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BIMENCLOSURES

ALL METAL BIMCASES

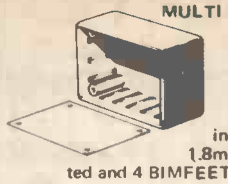
Red, Grey or Orange 14swg Aluminium removable top and bottom covers. 18 swg black mild steel chassis with fixing support brackets.

BIM 3000
(250x167.5x68.5mm)
£14.58

MINI DESK BIMCONSOLES

Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.

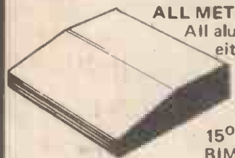
BIM 1005 (161 x 96 x 58mm) £2.18
BIM 1006 (215 x 130 x 75mm) £3.05

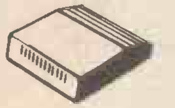


MULTI PURPOSE BIMBOXES

Orange, Blue, Black or Grey ABS with 1mm Grey Aluminium recessed front cover held by screws into integral brass bushes. 1.8mm pcb guides incorporated and 4 BIMFEET supplied.

BIM 4003 (85x56x28.5mm) £1.18
BIM 4004 (111x71x41.5mm) £1.62
BIM 4005 (161x96x52.5mm) £2.19





ALL METAL BIMCONSOLES

All aluminium, 2 piece desk consoles with either 15° or 30° sloping fronts, sit on 4 self-adhesive non-slip rubber feet. Ventilation slots in base and rear panel for excellent cooling. See latest catalogue for new styles and sizes

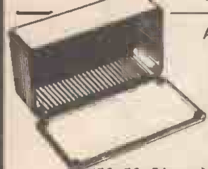
Colour Code	Top Panel	Base
A	Off White	Blue
B	Sand	Green
C	Satin Black	Gold

15° Sloping Panel	30° Sloping Panel	
BIM7151 (102x140x51[28] mm)	BIM7301 (102x140x76[28] mm)	£10.67
BIM7152 (165x140x51[28] mm)	BIM7302 (165x140x76[28] mm)	£11.44
BIM7153 (165x216x51[28] mm)	BJM7303 (165x183x102[28] mm)	£12.61
BIM7154 (165x211x76[33] mm)	BIM7304 (254x140x76[28] mm)	£13.82
BIM7155 (254x211x76[33] mm)	BIM7305 (254x183x102[28] mm)	£15.36
BIM7156 (254x287x76[33] mm)	BIM7306 (254x259x102[28] mm)	£16.67
BIM7157 (356x211x76[33] mm)	BIM7307 (356x183x102[28] mm)	£17.58
BIM7158 (356x287x76[33] mm)	BIM7308 (356x259x102[28] mm)	£18.55

LOW PROFILE BIMCONSOLES

Orange, Blue, Black or Grey ABS body has ventilation slots as well as 1.8mm pcb guides and stand-off bosses in base. Double angle recessed front panel with 4 fixing screws into integral brass bushes. 4 BIMFEET supplied.

BIM 6005 (143 x 105 x 55.5 [31.5] mm) £2.37
BIM 6006 (143 x 170 x 55.5 [31.5] mm) £3.08
BIM 6007 (214 x 170 x 82.0 [31.5] mm) £4.12



ABS & DIECAST BIMBOXES

6 sizes in ABS or Diecast Aluminium. ABS moulded in Orange, Blue, Black or Grey. Diecast Aluminium in Grey Hammertone or Natural. All boxes incorporate 1.8mm pcb guides, stand-off supports in base and have close fitting flanged lids held by screws into integral brass bushes (ABS) or tapped holes (Diecast).

	ABS		Diecast	Hammertone	Natural
(50x50x31mm)	N/A		BIM5001/11	TBA	£1.02
(100x50x25mm)	BIM2002/12	£0.96	BIM5002/12	£1.46	£1.19
(112x62x31mm)	BIM2003/13	£1.13	BIM5003/13	£1.78	£1.46
(120x65x40mm)	BIM2004/14	£1.35	BIM5004/14	£2.24	£1.82
(150x80x50mm)	BIM2005/15	£1.52	BIM5005/15	£2.84	£2.28
(190x110x60mm)	BIM2006/16	£2.37	BIM5006/16	£3.94	£3.33

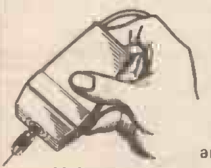
Also available in Grey Polystyrene with no slots and self-tapping screws
BIM 2007/17 (112x61x31mm) £1.00

EUROCARD BIMCONSOLES

Orange, Blue, Black or Grey ABS body accepts full or ½ size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.

BIM 8005 (169x127x70[45] mm) £4.12
BIM 8007 (243x187x103[66] mm) £6.10

BIMTOOLS + BIMACCESSORIES



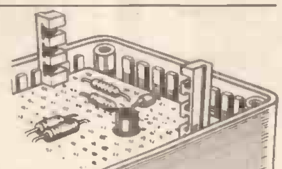
MAINS BIMDRILLS

Small, powerful 240V hand drill complete with 2 metres of cable and 2 pin DIN plug. Accepts all tools with 1mm, 2mm or .125" dia. shanks Drills brass, steel, aluminium and pcb's. Under 250g, off load speed 7500 rpm. Orange ABS, high impact, fully insulated body with integral on/off switch £10.53

Mains Accessory Kit 1 includes 1mm, 2mm, .125" twist drills, 5 burrs and 2.4mm collet £2.48

Mains Kit 2 includes Mains BIMDRILL as above, 20 assorted drills, mops, burrs, grinding wheels and mounted points, 1mm, 2mm, 2.4mm and .125" collets. Complete in transparent case measuring 230x130x58mm £22.14

BIMDAPTORS



Allows pcb's to be flat mounted sandwich fashion in BIMBOXES, BIMCONSOLES, and all other enclosures having 1.5mm wide vertical guide slots. One plastic BIMDAPTOR on each corner of pcb(s) enables assembly to be simply slid into place. 54mm long, 10 slots on 5mm spacing and can be simply snipped off to length. £1.08 per pack of 25.

BIMFEET

11mm dia. 3mm high, grey rubber self-adhesive enclosure feet. £0.77 per pack of 24

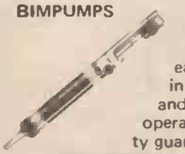
12 VOLT BIMDRILLS

2 small, powerful drills easily hand held or used with lathe/stand adaptor. Integral on/off switch and 1 metre cable.

Mini BIMDRILL with 3 collets up to 2.4mm dia. £ 8.10
Major BIMDRILL with 4 collets up to 3mm dia. £13.60

Accessory Kits 1 have appropriate drills and collets as above plus 20 assorted tools. Mini Kit 1 – £15.12, Major Kit 1 – £19.44. Accessory Kits 2 have appropriate drills, collets plus 40 tools and mains-12V dc adaptor. Mini Kit 2 – £34.02, Major Kit 2 – £39.42. Accessory Kits 3 as appropriate Kits 2 plus stand/lathe unit. Mini Kit 3 – £45.36, Major Kit 3 – £50.76.

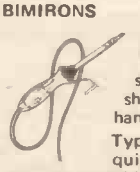
BIMPUMPS



2 all metal desoldering tools provide high suction power and have easily replaceable screw in Teflon tips. Primed and released by thumb operation with in-built safety guard and anti-recoil system.

BIMPUMP Major (180mm long) £7.99
BIMPUMP Minor (150mm long) £6.80

BIMIRONS

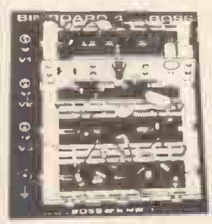


Type 30 General Purpose 27 watt iron with long life, rapid change element, screw on tip, stainless steel shaft and clip on hook. Styled handle with neon. £4.05

Type M3 Precision 17 watt iron, quick change tip, long life element, styled handle with clip on hook. £4.43

BIMBOARDS

DIL COMPATIBLE BIMBOARDS



Accept all sizes (4-50 pin) of DIL IC packages as well as resistors, diodes, capacitors and LEDs. Integral Bus Strips up each side for power lines and Component Support Bracket for holding lamps, switches and fuses etc. Available as single or multiple units, the latter mounted on 1.5mm thick black aluminium back plate which stand on non slip rubber feet and have 4 screw terminals for incoming power.

BIMBOARD 1 has 550 sockets, multiple units utilising 2, 3 and 4 BIMBOARDS incorporate 1100, 1650 and 2200 sockets, all on 2.5mm (0.1") matrix.

BIMBOARD 1 £ 8.83
BIMBOARD 2 £21.01
BIMBOARD 3 £29.84
BIMBOARD 4 £38.79

DESIGNER PROTOTYPING SYSTEM

1, 2, or 3 BIMBOARDS mounted on BIM 6007 BIMCONSOLE with Integral Power Supply (±5 to ±15Vdc @ 100mA and fixed +5Vdc @ 1A) All O/P's fully isolated. Short circuit and fast fold back protection. Power rails brought out to cable clamps that accept stripped wire or 4mm plug.

DESIGNER 1 £55.62
DESIGNER 2 £61.02
DESIGNER 3 £66.42

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7401	£0.09	7428	£0.25	7473	£0.22	74110	£0.35	74166	£0.75
7402	£0.09	7430	£0.08	7474	£0.22	74111	£0.55	74167	£2.00
7403	£0.09	7432	£0.20	7475	£0.27	74118	£0.75	74174	£0.60
7404	£0.09	7433	£0.28	7476	£0.22	74119	£1.10	74175	£0.60
7405	£0.09	7437	£0.20	7480	£0.40	74121	£0.22	74176	£0.55
7406	£0.22	7438	£0.20	7481	£0.80	74122	£0.35	74177	£0.55
7407	£0.22	7440	£0.10	7482	£0.65	74123	£0.38	74180	£0.80
7408	£0.12	7441	£0.45	7483	£0.55	74136	£0.50	74181	£1.25
7409	£0.12	7442	£0.38	7484	£0.82	74141	£0.50	74182	£0.55
7410	£0.09	7443	£0.68	7485	£0.65	74145	£0.54	74184	£1.00
7411	£0.15	7444	£0.68	7486	£0.22	74150	£0.65	74190	£0.68
7412	£0.14	7445	£0.64	7489	£1.60	74151	£0.45	74191	£0.68
7413	£0.22	7446	£0.60	7490	£0.30	74153	£0.45	74192	£0.65
7414	£0.45	7447	£0.45	7491	£0.60	74154	£0.80	74193	£0.60
7416	£0.22	7448	£0.52	7492	£0.32	74155	£0.48	74194	£0.55
7417	£0.22	7450	£0.09	7493	£0.28	74156	£0.48	74195	£0.55
7420	£0.09	7451	£0.09	7494	£0.70	74157	£0.48	74196	£0.60
7421	£0.19	7452	£0.09	7495	£0.45	74160	£0.55	74197	£0.58
7422	£0.15	7453	£0.09	7496	£0.48	74161	£0.60	74198	£1.00
7423	£0.20	7454	£0.09	74100	£0.80	74162	£0.60	74199	£1.00
7425	£0.18	7460	£0.09	74104	£0.35	74163	£0.60	74279	£1.00
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S143

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All 3 at SPECIAL PRICE of £1.20*

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No. MVR7824	μA7824	TO220	55p

Negative

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μA723C TO99 38p — 72723 14 pin Dil 38p

LM309K TO3 £1.20

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S110 Mixed Bundle. P.C.B., Fibre-glass/paper, single and double-sided. Fantastic value 75p

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Code No's shown below are given as a guide to the type of device. The devices themselves are normally unmarked.

No. 16130	100 Germ. Gold bonded diodes like OA47	40p
No. 16131	150 Germ. Point contact diodes like OA70/81	40p
No. 16132	100 200mA Sil. diodes like OA200	40p
No. 16133	150 75mA Sil. Fast switching diode like IN4148	40p
No. 16134	50 750mA Sil. top hat Rects.	40p
No. 16135	20 3 amp Sil. stud Rect.	40p
No. 16136	50 400mw Zeners D.O.7 case	40p
No. 16137	30 NPN Plastic trans. like BC107/8	40p*
No. 16138	30 PNP Plastic trans. like BC177/8	40p*
No. 16139	25 NPN trans. like 2N697/2N1711 TO39	40p
No. 16140	25 PNP trans. like 2N2905 TO39	40p
No. 16141	30 NPN trans. like 2N706 TO18	40p
No. 16143	30 NPN Plastic trans. like 2N3906	40p*
No. 16144	30 PNP Plastic trans like 2N3905	40p*
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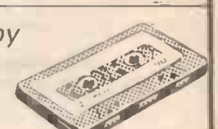

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BC170	•6p	BF182	25p	TIP30C	38p	2N1304	15p	2N3903	•11p
BC171	•6p	BF183	25p	TIP31A	32p	2N1307	18p	2N3904	•11p
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BA144	5p	BY127	•10p					IN5402	12p
BA148	10p	BYZ10	32p	OA47	5p	IN34	5p	IN5404	13p
BA173	10p	BYZ11	32p	OA70	5p	IN60	6p	IN5406	16p
BAX13/		BYZ12	32p	OA79	7p	IN914	4p	IN5407	17p
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Projects... Theory...

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The constructor has gained directly from developments in components and in hardware. Neater, more professional looking projects are the order of the day. And of course the standing of the amateur is greatly enhanced by the evidence of a well organised and neatly asembled piece of equipment. The means are there, the circuit designs flow forth in abundance and variety month after month from magazines such as EVERYDAY ELECTRONICS. In short, one might say the constructor is sitting pretty.

But this hobby embraces other activities such as experimenting and designing, as well.

Experimenting, or to use a more homely expression, playing with circuits, is an absorbing exercise whatever the final outcome may be. It is, after all, the best way to learn once the basics have been mastered. It is also, perhaps more importantly in the hobby context, fun.

In comparison with the constructor, the experimenter or designer has not received quite the attention that is his due. Representing a minority section of all electronics enthusiasts, this is in a sense understandable although it is a situation that requires rectifying.

Contemporary components, hardware and assembly techniques should be applied just as diligently and effectively to aid the experimenter as the project builder. That is what we have long believed, and our thoughts in this connection have materialised in the form of the *EE Labcentre*.

We believe that anyone with a serious interest in electronics will be proud to possess this equipment. The initial outlay in parts will be a good investment over the years. For this is no toy, it is not limited in any way to hobby activities, but will serve the practising professional equally well (a point that parents of budding engineers might note when the cost of this project is weighed).

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Everyone wants to learn more about microprocessors—and rightly so. They represent the "biggest thing" in electronics since the transistor. Our new series *Microprocessor Basics* will help you understand what they are all about.

Fred Bennett

Our April issue will be published on Friday, March 16. See page 171 for details.

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Telephone enquiries should be limited to those requiring only a brief reply. We cannot undertake to engage in discussions on the telephone, technical or otherwise.

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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.

Everyday ELECTRONICS

VOL. 8 NO. 3 MARCH 1979

CONSTRUCTIONAL PROJECTS

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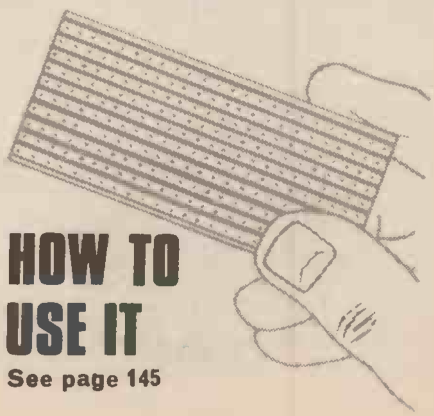


HOW TO USE IT

See page 145

By B. Hamill

CAR DIRECTION INDICATOR

WITH HAZARD FLASHER OPTION

THE CONVENTIONAL electro-mechanical flasher units fitted to most vehicles have many drawbacks, principally because they rely on the expansion and contraction of a length of wire connected in series with the indicator lamps; any variation in the current drawn by the lamps, caused by low battery voltage or corrosion of the lamp connections etc, is usually sufficient to send the flashing rate well outside the legal limits of between 60 and 120 flashes per minute.

The unit described in this article is designed to replace a conventional flasher with only a few minor connections to the vehicles wiring. In addition, the device provides an audible warning tone as well as the normal dashboard warning lamp. The main circuit is designed for negative earth vehicles but can be modified for positive earth and/or 6 or 12 volt systems.

This choice of systems thus makes the unit very versatile indeed.

CIRCUIT DESCRIPTION

The complete circuit diagram is shown in Fig. 1, and consists of IC1 connected to form two astable multivibrators running at different frequencies. One oscillator drives the relay RLA via TR1. The frequency of this oscillator is determined by C1 and R2, resistor R1 compensating for variations in supply voltage and temperature.

Although C1 is a fairly high value capacitor, a non-electrolytic type must be used, since C1 is charged in opposite directions during each half of the cycle.

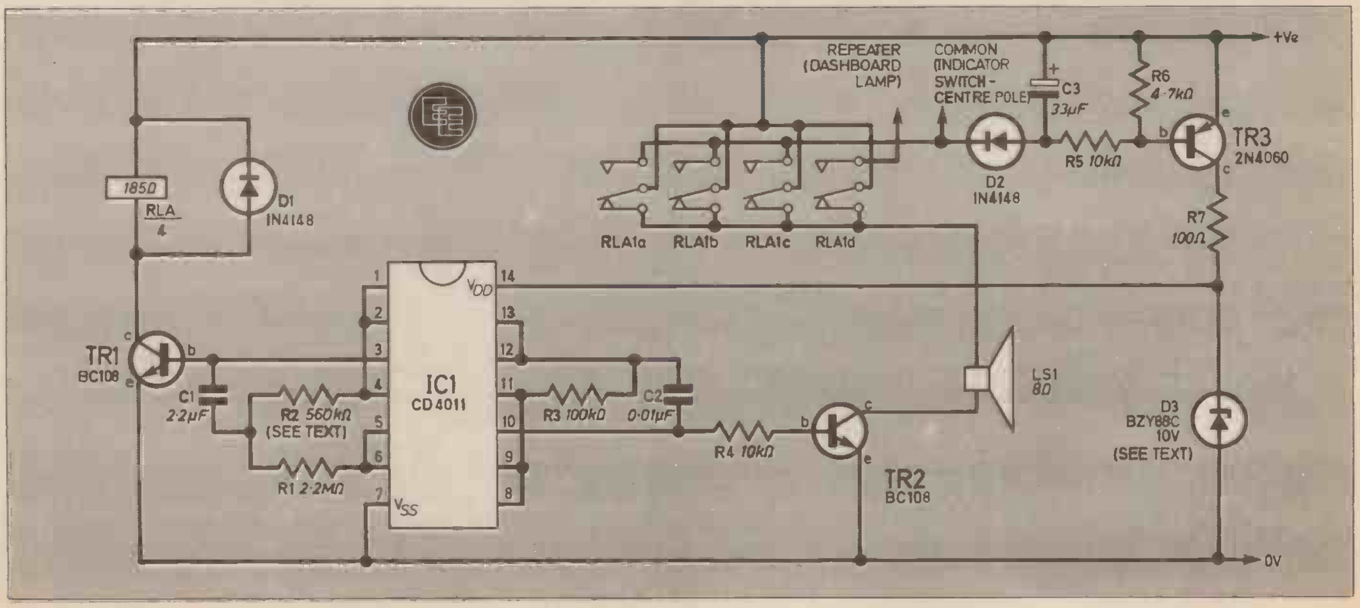
The other oscillator, whose frequency is determined by C2 and R3, generates a tone of approximately 600Hz, which is amplified by TR2 and drives the small loudspeaker LS1.

When the car's indicator switch is moved either way from the centre off position, C3 is connected through D2 and the indicator lamps to earth, and thus charges up to the supply voltage.

The base of TR3 swings negative with respect to its emitter, and since the TR3 is a *pnp* device, it turns on. This switches on the supply voltage to IC1, which is stabilised by resistor R7 and the Zener diode D3.

The two oscillators then start operating, opening and closing

Fig. 1. Complete circuit diagram of the negative earth version of the Direction Indicator.



RLA which in turn switches on and off the indicator lamps. During the period in which the lamps are on, D2 is reverse biased and prevents C3 discharging. This capacitor discharges slowly through R5 and R6, holding TR3 on until the relay contacts open again, whereupon it is immediately recharged.

The speaker, LS1 is connected to the positive line through one of the relay contacts, so that the audible tone is switched on and off synchronously with the lamps. The dashboard repeater lamp is connected similarly.

By connecting the loudspeaker in this way, it serves as a constant check on the operation of the device, since the audible tone will only function if all parts of the circuit are operating normally. When the indicator switch is returned to the off position, the lamps stop flashing immediately and C3 is discharged by R5 and R6, switching off TR3; this removes the power supply from IC1, thus turning off TR1 and TR2.

COMPONENTS approximate cost
£5 or £7.50 with hazard option

CONSTRUCTION starts here

In the prototype, the circuit was built on a piece of 0·1 inch matrix stripboard having 12 strips by 36 holes, the layout of which is shown in Fig. 2.

Since the integrated circuit is a CMOS type, it should be handled with care. An i.c. socket should be used for this component, which should not be inserted until all other wiring is complete.

Begin construction by inserting the resistors, note that these must be miniature types to avoid overcrowding of components on the board, continue by inserting the capacitors, of which C3 and particularly C1 should be as small as possible, observing the polarity of C3.

The connecting wires and the relay may now be mounted on the board. The length of connecting wires required will depend on the position of the original flasher unit in the vehicle. If this is situated in the engine compartment, the wires should be long enough to allow the new unit to be placed in the passenger compartment, preferably under the dashboard.

VEHICLE WIRING

In the prototype, the connections to the vehicle wiring were made by a plastic block connector, although "spade" terminals similar to those used on the original flasher unit may of course be used. In addition to the three original connections; POSITIVE, COMMON, and REPEATER, the unit requires a connection to the vehicle chassis.

The relay used in the prototype was a miniature type with four sets of changeover contacts. Three of these are connected in parallel to carry the lamp current, typically 3·5A or more for a 12 volt system, and the fourth is used to switch the dashboard repeater lamp and the loudspeaker. The connections required for the most common type of miniature relay, and as used on the prototype are shown in Fig. 2. The relay coil is connected to the circuit board by short lengths of wire.

Complete the construction by connecting the diodes and transistors and the loudspeaker. The

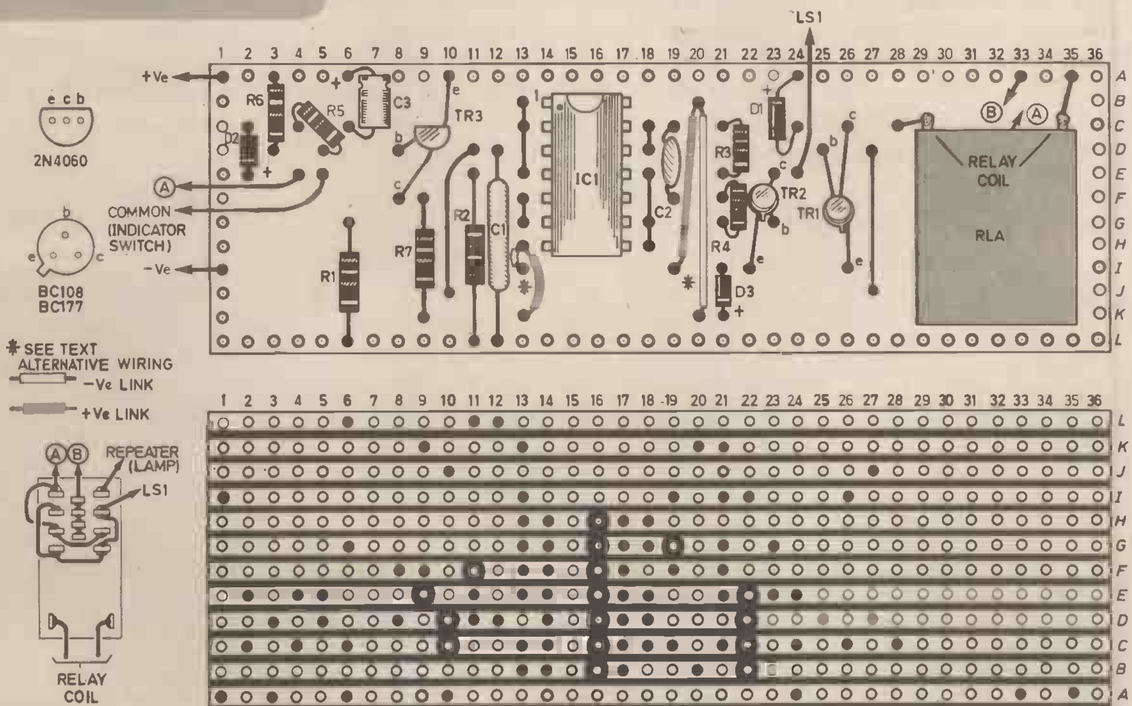


Fig. 2. Stripboard layout for the unit. This layout applies to both the negative and positive earth versions, although see text regarding variations, polarised components and different transistors, for the positive earth version. The two links shown tinted are required only for the positive earth version and should be disregarded for negative version.

integrated circuit may now be inserted, taking care to ensure that it is correctly oriented.

SIX VOLT OPERATION

The basic circuit shown in Fig. 1 is designed to operate on 12V negative earth systems. For those constructors who may have vehicles which use a six volt system, although rare, can modify the circuit to suit. There are only three changes to be made:

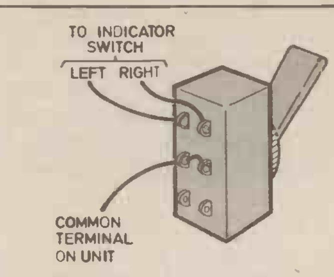
1. Change the value of R2 to 470kΩ.
2. Change the Zener diode D3 to a 4·7V device.
3. The relay used must be changed for one which operates on 6V.

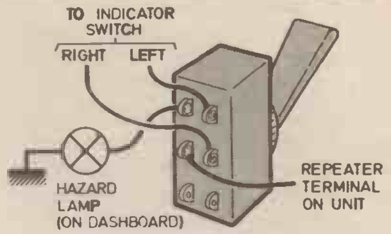
POSITIVE EARTH

For positive earth systems several changes are required together with minor changes to the layout. The changes are as follows:

1. Connect the positive supply of the circuit to car chassis, connect the negative terminal to positive of the car electrical system.
2. Reverse the polarities of all diodes and the electrolytic capacitor C3.
3. Substitute BC177 *pnp* transistors for TR1 and TR2. Change TR3 to a BC108 *npn* device.
4. Connect pin 7 of the i.c. to point *K*13, connect pin 14 to point *I*19 on the stripboard layout. These changes in links are clearly shown in the diagram of Fig. 2 as tinted wires. Remove the original wire links, shown as plain open wires.

Hazard Flasher Modifications





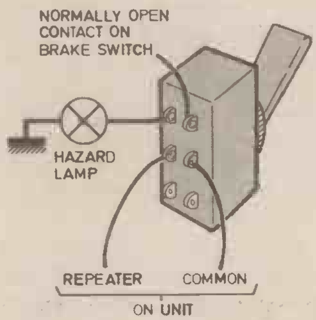


Fig. 3. (Top Left) Simple switch wiring to incorporate a hazard flasher option with the direction indicator. This is perhaps the simplest but does not have monitor lamp.

Fig. 4. (Top Right) Second and perhaps the safest circuit. It is recommended that this circuit is used despite its operating inconvenience.

Fig. 5. (Bottom Left) By using this circuit a heavy duty relay could be avoided.

NEGATIVE EARTH AND HAZARD WARNING WIRING

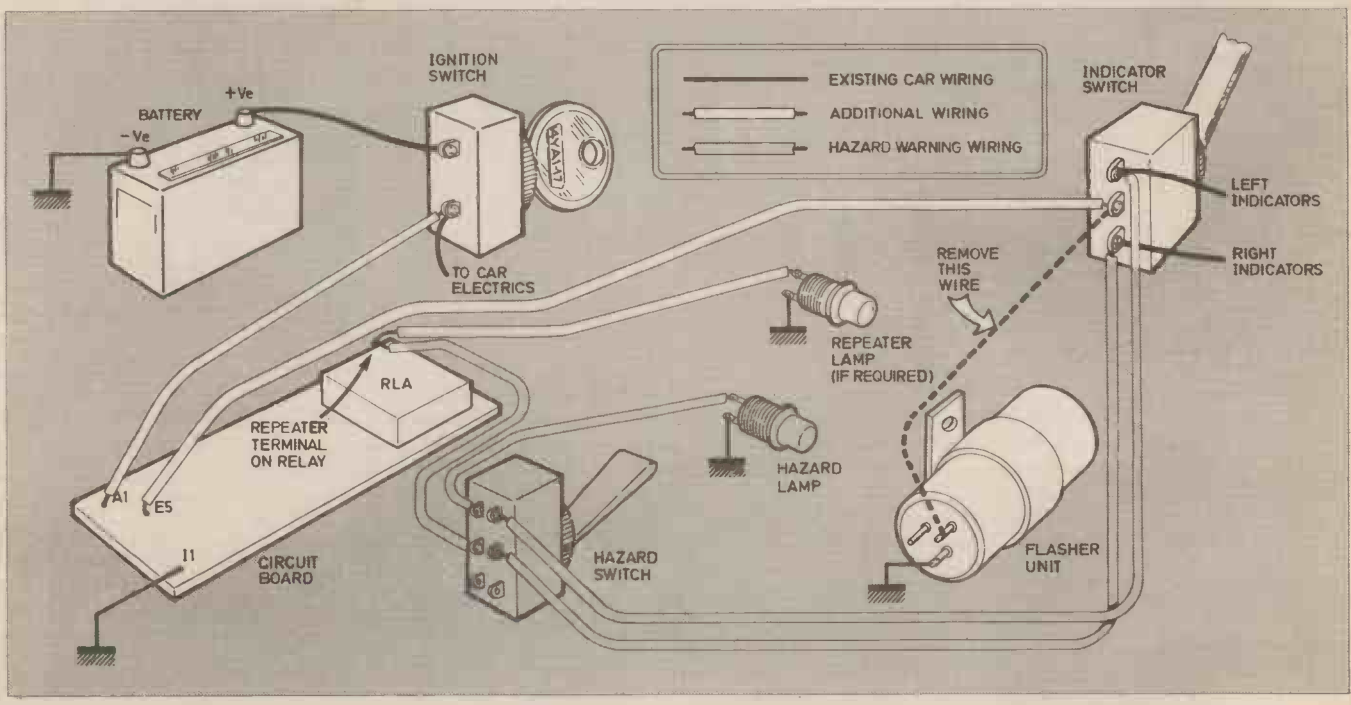


Fig. 6. Simplified wiring diagram of how to fit the unit into the car electrical system. As with all car projects it is advisable to check with the car workshop manual to find the exact wiring details. Also shown is the additional wiring required to incorporate the hazard flasher option. We have selected the circuit of Fig. 4 to show how this is done.

