Transistor TR2. TR2 drives TR1 which then compensates for the output change, so stabilising the output. Potentiometer VR1 is a *reverse* log type which allows a closely linear relationship between rotation angle and output voltage. A linear potentiometer leads to cramping at the lower end of its rotation.

The bridge rectifier (D1-D4) is made up from four discrete diodes, types 1N5401, which are 3A devices rated at 100V r.r.m. Smoothing is carried out by capacitor C1. This capacitor has to be rather large if a 2A output capability is required; taking it that

Fig. 5.4. Complete circuit diagram for the 1.5V-25V Variable Power Supply. The solid circles refer to circuit board connection points.



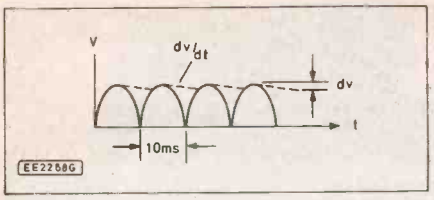


Fig. 5.5. Ripple voltage calculations for capacitor C1 selection.

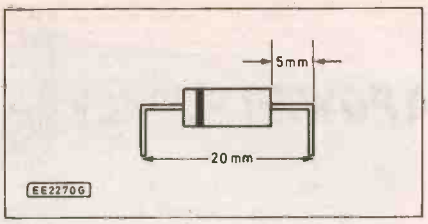


Fig. 5.7. Using long-nosed pliers, bend the diode leads to suit board hole spacing.

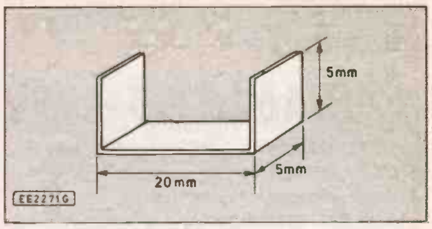


Fig. 5.8. Suggested alternative heatsink dimensions for IC1.

the maximum input ripple voltage to the 723 regulator should not exceed 2V when the full current is being drawn, then since ripple gradient dV/dt = 1/C (see Fig. 5.5) and dV = 2V, dt = 10ms for 50Hz supplies, we get C = 2 x $^{10}/2$ = 10kμF.

We also need a ripple current rating of at least twice the average worst case ripple current we are likely to draw from the capacitor. Therefore, for this unit we need a ripple rating of at least 4A. The specified capacitor has a rating of 5A which gives us something in hand. If you use an alternative capacitor, keep these figures in mind.

It is suggested that both voltage and current meters be fitted to the complete unit. A voltmeter is almost certainly necesary and an ammeter is well worth inclusion. The circuit for the two meters is shown between the Volts Adjust control and the output terminals in Fig. 5.4. These are wired between the board output terminals and the front panel of the unit. If the specified meters are used, no rescaling is necessary.

CONSTRUCTION

All components are mounted on a single-sided printed circuit board except the mains transformer T1, the power controller transistor TR1, the Output Voltage Adjust control VR1 and the Current Limit switch S2. A ready-drilled board is available from the *EE PCB Service*, code EE663.

The printed circuit board component layout and full-size copper foil master pattern is given in Fig. 5.6, with an indication of the wiring from edge Vero pins to the various external components and controls. The lettering on the board matches that shown on the circuit diagram and Fig. 5.10.

There are one or two points of importance to be noted about mounting components on the board. The first concerns capacitor C1. This is a p.c.b. mounting type of capacitor and the component used has five fixing pins. Only two of these are for the positive and negative connections, the other three ***must*** be left isolated.

If you use the specified component, the board positions will be correct. However, you may obtain, or already have, an alternative capacitor; in this case the board will have to be drilled to accommodate the alternative pin arrangement. This may necessitate linking up to the positive and negative copper rails on the board with a short length of wire but this should not be too difficult to cope with.

The essential thing is the physical size of an alternative; height is not too important, but diameter is. If the diameter is greater than some 45mm, there may be a problem of accommodation.

Diodes D1 to D4 and the solitary D5 have rather thick (1.3mm) connecting wires and great care must be exercised in bending these to suit the board spacing holes. It is best to grip the wire close to the body of the diode with a pair of thin-nosed pliers and then bend the wire at right angles with the fingers. Fig. 5.7 shows the necessary dimensions.

Fit these diodes snugly into their board positions, *noting the polarities*, but leave a space of about 3mm (⅛in) between them and the board; do *not* press them down hard on to the board. The same applies to the 2.5W resistor R6; let it stand clear of the board by at least 5mm(3/16in).

HEATSINKS

The regulator IC1 needs a standard 14-pin d.i.l. holder and a heatsink. The driver transistor TR2 also has a heatsink.

COMPONENTS

Shop Talk see page 716

Resistors

R1,R5	1k (2 off)
R2	390
R3	220
R4	100
R6	0Ω22 2.5W
R7	180

All 0.25W metal film, except where stated.

Potentiometers

VR1	10k rotary, reverse log.
VR2	1k min. skeleton preset, hori.
VR3-VR6	470 min. skeleton preset, hori.

Capacitors

C1	10,000μ 40V 5A
C2	1n polyester
C3	4n7 polyester
C4	10μ tantalum 35V
C5	0μ1 polyester

Semiconductors

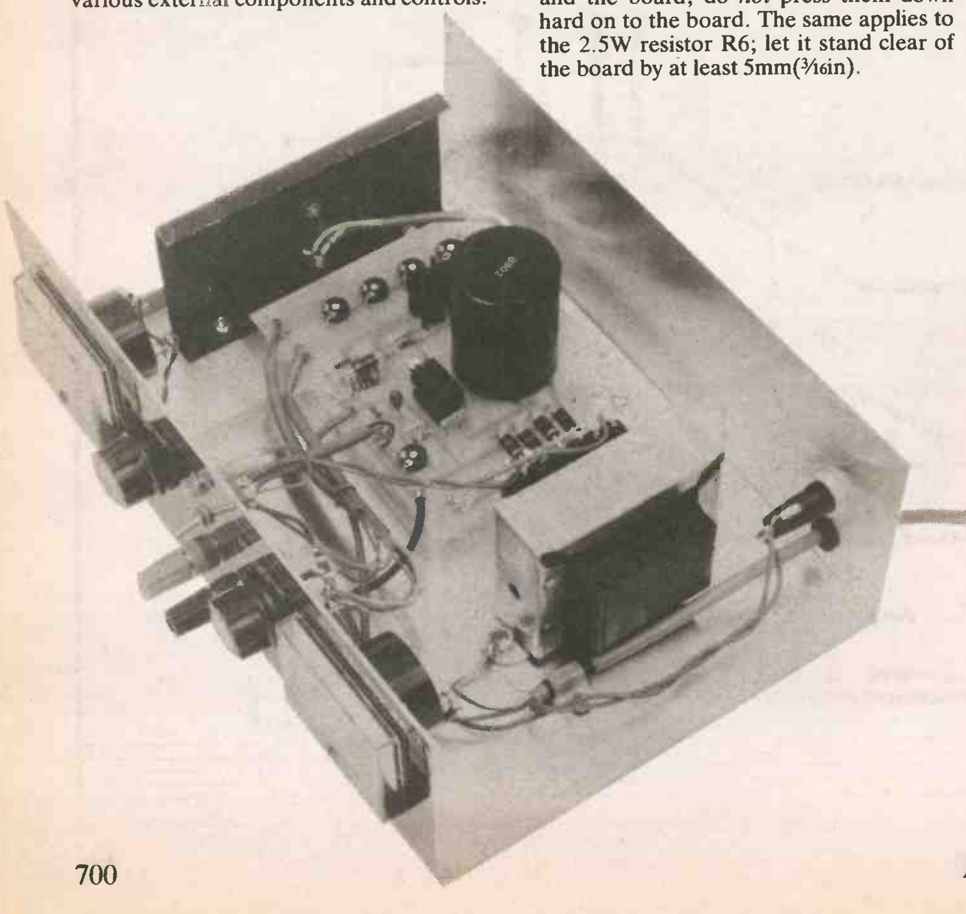
D1-D5	1N5401 3A 100V rec.
TR1	2N3055 or 2N3771 *npn* power
TR2	TIP31A *npn* power
IC1	LM723 variable voltage regulator

Miscellaneous

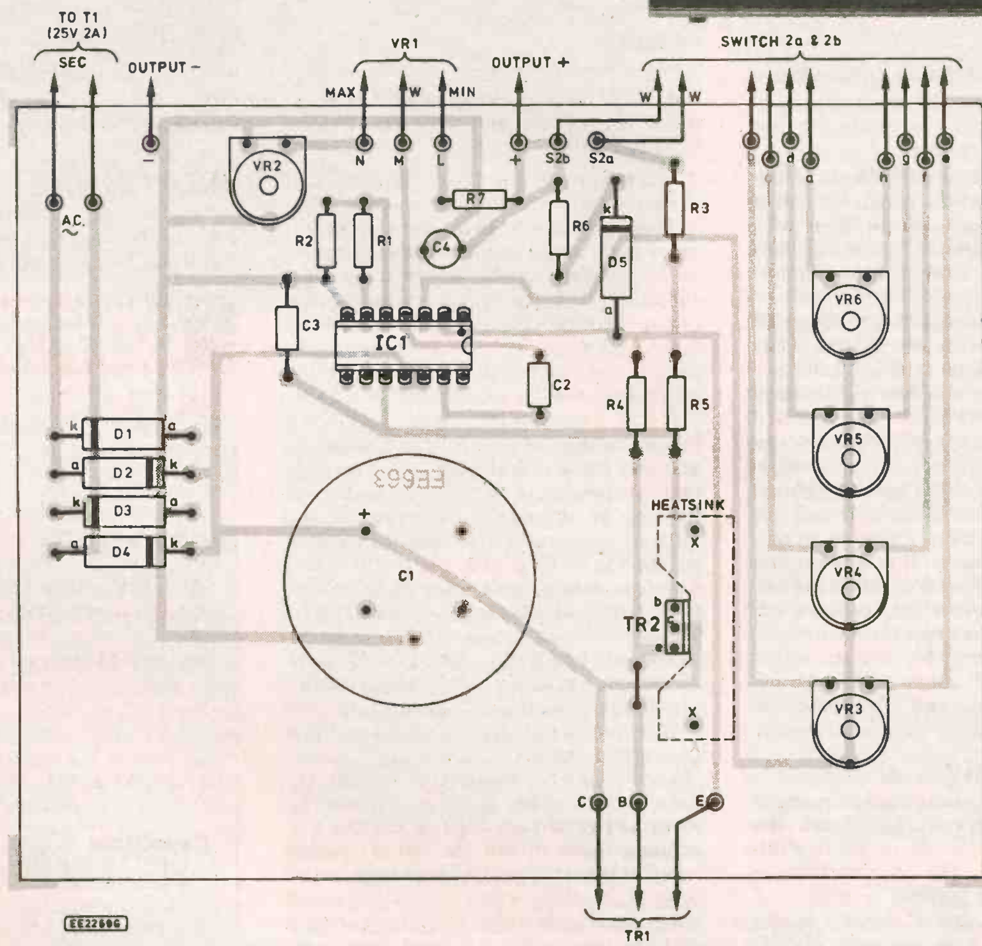
S1	Mains d.p.d.t. on/off toggle
S2	3-pole 4-way min. rotary, Lorlin
T1	25V/A Mains transformer, 12V-0V-12sec
ME1	0-25V moving coil meter
ME2	2A moving coil meter
LP1	220-250V neon indicator

Printed circuit board, available from *EE PCB Service*, code EE663; case, vinyl covered 305mm x 159mm x 133mm; heatsinks, 14s.w.g. aluminium (see text), clip-on (for IC1, RS 434-059) and finned (for TR2, RS 403-162); SK1, SK2 4mm type, 1 black, 1 red; 500mA cartridge fuse; connecting wire; solder etc.

Approx. cost Guidance only **£50**



VARIABLE 1.5V-25V 2A POWER SUPPLY



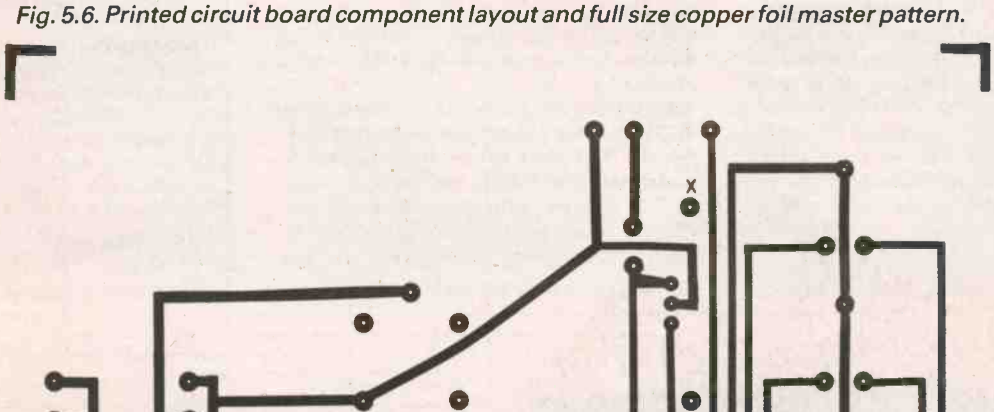


Fig. 5.6. Printed circuit board component layout and full size copper foil master pattern.

The regulator IC1 should have a clip-on type of heatsink but if this is not available, a piece of 16s.w.g. aluminium bent to the dimensions shown in Fig. 5.8 will do. This is simply glued to the top of the i.c. using a thin layer of a quick setting epoxy resin.

Transistor TR2 is attached to a small finned heatsink which is designed to fit into the board and soldered at the two points *X-X* (see photographs). When fitting TR2 to its heatsink (and to the board) take care that the three connecting leads are not shorting out to the heatsink.

Preset potentiometers VR3 to VR6 should be the enclosed rather than open skeleton types, but you can use the latter if you can't get hold of anything else. The rest of the components need no special comment. The usual care in soldering must be followed for the whole of the assembly, and watch out all the time for solder bridges and splashes, particularly around the i.c. connections and all parts where the copper track spacings are close.

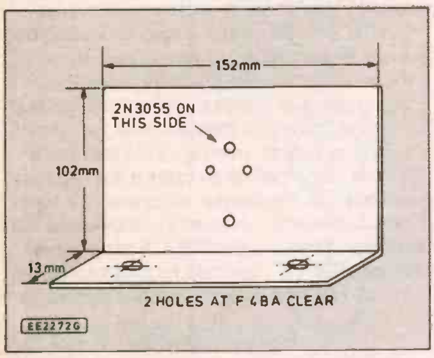


Fig. 5.9. Dimensions and drilling details for the main heatsink.

MAIN HEATSINK

The main heatsink for the power transistor TR1 is made out of a piece of 14s.w.g. aluminium sheet measuring 152mm by 102mm plus a 13mm turn-over. You may, if you wish, use a commercially made one, but it should have a rating of at least 2°C/W.

It is now simply a matter of fitting the controller transistor TR1 to the heatsink and providing the connections from the board to TR1, the actual positioning of board and heatsink inside a suitable box is not particularly critical.

Bend the aluminium to the dimensions shown in Fig. 5.9. If you cannot get hold of 14s.w.g. aluminium or have bending troubles, use 16s.w.g. but it might be advisable to add an extra "inch or two" to the width if you do this.

Either before or after "blacking" the heatsink, lay the insulating washer on it and mark through the three pinout hole positions on the heatsink. Drill the heatsink and mount the 2N3055 transistor slightly below centre on the heatsink, using the insulating kit.

Position the heatsink at one end of the base of the case and mark through and drill suitable mounting holes in the bottom of the case. Mount the mains transformer at the other end of the case as indicated in the photographs.

There should now be enough space between the heatsink and mains transformer to take the completed circuit board. Lay the circuit board in position and mark through the mounting holes onto the bottom of the case. Remove the board and drill suitable mounting holes in the bottom of the case.

The circuit board shoud now be mounted in position on about quarter to half inch spacers. Just prior to mounting the board, solder the base, emitter and collector wires to TR1 pins and bring these down so that after the board is screwed to the base of the case, these wires can connect to the appropriate Vero pins *B*, *E* and *C* on the board.

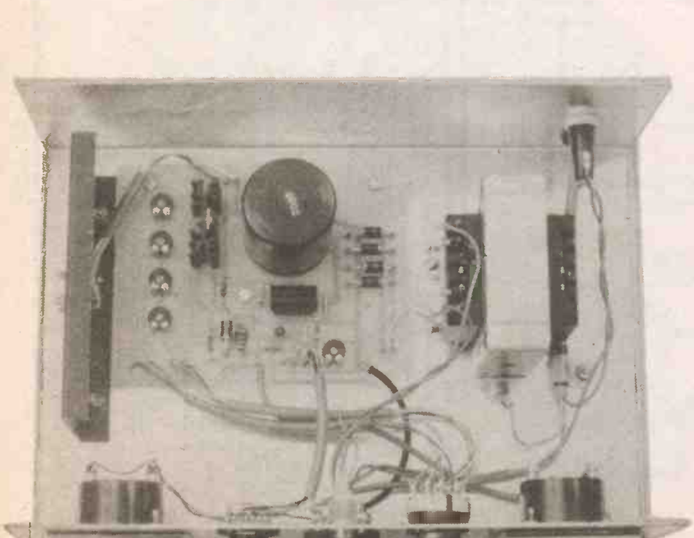
BOXING UP

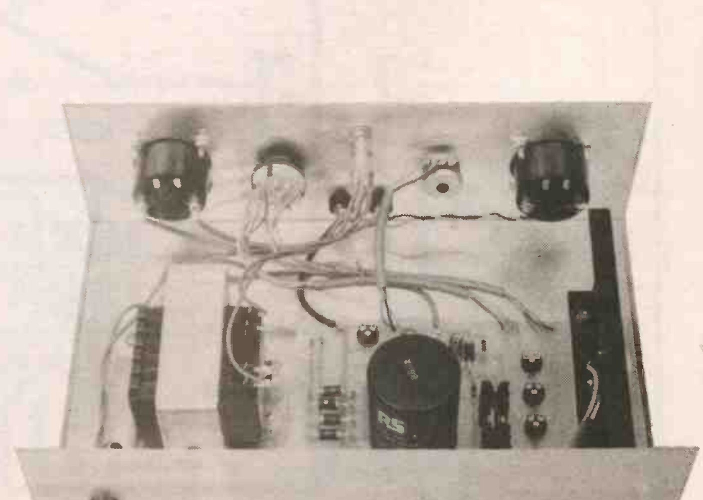
The case used for the prototype was one of the vinyl covered types. This is a simple two-piece box which makes assembly very easy. Strictly speaking, it is a bit larger than is necessary for this job, but plenty of room never did harm, and the only thing to watch out for if you use an alternative is the height which should be at least 102mm.

The reason for this is that the heatsink panel should be mounted vertically. You *can* mount it horizontally if you wish, but the cooling isn't so efficient.

The only parts bolted to the floor of the case are the heatsink, circuit board and the mains transformer. Everything else is on the front panel, apart from the fuse which is best mounted at the rear, alongside the entry point for the mains cable.

A suggested front panel layout is shown in the photograph above. As the box is a plain aluminium finish, it is well to give a coat of suitable spray paint before attaching Letraset style lettering. The "current limit" ranges are shown as 0.5A, 1.0A, 1.5A and 2.0A. These can, in fact, be any values you like, so if you want other levels, mark your panel accordingly. Setting these levels up is discussed later.





INTERWIRING

The interwiring connections are made in accordance with the circuit diagram Fig. 5.4, board layout Fig. 5.6 and Fig. 5.10. It is best to start by wiring up the meters and connecting these to the positive (+) and negative (−) output points on the board. Use a flexible 16/0.2mm wire for this.

Next, connect the pins *L*, *M* and *N* on the board to the Voltage Adjust control potentiometer VR1, noting that the *maximum* output voltage is obtained when the slider is at the VR2 end of the track. As already indicated, this control should be a *reverse* log potentiometer.

Wire two of the current limit switch poles or "wipers" to points S2a(w) and S2b(w), and their associated switch tags to *a* — *h* board points. It is as well not to use Vero pins for the latter eight positions but to solder the wire directly to the board. 7/0.2mm is a suitable gauge here and preferable to single strand wire. This is the only place where a wiring connection might go wrong, so care is needed.

The Lorlin switch S2 is a 3-pole, 4-way component, of which only two of the poles are used. The switch is numbered and lettered A, B and C for the three sliders and these connect respectively to the contacts 1-4, 5-8 and 9-12 as the switch is rotated clockwise. If you follow Fig. 5.11, there shouldn't be any confusion. Keep all these wires in a neat bundle on their way across to the board; they do not carry heavy current.

The mains transformer secondary winding is now connected to the a.c. terminal pads and the primary wiring (neon LP1, fuse FS1 and on-off switch S1) completed. The fuse should not be more than a 1A rating. And, as always with any mains wiring, treat this side of the system with respect.

SETTING UP

To set up the unit, first of all turn all preset potentiometers to the middle of their tracks. Set the output voltage control VR1 to minimum (fully anticlockwise) and the current-limiting switch S2 to its first (0.5A) position. Then shut your eyes and switch on.

When you open them, the neon indicator should be lit and the voltmeter ME1 should be indicating a small output, typically 1.5V. This is the normal minimum output from this unit. The ammeter ME2 should remain at zero.

Advance the voltage control VR1 carefully and check that the output voltage increases. When the control gets to its maximum position, adjust preset VR2 so that the voltmeter reads 25V. This completes the voltage setting.

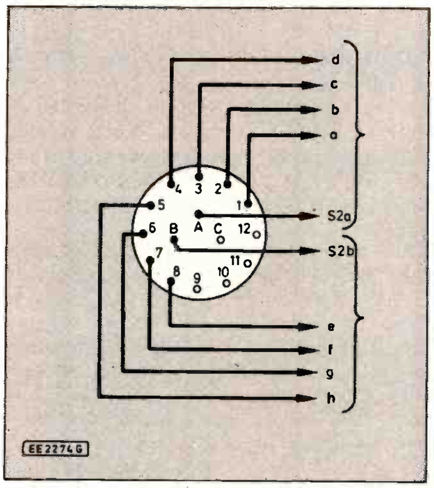


Fig. 5.11. Wiring from the "current limit" switch S2 to the circuit board.

CURRENT LIMITING

If all this has happened uneventfully and there has been no sign of circuit discontent, we can now get on with setting up the four current-limit stages. This procedure is best done fairly quickly, not that any damage is going to result if you happen to be slow, but unnecessary heating will be avoided.

Make sure that the current limit switch is in its most anticlockwise position (corresponding to the 0.5A limit), then put a temporary short circuit across the output terminals. Adjust VR6 (nearest the top of the board) until the ammeter reads 0.5A. Switch to the next position (1.0A) and adjust VR5 until the ammeter reads 1A. Repeat this procedure for the 1.5A and 2A positions of the switch.

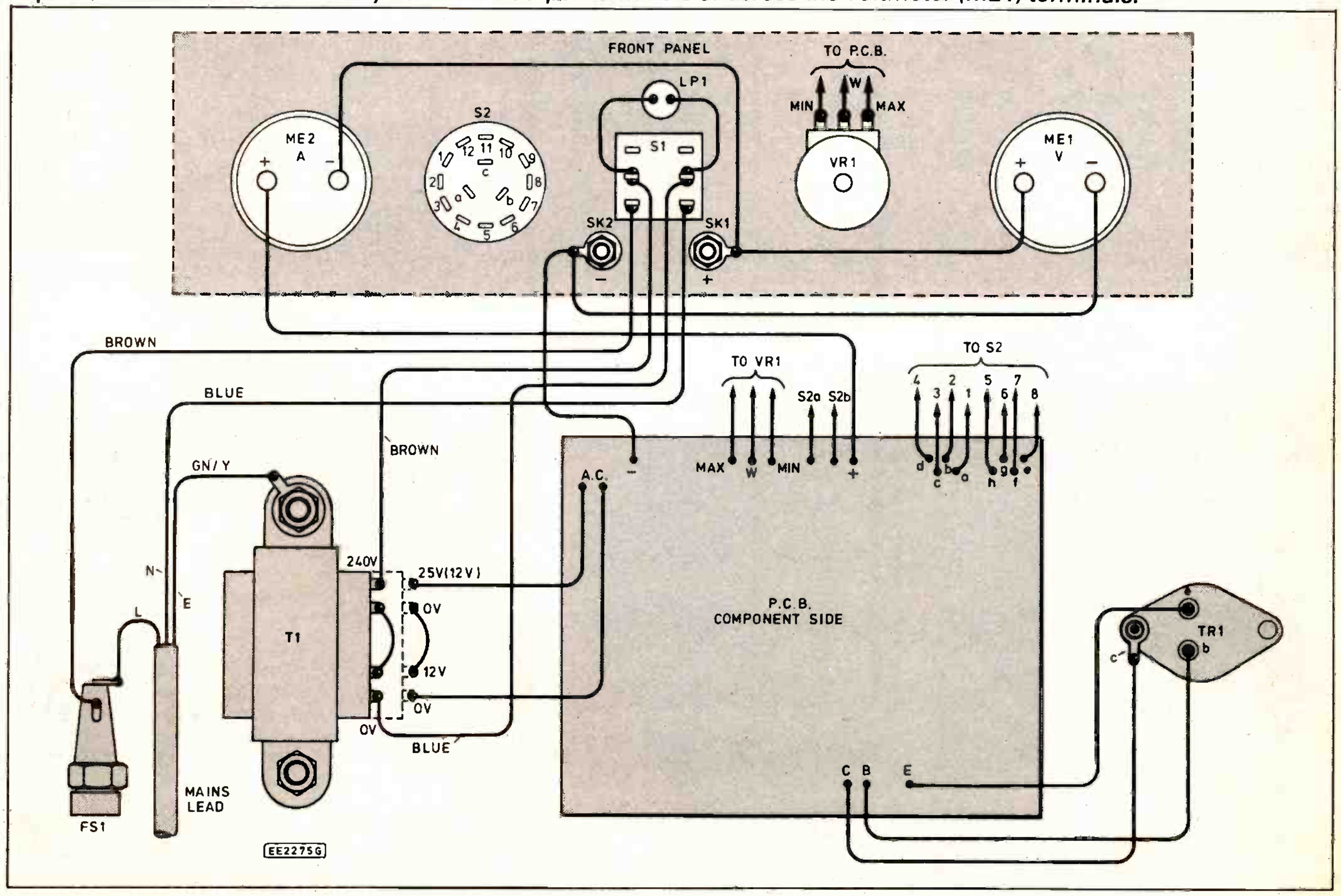
While this is going on, of course, the voltmeter will read zero. Remove the short circuit and the unit is now ready for use.

You may wish to set up alternative current limits, for instance, you might prefer 0.25A, 0.5A, 1.2A and 1.8A for some reason. Just follow the above drill, adjusting the potentiometers to suit the limits you want. ***Do not exceed a maximum current of 2A however.***

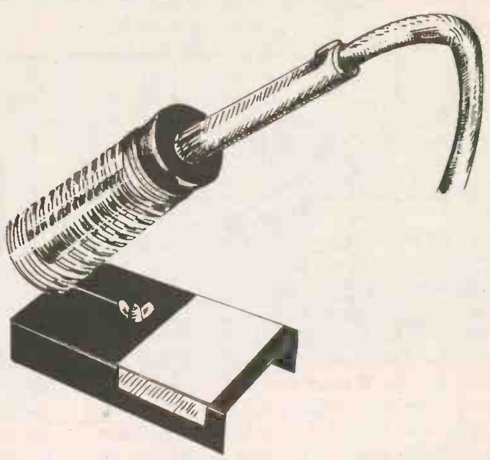
Keep in mind when using this power unit, that once the current limit on any of the four ranges is reached, the voltage output will stay put and cannot be further increased. For example, suppose you have a load connected whose resistance is 20 ohms. Then on the 0.5A limit position, the greatest voltage you can have before 0.5A is reached is 10V, so the voltmeter will not go past the 10V position.

This completes our series of articles on power units and trust you have found something that fits your requirements among them. □

Fig. 5.10. Interwiring from the circuit board to front panel components, TR1, fuse and mains transformer. Note that capacitor C5 can be wired directly across the output terminals or across the voltmeter (ME1) terminals.



IRON-ON REMINDER



R. M. WORTHINGTON

This simple, inexpensive unit will remind you to turn off your soldering iron when it is not being used.

FORGETTING about a switched-on soldering iron can have results varying from pitting and oxidation of the bit to fire hazard, especially if left overnight. So, for electronics constructors who habitually nod off, or wander away to watch "Neighbours", this circuit will provide a reminder when it's needed.

A small sensor is mounted close to the position of the soldering iron bit, when in its stand. Then, if the iron remains switched on and unmoved, for a set length of time, a 70dB alarm sounds. The main unit, physically small and battery powered, can be mounted at a distance from the temperature sensor, and the circuit will turn itself off after a set number of hours. The self-defeating expense of a mains supply or heavy battery consumption is thereby avoided.

CIRCUIT

The circuit diagram for the Iron-on Reminder is shown in Fig.1. IC3 is the 7555, operating in monostable mode, which was chosen for its extremely small standby current. IC3 is triggered, at the start of any electronic assembly work, by pressing S2. The values of R10, R11 and C3 then determine its "on" period (T = 1.1RC). In this case each of the values is very large, so the voltage at pin 3 stays high for several hours. (It is possible that due to leakage in C3 that it will never charge — should this happen R11 can be reduced in value to achieve a suitable on time).

IC1, a 1458C, is the dual version of the 741 chip, so two separate 741s could, of course, be used in its place. However, the 1458C is more compact, takes less current, and is often cheaper than the separate form. It takes a modest 3mA or so during the "on" time.

Diode D1 is used as a temperature sensor, both D1 and D2 being inexpensive silicon diodes. The output of IC1a goes high if the voltage at pin 3 (non-inverting input) is higher than at pin 2 (inverting input). This occurs if D1 is at a higher temperature than D2, its resistance decreasing and the voltage at pin 2 falling.

COMPONENTS

Shop Talk see page 716

Resistors

R1	4k7
R2,R3,R5 to R7,R9	10k (6 off)
R4	8M2
R8,R13	47k
R10	10M
R11	1M
R12	270

All ¼ W Carbon

Potentiometer

VR1	4k7 preset

Capacitors

C1	100μ elect. 12V
C2	10μ elect. 12V
C3	1,000μ elect. 12V

Semiconductors

TR1	2N697 *npn* transistor
IC1	1458C dual op. amp.
IC2	555 timer
IC3	7555 CMOS timer
D1 to D3	1N4148 silicon diode (3 off)
D4	red l.e.d.

Miscellaneous

S1,S2	s.p.s.t. push to make switch
WD1	6V 240ohm buzzer (MB726 or similar)
B1	9V PP3 battery and connecting clip.

Veroboard 36 holes by 16 strips; suitable small plastic case (approx 100 x 76 x 41mm); connecting wire etc.

Approx. cost Guidance only **£7.50**

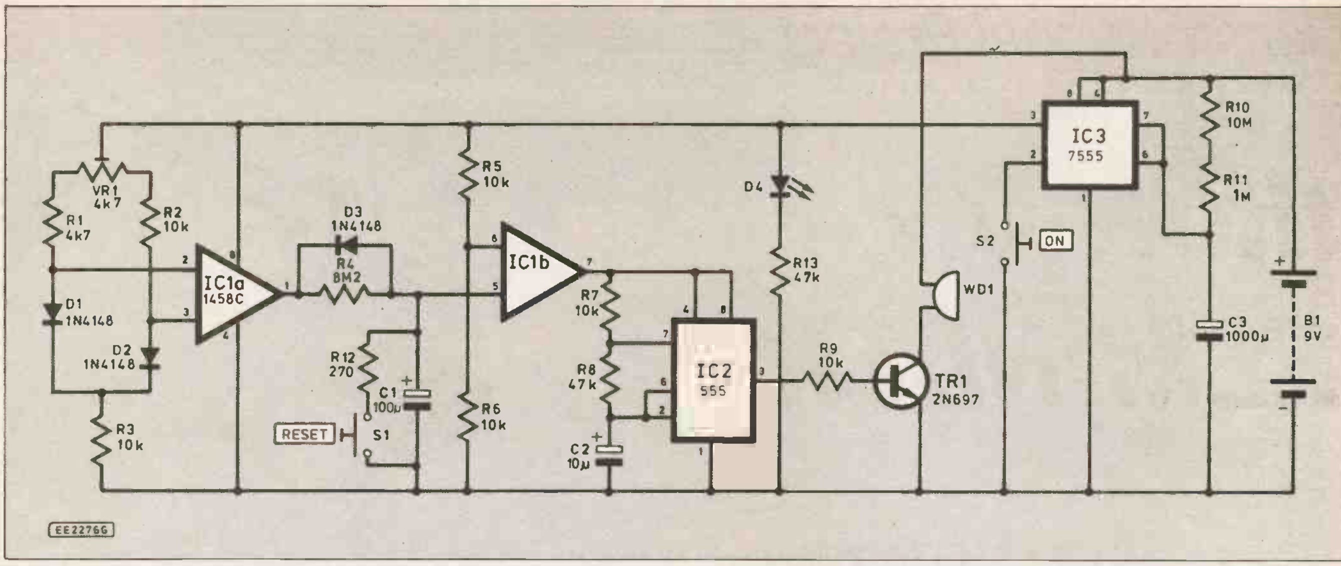
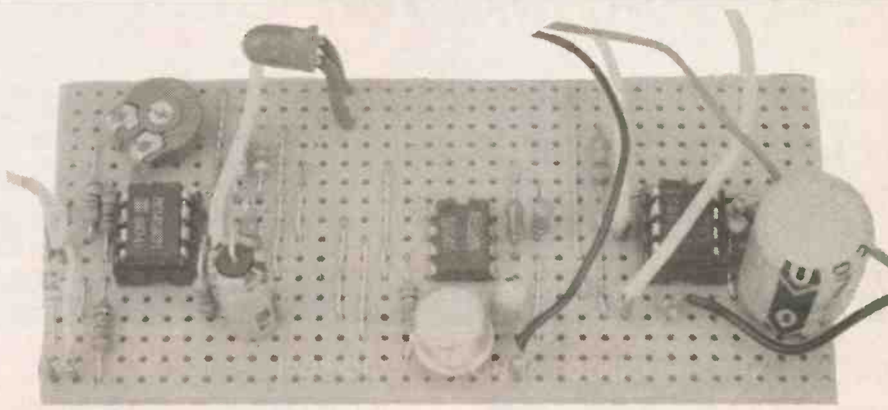


Fig. 1. Complete circuit diagram of the Iron On Reminder.



Capacitor C1 then starts to charge up through a high value resistor and, when its voltage becomes greater than at pin 6, the output of IC1b goes high. This takes about 15 minutes: D3, normally reverse biased, discharges C1 if the output of IC1a goes low, should, for example, the soldering iron be moved from its stand and D1 cool.

Otherwise, IC2, the common 555, will intermittently sound the buzzer (a 6V, 240 ohm type MB726, was used in the prototype), until the reset switch S1 is pressed.

A l.e.d. (D4) and 47k resistor (R13), connected from IC3 Pin 3 to ground provide a battery indicator — these components may be omitted if not required. Since the l.e.d. will not be very bright, problems from ambient light are avoided by mounting the l.e.d. a few mm behind a small hole in the case.

CONSTRUCTION

The prototype circuit was built on Veroboard, one possible layout being shown in Fig. 2. It might be easier for testing if sockets are used for IC1 to IC3, but all three can be soldered in without too much risk of damage. All inputs and outputs of the 7555, a CMOS device, are protected against static discharge, so no special treatment is needed.

The tiny current needed to trigger the 7555 means that pin 3 may stay permanently high after triggering, due to stray signals in the wire from pin 2. A resistor (say 4k7) from pin 2 to +9V cures this.

Diode D2 can be mounted inside the case, with holes drilled to allow air circulation. The positioning of the buzzer depends on the size of the case used. Either a pattern of holes are drilled in the case, the buzzer mounted inside, or the leads can pass through a small hole in the case with the buzzer on the outside

Switches S1 and S2 are both "push to make" switches. Whilst the 7555 can be simply arranged to act as a touch switch, it was considered better to have the reliability of an ordinary switch, earthing pin 2 to ground.

Switch 1, which stops the buzzer sounding, resets but does not turn off the circuit. It is connected across C1, in series with a low value resistor to prevent damage to the switch contacts.

The completed board should be checked for the usual problems, such as solder

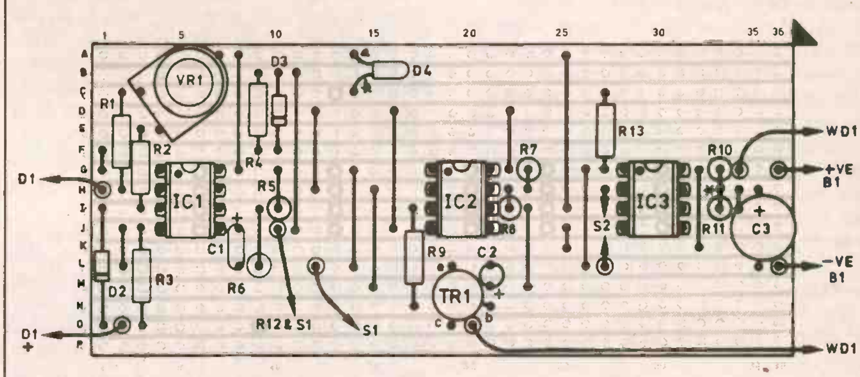
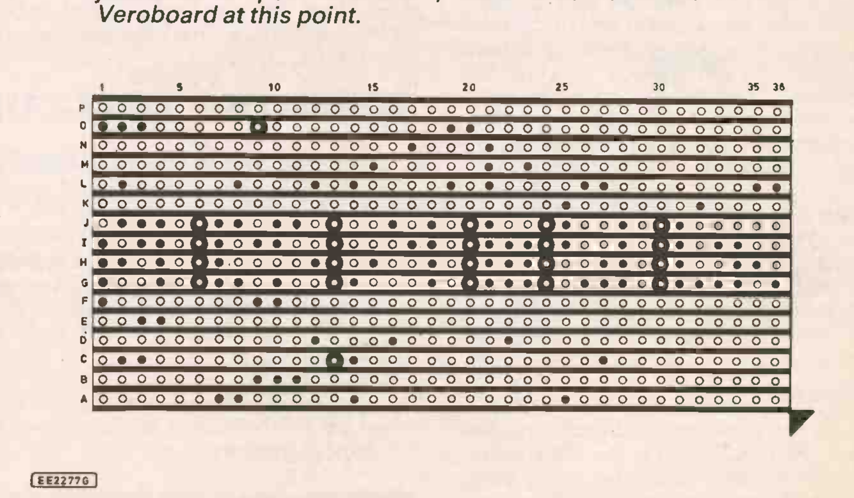


*Fig. 2. Veroboard layout and wiring. Note that R10 and R11 are joined at the point marked *, there is no connection to the Veroboard at this point.*



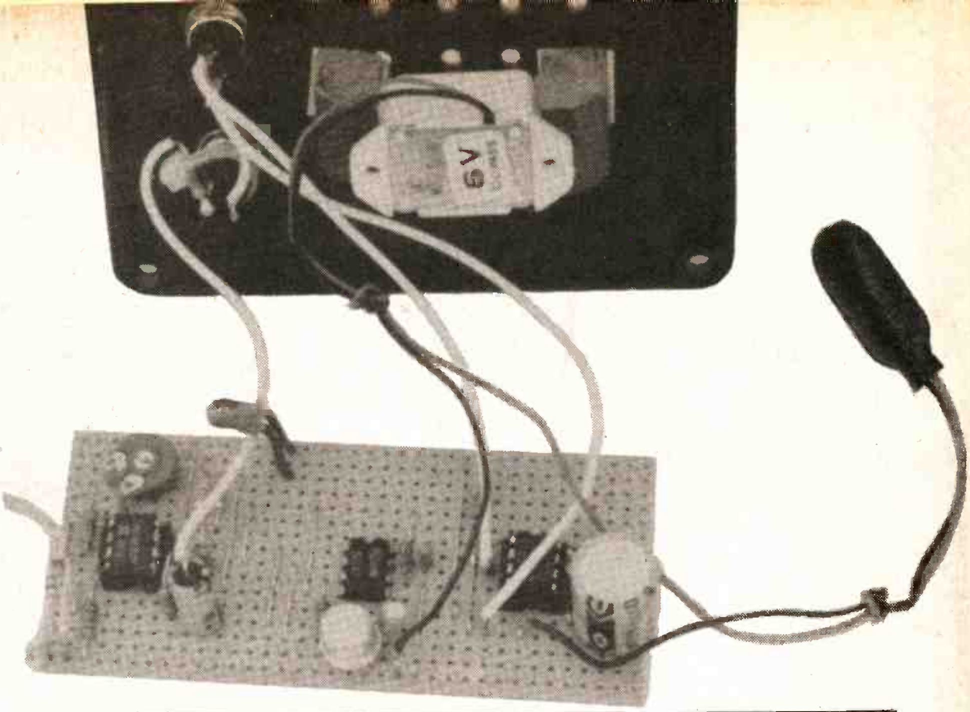
bridges or unmade cuts in the copper tracks, before adjustment.

