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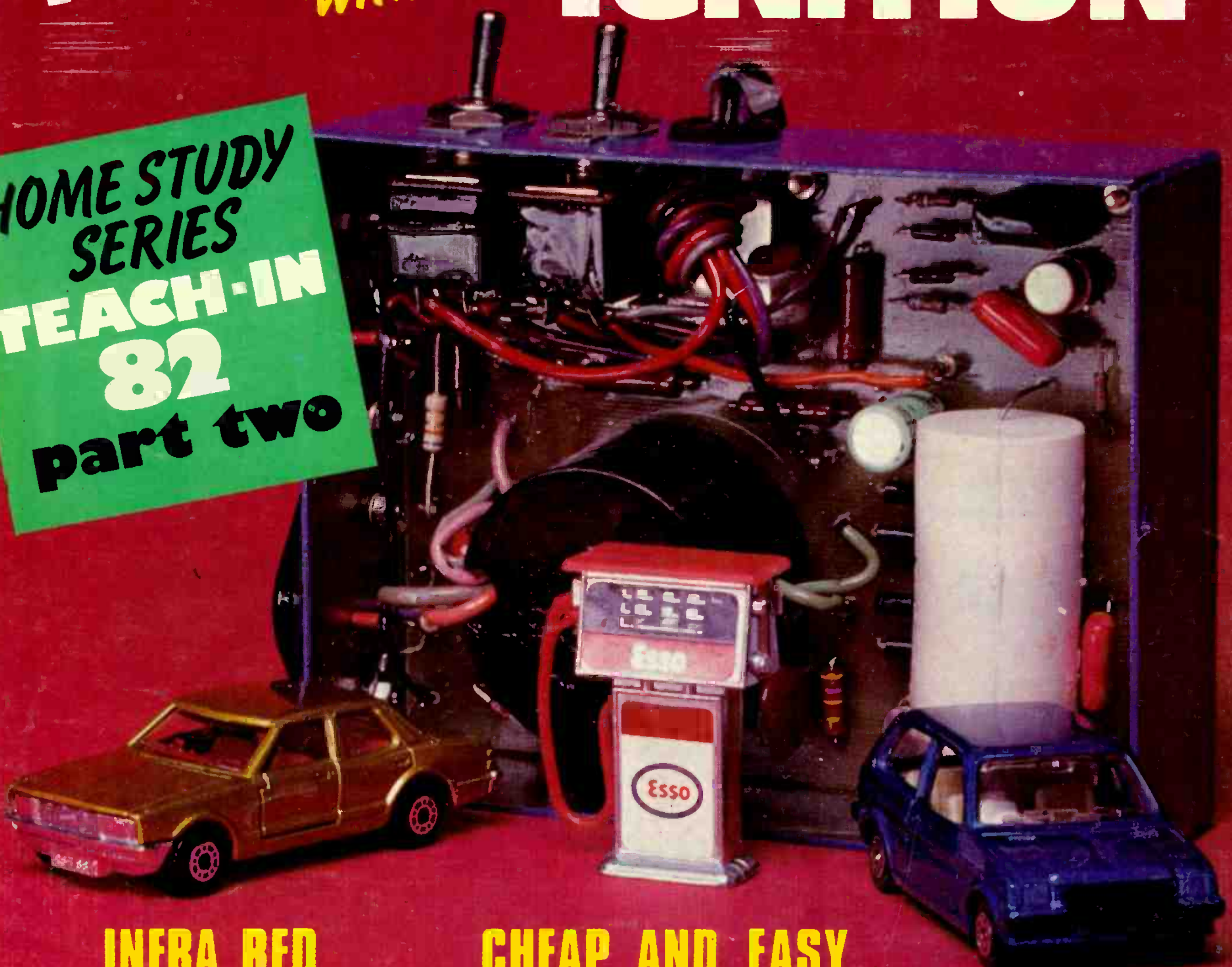

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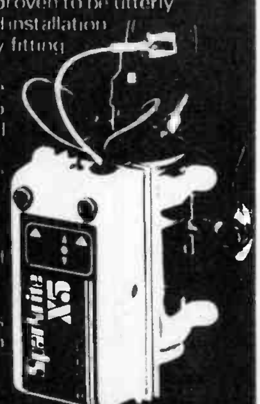

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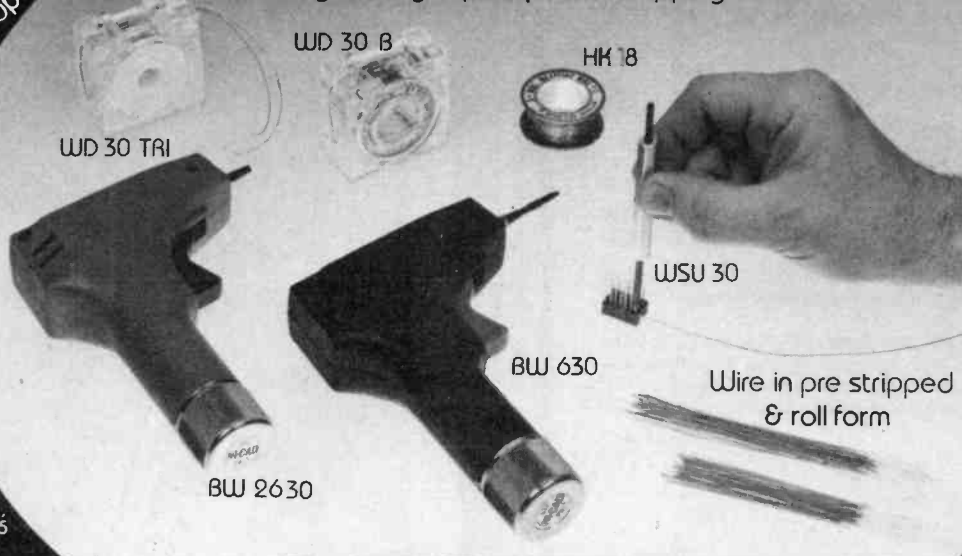

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18	4	2	3·98	1·43
68	3	1·5	3·46	1·43
85	5	2·5	6·06	1·43
70	6	3	6·67	1·43
108	8	4	8·03	1·43
72	10	5	8·66	1·73
116	12	6	9·31	1·90
17	16	8	11·46	2·05
187	30	15	19·23	2·35
232	40	20	27·61	4·50

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VOLTS 6 — 30 — 0 — 30

TYPE	AMPS 30v	AMPS 60v	PRICE £	P/P £
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126	2	1	6·36	1·43
127	4	2	7·86	1·73
125	6	3	11·78	1·90
123	8	4	14·72	2·20
40	10	5	17·10	2·20
120	12	6	19·44	2·35
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69	250	7·54	1·43
53	350	9·73	1·90
67	500	11·70	2·20
83	750	13·51	2·05
84	1000	18·31	2·35
95	2KVA	34·36	5·00
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57	5	97·85	6·50
101	10	179·05	10·00

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SEC 0V 12V 15V 0V 5V 9V 15V
VOLTS AVAILABLE 3 — 15 — 0 — 15

TYPE	AMPS 15v	AMPS 30v	PRICE £	P/P £
112	1	0·50	2·84	1·10
79	2	1	3·29	1·10
3	4	2	6·18	1·43
20	6	3	7·19	1·73
21	8	4	8·52	1·73
51	10	5	10·57	1·90
117	12	6	11·94	2·05
88	16	8	16·14	2·20
89	20	10	18·54	2·35
90	24	12	20·57	2·55
91	30	15	23·63	2·65
92	40	20	33·21	4·50

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SEC 0V 36V 48V 0V 36V 48V
VOLTS 12 — 48 — 0 — 48

TYPE	AMPS 48v	AMPS 96v	PRICE £	P/P £
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SEC 0V 20V 25V 0V 8V 15V 25V
VOLTS OUT 5 — 25 — 0 — 25

TYPE	AMPS 24v	AMPS 50v	PRICE £	P/P £
102	1	0·50	3·29	1·43
103	2	1	4·09	1·43
104	4	2	7·65	1·73
105	6	3	9·09	1·90
106	8	4	12·24	1·90
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the heart of a system that grows with you.

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

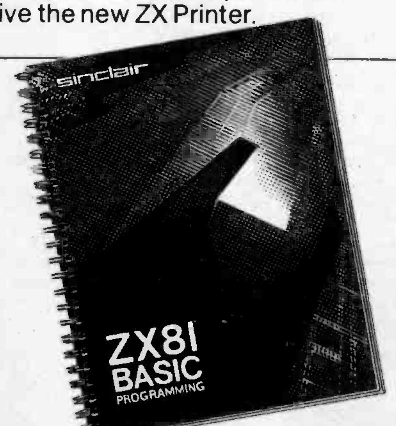
In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.



New BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
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- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

uter-

Available now-the ZX Printer for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings – particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY.

Qty	Item	Code	Item price £	Order Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	49.95	
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Projects... Theory... and Popular Features...

IN THE BEGINNING

Techniques change with the years but basic principles remain for all time. This is shown in the present day version of the crystal set. Developments in semiconductors have resulted in greatly improved signal detectors which are simply wired into the circuit and forgotten. Rather different to the early crystal with its accompanying cat's whisker that required careful and diligent manipulation in order to find the sensitive spot.

In *Before The Chip* the writer recalls some early days of electronics and refers in particular to that most notable period in the 'fifties when the transistor appeared on the scene for the first time. No doubt this pre-Beatle era will seem ages ago to our younger readers. On the other hand we have readers whose memory range is likely to be far more extensive (if you believe electronics is for younger folk alone, tell that to those enthusiasts of four-score plus). These senior readers will be able to recall some of the very earliest wireless receivers and the tussles they had to coax a signal from the enigmatic lump of mineral.

Some of the fun and excitement of those pioneer radio days can be recaptured through building the *Experimental Crystal Set* described this month. Home-made coils provide a coverage of medium and short waves and, incidentally, contribute to that sense of personal achievement that is generated when signals are picked up from a piece of equipment built largely with one's own hands.

In these present times of computers, TV games, music synthesisers and other elaborate concoctions of electronic circuitry, it is no bad thing to pause now and again and take a look back at the origins of all this modern sophistication. And the humble diode lives on in logic gates, clipping circuits and the like—in multifarious applications far removed from radio reception—an indispensable member of the semiconductor team that electronics relies on.

SEMICONDUCTOR STABILITY

Looking back in a more modest way, we observe a decade has now passed since EVERYDAY ELECTRONICS first appeared. Among transistors commonly used in our early days were several old stalwarts still going strong today. More surprisingly perhaps is the fact that some (like the BC108 for example) cost only the same as they did 10 years ago. Alas, the trend of diminishing prices which has been a most welcome characteristic of semiconductors over the years is not typical of materials and parts in general. Still, for this small mercy at any rate we have a lot to be thankful.

Fred Bennett

Our December issue will be published on Friday, November 20. See page 743 for details.

Readers' Enquiries

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

We cannot undertake to engage in discussions on the telephone.

Component Supplies

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

Everyday ELECTRONICS

VOL. 10 NO. 11 NOVEMBER 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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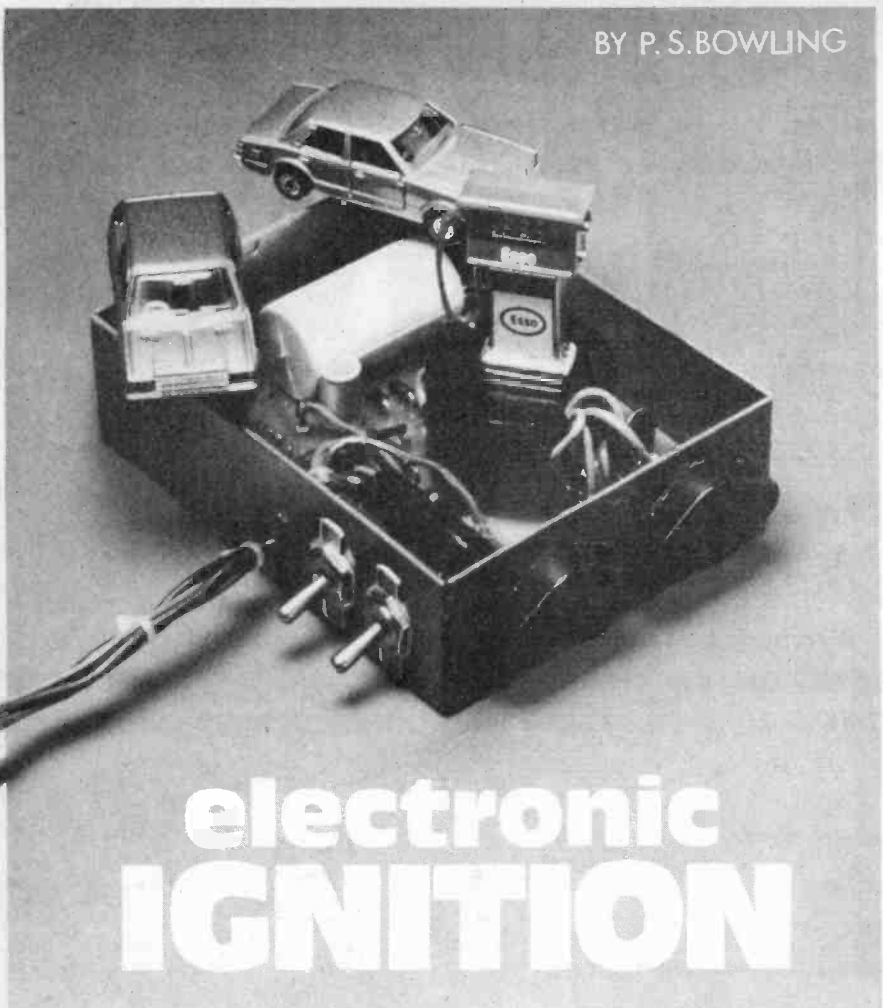


IT is becoming increasingly evident that electronic ignition increases the efficiency of the motor car. Once fitted, the motorist can experience improved starting, especially in the cold, smoother acceleration and most important, lower fuel consumption.

The conventional ignition system fitted to most modern day cars generates the voltage required to produce a spark by interrupting the current flow through the primary windings of a transformer (the "coil") generating a back e.m.f. in the region of 400 volts which induces a secondary voltage of about 25,000 volts.

However, some of the disadvantages inherent in this system are high current consumption, slow rise time, misfire due to points bounce and low output when starting.

In order to produce an electronic counterpart which overcomes these disadvantages, 500 volts has to be produced. This is done with an inverter circuit. The generated voltage is used to charge a capacitor, which is discharged through the primary winding of the coil producing a fast healthy spark in the order of 25kV, see Fig. 1.

CIRCUIT DESCRIPTION

Referring to the circuit diagram shown in Fig. 2, the inverter consists of TR1-TR2 in conjunction with transformer T1. Bias is provided by the potential divider R3-R4-D3, which is fed via R1-R2 and the feedback windings of T1. This unconventional bias arrangement gives the inverter the ability to work down to very low voltages (less than 3 volts).

The output of the inverter is rectified by the bridge D4-D7 and should be 500V ± 25V for an input voltage of 13·75, so watch those fingers! The rectified output is smoothed by C2, which is a disc-type capacitor for spike reduction. R6 is fitted to keep a minimum load on the inverter thus preventing the voltage rising too high and damaging C3 and CSR1.

C3 is the discharge capacitor, and charged to 500 volts; thus when the thyristor CSR1 is fired, C3 is effectively connected across the coil. The thyristor is triggered when its gate is pulsed by the opening of the points via the simple R-C network R8, C4 and C5. This configuration helps eliminate the effects of "points bounce". R9 provides this circuit with a current of 100mA which is sufficient to keep the points clean but not damage the contacts.

TR3 removes the bias from TR1 and TR2 when the ignition fires, because at this point the inverter output is effectively shorted by the thyristor, and could result in these transistors passing a large d.c. current. TR3 is triggered via R-C network R5, R7 and C1, providing the same protection as the thyristor firing circuit. The Zener diodes D1 and D2 are fitted to protect TR1 and TR2 against excessive spikes being fed back from the transformer.

The author fitted changeover switches S1 and S2 to his model just in case the unit failed, then conventional ignition could be selected. This also gives added anti-theft protection by immobilising the car by selecting electronic ignition on one switch and conventional on the other.

CONSTRUCTION starts here

TRANSFORMER

It is suggested the transformer be wound first, great care being taken that the correct number of turns are wound and in the right order. If the ferrite core gets damaged it is possible to repair with Araldite. A Mullard pot core is used to keep the size

PERFORMANCE SPECIFICATION

The unit will only operate on **negative earth** wired cars.

Operating voltage	5·5—14V max
Current consumption (stand-by)	500mA @ 13·75V
Current consumption (6,000 rpm)	1·3A @ 13·75V
Current through points	100mA @ 13·75V
Output with standard coil	> 25kV @ 13·75V
Output with sports type coil	> 30kV @ 13·75V
Max r.p.m. (4 cylinders)	8,000 r.p.m.

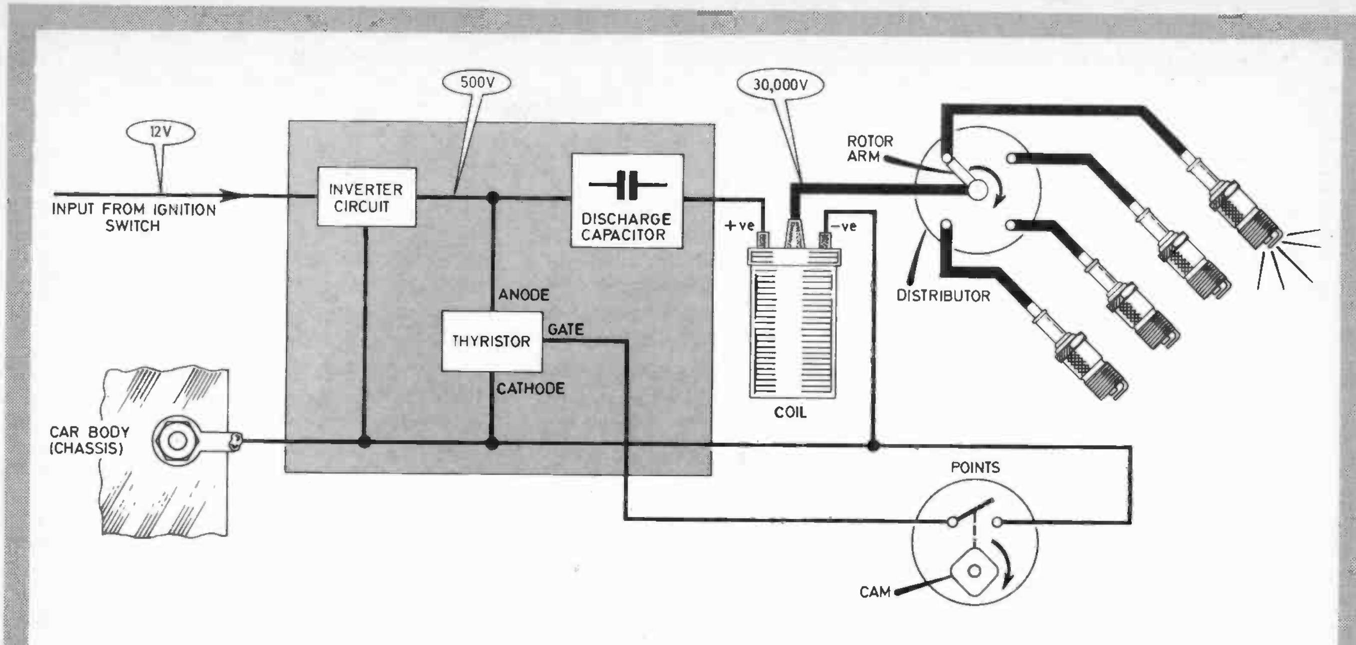


Fig.1. Block diagram for a capacitive discharge electronic ignition system.

down and efficiency up and two types of core were tried on the prototype, Mullard types FX2243 and FX3288, both being acceptable but the latter giving greater power output though unfortunately being more expensive!

The first winding to go on to the bobbin is the secondary. Take the bobbin and start winding one complete set of turns using 34 s.w.g. enamelled copper wire. It takes about 50 turns to fill one layer of the bobbin. Continue winding in this fashion until 350 turns are complete, that is seven complete layers of the bobbin. When this stage is reached, tape the whole winding down using thin strips of insulating tape. Fit sleeving over the wire tails to insulate them, and label the start and finish of this winding "7" and "8" respectively.

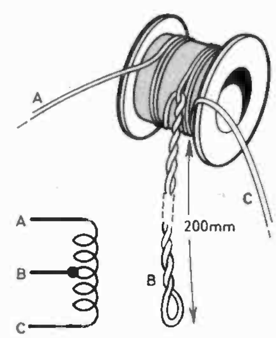


Fig.3. Method of producing a centre-tapped transformer winding.

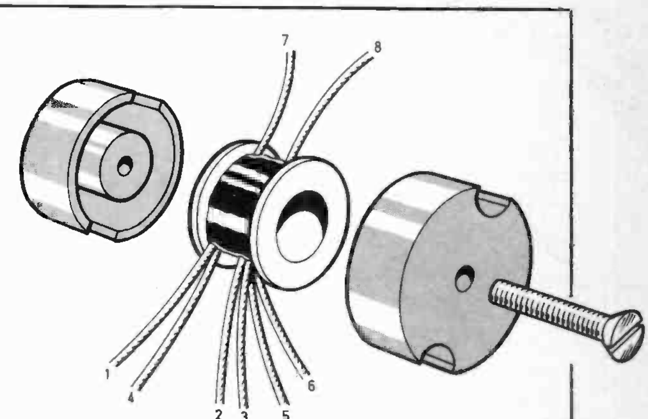
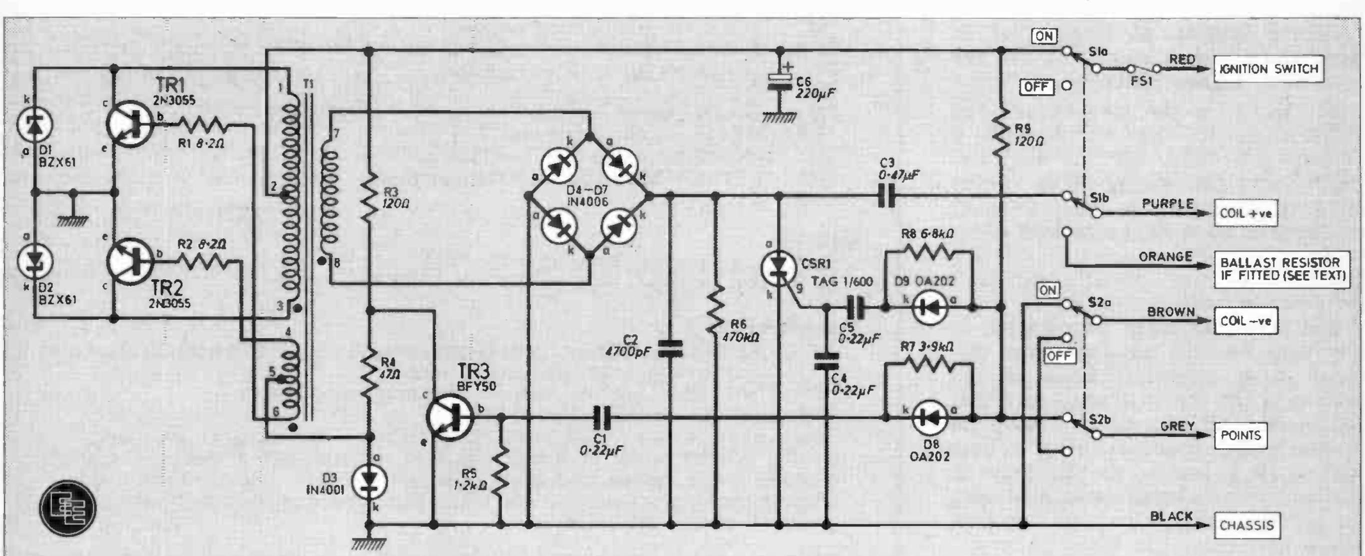


Fig.4. Exploded view of the transformer assembly showing the two halves of the pot core and the fully wound bobbin.

Fig.2. Circuit diagram of the electronic ignition unit.



Next the primary. Starting at the same end of the bobbin and using 22 s.w.g. enamelled copper wire, wind 10 turns in the same direction as before. The 10 turns should end approximately in the centre of the bobbin; a tapping should be fixed here by twisting about 200mm of wire together as shown in Fig. 3.

Now wind a further 10 turns in the same direction filling the whole bobbin and tape down as before. Sleeve the tails and label the start, tapping and finish with "1", "2" and "3" respectively.

Now comes the feedback winding. Using 34 s.w.g. wire and starting at the same end of the bobbin, wind 3 turns in the same direction as before, finishing the tapping in the centre of the bobbin. Bring out a tapping in the same fashion as for the primary and then wind a further 3 turns in the same direction and tape down.

Once again sleeve the wire tails and label the start, tapping and finish of the winding with "4", "5" and "6" respectively. Fit the bobbin into the pot cores, bringing the wire tails out through the slots in the ferrite as shown in Fig. 4.

PRINTED CIRCUIT BOARD

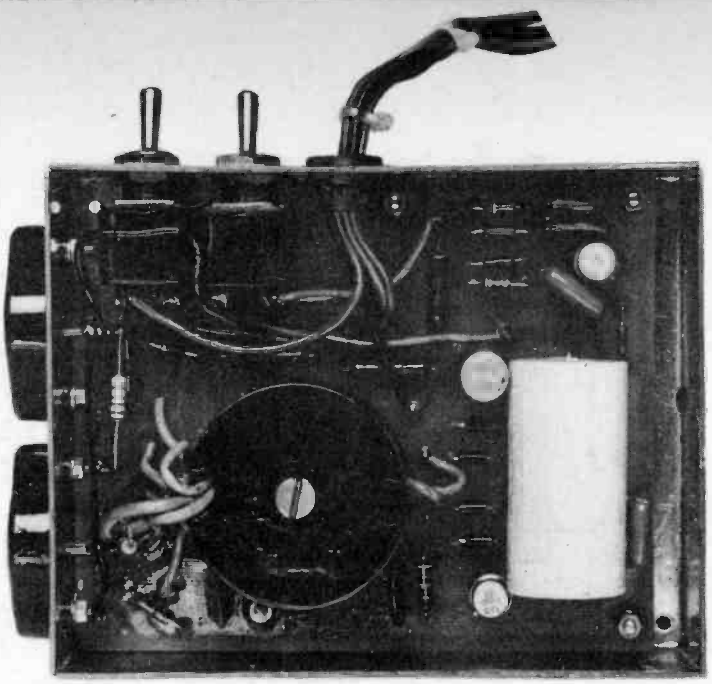
The prototype circuitry was assembled on a piece of glass fibre printed circuit board, size 122mm × 100mm with a cut-out to accommodate the two changeover switches S1 and S2. The foil pattern (copper tracks) for the p.c.b. is shown full size in Fig. 5.

This Fig. also shows the layout of the components from the top side of the board. When assembling the p.c.b. the resistors should be mounted first followed by the capacitors and finally the semiconductors. It is recommended that all the components be mounted approximately 2mm (about the thickness of a matchstick) above the top surface of the p.c.b. Attach sufficient lengths of flying lead to reach the switches S1 and S2 and the transistors TR1 and TR2.

At this stage the transformer can be secured to the board with a countersunk 2BA screw, nut and washer and the wiring made to the relevant pads on the p.c.b. keeping the leads as short as is practical.

CASE

The next step is the preparation of the case. To drill the four 3mm diameter p.c.b. mounting holes in the bottom of the box it is suggested that the board itself be used as a template to mark the positions of the hole centres (it is best to do this prior to any components being assembled onto the board) as this will assure accurate alignment.



The completed circuit board assembly mounted inside the case.

COMPONENTS

See Shop Talk page 737

Resistors

R1	8·2Ω
R2	8·2Ω
R3	120Ω 1W
R4	47Ω 1W
R5	1·2kΩ
R6	470kΩ
R7	3·9kΩ
R8	6·8kΩ
R9	120Ω 3W

All ¼W carbon ± 5% except where stated.

Capacitors

C1	0·22μF polyester
C2	4700pF disc ceramic 1,000V working
C3	0·47μF mixed dielectric 1,000V working
C4	0·22μF polyester
C5	0·22μF polyester
C6	220μF 16V elect. single ended

Semiconductors

D1	BZX61C30 30V 1·3W Zener
D2	BZX61C30 30V 1·3W Zener
D3	1N4001 1A 50V silicon rectifier
D4	1N4006 1A 800V silicon rectifier
D5	1N4006 1A 800V silicon rectifier
D6	1M4006 1A 800V silicon rectifier
D7	1N4006 1A 800V silicon rectifier
D8	OA202 general purpose
D9	OA202 general purpose
TR1	2N3055 silicon *npn* power TO-3
TR2	2N3055 silicon *npn* power TO-3
TR3	BFY50/BFX84 silicon *npn* medium power
CSR1	TAG1/600 thyristor

COMPONENTS approximate cost £21

Switches

S1	d.p.d.t. toggle 250V 3A
S2	d.p.d.t. toggle 250V 3A

Miscellaneous

T1 FX2243 or FX3288 pot core (2 halves required), DT2206 bobbin, 22s.w.g. and 34s.w.g. enamelled copper wire.
FS1 5A, 1·25in fuse link, in-line holder (automobile type).
Aluminium box size 133 × 120 × 38mm (Type AB10).
Single-sided printed circuit board 122 × 100mm, TO3 transistor mounting kit (2 off), TO3 transistor covers (2 off), PVC covered 19/0·2 wire (red, black, orange, purple, brown and grey), Veropins, screws, nuts, washers, 6BA spacers, sleeving, spade terminals, solder tags, solder, varnish, matt black paint, grommet, ratchet cable ties.

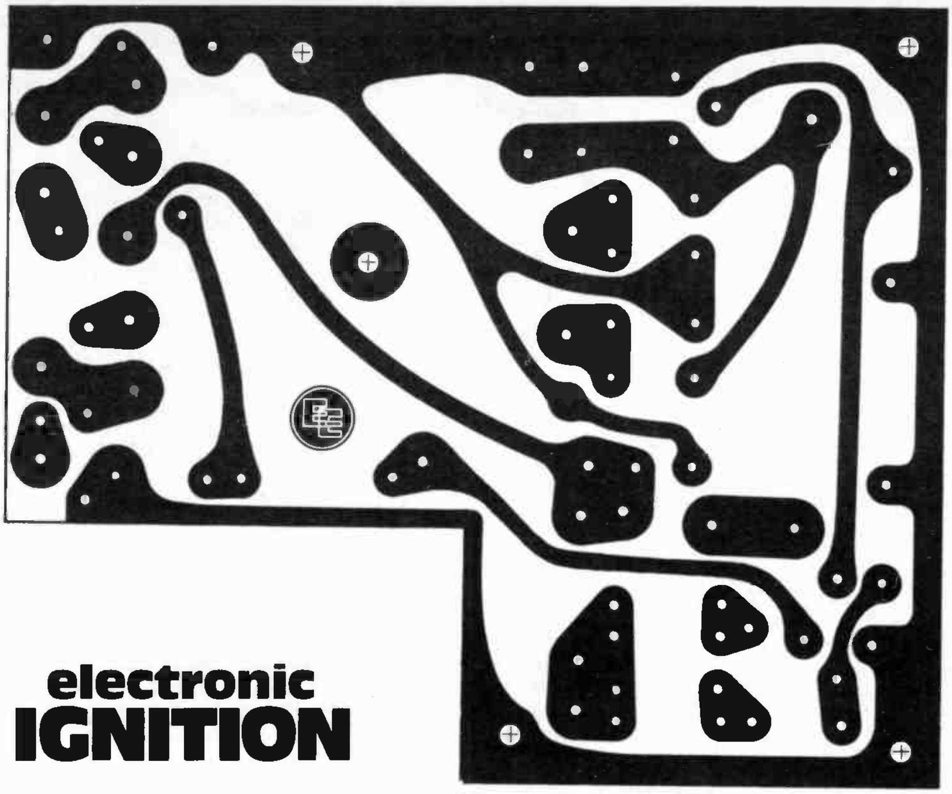
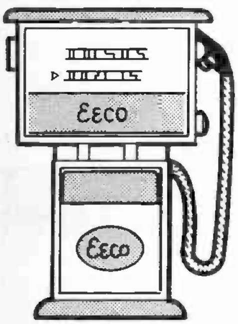


Fig.5. Full-size master of the printed circuit board



electronic IGNITION

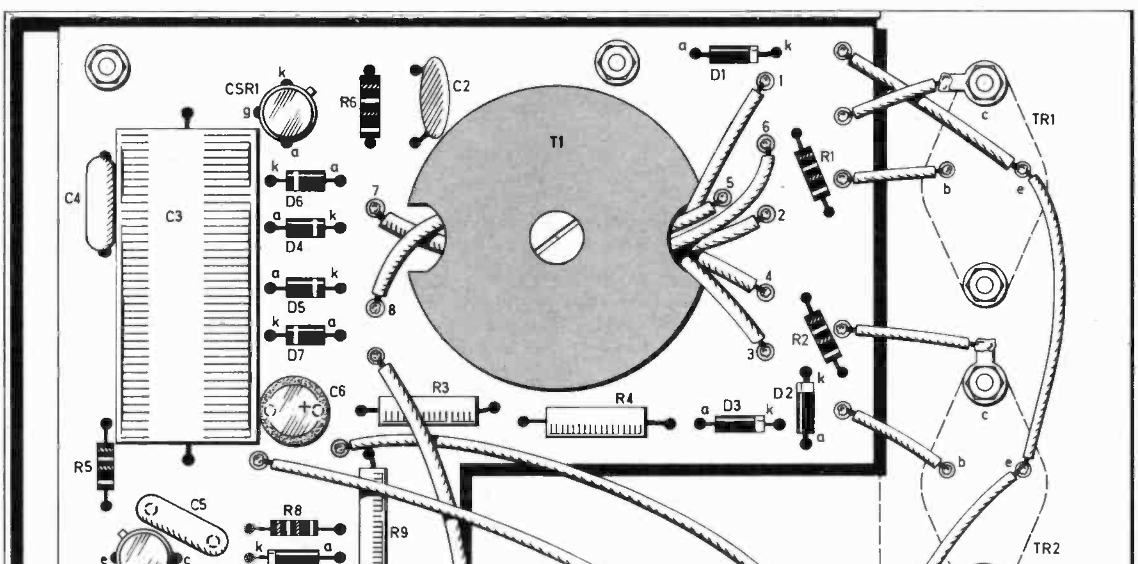


Fig.6. View inside the case showing the layout of the components on the p.c.b. and the interwiring of the ignition unit. The sides of the case have been folded flat for clarity.

