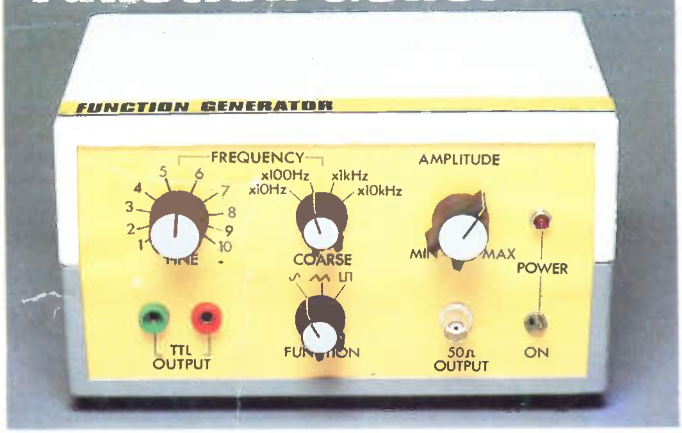
Easy to build projects for everyone

Everyday ELECTRONICS

APRIL 83
80p

TEST GEAR 83
Function Generator



Novelty Egg Timer

Add-on Amplifier for ZX spectrum

CAR RADIO POWER BOOSTER

Flanger Sound Effect

Australia $1·35 Malaysia $4·95 IR £1·19 (inc. V.A.T.)

Everyday ELECTRONICS

VOL. 12 NO. 4 APRIL 1983

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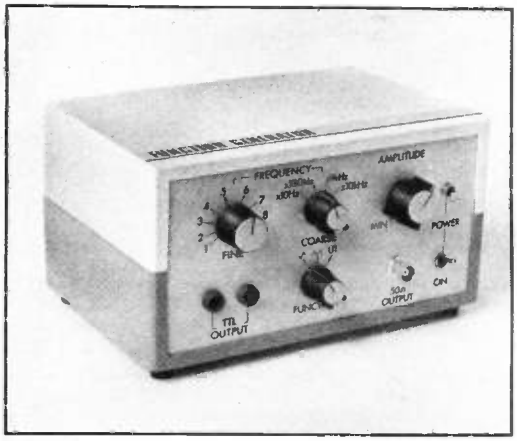
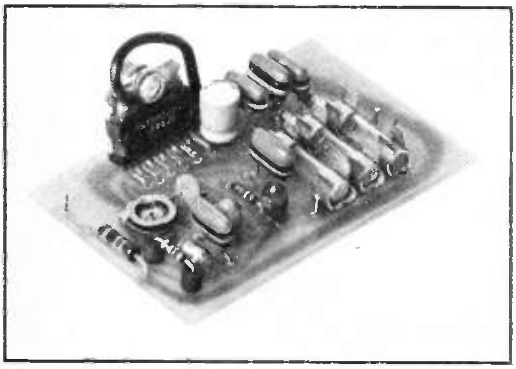
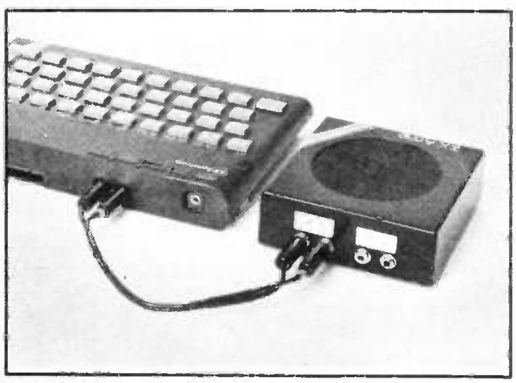
COMMENT . . . POPULAR FEATURES . . .







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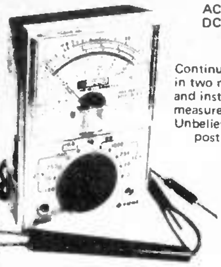
MINI-MULTI TESTER

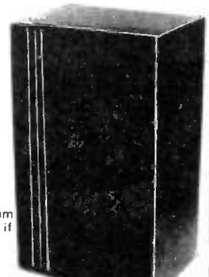
Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale.
11 instant range measures: DC volts 10, 50, 250, 1000. AC volts 10, 50, 250, 1000. DC amps 0 – 100 mA.



Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only **£6.75 + 60p** post and insurance.

FREE Amps range kit to enable you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but if you already own a Mini-Tester and would like one, send £2.50.

SUPER HI-FI SPEAKER CABINETS



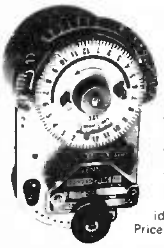
Made for an expensive Hi-Fi outfit – will suit any decor. Resonance free. Cut-outs for 6½" woofer and 2½" tweeter. The front material is Dacron. The completed unit is most pleasing. Supplied in pairs, price **£6.90** per pair (this is probably less than the original cost of one cabinet) carriage £3.00 the pair.

GOODMANS SPEAKERS

6½" 8 ohm 25 watt £4.50. 2½" 8 ohm tweeter. £2.50. No extra for postage if ordered with cabinets. Xover £1.50.

DITTO but for 8" speaker and 4" tweeter. **£7.50 + £3.50**.

VENNER TIME SWITCH



Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2.95**. These are without case but we can supply a plastic base **£1.75** or metal case **£2.95**. Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

THERMOSTAT ASSORTMENT

10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 – 100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around £15.00 – however, you can have the parcel for **£2.50**.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, multi-turn pots and data on the 50 projects.

YOURS FOR ONLY £11.50 plus £3.00 post.

EXTRACTOR FANS

Mains operated – ex-computer.
Woods extractor 5" – £5.75, Post £1.25; 6" – £6.95, Post £1.25
4"x4" Muffin 115v. £4.50. Post 75p.
4"x4" Muffin 230v. £5.75. Post 75p.
5" Plannair extractor £6.50. Post £1.25.

ROTARY WAFER SWITCHES

5 amp silver plated contacts. ¼" shaft. 1" dia. wafer.

Single wafer types, **29p each**, as follows:

1 pole 12 way	2 pole 6 way	3 pole 4 way
4 pole 3 way	6 pole 2 way	4 pole 3 way

Two wafer type, 59p each, as follows

2 pole 12 way	4 pole 5 way	4 pole 6 way
6 pole 2 way	8 pole 3 way	12 pole 2 way

3 wafer types 99p each,

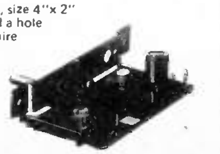
9 pole 4 way	6 pole 5 way	6 pole 6 way
	12p 3 way	18p 2 way

EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. **£6.90 + £1.50 post.**
(This is easily reversible with our reversing switch - **Price £1.15**).

MINI MONO AMP

on p.c.b., size 4"x 2" approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of **£1.15 each, or 10 for £10.00.**

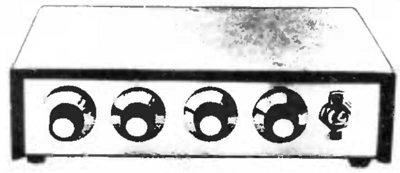


POPULAR PROVEN PROJECTS

MULTI-CHANNEL or ROBOT CONTROLLER

This is two kits. The 8 channel transmitter kit and the 8 channel receiver kit. Each kit comes with diagrams and notes, but no circuit boards, the component layout being left to you. The data shows how to drive, reverse and steer two or more motors. With spare channels to perform other functions. Price **£9.50 for both kits.**

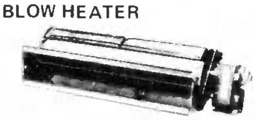
3 CHANNEL SOUND TO LIGHT KIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special price is **£14.95** in kit form or **£25.00** assembled and tested. Case & metal Chassis No. Fully punched and prepared.

WHY BE COLD - Build a tangential blower heater.

TANGENTIAL BLOW HEATER



2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for **£4.95**. post £1.50.

CAR STARTER AND CHARGER KIT

In an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250 watt mains transformer, 40 amp bridge rectifier, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. **Price £12.50 + £3.00 post.**

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox – all electronic parts and circuit. **£2.30.** (not licenceable in the U.K.).

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. **£6.90** complete kit. (not licenceable in the U.K.)

FM RECEIVER

Made up and working, complete with scale and pointer needs only headphones, ideal for use with our surveillance transmitter or radio mike. **£5.85.** or kit of parts £3.95.

3 - 30v VARIABLE VOLTAGE POWER UNIT

With 1 amp DC output, for use on the bench, students, inventors, service engineers, etc. Automatic short circuit and overload protection. In case with a volt meter on the front panel. Complete kit **£13.80.**

INTERRUPTED BEAM

This kit enables you to make a switch that will trigger when a steady beam of infra red or ordinary light is broken. Main components – relay, photo transistor, resistors and capacitors, etc. Circuit diagram but no case. **Price £2.30.**

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – complete mains operated kit, case included. **£11.95** plus £2.00 post.

RADIO STETHOSCOPE

Easy to fault find – start at the aerial and work towards the speaker – when signal stops you have found the fault. **Complete kit £4.95.**

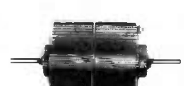
INVISIBLE AND SILENT SENTINEL

Ultra-sonic beam when broken could warn you of visitor – two kits - transmitter & receiver. To operate light or bell. **£9.50.**

BURGLAR ALARM

Complete kit includes 6" extrenal alarm bell, mains power unit, control box with keyswitch, 10 window/door switches, 100 yards of wire. With instructions. **£29.50.**

12v MOTOR BY SMITHS



Made for use in cars, these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. These have a good length of ¼" spindle – **price £3.45.**
Ditto, but double ended **£4.25.**
Ditto, but permanent magnet, **£3.75.**

WATERPROOF HEATING WIRE

60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses – around water pipes, under grow boxes in gloves and socks. 23p a metre.

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3 core and screened power flex cable:	
3 cores each 50.025 (equiv. 2.5mm) per metre	.40
3 cores each 30.025 (equiv. 1.5mm) per metre	.30
3 cores each 24.02 (equiv. 1mm) per metre	.20
Armoured cable 1.5mm, 3 core	.40
Extension lead, 3 cores. .5mm pvc covered/100 M	£9.50
Extension lead, twin .5mm rubber covered/1000 metres	£60.00
Iron flex. Woven cotton covered, rubber insulated 2 core 100 metre	£12.50
FIGURE 8 FLEX, heavy duty .75mm. 600 metre	£19.00
Figure 8 Flex per 100 metres	£3.00

PROJECT CASES - CABINETS - BOXES

Black plastic boxes, 2 7/8 x 4 1/8 x 3" deep	.50
Ditto 3 5/8 x 2 3/4 x 1 3/4" deep	.40
Ditto 3 7/8 x 2 3/4 x 1" deep	.30
Plated metal box 7½ x 4½ x 1½" deep	£1.00
Dark grey half boxes. May be joined to make three different depth boxes: 4 5/8 x 2 5/8 x 3/4" deep	.20
4 5/8 x 2 5/8 x 1" deep	.25
White plastic box ideal for touch switch, transmitter, etc. through top is square hole. 3½ x 3½ x 3½"	.50
Loudspeaker cabinet for 6½" speaker	.95
PORTABLE RADIO CASE – 5" speaker, size approx 6¼ x 3¾ x 2" deep	£1.00

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Standard open relays 3 x 8 amp c/o contacts:	
6 volt dc coil .90; 110 volt ac coil	.50
24 volt dc coil .50; 230 volt ac coil	.90
1 x 8 amp changeover, 230 volt AC coil	.60
Enclosed plug in round base relays – 3 changeover contacts:	
50 volt coil (ex-fruit machine)	.40
110 volt coil 2 changeover	.50
12 volt coil 3 changeover	.80
8 pin bases. Bases for 2 changeover relay	.20
11 pin bases. Bases for 3 changeover relay	.25
Miniature relays: 12 volt 2 changeover	.60
12 volt 4 changeover	.75
28 volt	.50
48 volt	.50

POWER SUPPLY UNITS

In car, 12 volt for using 6 volt equipment	£1.25
Mains to 24 volt Mullard, Stereo	£1.90
Mains to 12 volt, 800mA	£1.50
Mains to 50 volt 25cps for telephone ringing	£2.00

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Photo transistors, Mullard seconds 75% working, 100 for	£5.00
Full wave rectifier 440v 2 amp	.20
g.p. 50V Silicon diodes	.02
Silicon transistor, 107, 109 etc.	.03
Germanium transistors	.05
Surface barrier transistors	.25

PANEL METRES & INSTRUMENTS

Volt meter 0 - 200 volts, 2½" round	£1.50
Milli amp meter, 500 ma 2½" round	£1.00
– amp meter, not wire scaled, 0 - 9 amps	£1.20
Ammeter, 2½" round, centre zero. 500ma	£1.00
Charger panel meters. 1¾" dia. scaled 3 amp	.35
Panel meter, 1 5/8" square, scaled Vu	.60
Panel meter, Amstrad, 40mm sq. centre zero, scaled 1, 2, 3	.50
Edgeways panel, 3". 0 - 25 ma, ex-GPO	£1.00

AMPLIFIERS

½ watt, Japanese made with v.c.	£1.50
1 watt, Mullard Module 1172	£1.00
4 watt, Mini-amp with v.c.	£1.00
Pre-amp, Mullard ref. 9001 module	.80

BULBS & LAMPS

Torch bulbs, 3.5v MES. Box of 25	.35
Pilot light bulbs 6.2v .3A 11mm box of 50	£1.00
6.2v .3A 14mm box of 10	.30
12v .5A 16mm box of 10	.50
Car bulbs: 18 watt SBC	.12
SBC Lamp holders	.15

MAINS TRANSFORMERS

6 volt 1 amp	.50	35 volt 2 amp	£2.00
6.3 volt 2 amp	£1.00	38 volt 2½ amp	£2.50
12 volt ¾ amp	.75	26 volt 10 amp	£4.00
12 volt 4 amp	£2.00	50 volt 2 amp	£2.00
12 volt 1 amp	£1.00	12 - 0 - 12, 2 amp	£2.50
8.5 - 0 - 8.5 1 amp	£1.00	12 - 0 - 12, 1 amp	£2.00
18 volt 1 amp	£1.50	100W auto 115v o/p	£2.00
25 volt 1½ amp	£1.50		

MOTORS - MAINS & BATTERY

3 - 6 volt battery motor, very small	.15
3 - 12 volt battery motor, very low current	.20
Mains motor with gear box 5 rev minute	£2.25
80 rev per minute	£3.00
110 rev minute	£2.00
200 rev minute	£1.50
Mains motor, double ended fan motor	£1.20
Ditto single ended fan motor	£1.00
Fan blade for above	.50
Mains motor, double ended, very powerful 1½" stack	£1.50
Mains instrument motors with gear box: 1 rev 24 hours	£1.50
1 rev 1 hour	£1.50
16 rev minute	£1.50
4 rev minute	£1.50
2 rev minute	£1.50
1 rev minute	£1.50
Motor clockwork, set up to 1 hour	.38
Motor, clockwork set up to 1 hour with ringer	.75
Mains motor ¼ h.p. 1425 revs, ex-computer	£4.25
Vent opening motor with end stop switches	£12.50
12 volt motors, Smiths, single ended ¼" spindle	£1.50
12 volt motors, Smiths, double ended ¼" spindle	£2.00
12 volt motors, P magnet type, single ended	£1.75
1½ h.p. motor 3450 rpm 100 volt. 50Hz. New	£5.00

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Everyday ELECTRONICS

VOL. 12 No. 4 APRIL 1983

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EVERYDAY ELECTRONICS AND COMPUTER PROJECTS

NEXT month EVERYDAY ELECTRONICS takes on a new look. Apart from introducing a change of type style, our title will be amplified to make clear our commitment to serve the interest of microcomputer users. As a constructors' magazine our overall policy is unaltered—our central purpose is (as always) to put electronics to effective use in any way possible, and to serve any and all interests wherever practical.

But the increasing importance of computing means that, quite naturally, we will be giving increasing attention to this area and we feel it right to make this clear to personal computer users in general.

Some idea of the scope for the electronics circuit designer and builder in the field of personal computers has been demonstrated in the pages of EE over the last twelve months. But this is only the beginning and an exciting and rewarding area for the project builder is now really opening up as microcomputers multiply in type and the numbers in use increase at a phenomenal rate.

Day by day more EE readers are becoming personal computer users. They will quickly and naturally seize the opportunities to enhance the usefulness of their machines by building for themselves add-on units that would be expensive to buy ready made—always supposing that similar units *are* available as commercial products.

There is, of course, the vast number of microcomputer users who have no technical knowledge nor practical experience in building electronic circuits. This is where EE will offer a special service with its easy to follow features dealing with theoretical matters and all practical aspects of circuit construction.

We do, however, stress that this new emphasis on the computer area will not be at the expense of other interests served by EE. The answer to this apparent conundrum is extra pages of editorial matter in every issue. For this enlarged and enhanced EVERYDAY ELECTRONICS we shall be asking our readers for another 5p. A modest increment in the circumstances, we believe our readers will agree. For details of the contents and the free gift that comes with the May issue please turn to page 231. You won't want to miss it, so why not place a firm order with your local newsagent now.

Fred Bennett

Readers' Enquiries
We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.
We cannot undertake to engage in discussions on the telephone.

Component Supplies
Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

All reasonable precautions are taken to ensure that the advice and data given to readers are reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.

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Certain back issues of EVERYDAY ELECTRONICS are available worldwide price £1·00 inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.

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ZX SPECTRUM AMPLIFIER

BY V. TERRELL

THE BEEP command is used to produce sound from the Spectrum. Unfortunately the level of this sound is extremely low. In fact, even in a quiet room notes above and below middle-C can be difficult to hear. It was therefore thought necessary that if use of the BEEP command was to be fully realised the sound level had to be increased. This was accomplished by the amplifier described here. Apart from being considerably louder the quality of the sound was enriched.

FEEDBACK

Fig. 1 shows the tape circuitry of the Spectrum. The sound originates from the ULA chip, and as can be seen, is fed to both EAR and MIC sockets. Initially when tested the tones at the MIC socket sounded smoother than those at the EAR socket, and so the MIC "output" was used to feed the amplifier. Because the Spectrum EAR and MIC sockets are interconnected, when making a program SAVE, feedback can occur with certain types of cassette recorder. The reason being that whilst recording, the MIC signal also appears amplified at the EAR socket, this is then fed via the computer MIC and EAR sockets back to the cassette's MIC input thus forming a loop. Page 21 of the Spectrum Introduction Booklet suggests pulling the earplug out every time a SAVE is made. To overcome this problem with some cassette recorders, a switch to interrupt the EAR lead between player and computer has been incorporated in the design of the amplifer. Of course this switch can be omitted and a link wire fitted, if your recorder is able to SAVE properly with both leads in.

CIRCUIT DIAGRAM

The complete circuit diagram for the ZX Spectrum Amplifier is shown in Fig. 2. The integrated circuit amplifier ICI requires few external components to produce a $\frac{1}{4}$-watt amplifier. (The gain of the i.c. can be increased if required by placing suitable components between pin 1 and 8, this however was not necessary because of the high level of signal available at the MIC socket.) The gain of the i.c. without feedback is set at about ×20.

In series with the volume on/off control VR1 is R1, to limit the signal fed to the amplifier by a factor of 10 to prevent overloading. Decoupling capacitor C1 prevents high frequency oscillations and should be fitted as close as possible to pin 6 of the i.c. Capacitor C2 and resistor R2 in series at the output, form what is known as a Sobel network to stabilise the output stage. Coupling capacitor C3 connects the output of the amplifier loudspeaker, LS1.

The SAVE/LOAD switch S1 when open breaks the EAR connection from computer to cassette, to prevent feedback when saving, as discussed earlier. S1 is closed for loading. The fact that R1 and VR1 are across the MIC socket SK1, in no way affects the saving of programs because of the high value of R1.

The quiescent current, that is, the current drawn by the i.c. with no signal applied, is very low, so the battery should last a reasonable length of time.

PRINTED CIRCUIT BOARD

All components with the exception of LS1 and the four jack sockets are mounted on a small printed circuit board size 95 × 32mm. The full size master pattern to be etched on this board is shown in Fig. 3. The black areas represent the copper tracks to remain after etching.

Fig. 1. Circuit diagram for the tape circuitry of the ZX Spectrum.

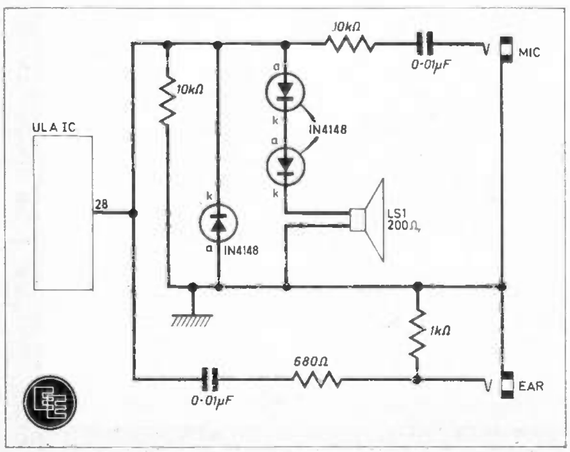
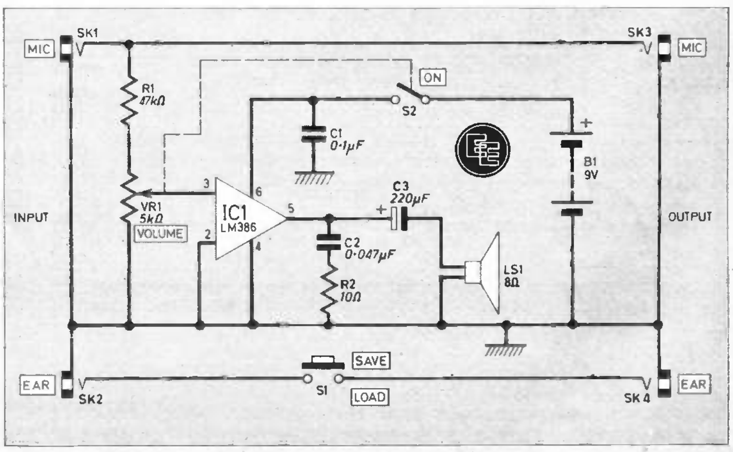


Fig. 2. The complete circuit diagram for the ZX Spectrum Amplifier.



COMPONENTS

Resistors
R1 47kΩ R2 10Ω
Both $\frac{1}{4}$ watt carbon ±5%

Capacitors

C1	0·1µF monolithic or disc ceramic
C2	0·047µF polyester type C280
C3	220µF 16V elect. radial leads

Semiconductors

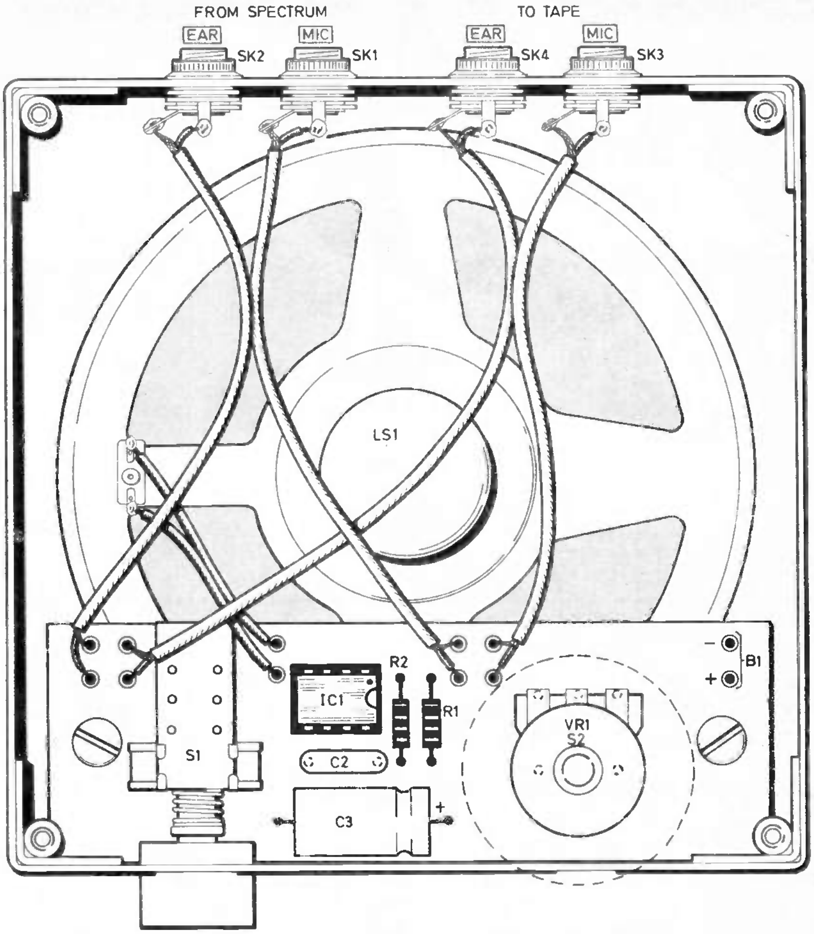
IC1	LM386 400mW audio amplifier 8-pin d.i.l.

Miscellaneous

S1	Push-on, push-off latching p.c.b. mounting
VR1/S2	5kΩ carbon edge-wise control with s.p.s.t. switch
SK1–4	3·5mm chassis mounting jack socket (4 off)
LS1	8 ohm loudspeaker approx. 90mm diameter
B1	9-volt PP3

Printed circuit board single-sided, size 95 x 32mm; aluminium for case 18 s.w.g.; threaded spacers and screws 6BA; speaker grille cloth; rubber feet (4 off); jack plugs 3·5 (4 off); 8-pin d.i.l. socket (1 off); PP3 battery clip; 0·1 inch Veropins (12 off); screened cable approx. 30cm; solder, glue.

Approx. cost Guidance only £7



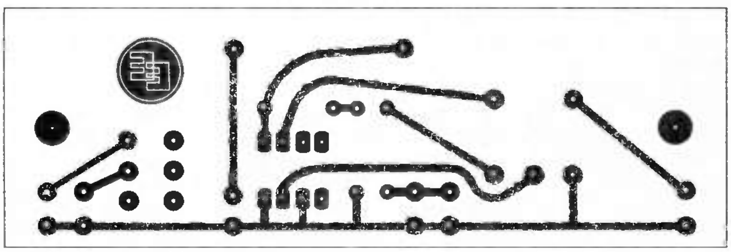


Fig. 3. Full size printed circuit board master, component layout and interwiring details for the ZX Spectrum Amplifier.

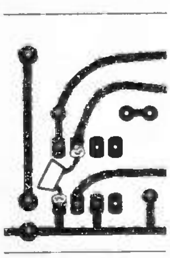
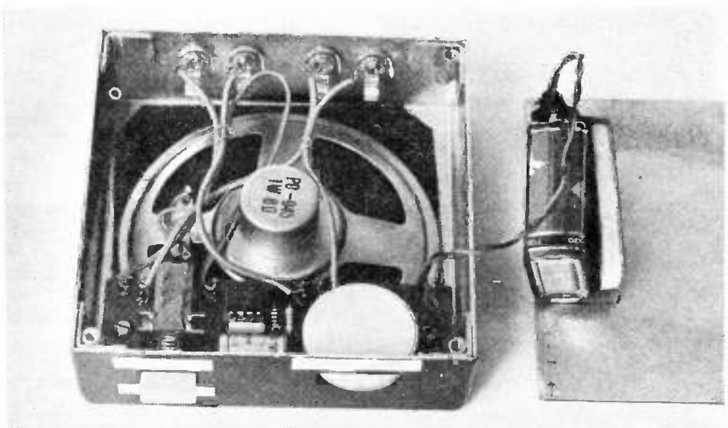


Fig. 4. Capacitor C1 mounted on the track-side of the board as close as possible to the pins of IC1.



Completed amplifier showing the battery in position on the lid.

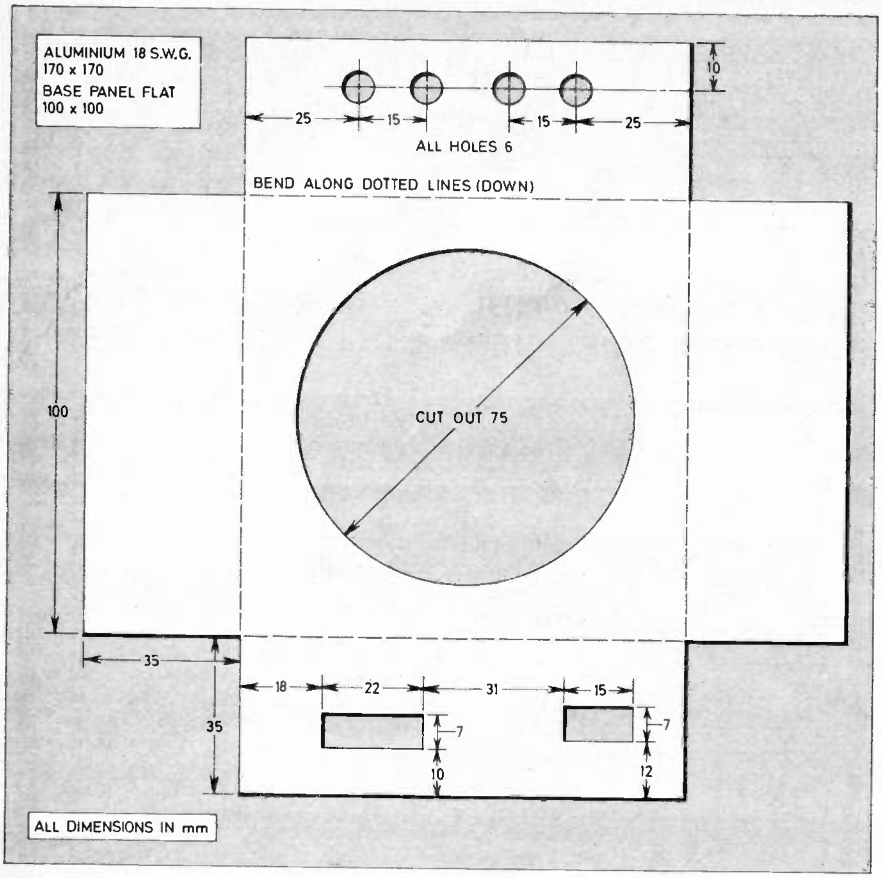


Fig. 5. Drilling and bending details for the suggested aluminium case.

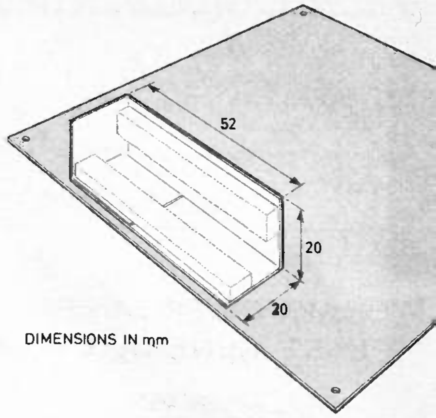


Fig. 6. Details of the battery compartment. Foam strips are used to hold the battery in position.

Begin by inserting and soldering in place the i.c. socket (recommended), followed by the smallest components and ending up at the largest, S1, see Fig. 3. Veropins are used to connect flying leads to the board. This allows the board to be fitted in its case with other case mounted components and then interwired.

Note that C1 is soldered directly to the underside of the board beneath the i.c. This was found to be the best position to locate this component. See Fig. 4.

CASE DETAILS

The prototype case was constructed from 18 s.w.g. aluminium, details are shown in Fig. 5. The overall size of the case is determined by the size of the speaker, it is recommended that the speaker used should not be less than 75mm diameter. All holes are made prior to bending.

The size and position of the slots for S1 and VR1 should be adhered to because they relate to the relative positions on the printed circuit board, S1, and the knob fitted to VR1. Once the slots are made, the p.c.b. can be offered up to locate the correct position for the board fixing pillars, these can be glued with Araldite and left to set. The other threaded fixing pillars are glued to the corners of the box to allow the base panel to sit just inside.

The prototype case was sprayed with a coat of primer followed by several coats of black gloss. A piece of speaker grille cloth was then glued in place with Bostic clear. When dry, the speaker can then be glued to the cloth, and allowed to dry before securing the p.c.b. and sockets into the case. Finally, the four self-adhesive rubber feet are fixed to the base plate and the case labelled as required.

ASSEMBLY

When the case and p.c.b. are ready, the final stages of assembly may be carried out. Fit the board in place followed by the four sockets on the rear of the case. Wire up using screened cable. Solder the speaker leads and battery leads in place to complete the unit wiring.

A small flimsy bracket, to position and retain the battery in the case, was constructed from cardboard and self-adhesive foam. Details are provided in Fig. 6. The unit may now be tested.

With the on/off switch in the "off" position check that the i.c. is correctly orientated. Insert the battery and switch on. A faint click should be heard. If a test meter is available check the voltage at pin 5 of the i.c. this should read 4·5 volts, half the battery voltage. The supply current without any input should read approximately 3mA.

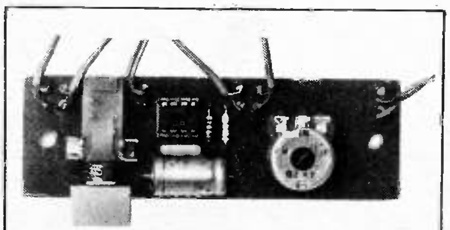
FINAL TESTING

To enable the unit and the cassette recorder to be connected up, an extra lead set will be required. This can either be completely made up, or by using the existing leads supplied with the Spectrum, and cut in half with four 3·5mm plugs soldered, one to each end, to the ends.

Connect up Spectrum to amplifier and set up the BEEP command to give a range of notes to check the amplifier.

Next LOAD and SAVE a few programs to check all is functioning. To cue programs already on tape, S1 is switched to the LOAD position, the amplifier turned up and the cassette played in the normal way. This method eliminates the need to keep pulling the cassette earplug whenever you want to cue the tape, the EAR socket doesn't become intermittent and the cassette volume control can be left unaltered. □

Completed amplifier plugged into the ZX Spectrum.