SETTING UP

The only adjustment required is the setting of VR1 (4k7 preset). This, together with the distance of the sensor from the bit, has to be arranged so that pin 1, IC1 goes low quickly after the soldering iron is moved from its stand. The time for pin 1 to go high, when the iron is replaced, is less crucial.

Preset VR1 is turned so that the voltage on pin 1 just goes high (from about 2V to about 8V). It is then backed off a fair distance and the arrangement tested out. The sensor should not, of course, be in contact with the bit; the circuit measures small differences in *air* temperature. Provided that D1 is warmer than D2, the correct operation of IC1b and IC2 can be checked by shorting out R4.

The control box is then mounted in a convenient position for everyday use. □



FOR YOUR ENTERTAINMENT

BY BARRY FOX

Presence Pain

Just what it is that compels sound and studio engineers to lift the mid band, between 2kHz and 5kHz, and give music added "presence"?

They do it at concerts, and they do it with CD masters. For many listeners, the result is a painful experience.

Is this because engineers have a mid range dip in their own hearing, caused by prolonged exposure to excessively loud sound? Certainly people who work in noisy factories start to lose their hearing in this frequency band. It's known as "the 4k dip".

Or is it that as people grow older and more boring, they suffer natural roll-off at the high frequencies, making the mid band sound artificially louder anyway?

If so, then perhaps there should be one sound mix for young audiences, with mid range lift, and another mix for older audiences, with low and h.f. lift.

The obsession with boosting mid range on recorded material is a bad hangover from the days of vinyl LP releasing. The scenario goes like this. The artist goes to the studio, makes a multi-track recording and mixes it down into stereo. He then goes proudly to the record company and says "Here's my tape". The tape he plays them is a flat i.e. true, copy of the studio master so it sounds exactly as the artist wants it to sound. The record company makes flat cassette copies and those too sound pretty much the same.

Master

Now the time comes to make master discs, and usually it's the LP master first. The record company books time at a cutting room that the artist likes, and the cutting engineer there makes a copy master, with the music split into two halves (for sides A and B) and frequency "equalization" tailored to suit the characteristics of a vinyl LP. Bass frequencies are trimmed, to avoid excessive groove modulation; high frequencies are trimmed to avoid overloading the cutter or cause mistracking on the cheap cartridges that most record buyers will be using. At the same time, the mid range between 2kHz and 5kHz is lifted to make the mix sound louder.

Then someone from the record company says, "Please make me a CD master tape as well". This involves converting the music into digital code and copying it onto a U-Matic cassette, without any break between A and B sides and perhaps with a few extra tracks to make the CD seem better value for money.

The U-Matic tape has digital time code along the edge and digital subcodes are added to mark the beginning and end of individual music tracks on the tape. When these codes end up on the disc, they control the player.

Headache

Chances are that there is not enough time to re-think the equalization. So the mid range lift stays in. And because CD players reproduce a flat signal, the mid range lift ends up coming out of the loudspeakers. So the final sound is quite different from the artist's master mix. Excessive presence gives sensitive listeners a headache, just like the excessive presence from a concert sound system.

If you happen to have a 27 band graphic or parametric equalizer handy, try pulling back the mid range next time you hear a CD sounding brittle. The effect can be quite magical. Of course a more sensible solution would be for the record companies to make separate masters for CD and LP releases and stop putting presence lift on CDs.

MORE BETTER!

The soap powder industry eventually ran out of adjectives. You can't get much "whiter than white". It looks as if the video tape industry has now hit the end stops, too.

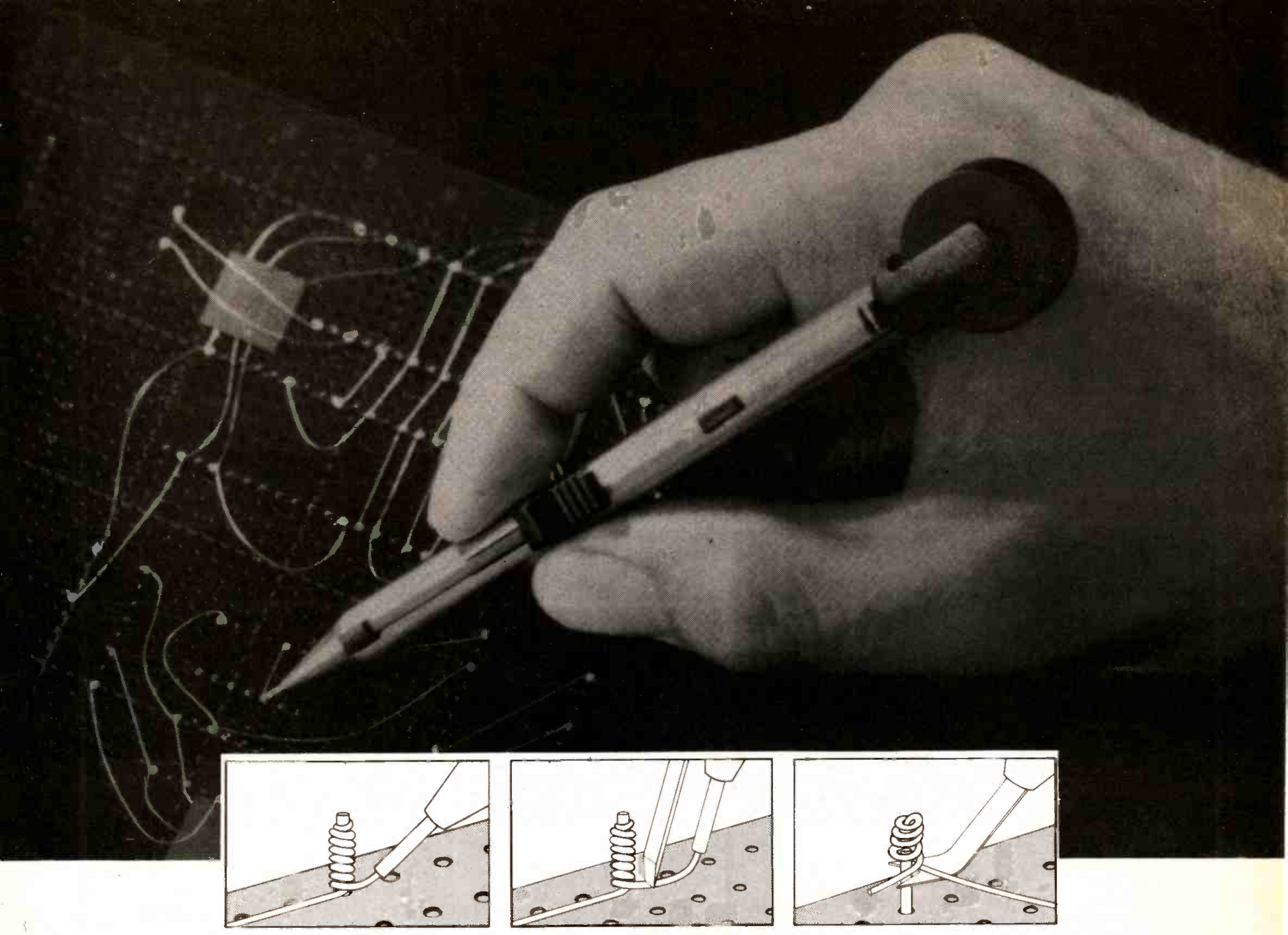
No-one knows the difference between "extra high grade super" and "pro hi fi super HG" or "superior master professional" cassettes (not even the firms selling them) so everyone just buys the cheapest pack of three name brand E-180s on offer.

In April, Fuji in Japan introduced the world's first "double coated" or DC video tape. Now, less than six months later, there is "super double coating". What's the difference?

Easy; I quote.

"Super DC magnetic particles are even more ultra-fine than the DC formulation and the magnetic layer surface is even more ultra-smooth".

Now you know.



EASIWIRE

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EE SEISMOGRAPH

TONY HOPWOOD and ANDY FLIND Part Two

Is this the first homebrew Seismograph? Watch for earthquakes and nuclear tests around the world.

HAVING completed the description of the electronics involved in the seismograph last month, we now turn our attention to the mechanical assembly.

MECHANICS

The mechanical construction of the seismometer is straightforward, and requires no precision engineering. Most of the materials can be obtained as scrap and recycled as befits an earth sciences project! The one critical operating parameter is friction, so the sensing beam must pivot on a hard smooth surface like a small ball bearing. I used the flywheel spindle of a defunct cassette player because it had a hardened and ground spherical bearing surface. This sits in a conical counterbore on a quarter inch bolt head screwed into the back post. A ballpoint pen end will work just as well.

Size of the instrument is a matter of choice. I built a rather large unit because I had room for it. In urban areas, an instrument with a longer period than 6 seconds will tune out most of the traffic vibration, and the size can be cut by increasing the mass and keeping the beam angle to a minimum. This means better quality mechanical engineering!

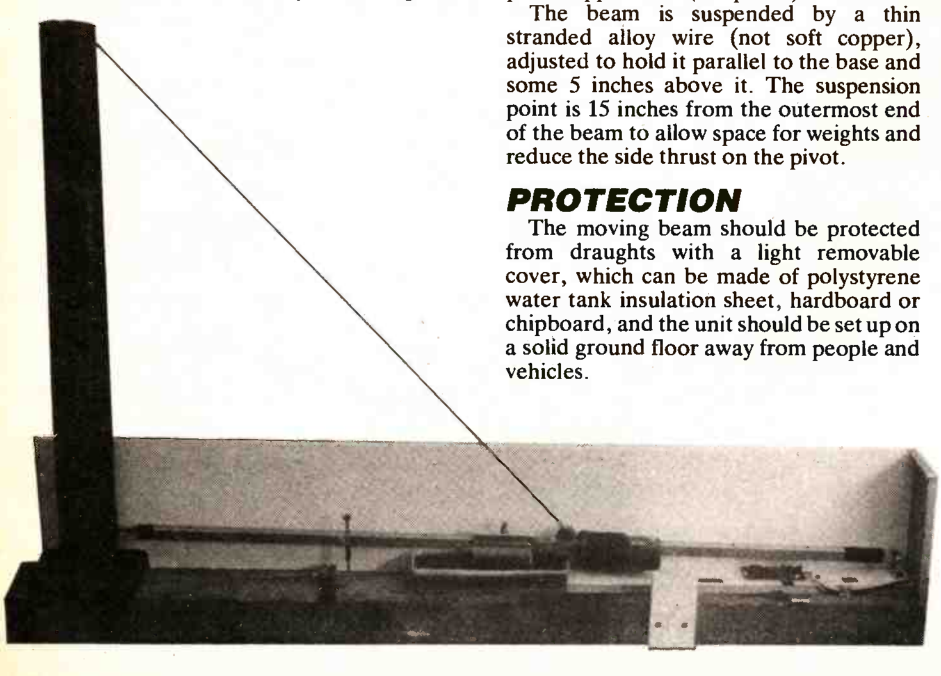
I used a 48 inch long pendulum beam of 20mm square section aluminium tube (ex clothes dryer). The beam must be light and rigid, because it will be loaded with extra weight to "tune" it. (Fig. 1).

The base is a 60 inch length of 5 inch × 3 inch timber. At the pivot end it is screwed onto a tranverse 24 inch piece of 1.5 inch square steel box section fitted with ⅜ inch levelling screws. A piece of angle with a single levelling screw is fitted to the sensing end.

The pendulum beam hangs from a 36 inch vertical iron post coach bolted to the wooden base and thus kept insulated from earth. The unit should work just as well if the post is fixed to a SOLID ground floor or the beam is hung from a basement wall. Ordinary cavity walls are not rigid enough, and may prove too sensitive to people, weather, traffic and temperature changes.

At the top of the post is an adjustable screw eyebolt vertically above the beam pivot support bolt (see photo).

The beam is suspended by a thin stranded alloy wire (not soft copper), adjusted to hold it parallel to the base and some 5 inches above it. The suspension point is 15 inches from the outermost end of the beam to allow space for weights and reduce the side thrust on the pivot.



PROTECTION

The moving beam should be protected from draughts with a light removable cover, which can be made of polystyrene water tank insulation sheet, hardboard or chipboard, and the unit should be set up on a solid ground floor away from people and vehicles.

it is mechanically set up first. The oscillation period depends on the angle the beam makes with the horizontal and its effective mass. To give an accurate seismic response, mechanical damping must be added. Liquid damping is simplest using an adjustable aluminium vane (100 × 50mm) under the beam which dips into a container of paraffin or light oil or even water if there is no risk of freezing.

If the instrument is installed in an outbuilding with wide temperature swings, paraffin will give the most constant damping, but will need a larger vane than oil.

LOADING

The beam is loaded with up to 5kg of extra weight near the end. I used short lengths of scrap iron pipe slipped on to the beam.

When the beam is loaded, the pivot end of the instrument is jacked up about 10mm to turn it into a sensitive long period pendulum. This is a matter of trial and error. The important thing is to establish a stable mechanical zero and period greater than 7 seconds.

Once a period of 7-10 seconds is achieved, the damping is set by adding liquid to the vane bath — a small plastic food container is ideal for this — until the pendulum comes to rest after one and a half to two swings.

SENSING

The sensing coils and electronics are now fitted. Care should be taken to arrange a non-metallic mount for the sensing coils — I used a plastic pipe clip for the static coil and a piece of square section insulating plastic bar clearance drilled for the moving coil, and pressed into the end of the sensing beam. The coil must be a LOOSE fit in the hole, to avoid damaging the windings and may be secured by wax or Blutack.

The lead from the moving coil needs to be very flexible. I used baby alarm twinflex, which is fed inside the beam to a hole close to the pivot. A loop is then taped to the support column, and the lead taken to the detector board pins. The detector board is mounted on the wooden base.

After assembly, the instrument may take a few days to settle down, but thanks to the generous clearances in the pick off system, no great precision is needed, and deviation from zero can be corrected by the jacking screws.

The beam and support pillar should be bonded to the negative rail of the electronics. If the instrument is to be used at

Mountings of the support post—part of the authors collection of vintage valves can also be seen!

some distance from the monitor point, it must only be earthed there — any earth connection or leakage at the instrument can cause puzzling zero shifts from stray earth currents.

The supply and output are relatively low impedance d.c., so unscreened cable can be used for distances of up to 50 yards, but high ambient mains induction may put extra noise on the trace from domestic appliances. I used ordinary three core mains cable for the 50 yard run to my instrument in a workshop with a concrete floor down the garden.

ALIGNMENT

With the electronics in place, the instrument should be mechanically and electrically aligned with the help of a plus/minus 1 volt meter between output and "test point".

At this point you will see that the device is extremely sensitive. Centre the beam using the jacking screws to an accurate visual zero, and correct the electrical zero using the controls on the power unit.

You now have a seismometer!

TESTING

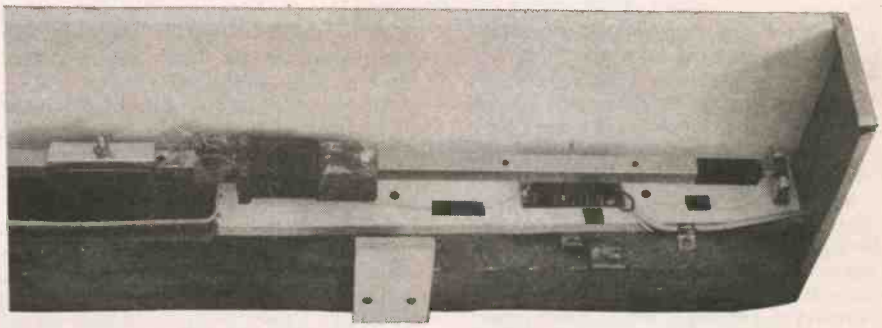
Test for stable zero by blowing the beam gently to one side, it should settle after a few swings. If it doesn't return to zero, jack up the beam support screws until it does. Make sure the damping gives one and a half to two swings return from a small offset. If you still can't get a stable zero with the beam raised to 25mm out of level, the pivot needs improving or the signal lead is too stiff and not far enough from the free end of the beam. In general, a shallow angle gives a longer period and higher sensitivity.

The system is so sensitive that you will find it impossible to position it accurately by touching the beam. Blowing is one way. I fine tune the mechanical zero by sliding a permanent magnet about under the iron weight on the beam. A magnetic cupboard catch without its keeper is ideal.

The sensitivity is so high that someone standing on the concrete floor by the instrument will give an output swing of around 300mV as the floor bends!

OPERATION

When I first started using a seismograph, I had no idea what to expect. The first sur-



General arrangement of the beam, sensing coils, damping vane and detector board. Part of the draught protection can be seen in place.

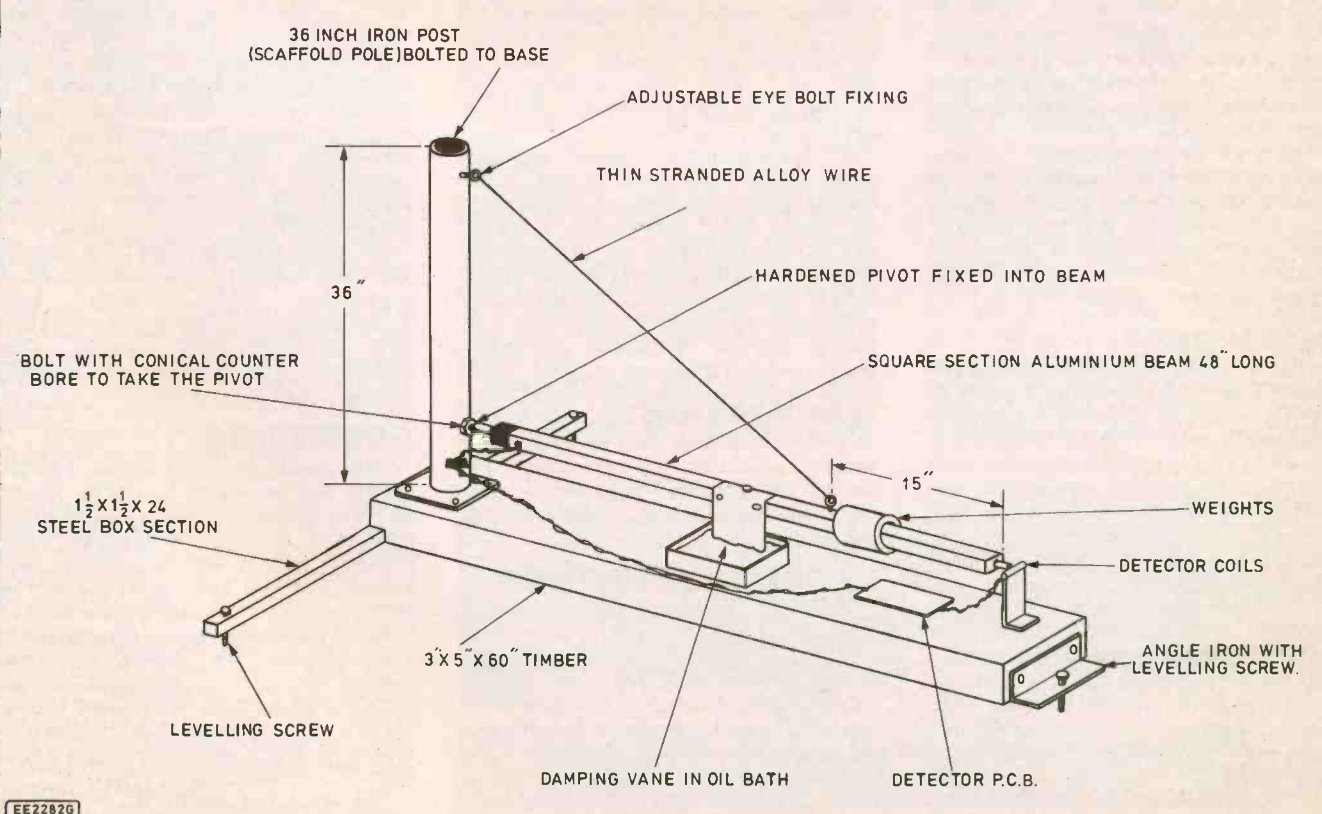
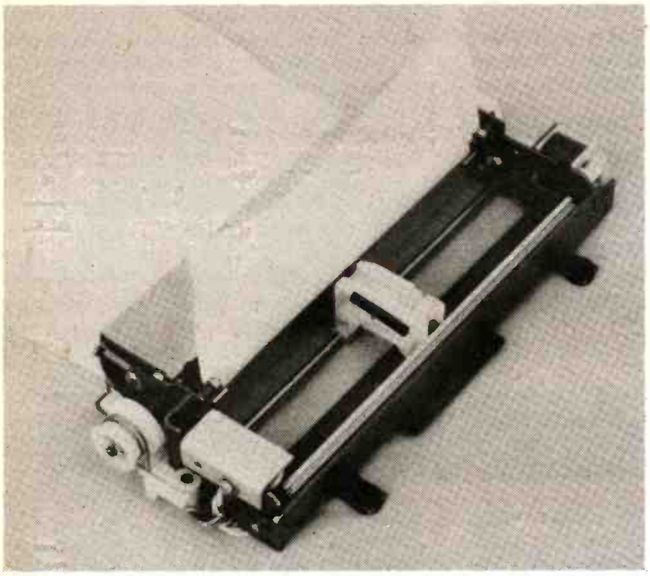


Fig. 1. Construction of the Seismograph.



The small plotter available from Display Electronics, paper width is approx 110mm.

The control unit for the Seismograph. The construction of this was described last month.

prise is the background noise level or microseisms caused by low pressure weather systems, traffic, trains and tidal tilts if you are within 30 miles of the coast. This activity can be impressive on "noisy" days.

Large earthquakes are mercifully uncommon, but shocks detectable all over the world occur several times a week, so it is necessary to make a continuous recording for later examination.

Electronic or digital recording of seismic signals is impractical for the amateur because a visual examination of the analogue record is still the only way of extracting the onset of a distant event from the local microseismic background. A professional seismic observatory will have up to 12 different sensors for full coverage. These outputs are converted to frequency modulated audio channels for on site recording on slow speed one inch magnetic tape recorders.

The tape recordings are then visually reviewed on a VDU at base so significant events can be bracketed, digitised and downloaded onto disc and printed out for further examination.

The need for an analogue real time recording of the seismic signal has a great influence on the choice of chart recorder. for adequate detail, a minimum speed of 15mm per minute is required. This translates to about one metre per hour — so paper economy is important.

RECORDER

The traditional mechanical seismograph used a large drum covered with paper or smoked glass. The drum was arranged to move axially about 6mm per revolution to give a very long spiral trace for each recording. These days, a spiral trace electronic seismograph recorder can be built using standard electronic servo components and mechanical ingenuity. But this is perhaps beyond the scope of many readers.

For those who don't want to build a recorder, paper economy can be obtained on linear trace machines, by constructing a hand winder to rewind the chartroll and running multiple parallel traces. Most types of chart recorder — especially old ones can be adapted for use with this project.

It is possible to convert machines from expensive sprocket drive paper to narrower or cut down plain paper rolls (Telex, Fax, calculator or till), by improvising a rubber pinch wheel between tha middle of one of the guide bars and the chart roll to drive the paper by friction. Precision rubber rollers can be made from ordinary black rubber grommets pressed onto a piece of brass or plastic tube and ground to fit the clearance between guide bars and chart drive roll. The roller is ground to size by fitting it on a screwdriver or suitable bearing and holding it at an angle against a bench grindstone wheel so it spins rapidly as the rubber is evenly ground away. Wear gloves and eye protection!

Accurate timing is important for seismographic observation, so timing marks should be added on the trace either by hand later or by means of a generator. The simplest timing mark generator is a mains synchronous motor operating a microswitch every minute. If a changeover microswitch is used, a small capacitor can be charged to a few volts d.c. through a resistor and discharged to make a pip on the trace every minute. Some recorders have internal timing mark generators, and these can be triggered by the timer.

It is essential that the marker is superimposed on the trace, not on the side of the chart if spiral or multiple track recordings are made. New synchronous 1 r.p.m. motors are expensive, so an attractive option is the defrost cycle controller from a defunct microwave oven. These are usually small cased synchronous timers with a 30 second on and 30 second off mains switched output which can be used to pulse a relay to generate isolated low voltage timing marks. If hour marks can also be added, they can be distinguished by switching a small d.c. offset on to the trace for a few seconds or lifting the pen to leave a short gap if the recorder has a remote pen lift facility.

RECORDER SUPPLIES

There are a number of possible sources for used chart recorders of various types. These were often used in industrial boiler houses (thermocouple recorders) and of course in school or college labs or as electrocardiographs in hospitals etc. (although the paper speed on the latter would need to be reduced).

Various circular paper type recorders could also be used to give a reasonable recording for the Seismograph. It should not be too difficult for most readers to unearth a suitable instrument in an electrical "junk shop" or through local industry or educational establishments, etc. Most of the original users have now changed to different methods of recording and very often chart recorders are no longer needed; while many of them look distinctly "old fashioned" they are usually excellent examples of precision engineering and are rarely worn out or broken.

An alternative is an excellent little plotter now available for under £50 from Display Electronics. However, this unit will require some additional electronics before it can be used as a chart recorder. The pen is driven by a stepper motor and therefore the analogue output of the Seismograph will need converting to drive the pen. The paper drive stepper motor can be driven with the *Stepper Motor Interface*. (EE Aug '85 — a kit for this is available from Magenta Electronics Ltd. — see Editorial page for information on obtaining back numbers) using a simple multivibrator to provide the clock pulses which would normally come from a computer. From time to time Display Electronics also have limited quantities of other chart recorders; they are at 32 Biggin Way, Upper Norwood, London SE19 3XF Tel: 01-679 4414.

For those that can afford it a suitable new chart recorder is available from Lloyd Instruments PLC, Whittle Ave., Segensworth West, Fareham, Hants PO15 5SW. Tel: (0489) 574221 for your nearest distributor. The Graphic 450, which is suitable, costs about £500.

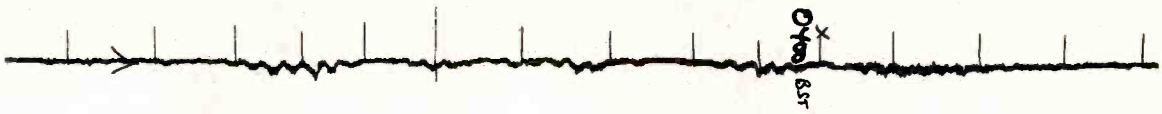
OBSERVING

Earthquakes are truly natural random events, and cannot be predicted, so the only way to catch a big one is to keep the equipment running continuously. This means logging the start and finish of each trace carefully so that the arrival time of any event can be determined accurately from the minute markers.

Earthquakes are caused by stress induced fracture and movement of the earth's crust and the semi-liquid mantle under it, and can occur at depths down to 500km, although most occur in the upper 50km of the solid crust.

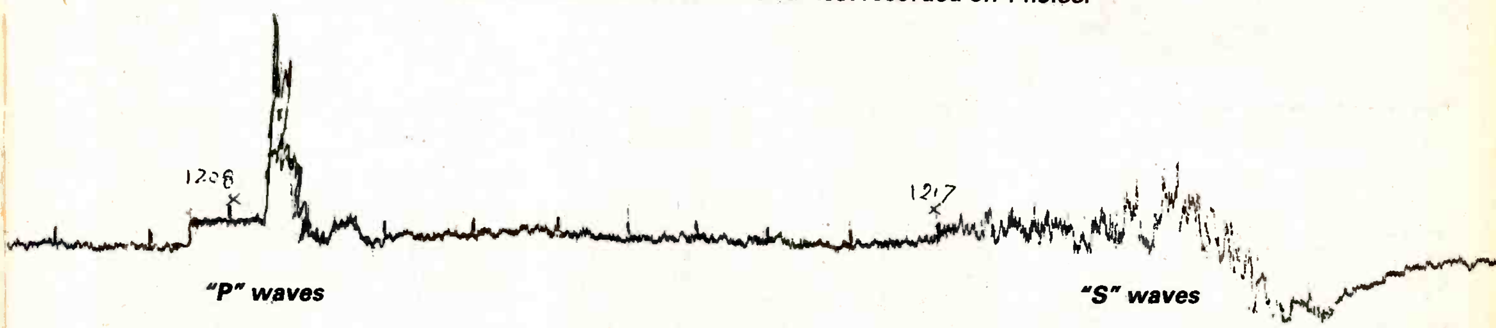
The energy released is transmitted radially from the fracture, and has most effect on the surface immediately above. A

RECORDINGS MADE WITH THE SEISMOGRAPH



"Antipodean" surface waves recorded on 22.10.88.

The Russian 150 kiloton nuclear test recorded on 14.9.88.



The Armenian earthquake recorded on 19.12.88. This recording shows a typical aftershock — unfortunately the Seismograph was not recording when the main shock took place.

shallow earthquake will create a comparatively small area of devastation whereas a powerful deep event will lay waste large areas.

Earth tremors are rare in the UK, so the waves recorded on the seismograph will be altered and attenuated by the track they take from the distant epicentre to the recorder.

The earth appears to comprise a heavy molten nickel-iron core about 5000km in diameter, overlaid with a lower density viscous and semi solid mantle which supports and "floats" the solid surface crust and continental plates.

The speed of propagation of an earthquake wave varies with density. The liquid core of the earth does not transmit earthquake waves at all, so waves from an event in the eastern hemisphere reach us via the mantle and crust, passing round the core.

The different densities of the crust and upper mantle modify the speed of the waves. The deepest waves skirting the core travel at 8km/second. These waves that are "ducted" in the interface between the crust and mantle make 5km/second, and the surface waves make 4km/second.

An analysis of the difference in arrival times and character of the waves from a specific event will give a clue to the location of the epicentre, and when three or more sychronised recordings are compared, the exact location may be calculated.

COMPUTERISING

Mention was earlier made of the difficulty of computerising seismographic records. The biggest problem is distinguishing the characteristic small early signals of a distant event from the local microseismic background.

It is largely a question of frequency. Most microseismic waves are of 3 to 6 second period, whereas the first waves from an event less than 5000 miles away are of 0.5 to 2 second period, arriving through the mantle at 8km/second. They are known as "P" (primary) waves and represent the actual sharp impulse accompanying the energy release at the epicentre. There are no P waves from events sufficiently distant for direct propagation to be blocked by the core.

Next to arrive are the first "S" (secondary) waves. These travel at 5km/second in the discontinuity between the mantle and crust, and have world wide range. Last to arrive are the slow and dramatic surface waves, with periods from 8 seconds upwards, travelling at 4km/second.

Earthquakes from the activity zones around the Mediterranean and into Russia will show all three wave types, and the signals from a large event should stand out clearly enough to allow a rough calculation of its probable distance from the differences in arrival times, before it gets on the news!

Sometimes very long trains of large waves over 15 seconds period may appear, these are usually the surface waves from earthquakes in the Pacific basin, which somehow strike an antipodean resonance in the UK (see traces shown)!

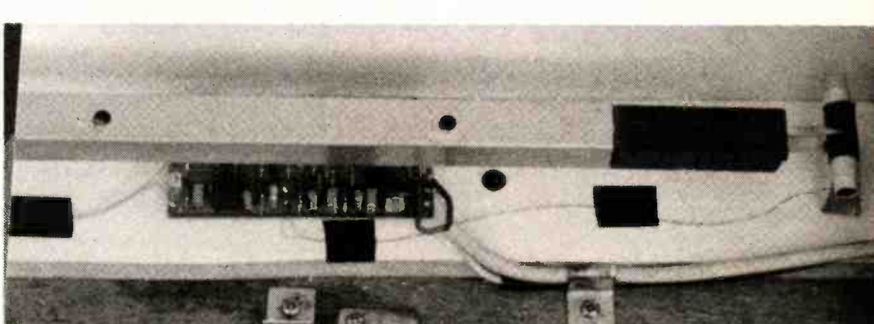
Occasionaly tremors in the UK may also be logged. The signals are normally direct primary waves with no secondary or persistent surface wavetrains for such minor events.

The instrument is also sensitive enough for nuclear test watching. The recording shown was made from a well publicised 150 kiloton Russian underground test.

FURTHER INFORMATION

Further information on seismology can be obtained from; British Geological Survey, Murchison House, West Mains Road, Edinburgh EH9 3CA. Information can also be obtained from museums and universities which have their own seismographic stations.

There are few books on amateur seismology — one such is *The Amateur Scientist*, a compilation of *Scientific American* projects UK published by Heinemann in 1962. This book is now out of print but libraries may have a copy. □



Mounting of the detector p.c.b. and coils.

Robot Roundup

NIGEL CLARK

DOMESTIC

The hunt for a viable domestic robot has been held up by the liquidation of **Personal Robots Ltd,** the company which was doing the feasibility study. An iterim report was completed before liquidation proceedings began but further papers from the company cannot be released until the liquidation has been completed.

In the meantime the working party set up under the Department of Trade and Industry's Advanced Robotics Initiative will continue its work on the basis of the information released so far.

It is understood that the study has concentrated on three suggestions involving a hotel domestic, a household cleaner and a device for use in assessing the possibilities of other devices. The emphasis appears to be on mobiles of one form or another.

If the working party is happy with the suggestions, and I understand that many members have welcomed them enthusiastically, the next stage involves evaluation to see if it would be worthwhile developing any of them commercially.

It is at this point that the group will have to become fairly hard nosed in its approach as outside funding will be required to continue its work. The DTI after having financed the feasibility study in full is only offering to pay 50 per cent of the next phase.

The information which should eventually be provided in the full feasibility study includes whether the ideas are technically possible, if they can be produced at an economic cost and whether there will be a demand.

While accepting that a large amount of work must have gone into the study, which took about 18 months, there seems to have been no attempt to break away from the thinking which has bedevilled robotics for years. It is the search for the all-singing, all-dancing, even all-paranoid, humanoid so beloved of literature over the centuries. It was emphasised by the DTI when it set up the group last year saying that the search was on for robot butlers and gardeners.

The resulting list shows all the signs of accepting that assumption and being technology-driven rather than demand-driven. They are the best attempts at providing a humanoid that can be achieved with the present technology. The ideas do not start from a proven demand for which the best answer, both in cost and technology terms, is being provided. There also seems to be a hint of desperation resulting in two general applications and the acceptance that further work is necessary with the investigation suggestion.

I hope that I am wrong and that something worthwhile comes out of this work. With the evidence so far and the fact that the company doing the study could not find a way of remaining in business I am not hopeful.

ARMDROID SAGA

The Armdroid story refuses to die. Just when it appeared that one of the pioneers of the small robot market in the UK had been laid to rest up pops someone else with an updated version and claims that it is the only true holder of the rights to the five-axis arm.

Hasfield Systems is the latest to enter the fray making its move with superb timing as **Shestotech** decided, quite independently, to call it a day.

As mentioned last month Hasfield is offering the Armdroid HS 1B for £750 with a toothed-belt drive to overcome the old Armdroid problem of slippage with the ordinary belt drives. It is also offering an upgrade of existing Armdroid machines for £300.

All of which is very familiar stuff and duplicates the original intentions of **Colne Robotics,** which had some success with the machine when it was introduced more than six years ago. Colne was planning the upgrades when it went into liquidation about three years ago.

At that time John Allright and Nick Ourousoff, who now run Hasfield, were working at Colne. Their claim to the rights is based on Ourousoff being the designer of the original Armdroid.

That makes them the third claimant to the Armdroid legacy. Chris Magee said that he had bought the rights following the liquidation as well as to other Colne products such as the vision system. His company, **Concorde Robotique,** went bust last year and as yet he has no plans to return to the market.

Shestotech claimed the rights on the basis that it has absorbed **Richman Logic,** formed by other ex-Colne employees, who said that they had designed the Armdroid, (their Armtech 2000 had a toothed belt drive and an upgrade was offered).
At one stage Shestotech was also offering a work cell however that was the first package to disappear and earlier this year the Armtech was dropped altogether as Shestotech decided to return to its distribution roots. Richard Shestopal of Shestotech has said that the rights are on offer if anyone is interested.

Hasfield's innovation is that a version is being developed to work with the Nimbus AT as well as the usual micros including the Apples, IBMs, Commodores and BBCs.

The company decided to launch their Armdroid following interest from France in a machine of the same type which lead to a large order. Hasfield heard of the interest because of its other arm, the Gamma, which is sold as part of a package for laboratories.

In case anyone has forgotten the Armdroid has five axes plus a standard three-fingered gripper and a two-fingered option. There is also an optional grip force sensor on the HS 1B. The arm is powered by stepper motors with toothed belt drive. Reach is up to 480mm and it can lift 250 gms.

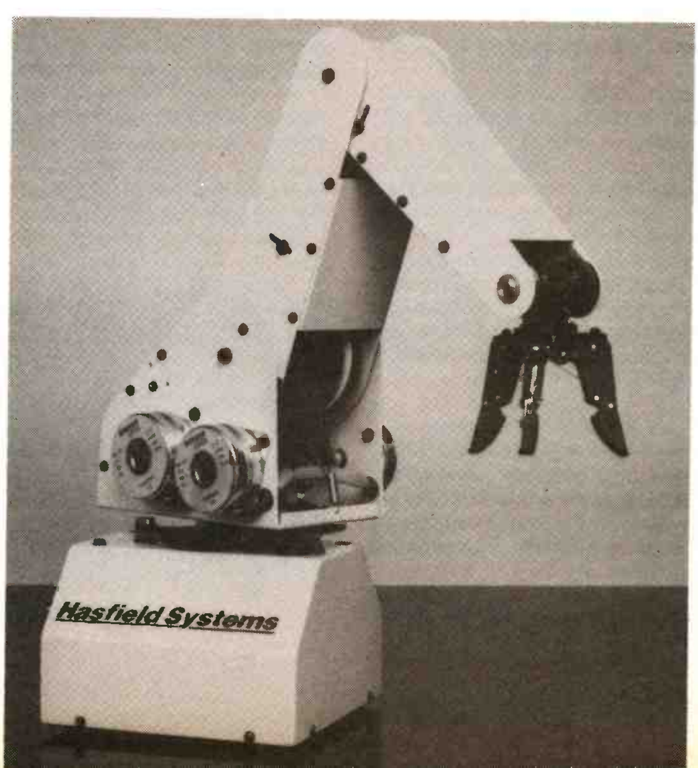
Instructions, which move the arm to the required positions and are then remembered for repetition, are entered via the host micro.

