CB RADIO – NEWS AND VIEWS INSIDE

Hobby Electronics

October '80

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55p

SPECIAL ISSUE

ELECTRONICS AROUND THE HOUSE

Including six DIY projects for the home

WITH THIS ISSUE YOU CAN BUILD:

AN INTRUDER ALARM TO PROTECT YOUR VALUBLES

A TUG-OF-WAR GAME TO TEST YOUR STRENGTH

A TEMPERTURE CONTROLLED SOLDERING IRON

AN INEXPENSIVE LIGHT DIMMER

AS ADVERTISED ON LOCAL RADIO

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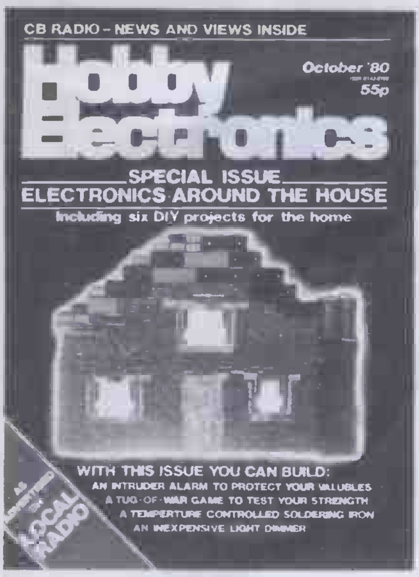
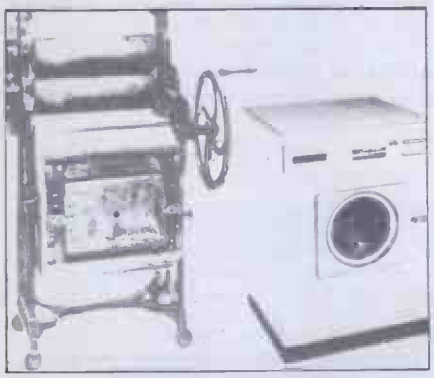
ELECTRONICS HAVE GROWN UP
WHY DON'T YOU, TOO



A DIMunitive project, see page 33.



Manual to Microchip - see page 43.

Prevent pinching, see page 59.

Hobby Electronics

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PROJECTS

FEATURES

NEWS & INFO

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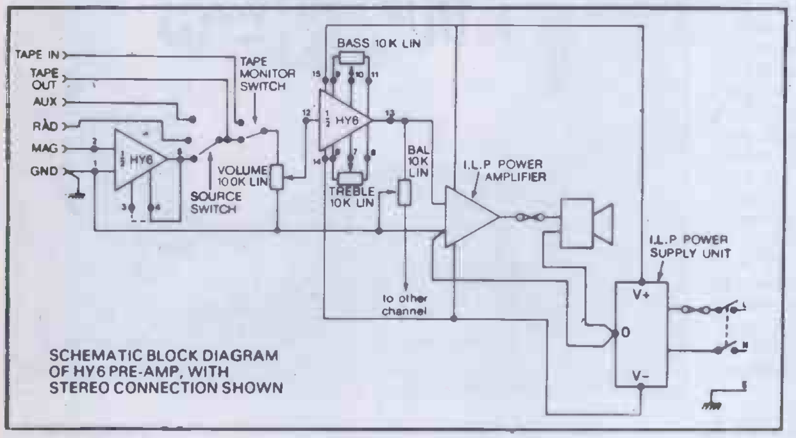
this time with two new pre-amps