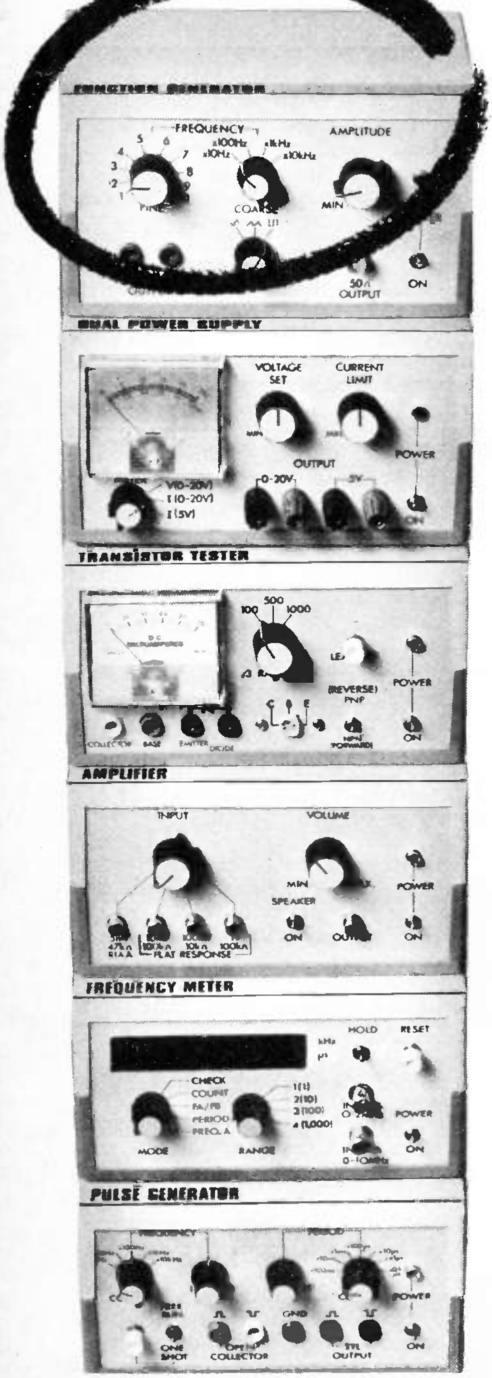
Components mounted on the circuit board. The plastic knurled "cap" for the volume control has been removed for clarity.

TEST GEAR 83 FUNCTION GENERATOR

UNIT TWO

BY J. R. W. BARNES

THE TEST GEAR 83 SERIES CONSISTS OF:
DUAL POWER SUPPLY ● FUNCTION GENERATOR ● TRANSISTOR TESTER
PULSE GENERATOR ● LABORATORY AMPLIFIER ● FREQUENCY METER



AUDIO signal generators are used in a wide range of applications, other than the most obvious one of checking amplifiers. For example, they can be used for testing sound circuits in television receivers or employed in more general use as a signal source to check that individual parts of an electronic system are functioning correctly.

Another typical application would be to determine the frequency response of a filter circuit.

GENERAL REQUIREMENTS

The general requirements of a signal generator are as follows:

Frequency Range. The normal range offered is 10Hz to 100kHz, with more expensive instruments offering frequencies up to 1MHz. For most home applications however, these higher frequencies are unnecessary.

Accuracy and Stability. These two parameters have an enormous effect on the cost of an instrument. However, calibration accuracies of better than 10 per cent are seldom required. The exact frequency can be determined with either a 'scope or a digital frequency meter, if required. The actual frequency scale on the instrument can be either linear or logarithmic, a linear scale is preferred since it is easier to set the frequency.

Output Impedance. The output impedance, if specified as constant, is usually 50 or 600 ohms. This is to enable the output of the generator to match the impedance of the coaxial cable, and the impedance of a twisted pair transmission line, respectively.

This prevents the signal from being reflected back at the ends of the cable, much in the same way as a wave travels down a "Slinky" coil then, when it hits the end, part of the energy is absorbed and part is reflected.

It is desirable to have a low output impedance, since when the load impedance is equal to the source impedance, the output voltage is reduced by a factor of two.

Output Voltage. For general purpose work with amplifiers, 1V r.m.s. is adequate. To determine the functional properties of an electronic system, a larger output is better. Some method of adjusting the output amplitude is usually provided. This may simply be a potentiometer or an accurate attenuator.

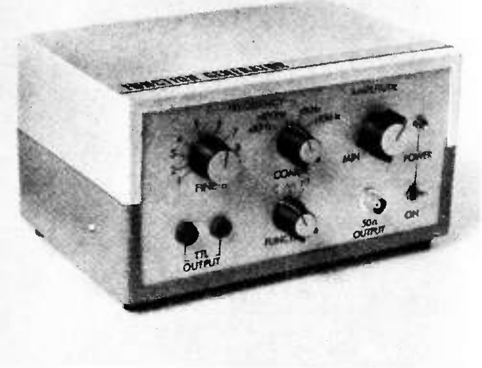
Waveforms. different types of waveforms are available; including squarewaves, pulses, sawtooth (ramp) and sinewaves. The difference here is between the signal sources which generate the waves and those that synthesise them. There are two common ways of making a sinewave, it can either be generated in an oscillator such as a Wien bridge type, or it can be made by rounding the peaks off a triangular wave.

This latter technique is widely used in function generators as it is easier to first make a triangular wave then convert it to a sinewave, than try to generate a triangular wave from a sinewave.

Sinewaves which are generated have a lower distortion content than can be obtained by electronic shaping. For accurate distortion measurements on an amplifier, a generated wave is therefore essential. Squarewave tests are frequently carried out as a check of amplifier perfor-

SPECIFICATION

Frequency range:	Continuously variable from 10Hz to 100kHz in four linear ranges	**Output impedance:**	47Ω measured at 1kHz (variable output)
Range switch:	× 10Hz (10Hz to 100Hz) × 100Hz (100Hz to 1kHz) × 1kHz (1kHz to 10kHz) × 10kHz (10kHz to 100kHz)	**Output impedance:**	100Ω (fixed TTL compatable output)
		Total harmonic distortion:	0·5% for the sinewave (measured at 1kHz)
		Rise time:	0·5μs (variable output squarewave into 50Ω)
Waveforms:	Sinewave, triangle (saw-tooth) and squarewave. Separate TTL compatable squarewave	**Rise time:**	35ns (fixed TTL squarewave output into 100Ω)



mance. The rise time of the output wave indicates the high frequency performance.

The Function Generator described here is of the synthesis type. The heart of the circuit is a 2206 waveform generator i.c. The unit provides two simultaneous outputs, a 5V squarewave TTL compatable output and an adjustable amplitude output with sine, triangular and squarewave outputs. The TTL output may be used for logic experiments, but it is also convenient for synchronising an oscilloscope or driving a frequency meter.

The main output has a 50 ohm output impedance and is capable of producing up to 6V into a 50 ohm load and 12V into a high impedance. The full specifications are given on page 205.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Function Generator is shown in Fig. 1. The circuit is built around the waveform generator, IC1. The coarse frequency range is switched by S1 and the capacitors C1 to C5, and the fine frequency is controlled by the current drawn out of pin 7. The frequency (f) is given by

$$f = \frac{320 \times I_t}{C_t}$$

In order to give the frequency control a linear scale, it is essential that I_t is directly proportional to the dial positon. This is accomplished with the aid of IC1. Zener diode D1 is used as a voltage reference and a portion of this, determined by preset VR1 and FREQUENCY control potentiometer VR2, is buffered by IC1 used as a voltage follower.

The voltage difference between the output of the op-amp and pin 7 of IC2 results in the timing current I_t flowing through R3. Preset VR1 is used to set the minimum frequency and the maximum frequency is fixed and determined by R3.

Switch S2 is used to select the output waveform. The resistors R5 and R7 ensure that the peak-to-peak amplitude of all the waveforms is the same. The amplitude of the triangular and squarewaves must however be set by adjusting VR3.

The output of the waveform generator is amplified by IC3. This is used in the non-inverting mode. Complementary symmetrical emitter followers, TR2 and TR3 provide current gain. Fixed biasing for the output transistors is provided by the forward biased silicon diodes, D3 and D4.

The feedback for the amplifier is by resistors R11 and R12, these set the gain to about 5·6. The output amplitude is controlled by VR4.

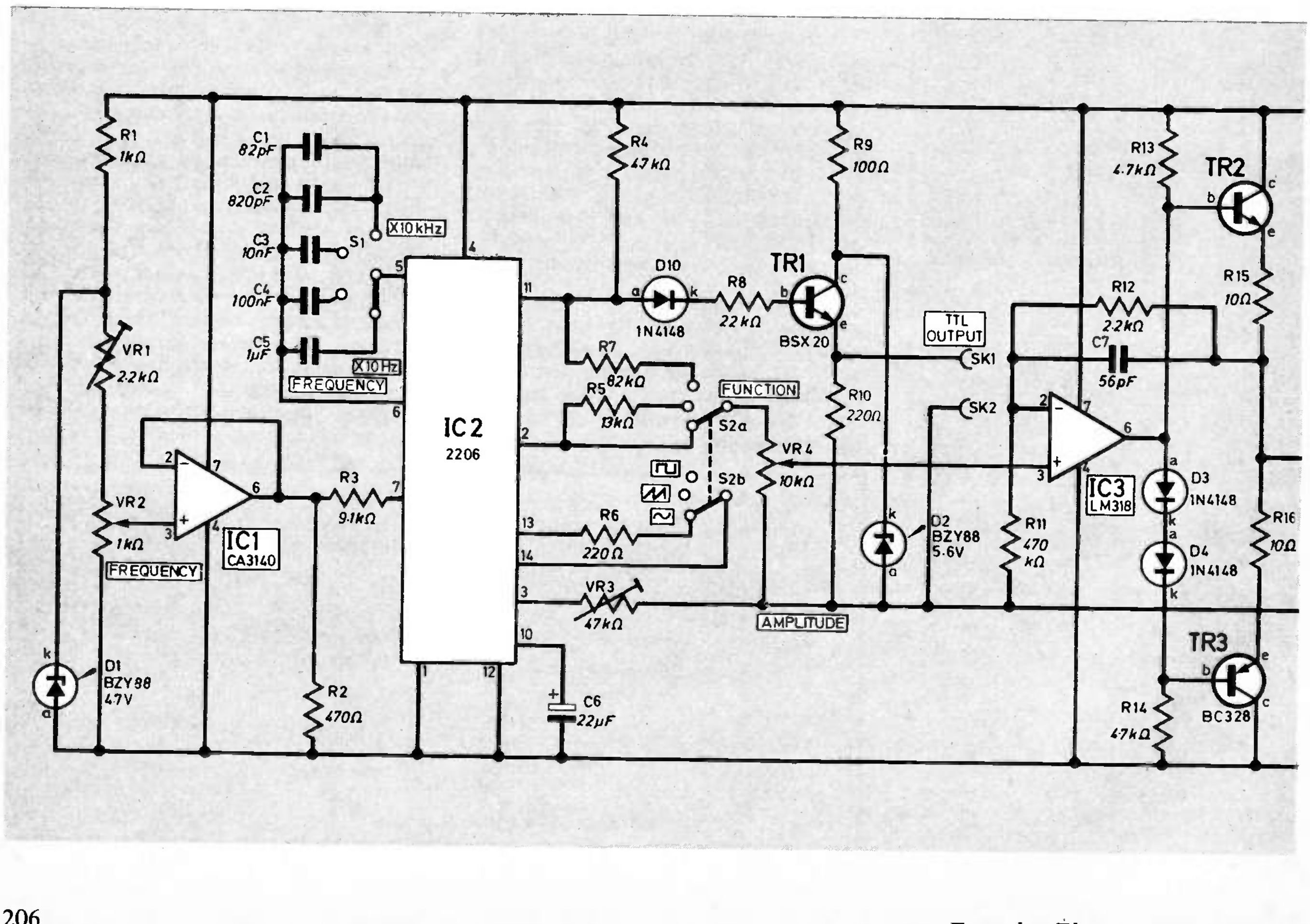
The TTL output is taken from the emitter follower TR1, the collector voltage is clamped by the Zener diode D2 to 5·6V. Diode D10 protects the transistor from the reverse base-emitter voltage during negative excursions of pin 11 of IC2.

It should be stressed that the performance of the TTL output is heavily dependant on the switching characteristics of TR1, and constructors should not substitute another type unless they are sure they have similar high frequency behaviour.

POWER SUPPLY

The power supply is very conventional, the two i.c. voltage regulators, IC4 and IC5 are used to provide positive and negative 12-volt rails. A centre-tapped transformer T1, and bridge rectifier together with smoothing capacitors, provide a source of d.c. for the regulators.

Fig. 1. Complete circuit diagram for the Function Generator. The power supply/voltage regulator section is shown on the opposite page.



CONSTRUCTION starts here

CIRCUIT BOARDS

The generator circuit is built on a printed circuit board 100 × 160mm. The layout of the copper tracks is shown in Fig. 2. It should be noted that the tracks which apparently go nowhere, form an essential interleaved ground plane which is necessary to maintain waveform purity. The component layout is also shown.

It will assist wiring later if Veropins are inserted in the board for the flying leads. Once they have been soldered in place, continue construction with the components. The order of construction is unimportant but the normal practice of links, i.c. sockets, resistors, capacitors, and finally the diodes and transistors can be used. Care should be taken to ensure the correct polarity of the diodes and electrolytic capacitors.

The power supply p.c.b., shown in Fig. 3, can be assembled. Again check the polarities of the diodes and capacitors. It is a good idea at this stage to test the

COMPONENTS

Approx cost Guidance only **£24**

Resistors

R1	1kΩ
R2,11	470Ω (2 off)
R3	9·1kΩ ±2%
R4,13,14	4·7kΩ (3 off)
R5	13kΩ
R6,10	220Ω (2 off)
R7	82kΩ
R8	22kΩ
R9	100Ω
R12	2·2kΩ
R15,16	10Ω (2 off)
R17	47Ω
R18	680Ω

All ¼W carbon ±5% unless otherwise stated

See **Shop Talk** page 217

Potentiometers

VR1	2·2kΩ miniature preset
VR2	1kΩ linear control
VR3	47kΩ miniature preset
VR4	10kΩ linear control

Capacitors

C1	820pF polystyrene
C2	82pF ceramic
C3	10nF Siemans
C4,10,11	100nF Siemans (3 off)
C5	1µF Siemans
C6,8,9	22µF 40V elect. (3 off)
C7	56pF ceramic
C12,13	470µF 63V elect. (2 off)

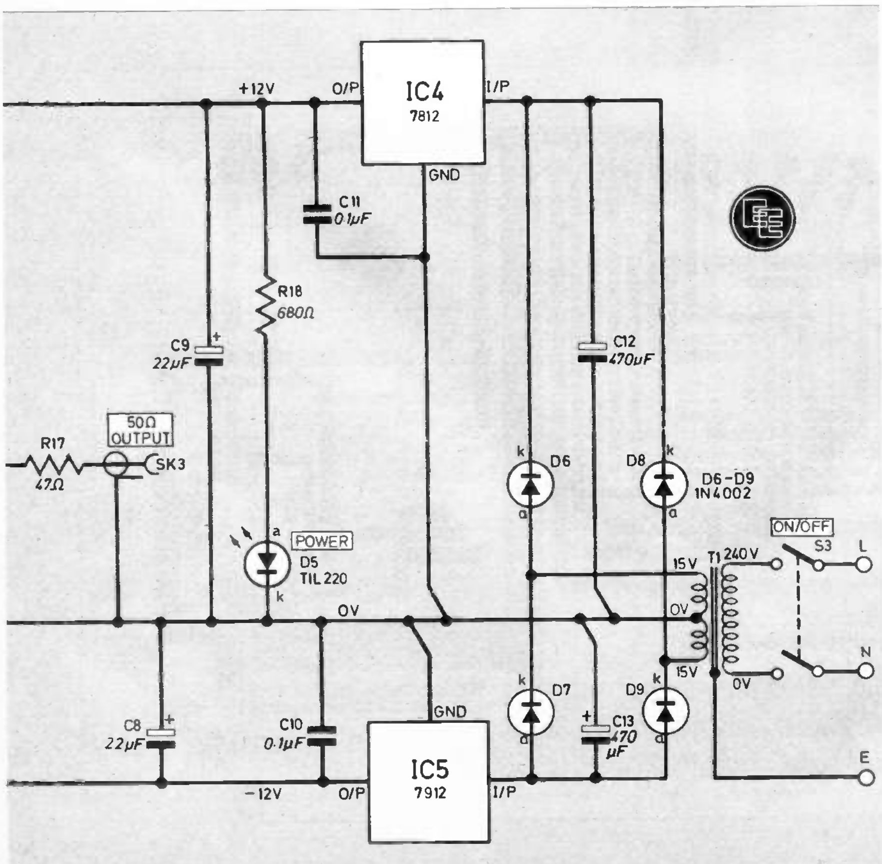
Semiconductors

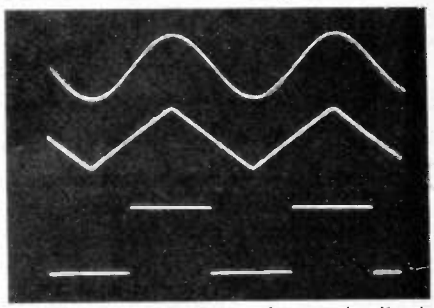
D1	BZY88 C4V7 Zener
D2	BZY88 C5V6 Zener
D3,4,10	1N4148 silicon (3 off)
D5	TIL220 0·2in red l.e.d.
D6–9	1N4002 silicon (4 off)
TR1	BSX20 silicon *npn*
TR2	BC338 silicon *npn*
TR3	BC328 silicon *pnp*
IC1	CA3140 MOSFET op-amp
IC2	XR2206 waveform generator
IC3	LM318 op-amp
IC4	7812 +12V, 1A regulator
IC5	7912 −12V, 1A regulator

Miscellaneous

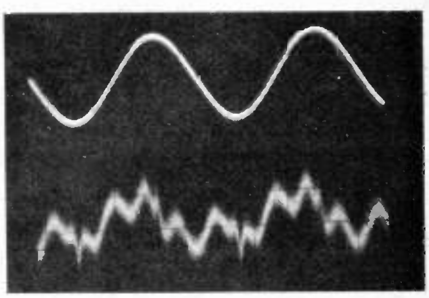
S1	3-pole, 4-way midget rotary
S2	4-pole, 3-way midget rotary
S3	d.p.d.t. miniature mains toggle
SK1	4mm banana socket red
SK2	4mm banana socket green
SK3	50Ω b.n.c. socket
T1	6VA p.c.b. mounting mains transformer with 0–15V, 0–15V secondaries (rated at 200mA)

Verocase type 202-21036C; single-sided p.c.b. size 150 × 65mm and 150 × 100mm; l.e.d. holder; control knob (4 off); Veropins; 7/0·2mm wire; mains cable; grommet; P-clip; 8-pin d.i.l. holder (2 off); 16-pin d.i.l. holder; Mounting hardware (M3 or 6BA).





Oscillogram of the waveforms obtained from the Function Generator.



Total harmonic distortion (THD) factor at 1kHz of the prototype unit showing a 0·5 per cent distortion.

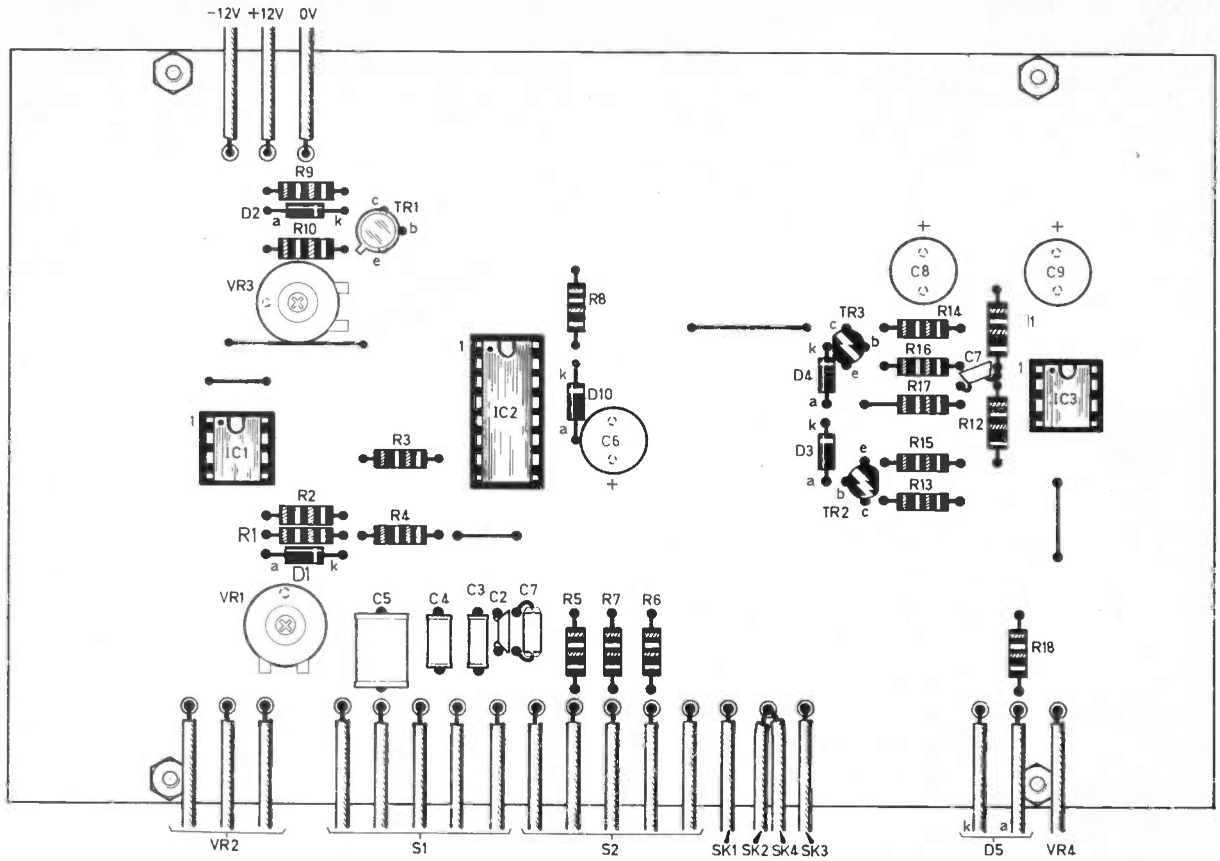
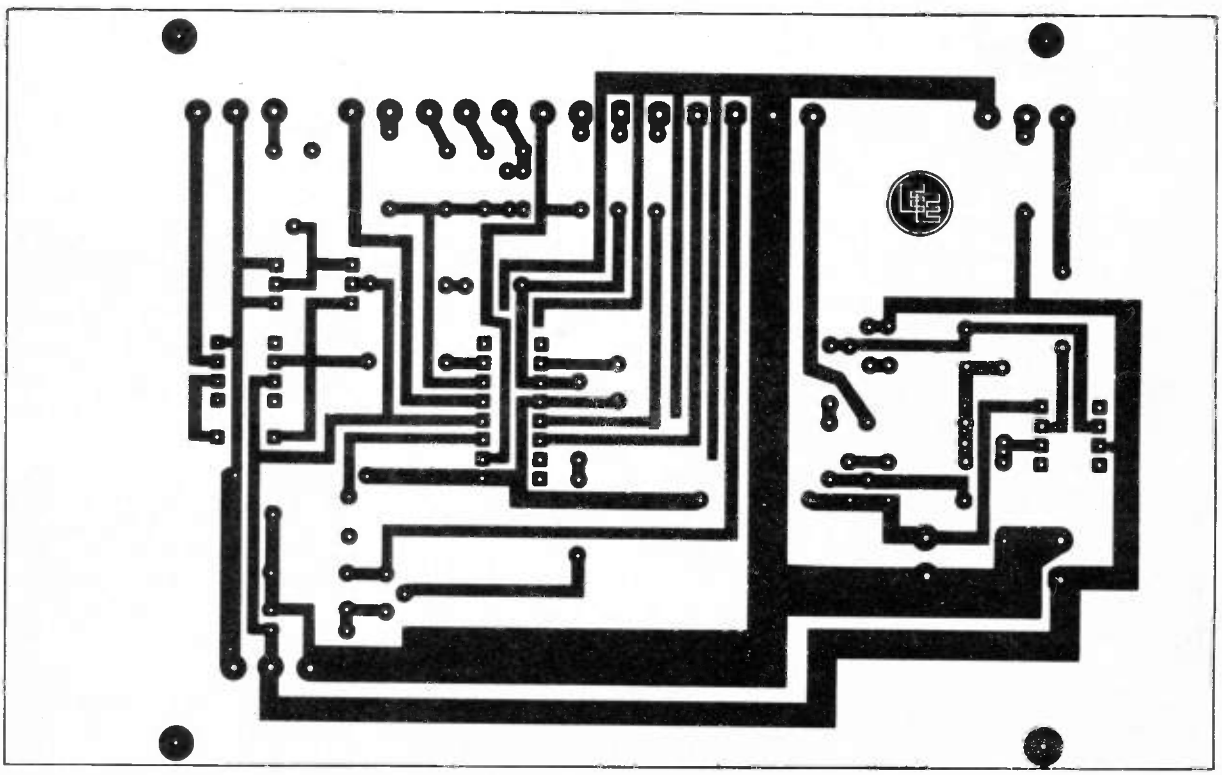


Fig. 2. Component layout (above) and full size printed circuit board master (below) for the waveform generator board (p.c.b.2).



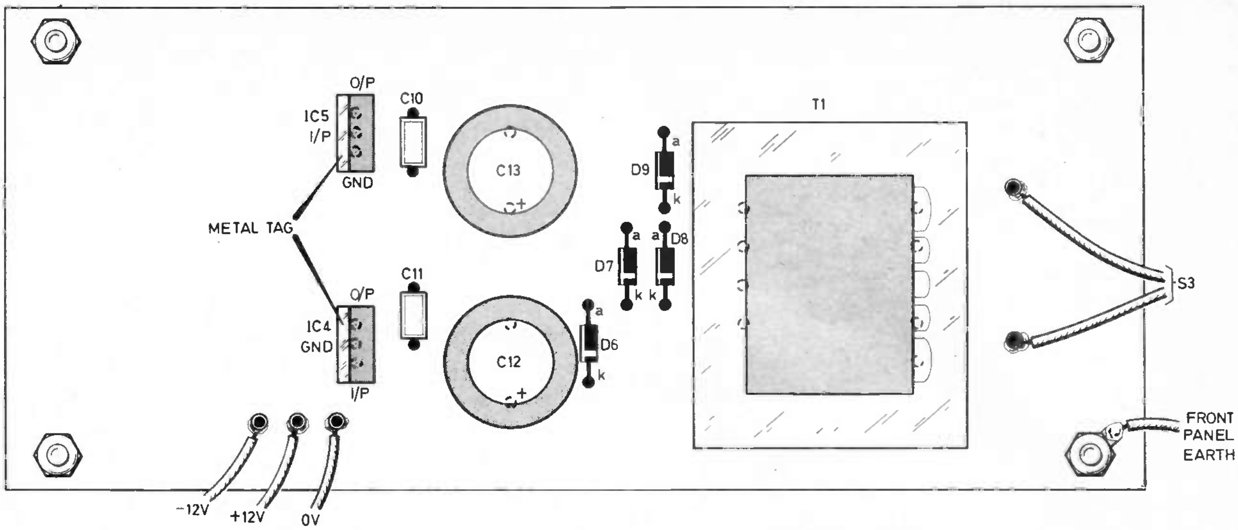
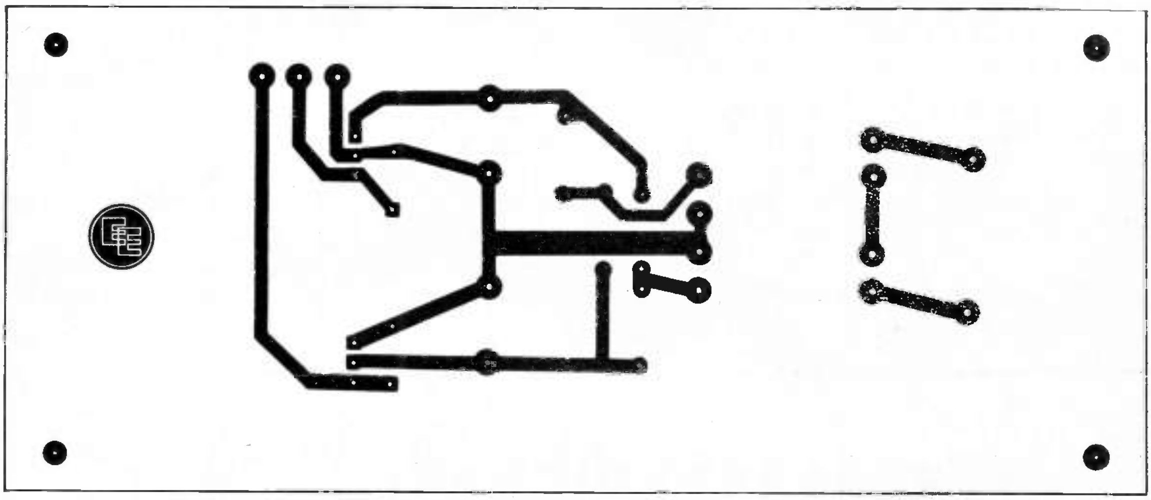
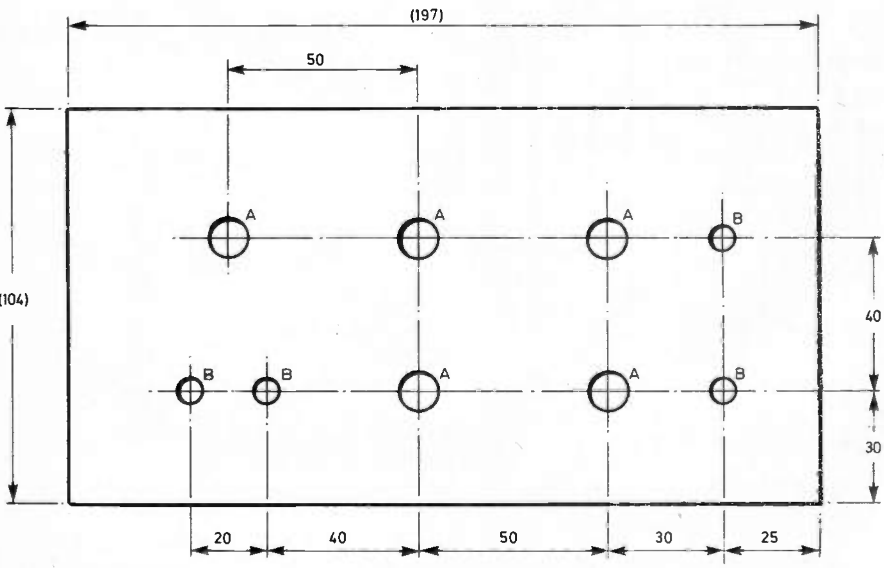


Fig. 3. Component layout (above) and full size printed circuit board master (below) for the power supply board (p.c.b. 1).

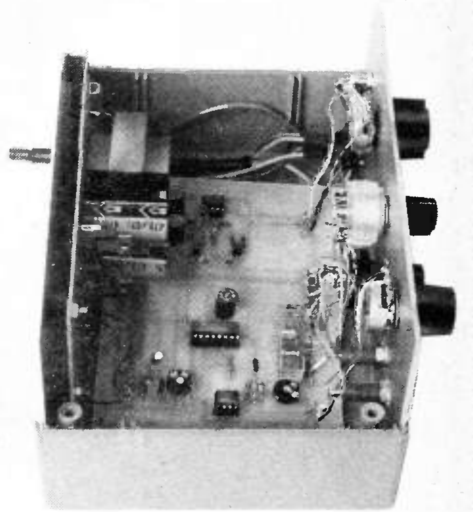




5 OFF 'A' HOLE DIA 10
4 OFF 'B' HOLE DIA 6·2

ALL DIMENSIONS IN mm

Fig. 4. Drilling details for the aluminium front panel.



Positioning of the waveform generator board (p.c.b.2) and the power supply board (p.c.b.1) inside the case of the completed unit.

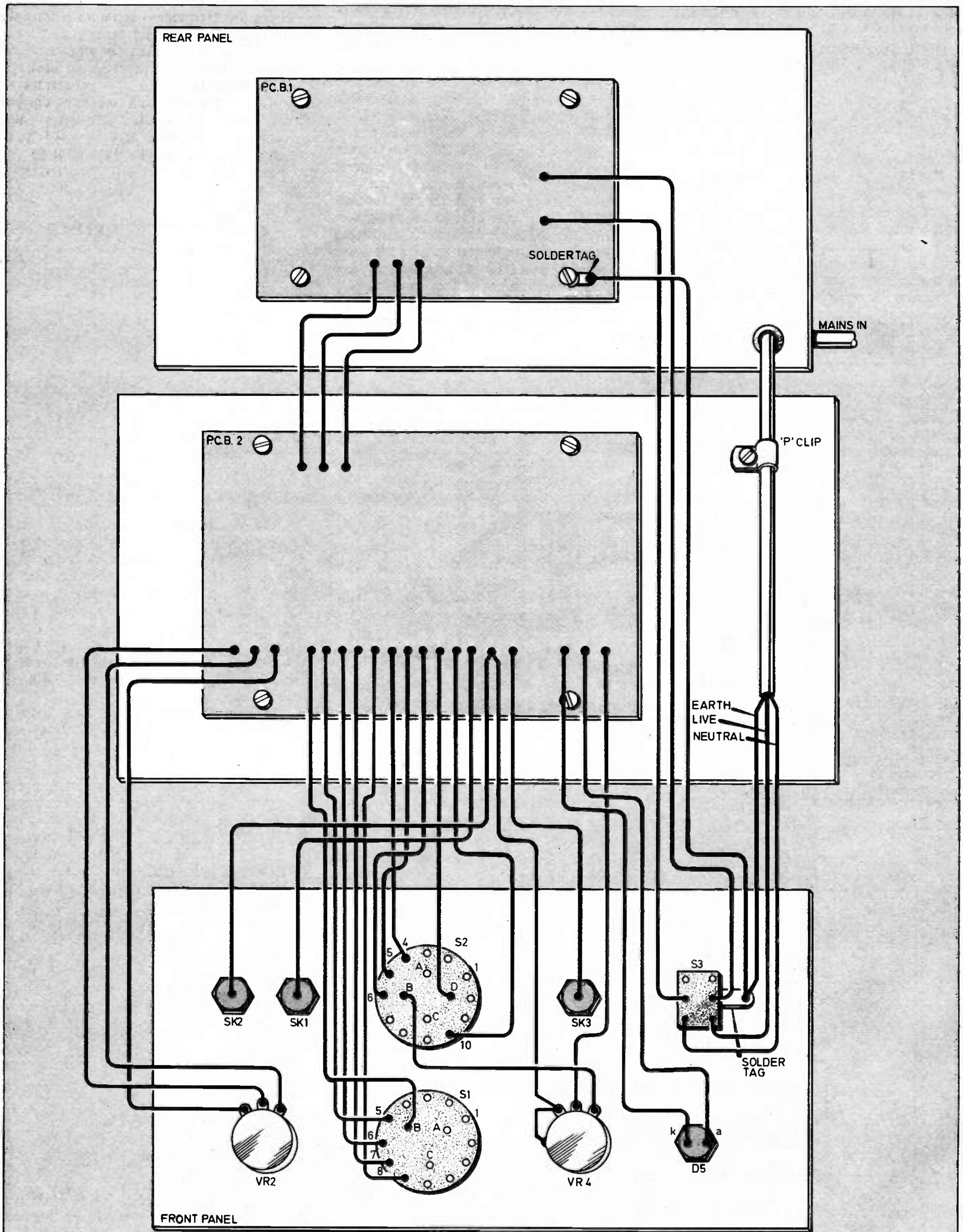


Fig. 5. Interwiring details for the front, base and rear panels.

power supply before connecting it to the main board. Carefully connect a mains input to the board and measure the d.c. outputs; they should be ± 12V.