TREKKER EXTENSION

Clwyd Technics is extending the use of the Trekker mobile by producing an extension pack for use in primary schools. If the new pack is as thorough as the existing material for secondary schools it will be well worth considering for younger pupils.

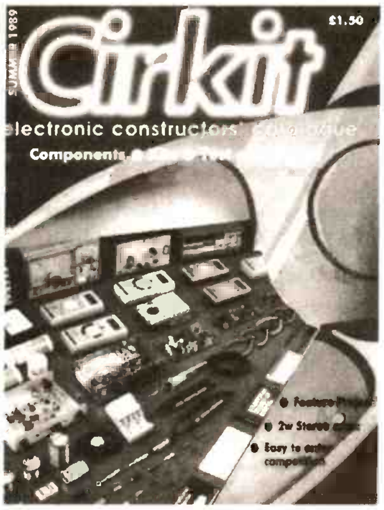
Valiant Technology has develoiped a spin-off from its Roamer. The control unit, fitted to the top of the mobile is being offered separately for controlling other mobiles. It is being priced in the region of £150.

Two more arms have disappeared from the British market. **Morgan Automation** is no longer distributing the Teachmover from the US, nor the Israeli-built Scorbot.



Cirkit NEWS

OCTOBER 1989



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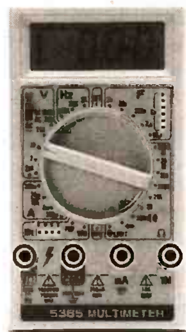

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ac volts: 200mV-750V
dc current: 200uA-10A
ac current: 200uA-10A

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a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month I shall make a start on a bumper crop of queries and tips received from readers. We begin by delving into the memory of MGT's exciting **SAM COUPE.**

More about Sam

Last month I extolled the virtues of the extensive I/0 provision which Miles Gordon Technology have built into the SAM COUPE. This month we deal with another hardware-related topic; the allocation on memory within the SAM.

The COUPE has a capability of 512K bytes of RAM. The basic machine comes with 256K bytes fitted and with two sockets for a further 256 bytes. The dynamic RAM devices used are 256K x 4 bit chips offering fast 100ns access times. These chips have 20-pin plastic d.i.l. packages.

Since the Z80 offers only a basic 64K addressing range, the COUPE makes use of an Application Specific Integrated Circuit (ASIC) to manage the addressing of this memory. Effectively, the 512K byte memory is divided into 32 pages, each of 16K bytes.

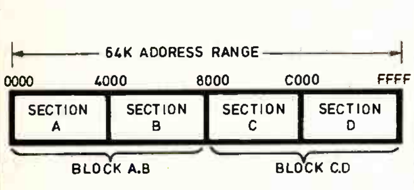


Fig. 1. Memory paging system used in the SAM COUPE

The ASIC controls the memory paging by means of two 8-bit read/write registers. These are known as the Low Memory Page Register (LMPR) and High Memory Page Register (HMPR). These two registers occupy I/0 addresses of 250 and 251 decimal respectively.

The lower five bits of each of the memory page registers are used to represent the page number (0 to 31). In a machine with the basic 256K bytes fitted, the valid page numbers will, of course, range from 0 to 15 (rather than 0 to 31).

The paging system is best understood by thinking of the Z80's 64K address range as being divided into two blocks each comprising two sections of 16K. The 16K sections are represented by the letters A to D, as shown in Fig. 1. Note that the LMPR manages the block A.B whilst the HMPR manages the block C.D.

As an example, let us assume that we wish to allocate Pages 0 to 3 to Sections A to D respectively. A binary 00000 must appear in the lower five bits of the LMPR. Page 0 of memory will then be allocated to Section A of the CPU address range. Section B is always automatically allocated one page above Section A and thus Page 1 will be allocated to Section B. Similarly, binary 00010 must appear in the lower five bits of the HMPR. Page 2 of memory will then be allocated to Section C of the memory range whilst Page 3 will be allocated to Section D. This example is shown in Fig. 2.

It is important to note that the upper three bits of the memory page registers are also used and we would need to take this into account when writing data into the LMPR and HMPR. Furthermore there is a third memory paging register that we need to be aware of. This is the Video Mode Paging Register (VMPR). In this register, the lower five bits are used to allocate the memory page (0 to 15, or 0 to 31 in an expanded COUPE) used for the screen display memory.

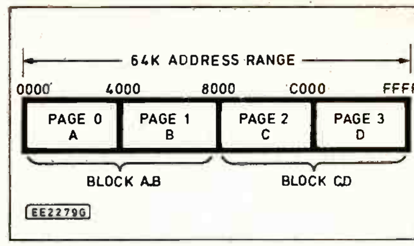


Fig. 2. Example CPU address map

Your Letters

John Pillips writes from Motherwell with a plea for *"more pokes like those in August's On Spec"*. Yes John, I do have a few more up my sleeve but I was hoping that some of our regular readers would put pen to paper and provide me with a few that *I* didn't know about! In any event, I promise to let you have another batch in a future *On Spec.*

E Kemp has spotted a double microdrive unit which J. and N. Bull Electrical can supply for £5. He (and I) wonder if anyone has any information on these units and has successfully interfaced them to a Spectrum. I must admit to being an avid reader of J. and N. Bull's advertisements (they seem to have a great deal of useful "bits and pieces") but I must have missed this one.

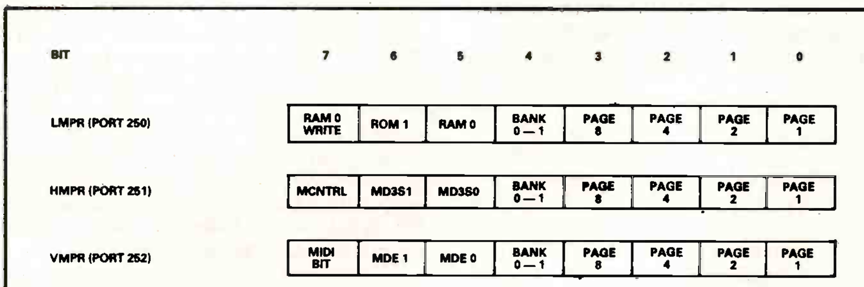


Fig. 3. Memory paging registers

The significance of the bit positions within the LMPR, HMPR and VMPR is shown in Fig. 3. Note that bit-5 is used to determine which of the two 256K memory banks is used. Where bit-5 is set to logic 1, the upper bank (Bank 1) is being used. In an unexpanded machine these bits will *always be at logic 0.*

The function of the upper three bits in each register can be found from the following table:

Register	Bit	Abbreviation	Function
LMPR	5	RAM0	When set to logic 1, RAM replaces the first half of the ROM (i.e. ROM0) in Section A of the CPU address map.
LMPR	6	ROM1	When set to logic 1, the second half of the ROM (i.e. ROM1) replaces the RAM in Section D of the CPU address map.
LMPR	7	WPRAM	When set to logic 1, the RAM in Section A of the CPU address map is write protected.
HMPR	5	MD3S0	Gives bit-3 (BCD value 4) of the colour look-up address (available only in Mode 3).
HMPR	6	MD3S1	Gives bit-4 (BCD value 8) of the colour look-up address (available only in Mode 3).
HMPR	7	MCNTRL	When set to logic 1, the COUPE looks to its expansion connector for high memory. (The external signal XMEM goes low).
VMPR	5	MDE0	Bit-0 (BCD value 1) of screen mode control.
VMPR	6	MDE1	Bit-1 (BCD value 2) of screen mode control.
VMPR	7	TXMIDI	In write mode, this bit directly drives the MIDI OUT channel.
VMPR	7	RXMIDI	In read mode, this bit is an input from the MIDI IN channel.

L. Peterson from Tottenham asks several questions. He intends interfacing a 3.5 inch Chinon drive to an MGT Plus-D interface along the lines which I suggested in a recent *On Spec.* There is really nothing to it provided you have the necessary cables and connectors (MGT can supply the necessary ribbon cable ready fitted with the appropriate connectors). The only other item required is the power supply and J. and N. Bull can supply this in kit form or as a surplus ready-made switched-mode unit. In either case, the wiring is very simple. Mr Peterson also asks if a Spectrum-Plus can be upgraded to 128K. The sad answer is "no"!

Phil Davidson from Hull is having problems with the Spectrum EPROM programmer. The computer appears to "lock-up" when he performs any EPROM "blowing". The board has been thoroughly checked and Phil wonders what is wrong. Phil does not say whether he is able to read an EPROM correctly. If he can, my guess is that the problem could be associated with the power supply. Has anyone else suffered from this problem?

A very interesting letter from **Kevin Allen** of Nottingham has arrived on my desk. Kevin has two Issue Three Spectrums and has been experimenting with connecting them together. Kevin's first attempt has been to make use of serial data transfer by linking the two cassette ports together. He uses a simple in-line amplifier (a single BC109 operating in common emitter mode). Data can then be transferred between the two machines using the normal cassette commands.

Kevin also hopes to link the two machines for parallel data transmission (via PI0 devices fitted to each computer). He should then have a means of doubling the memory and processor power available to an application written specifically to take advantage of this unique arrangement.

This is indeed a fascinating area for experimentation and is one which should prove to be more powerful and adaptable than Sinclair's serial ZX-network. My own preference would be not to use PI0 devices but to employ tri-state octal bus-transceivers in conjunction with an external bus which could allow the arrangement to be relatively easily extended to accommodate further machines.

Each machine could be given a unique address and an interrupt handler set up to provide a flexible system for dealing with multi-processing. One Spectrum could deal with all of the I/0, another with number crunching, and so on. Who needs 16-bit processors when you could have half a dozen Z80's on the job — the mind boggles!

Radio Spectrum

Derek Dillon has a Spectrum 128K and he is working on a machine code Morse decoding program. Derek is attempting to use the Spectrum's "EAR" socket for input, but the address (254 decimal) gives discontinuous reading of various sine wave inputs. Derek's routine is based on the assembly language instruction; IN A,(254).

Having recently re-kindled my old interest in amateur radio with a brief foray on 6m, I too would be very interested in a program which can read Morse code! Furthermore, there must be quite a number of amateur radio enthusiasts who use the Spectrum computer in conjunction with their hobby. I seem to remember a regular feature in *Practical Wireless* (entitled *Computing in Amateur radio*) which regularly featured software and hardware for the Spectrum. Please drop me a line if you know of any software routines or can provide details of a hardware interface that can help to solve this particular problem!

P. J. Taljaard writes from South Africa with another problem related to a radio application for the Spectrum. Mr Taljaard is looking for a program which will allow him to receive pictures from weather satellites. Alternatively, he also has an HP PC available and would be interested in receiving details of equipment for weather satellite reception for use with this computer system.

In order to receive weather pictures from satellites you will, of course, need a receiver and antenna system. A complete Meteosat system (comprising receiver, aerial, computer interface, grey-scale adapter, 14 inch colour monitor, and a 1M byte Atari ST computer) will set you back something in the region of £1700. Such systems are available in the U.K. from Garex Electronics (specialists in weather satellite reception) and they can be contacted at Harrow House, Akeman Street, Tring, Herts, HP23 6AA (☎044 282-8580).

Garex can supply the Timestep animated weather satellite display system (for the Atari 1040-ST) for £299 (including U.K. postage and VAT). I have seen this system in operation and it is really quite amazing. I doubt very much that the humble Spectrum (with only 64K RAM) can cope with this sort of application. Doubtless someone will write and prove me wrong!

Parallel Printer Interface

R. Wildash from Basingstoke has recently built the *EE Spectrum Parallel Printer Interface* (E.E. January 1989). Mr Wildash is using the interface with an Issue Three Spectrum and has, unfortunately, encountered a few problems. The interface appears to "miss" characters when printing and it appeared that the Z80-PI0 was mysteriously resetting itself. Mr Wildash set to work with a logic probe and found that the $\overline{M1}$ signal (pin-37 of the PI0) was in a high-impedance state. Mr Wildash writes:

"Thinking that the pull-up resistor in my Speccy was open-circuit, I removed the case and found no pull-up resistor was fitted to the Z80 M1 line.

I decided to modify the EE Printer Interface *as follows; remove R2 (4.7k) and fit a 10k from pin-37 of the PI0 to +5V. Link out T24 of the edge connector to pin-37 ($\overline{M1}$) of the PI0."*

Mr Wildash's circuit modification is shown in Fig. 4. So, if you have had similar problems with this project, it would be well worth carrying out this modification.

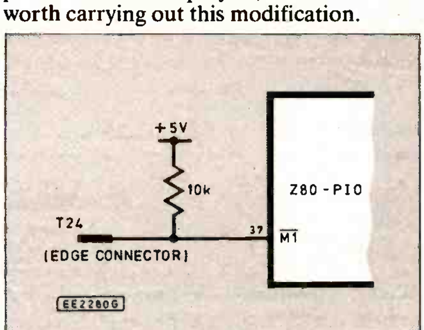


Fig. 4. Recommended modification to the EE Printer Interface

John Whitelock writes from Newton Abbott. Like me, John started out with a Model 1 Tandy Machine. However, since acquiring a Spectrum and a Plus-D disk interface the Model 1 has taken a back seat. John has upgraded his Spectrum with a DK'tronic keyboard but still finds that this does not compete with the Tandy. John writes:

"I have not yet seen any notes about the keyboard of the SAM and this aspect is one of the most important to me and probably to many other people who might buy one. Perhaps you could give your opinion of the SAM keyboard?"

Well, John, I certainly agree that the original Spectrum keyboards were a disaster (this comment applies equally to the original Spectrum and the Spectrum-Plus and 128K machines). The Plus-Two and Plus-Three, however, have excellent keyboards. Both are comfortable to use and are very positive. However, even with these latest Amstrad/Sinclair offerings there remains the awkward problem of the multiple use of keys. In particular, I find having to continuously refer to my Plus-Two manual for keywords when in 48K mode frustrating to say the very least!

Fortunately, the SAM COUPE scores highly as far as its keyboard is concerned. The membrane-type keyboard has 71 full-travel keys and the layout is reasonably conventional (although I would have preferred isolated cursor control keys). The SHIFT and SYMBOL SHIFT keys are usefully duplicated at the left and right of the SPACE BAR. The EDIT key is also prominently placed (to the left of the SPACE BAR). The COUPE has ten function keys (more generous than the Sinclair QL) and these are arranged in a block to the left of the keyboard.

Electrically, the keyboard is arranged on an 8 x 9 matrix and is addressed using two ports. KEYBOARD (address 254 decimal) and STATUS (address 249 decimal). The KEYBOARD port is responsible for the lower five bits (K1 to K5) while the STATUS port is responsible for the upper three bits (K6 to K8) of the input. The nine output scan lines are made up by the CPU address lines AD8 to AD15 together with the ASIC RDMSEL line.

In any event, the SAM keyboard is well thought out and should more than satisfy most users. Likes and dislikes concerning keyboards tend to be a rather personal thing and, despite all the efforts of manufacturers like MGT, I suspect that John Whitelock and I will still hanker after our old Tandy keyboards for many years to come!

Help!

R. Garas from New Malden is a relative newcomer to E.E. and expresses interest in the field of computer numerical control (CNC). A number of simple designs for interfacing motors and position sensors have appeared in the previous instalments of *On Spec* and, to provide Mr Garas with a few pointers, I wonder if any reader has put any of these to use with machine tools of any sort? If you can help, please drop me a line with some brief details so that I can pass them on to Mr Garas.

Next Month: Some more queries and tips plus — space permitting — we show how the humble Spectrum can be used with minimal software and hardware to operate as a sophisticated programmable clock/timer. This project has a wide variety of applications from timing your "three minute" egg to operating your darkroom equipment.

In the meantime, if you would like a set of the latest *Update* sheets, please drop me a line enclosing a large (250mm x 300mm) and adequately stamped (currently 42p for UK postage) and addressed envelope. Please note that I am unable to provide individual replies to queries. Instead, I will do my best to provide answers in future instalments of *On Spec*. Mike Tooley, Faculty of Tech., Brooklands College, Heath Road, Weybridge, Surrey, KT13 8TT.

SHOP TALK

BY DAVID BARRINGTON

Stabilized Power Supplies

Running through the components required to construct the *Variable Stabilized Power Supply*, a couple of items may take some tracking down locally.

One such item appears to be the LM723 variable voltage regulator chip. To date the only listing for this device we have been able to trace is from **SCS Components** (☎ ***0273 206875***).

The 4A 40V working electrolytic capacitor used in the author's model is a RS printed circuit board type 104-382 and should be available from any *bona fide* RS stockist or by mail order through **Electromail** (☎ ***0536 204555***). An alternative capacitor is listed under the Siemens B41306 range from **Electrovalue**.

The mains transformer was also purchased from RS through Electromail and is coded RS207-251. Many of our advertisers now supply special transformer kits for making up your own transformer. Alternatively, specialist transformer suppliers such as **Jaytee Electronic Services** should be able to come up with a suitable unit. The specified transformer has two secondary windings rated at 12V 2A which are wired in series to obtain the required output.

The finned heatsink, which is clamped to the driver transistor TR2, is a p.c.b. mounting type from Electromail, code 403-162. It is probably easier and cheaper to make your own heatsink for the regulator i.c. from a piece of 16 s.w.g. aluminium.

The range of panel meters stocked by most of our component advertisers is fairly wide ranging and they should be able to supply a suitable meter for both current and volts readout; it may require the scales to be altered. The prototype model used two meters from the Electrovalue T-series, designated T31 for current reading and T32 for volts. If the specified meters are used it will not be necessary to recalibrate the scales.

When ordering the rotary potentiometer VR1 be sure to specify a "reverse log" type. The printed circuit board is available from the *EE PCB Service*, code EE663 (see page 756).

Logo, Lego and Spectrum

The 6V miniature relays used in *Logo, Lego and Spectrum* project may prove a little difficult to locate locally. The ones used in the prototype model were ordered through **Maplin** and are listed under their "Ultra Miniature" range, code FM91Y (Ult-Mn 6V SPDT).

Other relays can be used provided they have contacts rated at 2A and a coil resistance of about 100 ohms. The contact ratings will, of course, depend upon the type of load and application required.

A large size Technical Lego set (e.g. 8055) contains one of the small motors (see text) and a large selection of parts. Typical price is £20. Smaller sets are available. The small motor set (8700) contains motor, battery box and some more parts and is typically £16. However, by writing direct to Lego Spares Service motors can be obtained as single units (about half the price of the set). Other parts are also available.

The gearbox set to gear down the small motor is typically £12. This contains two gearboxes, a set of chain links and a few other technical bits. To make a start on a roving robot you need at least two motors with sufficient gearing (either cogs or gearboxes) to achieve sensible speeds (see text) together with sufficient technical beams to hold the structure together. Cost — guidance only — £25.

Readers experiencing any difficulty in obtaining Lego kits can contact them direct at **Lego UK Ltd., Dept EE, Wrexham, Clwyd. LL13 7TQ**. We also understand that **Magenta Electronics** (☎ ***0283 65435***) are a recognised stockist of Lego kits and should be able to obtain most parts.

The relay/Interface Box printed circuit board, code EE664, and the Control board, code EE660 (last month) are available from the *EE PCB Service*, see page 756.

EEG Biofeedback Monitor

Most of the semiconductor devices required for the *EEG Biofeedback Monitor* appear to be stocked by most of our component suppliers and should not prove difficult to locate.

The only item, apart from the electrodes, that could cause concern is the high sensitivity, high voltage opto-isolator IC6. This was purchased from **Maplin** order code, RA57M (Hi-Sensitivity Opto).

For those readers who do not wish to make up their own electrodes, the author suggests a commercial alternative from **Audio Ltd.** (☎ ***01 743 1518/4352***). The ones used with the prototype model are from Audio's Monitor AM model and were purchased as an electrode kit for the sum of £17.80, including postage — see "Postscript" to article.

The two printed circuit boards for the biofeedback project are available through the *EE PCB Service*, codes EE661 and EE662 (see page 756).

Wash Pro

We cannot foresee any component purchasing problems for constructors undertaking the *Wash Pro* project.

The "sensor" foil and fixing brackets should be available from most good home security specialists, such as **Riscomp**. In the prototype model, the sensor foil was made up from lengths of self-adhesive window security foil. The foil is connected to the electronic control unit via two screw terminating blocks. The foil and terminals were purchased from Maplin and are coded YW50E and YW51F respectively.

The small printed circuit board is available from the *EE PCB Service*, code EE643.

Two-Tone Siren

We do not expect readers to encounter any component sourcing problems when building the *Two-Tone Siren*, this month's "pocket money" project.

The self-adhesive insulator strips or "feet" for mounting the circuit board in the case should be generally available. No doubt readers will have their own ideas about alternative methods of mounting the board in the case. This also applies to the method of mounting the small loudspeaker.

EE Seismograph

As mentioned in the article, the mechanical "bits and pieces" for the *EE Seismograph* were obtained from various sources of scrap materials and constructors will have to use their own ingenuity to devise suitable "hardware" for the mechanical assembly. For instance, the main support post could be made from a piece of scaffold pole.

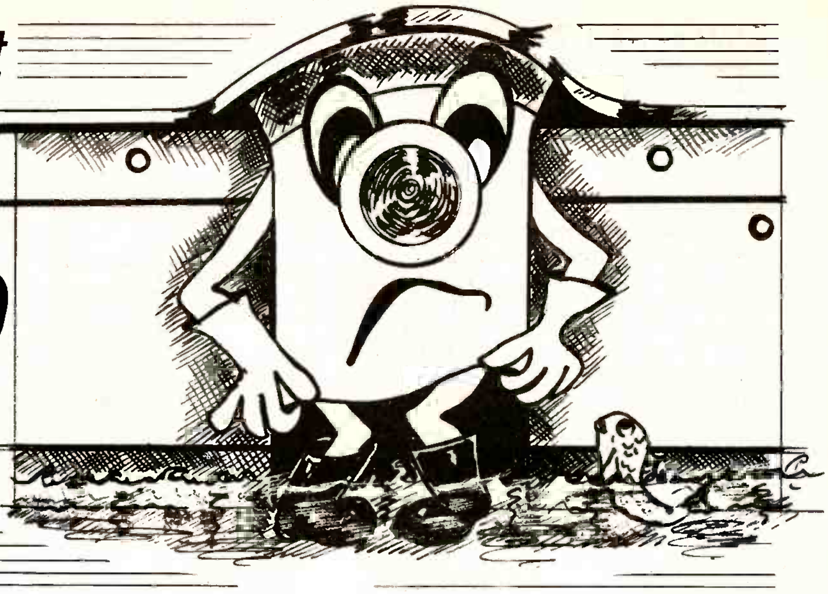
Also, whether you can still obtain thin steel guitar strings and whether these will be suitable for suspending the pendulum beam is open to experiment. A suggested possible source for a suitable plotter and likely interface is given in the article.

The two printed circuit boards for the "electronics section", described last month, are available from the *EE PCB Service*, codes EE658 (control) and EE659 (detector).

Iron-On Reminder

Checking through our catalogue library and as far as we can see, all the components called up for the *Iron-On Reminder* are standard items and should be available "off-the-shelf".

Constructional Project



WASH PRO

STEVEN HOLLAND

Avoid a major flooding in the kitchen by installing this low-cost "early warning" system.

THIS *Wash Pro* project was designed to be used in a kitchen or utility room where a washing machine, dishwasher or something like that are likely to be used. The basic principle of the project is to detect the presence of water on the floor or a wet carpet.

The sensors are placed either on the skirting board or along the floor. The sensors will also operate under a kitchen type carpet. If used on the skirting board the strips should be placed vertically running towards the ground. When the floor gets damp, either under the carpet or on the skirting the unit will activate and a two tone warbling effect will be heard.

The unit operates from a 6V power pack and the batteries will last a pretty long time, even if left switched on. Ideal if there is a possibility of the unit being forgotten to be switched on.

CIRCUIT DESCRIPTION

The full circuit diagram for the Wash Pro is shown in Fig. 1. The detection part of the circuit comes from the two foil strips—these strips can be obtained from most security shops or via mail order. The terminators are the associated blocks that are used to stick on a window.

When the tape is to be stuck to the floor choose a position that the tape is less likely to be scuffed or damaged by the wheels of the washing machine etc. This only really applies if the tape is stuck to Lino rather than under carpets (Flotex).

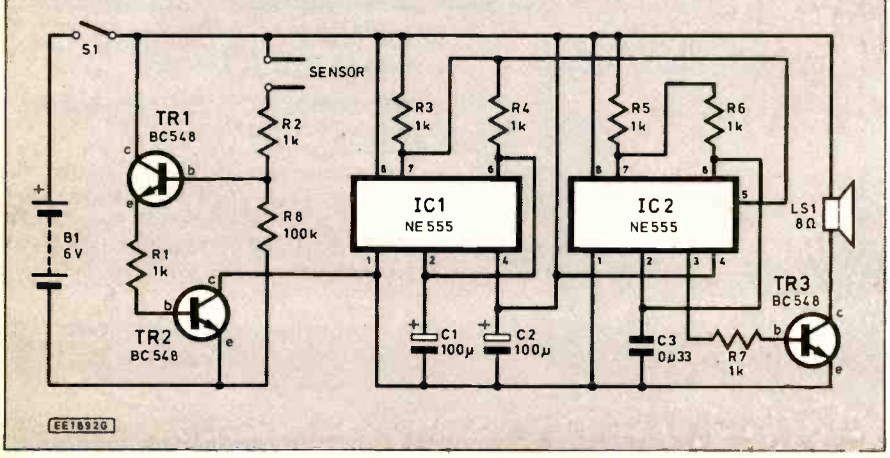
When the damp is sufficient to operate the circuit (*short across the sensors*), this is what goes on. The BC548 transistor (TR1) switches on and supplies a base voltage to transistor TR2.

This then switches a negative voltage to turn on the oscillator section. There are a number of ways in which to turn on the oscillator but this method uses the least current and so maximise the life of the batteries.

When a negative feed is passed to the two i.c.s they then drive transistor TR3 which drives the loudspeaker and so emits a warbling effect, the tone and frequency of the warble can be adjusted by the two capacitors C1 and C3. The values shown were chosen to create the most alerting tone.

The most suitable power source for the unit is 6V, in the form of four AA size batteries. It is advisable not to use rechargeable batteries because NiCads discharge fairly quickly even with no load and so not giving you the service you need. Batteries like Duracell last a considerable time longer and are cheaper anyway. Rather than dedicating four NiCads which could be put to a more economical use elesewhere.

Fig. 1. Complete circuit diagram for the Wash Pro.



COMPONENTS

Shop Talk see page 716

Resistors
R1-R7 1k (7 off)
R8 100k
All 0.25W 5% carbon

Capacitors
C1 100µ radial elec. 10V
C2 100µ radial elec. 10V
C3 0.33µ poly layer

Semiconductors
TR1, TR2, TR3 BC548 *npn* gen. purpose
IC1, IC2 NE555N timer (2 off)

Miscellaneous
S1 Submin. On/Off switch
B1 6V, four 1.5V AA size batteries and battery holder

Printed circuit board, available from *EE PCB Service*, code EE643; plastic case to suit; 8-pin d.i.l. socket (2 off); 8 ohm speaker; length of window security foil; window foil connecting blocks (2 off); Veropins (6 off); connecting wire; solder etc.

Approx. cost Guidance only **£10**

CONSTRUCTION

If this project is to be constructed on strip board it should be fairly simple but it is advisable to use d.i.l. sockets to give the i.c.s protection against damage. But for beginners we would recommend you design or buy the ready made printed circuit board. This board is available from the *EE PCB Service*, order code 643.

As for the construction on the p.c.b. this is also very straight forward. The printed circuit board component layout and full size copper foil master pattern is shown in Fig. 2. To start with simply check the board for any broken tracks or tracks that haven't etched properly.

Now insert the two 8-pin d.i.l. sockets and carefully solder the pins. Next solder the resistors in their correct place followed by the capacitors, remembering the polarity of the electrolytics.

Solder in position the three transistors, being careful not to *overheat* the small plastic devices. Then finally solder all six Vero pins/wires and the remaining wire link.

Inspect the constructed board and check for any solder splashes or dry joints. When you are satisfied all components are correctly soldered in you may insert the two NE555 i.c.s.

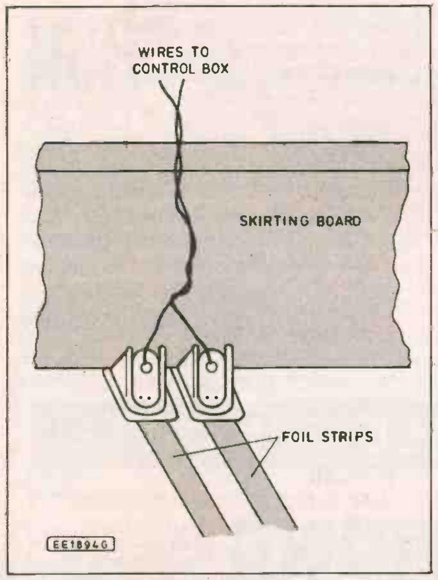


Fig. 3. Suggested arrangement for siting the sensor foil strips. Choose a position that is less likely to cause an obstruction or be scuffed by the washing machine wheels or footware.

IN USE

When the "sensor" tape has been stuck to the floor or a suitable position, and the connections from the blocks to the circuit board have been made – switch the unit on. SILENCE hopefully assuming the tape is dry and not stuck to a damp floor.

To test the circuit use a damp cloth, across the sensors, to operate the unit. If all is well the unit should start to sound. If this doesn't happen, check all your connections.

Situate the tape in the most likely place that leakage will occur and this project should look after the kitchen floor for you. It is recommended that the unit be tested a couple of times a year just to test the batteries. □

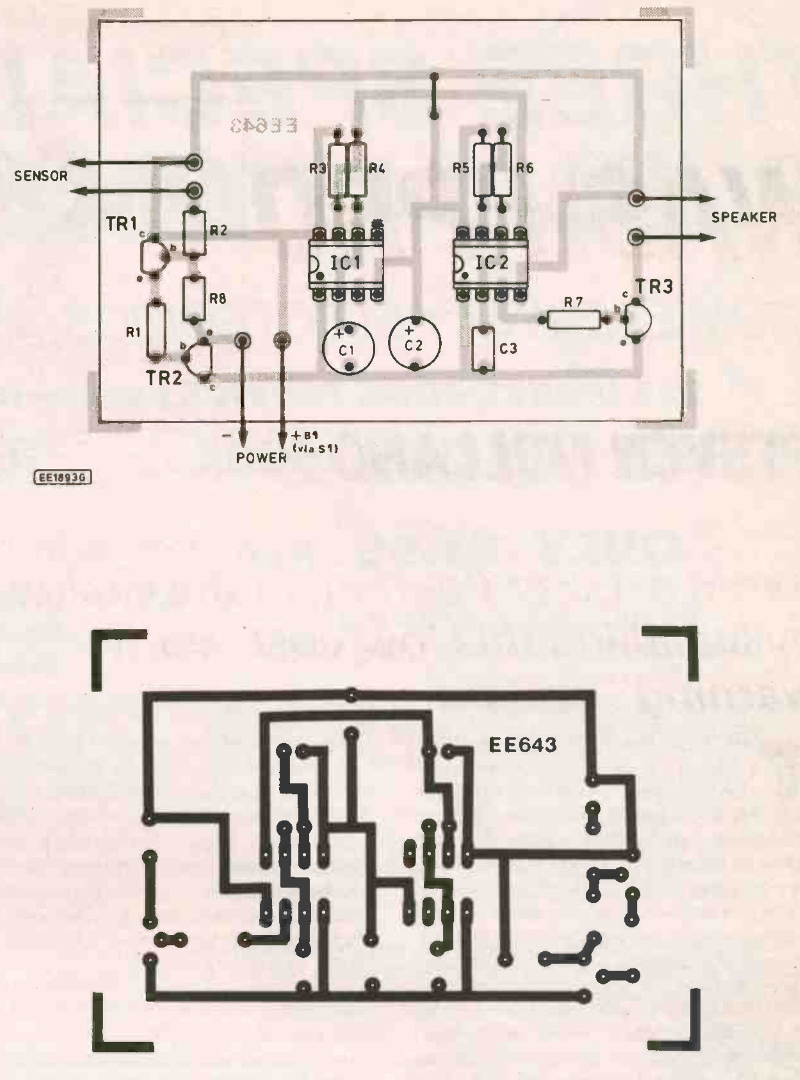
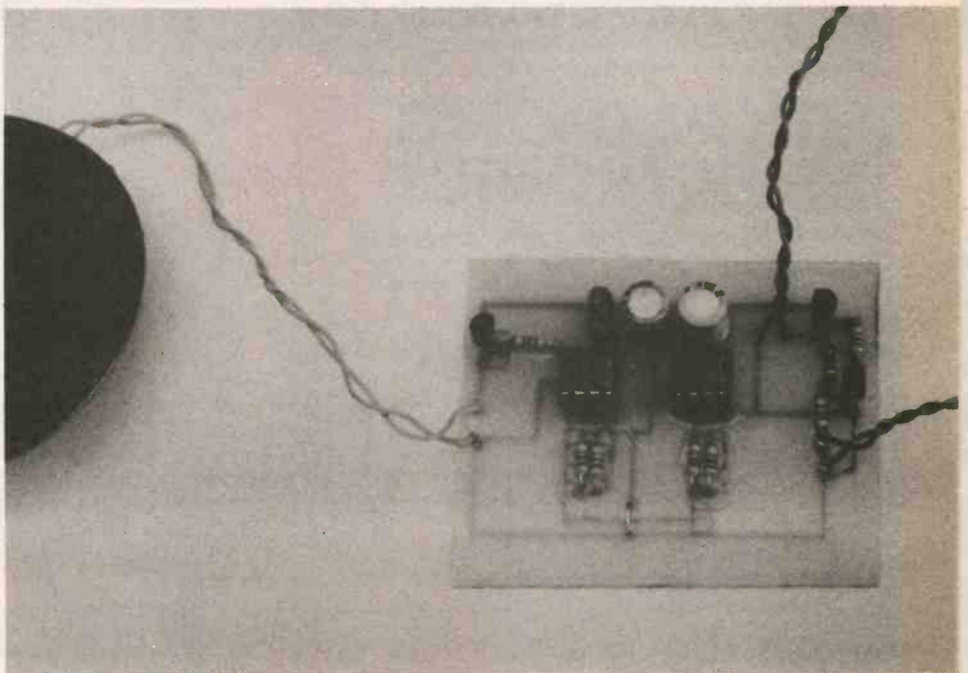


Fig. 2. Printed circuit board component layout and full size copper foil master pattern. The completed board, with leads to the warning loudspeaker, is shown in the photograph below.



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Constructional Project

EEG BIOFEEDBACK MONITOR

ANDY FLIND

Investigate your brain's Alpha, Beta and Theta waves. Learn to really relax or delve deeper with this excellent monitor.

A BIOFEEDBACK system is normally used to make some normally imperceptible body function apparent to its user, often so that it can be strengthened or suppressed. The GSR (Galvanic Skin Response) monitor, which measures skin conductivity, is quite well-known. Skin surface resistance rises during relaxation, so someone who learns to increase skin resistance is in fact reducing stress.

Similarly, migraine sufferers have been taught to increase the temperature of their palms, as resulting changes in blood flow can apparently alleviate the headache. The ultimate objective for most amateur enthusiasts, however, is the construction of an EEG (for "Electro-EncephaloGraph") "brain-wave" monitor.

EEG

The study of EEG patterns is a relatively new science. The presence of various electrical signals within the brain was first discovered in 1924 by a German scientist, Hans Berger, now generally regarded as the "father" of the art. Berger discovered "Alpha" and "Beta" waves with the aid of electrodes placed on the head of his son, Klaus.

Use of this knowledge was limited for many years simply to clinical diagnosis. In 1958 however an American psychologist, Joe Kamiya, began experiments to discover whether subjects connected to an EEG machine could learn to increase production of various brain signals, especially Alpha, and so the use of the EEG as a true biofeedback tool began.

The sixties, of course, was the decade of flower-power, hippies, and an increased interest in all things of a spiritual nature. Some interesting research demonstrated that during deep meditation, "Zen" and Yoga practitioners produced extraordinarily high levels of Alpha activity, so the notion arose that biofeedback might bypass the years of intense training of traditional Zen and Yoga schools.

In America simple, inexpensive EEG training machines were promoted as a way to instant "Nirvana". Sadly, it seems they cannot in fact achieve this for their users, but there is little doubt that Alpha training through biofeedback can assist the attainment of deep relaxation. This is valuable by itself in these stressful times, and for some it may provide a springboard into deeper meditation and spiritual progress.

BRAIN ACTIVITY

The brain produces various frequencies of electrical activity, most of which have been classified and named by researchers. The best known is the Alpha rhythm, about 7 to 14Hz, normally produced when the subject is awake but relaxed with eyes closed. Below this are Delta, 4Hz or less, found in sleep and in babies up to about a year old, and Theta, 4 to 7Hz.

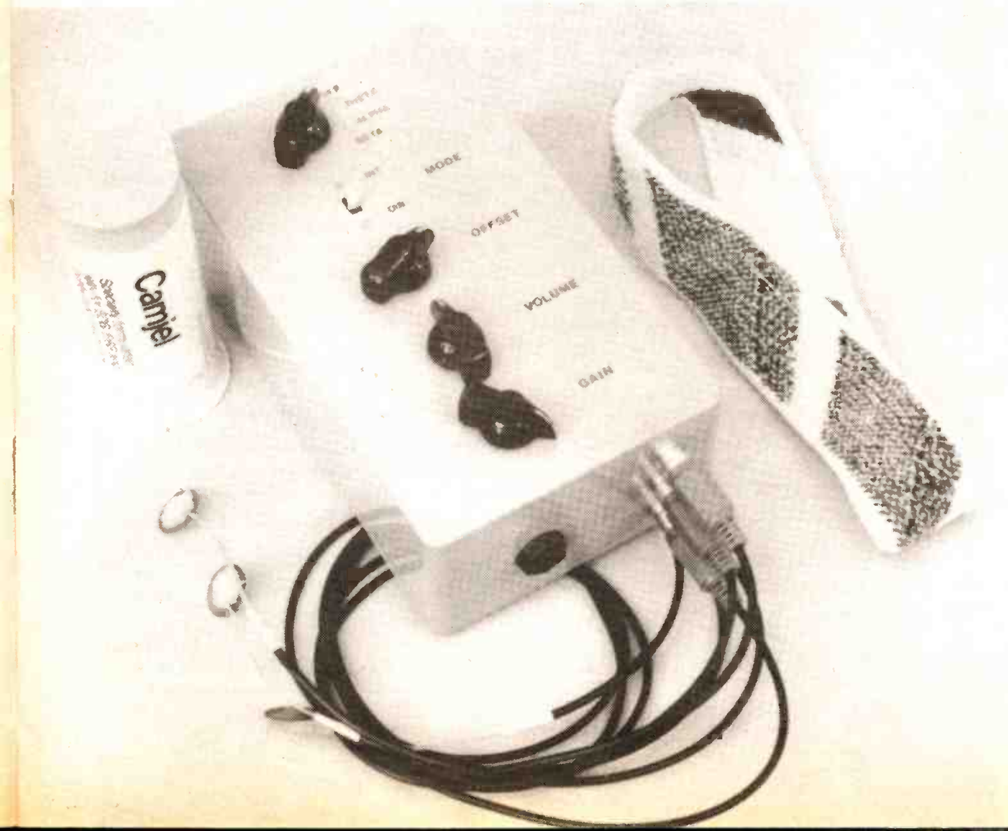
Theta is attracting some attention, as training in it has enhanced visualisation and creative abilities for some subjects. It has also been detected in some Zen masters during deepest meditation. Beta, from 14Hz upwards and usually strongest around 20Hz, is indicative of normal conscious activity. You will (hopefully!) be producing Beta right now as you read this article.