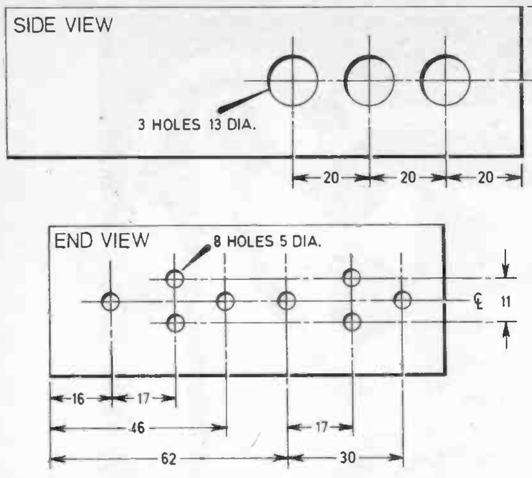
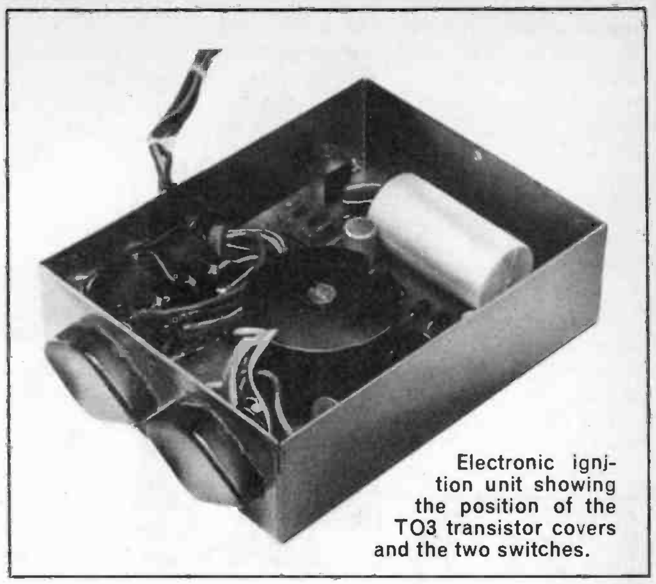


Fig.7. Case drilling details for the transistor and switch mounting holes.


Electronic ignition unit showing the position of the TO3 transistor covers and the two switches.

Also at this point any mounting holes for securing the unit to the car bodywork must be drilled ensuring that they will not be obscured by either the p.c.b. or the switches after the final assembly of the unit. The mounting holes for the switches and transistors TR1 and TR2 are shown in Fig. 7.

Before anything is mounted to the box, it should be sprayed matt black as this will not only enhance the appearance but also improve thermal dissipation.

On the four board mounting holes on the bottom of the box, it is suggested that the 0·25in high 6BA clearance spacers are glued into position to make construction easier.

TRANSISTORS

TR1 and TR2 can now be mounted onto the end of the box with mica washers to isolate the collector (case) of the transistor from the metalwork. Plastic bushes must also be used to insulate the fixing screws and the transistors should be smeared with silicone grease to aid thermal conduction. Before the plastic covers are glued onto TR1 and TR2, check the resistance between collector and chassis is high.

Fit the changeover switches, and then secure the board down with long countersunk 6BA screws. TR1 and TR2 should now be wired to the board. Do not wire the switches in until the unit has been bench tested.

TESTING

If a regulated power supply is available (a couple of 6V lantern batteries will do) connect this to the unit via a 1A fuse. Switch on with the output set at the lowest voltage at which the unit will operate (3 volts). A high pitched whine should be heard from the unit. If a 'scope is to hand connect it to the collector of TR1 or TR2. A square wave should be seen here with a peak to peak voltage of twice the supply voltage. Measure the output from the bridge D4-D7 across a suitable point (R6). The voltage here should be 500V d.c.$\pm$25V for a 13·75V input.

If the inverter fails to start, check the feedback windings are going to the correct transistors, TR1, TR2 are wired correctly and the polarity of D1, D2 and D3. The current drawn at 13·75 volts would be in the order of 0·5A.

When the unit is fully functional wire in the switches and feed the leadouts through the grommeted hole in the side of case, fitting the appropriate spade connector to each lead. The inline fuse holder containing FS1 must be fitted into the positive (red) lead going to the ignition switch.

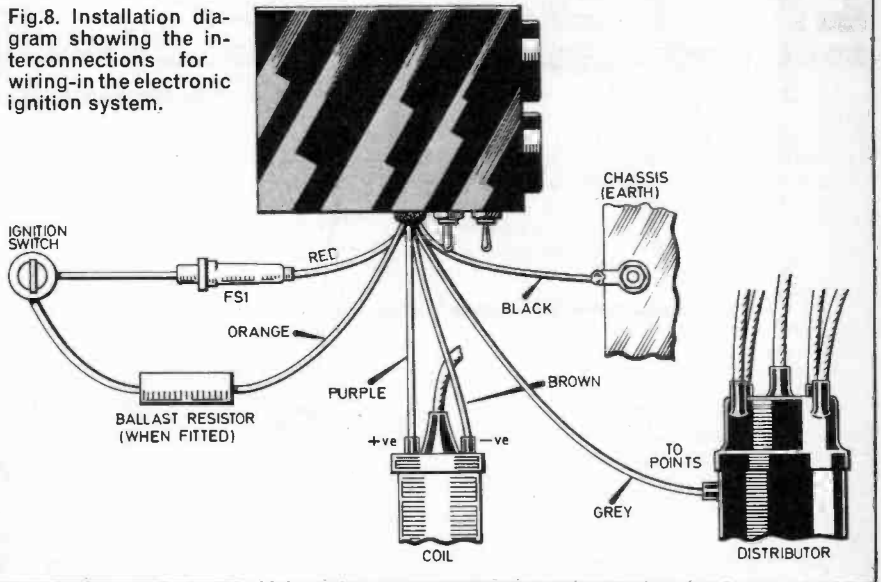
The author strongly recommends that all soldered connections to the transistors, switches and Veropins are sleeved and then the whole assembly is coated with clear varnish. The leadouts must be firmly clamped together with a ratchet cable tie inside the box to act as strain relief in the event of the wires being pulled sharply.

The unit can now be mounted to the car using self tapping screws, fitting it as close to the coil and distributor as possible but obviously not in a position where the elements would attack it.

INSTALLATION

Before the unit is wired to the car it should be established what type of ignition is fitted to your motor. Some vehicles have what is known as ballasted ignition. Basically this type of ignition uses a 6 volt coil with a series

Fig.8. Installation diagram showing the interconnections for wiring-in the electronic ignition system.



resistor, and once the car is started the resistor is shorted to give greater output. The resistor is usually a wire-wound type fitted to the body, but be careful as the resistor is sometimes in the form of resistance wire.

See Fig. 8 for the method of installation. The supply (red) lead is connected via FS1 to the "on" position of the ignition switch and the orange lead to the solenoid end of the ballast resistor.

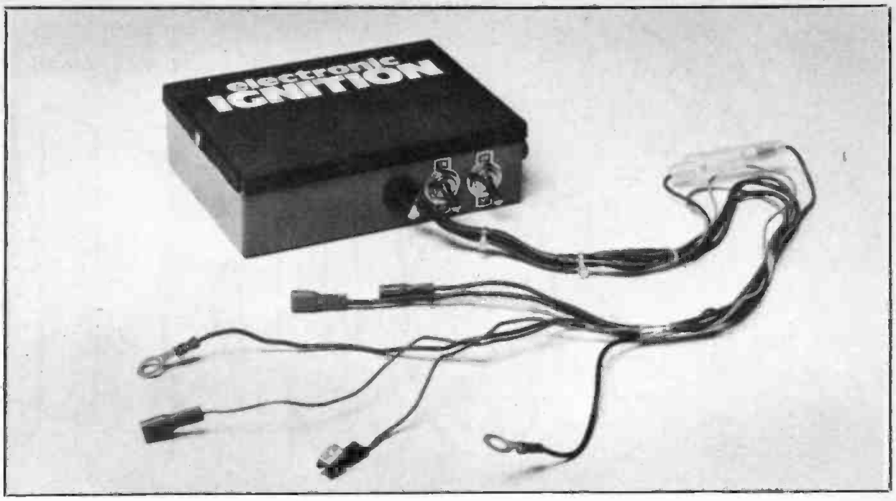
Should no ballast resistor be fitted, as on many older models, this lead is connected to the same terminal on the ignition switch as the red lead.

The purple and brown leads are connected to the positive and negative terminals of the coil respectively and the grey lead is connected to one side of the contact breaker points in the distributor. The black lead must be firmly bolted down to the bodywork of the car to ensure good chassis contact.

Finally, remove any suppression capacitors (condensers) from the coil as they will affect the operation of the unit.

When the ignition is fitted and wired it is suggested the distributor, rotor arm, and ignition leads are cleaned and checked. There is no point in producing 30kV only to throw it away! It has also been found advantageous to open the spark plug gap, in the case of the author's car, to 40 thousands of an inch.

Now comes the greatest test; will it work on the engine? First just switch on the ignition and check if the high pitched whine can be heard. Then start the engine which should catch first time. A test drive should show an immediate improvement in acceleration, however it may also be found that a slightly weaker petrol mixture is in order.



Finished unit with all wire terminations shown

PERFORMANCE

Once the unit is fitted to the car an all round improvement in performance will be found. The most stunning is starting, especially when the car is left out in severe winter weather. The author's car is purposely left out in the elements and always starts first time and has seen as much as a 20 per cent improvement in fuel consumption, but the figure of 6 per cent is closer to reality but even this is a saving of about £20 per year for the average motorist.

The savings don't stop there either, as spark plug life is extended due to the fast rise time (30μS). The only wear on the points is now mechanical so its life should virtually outlast the cars.

The strain on the battery and starter motor is also greatly reduced, in fact once the unit is fitted you wonder how you ever managed without one!

None of the components are critical, values can be changed by 20 per cent without effecting the performance greatly. Virtually any general purpose diode will do for D3, 8, 9, and for D4-D7 any 1 amp 800 p.i.v. diode will suffice. Again, any medium power *npn* silicon transistor will work in place of TR3. The gauge of wire for T1 is not too critical, only the turns ration should be kept constant.

LETTERS

I have discovered a method of making printed circuit boards to take i.c.s by using only a Dalo etch resist pen, which I would be grateful if you would pass it on to your readers via the *Letters* page.

I am sure that this method of making p.c.b.s to take i.c.s will be of great use to those readers who, like myself, can only afford a Dalo etch resist pen and thus cannot use transfers.

First clean the board in the normal way with wire wool. Then cut a piece of 0·1 inch matrix Veroboard or matrix board, 4 holes wide, and a few holes longer than the i.c. you want to use.

Place this over the spot where the i.c. is to be mounted, clamp the "sandwich" in the vice and fit your hand-drill with a $\frac{1}{32}$ inch bit. Using the Veroboard holes as a guide, drill the p.c.b. board with the required number of holes, and take it out of the vice.

Now poke the tip of the Dalo pen vertically into each of these holes in turn, wiggling it about a bit each time. A narrow ring of resist will be left around the outside of the hole. The rest of the tracks can now be filled in the normal way.

C. G. Bulman
Droitwich, Worcs.

Buffered CMOS Explained

May I bring to your attention an error which is repeatedly perpetrated in your pages, in particular in your reply to a letter published in your August issue. I refer to logic integrated circuits belonging to what is commonly known as the CMOS family.

The term buffered applied to these i.c.s implies that there is an amplifier, usually consisting of two *p*-channel MOSFETS and two *n*-channel MOSFETS, interposed between the output of the logic circuit and the output pin of the i.c. This is a desirable feature and is incorporated in the RCA COSMOS and the Mullard LOCMOS devices.

The buffer amplifier serves to give the i.c. a lower output impedance which allows faster operation of the i.c.s as the low impedance charges wiring capacitancies faster, provides greater output current capability (useful for driving l.e.d.s for example). Also in cases where the input voltages to the logic gates are changing slowly, the extra voltage gain provided by the buffer causes the output voltage to swing more cleanly between the logic 1 and logic 0 levels.

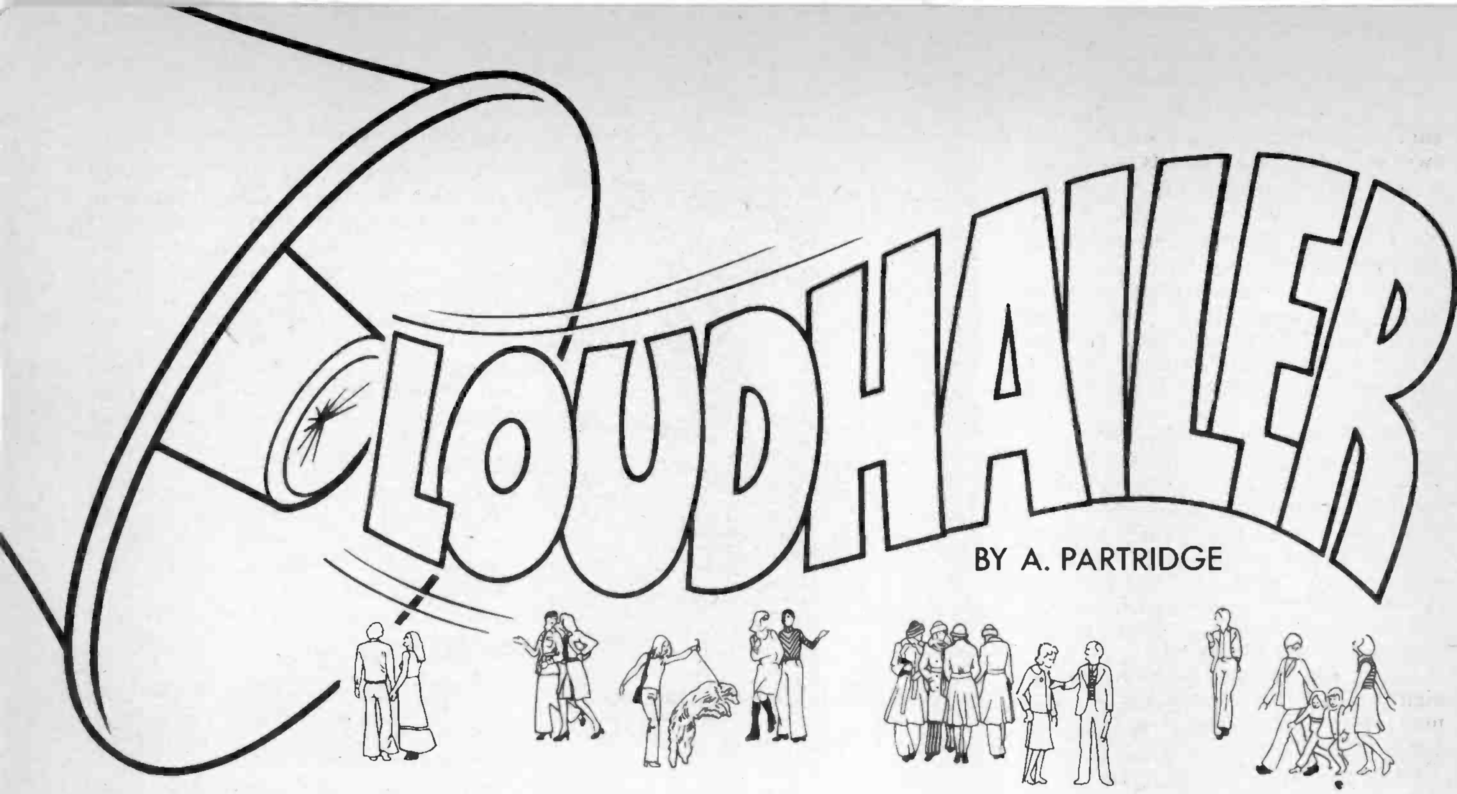
Static protection of pins is entirely different. The inputs of the Mullard LOCMOS range are protected from excessive voltage by two clamp diodes and a resistor.

Personally I prefer unprotected types, since when these i.c.s are used in non-logic applications such as oscillators for example, the protection circuit clamps the input to between 0V and the full supply voltage, affecting circuit operation, whereas no damage to the i.c. would in fact result if the gates of the internal MOSFETS were allowed to attain potentials of ±30V with respect to the MOSFET channels.

I hope this may be of use to you.

Peter F. Vaughan,
Lynton, Devon.

We certainly made a bloomer when replying to Mr. Robson, Readers' Letters, *August issue, and thank Mr. Vaughan for bringing this to our attention and fully explaining the meaning of "buffered CMOS". We apologise to our readers for this mistake.*



BY A. PARTRIDGE

A MEGAPHONE or loudhailer is always a useful instrument to have at fêtes rallies, carnivals and shows.

In this article we describe the construction of a simple megaphone suitable for many applications where the cost of a commercial unit cannot be justified. The output power of 1W is somewhat limiting but enables the unit to operate for long periods from small, low capacity batteries.

Use of an integrated circuit audio amplifier simplifies construction, reduces cost, and eliminates any setting up adjustments.

A significant cost saving may be implemented by the use of a home-made horn speaker. An off-the-shelf horn speaker unit will of course work perfectly well but we found the home-made type to be quite adequate, particularly with the relatively low power of the amplifier.

CIRCUIT DESCRIPTION

The circuit of the Loudhailer, based around the LM380N amplifier, is shown in Fig. 1. The signal from the microphone, MIC 1, is fed via the volume control potentiometer, VR1, to a single transistor preamplifier stage consisting of TR1.

Any r.f. pick-up from the microphone is filtered out at the output of the preamplifier via the R-C network R5 and C3, and the signal is then coupled to the input of the power amplifier, IC1, by C2. As previously mentioned this amplifier is an LM380N integrated circuit and is wired as a non-inverting type with the inverting input connected to ground.

The output from IC1 is coupled to the speaker through C5, a d.c. blocking capacitor whilst the R-C network R6 and C7 has been added to the output to improve the i.c.'s stability under certain load conditions.

PUSH-TO-TALK SWITCH

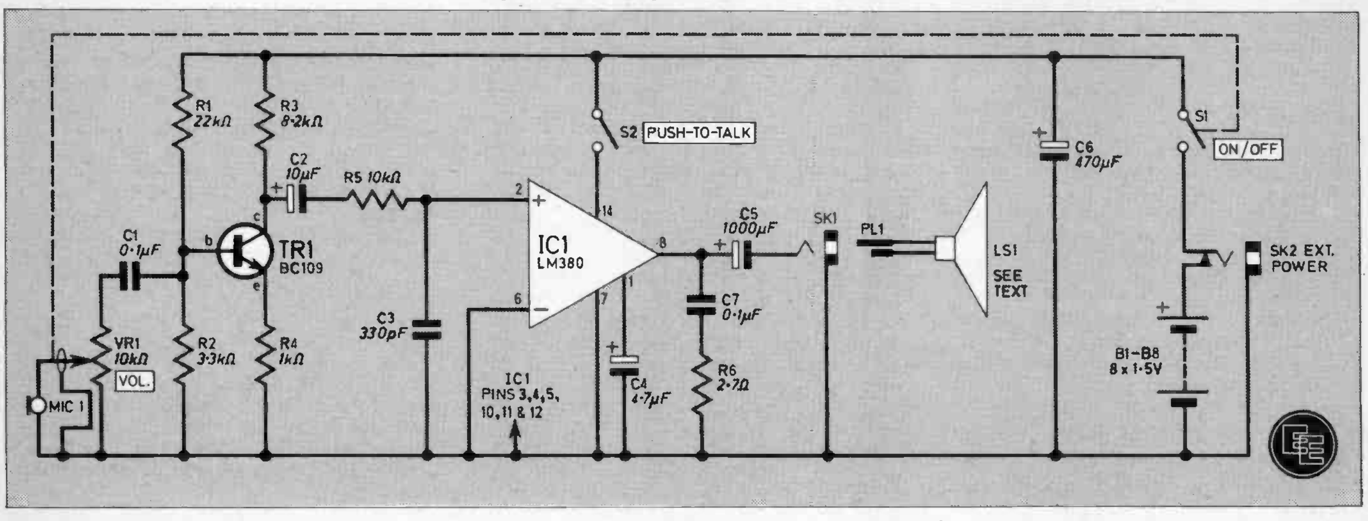
So far nothing has been said about the unusual position of the push-to-talk switch, S2.

Normally a push-to-talk switch would be wired in series with the supply. However, there was found to be a five second delay before the loudhailer became operational after switch-on.

This delay is due to the capacitors in the preamplifier requiring time to charge and preventing the full signal from reaching the power amplifier. The solution is to keep these capacitors "powered up" and so S2 switches off the main amplifier, IC1, but not the preamplifier. Therefore, a second switch (S1) to disable the entire circuit was included, being part of the volume control VR1.

Since the current drain when S2 is off is in the order of 2mA, it should not prejudice battery life during

Fig. 1: Circuit diagram of the Loudhailer.



short periods of non-use with S1 left switched on. On the prototype S2 was a non-latching toggle switch mounted in the base of the box just in front of the handle so as to act like a trigger when in use.

MICROPHONE

It was decided to use a readily available dynamic cassette type microphone for the input.

The microphone can be a dynamic insert or a salvaged cassette microphone with the "business end" cut off and glued to the box with epoxy resin, as in the prototype. If purchasing a microphone for this purpose, make sure that it has a unidirectional response so that acoustic feedback will not be a problem. Electret microphones are not suitable for this unit.

Power for the unit is supplied by eight 1·5V batteries and provision is made for an external power source (such as a 12V car battery) via SK2. This socket must be of the switching type so that the internal battery pack is disconnected when external power is being used. The power supply rail is decoupled by capacitor C6.

COMPONENTS

It is suggested that before construction commences, the constructor has to hand all the parts for this project. The layout of the parts within the box is of necessity tight and the constructor is advised to buy carefully with this in mind.

In some cases it may be found necessary to use a different layout to that shown or use a slightly larger box.

CONSTRUCTION starts here

CIRCUIT BOARD

Begin work on the circuit board by cutting a piece of 0·1 inch matrix stripboard to the correct size with a fine hacksaw.

Remember that the size of your board may vary slightly from that illustrated in Fig. 3, this again will depend on the size of the box chosen. It is a good idea to check the fit of the board in the box before any components are mounted on it.

Next make the breaks in the copper strips in the positions indicated. Assemble the components onto the board beginning with links and progressing through resistors, capacitors and the transistors, leaving C5 until last, this being mounted on the reverse side of the board.

The completed prototype employing a commercially available horn unit.

Before IC1 is installed its heatsinks must be fitted. The heatsinks are made from thin copper sheet, the dimensions of which are shown in Fig. 5 and are soldered to pins 3, 4, 5 and 10, 11, 12 of the i.c. as illustrated.

Great care must be taken to prevent any solder shorting out any other pins and the soldering iron must not be held on the i.c. legs for too long. It helps to "pre-tin" the tabs on the heatsinks to aid the flow of solder for this operation.

The i.c. can now be fitted into the board, ensuring that it is correctly orientated.

The flying leads may now be wired to the board to connect to VR1, S1, S2 and the speaker socket, and the board can be put aside while the box is prepared to take the remaining parts.

CASE

The case used in the prototype to hold the circuit board, batteries and other parts, and to support the horn speaker, was a standard plastics box with an aluminium lid and measuring 130×70×40 mm. Moulded slots inside the box held the circuit board in position, but self-adhesive board guides may be used instead.

The horn speaker is attached to the removable aluminium lid of the box, while the microphone is mounted at one end. The other end houses the on/off volume control, the push-to-talk toggle switch and the two jack sockets SK1 and SK2 (see Fig. 6).

When buying the box ensure that it will accommodate the battery holders and is rigid enough to support the horn speaker.

HANDLE

A loudhailer is a portable device and must be easy to hold, a balanced handle with a good grip is essential.

To this end a moulded bicycle handgrip, pushed over a length of 20mm dia. dowel (of the type used for broom handles) was used as a handle for the prototype. The handle is angled forward by 15 degrees from the vertical and is mounted towards the front of the box to balance the mass of the speaker against that of the batteries. (See Figs. 4 and 6.)

The handle is held in place with a single large woodscrew with a large washer under the head to prevent it pulling through and damaging the plastic base of the box.

HORN SPEAKER

Commercial megaphone designs use a horn speaker which is specially made and an integral part of the device. In a home-made loudhailer the same neat result can be a little more difficult to achieve.

The prototype used a 140mm horn speaker and this was mounted directly on top of the box. This speaker is intended for permanent, fixed mounting and is in consequence quite heavy. Horn speakers are also expensive so for those on a tight budget, a home-made horn speaker can be made from a domestic plastic funnel and a small 76mm diameter transistor radio type speaker.

The home-made horn speaker shown in Fig. 2 is lightweight and costs very little. The speakers found in transistor radios have no difficulty coping with the power force from the loudhailer and the home-made speaker sounds similar to a ready-made one. The only disadvantage of this speaker is that it is more prone to acoustic feedback and limits the maximum volume available from the loudhailer.

In order to reduce this feedback, the speaker must be mounted into the the funnel with a flexible gasket. We found that a length of extruded grommet strip of the type used for irregular holes is ideal and this must be securely glued in place. (The connecting cable having first been soldered to the speaker terminals and fed through the "pointed end" of the funnel.)

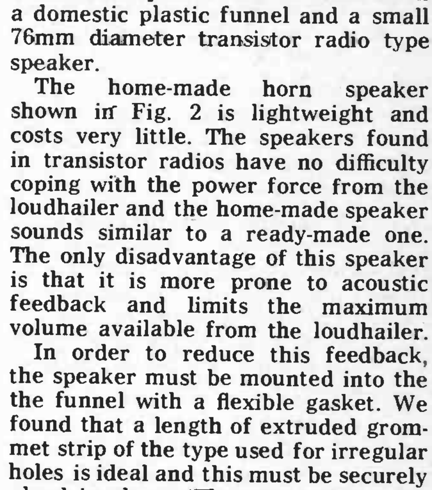
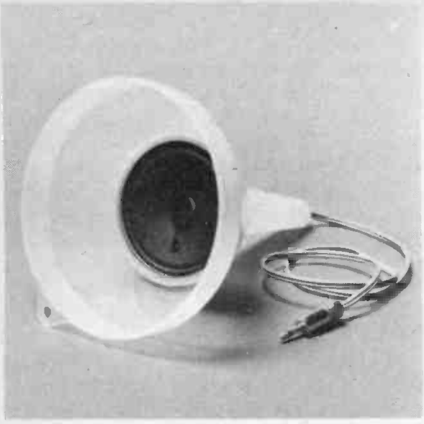


Fig. 2. Home-made version of the horn speaker showing a suggested method of mounting.



The home-made version of the horn speaker.

COMPONENTS

Resistors

R1	22kΩ	R4	1kΩ
R2	3·3kΩ	R5	10kΩ
R3	8·2kΩ	R6	2·7Ω

All $\frac{1}{4}$W carbon ± 5%

See Shop Talk page 737

Capacitors

- C1 0·1μF polyester
- C2 10μF 16V elect
- C3 330pF ceramic
- C4 4·7μF 16V elect
- C5 1000μF 16V elect
- C6 470μF 16V elect
- C7 0·1μF polyester

All electrolytic capacitors are single ended types.

Semiconductors

- TR1 BC109 silicon *npn*
- IC1 LM380N audio amplifier 14 pin d.i.l.

Miscellaneous

- LS1 140mm dia horn speaker, 8Ω (see text)
- VR1/S1 10k lin. carbon potentiometer with integral on/off switch
- S2 s.p.s.t. momentary action toggle
- SK1 3·5mm chassis mounting jack
- SK2 3·5mm chassis mounting jack, switched
- PL1 3·5mm jack
- MIC1 Dynamic microphone insert or cassette microphone (see text)
- B1-8 'AA' size 1·5V cells (8 off)

Stripboard: 0·1 inch matrix, 23 holes × 14 strips; 4 × AA size battery holder (2 off); knob for VR1; plastic box with aluminium lid—130 × 70 × 40mm; 20mm dowel and moulded bicycle hand grip for handle; copper sheet for heatsink; mounting hardware for handle and speaker; connecting wire; screened cable.

Approx. cost Guidance only £12 excluding speaker

FINAL ASSEMBLY

The box, having been drilled to take the remaining parts, mount VR1, SK2, S2, the microphone and the handle. In the prototype the battery holders were a firm push fit in the box and consequently required no other mounting arrangements. Other styles of battery holder may require fixing and this will have to be taken into account.

Switch S2 is specified as a momentary action toggle switch as this type of switch can be conveniently mounted inside the box in front of the handle and operated by the forefinger. If a pushbutton or lever operated microswitch is substituted for S2 it may have to be mounted externally on a bracket if the loudhailer is to be one-hand operated.

Fixing arrangements for the horn speaker will also vary so this is left to the constructor.

Slot the circuit board into the box and solder the flying leads to their various destinations. Also complete the wiring between S1, the external power socket and the batteries and between VR1 and the microphone. (See Fig. 6.)

If the external power socket SK2 is omitted then the positive battery connection should be wired directly to S1.

In the prototype the wiring to the microphone was made with shielded cable to avoid stray pickup or interference. Fit a jack plug to the lead from the horn speaker to mate with SK1 and the unit is ready for testing.

TESTING

Testing of the completed unit is best carried out with the lid of the box removed to observe any possible signs of distress. Before the unit is first switched on, a final, comprehen-

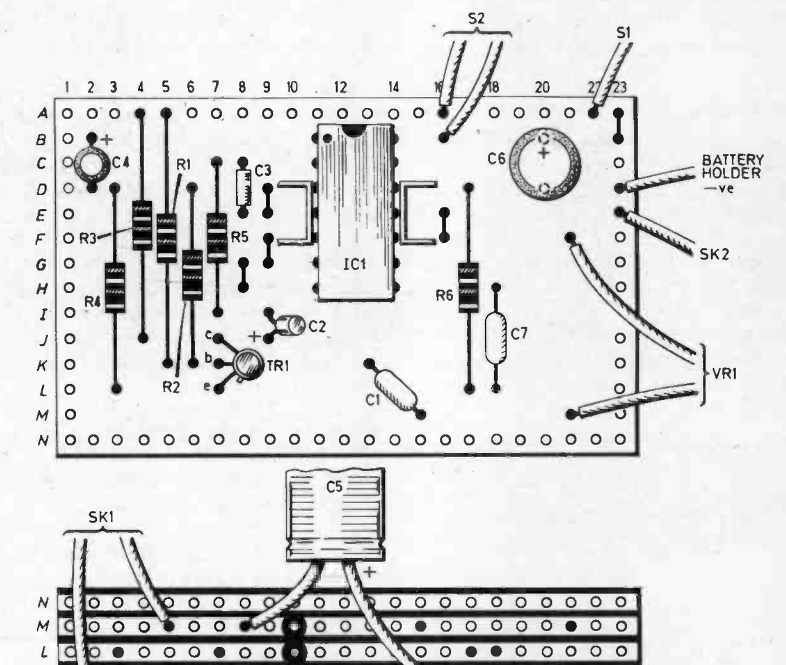


Fig. 3. Stripboard component layout showing trackbreaks on underside view. Note that C5 is mounted on underside of board.