When the supply is working, the final assembly can be completed. Solder 150mm lengths of stranded wire to the Veropins and it will help if several different colours are used.

CASE

The Function Generator is housed in a Verocase type 202-21036C. The main circuit board is situated in the bottom half of the case, the moulded pillars in the base are used together with the self-tapping screws supplied. The second p.c.b. containing the power supply section is bolted to the rear panel using 8mm long spacers and M3 screws.

The drilling details for the front panel are shown in Fig. 4. The diameter of some of the holes may need to be adjusted to suit the actual components used.

The generator p.c.b. is screwed to the pillars in the base of the case using self-tapping screws. With the front panel in place the other ends of the flying leads can be attached. In general, the wires should be kept short and the wiring should be similar to that of the prototype, this being necessary to avoid interaction and waveform crosstalk. Interwiring details are given in Fig. 5.

The output socket on the prototype was a b.n.c. type and while these are commonly used on commercial instruments, they are rather expensive and can be replaced by the cheaper phono type.

TESTING AND CALIBRATION

Having checked the wiring for mistakes, set both presets (VR1 and VR3) to their mid positions. Connect a loudspeaker to the output of the Function Generator, then turn the unit on. A tone should be heard from the loudspeaker. Check the functions of the controls; the AMPLITUDE control should alter the loudness and the FREQUENCY controls the tone (only the lower end of the highest frequency range is audible).

The calibration procedure depends very much on the equipment available. An oscilloscope is really essential for accurate calibration.

Amplitude. The amplitude of the sine and triangular waves is adjusted by VR3. Set the output of the unit, with S2, to squarewave position and measure the output amplitude. The preset is then adjusted to give the same peak-to-peak amplitude as the squarewave.

This test can also be done with a multimeter. Set the meter to read about 5V a.c. and the Function Generator frequency to the centre of the lowest range. Measure the amplitude of the squarewave output with the AMPLITUDE control turned fully up, then switch to the triangular wave output and adjust VR3 to give a reading of half the original reading.

Frequency. There is no facility to adjust each range, only one control which sets the minimum frequency. Although individual calibrated scales can be made for each range, this was not thought to be essential.

There are two methods of setting the minimum frequency. The first is to use an accurate oscilloscope and measure the output against the timebase.

However, for those without access to any test equipment, copy the scale as shown in Fig. 6 and position this scale behind the frequency control potentiometer. Fasten a suitable knob to the spindle so the stops line up with those on the scale. Adjust the knob to read about 4·4 and set the FREQUENCY range switch to 100 to 1kHz (that is 440Hz).

During test card transmissions on BBC2, a 440Hz signal is broadcast for a period of four minutes on the hour. With the speaker again connected to the output of the Function Generator, it can be tuned by ear to the 440Hz signal from the TV set.

The unit can, of course, be calibrated with a digital frequency meter (perhaps a local technical college could help).

IN USE

The Function Generator will provide all the low frequency signal an enthusiast will require. To obtain maximum benefit from it, an oscilloscope is required. The reverse is also true in that an oscilloscope is of greater use with a signal generator.

Bandwidth test can however be carried out using an audio frequency a.c. voltmeter. The unit can be used as a signal injector, couple the signal to the circuit under test with a 0·1μF capacitor, as the Function Generator output is d.c. coupled.

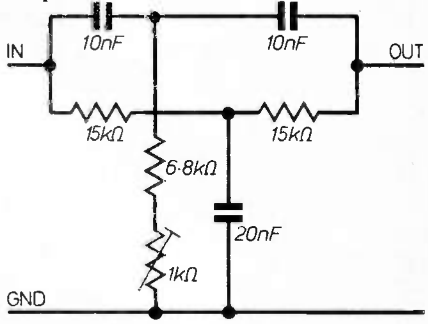


Fig. 6. Circuit diagram for a notch filter used in THD measurements.

MEASUREMENT OF THD

The notch filter shown in Fig. 7 was constructed using carefully selected components. The centre frequency of the filter is around 1kHz. By careful adjustment of the oscillator frequency and fine trimming of the filter using the 1 kilohm preset, the minimum output was observed on a 'scope. The r.m.s. value of the input and output of the filter were then measured, using a true r.m.s. multimeter (100kHz bandwidth).

The total harmonic distortion (THD) is given by:

$$\mathrm{THD} = \frac{\text{output}}{\text{input}} \times \frac{100}{1}\%$$

For the example shown in the oscillogram, the measurements of input and output were as follows:

Upper trace (output) $= 21$mV r.m.s.

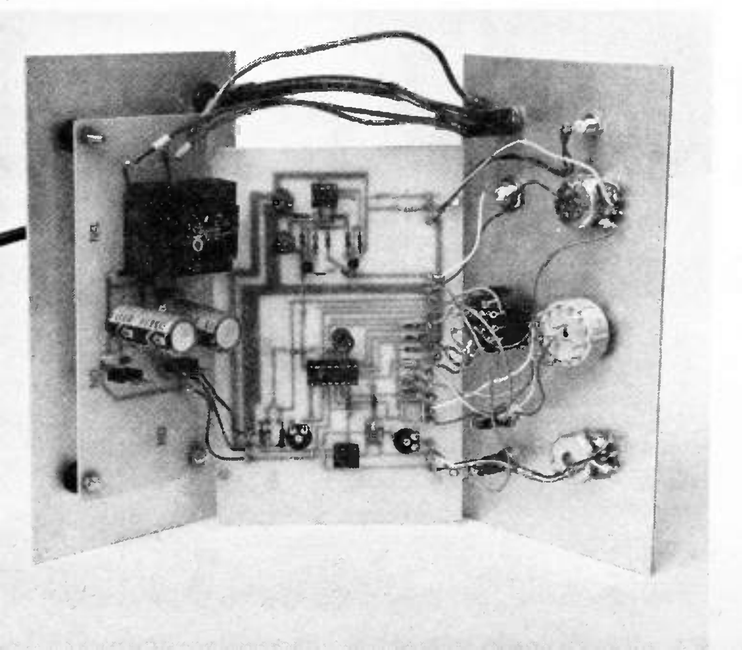
Lower trace (input) $= 4$V r.m.s.

Therefore

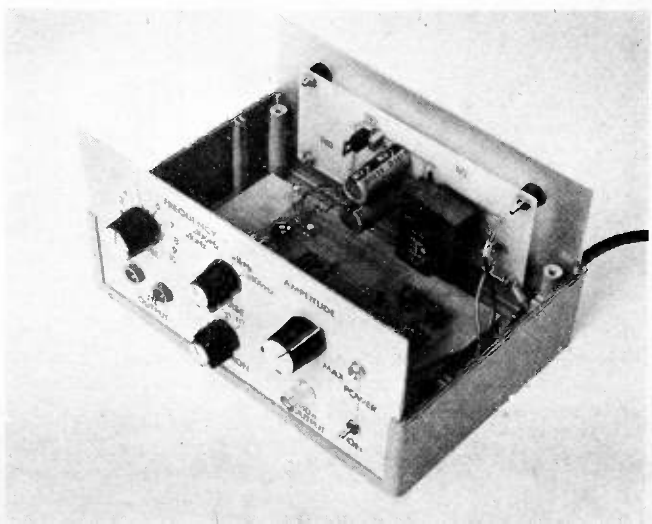
$$\mathrm{THD} = \frac{21 \times 10^{-3}}{4} \times \frac{100}{1}\% = 0{\cdot}5\%$$

These measurements were taken from the prototype Function Generator using a dual beam oscilloscope. □

The completed wiring to the board and front panel mounted components prior to inserting inside the top and bottom sections of the case.



Power supply board mounted on "bushes" on the rear panel.



Novelty Egg Timer

BY L. S. COOK

MODERN electronics provide a means of creating devices which, although now taken for granted, would not have been so simple in the days of the thermionic valve. An obvious example is the omnipresent "timer", which appears in numerous guises in countless applications.

Yet another is featured here, as one intended to assist in that commonplace culinary activity of boiling an egg!

DISCRETE COMPONENTS

Perhaps "modern electronics" is not an accurate description for the timing section of this design, for it comprises discrete components only and therefore the "middle ages of electronics" would seem more appropriate! However, this gives the constructor the satisfaction of actually building the Timer and not merely plugging in an i.c.

One i.c. is utilised in the circuit, in the alarm section, which produces both an audible and visual indication that the timing period has expired.

When sounding, the alarm section draws a current of about 3mA (from a 9V supply) and during the timing period, the circuit requires only 20μA. Thus the humble PP3 9V battery will be quite adequate.

The timing period is continuously variable from one to eight minutes on a virtually linear scale.

CIRCUIT DESCRIPTION

The timing element of the circuit depends on two basic principles: the charging of a capacitor through a resistor; and the voltage required between the base and emitter of a transistor to allow it to conduct.

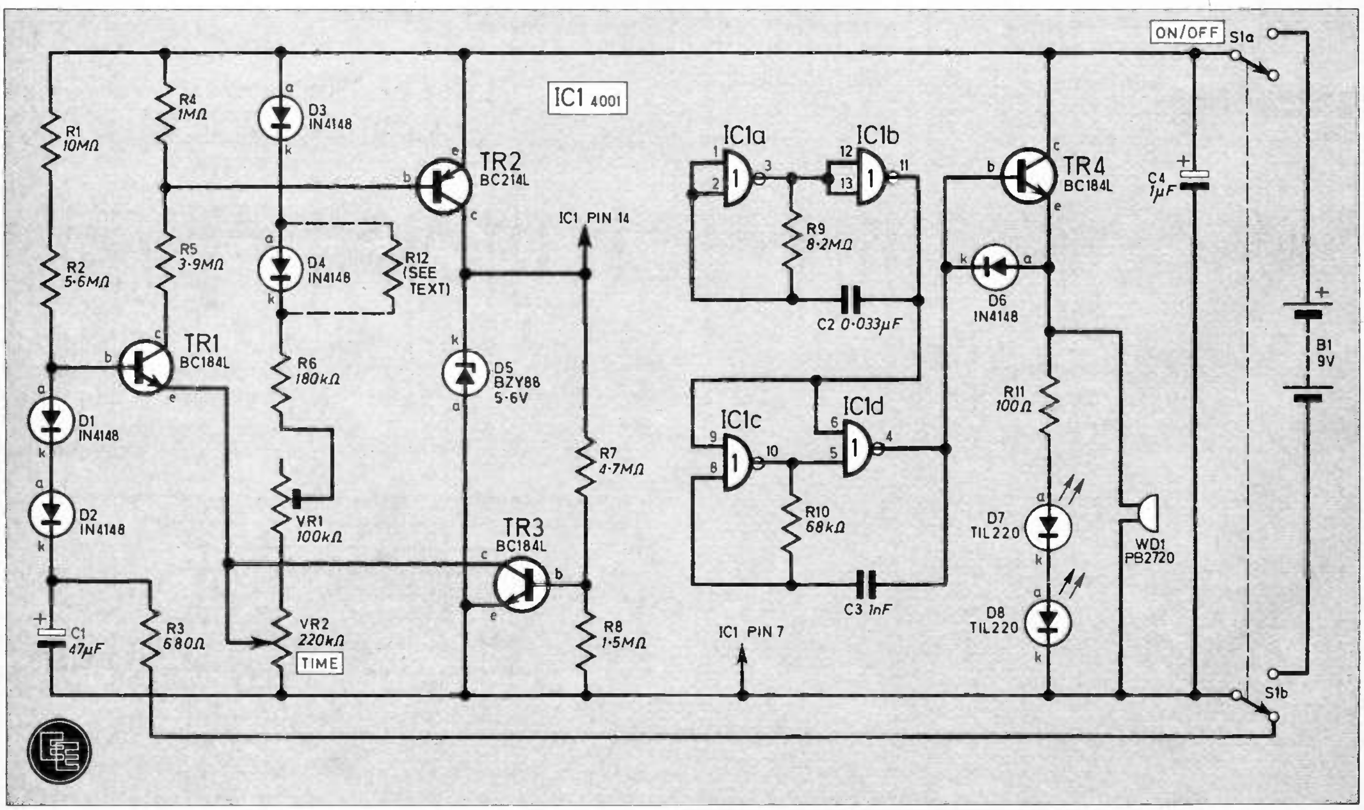
Referring to the circuit diagram in Fig. 1, the transistor in question is TR1 and the resistance and capacitance are R1 + R2 and C1, respectively. High stability resistors are strongly recommended for this application and a tantalum bead capacitor for C1 is essential for its low leakage and relatively stable properties.

When the supply is connected via S1, C1 charges through R1 + R2. Once the potential at the base of TR1 is about 0·5V above that at its emitter (this can be adjusted with VR2), this transistor starts to conduct. However, initially, the current flowing is very small and the rate of increase is too low to be of use, so TR2 amplifies the collector current.

This turns on TR3 which pulls down the potential at the emitter of TR1, thus accelerating the "switch-on" of TR1. With the whole cycle, about 5·6V (stabilised by Zener diode D5) rapidly appears at the collector of TR2.

Before TR1 conducts, R4 and R8 ground the bases of TR2 and TR3, respectively, to reduce the leakage current through these transistors which could

Fig. 1. Complete circuit diagram of the Novelty Egg Timer.



otherwise have a noticeable effect at the low currents involved.

DIODES

Diodes D1 to D4 are included to help make the circuit independent of supply voltage. It can be shown that this is achieved if the voltage drop across each of these pairs of diodes is equal to the junction potential of TR1. Two diodes are required in each position in this case since at the low currents involved, the drop across just one diode is considerably lower than that at the base-emitter junction of a transistor.

Owing to slight variations in characteristics between components even of the same type, it is possible that the voltage drop across D3 and D4 is too great; resistor R12 would reduce this and could be included if it is found that the timing varies with supply voltage.

D1 and D2 also prevent C1 from discharging through TR1 when it starts to conduct.

In order to produce a near linear scale on the dial, a logarithmic law potentiometer is required for VR2 to follow the rate at which C1 charges. VR1 is included for calibrating the Timer.

The voltage now established at the collector of TR2 supplies power to IC1, a CMOS 4001 quad 2-input NOR gate. This enables the square-wave oscillator consisting of IC1a, IC1b, R9 and C2. At a frequency of between 1Hz and 2Hz, this intermittently enables a second oscillator, formed by IC1c, IC1d, R10 and C3. The frequency of the second oscillator has been chosen to cause the transducer, WD1, to resonate with sufficient loudness.

The two l.e.d.s D7 and D8 (the "eyes") and WD1 are connected in the emitter circuit of TR4, so the current taken by IC1 is kept low and the wastage through D5 at higher supply voltages (such as with a fresh battery) is minimised. D6 provides the discharge path required by WD1 at the bottom end of the square-wave and C4 provides decoupling.

C1 is discharged through R3 when S1 is switched off ready to start the next timing cycle.

COMPONENTS

Approx. cost Guidance only **£4.50**

Resistors

R1	10MΩ
R2	5·6MΩ
R3	680Ω
R4	1MΩ
R5	3·9MΩ
R6	180kΩ
R7	4·7MΩ
R8	1·5MΩ
R9	8·2MΩ
R10	68kΩ
R11	100Ω
R12	see text

All ¼W carbon film ±5%

See Shop Talk page 217

Capacitors

C1	47µF 6V tantalum bead
C2	0·033µF polyester (C280)
C3	1nF ceramic disc
C4	1µF 35V tantalum bead

Semiconductors

D1–4,6	1N4148 silicon (5 off)
D5	BZY88 C5V6 5·6V Zener
D7,8	TIL220 5mm red l.e.d. (2 off)
TR1,3,4	BC184L *npn* silicon (3 off)
TR2	BC214L *pnp* silicon
IC1	4001B CMOS quad 2-input NOR gate

Miscellaneous

VR1	100kΩ miniature horizontal preset
VR2	220kΩ logarithmic control
S1	d.p.d.t. sub-miniature slide switch 19mm between fixing centres
WD1	PB2720 piezo electric transducer
B1	PP3 9V battery

0·1in matrix stripboard, 10 strips by 24 holes; PP3 battery clip; 14-pin d.i.l. holder; 7/0·2mm wire (assorted colours); rigid wire (for links).

Case materials

2mm dia. galvanised steel wire (approx. 2·7m long); aluminium mesh, 250 × 150mm (as used to repair rust holes in car bodies); two-part resin filler such as Plastic Padding or Isopon (*not* the smallest size); 13mm thick balsa wood (often sold in bundles of off-cuts); plastic screw cap (35–40mm dia.); thin plastic sheet; foam rubber; glue; paint; assorted fixings.

CIRCUIT BOARD

Most of the components are mounted on a readily available piece of stripboard, 10 strips by 24 holes, on a 0·1in matrix. Owing to the necessary compactness, five wire links are required on the *trackside* of the board and many components are mounted upright.

When shaping the leads of the vertically mounted components, grip the leads

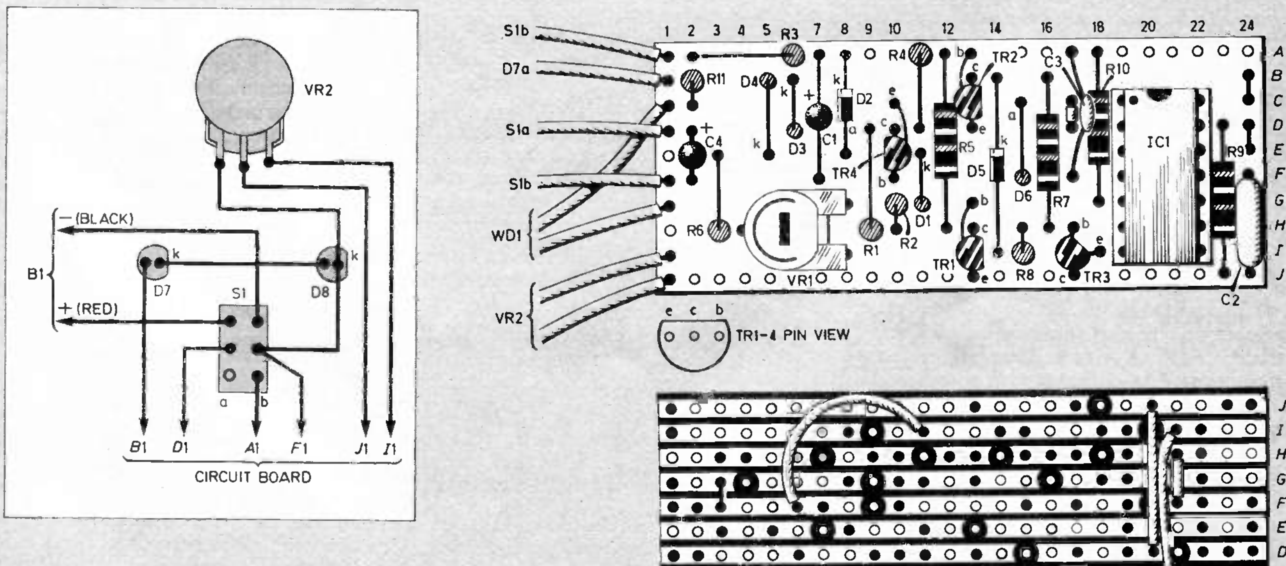
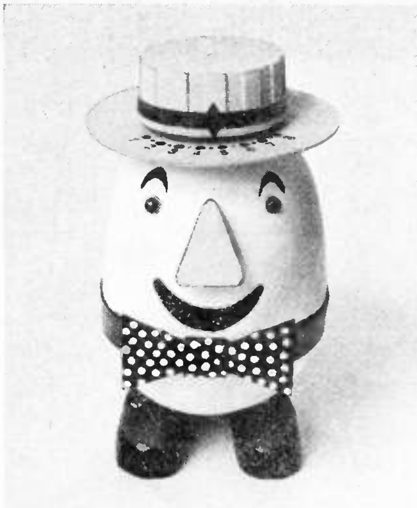


Fig. 2. Stripboard layout and underside view of the Egg Timer circuit board. Note the links on the underside. Inset shows the wiring to components mounted in the casing.



firmly with a pair of long-nosed pliers close to the component body and bend the free end to the appropriate angle.

Commence by making the 23 breaks on the underside of the board as shown in Fig. 2, using a special track-break tool or a small drill bit. Then solder the links on to the track (solder) side using insulating wire.

The other half of Fig. 2 also shows the top (component) side of the board. Solder in the i.c. holder, VR1, and the three wire links using insulated wire for the link under C3.

The remainder of the components can now be assembled, leaving the semiconductors until last to avoid the risk of possible damage.

It may be found that the value of R10 given does not provide the ideal frequency for the transducer WD1 (again, variations occur in components of the same type), so this resistor should be soldered in with its leads at full length. This is a good method of connecting any select-on-test components as it makes replacement far easier later on.

The resistor can be firmly soldered in once the optimum value has been ascertained.

CHECKING

Check very carefully the positions of all components, remembering the orientation of all diodes and polarised capacitors. Ensure that there are no fragments of copper or blobs of solder shorting the adjacent tracks. Attach flying leads, approximately 150mm long, to all appropriate points.

At this stage it is worthwhile testing the circuit, so connect the switch S1, potentiometer VR2, l.e.d.s D7 and D8 (one l.e.d. is sufficient for testing purposes), transducer WD1 and a battery connector. These components will need to be disconnected again before assembling into the case.

Set the switch to the "off" position. The preset VR1 (on the circuit board) is then adjusted so that its resistance plus that of R6 is equal to the full-track (maximum) resistance of VR2. The relevant measurements can be made with the components "in circuit" using the resistance range of a conventional multimeter with the negative (black) probe at the "top" end (in relation to the circuit diagram).

This adjustment is not critical; it slightly improves the linearity of the scale. If a suitable meter is unavailable, simply estimate the approximate setting of VR1.

Insert IC1, a fresh battery and set VR2 to about 100 degrees from a fully clockwise position and switch on. The alarm should be triggered after four to five minutes, but this must be timed reasonably accurately.

Switch off, then repeat the test on exactly the same setting of VR2, but with a 6V source. A difference of several seconds can be tolerated but if the discrepancy is too great, the additional resistor R12 may improve matters and a value of 470 kilohms can be taken as a starting point.

THE CASING

Before commencing, it is advisable to fully understand what is involved, as it is a lengthy operation requiring much patience. The method is outlined here with most details given in Fig. 3.

The measurements should only be used as a guide since it is virtually impossible to obtain the same results a second time. Also component sizes may vary slightly.

The case is built in two sections to permit access to the inside. Galvanised steel wire, 2mm in diameter, is used to form a framework for supporting an aluminium mesh to be covered with a two-part resin filler (such as Plastic Padding).

The feet and nose are cut and shaped from balsa wood, the crown of the hat is a screw cap from a discarded container (or a large control knob) and the brim of the hat and the bow-tie are cut from thin plastic sheet.

WIRE FRAME

To make the loops in the wire, and to tighten the supporting struts on the framework, a pair of strong (electricians) pliers are used. It is helpful to form the loops for the l.e.d.s (eyes) before the wire is coiled, their centres to be about 360mm and 390mm from the top end of the wire.

Ensure that the l.e.d.s fit, and also, after shaping the frame, check that the potentiometer, the switch, and the transducer will fit in the correct positions in order to make the "face".

Add the three aluminium mesh pieces, which are placed between the vertical struts, and secure by folding them over at the top and bottom. The mesh is slightly malleable but some creases are inevitable and these must be well flattened.

The bottom half is fashioned in the same way ensuring that it mates up with the top piece.

The resin filler is usually supplied with a separate hardener and as it hardens very rapidly when mixed, use only a small quantity at a time. When coating the mesh, press the filler paste firmly into the spaces and remember to leave holes for the l.e.d.s and the switch tang.

When sufficiently hardened (after about 20 minutes), sand smooth with a coarse grade silicon carbide paper ("wet and dry"); any cracks or irregularities appearing can be refilled later. File smooth any wire that protrudes above the profile of the egg shape and clean up the holes for the switch and l.e.d.s.

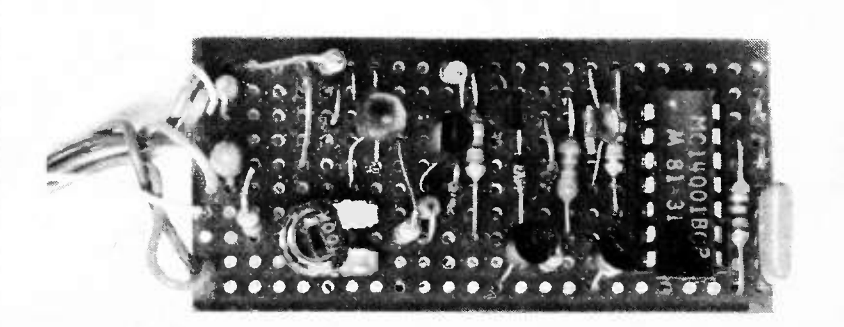
Make two additional mounting holes for the slide switch at either end of the elongated "nose" hole and a further two mounting holes for the transducer. A neat sound hole is also required in the mouth position.

ASSEMBLY

Secure the slide switch in position with two small screws, sinking the screw heads below the surface. Either small self-tapping screws (counter-sunk heads) or screws with suitable nuts can be satisfactorily used here.

Add the transducer in the same manner but note that this component will not lay flat against the inside of the body due to the curvature of the "egg" shape. Insert the two l.e.d.s and preform their leads carefully with pliers if necessary.

The feet are made from 13mm thick balsa wood blocks as shown in Fig. 5 and shaped to fit the contour of the base section of the egg. A hole about 7mm in diameter is required between the feet to allow for the fixing screw of the two halves. Attach the feet with glue and two small screws in each.



The circuit board from the prototype model.

Novelty Egg Timer

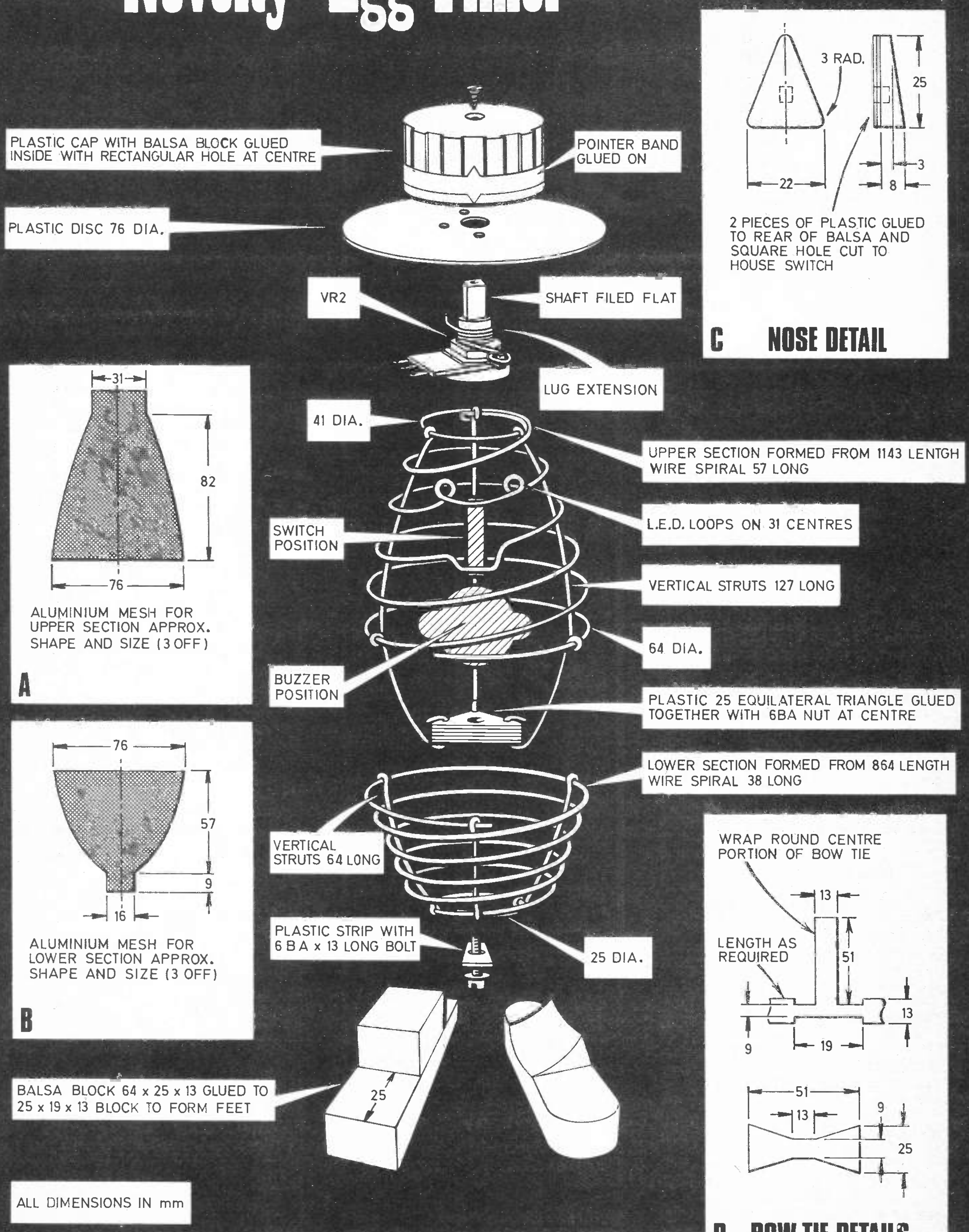
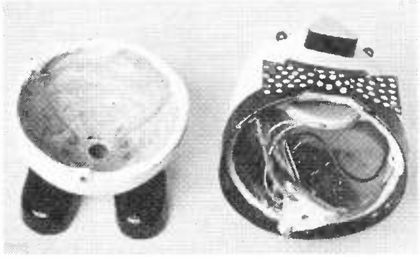
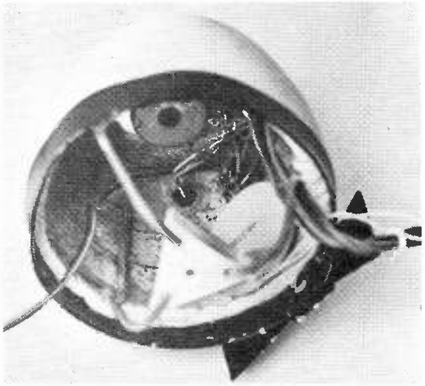


FIG.3 EXPLODED VIEW SHOWING CONSTRUCTION BEFORE CASING

Novelty Egg Timer with the hat crown removed showing the mounting of VR2.

Two screws remove the brim and free the potentiometer.





The two halves of the case can be clearly seen, the bottom half showing the wire frame. Photograph (right) shows a close-up of the wiring inside the top half of the case.

The final layer of filler can now be applied to cover the sunken screw heads, fill the gaps around the joints of the feet and any other irregularities. If desired, the whole body can be covered with a thin coat of filler and then gently dabbed with a damp sponge to achieve an egg-shell texture. When dry, the whole body can be given a coat of paint.

The nose is fashioned from another piece of balsa wood and glued to the tang of the switch. The bow-tie is cut from a thin plastic sheet and glued to the top half of the body so that it overlaps the lower section. This conceals the joint.

POTENTIOMETER

The brim of the hat holds the control potentiometer, VR2, in place. It is made from a piece of thin plastic (or strong card), 75mm diameter. A 10mm diameter hole is cut in the centre to hold VR2, and the brim is then fixed to the top section with two screws into the loops formed by the wire.

The crown of the hat is made from an old screw-cap from a plastic container. A large block of balsa wood is glued into the crown and a hole is drilled in the centre of this to attach it to the spindle of VR2.

The final wiring can now be completed, keeping all wires about the same length to make it possible to withdraw the board from the body.

A piece of foam rubber (not the conducting type) is wrapped around the circuit board and the battery, and these are inserted into the top section. More foam rubber can be added for additional support.

CALIBRATION

With WD1 in place, the optimum value for R10 can be found. Values in the range 56 to 82 kilohms can be tried. When the resistor producing the best (loudest) effect is found, it can be soldered permanently in place.

Turning the hat fully clockwise will enable the alarm to sound immediately on switch-on.