By means of electrodes on the scalp, all these electrical signals may be detected, and displayed to the user. The only difficulty is that they are of very low voltage, typically 5 to 20 microvolts, and most users will be trying to detect them in the presence of several volts of induced 50Hz a.c. powerline hum.

ELECTRONICS

Until recently the electronics design was difficult, as the amplifier required a high input impedance coupled with a very low noise figure. Noise is a problem at low frequencies. Below the audio spectrum the noise generated by most semiconductors increases dramatically and op-amps such as the 741, and many discrete transistors, are quite useless for the task.

One wonders how Berger coped all those years ago. Apparently he used a type of galvanometer, without benefit of amplification at all. Recently however, the appearance of specialised "low-noise" op-



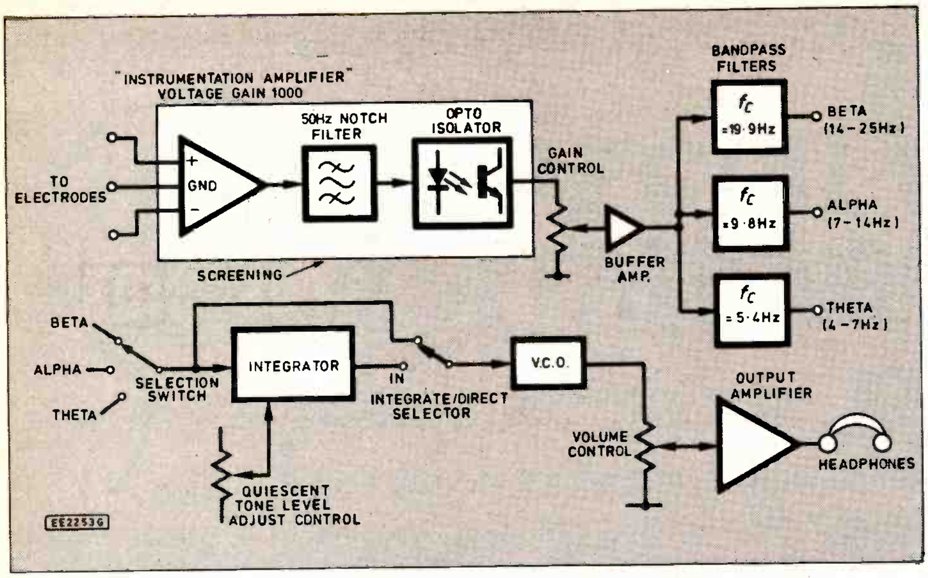


Fig. 1. Block diagram of the EEG Biofeedback Monitor

amps such as the OP-07 has made it possible to produce a simple and effective EEG monitor design for home construction.

INSTRUMENTATION AMPLIFIER

A block diagram of the Monitor is shown in Fig.1. The first stage is an "instrumentation amplifier" with a voltage gain of a thousand and a very high rejection of unwanted "common-mode" signals such as "hum". This is followed by a notch filter to remove remaining traces of 50Hz noise, and an opto-isolator. This provides safety if the project is coupled to mains-driven equipment such as computers or amplifiers. **With electrodes sited on the user's head safety is obviously of paramount importance!** At the same time, the isolation prevents possible entry of hum through the output. This part of the circuit is assembled on a separate p.c.b. and carefully screened in the finished assembly.

With the minute EEG signals now raised to useable levels and stripped of mains hum, the remaining circuitry, on a second p.c.b. is concerned with processing and output. Three filters extract Beta, Alpha and Theta signals, which are available simultaneously. They could be interfaced to a computer for graphical screen presentation, though there are obviously many interesting possibilities. A switch selects one of them to control a VCO, for an audio output on headphones. The VCO is driven either directly or through an "integration" circuit that gives an output corresponding to average level. Users will quickly establish their own preference from these two outputs.

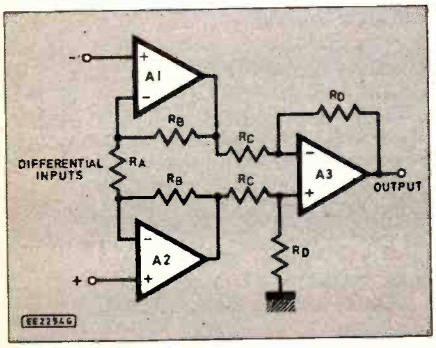


Fig. 2. Simplified diagram of an instrumentation amplifier

For readers not familiar with the "instrumentation amplifier" used for the input, a simplified diagram appears in Fig.2. It consists of three op-amps. A voltage common to both inputs will appear, unamplified, at the outputs of both A1 and A2. A voltage applied to one input appears, with a gain of $(R_a+R_b)/R_a$, at the output of the appropriate amp. However the current drawn through R_a will cause an almost equal but opposite output to appear at the output of the other amp.

These signals are combined in A3, a unity-gain differential amplifier circuit. The output from this is the difference between its inputs, voltages common to both being rejected. This configuration provides differential amplification, very high rejection of common-mode signals, high input impedance (since both signals go to op-amp non-inverting inputs), and a potentially high gain of, approximately, $(R_a+2R_b)/R_a$. The circuit is often seen in industrial applications such as electrometer amplifiers. In this project the use of OP-07 amplifiers gives the additional advantage of very low noise.

CIRCUIT — FRONT END

The full circuit for the "front-end" board is shown in Fig.3. The instrumentation amplifier consists of IC1, IC2 and IC3. This is similar to Fig.2, but the inputs are a.c.-coupled through C1 and C2 with extra protection provided by R1 and R2. High frequency roll-off is introduced by C3 to C6 to reduce gain at unwanted frequencies. R3 and R4 provide input bias, VR1 allowing adjustment to compensate for op-amp offset voltages. VR2 trims for maximum common-mode rejection.

Remaining traces of 50Hz hum are then removed by the filter constructed with dual op-amp IC4. This is a modified "twin-T" notch filter, with active feedback to the common point to sharpen the notch. Clamp diodes D1 and D2 prevent overload of the output stage IC5, an op-amp which drives opto-isolator IC6. To avoid overloading the auxiliary negative supply this stage draws all it's power from the positive rail.

A "split" supply of plus and minus 5 volts is provided for this circuit. In order to avoid a multiplicity of batteries, the output of a single 9-volt PP3 is first reduced to 5 volts by regulator IC7, then the negative supply is generated by IC8, an ICL7660 "negative converter" chip.

CIRCUIT — SIGNAL PROCESSING

The second, signal processing, part of the circuit is shown in Fig.4. The input is developed across R1, a 470 ohm emitter load for the opto-isolator transistor. The isolator specified has a "transfer ratio" of about 100 per cent, so in this circuit the output across R1 will about equal the input. The "raw" signal appears at a socket, for connection to other equipment if required. VR1 controls overall gain and is follwed by buffer IC1a, one of four amplifiers in a TL064 i.c. The other three form two-pole bandpass filters, with "Q" factors of about 6.5, and centre frequencies of 19.9, 9.8 and 5.4Hz for a selection of Beta, Alpha and Theta respectively.

Although EEG circuits often use a single filter with switchable frequency, there is little extra complication in providing three separate filters. The outputs are available simultaneously for recording and experiments, and switch connections are simplified. If the filter capacitor values are reasonably small some of the associated resistors will have high values, so the TL064 with f.e.t. inputs was picked for the amplifiers.

OUTPUT

A project intended for relaxation training should not sound harsh to the ear. The output from this circuit is a low hum, with pitch varied by the input signal. This is produced by the VCO in IC3, a CMOS 4046B "phase-locked loop". As the VCO output is a squarewave, the harsher components are filtered out by R23, R24 and C13, C14 before it goes to output amplifier IC4. This is a 741 op-amp, which is quite capable of driving headphones at a reasonable level, especially the miniature type intended for use with "personal" stereos.

The filter outputs can drive the VCO either directly, or through the "average level" circuit around IC2, giving an output pitch that rises with overall input amplitude. To avoid a rather "lumpy" output at the very low frequencies involved, the level detector is not the usual half-wave arrangement. Instead an "absolute-value" circuit is used, consisting of IC2a and associated components. Output from this is buffered and then integrated by IC2d. IC2c and VR2 provide a variable reference for "threshold" adjustment. In use it sets a level which the signal must exceed before the output pitch starts to rise.

This part of the circuit has it's own power supply, both for safety isolation and to prevent the possibility of feedback through the power rails. With the exception of IC2 and IC4, everything operates from the 5-volt regulator IC5.

CONSTRUCTION — FRONT-END. P.C.B.

Construction should commence with the assembly of the front-end p.c.b. The component layout for this is shown in Fig.5. Both p.c.b.'s are lengthened in order to fit into the moulded slots of the specified plastic case. For different arrangements they could be trimmed short, but this should only be altered by constructors who are confident that they understand the screening requirements.

For ease of construction, the routine of

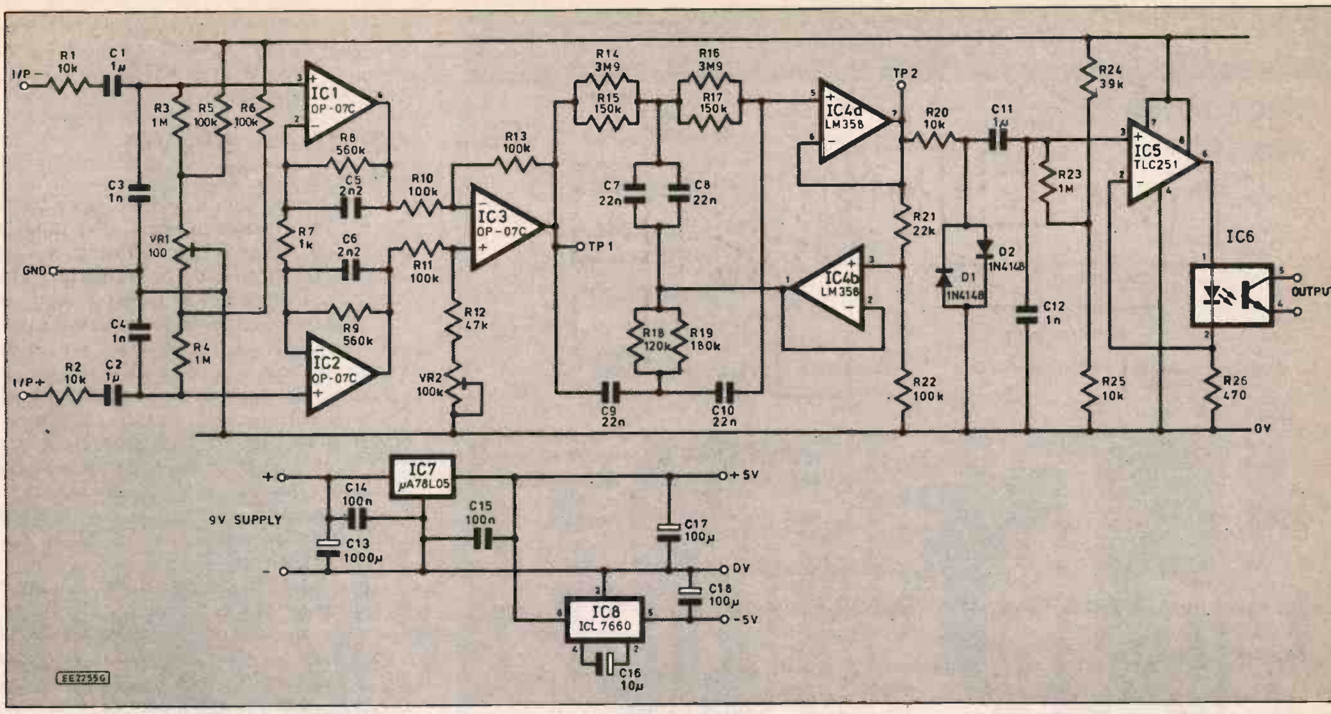
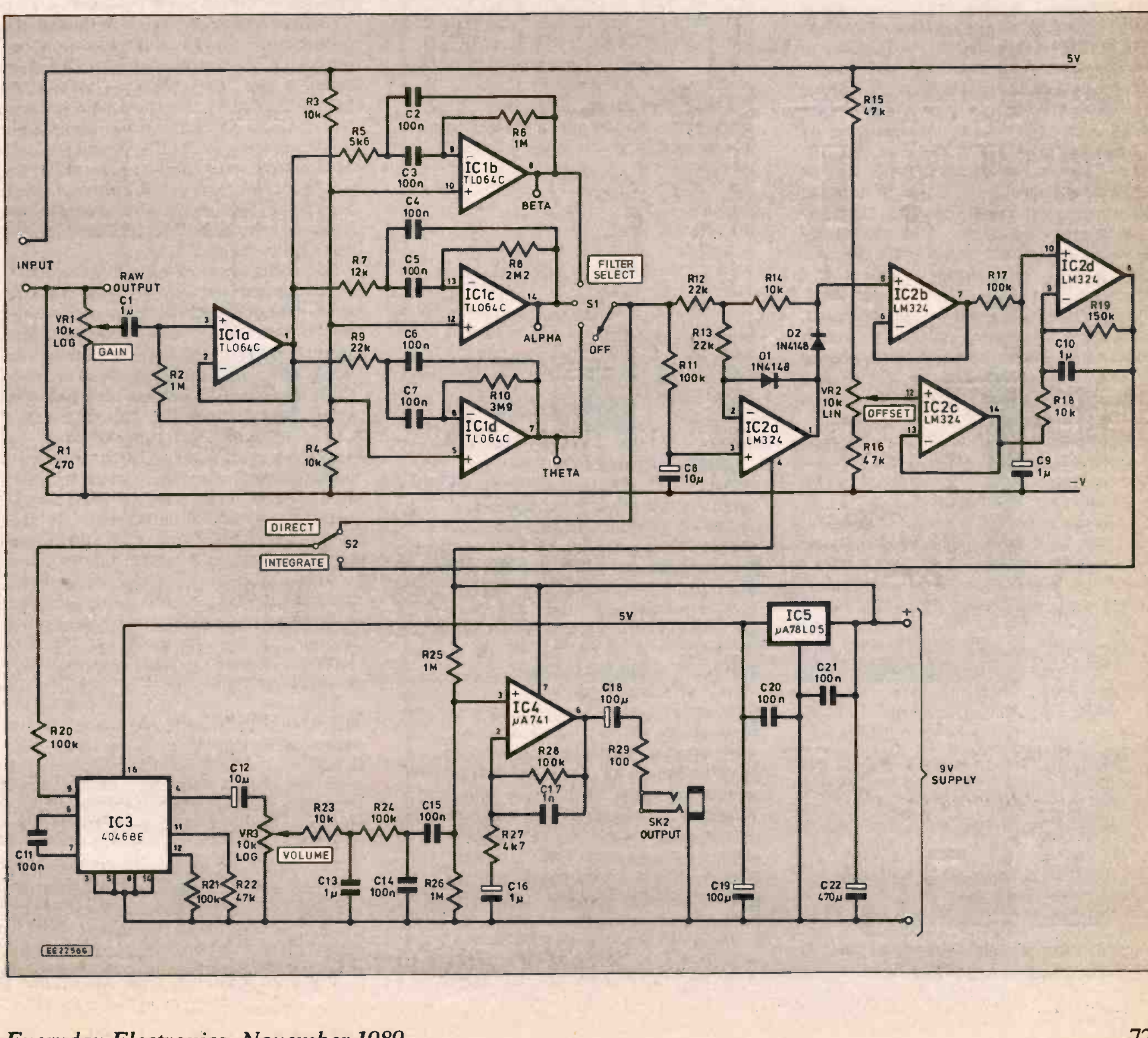


Fig. 3. Circuit diagram of the "front end" of the EEG Monitor

Fig. 4. Circuit diagram of the signal processing section of the Monitor.



COMPONENTS

Approx. cost Guidance only **£45**

FRONT END P.C.B.

Resistors

R1,R2, R20,R25	10k (4 off)
R3,R4, R23	1M (3 off)
R5,R6, R10,R11, R13,R22	100k (6 off)
R7	1k
R8,R9	560k (2 off)
R12	47k
R14,R16	3M9 (2 off)
R15,R17	150k (2 off)
R18	120k
R19	180k
R21	22k
R24	39k
R26	470

All metal film, 0.6W 1%

Shop Talk see page 716

Potentiometers

VR1	100 sub-min hor. preset.
VR2	100k sub-min hor, preset.

Capacitors

C1,C2, C11	1µ polyester layer (3 off)
C3,C4	In polystyrene (2 off)
C5,C6	2n2 polystyrene (2 off)
C7 to C10	22n 1% polystyrene (4 off)
C12	1n polystyrene
C13	1000µ axial elect. 10V
C14,C15	100n polyester layer (2 off)
C16	10µ axial elect. 25V
C17,C18	100µ axial elect. 10V (2 off)

Semiconductors

D1,D2	1N4148 silicon diode (2 off)
IC1 to IC3	OP-07C low-noise op-amp.
IC4	LM358 dual op-amp
IC5	TLC251 LIN-CMOS op-amp.
IC6	High sensitivity, high voltage opto-isolator (Maplin order code RA57M).
IC7	µA78L05 5V 100mA positive regulator.
IC8	ICL7660 voltage convertor.

Miscellaneous

Printed circuit board available from the *EE PCB Service*, order code EE661; 7 x 8-pin d.i.l. sockets.

PROCESSOR P.C.B., CASE AND CONTROLS.

Resistors

R1	470
R2,R6, R25,R26	1M (4 off)
R3,R4, R14,R18, R23	10k (5 off)
R5	5k6
R7	12k
R8	2M2
R9,R12 R13,	22k (3 off)
R10	3M9
R11,R17 R20,R21 R24,R28	100k (6 off)
R15,R16 R22	47k (3 off)
R19	150k
R27	4k7
R29	100

All metal film, 0.6W 1%

Potentiometers

VR1,VR3	10k log. carbon, (2 off)
VR2	10k lin. carbon,

Capacitors

C1,C10, C13,	1µ polyester layer
C2 to C7, C11,C14 C15,C20, C21	100n polyester layer (11 off)
C8,C12	10µ axial elect. 25V (2 off)
C9,C16	1µ axial elect. 63V (2 off)
C17	1n ceramic plate
C18,C19	100µ axial elect. 10V (2 off)
C22	470µ axial elect. 10V

Semiconductors

D1,D2	1N4148 silicon diode (2 off)
IC1	TL064C quad J-FET op-amp.
IC2	LM324 quad op-amp.
IC3	4046BE CMOS PLL,
IC4	µA741 op-amp.
IC5	µA78L05 5V 100mA positive regulator,

Miscellaneous

S1	rotary switch, 3-pole 4-way
S2	slide switch, 1-pole 2-way
SK1	DIN socket, 5-pin 240 degree,
SK2	stereo jack socket.

Printed circuit board, available from the *EE PCB Service*, order code EE662; material for screening p.c.b. (see text); 2 x 14-pin d.i.l. sockets; 1 x 16-pin d.i.l. socket; 1 x 8-pin d.i.l. socket; case, ABS plastic box 190 x 110 x 60mm; 4 x control knobs; 4 x phono chassis sockets; 2 x PP3 battery holders with connectors; silver sheet etc., see text.

fitting the components in order of physical height should be followed. There are two links on this board. Sockets are recommended for all chips except IC7, to avoid undue handling of the devices themselves and to assist testing and adjustment. Note that IC's 5 and 8 are CMOS devices so the usual precautions should be observed.

The resistors should all be one per cent metal film type, these are now standard from most major suppliers. Other types may result in impaired noise or hum rejection performance. The four 22n capacitors in the hum filter, C7 to C10, are one percent tolerance types instead of the usual five percent. Since the layout was finalised the author's supplier has changed the source of these capacitors and the new ones are about twice the diameter of the originals. They also look like the normal five per cent type! Inquiries confirmed that they are indeed one per cent, this being indicated by the letter "F" beneath the value marking. They are a tighter fit on the board, possibly overlapping adjacent components, but should not cause real problems.

American readers will have to recalculate the filter resistance values for 60Hz mains, whilst those without mains electricity can omit it! Although opto-isolator IC6 is a 6-pin device an 8-pin socket is used as 6-pins are rare. IC6 is fitted at the top of this socket.

FRONT-END CHECKING

The front end p.c.b. can now be checked and adjusted. It should first be powered without i.c.'s save for regulator IC7. Following a brief surge as the electrolytics charge, the supply current should settle to about 2.5mA. and the 5 volt positive supply should appear across C17, the upper 100µ capacitor. If this seems OK IC8, the ICL 7660, can be inserted, the board powered again, and a check made for the negative 5 volt supply across C18, the lower 100µ capacitor.

There should be a total of 10 volts across both capacitors, of course. The supply current increase should be negligible as the 7660 draws only 100µA. Following this, IC5 and isolator IC6 can be fitted. This should raise the drain to about 4.5mA, whilst pin 2 of IC6 (centre, left-hand side) should have a potential of 1V.

If all seems well so far, the two inputs at the left-hand side of the board should be shorted to the "ground" point between them, the 100ohm trimmer VR1 set to about half-travel, and the first two OP-07's, IC1 and IC2 inserted. This will raise the supply current to about 7.5mA. Their output voltages (pin 6) can be checked, and the effect of VR1 noted. It should be possible to zero both outputs with VR1, though allowance should be made for the slow response. (This check initially failed on the prototype, revealing a faulty OP-07!)

After this IC3 can be fitted, raising the current to about 9.5mA. With a meter connected to test point 1, IC3 output, VR1 should be carefully adjusted for zero voltage. Inserting IC4 should raise the supply current to the final value of about 10.5mA, and test point 2, IC4a output, should also be at 0V.

A fairly tricky adjustment follows, the setting of VR2 for best "hum" rejection. To avoid problems of spurious hum pickup during this adjustment the board should be placed on an insulated conductive surface, to which its "ground" rail must be con-

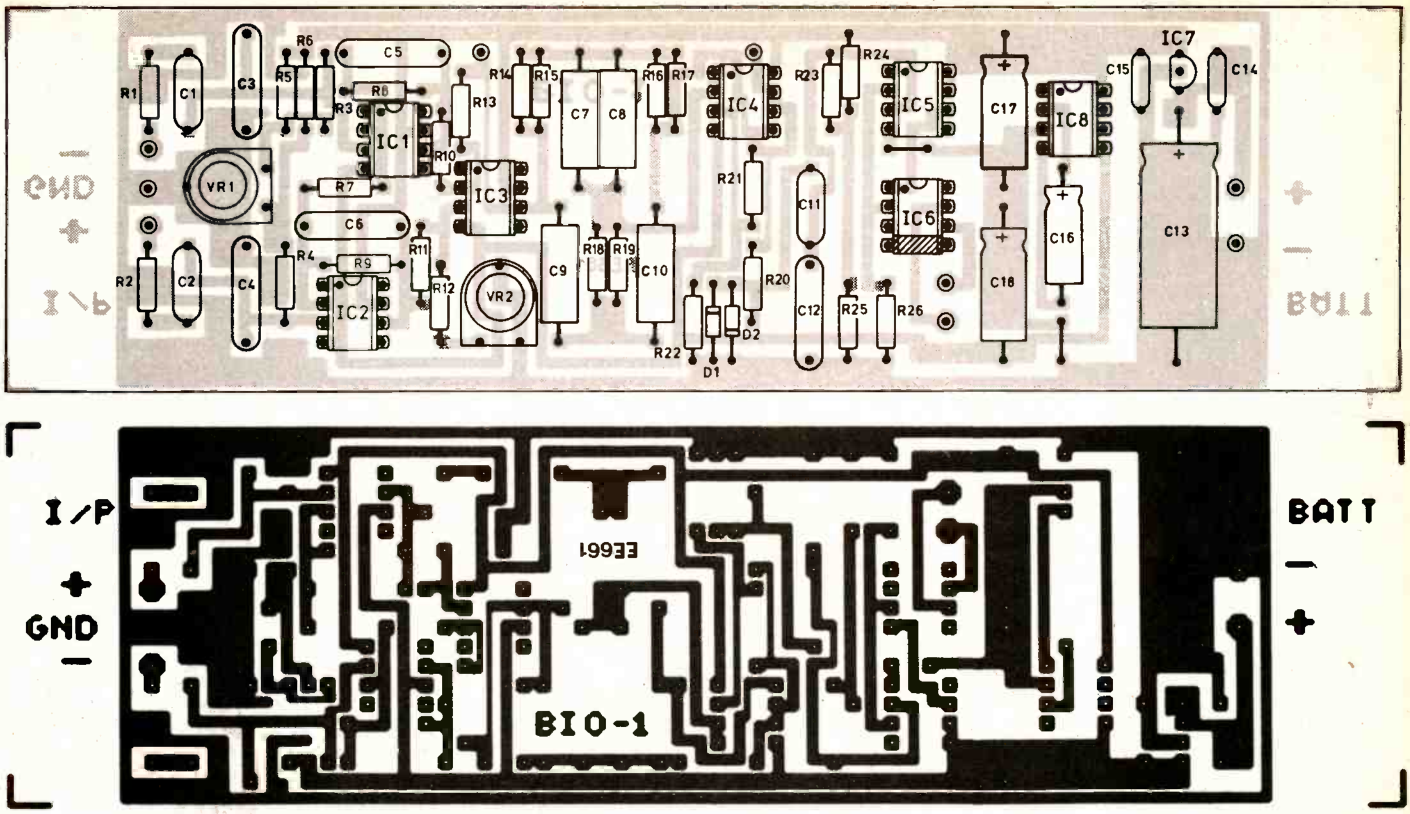


Fig. 5. Front end p.c.b. layout and wiring

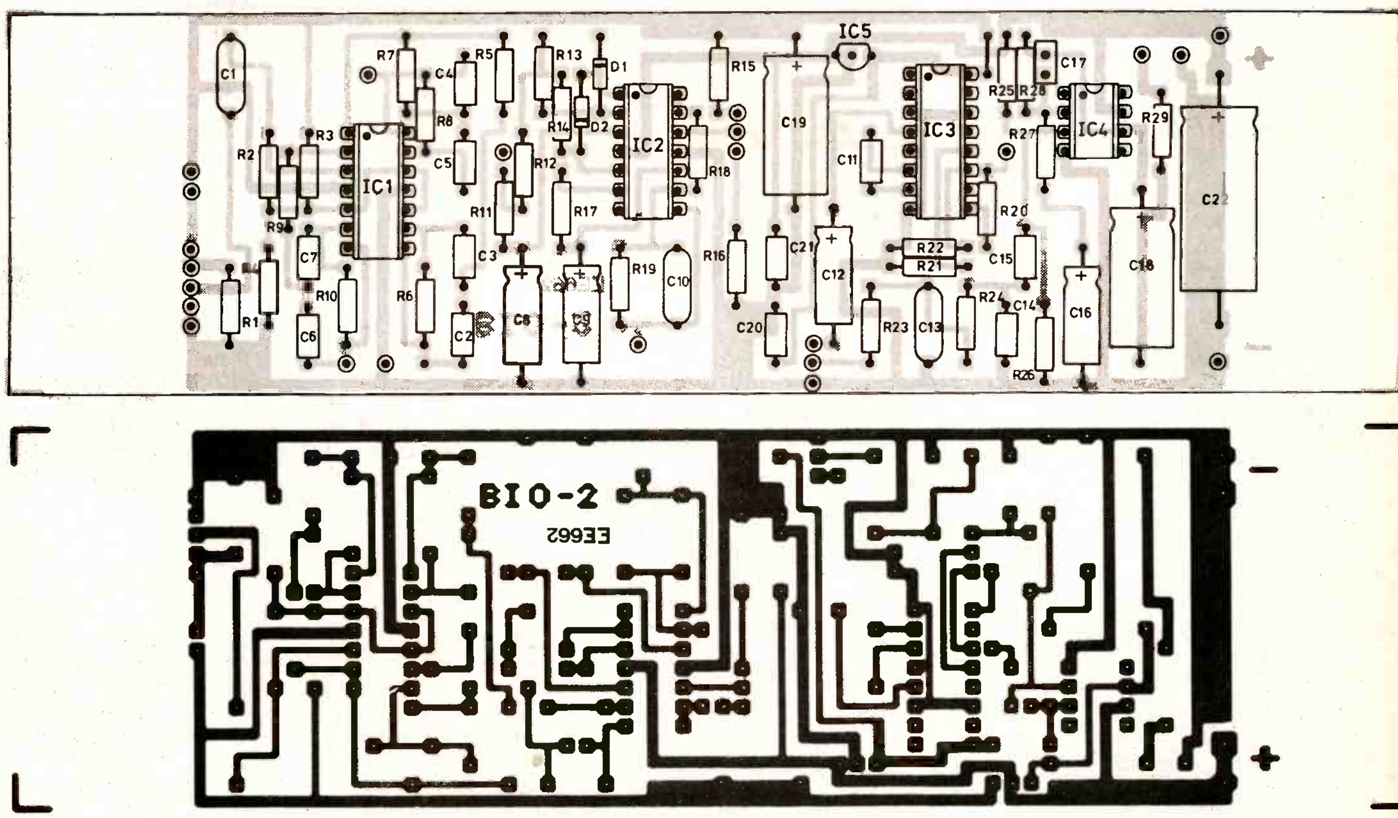


Fig. 6. P.C.B. layout and wiring of the signal processing board

nected. A sheet of kitchen foil overlaid with cardboard will suffice. The inputs should be disconnected from ground but coupled together and a 50Hz input applied to them.

If a signal generator is available this input should be about one volt r.m.s., if not a finger placed on them will probably inject about the right level in most workshops! A means of monitoring test point 1 is required, ideally an oscilloscope, though a millivoltmeter will do. Most DVM's have a suitable range (no serious constructor today should be without one). VR2 should be trimmed for minimum a.c. output at the test point. If the optimum adjustment is difficult to find, hum is probably still being induced into the circuit from some external source.

This adjustment proved almost impossible on the prototype until the grounded conductive sheet was set up as described, when it became easy. If a 'scope and generator are available, test point 2 can be monitored whilst the frequency is varied and the effect of the filter observed, although this is not essential. A final check on the adjustment of VR1 is advisable.

The completed "front-end" p.c.b. may be used on its own for experiments if desired, though the comments on screening, given in the description of final assembly, should be noted.

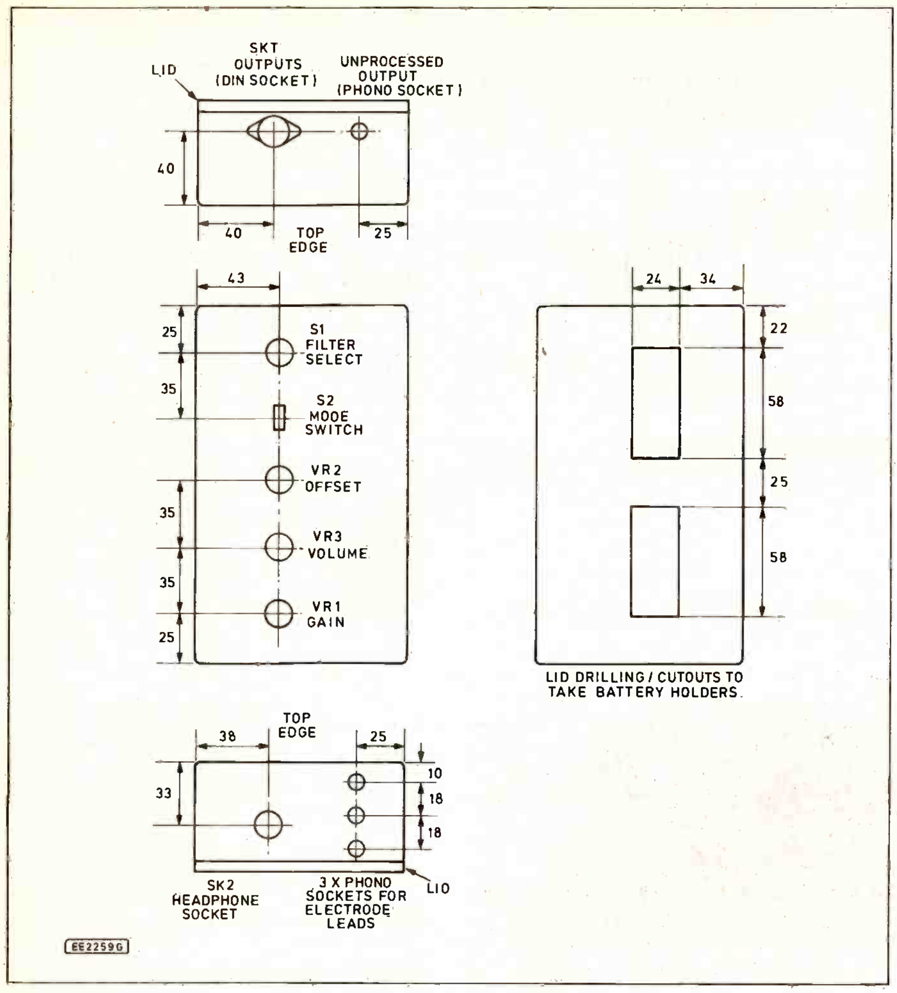


Fig. 7. Case drilling details

CONSTRUCTION — SECOND P.C.B.

Assembly of the second p.c.b. is simpler than that of the first. The layout is given in Fig.6. Again sockets should be used for the i.c.'s, and CMOS handling precautions observed for IC3. Since testing requires most of the controls to be connected, it is as well to complete it and assemble the entire project into the case, an ABS box, size 190 x 110 x 60mm, before commencing.

As the layout is fairly compact full case drilling details are given in Fig.7. The layout of controls, sockets and p.c.b.s is shown in Fig.8, whilst their connections appear in Fig.9. The Delta/Alpha/Theta switch S1 has a fourth position, "Off", which controls battery supplies to both printed circuit boards. The front-end p.c.b. has screens placed to either side and connected to the input "ground" point. Spare pieces of p.c.b. material, with the copper facing outwards, are ideal, but suitably insulated sheet metal or even stiff card and kitchen foil could be used.

Note that when the boards and controls are placed as shown, there is room for the two snap in battery holders to fit between them. Four stick-on rubber feet keep these holders clear of surfaces on which the unit is placed.

TESTING — SECOND P.C.B.

Testing of the second p.c.b. can proceed as follows. Firstly it should be powered up by itself, without i.c.'s save the regulator, IC5. Following an initial surge the supply curent should settle to about 5mA. The presence of 5 volts across C19 can be checked. IC4 should now be fitted, raising the drain by a couple of milliamps. With a 9 volt supply the voltage at IC4's output, pin 6, should be about 4.5 volts.

If the headphones are connected and a finger placed on the bottom of the 100n capacitor C15, a loud hum will probably be heard. The same finger on the top of the 10uF capacitor C12 (or pin 4 of IC3's socket), should cause a softer hum, adjustable with volume control VR3. IC3, the 4046B chip, can now be fitted and S2 switched to "integrate". This should produce a horrible noise, half hum and half tone. Connecting pin 8 of IC2's socket to negative supply should produce a clear, steady, low frequency tone, whilst taking it to the 5 volt positive supply will result in a higher tone, slightly more than an octave up.

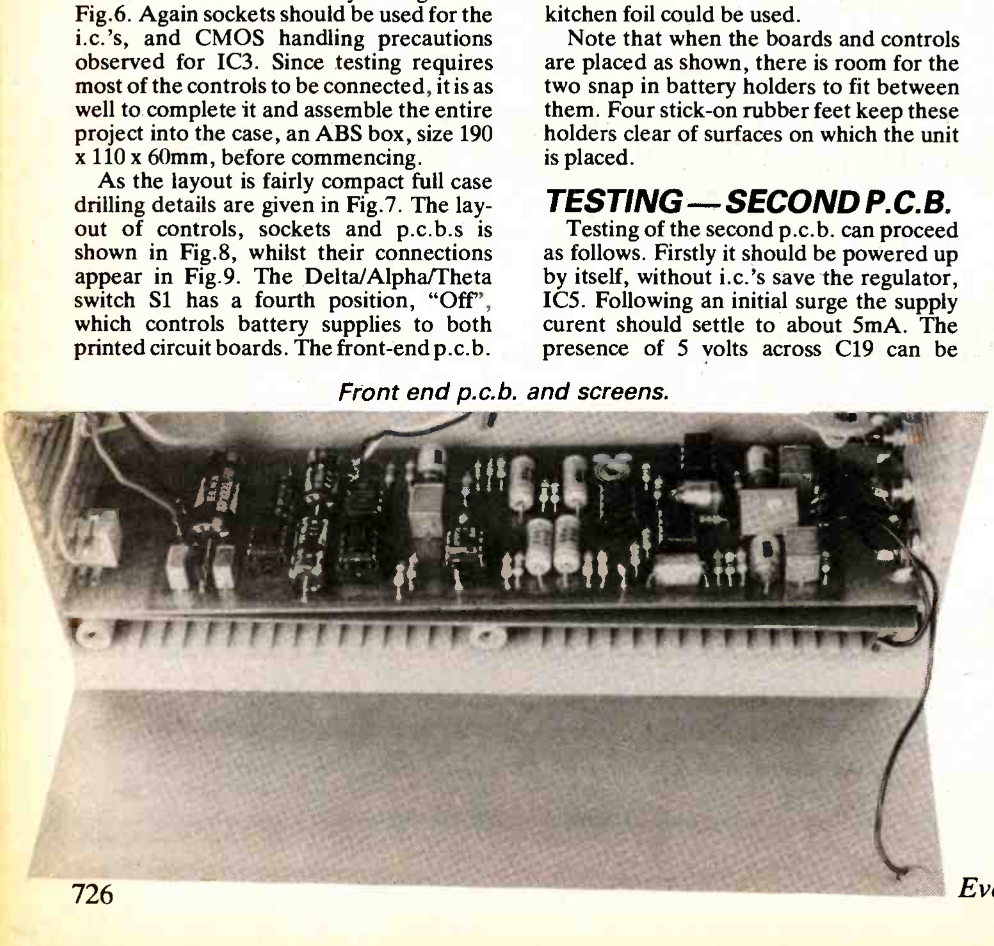
Next the TL064, IC1, can be fitted, and S2 set to "direct". All three "on" positions of the selector switch S1 should produce clear, steady tones. IC1's outputs, pins 1,7,8 and 14, should be checked as being about 2.5 volts; being the four corner pins they're easy to locate! Touching the top of 1μ capacitor C1 to +5 volts on any range should produce a sharp rise in pitch, follwed by a return to the original output tone during which "ringing" at the selected "Brainwave" frequency should be clearly audible.

Finally IC2, the LM324, can be fitted, S2 set to "integrate", and the effect of offset control VR2 tried. About halfway around its travel this should start to increase the output frequency. Set just below this point, a finger touched to the top of C1, to inject hum, should produce a rise in pitch. The total current drawn by the complete board should be around 7 to 8mA, though this will depend to some extent on output volume.