HAZARD FLASHER

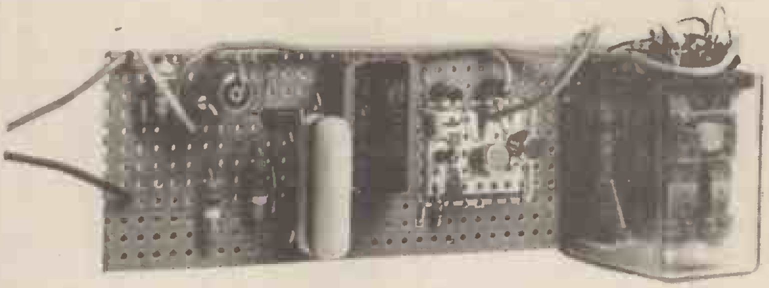
The Direction Indicator can easily be used to operate as a hazard flasher. There are several ways of doing this, depending on whether an additional dashboard indicator lamp is required to monitor the operation of the hazard lights. All require a heavy duty double pole double throw toggle switch in addition to the original circuit, and a heavy duty relay with 7A contacts in place of RLA.

It may be necessary to increase the rating of TR1 which may be needed depending on the current flowing in the coil of the new relay. A BFY51 is suitable in the case of negative earth systems, and a BFX88 for positive earth.

Three circuits can be used—the choice is entirely up to the constructor.

The first, Fig. 3 is perhaps the simplest, in terms of operating convenience but does not use an indicator lamp to monitor operation.

The second, Fig. 4, although has an indicator lamp incorporated does have the inconvenience in that both the toggle switch and car indicator switch must be operated. Some people will however find this method safer as with the first method no indication is given that the lights are actually flashing—dangerous if you are actually driving with them on.



The last method, Fig. 5, does avoid the use of a heavy duty relay, which may or may not be easy to obtain, but only flashes the brake lights and gives no indication at the front of the vehicle.

Whichever method is chosen it is sure to be a worthwhile addition, and will certainly give peace of mind in the unfortunate situation of a breakdown.

CONNECTION TO CAR

The diagram of Fig. 6 shows very simply how to connect the Direction Indicator into the cars electrical system. Also shown are the connections required if the hazard flasher facility is also required.

There are one or two points to remember when actually wiring, one of which would cause the unit to be destroyed if connected incorrectly. These are as follows:

FLASHER UNIT

It is important to disconnect the flasher unit entirely from the wiring. Normally there is only one lead going to the indicator switch from the flasher unit, and this is removed. Depending where the Direction Indicator is to be mounted it may be easier to remove the lead from the flasher unit and connect it to the circuit board. Alternatively the lead can be disconnected from the switch, but should be well isolated. The lead from the circuit board can then be connected direct to the switch.

REPEATER LAMP

The lead marked REPEATER is not normally required on most of todays modern vehicles, as the normal repeat lamps are connected in parallel with the indicator lamps. Thus normal operation is still retained. However older cars may not have this facility, so it is a good idea to have some positive indication that the indicators are actually working.

To have this facility all that is needed is to connect the REPEATER

COMPONENTS

NEGATIVE EARTH VERSION

Resistors

R1 2·2MΩ
R2 560kΩ (12V) 470kΩ (6V)
R3 100kΩ
R4 10kΩ
R5 10kΩ
R6 4·7kΩ
R7 100Ω
All ¼W carbon ± 5%

Capacitors

C1 2·2μF miniature polyester
C2 0·01μF polyester
C3 33μF 16V elect.

Semiconductors

TR1 BC108 silicon *npn*
TR2 BC108 silicon *npn*
TR3 2N4060 silicon *pnp*
IC1 CD4011 Quad 2-input NAND gate
D1 1N4148 or similar silicon diode
D2 1N4148 or similar silicon diode
D3 BZY88C10V 10V 400mW Zener diode (12V) *or* BZY88C4V7 4·7V 400mW Zener diode (6V)

See Shop Talk page 144

Miscellaneous

LSI 8 ohm miniature loudspeaker 75mm diameter
RLA 6V or 12V miniature relay with four sets of change over contacts (RS type 348 942).
Stripboard: 0·1 inch matrix 12 strips x 36 holes; 14 pin i.c. socket; small plastic case to suit; connecting wire.

POSITIVE EARTH VERSION

As above but change TR1 and TR2 to BC177 silicon *pnp*, and TR3 to BC108 silicon *npn*.

HAZARD FLASHER MODIFICATION

Use components as above for negative or positive earth as required, and add: heavy duty d.p.d.t. toggle switch; small panel mounting lamp (voltage as required); substitute heavy duty relay (7A contacts) for RLA.

lead to a lamp mounted somewhere conspicuous on the dashboard. Note however that this does not give an indication of which side is working, merely that they are at all!

HAZARD FLASHER

The hazard flasher wiring also shown in Fig. 6, shows only one version which can be wired up. The toggle switch and lamp as already explained are extras, and can be mounted in any convenient position on the dashboard.

ADJUSTMENTS

Before installing the unit in the vehicle, it should be tested as follows; connect a 6 or 12 volt supply as appropriate, and connect a small lamp of the same voltage between the negative supply line and the COMMON (positive end of D2) connection.

The lamp should flash at a frequency of 1 to 2Hz, and the tone should appear in the loudspeaker. If all is well, the unit may be fitted in a suitable box and mounted in the vehicle. Before doing this, it is a good idea to varnish the underside of the circuit board with quick drying paint, in order to waterproof the unit—the interior of a car can be quite moist at times!

Because of the variation in transfer voltages of the logic gates of ICI, it may be found that the flashing rate is outside the required legal limits. If this is the case, the value of R2 should be increased if the flashing rate is too high, or decreased if the flashing rate is too low. Remove IC1 from its socket before modifying the circuit board.

Some constructors may prefer to select the correct value of R2 by attaching two leads to the board in place of R2, and connecting a 1 megohm potentiometer between them. When the correct setting has been found, the resistance may be measured with an ohmeter, and the nearest available value of resistor used for R2.

It is not advisable to use a preset in place of R2 as a permanent feature, as the value of this preset is very likely to change when subjected to the adverse operating conditions experienced inside a vehicle.

IN USE

There should be no problems in using the device, the prototype having been installed in the authors car for some time now. As the unit is so versatile, it could be readily adapted for other uses as required. It is equally suitable for motorcycles, although where to put all the extra switches etc could pose a problem! The hazard facility would certainly be welcomed by most bike owners.

No doubt other uses will come to mind. ⌑

I was pleased to see an Exhibition again in London, devoted more to the amateur constructor. I refer, of course, to the Breadboard Exhibition at Seymour Hall in November. The journals represented included EVERYDAY ELECTRONICS.

I thought there was rather a predominance of musical instruments and electronic games, I would like to have seen more discrete components on view and better still on sale. Some stands it is true, were selling goods but half the fun of going to an amateur Exhibition is being able to purchase goods (especially bargains). I do hope this will be an annual event, but could not a more appropriate title be found for it?

I am fairly impervious to shocks caused by inflation, but I must confess even my eyebrows went up a shade recently, when I learned that the retail cost of a small 500pF solid dielectric variable capacitor is now £4·95!! I suggest, that where such a device is incorporated in a constructional design it could in many cases be replaced by a 500pF compression trimmer fitted with a brass spindle. Cost about 50–60p.

Wrong Again!

Everywhere I see adverts telling me that there are now small computers for the home at relatively modest prices, but what I cannot fathom is, what I would do with one if I had it. I suppose I can get the news and weather twenty-four hours a day and the share index.

However, I do not want any of these things anyway, though it reminds me of something my brother told me recently. When he was Editor of an electronics trade publication which shall be nameless, he had a girl, who apart from making the tea and typing, also looked after all his records. One day he was informed his girl would be replaced by a computer. Naturally he wanted to find out what advantage this would bring about. For a start he said, my girl can produce complete data on all our advertisers and customers in thirty seconds flat. Can the computer beat that? "Oh! dear me no", they said, it will take the computer two or three days!! "Ah! well" said my brother it will save the cost of the girl's salary, probably over two thousand five hundred a year and she is leaving to get married anyway. Wrong again! They pointed out that the computer time has to be paid for, and it will cost the company up to double the girl's salary!

My brother concluded ruefully, that by becoming computerised, the job would take ten times as long, and cost twice as much. You have got to hand it to those computer salesmen, they really could sell sand to the Bedouin.

Sounds Vintage

There seems to be a great revival of interest in vintage radio, which includes all radios or radiograms made up to the outbreak of World War II. I recently read of one gentleman who started collecting them and quickly filled up his house. Then friends started pestering him to sell them some. He now has a very profitable business, almost any old mains set fetching at least £50. Strange to think that only a few months ago they could probably have been picked up off the local rubbish dump for nothing!

Following on from this I was delighted to see my old friend Norman Stevens, one time Editor of *Practical Wireless* has now started a publication called *Sounds Vintage*. I would like to wish it every success.

Talking of publications a friend of mine sends me every month one of the most popular American Electronics Magazines. I am bound to say, it's not a patch on EVERYDAY ELECTRONICS. To borrow a phrase "You Lucky People".

By A. R. Winstanley

THE DEVICE to be described here is designed to generate an audible tone after a predetermined delay. The delay period can be adjusted between approximately three seconds and one hundred seconds, but much longer delays can be obtained by experimenting with component values.

Suggested uses include its utilisation in children's games as a "time up" buzzer, or possibly delayed action burglar alarms. The photographer will also find it most useful.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. Transistor TR1 is a special type of transistor called a "unijunction transistor". In this circuit it is normally off, that is, there is a very high resistance between base 2 and base 1.

Capacitor C1 is a large electrolytic capacitor which charges up slowly through VR1 (a variable resistor) and R1, until the potential at the emitter of TR1 is approximately 5·5V.

At this point the unijunction transistor rapidly switches over and C1 is able to discharge through the transistor and R3 to ground. The electrolytic capacitor will then recharge and the whole process is repeated until the power supply is removed from the circuit.

Note that by adjusting C1, R1 or VR1, different time delays can be achieved.

TRIGGER PULSE

The positive discharge pulse at base 1 of TR1 is transmitted by C2 to the gate of CSR1. This device is a controlled silicon rectifier or "thyristor" and normally a very high resistance exists between anode (a) and cathode (k). Once however, a suitable pulse is received at the gate terminal (g), the thyristor will rapidly trigger and the anode to cathode resistance falls to a very low value. The circuit to WD1, a miniature audible warning device consuming only 15mA, is therefore completed and the buzzer operates.

A thyristor will remain in this conductive state once a pulse is transmitted to its gate. It can be reset by removing the power supply or reducing the anode/cathode current to a very low value. Resistor R4 is included in the anode circuit to ensure that a minimum holding current is always flowing when the c.s.r. is conductive, therefore preventing it from resetting undesirably.

The audible warning device could be replaced with a visual indicator but the load must not exceed the forward current rating of the thyristor (500mA) and due attention should be paid to the capacity of the PP3 battery from which the circuit operates.

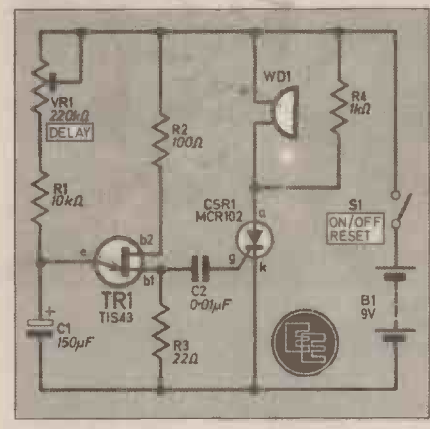


Fig. 1. Circuit diagram of the Time Delay Indicator.

CONSTRUCTION

The circuit is housed in a Bimbox, type BIM2003/13 plastic box measuring 112 x 62 x 31mm, although any similar size case can be used. The circuit itself is built onto a small piece of 0·1 inch stripboard measuring 23 holes by 9 strips as shown in Fig. 2. This is trimmed from the standard 10 strips x 24 holes stripboard and enables the circuit board to be retained in the p.c. guides moulded into the interior of the plastic case.

Construction is quite straightforward. The only points to watch are correct orientation of the transistor and thyristor leads. Also make sure you connect the electrolytic capacitor and audible warning device the right

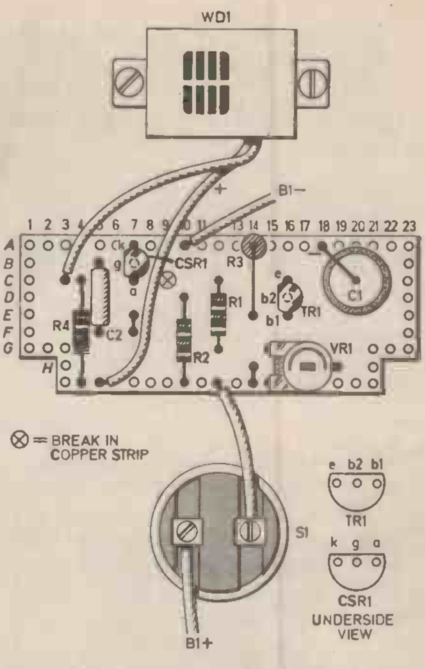


Fig. 2. Complete wiring details for the unit. Note that if you are using the Free piece of stripboard with this issue, one strip and a column of holes need to be removed. This is to allow the board to be vertically mounted within the specified case, using the fixing slots. Also note the two cut-outs and one break to be made.

COMPONENTS

See Shop Talk page 144

Resistors
R1 10kΩ
R2 100Ω
R3 22Ω
R4 1kΩ
All ¼W carbon ± 5%

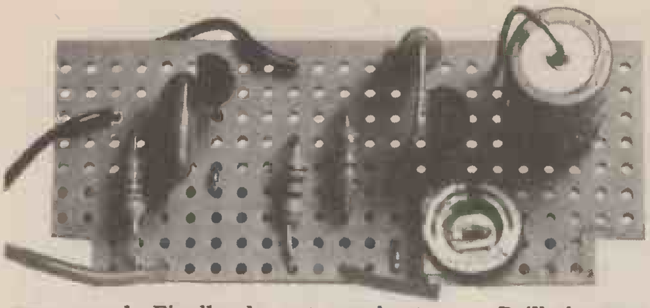
Potentiometer
VR1 220kΩ miniature horizontal preset

Capacitors
C1 150µF 10V elect.
C2 0·01µF polyester

Semiconductors
TR1 TIS43 *n*-channel unijunction transistor
CSR1 MCR102 or similar thyristor (0·5A 30V)

Miscellaneous
WD1 9V 15mA audible warning device (Maplin)
S1 s.p.s.t. "Hekla" rocker switch (Maplin)
B1 9V PP3 battery
Stripboard: 0·1 inch matrix 9 strips × 23 holes; plastic case: Bimbox type BIM2003/13 blue or similar 112 × 62 × 31mm; battery clip to suit B1; lettering as required; connecting wire.

Approx cost—Guidance only
£2.50 excluding case



The completed circuit board showing layout of components. Note the two small link wires. If you use the specified case and the stripboard given Free with this issue you must remove one strip and a row of holes, and cut the corners as shown. This allows the lid to hold the board in place

way round. Finally do not overheat the semiconductors (TR1 and CSR1) in the soldering process. A heatshunt is advised for this process.

Drill the case as necessary to take the switch and buzzer. The latter item is mounted on the exterior of the case using two 8BA bolts. Complete the unit and arrange the internally-retained components to conform with the overall arrangement used in the prototype unit.

The case could be lettered if desired; use rub-down lettering and then give the case a light coat or two of clear aerosol lacquer. This should all be done just after the case has been drilled.

The battery can be retained using double sided adhesive foam strips.

Once constructed, set the preset resistor to give the desired delay before the alarm sounds. The device is then complete and ready for use. ⌑

By Dave Barrington

CONSTRUCTIONAL PROJECTS

Just a look at the list of this month's construction projects should send most readers rushing for their soldering irons.

Time Delay Indicator

For the *Time Delay Indicator* a thyristor type MCR102 is called for and could prove a problem. However, this should be available from Maplin. Also, any other type which requires a 0·8V at 0·2mA gate trigger signal will be suitable.

The audible warning device and switch is available from many of our advertisers. An alternative warning device is obtainable from Progressive Radio, 31 Cheapside, Liverpool, L2 2DY, price 78p (postage extra). Specify the 9V version. The Bleeptone from Home Radio or the Mini-Bleeptone from Verospeed (£3·80 plus VAT) are also suitable types.

Direction Indicator

One or two points need to be made regarding the *Direction Indicator*. The transistor type 2N4060 may be difficult to obtain, but is listed by Maplin Electronic in their catalogue. Also, the 2N4061 or 2N4062 may be used for TR3.

The relay specified does not necessarily have to have four sets of contacts, they must however be changeover types, as three sets of contacts are wired in parallel merely to be on the safe side when carrying the large currents required by the indicators. Any other relay, provided it can handle the current requirements, with at least two sets of changeover contacts can be used.

When incorporating the "Hazard Flasher" modification, a heavy duty relay is specified. This relay replaces the existing one only if the original cannot handle the increased current.

One Transistor Radio

There should be no problems with components for the *One Transistor Radio*, but some readers may experience difficulty in locating the Dilecon 300pF variable capacitor Cl. Maplin, Watford, Home Radio, Greenweld are just four of our advertisers who should be able to supply.

Versatile Power Supply

The only item that could be troublesome in the *Versatile Power Supply*, this month's *Mini Module* project, is likely to be the mains transformer. This transformer calls for a 9V-0-9V secondary and many of our advertisers should be able to supply an equivalent.

2020 Tuner Amplifier

This month we get to grips with the hardware for the *2020 Tuner Amplifier*. The cord drive assembly for the radio section is available from Maplin Electronics.

For those readers who are not too keen on doing their own metal bending a kit of undrilled metal work is available from Kitson's Sheet Metal Ltd., It may be possible that readers can make arrangements with their local stockists who may be prepared to do the necessary bending.

Labcentre

Our major constructional article this month is the *EE Labcentre* and we are sure it will appeal to both the professional and amateur alike. Provided details are followed carefully it should not present any difficulties in construction and only a few components warrant further mention.

The "executive" type briefcase used to house the electronics and tools is, of course, arbitrary and readers may use any suitable housing of their own choice. The "test bed" or breadboarding strip used in the prototype was of American origin but there are now many alternative types available from advertisers which would be suitable.

We found that the Super Strip SS2 from Lektrokit Ltd. London Road, Reading, Berks. RG6 1AZ is identical to the original at a cost of £11·50 including postage. The SS2 is also available from Maplin, Watford and Marshalls.

Should the mains switch with built-in neon prove troublesome to obtain it can be replaced with a standard mains switch and a separate mains neon indicator.

As the *Labcentre* is going to see regular service we suggest readers use a good quality printed circuit board for this project. If readers do not feel capable of making their own board they can be purchased from C.C. Consultants, 77 St. Marks Road, Worle, Weston-Super-Mare, Avon BS22 0HN, who hold the copyright for the p.c.b. design. The cost is £4·85 including postage.

Components Sale!

We understand that in readiness for their move to new premises shortly, Home Radio are going to offer drastic price reduction on certain components. Items being offered are new stock surplus to current catalogue.

This offer is to personal shoppers only at their current address from March 24 to 31.

SQUARE one FOR BEGINNERS

One of the many forms of circuit board available to the home constructor of electronic projects is stripboard. A usable piece of this is given FREE with this issue and the *Time Delay Indicator* is one example of a project to be built on this, see page 143.

As can be seen by examining this board (Fig. 1) it consists of a number of parallel strips of copper bonded to synthetic-resin-bonded-paper (usually abbreviated to s.r.b.p.) which is an insulating material. The strips are punched at intervals so as to produce a matrix of holes. The matrix pitch (the distance between holes on the same strip) can be either 0·1 inch or 0·15 inch.

Our particular board has a pitch of 0·1 inch. It has 10 strips and each strip has 24 punched holes. So a project requiring this board would specify in the components list: Stripboard, 0·1 inch matrix 10 strips x 24 holes.

If the required size for a particular project is non-standard (as is most likely), the required piece may be cut from a larger sheet (Fig. 1). This is easily carried out with a junior hacksaw and the edges then filed smooth. The cut end should be examined for possible copper whiskers bridging adjacent tracks.

MOUNTING COMPONENTS

Components are intended to be mounted on the unclad side of the board—referred to as the topside, and their leads pushed through the punched holes. The leads are then cropped to about 2mm or so protruding beyond the copper strip—or underside, see Fig. 2. The leads should be bent in opposite directions to prevent the component falling out when the board is turned over for soldering, Fig. 3.

For components such as capacitors, resistors, diodes and wire links, the leads will need to be bent at right angles to the component body axis (Fig. 4) the bends being made at the correct points to span the allotted holes. This is easiest achieved by use of a wire bending tool such as that given free with the May 1977 issue of E.E. Without this pliers will be needed, see Fig. 5.

COPPER STRIPS

The copper strip acts as "electrical wiring" between the components to connect them in the configuration of the circuit diagram.

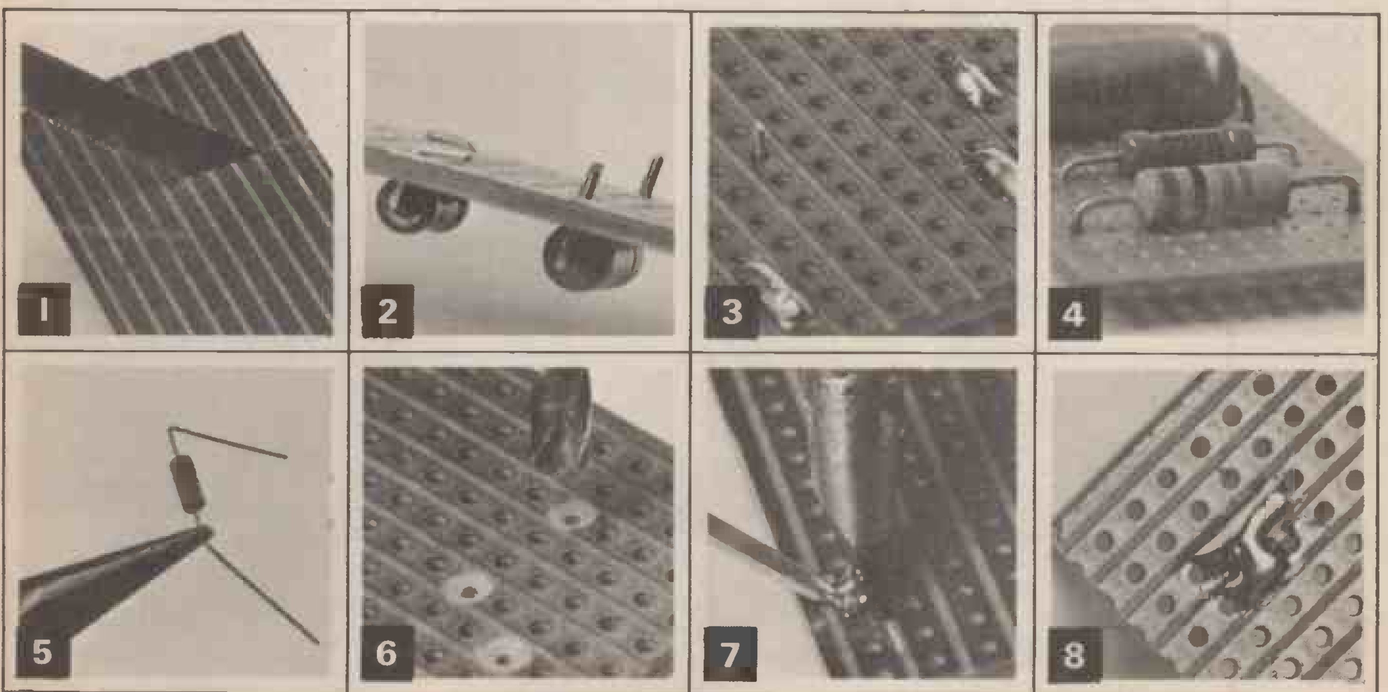
The number of copper strips may effectively be increased by making "breaks" along the strip to divide them into two or more strips. This can be achieved by cutting away the copper at a particular point. A tool made for this job is a spot-face cutter but an ordinary twist drill-bit achieves the same result.

The tool or drill bit is placed in a punched hole closest to the required break point and twisted so as to cut away the copper, as shown in Fig. 6.

SOLDERING

Flying leads can be connected directly to the copper strips on the underside or from the topside through a hole. Either way, the tinned wire should be bent to be in contact with the strip. A tinned soldering iron tip is positioned to be in contact with both lead, and copper strip and solder placed on a convenient point to melt onto the strip and wire (Fig. 7)—not the iron bit! Remove the iron and solder and allow the joint to cool.

A smaller iron "bit" is required for work on 0·1 inch matrix board than on the 0·15 inch variety. The maximum size for convenience on a 0·1 inch board is 3mm to avoid solder bridges, Fig. 8.



1 TRANSISTOR RADIO

With optional single transistor audio amplifier

By F. G. Rayer

THE ONE-TRANSISTOR radio to be described here is an easily constructed project and is intended to provide headphone reception of medium and long wave transmissions. A crystal diode receiver is often built because of its simplicity, but incorporating an amplifier provides very much better volume, and needs few extra components. Subsequently, an additional audio stage can be added, and in many areas this allows loudspeaker reception.

CIRCUIT DESCRIPTION

The circuit diagram for the radio is shown in Fig. 1. Sockets SK1 and SK2 are optional aerial connections, SK1 is best for a long aerial, and SK2 for a shorter wire. The aerial is connected to whichever socket gives best results.

For medium wave reception S1 is closed, so that only the m.w. coil L1 is in use, and is tuned by C1. Opening S1 places L2 in series with L1, for long waves.

The value for C1 can be anything from about 250pF to 500pF, solid dielectric or air spaced, so a component to hand or from an old receiver may be put to good use.

Many surplus or other types of diodes will also prove to be satisfactory for D1. It needs to be a point-contact or detector type, not a power rectifier or silicon type. A surplus item can easily be checked in this position.

Transistor TR1 provides high gain for audio signals, and the output is developed across R2.

As resistor R2 provides collector current, a crystal earpiece can be plugged into the output socket. A magnetic high impedance headset can also be used, and will generally give much more satisfactory listening. Such phones could have an impedance of between 2 and 4 kilohms. If such phones were always to be used, R2 could even be omitted.

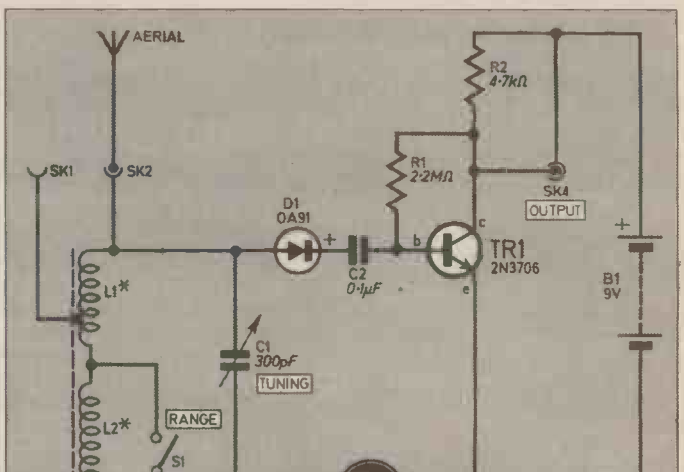


Fig. 1. Circuit diagram of the One-Transistor Radio.

CONSTRUCTION starts here

COILS

The two coils, L1 and L2, are wound on a ferrite rod about 120mm long, however, this length is not important and any size to hand can be used.

Coil L1 has 75 turns in all, and the tap is 20 turns from one end. A tube made out of postcard or similar material is wound about twice round the rod. Put a little adhesive on the card. It is best if the tube is a sliding fit on the rod, so it can be loose. The coil uses 28 s.w.g. enamelled wire, but a small change in wire gauge is unimportant. Secure the ends with cotton or dabs of adhesive. Scrape the ends and the tap for soldering.

For L2, glue two card discs about 20mm in diameter to a card tube, with a winding space of 16mm between them. Pass a length of 34 s.w.g. enamelled copper wire through a small hole, then "pile" wind 250 turns. Cement the end or cover the winding with adhesive tape.

The coils should be placed so that the direction of rotation of turns is the same throughout. This can be noted when winding, or L2 can be slid off the rod and turned over, if l.w. reception is found to be poor.

The rod is mounted on a block of wood about 25 x 20 x 10mm, with adhesive between rod and block, and on the base. A screw driven from below into the block will make this secure.

CIRCUIT BOARD

The circuit board is 0·15 inch stripboard having 7 strips by 25 holes, to allow space for the additional audio amplifier. The drawing of Fig. 2 shows the layout for the receiver section only.

Place the components as shown, and solder the leads to the foil. Snip off excess length of wires, and check that no shorts arise between adjacent foils. Only one foil break is needed, under C2.

Solder on leads for SK2, positive, earth and output connections. Also drill two holes for mounting.

BASE AND PANEL

The remaining and complete wiring details are shown in Fig. 3. Slots for S1 and S2 are made by drilling holes and enlarging them with a small flat file. The switches are fixed with short screws or bolts through the panel. Panel and base are secured together with screws and adhesive.

The board is then placed as in Fig. 3 and fixed with screws. Two small rubber grommets are put on the screws under the board, to give clearance. If metal nuts or washers are used, check they do not cause a short circuit between the foils.

Also shown in Fig. 3 are the modifications required to the wiring when the additional amplifier is to be used. If constructing just the receiver, these modifications shown as dotted wires can be ignored. See later for details on the amplifier.

CASE

A scale for use with C1 is drawn on card or paper as shown in Fig. 4. Any kind of 9V battery can be used, polarity must of course be correct. A PP9 or similar large battery is most suitable when the extra stage will be used.