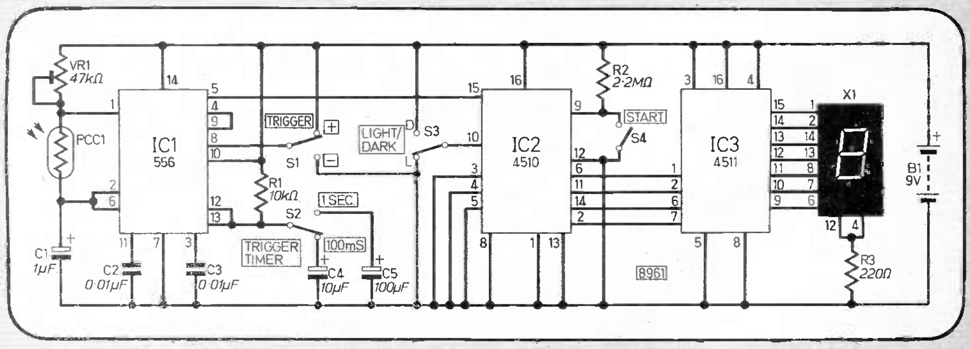
To calibrate the Timer, make a temporary mark on the crown of the hat. Note the times obtained on several different settings and make light pencil marks on the brim to correspond to the mark on the crown. This can be done onto a piece of tracing paper placed on the brim to prevent damaging the paint.

When sufficient marks have been made to cover the range one to eight minutes, mark the positions of whole and half minutes. This may require a certain amount of estimation—remember that the scale is not exactly linear. These positions can be checked with a watch or clock with a second hand.

Shift the marks so that they appear at the front and make them permanent using Letraset type dry-print transfers. A hat band with a pointer completes the Novelty Egg Timer. □

CIRCUIT EXCHANGE

DIGITAL DARKNESS/LIGHT MEASURER

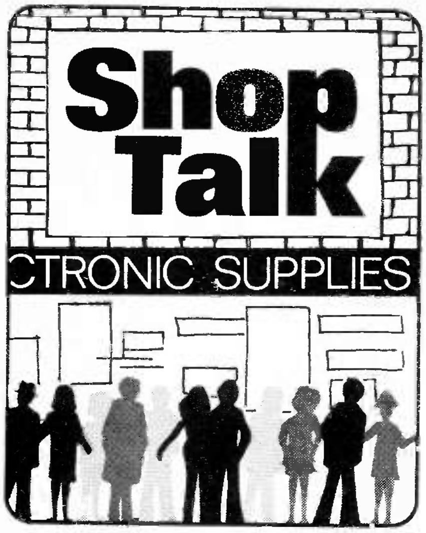


This circuit consists of the dual monostable/astable multivibrator chip 556 wired up as an astable multivibrator which works for 1 second or 0·1 second (selected by S2). The b.c.d. counter 4510B counts how many times the multivibrator vibrates in 1 second or 0·1 second, as controlled by VR1, and the 4511B decodes this counting on to the l.e.d. display X1.

To operate, select how many seconds you want (1 or 0·1), select whether you want it to perform as a light measurer or a darkness measurer, release the start switch until a "0" appears on the display and then turn it back on again, and then pull the trigger switch from negative to positive. You can also adjust the preset resistor VR1 until the unit is working satisfactorily.

Philip Dalton,
Barkton,
Cheshire.

MORE ON PAGE 232



By Dave Barrington

Self-Feed Soldering Iron

As one of the most common causes of poor soldering can often be tracked down to bad technique and to the person not feeding the soldering iron and solder simultaneously to the intended joint. Even though the proposed connection has been thoroughly cleaned, feeding the solder to the iron tip and then applying the iron to the join runs the risk of a poor or "dry" joint. Unless, of course, the components have been pre-tinned first the solder will not "flow" using this method.

We appreciate that adopting the correct procedure sometimes means wishing for a "third hand", where ever possible the solder and iron tip should always be applied simultaneously to the work piece.

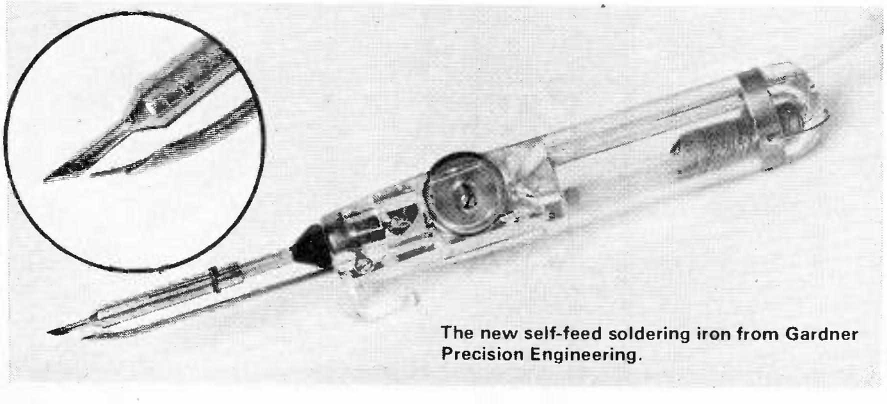
A self-feed soldering iron would certainly help overcome these problems and possibly pay for the additional outlay in terms of time-saving and bad soldering.

One such iron has just been brought to our attention and is being marketed by Gardner Precision Engineering, and, as far as we are aware, is the only type at present offered for sale.

The soldering iron handle is transparent and the flux-cored solder is "visually" housed in the handle and fed down a stainless steel tube to the iron bit. The solder is dispensed by operating a knurled wheel with the index finger of the hand holding the iron.

The soldering iron is rated at 18 watts and comes complete with 4 metres of solder. Replacement of the solder is carried out by removing a spring clip and inserting a refill.

The cost of the iron is £14.95 and further details can be obtained from Gardner Precision Engineering, Dept EE, North Road, Woking, Surrey GU21 5DS.



The new self-feed soldering iron from Gardner Precision Engineering.

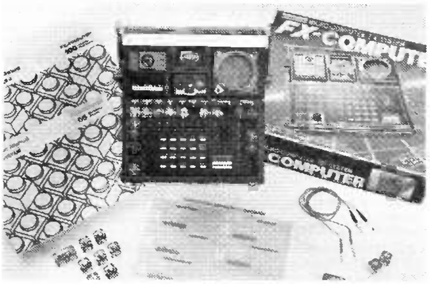
Computer Kit

We have just received the new FX Computer Kit and first impressions are that it appears an ideal "training tool" for an introduction to electronics and computing.

The kit consists of two instruction manuals containing details of computer and electronic projects, keyboard module, component "bricks" or cubes, and a moulded case which acts as the experimenters "test bed".

There are 100 programs/65 electronic projects provided with the FX Computer Kit (cost £69.95 plus £3 for p&p) and is available from Electroni-Kit Ltd., Dept EE, 388 St John Street, London EC1V 4NN.

We shall be publishing a full report in our May issue.



The FX Computer Kit from Electoni-Kit.

CONSTRUCTIONAL PROJECTS

ZX Spectrum Amplifier

The case used in the prototype model of the *ZX Spectrum Amplifier* was made from a sheet of 18 s.w.g. aluminium. However, there are numerous plastics cases stocked by advertisers that could be used provided the chosen speaker fits inside.

One of the general "potting" cases would be suitable and a black version would match nicely with the Spectrum. If a plastics case is used remember to "common" the sockets as shown in the circuit with a length of wire "trapped" between the case and the metal body of each socket.

The 400mW audio amplifier, LM386, is listed by Cricklewood, Greenweld, Rapid, and TK Electronics.

The push-on, push-off latching p.c.b. type switch is stocked by several advertisers, including Maplin, Greenweld and Tandy. The volume on/off switch is one of the types commonly used in radios and usually sold as "thumbwheel" potentiometers, incorporating on/off switch.

The volume control, with integral switch, used in the authors model was obtained from Maplin and was purchased with a "press-on" plastic knob. These are listed as Edge Controls under their Resistor section—order No. BW06G. The large "thumbwheels" should be ordered as: BW10L (Edge Knob Large Grey).

If one of the common "radio" potentiometers are used, it may be necessary to re-position the circuit board to enable the control knob to protrude through the side of the case.

Test Gear '83—Function Generator

Most of the semiconductor devices listed for the *Function Generator,* Unit Two of our Test Gear '83 series, should be available from most semiconductor stockists.

However, the waveform generator type XR2206 appears to be only available from Technomatic Ltd., Dept EE, 17 Burnley Road, London NW10 1ED. They also stock the complete list of semiconductors

The Siemens capacitors are stocked by Electrovalue.

Car Radio Power Booster

The 20W dual power amplifier type TDA2004 used in the *Car Radio Power Booster* is available from most of our semiconductor advertisers and should not cause too many purchasing problems.

When building this project be sure to connect the "earth" lead to the heatsink of IC1 as outlined in the article. Also, be sure to check the power ratings of your car speaker system.

Flanger Sound Effect

All components for the *Flanger Sound Effect* are available from Maplin Electronic Supplies. The semiconductor devices are also stocked by Cricklewood, Rapid, Watford and Technomatic.

When purchasing the push-button toggle switch, S1, be sure to specify the heavy duty "foot-operated" type as these are especially robust and more suited to the "heavy" treatment that this unit is likely to be subjected to.

Novelty Egg Timer

The resin filler for the "body" of the *Novelty Egg Timer* should be available from most motor spares shops or from most branches of Halfords. It may be possible to use one of the "Potato Man" kits from toy shops for making the figure.

The piezo alarm transducer is now stocked by most advertisers.

Expanded Add-on Keyboard for the ZX81

The keyboard and additional key switches and "tops" for the *Expanded Add-on Keyboard for the ZX81* are available from Redditch Electronics, Dept EE, 21 Ferney Hill Avenue, Redditch, Worcs B97 4RU.

THE ELECTRONICS OF it INFORMATION TECHNOLOGY

PART SIX

BY T.E. IVALL C.Eng., M.I.E.R.E.

WHEN we store a piece of information such as a telephone number, we record it in some place where it can be easily referred to and read. And to allow us to find it easily when we want it, we identify and label the **storage location** in some way.

These simple requirements for notebooks, files, card indexes and the like apply equally to the electronic storage of information in **IT** systems.

ANALOGUE AND DIGITAL STORES

First we should remind ourselves that there are two fundamentally different forms of electronic storage: analogue and digital. They work on equivalent principles to the analogue and digital methods of representation discussed in the December 1982 issue.

With analogue storage, an electrical quantity is made proportional to some physical quantity in the outside world. One familiar example is in the diode detector used in a.m. radio receivers, Fig. 6.1.

Here the capacitor *C* stores a charge which, through the action of the diode and the capacitor-resistor time constant, varies in proportion to the amplitude of the audio signal modulating the incoming r.f. carrier. Obviously this is a very temporary storage—from one r.f. half-cycle to the next.

USE OF TWO-STATE DEVICES

Digital stores, on the other hand, hold separate numbers or other characters, in the form of discrete electrical symbols. In most **IT** systems, in fact, they store the binary digits of the already encoded digital information.

As we saw in the previous article, any information can be represented in two-state form by a variety of devices, and this principle applies equally to digital storage. The most common two-state storage devices are based on current flows, electric charges and magnetisation.

For example, to store an alphanumeric character encoded as a group of 8 binary digits (bits) we could use a row of 8 capacitors as shown in Fig. 6.2. Each capacitor is either charged, to represent "1", or uncharged, to represent "0". As distinct from the analogue capacitor store in Fig. 6.1, the actual value of the "1" charge is of no significance: it only has to be distinguishable from the "0" uncharged condition.

The same row of capacitors could be made to hold different patterns of charge/no charge, by suitable electronic switching, and so store a variety of 8-bit characters. This principle is, in fact, used in one type of integrated circuit memory which allows its stored contents to be repeatedly changed—the **dynamic random access memory** (DRAM).

CONCEPT OF BIT CELL

Each capacitor in Fig. 6.2 can be considered as a cell for storing a single binary digit, 1 or 0. This concept of the "bit cell" applies, in fact, to all digital stores. For example, a row of on/off switches acting as bit cells (see Fig. 2.2, December issue) can store binary information put in by hand.

An electronic circuit widely used as a bit cell is the bi-stable or flip-flop. As shown schematically in Fig. 6.3, one stable state constitutes the storage of a 1 bit while the other stable state constitutes storage of a 0 bit.

Here the binary information is stored as sustained current flows and non-flows through the semiconductor devices forming the flip-flop. The principle is used in i.c. semiconductor memories such as the **static random access memory** (SRAM).

MATRIX ORGANISATION

To organise the capacitor of flip-flop bit cells into a complete workable store requires a good deal of electronic circuitry. Semiconductor i.c. memories are organised on the matrix principle shown simplified in Fig. 6.4. This type of array is convenient for manufacture, economical in connections and suited to the bus systems (February article) used in digital computers.

The location of each bit cell—its **address**—is identified by the connecting conductors which intersect at that cell. For example, the bit cell shown in black is at the intersection of row conductor *B* and column conductor 3.

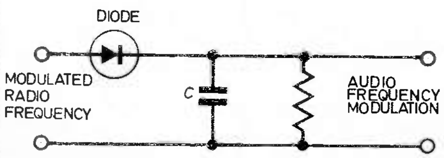


Fig. 6.1. The capacitor *C* in this diode detector circuit is an example of an analogue store. The charge it holds varies in proportion to the amplitude of the signal modulating the incoming r.f. carrier.

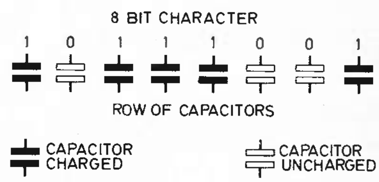


Fig. 6.2. Row of capacitors providing bit cells to store a group of binary digits. Each charged capacitor represents a 1 bit stored and each uncharged capacitor a 0 bit stored.

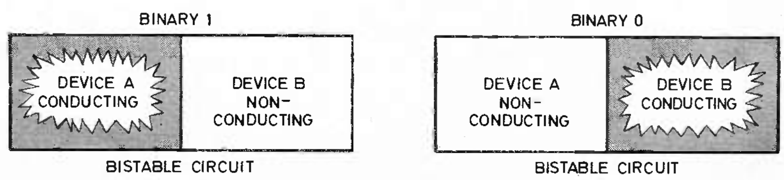


Fig. 6.3. A bit cell can be formed by a bi-stable or flip-flop circuit made from two interconnected semiconductor devices, A and B. Binary information is stored by current flow being maintained in either one half (A) or the other half (B) of the bi-stable (one half "on" and the other "off").

The matrix arrangement provides a means of calling-up, or "addressing", a whole group of bit cells—for example: 8 cells for an 8-bit character. In addition there are connections to carry the bits to be written-in or read-out, to command the whole store to either write or read, to bring the store into operation or hold it out of action and, of course, to supply power.

As an example, a small semiconductor memory has 32 rows and 32 columns of conductors, giving access to 32 × 32 = 1024 bit cells*. Since $1024 = 2^{10}$ this memory can be addressed from 10 pins on the i.c. package.

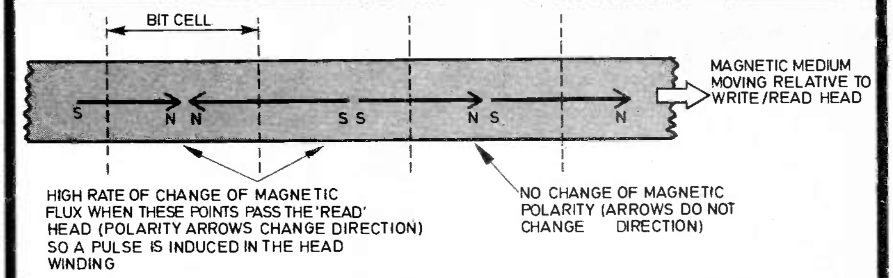


Fig. 6.5. Basic principle of digital magnetic disc and tape stores. Bit cells are formed from successive areas of magnetisation, shown here as arrows, along a track. Their relative directions of magnetic polarity provide the means for storing binary information, at the points where the areas abut (either high rate of magnetic flux change or zero flux change).

MAGNETIC STORES

This matrix organisation is also used in magnetic core memories. Here the bit cells are small ferrite rings which are switched electromagnetically between two opposite-polarity saturated states of magnetisation to constitute storage of 1s or 0s. Magnetism is, of course, a most useful form of information storage and is exploited most commonly in disc and tape stores.

The physical principle employed is similar to that of the ordinary tape-recorder, in that a moving medium is magnetised by an electromagnet fed by electrical signals—but with an important difference. A tape-recorder for audio or video signals stores *analogue* information, whereas the corresponding tape store for **IT** systems holds *digital* information.

In disc or tape stores the bit cells are areas of magnetisation with different polarities formed along a track in the moving medium. There are, of course, two possible directions of magnetic polarity along a track, *N–S* and *S–N*, and these are used to constitute the binary digits 1 and 0 as shown in Fig. 6.5. Usually the same electromagnet, or magnetic head, is used for both writing and reading.

USE OF FLUX CHANGES

Each bit cell is located at the point shown in Fig. 6.5, where one area of magnetisation abuts the next one. If the two adjoining areas have opposite directions of polarity a high rate of change of magnetic flux is created when this point in the medium moves past the head and so induces a pulse in it on read-out. This pulse could represent a 1 bit.

When two adjoining areas of magnetisation have the same direction of polarity there is no such change of flux and consequently no pulse from the reading head. This condition could represent a 0 bit.

ELECTRONIC LOGIC—THE INFORMATION OF STATES

IT systems also use electrical quantities to represent a different kind of information from that discussed so far. Here the electrical symbols stand for **states** or conditions in the outside world rather than physical quantities—for example,

* Incidentally, this explains why i.c. semiconductor memories do not have storage capacities in nice round decimal numbers like 1000 or 10,000 bits. Note that whereas 1000 is represented by the symbol k (abbreviation for kilo-), 1024 bits is abbreviated to K. So a 64K memory, for example, has a capacity of 65,536 bits.

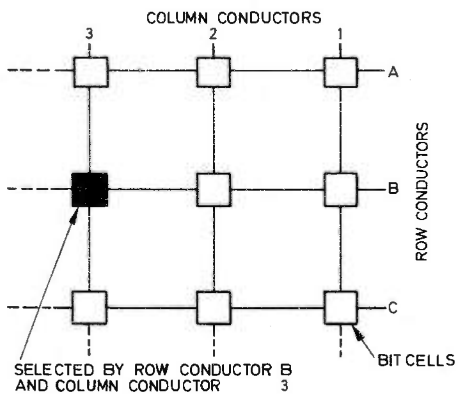
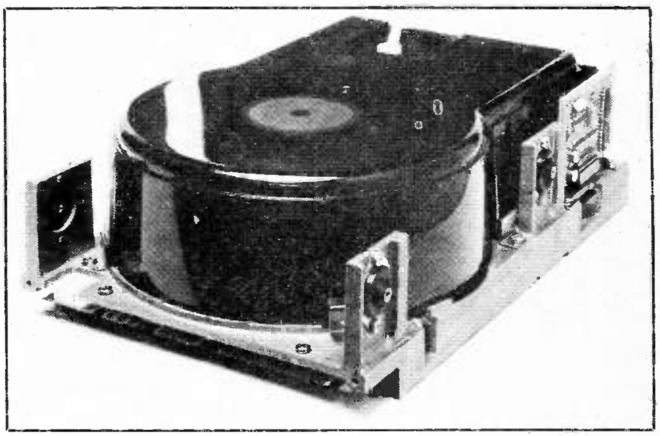
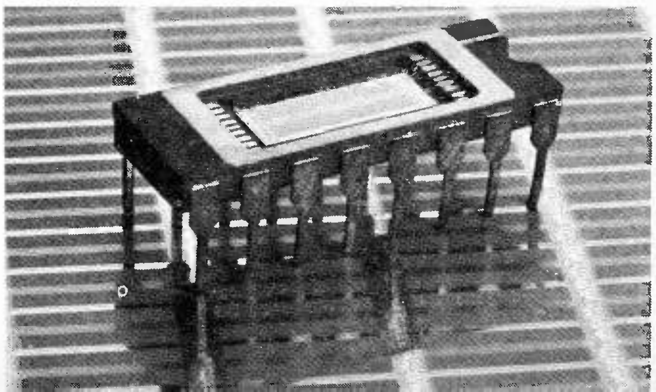


Fig. 6.4. Matrix organisation of semiconductor i.c. memories. Any bit cell can be "called up" or addressed, for writing a digit into it or reading a digit out of it, by means of the pair of connecting conductors, row and column, which intersect at that cell.

This magnetic disc store from Thorn EMI Datatech has a storage capacity of 11 megabytes.



Semiconductor i.c. memory made by Siemens is a dynamic RAM with a storage capacity of 64K (65,536 bits).



the "on" state or "off" state of an electric motor rather than its speed, torque or any other such quantity. This is the province of **electronic logic.**

Nevertheless, among the various states which electronic logic can be used to manipulate are the two states of binary notation. So in this respect it can handle, indirectly, any physical quantity that might be encoded in binary form. This happens in the logic circuits of digital computers.

But fundamentally electronic logic is a mechanisation of the formal deductive logic taught as an academic subject—with its premises, true and false statements, valid and invalid arguments and so on. Historically it is one end of a long line starting perhaps with Aristotle, passing through the mediaeval scholars with their syllogisms, through symbolic logic and George Boole's logical algebra to the present age of computers.

LOGIC OF LIFT CONTROL

The best way to understand this side of information technology is by a concrete example. Let's suppose we want to control the electric passenger lift shown in Fig. 6.6. For safety reasons we want to make sure that the lift motor will start running only when a button in the lift is pressed *and* the lift doors are closed. A sensing switch detects when the doors are in fact closed.

Possible states of the button, the door sensing switch and the motor, are shown in Fig. 6.6, with a graphical symbol to represent each of these states. To clarify exactly what our control device, Fig. 6.7, is required to do, we can use these symbols to tabulate all the possible combinations of states of the button and switch, and, beside them on the right, put the symbols for the corresponding required states of the lift motor. See Table 6.1 below:

Table 6.1

a	○	◇	□
b	●	◇	□
c	○	◆	□
d	●	◆	■

In condition *a* both the button and the switch are not operated, and, of course, the lift motor must not be running. In *b* the button is pressed but the door switch is not actuated, so again the lift motor must not be running. In *c* the door switch is actuated but the button is not pressed, so once more the motor must not be running.

In *d*, however, both the button and the door switch are operated, so the motor should be running.

TRUTH TABLE

This logical breakdown of the required action of the control system is a **truth table,** like the truth tables used in deductive logic. The same table, in fact, could be written in terms of the *T* (true) and *F* (false) letter symbols commonly used in deductive logic, as we are concerned here with control devices which can have only two states—on and off.

For example, if at a given moment the statement "the button is pressed" is true (*T*), the contradictory statement "the button is not pressed" must be false (*F*), since the button cannot be pressed and not-pressed at the same time. So, to describe the two conditions of the button in this symbolism we really only need one statement, "the button is pressed", which can be labelled either *T* or *F*. Similarly for the states of the door switch and the lift motor.

Using this scheme the Truth Table 6.2 (below) would be:

"Truth" Table 6.2

	●	◆	■
a	*F*	*F*	*F*
b	*T*	*F*	*F*
c	*F*	*T*	*F*
d	*T*	*T*	*T*

where the first column refers to the button, the second to the door switch and the third to the lift motor.

It happens that this second table is the general truth table for a *conjunction* in deductive logic. As the name indicates, a conjunction is an expression consisting of two statements linked by the concept "and". For example, "(the button is pressed) **and** (the door switch is not actuated)" in our control problem. The truth table displays all combinations of true and false statements (here describing states) that are possible with a conjunction.

USING AN 'AND' GATE

We see, then, that the lift control requirements set out in the first table are satisfied by the truth table of the "and" truth-functional operator, as this is called in logic. So we need an electronic device that operates according to these conditions in this truth table.

In fact, this is provided by a device acting similarly to the electronic gate shown in Fig. 2.8(a) of the December 1982 article. This gate is, in effect, a coincidence detector—it produces an output signal when, and only when, two identical input signals are presented to it simultaneously.

A device of this kind working to the rules of the conjunction truth table is an AND logic gate. Its application to the lift control problem is shown schematically in Fig. 6.8—which is virtually the same as the "requirements" diagram Fig. 6.7.

Electronic logic gates used to be available as separate components but now, because of increasingly complex applications, they are usually grouped and packaged in various ways in integrated circuits. Their logic states, as shown in Fig. 6.8, are represented by electrical symbols, for example, a high voltage signifying *T* in the Truth Table 6.2 and a lower voltage signifying *F* in the Truth Table 6.2.

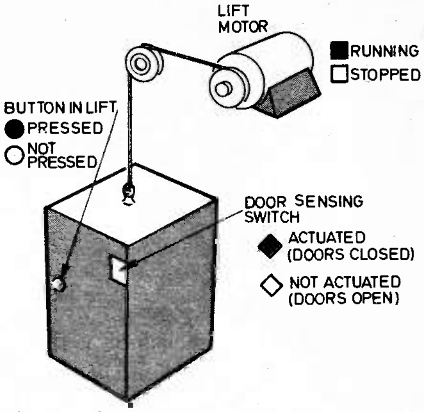


Fig. 6.6. Switching control requirement for this lift illustrates various "states"—information of the kind that electronic logic handles.

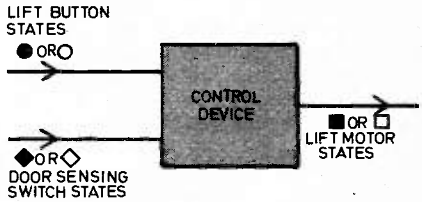


Fig. 6.7. Schematic of the logical system needed to control the lift motor from the button and the door sensing switch. The graphical symbols stand for the various states shown in Fig. 6.6.

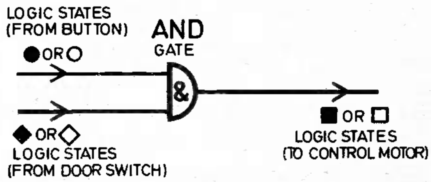


Fig. 6.8. The device which ensures the required control action for the lift in Fig. 6.6 is an AND logic gate. Compare this with the "requirements" diagram Fig. 6.7.

As an illustration, consider the truth-function *b* in Truth Table 6.2. One input of the Fig. 6.8 AND gate receives a high voltage, signifying *T* ("button pressed" is true) and the other input receives a low voltage, signifying *F* ("door switch actuated" is false). As a result the AND gate output issues a low voltage signifying *F* ("lift motor running" is false) and this can be used to ensure that the lift motor is in the "stopped" or off state.

Other truth-functional operators and their truth tables can be mechanised in similar ways, producing electronic logic gates for negation (NOT), disjunction (OR) and the combinations of: negation with conjunction (NAND); and negation with disjunction (NOR). Two NAND gates can be interconnected to form the bi-stable circuit in Fig. 6.3, while two further NAND gates would convert this into a gated bi-stable or latch.

To be continued

Flanger sound effect

BY R A PENFOLD

ALTHOUGH flanging is probably not one of the best known musical effects, it is undoubtedly one of the most interesting, and flangers seem to be rapidly gaining in popularity. It is a complex effect which is similar in some respects to the well known phasing effect.

One method of producing the phasing effect is to have a delay line that has a delay time which is automatically varied, and the delayed and undelayed signals are then mixed. At some frequencies the two signals will be in-phase and will combine to produce "peaks" in the frequency response, and at other frequencies the two signals will be out-of-phase and cancel each other to produce "troughs" in the frequency response.

By varying the delay time the peaks and troughs are moved up and down the audio spectrum to produce the phasing effect.

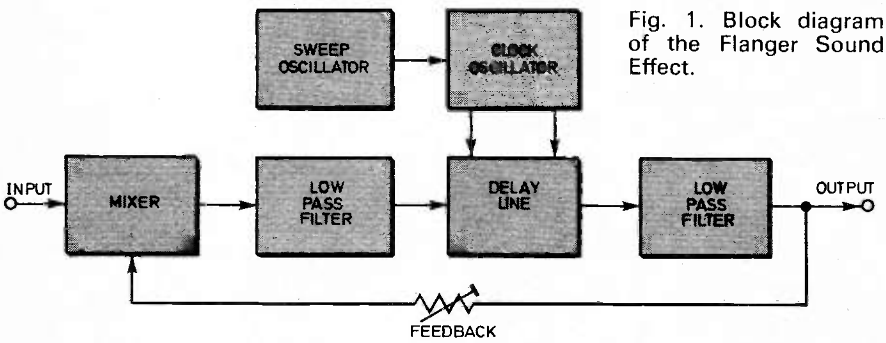


Fig. 1. Block diagram of the Flanger Sound Effect.

FLANGING

The block diagram (Fig. 1) shows how this basic arrangement is modified to produce the flanging effect. All that has changed is that the mixer has been placed at the input of the delay line rather than at the output.

The two low-pass filters and the clock oscillator form part of the delay line. The clock oscillator controls the delay time, and by varying the frequency of this oscillator, the sweep oscillator gives the required variations in delay time.

By placing the mixer at the input of the delay line, a regenerative action is introduced into the system, and this has the effect of boosting the peaks in the frequency response.

A feedback control enables the intensity of the effect to be controlled, and this can be set to produce very large peaks in the frequency response and a very strong effect.

Although there is little difference between a delay line phaser unit and the Flanger, the flanging effect is more obvious when used with a complex signal.

DELAY LINES

The type of analogue delay line used in this application is the Charge Coupled Device (CCD) or "Bucket Brigade" delay lines as they are often called. These devices consist of a series of capacitors and electronic switches, with the input signal periodically applied to the first capacitor in the chain.

Before the capacitor takes each input sample, its charge voltage is passed on to the next capacitor in the series, then as the input is sampled, this charge is further passed on to the next stage in the series. Both these charges are again passed on before a further input sample is taken, and the existing charges are similarly passed along the chain. This action of passing on existing charges, then sampling the input while passing on existing charges is illustrated in Fig. 2.

Most CCD delay lines have between 512 and 4096 delaying stages, and the TDA1022 (IC2) used in this design is a 512 stage type. It is not possible to obtain an output direct from stage 512 of the device for two reasons. One is simply that, like every delaying stage in the line, the circuit alternates between carrying a charge and being discharged.

This occurs because each stage cannot simultaneously pass on its charge and take the charge from the previous stage, and the resultant "gaps" in the delaying stages are shown in Fig. 2. To overcome

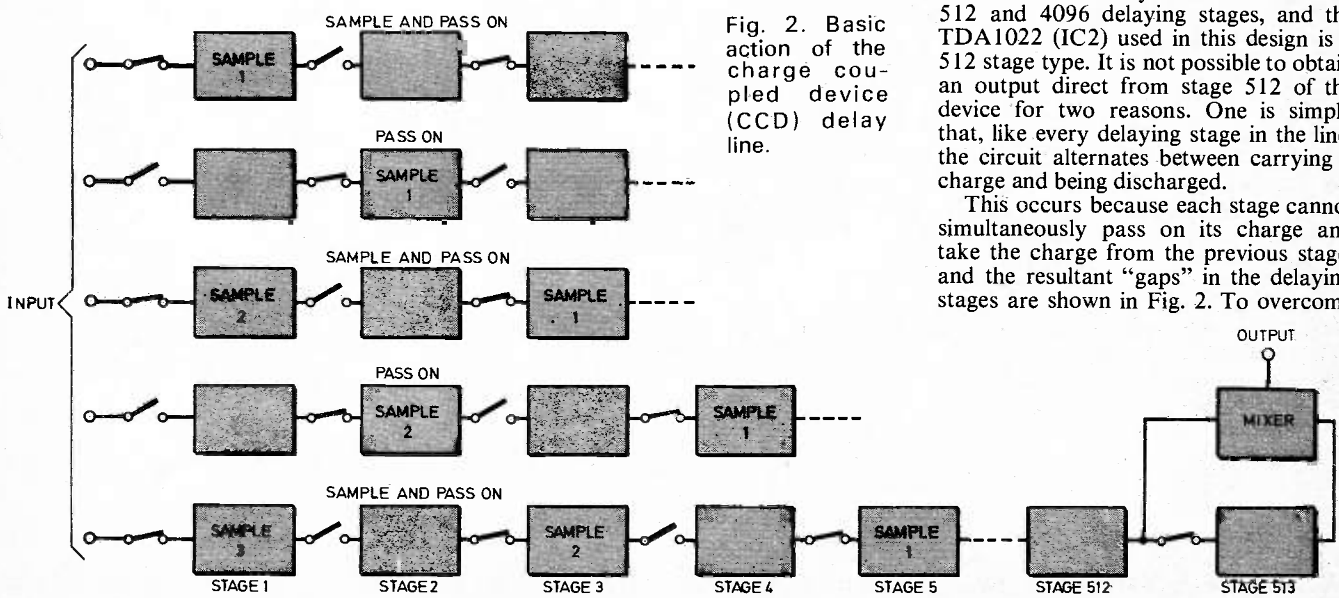
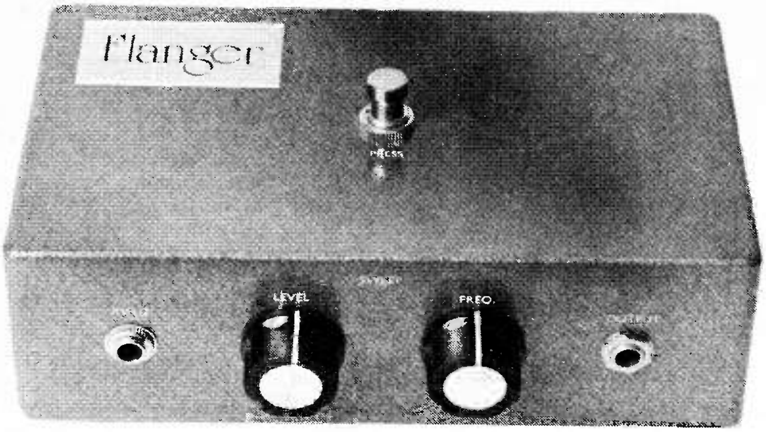


Fig. 2. Basic action of the charge coupled device (CCD) delay line.



this problem, a 513th stage is added to the output, and the output of this is mixed with the output of stage 512.

Stage 513 then provides an output signal during the periods when stage 512 is unable to do so, and stage 512 provides an output signal when stage 513 cannot. Hence an output is always present.

STEPPED OUTPUT

The second problem is that the output voltage changes in a series of steps. If a high enough sampling rate is used, this can be overcome by using a low-pass filter at the output so that the high frequency component produced as the output jumps from one sample level to another are eliminated, and a smooth, continuous waveform is generated.

In order to obtain satisfactory results, the sample rate should be more than three times the maximum input frequency. The sample rate is controlled by a clock oscillator.