LOUDHAILER

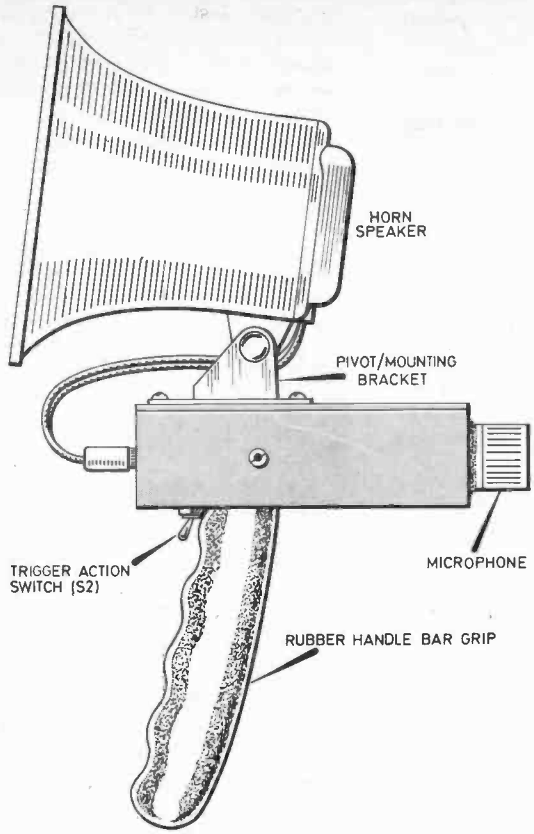


Fig. 4. Completed Loudhailer.

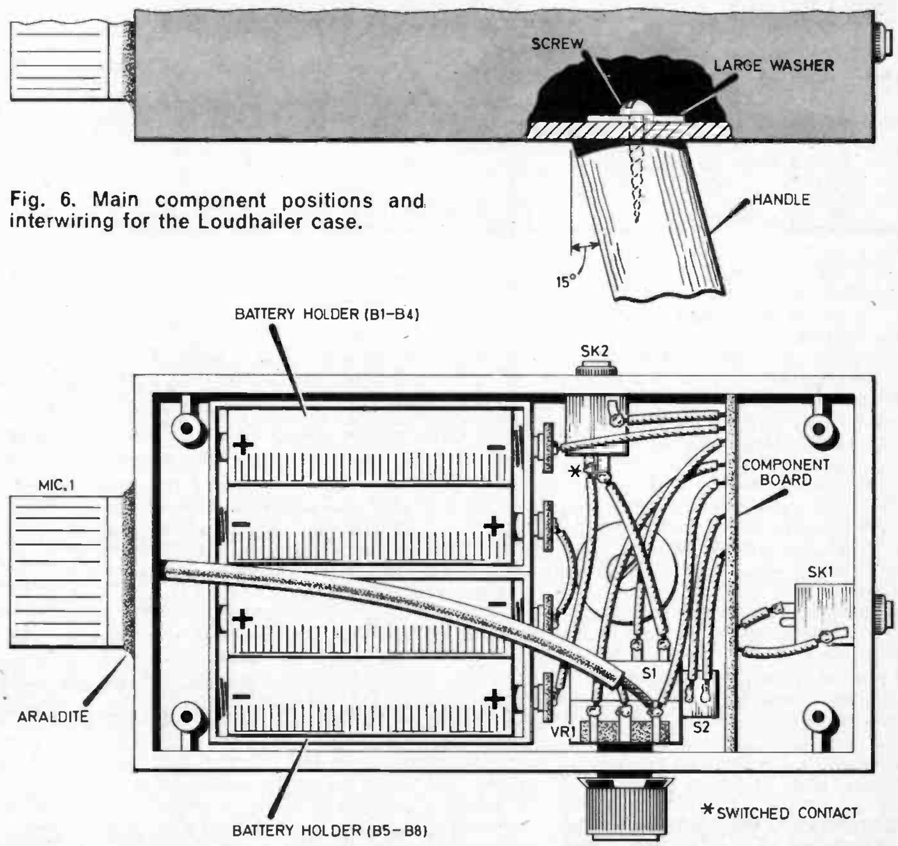


Fig. 6. Main component positions and interwiring for the Loudhailer case.

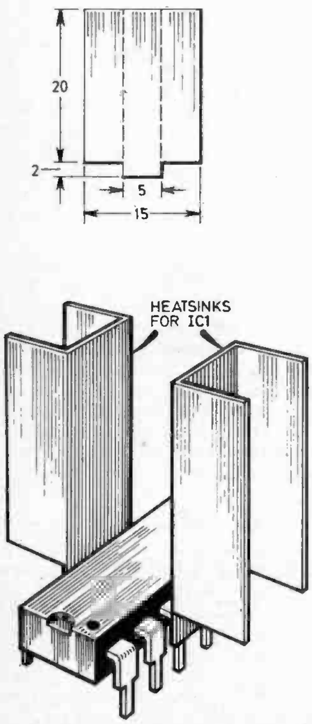


Fig. 5. Heatsink details for IC1.

sive check of all wiring is advised in case any faults are present.

Be absolutely sure that the battery polarity is correct or the i.c. and transistor may be destroyed at switch-on.

Now with VR1 "off" and S2 not activated, insert the batteries into their holder and plug in the horn speaker of your choice.

Switch the unit on at VR1 and wait for about five seconds. Now with VR1 set to minimum volume, activate S2 and if all is well a gentle "click" will be heard from the speaker. If you are blasted by a loud howling, the outer terminals of VR1 are probably connected in reverse, meaning the volume will be at its maximum setting.

All being well with this test, slowly rotate VR1 clockwise and speak into the microphone. You should hear your voice from the horn speaker, the volume dependent upon the setting of VR1.

At some volume level the unit will begin to howl. This is the point at which acoustic feedback occurs and will vary according to the surroundings. The howl can be stopped by turning down the volume or by shielding the microphone from the sound from the speaker.

At this stage the external power socket may be tested for correct operation, if fitted. Connect a 12V supply to a suitable plug, making sure of polarity—tip positive in the prototype—and insert the plug into SK2. The unit should operate as before.

IN USE

For normal operation, switch the unit on at VR1 and use S2 as a push-to-talk switch. As previously mentioned, the prototype draws less than 2mA when S2 is off, so S1 can be left on but it is recommended, though, that the unit be switched off at VR1 when long periods of non-use are anticipated.

Earlier, the subject of acoustic feedback was touched upon. If this is a problem even at low volume levels, it is possible that vibrations from the horn speaker are reaching the microphone through the box. In this case, it will be necessary to isolate the microphone from these vibrations by mounting it in foam or some other 'floating' mount. Alternatively, or in fact, in addition to, a mat of dense cork or rubber may be sandwiched between the base of the speaker mount and the box.

Finally, please remember that loud noise in the wrong place and at the wrong time, can be regarded as a form of pollution. Don't give yourself and other users of public address equipment a bad reputation by using it to infringe upon the rights of others. ⌑

Mature Advice

As you begin to mature in years and the first hint of grey adds a touch of distinction to your appearance, you are assumed to have knowledge and more important still, wisdom. It is at this point that people seek your advice and while it is flattering it also brings responsibility.

Let me give you two examples of this. First at the top end of the scale. A few years ago a firm of components distributors, who were, and still are almost a household word, asked my partner and myself out to lunch and before we reached the main course it was clear what they were seeking was guidance.

In effect they said, "Every year our shareholders expect us to increase our profits, the only thing we haven't tried is the retail market, what do you advise? If we do go ahead we shall buy you out and keep you on as managers".

They didn't expect an immediate answer but rang me up a fortnight later. What I told them was this, "You are one of the most efficient firms in the business, if you do go ahead, you will make a profit, but after a year or two you will be so appalled how small it is that you will wonder if it was worth the trouble". They thanked me for my trouble and said they had come to the same conclusion themselves.

The final outcome of this story was less satisfactory, because about three years later they did go into the retail trade, ran it for three years and then got rid of it. Why they decided to ignore my advice I shall never know, unless they thought I was telling them a yarn to prevent competition!

Coming now to the bottom end of the spectrum, I had a reader who told me he had recently been made redundant, and was wondering if he should use part of his redundancy money to start a components shop. He was asking my advice on something which to him was crucial, and I felt I had a greater responsibility in replying to him than the previous individuals mentioned. I told him I wished to be as helpful as possible, but it would take a twenty-page letter to begin to do justice to his question. I pointed out that the last thing I wished to do was to deter him, and that his idea was feasible, even at the present time. Only the previous day that entrepreneur extraordinary, Clive Sinclair, said in an article, that a recession was the ideal time to start a new business, and he gave sound reasons for saying it.

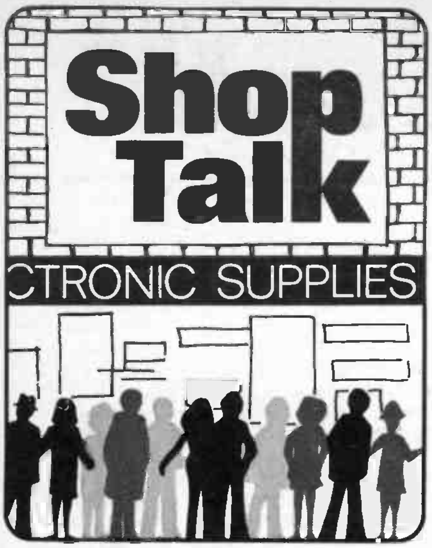
However, I did warn our reader to approach the idea with extreme caution and not to commit all his reserves in case the worst should happen.

More Fun

Several years ago an Uncle of mine asked me to make him a stereo radiogram. I was very pushed at the time so I bought a set of those Mullard Modules, which I knew were excellent, and a turntable and pickup. A friendly carpenter did the rest, my Uncle was delighted with it and in his estimation, next to me Doctor Moog came nowhere. However, when you analyse it, what did my achievement prove? Simply that I was capable of putting a series of coloured wires in numbered holes and screwing them up.

I thought of this the other day when a friend of mine said he was giving up constructing. I asked him why and he said, in the old days when you could take a dozen or so discrete components, you really felt you were making something worthwhile and learning about electronics at the same time. Now you take a couple of i.c.s join one numbered tag to another and achieve the same result, but all the interest and the fun is gone and nothing is learnt from it.

It is quite a problem because a magazine like EVERYDAY ELECTRONICS has to offer a range of projects to suit all abilities, from the raw beginner, who, if he joins two transistors together and gets results is over the moon, to the University graduate who wants to build a complicated piece of test gear. I am concerned, that in order to be in on the latest discovery, projects will become more complex, use more i.c.s until the whole fun of building is gone. After all, it would be a shame if we damaged our hobby by being too clever.



By Dave Barrington

Choosing a Soldering Iron

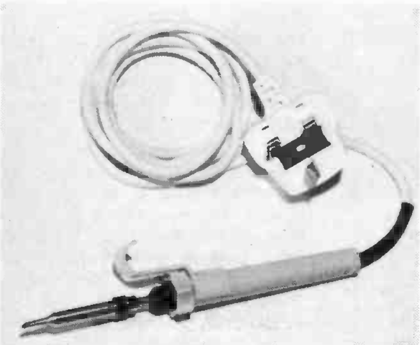
Probably one of the first and most important items the newcomer to electronic construction should purchase is a soldering iron. Fortunately the standards set by British manufacturers are very high and the chance of buying a "rogue" iron is almost nil.

There are quite a few irons on the market to select from and choice will finally be dictated by one's pocket. However, we recommend that a little extra outlay now will more than pay for itself in the years to follow. They can range from no temperature control to fully electronic control of bit temperatures.

To emphasise the comments in this months *Square One* page, an iron rated between 15 and 25 watts is adequate for nearly all projects published in EE. For bit sizes we would suggest a selection of 1·6, 3 and 4mm preferably of the long life iron plated type.

Try to choose an iron that is well balanced, easy to handle and has an adequate length of mains cable. Also, make sure you choose an iron with an anti-roll handle. This can take the form of a hook or a many sided "collar".

If not supplied with the iron, we recommend the purchase of a protective stand. These usually take the form of a protective metal coil fixed to a weighted base. Incorporated in the base is usually space for spare bits and a tray with a wiping sponge for "cleaning" the iron tip.



The Antex CS soldering iron.

Another useful aid to soldering, or in this case desoldering, is "solderwick" or desoldering braid. As the name implies the "wick" is immersed in the molten solder which is drawn up the wick leaving the joint free from solder. Stocked by most advertisers, it is certainly worth keeping a small supply in the workshop.

It has been our experience that the most popular irons have been the British manufactured C and X series from Antex and the Litesold L series.

The Litesold L series from Light Soldering Developments are only available direct. The heating elements are enclosed in a stainless steel shaft and insulated with mica and ceramic. It is claimed that the bits will not "seize-up" and are completely interchangeable.

The latest Antex CS and XS miniature irons are fitted with a fused, moulded 3-pin mains plug and are rated at 17 and 25 watts respectively.

Apart from the interchangeable bits the irons feature a detachable hook-cum-finger protector.

Catalogues Received

Only two new catalogues have been received this month, but both are excellent examples of how a components catalogue should be presented to customers.

Well renowned for their special "bargain paks", it is only when you flip through the new large size 64-page components catalogue from Bi-Pak that you realise the range of devices and products stocked. These include aerials, cases, wires and cables, meters and p.c.b. accessories.

Some 21 pages are devoted to semiconductor and opto devices. Of these four contain transistor technical data.

The catalogue is lavishly illustrated, costs £1, (which includes 25p postage and packing) and is available from Bi-Pak, Dept EE, P.O. Box 6, Ware, Herts SG12 9AD.

The inclusion of approximately 20 new additions may not appear to be very many, but when you consider there are already 144 pages crammed with products in the latest Verospeed catalogue it must become hard to find new items for inclusion.

The catalogue is excellently illustrated, and the use of colour to indicate important information, such as component title, order code and price, seems a good innovation. They also claim a same day despatch service, on orders received before 3 p.m.

Copies of the 12th edition Verospeed components catalogue can be obtained from Verospeed Ltd, Dept. EE, Stanstead Road, Boyatt Wood, Eastleigh, Hants SO5 4ZY.

CONSTRUCTIONAL PROJECTS

Experimental Crystal Set

Readers should have no problems in selecting a tuning capacitor (C1) for the *Experimental Crystal Set* as practically any air spaced type valued at 350pF, 365pF and 500pF will suit.

If an aerial tuning capacitor C2 is going to be incorporated, then one of the mica dielectric compression trimmers could be used. This could range from 10 to 110pF or 20 to 250pF, the latter range would be preferable.

We understand that Home Radio are able to supply a suitable compression trimmer with a special spindle converter to enable a control knob to be used with the aerial capacitor.

Most component advertisers should stock the wire for the tuning coils, however if any readers experience difficulty then Industrial Supplies and The Scientific Wire Co., should be able to help. Their addresses can be found under our classified advertisements section.

The choice of mono headphones is left to individual taste, but they must be at least 2 kilohms impedance. This is quite a common value and available from most component suppliers.

Loudhailer

All components for the *Loudhailer* project are readily available items and should not prove difficult to purchase.

Practically any plastics case with an aluminium lid will suffice for housing the components. The reason for calling up a case with an aluminium lid is because of the need for additional strength to take the horn loudspeaker.

One of the many ABS plastics cases with an aluminium lid or one of the ever popular metal diecast boxes would appear to be most suited for this project.

It may be necessary to order a larger case as the only ones we have located measure approximately 161 × 96 × 59mm and 150 × 80 × 50mm respectively.

One of our Advertisers, J. Bull Electrical offers a 5in horn speaker on a swivel base that seems tailor made for the job. Originally intended for car use, it costs £5·85 inc. p & p and is rated at 8 watts 8ohms.

Electronic Ignition

The only components likely to cause concern in the *Electronic Ignition* are the ferrite cores, bobbin and the thyristor.

The only source of supply we have been able to locate for the thyristor type TAG1/600 is Maplin Electronic Supplies.

The ferrite pot cores (type FX2243) and bobbin seem to be only stocked by GMT Electronics, Dept EE, PO 301, Hampton Street, Birmingham B19 3JR.

Simple Infra Red Remote Control

The relay called up for the *Infra Red Remote Control* is available from Maplin Supplies and should be ordered as HY20W. However, practically any 6/12V relay having a coil resistance of 185ohms or more can be used, with contacts to suit the final application.

The LD271 infra-red l.e.d. is quite common, but the SFH205 infra-red photo diode would appear to be only available from Watford Electronics.

Pressure Mat Trigger Alarm

The TLO82CP twin op-amp integrated circuit used in the *Pressure Mat Trigger Alarm* is available from Watford Electronics. The CA3240E and the LF353 are possible alternatives but neither of these devices have been tried.

There appears to be only two sources of supply for the pressure mats and these are available from J. Bull and Maplin.

We understand that J. Bull supply two sizes of pressure mat. As two mats are called for in this project they are prepared to supply them at a special price of £5 for the large size and £4 for the smaller size. The price for one-off mats is £2 and £1·50 plus VAT respectively.

Everyday News

ORACLE WORLD FIRST

The world's first commercial teletext service is being inaugurated by Oracle Teletext Ltd, a new company jointly owned by all the ITV companies, and coincides with this month's Government's National Teletext Month.

The most important technical development is the addition of two further broadcasting lines to Oracle's transmission. This will effectively halve its present access time and, more importantly, will make regionalisation of the service possible.

The first of the regional areas will be Scottish Television, followed by Channel TV. Oracle hope to expand into a fully regional service by 1984-85, providing for local advertising as well as news and information services.

Would-be advertisers are offered two basic types of advertisement. A Fractional Page, one or two lines at the bottom of an ordinary information page, for £300 per week if he chooses the placement of the message, or £200 if choice is left to the producer. A Whole Page can cost up to £400 per week.

For extending messages a "rolling pages" facility is available. Clients booking whole page automatically get a fractional page and space in an advertisers index.

System-X On Stream

Britain's first System X all-electronic local telephone exchange is now successfully in full-time public service.

The exchange is initially providing telephone service to about 1,000 customers in Woodbridge, Suffolk. It has been carrying test calls since January, as part of a planned commissioning programme that has brought the exchange "on stream" earlier than originally planned.

The Woodbridge System X unit will be extended to serve up to 6,000 customers and provide new services, such as code calling and automatic call diversion. These are called "star" services.

Viewdata in Moscow

The Moscow Hospital Authority and Stankoimport (a Russian machine-tool trade agency) are now using private Viewdata Plus R800 systems supplied by Rediffusion Computers.

Other systems have been installed in Czechoslavakia, Malaysia and Ireland and exports are now approaching £2 million in value.

Long-distance look

British Telecom Research is developing a long-distance low-cost TV surveillance system. This will enable distant scenes to be viewed over ordinary telephone lines.

A slow-scan technique is used in which the TV field from the camera is digitalised, stored and transmitted at slow rate, then reconsti tuted at the receiving monitor. High sensitivity Cotron 'Guardsman' cameras provide see-in-the-dark capability.

INTELSAT GROWTH

There are now some 300 ground terminals in 140 countries and territories locked in to the Intelsat international satellite communications network. Its spacecraft in orbit now handle about two-thirds of the world's total trans-oceanic communications.

Two more earth terminals have just been ordered from Marconi for Hong Kong, bringing the number there to four. All the Hong Kong "dishes" are designed to withstand wind speeds of 210 mph experienced in typhoon conditions.

CMOS LINK

Rival firms Marconi Electronic Devices and Plessey Semiconductors are to swap technical know-how and second-source each others CMOS products in a joint bid to attack the CMOS gate array market.

For a start the two research teams at Caswell (Plessey) and Hurst Research Laboratories (MED) will operate in parallel.

MICRO BOOST

Scotland is retaining its popularity as a European base for i.c. manufacture. Building work has commenced at the £40 million plant for Nippon Electric Company at Livingston, and Motorola is to invest £60 million in extensions at their existing site at East Kilbride.

In hybrid microcircuits, Smiths Industries has invested £1·5 million in expanding its Micro Circuit Engineering subsidiary, British Aerospace Dynamics has opened a new £1 million laboratory at Stevenage, and ITT has invested £1 million at Great Yarmouth on extensions to bring together both thick and thin film operations at a single site.

In Agreement

A new agreement has just been signed with the Hong Kong Government in which Cable & Wireless has a franchise to operate and manage the country's external telecommunications for another 25 years. A new similar agreement has also been reached with the Barhain Government.

At home C & W is involved in a consortium with BP and Barclays Merchant Bank to set up a trunk digital data network between major cities and trading centres based on optical fibre and microwave technology.

Bristol has been chosen by Hewlett-Packard as the best site in Europe for a £25 million investment in R & D labs and a production unit for magnetic disc memories. About 1,300 people will be employed by 1986 with a possible expansion to as many as 8,000 people by the 1990s.

OPEN DAY FOR DISABLED

The Manchester branch of the British Computer Society's Disabled Group are holding an "Open Day for the Disabled" at the National Computing Centre, Manchester, on Saturday, October 24, 10 a.m. to 4 p.m.

The "Open Day" will consist of exhibitions and talks to demonstrate the valuable work of the disabled in computing. Help and guidance will be on hand for the disabled person who seeks to make a career in the computing industry.

OVERSEAS NEWS

WAGGON TRAIN

West German Federal Railways have bought British-developed software for computer management of rail freight movement throughout the Federal Republic.

The central data base stores all the information on up to 200,000 individual waggon movements every day from inputs from more than 4,000 data terminals.

Labelled Programmes

German engineers are thinking of labelling radio programmes broadcast on V.H.F. into groups such as pop music mood, concerts or news. This would be achieved by adding a supersonic tone to each type of programme. At the receiving end you would press a button for the type of programme required and the receiver would search for the selected type.

Another variant is to programme the receiver on a music programme to a volume level of "background" with the receiver reverting automatically to normal room volume when the news comes on. The same idea would be valuable in a car to alert the driver to traffic news without having to adjust any controls.

Bilingual Stereo

A novel feature of the multi-channel sound system available to West German TV viewers is that it can be used for stereo sound and for bilingual transmission. Thus; in the case of an English language film the viewer can select on the sound channel either the original English sound or a dubbed German version.

When not used for bilingual transmission the system operates in stereo sound.

REALISM

The new ship-handling simulator being installed at the University of Wales Institute of Science and Technology, Cardiff, will be used as a research tool as well as for the training of ships' officers.

It includes a full-scale ship's bridge and is the first in the world in which all visual scenes from the bridge windows are generated entirely by computer using the Marconi Tepigen system.

—ANALYSIS

UNITED KINGDOM LTD.

In an open society with free speech anyone can say almost anything. Freedom of expression is inherently good but is open to abuse, not so much by outright falsehood which is often obvious, but by propagation of half-truths or distortion. Thus, in periods of economic depression there is always the tendency, especially so in political debate, to exaggerate policy failure of one's opponent and, conversely, to minimise success.

The general impression soon gets round that UK industry and UK trade is a flop. We seem to have a habit of talking ourselves into depression. True there are some flops, just as in any race there are winners and also-rans. But why should we always be moaning about losers when we could be boasting about winners?

In 1980 UK Ltd as a trading nation exported £4,126 million of equipment and services in the electrical engineering sector, some 37 per cent of all sales. If we take separately the so-called electrical machinery sector, the one that includes electronics and telecommunications, we exported 48 per cent of all sales. Sure, electrical engineering and electronics are struggling, but only in coping with all their present work and ensuring an even more prosperous future.

I only have room to quote one example but it's a cracker. A single order worth £550 million for construction of a huge power station in Hong Kong won by UK Ltd against international competition. It will be among the largest in Asia generating 2,640 megawatts of power. Main contractor is GEC with a host of sub-contractors throughout the UK, supporting employment stretching over six or even seven years. Although the big items are the boilers (by Babcock) and turbine generators (by GEC) there will be a huge electronic content in process control and instrumentation.

Why do we not talk more of 450 UK engineering companies operating in 120 different countries and currently handling £40,000 million worth of business? Hardly a nation of has-beens although some slick talkers would have us believe so.

Brian G. Peck.

Electronic Car Park

Access to car parks on a new housing estate in Amsterdam is electronically restricted to residents using EMIDATA magnetically encoded cards which open and close the entry and exit barriers. Cards are changed monthly and the system will reject any attempt to use the same card for parking a second car, thus foiling multiple use.

The contract with EMIDATA is for supply of 7,000 cards a month for the next five years.

Videography

With video recorder sales world-wide now in millions, a new hobby of creative videography is developing fast and threatening the well-established home-movie hobby.

Principal advantage of video is instant playback of shots to check quality, and electronic editing, neither of which is available with cine film.

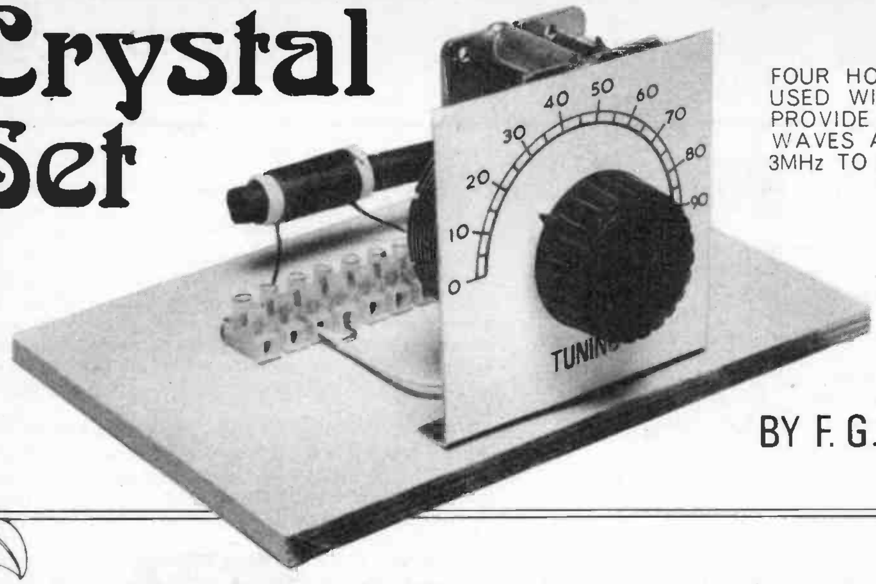
GEC's total turnover in 1980-81 hit a new record of £3,462 million. Electronics accounted for £1,235 million of the total and was £200 million higher than the previous year. GEC's exports have grown 20 per cent in the past year.

Correction Slip

We have been asked to point out that Technical Press have found it necessary to issue an errata slip for parts one and two of their "Electronics for the Service Engineer" books. Copies are available from Technical Press, Freeland, Oxford OX7 2AP.

EXPERIMENTAL MEDIUM WAVE AND SHORT WAVE

Crystal Set



FOUR HOME-MADE COILS CAN BE USED WITH THIS RECEIVER. THEY PROVIDE A COVERAGE OF MEDIUM WAVES AND SHORT WAVES FROM 3MHz TO 20MHz APPROXIMATELY.

BY F. G. RAYER

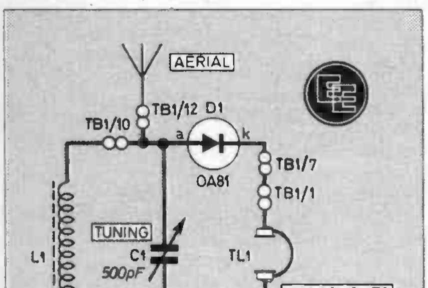
THE POPULARITY of the crystal radio arises from its simplicity, and the fact that it needs no power supply. The circuit here allows for easy experiments with tuning, aerial and diode coupling, and frequency coverage. Wrong connections can cause no damage to any components.

Such a receiver is generally used for long and medium waves, but short waves are also readily available. It will normally be possible to receive some overseas transmissions.

BASIC CIRCUIT

The basic circuit is shown in Fig. 1. The coil L1 may be air cored, or have a ferrite rod placed in its winding. Capacitor C1 (in conjunction with aerial-earth capacitance) tunes the circuit to resonate with the wanted signal, and the diode D1 "detects" or demodulates this, so that the programme is heard in the headphones.

Fig. 1. Basic circuit of the Experimental crystal set.



As will be seen, this basic circuit can be modified in various ways, to obtain improved results.

BASEBOARD ASSEMBLY

A 12-way strip connector, TB1, can be screwed down to a wooden baseboard, 165 x 130mm as in Fig. 2, to provide an easy method of joining up the components. Tuning capacitor C1 is bolted to a bracket of scrap metal which is then screwed firmly down to the baseboard. Thin wood screwed to the front edge of the baseboard would do instead. A knob with pointer is fitted to C1, and a scale is drawn and fitted behind this.

Except for C1, all connections are made by the terminals of the 12-way screw terminal block as shown in Fig. 2. Loosen the screws with a small screwdriver, insert the bared ends of the wires, and tighten the screws. The various locations on the terminal block, TB1, are also shown in the circuit diagram, Fig. 1.

AERIAL, EARTH AND HEADPHONES

Crystal receivers need a wire aerial, preferably some 25m long. If this is out of doors, high and clear of earthed objects, signals will be improved.

The earth lead can be run to a cold water pipe if you still have metal pipes, or better still to an earth rod or spike. Or it may be soldered to a bare metal can buried in damp soil. Stranded, insulated wire, or aerial wire can be used for aerial and earth leads.

INDUCTORS

The following four coils are suggested for initial use as L1:

Coil 1: Make a thin card tube to slide on a 10mm diameter ferrite rod, and on this tube wind about 105 turns of 32 s.w.g. enamelled wire, side by side. Secure ends with adhesive.

Coil 2: Make a similar coil to to coil 1 having about 15 turns of 24 s.w.g. enamelled wire on the card tube. Loops of cotton will help hold the ends in place.

Coil 3: Wind nine turns of 20 s.w.g. bare tinned copper wire on an object about 20mm in diameter. Remove and stretch to separate the turns, to obtain a coil about 25mm long.

Coil 4: Make a similar coil to coil 3, but with five turns.

Also have a ferrite rod some 60 to 75mm long. Coils 1 and 2 will enable medium waves and the longer short wave bands to be covered. Coil 3 covers about 3—10MHz with the ferrite placed in it, or 6—18MHz with the ferrite rod removed. Coil 4 covers about 6—13MHz with the rod in, and about 9—20MHz without the rod.

It will be noted that as the ferrite rod is inserted, any particular signal has to be re-tuned by opening C1. This arises because the ferrite increases the inductance of the winding, so less parallel capacitance is needed for the same resonant frequency.

EFFICIENCY CHECKS

Tune in a m.w. transmission using coil 1 which gives good headphone volume. Place a microammeter or multi-range meter on a sensitive range in series with the headphones. A reading of 50-100μA or more may be obtained, depending on aerial, earth, headphone resistance, coil and detector efficiency.

Placing the ferrite rod in the coil and re-tuning should boost the meter reading to some extent. Surplus or other detector diodes can be tried by substituting them in turn and noting the meter reading.

Improvements to the aerial (or earth) will show up too, as a rise in meter reading.

Should you experiment with a crystal earpiece, which gives no direct current circuit, clip the meter across the phone leads, that is, D1 cathode to earth.

AERIAL COUPLING

The aerial loads the tuned circuit heavily when connected as in Fig. 1. The series capacitor, C2 connected in Fig. 3a, reduces this loading. A variable or pre-set component, about 250pF maximum is most suitable.

Connecting the aerial to a tapping on the coil, as in Fig. 3b, also sharpens tuning. It may also increase volume. Try about 2 turns from earth for coil 4, or 4 turns from earth for coil 3. Another method is to have a coupling primary, as in Fig. 3c. This consists of a second coil, with about one third the turns of the original wound on top of the existing coil.

You can even combine these methods to find what best suits the aerial in use.

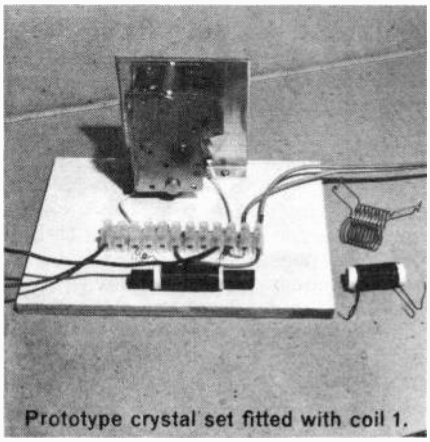
The diode can be disconnected from the end of L1, and taken to a spare position on TB1, for example location TB1/9. You can then run a flying-lead fitted with a crocodile clip from this position, connecting it to various tappings on the coil as required as in Fig. 3d.

This method also reduces loading on the tuned circuit. Coils with spaced turns of bare wire are readily tapped. For other coils, small loops can be made every ten turns or so, and clips can be attached to these when selecting tappings.

SHORT WAVES

For s.w. reception, a reasonably efficient outdoor aerial is recommended, and evening listening in the region around 5—9MHz in particular.

There is no amplification, as with a valve or transistor receiver, and certain frequences will be dead at various particular times of day. So if the receiver works satisfactorily on medium waves, but no s.w. signals are heard, check again at evening, or after dark, when conditions are different. ⌑



Prototype crystal set fitted with coil 1.

Components

C1 365pF air spaced variable capacitor
D1 OA81 or similar point contact germanium diode
TL1 high impedance magnetic headphones
TB1 12-way plastic screw terminal block

Enamelled wire, 32 and 24 s.w.g. for L1; 20 s.w.g. tinned copper wire for L1; ferrite rod, 75mm long by 10mm in diameter; wire for aerial, 25m long; materials for earth (see text); baseboard, 6mm plywood, 165 × 130mm; scrap metal for bracket for C1; crocodile clip (see text); knob.