The case shown is made from thin wood. Beading forms a ¼ inch edge round the front, so that the receiver can be pushed in from behind, and secured with small screws from below.

The pieces need to be sawn accurately, and fitted together with wood adhesive. When this is hard, smooth the joints with glasspaper on a block. The case was covered with wood grain adhesive material as used for shelving, but could be painted. There is no back to the receiver, although one could of course be added.

Space is available on the front panel for a 65mm diameter speaker. This is optional to plugging in an external speaker. Where the internal speaker is going to be fitted, cut a hole in the panel to match its cone.

COMPONENTS

RECEIVER

See Shop Talk page 144

Resistors
R1 2·2MΩ
R2 4·7kΩ
Both ¼W carbon ± 5%

Capacitors
C1 300pF (Dilecon) variable solid dielectric
C2 0·1μF polyester

Semiconductors
TR1 2N3706 silicon *npn*
D1 OA91 or similar germanium point contact diode

Miscellaneous

S1, 2	single-pole single-throw slide switch (2 off)
SK1, 2, 3	4mm sockets (3 off different colours)
B1	PP9 9V battery
L1	75 turns 28 s.w.g. enamelled copper wire (see text)
L2	250 turns 34 s.w.g. enamelled copper wire (see text)
SK4	3·5mm jack socket

Stripboard: 0·15 inch matrix 7 strips x 25 holes; battery connector to suit B1; ferrite rod 120 x 10mm; one large knob; material for scale; thin card for coils; connecting wire; headphones as required; Fablon or similar material.

AMPLIFIER

Resistors	Capacitors	Semiconductor
R3 47kΩ	C3 0·47μF polyester	TR1 2N3706 silicon *npn*
R4 220Ω	C4 640μF 10V elect.	
Both ¼W carbon ± 5%	C5 100μF 10V elect.	

1 TRANSISTOR RADIO

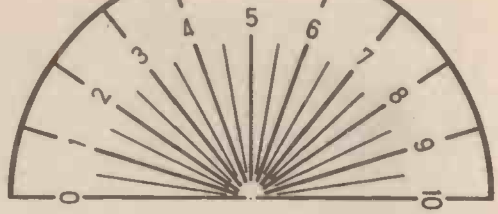


Fig. 4. Scale as used on the prototype. This is drawn full size and may be traced.

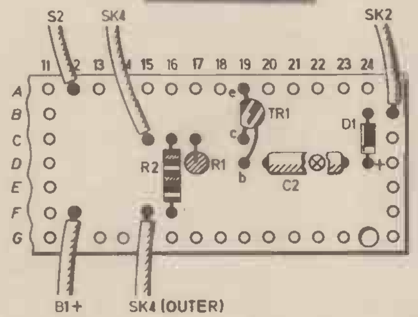


Fig. 2. Stripboard layout. There is only one break to be made and this is under C2 at location *D*22. A large board has been used so that the amplifier can be incorporate easily at a later date, hence the board is shown only in part.

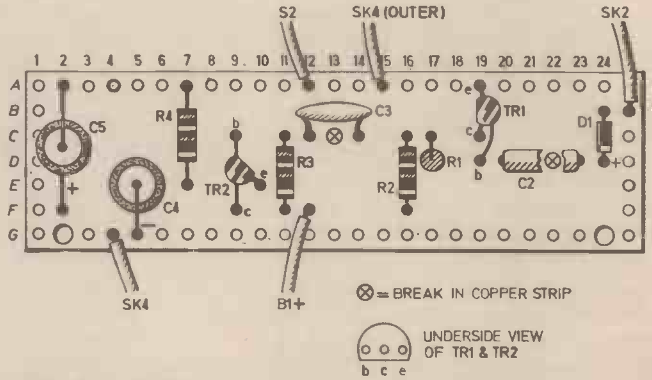


Fig. 7. Stripboard layout for the amplifier, which' also includes the previous layout of Fig. 2 for clarity. One further break is required and this under C3 at location *C*13.

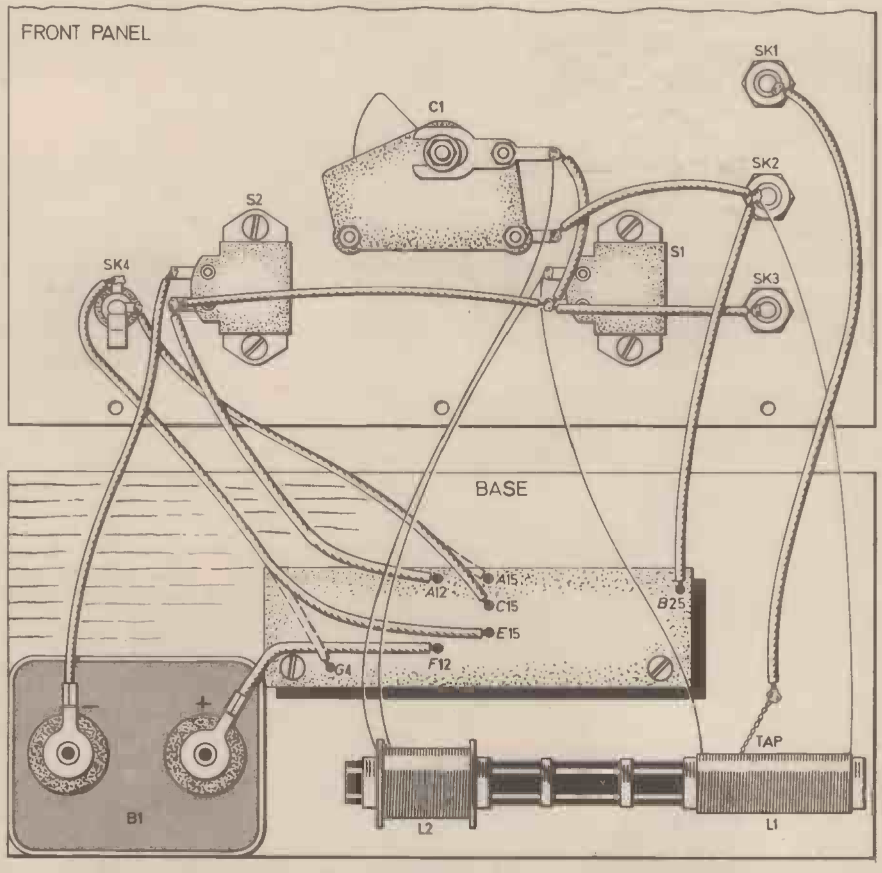
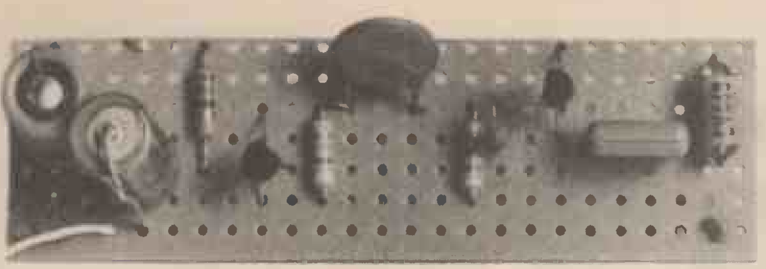


Fig. 3. Wiring diagram showing interconnections between the components on the front panel. If the amplifier stage is to be used, connect the leads from SK4 to points *G*4 and *A*15, otherwise connect them to *C*15 and *E*15 for the radio only. No other change in wiring is necessary. Dimensions for the front are not critical.

ONE-TRANSISTOR RADIO CHASSIS AND CASE CUTTING LIST

Top and Bottom	215 × 115 × 4mm (2 off) *Plywood*
Sides	130 × 115 × 4mm (2 off) *Plywood*
Front Panel	202 × 128mm (1 off) 4mm *Hardboard*
Base	128 × 90 × 10mm (1 off) *Softwood*
Edging	Quarter-round beading, about 750 × 5mm
Covering	Fablon or similar

COMPONENTS approximate cost £4.50 excluding case



It is clear that many other cases could be used—such as plastic boxes, or one of the ready-made cases which can be purchased. A metal box is *not* recommended.

AERIAL

A receiver of this type requires an external aerial, and also an earth, if possible.

An outdoor aerial which is high and clear of earthed objects such as buildings is best of all. This can be made from some 12 to 22 metres or so of 7/26 or other aerial wire, one uncut length forming the horizontal section and down lead. The horizontal portion is supported by an insulator each end, and cords running to high anchor points—these may be found at the house, with a tree, post or other building for the distant end. Bring the wire down and into the house, probably at a window. One method is shown in Fig. 5.

Less ideal and shorter outdoor aerials can also give quite good results. These may have only one high support and may slope, or may be nearer to buildings than preferred.

Indoor aerials are satisfactory in many areas, and especially at ceiling height in a bedroom, or in a loft space. Thin bell wire can be almost invisible. It can be stretched along two walls, *not* folded back on itself in a complete loop.

EARTH

For the earth connection, a lead clipped to a descending metal water pipe is usually good, do *not* use a gas pipe. A wire may be taken to an earth spike driven into the ground, or may be attached to a metal can buried in damp soil. In some areas reception can be adequate with no earth, but the improvement obtained when an earth is present is so great that it is worth while.

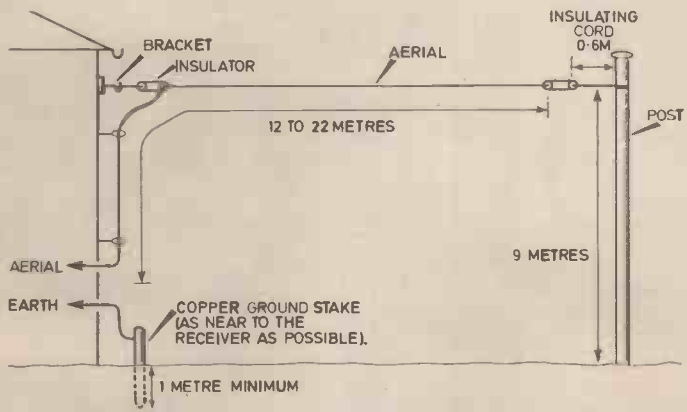


Fig. 5. One method of erecting an outdoor aerial. The post can in fact be any convenient support, a tree, another building etc. In any aerial installation it is important to keep the lead from the earth to the receiver as short as possible.

It is quite easy to experiment with various aerials and earth connections.

IN USE

Band coverage should be suitable with the windings located as shown. If C1 is under 300pF, L1 and L2 can be pushed a little farther on the rod. If it is 500pF, L1 can be slid a little nearer the rod end.

The socket marked as AE2 gives best volume from any aerial. But with a long aerial selectivity may be too poor. Using AE1 helps correct this.

Selectivity can be increased by placing a capacitor in series with the aerial lead to the receiver. It will generally be put between the aerial and socket in use. A preset or variable capacitor with a maximum value of around 150pF will be most suitable.

It can then be adjusted for best results, and can be an important aid in receiving signals without interference. Various small value fixed capacitors could also be used instead.

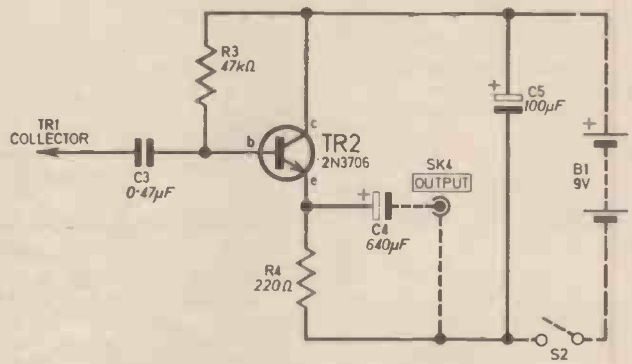


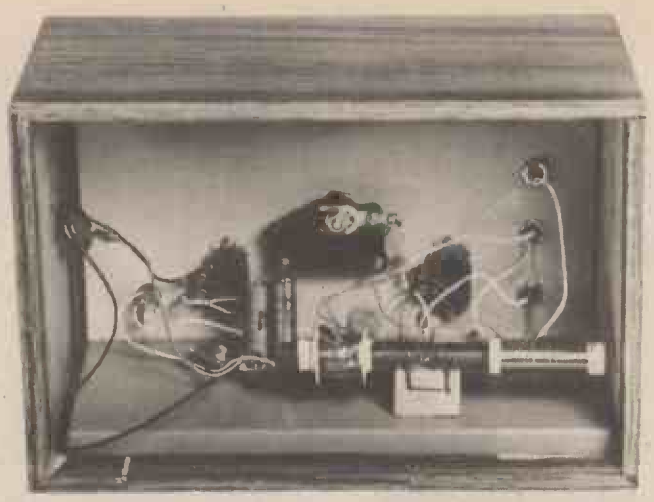
Fig. 6. Circuit diagram of the additional amplifier stage. Note that SK4, S2 and B1 are common to the receiver and are shown dotted to distinquish this point.

ADDITIONAL AUDIO AMPLIFIER

The circuit of the extra audio stage which can be added to the original circuit is shown in Fig. 6. It requires few components, gives a considerable degree of amplification, and will work into all sorts of output loads.

Audio signals come from the collector of TR1 to C3, which is the base coupling capacitor for TR2. Base bias is obtained via R3.

After amplification, the audio signal output is developed across



Looking from the back inside the unit. Note how the ferrite rod is mounted to the base. In this version the optional amplifier has been added.

the emitter resistor R4. Capacitor C4 couples audio signals to the output jack. As this capacitor isolates the emitter and output circuits, operation of TR2 is not upset by any other circuitry connected to the output jack.

WIRING

It is necessary to remove the board, and place the additional components as in Fig. 7. Components up to R2 will already be present of course. Take off the old output leads, which are no longer needed and rewire accordingly.

Do not overlook the foil break under C3. Also note the correct polarity of the electrolytic capacitors C4 and C5.

When the finished board is replaced, the diode and earth leads are restored as originally.

OUTPUT

An earpiece or headphones as employed originally can be used. Again, a good headset of medium impedance will give best results.

Signals should prove to be very considerably increased in volume. It will be found that adequate loudspeaker results may be obtained where reception conditions, and the aerial and earth, gave good volume with the simpler circuit.

A loudspeaker of about 75 to 80 ohms will be most suitable. A sensitive and efficient speaker, in its own cabinet, can give quite loud reproduction.

Speakers of somewhat lower impedance can also give good results, but volume will tend to fall off considerably if the speaker is of very low impedance—2 or 3 ohm. Generally, the unit would be at least 15 ohm, or preferably at least 30 ohm. Low impedance speakers can be used with a matching transformer, if these are already to hand.

With headphones, volume is likely to be too great for comfort, so it may be necessary to bring into use aerial socket SK1, or to fit a variable capacitor in the aerial lead as described earlier. ¤

EE CROSSWORD No 13

BY D.P.NEWTON

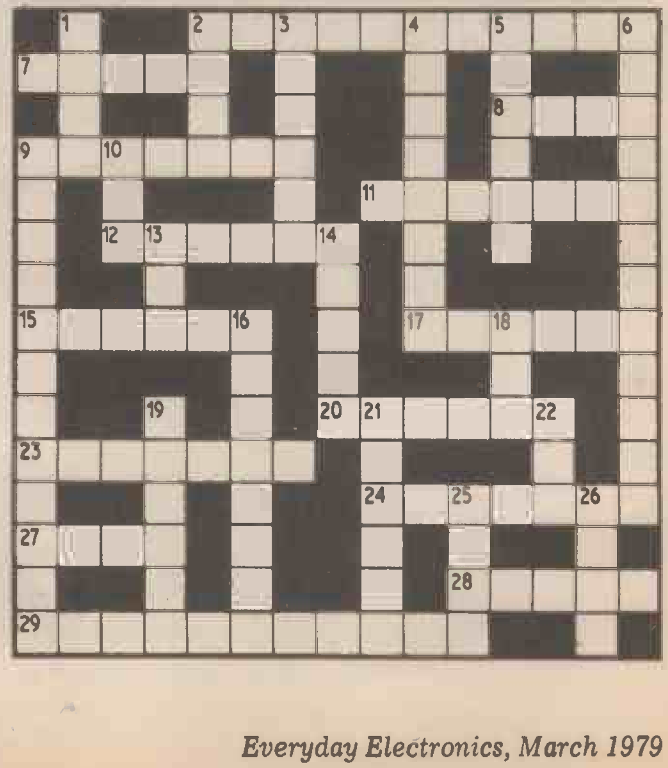
ACROSS

2 Units designed for a visual display pastime (2, 5, 4).
7 Ray, but not of sunshine.
8 About 10^{-9} for a year.
9 The things that are left but essentially an electrical supply.
11 Bulb accused of indecent exposure?
12 The hoped for l.s. output.
15 Fill the mind completely.
17 Set of connected things but not necessarily electronic.
20 To free oneself.
23 Sitting on the electrical fence.
24 Staccato noise — sometimes from a loose wire.
27 Crowd exspresion in unison.
28 Almost too much from the amplifier.
29 Honestly, it's a device for galvanic skin response (3, 8).

DOWN

1 To be stripped naked, as with wire.
2 Hackneyed conveyance.
3 Overcome by the third state of matter.
4 Monocle.
5 The rude means of tuning.
6 Calculator with additional capabilities.
9 Means of remote manipulation (5, 7).
10 Root mean square is confused initially for a woman.
13 Brown unit.
14 Musical background of a meter.
16 Without deviation and neat, too.
18 Amps, weakened without one, gives a fool.
19 Hoarded, as by capacitors.
21 Electrical receiver.
22 Moose.
25 Partly open.
26 Quieten.

Solution on page 163



LAB CENTRE

PART 1

By R. W. Coles and B. Callen

How many readers are lucky enough to have a fully equipped workshop or room where they can practice their hobby in harmony with the rest of the household? Very few we would estimate. The trouble seems to be that most residences are not really designed for those people who have ordinary hobbies like lion-taming, boat building or the ever popular electronics! And what about the many budding electronics enthusiasts who live in flats or bed-sitters or caravans? For them, things must be even worse.

Electronics, while perhaps a more domestically acceptable hobby than many others, *can* be a messy business. A bewildering array of interconnected power suppliers, amplifiers, multimeters and other test equipment is often required, and to set the whole thing off there will be the usually less-than-beautiful new-project "birdsnest".

Even the more accommodating wives and mothers are likely to draw the line at that sort of lash-up adorning the kitchen or dining room table for more than a few hours, and what happens when dinner's ready? After all, it took hours to get the whole thing connected up in the first place.

With the plight of this unfortunate and numerous band of electronics enthusiasts firmly in mind a long look was taken at the space problem. Attention was turned to the prospect of an "instant' electronics lab, one which would require neither bulging biceps nor miles of multi-coloured wire for its ready-for-use assembly.

The result is Labcentre and now one can't help wondering why on earth it hasn't been done before!

BASIC REQUIREMENTS AND FACILITIES

The requirements for the Labcentre were an all-purpose electronic laboratory which could be rapidly put into operation on a kitchen table or any similar flat surface after being stored for a time in a cupboard for instance, or after a bus trip across town. No "toy" laboratory would do, the system had to contain all the necessary bits and pieces including tools, power, supplies, test equipment and component storage, so that not only could those all important experiments be conducted, but also the design, construction, and testing of complete projects without recourse to a soldering iron.

Tools were a must of course and the usual assortment of cutters, pliers, screwdrivers and so on were chosen, and mounted on a removable toolboard in the lid of the case. The final choice of which tools to stock will of course be a matter for the individual constructor/designer.

Power supplies are always a problem. An easy way out would have been to include a single variable power supply, but examination of a cross section of projects revealed that usually several supply rails were needed, the most popular voltages being +5 volts (for TTL logic) and ±15 volts (for operational amplifiers and CMOS). It was therefore decided to incorporate such a multi-output supply accordingly. The 5V rail can supply currents up to 500mA, and the ±15V rails, 250mA.

Other voltages that may be required up to 15V (e.g. 9V, 6V, 4·5V) can easily be achieved by means of a Zener diode and series resistor connected across the +15V supply, and sited on the breadboard.

A multimeter was considered essential, but after examining the possibility of building one into the design, this

COMPONENTS approximate cost £40 excluding breadboard/case

was rejected in favour of a separate meter of conventional design. After all, most electronics enthusiasts already own one. Sufficient space is available in the final casing to accommodate most medium sized multimeters.

SIGNAL GENERATOR

A signal generator is an essential part of any designers set-up. This and more is achieved by using a function generator i.c.

A function generator, for those who haven't come across this relatively new instrument before, is rather like a signal generator but with the added facility of being able to choose the shape of the output waveform.

Some function generators have a wide variety of possible waveshapes; the Labcentre generator has a choice of sinewaves, triangular waves and square waves.

Apart from the choice of ouptut waveshape, the usual signal generator facilities of variable frequency and variable output voltage amplitude are available. Output frequencies of from 1Hz to 100kHz in two switched ranges are available, at continuously variable voltages from 0 to 10 volts.

A choice of sine or triangle waveforms can be selected at the flick of a switch. Square waves of the same frequency and even divisions up to eight are simultaneously available at 5V and 15V amplitudes.

The fact that square waves are rich in harmonics means that they can also be used to advantage when testing audio amplifiers or even radio receivers.

AUDIO AMPLIFIER

An audio amplifier and small loudspeaker can be very useful for checking out tuner front ends, alarm circuits, oscillators, preamplifiers etc. and so were included in the design. The amplifier can deliver up to about 350 milliwatts which incidentally is quite loud. The speaker may be disconnected by means of a switch thus allowing it to be used for other functions.

DE-BOUNCED PUSH BUTTON

Nowadays, digital logic circuitry using TTL or CMOS is becoming increasingly popular. In view of this a de-bounced push button pulser was embodied in the unit.

The push button pulser is a simple but invaluable aid for use with flip-flop and counter circuits. A depression of the button generates a logic high level at one output for as long as the button is pressed. Releasing the button causes the output to revert to logic 0.

This could have been done with only a switch, but the dreaded "switch bounce" would in fact cause a rapid oscillation during the make or break of the switch and any flip-flops or counters connected might toggle many times for each depresion. The addition of this circuit prevents this happening and gives fast clean pulse edges.

A facility to allow the visual monitoring of logic levels is afforded by the inclusion of a bank of four buffered l.e.d.s with input sockets. The buffers are CMOS drivers which will turn on an l.e.d. for any input voltage between 2 and 15 volts making them suitable for TTL and CMOS logic.

SPARE SWITCHES AND SOCKETS

Close to the breadboarding area are sited a collection of four uncommitted toggle switches with sockets so that they can be wired into user circuitry on the breadboard to provide logic levels, control selection, or any one of a hundred other jobs for which a switch is needed.

At the rear of the console front panel is a simple but useful facility provided by a pair of 13A switched mains sockets. These sockets are powered via the console mains lead and are there to provide power to the soldering irons, lamps or equipment such as an oscilloscope which may be needed during a project. When, as often happens, you have only a single wall socket within easy reach, this facility makes life so much simpler!

BREADBOARD

In the past, many ingenious "breadboarding" systems have undoubtedly been used by constructors including the dreaded "birdnest" (a nest of interconnected components, soldered joints croc-clips, etc.).

The Labcentre uses a commercially available breadboard system as the basis of interconnecting components for design and test. No soldering is required whatsoever thereby being extremely economical on components allowing them to be used over and over again.

There are many different shapes and sizes of commercial breadboards currently on sale of the plug-in type used here, and any one (or more) may be used in this project.

The type used in the prototype (size approximately 165 x 55mm) has 640 plug-in tie points for circuit components plus eight distribution buses (200 tie points), and can hold up to nine 14-pin d.i.l. i.c.s. Such a board is the Letrokit Super-Strip SS-2.

Connecting wires and component leads are simply pushed into the sockets which contain nickel-silver alloy sprung contacts which accept wire thicknesses of up to 20 s.w.g. Connection between breadboard and Labcentre circuitry is made with wire terminated in a 2mm plug.

BRIEF CASE

All the electronics have been housed in a single "console" whose dimensions (31 x 19 x 8cm) have been tailored to suit a *Custom* executive style brief case, leaving room for component and instrument storage.

The brief case is not essential by any means. Everyone will have their own ideas about how to develop the Labcentre concept, and these could include wiring the console as an independent unit or building a "custom" case in wood or metal. If you already have a brief case of suitable dimensions, you do not have to dedicate it to Labcentre exclusively, as all the parts are instantly removable so that you can use your case for any other purpose at the drop of a soldering iron.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Labcentre appears in Figs. 1.1 and 1.2, the power supply having been detached from the rest of the circuitry

Shows the Lektrokit Super-Strip SS-2 breadboard recommended for the Labcentre.

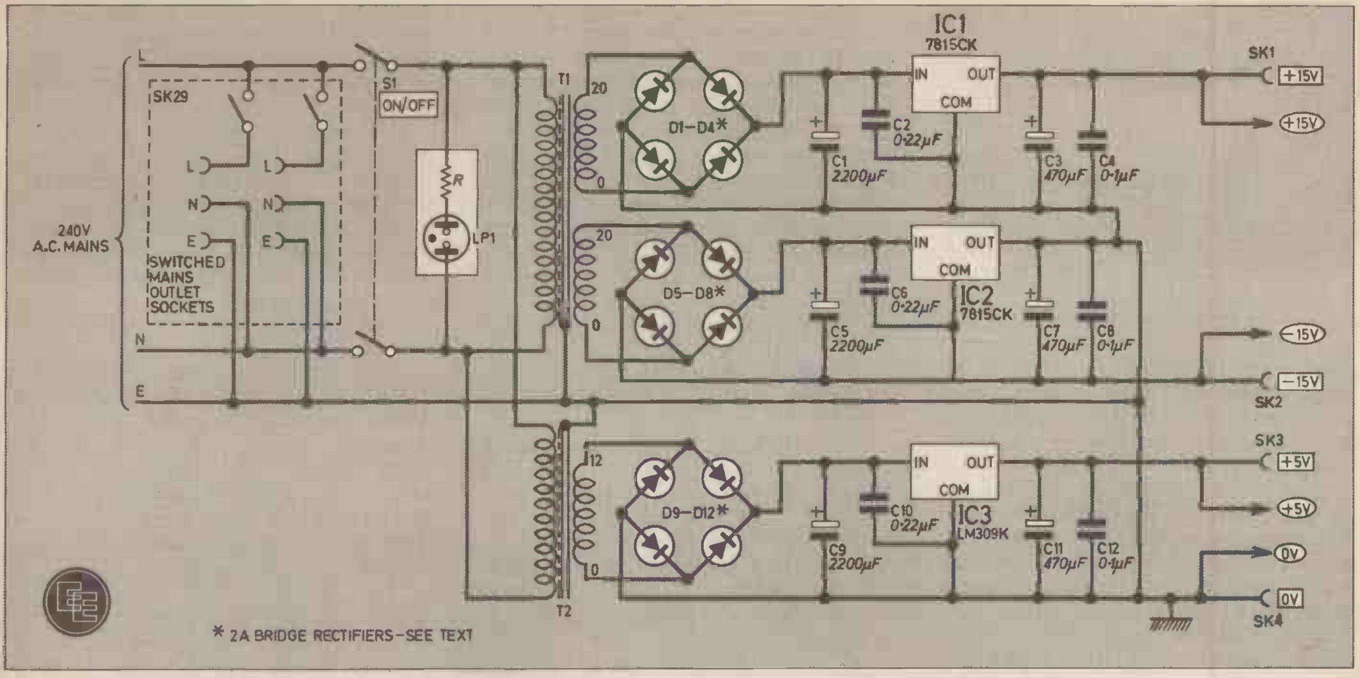


Fig. 1.1. The circuit diagram for the multioutput power supply section of the Labcentre.

for clarity. As can be seen, the overall circuit diagram appears as a number of distinct sections and each of these will be described in turn.

POWER SUPPLIES

The circuit of the power supplies is shown in Fig. 1.1.

Thanks to the very capable fixed voltage power regulators now widely available, the power supply is quite easy to build and can be readily understood. The transformers T1 and T2 reduce the 240V a.c. mains to the lower a.c. voltages required to supply the 15V and 5V regulators, IC1 to IC3. Three rectifier bridges (D1-D4, D5-D8 and D9-D12) and three smoothing capacitors (C1, C5, C9) provide the raw d.c. inputs to each of the three fixed voltage regulator i.c.s which are housed in individual TO-3 power transistor cans mounted on small heatsinks.

REGULATORS

Inside each of the regulator packages there is a complex analogue circuit which includes a Zener diode reference, several high gain amplifier stages and a power transistor which acts as the "business end" of the regulator. Also included is a protection circuit which limits the output current of the regulator under short circuit or fault conditions. A useful facility for a power supply which is used for "breadboard" purposes!

The regulators IC1 and IC2 are both 15 volt types but notice that IC2 does *not* have its common (COM) or case terminal connected to 0V like the other two. This is because we are using a *positive* regulator in a circuit where the positive regulated output pin is connected to 0V, and means in practice that the IC2 heatsink must not be allowed to touch the other two.

Capacitors C2, C6 and C10 are used to ensure regulator stability at high frequencies where the inductance of the connecting wires becomes significant and circuit oscillation is a real possibility. They are mounted as close as possible to the regulators themselves. Capacitors C3, C7 and C11 help to prevent transient outputs which the regulator itself cannot eliminate, and also reduce the regulator output impedance at high frequencies. The low value capacitors C4, C8 and C12 eliminate possible high frequency oscillations on the supply lines.

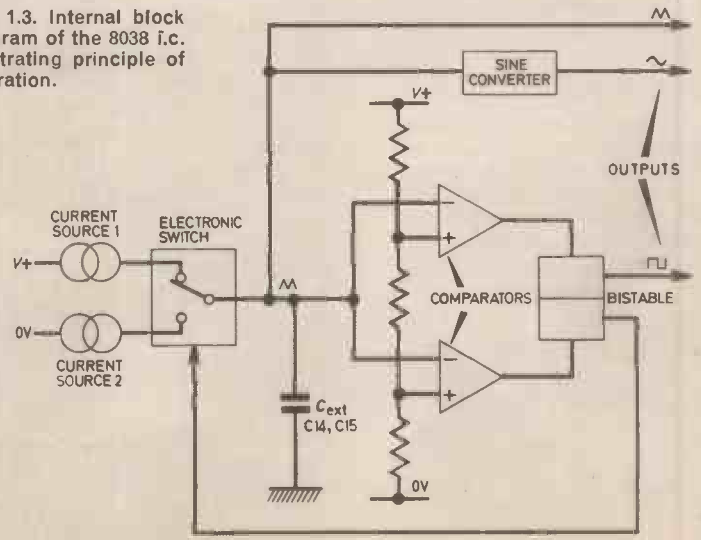
FUNCTION GENERATOR

The function generator design (Fig. 1.2) utilises the now freely available Intersil 8038 integrated circuit mated with a wide bandwidth operational amplifier, the Signetics NE531. The aim was to produce an untemperamental circuit which used inexpensive components and yet which would provide the widest possible frequency range and an adjustable output voltage.