The delay depends upon the number of stages and the clock frequency. Although it might be expected that dividing the number of delay stages by the clock frequency would give the delay time, it must be remembered that samples pass *two* stages down the delay line for each input sample. The delay time is therefore equal to the number of stages divided by *twice* the clock frequency.

CIRCUIT DESCRIPTION

Fig. 3 shows the complete circuit diagram of the Flanger. The input mixer stage, op-amp IC1, gives unity voltage gain and an input impedance of 100 kilohms. A controlled amount of feedback is taken from the output via VR1, and R4 gives a voltage gain of about 6dB (about two times) at the input of the mixer stage. A small amount of voltage gain is needed to compensate for losses through the delay line.

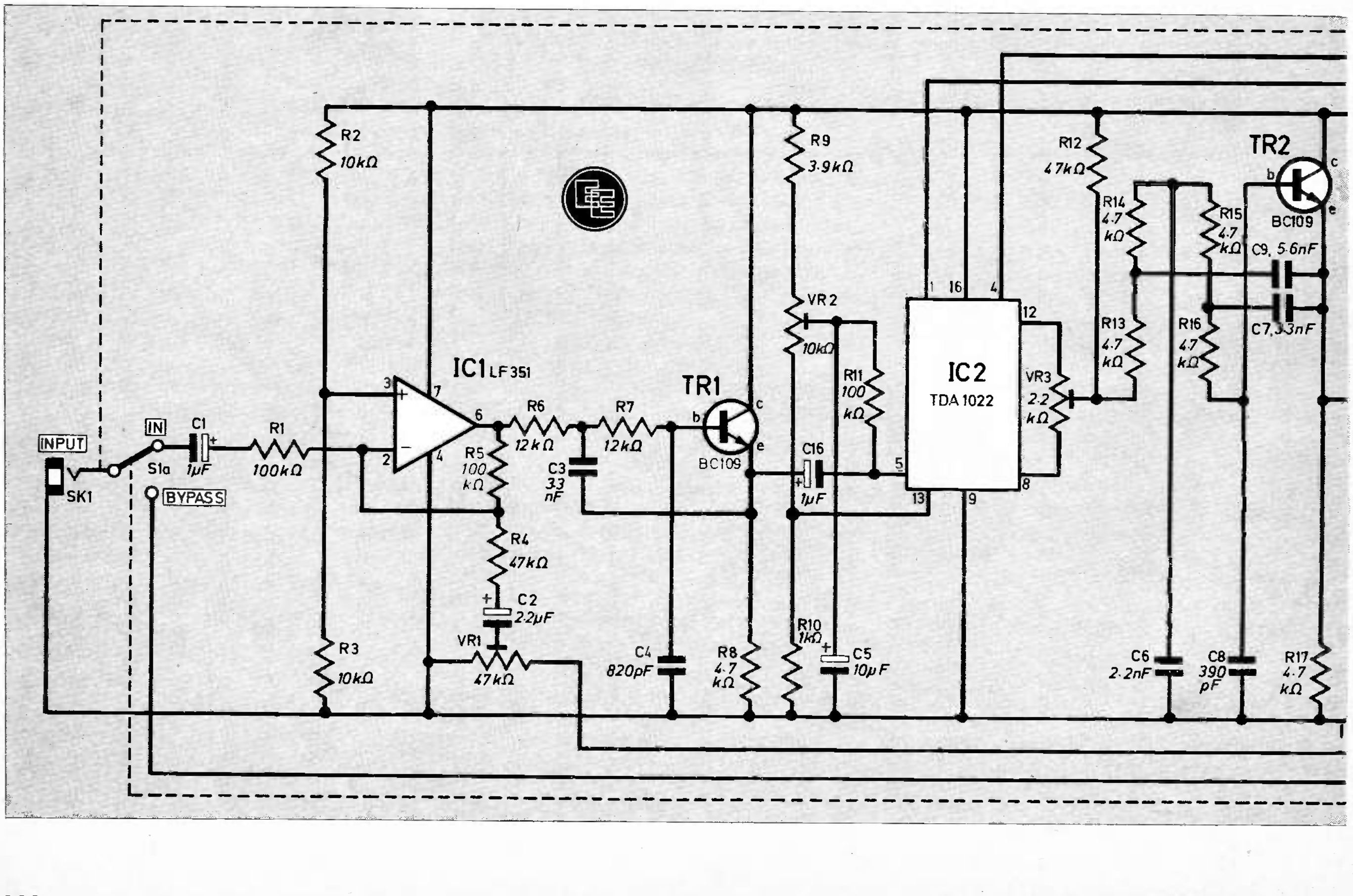
LOW-PASS FILTER

TR1 forms a simple low-pass filter having a cut-off frequency of about 12kHz and a nominal attenuation rate of 12dB per octave. This means the circuit has less than the full audio bandwidth of 20kHz, however, a 12kHz bandwidth is adequate in this application.

The point of having a low-pass filter at the input to the delay line is to remove any signals at frequencies close to the clock frequency, and thus prevent a form of distortion known as aliasing distortion. While audio signals should not have any significant components at high enough frequencies to cause aliasing distortion in this instance, it is not uncommon for electronic instruments to produce strong harmonics at frequencies well beyond the upper limit of the audio frequency range.

IC2 is the TDA1022 delay line device, and R9, R10 and R11 plus VR2 are used to provide two bias voltages for this i.c. The first bias voltage can be varied by means of VR2 and is used to bias the input of IC2 to give the optimum overload margin. The other bias voltage is fixed, a little under one volt, and is fed to pin 13 of IC2.

Fig. 3. Complete circuit for the Flanger Sound Effect. The clock oscillator and voltage regulator is shown on the opposite page.



A simple passive mixer, VR3, is used to mix the outputs from stages 512 and 513 of IC2. This is adjusted to balance the outputs and give minimum breakthrough of the clock signal. R12 is the output load resistor for IC2.

The output of IC2 is effectively modulated with the clock signal, and it is necessary to attenuate this high frequency signal as it could have an adverse effect on any equipment the Flanger is coupled to.

A four stage active low-pass filter based on TR2 having a cut off frequency of about 12kHz and a nominal attenuation rate of 24dB per octave is used at the output of the delay line to counteract this.

S1 is used to switch in the Flanger or bypass it as required. Although there is a loss of about 5dB or 6dB through the circuit, the regeneration applied to the circuit effectively cancels out these losses, and there is no apparent change in volume as the flanging effect is switched in and out.

CLOCK OSCILLATOR

The clock oscillator must provide two antiphase clock signals. As can be seen from Fig. 2, the electronic switches in the delay line do not all open and close together, and effectively there are two sets of switches operating in antiphase. It is this that necessitates the two clock signals as the TDA1022 has no internal inverter to give the required out-of-phase operation of the two sets of switches.

The CMOS 4046 phase-locked-loop (IC4) forms the clock generator in this design and is used as a voltage controlled oscillator. One of the phase comparators of IC4 is used as an inverter to generate the two antiphase output signals. The operating frequency of IC4 is determined by the values of C13 and R20, and a control voltage applied to pin 9 can vary the frequency of oscillation over a very wide range.

SWEEP OSCILLATOR

The sweep oscillator uses a CMOS 7555 timer. VR4 controls the sweep oscillator frequency and gives a range of approximately 10Hz at minimum resistance to 0·1Hz at maximum resistance. VR4 is a logarithmic potentiometer as this gives better control at the high frequency end than can be obtained using a linear potentiometer.

The output waveform generated across C12 is roughly triangular, and this gives good subjective results when used as the sweep signal. With the wiper of VR5 at the positive supply rail end, the operating frequency of IC4 is quite high. The peaks and troughs in the frequency response of the circuit are therefore at quite high audio frequencies.

As the wiper of VR5 is brought down towards the other end of its track, the operating frequency of IC4 is swept over an increasingly wide frequency span. The peaks and troughs in the response of the circuit are then swept further across the audio band. VR5 acts as a simple DEPTH control.

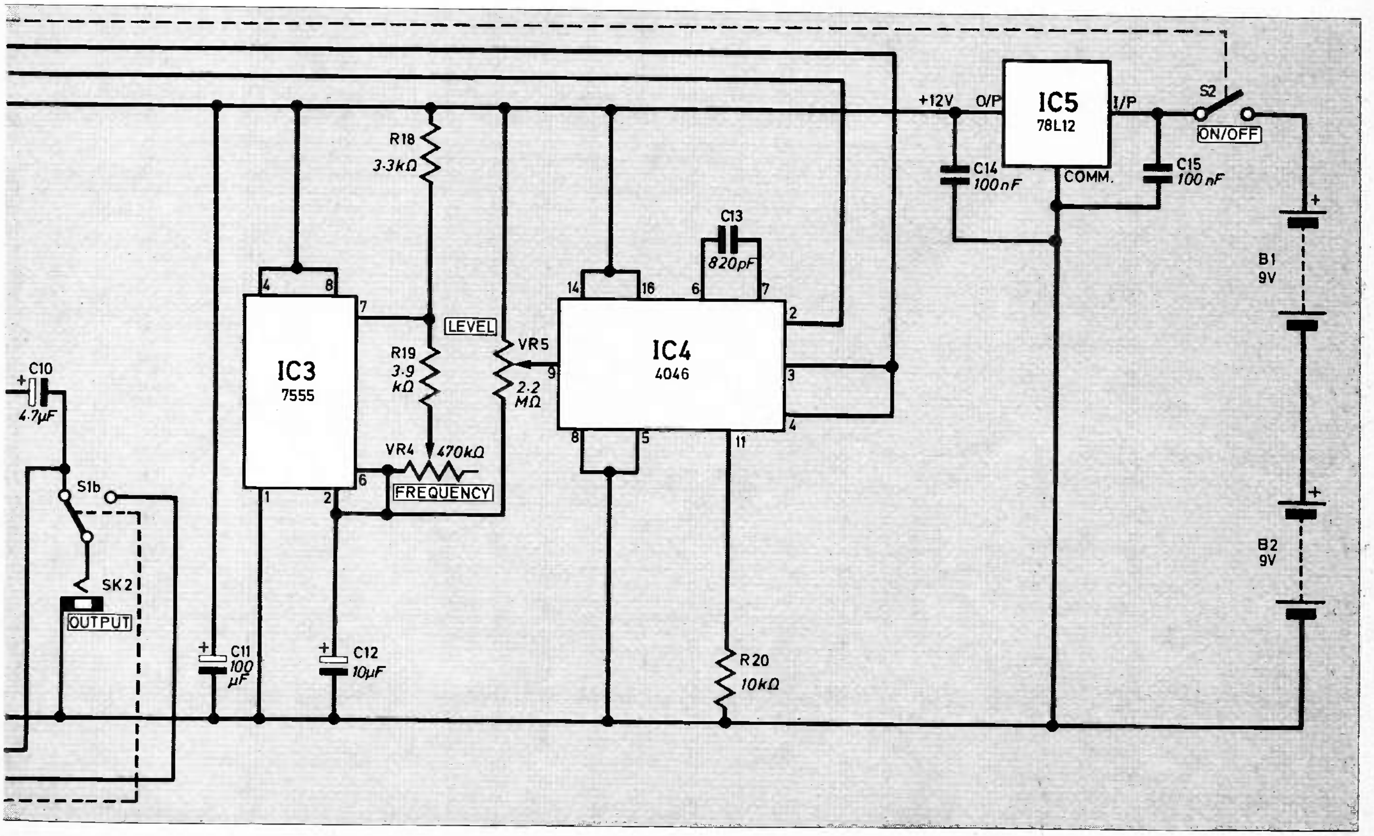
The circuit requires a 12V supply, stabilised to prevent drift in the clock oscillator frequency. Two 9V batteries in series together with a small 12V monolithic voltage regulator (IC5) are used to give a stabilised supply. S2 is the ON/OFF switch and on the prototype this is a set of make contacts on the input socket, SK1.

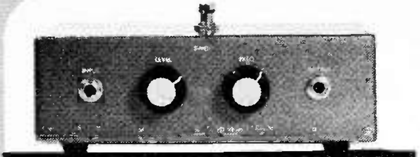
CONSTRUCTION starts here

CIRCUIT BOARD

A piece of 0·1in matrix stripboard having 50 holes by 31 strips accommodates all the components except the controls, sockets, and batteries. A board of this size is easily produced by trimming five copper strips from a standard 50 holes by 36 strips board. Details of the component panel are shown in Fig. 4.

Both IC2 and IC4 are MOS devices, and neither are the cheapest of integrated circuits. It is therefore recommended that these should be fitted in 16-pin d.i.l. i.c. sockets, and the normal MOS handling





COMPONENTS

Flanger sound effect

BY R A PENFOLD

COMPONENTS approximate cost £23

Resistors

R1,5,11	100kΩ (3 off)
R2,3,20	10kΩ (3 off)
R4,12	47kΩ (2 off)
R6,7	12kΩ (2 off)
R8,13–17	4·7kΩ (6 off)
R9,19	3·9kΩ (2 off)
R10	1kΩ
R18	3·3kΩ

All $\frac{1}{4}$W carbon ±5%

Potentiometers

VR1	47kΩ miniature horizontal preset
VR2	10kΩ miniature horizontal preset
VR3	2·2kΩ miniature horizontal preset
VR4	470kΩ log. carbon
VR5	2·2MΩ lin. carbon

Capacitors

C1,16	1μF 63V elect. (2 off)
C2	2·2μF 63V elect.
C3,9	3·3nF polystyrene (2 off)
C4,13	820pF polystyrene or ceramic (2 off)
C5,12	10μF 25V elect. (2 off)
C6	2·2nF polystyrene
C7	5·6nF polystyrene
C8	390pF polystyrene or ceramic
C10	4·7μF 63V elect.
C11	100μF 25V elect.
C14,15	100nF polyester (2 off)

Semiconductors

IC1	LF351 f.e.t. op-amp
IC2	TDA1022 analogue delay line
IC3	7555 CMOS timer
IC4	4046B CMOS phase-locked-loop
IC5	78L12 12V, 100mA voltage regulator
TR1,2	BC109 silicon *npn* (2 off)

Miscellaneous

S1	d.p.d.t. sequential heavy duty push-button
SK1/S2	6·3mm jack socket with d.p.d.t. switched contacts
SK2	6·3mm jack socket
B1,2	9V PP6 batteries (2 off)

Stripboard, 0·1 inch matrix 50 holes by 31 strips; diecast case, 190 × 110 × 60mm; 16-pin d.i.l. i.c. sockets (2 off); control knobs (2 off); Veropins; 6BA screws, nuts, and 6·3mm long spacers; PP6 battery clips (2 off); 7/0·2mm wire.

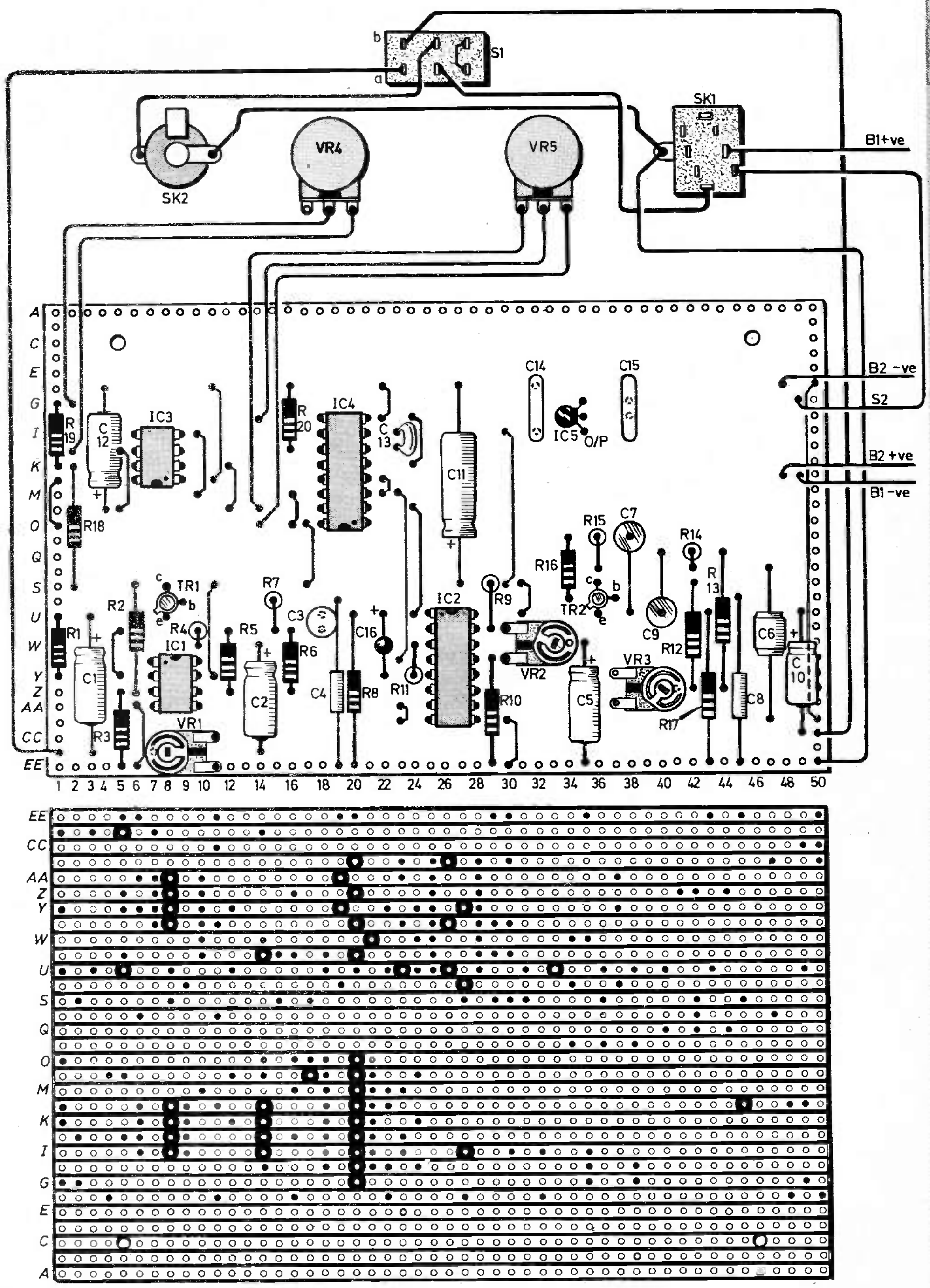


Fig. 4. Component layout, interwiring details and underside of the stripboard showing breaks (41) in the copper strips. The circuit board is mounted on the base of the diecast case and is shown in the photograph on the opposite page.

precautions should be taken. Although IC3 is a MOS device it has built in protection circuitry that eliminates the need for any handling precautions.

The use of pins at points on the board where wire connections will be made to the controls and sockets is advisable. The completed board is mounted to the base panel of the case using 6BA (or M2·5) fixings, including 6·3mm long spacers which prevent solder joints on the underside of the board from short-circuiting through the case.

Check the board thoroughly for mistakes before finally fitting it in place, making sure that none of the link wires or breaks in the copper strips have been omitted, and that there are no accidental short-circuits between copper strips due to solder blobs.

DIECAST BOX

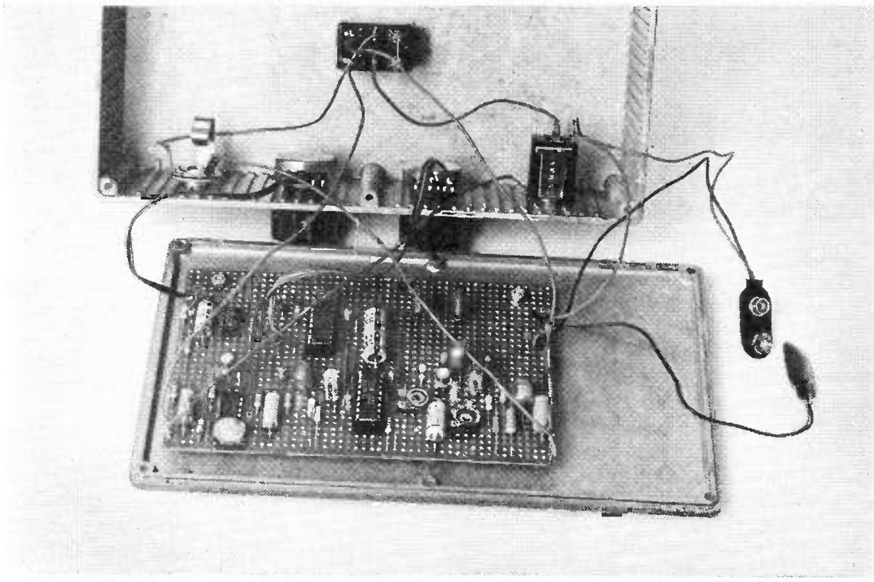
The specified case is a diecast aluminium box having dimensions of about 190 × 110 × 60mm, and this is a little larger than is absolutely necessary. However, it does house all the components without crowding, as well as providing a tough, screened case for the unit. It is used up-side-down so that the removable lid becomes the base panel.

S1 is mounted at the centre of the top panel of the case, and this switch is a heavy duty, sequential operation, push-button type. This enables S1 to be operated by foot if desired. The two potentiometers and the two sockets are mounted along one side of the case.

The final wiring of the unit is also shown in Fig. 4.

ADJUSTMENT

Initially VR1 should be adjusted fully anti-clockwise, and both VR2 and VR3 should be set at about the midway point.



The circuit board mounted in position on the base of the diecast case and side mounted components.

If a signal generator and an oscilloscope are available, VR2 is adjusted to give symmetrical clipping. If suitable test gear is not available, VR2 must be set by ear to produce an output free from obvious distortion.

VR3 is adjusted correctly by monitoring the signal at its wiper terminal with an oscilloscope and finding the setting that gives the minimum breakthrough of the clock signal. There should be no input to the unit when doing this.

A simple alternative is to solder a 100nF capacitor in parallel with C13, so that the clock frequency is reduced to an audio frequency. The breakthrough can then be heard on the output of the unit, and VR3 is adjusted to null this signal. The additional capacitor is then removed.

VR1 is given the setting which is considered to produce the best effect, and the further this is advanced in a clockwise direction the more extreme the effect of the unit. However, if VR1 is advanced too far there will be sufficient feedback to produce oscillation, and VR1 must be kept below this point. This control could be replaced with 47 kilohm linear potentiometer mounted on the front panel if preferred.

The circuit can handle signal levels of a little over 2V r.m.s. without overloading, although using a lot of feedback produces pronounced peaks in the frequency response that reduces this figure somewhat. With an input level of no less than 250mV r.m.s., the circuit will have a signal-to-noise ratio in excess of 60dB. □

JACK PLUG & FAMILY...

BY DOUG BAKER

LETTERS

Bouquet

Sir—I have only just begun a serious study of electronics and I find your magazine and its projects both entertaining and useful, especially those for test instruments, for example, the *Oscilloscope Companion* which I am just constructing at the moment.

I find the information on prices, new products, catalogues and various articles about p.c.b. construction and the very informative *Square One* and *Introducing Electronics* features very commendable additions to an already excellent magazine.

I first obtained several issues of EE from the library and after reading them my mind was made up and I sent away for information about back issues and a subscription, that was how impressed I was! I do recommend this magazine to anyone—whether beginner or professional.

My message to the creators of EVERYDAY ELECTRONICS is that you have a highly commendable magazine with an excellent layout so keep up the fantastic job you're doing!

G. Smaill,
Auckland,
New Zealand.

Brick-Bat

Sir—I am the Head of Physics in this school and have been responsible for distributing copies of EVERYDAY ELECTRONICS to my pupils. (We took 24 copies of your December 1982 issue.)

I am however writing to express my concern at the content of the recent issues. I feel that the articles are of far too limited an appeal—the SEDAC prizewinners being the classic examples.

Surely these are not of general interest to your target group. In the past, you published far more articles which were really of general interest and within the reach of relative newcomers to electronics (and their pocket money!).

If this trend continues, I feel that I will no longer feel justified in suggesting to my pupils that they subscribe to EE.

G. T. Jones,
Glan-Y-Mor School,
Pwllheli,
Gwynedd.

A Good Strip

Sir—I would like to add to the "Keep It On Stripboard" campaign, but would also like to comment on the various complaints that you have received from readers in the past.

Many people have sent letters into your office about the p.c.b.s that are included in your magazine for various projects. I myself, hate p.c.b. etching for two reasons: the first is because it is a lengthy and laborious task, and the second is because it is expensive.

So instead, if there is a project that I wish to construct, then I make some sketches on rough paper of stripboard layouts and then pick out the best one. It is then just a matter of construction.

I use this technique because it is easy and only takes approximately a quarter of an hour on average, and because I can get stripboard free.

Proof that this system is simple lies in the fact that I, myself, am only thirteen years old.

Rodney Casbierd,
Cippenham,
Slough.

Meeting Point

Sir—Computer clubs have become extremely popular and new clubs are springing up all over London, bringing people of all ages and fields together with a common interest in computers. These clubs cater for people who simply have an interest in computers and what they can do, or want to get together with similar home computer enthusiasts.

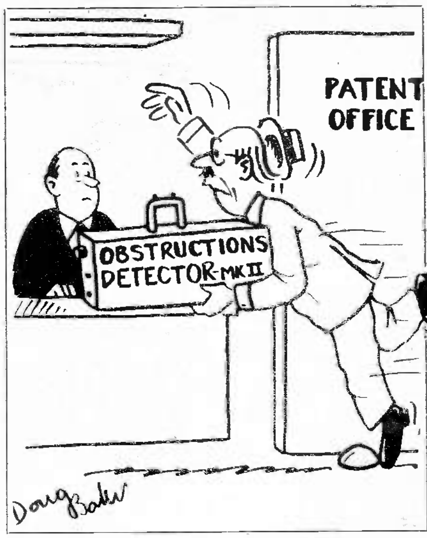
Perhaps you've just acquired a brand new home computer or are thinking of buying one yourself and would like to join one of the many London Clubs. If so and you would like further information write to the Association of London Computer Clubs.

The Secretary,
Association of London Computer Clubs,
North London Hobby Computer Club,
The Polytechnic of North London,
Holloway, London N7 8DB.

Radio Rally

Sir—The 3rd Denby Dale Rally will be held on June 19 at Shelley High School, Skelmanthorpe, Huddersfield.

At the 10th Annual General Meeting, G. Grayson G3YWI was elected chairman, myself as secretary, and M. Littlewood G3OYI as treasurer. New licensees are well represented on the committee.



If any readers would like information on forthcoming Denby Dale (Pie Hall) and District Amateur Radio Society events they should contact the Secretary.

Sec. J. Clegg G3FQH,
8 Hillside,
Leak Hall Lane,
Denby Dale,
Huddersfield HD8 8QZ.

Great Fun

Sir—In my retirement from a full life in mechanical and electrical engineering I have taken up electronics as a hobby. I have taken EVERYDAY ELECTRONICS regularly for nearly three years, and have found it to be full of interest, most instructive from the "Teach-Ins" to projects, some of which I have put together with great fun.

I write to wish you continued success.

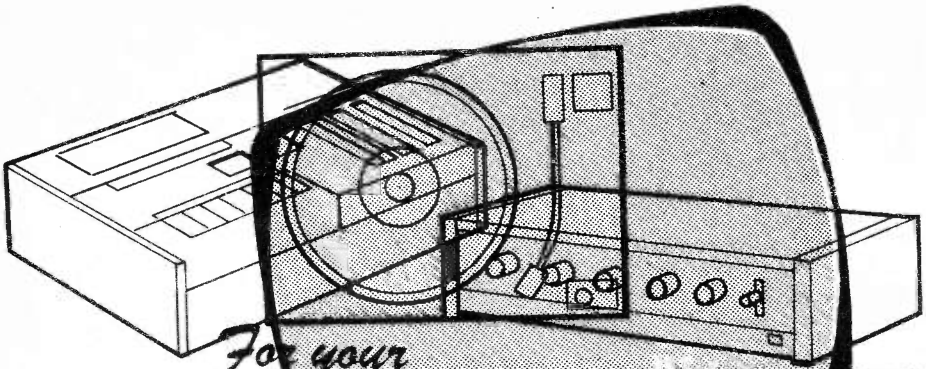
Sir Arnold Lindley,
Shipley,
West Yorkshire.

PLEASE TAKE NOTE

Beat the Relay *(November 1982)*

The circuit diagram (Fig. 1, page 736) and the stripboard layout (Fig. 2, page 737) show the electrolytic capacitors C1 and C2 drawn with the wrong polarity.

They should be reversed so that the positive end (+) is connected to the collector (c) of the respective transistor.



For your ENTERTAINMENT

By BARRY FOX

Cellular Radio

You will be seeing a lot about cellular radio in print over the next few years. But even if you read everything that's written, you are likely to end up very confused.

The object of cellular radio is to make more room in the crowded airwaves for mobile radio telephones, for instance, car phones. Essentially it's a way of getting a large number of radio operators to share a small number of frequencies.

In June 1982 the Home Office promised 30MHz of the radio spectrum for radio telephone use. In November 1982 the frequency range 854–960MHz was allocated.

To stimulate competition and free enterprise, but not leave British Telecom out in the cold, the Department of Industry decreed that two competing networks should share the allocated spectrum. The DI promised one licence to Sectel, which is a joint venture between Securicor and British Telecom, and threw the other open to private industry.

Five firms applied for a licence to use the other half of the spectrum. The five were: Racal-Millicom, National Radiophone Services (which includes Ferranti) Cellular Radio (which includes Cable and Wireless and Air Call), Metagate of Thanet and Rushbridge of London.

The Department of Industry then set up an advisory panel who in turn employed SRI International to evaluate the bids. But the panel didn't pay any heed to the technology. It adopted what it called "a systems neutral" approach and concentrated on the prospects of jobs in Britain likely to be created by the five bidding companies.

In the end the panel chose Racal, because this British company said it would spend heavily on research and development over the next ten years, make the hardware in Britain and generate 6000 jobs by 1989. This would be in addition to any jobs created by BT.

But there's a small print proviso. Racal will only be able to create these jobs if it can use American technology of its choice and if other European companies follow the British lead, and so create an export market.

The Systems

This is where things start to get confusing. There are at least five different cellular radio systems. Each divides the city up into cells a few miles across, with its own radio transmitter. The mobile phones in the area operate on a range of frequencies which a central computer allocates as they fall free. So waiting time is cut down.

In Norway, Sweden and Denmark they use what is known as the Nordic system. Those countries are most unlikely to switch if a different system is adopted in Britain. In Japan, Nippon Telephone and Telegraph or NTT (the Japanese Post Office) has been using a different system since 1979.

In Germany, Siemens has proposed another approach. But the front-runners for Britain and most of Europe are the Automatic Mobile Phone System or AMPS, developed by AT and T and Bell Labs in America, and the MATS-E system developed by Philips in Germany.

Both these systems transmit the speech signal by f.m., and carry the computer control signals on a different frequency. It's the manner of handling the control signals that differs. Whereas the American AMPS system has been proved to work, MATS-E is still under development. But it is favoured by some authorities in Europe, if only because it is European.

The fly in the ointment for anyone hoping to be one of the 6000 promised manufacturing jobs, is that Racal wants to use a modification of the American AMPS system developed by its American partner company Millicom. The small print of the Racal promise, which won it the British contract, is that if the company is forced to use another system, such as MATS-E, then the promise of 6000 manufacturing jobs in Britain may no longer hold good. But in true Catch 22 fashion, if AMPS is adopted for Britain, and the rest of Europe goes for MATS-E, there won't be an export market to create manufacturing jobs in Britain!

Ignoring Technology

Under the circumstances it does seem extraordinary that the Department of Industry made a contract decision without even considering the technology. And heaven help any journalist who tries to analyse the competing technologies.

British Telecom and Securicor, its partner in the cellular radio venture, have analysed the five competing technologies. But, because its plans are a trade secret, BT will not say which system it prefers. For the same reason Racal does not want to talk details about the preferred AMPS technology.

When I raised the question of technology at a Department of Industry press conference, I was told by one of the Minister's aides that if I wanted to write about the technology, I should get my information by reading what had already been written in the press. In other words, I should regurgitate other peoples' opinions and errors! Small wonder there has been so much confusion about cellular radio.

Recording with Videodiscs

It's no secret that videodisc sales are *not* booming. People only want to buy a videodisc player after they have bought a video tape-recorder. This is probably because none of the three videodisc systems developed for domestic use (Laservision from Philips, SelectaVision from RCA and VHD from JVC) can record as well as replay. But several research laboratories in Japan have now developed videodisc systems which can record, replay and even erase unwanted recordings. So far record-capable videodiscs have been too expensive for domestic use. But now NHK Laboratories have come up with what could be a budget system. Perhaps this is why some firms have mysteriously lost interest in selling ordinary videodisc systems which can only replay pre-recorded disc programmes.

The NHK system is a mixture of magnetic and optical technology. A glass disc with a thin coating of gadolinium-cobalt alloy rotates under a fairly low powered laser. The disc is bathed in a magnetic bias field and the laser heats a tiny area of the surface so that its coercivity changes and its magnetic characteristic switches in the bias field.

On replay the disc is spun under a lower powered laser which senses the tiny changes in optical characteristic which follow from the magnetic changes. To erase, the disc is spun under the laser in a reverse bias magnetic field.

Whilst in Japan recently, NHK told me that it would take a couple of years yet before the system is viable for domestic use. But it could well be worth waiting for. For instance, it can be used for recording digital sound.

Home video enthusiasts could also use the disc for editing, by transferring selected passages of a recording from tape onto disc, and then back again onto tape.

Everyday News

. . . Dateline 29 February 1984

COMPUTER SAVES LONDON

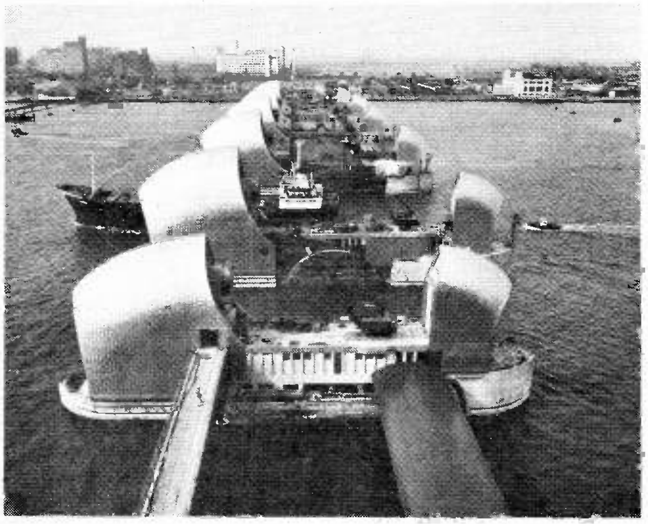
—London saved from floods by swift action of Computer and Officers at London's Thames Barrier . . .