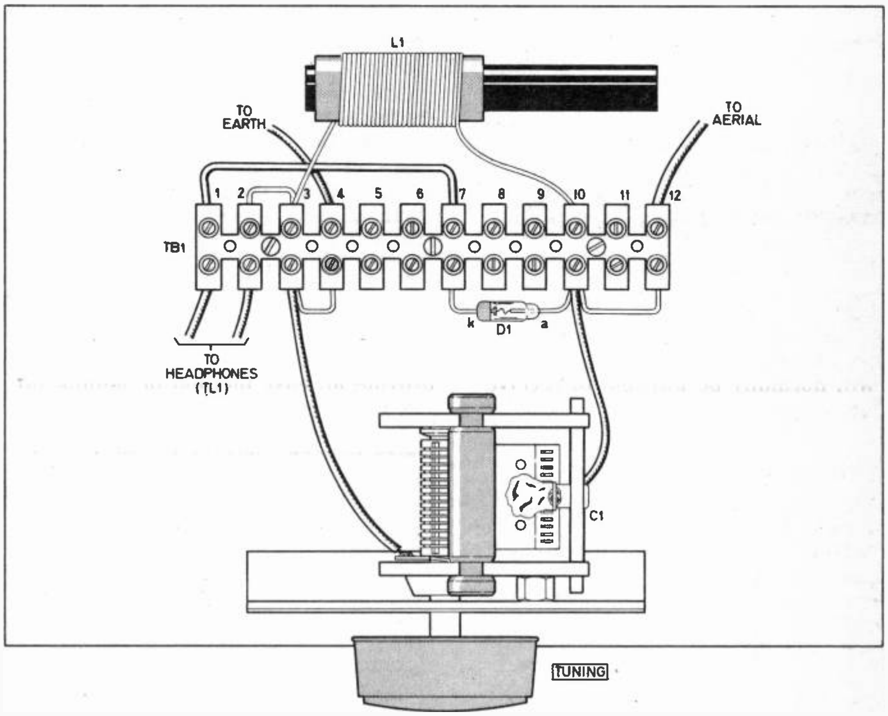


Fig. 2. Baseboard layout and interwiring for the crystal set.

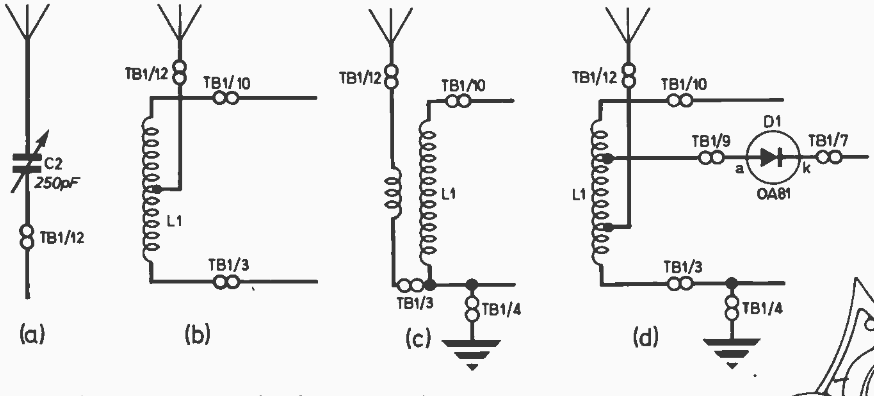


Fig. 3. Alternative methods of aerial coupling.

Before the CHIP

BY R. D. RAILTON

IT's only when someone brings you up short in a conversation about past experiences with a question like—*What is an EF50?*—that you realise just how much technology has flowed down the drain since you built your first crystal set. Now go and ask me what a crystal set is—I dare you.

As someone who has always been involved in one way or another with technology and usually with the electronic side of that art, I find it hard not to be jealous of the youth of today, with access to pocket calculators, microprocessors, colour video and many more items which were far less than pipe dreams in the forties when I did indeed build my first crystal set. But in a way they have lost out because so much of the fun of making things out of virtual rubbish is now just not possible. After all, whoever heard of manufacturing semiconductors at home—although, come to think of it, it has been done.

Transistors are still around so you all know what one looks like: it's a little can with three wire legs that you sometimes have to use to amplify a signal before you feed it to a chip—O.K. Or perhaps it's a little black lump of encapsulation with wire legs. Anyway, it's development marked the total change of the world of electronics which has led to the microprocessor and all its associated paraphernalia.

Way back in 1951 or 52 this development called a transistor was hailed as being the thing which would make all valves so much scrap in a matter of months. A couple of years later it became obvious that indeed there was more to this new device than at first seemed the case and there were those amongst us who felt it important to obtain some for themselves. But as with all new developments none were to be had except at great cost.

MAKE A TRANSISTOR

A good friend (it's always a good friend when I can't remember the name) said that you could make your own transistor by simply sticking two pins into a lump of germanium. Indeed, articles did appear in various of the learned press at the time purporting to show you how to do this wonderful trick. And of course we had to try. So those of us who could—even then—still remember what a crystal set looked like, sought out our old treasures and removed the most important item, the crystal which, as it happens, is a lump of nothing less than germanium.

For those of you who have never heard of a crystal set it is the simplest form of receiver you can have for radio signals. It has lots of disadvantages, not least of which is that it is very insensitive and very unselective. However, it sufficed in the early days of radio as there were only a few transmitting stations, so the second weakness was never really a problem.

The crystal set uses a simple tuned circuit, comprising a coil and condenser (capacitor nowadays I believe). This feeds a signal to the rectifier or diode. The rectifier or detected signal is then made audible by means of a pair of headphones. What could be simpler.

THE CATS WHISKER

The only problem was that diode—it was a poor thing of very variable sensitivity and to make it do its best you had to use a tiny bit of spring wire commonly called a Cat's Whisker to search on its surface for a sensitive spot where the rectifying action worked.

What you were really looking for (as we *now* know) was a spot on the crystal where local impurities created a zone which could be used as a diode. Now, a transistor can be likened to a couple of diodes connected in series and both facing in opposite directions, the base being the common connection of anodes or cathodes. Thus it was reasoned— I always assumed—that if you were very lucky it should be possible to find a zone on your lump of germanium where two diodes could be created with the correct polarity relationship. And so you would have a "transistor".

At any rate, that was the idea. In practice, of course, it turned out to be something yet again and I have to admit that for me it never did work.

After that little episode I for one was forced to admit that it is easier to buy the bit than to make it.

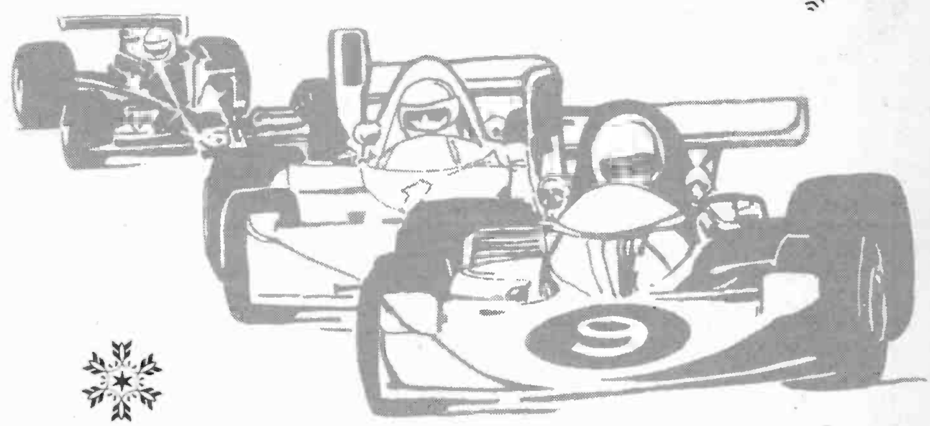
JACK PLUG & FAMILY... BY DOUG BAKER

Everyday ELECTRONICS

DECEMBER 1981 ISSUE
ON SALE, FRIDAY, NOVEMBER 20

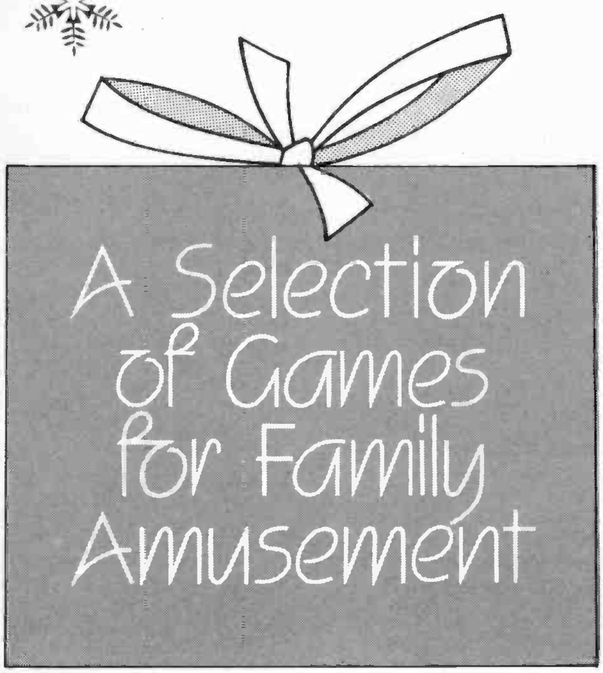
IDEAS for CHRISTMAS

Get organised with these projects



RACE TRACK SPEEDO

An accessory for model car race-tracks. Measures the average lap speed of the car, and lap times up to a period of 9·9 seconds.



CHRISTMAS TREE LIGHTS FLASHER

Variable switching rate from three times a second to four times a minute for lighting loads up to 1250 watts.

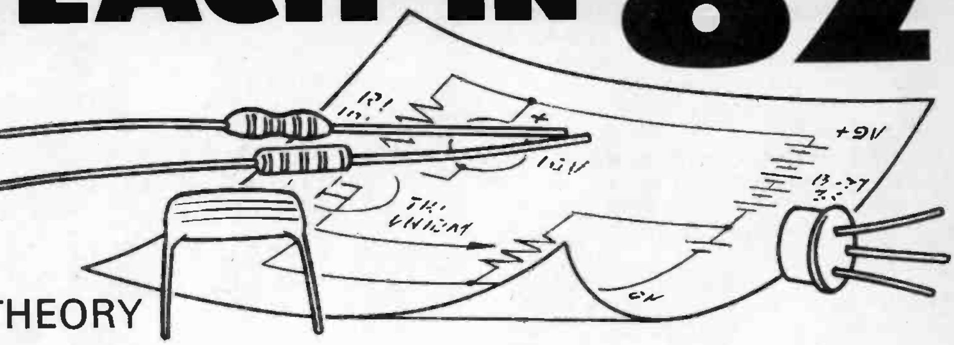
GUITAR ADAPTOR

A de-equalising RIAA filter that allows an electric guitar to be played through a magnetic "phono" input on a hi fi amplifier.

EE TEACH-IN 82

PART 2

BY O.N. BISHOP



BASIC ELECTRONIC THEORY
WITH EXPERIMENTS

UNDERSTANDING AND USING THE VMOS TRANSISTOR

LAST MONTH we noticed the rather strange behaviour of the VMOS transistor. Its resistance seemed to vary in an unpredictable way when we touched the gate terminal wire. An explanation was promised and is given below, but first we must look more closely at the nature of the material which is inside the transistor. This material is a slice (or "chip") cut from a crystal of the element, **silicon.**

In a crystal of pure silicon the atoms are all alike and are arranged regularly, as shown in Fig. 2.1. Each atom consists of a nucleus which carries a positive charge, surrounded by a cloud of electrons, which are negatively charged. The total positive and negative charges are equal but opposite, so the atom as a whole shows no charge.

At low temperatures the electrons remain firmly attached to the atom, circling endlessly in orbits around the nucleus. A chip of pure silicon has no electrons available to carry current when it is cold. It is a **non-conductor.** If it is warmed, some of the electrons gain energy and can escape from the atoms.

These **free electrons** can carry charge when in an electric field—if, for example, we connect the opposite sides of the chip to a battery. The silicon is now a conductor. Substances such as silicon which can be conductors *or* non-conductors, depending on their temperature, are called **semiconductors.**

In last month's experiments you found that the resistance of the thermistor and the transistor decreased when you warmed them. In other words, their conductivity improved. This is due to the extra electrons set free by warming them.

Pure silicon is a poor conductor compared with a metal, for it has very few free electrons. To increase its conductivity we can **dope** it with atoms of other elements.

DOPING

Doping is generally done by heating the silicon in a furnace and allowing the atoms of the other element to diffuse into the crystal. These atoms take their place among the silicon atoms (Fig. 2.2).

If the silicon is doped with atoms of phosphorus, for example, the phosphorus atoms each have a "spare" electron. This is easily able to leave the atom to act as a charge carrier. It carries *n*egative charge, so silicon doped in this way is called *n*-type.

HOLES

We can dope the silicon with an element such as boron (Fig. 2.3). Compared with silicon atoms, boron atoms lack an electron, so there are vacancies or spaces in the crystal where electrons ought to be. These are called **holes.** Holes attract free electrons to fill them, so they act as if they are positive charges.

When an electron escapes from an atom and fills a hole, another hole is created at the atom the electron has just left. This too can be filled by another escaping electron. *In effect* a hole travels along a bar of silicon which is an electric field (Fig. 2.4).

Semiconductors doped in this way carry charge because the holes can "move". Conduction is by holes, which are considered as positive charges, so the material is called *p*-type silicon.

The VMOS transistor is a particular type of MOS transistor. MOS stands for "metal-oxide silicon". Diagram Fig.2.5 shows how one type of MOS transistor works.

It consists of a piece of *p*-type silicon with two small regions of *n*-type. One surface of the piece is coated in silicon dioxide, which is a very good insulator.

Fig. 2.1. Part of a crystal of pure silicon in diagramatic form(not to scale).

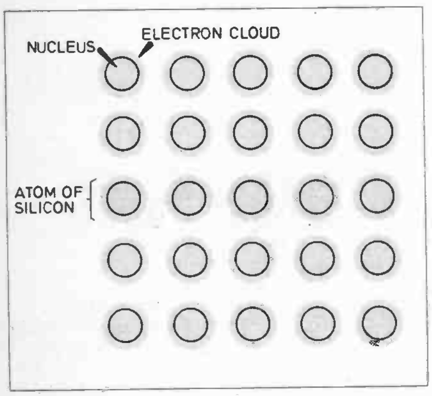


Fig. 2.2. Part of a crystal of *n*-type silicon (very diagramatic).

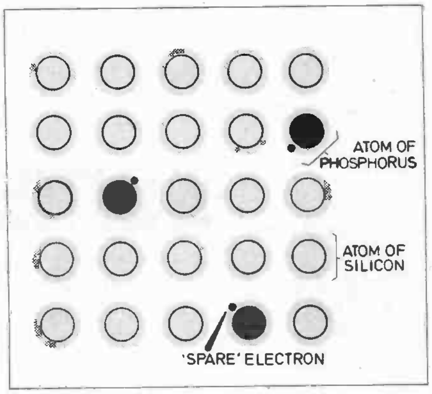
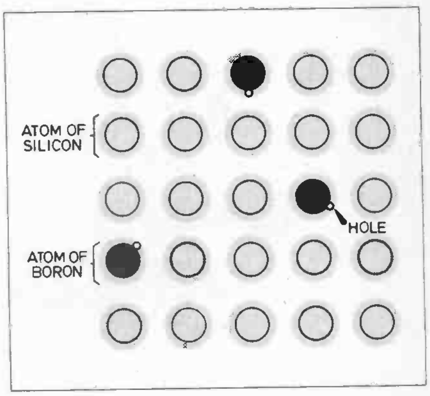


Fig. 2.3. Part of a crystal of *p*-type silicon (very diagramatic),



The fact that silicon dioxide is such a good insulator is one of the reasons why silicon is so widely used in preference to other semiconductors such as germanium.

In Fig. 2.5a, no current can flow through the bar, as will be explained next month. However, if we charge the gate electrode positively the holes in the *p*-type silicon are repelled (like charges repel).

This creates a region of *n*-type silicon joining the two doped *n*-type regions. There is now a path for electrons to flow through the transistor, Fig. 2.5b.

The more strongly we charge the gate electrode, the wider the path and the easier it is for current to pass. The greater the charge, the smaller the resistance of the transistor becomes.

EXPERIMENT 2.1

A MOS transistor as a touch switch

Look at our circuit diagram for a simple touch switch (Fig. 2.6) and how to set it out on the Minilab breadboard, Fig. 2.7.

When you place your finger across the gap between the two wires *A* and *B*, the gate becomes positively charged. Electrons are attracted toward the positive terminal of the battery, leaving the gate more positive than it was before.

The current is very small indeed—it can not be large because the gate is completely insulated from the rest of the transistor by the layer of silicon dioxide. Because of the effect of the field around the gate, current flows through the transistor and the light emitting diode D1 is turned on.

There will be more about light emitting diodes (l.e.d.s) next month. For the moment, try other ways of altering the charge on the gate. Try bringing your hand *near* to wire *B* without actually touching it. Try rubbing a plastic ball-point pen or a plastic comb with a dry duster and bring toward *B*.

Add a one megohm (1MΩ colour code: brown black, green) resistor between sockets *B23* and *B24* on the breadboard. This discharges the gate after is has gained charge (it lets electrons leak back from the 0V line). What effect has this on the action of the touch switch?

EXPERIMENT 2.1

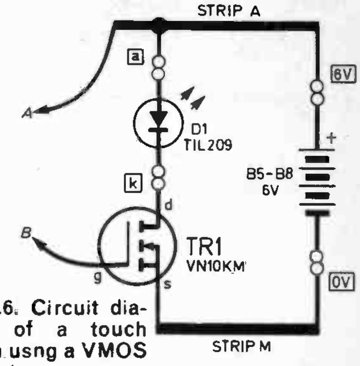
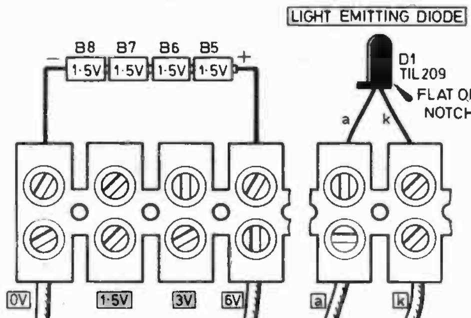


Fig. 2.6. Circuit diagram of a touch switch usng a VMOS transistor.



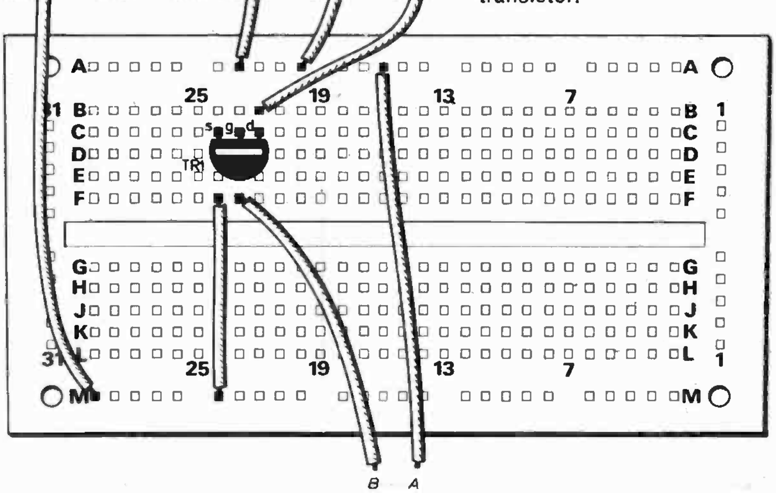


Fig. 2.7. The layout on the breadboard and interwiring for the circuit in Fig. 2.6.

Fig. 2.4. Conduction by holes in *p*-type silicon.

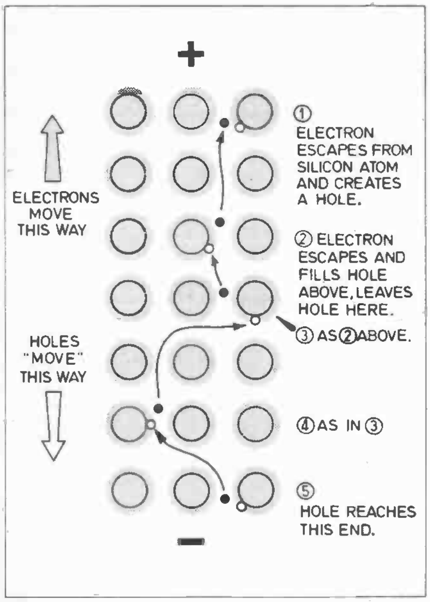
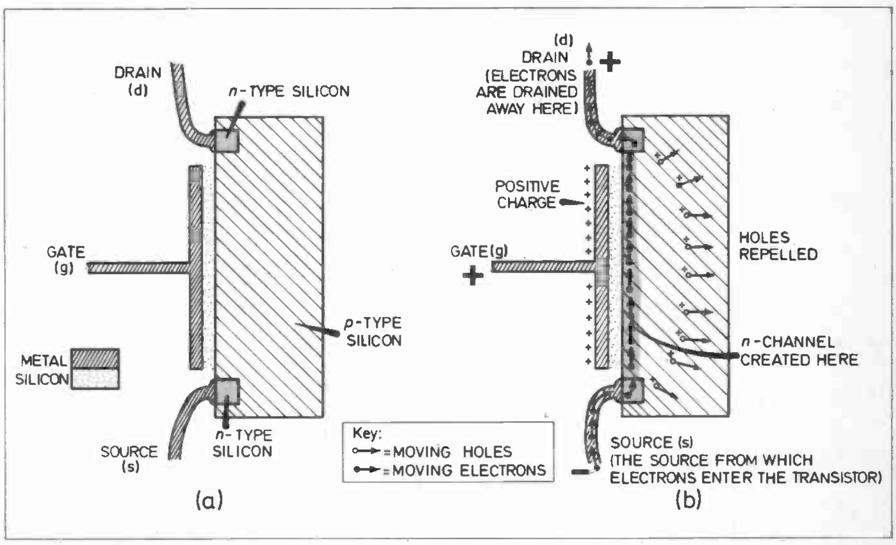


Fig. 2.5. How a MOS transistor works.



EXPERIMENT 2.2

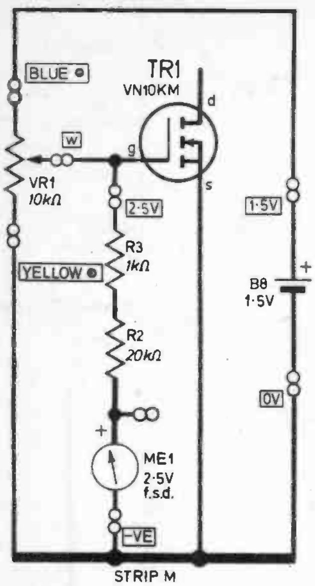


Fig. 2.8. Stage 1 of Experiment 2.2 to observe and measure the action of a MOSFET. Here we are calibrating *V*IN.

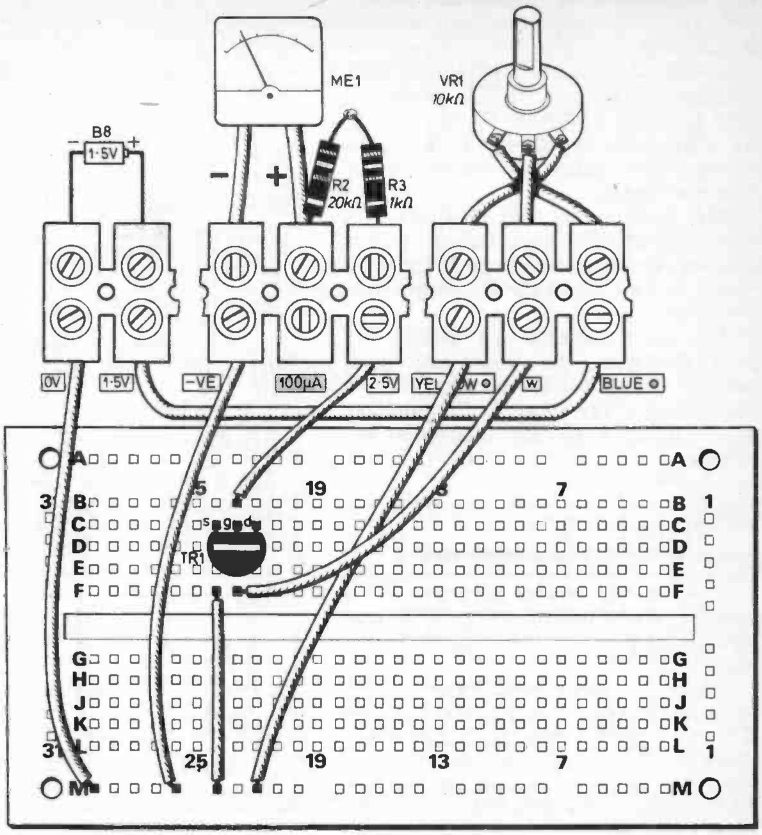


Fig. 2.9. Layout and interwiring for the circuit of Fig. 2.8.

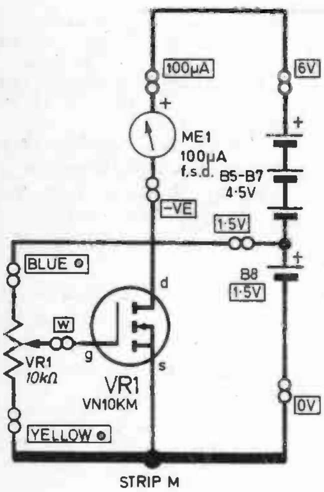


Fig. 2.10. Stage 2 of Experiment 2.2. Current flow through TRI for known *V*IN is being measured.

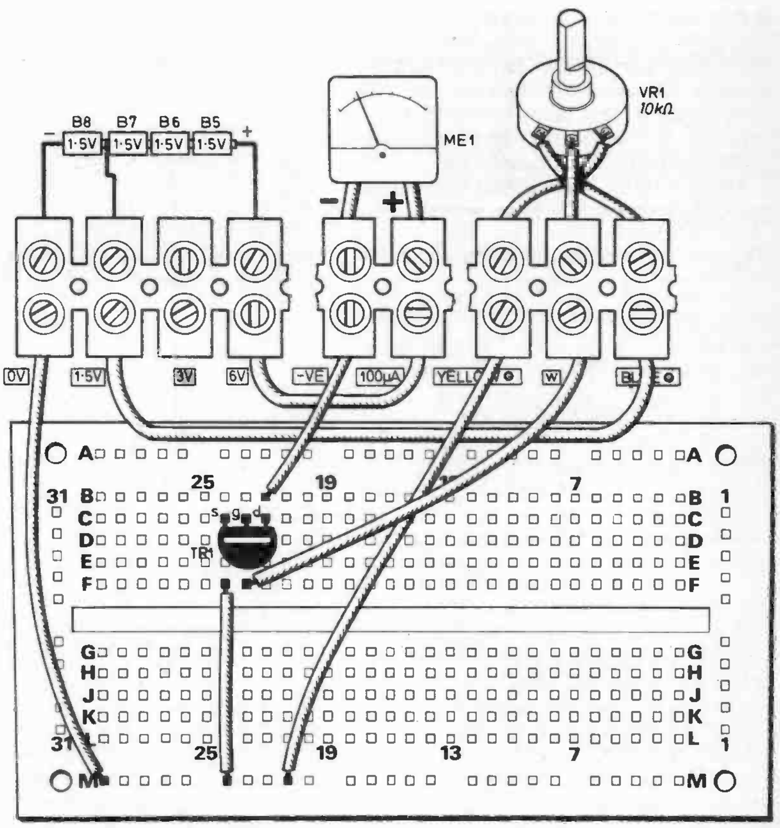


Fig. 2.11. Layout and interwiring for circuit in Fig. 2.10.

EXPERIMENT 2.3

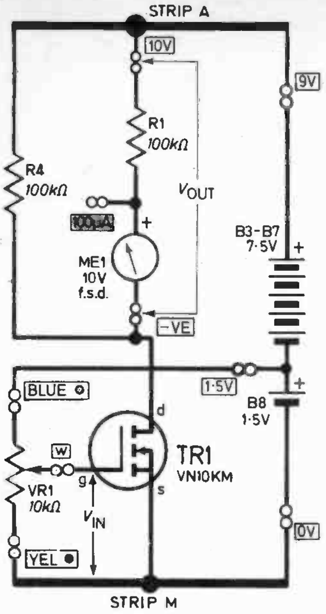


Fig. 2.12. Circuit for investigating voltage amplification using a MOSFET.

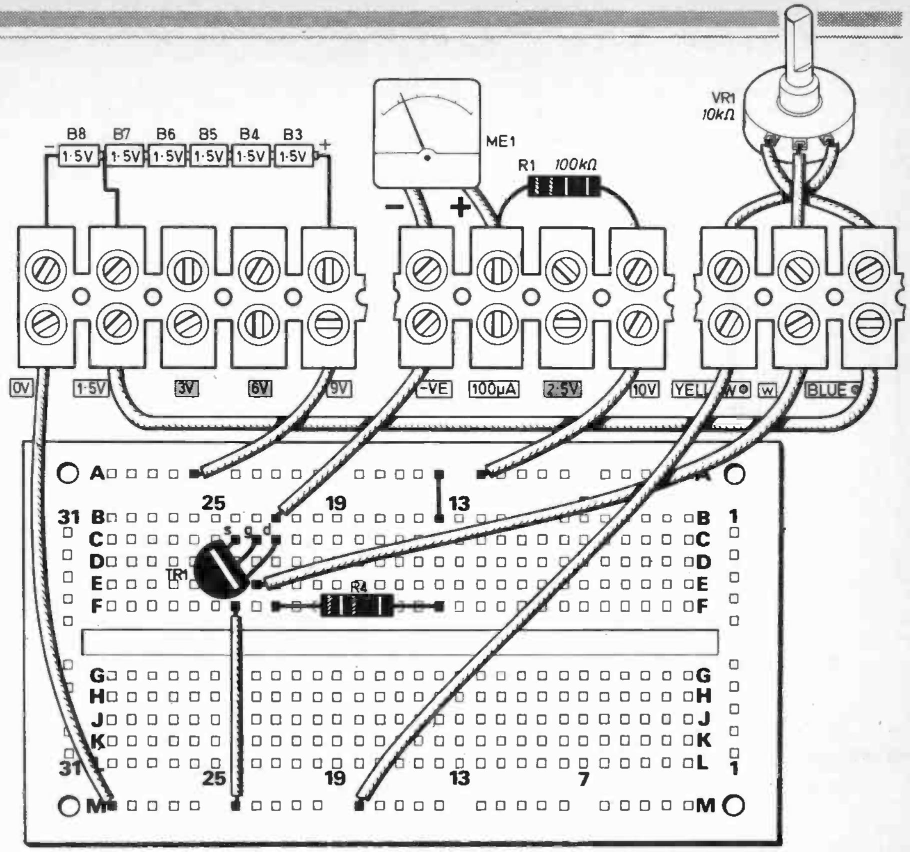


Fig. 2.13. Layout and interwiring on breadboard for circuit in Fig. 2.12.

ERRATUM

In last month's Teach-In, one of the identifying spots on potentiometer VR1 in Figs. 1.10 and 1.11 was incorrectly marked: RED should be changed to YELLOW to be in accordance with the colour coding used on the *Minilab* circuit diagram, Fig. 1 on page 665.

EXPERIMENT 2.2

Measuring the action of a MOSFET

The circuits for determining the action of a MOSFET are in two stages and are shown in Figs. 2.8 and 2.10. The component layouts and wiring to the breadboard are shown in Figs. 2.9 and 2.11 respectively.

In this experiment potentiometer VR1 is being used as a potential divider, (see last month). First connect the meter as in Fig. 2.9 to measure the voltage produced by 10 different positions of VR1. Make a note of these 10 settings on the control dial for later reference.

The resistors R2 and R3 in series with the meter were selected for the meter used in the Minilab (see last month). This has an internal resistance of 4 kilohms (4kΩ).

Teach-In '82 kit suppliers will have selected transistors to suit the meter they have supplied, this may be other than a 4 kilohm type meter. It is possible that only a single resistor will be required and supplied.

Next wire the meter between the transistor and the +6V line (Fig. 2.11). Set VR1 to each position in turn and measure the current through the transistor.

Does current increase as the voltage at the gate increases? What is the increase in current if the voltage is changed from, say, 0·75V to 1·0V?

Use your measurements to calculate the **transconductance** g_m (or mutual conductance) of the transistor:

$$g_m = \frac{\textit{change in output voltage}}{\textit{change in input voltage}}$$

The units of transconductance are **amps/volt.** This is the inverse of the unit of resistance, which is **volts/amp,** usually called **ohms**.

The opposite of resistance is conductance and transconductance is a special example of this. The unit of conductance (amps/volt) is the **siemens**, symbol *S*.

ANOTHER USE FOR RESISTORS

When a current passes through a resistor, a p.d. or voltage difference is created between the ends of the resistor. This is a result of **Ohm's Law.** For example, if a current of 2A passes through an 18ohm(Ω) resistor, the p.d. is $V=IR=2\times 18=36$ volts. Here is another use for resistors—turning a current into a voltage.

EXPERIMENT 2.3

Voltage amplification

The circuit for investigating **voltage amplification** is given in Fig. 2.12 Component layout can be seen in Fig. 2.13.

In this circuit the current through the transistor passes through a resistor R4. When it does this a p.d. develops across the resistor. The meter is now being used as a voltmeter.

Set VR1 in each of the positions you used in Experiment 2.2. This gives 10 different values of V_{IN}. For each V_{IN} measure the output voltage (V_{OUT}) across the resistor.