Finally, the front-end board should be powered, the gain control VR1 turned right down, and the voltage across R1 (and VR1) checked as being about one volt d.c. If the circuit is set to "integrate", advancing VR1 should cause a rise in output pitch as noise finds its way into the open-circuit inputs. A finger placed over them should increase this output. The final supply current drawn by the output board should be about 10mA, the increase being due to the current drawn by the opto-isolator and R1.

The project is now operational and can be put to use as soon as suitable electrodes have been prepared.

Front end p.c.b. and screens.



ELECTRODES

A large factor in the successful operation of this project is the manner in which it's electrodes are made and used. It follows that considerable care should be taken with these, so they will be covered in some detail.

Most metals, if placed in contact with the body, set up a kind of battery action with acids secreted by the skin. Movement, however small, results in fluctuation of the voltage produced by this "battery" which can cause severe interference with the very low-level signals sought with this project. Because of this, it is wise to select the electrode material with the lowest possible level of this problem, this being silver with a silver chloride coating. This isn't as difficult or expensive as it sounds.

A piece of thin silver sheet about an inch square is required. In the author's case this came from an amateur silversmith friend, though a local jeweller and trophy-supplier confirmed that they would have no trouble in supplying such an item for about £6.00.

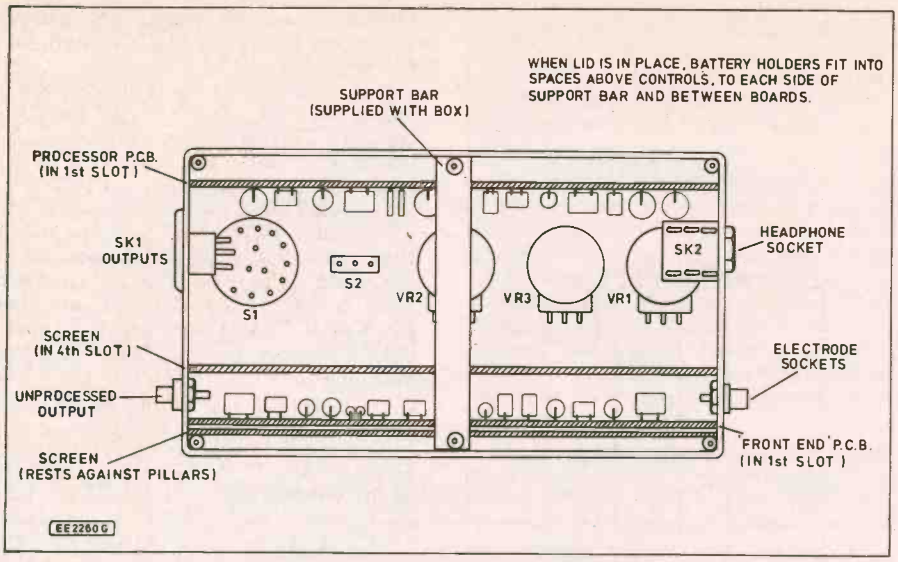


Fig. 8. Layout of the various controls, sockets and p.c.b.s in the case.

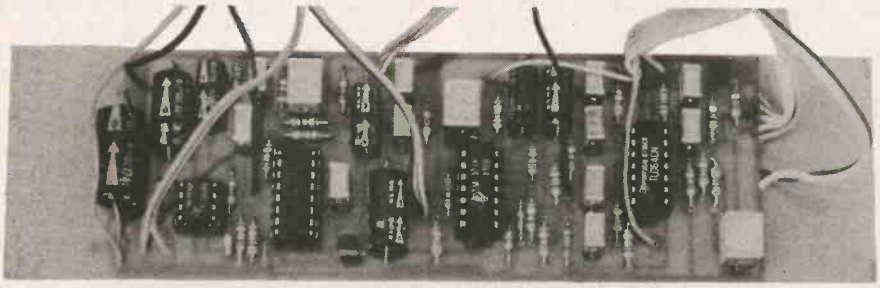


Fig. 9 (below) Interwiring of the monitor

From this, three discs about the size of a new penny should be cut. Silver is quite soft, the sheet can be cut with sharp scissors. Keep the scrap, which will be needed for the chloriding process.

This project was originally designed to use screened electrode leads (see photo), but this was later found to be unnecessary. The sockets have provision for screen connections; if for any reason screened lead is used it should be the low-noise type. However, for most users thin, flexible single-core wire will be fine (see photo). Leads made from this, each about a metre long, should be soldered to the centre of each disc, and the joint sealed and insulated with a blob of Araldite resin. Fig.10 shows this.

The other side of each disc should be thoroughly cleaned before the chloriding process. This consists of placing them in a tumbler of water containing a teaspoon of dissolved salt, and passing a small current through them to a common electrode consisting of the remaining, scrap silver. This will coat them with black silver chloride. The arrangement for this is shown in Fig.11. Each electrode has a 10k series

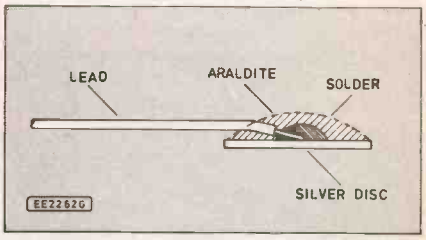
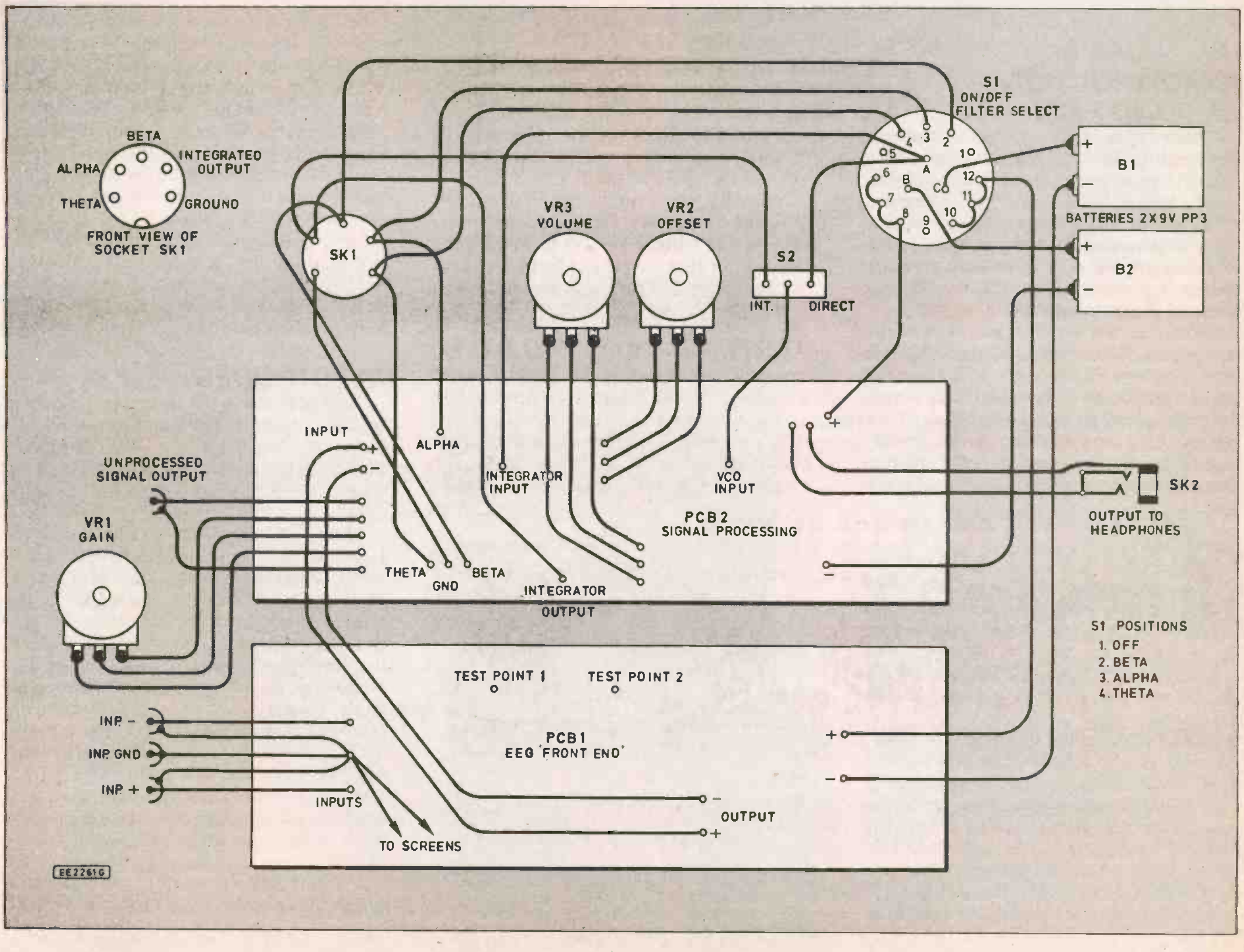


Fig. 10. Construction of an electrode



resistor. For keeping them in place around the tumbler, clothes pegs will be found useful.

The plating process takes an hour or two. Stop when the electrodes are seen to have a uniform coating of black chloride, as an excessively thick coating seems to have a fairly high resistance. They should be handled gently to avoid damaging the coating and, when not in use, kept in the jar with a tiny polarising current applied through a common 1M resistor.

ATTACHING THE ELECTRODES

Attaching the electrodes to the head presents problems. Skinheads will not experience any difficulty of course, but the rest of us will find that hair tends to get in the way! Alpha, when present, tends to be strongest between the occipital (that's the back of the head) and temporal (above the ears) areas.

An electrode siting combination that seems to work fairly well consists of the "ground" electrode below the left ear, just behind the jawline, one of the two signal electrodes at the centre of the forehead, just below the hairline, and the other at the back of the head, a bit to the left, a bit above a line drawn around between the ears. The first two of these can be attached with sticking plaster, whilst the last is held with an athlete's elastic headband, obtainable from sports equipment shops.

Keeping impedance between the electrodes as low as possible is very important. As the top layer of the skin is fairly resistive, it should be prepared by a good scrub with a pad dipped in surgical spirit before the electrode is applied. An electrode "gel" should be rubbed into the spot where it is to be placed, and a blob of it placed on the electrode before application. This procedure works equally well through hair, though a larger blob of gel is applied to an electrode which must make contact through this.

Proper EEG gels are hard to come by, but a reasonably effective substitute available from any chemist is "K-Y Lubricating Jelly". As this is a family magazine, the stuff's normal purpose will not be divulged here. However, it is suggested that users might like to inform the chemist of the intended use, it might reduce the old-fashioned looks received!

To ensure a good contact, it is really essential to check the impedance between the electrodes. Although the author has never (knowingly!) sustained any harm from the use of an ordinary ohmmeter for the job, this is not going to be recommended here. Next month full constructional details of a checker developed especially for the purpose will be given.

IN USE

Ordinary headphones can be used with this project, but may tend to get caught up in the electrode leads. The miniature type supplied for personal stereos are better, but best of all are the type which have no headband and fit right inside the ears. They needn't be capable of high quality, a cheap pair will do.

Having secured the electrodes in place, the next step is the attempt to generate some signals with its aid. Most users will wish to begin with Alpha, since this is the best known and most useful of the signals that can be detected. The difference between "direct" amd "integrated" output will be immediately apparent, and the user will quickly develop a preference for one of the two.

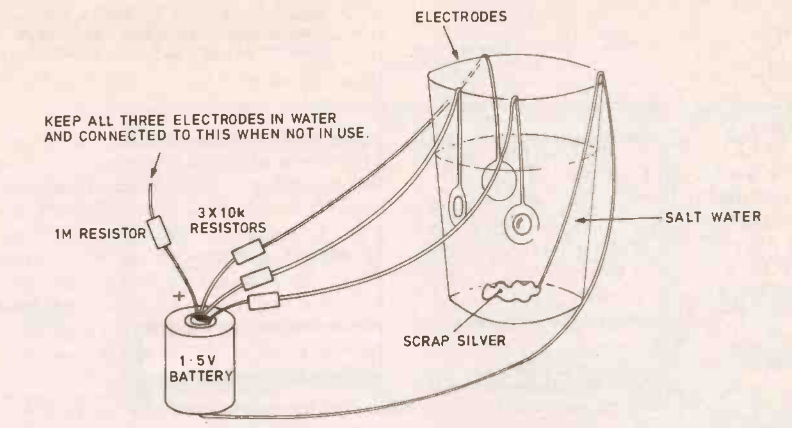
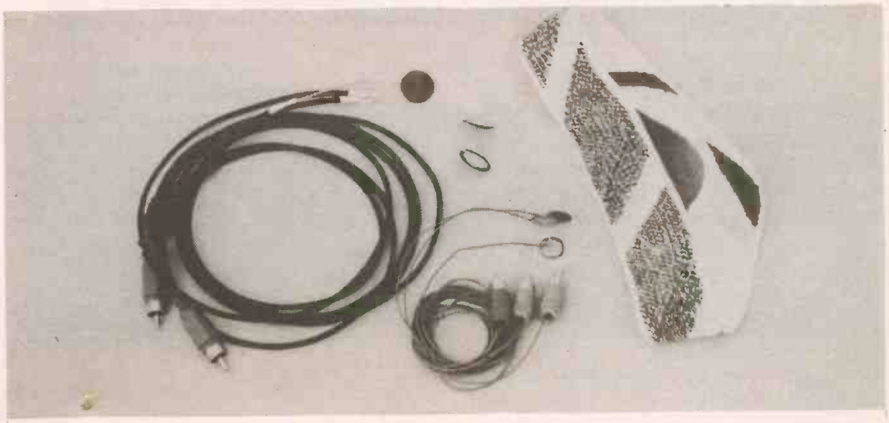


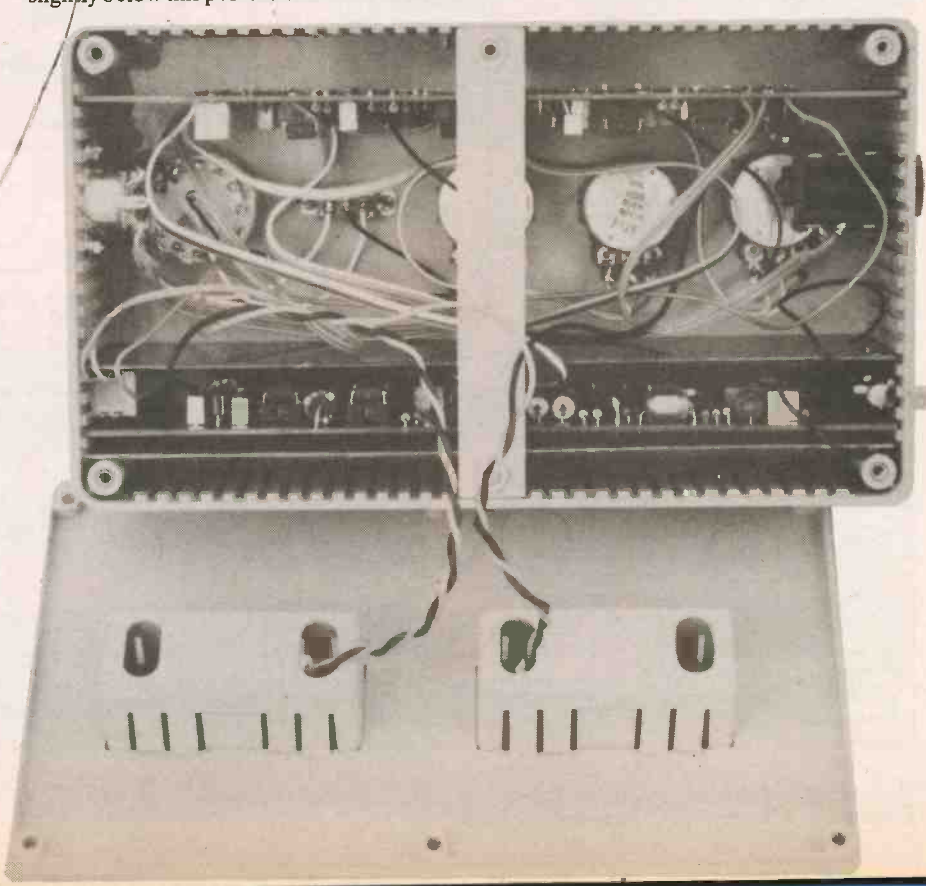
Fig. 11. Set-up for plating the electrodes

The authors two sets of electrodes.



Perhaps "direct" is best for the beginner, who will wish to hear any bursts of the sought activity immediately, whilst more experienced users may wish to use the integrated output to try and produce sustained steady output levels. If the latter is in use, the "offset" control should be backed off until further movement does not produce any further reduction in the output tone fequency. It may, in fact, be set slightly below this point to eliminate noise.

For both types of output, the "gain" should be set just below the point where noise causes spurious output. Then, sitting quietly with eyes closed, should soon result in the production of some Alpha signals. Paradoxically, trying harder to produce Alpha will stop it, one really has to "let go" for results. This is quite hard to do at first, but a few half-hour daily training sessions should soon produce the knack. □



POSTSCRIPT

Since this article was written, the author has learned of the existence of a firm by the name of Audio Ltd, who produce a range of Biofeedback equipment, accessories and literature which may be of interest to readers.

In the EEG biofeedback field they manufacture and market a range of monitors and accessories, and offer courses in Biofeedback training, ably led by Mrs. Isabel Maxwell Cade and Peter Staples. They offer a range of publications on the subject, including *The Meaning of EEG*, by Geoffrey Blundell, which is thoroughly recommended to readers wishing to research the subject in more depth.

Their top-of-the-range EEG monitor is a machine named the "Mind Mirror", used in their training sessions. This reads both sides of the brain simultaneously, displaying signals present in fourteen different frequency bands, on sixteen-step l.e.d. bargraph displays. The result is a kind of real-time "picture" of the brain's electrical activity. As can be imagined, the "Mind Mirror" is a most impressive piece of equipment. Snag is, it costs around £2500! However, it may be experienced at their courses, or hired by the day or week.

Audio Ltd. manufacture two simpler EEG monitors, the cheapest of which, at about £235.00, is the "Monitor AM".

Audio's EEG electrodes can be used with the E.E. EEG monitor, saving the trouble of making the chlorided silver ones described. Most suitable are those sold for their "Monitor AM", as this, like the E.E. design, has only one channel.

A "Monitor AM Kit" was purchased for evaluation with the prototype, at a cost of £17.80 incl. p. and p. It consisted of electrode buttons, foam electrode pads, a wiring harness and connector set, a "Velcro" headband, and a dispenser of professional EEG electrode gel. In addition the kit contained a high-quality earpiece which may be used with this project and a battery box for eight "AA" cells which readers may find useful elsewhere!

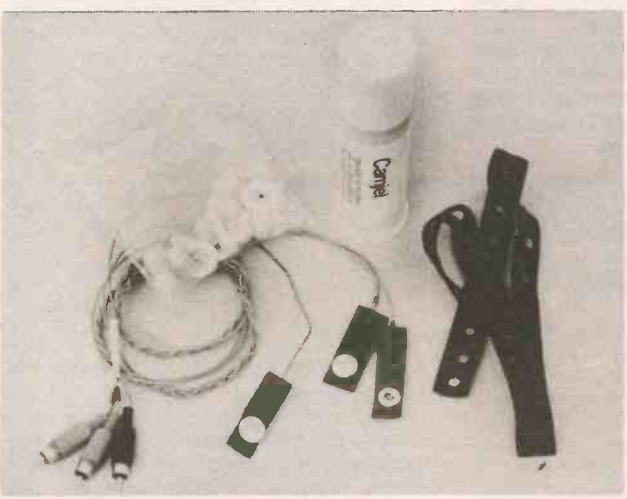
The electrode wiring harness consists of three leads plaited together, two grey, screened ones, and a blue one for "ground". At the equipment end these are terminated in a 3.5mm stero jack plug. The phono sockets of the E.E. design may be replaced by a suitable socket, or phono plugs fitted to the harness. As termination of the two screened leads is fiddly, the former is recommended. Of course, a simple 3.5mm-to-phono adapter could be made.

Audio advise users to place the Velcro headband around the head at a height where it will not slip down too easily. A blob of gel should be placed in the centre of each electrode disc, then a foam pad pushed into it, and more gel applied and worked into the foam, with a final blob on top. The hair should be parted at the point of application, then the electrode placed under the headband with the connector projecting through one of the holes punched in this and the appropriate connector pressed home from the other side. Positions are centre of forehead for "ground", behind the ear for one of the signals, and about three inches around towards the back of the head for the other.

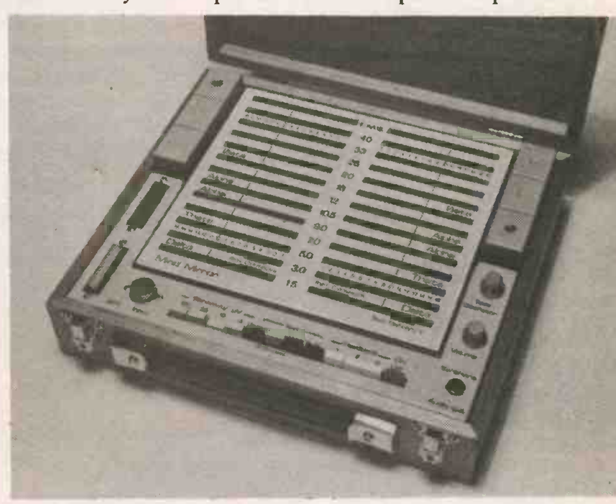
In practice, the author found it difficult to use the Velcro band without assistance and preferred to place the electrodes with their connectors snapped on beneath an elastic sweat band. A good scrub of the skin surface at each electrode site was as beneficial as before too. It proved easier to achieve and maintain a good connection with these electrodes than with the home-made ones. Despite their not being chlorided silver, no significant noise problems were encountered.

Readers wishing to know more, or purchase a set of these electrodes, can contact Audio Ltd. at 26-28 Wendell Rd., London W12 9RT. Phone 01-743-1518/4352.

Between 11.00am and 4.00pm on Mondays and Fridays, Isabel Maxwell Cade is present to answer queries in person.



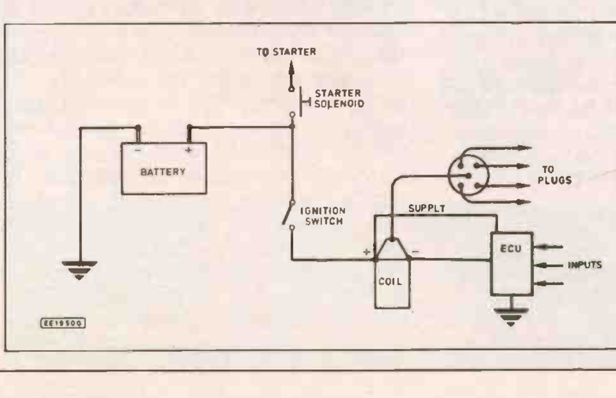
The Audio Ltd., Monitor AM electrode set — the plugs have been changed.



The Audio Ltd., Mind Mirror

PLEASE TAKE NOTE

In the article *Car Electronic Ignition Systems* last month the captions for Fig. 10. and Fig. 11 were transposed. In addition to this the block diagram (Fig. 11) should have been as shown below.



Introducing Digital Electronics page 658 last month, the corrected outline is not for the 7400 it only applies to the CMOS 4011.

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

NOVICE LICENCE SUBMISSION

The Radio Society of Great Britain's proposals for an amateur radio novice licence were presented to the DTI on 20th July at a Project YEAR (Youth into Electronics via Amateur Radio) conference jointly hosted by the RSGB and the DTI.

The proposals are contained in a 46 page discussion document which begins by describing the objectives of Project YEAR:

"1. to introduce young people to amateur radio as a more creative pursuit in itself.

2. to use the well-tried and established medium of amateur radio as a practical and enjoyable aid to getting young people interested in electronics, physics and engineering — possibly as a prelude to a career."

The document includes proposals for a detailed course syllabus, instructor accreditation and examinations. It proposes that holders of a Novice "A" licence be permitted to use Morse, telephony, data, RTTY and TV modes on selected bands from h.f. to u.h.f.. A novice "B" licence not requiring a Morse test would give access to novice bands above 30MHz. Novices would be able to operate full class A/B stations under supervision.

It may be some time before the DTI responds to these proposals and of course not all may be accepted and approved. It can be assumed, however, that in the not-too-distant future entry into amateur radio will be easier than at present, although it will still be necessary to pass the present examinations to obtain the full Class A or B licences.

ANOTHER APPROACH

In the USA all amateurs must pass a Morse code test to obtain their licences and the big news there, according to the W5YI REPORT, is that the national society, the American Radio Relay League, have petitioned the Federal Communications Commission for a code-free licence to make entry into amateur radio more attractive.

This would be similar to the UK class B licence, except that under the ARRL proposal operation would only be permitted on bands of 220MHz and above as opposed to the UK use of 50MHz and above. The ARRL apparently feels that Morse code is the barrier which stops newcomers coming in to the hobby.

It is interesting to compare the two approaches. In the UK we have had code-free entry, via class B, since 1964 and are still not recruiting enough new amateurs. We are now moving on to the idea of a novice licence with lower examination standards and slower (5wpm) Morse tests. In the USA there is already a novice licence — and that is apparently not producing enough new recruits either!

The RSGB reports good support from its own members for the concept of a novice licence. It is also supported by a number of companies and organisations which could conceivably benefit from Project YEAR, and by the Scout and Guide Associations who see it as a useful extension of their activities. It seems doubtful, however, if many views have been received from those who the Society want to attract into the hobby.

EE READERS

The readers of EE, with their interests in electronics, construction, computers and associated subjects, must surely include many such potential recruits and it would be interesting to hear their views. Are there readers (of any age) who feel that amateur radio might have something to offer them but who hold back for some reason or another? Will the RSGB's proposals for a novice licence tempt you to "have a go" when they come to fruition?

Or are there other aspects that would still deter you? I would welcome your views. I will even pass them on to the RSGB! Letters addressed to me via the editor will be most welcome.

AMATEURS IN SPACE

NASA has provisionally approved the inclusion of the Space Shuttle Amateur Radio Experiment (SAREX) on the secondary payload list of flight STS 35, scheduled to fly in March 1990.

Crew member Ron Parise, WA4SIR, will operate the station hoping to communicate with amateurs around the world via voice, video and (for the first time from space) packet radio. The shuttle's orbit will allow amateurs between latitudes 46° North and 46° South to communicate directly with the spacecraft and the SAREX transmissions will be receivable on standard scanner-radios.

Remember the story of the two Russian astronauts who became radio amateurs while in space (EE April 1989)? One of them, electrical engineer Musa Manaroff, U2MIR, visited NASA recently as a "specimen" to prove humans can survive 366 days and 5,856 orbits with no long term effects.

He said that his Yaesu FT290 transceiver was shipped up in November 1988 while he was aboard the Mir spacecraft. Initially an SWL (short-wave listener), he was allocated his unique call-sign for transmissions from the spacecraft and hopes to be allowed to retain it on a permanent basis. He has been given honorary life membership by AMSAT, the Amateur Radio Satellite Corporation. (W5YI REPORT).

PHONE TIPS

For serious operating, whether as a licensed amateur or as an SWL, it is preferable to use headphones rather than a receiver's loudspeaker. Phones improve the ability to hear very weak signals; they isolate the operator from distracting extraneous noises; and make radio operating far more acceptable to other people in the vicinity!

It follows from this that earmuffs should fit comfortably against the head to ensure proper isolation, although too tight a fit can cause discomfort and pain. It is also desirable to keep the audio gain turned down. This is less tiring and minimises the risk of TTS (temporary threshold shift) hearing loss which can occur with high audio levels.

Most modern receivers are designed to be used with low impedance phones and many people use standard hi-fi headphones, wired for mono operation, with them. But hi-fi reproduction over a wide range of frequencies is not what is wanted. A frequency range of about 300 to 3000Hz is required for speech, and Morse signals are usually received on a single frequency around 700-800Hz.

Attenuation of audio frequencies outside the wanted range improves reception of the wanted signal. Communications headphones with limited audio ranges are obtainable, although these can be expensive, and for Morse reception the old high impedance (2 to 4 kilohms) magnetic diaphragm headsets can be useful if a step-up audio transformer is used to match their impedance to that of the receiver output. These phones have a resonant peak around 1kHz which creates a very good mechanical filter.

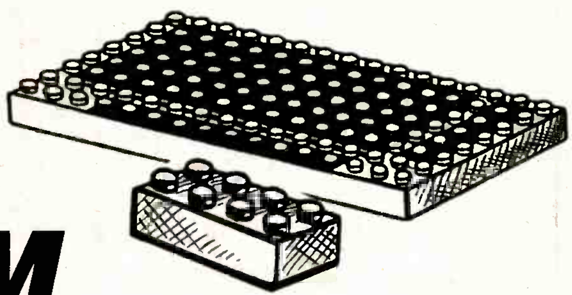
Many amateurs use home-made or commercially available audio filters, fitted between the receiver and their headphones, which limit the frequency range of the signals reaching the phones. In the case of CW (Morse) some filters provide a tunable centre frequency and a variable bandwidth going down to 80Hz or less. This itself brings problems as it is tiring to the ears to listen to a single-tone note, free of harmonics, for any length of time.

A simple way to improve reception on a noisy band is to reverse the connections to one earpiece when the pair are normally wired in phase. This improves the ability to hear a weak signal by up to 30 percent as the hearing system tends to cancel noise out of phase which is presented to both ears.

When buying headphones there are several factors to consider. Some are heavier than others (the heavier ones tend to be more sensitive). Comfortable effective earmuffs are essential. The price obviously has to suit the user's pocket, but the marginal improvement gained from buying at the top of the range of any particular type may not justify the extra expense. Buying communications headphones with restricted frequency ranges means you are getting something specially made for the job. But cheap stereo phones with not too good a bass response, used with an audio filter, can give quite a good account of themselves.

Series

LOGO, LEGO AND THE SPECTRUM



ALAN HARPER Part 2

Build this interface card and introduce your Spectrum to the excitement of Legoland

In this part of the article we describe the construction of the interface box, look at basic Lego arrangements and some LOGO.

INTERFACE BOX CONSTRUCTION

The Interface Box contains a p.c.b. on which is mounted the relays and de-bounce circuit Fig. 7. In addition the Interface Box contains PSU 2.

Construction and test philosophy is similar to that used for the interface card: Test p.c.b. tracks for continuity. Add wiring, connectors and i.c. sockets, check continuity. Test and insert resistors. Check again. Test capacitors, insert capacitors. Test relays, insert relays. Check again. Insert IC12 and IC13. Check action of the de-bounce circuit by applying a suitable voltage to the input end of resistors R33 and R40 and checking the output terminals of IC11 and IC12.

Carefully mark and drill the case and insert SK1 to SK50 (Fig. 5 suggests a suitable layout for the socket positions). Wire sockets to cables. Each group of sockets (e.g. SK1 to SK8) are wired to separate p.c.b. pins. Mount PSU 2 in the Interface Box. Care is needed to ensure that the heat sink has adequate ventilation and that the mains supplies are well insulated.

Both units can now be connected together and connected to the Spectrum. The relays should respond to the OUT 159,NN command and closing the "switches" (e.g. by connecting SK33 to SK25) should produce appropriate changes when in response to a PRINT IN 159 statement. If you really want the ultimate in software built in test you could use each relay to close each switch (e.g. connect SK1 to SK33, SK9 to SK25 etc) and run the following code.

```
10 FOR NN=0 TO 255
20 OUT 159,NN
30 LET XX=IN 159
40 IF XX=NN THEN GOTO 60
50 PRINT "ERROR NN=";NN;"
   XX=";XX
60 NEXT NN
```

This will sort out who can keep their data bus the "right way up" through a wiring maze. (I failed! SK32/40 is the least significant bit in my system instead of SK25/33. It is not really significant providing you know which end is which. How the cable ended up with half a twist I'll never know. One day I'll re-wire the connector.)

LEGO ROBOTS

Today's Technical Lego provides a fascinating array of bricks, cogs, wheels, motors, levers, rods, and beams which, with a little imagination, can be used to construct a wide variety of powered vehicles. The ease with which changes can be made and additional features added make Technical Lego an ideal material from which to build robots for simple experimentation purposes. In addition it is a construction material with which most youngsters are already familiar (see *Shoptalk* for buying details).

BASIC ROBOTICS – MOTORS, GEARS AND GRIPPERS

The most fundamental component is the motor. Both 4.5V and 12V types are available. This project has used the 4.5V type. Use of this voltage simplifies the power supply requirements in the interface box. The 4.5V motors are available in two types. These are illustrated in Fig. 8.

The small motor consumes about 100mA (no load) rising to 200mA under the sort of load which significantly slows the motor. The shaft speed is quoted as 4000 r.p.m. (though I measured 5000 r.p.m. under no load conditions). This means that when coupled to a typical wheel linear speeds of 10m/s (20 m.p.h.) could be achieved! Clearly the small motor has to be geared down significantly to be of any use.

The large motor (Fig. 8) consumes about 200mA (no load) rising to 400mA under significant load. It is not recommended that the motors sustain this type of load for any length of time. However, these figures underline the need for the separate large capacity p.s.u. for the interface box. The advantage of this significantly larger motor is that it incorporates some gearing down and I assume that the larger current consumption implies a larger torque. Speed measurements indicate 400 r.p.m. (no load). This provides a times ten reduction on the nominal figure for the small motor. In practise further gearing down is necessary.

Further gearing down can be achieved by the use of the many cogs available. One type have teeth which mesh together to transmit the drive from one cog to another. This provides a direct connection from the motor through to the wheel, though there is limited play between teeth and some torsional twist in the shafts.

The other type of cogs are connected by

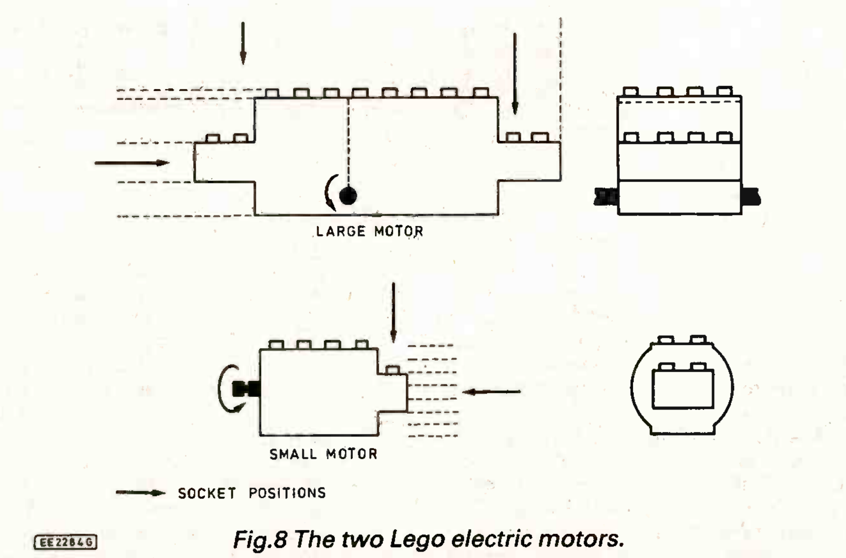


Fig.8 The two Lego electric motors.

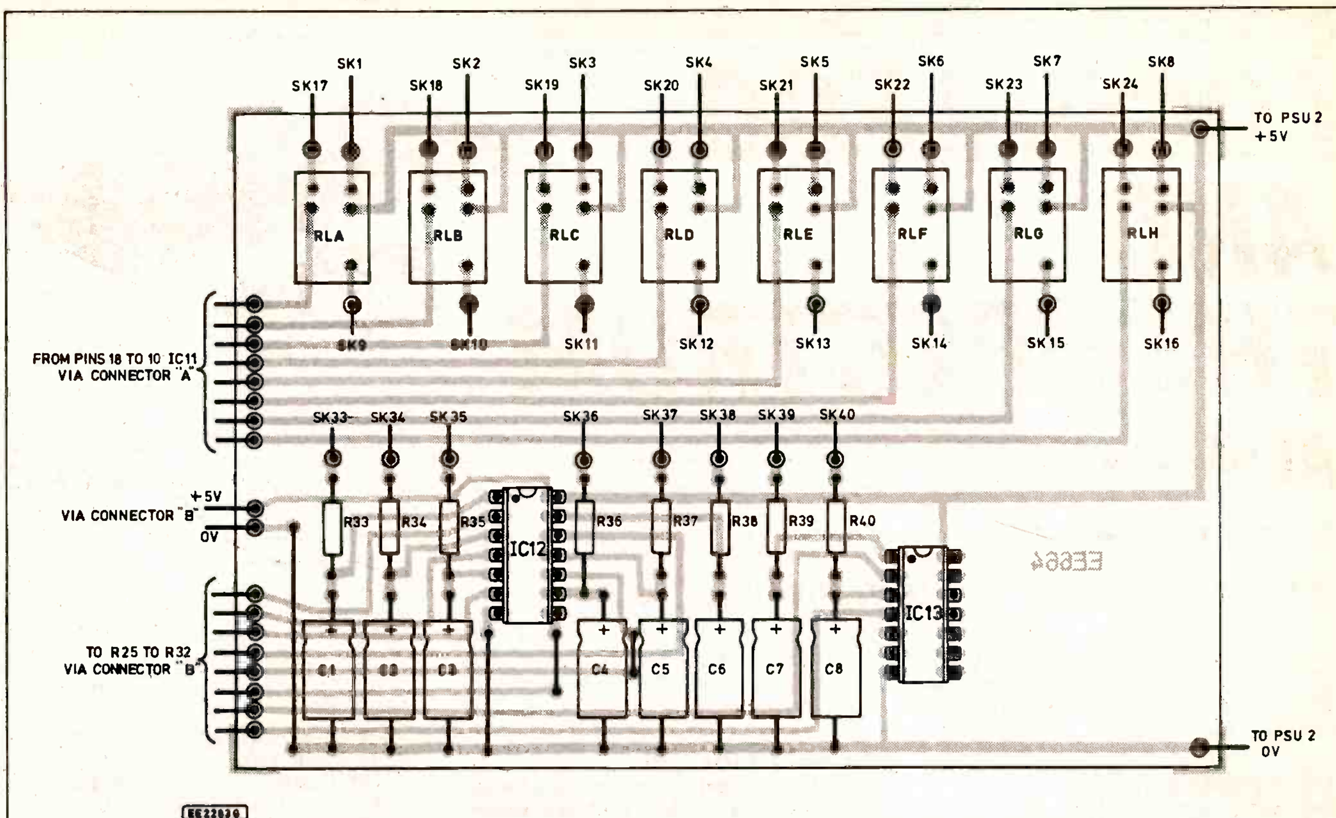
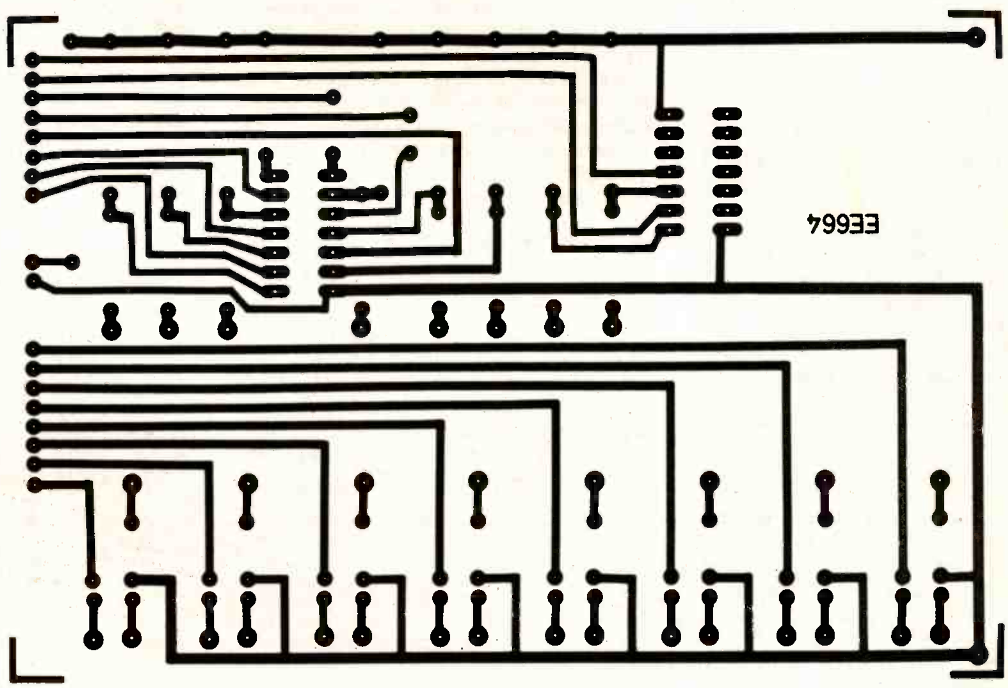


Fig. 7. Interface Box p.c.b. layout and wiring.