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN

HY6 *mono* HY66 *stereo*

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Shoulder Sounds

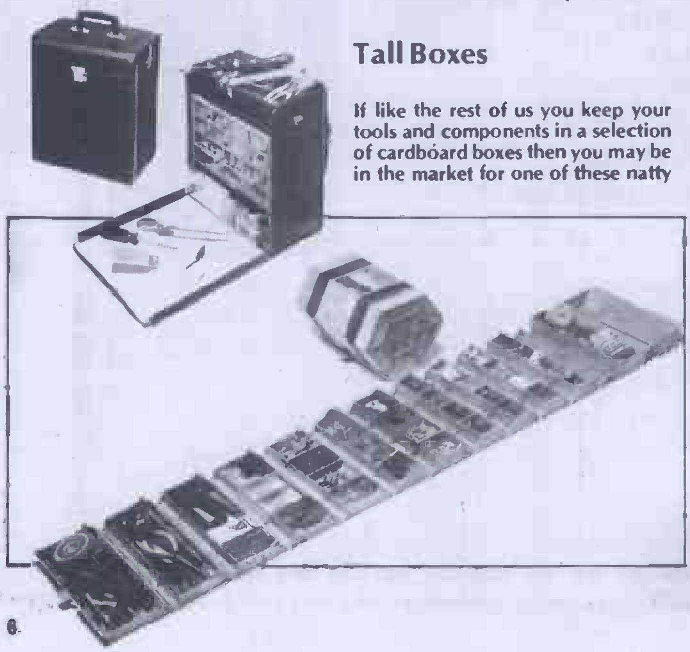
You may have heard of the 'Bone Fone', it's a kind of flexible stereo radio that hangs around your neck. Well, we've just had the opportunity to try one out. The Bone Fone has been on sale in the USA for a few months now and it's proving very popular with joggers and skaters. Not having too many joggers or skaters in the HE office our 'field tests' have been a little less than vigorous. Initial reports were less than enthusiastic as stereo reception was a little noisy, which we discovered was due to our review model having an aerial designed for the US market. Once outside the office though, things improved dramatically (it must be the bars on the doors and windows designed to keep us in). Stereo reception was quite acceptable and the AM side worked OK under all conditions.

Only two little niggles, in the first place the controls are badly sited, it's quite difficult to tune it in by 'feel' only and the stereo indicator light might as well have been left out as there's no way you could ever see it unless you looked at yourself in a mirror. The second problem arose when gyrating with the music (as is our wont after the odd shandy), the directional nature of FM transmissions caused a certain amount of fading which could be awkward for joggers unless they jog in straight lines, parallel to the transmission path. In all fairness though we suspect this may be due to the aerial which is not really suitable for our FM service. The US style of 'saturation' FM broadcasting dictates that a certain amount of insensitivity be built in. The Bone Fone will be available in the next couple of weeks. Kramer and Co are the people to see, take along £39 and the Bone Fone will be all yours. Kramer and Co lurk at 9 October Place, London NW4 1EJ.

Knight Moves

You guessed it, another chess computer, this one is called simply 'Intelligent Chess' and comes from Optim Games Ltd. At around £295 it must be one of the most expensive chess computers ever but it does have an impressive line up of features. First away is the built-in cassette recorder, it will record up to 1,000 different games and/or an audio commentary on a C90 cassette. The cassette recorder can be used with the 'Teacher' cassette (supplied free) to help a beginner with the basic moves, optional extras include a selection of other pre-recorded casstes with titles like 'All Karpov's games' or 'All named variations'. The game is displayed directly on to a standard colour TV set and will play in any one of 13 levels.

Intelligent Chess is the first British designed chess computer and has an impressive pedigree. International chess master David Levy was responsible for the overall design and Barry Savage of 'Softy' fame was responsible for the electronics. The programmer is one Mike Johnson, winner of the first European microprocessor chess tournament in 1978. With names like that how can it fail? The game will be available in October. Optim Games live at 45 South Street, Bishops Stortford, Hertfordshire.



Tall Boxes

If like the rest of us you keep your tools and components in a selection of cardboard boxes then you may be in the market for one of these natty little tool/component recepticles.