Now you can compare two voltage changes, to calculate the voltage gain of the circuit:

$$\text{voltage gain} = \frac{\textit{change in output voltage}}{\textit{change in input voltage}}$$

For example, increasing V_{IN} from 1·2V to 1·4V (a change of 0·2V) might make V_{OUT} rise from 0·8V to 5·3V (a change of 4·5V). The voltage gain ofthe circuit is $4{\cdot}5/0{\cdot}2=22{\cdot}5$.

This experiment shows how a transistor can be used as a voltage amplifier (or more precisely as a voltage *change* amplifier). Later we will measure the gain of other types of transistor.

EXPERIMENT 2.4

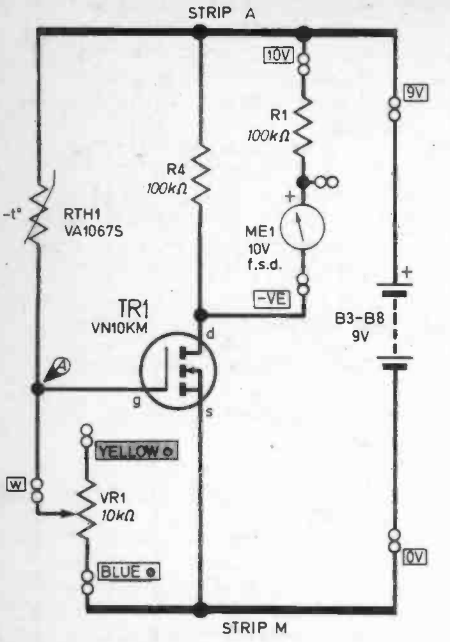


Fig. 2.14. The circuit for an electronic thermometer.

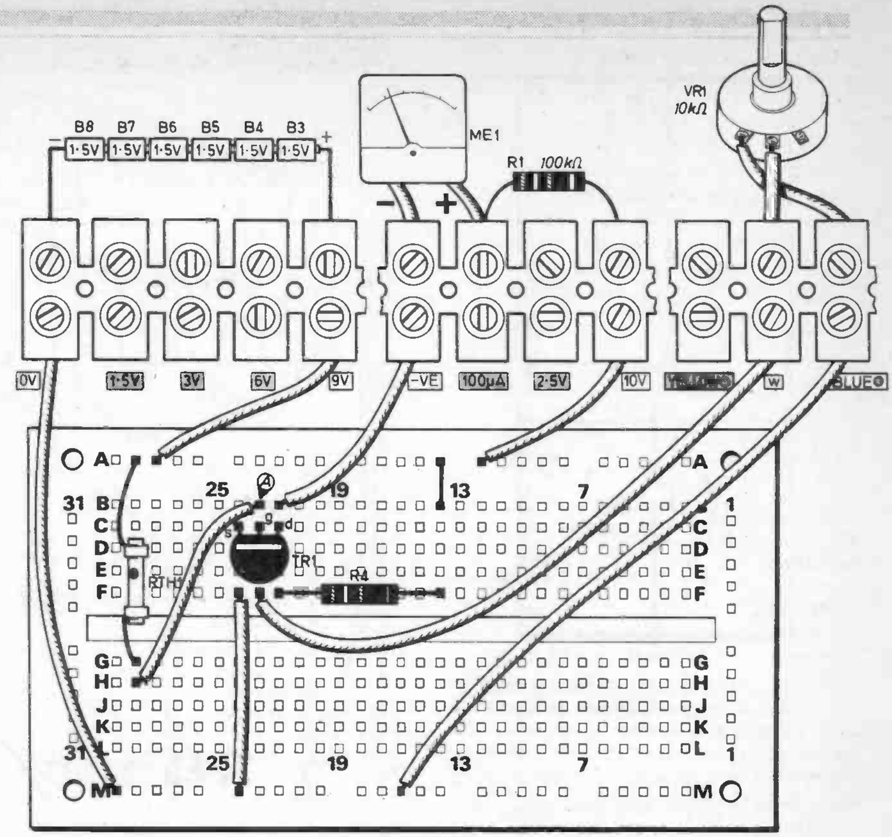


Fig. 2.15. (right). Layout and interwiring for circuit in Fig. 2.14.

EXPERIMENT 2.5

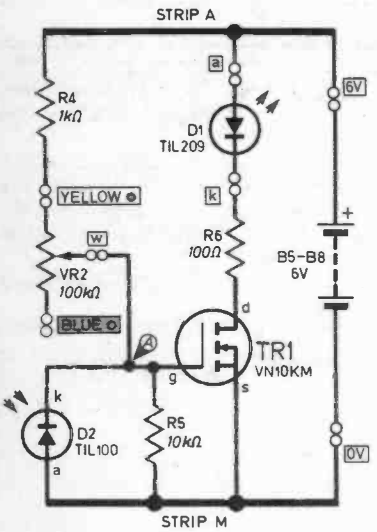


Fig. 2.16. Circuit for investigating the action of a light triggered switch.

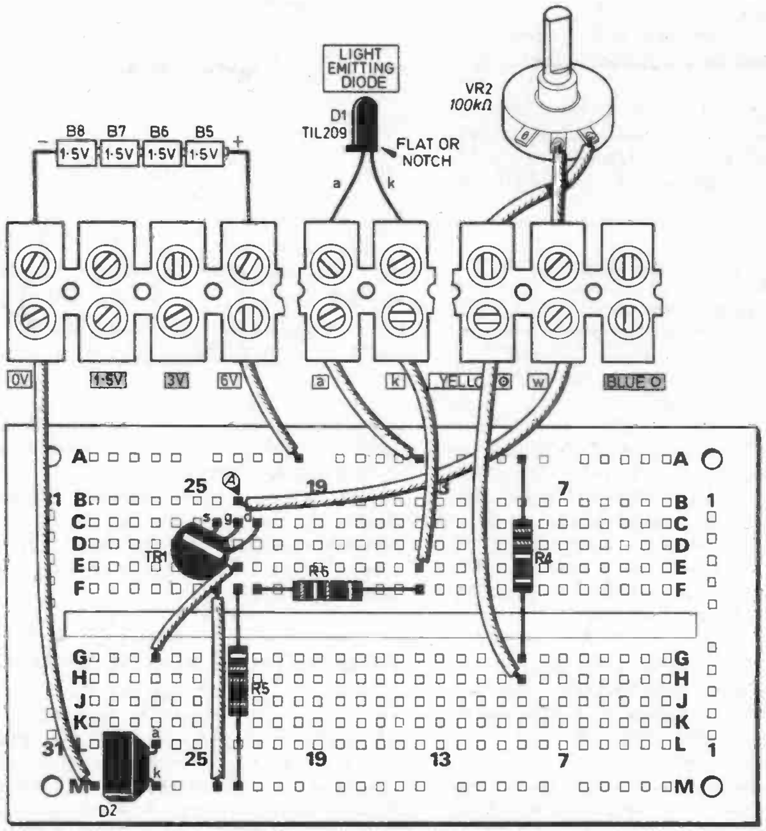


Fig. 2.17. Layout and interwiring on breadboard for the circuit in Fig. 2.16. Check connections to diodes before making final connection to power supply. Note that this circuit uses a 100 kilohm potentiometer (VR2 on *Minilab*).

EXPERIMENT 2.4
Electronic thermometer

In the circuit diagram Fig. 2.14, the thermistor RTH1 and VR1 act as a potential divider. The component layout is shown in Fig. 2.15.

As temperature changes, the resistance of the thermistor changes. Increased temperature sets free more electrons and so decreases the resistance. This makes the potential at point *A* change, so the potential of the gate changes too.

Adjust VR1 until the reading on the meter is about 3V. Now warm the thermistor by gripping it between your fingers. Then touch some other warm (*not* hot) object against it.

Touch a lump of ice against it. Watch the meter to see how the voltage across R4 is affected by the temperature of the thermistor. The changes of voltage at point *A* are quite small but they are amplified by the transistor so that there is a large change in the reading on the meter.

If you were to put the thermistor in various places with known temperatures, you could mark the scale of the meter in degrees Celsius (Centigrade). Then this circuit could be used as an electronic thermometer.

TRANSISTORS AT WORK

This month we have seen two ways in which transistors are used. They can be used as **switches,** to turn things on and off (Expt. 2.1), and they can be used as **amplifiers** (Expts. 2.2-2.4).

These are the two main uses of transistors in electronics. This applies not only to the VMOS transistor but to the other types which we shall be using later.

EXPERIMENT 5
Light-triggered circuit

The circuit in Fig. 2.16 is another example of the use of a transistor as a switch.

In this case it is triggered by light. The component layout on the breadboard is shown in Fig. 2.17. It uses a **photodiode** (D4), a semiconductor device that is sensitive to light.

Adjust VR2 until the l.e.d. (D1) just switches off. When this happens the potential at the gate of TR1 is just not enough to allow current to flow to light the l.e.d. Now cover the photodiode with your hand.

While light was shining on the photodiode the energy of the light helped to set electrons free from the atoms of the semiconductor. These allowed a small current to flow; the photodiode acted as one resistor of a potential divider.

When the photodiode is shaded, there is less light, so there are fewer free electrons to carry charge. Its resistance increases. This raises the potential at *A* and turns on the transistor. Current flows through the transistor and lights the l.e.d.

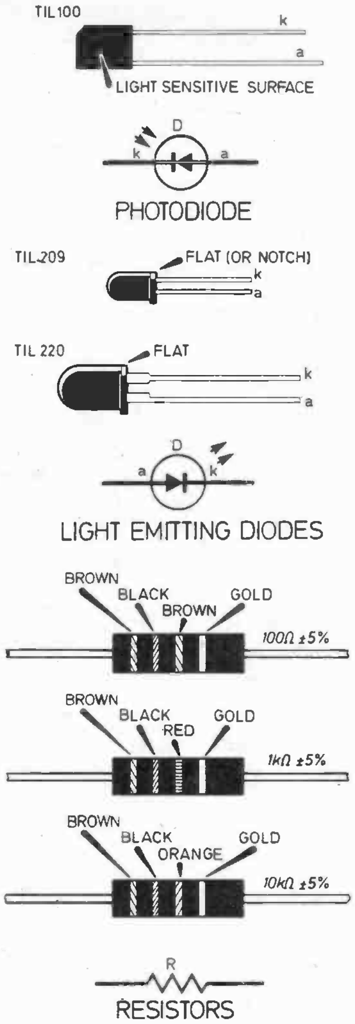
THE FIELD EFFECT

The VMOS transistor works because of the electric field around the gate electrode, which repels the holes and increases conduction. The transistor is known as a **field effect transistor,** or f.e.t. for short.

In this transistor, as in all MOSFETS, the gate is insulated from the body of the transistor by the layer of silicon dioxide. The difference between VMOS and the other types of MOSFET is that the silicon is etched to produce deep V-shaped grooves in its surface.

Conduction occurs down the sides of the grooves. The path is narrow but, by making the grooves fairly long, we can build a transistor which is able to carry a large current.

TEACH-IN 82 COMPONENTS IDENTIFIED



QUESTION TIME

2.1. Antimony is another element with a "spare" electron on each atom. If pure silicon is doped with antimony, what type of semiconductor is made?

2.2. In which direction do holes move in an electric field?

2.3. What does MOS stand for?

2.4. If a current of 10mA passes through a 2·2kΩ resistor, what potential appears across the resistor?

2.5. If the circuit of Expt. 2·3 has a gain of 20, what change in VOUT will be caused when VIN increases by 0·15V?

2.6. Name the three electrodes of an f.e.t.

2.7. Which one of the electrodes of an f.e.t. is connected to the 0V line?

2.8. What alteration to the circuit of Expt. 2·5 would make the l.e.d. turn off when the photodiode is covered?

2.9. What charge is produced on a plastic ball-point pen when it is rubbed with a duster? (Hint —try Expt. 1 again.)

2.10. In Expt. 2 the voltage was increased from 1·0V to 1·2V. The current increased from 10µA to 70µA. What is the transconductance of the transistor?

Answers in Part 3.

The VMOS transistors are therefore used mainly is power transistors. The VN10KM used in this series can carry up to 0·5A, and larger versions can carry up to 2A.

The f.e.t.s can be made in other ways too, and this will be one of the subjects dealt with in next month's article. We shall also find out a lot more about diodes of all kinds.

To be continued

PART 1 ANSWERS

1.1. Electrons.

1.2. Forced apart.

1.3. Coulomb.

1.4. Electrons, positive ions, negative ions.

1.5. 6 coulombs.

1.6 Metals.

1.7. Full-scale deflection.

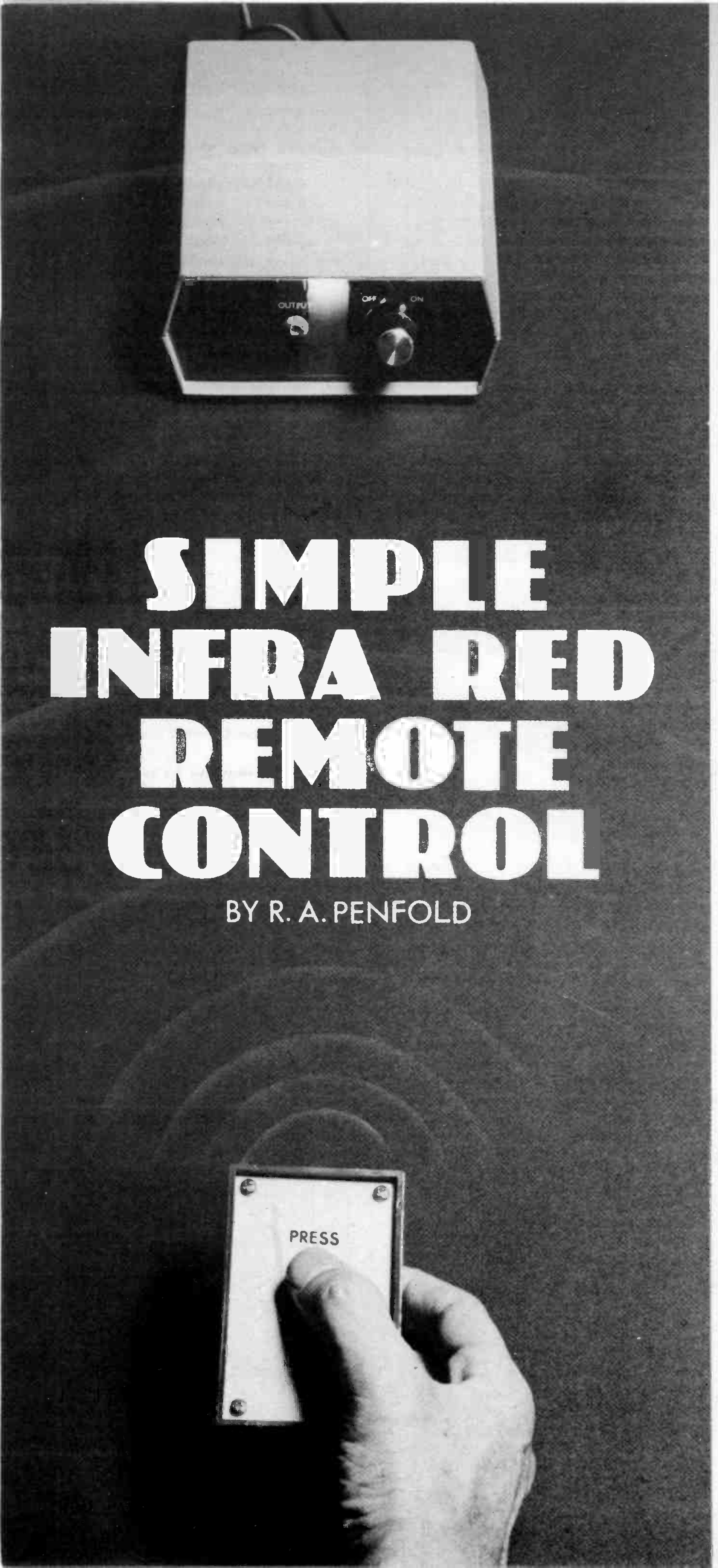
1.8. 12kΩ

1.9. Blue, grey, brown; (680 ohms).

1.10. 1 volt.

SIMPLE INFRA RED REMOTE CONTROL

BY R. A. PENFOLD



A FEW years ago, ultrasonics was the automatic choice when a short range remote control system was required. These days there is the alternative choice of an infra-red system, and there are certain advantages to this method.

One is simply that infra-red emitter and detector diodes are less expensive than ultrasonic transducers, and they are also much more compact. Ultrasonic systems are sometimes prone to spurious operation due to high frequency ambient sounds, but spurious operation of an infra-red system is not normally a problem.

One slight drawback of an infra-red system is that it gives marginally less range than an ultrasonic system of comparable complexity. However, a range of about 9 metres or so is readily obtained, and is sufficient for the applications for which short range systems of this type would normally be used.

VARIOUS APPLICATIONS

The system described here is a simple on/off switching type where a pair of relay contacts at the receiver close while a push button switch at the transmitter is depressed.

The prototype is used as a cordless remote control for the slide change mechanism of an automatic slide projector, but it could be used in other applications, such as the remote control of electrically operated garage doors, or it can even be used as a broken beam burglar alarm. In the latter application it has the advantage over simple broken light beam alarms of using a beam which is invisible, and not readily detectable by an intruder.

BASIC ARRANGEMENT

Fig. 1 shows the basic arrangement used in this remote control system. The transmitter consists of an audio oscillator driving an infra-red emitting l.e.d. via a buffer amplifier which provides the high peak drive current required by the l.e.d. The l.e.d. is only pulsed for short periods at this high operating current so that it provides strong bursts of infra-red radiation, but consumes only a modest average current.

This method enables a strong peak output to be obtained from the transmitter using just a single l.e.d. of an inexpensive and readily available type, and the modest current consumption can be provided by a small 9 volt battery.

Infra-red radiation comes in the space between microwaves and visible red light in the electromagnetic frequency spectrum. Infra-red l.e.d.s produce no output in the visible light spectrum, and the output from the transmitter is therefore undetectable by the human eye.

MODULATED BEAM

Some readers may be puzzled about the use of a modulated beam, rather than a simple continuous type. The problem with a continuous beam is that it could only be a very low power type if it were to use inexpensive and readily available parts. It would therefore produce very little change in the receiving photocell when it was switched on and off, making it difficult to produce a system of good sensitivity, plus good immunity to changes in the ambient infra-red level.

TRANSMITTER CIRCUIT

Fig. 2 shows the complete transmitter circuit, and this is based on a 555 timer i.c. (IC1) used in the astable (free running) mode. R1, R2, and C2 are the timing components, and the specified values give an operating frequency of about 4·5kHz. This is low enough to obtain a good efficiency from the photocells and easily obtain the high gain required at the receiver, but is high enough above 50 hertz to easily provide good rejection at this frequency in the receiver circuit.

strong pulses of current during the brief periods when the output of IC3 is negative going.

R3 limits the peak current fed to D1 to about 450mA, giving an average l.e.d. current of approximately 40mA. The total current consumption of the circuit is about 48mA, the additional current being that consumed by IC1.

S1 is the on/off switch, and is a non-locking push button type. C1 is a supply decoupling capacitor.

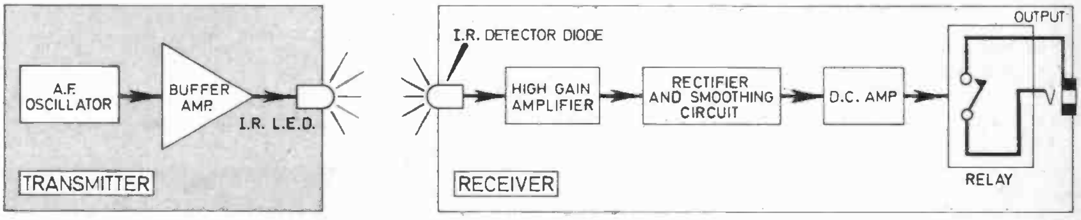


Fig. 1. Block diagram showing the basic arrangement of the complete system.

By using a pulsed beam, the weak audio signal produced by the receiving photocell as it responds to the infra-red pulses can be considerably boosted by a high gain audio amplifier. The output of the amplifier is then rectified and smoothed to produce a strong d.c. bias which can be used to drive a relay by way of a d.c. amplifier. This system is therefore immune to most ambient infra-red, and is only affected by modulated infra-red sources.

In practice, apart from the transmitter, the only source of modulated infra-red is likely to be mains lighting. It is simple to make the system virtually immune to interference by mains lighting, since the mains frequency is only 50 hertz. The audio amplifier is merely designed to have a very poor response at this low frequency, and the transmitter is given a fairly high operating frequency, where the amplifier exhibits its full gain.

The circuit is a sort of relaxation oscillator, with C2 first charging to $^2/_3$ V+ via R1 and R2, and then discharging to $^1/_3$ V+ through R2 and an internal transistor of IC1. C2 is continuously charged and discharged in this manner.

The main output of IC1 is at pin 3. This terminal is at virtually the full positive rail potential while C2 is charging, and at little more than the negative rail voltage when C2 is discharging.

As C2 charges through the relatively high resistance of R1 and R2 in series, but discharges through only R2 and the low internal resistance of IC1, the charge time of C2 is far longer than the discharge time. The output from pin 3 is thus a series of brief negative pulses, with an actual mark space ratio of about 10 to 1.

TR1 is an emitter follower buffer stage, and this has infra-red l.e.d. D1 and current limiting resistor R3 as its emitter load. TR1 drives the l.e.d. with

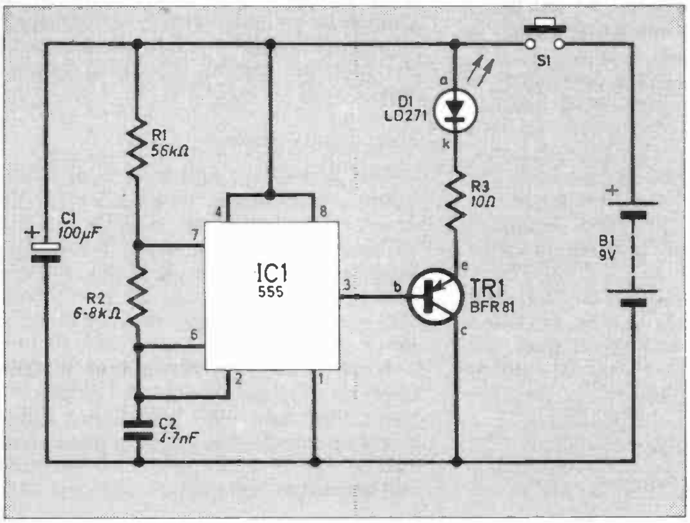
TRANSMITTER CONSTRUCTION

The transmitter can be housed in virtually any small plastic case. The prototype is housed in one which has approximate outside dimensions of 80 x 50 x 30mm, and this was found to be small enough for comfortable hand-held operation, and just about large enough to accommodate all the components.

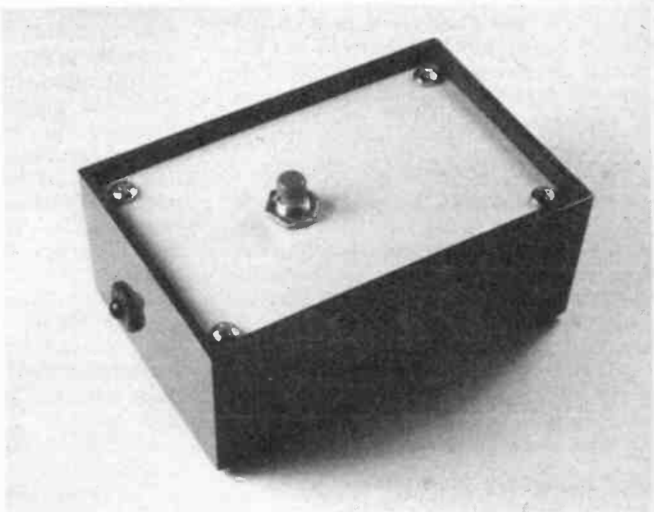
A mounting hole for S1 is drilled in the top panel of the case just forward of a central position. The panel holder for D1 is mounted on the front panel of the case, low down and offset to the left (when viewed from the front).

The circuit is constructed on 0·1in matrix stripboard size 13 strips by 17 holes. After cutting out a board of the required size and drilling the two 3·3mm diameter mounting holes, it is advisable to remove any jagged edges using a small flat file. The four breaks

Fig. 2. Circuit diagram for the infra-red transmitter.



The completed transmitter housed in a small plastics box.



INFRA RED TRANSMITTER

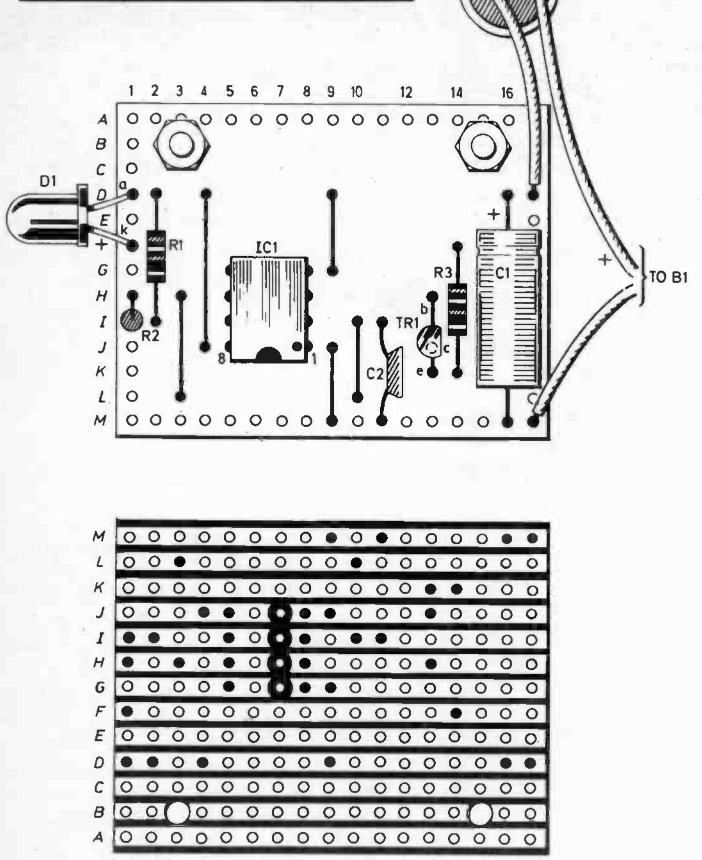
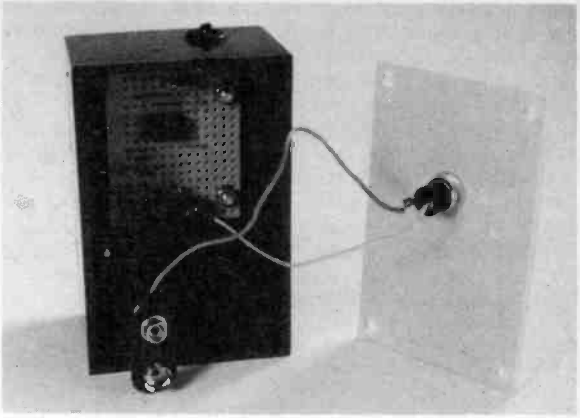


Fig. 3. Component layout and wiring details for the infra red transmitter.



The transmitter with top panel removed. The "trigger" switch S1 is shown mounted on the top panel.

COMPONENTS

Resistors
R1 56kΩ R2 6·8kΩ R3 10Ω
All $\frac{1}{3}$W carbon ±5%

Capacitors
C1 100μF 10V elect.
C2 4·7nF ceramic plate

Semiconductors
IC1 555 timer i.c.
TR1 BFR81
D1 LD271 infra-red l.e.d.

Switch
S1 Push to make, release to break type

Miscellaneous
B1 PP3 battery and connector.
Plastic case, 80 × 50 × 30mm (Teko size TEKP1P, West Hyde Developments).
0·1in matrix stripboard, 13 strips × 17 holes; wire; solder.

in the copper strips are then made. The components and link wires are then soldered into place.

Mount the completed component panel on the base panel of the case in a position that enables D1 to be fitted into its panel holder. Short M3 or 6BA mounting screws are used. The battery fits into the space at the rear end of the case.

TESTING THE TRANSMITTER

It is advisable to thoroughly check all the wiring once or twice before connecting a battery and operating the unit, since a mistake could easily result in some of the components being damaged. If possible, connect a multimeter set to read about 100mA f.s.d. in series with the positive battery lead, so that the current consumption of the unit can be checked. If this is not in the region of 45 to 50mA, release S1 at once and recheck the wiring, for errors.

RECEIVER CIRCUIT

The receiver is somewhat more complicated than the transmitter, as can be seen from its circuit diagram which appears in Fig 4. The photocell used to detect the infra-red pulses is a special photo-diode, D1.

Most photodiodes are sensitive to infra-red, but the type used here is designed for high sensitivity in this part of the electromagnetic spectrum, and it has an integral filter which virtually eliminates any response to visible light. This prevents ordinary light sources from interfering with the unit.

R1 is the load resistor for D1, and the voltage at the junction of these two components depends upon the leakage current passed by D1, which is connected so that it is reverse biased.

The pulses of infra-red from the transmitter cause the leakage current to increase, producing a series of negative voltage pulses at the junction of R1 and D1. These pulses are very low in amplitude, being below one millivolt except when the unit is used at very short range. They must therefore be subjected to a very high degree of amplification in order to produce an output of useful magnitude.

PREAMPLIFIER

TR1 is a j.f.e.t. and is used as a low noise preamplifier. It is used in the common source mode, and C2 is used to couple the output from D1 to the input at its gate terminal. This stage provides a useful gain of over 20dB (10 times) and has a very low noise level.

Most of the gain is provided by two high gain common emitter amplifiers using TR2 and TR3. These are quite conventional in design. C5 is used to roll off the high frequency response of the amplifier in order to aid stability.

POOR RESPONSE

The circuit is given a poor response at 50 hertz merely by using low value coupling capacitors between the various stages of the amplifier.

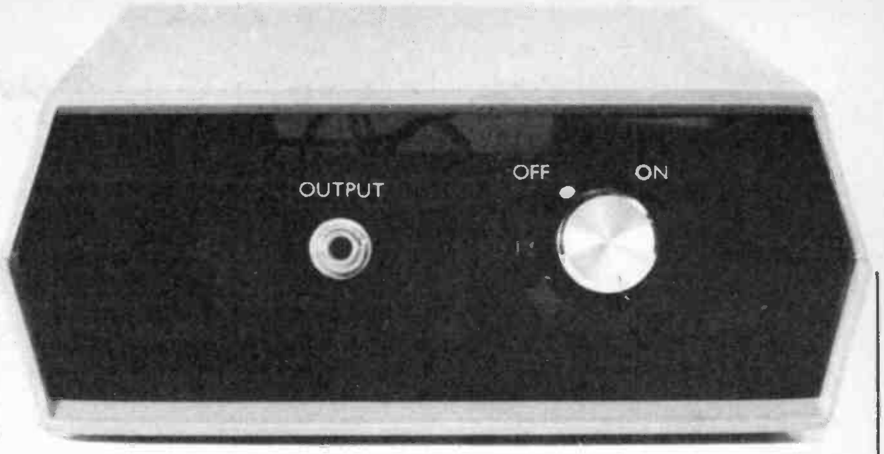
C7 couples the strong signal at TR3 collector to a rectifier circuit using D2 and D3. A series of positive pulses are produced at the output of the rectifier, and these are used to bias TR4 into conduction. C8 integrates the pulses so that TR4 is continuously biased into conduction, and not rapidly pulsed on and off.

TR5 is an emitter follower buffer stage which drives the relay coil that forms its emitter load. With TR4 switched on, virtually the full supply voltage is fed to the relay coil, and normally open relay contacts RLA1 close and operate the controlled equipment.

Of course, if the transmitter is not operating there are no input pulses to switch on TR4. Its collector potential then becomes equal to almost the full positive supply voltage, and the voltage fed to the relay coil is practically zero. With the relay coil non-energised, the relay contacts remain open. The relay contacts can thus be made to close and open by switching the transmitter on and off.

D4 is used to suppress the reverse voltage spike that would otherwise be developed across the relay coil as it was switched off. D4 short circuits this high impedance signal, limiting it to only about 0·65 volts in amplitude, thus limiting it to a level which is far too low to damage any of the semiconductor devices in the circuit. C1, R7, and C9 are supply decoupling components.

The only control is on/off switch S1. The current consumption of the circuit is about 2·8mA under quiescent conditions, rising to about 30mA when the relay is activated.



COMPONENTS

See Shop Talk page 737

Resistors
- R1 15kΩ
- R2 27kΩ
- R3 4·7kΩ
- R4 2·7kΩ
- R5 1·8MΩ
- R6 4·7kΩ
- R7 220Ω
- R8 1·5MΩ
- R9 4·7kΩ R10 8·2kΩ

All ⅓ watt carbon ±5% (10% over 1MΩ)

Capacitors
- C1 100μF 10V
- C2 2·2nF ceramic plate
- C3 1μF 25V elect.
- C4 4·7nF ceramic plate
- C5 120pF ceramic plate
- C6 4·7nF ceramic plate
- C7 100nF type C280
- C8 47nF ceramic plate
- C9 100μF 10V elect.