"belts" (any thin elastic band). Clearly these can slip if the end device is obstructed. Each type provides roughly the same gearing ratios. Each is suited to particular applications. In general I use toothed cogs for driving wheels where I wish the model to overcome the obstruction and belt drive to devices such as grippers where crushing the object is seldom the objective.

Additionally toothed drives to grippers are apt to put the model into "self-destruct" if they over-run. The torque available at the end of a gear train can be surprising considering that the basic motor can be easily stopped by gripping the output shaft between two fingers.

GEARING

Despite the use of the off gear trains dealing with the small motor can still present problems. For example suppose we want a floor roving robot to move about one metre in five seconds and that we are going to use the medium size wheel which is forty three millimeters diameter then distance travelled in one revolution of the wheel is given by;

Distance Travelled=$\pi\times$Wheel Diameter=3.14×43mm=135mm

In one second we want to travel 200mm. Revolutions per second required =200/135 r.p.sec. Revolutions per minute required =60×(200/135)r.p.m.=88r.p.m. The speed of the small motor is typically 4500 r.p.m. Consequently we need a gear ratio of about 50. The gear ratios available from the toothed cogs are, 1.5, 2, 2.5, 3 and 5. The ratio of five for example is achieved by mounting the 8 toothed cog on the motor output shaft and the 40 toothed cog on the next shaft.

To achieve the required gear ratio of 50 it is necessary to find a combination of the basic ratios which when multiplied together give 50. For this example an exact solution is obviously given by 50=2×5×5. This requires four shafts (the speeds will be 4500, 900, 180, 90 r.p.m.) and six cogs. (3×8 teeth, 2×40 teeth and one 16 tooth). This may be acceptable. However, this configuration takes up space which can make construction somewhat complex and, if it is to be duplicated for each drive wheel, tends to use up the supply of cogs.

Two solutions are possible. One possibility is to use the large motor which gives a ×10 reduction needing only a further ×5 which is immediately available (a 40 tooth with an 8 tooth cog). Though bulky in general this is a better proposition than a four shaft gear train. However, probably the best solution is to purchase the Lego gear box set which provides two ×20 gear boxes which fit directly onto the small motor and occupy very little extra space. (When fitted to the small motor the total volume is still only about half that of the large motor).

In the example above all that is then required is a ×2 cog combination to give a total reduction of ×40 which is probably close enough to the original requirement.

GRIPPING

No robot would be complete without some form of gripping capability. Again Technical Lego provides the basic building blocks from which a variety of such devices can be constructed. Two adjacent toothed cogs of the same size will drive shafts in opposite directions at the same rate. Technical Lego plates can be attached at right angles to the shafts. This is illustrated in Fig. 9. A belt drive with suitable gearing is attached to one shaft. A further possibility which uses a basic rack and pinion mechanism can be constructed. This is also shown in Fig. 9.

There are also several miscellaneous items of interest. One toothed cog is designed to turn a drive shaft through a right angle. If a smaller change is required a universal joint is available (this probably works up to about thirty degrees). With enough ingenuity it must be possible to build a complete gearbox!

Chain links (like a bicycle chain) can be used to provide drive between separated toothed cogs. A complete hydraulic system is available which must have a potential for transmitting limited mechanical drive to remote positions.

A few thoughts on buying Lego are appropriate. Lego is stocked by most toy shops. The better offers are usually to be found at the larger discount "mega stores" which are springing up in many areas. In my case a large selection was already available with which to plan. However, eventually my children demanded the return of the more critical items, such as motors, for normal construction use. Fortunately it is unnecessary to purchase complete sets to obtain special pieces since the Lego spares service (detailed on the back of most Lego catalogues) will supply many items direct. However, since Lego is not cheap it is worth doing some basic planning of the sort indicated above before parting with your money.

A COMPLETE ROBOT

An outline plan for a roving robot is given below. The hardware and software design is restricted to the control of the two drive motors. From an understanding of this the reader can easily extend the ideas to the control of grippers and the reading of impact sensors.

A workable configuration for a floor roving robot, shown in Fig. 10, consists of two drive wheels on a common platform. Each wheel is connected to a separate motor by a suitable gearing train. By switching the polarity of each motor the robot can be made to move forward (both motors driving the same way), backwards (reverse the polarity of both motors), turn (reverse the polarity of one motor) and stop (switch off both motors). How to achieve the polarity changes is described below.

A third smaller wheel or just a smooth support provides the remaining pivot. Between the two drive wheels is a platform which can take a working tool such as a gripper. By careful use of the large technical beams the structure can be made sufficiently robust to withstand direct impact with a wall or two. However, a lemming like plunge from a table tends to be fatal.

The Lego beams can also be configured to provide suitable mounting points for impact sensors. Lego have available a small plate with a right angle bend which can be drilled out to take a push to make switch to act as such a sensor.

The unit can be tested by just connecting each motor to a separate Lego battery box. Most battery boxes either have a polarity reversing key fitted or this is provided as a simple add on unit. (Be careful with the polarity switch if you use a Lego battery box to power up the odd 74LS** chip when under test. They don't appreciate reversed polarity.)

WIRING

Wiring of a single motor is illustrated in Fig. 11. Two relays are dedicated to the control of one motor. SK9 of RLA and SK10 of RLB are each connected to one side of the motor (SK51 and SK52). The 0V supply rail is connected to SK1 of RLA and SK2 of RLB. The 5V supply rail is connected to SK17 of RLA and SK18 of RLB.

Switching RLA and RLB will connect all combinations of 0V and 5V to the motor terminals (SK51 and SK52). Two of the possible combinations (0V on both SK51 and SK52 and 5V on both SK51 and SK52) will stop the motor. The other two combinations (SK51=0V, SK52=5V and SK51=5V, SK52=0V) will cause the motor to rotate in opposite directions. The

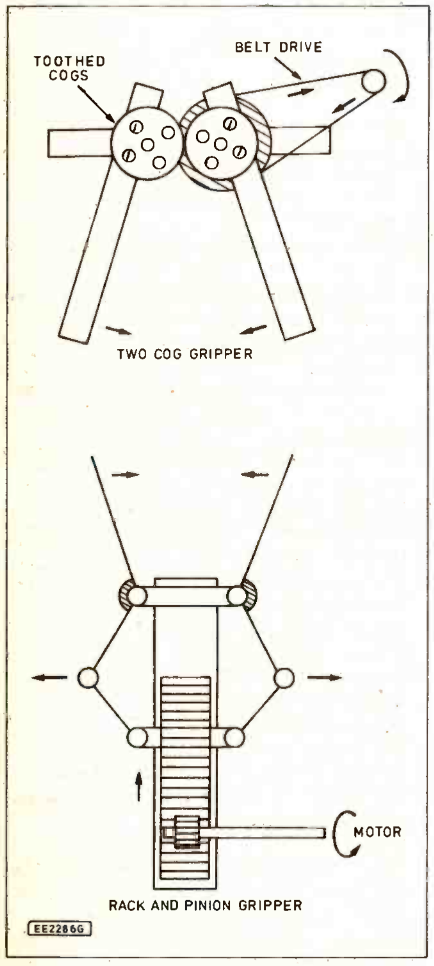


Fig. 9. Two forms of gripper.

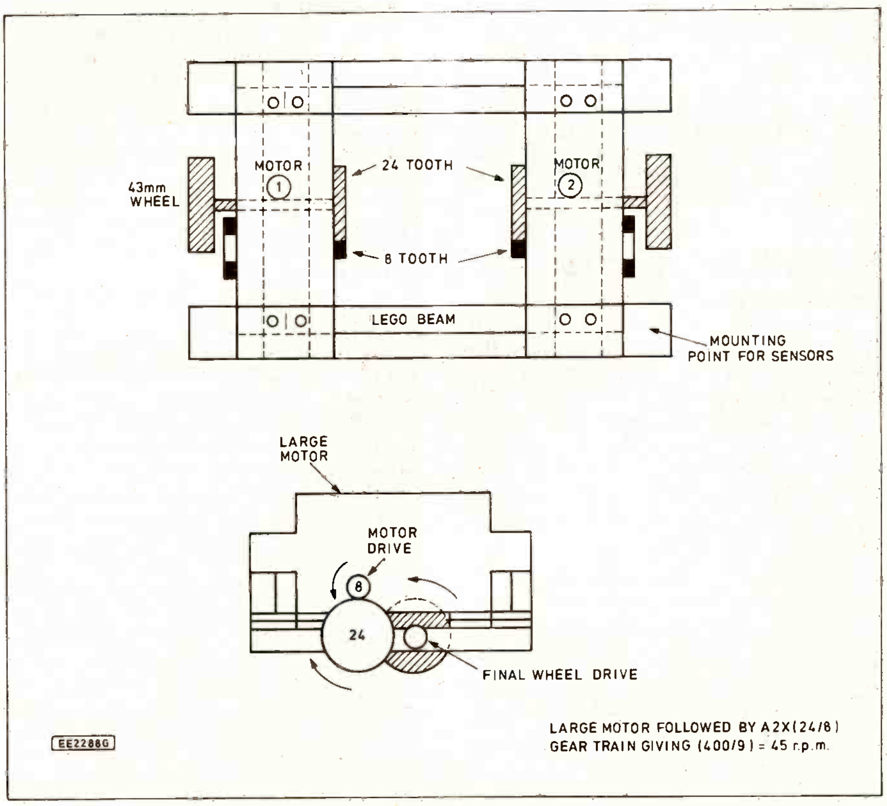
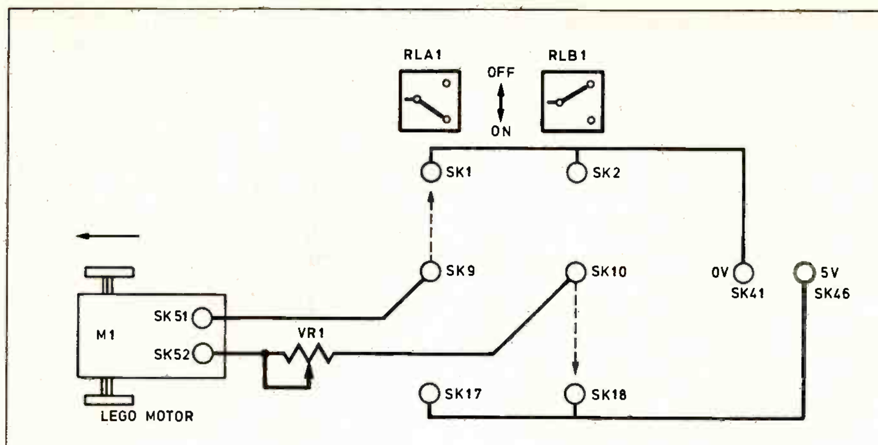


Fig. 10. Basic buggy arrangement.



RLA1	RLB1	SK51	SK52	MOTOR
ON	ON	OV	OV	STOP
OFF	OFF	5V	5V	STOP
ON	OFF	OV	5V	FORWARD
OFF	ON	5V	OV	REVERSE

Fig. 11. Arrangement of motor wiring.

function of VR1 will be explained shortly. RLC and RLD are similarly dedicated to the control of the second motor.

The connection between the robot and the interface box is made with a long length of thin ribbon cable. (Two leads for each motor plus two for each impact sensor plus spares). It may have been noticed when testing the robot that when both motors are running backward or forward that the robot fails to travel in a straight line. This is caused by minor differences in motors and gear friction levels. Though very high accuracy is an unrealistic objective it is possible to produce an acceptable straight line motion. This is achieved crudely by the use of VR1 (Fig. 11). VR1 is variable resistance of about 10 ohms. Identify the faster motor and adjust that motor's resistor until a straight line is obtained. I'm sure more sophisticated solutions are possible but this one does work.

Since the relays control the motor and the computer can control the relay we have almost arrived. Now it's only software! (This observation will bring tears to the eyes of most engineers).

SOFTWARE–SIMPLE BASIC ROUTINES

Though the final objective is the use of Lego when developing the software the best way to start is with something very simple in BASIC.

Assuming that the motors have been wired as in Fig. 11 and that the least significant bit of the data bus controls the state of RLA then the following software can be used to quickly establish how to control the movement of the robot.

```
10 INPUT A$
20 OUT 159,A$
30 GOTO 10
```

Assuming that OUT 159,0 switches both motors off then inputing A$=5 or 6 or 9 or 10 in turn should produce all the possible motions of the robot. This is because,

5 decimal=0101 binary
6 decimal=0110 binary
9 decimal=1001 binary
10 decimal=1010 binary

This sequence must take the combined switching of both motors through all the combinations of movement.

Once this is established the following "demonstration" programme can be written.

```
10 INPUT A$
20 IF A$="Q" THEN STOP
   :REM QUIT
30 IF A$=" " THEN OUT 159,0
   :REM STOP
40 IF A$="L" THEN OUT 159,5
   :REM LEFT
50 IF A$="R" THEN OUT 159,10
   :REM RIGHT
60 IF A$="F" THEN OUT 159,6
   :REM FORWARD
70 IF A$="B" THEN OUT 159,9
   :REM BACK
80 GOTO 10
```

This routine provides a means of stopping both the robot (just press enter) and the programme (press Q) as well as driving the robot (by using L,R,F,B or whatever you want). If you have a joystick the idea can be extended so that the robot responds directly to the commands from the joystick.

This routine could be developed further. However, the Logo language is ideally suited to storing a sequence of more complex instructions.

LOGO

The information given below is not intended to be a LOGO manual. Some familiarity with the simple LOGO functions (FD, LT, RT, BK, REPEAT) will be assumed together with some limited knowledge of how to write new procedures and use the editor. The main objective of the material below is to demonstrate how to write two new procedures equivalent to the BASIC function IN and OUT. This requires the use of machine code though it can easily be assembled by hand. Consequently an elementary understanding of use of machine code within BASIC will be assumed in the explanation. However, the machine code routines are totally transparent to the user. This means that providing the coding instructions are carefully followed it is possible to use the machine code without a full understanding.

LOGO has new names for a number of familiar BASIC instructions. Those of immediate relevance are given below.

BASIC	LOGO
POKE NN,VV	.DEPOSIT NN VV
PEEK NN	.EXAMINE NN
USR NN	.CALL NN
CLEAR NN	.RESERVE XX
LET X=3	MAKE "X 3
PRINT X	PRINT :X
PAUSE NN	WAIT NN

Note that the dot (.) in these particular LOGO procedures is not an optional extra and the lack of a comma in .DEPOSIT NN VV is not a typing error. The CALL instruction is a proper call instruction in that it does not need to be embedded in any other instruction like the RAND USR NN of BASIC. The value XX in .RESERVE XX is the number of bytes you wish to reserve for machine code rather than the new address of RAMTOP. (XX=RAMTOP–NN).

If space is required for machine code the .RESERVE XX instruction must be entered immediately LOGO is loaded. Failure to do this results in having to reload LOGO. This takes about five minutes and is one of the very few annoying features of the language. Logo differentiates very clearly between variable names e.g. X and the contents of a variable designated by :X.

Since the procedures IN and OUT do not exist within LOGO the first move is to develop direct equivalents. These can then be used as building blocks to develop equivalent procedures to LOGO's FD, BK, LT and RT that as well as moving the screen turtle cause the robot to respond in a similar manner.

The key to the problem is the simple assembler listing given below.

```
LD A,(XX)
LD C,A
LD A,(YY)
OUT (C),A
RET
```

This routine functions as follows.

a) The contents of address XX are loaded into the accumulator A.
b) The contents of A are loaded into the C register.
c) The contents of address YY are loaded into A.
d) The contents of A are output to the port whose value is held in the C register.
e) The routine returns to the calling programme.

To make this listing clearer consider this routine as a machine code subroutine within BASIC.

```
10 CLEAR 64000        :REM Lower RAMTOP
15 REM Machine Code Subroutine
20 POKE 64800,58      :REM LD A,(XX)
21 POKE 64801,0       :REM XX=254*256+0
22 POKE 64802,254     :REM       =65024
23 POKE 64803,79      :REM LD C,A
24 POKE 64804,58      :REM LD A,(YY)
25 POKE 64805,255     :REM YY=253*255+255
26 POKE 64806,253     :REM       =65023
27 POKE 64807,237     :REM OUT (C),A
28 POKE 64808,121     :REM
29 POKE 64809,201     :REM RET
30 REM End of machine code
40 POKE 65024,159     :REM Port Address
50 POKE 65023,255     :REM Value to be output
60 RAND USR 64800
70 STOP
```

This programme lowers RAPTOP (by lots), loads (POKES) the machine code into RAM starting at address 64800, places the output port address (159) into location 65024 in RAM, places the value to be output (255) into location 65034 in RAM and calls the machine code subroutine at address 64800. The routine thus performs the equivalent of the BASIC function OUT 159,255.

To load the machine code into LOGO the new procedure CODE is defined.

```
TO CODE
  .DEPOSITE 64800 58
  .DEPOSITE 64801 0
  .DEPOSITE 64802 254
  .DEPOSITE 64803 79
  .DEPOSITE 64804 58
  .DEPOSITE 64805 255
  .DEPOSITE 64806 253
  .DEPOSITE 64807 237
  .DEPOSITE 64808 121
  .DEPOSITE 64809 201
```

Remember to .RESERVE space as soon as LOGO is loaded as a direct input. This cannot be done as part of CODE since it will not be the first executed procedure! (What a pain).

Running CODE will load the machine code into RAM. Writing an analogous instruction to OUT address, value is now simple. The new procedure is as follows.

```
TO OUT :address :value
.DEPOSITE 65024 :address
.DEPOSITE 65023 :value
.CALL 64800
END
```

Now OUT 159 255 in LOGO will work exactly the same as in BASIC.

The new LOGO procedure for IN is similarly derived. The assembler routine is similar in principle to the one given above for OUT.

```
LD A,(XX)
LD C,A
IN A,(C)
LD (YY),A
RET
```

This routine functions as follows.

a) The contents of the location XX are loaded into the accumulator A.
b) The contents of A are loaded into register C.
c) The contents of port address C are loaded into A.
d) The contents of A are loaded into location YY.

As a BASIC routine this could be written as follows.

```
10 CLEAR 64000
15 REM Machine Code
20 POKE 64900,58   :REM LD A,(XX)
21 POKE 64901,0    :REM XX=254*256+0
22 POKE 64902,254  :REM      =65024
23 POKE 64903,79   :REM LD C,A
24 POKE 64904,237  :REM IN A,(C)
25 POKE 64905,120  :REM
26 POKE 64906,50   :REM LD (YY),A
27 POKE 64907,255  :REM YY=253*256
                        +255
28 POKE 64908,253  :REM      =65023
29 POKE 64909,201  :REM RET
30 REM End of machine code
35 POKE 65024,159  :REM Put port address
                        in RAM
40 RAND USR 64900: REM Call machine
                        code routine
50 PRINT PEEK 65023:REM Print contents
                        of Port 159
60 STOP
```

This programme lowers RAMTOP, inputs the machine code to RAM, places the port address into RAM at location 65024, calls the machine code routine which reads the Port 159 and places the contents in RAM location 65023. Finally the contents of location are printed. The routine performs the equivalent of PRINT IN 159.

As before the code is input to LOGO by adding the following instructions to the procedure CODE.

```
.DEPOSITE 64900 58
.DEPOSITE 64901 0
.DEPOSITE 64902 254
.DEPOSITE 64903 79
.DEPOSITE 64904 237
.DEPOSITE 64905 120
.DEPOSITE 64906 50
.DEPOSITE 64907 255
.DEPOSITE 64908 253
.DEPOSITE 64909 201
```

Any of these locations can be checked by PRINT .EXAMINE nn where nn is the location in RAM. An equivalent IN function can now be constructed as follows.

```
TO IN :address
.DEPOSITE 65024 :address
.CALL 64900
OUTPUT .EXAMINE 65023
END
```

Now PRINT IN 159 in LOGO will print the contents of port 159.

The OUTPUT statement in the IN procedure is required to allow a LOGO function to return a value.

That completes the difficult section. Now the procedures IN and OUT have been defined it is a simple matter to construct the remaining routines. Essentially we want to be able to enter something like F 20 and as a result we want the screen turtle and the robot to move forward. This is achieved by the procedure shown below.

```
TO F :number
FD :number
OUT :address :forward
WAIT :number * :scf
OUT :address :stop
END
```

The routine moves the screen turtle forward (FD). The next instruction switches on the robot's motors in a forward direction. (A DATA procedure makes :forward contain the value 6 which corresponds in my wiring scheme to forward motion). Execution then halts for (:number * :scf) 50ths of a second. (The value :scf is 10 and is held in DATA. The variable name scf means scale factor forward.) After the WAIT period has finished the robot motors are switched off.

The procedure DATA is shown below. It has no inputs. In BASIC it is equivalent to a series of LET statements.

```
TO DATA
MAKE "address     159
MAKE "forward     6
MAKE "backward    9
MAKE "left        5
MAKE "stop        0
MAKE "scf         10
MAKE "scb         10
MAKE "scl         0.98
MAKE "scr         0.98
END
```

The idea here is that if any parameter changes are needed they are restricted to the DATA procedure. No other procedure should ever need editing.

The procedure to move the robot backwards is virtually identical to that for forward motion.

```
TO B :number
BK :number
OUT :address :backward
WAIT :number * :scb
OUT :address :stop
END
```

The parameters :backward, :scb, :address and :stop are given values in DATA. The two routines for rotation also follow a very similar pattern. However, for these routines there is an additional requirement. To be of most use L 90 should produce a left turn through a right angle and L 180 a full half turn. If this can be achieved it is a reasonable assumption that the intermediate angles are about right.

To achieve this requirement you could determine how long it takes for the robot to turn through a right angle. However a better alternative is an interactive experiment. First code the routines as shown below.

```
TO L :number
LT : number
OUT :address :left
WAIT :number * :scl
OUT :address :stop
END

TO R :number
RT :number
OUT :address :right
WAIT :number * :scr
OUT :address :stop
END
```

Now guess a number for :scl and input L 180. Adjust :scl until the robot turns through 180 degrees. Check that L 90 produces a left turn through 90 degrees. It should work providing the rotation speed is constant. Accuracy for small angles may be subject to "starting up" errors. (e.g. stiction, slip, twist in the shafts).

The turning requirement also illustrates why the robot is powered from a 5V source. If powered from batteries the value of :scl would be a function of the state of the battery. The required value would change from one week to another as the batteries discharged! In general you should find that :scr, the scale factor for right turn is identical to : scl, the scale factor for left turns.

Now try,

REPEAT 4 [L 90 F 100]

The robot should move round a square ending up where it began though this does depend somewhat on the state of the carpet.

To simplify operations all the routines above are saved as one LOGO file (INOUT) together with a routine START.

```
TO START
CODE
DATA
END
```

The routine START merely calls CODE and DATA.

Operation runs as follows,

Switch on power to the interface unit. This is best done first. I have found that switching on after loading LOGO can reset the Spectrum.

a) Load LOGO.
b) Type .RESERVE 500 in direct mode — Do not forget!
c) Load INOUT–this loads START, CODE, DATA, IN, OUT, L, R, F, B.
d) Run START.

CONCLUDING REMARKS

The ideas on robot construction and LOGO software given above represent the "tip of the iceberg" of possibilities. Control of grippers and reaction to input sensors has been left as an "exercise for the reader". The floor roving robot is only one of a multitude of possible configurations of electro-mechanical equipment. Other possibilities include cranes, robot arms, hydraulic systems, simple plotters and many others. Ultimately I'm sure the control requirements will outgrow the simple interface described above. However if this were not so there would be no excuse to build any more electronic projects and that would never do! □

LOOKING AFTER NiCads

IAN HICKMAN

Simple modifications to an inexpensive commercial NiCad charger will ensure long life for your batteries.

BATTERY powered equipment offers the great convenience of "go anywhere" portability—at a price, electrical energy derived from the mains supply being immeasurably cheaper than that obtained from batteries. I use the word battery loosely, in the modern sense, to mean either a battery or a single cell.

Strictly, a battery (of cells) is an arrangement of two or more cells connected in series so as to provide a higher voltage, e.g. a 9V zinc-carbon (6 cell) PP3 battery used in a pocket "tranny" portable.

SECONDARY BATTERIES

Compared with primary (use and throw away) batteries such as zinc-carbon, zinc chloride, alkaline manganese, lithium or oxide types, secondary (rechargeable) batteries can save their cost many times over. However, in practise the hoped-for economies sometimes do not materialise.

One may find that the NiCad cells powering a "Walkman" type personal stereo player, for example, seem to last no time at all before needing recharging, so that it is less trouble to revert to ordinary primary cells. In such a case, the problem often lies not with the cells but with their maintenance and conditions of use.

A professional NiCad battery pack, as used with a military radio transceiver for example, will have been assembled from individual cells chosen all to have exactly the same amp-hour capacity, so that in use they all become discharged at the same time. Likewise, when recharged they will all have become fully charged at the end of the rated charge time. Consumer equipment, on the other hand, is often powered not from a NiCad battery as such, but rather an ad hoc collection of NiCad cells which, even if all bought at the same time, have only nominally the same capacity.

Worse still, a typical NiCad battery charger cannot be relied upon to deliver exactly the same number of ampere-hours of charge to each and every cell when they are recharged. The result is that the weakest cell may become discharged before the others and then be subject to reverse charging from the remaining cells. If furthermore it receives less recharging than the others, it may become discharged progressively sooner on each charge-discharge cycle.

The exception is the true battery, such as the 8.4V NiCad PP3, where of course the cells are permanently connected in series inside the battery. (This battery, usually of mass plate construction and therefore not suitable for fast charging, actually contains seven cells, since a NiCad cell only produces 1.2V, unlike a zinc-carbon cell.)

USE AND MAINTENANCE

Careful use and maintenance can prevent the problem of early exhaustion of one cell. If you have a lab. bench stabilized power supply with a continuously adjustable current limit, this can be used to charge all the NiCad cells in a piece of equipment in series, thus guaranteeing that they all receive the same total charge. It is often not even necessary to remove them from the radio/cassette or whatever.

Just remove the battery cover and poke the bared end of the positive lead down between the positive battery contact and the battery, and similarly for the negative lead. Set the power supply current limit to minimum and the output voltage to maximum. Switch the supply on and advance the current limit control to the recommended charging current, e.g. 45mA for AA size cells.

If you never run the equipment from an external d.c. supply then an even more convenient scheme is possibe. Just rewire the external d.c. input socket so that inserting the plug does not disconnect the battery. Now, the current limited supply can be simply injected via the socket. A wise precaution is to include a resistor, to limit the charging current to a safe value in the event of a constant voltage source being plugged into the socket. This can be simply wired across the socket's break-contact, which is designed to disconnect the equipment from the internal battery when an external power plug is inserted, see Fig. 1. For a medium sized radio/cassette using 6 C cells, a 22 ohm ½ watt resistor is suitable.

SIMPLE CHARGER

I recently purchased, for the very modest sum of £3.95, a mains operated NiCad battery charger designed to charge two or four AA cells; Fig. 2 shows the circuit diagram of the charger as purchased and, as you can see, it offers a choice of standard or fast charge rates. The circuit is entirely typical of various makes of charger from the far east.

Two of the cells are charged on one half cycle of the mains and the other two on the alternate half cycle. The charging current is thus discontinuous or "dirty d.c.". which is actually reckoned to be better for the purpose than smooth d.c. It also explains how the l.e.d.s light—50mA of smooth d.c. would not produce the necessary 1.8V (or thereabouts) voltage drop across 18 ohms.

On "normal" charge, the 39 ohm resistor and the total transformer winding resistance referred to the secondary are common to both charging circuits. Assuming the voltage drops across the rectifier diodes, the 10 ohm resistors and the l.e.d.s are equal, then the charging currents will be equal—assuming the voltage drops across the cells in each circuit are also equal.

The charging current on "normal"

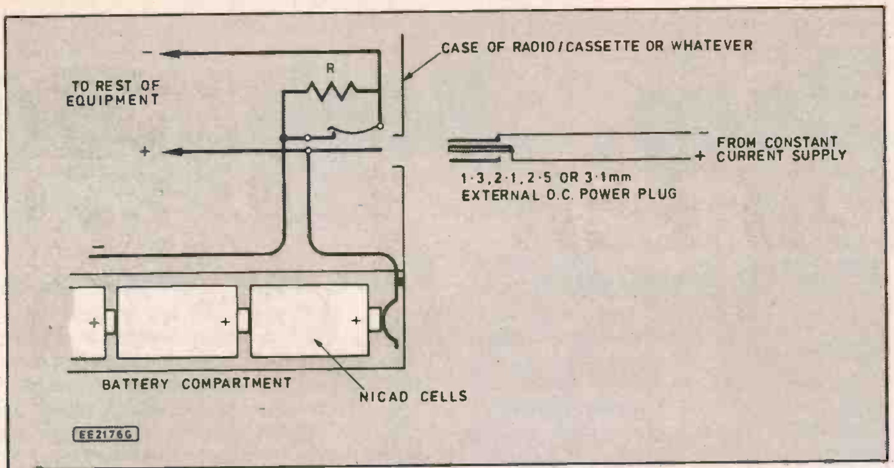


Fig. 1. Charging cells in the equipment. Centre pole positive shown—check polarity on unit.

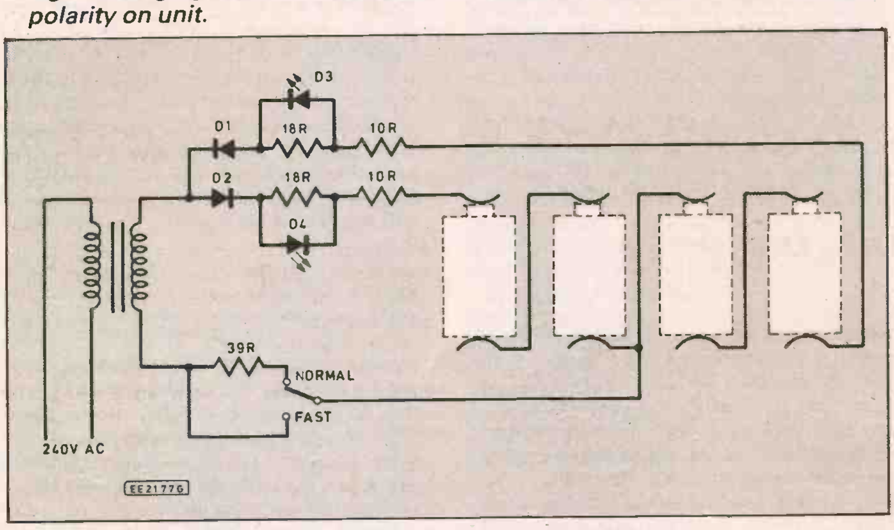


Fig. 2. Circuit of the commercial charger.

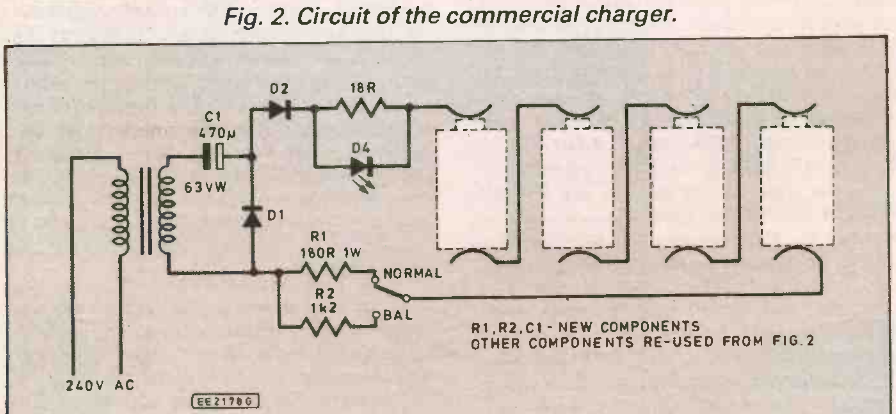


Fig. 3. Modified charger circuit.

proved to be about 63mA in each circuit, distinctly above the recommended value of 45 or 50mA, depending on the make of NiCad AA cell. On "fast" charge, the current was over 150mA and, without the equalising effect of the 39 ohm resistor common to both charging circuits, the balance was poorer—all resistors were 5% tolerance.

Note that "fast" charge **should only be used** if you are certain that ALL the cells are FULLY discharged, and the recommended charging time **should NEVER be exceeded**, as overcharging at the "fast" rate is even more damaging to cells than overcharging at normal rate.

MODIFIED CHARGER

Unfortunately my personal radio/stereo cassette uses three AA cells, which left me with a problem. Two of the cells could be charged in one circuit, and the third cell in the other, using a dummy battery to complete the circuit. However, the charging currents would not be identical, due to the drop across two cells in one circuit against only one in the other.

I considered changing the dummy battery from a straight-through connection, to two silicon diodes in series, to simulate the volt drop across a NiCad, but exact equality of the charging current could still not have been guaranteed. The only way to ensure this is to charge all the cells, be it two, three or four, in series. It was therefore decided to modify the charger circuit.

The circuit of the modified charger is shown in Fig. 3. If all the cells are to be charged from the same current, then a higher voltage back e.m.f. must be overcome and a higher charging voltage is necessary. This was obtained from the same transformer by using a half wave voltage doubler circuit, involving the addition of C1. No smoothing capacitor was used, giving a dirty d.c. charging current as before. For safety, a generously rated 63V electrolytic was used. R1 was chosen to give a charging current of 45mA with four cells on charge, the current being slightly higher with three or two, but not excessive even with one.

The small increase in current when charging less than four cells can be avoided entirely by using dummy batteries fitted with diodes as mentioned above. In the interest of kindness to batteries, the "fast" charge facility was dropped entirely—this also ensured that the transformer was running well within its VA rating in the modified circuit. The alternative switch position was retained, however, and redesignated BAL, with an additional 1k2 series resistor. The reason for this will appear in a moment.

DISCHARGE

Another very useful gadget was invented to assist in maintaining my NiCad cells in good condition. It consists of a battery holder designed to accept four D cells side by side, modified so that each cell position has a 1.25V 0.25A torch bulb (of the integral lens variety used in miniature flashlamps) wired in parallel.

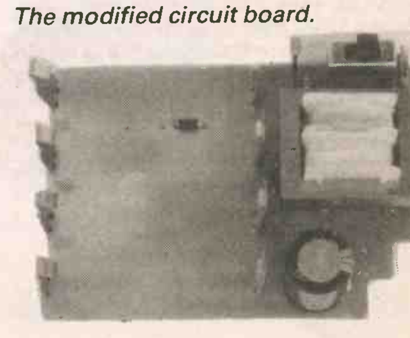
In addition to D cells, the holder will also accept C and AA cells, with the aid packing pieces consisting of one inch lengths of wooden lath wrapped in baking foil. When the set of NiCads ceased to operate my personal stereo, I tried the three cells in the bulb gadget. Sure enough, one cell was flat, whilst the other two lit their bulbs for ages. When they finally expired, I put them in the Fig. 3. charger, safe in the knowledge that they were all in exactly the same state of discharge. Following the normal 14 hours charge they operated the personal stereo for much longer than previously, and have continued to do so through many charging cycles.

OVERCHARGING

Overcharging NiCads, even at the normal charge rate is not recommended, but they will withstand overcharging at a lower rate—say 20 per cent of the normal rate or 10mA for AA cells—without coming to any harm. So every so often, following a normal charge, I switch to the "Bal" (balance) position and leave the cells on charge for another 12 hours. This "balancing charge" ensures that even if one of the cells is a bit on the low side, it finally reaches the fully charged state, ready for the next discharge cycle.

Given this sort of care, your NiCads will last and last, giving you the 500 plus charging cycles promised by the manufacturer. □

The modified circuit board.



. . . New for Old . . . Public Domain . . . Function Keys . . .

I AM not sure exactly how long I have been a proud BBC computer owner now, but it must be something like six to seven years. This means that my trusty BBC model B is now a similar age, and still going strong. On the other hand, most pieces of electronics are designed to last for about five years or so, and my BBC model B could be regarded as being on "borrowed time".

Looking on the bright side, manufacturers of electronic goods have an agreement under which they are supposed to keep stocks of spares for at least the five year design life of their equipment. Although the original BBC model B computer has been out of production for some years now, spares should be available for several more years since the model B's successors are not radically different.

As far as I am aware, the Master 128 is still available new. In fact it is reported to be selling better than the Archimedes range of computers!

Reconditioning

If my BBC B computer is anything to judge by, one of the main problems with an old computer that has seen a good deal of use is that it looks its age (or even older). It would seem that virtually all the components in the BBC computers are still readily available. This does not just include the standard "off the shelf" components such as the 6502 microprocessor and the numerous TTL chips. The few custom chips in the BBC machines are available, as are items such as the power supply and the case. The cream coloured case of the computer tends to show the dust and dirt, and cleaning it with detergent can produce a much better looking machine.

If the case shows signs of damage, it might be worthwhile investing in a new one. Removing everything from the old case and fitting it into a new one might seem like a major operation, but it is not really too difficult. Remove the four large screws that hold the top of the case in place, then take out the bolts that hold the keyboard in position. The main circuit board can be removed once the large screws that fix it to the mounting pillars moulded into the base section of the case have been unscrewed.

Actualy, there is a minor complication here in that the video output socket must be removed before the board can be taken out of the case. This involves desoldering the two leads from the connector, and then unscrewing its mounting nut. Three screws on the underside of the case hold the power supply module in position.

Remember to make notes when you unplug or desolder any component or wire, so that there is no difficulty in getting it all back together again properly in the new case!

Keyboard

Computers tend to have long lifespans as there are few moving parts to wear out. The main exception is the keyboard which has very definite limits on its operating life. Although not to everyone's liking, the BBC has a high quality keyboard that few other home computers can match. I quite happily used a BBC micro for word processing for a number of years. It is not an inexpensive membrane switch type, but a "proper" unit having a number of individual push button switches. You can obtain both replacement switches and complete keyboards.

The standard problems with well worn keyboards are missing characters, or multiple characters. Surprisingly, it is the latter that is the more common problem in my experience.