The resulting circuit uses no difficult-to-wind inductors, being tuned by means of a variable resistor and a fixed capacitor.

The 8038 is a fourteen-pin integrated circuit of monolithic construction which produces simultaneous output waveforms of square, triangle, and

Fig. 1.3. Internal block diagram of the 8038 i.c. illustrating principle of operation.



sine shape over a wide frequency range with high stability and low distortion. The basic circuit elements inside the i.c. are shown in Fig. 1.3.

RAMP VOLTAGE

The external capacitor C_{ext} is charged, via the constant current source 1, so that the voltage across it is a linearly *rising* ramp. This ramp voltage is applied to a pair of comparator circuits (very high gain amplifiers) which each have a reference input derived from the circuit supply voltage.

As the rising ramp reaches the threshold of the upper comparator, the comparator fires and its output changes state, resetting the bistable flip-flop which changes the position of the electronic switch so that a second constant current source is connected to the charged capacitor. This discharges the capacitor producing a linear, *falling* ramp voltage across the capacitor.

When this linear ramp voltage falls to the threshold level of the lower comparator circuit, it fires in its turn and changes the state of the flip-flop back to the starting condition.

The flip-flop changes the position of the electronic switch to reconnect the other current source, the ramp starts to rise once more, and the whole process repeats itself indefinitely at a rate determined by the current through the current sources and the value of the capacitor, C_{ext}.

The complete circuit of the function generator is shown in Fig. 1.2, and here C_{ext} is chosen as either C14 or C15 to provide coarse frequency control, while fine frequency setting is made possible by VR2 which varies the current source outputs via the control terminal, pin 8.

Varying the ratio of the currents from current sources 1 and 2 will alter the symmetry of the output waveforms, and VR4 is provided so that this symmetry can be properly adjusted via the individual current source control pins, 4 and 5.

With Labcentre, the aim is to adjust VR4 for a 1:1 mark-to-space ratio on the square wave output, which guarantees a symmetrical sine and triangle wave output.

It is possible to adjust VR4 to give a sawtooth output waveform instead of a triangle should this ever be needed, but this will cause the sinewave output to become very distorted.

SINEWAVE OUTPUT

The sinewave output is derived from the triangle waveform using a circuit block inside the 8038 known as a sine-converter. The sine-converter consists of two fixed-biased transistor "trees" which are used to vary the gain of the converter stage depending on the input voltage level.

As the input voltage rises towards a maximum (or drops towards a minimum) additional transistors in the appropriate tree conduct to vary the ratio of a potential divider and hence the slope of the output waveform. The fact that each transistor turns on gradually, rather than suddenly at some precise threshold level, ensures that the changes in slope of the output waveform appear to occur quite smoothly, giving a very good approximation to a sinewave.

Two trees are required, one for the positive half-cycle and one for the negative half cycle, and fine adjustment of the sine shape is made possible by VR5 and VR6 which adjust the current in each leg of the potential divider.

The sine and triangle wave outputs of the 8038 (pins 2 and 3) are not suitable for driving even medium impedance loads as they stand and so to give a good drive capability in the final circuit they are buffered by means of an NE531 operational amplifier (IC5).

Potentiometer VR7 acts as an output voltage control, and R1 and R2

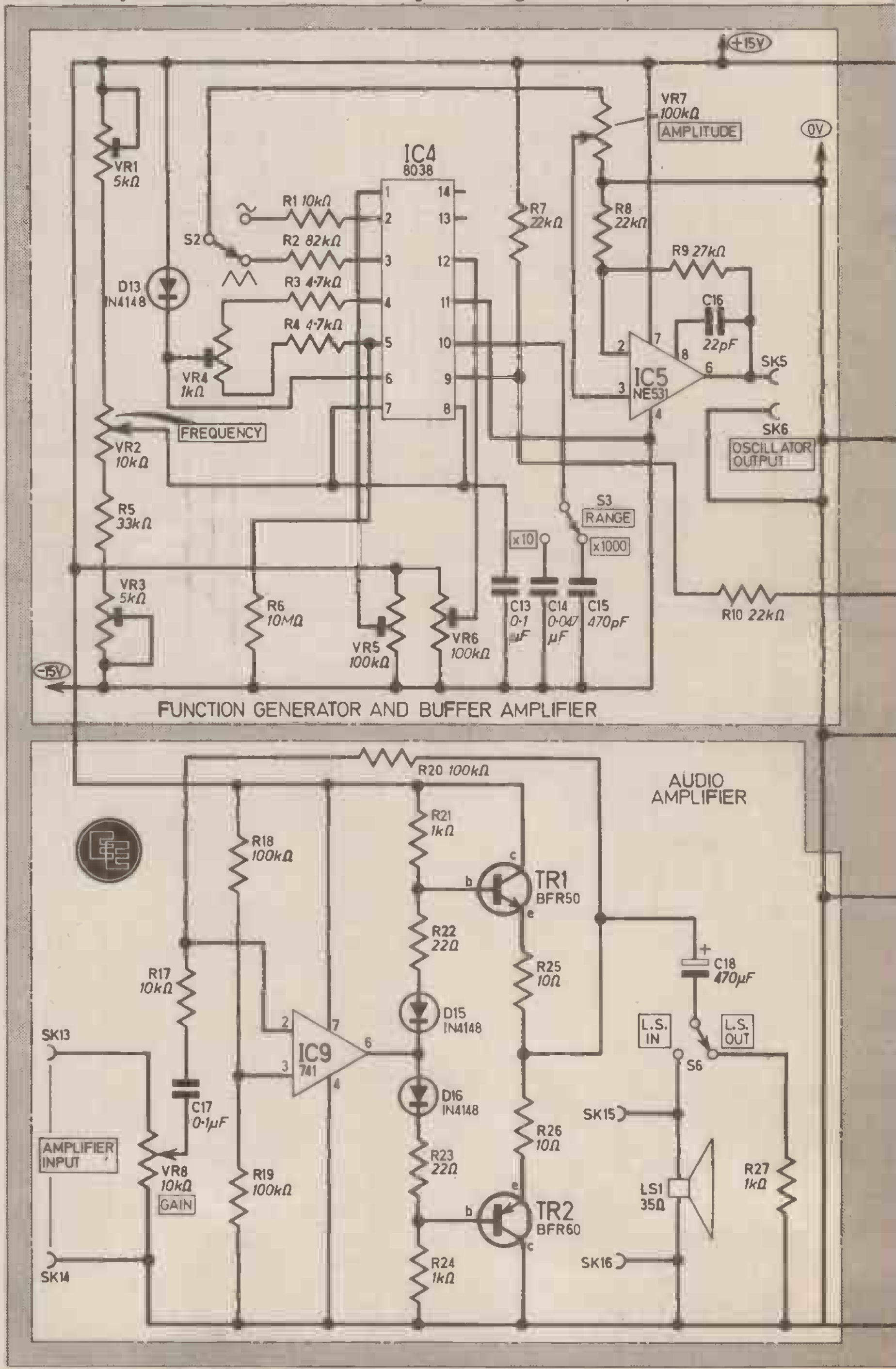


Fig. 1.2. The main circuitry of the Labcentre containing Function Generator, Level Translator/Clock Divider, De-bounced Pulser, Audio Amplifier and l.e.d. Drivers.

ensure that the sine and triangle wave outputs are of equal amplitude.

The NE531 is an operational amplifier chip with an enhanced high frequency performance which makes it ideal for our purposes, but it is pin compatible with the very common 741 device, and during initial circuit testing at l.f. (up to 200kHz) a 741 can be substituted if required.

Finally the square wave output of the 8038 (pin 9) is converted into a 15 volt logic swing suitable for driving CMOS with R7, R10, and D14. This output is used to drive the CMOS counter, IC6, and one of the buffer stages in IC7.

LOGIC CIRCUITS

The clock pulse generator circuit is shown in more detail in Fig. 1.4. The output from the function generator is fed to pin 15 of IC6 (MC14516) which is used here as a straightforward binary counter. The MC14516 is actually a sophisticated chip with provision for parallel loading, reversible counting, and asynchronous clearing, but in this application these facilities go unused, which accounts for the large number of pins which are "tied down" to 0V.

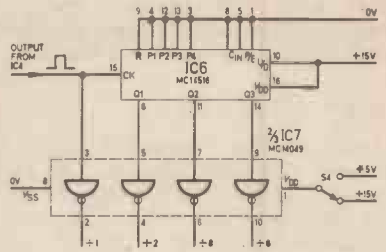
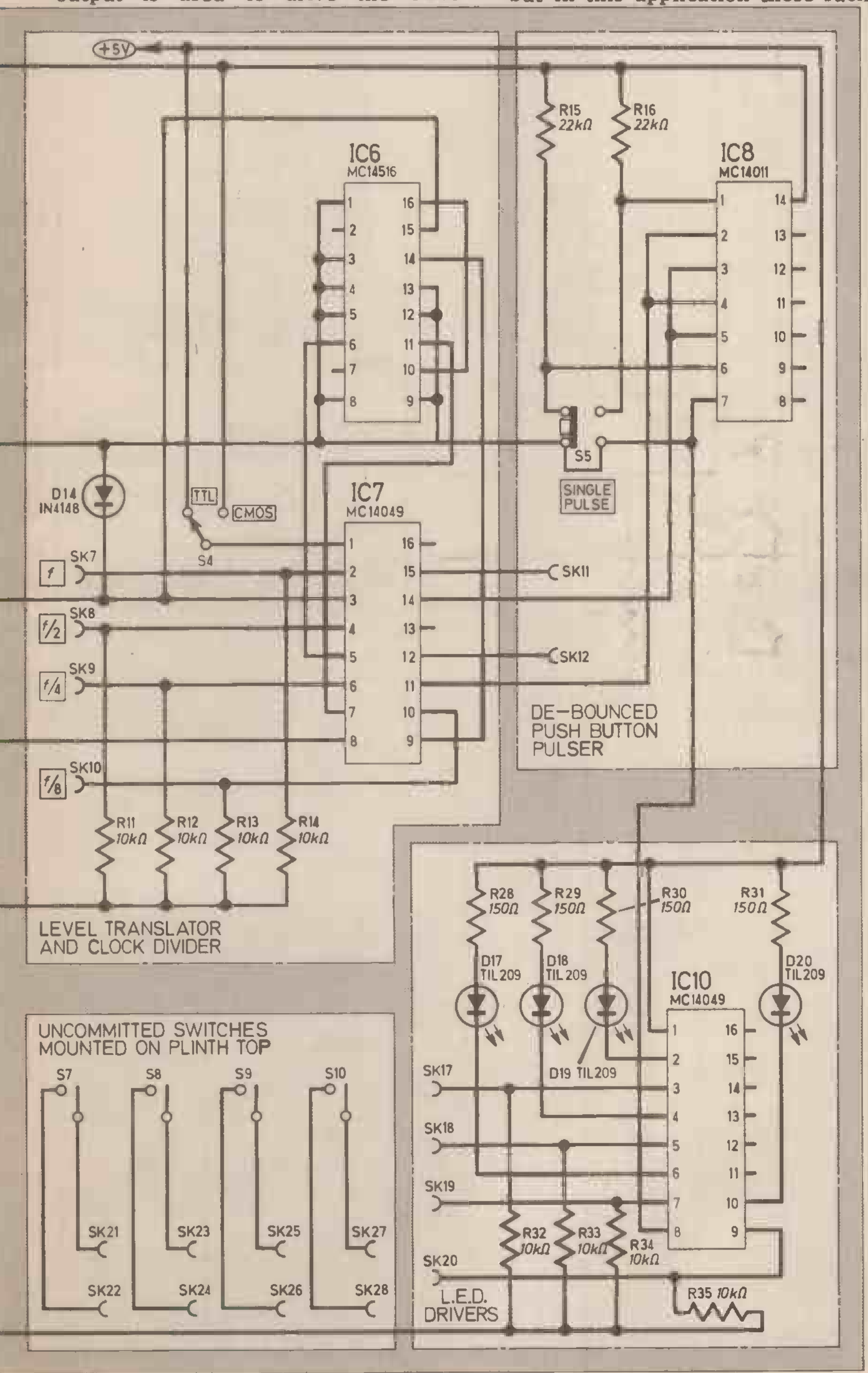


Fig. 1.4. The circuit of the Level Translator/Clock Divider in detail.



Each of the four flip-flops inside the MC14516 divides the function generator output by two, but due to lack of front panel space, only three of the divided outputs are actually utilised.

Four of the buffers of IC7 provide a high drive capability, or "fanout" which allows several standard TTL loads and an almost unlimited number of CMOS loads to be driven. They also provide a neat solution to the problem of providing two different logic swings of 0-5V and 0-15V which was a requirement of the design.

The MC14049 is not only a buffer but also a level translator designed to convert input logic swings of up to 15V to an output swing determined by the voltage applied to its V_{CC} pin. By switching the voltage to the V_{CC} pin between 5V and 15V it is therefore possible to choose either TTL or 15V CMOS compatibility for all six outputs from the one chip.

At this point it is worth pointing out that the TTL, or 5V logic swing, is of course quite suitable for driving CMOS circuitry *which runs from 5V supplies*. The 15 volt CMOS outputs are needed only where high speed or op-amp compatibility is required when using CMOS logic. It is also prudent to point out that the 15V setting *must not* be used with TTL logic, or with CMOS logic using 5V supplies!

PULSER

The operation of the push button pulser circuit is shown more fully in Fig. 1.5. It is a simple but very useful facility when breadboarding logic circuits which utilise registers or counters. The two MC14011 NAND gates of IC8 are cross-coupled to form a simple set/reset latch which can be *set* (i.e. the Q output at logic 1 and the $\bar{Q}$ output at logic 0) by depression of the push button. The *reset* state is regained when the push button is released, and the transitions from one state to the other are "clean" with no contact bounce of the sort which would occur with the switch alone wired up to do the job.

COMPONENTS

Resistors

R1	10kΩ	R12	10kΩ	R23	22Ω
R2	82kΩ	R13	10kΩ	R24	1kΩ
R3	4·7kΩ	R14	10kΩ	R25	10Ω
R4	4·7kΩ	R15	22kΩ	R26	10Ω
R5	33kΩ	R16	22kΩ	R27	1kΩ
R6	10MΩ	R17	10kΩ	R28	150Ω
R7	22kΩ	R18	100kΩ	R29	150Ω
R8	22kΩ	R19	100kΩ	R30	150Ω
R9	27kΩ	R20	100Ω	R31	150Ω
R10	22kΩ	R21	1kΩ	R32	10kΩ
R11	10kΩ	R22	22Ω	R33	10kΩ
				R34	10kΩ
				R35	10kΩ

All ¼W carbon film ± 5%

Capacitors

C1	2200μF 25V elect.	C10	0·22μF polyester
C2	0·22μF polyester	C11	470μF 25V elect.
C3	470μF 25V elect.	C12	0·1μF disc ceramic
C4	0·1μF disc ceramic	C13	0·1μF disc ceramic
C5	2,200μF 25V elect.	C14	0·047μF polyester (radial lead)
C6	0·22μF polyester	C15	470pF polystyrene
C7	470μF 25V elect.	C16	22pF polystyrene
C8	0·1μF disc ceramic	C17	0·1μF disc ceramic
C9	2200μF 25V elect.	C18	470μF 16V elect. (radial leads)

Potentiometers

VR1 5kΩ miniature cermet 20-turn trimpot (¾ inch Spectrol type 43P)
VR2 10kΩ lin. wirewound
VR3 5kΩ miniature cermet 20-turn trimpot (¾ inch Spectrol type 43P)
VR4 1kΩ miniature horizontal carbon preset
VR5 100kΩ miniature horizontal carbon preset
VR6 100kΩ miniature horizontal carbon preset
VR7 100kΩ lin. carbon
VR8 10kΩ log. carbon

Semiconductors

D1–D4 2A bridge rectifier
D5–D8 2A bridge rectifier } type SO2 (μ-Electronics)
D9–D12 2A bridge rectifier } or KBPC102 (General Instruments)
D13–D16 1N4148 silicon (4 off)
D17–D20 TIL209 red light emitting diode with panel mounting bush (4 off)
TR1 BFR50 silicon *npn*
TR2 BFR60 silicon *pnp*
IC1, 2 15 volt positive voltage regulator type 7815CK or LO37T1—TO-3 case style (2 off)
IC3 5V positive voltage regulator type 7805CK, LM309k or LO5T1—TO-3 case style
IC4 8038 function generator i.c.
IC5 NE531 operational amplifier 8 pin d.i.l.
IC6 MC14516 or CD4516 Binary up/down counter
IC7 MC14049 or CD4049 Hex inverter/buffer
IC8 MC14011 or CD4011 Quad 2-input NAND gates
IC9 741 operation amplifier 8 pin d.i.l.
IC10 MC14049 or CD4049 Hex inverter/buffer

See **Shop Talk** page 144

Miscellaneous

T1 Mains primary, 0–20V, 0–20V 150mA secondary
T2 Mains primary, 0–12V, 0–12V 250mA secondary (or 0–12V 500mA)
S1/LP1 Mains on/off rocker with built-in neon
S2–S4 Miniature single-pole double-throw toggle (3 off)
S5 Two-pole changeover push button
S6–S10 Miniature single-pole double-throw toggle (5 off)
SK1–SK4 Heavy duty panel mounting screw terminals/sockets (1 red, 1 black, 1 green, 1 yellow)
SK5–SK28 2mm panel mounting sockets (24 off various colours)
SK29 Individually switched double mains outlet socket
LS1 Miniature moving coil loudspeaker, 35 ohms impedance 50mm diameter

Printed circuit board (copyright held by C. C. Consultants—see Shop Talk); Letrokit Super-Strip SS-2; terminal pins (58 off); i.c. sockets: 8 pin (2 off), 14 pin (2 off), 16 pin (3 off); 4BA fixings: nuts (20 off), bolts (10 off), solder tags (1 off); 6BA fixings: nuts (8 off), bolts (4 off), washers (12 off), solder tags (2 off); heat-sinks type (3 off); heatsink compound; mains cable; connecting wire.

The outputs of the pulser latch are level translated and buffered by the remaining two MC14049 buffers in IC7, and are therefore controlled by the TTL/CMOS switch (S4) as required.

The buffered light emitting diodes D17-D20 also make use of the level translation ability of the MC14049 device, although here the V_{CC} pin and the l.e.d.s are wired permanently to 5V, and input logic swings can be from 0 to 2·5V to 0 to 15V for reliable operation of the lamps. The resistors in series with the lamps liimit the l.e.d. current to a safe value and ensure uniform brilliance across the display.

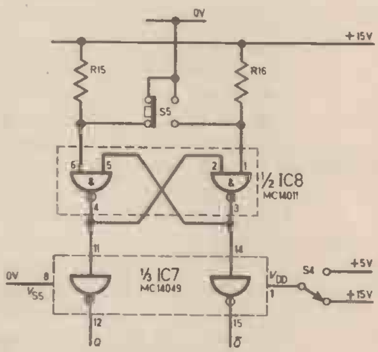


Fig. 1.5. Detailed circuit of the Debounced Pulser. Only one pulse is produced for the depression of S5.

AUDIO AMPLIFIER

Monolithic audio amplifiers (power amp i.c.s) were rejected because those tried turned out to be too temperamental and the requirement was a very forgiving design! The final circuit uses a 741 op-amp and a complementary pair of silicon transistors in plastic packages.

In a nutshell, the 741 acts as a voltage amplifier and provides sufficient current to drive the output transistors. The transistors themselves act as current amplifiers in the emitter-follower configuration providing a low impedance output capable of driving the speaker.

The voltage gain of the whole amplifier is set by negative feedback via R24. Potentiometer VR8 acts as an input attenuator/volume control, and the 741 is operated across only one half of the 15-0-15V supply with the amplifier virtual-earth point set at about +7·5V by R22 and R23. When not in use, the output of the amplifier positive plate of C18 should float at a d.c. voltage of about 7·5V with no input signal. Measuring this voltage is a useful test for correct circuit operation.

With the loudspeaker switched off, a dummy load (R31) is connected across the output of the amplifier and the speaker becomes available for use as an input or output device for breadboard circuits.

To be continued

MINI~MODULES

By George Hylton

Handy "Beginner" projects based on simple circuits and featuring a variety of building methods.

6 VERSATILE POWER SUPPLY

THIS month's Mini-Module is designed to avoid the need for batteries to power low-consumption circuits like most of those in this series. It is a mains power unit. Instead of a straightforward "battery eliminator" (also known, nowadays, as an "a.c./d.c. converter") this one has an output voltage adjustable from about 1 to 9 volts.

The output voltage is stabilised and this stabilised output is provided with an overload protection circuit which limits the current to what the unit can safely deliver.

There is also an unstabilised output, which is not protected in this way but which is useful for certain purposes.

The stabilised output can be thought of as a variable voltage tapping on the unstabilised supply and the two can be used together so long as the total current drawn is not more than the mains transformer can deliver.

THE CIRCUIT

Referring to the circuit diagram (Fig. 1), the left hand group of components T1, D1, D2 and C1 form a conventional power supply unit with push-pull rectification. (For reasons which there is no space here to give it is safest to use a transformer with a nominal current rating of at least 100mA.)

The voltage drop across the l.e.d., D3, is constant at about 1·8V. This constant voltage, applied to the base of TR1, causes a collector current to flow which is set by R2 to about 1·7mA. If TR2 is non-conducting all this current flows into the base of TR4. If TR4 had an amplification factor (h_{FE}) of 100, its collector current would then be about 170mA, and its emitter current slightly greater.

The emitter current of TR4 is the output current of the stabiliser. To effect stabilisation it is necessary to sense when enough current flows out of TR4 emitter to set up the required voltage across the load, then prevent the current from rising any higher.

This job is done by TR2. A fraction of the output voltage is applied, via VR1 and R3, to TR2 base. When this base voltage reaches about 600mV, TR2 begins to conduct. Since its collector current has to come from TR1 the result is that some of TR4 base current is now diverted through TR2. This prevents the output voltage from rising higher than the set value.

Naturally the system works just as well in reverse. If the output voltage falls, TR4 diverts less current from TR4 base and counteracts the fall.

OVERLOAD PROTECTION

To protect against overload a means is provided of limiting the current through TR4 when the load (output) current reaches its safe maximum. To do this the collector current of TR4 (which is almost the same as the load current) is passed through a small resistance R5.

With R5 equal to 10 ohms the voltage drop is 600mV when the current is 60mA. This voltage (via R4) turns on TR3. At first nothing much happens but as the load current rises beyond 60mA a point is reached at which TR3 is turned on so hard that it saturates and short-circuits he l.e.d., D3. This robs TR1 of its base voltage and it collector current falls, restricting the output by limiting the base current available for TR4.

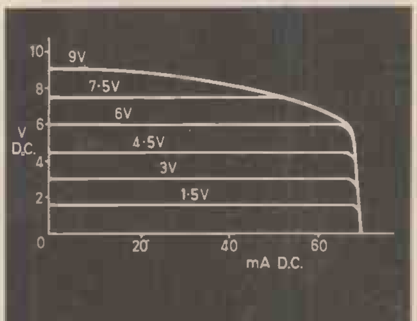


Fig. 2. Output characteristics.

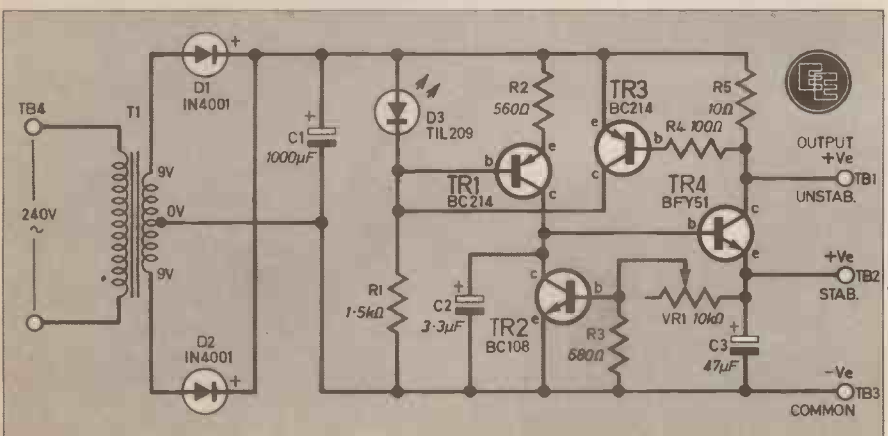
OUTPUT CHARACTERISTICS

The effect of this restriction can be seen from the graph (Fig. 2) which shows how the current is limited to 70mA. (The actual limiting current varies somewhat from unit to unit because of transistor variations and resistance tolerances. If necessary it can be reduced by increasing R5.)

Fig. 2 also shows that the output at high voltages is restricted to about 20mA before it begins to fall. This is not the effect of the stabiliser but of the fall in unstabilised output from the transformer-rectifier part of the circuit. This is normal and is due to the resistance of the transformer windings.

The unstabilised output has to be some 2V greater than the stabilised output for D3 and TR1 to function properly. With no load the unstabilised

Fig. 1. Circuit diagram of the versatile power supply unit.



output of a rectifier driven from 9V r.m.s. is around 12V but as the load increases the voltage falls. (In the prototype the unstabilised output falls to 8V for a 70mA load, which explains why full output current is obtained for output voltages up to 6V but not for higher voltages.)

In general the high-voltage performance will be improved by substituting a larger mains transformer for the miniature one used in the prototype; but it won't fit the small plastic box used to house the prototype so a larger case would be required.

CONSTRUCTION

A plastic box is recommended. (If a metal box *is* used it is essential to use a three-core mains cable and to connect the metal box to the earth lead.)

The prototype was housed in a "Norman" multi-purpose plastic case type PB1. This case is on the shallow side for housing a mains transformer: the "Brazennose" (Japanese) Model 909/1 transformer used in the prototype is 25mm high and only just fits in. This presented a small constructional problem.

The solution was a double-layer base, with a piece of Formica to carry the transformer with the minimum of added thickness and a smaller hardboard "circuit panel" cut to fit round the transformer and glued to the Formica, after circuit assembly. See Fig. 4.

For those who want to avoid the depth problem there are plastic boxes on the market which are deeper than the one used, for example the Type MB2 from Ace Mailtronix, this is 95 x 71 x 35mm and the lid fixes at the corners, which makes baseboard construction easier. (The Norman case fixtures fall in the centres of the short sides and the base has to be notched to fit round the fixing pillars; cutting off corners is simpler.)

A further point to watch in construction concerns the voltage control potentiometer VR1. This is fitted to the lid. It must not protrude so far into the box that it touches the circuit. With a shallow box this precludes the use of a potentiometer with a combined mains switch. The prototype has no mains switch and must be turned off by unplugging or switching off the power point which supplies the mains to it.

Ordinary pins are driven through the circuit panel to provide anchoring and soldering points for components and wiring.

OUTPUT TERMINALS

For good insulation the mains cable is terminated inside the case on a small piece of two-ampere plastic "choc block" terminal strip, TB4.

COMPONENTS

Resistors
- R1 1·5kΩ
- R2 560Ω
- R3 680Ω
- R4 100Ω
- R5 10Ω
- All carbon, 5% tol. ¼W

Potentiometer
- VR1 10kΩ carbon track, log. or linear

Capacitors
- C1 1,000μF 25V elect.
- C2 3·3μF 12V elect.
- C3 47μF 12V elect.

Semicondutors
- D1, D2 1N4001 50V 1A rectifier (2 off)
- D3 TIL209 l.e.d., red
- TR1 BC214 *pnp* transistor
- TR2 BC108 *npn* transistor
- TR3 BC214 *pnp* transistor
- TR4 BFY51 *npn* transistor

Miscellaneous
- T1 Mains transformer 0–240V primary; 9-0-9V 100mA secondary. (Brazennose 909/1 or similar).
- Plastic case (Norman PBI or see text). Formica, hardboard. Four 2-way terminal blocks. Pointer knob. Mains flex, twin, 2A.