THE above message could, in theory, be making headline news in our newspapers next year if the GLC proposals for a special computer back-up to monitor conditions in the Thames estuary—in a further effort to avert any possibility of flooding in central London—is carried out.

The computer will keep a round-the-clock watch on rainfall and river levels, winds and atmospheric pressures, and warn barrier officers when flood gates should be closed.

The system will be used to extend the warning time given and will be accomplished by the computer monitoring and translating information from radar signals on rainfall intensity, from an installation in the Chilterns, and predicting how individual water levels in the tributaries will be effected.

To design the system, the GLC has appointed Wootton Jeffreys & Partners, who will also be responsible for preparing tenders and overseeing installation. Work on the project is expected to commence shortly and be completed by the year end.



Photos courtesy—Richard Costain Group PLC.

CB INTERFERENCE

The problem of operating CB transmitters close to domestic TV, radio and audio has continued to result in many complaints of interference, reports our Radio correspondent, Pat Hawker. During 1982 these averaged nearly 1000 per week, totalling over 46,000. However after peaking at 4952 in March 1982 the numbers have dropped gradually and were down to 2590 in December 1982—but still a higher monthly total than in the "illegal" months of 1981.

How many complaints were due to illegal a.m. and how many to legal f.m. has not yet been released. However, it has been stated in Parliament that in the twelve months to September 1982 there were 2300 prosecutions for illegal operation. It has also been disclosed that British Telecom has questioned whether they should continue to be responsible for tracing interference on behalf of the Home Office.

VIDEOCONFERENCE

Claimed to be the World's largest videoconference, The International Teleconference Symposium will be staged in the Royal Lancaster Hotel, London, in April 1984, and will involve the first ever live link-up between four continents. The participating towns are Philadelphia, Sydney, Tokyo and Toronto.

Delegates in this intercontinental symposium on teleconferencing will be able to see, hear and speak to their partners across the world as if they were in the same room. Both video and audio techniques will be covered.

British Telecom International, the European host to the symposium, have now issued a call for papers. There will also be an exhibition of equipment.

The International Teleconference Symposium is being run under the auspices of Intelsat by BTI in conjunction with Comsat (USA), KDD (Japan), OTC (Australia) and Teleglobe (Canada).

Philips new fibre optics plant at Eindhoven, due for completion this year, is planned to produce 30,000km of fibre annually. Up to 7km in length will be drawn from a single mould compared with only 1·2km on older equipment.

Digital TV goes by Optical Fibre

Digital television signals to the recently approved CCIR Standard have, for the first time, been successfully transmitted by optical fibre link between two BBC television studio centres.

The optical fibre cable was installed in the existing ducts between the BBC studios at Lime Grove and Television Centre, a path of about 800 metres.

Ambit International has been nominated—together with Electroplan and Manhattan Skyline—for the title of All Electronics Show/Electronic Times "Distributor of the Year" Award.

. . . from the World of Electronics

UK Leads The World

A recent World Survey of Electronic Developments, released by Prestwick Publications of New York, reveals that the most significant breakthroughs in electronics are not just from Japan, or for that matter, from the United States. Europe, for example, holds a commanding lead in the area of circuit design with 41 per cent of the world's total of developments and is tied with Japan in the area of electronic applications with 38 per cent.

The US leads in computer technology with 52 per cent of the developments and in communications and information processing with 46 per cent.

Japan, as expected, leads the world in automation control and robotics with 51 per cent and integrated circuits with 46 per cent.

The Post Office has appointed Mr Charles Read as its first Director of Information Technology.

As a member of the Information Technology Advisory Panel which advises Ministers on IT policy, he chaired the working group which reported to the Prime Minister on Cable TV and related systems.

Fidelity Radio is to design and make British Telecom's first cordless telephones with an initial order worth over £1 million. Mobile user range is 200m from the base unit.

MICROQUEST

Young people with an idea for using microelectronics in industry can win £1000 in a nationwide competition jointly sponsored by Williams & Glyn's Bank and the Department of Industry.

Open to 16 to 19 year olds working in industry or on a Government sponsored training scheme, they are being asked to identify a way in which microelectronics could be used to improve efficiency in their firm and to describe it in less than 100 words.

The best ideas will be selected and those contestants will be invited to submit a detailed 2500 word project explaining how their idea could be implemented. The winners, one from each of the DoI's ten regions, will each receive £250 and will go forward to compete against one another at national level. The final will be held in London in October 1983—the overall winner will receive a prize of £1000, the runner-up £500, and the third placed contestant £250.

The government sponsored Microelectronics Application Project is getting a further £30 million funding to top up the £50 million already spent since 1978.

MAP has created 30,000 training places and offered support to more than 800, mostly small, firms on development projects.

WHERE ARE THE GIRLS?

Forty-two per cent of all people employed in the UK are women. In engineering only one in 500 is a woman. This compares with one in 50 in the USA and 1 in 3 in the USSR in engineering.

Wrong Number

Cordless telephones which meet Home Office performance specifications have been exempted from the need for a Wireless Telegraphy licence by regulations made by the Home Secretary.

However, few of the cordless telephones at present on sale or in use illegally, will be exempt because they do not operate on the appropriate radio frequencies or do not meet other technical requirements.

Nordic MAC

The UK's MAC system for satellite broadcasting has been successfully demonstrated to the Nordic Council of Ministers in Stockholm. This is the first time demonstrations of the system have been given outside the UK.

Ministers and representatives from the Scandinavian broadcasting and telecommunication organisations saw high-quality television pictures, accompanied by multiple-channel sound, transmitted from the IBA Engineering Centre, Winchester via the European Orbital Test Satellite (OTS), stationed 36,000km above the Equator over West Africa.

Demonstrations included direct comparisons with conventional PAL-encoded colour signals.

Edinburgh University is receiving a £2½ million boost to its Microfabrication Facility from grants awarded by the Science and Engineering Research Council.

Tokyo, 1983—**Mitsubishi Electric Corporation announced that it plans to manufacture VTRs in its UK factory for sales in the European market.**

The initial production of 5000 units per month will be made at the Haddington Works. The company envisages a full-scale production of 10,000 units per month.

Parts for the VHS-type VTRs will be supplied from Japan at the start but as many parts as possible will be bought on the EC market.

Kouji Imakita, Executive Vice President, said: "We believe that planned VTR production in the UK will go some way towards promoting economic cooperation between Japan and EC countries.

Sinclair Developments

After his highly successful and much publicised journey into the stronghold/vaults of the City investors, Clive Sinclair of Sinclair Research has announced a new corporate structure. This consists of an enlarged board of directors and organised operationally into current and advance products divisions.

As chairman and chief executive, Clive Sinclair, retains overall control of all company activities in both areas. He will also personally supervise the advance products division which is concentrating on the development of the company's forthcoming flat-screen Microvision pocket TV, now under pre-production testing at the Timex plant.

It is also researching, at its St Ives and Winchester facilities, future consumer and business applications of the flat-screen and new solid-state technologies.

The current products division, under managing director Nigel Searle, will be responsible for marketing the company's existing personal computer range and the continuing development programme for new personal computers, computer peripherals and software. Entirely new products, once launched, will also be transferred to this division.

Joining Clive Sinclair, Nigel Searle and Chris Fawkes on the board are finance director Bill Matthews, production director Dave Chatten, and newly-appointed research and development directors, Jim Westwood and David Southward.

Kenneth Dick CBE, FCA, chairman of New Court Trust plc and a non-executive director of N. M. Rothschild & Sons Limited, has also been appointed to the board as a non-executive director.

Semiconductor News . . .

The recently announced Inmos IMS 1400 16K byte static RAM family in plastic packages is now held in stock by Rapid Recall for immediate delivery.

These devices have, until now, only been available in ceramic packages or leadless chip carriers.

★★★★★★

Figures just released by Zilog (UK) show that the sales of their System 8000 family of advanced 16-bit microcomputers have far exceeded original predictions.

In the market-place for only one year, the total number of System 8000s now in use is greater than 500.

★★★★★★

Two new hybrid i.c.s for inductive proximity detectors (types OM386 and OM387), which fit inside a Cenelec M8 hollow stud, have been announced by Mullard.

Suitable for positive and negative supply voltages, the output of either i.c. can drive the coil of an electro-magnetic relay. Operating from a 10V to 30V supply the output current is approximately 400mA. The detection range is 1·5mm when used in an M8 tube and is set by an external resistor.

RADIO WORLD

By Pat Hawker, G3VA

Your Personal Humanoid

The consumer electronics industry continues to seek new outlets for its frighteningly large production capacity. Even the boom market in video recorders is unable to absorb the flood of machines now being produced—and sophisticated video games are in a highly competitive situation.

Video games, video discs, home computers, teletext, smoke detectors, microwave ovens, digital audio and now your own robot. Humanoids that can talk, move around, perform simple household tasks are all set to move out of the sci-fi stories and into our homes.

In North America, Androbot Inc., Heath (Zenith Radio), Robotics International and other firms are all reported to have lovable, intelligent little monsters moving along production lines with price tags from about $1000 upwards, although sales are expected to be modest for the next few years, then building up as more software programs become available. Indeed, early models seem aimed partly at educating humans as to how to stay in control: one manufacturer provides a two-volume, 1200-page course in robotics.

With names like Hero 1, Bob and Genus we are clearly expected to treat the humanoids as companions as they busy themselves vacuum cleaning floors, delivering drinks to guests, looking after home security, teaching any "live" children, exercising their electronic vocal chords or just shuffling around the room. The idea doesn't exactly grab me but then I am still surprised at how many people are buying home computers.

Living History

Both for newcomers and for those for whom electronics is a full-time profession there is nowadays so much technology to learn that few students have much time to spare for learning about the personalities who created all the technology. Yet every device, every component, every circuit had to be developed or discovered by someone or by some team.

The result is that we tend to oversimplify. We say Marconi invented radio communication, Lee De Forest the thermionic amplifier, Baird television, Watson-Watt radar and the transistor by a team at Bell Telephone Laboratories.

Whether or not you accord priority to this short list—and that partly depends on which country you live in—it ignores the really major contributions made by tens if not hundreds of brilliantly innovative engineers, physicists and scientists; many no longer with us but others who are still alive or with colleagues or close relatives still living.

The pioneers of television (Perskyi first used the term "television" in 1900) include many names apart from Baird though I wonder how many will be familiar to readers: Nipkow invented the scanning disc in the 1890s; Rosing and Campbell-Swinton outlined the principles of electronic television before 1910; V. K. Zworykin conceived the iconoscope in 1923 (although the patent was not issued until 1938 by which time McGee had developed the basically similar Emitron tube in the UK).

Blumlein invented many of the TV circuit techniques; Ballard invented interlacing in 1932; Brown led the RCA team that did so much to bring compatible colour to our screens; Bedford originated "mixed highs" or frequency interleaving for colour.

Bruch in Germany invented PAL; DeHaan in Holland the Plumbicon tube; German engineers pioneered VHF and UHF transmission; Yagi his aerial. One could add many names to this list.

Zworykin, who in later years turned his attention to medical electronics, died only last year; several of those on my list are still happily with us but no longer young. This January, I had the pleasure of meeting the widow of John Logie Baird; a former professional musician and music-teacher, she lives in South Africa with her many lively and vivid recollections of her husband who died in 1946. Her son lives in Canada, her daughter in Scotland.

Mists Of Time

The Royal Television Society has recently appealed to its members to put on record any personal recollections of the early days of television that may otherwise soon be lost in the mists of time.

The four large volumes of BBC history by Asa Briggs tell the formal story, with the lesser known engineering history by E. L. Pawsey. The first volume of Bernard Sendall's history of "Independent Television in Britain" published last Autumn provides an informal and unique insight into the political, commercial and administrative problems that had to be overcome in setting up ITV in the period 1946–62.

There have been many biographies published of John Logie Baird, including one by Michael Hallett who looks after the IBA's "Broadcasting Gallery". There is a useful 40-page monograph on A. A. Campbell Swinton—a remarkable engineer who among many other things was the first president of the Wireless Society of London (now RSGB) and held the amateur (experimental) callsigns 2HK and 2HL—by T. H. Bridgewater whose own career spanned the entire development of broadcast television.

Bridgewater joined the Baird Television Company in 1928 in the days when 30-line mechanical TV was transmitted from Long Acre (2TV) and then became one of the first three BBC television engineers in 1932 when the BBC took over responsibility for the low-definition transmissions. He retired in 1968 as Chief Engineer, Television.

As the engineer largely responsible for the first BBC TV outside-broadcast from France, Tony Bridgewater could claim to be the pioneer of international TV.

But the ranks are thinning. The very first BBC TV engineer, Douglas Birkinshaw, died last October. After working on the 30-line system from 1932 he became engineer-in-charge of Alexandra Palace when that station opened in 1936 using both the Baird 240-line and the Marconi-EMI 405-line systems.

His interest in broadcasting began when he joined Oundle school's wireless society, a group that built one of the experimental stations that broadcast concerts and programmes before the BBC started in 1922.

Vintage Valve

In his new book "Practical Handbook of Valve Radio Repair", Chas E. Miller recalls his adaption some years ago of a famous phrase: "The valves are going out all over Europe, and we shall not see them lit again in our time". He points out that he has been proved wrong, that there has been a resurgence of interest in the collection and restoration of old valve sets.

Indeed, recently I was asked to identify an early Eddystone communications receiver that had been retrieved from a dustbin. It was the 1939 Eddystone ECR model, sold originally for £45, no small price to pay in those days.

Historically it was possibly the very first receiver built in England for amateur radio to include a variable-selectivity, phasing-type crystal filter. It was soon superseded by that firm's wartime model 358. There is little doubt that old valve models in good working condition will become increasingly rare.

A criticism of the book is that it is restricted to standard domestic models and includes few that really deserve to be considered "vintage". But for anyone interested in the development of radio receivers between 1922 and about 1960 when the solid-state revolution began in earnest, this book has much to offer, including some fascinating old advertisements and hundreds of old circuit diagrams.

The Young Tutor

With many of the key-pad, keyboard, push-button, remote-control devices it needs young, agile brains to operate them. For some consumer electronics it is said you are too old at twenty.

There seems to be an increasing number of successful candidates for the Radio Amateurs' Examination at around the minimum age of 14. But it is still unusual to find a schoolboy, who while still under 18 years of age, has successfully tutored 14 enthusiasts—of all ages—through the R.A.E.

John Morris, GU6BGI of the Guernsey Amateur Radio Society has done this. In December 1982 his latest batch of nine pupils, 14 years of age upwards, passed all the RAE papers that they took. John Morris takes his A-level examination this summer after which he hopes to train as an Air Traffic Control Officer. He is active on 144MHz using home-constructed equipment.

MAY 1983 ISSUE ON SALE
FRIDAY, APRIL 15

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Everyday ELECTRONICS

NEON NIGHT LIGHT

BY D.A.CORDER

THIS project is a homemade alternative to the commercially made glow-lights. Its main advantages are the reduction in cost and its simplicity. Although the neon does not produce much light it is enough to dimly illuminate objects within a close proximity. The Neon Nightlight also has the advantage that it will only consume small amounts of power.

The room inside a 13A plug is very limited and this should be taken into account when buying the plug. If in doubt take the neon filament to the shop with you.

CIRCUIT AND OPERATION

The circuit diagram for the Neon Nightlight is shown in Fig. 1. The neon LP1 receives a current through the limiting resistor R1. The resistor R1 is placed in the circuit to prevent the neon burning out, and should have a value of around 220kΩ.

PLUG ASSEMBLY

A standard flat-pin 13A plug is used to house the components, and the positioning and wiring is shown in Fig. 2. One end of the resistor R1 is connected to the *L* terminal of the plug, with the remaining end being soldered to one of the two neon connections. A short length of wire is then used to connect the remaining neon connection to the *N* terminal of the plug.

To avoid possibilities of short circuits, all leads should be insulated with plastic sleeving or insulating tape.

A rectangular section is then cut from the plug lid and this is made by drilling two holes and removing the remaining plastic with a file. When drilling the holes make sure that the distance between them is less than the length of the neon filament. This will prevent the neon connections being exposed. A small piece of transparent material may then be stuck over the rectangular section to protect the neon.

The next step is to remove the flexible cord securing grip and block the mains cable inlet hole with a wooden or cork plug which should be cemented in.

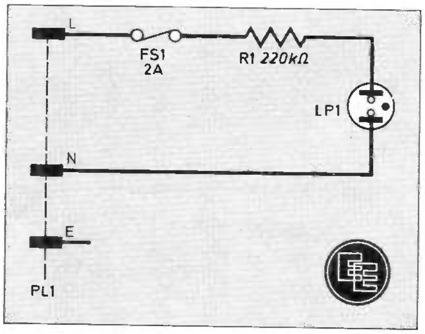


Fig. 1. Complete wiring diagram of Neon Nightlight.

IN USE

Remember that even though the *E* terminal of the plug is not being used, the terminal must not be removed as the plug socket will not operate without the *E* pin.

When all connections inside the plug have been checked, a 2A fuse can be fitted and the unit is ready for use. □

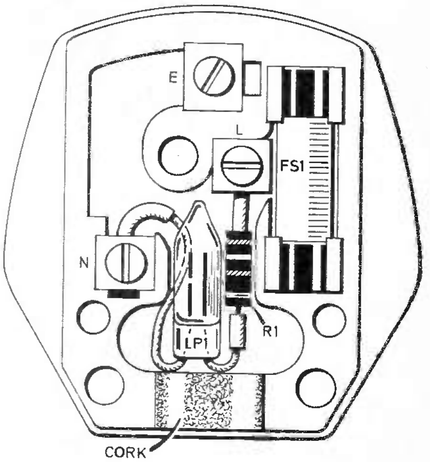


Fig. 2. Diagram showing layout of components and wiring.

COMPONENTS

R1 220kΩ
½W carbon ±10%
FS1 2A or 3A fuse
LP1 wire-ended neon
PL1 flat-pin 13A mains plug
1mm plastics sleeving or insulating tape; cork; clear plastics.

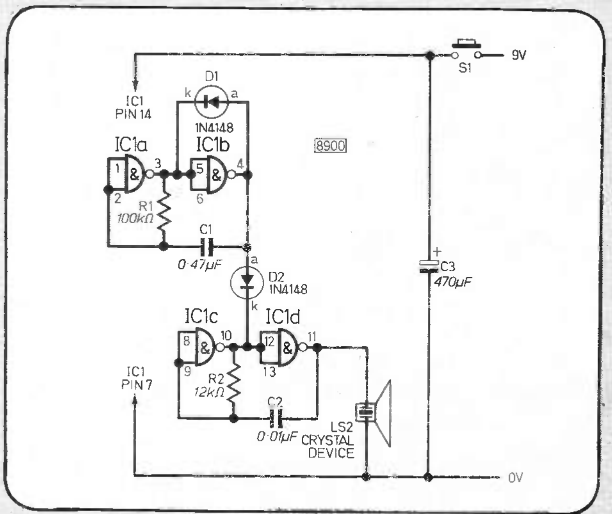
Approx. cost Guidance only **£1.50**
See page 217

CIRCUIT EXCHANGE

WARBLING OSCILLATOR

THIS Warbling Oscillator is designed around a 4011 CMOS i.c. The four gates of IC1 are connected to form two oscillators. The higher frequency of the oscillator formed by gates IC1c and IC1d is pulsed at a lower frequency by D1. D2 causes the output to warble. When S1 is released the output fades slowly due to C3 discharging. No values are critical except LS1 which must be a crystal transducer. I used a device from a doctor's radio paging bleeper.

David Cross,
Gidea Park,
Essex.



MORE ON PAGE 237

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5	PB 103	2250	24	**40.95**	46.57	
6	PB 104	3060	32	**51.45**	58.07	
7	PB 203	2250	24	**74.50**	83.95	5V @ 1A
8	PB 203A	2250	24	**76.00**	72.45	5V ± 15V
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EXPANDED ADD-ON KEYBOARD *for the* ZX81

PART TWO BY J. M. STEJSKAL

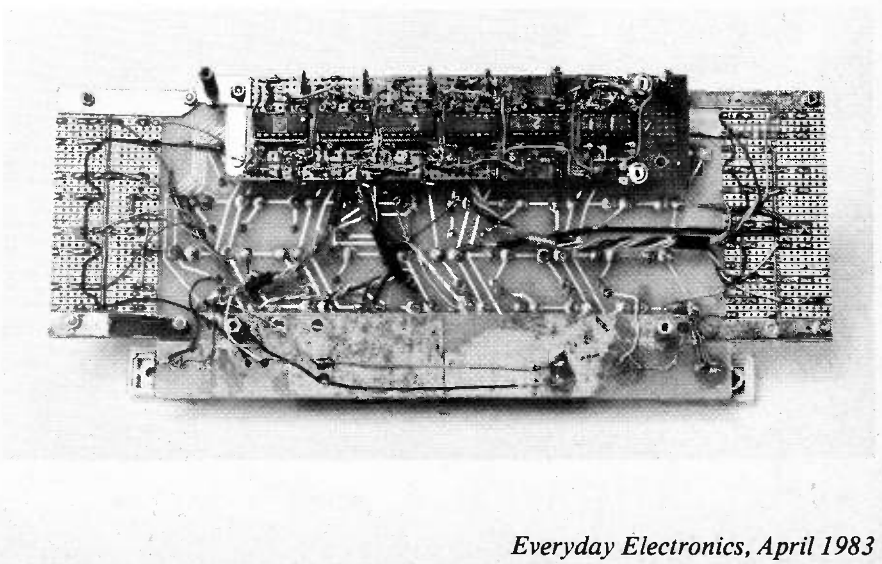
LAST month in Part 1 we dealt with the theory of the design. We now show how to build and test the unit.

CIRCUIT BOARDS

The circuitry was constructed on four separate circuit boards and fitted by means of home-made brackets to the main keyboard p.c.b. The plans shown here are for the original prototype, not very elegant admits the designer, but nevertheless quite efficient. No doubt some constructors will design a single p.c.b. to accommodate all circuitry.

The circuitry requires a +5V power supply. On the prototype this was picked up from the ZX81 internal supply as was the 0V line. These were connected to the edge connector receiving KBD0 to KBD4 and A8 to A11 from the ZX81 to connect to the main circuit board. On the Redditch keyboard there are two spare positions on the rear finger set. They were used by the author to receive the two supply lines. An l.e.d. and series resistor (180 ohms) were fitted across these fingers also to act as a power on indicator for the extended keyboard circuitry.

Underside view of completed prototype Expanded Keyboard.



VEROSTRIP

The two circuit boards to be fitted to either end of the main keyboard are shown in Fig. 4 and photographs. These are lengths of Verostrip. This board already has a line of "breaks" in the copper strips running through the centre of the board length. Start by fitting and soldering the keyswitches to previously cut and drilled lengths for the two boards. All other connections to be made on the underside (copperside) of the board.

Assemble each board and fit the necessary linking wires between tracks using, in most cases, p.v.c. covered wire. Do not fit any off-board wiring or components at this stage. Next bolt both boards (A and B) to the main keyboard using a technique of drilled supports as shown in Fig. 4 or some other method you prefer.

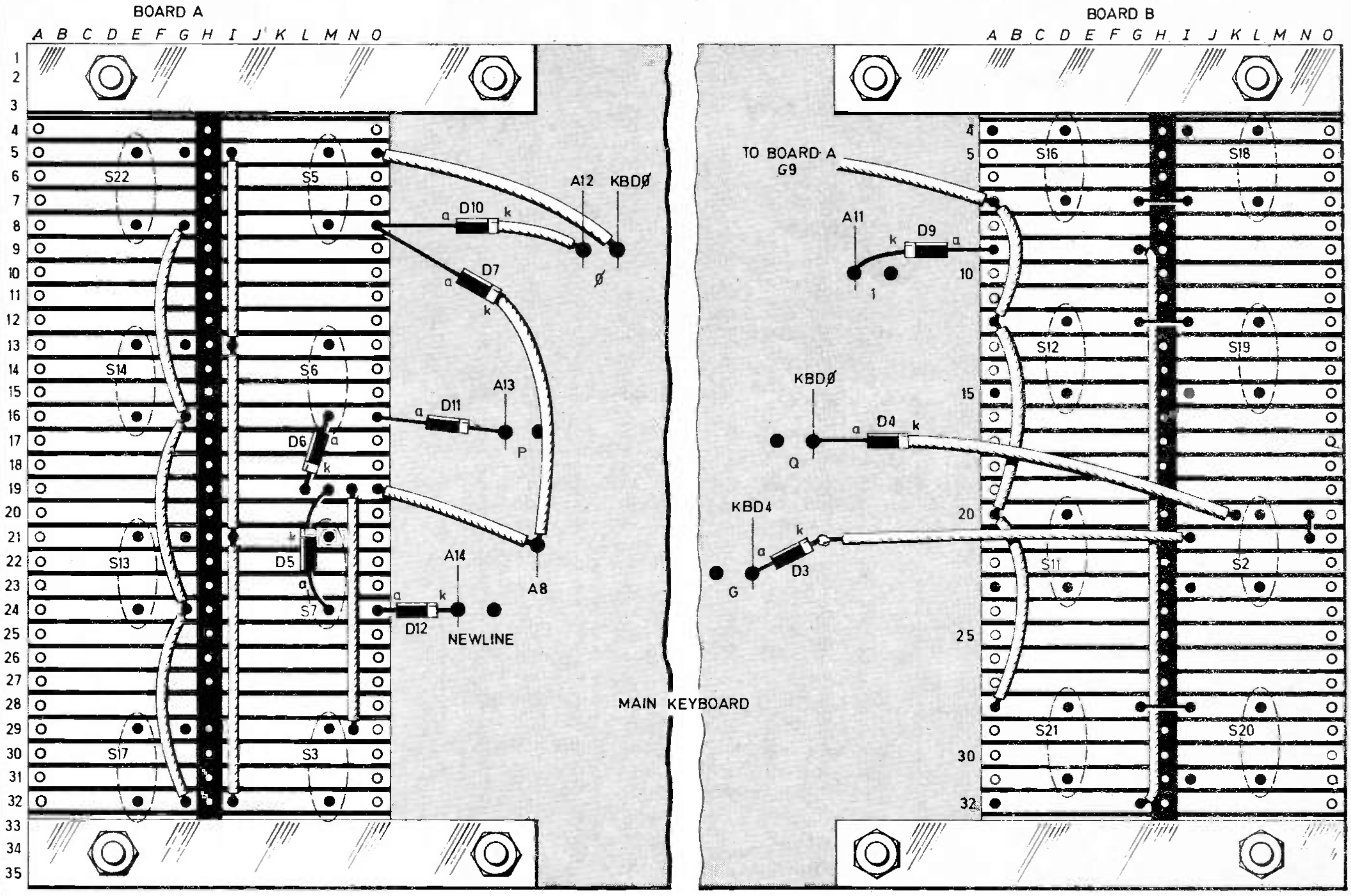
In the prototype, board C was made from a piece of fibre glass board with the key switches glued to one side with their leads protruding through holes suitably drilled in the board. One half of a length of Verostrip could be used instead, but will not be as strong as the fibre glass strip. A dedicated fibre glass p.c.b. would be the best choice. The board is bolted to the main p.c.b. using 25mm long threaded spacers acting as both nuts and mounting feet.

With A, B and C boards secured in place, the wiring and components interconnecting them to the main keyboard may now be soldered in place.

INTEGRATED CIRCUITS

The fourth board (D) is a piece of Verostrip and this holds the logic gates and their associated components for the remainder of the key switches, S11 to S22.

The component layout around each of the six i.c.s is identical. This layout is shown in Fig. 5 which also gives details of the breaks to be made along the copper strips on the underside as well as the existing breaks on the Verostrip.



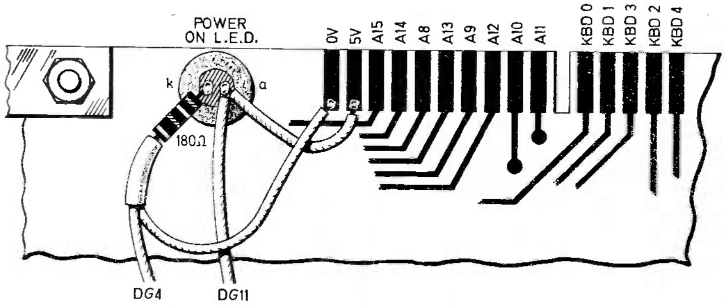
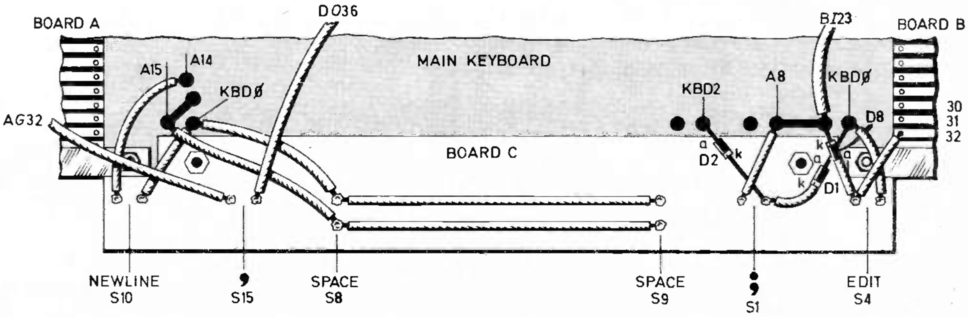
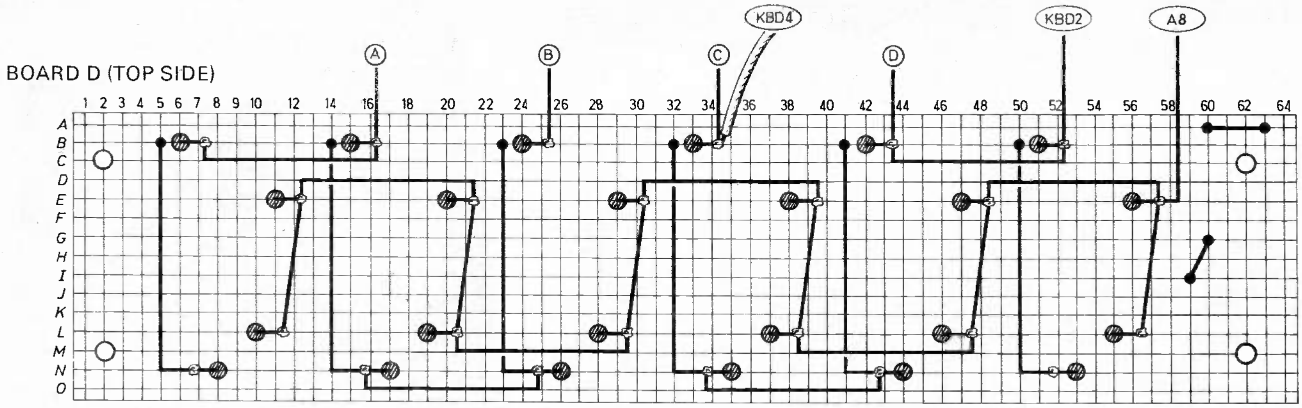


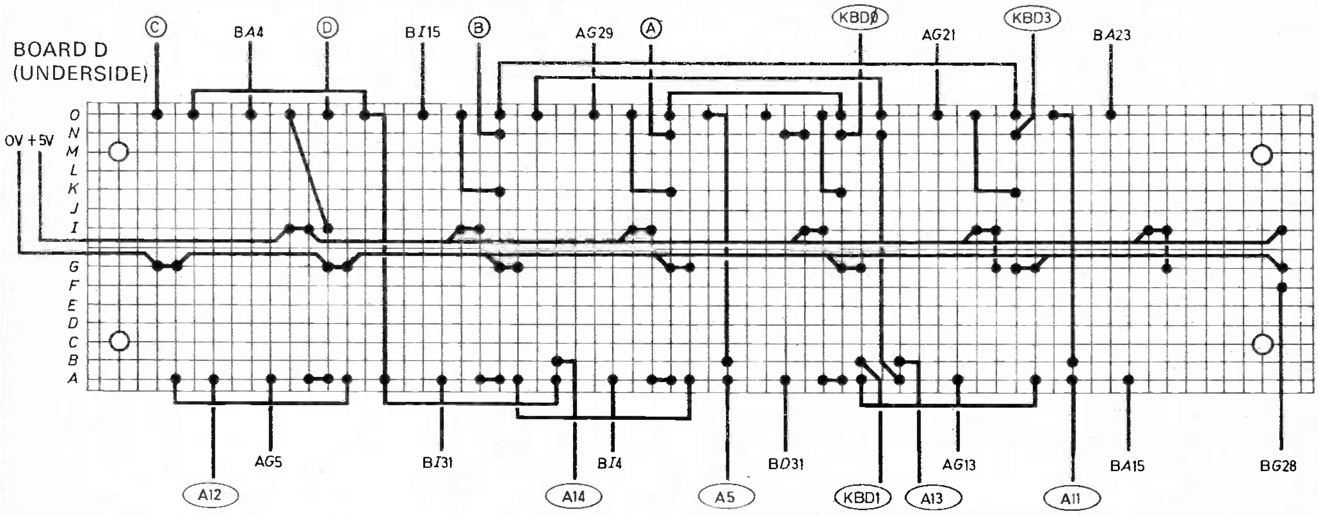
Fig. 4a (upper). Layout of the keyboard switches on the two extreme boards, A and B, and interwiring to each other and the main keyboard p.c.b. with fixing details.

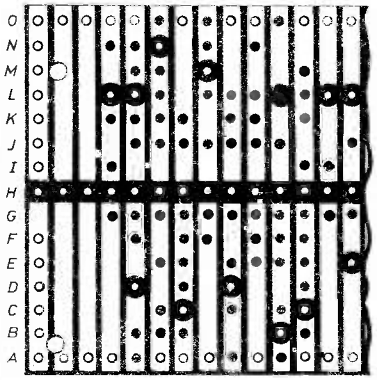
Fig. 4b (left). Labelling of the input finger set on the underside rear of the main keyboard p.c.b.