To give it its full (and rather splendid sounding) title, it's a 'Link-Hampson Multiple Services Cabinet', impressed huh? As you can see from the photograph the top section houses tools and the lower drawer cabinet will happily hold all your components. To stop them falling out on the floor a hinged front panel folds down to allow access to the clear plastic drawers. The outer case comes in a no-nonsense simulated leather (at least they're honest about it) with a sturdy carrying handle. Link-Hampson assure us that extra strength is guaranteed by incorporating reinforced side straps. All this can be yours (without the tools) for just £29.95, the cabinet on its own is only £10. Link-Hampson are awaiting your enquiry at 5 Bone Lane, Newbury, Berkshire RG14 5TD.

Just before we went to press we received news of another tool box, this one is called the 'Rolykit'. It's rather unusual in that instead of having separate drawers or boxes it rolls out from a handy looking hexagonal-shaped carrying case. At first glance it would appear that this is the ideal method of jumbling up all your carefully sorted bits and pieces but some clever design work has taken care of that. Each compartment automatically covers the one underneath. The manufacturers claim it can be dropped, thrown about and generally handled quite carelessly without any kind of spillage. Rolykit is being launched in the UK in a few weeks and two sizes will be available, the smaller at £12 and the larger at £15. The Rolykit has already been a great success in Holland, it will be interesting to see how it fares over here. The people to talk to are Co-Ordinated Marketing Services, 21 Great Portland Street, London W1N 5DB.

News from the Electronics World

Bug Swatter

Stories about phone tapping and bugging seem to be hitting the headlines with alarming regularity. It's not surprising that companies offering anti-bugging services are enjoying a mini-boom at the moment. Here we have an interesting device, it's called the Scanlock Mark V8. It's basically a broad band radio receiver that can 'scan' up and down a range of frequencies (10 to 1800 MHz) four times a second. It analyses all the signals on those frequencies, picking out any that are significantly stronger than the others. Once it has locked onto a likely transmission it tests it by emitting a short tone. All this can take less than one second. Scanlock will demodulate any signal, whether it is AM, FM, or Subcarrier (Phantom Modulation). It can also be used to detect 'sleeper' bugs that are activated automatically by radio control. Once the presence of a bug has been established the Scanlock can locate it by means of a hand-held antenna, a continuous tone from the Scanlock rises in frequency as the antenna gets closer to the bug.

The Scanlock is completely portable and can be used in a car. It comes with all the accessories, leather carrying case and Ni-Cad batteries. The price is available on application from Audiotel International Ltd, Saddlers Court, 100 Reading Road, Yateley, Surrey GU17 7RX.

Errata

Someone somewhere has really got it in for use, we even managed to get the Errata wrong last month. The correction on the overlay diagram for Pass The Loop should have said that IC2 and IC3 numbering was transposed, *NOT* IC1 & IC2. Heads will roll.

The Auto Probe last month had a similar error on the overlay diagram (Fig.3), LED 1 & LED 2 should be swapped over. Still with the Auto Probe, some people have been experiencing difficulty in obtaining the transistor Q1, this is not a critical component and almost any general purpose PNP type will do (the BC179 is ideal).

The Guitar Phaser overlay (Fig.3 yet again) shows the connections for Q1 & 2 Drain and Source reversed, the pin out diagram beneath Fig.1 is correct.

Last but not least it seems that one or two people have been experiencing instability problems with the Car Booster published in the July issue. We're not sure why but there's a possibility that a suspect batch of ICs have been floating around. If you are experiencing a low 1 Hz click then it can be cured by putting a 2R2 resistor in series with both C7 & C8 (on the earthy side) and removing the link from Pin 7 of IC1. Take the speaker connection via a flying lead from Pin 7 making sure it is well away from IC1.