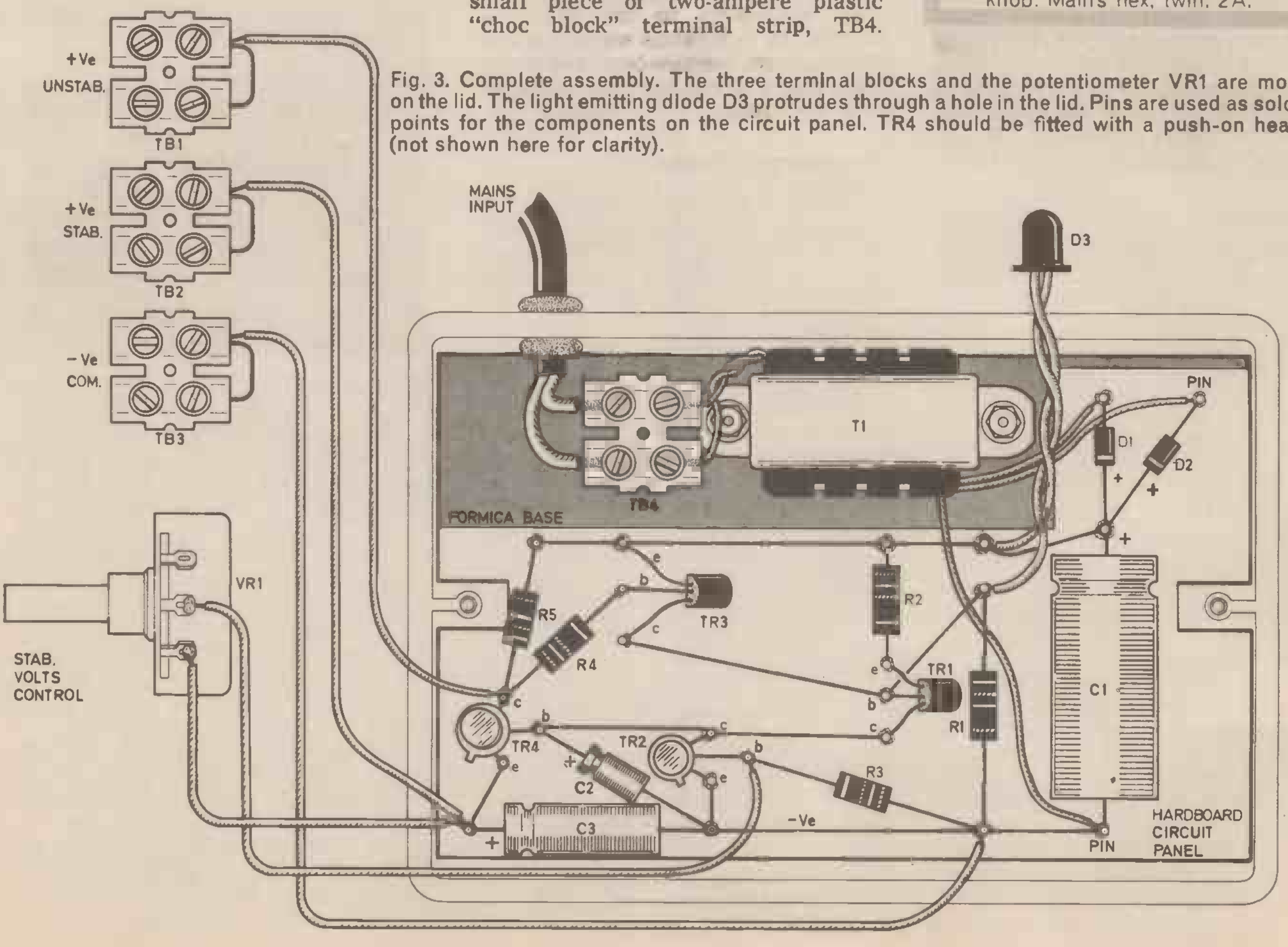


Fig. 3. Complete assembly. The three terminal blocks and the potentiometer VR1 are mounted on the lid. The light emitting diode D3 protrudes through a hole in the lid. Pins are used as soldering points for the components on the circuit panel. TR4 should be fitted with a push-on heat sink (not shown here for clarity).

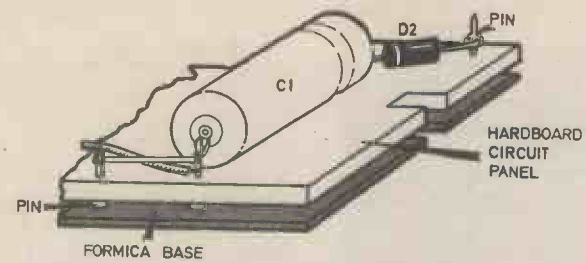


Fig. 4. A detail section showing sandwich construction of base-circuit panel.

Three other similar blocks, TB1, 2 and 3, are mounted on the lid to serve as output terminals—one for the unstabilised output, one for the stabilised output and one for the common negative terminal. The "choc blocks" are fixed by small self-tapping screws, from below.

It would, of course, be possible to bring the three output leads to a single terminal block with just three positions. Experience shows, however, that it is then very easy to connect to the wrong terminal, with disastrous results. So keep them apart!

The l.e.d., D3, functions not only as a voltage stabiliser for TR1 but also as a pilot light and an overload warning device. (It dims when there is an overload, including an overload of the unstabilised output.) For these reasons it should be mounted on the lid, where it can be seen, instead of shut up inside the case.

The BFY51 output transistor TR4 operates near the limit of its permissible dissipation under overload conditions. For this reason it is advisable to fit it with a good push-on heat sink.

VENTILATION

The mains transformer and TR4 both develop a fair amount of heat. However, a 9V 100mA transformer handles only about one watt and even under overload conditions when all the power is turned into heat inside the case there should be no cooling problem provided that the case itself is in the open and not covered up or boxed in. There is thus no need to drill ventilation holes.

Next Month: Transistor Tester

Sidebands

A READER remarks on the lack of any simple explanation of how sidebands are created when a carrier wave is modulated by an audio frequency.

The point is a good one. The reason for the absence of a clear description of *how* sidebands are generated in modulation, *why* they are of the frequencies mentioned in books for beginners, and so on, is just nobody has yet thought of a nice simple physical analogy.

The flow of current through a wire can readily be imagined from the flow of liquid through a pipe but there is no such easy analogy for the creation of sidebands.

This is a pity because on occasions the absence of any simple explanation has led engineers to waste time in a vain attempt to do the impossible. A notable example cropped up in the thirties when there appeared at a certain exhibition a radio receiver called the Stenode. It was claimed to be infinitely selective because it incorporated a filter so sharply tuned that only the carrier got through. Since the receiver worked this proved (it was said) that there are no such things as sidebands.

This must have come as a surprise to mathematicians. Their calculations had "proved" that if a steady single frequency is varied in amplitude (strength) then new frequencies are created—sidebands, in fact. If the variation is itself a steady frequency then (according to the mathematicians) the sidebands are in the form of two steady frequencies, one higher than the original carrier frequency and one lower.

Sum and Difference

These "side frequencies" are sum and difference frequencies. If the carrier frequency is 100kHz and is varied in amplitude at a rate of 1kHz then the sideband frequencies are 101kHz, the sum and 99kHz, the difference.

But calculations are one thing and demonstrations another. What was needed to settle the argument was a convincing demonstration that sidebands really exist. Nowadays it would be easy. All you'd need do would be to feed a modulated signal into a spectrum analyser. A picture would then appear on its cathode ray tube screen showing the carrier frequency and the sideband frequencies.

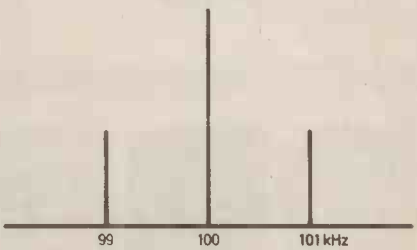


Fig. 1. Modulating a carrier with a single audio frequency.

In the case of a steady modulation such as 100kHz modulated by 1kHz the picture on the screen looks like Fig. 1. For speech and music or noise it is like Fig. 2, where the sidebands are not steady but fluctuate as different side frequencies appear and disappear.

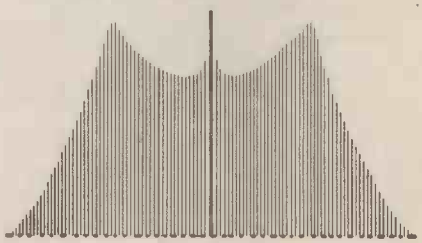


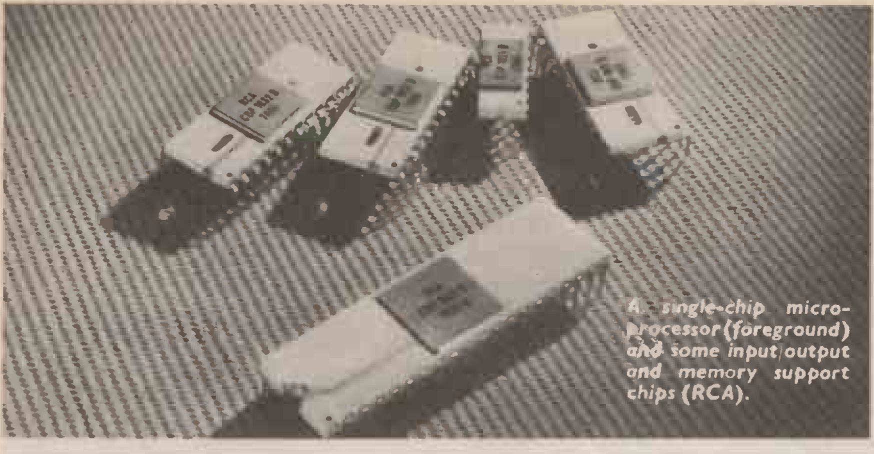
Fig. 2. A carrier being modulated by a whole range of frequencies.

Selective Receiver

Back in the thirties no such instrument was available in Britain so the National Physical Laboratory did the job another way. They constructed a very selective receiver, applied a steadily modulated signal and tuned across the spectrum, measuring the detector's d.c. output as the receiver tuned in first the lower side frequency then the carrier and finally the upper side frequency. The spectral lines were not as sharp as in Fig. 1, because the receiver tuning was not as sharp as a modern spectrum analyser's.

Sidebands exist: they are not just mathematical abstractions.

So how did the Stenode receiver work? Easy. It didn't just let the carrier through. It let some of the sideband energy through as well, though attenuated.



A single-chip microprocessor (foreground) and some input/output and memory support chips (RCA).

The NASCOM I computer system for the home user.

NINETEEN SEVENTY EIGHT could easily go down in history as the year the great British public "discovered" the microprocessor.

Not that microprocessors were *invented* in 1978, of course. They were first produced way back in the very early '70s by a small youthful American firm called Intel. A firm which is now a world leader in microprocessors and one of that select band of semiconductor giants which dominate the electronics industry.

No, the reason why 1978 was so special was that at last the previous trickle of microprocessor based products had turned into a sufficiently fast flowing stream for the mass media to sit up and take notice!

The newspapers (well some of them!) had never even heard of the integrated circuit let alone microprocessors, and so the effect of the joint discovery was shattering. Headlines such as: "MARCH OF THE MINI-BRAIN" and "LIFE AND WAR IN CHIP VALLEY" began to appear, and countless prophets heralded the start of a new industrial revolution.

A PROPER PERSPECTIVE

We of the electronics fraternity, of course, were able to put all this into a proper perspective, whether we were actually "into" microprocessors or not. But problems remain.

Before the big discovery, if you mentioned microprocessors in polite conversation, you would be greeted with glazed expressions and retorts of "Micro-*what*?" But since 1978 all that has changed. Let slip that you dabble with electronics and you will be mobbed with questions like "How many transistors does the average micro' chip consist of?" and "What is a ROM?" and "Are you going to control *your* domestic environment with a micro?".

If you don't actually know the answers, this can seem like the technological equivalent of having sand kicked in your face, and you may find your friends (now suffering from microprocessor shell-shock) quite indifferent to the finer technical points of your muscular four transistor egg-timer or that dynamic TTL train controller.

Take heart though, because EVERYDAY ELECTRONICS has the answer! Follow the *Microprocessor Basics* series for a few months and you will be thrilled by the gasps of admiration which follow your off-hand statements like "The average micro' chip consists of more than 5,000 transistors" and "A ROM is a read-only memory which is often used to hold microprocessor programs" or even "I am currently engaged in a project to control my central heating with a microprocessor. The fuel savings will be impressive."

Seriously though, quite apart from its use as a primer in conversational microprocessor one-upmanship, this new series will provide a solid introduction to the subject, and may well lead the interested hobbyist on to greater things. After all, the newspaper headlines weren't wrong, life will never be the same now that the microprocessor has arrived in force!

MICROPROC

WHAT IS A MICROPROCESSOR?

A microprocessor is a general purpose digital computer subsystem which, thanks to the semiconductor technology of Large Scale Integration (LSI) has been shrunk to fit on to a single chip of silicon, just like the familiar calculator and clock chips which are now so freely available.

The difference between the microprocessor chip and the other LSI chips is not in manufacturing techniques but in the internal circuit *design*. A clock chip and a calculator chip can be used in precious little else other than clocks and calculators. They are *dedicated*.

The calculator chip can certainly be thought of as a computer, but it is *not* a general purpose computer. It adds, subtracts, multiplies and divides under the control of an internal and unalterable program, will talk to *only* seven-segment displays, and will listen *only* to a numeric keypad.

A microprocessor chip on the other hand, is a *general purpose* device which is programmed by the user, *not* by the semiconductor manufacturer. When manufactured, the microprocessor is endowed with a set of primitive instructions which it will obey, things like ADD and LOAD and SHIFT. The program which strings these primitive instructions together, so that in combination they perform some higher level task such as the control of a television game for example, can be written by the manufacturer of the TV game (usually a much smaller fish than the semiconductor manufacturer), or even you and me, if we have a small general purpose microprocessor system!

The microprocessor can move data around, do simple sums and even make logical decisions on the basis of: IF a condition is true THEN do activity (i) ELSE do activity (ii). And it can do all this in just a few millionths of a second.

Clever as the micropocessor is though, it can't do everything. It usually needs large amounts of external memory (which can also be built up from semiconductor chips) to store data and programs and because it can't communicate with humans directly, it may need bulky mechanical devices such as keyboards and printers.

Add to these needs the requirement for *software* (human programming effort which is usually far more expensive to produce than the electronic components or *hardware* of a microprocessor system) and already you can begin to hear the air escaping from that highly inflated microprocessor myth of an all powerful chip which will solve everyone's problems almost overnight. Even in the age of the microprocessor, problems are solved by people, *not* silicon!

APPLICATIONS

Well, having re-established the undoubted supremacy of the human race, perhaps we had better take a closer look at just why micro's are being hailed as competitors to all!

The two most impressive things about microprocessor chips are (i) their very broad area of application and (ii) their as yet almost untapped potential for solving human problems.

There is a microprocessor chip to suit every pocket. At the high end, they are in direct competition with the traditional digital computers which themselves consist of several expensive circuit cards stuffed with regiments of 16-pin TTL integrated circuits. At the low end, they are doing jobs which would either have been done by relays and transistors or would not even have been attempted without the flexible power of a microprocessor.

The high-end applications are usually referred to as "data-processing" tasks, and one important spin-off here has been the introduction of the microprocessor based "Home Computer," a real computer at a hobby price, which can be programmed, just like its larger cousins, to play games, handle household accounts, and do all your maths homework!

The low-end applications are often called "controller" tasks, and microprocessors used in this area can sometimes be harder to spot. Simple controller systems do not need keyboards, printers, or display screens. Inputs and outputs are dedicated to simple tasks such as "start-pump", "overload", "lamp-on" and so on, and the microprocessors used do not need large amounts of memory or other peripheral circuits to perform effectively.

WIDE RANGE OF CHIPS

Despite the possibility of using a single type of microprocessor chip to handle data processing and controller tasks, in general this is not an economical proposition, and as a result the range of microprocessor chips available has become very wide.

At the high end, you can pay as much as £50 for a super-powerful 16-bit device, a bargain when you consider the room-sized computer it can help to replace. At the other end of the spectrum, manufacturers who build micro's into their washing machines or food blenders may be able to get the price of the chips they use down to a couple of pounds or less if they buy 100,00 of them at a time!

EXPERIMENTING WITH MICROPROCESSORS

Given this very broad range of prices and capabilities, many electronics hobbyists must be wondering how on earth they can enter this exciting and rather alien field, or even whether micro's should perhaps be left alone entirely because they seem too complex and too pricey.

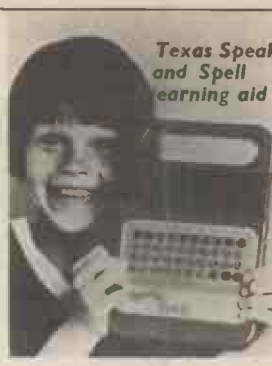
Our advice here is "Don't despair!" If you find microprocessors

ESSOR BASICS 1

MICROPROCESSOR APPLICATIONS ROUND-UP

Microprocessors are being used in everything from toys to powerful computer systems, and it will soon be impossible for any of us to get through the day without running into at least one, though we may not recognise it when we meet it!

Microprocessor-based Chess Challenger



Texas Speak and Spell learning aid

GAMES AND TOYS

At Christmas you may have noticed some new games with keyboards, displays, joysticks and other electronic appendages. Chances are, the games you saw were microprocessor based. The more sophisticated TV games centres are one example, and others are games such as Battleships, and educational "toys" such as the "Little Professor" and the incredible "Speak and Spell".

DOMESTIC APPLIANCES

In the home, you may be lucky enough to have one of those clever doorbells which play a variety of tunes to serenade your callers, at its heart is a single-chip microprocessor (see *EE Microchime*, February 1979). In the kitchen, washing machines, food mixers and blenders, central heating controllers and even sewing machines are ideal for micro' control, and in the living room you may soon have a microprocessor in your television set to provide channel selection, time-on-screen, and Teletext or Viewdata facilities. Your telephone may have a microprocessor call logger, your car a micro' controlled ignition system and dashboard instrumentation. You will soon be *surrounded* by the little blighters!

Microprocessor controlled Singer Futura sewing machine

FACTORY, OFFICE AND SHOP

In industry and commerce, the microprocessor is already well established, and its low cost computing power is helping to improve industrial efficiency.

In supermarkets, micro' based tills have fewer mechanical parts to wear out, and with a light-wand attached, they can help reduce mistakes and protect the nail polish of the check-out girls, by reading bar codes directly from the goods in your trolley. Restocking of supermarket shelves and the control of stock will also be streamlined by the use of a micro' based portable terminal and light wand which can be used to carry out rapid stock checks.

Microprocessors can also be used to directly recognise small vocabularies of spoken words, so that it is now possible to reduce operator fatigue by using voice control in some industrial situations.

Microprocessors are involved in the manufacture of everything from biscuits to cars, and if you enjoy the convenience of instant money from your banks cash dispenser, it's the micro' you have to thank.

In the office, word processor systems get round the inefficiencies involved in that age old problem, the report that has to be retyped over and over again. With a word processor, the secretary can insert new paragraphs, delete old ones, and see the result instantly on a VDU screen.

Assembly of an Herbert & Sons electronic weighing machine which incorporates a Gould Advance microprocessor control system

DATA PROCESSING

In data processing applications, microprocessor systems are taking large chunks out of the market traditionally filled by minicomputers costing £20,000 or more, and some of the latest micro' chips are so powerful that they outperform many of the so-called "mainframe" computers of ten years ago, at a fraction of the cost.

Last but not least, the microprocessor has brought us the "Home Computer," a general purpose system which can play games, balance household accounts, remind you of birthdays, telephone numbers, and recipes, carry out scientific problem-solving, produce graphic displays for fun or data presentation, and of course teach the gentle art of computer programming.

The now famous Commodore PET home computer and digital techniques fascinating, and want to get some hands-on experience, there is no reason to hesitate. Microprocessor systems have been produced with the electronics hobbyist in mind, and by following this series you should be well prepared to tackle the construction, programming, and application of your very own microcomputer.

EVALUATION CARDS

Microprocessor systems suitable for the home constructor are often called "evaluation-cards" because they were originally introduced to allow design engineers to get to grips with the particular microprocessor used. Systems of this sort usually consist of a mid-range microprocessor chip, such as the Motorola 6800 or the National SC/MP, surrounded by a clock oscillator, a small amount of software in read-only memory (ROM), a small helping of Read/Write Memory (Where you can store and run your *own* programs), a simple keyboard for data entry, and a seven-segment display.

As you may expect, the best way to learn about the operation of a microprocessor chip is to get some hands-on experience, and these inexpensive evaluation cards are ideally suited to provide this sort of tutoring. By contrast, the much more expensive "Home Computers" are great fun, and will certainly help to teach you computer programming, but they unfortunately will be of very little help if what you want to understand is the electronic, or hardware, aspects of microprocessing.

NEED TO KNOW

To gain the maximum benefit from *Microprocessor Basics* there are a few things you may need to brush up on. A basic knowledge of binary notation and techniques will be useful, and if you didn't do this at school, you should be able to get to grips with it in an evening or so, when armed with a suitable library book!

Binary is important because microprocessors rely on digital rather than analogue techniques for their operation. Data are represented by patterns of "Ones" and "Zeros", and when the data represents a number, the number must be expressed in a binary format where each BIT (Binary digIT) represents the presence (One) or absence (Zero) of a power of two. (That is 1, 2, 4, 8, 16, 32, 64 etc.) In binary, then, 0101 is equivalent to the decimal number 5, because the number contains one 1, no 2, one 4 and no 8.

The use of a system in which only two states exist makes good sense because a "one" can be simply represented by, say, a positive voltage of greater than 2·5 volts and a "zero" by a voltage of less than 0·5 volts. Alternatively switches, open or closed, or currents flowing or not flowing, can be used.

Microprocessors are not alone in using this sort of data representation, the computer at your bank, the calculator in your pocket, and the digital watch you may be wearing, all do things the same way (but they don't let you *see* that they do!).

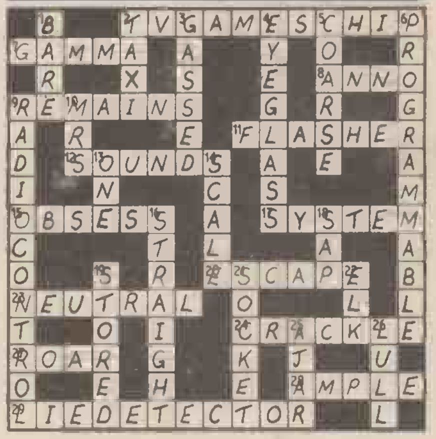
The "working-parts" of a microprocessor are logic gates and flip-flops, and so to understand micro's properly it is useful to have some familiarity with logic circuitry. (A good way to get this would be to study *Doing It Digitally*, EVERYDAY ELECTRONICS, October 1978 to September 1979).

Finally, if you have any knowledge of programming, either in flow chart form or in terms of programmable calculators or computers, this will help but it isn't essential.

Next month we will be taking a look at the microprocessor chips themselves, and later we will deal with microprocessor systems, programming, home computers, and using a hobby system.

To be continued

Crossword No. 13—Solution



JACK PLUG & FAMILY... BY DOUG BAKER

EE2020 TUNER AMPLIFIER PART 4

BY E. A. RULE

HI-FI SERIES

THIS month's article is devoted to the construction of the chassis assembly. This consists of three principal parts: the base plate or main chassis, the front panel, and the rear panel.

The remaining metal parts that have to be fabricated are a screening panel, the scale pan, and the tuning potentiometer bracket.

All these parts are made from sheet aluminium 2mm (14 s.w.g.) thick. Detailed drawings with full instructions for cutting, bending, and drilling are given in this article.

It will be seen that the base plate has turned-up edges, on all four sides, thus forming a shallow tray. This provides strength and rigidity; also means for fixing the front and rear panels.

Constructors lacking experience in metal work, or without the necessary equipment and facilities, are advised to purchase a set of ready-prepared parts. *See Materials List for name of supplier.*

It is recommended that *undrilled* parts be obtained. The average constructor should be able to perform this part of the preparation for himself, following the details given in the diagrams. This has the advantage of allowing minor adjustments to be made to the positioning of certain "critical" holes, should this prove necessary. For example, p.c.b. fixing and mains transformer fixing.

PROTECTIVE COATING

The aluminium for the front and rear panels should have a plastic or paper coating on one side. This is to protect the surface while cutting or drilling, and should be left in position until final assembly. These protective coverings can be marked out quite easily, but do not use too much pressure when scribing a line; mark only the covering, do not go right through or you will mark the metal surface underneath.

DRILLING

Always drill a small pilot hole before drilling to the required final size. If a drill of approximately 1mm outside diameter is used for the pilot hole there is no need to centre-punch first, although of course this will ensure even greater accuracy.

Mark out the holes by measuring from the centre lines where shown. This is to ensure that the front panel control holes line up with the pushbuttons when finally assembled together. Do NOT drill holes for p.c.b.s, screening panel, or mains transformer at this stage, but see below.

CHECK HOLE POSITIONS

Screw the front panel to the chassis base plate (five 8 BA C/SK screws and nuts). Place boards A and B in position with their pushbuttons located in the holes in the front panel. Carefully adjust the boards if necessary for correct alignment of all pushbuttons. Then using the large holes on the p.c.b.s as templates mark the exact position for each mounting

CHASSIS MATERIALS AND PARTS

TUNING DRIVE

Drive cord drum	Maplin type	RX43W
Tuning spindle		RX46A
Drive cord		BL73Q
Spacers 7mm (4 off)		FW35Q

See Shop Talk page 144

SHEET ALUMINIUM

2mm (14 s.w.g.)

Main chassis	500 × 270mm
Front panel	500 × 85mm
Rear panel	500 × 77mm
Scale pan	500 × 56mm
Screen	230 × 70mm
Bracket	60 × 30mm

A set of the above six items, cut and bent according to Figs 4·1 to 4·5 inclusive, but undrilled, is available from—Kitson's Sheet Metal Ltd., Roundtree Way, Norwich NR7 8SH

PERSPEX (3mm)

Rear Dial white 215 × 30mm
Front Dial clear, or tinted 200 × 24mm
Preset Cover, rear white 60 × 10mm
front clear, or tinted 66 × 12mm

HARDWARE

Screws, nuts and washers required for assembly of the chassis are included under HARDWARE in Part 2
The following items are additional to those listed in Part 2.
Capacitor fixing clips, horizontal
35mm dia. (for C58) RS type 543-383 (1 off)
25mm dia. (for C55a, b) RS type 543-052 (2 off)

Screws 4BA C/SK $\frac{3}{8}$ inch	(8 off)
Nuts 4BA full	(8 off)
Washers 4BA	(8 off)
Solder tag 4BA	(1 off)
Screws 6BA 1 inch	(3 off)
Screws 6BA $\frac{1}{2}$ inch.	(11 off)
Nuts 6BA	(14 off)
Washers 6BA	(11 off)
Cable ties RS type 543-428	(25 off)
Stick-on feet RS type 543-327	(4 off)
Screws 8BA C/SK $\frac{3}{8}$ inch	(4 off)
Nuts 8BA	(8 off)
Washers 8BA	(4 off)
Fibre Washers 8BA	(8 off)

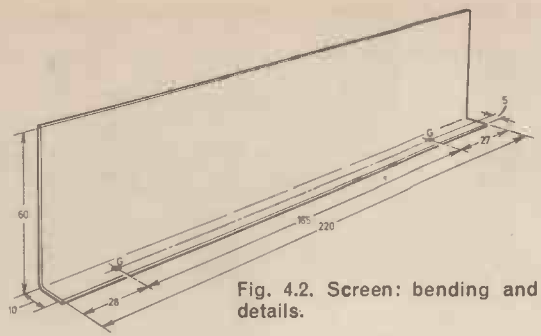
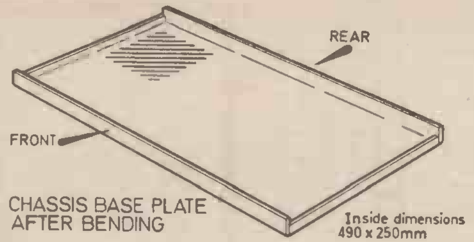


Fig. 4.2. Screen: bending and drilling details.



HOLE SIZES O/D
A = 10
B = 2·2 C/SK
C = 8·25
D = 5
E = 6·4
F = 11
G = 3
H = 6·6
I = 13
J = 4
K = 9·53
L = 7

ALL DIMENSIONS IN mm
MATERIAL
SHEET ALUMINIUM
2mm (14 S.W.G.)

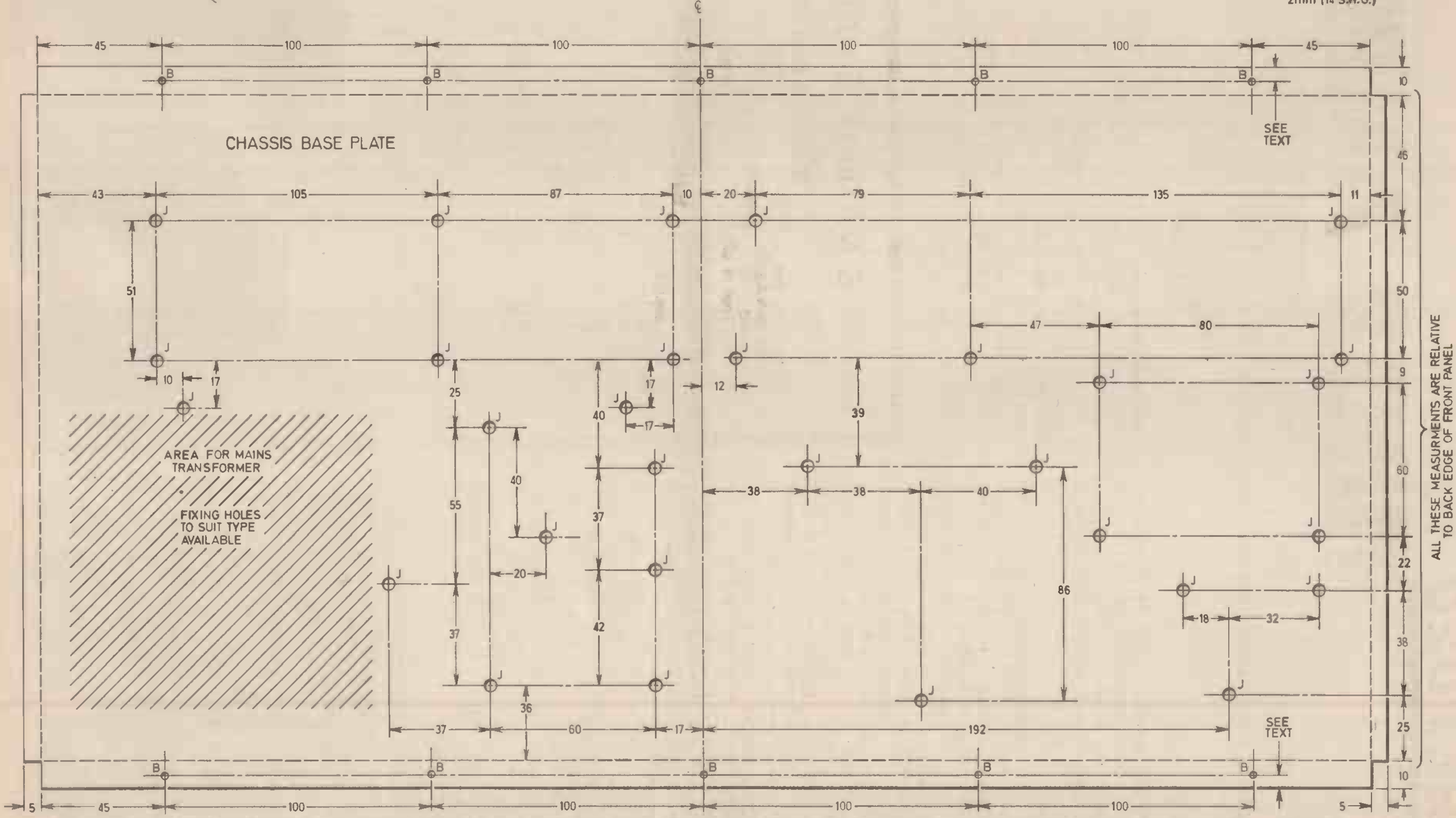


Fig. 4.1. Chassis base plate: bending and drilling details (viewed from underside). Small inset diagram shows final form after bending. Before marking drilling positions, mark a 2mm border around the underside of base plate. This will correspond with the inside dimensions of the "tray" and with the area denoted in this diagram.