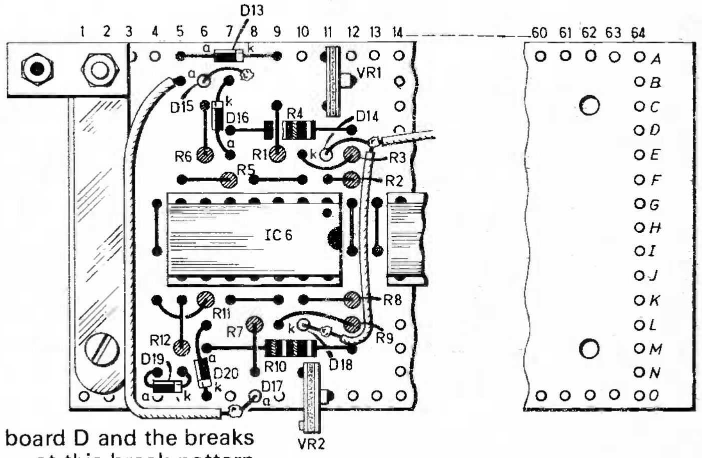
Fig. 4c (below). Board C with key-switch positions and interwiring to the main board and boards A, B and D.





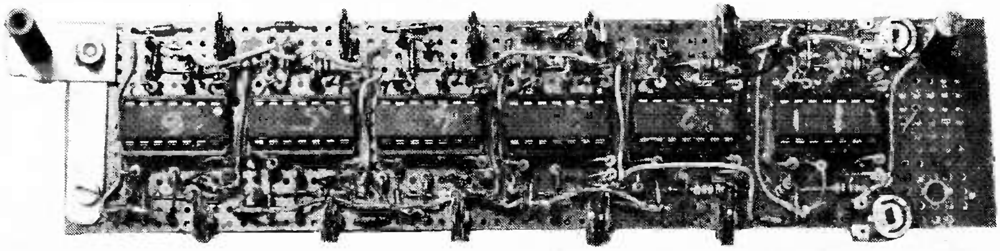




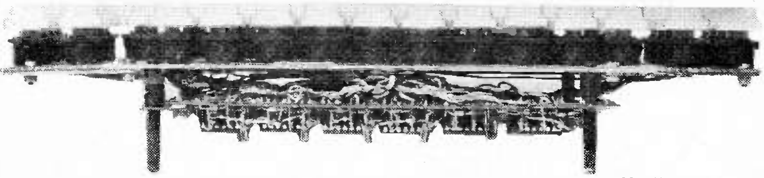


BOARD D

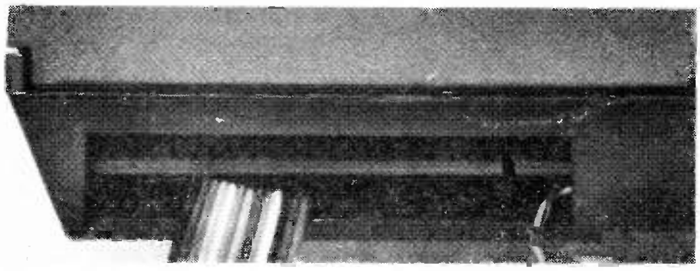
Fig. 5. The layout of one complete section on board D and the breaks to be made in the strips on the underside. Repeat this break pattern and layout (6 sections) along whole length of the Verostrip. Upper two drawings give interstage wiring on top and underside of board D. Use p.v.c. covered wire for all interconnections other than very short links.



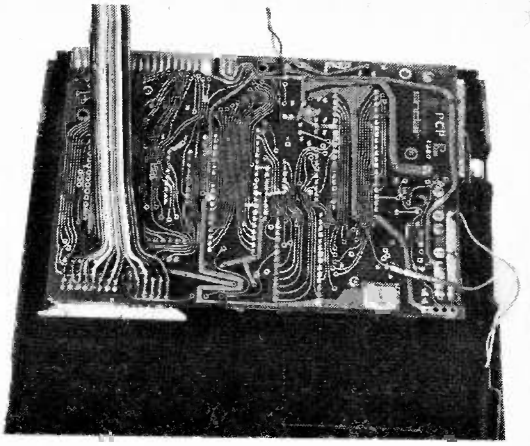
Close up plan view of board D topside.



Edge view of completed prototype fitted with stand-off pillars.



Ribbon cable exits ZX81 at expansion slot bus.



Connection to the ZX81 p.c.b.

Repeat this break pattern around each i.c. location along the board. This board is fitted to the main board using stand-off pillars and brackets. Drill the fixing holes for mounting these first. All i.c.s are fitted in sockets. This allows easy replacement at any time should this prove necessary.

Begin assembly of board D by soldering all the sockets to the prepared board followed by the link wires, resistors and diodes. Pay special attention to diode polarities. The cathode end (k) is marked with a band. With all the components assembled, the topside and underside interwiring may be carried out now. Thoroughly check this board before proceeding.

Dealing with an i.c. gate pair at a time, wire board D to the other boards, checking the operation of each i.c. as it is connected.

Make the connecting wires sufficiently long so that, after soldering to their correct destinations, they can be neatly bound and, when any adjustment, servicing or replacement becomes necessary, the complete i.c. strip can be detached and placed in front of the keyboard in the normal, upright position without having to disconnect anything.

SETTING UP

The six presets VR1 to VR6 need to be adjusted to give the required results. Consider the TO switch and its associated circuitry.

If the resistance of VR1 is too small either nothing happens when S11 is pressed or only a slight flicker on the screen will result. Increase VR1 resistance until the desired character (TO) appears, then increase slightly more and leave it there. A further increase will produce the unshifted character, in this case, 4.

The correct setting of VR1 ensures a stable operation of the "shift first" rule. It is possible to start the adjustment of VR1 with either the minimum or maximum resistance in the circuit, so position of each preset wiper is unimportant at switch on.

Should difficulty be experienced in producing the shifted character, then reduce the value of R5 position resistor to the next preferred value.

If R5 is too high, nothing shows apart from a screen flicker when the key is pressed. Neither a letter, number or a shifted character would appear (similar to low VR1). Reduce the value of R5 to 2·7kΩ, 2·2kΩ or 1·8kΩ (a resistance as low as 1·5 kilohms still works but the results may not be reliable). If several gates use the same A-line, reduce R5 in one or more circuits to 1·8kΩ. These tests and adjustments can be done at any time during construction, but the final setting of all presets and the final value of R5 position resistors can only be determined when all i.c.s are connected and working.

Although the resistors R2 and R3 are shown as 22kΩ, it may be necessary that, with some i.c.s, their value may have to be altered: R2 to 15kΩ, R3 to 10kΩ. As a general rule 22kΩ represents the most reliable value in almost every case. □

CIRCUIT EXCHANGE

TAMPERING DETECTOR

Most caravans plug into the car supply to provide lighting and power to other electrical systems. Anyone trying to steal the car would have to remove the plug to drive away.

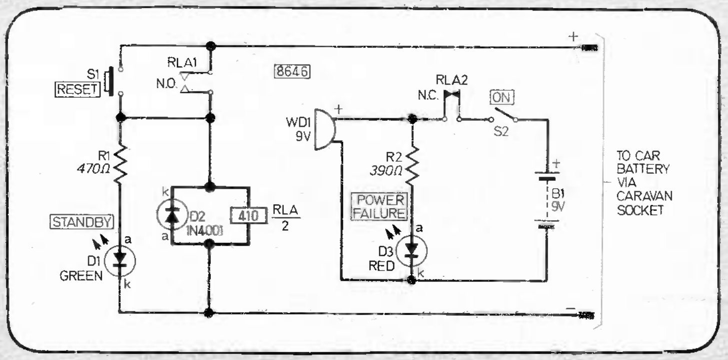
The circuit described here registers whether or not the plug has been removed.

With voltage applied to the caravan plug, one contact of RLA1 is "live". When the reset button of S1 is pressed, the relay coil RLA is energised and the normal open contacts of RLA1 engage, making the relay stay energised, even when the button is released. Diode D1 will light, indicating that power is applied.

When power is removed, by disconnection of the power plug, RLA1 opens and RLA2 closes making (when S2 is closed) WD1 sound and D3 light. Re-inserting the power plug back in its socket will not stop the buzzer from sounding until S1 is pressed again.

S2 switches off the unit when you want to drive away from the caravan without sounding the alarm!

Alex Clark,
Lichfield, Staffs.



MORE ON PAGE 238

COUNTER INTELLIGENCE

By PAUL YOUNG

Selective Problem

Two major problems face the component retailer today. The first being that the low unit price of discrete components, which in many cases has remained static over a number of years, makes it difficult to keep up with overheads that have escalated alarmingly.

The second is the proliferation of semiconductor devices. Looking through a catalogue of a well-known manufacturer recently, I found the total came to a staggering 32,000!!

To overcome the first, the retailer has been forced to diversify into the sale of items with a larger unit price such as radio, television, video recorders, and even computers. Therefore, you must not be surprised at his lack of enthusiasm for discussing what value resistor you should buy on a busy Saturday when the customer behind you is waving a fistful of tenners.

The second, he can only hope to solve by selective buying. This makes life very difficult, because he is torn between the desire to give good service, while at the same time knowing it is essential for his economic survival to only purchase those devices that will readily sell.

Well Done!

It is a human trait that we rejoice when David beats Goliath. A case that bears on our own hobby occurred recently.

The splash down of the nuclear fuel core, off the coast of Brazil, was another success and is the third time the school has beaten Russian and American scientists in announcing the news.

"We just had to rely on reports and radar data because the satellite's batteries went flat," said Mr. Geffrey Perry, science teacher.

The boys of Kettering school aided by their Science master and using their own home built electronic equipment, reported a Russian satellite falling to Earth. By their own skill they had beaten all the world's radio astronomers including the boffins of NASA with their wealth of priceless sophisticated tracking equipment.

We can only say, "Well done". It shows what the amateur enthusiast is capable of achieving.

Changed Character

My delight at poking fun at computers is well known to most readers. I am now a changed character and with good reason. Those of you who have been following the excellent BBC series, "Making the Most of the Micro" cannot have failed to have been touched by the experience of Richard Gomm that was shown at the start of the series.

Richard Gomm has a fine brain, an agile mind, a sense of humour and unbelievable courage. He suffers from Cerebral Palsy. Speech is difficult and the only part of his body he can move and to some extent control, is his head. He is endeavouring to write a thesis, and thanks to the computer he will be able to do it.

He grips a long spatula with his teeth and taps out the words on the keyboard letter by letter. This appears on the computer screen and he is able to correct it, before committing it to paper.

I found this spectacle deeply moving and decided that with this one use alone, the computer had more than justified its existence.

Electric Ambition

I have an ambition, before I depart this vale of tears, to own an electric car. Until now I have always thought that although technically feasible it would not happen in my lifetime, because if someone invented one, he or she would find it easier to sell to the oil Barons than trying to develop it and market it. It would then disappear.

However, I read recently that, that wizard supreme of electronics Clive Sinclair is now interested in the project and as his computers come off an assembly line at the rate of one every four seconds, I may be lucky yet.

BOOK REVIEWS

THE GRAMOPHONE GUIDE TO HI-FI

Author John Borwick
Price £12.50
Size 240 x 160mm. 256 pages. Hardback
Publisher David & Charles
ISBN 0 7513 8231 4

FROM the musical note struck in the very first chapter it is clear this is a book for people who love music written by a fellow devotee of the musical art. This note is sustained throughout, with a final emphasis in the appendix giving suggestions for a basic record collection. Mr Borwick is audio editor of *Gramophone* and a well-known broadcaster and lecturer in sound and recording topics.

The body of the work is concerned with the practical means to achieve the end—to recreate in the home as faithfully as possible the original sound from the concert hall. A history of sound recording is followed by basic physics of sound and music. Then the component parts of a complete audio system are described, with separate chapters each dealing with the record player, tape deck, tuner, amplifier and loudspeakers. The current state of the art in all these departments is well covered.

There is helpful advice on how to read specifications to aid the non-technical person when studying manufacturers' adverts and brochures, in preparation of the intending purchaser's first explorations of the hi-fi showrooms. As the author makes clear, the final assessment and decision on what to buy must rest largely on the customer's ears. But having read and digested the contents of John Borwick's book the task of selecting equipment and organising and looking after a hi-fi system can be approached with confidence.

F.E.B.

CIRCUIT EXCHANGE

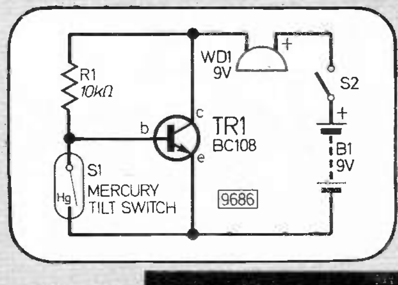
TILT ALARM

My idea is for a simple alarm circuit that activates when the sensor S1 is tilted from the vertical, the alarm stopping when repositioned.

The sensor S1 is a s.p.s.t. mercury switch, the contacts normally closed when the switch is held in the upright position. The transistor TR1 switches the buzzer off as soon as the sensor is returned to its upright position.

The mercury switch is available from Tandy stores. The complete unit can be built in a matchbox and used as an alarm or simple spirit level.

D. Cockburn, Middleton, Manchester.



MORE ON PAGE 241

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

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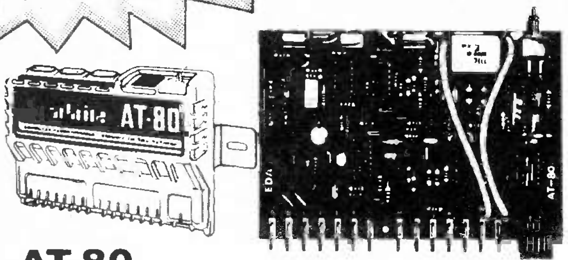

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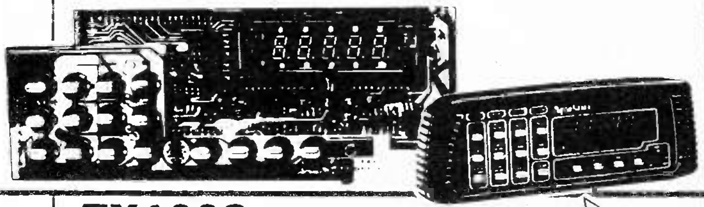

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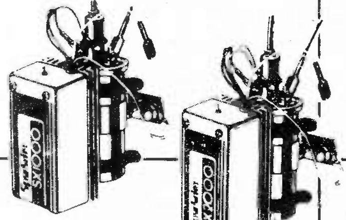

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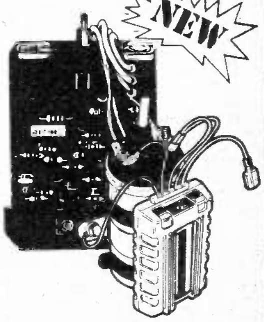
NEW



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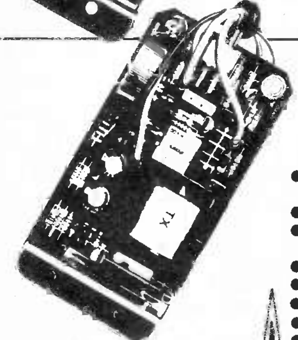

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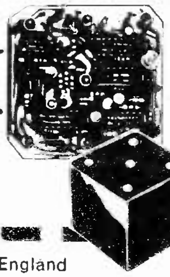

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This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 11¾" x 8½" x 3¼".

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Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors capacitors, hardware top cover, printed scale and mains transformer. You only supply solder and hook-up wire.

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Self assembly simulated wood cabinet - £4.50 + £1.50 p&p.

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PERSONAL LS AMP KIT

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Parts: Stereo power amp PCB with all components, £3.50 + 75p p&p. Power supply unit, £1.95 + £1.50 p&p. Pair of 4½" eliptical speakers, £1.50 the pair, + £1.00 p&p. Input & output sockets & plugs, £1.50. Recommended case (for the power supply and amp only), £2.95 + 80p p&p.
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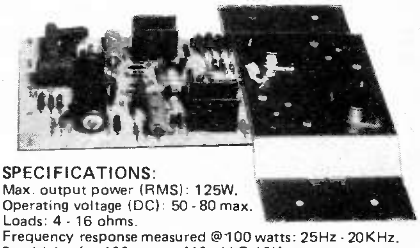
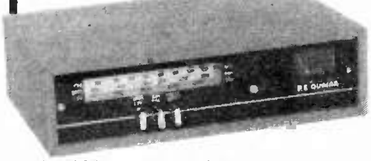
Supplied with all parts, circuit diagrams and instructions.

ACCESSORIES: Suitable mains power supply kit with transformer: £8.50 plus £2.00 p&p.
Suitable LS coupling electrolytic: £1.00 plus 25p p&p.



SPECIFICATIONS:
Max. output power (RMS): 125W.
Operating voltage (DC): 50 - 80 max.
Loads: 4 - 16 ohms.
Frequency response measured @100 watts: 25Hz - 20KHz.
Sensitivity for 100 watts: 400mV @ 47K.
Typical T.H.D. @ 50 watts, 4 ohms: 0.1%.
Dimensions: 205 x 90 and 190 x 36 mm.

P.E. STEREO TUNER KIT



This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July '81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.
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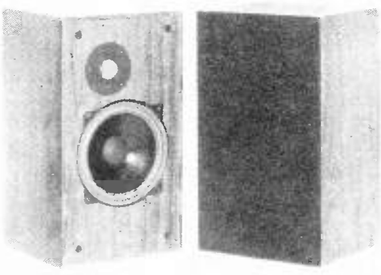

Originally made to sell for over £70. Unit comprises 8" bass/mid range and 4" soft dome tweeter and a 6 element crossover. Mirror image. Finished in rosewood. Size: 470mm high x 264mm wide x 225mm deep. Empty cabinets available separately if required. **£9.95 pair + £4.75 p&p.**

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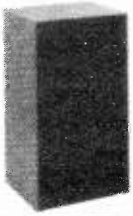

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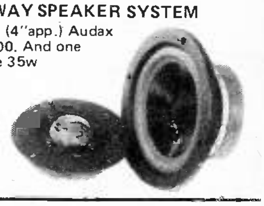

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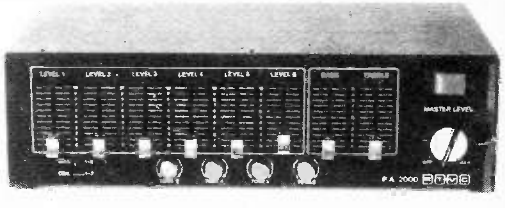

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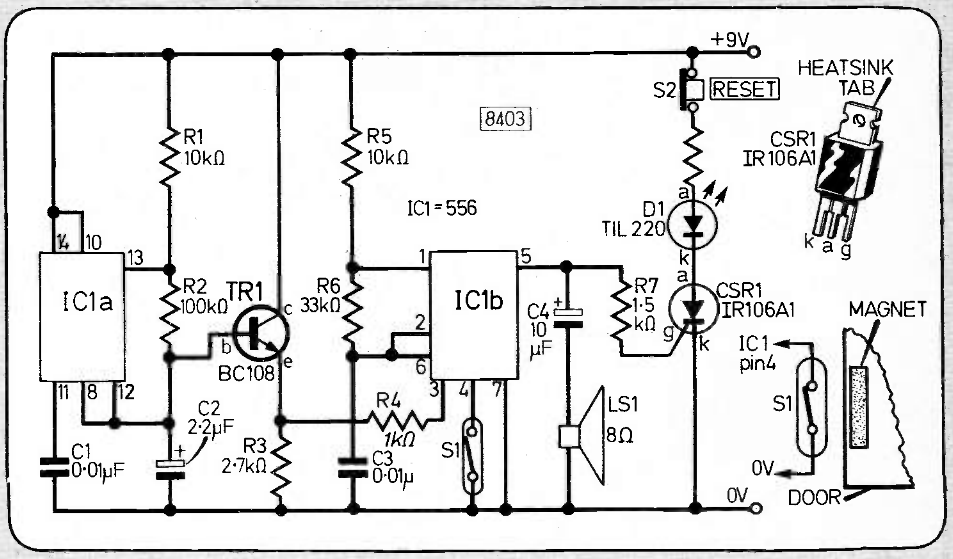
CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised.

Payment is made for all circuits published in this feature.

Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

DOOR ALARM WITH L.E.D. INDICATOR



This circuit gives out an "American" siren sound when the reed switch S1 is de-activated and also operates a light emitting diode (l.e.d.).

A magnet, mounted in a door, is sited beside the reed switch to hold the contacts closed, shorting the reset pin 4 of IC1 to the 0V line so that the siren will not sound. When someone opens the door, the magnet's influence on the switch S1 is removed and the siren sounds.

Once the door has been opened, the light emitting diode, D1 is also activated. It stays on even when the door is closed again because of the action of the thyristor CSR1. The push-to-break switch S2 resets D1 to standby.

The timing circuit is built around a 556 dual timer i.c. IC1a operating as a slow astable and IC1b as a fast astable producing the note.

The switch S2 and the l.e.d. D1 should be concealed outside the door. This is because the siren would go off as you enter or leave the room. Also, as the light emitting diode D1 remains on, once triggered, you have to be able to reset it before entering the room and as you leave.

M. Lawson,
Choppington, Northumberland.

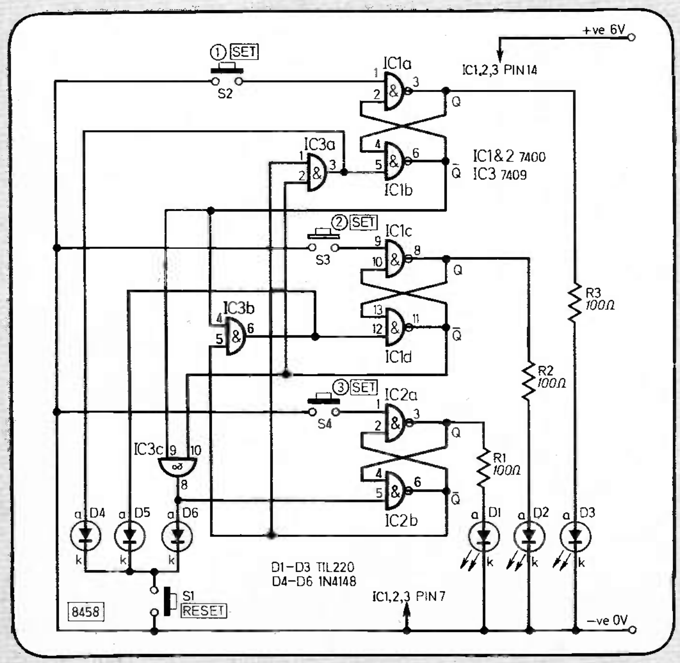
THREE WAY SNAP INDICATOR

This circuit uses three bistable latches. When one latch is set by its switch, the Q output goes high and lights an l.e.d. and the $\bar{Q}$ output puts a low on the inputs of two AND gates connected to the other two latches. Thus causing the outputs of these gates to go low also, resetting the other two latches and stopping them being activated.

So the first button to be pressed latches the appropriate l.e.d. and disables the other latches. If another button is pressed, the relevant l.e.d. will light, but not latch.

To reset the unit, switch S1 is pressed which resets every latch, using the diodes to stop all the reset inputs being permanently shorted as this would prevent the unit operating properly.

Lee Dowthwaite,
Workington,
Cumbria.



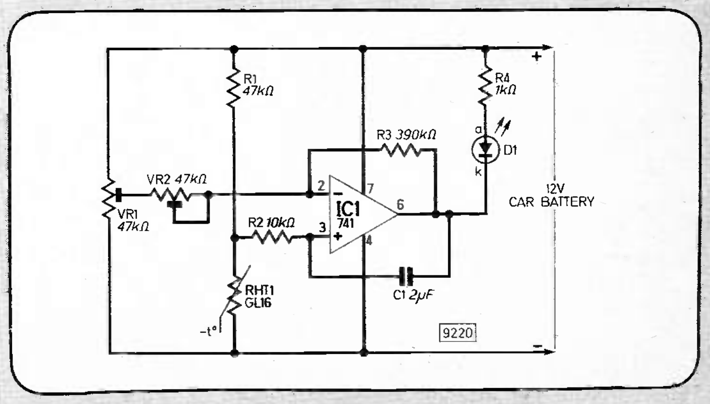
CAR OVERHEATING INDICATOR

This unit gives a timely warning before your car gets overheated. The l.e.d. D1 will flash at a regular rate when the temperature reaches a predetermined value as set by VR1.

When the temperature continues to rise the l.e.d. stops flashing and becomes continuously illuminated. The range of temperature over which it flashes can be set by VR2.

The unit is suitable for both positive and negative earth vehicles without modification. The frequency of flashing of D1 can be altered by changing the value of C1.

J. Sreekumar,
Kaloor, Cochin-17,
India.



Car Radio POWER Booster

BY C. LARE

IN general, car radio units do not have an adequate audio output level. This is because they use a simple class *A* or *B* output stage, which, off a 12-volt supply, can only produce 4-5 watts. This level of audio is often not sufficient to be heard above the ambient noise without driving the unit's output stages into severe overload.

BRIDGE MODE

One method of increasing the audio level is to use two standard amplifiers in *bridge mode.* This effectively multiplies the output power by 4 into the same impedance speaker. The maximum power available from a 12-volt supply is around 20 watts into 4 ohms.

This level of power has been found to be perfectly adequate when driving a pair of Pioneer TS107 speakers. Indeed, the value of higher powers must be questioned because it has been found that even gentle use of the bridge power booster masks the engine sound which is unwise if something starts to rattle prior to falling off. It is this method of power boosting which forms the basis of this article.

BRIDGE MODE AMPLIFICATION

Before considering the actual circuit in any detail it is necessary to understand the basics of bridge mode amplification. Consider Fig. 1, which shows the output stage of a typical amplifier. For clarity a class *B* type is assumed, although a class *A* would be just as appropriate. Before the decoupling capacitor the amplifier output sits at 6 volts ($\frac{1}{2}$ supply) without any audio input. The capacitor ensures that this d.c. voltage does not appear across the speaker.

Now, if an audio signal is applied to the amplifier the output will swing around the 6-volt level, and will obviously produce the highest sound levels as it approaches the 12-volt and 0-volt levels since these correspond to the largest deviation from the 6-volt centre line. The output will not actually reach 12 volts or 0 volts because of the voltage drop across the output transistors.

This voltage will be termed $V_{CE\ Sat}$, because it corresponds to the full-on condition of the transistor, or the saturation voltage drop. A typical value of $V_{CE\ Sat}$ is 2 volts, and so the maximum power of a single-ended amplifier such as the type in Fig. 1, is given by:

$$P_{out} = \frac{V^2}{R_L}$$

where R_L is the speaker impedance therefore

$$P_{out} = \frac{(V_s/2 - V_{CE\ Sat})^2}{R_L}$$

where V_s is the total supply voltage. Using typical values of R_L (4 ohms), V_s (12 volts) and $V_{CE\ Sat}$ (2 volts) the power output is easily calculated as being 4 watts, a figure to be found in most radio specifications.

A bridge mode amplifier uses two amplifiers, with one of the amplifiers connected to give an inverted output. The speaker is connected between the two amplifier outputs (Fig. 2). Obviously, as before, the two amplifiers will sit with a 6-volt output when no signal is applied. Thus, when no signal is present no current flows through the speaker, and as an added bonus therefore, no output decoupling capacitor is required.

If a positive signal is applied to the input the output of the non-inverting amplifier will rise, and the output of the inverting amplifier will fall by the same amount. The voltage across the load then, for any given input, is twice the voltage one would obtain from a single-ended amplifier. It also follows that, if the input voltage falls, the non-inverting amplifier output will fall as the inverting output rises, and the twice voltage condition is preserved.

The result of this is that the peak voltage across the load is no longer

$$\frac{(V_s - V_{CE\ Sat})}{2}$$

but

$$(V_s - 2V_{CE\ Sat})$$

(one $V_{CE\ Sat}$ drop on each amplifier), and so the actual output power is vastly increased as follows:

$$P_{out} = \frac{(V_s - 2V_{CE\ Sat})^2}{R_L}$$

and using the same values as before gives a power output of 16 watts. This is slightly lower than they hoped for

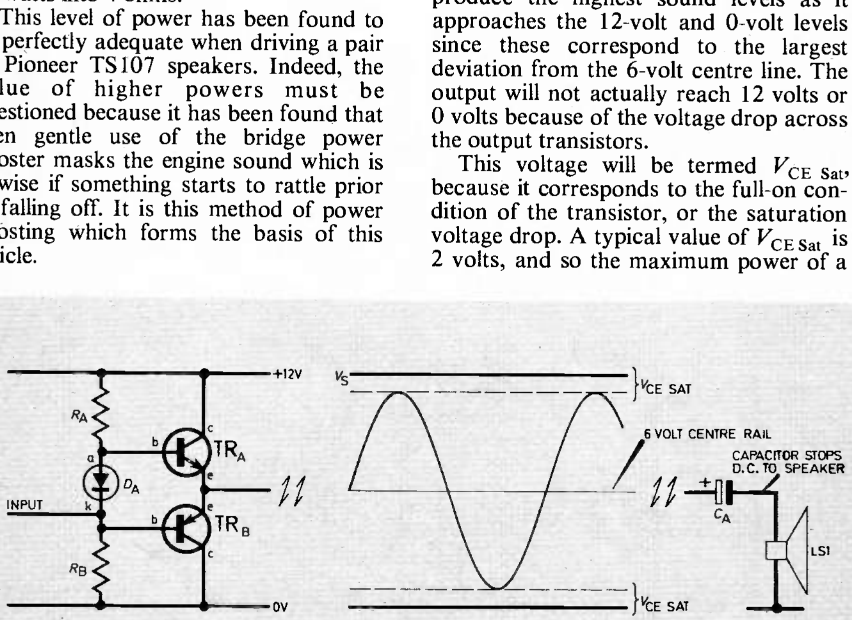


Fig. 1. Diagram showing the output stage of a typical amplifier.

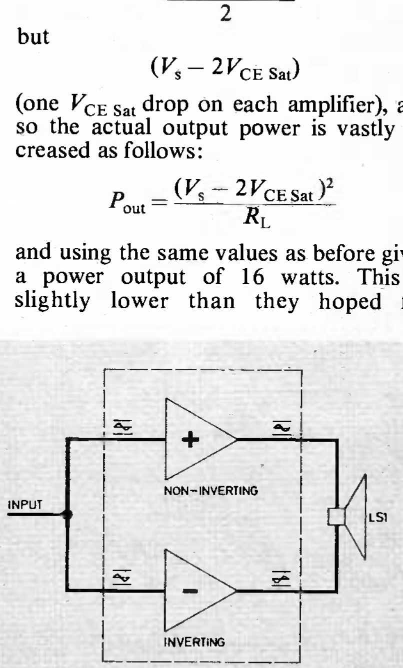


Fig. 2. Wiring diagram of two amplifiers in a bridge mode configuration.

because of the rather generous value of 2 volts assumed for $V_{CE\ Sat}$, and in fact, the prototypes managed 18·9 watts before clipping off 11·8 volts.

DUAL POWER AMPLIFIER

In this project use is made of a dual power amplifier available in a single package. The TDA2004 contains two identical power amplifiers, which may be connected in inverting or non-inverting mode, which makes it ideal for this application. Obviously the two amplifiers may be used separately in standard stereo modes.

The TDA2004 is particularly suitable for mounting in cars because it is an electrically robust device and can stand reverse polarity connections for the time it takes a fuse to blow, excessive temperatures, high voltage spikes and even output short-circuits.

CIRCUIT DESCRIPTION

The circuit for the Car Radio Power Booster is shown in Fig. 3. The first amplifier (pins 1, 2 & 10) is arranged as a non-inverting amplifier. Because of the internal structure of the device a current proportional to the input signal flows out of pin 2 (usually the non-inverting terminal), and this is fed to the second amplifier through its inverting terminal.

This amplifier has the non-inverting terminal connected to ground at a.c. frequencies by C6 which ensures stability. This configuration works because the input stage of the TDA2004 is a simple transistor with the base designated non-inverting input and the emitter-inverting input. The collector load is a current source, and so by connecting the two emitters together, change on one emitter as a result of an input moves the other emitter, which gives rise to out-of-phase output signals.

The two inverting inputs are decoupled by C2 to ensure that minute differences in the two amplifier sections do not cause a different nominal output voltage to occur, and hence a constant current flow through the speaker. Two *Zobel* networks on the outputs ensure stability by matching the impedance of the speaker to the amplifier over the entire frequency range.

The input is taken directly from the output stage of the radio. The waste power developed is passed into the 100 ohm resistor, R1. The signal is then divided down in level by R2 and VR1, which provides for level adjustment. Two ferrite beads and the 560pF capacitor C1 tend to filter out any interference from ignition, generator, or CB. The signal is then coupled into the TDA2004 via C9, a d.c. blocking capacitor.

The power is supplied via a 2-amp fuse and a 100µF electrolytic capacitor which together with the 0·1µF capacitor tends to decouple the i.c. The input stage of the i.c. is more sensitive to supply variations than the output, and is further decoupled by means of R4 and C8.