Provided you have good desoldering equipment, it is not too difficult to disconnect a switch from the keyboard printed circuit board, unclip it, and fit a replacement. If one keyboard switch is well worn, then it is quite likely that many of the others are also nearing the end of their lifespan. If a switch is faulty rather than worn, then replace it. Otherwise, I would recommend the replacement of the whole keyboard unit.

As I have pointed out once before, there can be problems with the lead that connects the keyboard to the main printed circuit board. Dirty contacts can result in some keys not functioning, and the computer can hang-up in the middle of its switch-on routine (giving only the initial "beep", with no sign of the second one). Removing the connecting lead and cleaning all four connectors with switch cleaner will effect a cure. In fact simply removing and replacing the lead usually seems to clean off the contacts sufficiently to restore normal operation.

IDC Plugs

If you experiment with BBC computer add-ons, you need to be careful when connecting and disconnecting your circuits to the computer. The IDC plugs on the underside of the computer are a bit inaccessible, and if you do not take due care it is easy to buckle one or more of the pins on one of these connectors.

Replacing a connector may seem to be a simple task, but multiway printed circuit mounting connectors are very difficult to remove from a board without seriously damaging the board. Provided they are not mishandled, these connectors are very hard wearing.

Two components that are in high-risk areas of the computer are the 6522 VIA that provides the user port and the D7002C analogue to digital converter that is largely responsible for the analogue port. Modern components are reasonably tough, and even if you should make a few mistakes when interfacing projects to either port, it is unlikely that either chip will be damaged. It can happen though.

Fortunately, both chips are in sockets, and are easily replaced. The D7002C is right next to the analogue port connector. The 6522 which provides the user port is IC69, which is the one between the user port connector and the 6502 microprocessor. The other 6522 is near the keyboard connector, and is only used for internal interfacing and the "firebutton" inputs on the analogue port.

Latch-up

It is worth noting that an excessive input voltage to the analogue inputs sometimes results in the D7002C latching-up and ceasing to operate properly. However, if this happens you will find that simply switching the computer off, waiting a few seconds, and then switching it on again restores normal operation.

This may seem a little strange, but with a lot of integrated circuits the result of slightly excessive input voltages is to switch on parasitic transistors. These are transistors that are not part of the chip design, but are a sort of unavoidable by-product of the chip design. Getting rid of these unwanted semiconductor junctions was one of the main hurdles that had to be overcome when the first attempts at making integrated circuits were made.

When the excessive input voltage is removed, the parasitic transistor might switch off with the device then reverting to normal operation. However, with MOS devices it is far from unknown for this latch-up problem to occur. The data sheets for some chips contain dire warnings to the effect that even slightly excessive voltages on certain pins can result in parasitic transistors being turned on, and the chip being destroyed by the massive current flow that this produces.

It is well worth keeping an aging BBC computer in full working order. There is still nothing quite as convenient and expandable if you wish to experiment with user add-ons. Possibly there never will be again. You can save yourself a lot of money by undertaking the more simple repairs yourself, but I would strongly advise leaving any drastic surgery to an authorised service centre.

BBC Puzzles

If you look at the printed circuit board of the BBC computer you will notice that some of the integrated circuits are in sockets, while others are soldered direct to the board. This seems to be standard practice with computers and many other electronic products. The general idea is to have the more complicated and expensive chips in sockets, and the smaller, cheaper ones connected direct to the board.

The larger devices are the ones that are most likely to go wrong, and the ones which are most difficult to remove if they are fitted direct to the board. Static sensitivity does not seem to be of overriding importance. Large non-MOS devices are often fitted in sockets, while cheap CMOS types are only very rarely socketed, Something that has often puzzled me is the fact that eight of the RAM chips on the main board of my (issue 3) Beeb are in sockets, while the other eight are soldered direct to the board. Does anyone know why half the RAM chips are worthy of sockets, and the other half are not? My only suggestion is that all the BBC micros were built as model As, with the Bs effectively being factory upgraded As.

Public Domain

Something else that puzzles me about the BBC computer is the lack of PD (public domain) and shareware software. In other words, programs that the authors allow to be distributed freely, either on the basis of no copyright being claimed, or on the basis of try before you buy (at a cost which is normally substantially lower than normal commercial prices).

The number of disks available for the popular 16 bit computers is into the hundreds, or even thousands per computer. 8 bit computers are generally less well served, but there are some disks available for the Ataris, Amstrad CPCs, etc. I have never seen any advertisements offering PD/shareware software for the 8 bit BBC computers (I believe there are a few Archimedes PD disks).

The majority of PD/shareware comes from the U.S.A., where sales of the BBC computer were never very great. On the other hand, the BBC machines tend to be used by enthusiasts rather than casual users, and there must be a great many users writing their own software. Does any reader know of sources for 8 bit BBC PD/ shareware software?

The Function Keys

Compared to many other computers, the function keys on the BBC computers are comparatively easy to use, in one way at least. They can in fact be used in several ways, but the most common is to put strings into them. Then, when the key is pressed, the string is inserted into the input buffer as if it had been typed as individual characters. This is done with the command ***KEY n string** where **n** is the number of the function key and **string** is the characters to be placed in the key. The string is not enclosed in double quotes. If you do this, the quotes become part of the string assigned to the key.

This can be used both in editing mode and from within programs. Some typing can be saved by entering common BASIC keywords into the keys, which can then be pressed to insert these keywords into program lines. When doing this, you would not normally want to put a carriage return code on the end of the string in the key, as you would nearly always want to add further items to the line. It is also handy when developing programs to put commands like LIST and RUN into function keys. In this case, it is normally a good idea to put the carriage return on the end of the string, so that the command can be executed with a single keystroke.

A problem arises here in that the command to put a string into a key is an operating system command, not part of BASIC, which means that the CHR$() function cannot be used. This is not too much of a problem with control codes which can be entered from the keyboard with the control key, as the | character can be used to represent CTRL. A carriage return can thus be entered as |M, a form feed (equivalent to CLS) as |L, and the printer can be turned on and off with |B and |C.

However, not all codes can be generated from the keyboard in this way. For those which cannot, it is possible to program the keys from BASIC (in a program or in direct mode) using the OSCLI function, which allows for BASIC string concatenation. (OSCLI is only available if you have BASIC 2.)

As an example, the OSCLI method to put LIST plus a carriage return into function key 2 would be **OSCLI "KEY 2 LIST"+CHR$(13)**. Note that the normal star is not included. In fact OSCLI strips any leading spaces and asterisks at the head of the string. Also, you can actually use upper or lower case for the command, as the operating system command line interpreter forces all characters to upper case.

There is a limit to how much you can assign to the function keys. One page of memory (i.e. 256 bytes) is reserved for this purpose, for all the keys. This is normally more than enough. However, if you re-program a key, the new definition is put into a new part of this memory, the old definition still occupying its old space. Obviously, frequent reassignment will result in running out of buffer space. The only solution to this is to clear all the existing definitions and begin again. This is done with the *FX18 command.

Next month we will consider the sound generator circuit and controlling it externally, plus more on the function keys.

Pocket Money Project

TWO TONE SIREN

CHRIS BOWES

Bring your model vehicle to life by adding an "emergency" siren. Could also be used as a "personal alarm".

THIS project is designed to produce a sound output which mimics the two tone siren used on some vehicles. As with all of the other projects in this series it is powered off a single nine volt battery and is thus completely portable. It is therefore possible to mount the project in a suitable case or to install it inside a model vehicle.

HOW IT WORKS

This project uses two 555 timer circuits, enclosed in a single integrated circuit package referred to as a 556 timer, working in the astable mode to produce the sound of a two tone siren. The basic Astable circuit for a 555 timer is shown in Fig. 1a. In this configuration the output of the circuit is made to switch between the two limits of 0V and the battery voltage, as shown in Fig. 1b, for time periods governed by the values of the resistors and capacitor in the timing chain RA, RB and C in Fig. 1a.

In the Two Tone Siren circuit one of the timers in the 556 is used to actually produce the sound output which is fed into a simple emitter-follower amplifier. The other 555 timer circuit is used as a much slower astable to operate the switching circuit which causes the output frequency to be varied.

CIRCUIT DESCRIPTION

The full circuit diagram for the Two Tone Siren project is shown in Fig. 2. IC1a is a slow running astable circuit the frequency of which is set by preset VR1, resistors R1, R2 and capacitor C1. Preset potentiometer VR1 is included in the circuit to allow the frequency of operation of IC1a to be varied.

The other half of the 556 timer, IC1b is also configured as an astable. The purpose of this timer is to generate the sound output of the siren. The oscillation of the astable circuit is in fact governed by the combined values of resistor R3, presets VR2, VR3, resistor R4, capacitor C3 and transistor TR1.

This arrangement may, at first, seem a little complicated but basically the low frequency output of the astable is governed by the combined resistance of R3 plus VR2 plus VR3. The frequency of the higher note produced by the astable is governed by the combined resistance of R3 plus VR3. Resistor R3 is included in the circuit to ensure that the frequency cannot exceed a specific maximum, even if VR2 and VR3 are adjusted to minimum settings.

Switching between the two output tones is achieved by saturating transistor TR1 by bringing the base voltage to a higher potential than its emitter. This is achieved by connecting the base of TR1 to the output, pin 5, of IC1a.

When IC1a's output is at 0V then TR1 is unsaturated and the output tone is set by the complete component chain from resistor R3 to capacitor C3. When the output at pin 5 of IC1a goes high then TR1 is saturated and effectively forms a short circuit between the emitter and collector. This shorts out preset VR2 so that the output frequency is set by the values of R3, VR3, R4 and C3. This causes a higher frequency to be generated.

Capacitors C2 and C4 are connected to the control voltage inputs (pins 3 and 11) of the respective timers. This causes the duty cycle of the astable circuits to be left in the optimum position.

The output from the second astable IC1b (pin 9) is fed via R5, which is a current limiting resistor to the base of transistor TR2. This is connected as an emitter follower circuit with its emitter taken to the 0V line through the loudspeaker (LS1).

Resistor R6 is included in the collector of TR2 to prevent the current flowing through LS1 exceeding its safe rated limit.

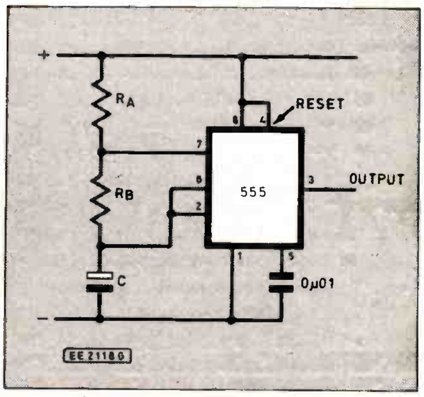


Fig. 1a. Using the 555 timer in the astable mode.

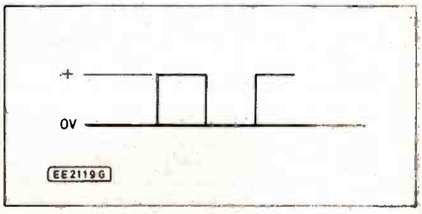
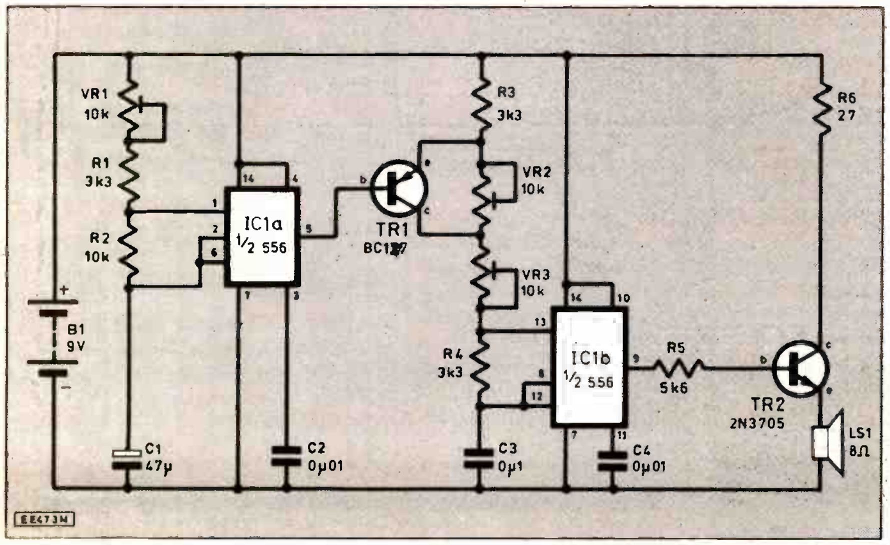
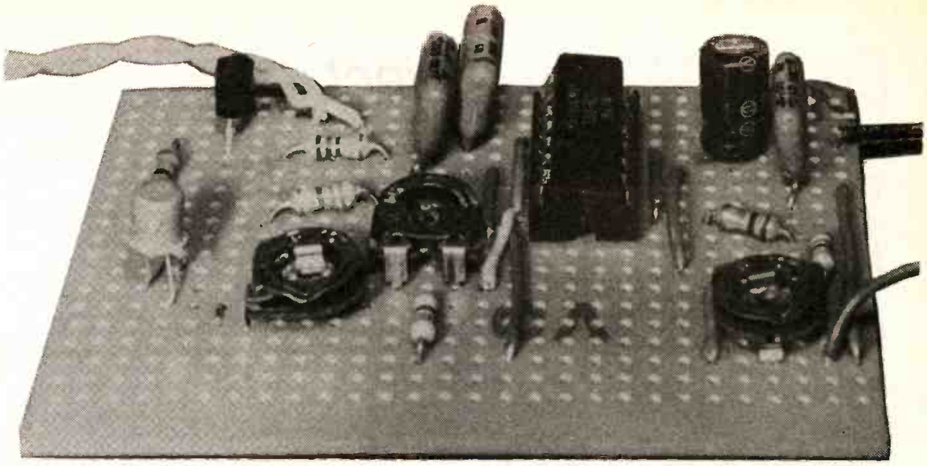


Fig. 1b. 555 timer astable timing diagram.

Fig. 2. Circuit diagram for the Two Tone Siren.



Similarly resistor R5 is included in the base circuit of TR2 to prevent the base emitter voltage exceeding the safe limit for the transistor.



CONSTRUCTION

The first task to be undertaken when constructing the Two Tone Siren is to cut a piece of stripboard to the correct size. You will need a piece which is at least 18 strips deep and 28 holes wide.

The board component layout and details of breaks required in the underside copper tracks is shown in Fig. 3. The breaks can be made using either a stripboard cutter or a small drill.

If holes are required for mounting the board by means of standoffs these should be drilled, using a 4mm drill, at this stage of the proceedings. It is important that these track breaks are made completely so that not even the merest sliver of copper remains to bridge across the trackbreak.

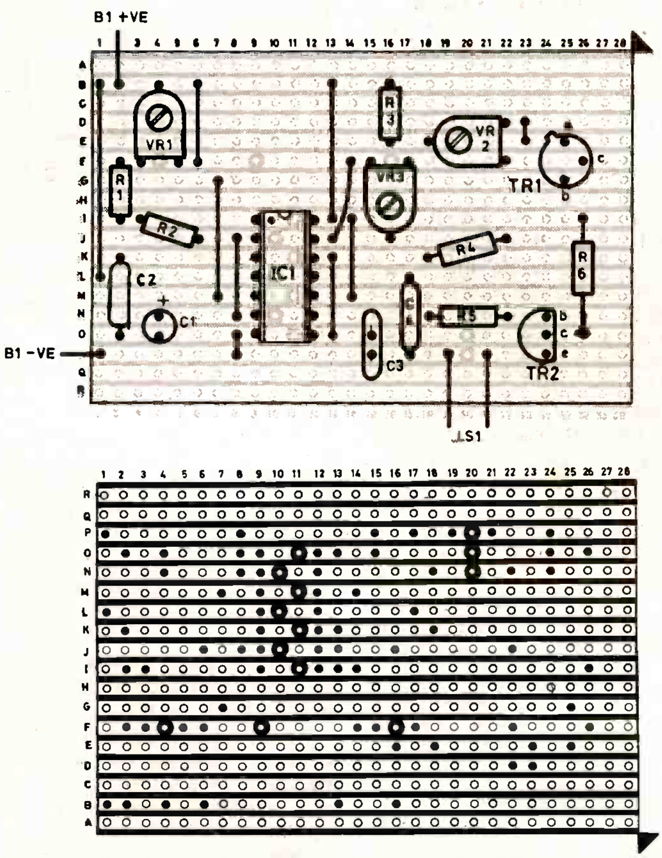


Fig. 3. Veroboard layout of the Two Tone Siren.

Once the track breaks have been made the board can be turned over, care being taken to make sure that it is correctly orientated. To help with this the strips and holes have been numbered/lettered in Fig. 3.

Although it does not make any difference to the operation of the circuit which order you insert the components into the stripboard you will find it easier to construct the circuit if the components are inserted in ascending order of size. The first stage in constructing this circuit should be to insert and solder the wire links into place. The wire links are made with insulated single core wire and before connecting the wire you will need to strip off the insulation from one end with the cutters and "tin" the bared wire by melting a little solder onto the wire.

The next task is to put the resistors in their correct places by first bending the wires of the resistor at right angles to the body of the component so that they will fit through the holes, as shown in Fig. 3. Using the numbers/letters guide put all of the remaining resistors into their correct position and solder them into place. Fit the three variable resistors (VR1, VR2, VR3) into their correct positions and solder them into place.

The next item to be inserted into position is the i.c. holder. Although it is possible to solder the i.c. directly into place, using a socket will both make the construction simpler and make for easier replacement if a fault should occur.

Next come the capacitors. C2, C3, and C4 are non polarised capacitors so it does not matter which way round they are inserted but C1 is an electrolytic capacitor so it is important that the negative and positive connections (as marked on the component case) are connected as shown in Fig. 3.

The final components to be mounted are transistors TR1 and TR2, which are also polarised so it is important that the tab on TR1 and the flat side of TR2 correspond with the positions illustrated and also shown in the photographs.

COMPONENTS

Shop Talk
see page 716

Resistors

R1	3k3
R2	10k
R3, R4	3k3 (2 off)
R5	5k6
R6	27

All 0.25W 5% carbon

Potentiometers

VR1, VR2, VR3 } 10k min. horizontal preset (3 off)

Capacitors

C1	47µ p.c.b. elect. 10V
C2	0µ01 Mylar
C3	0µ1 Mylar
C4	0µ01 Mylar

Semiconductuors

TR1	BC177 *pnp* silicon
TR2	2N3705 *npn* silicon
IC1	556 dual bipolar timer

Miscellaneous

LS1	8 ohm loudspeaker
S1	Min. toggle switch (optional)
B1	9V battery (PP3 type)

Stripboard, 18 strips × 28 holes; 14-pin i.c. socket; plastic case; self-adhesive stand-offs (4 off); battery connector; connecting wire; solder, etc.

Approx. cost Guidance only **£7.50**

The black wire from the battery connector goes to the point on the stripboard shown as B1−VE and the red wire to the place marked B1+VE. If you wish to add the optional on/off switch S1, connect the red wire to one of the switch terminals and another wire between the other switch terminal and the B1+VE connection on the stripboard. The loudspeaker should also be connected to the circuit, by means of two wires connected to the positions marked for the loudspeaker connections in Fig. 3.

The final step is to insert IC1 into its holder making sure that the notch on the i.c. corresponds with the notch shown in Fig. 3. Some versions of the 556 timer do not have a notch in one end but have a slight, circular dent near pin one. In this case the end with the indentation near pin one goes nearest to the edge of the i.c. which has the notch as shown.

shorting out the tracks. Once the board has been checked then the battery should be connected and the unit switched on.

You should be able to hear two alternating output tones being emitted in sequence from the loudspeaker at a rate which can be altered by adjusting preset VR1. The frequency of the two tones can be altered by adjusting presets VR2 and VR3, with VR2 affecting the frequency of both tones and VR3 altering the difference in frequency between the two tones.

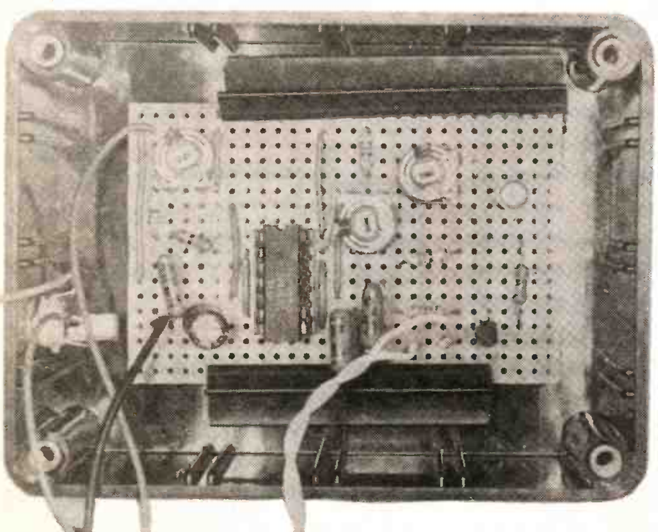
If the circuit does not operate correctly it will be necessary to check for faults. If no mechanical problems are found then it will be necessary to check the circuit through to see whether there is a faulty component. You will probably find that you will need the aid of a multimeter to perform this stage of the process.

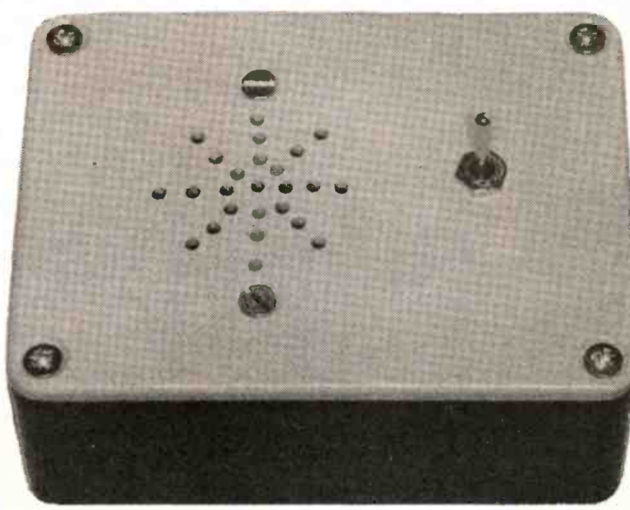
If the circuit fails to work when construction is completed fault finding is most

An alternating voltage should be measurable at pins 2 and 6. This voltage should be identical at both pins as they are connected together. A higher fluctuating voltage should also be measurable at pin 1 of the integrated circuit.

If these variations are not present you should carefully check the voltages present between 0V and the connections to the components in the timer frequency setting chain (VR1, R1, R2 and C1). The best way to do this is to check the voltages at the junctions of each of these components in turn and investigate where you failed to measure a voltage.

If all of these checks prove to be correct then the output from IC1a should be oscillating correctly. If this is not the case then you should investigate the integrated circuit to see if the i.c. itself is defective, by replacing it with another, identical device.





The completed unit showing the matrix of holes above the speaker and the optional switch.

CASE

Although the project can be easily used as it stands or be incorporated into another device you may wish to mount it in its own case. The easiest way to do this is to use self-adhesive p.c.b. mounting strips of the type shown in the photographs.

Alternatively 4mm holes can be drilled in the stripboard, prior to mounting components on the circuit board, in positions which do not interfere with the operation of the circuit. The positions of these holes should then be carefully marked on the body of the case and appropriate self-adhesive stand-offs mounted in suitable positions to support the stripboard.

Similarly suitable mounting holes must be drilled to accommodate the switch and loudspeaker. It will also be necessary to drill a matrix of holes in the case lid, through which the sound from the loudspeaker will be transmitted.

When preparing the case all of the holes required should be drilled before installing the circuitry. Similarly if the case is to be painted or lettered this should be completed before the circuitry is installed.

TESTING

Before connecting the battery and testing the circuit you should carefully examine the stripboard to make sure that all of the components are inserted into the correct places, are the correct way round and that there are no blobs of solder

easily done by dealing with the circuit in its three separate blocks.

ASTABLES

The first astable can be checked by placing the meter, set to "volts", on the output pin of the circuit (pin 5 of IC1). If this circuit is functioning correctly you should see the meter needle flicker rapidly between the two extremes of the power supply voltage (typically 0V and 9V).

If this is seen to happen then you may go straight on to the section which deals with fault finding of the second astable. If the output from IC1a is consistently at 0 volts then you should carefully examine the circuit to ensure that there is no short between the output of pin 5 and 0V connections.

If this is not the case then you should check that the battery voltage can be measured between a 0 volts connection (such as the negative connection of the battery) and both pins 14 and 4 of the i.c. Similarly you should check that the battery voltage can also be measured between a suitable supply volt connection (e.g. the battery positive connection) and pin 7 of the integrated circuit.

If this is found to be correct you should then measure the voltage between 0V and pins 3,1,2 and 6. A reasonably high (five volts or more) voltage shoud be measurable as a steady voltage at pin 3. If this is not the case then you should carefully check the connections to capacitor C2.

OUTPUT AMPLIFIER

The next section to check is the output amplifier and speaker. The best method to do this is to remove IC1 from its socket and, using a short piece of wire, make a brief connection between pin 9 of the i.c. holder and positive volts line. The speaker should be seen to move, producing a "click", with every connection and disconnection of this *temporary* link.

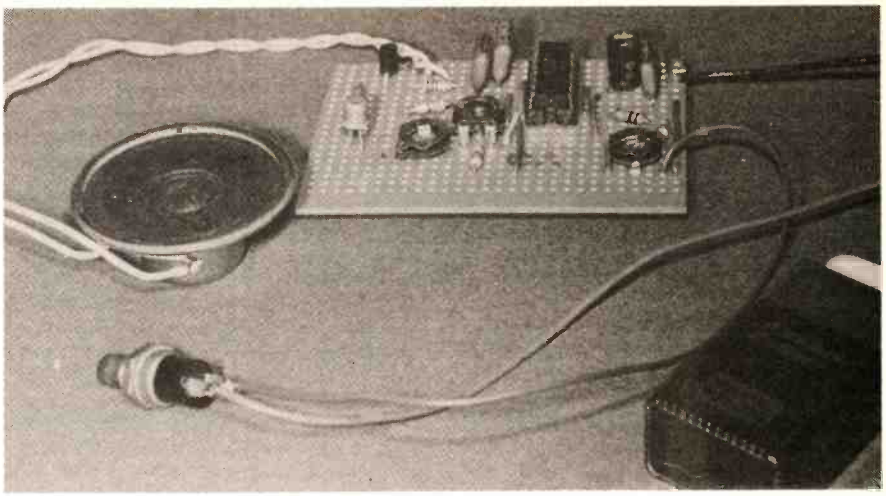
If this does not occur firstly check that there are sound connections to resistors R5, R6, transistor TR2 and the loudspeaker itself. At this point it is probably worth checking that there is a voltage approaching that of the battery measurable between 0V and each of the two ends of resistor R6.

If there is no voltage present at the connection between R6 and the positive volts line then you should investigate the connections along this track to determine where the break in the battery positive power rail occurs. If the battery voltage is present at one end of the resistor chain and 0V is present at the other end of the resistor chain this indicates that there is probably a short circuit in both the loudspeaker and/or TR2.

A possible cause of this would be that transistor TR2 has been connected into the circuit the wrong way round. You should therefore carefully check the connection (using Fig. 2 and Fig. 3 as a guide).

If TR2 has been connected into the circuit the wrong way round then you should remove it and replace it the correct way round and perform the previously mentioned checks again. It is, of course, possible that the transistor may have been blown by being wrongly connected, and the next stage would be to replace it with a fresh one.

After checking the loudspeaker amplifier circuit and ensuring that it is working it is now possible to check the second astable circuit. Unfortunately this circuit operates at a frequency of approximately 1,000Hz (1kHz).



If you have access to an oscilloscope then it is possible to check the output of the circuit as it stands but if an oscilloscope is not available then you may find that fault finding is helped by increasing the value of capacitor C3, by making a temporary connection across it with another capacitor of a value between 22μF to 100μF. This will slow down the speed of the oscillating output and allow you to treat the circuit as a slow speed astable.

The output available at pin 9 can then be checked by connecting the meter, again set to "volts", between a suitable 0V connection and pin 9. If this circuit is working correctly you should again be able to see the meter needle flick between 0V and the battery voltage in a regular manner.

If this does not occur then check the voltages between the battery negative connection and pins 7 to 14 of the i.c. You should also find that the battery voltage is present between 0V and pins 10 and 14 of the i.c. and that a voltage of at least 5V is measurable between any 0V connection and pin 11 of IC1.

You should be able to register a fluctuating voltage of the same magnitude between 0V and pin 8. A similarly fluctuating voltage, which is slightly higher than that present at pin 8, should be readable between 0V and pin 13.

If any of these checks reveal voltages markedly different from those indicated then you should investigate the connections to the components associated with the pins of the i.c. at which the "off spec" voltages are measured. If all is well with the components and their connections – but the circuit still refuses to work – then you should check that the i.c. is not faulty by substituting it for a new one.

SETTING UP

Once the circuit is operating it is a very simple matter to set it up so that it produces the desired output. The first step is to adjust preset VR1 so that the correct period of time elapses between the two tones.

Once this has been set then VR3 should be adjusted so that the ***high*** note is at the correct frequency. Adjusting VR3 also adjusts the lower tone but this should be ignored at this stage. Once the high tone has been set then VR2 should be adjusted so as to set the ***low*** tone to the correct frequency. □

ACTUALLY DOING IT!

by Robert Penfold

HAVING successfully built a project you may simply wish to "rest on your laurels" and do no further work on the unit. However, most constructors strive to achieve the best possible standard of finish on their projects, and take considerable pride in the appearance of their masterpieces. This is quite reasonable, and as I have pointed out before, you will tend to find that others judge your projects more by their appearance than the degree of electronic skill needed in their production. A scrappy looking project will fail to impress no matter how difficult building the electronics happens to be.

Adding some final touches to a project to enhance its appearance can be regarded as a worthwhile aspect of the hobby in its own right. Also, a neatly labelled and well laid-out front panel can make a project easier to use. On the other hand, this aspect of things can easily take over if you are not careful.

Getting a really professional finish can be an expensive and time consuming business. While producing really neat and professional front panels might be an interesting pastime, expending too much time and effort in this direction is perhaps slightly missing the point. You might be better off directing your time, money, and effort and money towards producing more projects!

UP TO SCRATCH

Here we will only consider some fairly inexpensive, quick, but quite effective methods of labelling front panels and generally improving their appearance. I suppose the main obstacle to getting a really good finish is often the scratches that some retailers seem to provide free with every case. In some instances these imperfections are probably due to rough handling somewhere between the production stage and you buying the case. In other cases the problem is due to the vulnerable nature of the panels, which are often made from aluminium or soft plastics which have little scratch resistance. With some metal cases a few imperfections seem to be an inevitable result of the way in which they are manufactured.

If the scratches are superficial it may well be possible to polish them out. Using a general purpose metal polish on an aluminium front panel will often bring it up to a near mirror finish, banishing any minor scratches. Even if an aluminium panel shows no signs of minor marks and scratches, it is still a good idea to polish it prior to adding panel legends.

Aluminium tends to tarnish quite rapidly, giving a relatively dull finish to which panel labels might not adhere properly. Simply giving an aluminium front panel a good rub with a piece of kitchen towel is usually sufficient to produce a good shiny finish.

Plastic cases are normally less prone to scratching, but a few minor imperfections are far from rare. The cure is much the same as for aluminium cases, with metal polish being used to remove the scratches. A word of caution is due here though. Metal polishes are mostly spirit based, and there is a slight risk of the spirit attacking the plastic. Try the polish on a small area inside the case to ensure that it has the desired effect before using it in a large way on the exterior of the case.

COVER UP

Deep scratches are more problematic. It might be possible to gradually polish them out, but this might take an impractically long time and leave you with a rather thin panel! It is often a matter of having to cover them over rather than remove them.

For an aluminium front panel one option is to cut a piece of thin aluminium to the same size as the panel, drill it in an identical manner, and then use it as a "dummy" panel over the real one. It is possible to buy a self-adhesive brushed aluminium effect veneer which is good for covering damaged panels, and which gives a very tough and professional finish. In fact the brushed aluminium panels on a lot of ready-made equipment is actually a plastic veneer of a similar type.

Obviously any veneer of a reasonably appropriate type can be used to cover over imperfections on metal panels. The same method is equally applicable to the front panels of plastic cases. Something that is unlikely to be effective at covering deep scratches is any kind of paint. The scratches will usually show through the paint perfectly well even after several coats, and painting a panel may well make any imperfections more obvious.

THE RUB

There are some up-market methods of producing panel labels, but these tend to be quite involved and costly. Simply adding rub-on transfers direct to the panel is a more practical approach for the hobbyist. These transfers are readily available from a number of sources, including some of the larger electronic component retailers, stationers (including a wide selection available from branches of W. H. Smiths), and artists' supply shops. Apart from letters in a wide range of fonts (lettering styles) and sizes, you might be able to obtain some symbols and other designs that are useful for labelling the front panels of electronic equipment.

Manufacturers instruction leaflets tend to make the production of labels look somewhat easier than it normally is in practice. It is generally assumed that the lettering will be applied to something like a large sheet of cardboard, whereas you might have to work on a small panel which cannot be removed from the rest of the case. Where possible, always remove the panel from the case, and always remove all controls, indicator lights, etc. from the panel before starting to label it. Clean the panel after everything has been removed from it, and try to touch it as little as possible until the labelling has been completed.

The exact method of working will depend on the make of lettering you are using. Most have some form of guide markers on the transfer sheet to aid the correct relative placement of the letters. You will often need to mark lines on the panel so that neat words are produced with all the letters at the same height.

Any guide lines must be marked using something that will be easily removed. Soft pencils are often recommended for this, but I generally find it easier to use a thin coloured tape. This is simply peeled off once you have finished. With the controls etc. removed the correct positions for the labels might be something less than obvious unless you add some positioning markers. Where possible try to mark these on the tape, or where they will be covered over by control knobs etc., so that there is no danger of any visible marks being left on the finished panel.

SELF CENTRED

The guides on the transfer sheet will help you to get neat rows of lettering, and experience with help in this respect a great deal more. In order to get really neat results you need to give some forethought to the positioning of the words as a whole. Normally you will wish to have words centred above the control (or whatever).

With a word such as "balance" for example, there are seven letters in the word, and the middle letter is the second "a". Rather than starting with the first letter and working through to the final one, it is better to lay down the middle one first, above a pre-marked centre marker, and work outwards from there.

With a word such as "volume" things are a bit more difficult, since there are an even number of letters, and hence no middle letter. You would therefore start with the "l" and the "u" placing them either side of the centre line marking. If you wish to obtain really neat results you must allow for the fact that some letters are wider than others. In the word "volume" for instance, the "l" is obviously much narrower than the "m".

There are two approaches to this problem, one of which is to use monospacing. In other words, you allow the same amount of space for each letter regardless of how wide it happens to be. This gives typewriter style words, and is reasonably neat if it is done accurately. In practice it might not be easy to use this method, since it is difficult to judge the spacing correctly "by eye", and any aids to correct letter spacing provided by the lettering system will probably not be aimed at getting good mono spacing.

Instead, any positioning aids will almost certainly be directed at getting good proportional spacing. This is where the amount of space for each letter is proportional to its width, and the empty space between letters is identical. A system used with some transfers is to have a horizontal line just below each letter. The length of each line is equal to the correct amount of space for that particular letter. The idea is to rub-down each line onto the panel along with its letter. If you butt one line accurately against the next, the spacing of the letters will be just right. Once a word has been completed, the lines are removed.

REMOVAL

A simple but effective way of removing any unwanted rub-down transfers from a panel is to press the sticky side of some adhesive tape onto the transfers you wish to remove. As the tape is pulled away, the transfers will probably come away with it as well. However, two or three attempts might be needed in order to completely remove the transfers. Take care not to remove more than you intended to.

Personally, I prefer not to use any spacing aids provided by the transfer system. For the neatest results it is probably best to do things "by eye", as you can then have nicely "kerned" lettering. Kerning goes some way beyond proportional spacing. If letters such as "A" and "W" appear side by side, they tend to look as though they are spaced too far apart when proportional spacing is used. Kerning places them closer together and gives better looking results.

This type of thing is not so important when using small lettering, but with large lettering mono-spacing can look pretty terrible, and non-kerned proportional spacing can look slightly rough. With a little practice, using your own judgement you should be able to produce some very neat looking labels.

The problem with the proportional approach is that the middle point of the label will not necessarily be at the middle of the middle letter, or half way between the two middle letters. In our earlier examples of "volume", the "l" takes up less room than the "m", offsetting the middle point towards the right. To counteract this the letters should all be fractionally shifted to the left.

PROTECTION RACKET

Rub-on transfers, if used skilfully, can give some very impressive results. Their real drawback for use on project front panels is their lack of durability. They rub off almost as easily as they rub-on, and if left unprotected will almost certainly be damaged before too long. The usual way of improving their permanence is to spray them with a clear lacquer such as Scotch "Spray Fix". While this will give a substantial improvement, you might still find that over a period of time the transfers tend to wear away.

Much better protection can be provided by covering the finished panel with the transparent self-adhesive material that is readily available from most stationers. This can give a really tough and professional looking finish, but it is a slightly risky way of doing things. The problem is that you must be sure to get the covering wrinkle-free first time. If you peel it back to have a second shot at getting it in position properly, you will find that some of the lettering comes away on the covering.

The best type of plastic for this type of thing is the heavy gauge type which is quite resistant to wrinkling. Unfortunately, this seems to be difficult to obtain these days, and the type sold by most stationers is a very thin gauge material that is much more difficult to use. Air-bubbles can be troublesome when using any self-adhesive covering. Pricking any bubbles with a pin will usually enable the air to be expelled and the material to be pressed down flat against the panel.

INDIVIDUALISM

Some cases are constructed in such a manner that it is very awkward to directly apply transfers to their front panels. With these it is often better to leave all the controls etc. in place, and make up individual self-adhesive labels which can be carefully manoeuvred into position and pressed into place. I normally use a clear backing material for this, but it will often tend to show up quite clearly as it will be more or less shiny than the panel. However, a coating of clear lacquer over the entire panel will help to disguise the backing material. Of course, you can use something like a plain white backing material if preferred, making no attempt to hide its presence. Provided you cut out neat rectangles of the material this will give quite an attractive finish.

Another approach to individual legends is to first rub the lettering on to a piece of plastic or aluminium. When a word has been completed, some transparent adhesive tape or transparent self adhesive plastic is placed over it and rubbed firmly in position. If the self-adhesive material is then carefully peeled away, the lettering should come away with it, leaving you with the required panel label.

This method has the advantage of giving a protective layer over the lettering, which produces a very tough and durable label. The disadvantage is that you might not always get all the lettering to come away on the self-adhesive material. This can result in a lot of wasted time, effort, and lettering.

A third approach is to make up a dummy panel made of thin aluminium, card, or plastic. This should be fully drilled so that once it has been labelled it can be glued in place over the real front panel. If done carefully, this method is the one that is likely to give the best results with awkward panels.

Although rub-on transfers are the obvious choice for panel lettering, they are not the only method available. In next month's article we will consider a couple of alternatives.

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An attractive and very functional pack of preset pots. The parcels contain a high proportion of top quality cermets, both single and multi-turn. In fact they outnumber the carbon types! All styles and types are represented: open, enclosed, vertical, horizontal, square, round, ¾" and 1¼" multi-turns, and so on. All values from a few ohms to several megs.