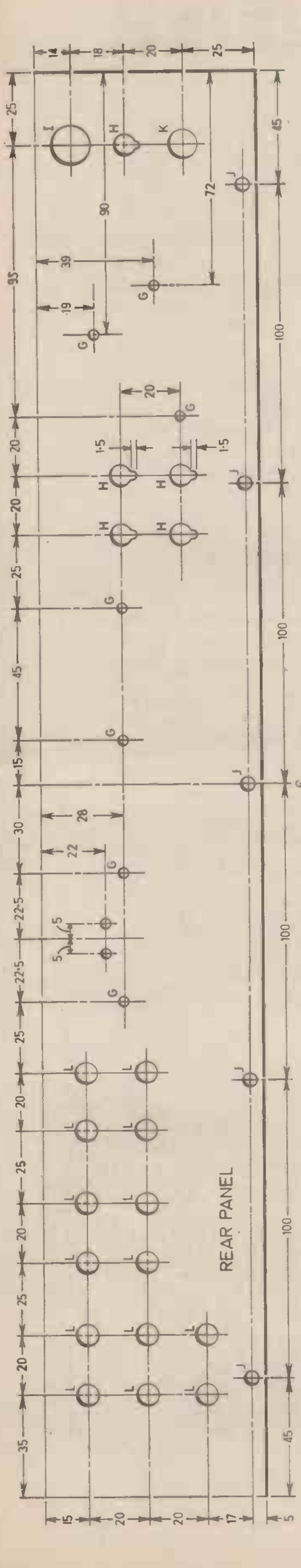


Fig. 4.3. Rear panel: drilling details.

HOLE SIZES O/D
A = 10
B = 2·2 C/SK
C = 8·25
D = 5
E = 6·4
F = 11
G = 3
H = 6·6
I = 13
J = 4
K = 9·53
L = 7

ALL DIMENSIONS IN mm
MATERIAL
SHEET ALUMINIUM
2mm (14 S.W.G.)

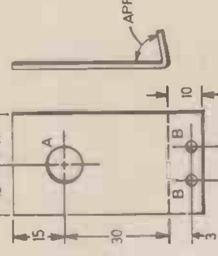
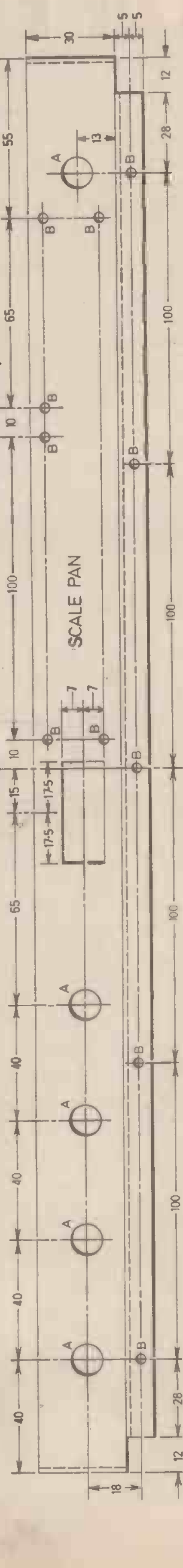


Fig. 4.5. (right) Tuning potentiometer bracket: bending and drilling details.



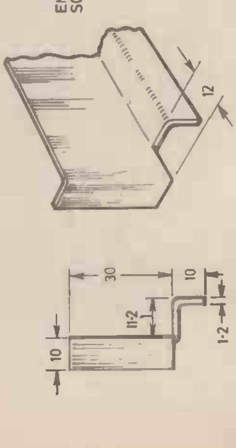


Fig. 4.4. (below) Scale pan: bending, cut-out and drilling details.

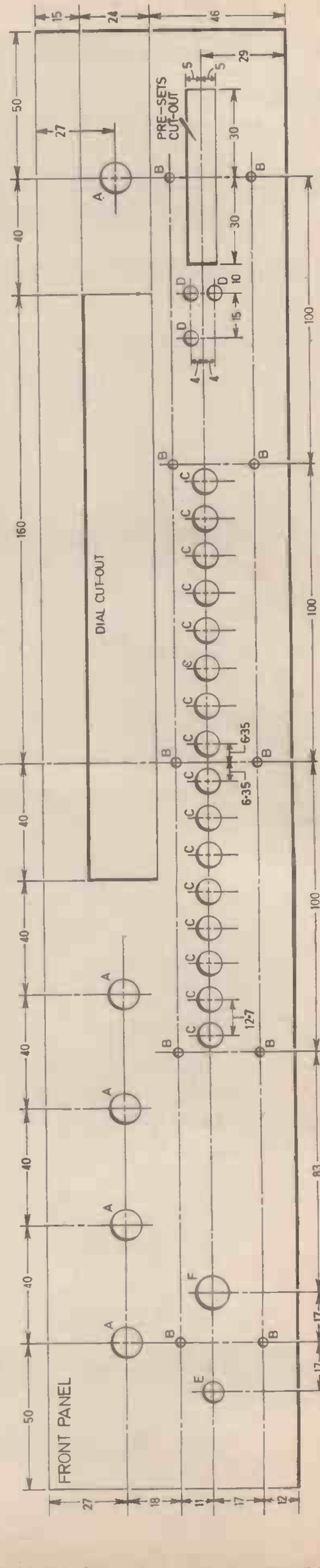


Fig. 4.6. (bottom) Front panel: drilling and cut-out details.

EE2020 TUNER AMPLIFIER

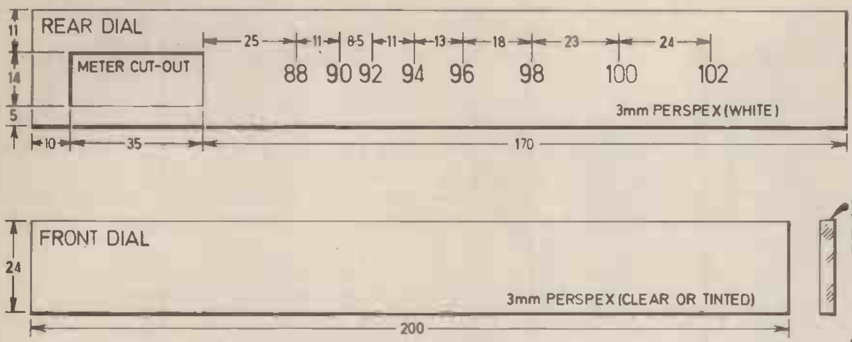


Fig. 4.7. Tuning dial.

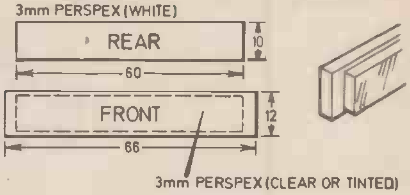


Fig. 4.8. Preset tuning cover: rear portion is glued to front in position shown.

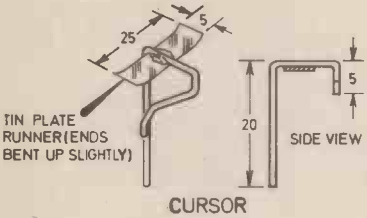


Fig. 4.10. Tuning cursor.

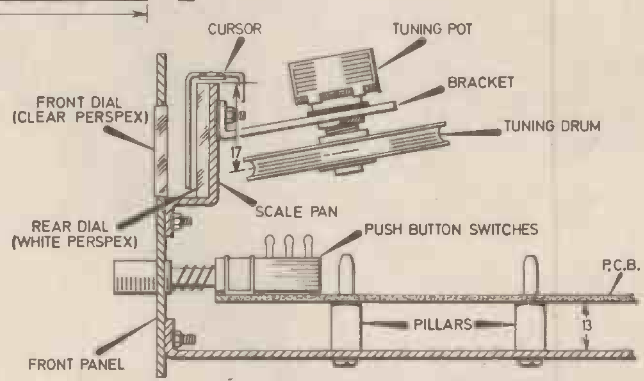


Fig. 4.11. Side section showing general assembly of scale pan, tuning drive, pushbuttons and p.c.b. fixing.

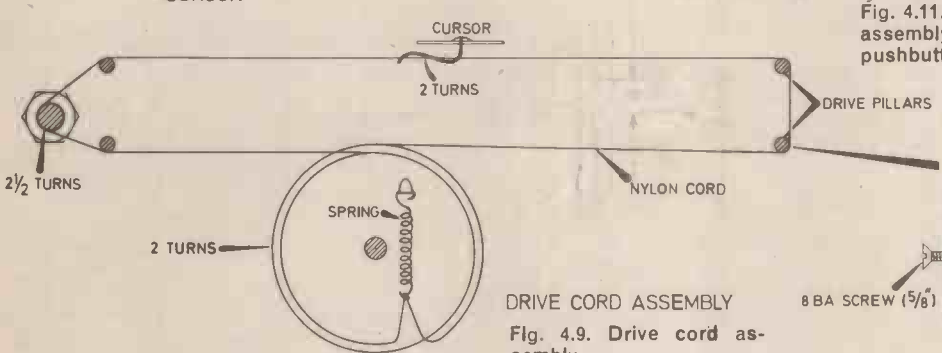
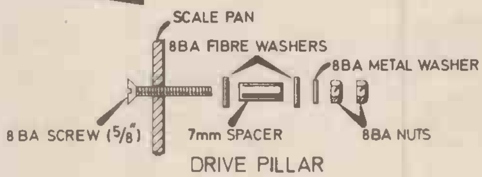


Fig. 4.9. Drive cord assembly.



ALL DIMENSIONS IN mm

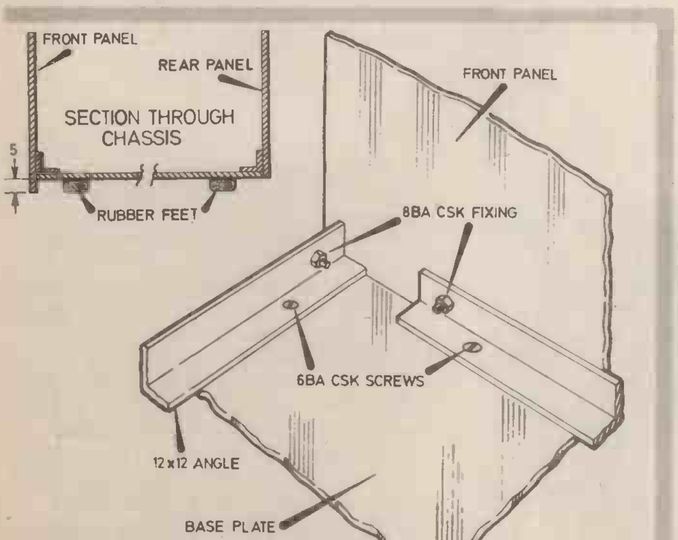
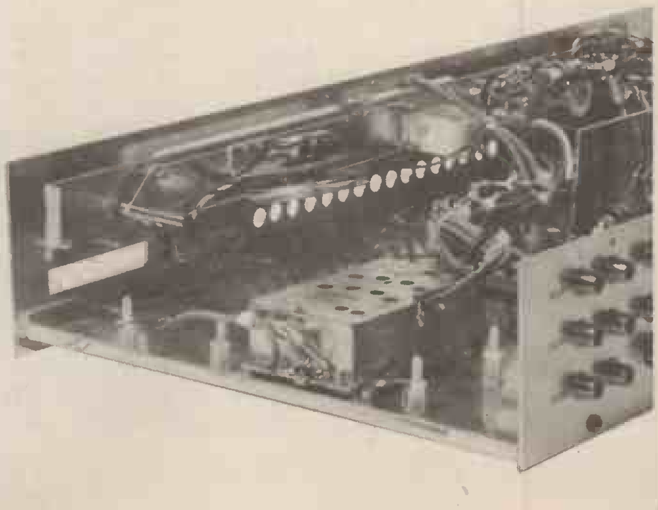


Fig. 4.12. Alternative method of assembly using angle strip to avoid any bending of chassis base plate.



pillar on the base plate. Also mark the two securing holes for the screening panel at rear of board B. Next position the remaining p.c.b.s and mark the base plate as before.

Now remove the front panel and complete the drilling of the base plate. Likewise use the mains transformer as a template for location of fixing holes in the base plate. The mains transformer should be located centrally in the area left of board E.

CUTTING THE SLOTS

The slots in the front panel and scale pan are cut using one of the round saw blades which fit a hack saw and meant for cutting shaped holes. Cut the slots undersize and file to the final size. Note that the Perspex in the front panel is a "force" fit, so final filing should be left until the Perspex panels are actually fitted.

ASSEMBLY OF CHASSIS

When satisfied that all holes and bends are correct, assembly of the chassis can begin. Start by refitting the front panel to the base plate (five 8 BA c/sk screws and nuts).

TUNING DRIVE AND SCALE PAN

Assemble the tuning drive upon the scale pan as follows. Secure the bracket to the scale pan (two 8 BA c/sk screws and nuts). Assemble the four drive cord pillars to the scale pan. See Fig. 4.9 for details.

Mount the tuning potentiometer on the bracket and fit the drum to the end of the spindle. See Fig. 4.11. Fit the drive cord to drum spring and wind round periphery of drum and take round the four pillars then return to drum and secure to end of spring.

Secure the tuning dial to the scale pan with a little glue. The tuning dial is held in place by double-sided sticky tape or blue tack. Alignment of meter cut-outs will give correct positioning. Do NOT fit meter at this stage.

After fitting the tuning scale, fit the tuning cursor (see Fig. 4.10) and check that it travels smoothly along the top edge of the scale. Check that potentiometer is fully anticlockwise when cursor is at left hand end of dial. Tighten grub screw on drum. Fit the volume, balance, bass, and treble potentiometers to the scale pan and then secure the scale pan assembly to the front panel (five 8 BA c/sk screws and nuts).

The clear Perspex panel should be fixed to the front panel before the scale pan. It is held in place by being a force fit from the rear of the panel and finally secured with a small touch of glue at each end.

REAR PANEL AND BASE PLATE

Screw the rear panel to the base plate flange (five No. 6 self-tapping screws).

Mount and secure on the base plate the Radio Unit (4 BA screws, washers and nuts), the clips for electrolytic capacitors C55a, b and C58, and the solder tag (4BA screws, washers and nuts).

Secure all 20 p.c.b. pillars* to base plate with No. 6 self-tapping screws. NOTE. The boards should not be fitted at this stage, but after the front and rear panel components have been mounted—see Part 5.

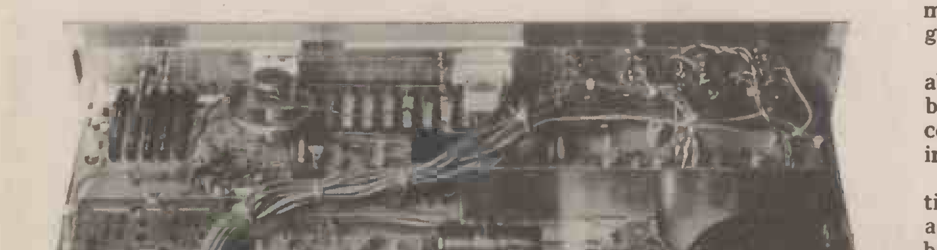
* Described in Hardware list on page 39 as "P.C.B. Spacers".

D.I.Y. METALWORK

For those who wish to undertake all metalwork themselves, the following guidance is offered.

If metal bending facilities are available, place the sheet between two blocks of hardwood (or a metal angle could be used) and clamp the whole in the vice, like a sandwich.

An alternative method of construction is to use 12mm (½ inch) aluminium angle instead of making bends on the base plate. Strips of angle should be screwed in place along the front, rear and side edges of the (unbent) base plate. One point to watch is that allowance must be made for the extra thickness of metal when working out the holes for fixing the front and rear panels. See Fig. 4.12.



To be continued

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APRIL
ISSUE ON SALE
FRIDAY, MARCH 16

Everyday News

COMPUTING—IT'S CHILD'S PLAY

The first-ever Computer Exhibition aimed at the 8 to 14 year old was held recently in London. Organised by the British Computer Society together with the Institute of Education, the exhibits allowed youngsters to approach and communicate with the many computer systems without fear.

The TV screens asked the question: What is your name? and when a child typed his name on the keyboard contact was made, the ice was broken, the computer started its program, the game begins. Chess, Othello, battle stations, noughts and crosses, they were all there; so too were members of the British Computer Society who manned the stands voluntarily and were more than helpful in assisting everyone overcome the fear of actually operating "a computer".

The "Young Computer Exhibition and Fun Fair" was held at the Bloomsbury Centre Hotel and the BCS conference "Living with Computers" was on at the same time. The organisers had anticipated fairly quiet days on the Thursday and Friday but the message was out and the school Christmas holidays still on . . . so, it was packed out.

A portable programmable computer "in-a-briefcase" system, which, when connected to a TV set (preferrably colour for clarity) enabled handicapped people to make better and easier use of electronics was shown by Ferranti. Fitted with an alphanumeric keyboard the prototype enables the user to control the home lighting, heating, fans, etc through machine codes that are visual and easy to understand, whilst also providing a basic and practical computer. Additional programs on mini-cassettes provide the necssary back-up for even the severely handicapped to achieve the same amount of control, even to producing typed letters using a simple two pushbutton unit remote from the equipments.

The National Police Computer showed their system of immediate investigations into the background of people. The files of CRO (Criminal Record Office) and General Information are now being held on Computer Records with instant access, and the idea of the stand seemed to be to let children know how "instant" justice will be in the future.

"What is a Computer Program?" was the title of a film show presented in the lecture theatre at the exhibition, but if children expected to find out the answer I fear they didn't. Unfortunately, the presenter assumed too high a level of basic (computer) knowledge that left the uninitiated not only bewildered and lost, but bored. Such descriptions as: Housekeeping, Executive and even Compiler were thrown at the young audience along with basic concepts of program routines. Alas, it was beyond them.

The Institute of Education stand enabled visitors to scan through information about College courses, University placements, etc using both a computer system and a separate microfilm file. This not only gave a clear idea of the education available it also simply showed the usefulness and adaptability of the two media.

Footnote

If any school wishes to receive a visit from a local member of the British Computer Society, they are quite happy to arrange this for you. Schools interested should write to: The British Computer Society, 29 Portland Place, London, W1.

COLOUR ON THE MOTORWAY

Drivers on the M1 Motorway will soon see coloured motorway signals which show recommended speed, a sign of the hazard ahead in the conventional red triangle, and the distance ahead of the hazard.

Ten of the new signals, which use fibre-optic technology, are to be installed experimentally by Rank Optics under a scheme originated by the Road Research Laboratory.

Girl of the Year

The 1978 winner of the Girl Technician Engineer of the Year award sponsored by the Caroline Haslett Memorial Trust and the IEETE was Erzsebet Kibble. Erzsebet received her reward from the Rt. Hon. Shirley Williams, M.P., Secretary of State for Education and Science. Mrs. Kibble, of Hungarian birth, is an assistant manager in Thorn-Ericsson Telecommunications (Sales) Ltd.

Despite schemes to encourage the ladies into engineering careers the number is still depressingly low, only some 5 per cent of all engineering entrants.

. . . from the World of Electronics

—ANALYSIS

THROUGH THICK AND THIN

The monolithic silicon integrated circuit is unquestionably today's glamour component in electronics. It's most developed form in very large scale integration (VLSI) has captured the popular imagination under the generic four-letter word, the "chip".

So swamped are we by incessant publicity on the "chip" that we are in danger of overlooking the fact that it is not the only form of microelectronics. A parallel development during the last decade has been thick and thin film technology in which circuits are laid down on a substrate, normally of ceramic material.

Film circuits can be quite simple resistor networks or quite complicated devices incorporating not only *R* and *C* and all the inter-connections but, by the addition of discrete components, tiny capacitors, transistors, diodes, even I.C.s, become monolithic in their own right. When active components are added in this way the device is called a hybrid integrated circuit.

The early problems of crudity in thick films have now been overcome and because of the economics of manufacture thick film circuits are now the dominant type. Resistive inks are available which allow resistors to be printed within the range of 5 ohms to 50 megohms and trimmed by laser beam to 1 per cent tolerance. Conductors, again printed, can be gold or palladium silver. Add-on capacitors can be as high in value as 100μF using tantalum chips. The whole assembly can be encapsulated and hermetically sealed. Thick film enthusiasts never tire of telling you how flexible, how reliable, how cost-effective thick film hybrids can be.

The electronic hobbyist is unlikely to use thick film circuits. He is better off with his accustomed laminates and P.C.B.s. But how many hobbyists need true microminiaturisation and the sort of reliability that is needed for the extreme environments of missiles, avionics or space satellites?

Nonetheless, the hobbyist should be aware that there are alternative methods of achieving a desired end and it is certainly true that the professionals in electronics see thick film hybrid integrated circuits as a growing technology with a large and expanding market, not as a direct rival to the silicon I.C. but as complementary to it in many applications. A case, in fact, of horses for courses.

Brian G. Peck

London's Portman Hotel has scooped its industry by becoming the first hotel to feature Prestel viewdata, the new television/telephone linked data information system developed by the Post Office, as a permanent feature at the hotel. The set, a Baird 26 inch colour model has been specially installed in the lobby where guests can access pages of information.

POCKET TV PRICE WAR

The new single standard Microvision TV receiver from Sinclair Radionic's is expected to be able to compete with Japanese competition. At a recommended price of £99 plus VAT it is less than half the price of the original multi-standard Microvision aimed at the US market.

ELECTRONICS SUMMER SCHOOL

The Department of Electrical Engineering Science at the University of Essex will be holding its annual electronics summer school for teachers during the week 9 to 13 July 1979. This year, as well as courses in linear circuit design and digital circuit design, a third course in electronic systems is also available which is closely related to the A.E.B. electronics systems A-level.

A programme of laboratory work is included on each course so that the lecture material is fully supported. Further information on the Summer School may be obtained from Dr. M. J. Hawksford or Mrs. J. E. Mead at the Department of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester CO4 3SQ.

A NEW LIGHT

The new managing director of Mullard Ltd, to succeed Jack Ackerman, is to be Ivor Cohen the divisional director of Philips UK Lighting Division.

This appointment follows the decision by Dr. J. M. Whitehead not to take up his appointment as MD of Mullards.

TESTING TIME

Almost 30 papers dealing with the latest developments in automatic testing and test and measurement systems will be presented at the "ATE/Test & Measurement Show '79", to be held at Wiesbaden, West Germany, from March 20 to 22, 1979.

Skyflash

Britain has won a £60 million order from Sweden for Skyflash air-to-air missiles. They will be used on Sweden's new Viggen JA-37 all-weather interceptor aircraft.

The semi-active radar homing head on Skyflash is made by Marconi Space and Defence Systems and the missile by the Dynamics Division of British Aerospace.

The IBM's new 64k RAM actually has over 66k bits of RAM on it, the idea being that the built-in spare bits can be used in chips that have comparatively large fault areas, thus improving yields and reducing scrap.

BUBBLE TIME

Data entry, editing and storage for commercial applications such as remote sales-order entry, computer time-sharing systems and newspaper reporting is possible with the Texas Instruments Model 765 portable bubble-memory terminal.

Because the terminal's bubble memory retains data even when power is switched off, information from a variety of sources can be stored in the terminal for as long as required, and then transmitted in a single batch over a normal telephone line using the built-in acoustic coupler. This enables batch transmission to take place during the telephone system's cheap rate times.

EE SPECIAL

DENSHI-GAKKEN KITS

THE SUBJECT of our report this month is the new completely solderless Denshi-Gakken EX-Series of Educational kits.

We had heard such glowing reports from various sources, including readers, that we thought it was time we investigated them more closely. We are very pleased that we did and that we can add our own endorsement to the ever growing list of admirers of their products.

KIT CONTENTS

These educational kits are not cheap, but when you purchase any product that is accepted as one of the best in its field they never are. The range runs from the EX-15 (£16·75), to the EX-150 (£39·75). The figures refer to the number of building projects possible with each kit.

Wanting to experience their complete range we chose the EX-150, which enables 150 circuits ranging from basic theory and test gear to an i.c. amplifier, a radio microphone and a lie detector to be built.

The kit consists of 46 plastics cubes with components mounted in the centres, including two transistors and two diodes; an i.c. amplifier module with loudspeaker and volume control; a plastic housing with ready mounted a.m. aerial, variable capacitor, on/off switch and a light sensitive cell (CDS). Also included in the kit is a microphone, an earphone, connecting leads and test probes.

Finally, the most important item in the kit is the 158-page instruction manual. This manual is excellently illustrated, each page containing a circuit diagram and an easy to follow "building block" component lavout together with any interconnecting details; i.e. microphone or test probes. The lavout diagram fills half a page and a brief introduction to the circuit is also included on the page.

COMPONENTS

At first sight the kit case looks like one of those "military style" radios (see photograph) that are so popular at the moment, but in fact this robust plastic casing also forms the experimenters "test-bed".

The top section of the case near the carrying handle takes the plug-in i.c. amplifier module, the meter, tuning capacitor, light sensitive cell, and the supply on/off switch.

The lower section of the case has a rectangular well which accepts the various component cubes. The base or floor of the well is marked up into a matrix of squares and the component cubes are located in these squares, held in position by small plastic locating pillars at the corners of the squares.

The sides of the well have sprung-metal connecting lugs which mate with identical connecting strips on the sides of the component cubes. The contacts on the sides of the well are also wired to the various components mounted in the top section of the case and a.m. aerial.

The top edge connectors being clearly marked for the cadmium cell, supplies, meter and volume control. The connections to the a.m. aerial being clearly marked on the left side of the well.

The component cubes are made of preformed plastic and have sprung metal connecting strips on the sides of the cubes. These connecting contacts also bend under the cube to accept components which are pre-soldered to the contacts and housed in the centre of the cube.

Some of these connecting contacts are linked by wires instead of components and are used as interwiring links between components and various points of a circuit. The top of the cubes are clearly marked with the circuit symbol and value of the component inside.

CONSTRUCTION

Once you have familiarised yourself with the various components, the first stage in building is to select the required components according to the chosen project.

A working project is then constructed by simply slotting the component cubes and connecting leads into the "test bed" as shown in the layout diagram in the instruction manual. No soldering or wiring being required as the cubes complete the electrical connections.

Provided the circuit symbols on the cubes agreed with the layout diagram and they were double checked for good electrical contact, simply by wriggling them in their allotted locations, we found the projects usually worked first time. When they did not work this was found to be due to human error.

CONCLUSIONS

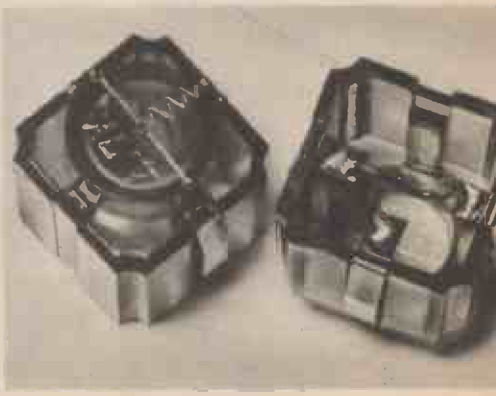
We found the kits well made and excellently set out, although we do not agree with the order the projects are presented in the instruction manual. Of course, if you do not wish to work through the manual from the first project to the last it is a simple matter to select a particular project and build a working model from that page.

We would question the education value, in terms of understanding the theory of electronics, but the kits certainly offer a very interesting variety of projects which will introduce beginners to the many possible applications of electronics.

It is possible to remove components from their cubes and insert others enabling the constructor to extend the range of circuits even further. We do NOT recommend the inexperienced constructor to attempt this.

The EX-Series of kits are available from Electroni-Kit, Dept EE, 20 Bride Lane, Ludgate Circus, London EC4 8DX. They are also supplying, free of charge, while stocks last, a 160-page Hamlyn book entitled "Electronics" with every kit purchased.

The method of mounting components inside the "building brick" and close-up view showing the circuit symbol and value of component in the centre of the cube



ROOM THERMOSTAT

Famous Satchwell, elegant design. Intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0.30 C. Special snip this month £3·25.

ROD THERMOSTAT—£3·00.

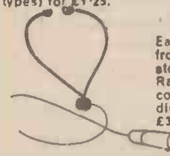
WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions. All parts and instructions to make £3·75.

MICRO SWITCH BARGAINS

Rated at 5 amps 250V. Ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 (two types) for £1·25.

RADIO STETHOSCOPE



Easiest way to fault find, traces, signal from aerial to speaker, when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube and twin stetho-set £3·95.

MULTISPEED MOTORS

Six speeds are available 500, 800 and 1,000 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is ¼ in. diameter and approximately 1 in. long. 230/240V. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price £2.

12V MINIATURE RELAY

dc operated with two sets of change over contacts. The unique feature of this relay is its heavy lead out wires; these provide adequate support and therefore the relay needs no fixing; on the other hand there is a fixing bolt protruding through one side so if you wish you can fix the relay and use its very strong lead outs to secure circuit components—an expensive relay; but we are offering it for only 87p each. Don't miss this exceptional bargain!

EXTRACTOR FAN

Ex computers—made by Woods of Colchester. Ideal for fixing through panel—reasonably quiet running—very powerful 2500 rpm. Choice of two sizes 5" or 6½" dia. £5, £6.

MAINS RELAYS

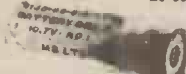
With triple 10 amp changeover contacts—operating coil wound for 230V a.c. Chassis mounting one screw fixing. Price £1·25

BURGLAR ALARM ITEMS

(Circuit free on application)

Trigger mats 24" × 18"	£2·45
13" × 10"	£1·95
Relay 24 volt	95p
9-12 volt	95p
Alarm Bell 24 volt	£7·50
9-12 volt	£2·25
Mains	on application
Reset, Switch, ordinary	45p
Secret type with key	95p
Wire—100 metres	£1·50
24v Power unit mains operated	£5·35

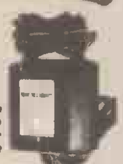
MERCURY BATTERIES



Bank of 7 Mercury cells type 625 which are approx. ⅝in. diameter by ¼in. thick in plastic tube giving a total of 10·7V.