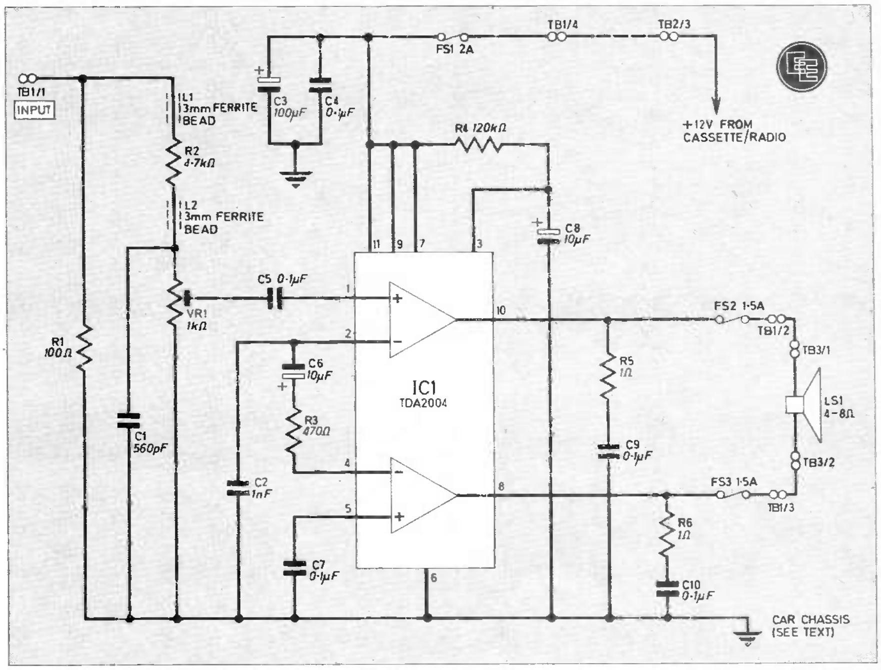


Fig. 3. Complete circuit diagram of the Car Radio Power Booster.

COMPONENTS

Resistors

R1	100Ω ½W
R2	4·7kΩ
R3	470Ω
R4	120kΩ
R5	1Ω
R6	1Ω

All ¼W carbon ±5% unless otherwise stated

Capacitors

C1	560pF polystyrene
C2	1nF ceramic plate
C3	100µF 16V elect. radial leads
C4	0·1µF polyester (C280)
C5	0·1µF polyester (C280)
C6	10µF 16V tantalum
C7	0·1µF polyester (C280)
C8	10µF 16V tantalum
C9	0·1µF polyester (C280)
C10	0·1µF polyester (C280)

Semiconductors

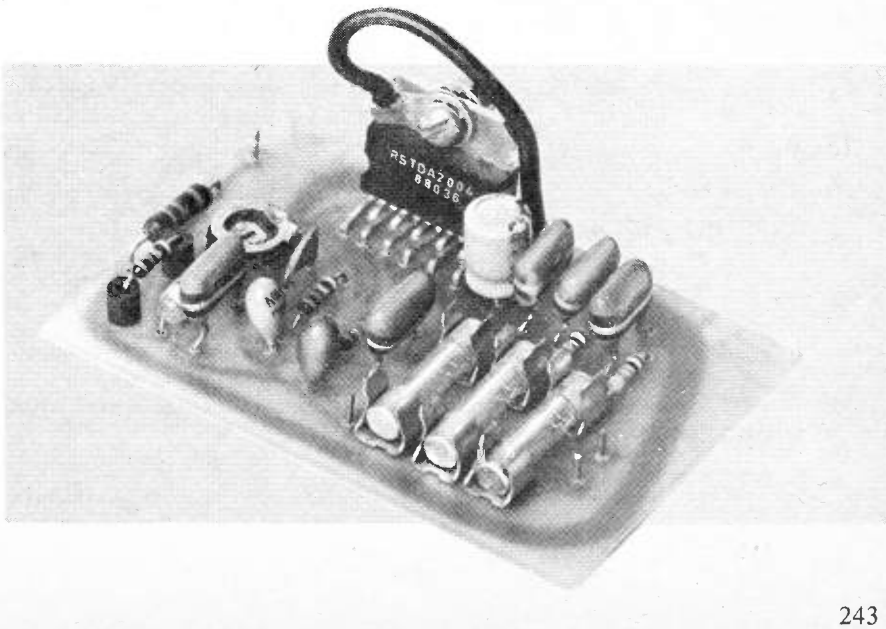
IC1	TDA2004

Miscellaneous

VR1	1kΩ miniature preset
FS1	2A 20mm fuse
FS2, 3	1·5A 20mm fuse (2 off)

Aluminium case type (AB11), 102 × 64 × 51mm; single-sided p.c.b. 90 × 50mm; 6 fuse clips; 2 ferrite beads; 4BA solder tag; 4BA nut and bolt; heatsink compound.

Guidance only
Approx. cost £10



Car Radio POWER Booster

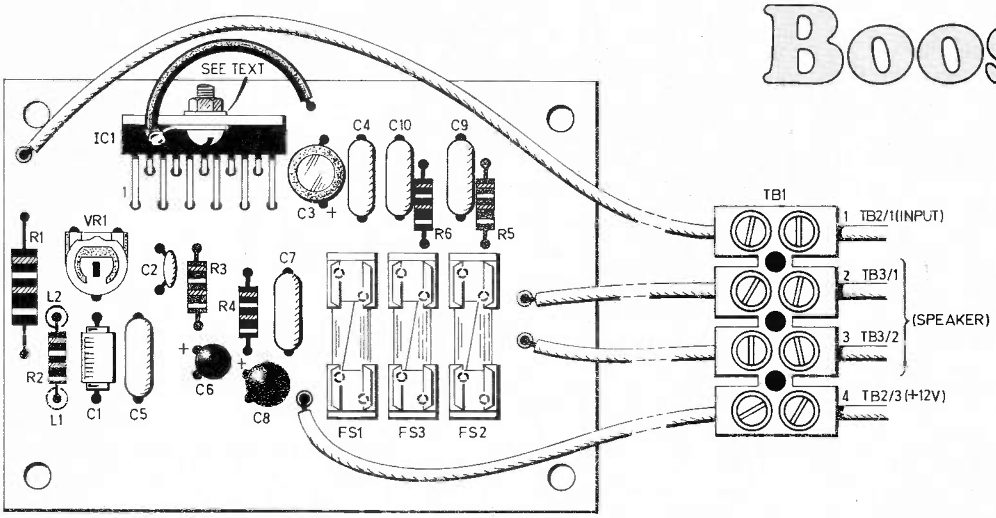
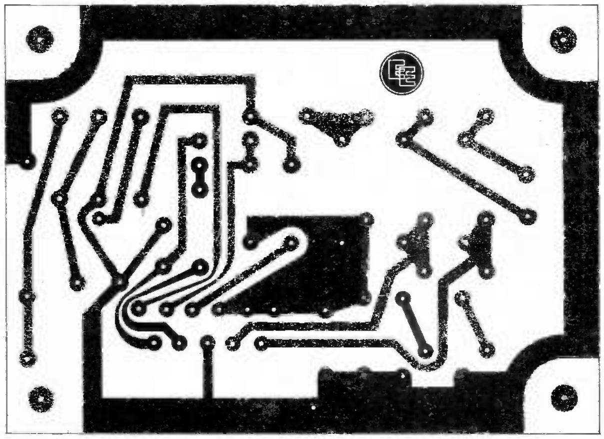
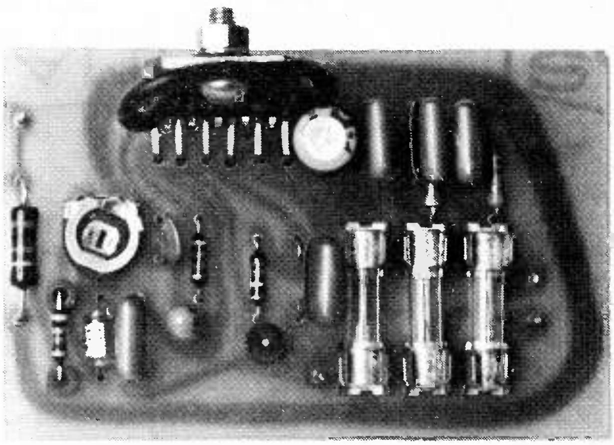


Fig. 4. Component layout, interwiring and full size printed circuit board.





Completed circuit board for mono version.

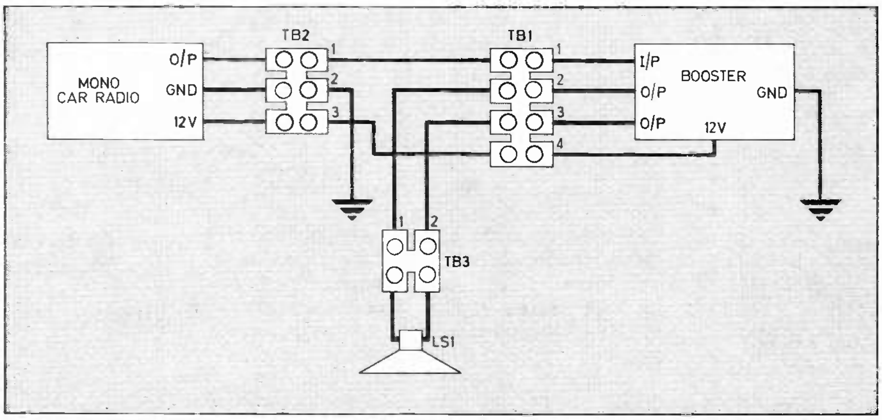


Fig. 5. Complete wiring diagram for a mono audio system.

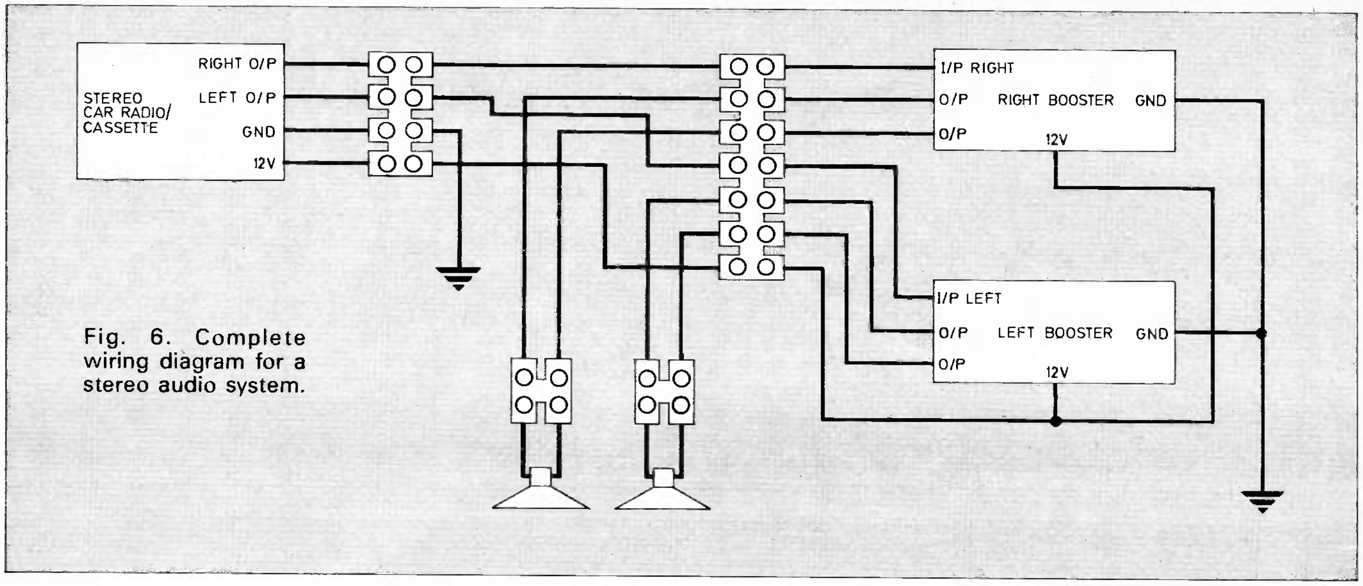


Fig. 6. Complete wiring diagram for a stereo audio system.

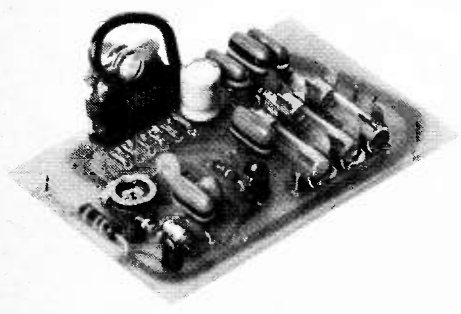
CONSTRUCTION starts here

PRINTED CIRCUIT BOARD

Construction of the booster is very simple indeed, and the only care that really needs to be taken is with the polarised capacitors. However, it is strongly suggested that the printed circuit board design is used, otherwise stability problems may well result. Note in particular that the *earthy* side of the input resistor, R1, is taken back to the central earth down a discrete track (Fig. 4).

Inserting the TDA2004 can be tricky, but patience and a small pair of pliers will insert it in the end. Don't forget the ferrite beads. It may well be necessary to bend in the fuse clips to stop them from touching, and this should be checked.

Finally, connect a piece of wire from the ground pin on the board to a 4BA solder tag, which should be bolted to the tag of the i.c.



TESTING

If a current limited supply is not available connect a 10 ohm resistor between the supply and the board. Connect the ground to the low side of the supply, using the solder tag on the i.c. to make the connection. Apply power and check that nothing becomes hot. Measure the standing current which should be between 60mA and 140mA.

Finally, check that both outputs are sitting at about 6 volts. If this is so connect up a 4-ohm speaker and a low impedance input. If the amplifier is to be run from a signal, rather than speaker levels, remove R1 and temporarily short-out the resistor R2.

Turn down the preset on the board and apply power. If all is still well turn up the preset and the output should become audible. If this does not happen check all the connections, particularly that all the legs of the TDA2004 are properly placed and soldered. The amplifier is now ready for installation.

INSTALLATION

The car must be negative earth if the amplifier is to be used as described. The heatsink of the i.c. may be bolted to any convenient bulkhead using the 4BA bolt, or a self-tapping screw, but some heatsink compound should be placed between the heatsink and the car chassis. Check continuity between the chassis and the amplifier ground, making it good if not.

Connect up a 12-volt supply from either the ignition switch or the radio "on" switch and then connect in the speaker. Some radios have two wires feeding the speaker outputs; in this case it will be necessary to establish with the aid of an ohmmeter which is the *earthy* one which is not used. For radios with only one wire where the speaker is returned to chassis there is no problem and the normal speaker feed should be connected into the booster input.

It is suggested that when installing your Car Radio Power Booster, terminal blocks should be used for wiring connections from the radio, booster and speakers. The terminal blocks may then be positioned using double-sided tape. Detailed terminal block wiring is shown in Fig. 5.

The finished booster should be housed in an aluminium box of a suitable size (AB11). Aluminium in particular has good heatsinking qualities. Note that if the audio booster is to be used for a stereo system an additional booster must be constructed. The two boosters can then be connected as shown in Fig. 6. If the boosters are connected as shown in Fig. 6, remember that the case should be solidly connected to the car chassis. □

SQUARE one FOR BEGINNERS

ELECTROLYTIC capacitors are found in many electronic circuits. In mains power supplies they are virtually indispensible. Elsewhere they are often the most convenient packages of capacitance since they are compact and cheap. But "electrolytics" have limitations which the user needs to keep in mind.

PRINCIPLE

If a sheet of aluminium is suspended in a solution of borax in a metal container (Fig. 1a) and a voltage applied, as shown, several things happen. At first, a relatively large current flows, because the solution is a conductive one (an electrolyte). Chemical action takes place at the aluminium plate, whose surface slowly becomes oxidised.

The oxide is an insulator which in covering the metal restricts the flow of current very severely. The oxide film acquires an electric charge to the battery voltage, and this charge dies away slowly after the battery is removed.

The aluminium plate becomes one plate of a capacitor whose dielectric is the oxide film. The other plate is the electrolyte, which connects to the metal container.

HIGH CAPACITANCE

The oxide layer is very thin: of the order of a ten-thousandth of a millimetre. Thin dielectrics mean high capacitance.

The capacitance can be increased by first etching the surface of the aluminium with acid before making the capacitor. The myriad "etch pits" increased the effective plate area considerably.

In the form described, the capacitor is a "wet" electrolytic. That is, it contains free liquid.

In practice, the positive plate or "anode" is made from aluminium foil and the metal container or "can" is also aluminium. The foil is often laid over with a spongy insulator and rolled up compactly.

The electrolyte is held in by a rubbery seal which often embodies a crude valve for venting gas, which can be created by further chemical action. Applying a voltage of the **wrong** polarity can make this happen with explosive suddenness!

Other forms are less "wet". The electrolyte is still there, somewhere (it has to be), but is either held in an absorbent material to make a "semi-dry" capacitor or chemically solidified to make a "dry" electrolytic.

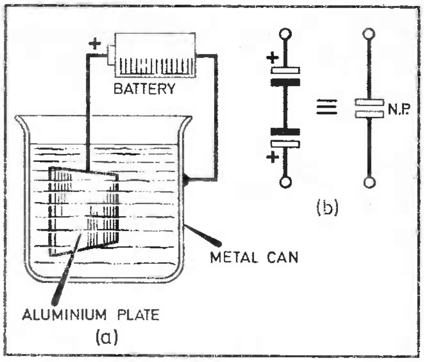
TANTALUM

If the metal tantalum is used instead of aluminium (and with a different electrolyte) the result is a rather superior capacitor, compact, of low residual ("leakage") current, and made to closer tolerances than the aluminium type. But also more expensive!

LIMITATIONS

The obvious limitation is that to preserve the oxide film an electrolytic must always be kept charged by a voltage of the same polarity. Reversing the polarity, or merely leaving the capacitor uncharged for a long time, causes the film to dissolve. Whether the capacitor can then be "re-formed" by applying a voltage marginally above the nominal working voltage depends on how far the damage has gone.

Fig. 1a. Demonstrating the principle and make up of the electrolytic capacitor. (b) Two electrolytics connected "back-to-back" to form a non-polarised capacitor.



If two electrolytics are connected "back-to-back" (Fig. 1b), one of them is always correctly "polarised", whatever the direction of the applied voltage. Non-polarised (N.P.) electrolytics are really like this, inside, and are therefore reversible, though hardly true a.c. devices.

A second limitation is imposed by the "leakage current", that is the small residual current which always flows, however long the "forming voltage" is connected. Tantalums have less leakage than aluminium electrolytics, but the leakage of both types can be reduced dramatically by operating a well-formed capacitor at a much reduced voltage.

If, on the other hand, the voltage is increased above the working voltage there is a very sharp increase in leakage current, and this may damage the capacitor. Voltage ratings must be observed! It is always safe to use a capacitor at less than its rated voltage, never safe to use it above its rating.

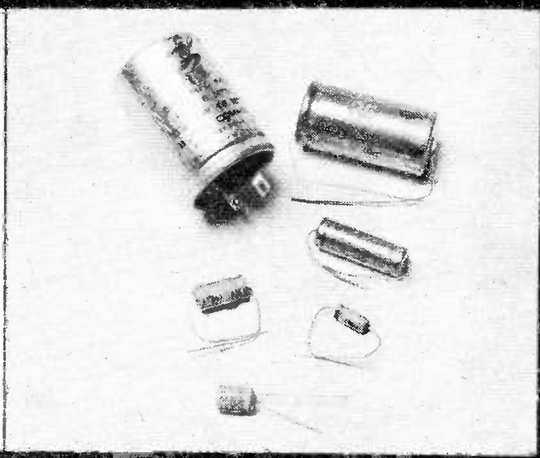
In most circuits in E.E. the highest voltage around is the battery voltage and it is wise to use capacitors rated at a somewhat higher voltage than this, say 16V or 20V for a 9V battery. Remember, however, that higher working voltage usually means a bigger component.

TOLERANCE

Because of the variability of the oxide thickness, aluminium electrolytics generally have very wide tolerances compared with other passive components. In many circuits it is important that the capacitance should not be less than a certain minimum.

This leads to tolerances such as: 1,000µF, +100%, −50%, which means that the true capacitance of this nominal 1,000µF capacitor could be as high as 2,000µF but in any case will not be less than 500µF. Tantalum electrolytics usually have more normal tolerances, such as ±20%.

A selection of electrolytic capacitors. The tolerance of these capacitors is generally very wide, often +100, −50 per cent and the leakage current, that is the d.c. current flowing between the plates, is also high. Typical uses include smoothing in power supplies and inter-stage coupling in audio amplifiers.



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ZX Expansion Module

This module incorporates the three functions of Microdrive controller, local area network, and RS232 interface. Connect it to your Spectrum and you can control up to eight Microdrives, communicate with other computers, and drive a wide range of printers.

The potential is enormous, and the module will be available in the early part of 1983 for around £30.

sinclair

Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS.
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The ZX Printer–available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set–including lower-case characters and high-resolution graphics.

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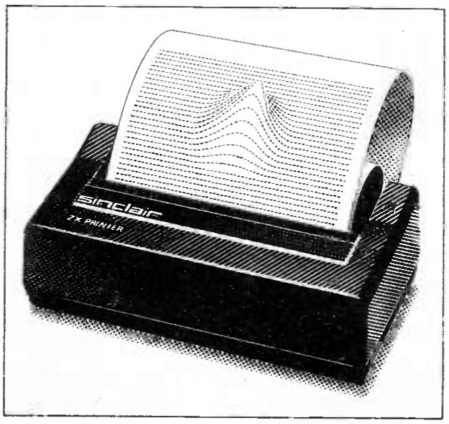

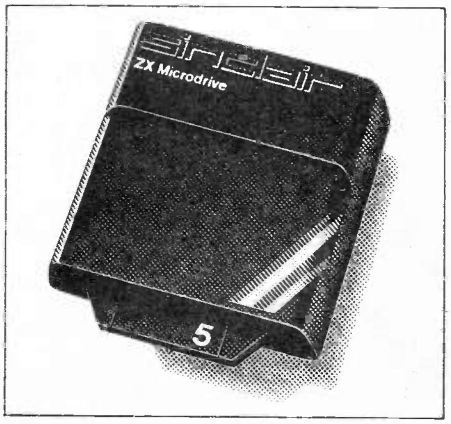

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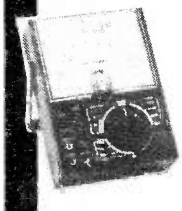

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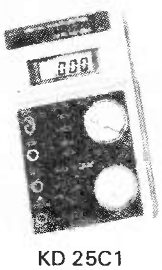

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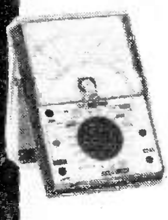

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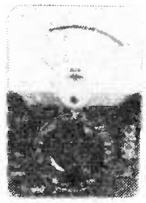

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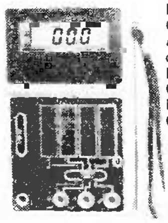

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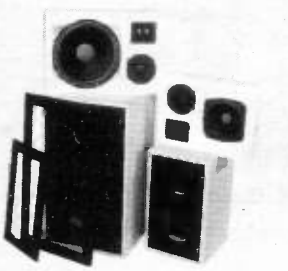

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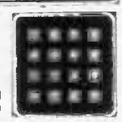
Price: **£11.70 each + 50p** P&P
(Any quantity)

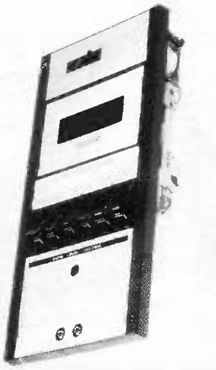
KEYBOARDS



MEMBRANE KEYBOARDS manufactured from a tough polycarbonate film mounted on 1mm glass fibre printed circuit board assembly incorporating silver plated contacts.

16 way numeric keyboard Standard keyboard providing 0-9 and A-F functions.
Size: 100mm × 100mm × 2mm. Price: £5.99 + 35p p&p

Alpha Numeric Keyboard Full size 55 key non encoded keyboard with the commonly required functions in a Qwerty array. Matrix output via a 16 pin DIL socket.
Size: 350mm x 100mm x 2mm. Price: £13.99 + 50p p&p

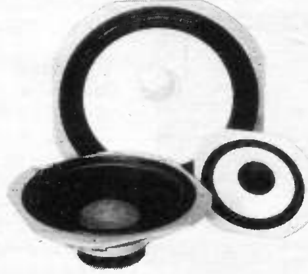


STEREO CASSETTE TAPE DECK MODULE.
Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided) **Dimensions:** Top panel $5\frac{1}{2}$in × $11\frac{1}{4}$in. Clearance required under top panel $2\frac{1}{4}$in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.50.**

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
Price: £28.50 + £2.50 P&P

LOUDSPEAKERS



15" 100 watt R.M.S. **(HI-FI, P.A., DISCO, BASS GUITAR)** Die cast chassis, 2" aluminim voice coil, white cone with aluminium centre dome. 8 ohm imp., Res. Freq. 20Hz., Freq. Resp. to 2.5KHz., Sens. 97dB (As photograph). **Price: £32.00** + £3 carriage.

12" 100 watt R.M.S. **(HI-FI)** Die cast chassis. 2" aluminium voice coil. Black cone. 8 ohm imp., Res. Freq. 20Hz., Freq. Resp. to 4.5KHz. Sens. 95dB. (As photograph). **Price: £23.50** + £3 carriage.

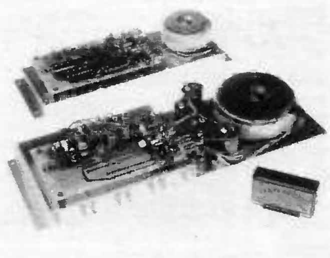
8" 50 watt R.M.S. **(HI-FI, P.A.)** 1½" aluminium voice coil. White cone. 8 ohm imp. Res. Freq. 40Hz., Freq. Resp. to 6KHz. Sens. 92dB. Also available with black cone fitted with black metal protective grille. (As photograph). **Price:** White Cone **£8.90**, Black cone/grille **£9.50** P&P **£1.25.**

12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. **Price: £22.00** + £3 carriage.

12" 85 watt R.M.S. **McKENZIE C1285TC (P.A., DISCO)** 2" aluminium voice coil. Twin cone. 8 ohm imp., Res. Freq. 45HZ., Freq. Resp. to 14KHz. **Price £22** + £3 carriage.

15" 150 watt R.M.S. McKENZIE C15 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. **Price: £47** + £4 carriage.

OMP POWER AMPLIFIER MODULES

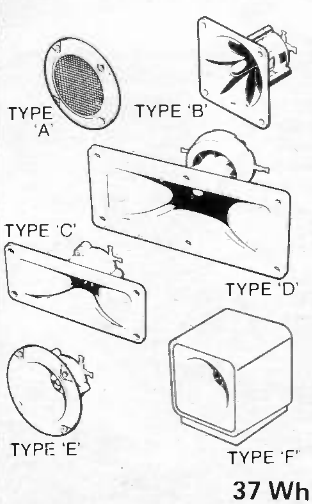


100 WATT R.M.S. AND 300 WATT R.M.S. MODULES
Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

SPECIFICATION:
Max Output Power: 110 watts R.M.S. (OMP 100)
310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof. 4-16 ohms.
Frequency Response: 20Hz — 25KHz +3dB.
Sensitivity for Max. Output:
500mV at 10K (OMP 100) 1V at 10K (OMP 300)
T.H.D.: Less than 0.1%
Supply: 240V 50Hz
Sizes: OMP 100 360 × 115 × 72mm
OMP 300 460 × 153 × 66mm
Prices: OMP 100 **£31.50 each + £2.00 P&P**
OMP 300 **£89.00 each + £3.00 P&P**
Vu Meter **£6.50 each + 50p P&P**

PIEZO ELECTRIC TWEETERS — MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is **not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £3.45 each.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £4.35 each.**

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.45 each.**

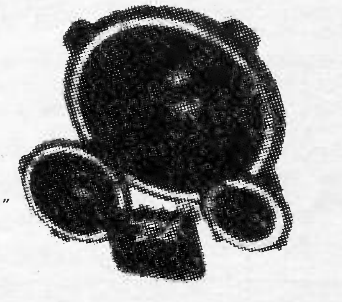
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £6.90 each.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.35 each.**

TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. **Price £10.75 each.**

P&P 20p ea. (or SAE for Piezo leaflets).

Matching 3-way loudspeakers and crossover



Build a quality 60watt RMS system 8ohms

Build a quality 60 watt R.M.S. system.

★ 10" Woofer 35Hz-4.5KHz
★ 3" Tweeter 2.5KHz-19KHz
★ 5" Mid Range 600Hz-8KHz
★ 3-way crossover 6dB/oct 1.3 and 6KHz
Recommended Cab-size 26" × 13" × 13"

Fitted with attractive cast aluminium fixing escutcheons and mesh protective grills which are removable enabling a unique choice of cabinet styling. Can be mounted directly on to baffle with or without conventional speaker fabrics. All three units have aluminium centre domes and rolled foam surround. Crossover combines spring loaded loudspeaker terminals and recessed mounting panel.
Price £22.00 per kit + £2.50 postage and packing. Available separately, prices on request.

12" 80 watt R.M.S. loudspeaker.
A superb general purpose **twin cone** loudspeaker. 50 oz. magnet. 2" aluminium voice coil. Rolled surround. Resonant frequency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance 8ohm. **Attractive blue cone with aluminium centre dome.**
Price £17.99 each + £3.00 P&P.

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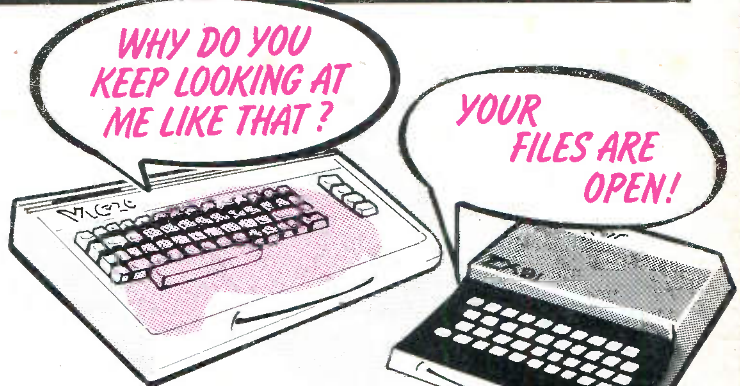
★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Mail order only. ★ All items packed (where applicable) in special energy absorbing PU foam. Callers welcome by **prior** appointment, please phone 0702-527572.

SPEECH SYNTHESISER FOR ZX81 and VIC20

THE MAPLIN TALK~BACK

Now your computer can talk!



★ Allophone (extended phoneme) system gives unlimited vocabulary.
★ Can be used with unexpanded VIC20 or ZX81 — does not require large areas of memory.
★ In VIC20 version, speech output is direct to TV speaker with no additional amplification needed.
★ Allows speech to be easily included in programs.

Complete kit only £24.95.
Order As LK00A (VIC20 Talk-Back).
LK01B (ZX81 Talk-Back).
Full construction details in Maplin Projects Book 6.
Price 70p. Order As XA06G (Maplin Mag Vol. 2 No. 6).

KEYBOARD WITH ELECTRONICS FOR ZX81

★ Full size, full travel keyboard that's simple to add to your ZX81 (no soldering in ZX81).
★ Complete with electronics to make "Shift Lock", "Function" and "Graphics 2" single key selections.
★ Powered (with adaptor supplied) from ZX81's own standard power supply.

Full details in Project Book 3 (XA03D) Price 60p.
Complete kit (excl. case) £19.95. Order As LW72P.
Case £4.95. Order As XG17T.
Ready built-in case £29.95. Order As XG22Y.

OTHER KITS FOR ZX81

3-Channel Sounds Generator (Details in Book 5).
Order As LW96E. Price £10.95.

ZX81 Sound On Your TV Set (Details in Book 6).
Order As LK02C. Price £19.95.

ZX81 I/O Port gives two bi-directional 8-bit ports (Details in Book 4).
Order As LW76H. Price £9.25.

ZX81 Extendiboard will accept 16K RAM and 3 other plug-in modules.
PCB: Order As GB08J. Price £2.32.
Edge Connectors (4 needed): Order As RK35Q. Price £2.39.

HOME SECURITY SYSTEM

Six independent channels - 2 or 4 wire operation. External horn. High degree of protection and long term reliability. Full details in Projects Book 2. (XA02C) Price 60p

MATINEE ORGAN

Easy-to-build, superb specification. Comparable with organs selling for up to £1000. Full construction details in our book (XH55K). Price £2.50.
Complete kits available.
Electronics (XY91Y) £299.95*.
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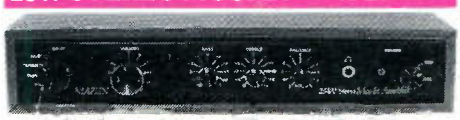
Demo cassette (XX43W) £1.99.

* Carriage extra

25W STEREO MOSFET AMPLIFIER



★ Over 26W/channel into 8Ω at 1kHz both channels driven
★ Frequency response 20Hz to 40kHz ± 1dB.
★ Low distortion, low noise and high reliability power MOSFET output stage.
★ Extremely easy to build. Almost everything fits on main pcb, cutting interwiring to just 7 wires (plus toroidal transformer and mains lead terminations).
★ Complete kit contains everything you need including pre-drilled and printed chassis and wooden cabinet.

Full details in Projects Book 3. Price 60p (XA03D).
Complete kit only **£55.20** incl. VAT and carriage (LW71N).

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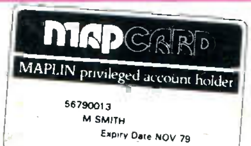

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MAPLIN'S FANTASTIC PROJECTS

Full details in our project books. Issues 1 to 5: 60p each. Issue 6: 70p.

In Book 1 (XA01B) 120W rms MOSFET Combo-Amplifier ● Universal Timer with 18 program times and 4 outputs ● Temperature Gauge ● Six Vero Projects.

In Book 2 (XA02C) Home Security System ● Train Controller for 14 trains on one circuit ● Stopwatch with multiple modes ● Miles-per-Gallon Meter.

In Book 3 (XA03D) ZX81 Keyboard with electronics ● Stereo 25W MOSFET Amplifier ● Doppler Radar Intruder Detector ● Remote Control for Train Controller.

In Book 4 (XA04E) Telephone Exchange for 16 extensions ● Frequency Counter 10Hz to 600MHz ● Ultrasonic Intruder Detector ● I/O Port for ZX81 ● Car Burglar Alarm ● Remote Control for 25W Stereo Amp.

In Book 5 (XA05F) Modem to European standard ● 100W 240V AC Inverter ● Sounds Generator for ZX81 ● Central Heating Controller ● Panic Button for Home Security System ● Model Train Projects ● Timer for External Sounder.

In Book 6 (XA06G) Speech Synthesiser for ZX81 & VIC20. ● Module to Bridge two of our MOSFET Amps to make a 350W Amp. ● ZX81 Sound on your TV. ● Scratch Filter. ● Damp Meter.

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