Semiconductors
- TR1 BF244B j.f.e.t.
- TR2 BC109C *npn* silicon
- TR3 BC109C *npn* silicon
- TR4 BC109 *npn* silicon
- TR5 BC179 *pnp* silicon
- D1 SFH205 infra-red photodiode
- D2 OA91 germanium
- D3 OA91 germanium
- D4 1N4148 silicon

Relay
- RLA Omron 306 ohm 6/12 volt coil, printed circuit mounting, single changeover contact (Maplin)

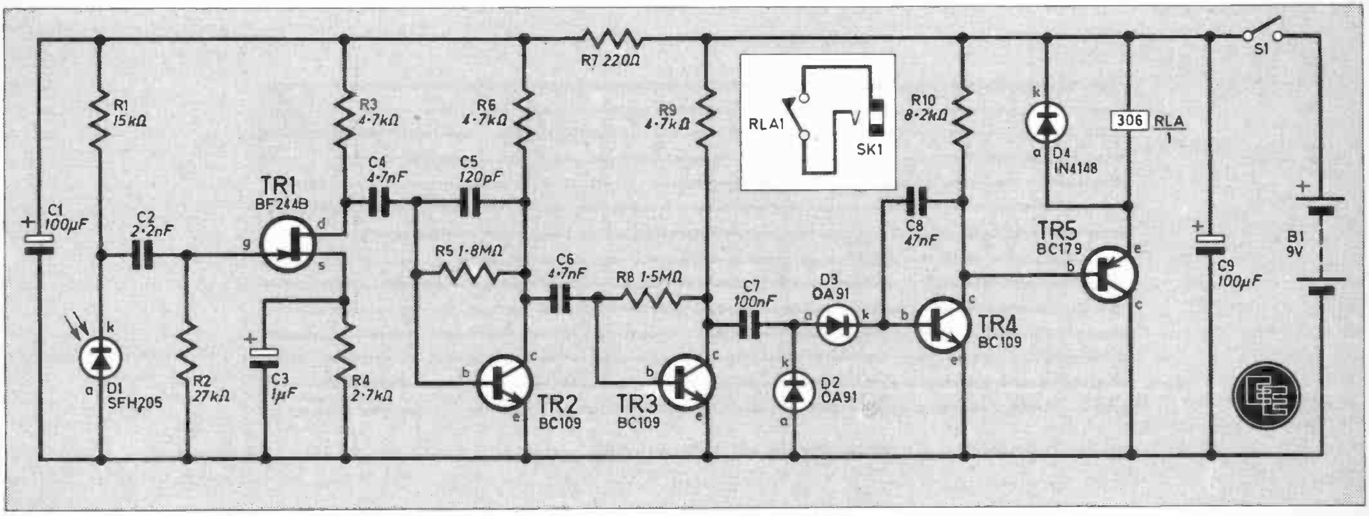
Socket
- SK1 Jack socket 3·5mm

Switch
- S1 Rotary on/off switch, or s.p.s.t. toggle

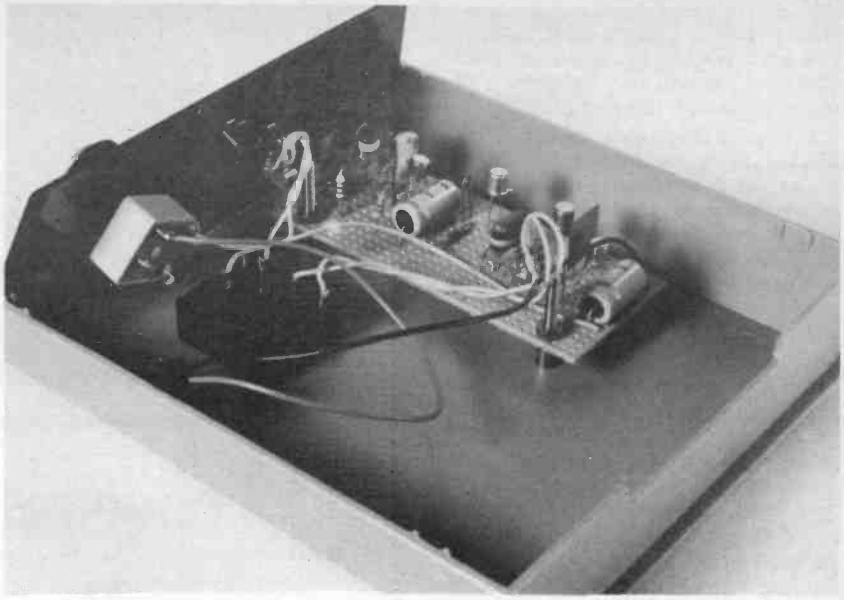
Miscellaneous

B1 PP6 battery and connector.
Case measuring about 150 × 135 × 55mm (Teko Nuova, size TEKD13, available from West Hyde Developments).
0·1in matrix stripboard 13 strips × 34 holes; control knob; wire; solder.

Fig. 4. Circuit diagram for the infra-red receiver.



INFRA RED RECEIVER



The completed receiver with top cover removed showing positioning of the circuit board, relay, on/off switch and output socket. If the front panel is not translucent then a hole will have to be cut opposite the infra-red photo diode D1. This diode can be seen to the right of the output socket.

COMPONENTS
approximate cost **£13** complete

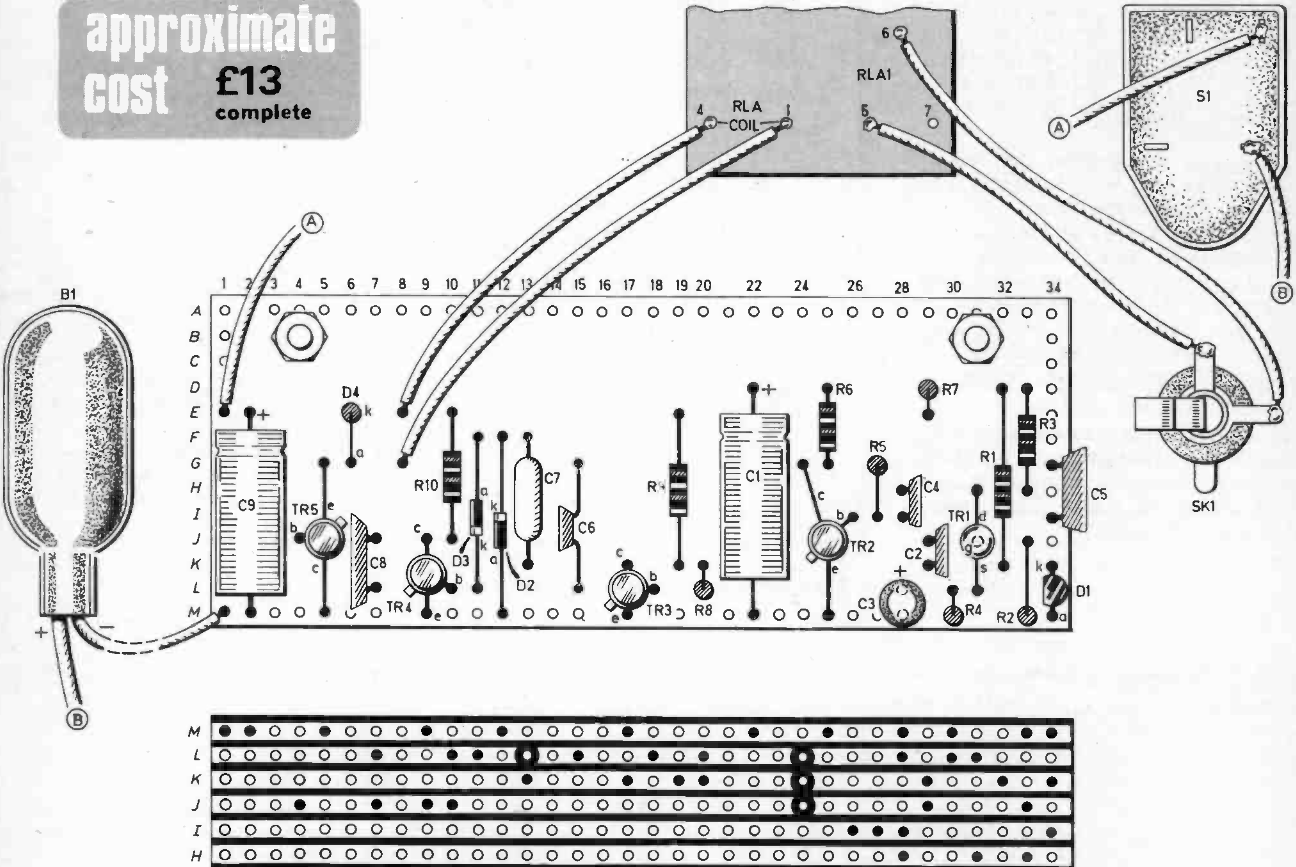
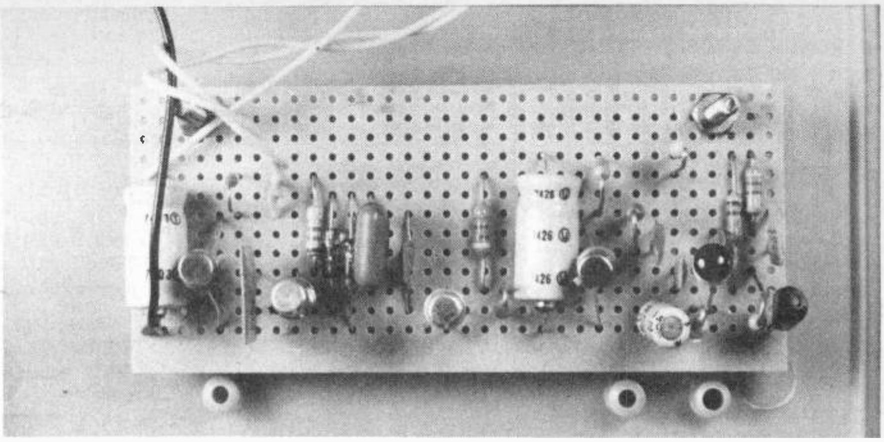


Fig. 5. Receiver circuit board component layout, underside details and interwiring to the off-board components.

RECEIVER CONSTRUCTION

Except for the battery, output socket, relay, and on/off switch, the components are assembled on a 0·1in matrix stripboard. This has 13 copper strips by 34 holes and is detailed in Fig. 5. This diagram also shows the connections to the off-board components.

Construction of the board is quite straightforward, but note that D2 and D3 are germanium devices, and are therefore relatively easily damaged by overheating when they are being soldered into circuit. It is advisable to either apply the soldering iron to the joints for no more than about one or two seconds when connecting these two components, or to use a heatshunt on their leadouts while connecting them.



The receiver circuit board. The photo diode can be seen at the bottom right corner.

CASE

The prototype is housed in a plastic case having approximate outside dimensions of 150 x 135 x 55mm. S1 and output socket SK1 are mounted on the front panel. The latter is made from a clear, red-tinted plastic material on the specified case, and this is virtually transparent to the infra-red beam from the transmitter. This permits the component panel to be mounted on the base panel of the case so that the sensitive surface of the detector diode (its curved surface) is close to and facing the front panel. The diode can then pick-up the infra-red beam through the front panel. The panel does, of course, absorb some of the infra-red radiation, but this only results in a marginal reduction in the range of the unit and does not seriously degrade performance.

If a case having an opaque front panel is used, a hole must be drilled in the front panel, and the component panel mounted so that D1 fits immediately behind this hole, so that the infra-red beam can pass through to D1.

RELAY AND LOAD

The relay is mounted at any convenient place on the base of the cabinet, and most modern types can simply be glued in position using a good quality general purpose adhesive. A few types will require a mounting bracket of some kind to be fabricated by the constructor.

On the prototype the relay contacts are connected to a 3·5mm jack socket, and this then connects to the projector via a twin lead terminated in the appropriate plugs.

If the unit is used to control a load that is powered direct from the mains, the output socket should be be a type which can be connected to the mains supply without any risk of dangerous mains wiring being exposed. Alternatively, the cable from the controlled equipment can be taken through a hole drilled in the case and connected direct to the relay contacts.

USING THE SYSTEM

The completed system requires no adjustment of any kind, and the relay should open and close in sympathy with operations of S1 on the transmitter if the output from the transmitter is directed towards the photodiode of the receiver. The photo-diode detector is sensitive over quite a wide range of angles, and the output from the transmitter is well dispersed.

Therefore, at short and medium ranges it is not essential for the transmitter to be aimed very accurately at the receiver. When used towards the limit of its range (about 9m or so), the aim of the transmitter is inevitably more critical though.

Of course, the system will not work if there is an obstruction between the transmitter and receiver, unless the object is reasonably transparent to infra-red (such as a window).

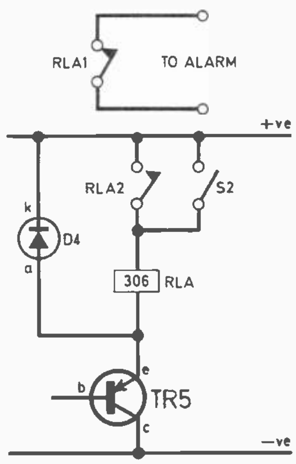


Fig. 6. The circuit can be modified to operate as a broken beam burglar alarm.

If the system is used in an application where the receiver will be switched on for very long periods of time, it would be advisable to use a mains power supply, or Ni-Cad rechargeable cells would also be a practical power source.

BROKEN BEAM ALARM

The system can be used as a broken beam type burglar alarm, but the receiver must be modified in the manner shown in Fig. 6.

S2 is an additional switch that is closed when the circuit is first set up, so that the circuit to the relay is completed. When the infra-red beam is received by the unit, additional normally open relay contact RLA2 closes, and completes the circuit to the relay. S2 can then be opened.

If an intruder breaks the beam, relay coil. When the intruder has passed through the beam and it is picked up by the receiver again, TR5 will switch on, but will not be able to drive the relay as relay contacts RLA2 will remain open. Thus, once the beam has been broken, the relay latches in the off state.

The first set of relay contacts can either be of the normally closed type, and used to directly control some form of alarm, or they can be wired into a comprehensive alarm system.

RELAY

The specified relay is unsuitable for use in this modified circuit since it has just one set of contacts. However, the circuit can employ any relay having a 6/12 volt coil with a resistance of about 185 ohms or more, and sufficient contacts of the required type. It would be normal to use key type switches in the circuits.

As the transmitter and receiver circuits will be left running for long periods in this application, both should be run from mains power supplies or rechargeable batteries ⌑

INTRODUCTION TO LOGIC

PART 7 BY J. CROWTHER

THE "NOR" GATE

"NOT OR" means, that we do NOT get an output if A OR B are logic 1.

Boolean Equation

Since $A+B$ means A OR B, and a bar means NOT, it follows that:

$\overline{A+B}$ means "NOT A OR B"

So the Boolean equations for a NOR gate are:

$\overline{A+B}=S$ for two inputs

$\overline{A+B+C}=S$ for three inputs

If we apply Demorgan's Theorem to $\overline{A+B}$ we get $\overline{AB}$ which represents two normally closed switches or relay in series. Therefore a NOR gate may be represented by relays as in Fig. 7.1.

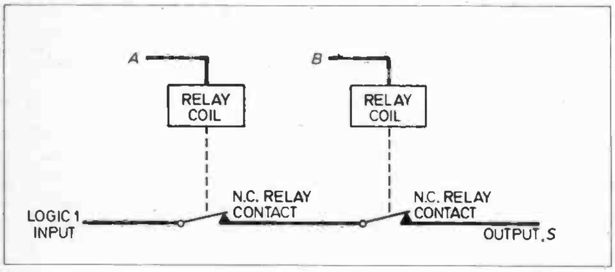


Fig. 7.1. A 2-input NOR gate realised using two normally closed relays connected in series.

Truth Tables

Two Inputs

Inputs		Output
A	B	$\overline{A+B}=S$
0	0	1
0	1	0
1	0	0
1	1	0

Three Inputs

Inputs			Output
A	B	C	$\overline{A+B+C}=S$
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Symbols

By comparing the above truth tables with those for the OR gate it can be seen that they are the inverse, therefore the "NOR" gate is an OR gate followed by a NOT gate and the symbol shows this.

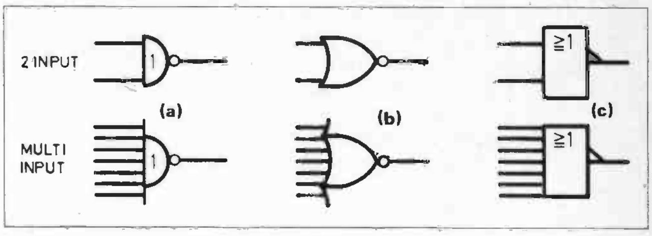


Fig. 7.2. Three different types of symbol for representing a NOR gate in a circuit.

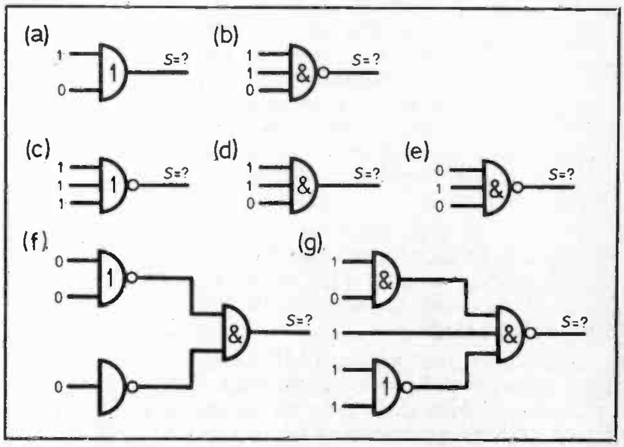
SUMMARY OF LOGIC GATES

Symbol	Equation	Definition
AND	$AB=S$	Output if A AND B are logic 1
OR	$A+B=S$	Output if A OR B is logic 1
NAND	$\overline{AB}=S$	No output if A AND B are logic 1
NOR	$\overline{A+B}=S$	No output if A OR B is logic 1
NOT	$\overline{A}=S$	Changes logic 1 to logic 0 and logic 0 to logic 1

Fig. 7.3. The five basic logic gates and their definitions.

Exercises

7.1. Derive the output state at S for the following gates and combination of gates.



EFFECTS OF LOGIC REVERSAL

It has been stated previously that positive logic is when the positive half of the waveform is defined as logic 1 and negative logic when the negative half of the waveform is defined as logic 0.

It can be seen from the two diagrams, Fig. 7.4 and Fig. 7.5, that in the transition from positive logic to negative logic, what was originally a logic 1 becomes logic 0 and vice versa.

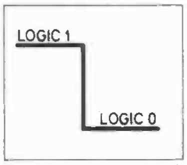


Fig. 7.4. Positive logic.

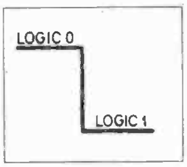


Fig. 7.5. Negative logic.

Now the truth table for a two input AND gate using positive logic would be:

Inputs *A*	*B*	Outputs *S*
0	0	0
0	1	0
1	0	0
1	1	1

However, if we now take the same AND gate but use negative logic, all the 1's in the table will become 0's and the the 0's will become 1's, the truth table will now become:

Inputs *A*	*B*	Outputs *S*
1	1	1
1	0	1
0	1	1
0	0	0

From this truth table it can be seen that there is an output if *A* is at logic 1 or *B* is at logic 1, that is it has become the truth table for a "positive logic" OR gate.

EFFECT OF LOGIC REVERSAL ON A NAND GATE

If we now examine the effect of changing from positive logic to negative logic on a NAND gate, again by using the truth tables, we get:

Inputs *A*	*B*	Outputs *S*
0	0	1
0	1	1
1	0	1
1	1	0

Truth table for a NAND gate using positive logic

Inputs *A*	*B*	Outputs *S*
1	1	0
1	0	0
0	1	0
0	0	1

Truth table for a NAND gate using negative logic

Once again it can be seen that the truth table for the NAND gate using negative logic is the same as the truth table for a NOR gate using positive logic.

From these two examples we have shown that the effect of logic reversal is to change AND gates to OR gates and NAND gates to NOR gates and vice versa.

For the purpose of this series we will be using the more common positive logic system.

CIRCUITS OF LOGIC GATES

Three circuit configurations can be used to achieve the basic logic functions.

(1) Diode-Resistor Logic (DRL)

Only diodes and resistors are used and since a diode is either "on" or "off" and cannot invert a signal, DRL circuits can only be used for AND and OR gates.

This type of gate has no power gain and consequently can only feed one or two inputs from its output. This configuration is sometimes referred to simply as Diode Logic (DL).

(2) Diode-Transistor Logic (DTL)

Diodes are used to obtain the logic functions and transistors give both inversion and gain, therefore DTL circuits can be used for all the basic types of gate and the output will feed up to three or four inputs.

(3) Transistor-Transistor Logic (TTL)

Transistors are used to achieve both logic and gain.

Since only transistors are used, the input impedance is high, which enables the gate to have more inputs (up to 13) and the greater power gain permits the output to feed up to ten inputs.

The number of outputs which can be fed to an input of a gate is referred to as **"fan-in"**, and **"fan out"** is the term applied to the number of inputs the output of a gate can supply.

TTL can only be used for NAND gates with positive logic, and NOR gates if negative logic is used.

THE "AND" GATE USING DIODE LOGIC

A three-input diode-resistor AND gate is seen in Fig. 7.6.

Suppose logic 1 is 6V, and logic 0 is 0V. If all the inputs were at 6V (logic 1), the diodes would be reversed biased and no current would flow through resistor R1, there would be no volts drop across R1 and the output would be at 6V (logic 1). This would also be the case if no connections were made to diode cathodes.

If any of the inputs dropped to logic 0 (0V), the diode in that input would be forward biased and conduct, current would now flow through resistor R1, and the voltage drop across R1 would cause the output to fall to logic 0 (0·6V approx.).

If the ohmic value of R1 was a lot larger than the forward resistance of the diodes nearly *all* the supply voltage would be dropped across R1 and the output would fall to almost 0V (logic 0).

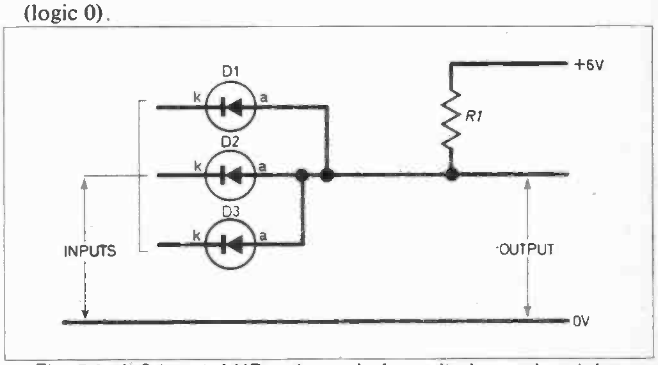
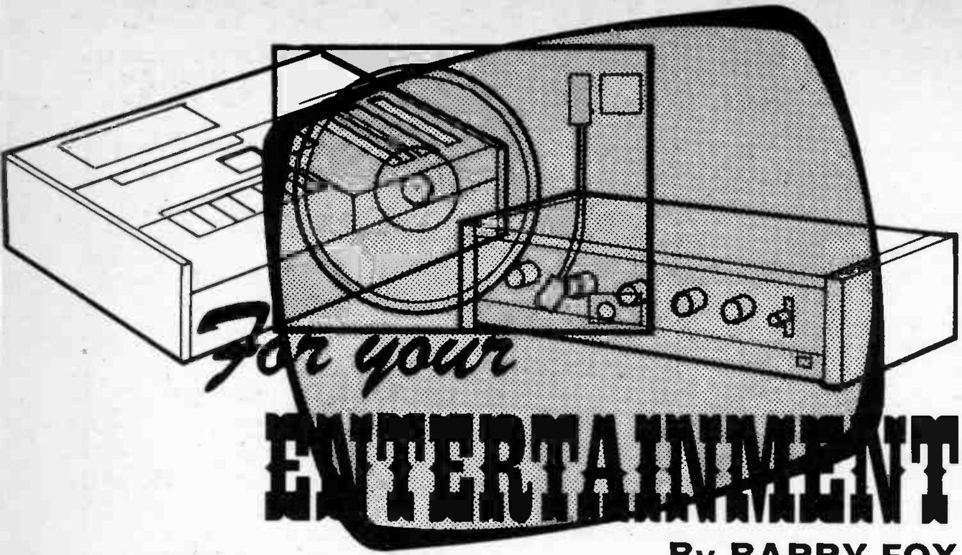


Fig. 7.6. A 3-input AND gate made from diodes and resistor.

TO BE CONTINUED



For your ENTERTAINMENT

By BARRY FOX

In the Picture

With very few exceptions, people who sell computers divide neatly into two types; the marketing men who know nothing about what they are selling and the boffins who communicate only with each other, cutting themselves off from the outside world by a moat of strange words.

Business users of computers can deal happily with the salesmen and computer enthusiasts can deal happily with the boffins. But this leaves a large grey area of potential users who would like to know more about home computers, but can't find anyone to explain the options open to them in plain, simple terms.

I chanced on an especially good example of this recently. In Japan I noticed that most desk-top computers, with built-in TV display screens, now offer a very high standard of resolution.

The words on screen are packed into 24 or 25 horizontal rows, each with space for 80 individual characters, and all very clearly legible. Compare this with some Western home computers and both teletext and viewdata, which offer only 40 characters in each of 24 rows.

The picture on the screen of a European TV set (as used to display teletext, viewdata and the output of some Western home computers) is built up from a raster of 625 lines. In Japan and the USA the raster is more coarse, at 525 lines.

So is higher definition achieved by increasing the number of lines in the raster? Or what?

Astonishingly I couldn't find anyone, either in the firms selling desk top computers with high definition displays, or amongst people who earn their living writing about them, who could answer the question. The marketing men could tell me about prices and the boffins could talk at length about programming. But no one could answer the simple question; how many TV lines go to make up the picture on the screen of a high definition home computer?

The computer experts couldn't relate to TV technology and the TV experts couldn't relate to computers. But by piecing together a few available facts I can offer a reasonable explanation for why the graphics and characters on some displays look clearer than others.

Teletext

Let's start with teletext and Viewdata, as available on modified domestic TV sets. The teletext or viewdata picture page is made up from 24 rows of information, with up to 40 characters in each row. Each character is created by lighting up appropriate groups in a rectangle seven dots high and five dots wide, a so-called 7×5 matrix.

For normal domestic television in Europe there are 25 pictures a second each formed from 625 horizontal lines. Fifty of these lines are lost for field blanking, which leaves 575 active lines for each picture. To prevent flicker the picture is formed from two interlaced scans of less than 300 lines each and written 50 times a second.

Domestic teletext is displayed in the same way. But professional Viewdata displays don't interlace the two fields, they write one over the other. This still prevents flicker (because the picture is being written 50 times a second instead of 25) and produces a much more precise and bright image.

The line structure is of course relatively coarse, only around 300 lines, which would be quite unacceptable for ordinary photographic reproduction. But for characters and graphics it is quite acceptable. Clarity can be further improved by making the display work in a digital fashion, the beam switching between white and black rather than through the scale of grey needed to reproduce photographic pictures.

A raster of around 300 lines is still perfectly adequate to write 24 rows of characters, each made up from a matrix 7 dots high, because this only needs 168 lines. The remaining lines go to provide the spaces between the rows and at the top and bottom of the picture.

Home Computers

Home computers rely on 24 or 25 rows of characters. To have more rows would make the writing illegible. So a home computer can easily feed display signals into a conventional TV set working on 525 or 625 line standard.

Alternatively, the home computer can have its own built-in screen and this needn't adopt any conventional TV line standard. For instance, one Japanese computer uses a 336 line raster to provide 24 rows of characters each formed from 7×11 dot matrices in 10×14 dot areas.

Simple arithmetic shows that 24 rows of character areas, each 14 dots high, equates with the raster of 336 lines. The spaces between rows are created because the characters are produced by the 7×11 matrix *inside* the 10×14 areas. Although it proved impossible to get useful information from the importers, it seems clear that the 336 line raster is over-written rather than interlaced.

Character Counts

The real difference between high definition home computers and low definition home computers, or teletext and Viewdata displays, is in the number of characters per row. Most home computers that plug into a domestic TV set offer only 40 characters per row, like Viewdata and teletext.

It can be argued that 40 characters a row is more than enough and that 80 characters a row produces a message which is too complex to read. But the real reason why designers use 40 characters instead of 80 is video bandwidth.

To write 80 characters in each row it is necessary for the scanning electron beam to change from light to dark very, very rapidly. This in turn means that the control signals must have a very wide bandwidth.

A domestic TV set may have a video resolution of no more than 4MHz, whereas a professional monitor or display screen of the type built into a high definition computer may have a bandwidth of around 12MHz. If you feed an 80 character-per-row signal into a low bandwidth TV set, the characters will smudge into each other on screen. Also definition on a colour screen will often be worse because of the shadowmask used to separate the red, green and blue phosphors.

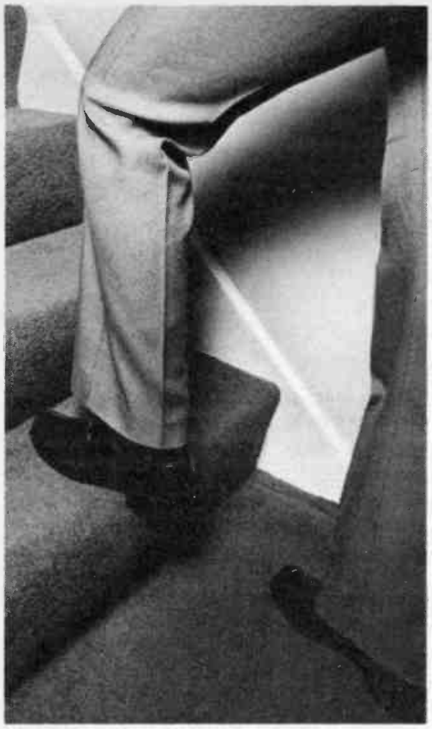
Only highest quality displays can cope with an 80 character signal. This is why the BBC, IBA and Post Office opted for 40 characters per row for teletext and viewdata. They wanted to put out signals which could be received by the lowest common denominator sets.

It's why home computers which are intended for use with a domestic TV set as display screen usually opt for 40 characters per row. And it's why computers which have a built-in monitor can offer 80 characters per row.

The designers simply ensure that the display screen and circuits can handle the bandwidth necessary to write 80 characters per row without smudging. A new tube from Mitsubishi can display more than 4000 characters at a time, in full colour!

The advantage of 80 characters is obvious, you can get more information on the screen at the same time. The disadvantage is that you may have difficulty in displaying that information on anything other than a screen designed for the system.

This of course explains why some home computers can be sold at enticingly low prices, and some systems with in-built displays appear surprisingly expensive. All the signs are that the next Japanese onslaught into Europe and America will be with high definition home computers, at enticingly low prices.



PRESSURE MAT TRIGGER ALARM

BY A.R. WINSTANLEY

THIS SIMPLE i.c. project has been specially designed as a control unit for pressure (or trigger) mats. The Pressure Mat Trigger Alarm has two inputs, each being a normally open pressure mat. The mat closes the circuit when an intruder steps onto it, and then an indicator lamp illuminates on the alarm unit. A warning buzzer also sounds.

Even if pressure is then removed from the mat, the lamp and buzzer will continue to operate as this design has a built-in latching action.

POWER SUPPLY

Power can be derived from the mains by means of a nine volt battery eliminator. Designs for these appear from time to time in *EE*. A rating of 9V 50mA will be more than ample.

Alternatively battery operation is possible. For short periods a PP3 battery can be used but if prolonged use is desired then a larger type is recommended.

TWO CHANNELS

The circuit diagram is shown in Fig. 1 where IC1 is a TL082 twin op-amp integrated circuit. This contains two separate operational amplifiers sharing a common power supply. One amplifier is used per channel and the circuit of just one channel will be described. The other circuit operates in an identical manner.

CIRCUIT DESCRIPTION

The resistors R1 and R2 form a potential divider holding the non-inverting input of IC1a at about 2V. The other input would be held at more than this by R3 and R4, say 3V, and so, by comparator action, the output (pin 1) of IC1a is low. This also holds the non-inverting input at a low voltage.

This means that D1, the visual indicator for channel 1, cannot therefore illuminate.

Once the normally open pressure mat on channel one is closed by an intruder standing upon it, then the inverting input is grounded to 0V, and so the output of IC1a will go high. The voltage at the non-inverting input slightly exceeding that at the inverting input causes this effect.

The output, being fed back to the non-inverting input, also holds this input high. Even if the pressure mat is now opened (weight being removed from the mat) pin 3 is still held at almost 9V, and pin 2 at only a couple of volts. The output therefore remains high. In other words, the circuit has latched.

Diode D1 will also illuminate. This high signal is directed by D2 into the base of TR1, a transistor connected as an emitter follower, with an audible warning device (WD1) as its load. The buzzer therefore sounds.

AUDIBLE WARNING

In this application a solid-state buzzer is used which draws roughly 15mA when sounding. Conventional electro-mechanical buzzers are not suitable in this circuit.

The lamp and buzzer continue operating until S1 is pressed. This normally closed push-button temporarily removes power from the circuit, so that when S1 is closed again, the two op-amps take up their quiescent state as described earlier.