Being in a plastic tube it is very easy to break up the battery into separate cells and use these for radio control and similar equipment. Carton of 25 batteries £1·60.

PP3/PP9 REPLACEMENT



Japanese made in plastic container with leads size 2in. × 1½in. × 1½in., this is ideal to power a calculator or radio. It has a full wave rectifier and smoothed output of 9V suitable for loading of up to 100mA. £2·53.

SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in. × 18in. £2·50. 13in. × 10in. £1·95.

MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer, rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1·95.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £3·45

Made up model £1·00 extra

8 POWERFUL BATTERY MOTORS

For models, Meccanos, drills, remote control planes, boats, etc. £2.

ROTARY PUMP

Self priming, portable, fits drill or electric motor, pumps up to 200 gallons per hour depending upon revs. Virtually uncorrodable, use to suck water, oil, petrol, fertiliser, chemicals, anything liquid. Hose connectors each end. £2.

SHORTWAVE CRYSTAL SET

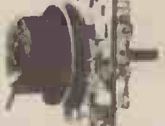
Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 10, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts £1·94—crystal earphone 55p including VAT and postage.

MULLARD UNILEX

A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of speakers this should sell at about £30—but due to a special bulk-buy and as an incentive for you to buy this month we offer the system complete at only £15 including VAT and postage.

HUMIDITY SWITCH

American made by Ranco, their type No. J11. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive micro-switch adjustable by a screw, quite sensitive—breathing on it for instance will switch it on. Micro 3 amp. at 250V a.c. Overall size of the device approx. 3½ in. long, 1 in. wide and 1¾ in. deep 75p.

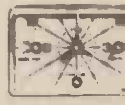


DELAY SWITCH

Mains operated—delay can be accurately set with pointers knob for periods of up to 2½ hrs. 2 contacts suitable to switch 10 amps—second contact opens few minutes after 1st contact 95p.

25A ELECTRIC PROGRAMMER

Learn in your sleep. Have radio playing and kettle boiling as you wake—switch on lights to ward off intruders—have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer Clock by famous maker with 15 amp on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours independent 60 minute memory jogger. A beautiful unit. £3·50.



MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied Model 1153 500mW. power, output £1·69

Model 1172—10 watts power output £3·94
Model 1172 1W. power output £2·25
Model EP9000 4 watt power output £2·90
EP 9001 twin channel or stereo pre-amp £2 90

TANGENTIAL HEATER UNIT

A most efficient and quiet running blower-heater by Solatron—same type as is fitted to many famous name heaters—Comprises mains induction motor—long turbo fan—split 2 kw heating element and thermostatic safety trip—simply connect to the mains for immediate heat—mount in a simple wooden or metal case or mount direct onto base of say kitchen unit—price £4·95 post £1·50 control switch to give 2kw. 1kw, cold blow or off available 60p extra.

3KW MODEL
£5·95
+ £1·50 P & P

2 k.w. model made in metal case with control switch £12·00

THERMOSTATS

Refrigeration as illustrated with 36" capillary £1·62.

Limpet Stat must be mounted in close contact calibrated 90°-190°F 15 amp contacts £1·62.

Appliance Stat fix like a volume control—15 amp contact 30°-80°F 85p.

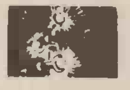
ditto but for high temps £1·25.

Over Stat—with Serson and capillary 85p

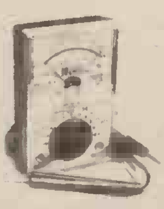
Wall Mounting by Satchwell £3·00

Boiler Stat. with control 20°-80°C £2·16

SOUND TO LIGHT UNIT



Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. £9·95.



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11 instant ranges measure:—
DC volts 10, 50, 250, 1000
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Complete with insulated probes, leads, battery, circuit diagram and instructions.

Unbelievable value only £6·50 + 50p post and insurance.

FREE Amps ranges kit 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 £1 50p.

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IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

Telephone Ringing Mains Unit Rather novel unit as it not only reduces mains to 50 volts but also reduces the mains frequency to 25 Hz, this frequency gives correct ringing note for GPO bells. These units were made for the GPO so obviously are first class. Completely enclosed and safe to mount on the wall or stand on a shelf. Price £3·20.

Telephone Extension Bells in bakelite wall box, these will save you missing calls when you are out in the garden or shed, etc. Price £3·16.

Variable Mains Supply A bench mounting unit which contains an isolation transformer for safety and a 2 amp variac for adaptability. With this you will be able to get continuously variable mains supply from zero to full voltage at 2 amps. A real time saving device, price only £20·75.

Answering Machines still available as last month's newsletter but supplies are going down rapidly and this may well be your last chance to acquire one of these.

A very large purchase this month enables us to offer a range of radio items. You will find the prices well below average:

Cassette Recorder/Player Japanese or Hong Kong made, these have all the normal facilities record, playback, fast rewind, etc., also sockets for stop/start, microphone, earphone and lead for mains as these operate from mains or HP1 batteries. £12·50.

Six Transistor Pocket Radios Medium wave only but with Radio 2 and Radio 4 changing places. Medium wave is all the average listener will want in the future. These little radios would make a lovely gift for a child. Modern design and in popular colours, please state preferred colour and give an alternative, price only £1·50.

AM/FM Radios There's no doubt that FM does give better reproduction in good areas so a more adult member of the family will be pleased with one of these. The ones we have are in leatherette cases and are battery/mains radios having the mains unit built in and are complete with mains plug. These cover medium wave and VHF with optional AFC. Price £6·75.

8 Track to Cassette Adaptors Cartridges are going out of popularity, cassettes on the other hand are being made in increasing numbers and cover practically every field of sound entertainment. Cassettes can be played in 8 track if you have an adaptor. We offer these adaptors complete in carrying case and the price is only £8·50.

Soft Toy Radios Not necessarily only for the younger members of the family as these are soft and cute and have universal appeal. Dolls, poodles, elephants and rabbits each with zip compartment at the bottom where the radio fits. Medium wave only, working from PP3 batteries. When ordering please state preference and if possible give an alternative. £4·50.

5 Band Portable. A very impressive radio in black imitation crocodile case, size approx. 12in. wide, 7in. high and 4in. deep. This has metal embellished carrying handle and a pullout chrome plated FM aerial, covers the following bands AM 535 to 1605 kHz. FM 88 to 108 MHz weather band 162.5 MHz and it has a logging scale. This battery/mains radio has the built in mains unit also serves as a charger if you use rechargeable batteries. The mains lead with plug tucks away in its own compartment, another feature is a dial indicator which shows state of batteries. A real snip at £10·50.

Car Battery Power Unit made for Rank Radio. This unit has been designed to operate 6V battery powered equipment from a 12V car battery, it provides a reliable source of stabilised voltage and gives protection to your equipment in case of accidental reversal of connections also against excessive car battery voltage should this occur. The unit is very robust and virtually everlasting if used sensibly. It uses a negative earth circuit but it will operate in a positive earth car providing the instument being played is not connected to the car chassis. A real bargain at £2·20.

Extension Speaker Cabinets A new delivery of these enables us to bring down the price quite a lot. We can now supply the smaller ones (11in. × 8in. × 4½in. approx.) at £1·95. Post £1·00 and we have a larger one with a silver finish size approximately 12½in. × 9in. × 5½in. Price of this is £1·69, post £1·50. If you can call and collect these cabinets you can save yourself the quite considerable postage and you only have to buy a few to get a discount as well. The quantity discount for these is a speacial rate of 25% if you buy four or more. Note these cabinets are very good quality (made for Rank Audio Systems) the grill material is Dacron.

Slide Switch Bargain Double pole changeover standard size with good length of connecting wire soldered to each tag—10 for £1·38.

Six Digit Counter Mains operated, 1 pulse moves counter through one digit, not resettable but all you have to do is to make note of the numbers before the start of each count. Real bargain at 80p

Be Prepared For possible blackouts and interruptions in electricity supply this winter! Have some emergency lighting nearby. We still have the fluorescent outfits for operating 12in tubes from 12V car battery and the price is still the same £3·95 plus 50p post complete with a 21in tube.

Stereo Car Speakers usual type in neat compact enclosures for the rear shelf of the car. 8 ohms 5 Watt £5·50 per pair.

Bleepers 6/12V battery or transformer operated, ideal for using in many alarm circuits but particularly for car and motor cycle alarms. These give a loud shrill note. American made by Delta Alarms. Price £1·08 + 8p. Large quantities available.

Most Useful Timer Up to 12 on/offs per 24 hours is what you can get from the Venner time switch if you fit our adaptor. The shortest on/or off time is one hour but you can use any combinations of on/off to make up the 24 hours. An obvious use for this is to control immersion heaters. These are real current consumers and even though the thermostats are working properly, economies can be quite considerable if a time switch is used. Our Venners are all capable of 20 amp switching. There are of course many other applications for the time switch, which you will remember in its basic form follows the sun switching on at dusk and off at dawn. Price £3·24 plus 50p post for switch with adaptor, extra for plastic case £1·08 or metal case £2·16 + 16p.

Safe Soilstat For growers who use soil heating on benches, economies can be made by using a thermostat but if mains voltage equipment is used then the thermostat must be enclosed in a waterproof and earthable container. We can now supply this price £3·78 + 28p. This container will accept the normal immersion heater type thermostat but for soil heating you want one which covers 50 deg. farenheit and upwards, we can supply these at £3·20.

Motorised Light Flasher We can offer two motorised units both capable of 2 000W of light. Our ½ second flasher changes every ½ second and the 2 second flasher changes every 2 seconds. Either type £6·40.

Frightening Fuel Bills could lose some of their sting if you fit double glazing but even if the fuel bill does not come down much you will have a more comfortable home less draughts, etc. Double glazing frames, movable in the Spring, can be quite easily made using rigid PVC sheetings. We have this, it is as clear as glass and virtually as everlasting. It is easy to fit as you can cut it, bend it, nail it, etc. A recent purchase enables us to offer this at well below current price. It is 600mm (23½in widel and available in any length (it rolls up like lino). Price 15p per sq ft. Minimum order 20 sq ft for £1·05 post 50p orders over £6·00 post free, longer lengths price negotiable.

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Super 6
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Super 10
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When it comes to oscilloscopes, you'll have to go a long way to equal the reliability and performance of Calscope.

Calscope set new standards in their products, as you'll discover when you compare specification and price against the competition.

The Calscope Super 10, dual trace 10 MHz has probably the highest standard anywhere for a low cost general purpose oscilloscope. A 3% accuracy is obtained by the use of stabilised power supplies which cope with mains fluctuations.

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The Super 6 is a portable 6MHz single beam model with easy to use controls and has a time base range of 1μs to 100ms/cm with 10mV sensitivity Price £162 plus VAT.

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GUITAR EFFECTS PEDAL (P.E. July 75)
Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.
Component set with special foot operated switches £7·69
Alternative component set with panel switches £5·05
Printed circuit board £1·43

GUITAR FREQUENCY DOUBLER (P.E. Aug. 77)
A modified and extended version of the circuit published.
Component set and PCB £4·52

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)
Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay and also providing filtering, Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.
Component set using dual rotary pot £6·89
Printed circuit board £1·62

GUITAR SUSTAIN (P.E. Oct. 77)
Maintains the natural attack whilst extending note duration.
Component set, PCB and foot switches £5·13
Component set, PCB and panel switches £3·71

WIND AND RAIN UNIT
A manually controlled unit for producing the above-named sounds.
Component set (incl. PCB) £4·26

VOICE OPERATED FADER (P.E. Dec. 73)
For automatically reducing music volume during "talk-over" —particularly useful for Disco work or for home-movie shows.
Component set (incl. PCB) £3·97

PHASING UNIT (P.E. Sept. 73)
A simple but effective manually controlled unit for introducing the phasing sound into live or recorded music.
Component set (incl. PCB) £3·20

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing.
Component set (incl. PCB) £4·74

TREMOLO UNIT
Based upon P.E. Sound Design circuit
Component set (incl. PCB) £2·94

TREBLE BOOST UNIT (P.E. Apr. 76)
Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.
Component set (incl. PCB) £2·61

WAH-WAH UNIT (P.E. Apr. 76)
The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller.
Component set (incl. PCB) £3·63

AUTOWAH UNIT (P.E. Mar. 77)
Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played.
Component set, PCB, special foot switches £7·67
Component set and PCB, with panel switches £4·93

FUZZ UNIT
Simple Fuzz unit based upon P.E. "Sound Design" circuit
Component set (incl. PCB) £2·05

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic or electronic musical instruments.
Main component set (incl. PCB) £14·93
Power supply set (incl. PCB) £6·28

SYNTHESISER TUNING INDICATOR (P.E. July 77)
A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.
Component and PCB (but excl. sw.) £7·45

DYNAMIC RANGE LIMITER (P.E. Apr. 77)
Automatically controls sound output to within a preset level.
Component set (incl. PCB) £4·58

CONSTANT DISPLAY FREQUENCY METER (P.E. Aug. 78)
A 5-digit frequency counter for 1Hz to 99999Hz with a 1Hz sampling rate. Readout does not count visibly or flicker due to display blanking.
Component set £24·05*
Printed circuit board £3·03*
*This kit & PCB are at 8% VAT (all others are 12½%)

MANY MORE KITS
for Synthesisers, Rhythm Generators, Electronic Pianos and other projects, big, small, simple or complex, are available, plus a range of keyboards, separate components and accessories. Details in our lists.

COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc, are not included but most of these may be bought separately

Fuller details of kits, PCBs and parts are shown in our lists.
CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

PHOTOCOPIES of texts for most of the kits are available—prices in our lists.
LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

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RADIO WORLD

By Pat Hawker, G3VA

VERY few of the people I talk to seem even to have heard of the American work directed towards providing multiplex stereo broadcasts over a single amplitude-modulated (a.m.) m.f. transmitter. Some indeed do not want to know as they say it has been difficult enough trying to persuade listeners to take advantage of the v.h.f./f.m. stereo broadcasts on the BBC national networks and the IBA local stations.

Stereo on medium waves

Indeed a.m. stereo is unlikely ever to be as good as f.m. stereo owing to the restricted frequency and dynamic ranges of European medium wave broadcasts. Nevertheless it could be attractive, particularly for car radios or in places where it is virtually impossible to receive strong v.h.f. signals.

In the USA investigations have been going on for several years in an effort to pick the best system of a.m. stereo from no less than five main contenders (all of which work but each of which has its own advantages and disadvantages). The contenders are: (1) Belar "a.m./f.m." system; (2) Harris "modified quadrature" system; (3) Kahn/Hazeltine "independent sideband" system; (4) Magnavox "a.m./p.m." (phase modulation) system; and (5) Motorola "compatible quadrature" system.

One of the attractions of the Kahn system (which has been used for some years at a Mexican station directed towards Southern California) is that you can achieve some stereo effect using two conventional medium-wave receivers by carefully tuning each to the opposite sideband from the other. But for best results all systems need special decoders which are unlikely to be widely available to the public until the FCC finally chooses one system.

One wonders if more research should not be done soon in the UK since otherwise we may be forced later to use an American system chosen to suit different standards and other broadcasting practices.

URP's abound

In these days of unidentified flying objects, it is worth noting that there are still a number of unidentified radio phenomena (URP) that still await full or satisfactory explanation. Among these I would put at the top of my list "long delayed echoes" (radio echoes with intervals of many seconds) and the sadly neglected "sweepers" and "creepers"—apparently natural radio emissions akin to atmospherics but with a finite frequency that sweeps rapidly across a given band, usually but not always in decreasing frequency and to be found most often between 20 to 30MHz (but sometimes much lower).

Sweepers were identified by American observers as long ago as 1958 and observed frequently in India during 1974 in an investigation organised by the University of Calcutta.

During the past year radio amateurs in many parts of the world including the UK, South Africa, Australia etc have all been observing these curious phenomena. Professor Martin Harrison, G3USF, of Keele University and Ted Cooke, ZS6BT of Johannesburg have been particularly active in this field, and I have recently listened to a series of excellent tape recordings made by Ted Cooke which graphically catch the curious sounds of these "unstable" signals.

Although apparently linked with the solar cycle and possibly with the conditions that give rise to Sporadic-E propagation (though this is far from proven) no entirely convincing explanation of their cause has yet emerged, although Ted Cooke has advanced a most interesting "energy loss" theory. Perhaps the biggest mystery of all is the lack of serious investigation of this apparently quite frequent phenomenon for 15 or so years after their original discovery, in comparison for example with the intensive scientific work on the very-low-frequency "whistlers" for which entirely satisfactory explanations now exist.

The rapidly chirping sweepers and the more buzz-like slow moving creepers would at least prove a more rewarding field of Investigation than the puzzling long delay echoes which, though reliably and quite frequently observed in the decade 1928-38, are nowadays so rare and fleeting that many investigators have given up in despair of ever observing one themselves!

World apart

Incidentally, for those who want to listen for intelligent beings in other worlds a new "preferred frequency for interstellar communications" has been proposed by three Japanese scientists. They advise us to tune to precisely 4829·659MHz, the spectral line of formaldehyde. At least this should be a change from 1420·406MHz, the hydrogen line, which has been the preferred frequency for a number of years.

Packet switching

Build a better mousetrap and the world will beat a path to your door, it is said—but is it true? Experience suggests that ideas may eventually be taken up by others but seldom in response to the innovator. Today, in 1979, in telecommunications the "in thing" is the concept of packet switching which divides input flow of information into small segments of data which are then sent through the line or radio network in a manner similar to the handling of mail "packets" but at immensely higher speeds.

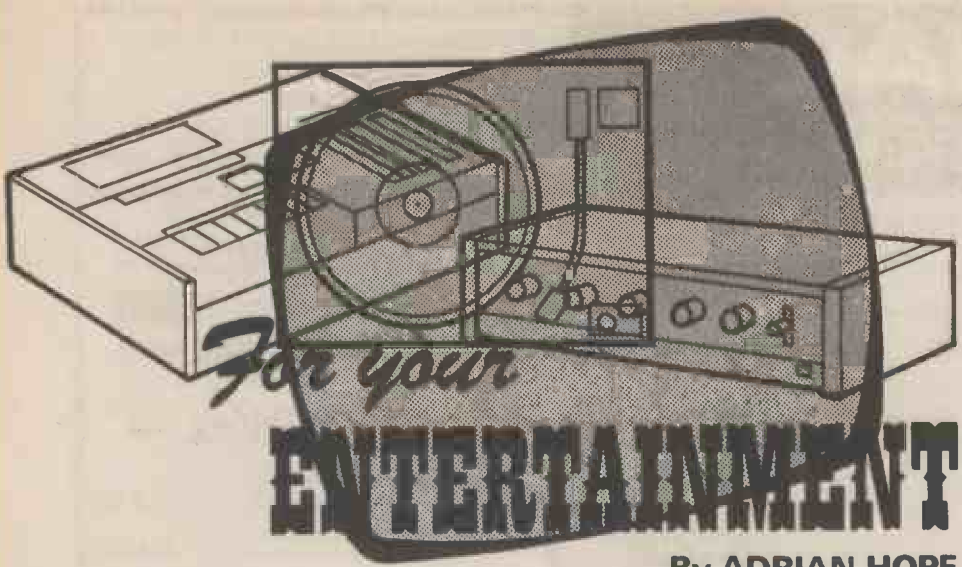
Who first thought out the idea? In the United States Paul Baran in 1964 for the US Air Force but they took no follow up action and the report sat largely ignored for many years until packet switching was rediscovered and applied by others.

In the UK, Donald Davies of the National Physical Laboratory actually coined the term "packet switching" and, unaware of Baran's work, circulated his ideas in 1965-66 and it is generally agreed that this should have led quickly to a UK project. In fact the communications world was hard to convince and again nothing happened for several years and so the UK lost its opportunity of blazing the way into a multimode packet switching network.

Of course, it is not enough to be an innovator unless the concept can be applied universally. I was very impressed by an editorial in Marconi's "Communication and Broadcasting" a year or two back:

"If the spread of technology is to be maintained so that its benefits can be shared by greater numbers of the world's population, the skills and expertise of the specialist have to be taken to the far corners of the world. It is not enough that technology should be sent haphazardly to an unprepared world. It is no good placing a piece of advanced equipment in a remote corner of the earth and saying 'You are now the happy recipient of this wonderful scientific achievement. Press Button A and your life will be magically improved' ".

There is, the editorial stressed, a responsibility to ensure that the ultimate user obtains the maximum benefit from his investment in new technology.



For your ENTERTAINMENT

By ADRIAN HOPE

Radio Dentist

Last Summer a country vet (not, I should add, James Herriot) appealed to the scientific press for help over a curious medical problem he had encountered. A Siamese cat patient had started to emit a high pitched musical note from its left ear, rather like a superhet whine!

No, it wasn't a joke. And the final explanation brought together some interesting, otherwise unlinked facts, some of them red herrings, if you will pardon the metaphor.

Cats, like dogs and other domestic animals, are able to hear much higher pitched sounds than humans. This is why the remote controls for some TV sets and hi-fi systems which operate with ultrasonic soundwaves can quite literally drive domestic pets to distraction.

Siamese cats are often more highly strung than mongrel "moggies" and are often very distressed by ultrasonic sounds. But in this case feline ultrasonic perception wasn't involved. The cat was unperturbed even though its ear was generating the sound.

It has long been known that humans can sometimes hear radio transmissions without the aid of a radio receiver. What usually happens is that an adjacent pair of metal tooth fillings, or a cracked single filling serves as a semiconductor junction. This then "detects" any powerful radio transmission that is by chance tuned to resonance.

This could account for the tales of shipwrecked survivors in lifeboats who pick up the sound of radio transmissions from search parties in the area.

In the USA recently a doctor's patient complained about the sound of radio broadcasts in her head. The doctor was astonished to find that the signal being detected by the patient's teeth was so strong that the received sound was audible not only to the patient but also to anyone else who put their ear close to the woman's mouth.

Just as the transformer of an amplifier will sometimes sing audibly in sympathy with the signals passing through it, so the woman's tooth fillings were singing in sympathy with the radio signals they were detecting in semiconductor fashion. So was the Siamese cat radiating the sound of a received radio carrier?

Almost certainly not. According to specialists in the field it is not unknown for human ears to sing a fixed pitch note in the manner of the Siamese cat. No one is quite sure exactly how it happens. But due to spontaneous vibration of muscle tissue or blood vessels near the ear, the ear drum is set in vibration and acts as a tiny loudspeaker.

The phenomenon is, of course, quite separate from that already well known, whereby we sometimes hear a singing in the ears, for instance after a gun shot or very loud noise. In this case the singing is heard only by the sufferer.

Differing Viewpoints

By now most readers will have heard of Teletext and Viewdata. But a brief re-cap might help.

Viewdata is a system which enables anyone with a telephone and a special television receiver and calculator style keyboard control to dial up a Post Office computer and ask it questions. The answers are then displayed on the TV screen.

Teletext is the broadcast system operated by the BBC and IBA whereby news flashes and the like are transmitted in digitally encoded message form buried in the analogue waveform of an ordinary television programme. Again a special receiver is needed and a similar calculator style keyboard control is used, this time enabling the user to select which of a hundred or so pages of information is to come up on the screen.

The important point is that the Teletext system is purely *passive.* The viewer can only select and read a page of whatever information is being transmitted. The Post Office Viewdata system is *active,* in that the subscriber can interrogate the Post Office computer via his telephone, in any of the information fields covered by the system.

So far these areas are pretty limited. For instance, when I tried to interrogate the Post Office computer on train timetables I found that only main line station information was stored in the computer. But doubtless it is only a question of time before the computer has been fed the timetable for every train running throughout the country.

Both Viewdata sets and Teletext sets have a fair amount of electronic circuitry in common, including the keyboard control of course. Both types of set reproduce ordinary television programmes in conventional fashion and both have character generation circuits that reproduce digitally coded messages as numbers and figures on the screen.

The differences arise in how the coded messages arrive and are handled. With a Teletext set they arrive "off air" down the aerial lead and with Viewdata they arrive via the hard wires of domestic telephone.

The Viewdata circuitry is rather more complex than the Teletext circuitry and it looks as if Viewdata-capable sets will cost more than Teletext-capable sets. It follows that Viewdata-capable sets will probably offer Teletext as a bonus but not *vice-versa*.

Matter of Generic

Incidentally, there is an interesting story behind the word 'Viewdata'. This was the working title given to the system by the Post Office engineers and it caught on. The Post Office tried to register and thus monopolise the word Viewdata with the British Trademarks Registry, which is attached to the British Patent Office.

This attempt was doomed to failure because even when incorporated in a picture or "logo" the word Viewdata is really nothing more than a simple combination of the two well known words "view" and "data". And under British trademark law it is impossible to register, and thus monopolize, such an obviously descriptive or "generic" term.

So the Post Office have dropped the idea of monopolizing the word "Viewdata" and are instead diverting their legal energies to registering the word "Prestel" as a trademark for the Post Office system of viewdata.

DOING IT DIGITALLY

PART 6

By O. N. Bishop

THIS month we shall be concerned with binary coded decimal systems, decoding and seven-segment displays.

BINARY AND BCD

Although TTL is well able to handle calculations in the binary system, there are practical reasons for retaining one feature of our decimal system. On a keyboard we enter a number as a series of single digits, representing thousands, hundreds, tens, units, and perhaps decimal fractions too. It is convenient if we design the circuit so that it handles each of these digits in order, but *separately*—just as we do when we perform an addition or a multiplication on paper.

If the answer to any column of our calculation comes to more than one digit, we *carry* the extra digit or digits over to the next column. The calculator circuit does this too. If we adopt this method of calculation, the machine needs to be able to work with only the digits 0 to 9, but in binary form. It does not need to be able to recognise larger numbers in binary.

For example, the number 4869 consists of the four digits 4, 8, 6 and 9. If we split this number into these four digits and then code each digit *separately*, we obtain a 16-digit number, see Fig. 6.1.

This system for representing a number is called *binary coded decimal*, or BCD for short. It needs far more digits than are used in the decimal system, and appreciable more than in the wholly binary system, but we gain in the simplicity of the circuits required for coding and decoding. A keyboard coder would need thousands of keys —one for each number that we would need to enter—or it would have to be backed up by complicated coding circuits.

In the same way, the final decoding is very complex for a binary number of ten or more digits. To split it into groups of four digits and then decode these to one of the ten digits 0 to 9 is far simpler. The results can be fed straight to the decimal display or the printout machine.

DECODING

A decoding circuit which has rather limited capability is shown in Fig. 6.2a but can be wired up on the Test-Bed as an example of how decoders work. It accepts only two BCD inputs, *B* and *A*, so consequently can decode only digits 0 to 3. Before going ahead with wiring up, we need to follow the logic of the type of gate used in this decoder.

This is a type we have not met before in this series. The four gates which are connected to the l.e.d.s are called NOR gates, or negative-OR. The truth tables for OR and NOR are given in Table 6.1, where it is seen that NOR is simply the inverse of OR.

Table 6.1. The OR and NOR truth tables

Input B	Input A	Output OR	Output NOR	Corresponding decimal digit
L	L	L	H	0
L	H	H	L	1
H	L	H	L	2
H	H	H	L	3

OR: High when either *A* OR *B* is high.
NOR: High when neither *A* NOR *B* are high.

An l.e.d. connected to the output of a NOR gate will light only when both (or all, if three or more) inputs are *low*. Thus it lights for *only one* of the four possible combinations of two inputs, which means that we can arrange for an l.e.d. to light only when the two inputs are of correct level. In addition to the NOR gates, we use two NOT gates to obtain the inverses of *A* and *B*, which we refer to as *A* and *B*.

Table 6.2. Truth table for the decoder

Decimal digit	Input A	Input B	Output 0	Output 1	Output 2	Output 3
0	0	0	1	0	0	0
1	0	1	0	1	0	0
2	1	0	0	0	1	0
3	1	1	0	0	0	1

The *truth table* for the decoder is given in Table 6.2.

The decoder is to be made up on the Test-bed using a 7402 (quadruple 2-input NOR) according to Fig. 6.2b. One of the required NOT gates is obtained from IC3, ready-wired on the Test-Bed; the other can be easily obtained by joining the two inputs of

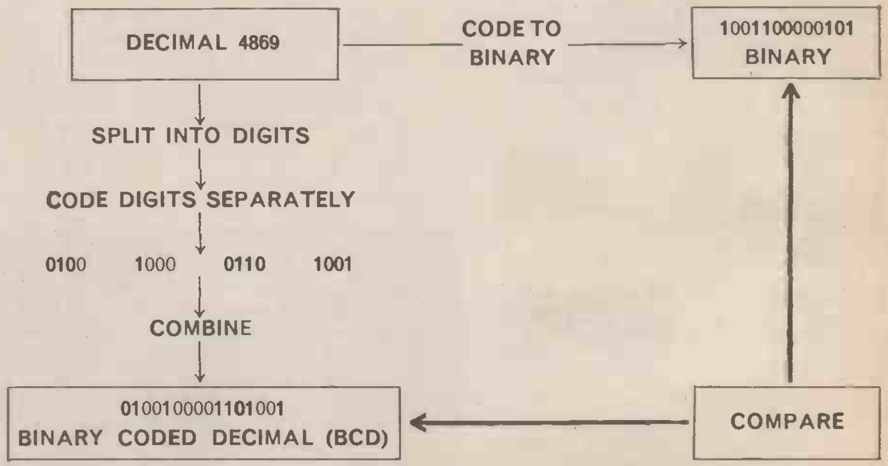


Fig. 6.1. Illustrates the difference between a number converted to binary and binary coded decimal.

the NAND gate of IC3. The pin numbers for the 7402 are given in Fig. 6.3.

Inputs *A* and *B* are provided from the keyboard, or by connecting *A* or *B* or both to ground. According to the binary input applied to the circuit, one of the l.e.d.s lights, to indicate the corresponding decimal number.

The circuit for decoding a four-digit binary input to one of the figures 0 to 9 is far too complex to be built on the Test-Bed. Such a decoder can be purchased, in integrated-circuit form, as the 74141. This accepts a four-digit binary input and has ten outputs (0 to 9), which go low when the corresponding binary input is applied.

A display controlled by this i.c. could be a row or ring of ten l.e.d.s, or a numerical display tube of the Nixie type. The latter are often used in cash-registers and shop scales.

The tube is a neon-filled discharge tube containing ten electrodes made from thin wire and arranged one behind the other. They are shaped like the ten digits 0 to 9. When a 'low' potential is applied to an electrode, the other electrode being positive, the neon gas in its vicinity glows blightly indicating the appropriate digit, the other electrodes remaining relatively invisible.