PARCEL 11A:
200 PRESETS for £6 + VAT
PARCEL 11B:
1000 PRESETS for £25 + VAT

RESISTORS

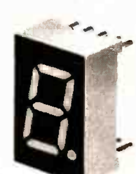
Supplied to you as they arrive with us: some bagged, some bandoliered, some reeled, some loose. The mixture has ¼W resistors in every single E12 value, with some E24 and an assortment of E96 precision types. Then there are ½W resistors and a nice selection of power types to 5W and above. The proportions vary from parcel to parcel, but you'll certainly have an excellent range of types and values. I have absolutely no intention of counting out tens of thousands of resistors, so these are sold by weight. As a rough guide 1000 ¼W resistors weigh about 240g, so there are over 4000 of these to the Kg.

PARCEL 13A:
10Kg RESISTOR PARCEL £30 + VAT

MONSTER OPTO PARCELS

If it has anything to do with light, it's in here. There are LEDs of all shapes, sizes and colours, seven segment displays, infra-red senders and receivers, bar graph assemblies, opto switches, and who knows what else. The larger parcels have LCDs too. An excellent selection of top quality devices.

PARCEL 12A:
100 OPTO DEVICES for £10 + VAT
PARCEL 12B:
300 OPTO DEVICES for £25 + VAT



SWITCHES

Take a rocker switch in one hand, a roller microswitch in the other, and have yourself a rock 'n' roll party! OK, the the jokes aren't up to much, but the switches are superb. Lots of rocker switches – ideal as spares for household gadgets. Some, so I'm told, fit the dashboard cut-outs on Ford cars, so just think of the extra lights and stuff you could fit! Then there are the toggles, the push switches, the rotaries and the sliders. All tucked up snugly, bless their cotton socks, in our switch parcels. And all for 10p each or less – it's enough to make you explode with joy. Well, nearly enough.

PARCEL 14A: 100 ASSORTED SWITCHES for £10! + VAT
PARCEL 14B: 300 ASSORTED SWITCHES for £25! + VAT

JUNK!

Bits of equipment, PCBs, components, hardware, mags, books, data, everything electronic turns up at some time or other in our legendary JUNK parcels. There's so much unsorted stuff around the place we hardly know what goes in there ourselves! The components won't be neatly packed – once we've combed their hair and dressed them in their Sunday best, they go onto one of lists. In the JUNK parcel you see them in the raw state.

The first 10Kg is yours for £18 + VAT. After that, the price is £1 per Kg, so 11Kg will be £19 + VAT, 12Kg will be £20 + VAT, and so on. Have as much as you like!

JUNK SPECIAL:
1 cwt for £50! + VAT

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Above 100n or so the price of non-electrolytic caps starts to rise steeply. To get one above 1μF will cost the earth, or at least a major planet. And not even an asteroid for change. These parcels contain caps to at least 4μ7. Replace those nasty non-polar electrolytics in your speaker crossovers, connect them across electrolytic smoothing and coupling caps in your hi-fi, stop using back-to-back tants in your projects. The larger caps will easily cost several £££s each from normal suppliers. We've got too many, so . . .

PARCEL 15A:
200 HV POLYESTERS for £10 + VAT
PARCEL 15B:
600 HV POLYESTERS for £25 + VAT

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Europe and Eire: Please add £6.00 carriage and insurance. No VAT
Outside Europe: Please add £12.00 carriage and insurance. No VAT

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H3

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The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.

MORE BOOKS NEXT MONTH – MORE BOOKS NEXT MONTH – MORE BOOKS NEXT MONTH

AUDIO & MUSIC

SYNTHESIZERS FOR MUSICIANS
R. A. Penfold
Modern synthesizers are extremely complex, but they mostly work on principles that are not too difficult to understand. If you want to go beyond using the factory presets or the random poking of buttons, this is the book for you.

It covers the principles of modern synthesis—linear arithmetic as used by Roland, phase distortion (Casio), Yamaha's frequency modulation, and sampling—and then describes how the instruments are adjusted to produce various types of sound—strings, brass, percussion, etc. The theoretical side of synthesis is treated in an easy to understand way—the technical information being restricted to what you need to know to use your instrument effectively.
168 pages **Order code PC105** **£6.95**

AUDIO
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems—amplifiers, oscillators, disc and magnetic recording and electronic music.
320 pages **Temporarily out of print**

INTRODUCTION TO DIGITAL AUDIO
Ian Sinclair
Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring digital audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.
All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.
This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product
128 pages **Order code PC102** **£5.95**

MAKE MONEY FROM HOME RECORDING
Clive Brooks
Now that you've spent a fortune on all that recording gear, MIDI and all, wouldn't it be nice to get some of it back? Well here's the book to show you how,

It's packed with money making ideas, any one of which will recoup the price of the book many times over. Whether you have a fully fledged recording studio at home, or just a couple of stereo cassette recorders and a microphone, you'll be able to put the ideas in this book into practice and make money.
105 pages **Order code PC104** **£5.95**

TESTING & TEST GEAR

GETTING THE MOST FROM YOUR MULTIMETER
R.A. Penfold
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.
In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages **Order code BP239** **£2.95**

HOW TO TEST ALMOST EVERYTHING ELECTRONIC—2nd EDITION
Jack Darr and Delton T. Horn
Describes electronic tests and measurements—how to make them with all kinds of test equipment, and how to interpret the results. New sections in this edition include logic probes, frequency counters, capacitance meters, and more. (An American book.)
190 pages **Order code T2925** **£6.95**

TEACH-IN THEORY & REFERENCE

ELECTRONICS TEACH-IN
Michael Tooley BA and David Whitfield MA MSc CEng MIEE (published by *Everyday Electronics*)
This value for money *EE* book provides a comprehensive background to modern electronics including test gear projects. A complete course in basic electronics; designed for the complete newcomer it will however also be of value to those with some previous experience of electronics. Wherever possible the course is related to "real life" working circuits and each part includes a set of detailed practical assignments. Includes details of eight items of related test gear giving full constructional information and diagrams for each one. They are: Safe Power Supply; Universal LCR Bridge; Diode/Transistor Tester; Audio Signal Tracer; Audio Signal Generator; RF Signal Generator; FET Voltmeter; Pulse Generator. An excellent companion for anyone interested in electronics and invaluable for those taking G.C.S.E. and BTEC electronics courses.
104 pages (A4 size) **Order code EE/T-I** **£1.95**

ELECTRONICS TEACH-IN 88/89—INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.
80 pages (A4 size) **Order code TI-88/89** **£2.45**

THE ILLUSTRATED DICTIONARY OF ELECTRONICS—4th EDITION
Rufus P. Turner and Stan Gibilisco
With more than 27,000 terms used in electronics today, this collection is THE most comprehensive dictionary available. Including all practical electronics and computer terms, it is as up-to-date as the latest advances in the field itself! Tables and data on subjects most often consulted for projects and experiments are included. Other conversion tables include English/metric and metric/English conversions for units of measurement of energy, power and volume, and Fahrenheit/Celsius temperature conversion charts.

Setting this edition apart from other electronic dictionaries is its emphasis on illustration. Featuring more than complete definitions, this fourth edition includes over 450 detailed drawings and diagrams.

All entries are listed in alphabetical order. Abbreviations and initials are listed in sequence with whole words. All terms of more than one word are treated as one word. (An American book.)
648 pages **Order code T2900** **£18.75**

MICROPROCESSING SYSTEMS AND CIRCUITS
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A truly comprehensive guide to the elements of microprocessing systems which really starts at the beginning. Teaches the reader the essential fundamentals that are so important for a sound understanding of the subject.
256 pages **Temporarily out of print**

RECOMMENDED READING

FOR INTRODUCING DIGITAL ELECTRONICS

ELECTRONICS—A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages **Order code NE10** **£4.95**

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias—tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages **Order code BP53** **£3.95**

MICROELECTRONIC SYSTEMS 2 CHECKBOOK
R. Vears
The aim of this book is to provide a foundation in microcomputer hardware, software and interfacing techniques. Each topic is presented in a way that assumes only an elementary knowledge of microelectronic systems and logic functions. The book concentrates on 6502, Z80 and 6800 microprocessors and contains 60 tested programs, 160 worked problems and 250 further problems.
Now replaced by Microelectronic Systems N2 Checkbook
Order code NE04N **£6.95**

TEACH-IN, THEORY & REFERENCE

ELECTRONICS-BUILD AND LEARN
R. A. Penfold
The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components–resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.

At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.
120 pages **Order Code PC103** **£5.95**

PRACTICAL ELECTRONICS HANDBOOK
Ian Sinclair
Ian Sinclair has now revised this useful and carefully selected collection of standard circuits, rules-of-thumb, and design data for professional engineers, students and enthusiasts involved in radio and electronics. Covering passive and active components, discrete component circuits (such as amplifiers, filters and oscillators) and linear and digital i.c.s, the book includes many items which are not elsewhere available in a single handy volume. The operation and functions of typical circuits are described, while mathematics is limited to that necessary for deciding component values for any application.
This revised edition contains more details on computers and microprocessors and has been brought up to date throughout.
199 pages **Order Code NE06** **£7.95**

DATA & COMPONENT IDENTIFICATION

TRANSISTOR SELECTOR GUIDE
This unique guide offers a range of selection tables compiled so as to be of maximum use to all electronics engineers, designers and hobbyists.
Section 1: Covers component markings, codings and standards, as well as explaining the symbols used.
Section 2: Tabulates in alpha-numeric sequence the comprehensive specifications of over 1400 devices.
Section 3: Tabulates the devices by case type.
Section 4: Considers particular limits to the electrical parameters when compiling the tables.
Section 5: Illustrates package outlines and leadouts.
Section 6: Consists of a surface mounting device markings conversion list.
192 pages **Temporarily out of print**

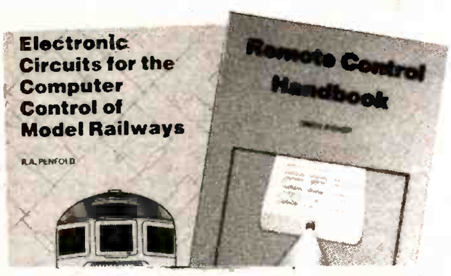
DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese digital i.c.s. Also includes details of packaging, families, functions, manufacturer and country of origin.
256 pages **Order code BP140** **£5.95**

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
A. Michaels
Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.
320 pages **Order code BP85** **£3.50**

CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS
M. H. Banani, B.Sc.(Eng.)
Illustrates the common, and many of the not-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc., in most countries throughout the world.
Chart **Order Code BP27** **£0.95**

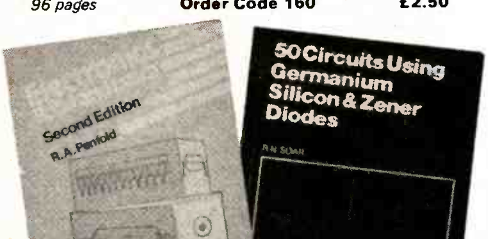
CIRCUITS & DESIGN

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS
R.A. Penfold
Home computers may easily be applied to the control of model railways and really quite sophisticated control, which needs only simple programming, is not too difficult to achieve. The main problem lies in interfacing the computer to the layout, but fortunately it is not too difficult or expensive to build suitable interfaces, and this book shows you how.
The projects consist of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electric points control etc. The use of computers does not have to be restricted to massive layouts. Something as simple as an oval of track with a single siding can be given a new dimension by adding computer control and much fun can be had from these relatively simple set-ups.
88 pages **Order code BP180** **£2.95**



REMOTE CONTROL HANDBOOK
Owen Bishop
Remote control systems lend themselves to a modular approach. This makes it possible for a wide range of systems, from the simplest to the most complex, to be built up from a number of relatively simple modules. The author has tried to ensure that, as far as possible, the circuit modules in this book are compatible with one another. They can be linked together in many different configurations to produce remote control systems tailored to individual requirements. Whether you wish simply to switch a table lamp on and off, or to operate an industrial robot, this book should provide the circuit you require.
226 pages **Order code BP240** **£3.95**

COIL DESIGN AND CONSTRUCTION MANUAL
B. B. Babani
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now rather old, with the exception of torroids and pulse transformers little has changed in coil design since it was written.
96 pages **Order Code 160** **£2.50**



30 SOLDERLESS BREADBOARD PROJECTS – BOOK 1
R. A. Penfold.
Each project, which is designed to be built on a "Verobloc" breadboard, is presented in a similar fashion with a brief circuit description, circuit diagram, component layout diagram, components list and notes on construction and use where necessary. Wherever possible, the components used are common to several projects, hence with only a modest number of reasonably inexpensive components, it is possible to build in turn, every project shown. Recommended by BICC-Vero.
160 pages **Order Code BP107** **£2.25**

BOOK 2–All projects use CMOS i.c.s but the items on component identification etc., are not repeated from Book 1.
160 pages **Order code BP113** **£2.25**

ELECTRONIC CIRCUITS HANDBOOK
Michael Tooley BA
This book aims to explode two popular misconceptions concerning the design of electronic circuits: that only those with many years of experience should undertake circuit design and that the process relies on an understanding of advanced mathematics. Provided one is not too ambitious, neither of these popularly held beliefs is true.

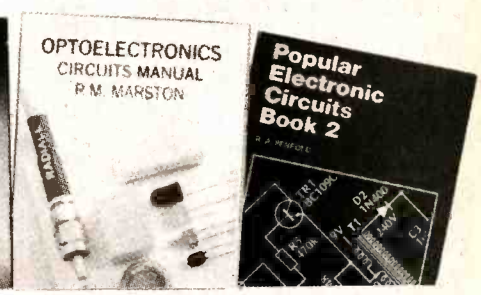
Specifically, this book aims to provide the reader with a unique collection of practical working circuits together with supporting information so that circuits can be produced in the shortest possible time and without recourse to theoretical texts.

Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.

As a bonus, ten test gear projects have been included. These not only serve to illustrate the techniques described but also provide a range of test equipment which is useful in its own right.
277 pages **Order code NE05** **£14.95**

AUDIO IC CIRCUITS MANUAL
R. M. Marston
A vast range of audio and audio-associated i.c.s are readily available for use by amateur and professional design engineers and technicians. This manual is a guide to the most popular and useful of these devices, with over 240 diagrams. It deals with i.c.s such as low frequency linear amplifiers, dual pre-amplifiers, audio power amplifiers, charge coupled device delay lines, bar-graph display drivers, and power supply regulators, and shows how to use these devices in circuits ranging from simple signal conditioners and filters to complex graphic equalizers, stereo amplifier systems, and echo/reverb delay line systems etc.
168 pages **Order code NE13** **£11.95**

OPTOELECTRONICS CIRCUITS MANUAL
R. M. Marston
A useful single-volume guide to the optoelectronics device user, specifically aimed at the practical design engineer, technician, and the experimenter, as well as the electronics student and amateur. It deals with the subject in an easy-to-read, down-to-earth, and non-mathematical yet comprehensive manner, explaining the basic principles and characteristics of the best known devices, and presenting the reader with many practical applications and over 200 circuits. Most of the i.c.s and other devices used are inexpensive and readily available types, with universally recognised type numbers.
182 pages **Order code NE14** **£10.95**



HOW TO DESIGN ELECTRONIC PROJECTS
R. A. Penfold
The aim of this book is to help the reader to put together projects from standard circuit blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements are also provided.
128 pages **Order code BP127** **£2.25**

KEY TECHNIQUES FOR CIRCUIT DESIGN
C. G. Loveday C.Eng MIERE
Deals with designing electronic circuits from scratch covering concepts such as target specifications, component selection (passive, discretes and i.c.s), the design cycle, derating and so on. Numerous design examples are given and several reader exercises all with fully worked solutions. The approach is essentially non-mathematical.
128 pages **Order code BM1** **£6.95**

50 CIRCUITS USING GERMANIUM SILICON AND ZENER DIODES
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most simple and inexpensive of components—the diode. Includes the use of germanium and silicon signal diodes, silicon rectifier diodes and Zener diodes, etc.
64 pages **Order Code BP36** **£1.50**

A MICROPROCESSOR PRIMER
E. A. Parr, B.SC., C.Eng., M.I.E.E.
Starts by designing a small computer which, because of its simplicity and logical structure, enables the language to be easily learnt and understood. The shortcomings are then discussed and the reader is shown how these can be overcome by changes and additions to the instruction set. In this way, such ideas as relative addressing, index registers, etc., are developed.
96 pages **Order code BP72** **£1.75**

POPULAR ELECTRONIC CIRCUITS –BOOK 1
POPULAR ELECTRONIC CIRCUITS –BOOK 2
R. A. Penfold
Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up procedures are described.
BOOK 1 *160 pages* **Order code BP80** **£2.95**
BOOK 2 *160 pages* **Order code BP98** **£2.95**

CMOS CIRCUITS MANUAL
R. M. Marston
Written for the professional engineer, student or enthusiast. It describes the basic principles and characteristics of these devices and includes over 200 circuits.

All the circuits have been designed, built and fully evaluated by the author; all use inexpensive and internationally available devices.
pages **Order code NE12** **£9.95**

PROJECT CONSTRUCTION

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R. A. Penfold
We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects
96 pages **Order code BP110** **£2.50**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages **Order code BP121** **£2.50**

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold
Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.
112 pages **Order code No. 227** **£2.25**

ELECTRONIC SCIENCE PROJECTS
O. Bishop
These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.
144 pages **Order code BP104** **£2.95**

MORE BOOKS NEXT MONTH

RADIO, TV, SATELLITE

BEGINNER'S GUIDE TO RADIO – 9th EDITION
Gordon J. King
Radio signals, transmitters, receivers, antennas, components, valves and semiconductors, CB and amateur radio.
266 pages **Order code NE08** **£6.95**

AN INTRODUCTION TO RADIO DXING
R. A. Penfold
Anyone can switch on a short wave receiver and play with the controls until they pick up something, but to find a particular station, country or type of broadcast and to receive it as clearly as possible requires a little more skill and knowledge. The object of this book is to help the reader to do just that, which in essence is the fascinating hobby of radio DXing.
112 pages **Order code BP91** **£1.95**

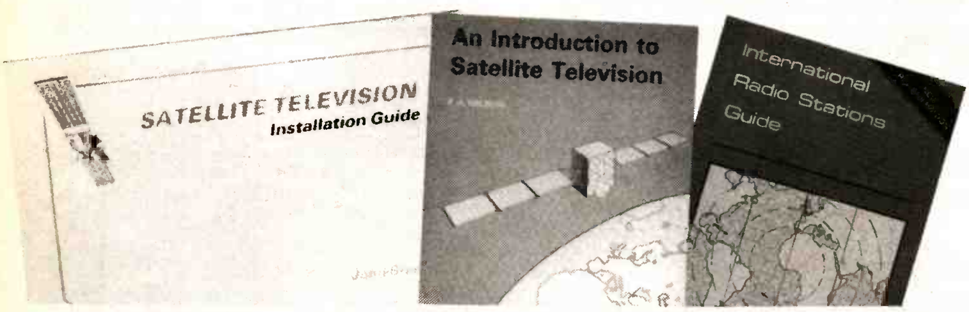
A TV-DXERS HANDBOOK
R. Bunney
Roger Bunney is probably one of the leading authorities in this country on the subject. Includes many units and devices which have been designed and used by active enthusiasts, and often, considerable ingenuity and thought have gone into the development of such units to overcome individual problems. A practical and authoritative reference to this unusual aspect of electronics.
128 pages **Order code BP176** **£5.95**

SATELLITE TELEVISION INSTALLATION GUIDE – 2nd EDITION
John Breeds
This book is now firmly established as a leading study manual for satellite TV installers, technical colleges who run City & Guilds courses, and training schools in major companies. It will be invaluable to anyone who wants to set up a dish receiver.

It covers all aspects of satellite dish installation: Installation of indoor unit, Geostationary satellites, Site survey, Dish assembly, Signal polarisation, Setting up the dish, Polar mount dish, TV downlead and relay cable and F-connectors, EIRP footprint contours, Trouble-shooting guide, Glossary of terms and Useful addresses.
56 pages (large format) **Order code JB1** **£11.95**

NEWNES SHORTWAVE LISTENING HANDBOOK
Joe Pritchard G1UQW
Part One covers the "science" side of the subject, going from a few simple electrical "first principles", through a brief treatment of radio transmission methods to simple receivers. The emphasis is on practical receiver designs and how to build and modify them, with several circuits in the book.

Part Two covers the use of sets, what can be heard, the various bands, propagation, identification of stations, sources of information, QSLing of stations and listening to amateurs. Some computer techniques, such as computer morse decoding and radio teletype decoding are also covered.
224 pages **Order code NE16** **£12.95**



COMPUTING

SERVICING PERSONAL COMPUTERS – 2nd EDITION
Mike Tooley BA
The revised and enlarged second edition contains a new chapter on the IBM PC, AT, TX and compatibles. It is essential for anyone concerned with the maintenance of personal computer equipment or peripherals, whether professional service technician, student or enthusiast.
240 pages (hard cover) **Order code NE15** **£20**

AN INTRODUCTION TO PROGRAMMING THE BBC MODEL B MICRO
R. A. & J. W. Penfold
Written for readers wanting to learn more about programming and how to make best use of the incredibly powerful model B's versatile features. Most aspects of the BBC micro are covered, the omissions being where little could usefully be added to the information provided by the manufacturer's own manual.
144 pages **Order code BP139** **£1.95**

AN INTRODUCTION TO COMPUTER COMMUNICATIONS
R. A. Penfold
Provides details of the various types of modem and their suitability for specific applications, plus details of connecting various computers to modems, and modems to the telephone system. Also information on common networking systems and RTTY.
96 pages **Order code BP177** **£2.95**

AN INTRODUCTION TO COMPUTER PERIPHERALS
J. W. Penfold
Covers such items as monitors, printers, disc drives, cassette recorders, modems, etc., explaining what they are, how to use them and the various types and standards. Helps you to make sure that the peripherals you buy will work with your computer.
80 pages **Order code BP170** **£2.50**

HOW TO GET YOUR COMPUTER PROGRAMS RUNNING
J. W. Penfold
Have you ever written your own programs only to find that they did not work! Help is now at hand with this book which shows you how to go about looking for your errors, and helps you to avoid the common bugs and pitfalls of program writing. Applicable to all dialects of the BASIC language.
144 pages **Order code BP169** **£2.50**

AN INTRODUCTION TO 6502 MACHINE CODE
R. A. & J. W. Penfold
No previous knowledge of microprocessors or machine code is assumed. Topics covered are: assembly language and assemblers, the register set and memory, binary and hexadecimal numbering systems, addressing modes and the instruction set, and also mixing machine code with BASIC. Some simple programming examples are given for 6502-based home computers like the VIC-20, ORIC-1/Atmos, Electron, BCC and also the Commodore 64.
112 pages **Temporarily out of print**

THE PRE-BASIC BOOK
F. A. Wilson, C.G.I.A., C.ENG., F.I.E.E., F.I.E.R.E., F.B.I.M.
Another book on BASIC but with a difference. This one does not skip through the whole of the subject and thereby leave many would-be programmers floundering but instead concentrates on introducing the technique by looking in depth at the most frequently used and more easily understood computer instructions. For all new and potential micro users.
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BY GEORGE HYLTON

LOW VOLTAGE CIRCUITS

It is sometimes necessary to operate electronic circuits from a low supply voltage. A familiar example is the battery operated wristwatch, where size and economy dictate the use of a single mercury cell.

Solar powered devices may also have to work at low voltage. A typical silicon solar cell delivers only about one-third of a volt, so it takes four solar cells to form the equivalent of one mercury cell.

Devices such as watches and calculators may need much higher voltages for powering l.c.d. displays. These higher voltages are manufactured by up-converting the cell voltage, a process which involves the use of some kind of oscillator to produce an a.c. voltage which can be stepped up and rectified.

Converters are outside the scope of this article, which deals with ways of making discrete transistors work at low voltage, in linear circuits. But some of the design considerations apply.

TURN-ON VOLTAGES.

No transistor can work unless there's enough voltage to turn it on. So far as bipolar (*npn* or *pnp*) transistors are concerned the important turn-on voltage is the one which makes the base-emitter junction conduct. For some germanium transistors this can be as low as 0.1V. For silicon bipolars the working value of base-emitter voltage (let's call it V_{BE}) runs from about 0.5V upwards to about 1V depending on the temperature, the construction of the transistor, and the collector current required. Some silicon transistors can function as low-frequency amplifiers at collector currents of a few micro-amps.

Field-effect transistors (f.e.t.s) of the depletion mode type have no particular gate turn-on voltage. In their case the important factor is the size of drain-to-source voltage needed for linear operation. This may be as low as 0.5V.

Enhancement-mode f.e.t.s do require a gate turn-on voltage. The fact that these f.e.t.s are used in some low-voltage i.c.s shows that the turn-on voltage can be low. Unfortunately, discrete devices with very low turn-on voltages don't seem to be available.

MICROPHONE BUFFERS

We do not propose to say much about f.e.t. circuits here, but there is one important application. Capacitor microphones are essentially small capacitances which deliver low audio voltages to very-high-impedance loads.

As every audiophile knows, high impedances readily pick up hum. To avoid this, capacitor microphones usually incorporate a buffer amplifier which presents a very high impedance to the microphone but feeds its signal to the outside world at relatively low impedance. The buffer amplifier is a f.e.t. (which can provide an input impedance of the order of 1000MΩ if required) and may be powered by a single built-in mercury cell.

CIRCUIT VOLTAGES

In a simple bipolar amplifier circuit (Fig.1) the supply voltage is shared between the load R_C, which drops V_L, and the transistor, which drops V_{CE}. For simplicity we will make the supply voltage (usually called V_{CC}) a standard 1.4V.

Most modern bipolars will work at low collector voltages (V_{CE}). For simplicity we can say (optimistically) that they'll work at V_{CE} down to zero. The collector voltage can then swing from 0V to $+V_{CC}$.

With a 1.4V supply this means that the maximum peak-to-peak output swing is 1.4V. To obtain this in a linear fashion requires operating the transistor with V_{CE} at the half-way voltage of 0.7V.

This leads us straight to a problem. With the conventional auto-bias circuit, Fig. 1a, the voltage available to drive base bias current through R_C is $V_{CE}-V_{BE}$. If V_{BE} is as high as V_{CE} then there is nothing left to drive base current, and the circuit cannot work as intended.

What happens in practice is that the collector voltage sets itself to something above V_{BE}. If V_{CE} is 1V and V_{BE} is 0.7V, 0.3V is available to drive I_B. One consequence is that R_B in this type of circuit has to be made much less than its rule-of-thumb textbook value of $R_C.h_{FE}$. The resulting negative feedback from collector to base reduces the input impedance.

To avoid these problems you must either find a transistor with a lower V_{BE} or use circuit Fig. 1b where the voltage available to drive I_B is (V_{CC} − V_{BE}). Unfortunately, Fig. 1b gives no protection against either temperature effects or variations in h_{FE}, so R_B in this case should be chosen to suit the individual transistor.

In practice, it is usually possible to use Fig. 1a in low-current (I_C=100μA or less) stages because V_{BE} is then reduced. It helps to select a transistor with high h_{FE}, so that the required base current ($I_B = I_C/h_{FE}$) is small and R_B is as high as possible in the circumstances.

DIRECT COUPLING

Some standard amplifier circuits are unsuitable or low-voltage operation. In Fig.2, the collector voltage of transistor TR1 can be seen by inspection to be $V_{BE}2$ + $V_{BE}1$. If these come to 1.4V, nothing is left for the load resistances. The circuit might work with germanium transistors, but it's a poor bet with silicon.

If, instead of transformer-coupling to input you insert a feedback resistance R_F from TR1 base to TR2 emitter and capacitively couple the input (as shown inset) further voltage is lost in R_F and the circuit is even less viable.

You might think that with silicon transistors direct coupling between stages is not possible at low V_{CC}.

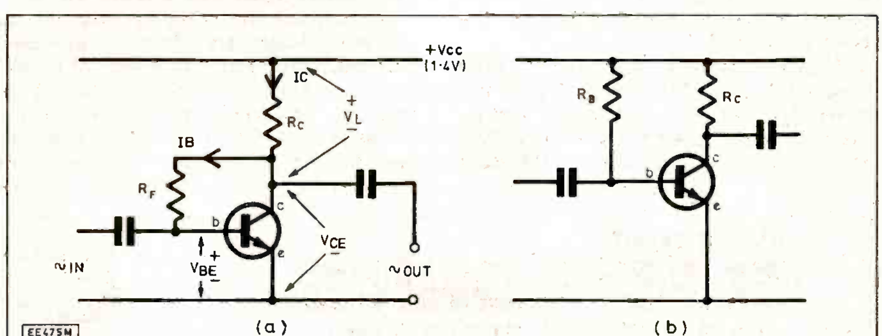

Fig.1. Single-stage amplifier circuits. (a) With auto bias. (b) With bias resistance connected to positive line.

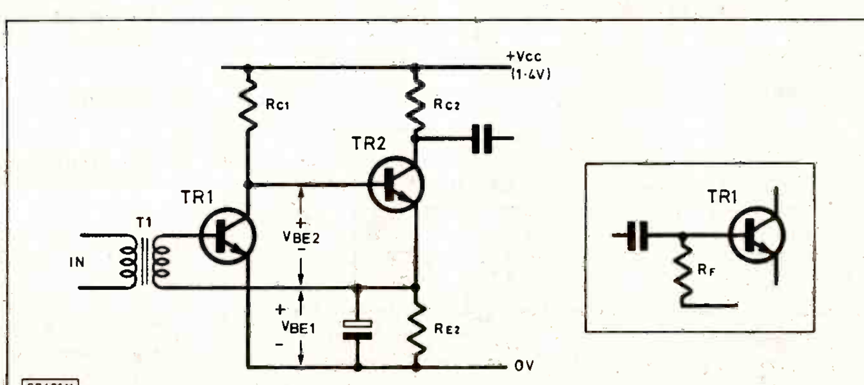

Fig. 2. This well-known direct-coupled amplifier circuit is unsuitable for low Vcc.

However, the Fig. 3 type of circuit can be made to work. Here the V_{CE} of TR1 is the V_{BE} of TR2, which is all right. Likewise TR2's V_{CE} is the V_{BE} of TR3.

To maximise output voltage TR3 collector should sit at half V_{CC} (i.e. V_{CE3} = 0.7V with our V_{CC}). The voltage drop across R_F is then 0.7V − V_{BE1}. If V_{BE1} = 0.5V the drop in R_F is 0.2V and I_{B1} = 0.2V/R_F.

Since the required value of I_{B1} depends on the gain of TR1 in practice R_F has to be selected or made adjustable. The voltage gain of this amplifier is R_F/R1 and its input impedance is R1.

To increase gain you have to settle for a reduced R1. This circuit has negative feedback (via R_F) over three stages. This incurs the risk of instability, because the cumulative phase shift at some frequency is 180° and at this frequency the feedback becomes positive. It can happen that the circuit is stable at some gains but not at others, so adjustment of R1 may help to find a stable condition.

This circuit has sometimes been used as a flea-powered audio amplifier in which R_{C3} is the resistance of the voice coil of a directly-driven loudspeaker. (It is normally bad practice to put d.c. through loudspeakers, but most will tolerate small amounts.) The maximum audio output power is half the d.c. power dissipated in the coil.

Since maximum output voltage swing is obtained (roughly speaking) by making $V_{CE3} = V_{CC}/2$, then the voice coil drops $V_{CC}/2$. The audio power is $V_{CC}/8R_{C3}$. For V_{CC} = 1.4V and an 8ohm speaker this gives 0.03W, or 30mW, but this assumes that the transistor works with V_{CE} down to zero so is optimistic. The d.c. through TR3 is $V_{CC}/2R_{C3}$, which in the present case is 1.4V/(2x8 ohm) = 87.5mA.

This is the starting point for a design. From here you work backwards through the stages, ensuring that each transistor can more than supply the base current of the next.

With this form of circuit it is quite possible to mix the polarities of the transistors. It may help to use a germanium *pnp* transistor for TR3 as shown inset: this gives TR2 a higher collector voltage.

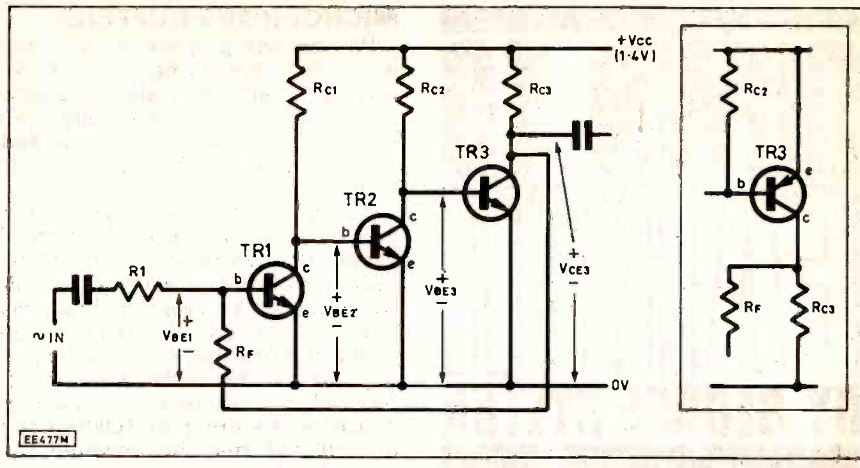

Fig. 3. Direct coupling is possible with this circuit. It may be useful to use a germanium pnp transistor for TR3.

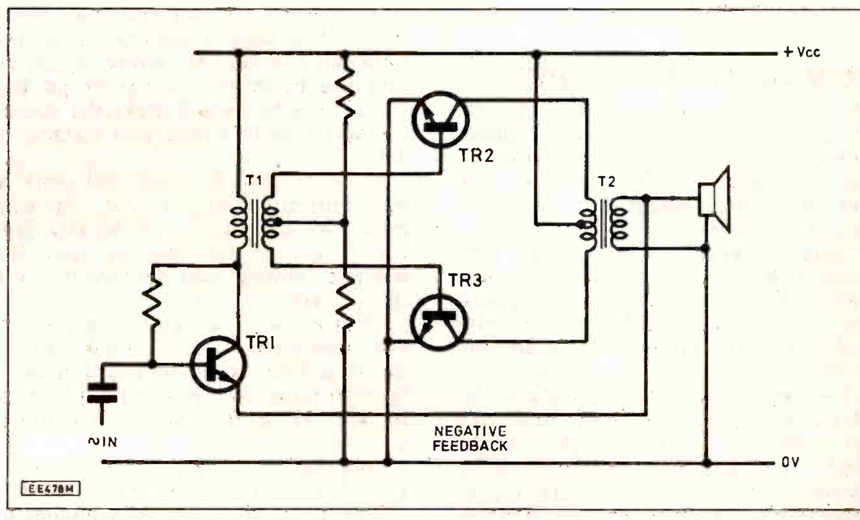

Fig. 4. Transformer coupling avoids loss of d.c. voltage in loads.

TRANSFORMER COUPLING

If instead of using resistances as collector loads, transformers are used for load coupling, the waste of power can be reduced. In the old-fashioned transformer-driven transformer-output class B amplifier (Fig. 4), the collector windings can in theory have very low resistance, so that practically no voltage is lost. Thus TR2 and TR3 have V_{CE} = V_{CC}, and the power output is greatly increased.

In practice, the tiny output transformers used in old pocket radios are often very inefficient. They may waste half the power. Even so, transformer coupling can still be worthwhile in terms of output power.

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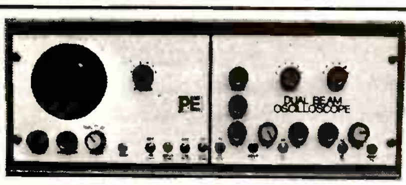

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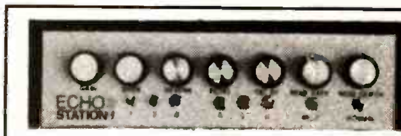

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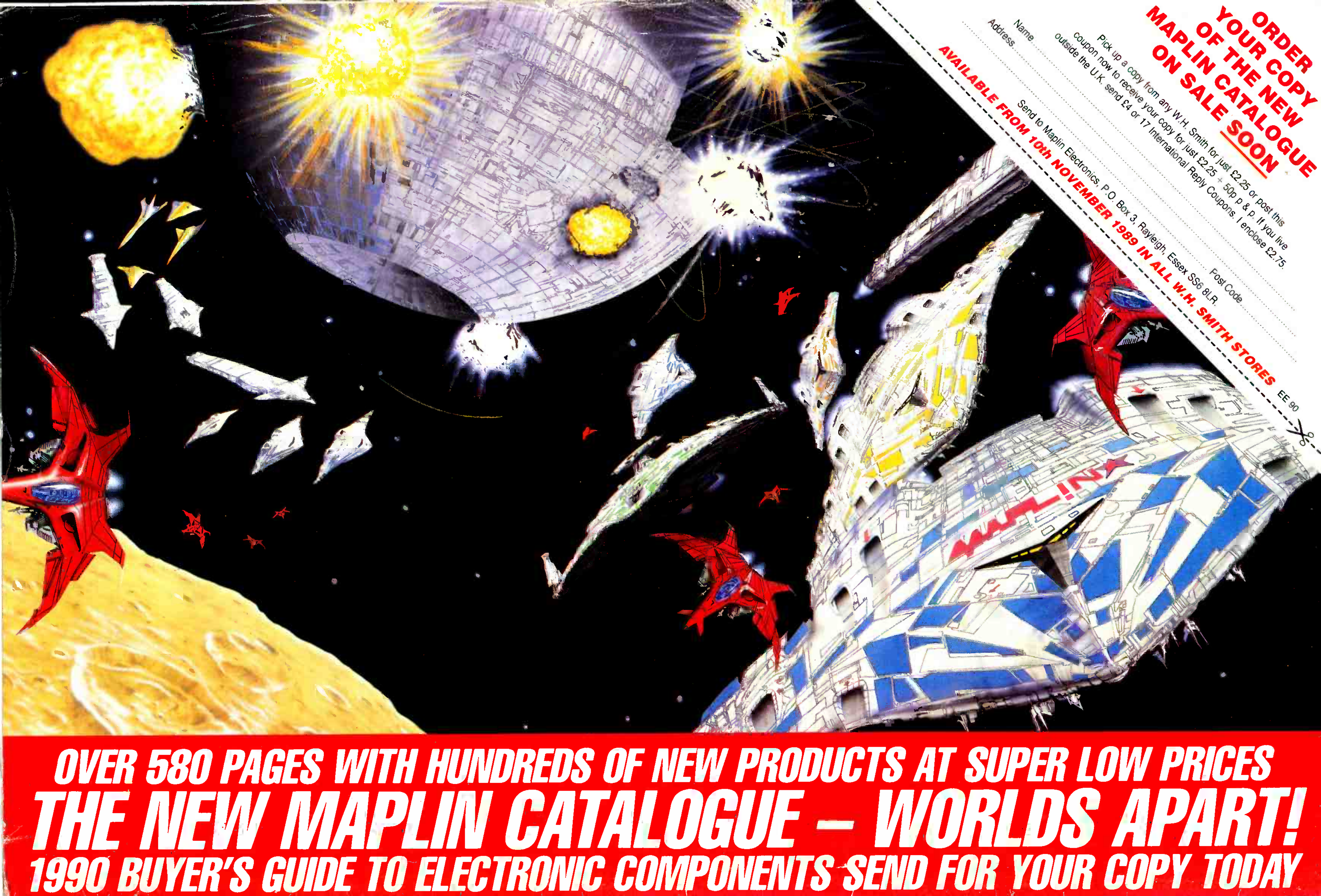
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