The other channel built around IC1b functions in a similar fashion. Diode D3 is the indicator lamp for channel two, and the output signal is coupled via D4 to TR1, which operates the buzzer WD1 as before.

COMPONENTS

Resistors

R1 100kΩ
R2 33kΩ
R3 68kΩ
R4 33kΩ
R5 560Ω
R6 100kΩ
R7 33kΩ
R8 68kΩ
R9 33kΩ
R10 560Ω
All ¼W carbon ± 5%

See Shop Talk page 737

COMPONENTS approximate cost £8·50 excluding mats

Capacitors

C1, 2 10μF 10V elect. (2 off)

Semiconductors

IC1 TL082CP dual op-amp
TR1 ZTX300 *npn* silicon
D1 TIL220 red l.e.d.
D2 1N4148 small signal silicon diode
D3 TIL220 red l.e.d.
D4 1N4148 small signal silicon diode

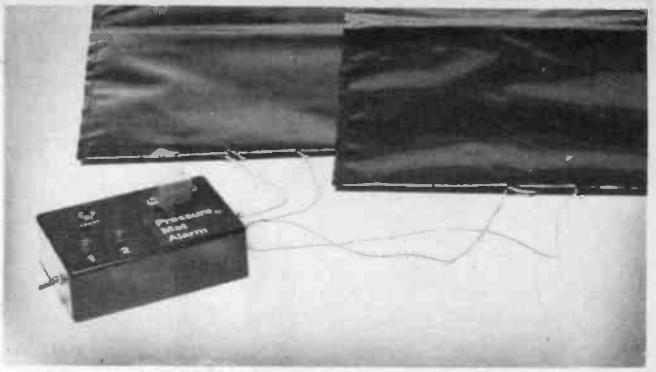
Switches

S1 push-to-break, release-to-make single pole
S2 s.p.s.t. toggle

Miscellaneous

WD1 9V solid state audible warning device
TB1 three-way screw terminal block
B1 9V PP3 type
Plastics case, 116 × 77 × 35mm, type PB1 (Maplin), or similar; stripboard, 0·1 inch matrix, 10 strips by 24 holes; pressure mats with normally open contacts (2 off); 8 pin d.i.l. i.c. socket; battery clip to suit B1; connecting wire to link up trigger mats to alarm unit; 6BA nuts, bolts and spacers to mount circuit board (2 off each); hook up wire.

Outside view of the finished unit. The terminal block for the pressure mat connections is shown on the right.



The control box wired into the pressure mats. The relative scale s of the unit and pressure mats can easily be seen.

CONSTRUCTION starts here

CASE

A plastic case type PB1 can be used if an external power source or a PP3 battery is used. This case measures 116×77×35mm but any other type of case with suitable dimensions can be used. If larger batteries are employed then a larger box may be needed.

The drawing in Fig. 2 shows the arrangement of electronic components on the 0·1 inch matrix stripboard, which measures 10 strips × 24 holes (standard size). The assembly is fairly compact, and quarter watt resistors must be used.

During assembly take care to orientate the transistor and diode leads correctly, and do not subject them to excessive heat during soldering. It is best to use a heatshunt if you are in any doubt.

I.C. SOCKET

The i.c. is not particularly cheap and it would be wise to protect it from the rigours of soldering by using an 8-pin d.i.l. socket. Obviously it is important to plug the chip in the right way round.

The stripboard can be bolted to the lid of the box with 6BA hardware and two clearance holes exist in the stripboard for this purpose. There are quite a few flying leads coming off the board, and using several colours of insulated wire may help in identification. General purpose multi-stranded wire can be used throughout.

FINISHING OFF

Connections to the pressure mats are made by a three-way screw terminal block TB1, one terminal being common to both loops. Three wires from the terminal block pass through a hole in the case to the stripboard within.

Similarly, the buzzer is mounted on the front with 8BA hardware, and its two connecting leads pass through an

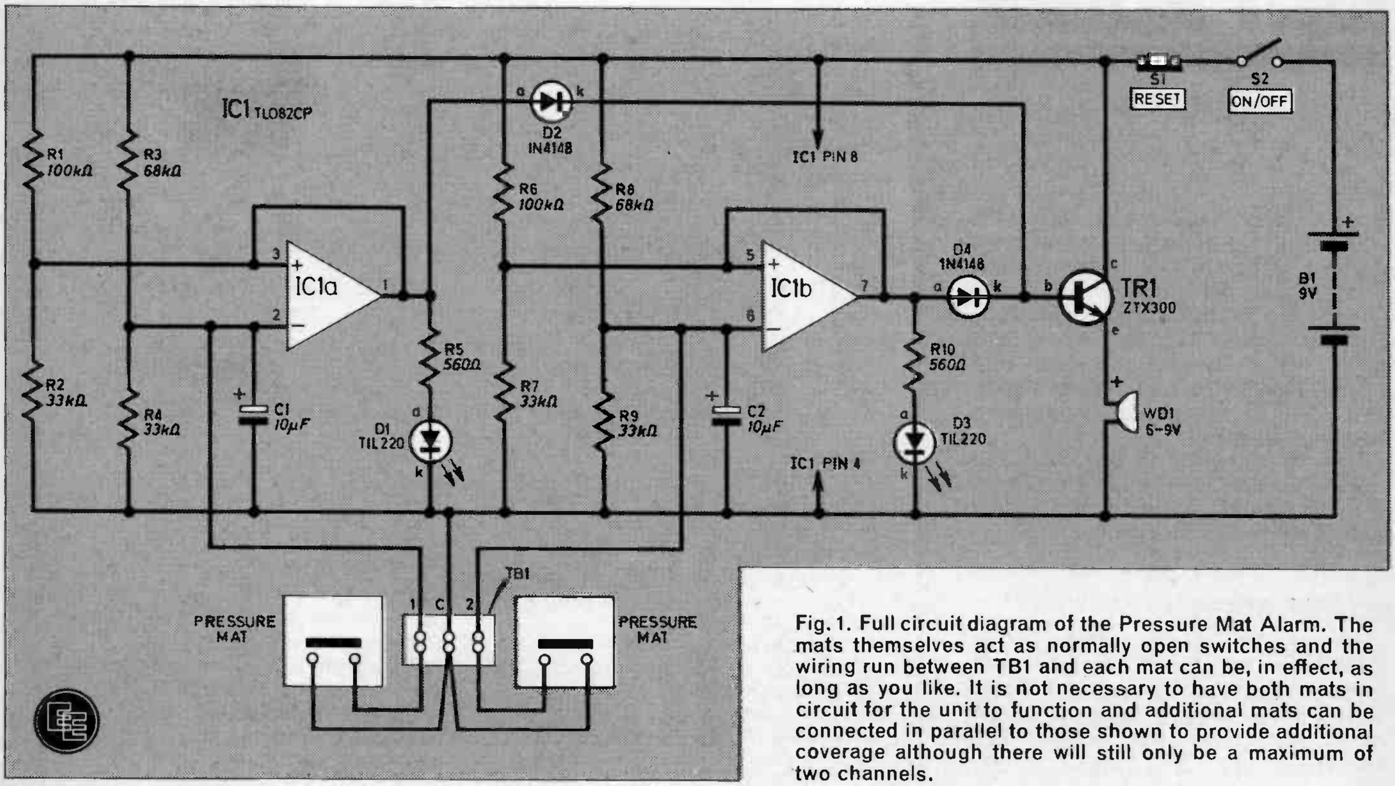
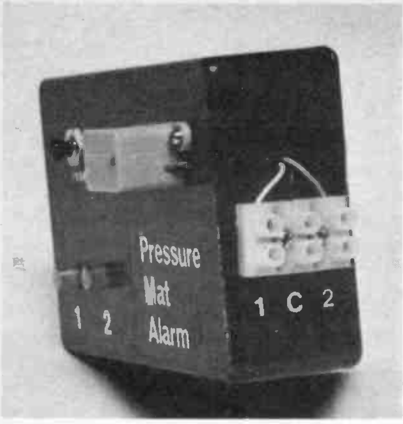
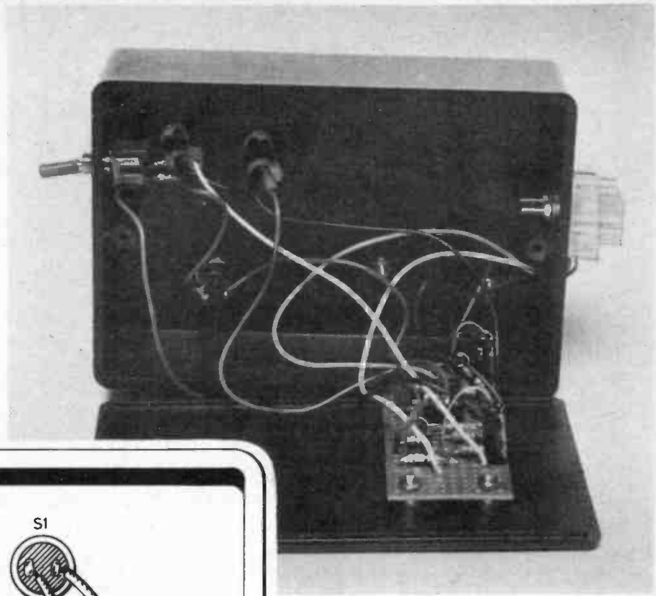


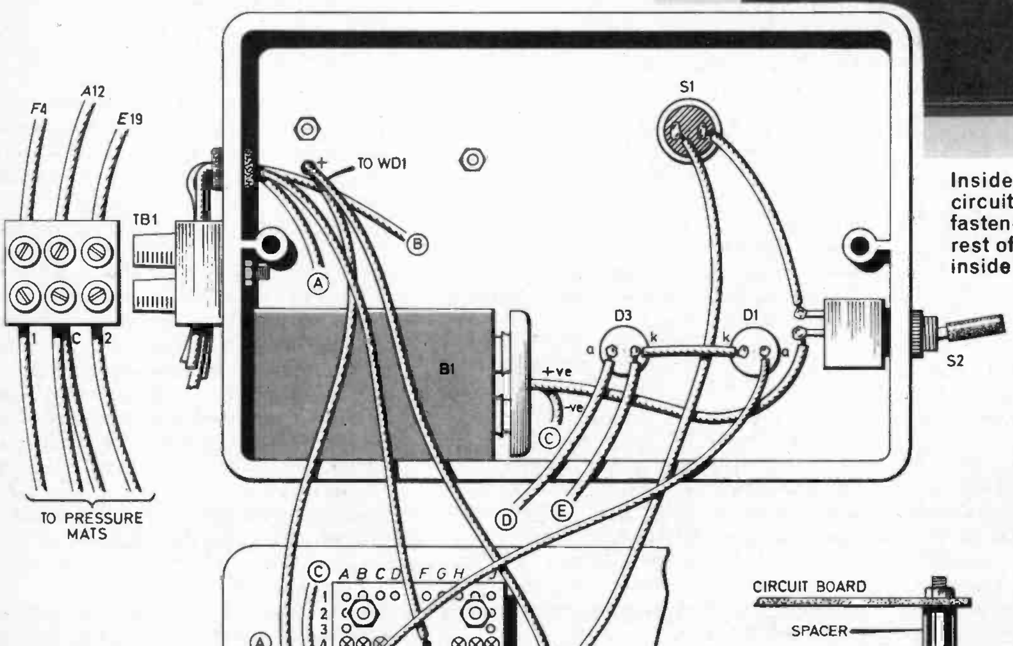
Fig. 1. Full circuit diagram of the Pressure Mat Alarm. The mats themselves act as normally open switches and the wiring run between TB1 and each mat can be, in effect, as long as you like. It is not necessary to have both mats in circuit for the unit to function and additional mats can be connected in parallel to those shown to provide additional coverage although there will still only be a maximum of two channels.

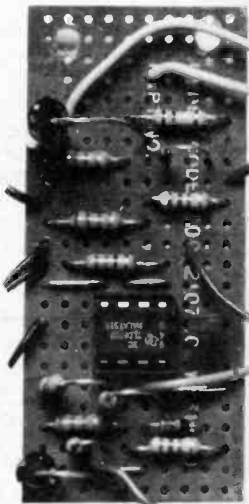


(left) End on view of the case showing the terminal block with each channel clearly marked and the buzzer with its connecting wires passing through a convenient hole in the case.



Inside view of the case. The circuit board can be seen fastened on the box lid with the rest of the components mounted inside the case.





The completed circuit board.

Fig. 2. Circuit board layout and component interwiring. Everything is contained in the one box apart from the pressure mats. These are not shown but their connections to the terminal block can be seen top left.

adjacent hole to the component panel within.

The two 0·2 inch light-emitting diodes D1 and D3 can be affixed to the front panel with the clips supplied with the l.e.d.s.

TESTING

With construction finished check out all the wiring thoroughly and then switch on. The buzzer may initially sound (and both l.e.d.s illuminate) but pressing S1 should reset the buzzer and extinguish the indicators. Shorting out the loop terminals should illuminate the appropriate l.e.d. and cause the buzzer to sound. Pressing S1 should reset the l.e.d. and buzzer once more.

You can hide the pressure mats in any suitable location but the mats must be on a flat surface. Several mats can be wired in parallel thus increasing the protection afforded by the system. However, the loop wires are not tamperproof and must be hidden under the carpets, or otherwise shielded.

Loop lengths of about 10 metres have been tried on the prototype unit with great success and this distance could easily be exceeded with good results.

Transient protection appears to be good and there should be little danger, if any at all, of the alarm being triggered by transients on the loop wires or power rails. ⌑

SQUARE one FOR BEGINNERS

FOR BEGINNERS

THE most common way to interconnect electronic components is to use a technique called *soldering*. Besides providing an excellent electrical connection a fairly strong mechanical fixing is also produced.

In soldering, a metal alloy called solder (made from lead and tin) is melted on to the metal surfaces (such as component leads, tags, pins and tracks) that are to be joined together and then allowed to cool and solidify. The solder becomes bonded to the surfaces to form a soldered joint.

SOLDERING IRON

To melt the solder an electric soldering iron is required. Irons intended for other work such as those heated in a flame or furnace of any kind are very definitely not suitable for electronics work.

The business end of an electric soldering iron is the bit, located at the tip of the iron. This is heated by conduction from the heat generated in an element fitted in the shaft of the iron. The element is usually heated by mains a.c. voltage.

Irons are classified by their heat capacity measured in watts; one rated between 15 and 25 watts will be suitable for all projects in *EE*. A selection of bit sizes say 1·5, 3 and 4mm diameter will meet the majority of requirements. The smallest will be ideal for soldering i.c. leadouts and the largest when making connections to the tags on potentiometers, switches and can-type capacitors for example.

SOLDER

The only solder really suitable for reliable soldered joints in electronic equipment is the type containing a flux, such as Ersin Multicore Solder which contains five cores of flux throughout its length. This is a non-corrosive flux which quickly cleans oxidised surfaces.

This may be bought in dispensers or on reels. At first the reels appear to be very expensive but are more economical than dispensers in the long term. Other fluxes or cleaning acids and chemicals should never be used on electronic equipment.

New bits are sometimes coated with a thin layer of protective grease for protection during storage and this should be wiped off before use with a damp cloth containing a little detergent such as washing up liquid.

TINNING THE BIT

Before commencing soldering, especially with a new bit, it should be tinned. This is done by plugging in the iron and when the bit is hot, melting solder on the bit so that it flows evenly over it, see Fig. 1.

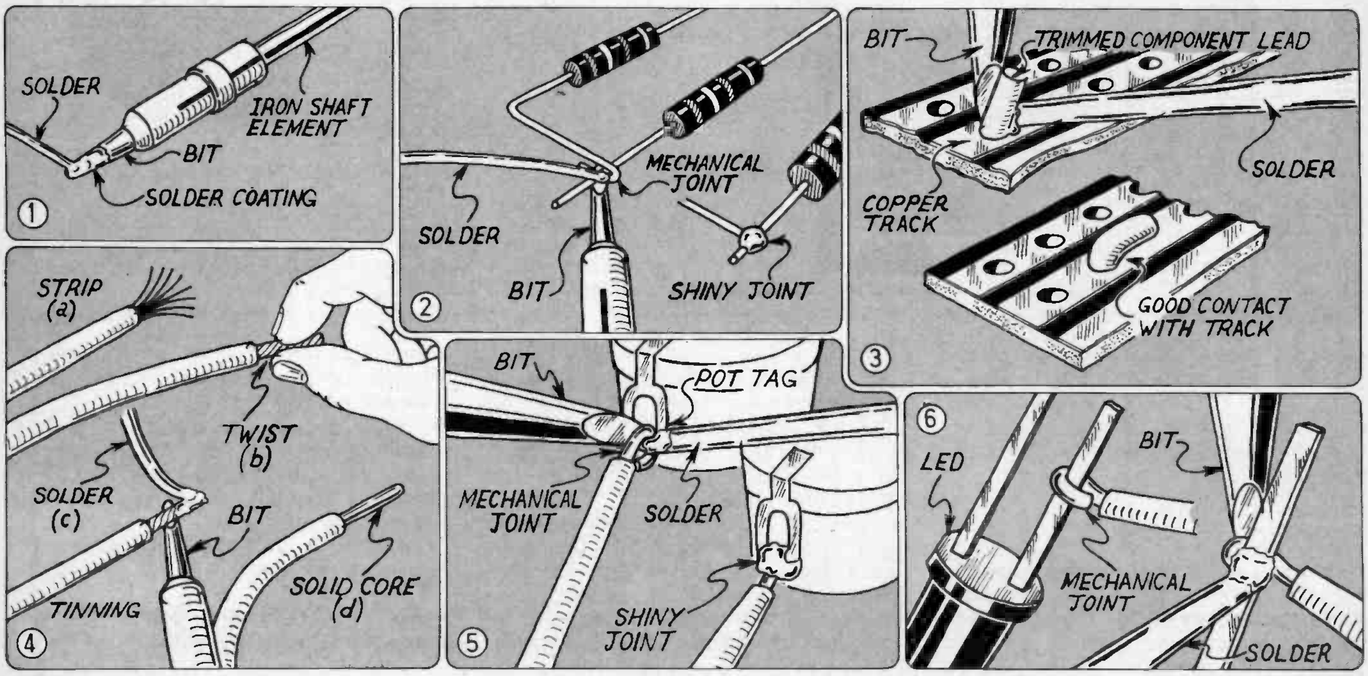
Excess solder may be wiped off on a piece of damp sponge fitted somewhere on the bench or iron stand. You will need this frequently during soldering to periodically wipe away any flux and solder that accumulates.

SUCCESSFUL SOLDERING

You will encounter many different kinds of connection between components and hardware but whatever type of joint is being made the same basic rules of soldering must be observed in order to obtain a good joint.

1—The iron should be tinned.
2—Both surfaces to be bonded must be perfectly clean and free from grease.
3—The surfaces to be joined together must be in good contact.
4—The bit must be used to simultaneously heat both surfaces.
5—The solder should be melted around the contact area, and not on the iron, and allowed to flow.

Continued on page 766



Continued from page 764

6—Remove the solder followed by the iron.

7—Do not disturb the joint while the solder is solidifying naturally.

A good joint will be seen to be smooth, shiny and globular in shape. If the above rules are not obeyed, a dry joint is the likely outcome. The main causes for such a joint will be due to 2 and 7 above. A dry joint may appear mechanically sound (many are not) but no electrical contact is made and the circuitry will not function satisfactorily—if at all. A dry joint has a dull ragged appearance.

CIRCUIT BOARDS

Soldering component leads to Veroboard or printed circuit boards (p.c.b.s) is fairly straightforward. Trim the lead so that only about 3mm protrudes beyond the copper track. The leads pass through small holes surrounded by copper (tinned copper in the case of a p.c.b.). Bending the lead slightly to make contact with the copper plate is sufficient. Alternatively, the lead may be bent at 90 degrees on to the copper to increase the contact area and at the same time make a semi-mechanical joint, see Fig. 3.

Place the bit so it makes contact with both lead and track and apply solder to the joint (not the iron) so that solder flows evenly. Remove solder followed by iron.

Veroboard is protected by a thin coat of lacquer to prevent tarnishing. However, if the copper is tarnished rub with emery cloth before soldering.

Most component lead-outs and tags are nowadays solder tinned during manufacture or plated with a non-tarnishing metal. However, tinned leads do become "dirty" and it is wise to clean them with emery paper before soldering if this is the case.

If too much tinning is removed, re-tinning is advised for easier soldering. This is done by heating the lead with the bit and applying solder to the lead (not the bit) so that solder flows evenly over its surface.

A much stronger joint can be made by making a mechanical joint prior to soldering, see Figs. 2, 5 and 6.

STRANDED WIRE

Soldering p.v.c. covered stranded wire to a component tag, pin or circuit board for example can often be a problem for the beginner.

Strip off about 8mm of insulation and using thumb and index finger twist all the strands together. Place a tinned bit at the extreme to heat up the wire and then melt solder onto the wire, see Fig. 4.

The solidified solder produces a solid core which is suitable for a number of different types of connection. It may be formed into a hook when connecting to a tag on a potentiometer or switch (Fig. 5) or another solid lead such as that from an l.e.d. (Fig. 6). It is also ideal for connecting to a screw terminal block in a straight or U-shaped form.

When it is to be soldered to a circuit board it can now be treated in a similar fashion to a component lead. However, when soldering a lead to a solder tag it has been found easier not to tin the wires, but to thread the strands through the eyelet, loop and twist tightly before soldering.

LETTERS

Lively Tune

I hope you will allow some comment at this late stage on the article on the theme of "Keep Music Live" (see *For Your Entertainment*) written by Barry Fox in your July issue.

For his advance warning on the horrors heading our way from Japan we are grateful but on his vague general observations his article seems to be unduly pessimistic, and, in some ways, already out of date.

The argument about discos versus bands I suppose will go on forever but the fact is that despite the problems that Mr Fox dwells upon many venues find that a "live" group, by virtue of its presence and the entertainment value of living people performing in front of audiences can far outweigh the superficial "minus" of their inability to reproduce the complex and/or doctored sounds heard on record.

The picture of "unenterprising and anaemic mock-ups of top twenty tunes" is in itself in danger of becoming a tired cliche. I don't know when Barry Fox became an ex-musician, but for years now it has become evident that there are scores of locally based "semi-pro" groups, electronically based, who produce amazingly competent and lively versions of a wide range of contemporary pop material.

At a completely different level, in most major cities music, frequently rock orientated, of real excellence can be heard in dozens and dozens of pubs—the new home of live music. The fact that this presents us with complex trade union problems in trying to gain a fair wage for musicians is a separate issue which in no way denies the validity of the fact that many otherwise "sad" pubs are given an enormous boost in trade by the presence of live musicians.

Then there is the touching belief that recorded music always starts on time. It does not appear to have struck Barry Fox that the mobile disco operators are also human beings with all their frailties. They are quite capable of arriving late, they are quite capable of not being able to provide what the public wants and they are quite capable of leaving behind dissatisfied customers at certain kinds of functions who wish that they had booked a band who would at least have been capable of responding with a greater flexibility to their needs.

Also, with all the sub cultures which abound in the consumption of popular music it is becoming difficult even for the mobile disco to provide just what it is that their hypothetical audience is supposed to need. The approaching middle aged swinger in his late thirties toting round his box of 60's soul classics is hardly likely to go down a storm at the local youth club, for example.

Referring to the two apparently contradictory motions from the Central London Branch which Barry Fox quotes. In the case of the first resolution asking for a fee which takes account of extremely early arrival—let us imagine that a musician is supposed to perform, in shall we say, Sheffield. I doubt that as an ex-musician even Barry Fox would think it reasonable that his/her fee would take no account whatsoever of the time taken to travel to fulfil the engagement in Sheffield assuming the musician was starting from London.

There is no inconsistency in asking for a fee which allows for the amount of time to be taken in fulfilling the engagement. Presumably even a mobile disco operator must build this time element into his fee.

But the second motion, about the deterioration in the casual dance business is not necessarily linked to the former at all. Because of the exigencies of the record business it is a sad fact that many excellent bands who put on tremendous live shows for the public who frequent the halls that they perform in do nowadays lack glamour and "image" through no fault of their own. This is an extremely complex problem and it is this aspect that was built into the attempt to get the problems of the band which keeps up to date with pop trends and yet still finds difficulty in touring discussed by a special working party of the Central London Branch Committee.

Finally, let me say that whilst the tone of this reply might appear to be somewhat hostile, we are grateful to Barry Fox for raising some of the questions. It does seem to me however that he is unduly negative in some of his conclusions and that whilst my reply on behalf of musicians cannot, in a discussion of this kind, be the final answer, we would urge that your readers, who presumably enjoy the work of live artists as well as those trapped forever between the grooves of vinyl or on video tape, will bear them in mind.

Brian Blain,
Musician's Union,
London SW9 0JJ.

PLEASE TAKE NOTE

Introduction To Logic Part 6 *(Sept. 81)*

Page 608. Under the heading "Similarly", the first line should read: "$A + B + C = \bar{S}$" and not "$A + \bar{B} + C = S$".

Page 609. Under the heading "Boolean Algebra Rules", the second line should read: "$\bar{A}$ means NOT A" and not "A means NOT A".

Audio Compressor Mixer *(Sept 81)*

In Fig. 1, page 615, C8 value should be amended to read "10µF".

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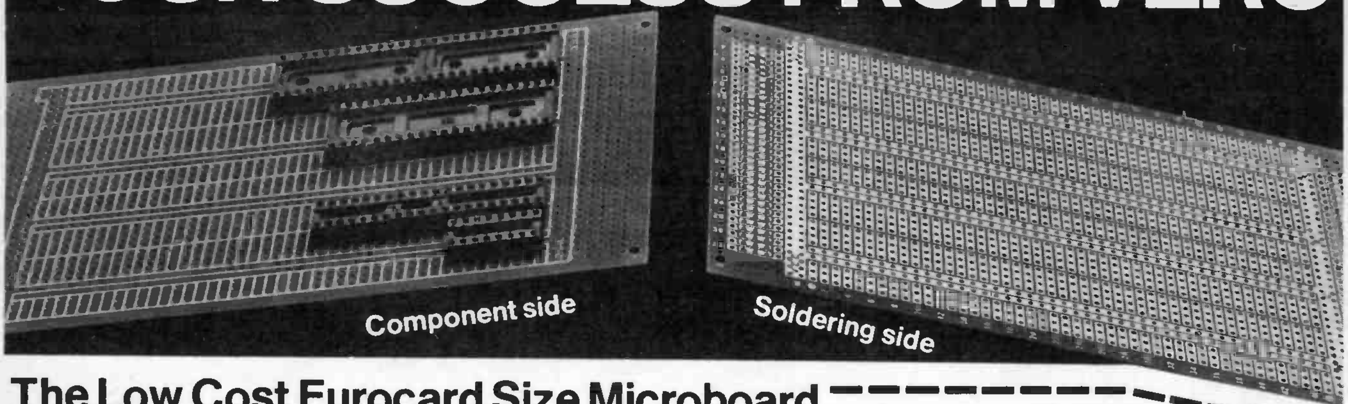

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CIRCUIT EXCHANGE

REACTION TIMER

This reaction timer indicates the players reaction time on a "non-related" scale. It does not show it in an actual time of a division of a second but simply on a comparing basis.

When switched on via S2, the machine will be automatically reset and the player must watch the decimal point closely, finger on S1. When the decimal point lights S1 must be pressed quickly to stop the clock which is clocking round. The lower the score shown the better. When the player takes his hand off the button it automatically resets and is ready for the next go.

There are three main stages: The delay pulse generator, IC2 and IC1b; the counter, IC1a and IC3; and the decoder and display, IC4 and IC5.

The delay pulse generator creates a brief pulse with S1 closed because of the simple Schmitt oscillator. This is inverted by IC2a and pin 8 on IC2c goes low, so the signal light comes on and C4 begins to discharge through VR2 which, when the voltage is low enough, enables IC3 allowing IC1 to clock. This runs at 50Hz, depending on the setting of VR1.

Diode D1 alters the freqency or mark/space ratio of the Schmitt oscillator output. It was found that without D1 the oscillator was too fast and I found I could never get a reaction time below nine.

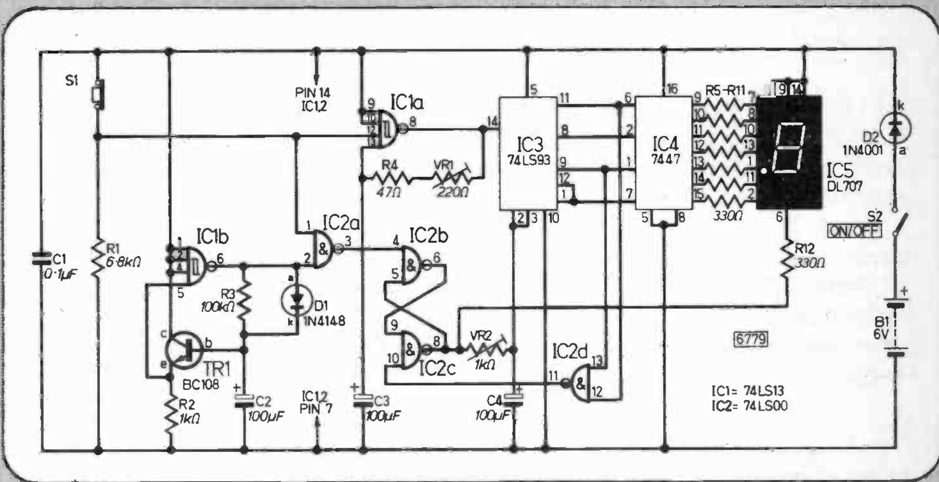
If the button S1 is not pressed it will clock to 10 (binary 1010) and make pin 11 of IC2 go low, resetting the latch for another go.

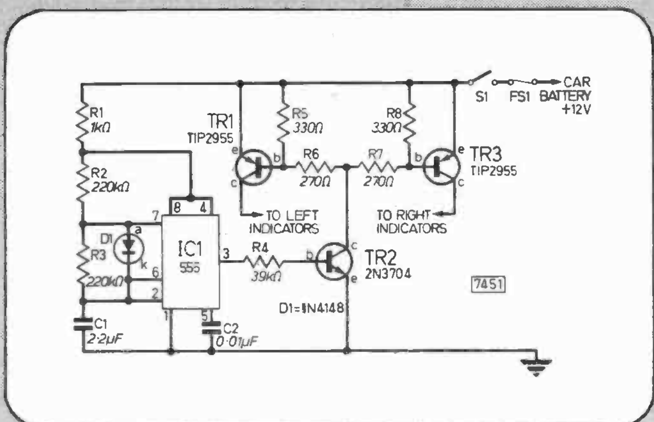
If during the clocking period S1 is pressed, pin 9 of IC1 will go low and stop the oscillator, leaving whatever number on the display still there.

Gate IC2a is there to inhibit pulses from IC1b when S1 is open, for this could set off the latch. Diode D2 is used to drop the 6V down to about 5·4V to make it usable for TTL. Capacitor C1 must be used and kept close to all the integrated circuits.

Potentiometer VR2 adjusts the delay and VR1 the speed of the clock. It should be set so an average time is 5 or 6.

J. Williams, Haddenham, Bucks.





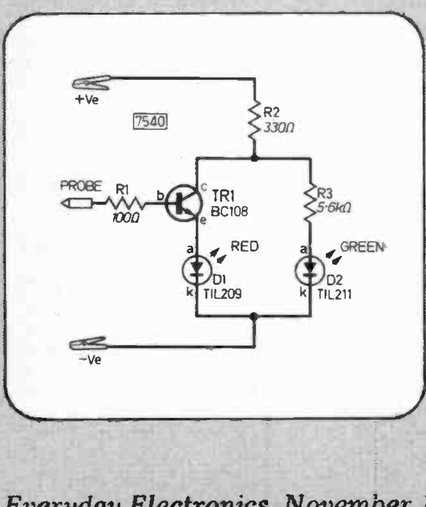
HAZARD WARNING FLASHERS

This design for hazard warning flashers, which I have successfully used on my own car, is based on a 555 timer i.c. wired as an astable multivibrator.

The external timing components have been chosen so as to provide the correct flash rate.

The collectors of the two TIP2955 transistors are connected directly to the direction indicator lamps and will cause no interference with the normal working of these indicators. These two transistors *must* be mounted on heatsinks.

K. P. Smith,
Eye,
Peterborough.



LOGIC PROBE

I have devised a simple logic probe for use with CMOS i.c.s.

If the input goes high (logic 1), the transistor is turned on and the red l.e.d. lights up. When the input is low (logic 0) the green l.e.d. will illuminate.

If a pulse brain signal is present at the input, then both the red and green l.e.d. will light up but at a reduced brightness due to them being pulsed on and off very rapidly.

The power can be taken directly from the circuit under test.

Andrew Evans,
Chorley,
Lancashire.

CIRCUIT EXCHANGE

RADIO WORLD

By Pat Hawker, G3VA

Lure of low power

Most of the radio amateurs I contact on the h.f. bands use c.w. or s.s.b. transmitters having a d.c. input power of about 40 to 200 watts, or occasionally 500 to 1000 watts. In the UK amateurs are limited to 150 watts d.c. input (s.s.b. 400 watts peak envelope power output).