In our display on the Test-Bed, we use a different type of decoding i.c., the 7447 which provides the special output needed for driving the seven-segment digital l.e.d. display.

7-SEGMENT DISPLAY

The seven-segment l.e.d. display is the most commonly used type of display to be found in almost all calculators, watches, clocks and a variety of measuring instruments with digital readout.

Each display unit consists of seven bar-shaped segments, arranged as in Fig. 6.4, and denoted by the letters *a* to *g*. Most displays also incorporate a small round l.e.d., the decimal point. The type used in the Test-Bed is the *common anode* type of display in

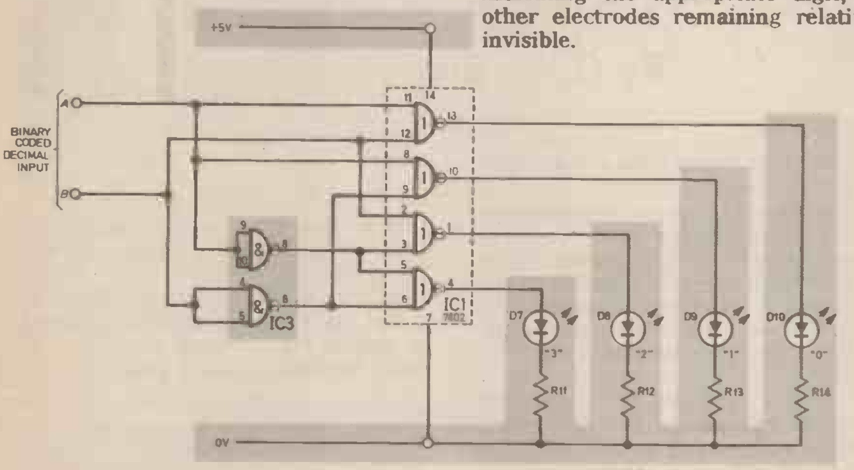


Fig. 6.2(a). A simple to binary to decimal decoding circuit for decoding numbers 0 to 3 made from discrete gates.

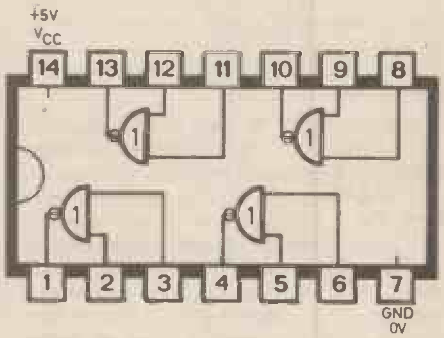


Fig. 6.3. Pinning details for the 7402 i.c.

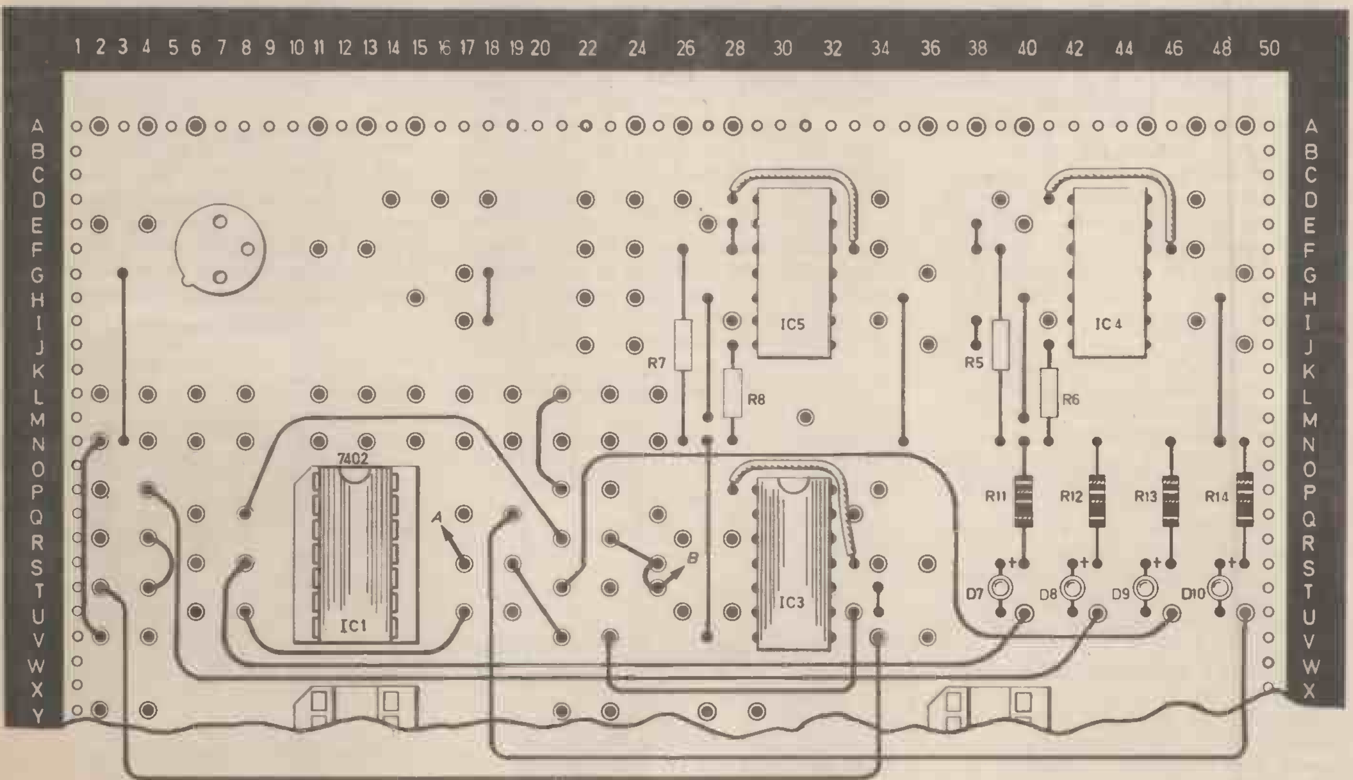


Fig. 6.2(b). Interwiring between components on the Test-Bed for the experiment of Fig. 6.2(a).

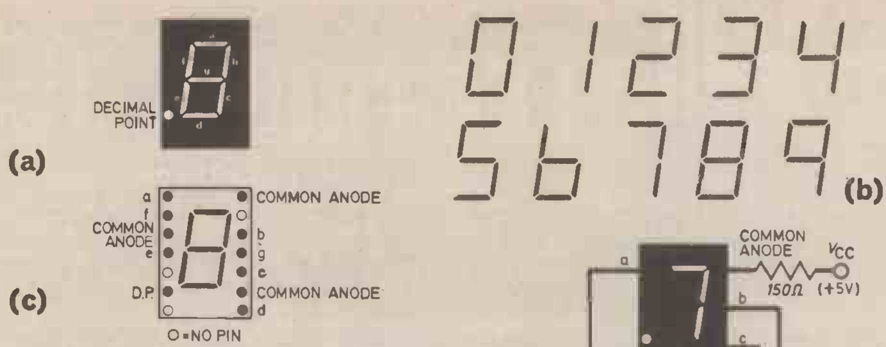


Fig. 6.4. Seven-segment l.e.d. numbered display: (a) front face showing lettered segments, (b) the way the numbers 0 to 9 are obtained, (c) pin connections for the device used in our Test-Bed viewed from above—the letters indicate connections to the cathodes, (d) how to wire the device to display decimal 7.

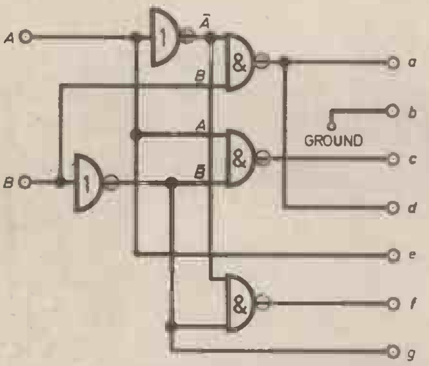


Fig. 6.5. A seven-segment decoder for digits 0 to 3.

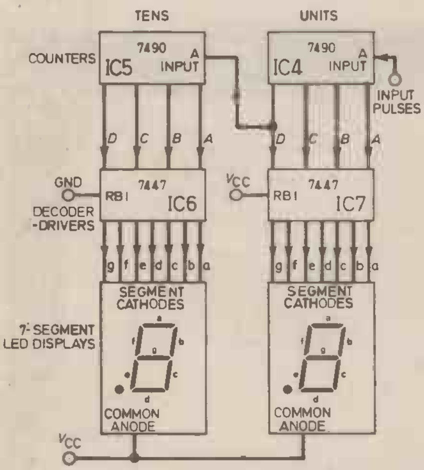


Fig. 6.6. The Test-Bed display wired up to count and display numbers from 0 to 99.

which the anodes of all segments are connected to a single pin (or all to two pins), and their cathodes are each connected to a separate pin. A resistor in series with the anode pin limits current to a reasonable level (about 20mA maximum) when V_{cc} is 5V.

To cause a segment to light its cathode must be grounded, or connected to a "low" TTL output.

If a spare display is at hand, or you care to disconnect one from the Test-Bed, try grounding the pins in various combinations to obtain the various digits. Table 6.3 will help.

Table 6.3. Decimal to seven-segment for common anode display

Digit	a	b	c	d	e	f	g
0	L	L	L	L	L	L	.
1	.	L	L	.	.	.	.
2	L	L	.	L	L	.	L
3	L	L	L	L	.	.	L
4	.	L	L	.	.	L	L
5	L	.	L	L	.	L	L
6	.	.	L	L	L	L	L
7	L	L	L	.	.	.	.
8	L	L	L	L	L	L	L
9	L	L	L	.	.	L	L

L=grounded or to TTL "low" output.

The table also tells us what outputs are required from the 7447 decoder. Before going on to investigate the 7447, why not design and build your own seven-segment decoder on the Test-Bed? Let it accept only two BCD inputs, and provide outputs for the display of digits 0 to 3. It can be done with only three NAND gates and two NOT gates, see 6.5. To check your logic, connect your circuit to the keyboard and to a seven-segment display.

To function as a decoder the circuit must have the truth table of Table 6.4.

Table 6.4. Seven-segment decoder truth table

Inputs		Outputs							Equivalent decimal
B	A	a	b	c	d	e	f	g	
L	L	L	L	L	L	L	L	.	0
L	H	.	L	L	.	.	.	.	1
H	L	L	L	.	L	L	.	L	2
H	H	L	L	L	L	.	.	L	3

Since for *a*, *c* and *d* we are aiming to obtain a *high* output for only one particular combination of *A* and *B* inputs we use NOR gates. These have high outputs only when *both* inputs are low. Output *a* can be obtained by feeding $\bar{A}$ and *B* to the NAND (see Fig. 6.5); inputs are both low for only decimal "1", as required.

Similarly, output *c* is the NOR of *A* and $\bar{B}$. Output *d* is the same as output *a* and is obtained from the same gate. Output *b* is to be low for all four digits, so is easily obtained by permanently grounding the *b* pin of the display. Output *e* follows *A* identically, so a direct connection can be made; similarly for *g*, which is the inverse of B ($=\bar{B}$). Output *f* needs to be high for three combinations of inputs, so we chose a NAND gate to provide this logical output, and feed it with $\bar{A}$ and $\bar{B}$, which are both *high* when the inputs *A* and *B* are both low (decimal zero).

If we were to build a decoder for more digits, much of the above logic would no longer apply. We would have to start from scratch and the final circuit would be far more complicated than that of Fig. 6.5.

TEST BED DISPLAY

The Test-Bed display system consists of three parts as shown in Fig. 6.6.

(1) **Counting circuit** to count incoming pulses and register their total number in BCD form. We use two 7490 decade counters, which can be wired in series to enable counting from 0 to 99.

(2) **Decoder-driver circuit** to decode the BCD output given by the counting circuit and to produce outputs for driving the 7-segment displays. Two 7447 i.c.s are used for this purpose.

(3) **The 7-segment displays**, of which we use two.

The action of the above, except the 7447 i.c.s, has been described in earlier parts of this series.

7447 DECODER–DRIVER

The 7447 works on the same principle as the 0 to 3 decoding circuit you built from the individual logic gates in Fig. 6.2a. As you might expect, the internal circuitry of the 7447 is a lot more complicated than

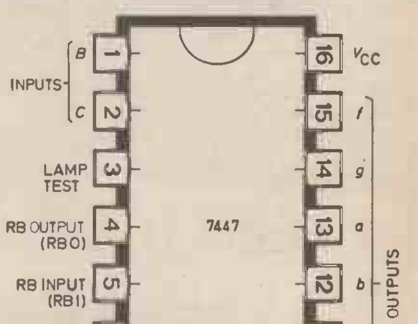


Fig. 6.7. Pinning details for the 7447 seven-segment decoder/driver i.c.

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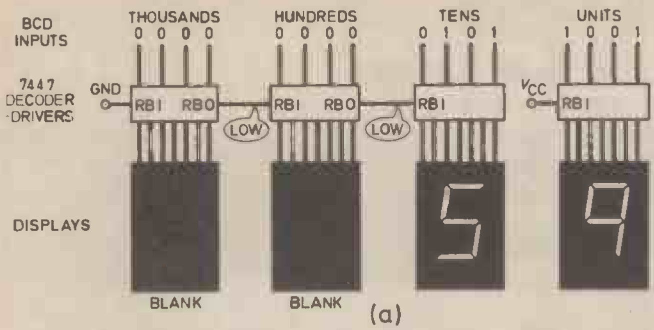

Fig. 6.8(a). Illustrating leading-edge zero blanking.

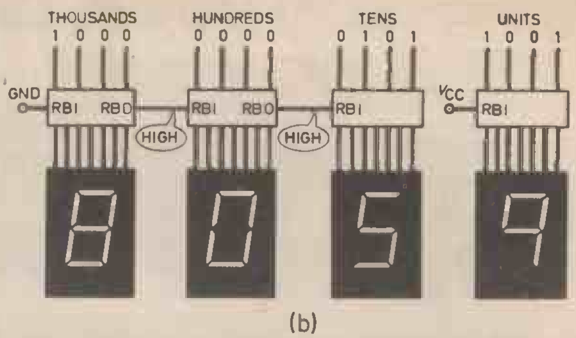

Fig. 6.8(b). Presence of a significant "thousands" digit causes zero to be displayed at the "hundreds" digit.

that of the 0 to 3 decoder. Its terminal connections are shown in Fig. 6.7. It has four terminals to receive the BCD input. There are seven output terminals (a to g) to drive the correspondingly lettered segments of the display.

The LAMP TEST input is normally held high. If it is made low, all outputs go low, making all segments of the display light up. This feature is for testing the display, but we do not use it here, so the LAMP TEST input is wired to V_{CC} (+5V).

RIPPLE-BLANKING INPUT

The action of the ripple-blanking input (RBI) is explained by reference to Fig. 6.6. Pulses arriving at the input are counted by IC4. The D output from IC4 is fed to the A input of IC5. When D goes low, as the output of IC4 changes from 1001 (=9) to 0000 (=0), IC5 registers one pulse; in other words, it counts the "tens".

The RBI of IC7 is wired to V_{CC}. The effect of this is that whenever the decoder receives a 0000 input, its outputs are such as to produce a 0 on the display. Thus, as pulses arrive at IC4, the display of units runs from 0 up to 9, back to 0 and so on. The RBI of IC6 is wired to ground (0V). The effect of this is that whenever the decoder receives a 0000 input, its outputs all go high, and the display is *completely blank*. Thus this display (the "tens" display) begins by being blank, then runs from 1 to 9, then goes blank, then repeats 1 to 9, and so on. By this means we obtain a sequence of two-digit numbers as we normally write them:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. . . .

If, instead of the arrangement shown, we connect the RBI pins of both decoders to V_{CC} there is no blanking, and the sequence of numbers would be:

00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12. . . .

If you prefer the latter sequence, you can change the RBI connection of IC6 to V_{CC} within the Test-Bed.

A system such as that of Fig. 6.6 is said to have *leading-edge zero-blanking.*

RIPPLE-BLANKING OUTPUT

The ripple-blanking output or RBO pin is used when we have a system with three or more digits, as in Fig. 6.8. Its operation depends on the fact that the conditions which produce a blank display (BCD inputs all low, and RBI input low) cause RBO to go low. In Fig. 6.8a, the "thousands" decoder is in this state and its RBO is providing a low input to the "hundreds" decoder. This has 0000 input, so the "hundreds" display is blank, too. Its RBO is low, but since the "tens" decoder has 0101 input, the "tens" display is 5. The "units" decoder has RBI wired to V_{CC} so it displays 0 even if all inputs to all decoders are 0000.

If the "thousands" input is suddenly changed to 1000 (Fig. 6.8b), the "thousands" display becomes 8. Its RBO goes high. Now, although the "hundreds" input is unchanged, and is still 0000, the "hundreds" display now shows 0 instead of being blank. In this way the complete number 8059 is displayed.

A similar arrangement is used if required to blank trailing-edge zeros following significant figures after a decimal point.

To be continued

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TELEVISION & RADIO 1979
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Publisher Independent Broadcasting Authority
ISBN 0 900485 32 9

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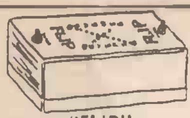

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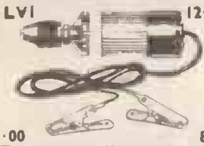

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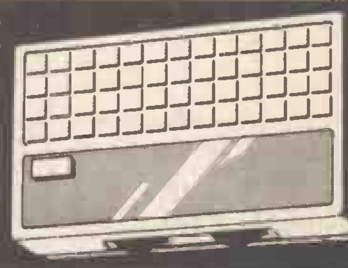

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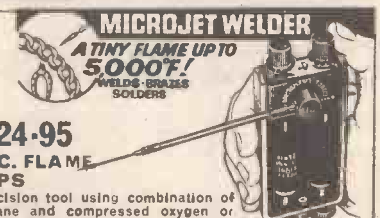

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Mag Issue	PROJECT	Ref	P.C.B.	KIT	KIT CONTENTS (see key)
1978 Jan	Audio Visual Metronome	E001	+ 65	5·50	B.E.H.L.
	Touch Switch	E002	+ 74	1·80	B.E.
	Code Scrambler	E003	+ 81	5·54	B.E.J.L.
	Rapid Diode Check	E004	+ 52	2·23	B.E.H.L.
Feb	Car Alarm	E005	+ 80	5·48	B.E.G.J.L
	Lead Tester	E006	51	4·17	B.E.H.L.
	Chaser Light Display	E007	1·75	19·88	B.E.H.L
	A.C. Meter Converter	E008	+ 60	5·37	B.E.H.L.
Mar	Audio Test (2 Pcb's)	E009	+1·74	14·78	B.F.G.J.
	C.R. Substitution Box	E010	—	8·45	E.H.L.
	Catch-a-Light	E011	+ 82	8·32	B.E.H.L.
	Weird Sound	E012	+ 62	5·29	B.E.H.L.
Apr	Roof Rack Alarm	E013	+ 60	—	
	Mains Delay Switch	E014	+ 94	12·48	B.E.J.L.
	Pocket Timer	E015	+ 60	3·46	B.E.H.L.
May	Flash Meter	E016	+ 75	11·09	B.E.H.L.
	Mains Tester	E017	+ 54	1·35	B.E.H.
	Teach In—Power Amp	E018	—	1·55	E.
	Power Pack	E019	+ 70	5·71	B.E.H.L.
Jun	Tele-Bell	E020	+1·00	10·69	B.E.H.L.
	Insitu—Transistor Tester	E021	+ 65	8·10	B.E.G.H.L.
	Teach In—S.W. Receiver	E022	—	2·61	E.
	Power Slave	E023	1·75	—	
	Visual Continuity Tester	E024	—	4·09	E.H.L.
Jul	Auto Night Light	E025	+ 85	9·39	B.E.G.H.L.
	Short Wave Radio	E026	—	7·86	E.J.
	Quagmire	E027	+1·40	7·39	B.E.G.H.
	Logic Probe	E028	+ 50	2·76	B.E.G.H.L.
Aug	Slave Flask	E029	+ 55	2·72	B.E.
	M.W. Mini Radio	E030	50	4·78	B.E.J.L.
	Audio Freq. Signal Generator	E031	+ 85	12·41	B.E.J.L.
	CHRONOSTOP	E032	+2·50	29·20	C.E.G.K.M.P.
Sep	R.F. Signal Generator	E033	—	15·82	E.H.
	Sound to Light Unit	E034	—	5·14	E.H.L.
	Guitar Tone Booster	E035	75	4·06	B.E.H.L.
	Car Battery State Indicator	E036	65	1·62	B.E.
Oct	C.M.O.S. Radio	E037	+1·45	10·32	B.E.G.H.L.
	Fuse Checker	E038	—	1·60	E.H.L.
	Treasure Hunter	E039	1·25	14·02	B.E.G.H.L.
	DOING-IT-DIGITALLY—TTL TEST BED	E040	—	20·65	N.
	DOING-IT-DIGITALLY—1st 6 PARTS	E041	—	3·60	N. (inc. add. comps.)
Nov	Audio Effects Oscillator	E042	—	2·40	E.H.L.
Dec	Water Level Alert	E043	+ 70	3·98	B.E.G.J.L.
Nov	SUBSCRIBERS TELE-TELL METER	E044	+2·80	19·50	C.E.G.K.M.P.
	Components to add 3rd digit to kit E044	E044A	—	2·75	E.
	Combination Lock (2 × PCB's)	E045	+2·55	19·90	B.E.H.L.
	Hotline Game	E046	+ 75	4·57	B.E.H.
Oct	Mini-Module—Passive Mixer	E047	—	2·47	B.E.H.
Dec	Audible Flasher	E048	—	79	E.H.
	Fuzz Box	E049	+ 75	5·20	B.E.H.L.
	Vehicle Immobiliser	E050	1·00	4·56	B.E.H.L.
	Mini-Module—Microphone Amp	E051	—	2·45	D.E.H.
1979 Jan	Mini Module—Continuity Tester	E052	+ 80	3·75	B.E.H.
	Lights Reminder	E053	+ 80	5·62	B.E.G.H.L.
	I'm First	E054	—	1·58	E.H.
	Roulette inc. colour printed wheel (2 × PCB's)	E055	+3·40	7·90	B.E.H.
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	EE 2020 Tuner Amp—Board E Hardware & wire	E061	1·40	23·56	B.E.G.H.
	EE 2020	E062	—	11·95	K.
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KEY TO KIT CONTENTS

- **A** Vero-board(s)
- **B** Printed Circuit Board(s)
- **C** With screen printed component layout
- **D** Tag strip
- **E** ALL Resistors, potentiometers, capacitors, Semi-conductors
- **F** As E but with exclusions—Please ask for details
- **G** Dil and/or transistor sockets and/or soldercon pins
- **H** Hardware includes Switches, Knobs, Lamps & Holders, Fuses & Holders, Plugs & Sockets, Microphones, Transformers, Speakers, Meters, Relays, Terminal Blocks, Battery Connectors, etc. BUT excludes nuts, bolts, washers, connecting wire, Batteries and special miscellaneous items.
- **J** As H but with exclusions—Please ask for details
- **K** As H but including connecting wire
- **L** Suitable Case(s)
- **M** Suitable Case with Screen printed facia.
- **N** Full kit to magazine specified standards
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2N3705	0.14	40408	0.82	BC108A	0.16	BC178A	0.22
2N3706	0.14	40409	0.82	BC108B	0.16	BC178B	0.22
2N3707	0.14	40410	0.82	BC108C	0.16	BC179	0.22
2N3708	0.12	40411	3.10	BC109	0.16	BC179A	0.22
2N3709	0.12	40412	0.68	BC109B	0.16	BC179B	0.22
2N3710	0.12	40414	4.99	BC109C	0.16	BC182	0.12
2N3771	2.15	40594	0.87	BC140	0.30	BC182A	0.12
2N3772	2.20	40595	0.98	BC141	0.32	BC182B	0.12
2N3773	3.15	40636	1.37	BC142	0.32	BC182L	0.12
2N3819	0.36	40673	0.80	BC143	0.32	BC182LB	0.12
2N3820	0.39	AC126	0.48	BC147	0.13	BC183	0.12
2N3903	0.20	AC127	0.48	BC147A	0.13	BC183A	0.12
2N3904	0.18	AC128	0.48	BC147B	0.13	BC183B	0.12

TRANSISTORS

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				BCY72	0.18	BFX88	0.30	MJ4502	4.90	TIP41C	0.97
				BCY77	0.70	BFX89	1.37	MJE340	0.62	TIP42A	0.86
				BD121	2.20	BFY50	0.35	MJE350	0.62	TIP42C	1.08
				BD124	2.20	BFY51	0.35	MJE370	0.62	TIP110	0.77
BC183C	0.12	BC307	0.16	BD131	0.55	BFY52	0.35	MJE371	0.66	TIP112	0.93
BC183L	0.12	BC307A	0.16	BD132	0.75	BFY90	1.35	MJE520	0.50	TIP115	0.83
BC183LA	0.12	BC307B	0.16	BD135	0.40	BR101	0.55	MJE521	0.70	TIP117	0.99
BC183LB	0.12	BC308	0.16	BD136	0.40	BRY39	0.55	MJE2955	1.65	TIP120	0.87
BC184	0.12	BC308A	0.16	BD137	0.41	BSY95A	0.37	MJE3055	1.05	TIP122	1.04
BC184B	0.12	BC308B	0.16	BD138	0.41	BU104	1.80	MP8111	0.40	TIP125	0.93
BC184C	0.12	BC309	0.16	BD139	0.43	BU105	1.55	MP8112	0.45	TIP127	1.11
BC184L	0.12	BC309A	0.16	BD140	0.43	BU109	2.00	MP8113	0.50	TIP130	1.16
BC184LB	0.12	BC309B	0.16	BD142	0.70	BU126	2.08	MP8121	0.40	TIP132	1.33
BC212	0.12	BC309C	0.16	BD239A	0.44	BU204	2.20	MP8122	0.45	TIP135	1.26
BC212A	0.12	BC413	0.16	BD239C	0.59	BU205	2.40	MP8123	0.50	TIP137	1.45
BC212B	0.12	BC414	0.17	BD240A	0.49	BU206	2.70	MP8513	0.50	TIP140	2.23
BC212L	0.12	BC415	0.16	BD240C	0.59	BU209	2.70	MPF102	0.33	TIP142	2.57
BC212LA	0.12	BC416	0.17	BDY54	1.55	J310	0.64	MPF103	0.44	TIP145	2.47
BC212LB	0.12	BC516	0.22	BDY55	1.90	J300	0.37	MPF104	0.44	TIP147	2.84
BC213	0.12	BC517	0.22	BDY56	2.10	ME0401	0.22	MPF105	0.44	TIP2955	0.70
BC213A	0.12	BC547	0.13	BDY57	5.90	ME0402	0.22	MPSA14	0.33	TIP3055	0.59
BC213B	0.12	BC547A	0.13	BDY58	6.50	ME0404	0.17	R2008B	2.45	TIS34	1.05
BC213C	0.12	BC547B	0.13	BF115	0.39	ME0411	0.22	R2010B	2.15	TIS43	0.47
BC213L	0.12	BC548	0.13	BF180	0.37	ME0412	0.22	TIP29A	0.49	TIS90	0.22
BC213LA	0.12	BC548A	0.13	BF195	0.16	ME0413	0.17	TIP29C	0.65	TIS91	0.27
BC13LB	0.12	BC548B	0.13	BF196	0.16	ME0414	0.22	TIP30A	0.54	TIS88A	0.44
BC214	0.12	BC549	0.13	BF197	0.18	MJ400	1.45	TIP30C	0.70	ZTX107	0.17
BC214B	0.12	BC549B	0.13	BF198	0.19	MJ430	1.45	TIP31A	0.54	ZTX108	0.17
BC214C	0.12	BC549C	0.13	BF199	0.19	MJ481	1.70	TIP31C	0.72	ZTX109	0.17
BC214L	0.12	BC557	0.13	BF200	0.38	MJ490	1.49	TIP32A	0.59	ZTX300	0.17
BC214LB	0.12	BC558	0.13	BF224J	0.22	MJ491	2.10	TIP32C	0.82	ZTX301	0.17
BC214LC	0.12	BC558A	0.13	BF225J	0.27	MJ901	2.45	TIP33A	0.86	ZTX302	0.27
BC260	0.17	BC558B	0.13	BF337	0.49	MJ1001	2.10	TIP33C	1.18	ZTX303	0.27
BC300	0.43	BC559	0.13	BF338	0.52	MJ2500	2.70	TIP34A	0.97	ZTX304	0.27
BC301	0.43	BC559A	0.13	BF450	0.24	MJ2501	2.75	TIP34C	1.31	ZTX500	0.16
BC302	0.37	BC559B	0.13	BF451	0.22	MJ2955	1.35	TIP35A	2.20	ZTX501	0.17
BC303	0.54	BC70	0.21	BFR39	0.30	MJ3000	2.15	TIP36A	3.00	ZTX502	0.19
BC304	0.60	BCY71	0.26	BFR40	0.29	MJ3001	2.35	TIP41A	0.76	ZTX503	0.16

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116B	8	200	0.54	0.34	prices
116C	8	300	0.61	0.35	on
116D	8	400	0.68	0.37	request
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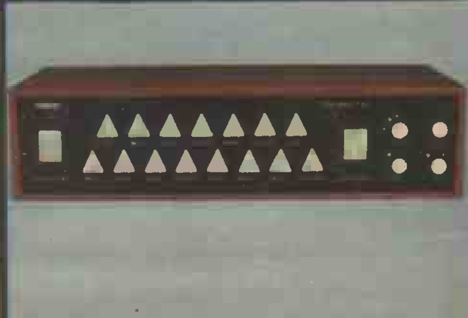

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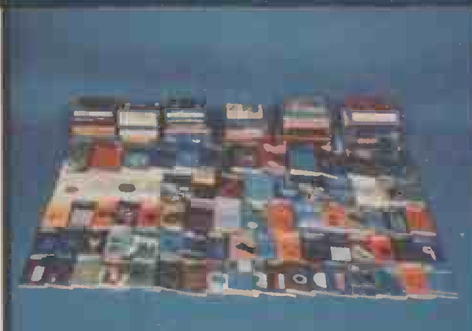

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