When I first obtained my licence in the 1930s, British amateurs, at least for the first six months, were limited to a maximum of 10 watts input (a power limit that still applies on 1·8MHz). Today, 10 watts or less power input is regarded, on the main h.f. bands, as "QRP" operation. Strictly speaking, the international signal QRP is a request to reduce power, but amateurs generally use it to indicate that they are operating with very low power.

With a reasonably good transmitting aerial, 10 watt signals, particularly on Morse, still put out a very reasonable signal, although very vulnerable to being swamped by the "QRO" (high power) stations. For the experienced operator it is a challenge to work long distances when using low power.

I must admit that it is some time since I have used QRP myself, but looking through recent pages of my log book I find that during the past few months I have had contacts with about 20 stations using 10 watts or less. This includes a number with 5 and 2 watts, and one contact with a keen Czech low-power enthusiast (OK1DKW) who told me he was using a transmitter with just 670mW output, but was putting in a very readable signal. Most of these QRP stations were in Europe, including a number in the USSR, one of them in Asiatic Russia (UA9FFC) and also a Canadian amateur (VE3ABT) in Toronto.

Pocket power

Some years ago, the American firm of RCA carried out interesting experiments with miniature pocket h.f. transmitters suitable for emergency use. For example, by aircrew forced down in a remote area where emergency v.h.f. aids would not have sufficient range.

The pocket transmitter weighed about 10oz (280g) and had an output of about 100mW. Yet it was shown that it could send digitally coded signals quite reliably over distances of 2000 miles or so on frequencies between 13 and 16MHz when used with resonant aerials made of thin, light wire in the form of a bent dipole. The aerial weighed only about 0·5oz (15g) and the vertical element was supported by the branch of a tree.

At the base station the incoming signals were received on a good communications receiver that had been modified to provide a very high order of frequency stability and with an extremely narrowband audio filter at the low second i.f. of 20kHz (noise bandwidth less than 1Hz). The major problem was to achieve a similar order of frequency stability in the pocket transmitter.

The frequency was deliberately swept over a span of about 20Hz and the crystal was designed to have optimum stability at 99 degrees F. It was then mounted in a small enclosure that could be held under the armpit of the user in order to form a human crystal oven!

Up the mountain

Similarly, to encourage the development of light-weight low-power equipment, Swiss amateurs run a *National Mountain Day* contest in which a complete 3·5MHz station has to be carried by hand part of the way up a mountain before it can be used to make contact with as many stations as possible.

A recent home-made NMD station had an all-up weight of only 300g (under 11oz) with the actual transceiver a mere 113g, the aerial (84 metres long) 109g and the batteries only 78g. Yet providing 2 watts output!

Technifear

As someone who has spent many years operating radio equipment, I have long come to accept (and actually like) equipment that has many controls, knobs, dials and switches. This is provided, of course, that they add useful flexibility and the range of adjustment is actually needed to achieve optimum performance.

It is another matter when it comes to producing electronic equipment for the public or for those whose speciality lies in some other field. For these the two prime requisites should be reliability and ease of operation.

Designs need to be "granny-proof" as the saying goes, though in practice the the age at which one begins to find it increasingly difficult to come to grips with complex controls can be as low as 30-35 years old. The Rubik cube fascinates the young but often appals the old!

Recently one of the doyens among newspaper columnists, James Cameron, wrote: "For a year we have had a new style gramophone—or radiophonic music-master or whatever it is called—but I have never turned it on for the adequate reason that I do not know how to make it work. My grandchildren get it going with a flick of a switch, but not I. For me it remains contemptuously mute staring back with its arrogant toothy face".

One manufacturer is said to have coined a new word "technifear" to describe consumer resistance to high-technology products. The firm is convinced that there are many people, not all of them grandmothers or grandfathers by any means, who refuse to use the latest consumer products because they are terrified by all the knobs, sliders and other controls that are so very different from a simple on/off switch.

I have met people who are convinced that many listeners still stick to medium-wave AM radio, despite the interference and poor frequency range. This is usually because they find telescopic aerials and the tuning too "fiddly", especially compared with the push-button or touch controls of modern television sets.

Clear instructions

Where products have lots of knobs and dials they should also have very *clear* instructions to go with them, preferably for all those who will *use* the product in the home. Also the sales staff really should be prepared to explain and demonstrate exactly how to get the best results.

A somewhat similar requirement for easier to use and more practical equipment has been expressed recently by Lee Lewis of Hammersmith Hospital who has suggested that "medical electronics is one area where technology goes beserk". One of the things he does *not* want is touch controls on bedside equipment: "In a hospital it is too easy to push the wrong one; we can't see if they are in or out, and the patient can touch them by mistake".

He also dislikes some of the complex displays, loads of switches, bells and buzzers, and excess of knobs. On the other hand a few extra sockets to allow machines to be interconnected would not come amiss.

What it really amounts to is that electronic designers should always keep in mind those who will *use* the equipment. They should give equipment what amateurs call "operability" that can vary all the way from a battery of knobs for those who can use them to good advantage to little more than an on/off switch for others!

Atlantic Highway

It is only a few months since the first of the new *Intelsat V* series of international telecommunications satellites was put into geostationary orbit with a nominal capacity for 12,000 simultaneous two-way telephone conversations between Europe and North America. This compares with 6,000 conversations via *Intelsat IVA* (launched from 1975 onwards), 4,000 on *Intelsat IV* (1971 onwards) and just 240 or so on the original *Early Bird (Intelsat 1)* in 1965.

Now the international satellite consortium, in which the UK owns around an 8 per cent share, is considering two separate proposals from Ford Aerospace and Hughes Aircraft for a series of *Intelsat VI* spacecraft. Each spacecraft will have a nominal capacity of a massive 40,000 two-way telephone circuits, to be launched from about 1986 onwards.

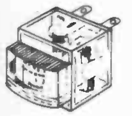
At this rate Buzby will soon be urging us all to make an American happy if only to keep the circuits busy. I doubt if British Telecom will let us do this for the "sixpence" that the early advocates of space communications used to suggest would be the cost of a call to Chicago!

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 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 £16.75 including VAT and post. FREE GIFT – buy this month and you will receive a pair of Goodman's eliptical 8"x 5" speakers to match this amplifier.

DELAY SWITCH

Mains operated – delay can be accurately set with pointers knob for periods of up to 2½hrs. 2 contacts suitable to switch 10 amps – second contact opens a few minutes after 1st contact. **£1.95.**



LEVEL METER

Size approximately ¾" square, scaled signal and power but cover easily removable for rescaling. Sensitivity 200 uA. **75p.**

½ PRICE CABLES! Flat P.V.C. covered mains cables – for lighting and power instalations.

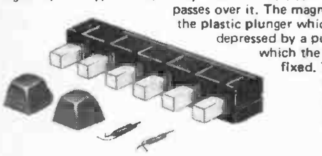
SIZE	TYPE	100 Mtres	CARRIAGE
1.5mm	Single	£ 3.95	£2.00
1.5mm	Flat twin	£ 6.50	£2.50
1.5mm	Flat three core & E	£ 9.85	£3.00
6mm	Single	£ 7.50	£2.50
4mm	Flat twim	£11.50	£3.50
6mm	Flat three core	£34.50	£4.50
16mm	Twin & E	£65 + £9.75	£10.00

INSTRUMENT BOX WITH KEY

Very strongly made (ply-wood sides with hard board top and bottom). This is black grained effect, vinyl covered, very pleasing appearance. Internal dimensions 12½" long, 4¼" wide, 6" deep. Ideal for carrying your multi range meter and small tools and for keeping them in a safe place. **£2.30.** Post paid if ordered with other goods, otherwise £1.00.

COMPUTER KEY SWITCHES (make your own keyboard)

These are for making up on a p.c.b. and consist of a vertical mounting computer type reed switch, which makes circuit when a magnet passes over it. The magnet is located in the plastic plunger which in turn is depressed by a push rod, to which the legended top is fixed. These are made up in banks of 6, price **£2.30** per bank of 6 (including tops)

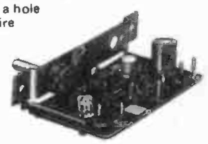


OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. **Price £11.50 + £2.50 post.**

GPO HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5⅝in x 3¼in x 1¼in is an extremely high gain (70dB) solid state amplifier designed for use as a signal tracer on GPO cables, etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only **£1.85.** Suitable 80ohm earpiece **69p.**

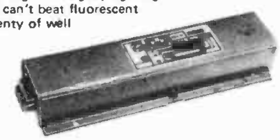
MINI MONO AMP on p.c.b., size 4"x 2"

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



12V FLUORESCENT LIGHTING

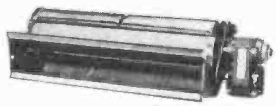
For camping – car repairing – emergeny lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer an inverter for 21" 13 watt miniature fluorescent tube. **£3.45.** (tube not supplied).



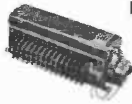
SONY HI-FI SPEAKER CABINETS

Made for an expensive Hi-Fi outfit – will suit any decor. Resonance free cut-outs for 6½" woofer and 2½" tweeter. The front is thick and stuck in after the speakers are fitted and the completed unit is most pleasing. Colour teak. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.50 the pair.

TANGENTIAL BLOW HEATER



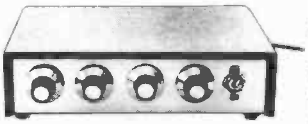
2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for £4.95. post £1.50.



MOTORISED DISCO SWITCH

With 10 amp changeover switches. Multi-adjustable switches all rated at 10 amps, this would provide a magnificent display. For mains operated 8 switch model £6.25, 10 switch model £6.75, 12 switch model £7.25.

3 CHANNEL SOUND TO LIGHT KIT



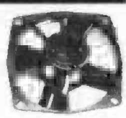
Complete kit of parts for a three-channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is £14.95 in kit form or £25.00 assembled and tested.

THIS MONTH'S SNIP

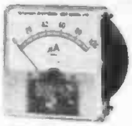
COMPUTER PRINTER FOR ONLY £4.95

Japanese made Epson 310 – has a self starting, brushless, transistorised d.c. motor to drive the print hammers, print drum – tape forward/reverse and paper feed.
Complete in module form with electronics including Printer Synchro Signal Amplifier & Printer Reset Signal Amplifier. Brand new and with technical and practical data. **£4.95** post £1.25.
Data separately for £1.00.

EXTRACTOR FANS – Mains Voltage



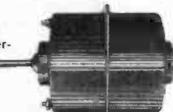
Ex-computer, made by Woods of Colchester, ideal as blower; central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 rpm but quiet running. Choice of 2 sizes, 5" £5.50. 6" £6.50. post £1 per fan.



100uA PANEL METER

Japanese made (Shinohara Electrical) so very good quality, these have a full vision front; are approx. 2" square and come complete with mounting studs and nuts. A thoroughly reliable instrument usually retailed at over £4, offered at a snip price this month of **£2.85** or 10 for **£25.00.**

12v MOTOR BY SMITHS



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

EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ⅛ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £6.90 + £1.50 post.

MINI-MULTI TESTER

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

Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 50p post and insurance.

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

FREE OUR CURRENT BARGAIN LIST WILL BE ENCLOSED WITH ALL ORDERS.

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

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

FM RECEIVER

Made up and working, complete with scale and pointer needs only a speaker, ideal for use with our surveillance transmitter or radio mike. **£5.85.**

CB RADIO –

Listen in with our 40-channel monitor. Unique design ensures that you do not miss sender or caller. Complete kit with case, speaker and instructions only £5.99.

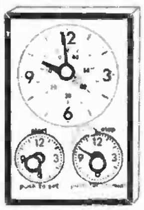
NEW ADDRESS FOR CALLERS:–
2, Bentham Road, Off Elm Grove, Brighton.
Telephone: Brighton 671457. Please phone before calling for anything special.

VENNER TIME SWITCH

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

STEREO HEADPHONES

Japanese made so very good quality. 8 ohm impedance. padded, terminating with standard ¼" jack-plug. **£2.99** Post 60p.



TIME SWITCH BARGAIN
Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with the dials. Comes complete with knobs. **£2.50.**

SAFE BLOCK
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit. £1.95.

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy if you have an amplifier to connect it to or a pair of high resistance headphones. **Price £11.95.**

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price **£2.30.** Crystal earpiece 65p. High resistance headphones (gives best results) **£3.75.** Kit includes chassis and front but not case.

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

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

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. **£2.50** complete kit.

8 POWERFUL BATTERY MOTORS
For models, Meccanos, drills, remote control planes, boats etc. **£2.50.**

WATERPROOF HEATING WIRE
60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses – around water pipes, under grow boxes in gloves and socks. **£2.50 for 10 metres.**

COMPONENT BOARD Ref. W0998
This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including 4 3amp 400v types (made up in a bridge) 8 transistors type BC107 and 2 type BFY-51 electrolytic condensers. SCR ref 2N 5062, 250uf 100v DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at **£1.15.**

FRUIT MACHINE HEART. 3 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". **£9.95. + £4** carriage.

4-CORE FLEX CABLE
White pvc for telephone extensions, disco lights, etc. 10 metres **£2,** 100 metres **£15.** Other multicore cable in stock.

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BI-PAK BARGAINS

"IRRESISTABLE RESISTOR BARGAINS"

Pak No.	Qty.°	Description	Price
SX10	400	Mixed "All Type" Resistors	£1
SX11	400	Pre-formed ¼-½ watt Carbon Resistors	£1
SX12	200	⅛ watt Carbon Resistors	£1
SX13	200	¼ watt Carbon Resistors	£1
SX14	150	½ watt Resistors 22 ohm-2m2 Mixed	£1
SX15	100	1 and 2 watt Resistors 22 ohm-2m2 Mixed	£1

Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects.

°Quantities approximate, count by weight.

"CAPABLE CAPACITOR PAKS"

Pak No.	Qty.°	Description	Price
SX16	250	Capacitors Mixed Types	£1
SX17	200	Ceramic Capacitors Miniature Mixed	£1
SX18	100	Mixed Ceramics 22pf-390pf	£1
SX19	100	Mixed Ceramics 470pf-.047uf	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50-100mfd.	£1
SX24	20	Tantalum Beads, mixed	£1

°Quantities approximate, count by weight.

AUDIO PLUGS, SOCKETS AND ACCESSORIES

25 pieces of Audio Plugs, Sockets and Connectors to include DIN 180°-240°, Inline 3-6 Pin, Speakers, Phono, Jack, Stereo and Mono, etc. etc. Valued at well over £3 normal. Order No. SX25. Our Price £1.50 per pak. Guaranteed to save you money.

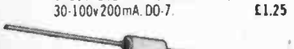
SX26	3 Prs. of 6 pin 240° DIN Plugs and Chassis Sockets.	50p
SX27	1 x Right Angle Stereo Jack Plug 6.3mm plus matching metal chassis mounting socket.	30p
SX28	4 Phono plugs and 2 dual phono connectors	30p
SX29	1 x 2.5mm Plug to 3.5mm Socket adaptor.	20p
SX30	1 x 3.5mm Plug to 2.5mm Socket adaptor.	20p
SX31	1 x 3.5mm Plug to Phono Socket adaptor.	20p

SX32	1 x Standard Jack Plug to Phono Socket adaptor.	25p
SX33	1 x Toggle Switch SPST Miniature. 125v 10A.	40p
SX34	1xToggle Switch SPDT Miniature. 125v 10A.	40p
SX35	1 x Rocker Switch SPDT Miniature. 240v 5A.	40p
SX36	1 x Right Angle Mono Jack Plug.	15p
SX37	20 pieces. 1, 2 & 4mm plugs and sockets (Banana). Matching colours and sizes.	£1
SX50	10 Assorted Switches. Toggle, Slide, Rocker, Push button.	£1

Guarantee

Satisfaction or your money back has always been BI-PAK's GUARANTEE and it still is. All these Sale items are in stock in quantity and we will despatch the same day as your order is received.

SX40	250 Silicon Diodes—Switching like IN4148 DO-35. All good—uncoded. Worth double our price. 45v 75mA.	£1.25
SX41	250 Silicon Diodes—General Purpose, like OA200/202. BAX13/16. Uncoded. 30-100v 200mA. DO-7.	£1.25



SX44	10 5A SCR's TO64. 3 x 50v, 3 x 100v, 2 x 200v, 2 x 400v. Super value less than ½ price.	£2
SX45	10 5A SCR's TO66. 2 x 50v, 2 x 100v, 4 x 200v, 2 x 400v. All coded. Brand new, a give away at...	£2

SEMICONDUCTORS FROM AROUND THE WORLD

100 A Collection of Transistors, Diodes, Rectifiers, Bridges, SCR's, Triacs, IC's both Logic and Linear plus Opto's all of which are current everyday usable devices. **100**

Guaranteed Value over £10 at Normal Retail Price

yours for only **£4·00** Data etc. in every pak. Order No. SX56

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Get a £1 FREE PACK. Orders over £10 excluding VAT. Choose £1 Pack free (or 2 x 50p) add it to your order and save even more money. This offer only applies to this advertisement.

This offer only applies to this advertisement

BI-PAK'S OPTO BARGAIN OF THE YEAR!

Valued at over £10—Normal Retail—we offer you a pack of 25 Opto devices to include LED's Large and Small in Red, Green, Yellow and Clear. 7 Segment Displays both Common Cathode and Common Anode PLUS bubble type displays—like DL-33. Photo Transistors—similar to OCP71 Photo Detectors—like MEL11-12. This whole pack of 25 devices will cost you just

25 **£4·00** **25**

AND we guarantee your money back if you are not completely satisfied. FULL data etc included.

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The lowest price ever.

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Pin.	10 off	50 off	100 off
8	75p	£3.00	£5
14	80p	£3.25	£5.50
16	80p	£3.25	£5.50
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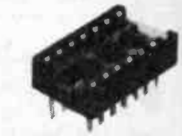

BARGAINS

SX42	20 small .125 Red LED's	£1
SX43	10 Rectangular Green LED's .2	£1
SX46	30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded. New	£1
SX47	4 Black Instrument Knobs—winged with pointer ¼" Standard screw. Fit size 29 x 20mm.	50p
SX48	5 Chrome knobs, standard push fit. 15mm.	50p
SX49	20 Assorted Slider Knobs. Black/Chrome, etc.	£1

MORE BARGAINS!

SX51	60 metres PVC covered Hook-up wire single and stranded. Mixed colours.	£1
SX58	25 Assorted TTL Gates 7400 Series. 7401-7460.	£1
SX59	10 Assorted flip Flops and MSI TTL	£1
SX60	20 Assorted Slider Potentiometers	£1
SX61	25 Assorted Potentiometers, Rotary, Dual, etc.	£1
SX62	40 Assorted Pre-Sets Hor/Vert etc.	£1

STILL MORE!

SLIDER POTENTIOMETERS

Plastic 40mm Travel Mono

SX63 5 x 470 ohms Lin	SX67 5 x 47k Lin
SX64 5 x 1k Lin	SX68 5 x 47k Log
SX65 5 x 22k Lin	SX69 5 x 100k Lin
SX66 5 x 22k Log	SX70 5 x 1 meg Lin

All at 50p per pack.

SX71	50 BC108 "Fallouts". Manufacturers out of spec on volts or gain. You test.	£1
SX72	A mixed bundle of Copper clad Board, Fibre glass and paper. Single and double sided. A fantastic bargain.	£1

SX52	6 Black Heatsink will fit TO-3 and TO-220. Ready drilled. Half price value.	£1
SX53	1 Power finned Heatsink. This heatsink gives the greatest possible heat dissipation in the smallest space owing to its unique staggered fin design, pre drilled. TO-3 Size 45mm square x 20mm high.	40p
SX54	TO-66 size. 35mm x 30mm x 12mm.	35p
SX55	1 Heat Efficiency Power Finned Heatsink 90mm x 80mm x 35mm High. Drilled to take up to 4 x TO-3 devices	£1.50 each

5 watt (RMS) Audio Amp

High Quality audio amplifier Module. Ideal for use in record players, tape recorders, stereo amps and cassette players, etc. Full data and back-up diagrams with each module.

Specification:
● Power Output 5 watts RMS ● Load Impedance 8-16 ohms ● Frequency response 50Hz to 25 KHz—3db ● Sensitivity 70 mv for full output ● Input Impedance 50k ohms ● Size 85 x 64 x 30mm ● Total Harmonic distortion less than 5%

BI-PAK'S give away price **£2.25** each.

You could not Build one for this price.

BI-PAK's COMPLETELY NEW CATALOGUE

Completely re-designed. Full of the type of components you require, plus some very interesting ones you will soon be using and of course, the largest range of semiconductors for the Amateur and Professional you could hope to find.

There are no wasted pages of useless information so often included in Catalogues published nowadays. Just solid facts i.e. price, description and individual features of what we have available. But remember, Bi-Pak's policy has always been to sell quality components at competitive prices and THAT **WE STILL DO.**

BI-PAK'S COMPLETELY **NEW** CATALOGUE is now available to you. You will be amazed how much you can save when you shop for Electronic Components with a Bi-Pak Catalogue. Have one by you all the time—it pays to buy BI-PAK.

To receive your copy send **75p** plus 25p p&p.

SX38	100 Silicon NPN Transistors—all perfect. Coded mixed types with data and eqvt. sheet. No rejects. Real value.	£2.50
SX39	100 Silicon PNP Transistors—all perfect. Coded mixed types with data and eqvt. sheet. No rejects. Fantastic value.	£2.50

MULLARD. ASZ 17 PNP.
Germ TO-3 Power Trans.

60 VCB 8A.		Poss Replacement for
32 VCE 30W		AD130/131/140/149
20 VEB Hfe 30min		OC25/26/28/35 2N3613/14/17/2N1533

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4001	12p	4520	70p
4002	12p	4560	£2·20
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4007	13p	74LS00	14p
4008	60p	74LS01	14p
4010	36p	74LS02	13p
4011	12p	74LS03	13p
4012	18p	74LS04	14p
4013	33p	74LS08	13p
4014	60p	74LS10	13p
4015	62p	74LS14	50p
4016	28p	74LS20	13p
4017	53p	74LS26	18p
4018	58p	74LS30	14p
4019	36p	74LS32	14p
4020	65p	74LS38	16p
4023	18p	74LS42	39p
4024	38p	74LS47	41p
4025	14p	74LS73	21p
4026	£1·28	74LS74	18p
4027	35p	74LS75	29p
4028	62p	74LS86	36p
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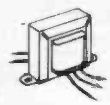

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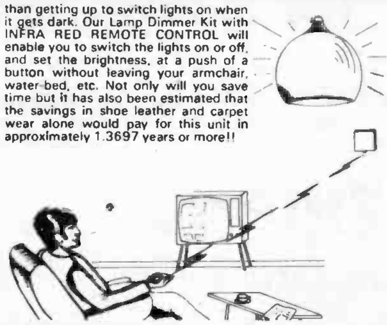

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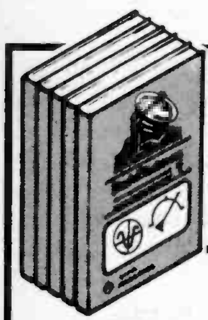

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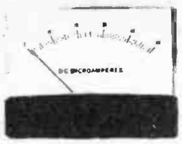

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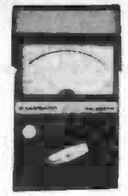

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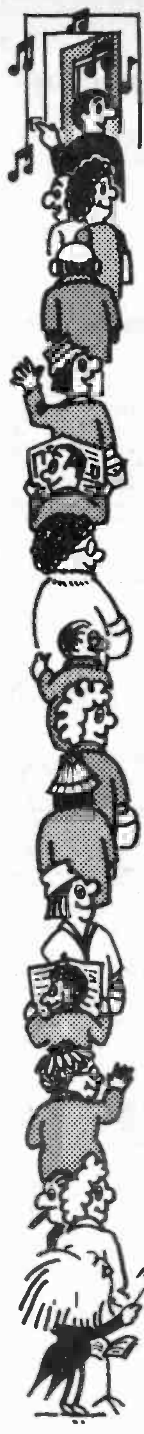

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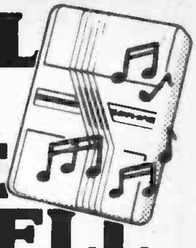

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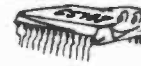

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7408	15	7432	25	7472	25	7494	35	74147	100	74170	165	74195	63
7409	16	7433	27	7473	28	7495	50	74148	75	74173	60	74196	63
7410	14	7437	27	7474	25	7496	45	74150	75	74174	65	74197	63
7411	20	7438	27	7475	38	7497	120	74153	45	74175	70	74198	90
7412	20	7440	17	7476	30	74100	80	74154	75	74176	55	74199	95

TRANSISTORS

				BC212L	10	BD132	35	TIP31A	45	2N2646	45
				BC213L	10	BD139	35	TIP32A	45	2N3053	23
		BC147	8	★BC214L	8	BD140	35	TIP33A	50	★2N3702	6
AC126	25	BC148	8	BC477	30	BFX29	25	TIP34A	60	2N3703	9
AC127	25	BC149	9	BC478	30	BFX84	25	TIP41A	60	★2N3704	6
AC128	25	BC157	10	BC479	30	BFX88	25	TIP42A	60	2N3705	9
AC176	25	BC158	10	BC547	10	BFY50	23	TIP2955	60	2N3706	9
AD161	40	BC159	10	BC548	10	BFY51	23	TIP3055	55	★2N3819	15
AD162	40	BC177	18	BC549	10	BFY52	23	ZTX107	12	2N3903	10
BC107	10	BC178	18	BC558	10	★BF244B	18	ZTX108	12	2N3904	10
BC108	10	BC179	18	BCY70	18	MJ2955		ZTX300	14	2N3905	6
BC108C	12	★BC182L	8	BCY71	18		100	ZTX302	15	2N3906	10
BC109	10	BC183L	10	BCY72	18	TIP29A	40	ZTX500	15	2N5459	30
BC109C	12	★BC184L	7	BD131	35	TIP30A	40	2N2369	17	2N5777	45

DIODES

1N4002	5p	★1N4148	2p
1N4006	5p	400mW	
1N5401	15p	★zeners	6p

INDICATORS

Amber Panel neon	45p
Red Panel neon	45p
LES lampholders in red blue, green, white,	28p
6V 50mA LES bulb	14p
12V LES bulb	16p

COMPONENT KITS

★★★★ ¼W Resistor Kit. Contains 10 of each value from 4·7Ω to 1M (total of 650 resistors) ★★★★ **480p each.**
Ceramic Capacitor Kit. Contains 5 of each value from 22pF to 0.01uF (total 135 caps.). **370p each**
Polyester Capacitor Kit. Contains 5 of each value from 0.01uF to 1uF (total 65 caps.). **575p each**

CAPACITORS AND RESISTORS

Polyester. Radial leads. 250V. C280 type. 0.01, 0.015, 0.022, 0.033, **6p;** 0.047, 0.068, 0.1, **7p;** 0.22, **9p;** 0.33, **13p;** 0.47, **13p;** 0.68, **20p;** 1.0u, **23p.**
Electrolytic. Radial leads.
0.47/63V, 1/63V, 2.2/63V, 4,7/63V, 10/25V, **7p;** 22/25V, 47/25V, **8p;** 100/25V, **9p;** 220/25V, **14p;** 1000/25V, **30p.**
Tantalum bead.
0.1, 0.22, 0.33, 0.47, 1.0 ≥35V, **12p;** 2.2, 4.7, 10 ≥25V, **20p;** 22/16V, **27p;** 47/6V, **27p;** 47/16V, **70p;** 100/10V, **90p.**
Polystyrene. 5% tolerance.
10p-1000p **6p.** 1500p-4700p **8p.** 6800p-0.012 **10p.**
Resistors ¼W 5% carbon film 4·7Ω to 10M. E12 series. **1p each.** ★★★★

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★741	14	CA3130	90	★LM324	40				
748	35	CA3140	45	LM339	50				
CA3080	70	★ICM7555	80	LM348	90				
		★LF351	40	LM377	150				
		LF353	85	LM380	80				
		LF356	90	LM381	120				
		★LM301A	25	LM382	120				
		LM318	85	LM387	120				
				LM1458	40	★NE555	17	★TL081	30
				LM3900	50	NE556	55	TL082	70
				LM3909	70	RC4136	90	TL084	90
				★LM3914	200	★SN76477	150	XR2206	300
				★LM3915	200	TBA800	80	ZN414	100
				LM13600	120	TBA810	95	ZN425E	390

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Veropins per 100	
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CONNECTORS

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3.5mm	10p	9p
Standard	16p	20p
Stereo	24p	25p
1mm	13p	13p
4mm	18p	17p

Red or black probe clip 35p

SOCKETS

★8 pin	7p	22 pin	20p
★14 pin	9p	24 pin	22p
★16 pin	10p	28 pin	26p
18 pin	15p	40 pin	32p
20 pin	18p		

Soldercon pins 60p/100.

REGULATORS

★78L05	30	79L05	65
★78L12	25	★7905	50
78L15	30	★7912	45
★7805	45	LM723	40
7812	60	LM317T	180
★7815	45	★LM323L	350

OPTO

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2N5777 transistor	45p

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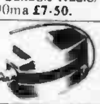

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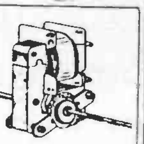

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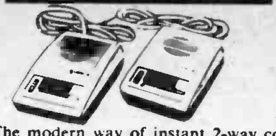

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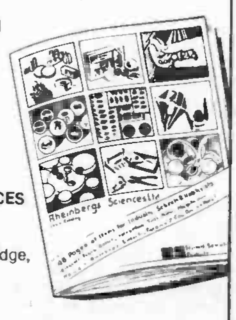

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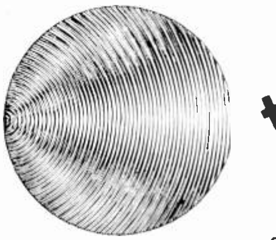

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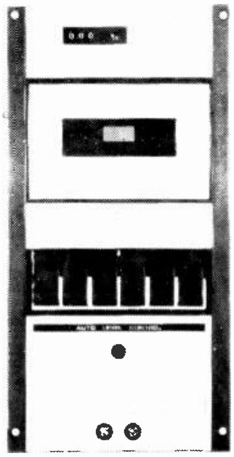

6 piano type keys

STEREO CASSETTE TAPE DECK MODULE. Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Auto-stop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity**: 100mV to 2V **Input Impedance**: 68K. **Output level**: 400mV to both left and right hand channels. **Output Impedance**: 10K. **Signal to noise ratio**: 45dB. **Wow and flutter**: 0.1%. **Power Supply requirements**: 18V DC at 300mA. **Connections**: The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions**: Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
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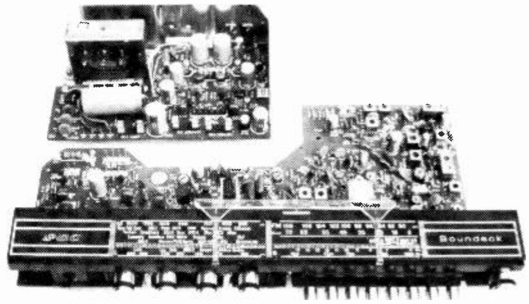
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) **£3.**



GEC AM/FM STEREO TUNER AMPLIFIER CHASSIS. Originally designed for installation into a music centre. Supplied as two separate built and tested units which are easily wired together. **Note**: Circuit diagram and interconnecting wiring diagrams supplied. **Rotary Controls**: Tuning, on/off volume, balance, treble, bass. **Push-button controls**: Mono, Tape, Disc., AFC, FM (VHF), LW, MW, SW. **Power Output**: 7 watts RMS per channel, at better than 2% THD into 8 ohms. 10 watts speech and music. **Frequency Response**: 60Hz-20kHz within ± 3dB. **Tape Sensitivity**: Output – typically 150 mV. Input – 300 mV for rated output. **Disc Sensitivity**: 100mV (ceramic cartridge). **Radio**: FM (VHF), 87.5MHz – 108MHz. Long wave 145kHz – 108kHz. Medium wave. 520kHz – 1620kHz. Short wave. 5.8MHz – 16MHz. **Size**: Tuner – 2¾in x 15in x 7½ in approx. Power amplifier – 2in x 7½in x 4½in approx. 240V AC operation. Supplied complete with fuses, knobs and pushbuttons, and LED stereo beacon indicator. **Price £23.50** plus £2.50 postage and packing.

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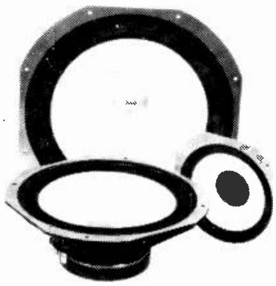
Specification and Price:–



15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet, 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each.** £2.50 Packing and Carriage each.

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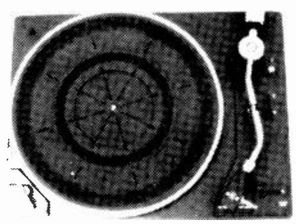

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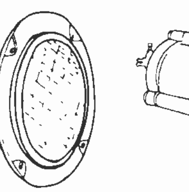

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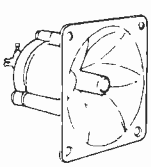

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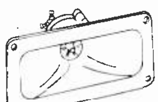

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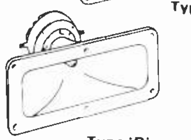

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