Book Reviews

Yet another pair of books from Babani Publishing Ltd, both with a workshop theme. The first is called Electronic Test Equipment Construction. (F G Rayer, ISBN 0900162 95 3, £1.75). As you might expect it contains constructional projects and advice on how to use a wide range of useful test gear. As anyone who has been faced with a dead project will tell you, fault finding with a wet finger and a light bulb is no fun. Several of the circuits have full constructional details though most are left up to the individual constructor. The designs include an FET Voltmeter, Field Strength Meter, Watt Meter, Capacitance Bridge and a worthy assortment of RF and AF Generators. A valuable addition to the budding faultfinder's library.

Number two is called Power Supply Projects. (R A Penfold, ISBN 0 900162 96 1, £1.75). You can't really go wrong with this one, it could be called 'Everything you ever wanted to know about Power Supplies', it really is very comprehensive. Projects range from the simplest unregulated, Half-Wave power supply to a 5-15 volt, 3 amp, fully stabilised bench supply. Again constructional details are left largely up to the individual. This book is aimed at the more experienced constructor.

Speaks For Itself!

"Does your watch tell the time?" "No, you have to look at it." OK, so it never was the funniest of jokes. Now it's not true either. Those wily Orientals at Sharp have devised a speaking clock, which is a lot more fun than the GPO's version even if it doesn't have the same cut-glass accent.

At first glance the Sharp CT-660 looks like an ordinary multi-function travelling alarm clock, with an LCD display. Leave it sitting on your desk, however, and it announces the time at half-hourly intervals. If you believe that clocks should be seen and not heard, this facility can be turned off. Press a button on the top of the clock and it tells you the current time. All of the other functions of the clock use the voice too. When the alarm goes off, a short fanfare is followed by an announcement of the time. Just to make sure you're awake, this is followed by a very penetrating rendition of Boccherini's Minuet. The clock reminds you of the time after five and ten minutes, tells you to hurry up, and plays the tune again (hope you like Boccherini).

In the timer mode, the elapsed time is spoken every minute, five minutes, or thirty minutes, for up to ten hours (depending on setting). The stopwatch mode is similar, except that the announcements are made every ten seconds and lap times and accumulated times are provided.

All this electronic trickery is packed into a tiny chrome case 114mm by 60mm by 22mm, which shows how advanced electronic speech generation has become. 'Talking Time' should be in the shops about now, and is ideal for gadget freaks or the blind. Wintjoy Ltd have a limited number of clocks at the moment for around £40 each.

Equal Opportunities

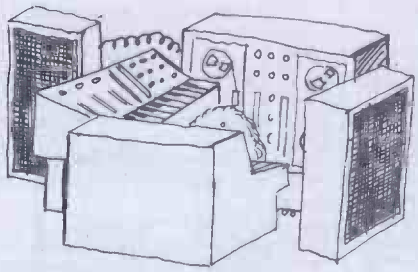
Yes, we've all seen car graphic equalisers before, we've even seen them with booster amplifiers but here's the catch, how many have you seen for only £25.00?

It sounds too cheap to be true but it's not, this well built booster/equaliser delivers 25 watts per channel with full equalisation over the range of 60 Hz to 15 kHz. It has a sturdy metal case with hefty heatsinks on the side. The quality is excellent, worthy of units costing several times as much. Connection to your existing stereo is a simple matter, all the common connector sockets are fitted and it is small enough to fit unobtrusively underneath the dashboard. The Harvard Graphic Equaliser Amplifier is currently being sold for this derisory sum by Minikits Ltd. You can find them at: 88 Hainault Road, Leytonstone, London E11 1EH.

Next Month

Hobby Electronics

ON SALE
OCTOBER 10th



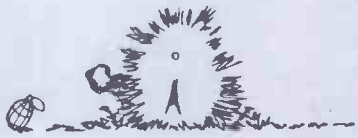
Thirty Pound Synthesiser

No, not weight, price! That's right, for around thirty quid you can build yourself this high quality, versatile and above all, economical synthesiser. Create outlandish noises, scare your granny, even play a few tunes. This easy-to-build unit features the latest LSI technology to reliably generate the sounds.

We're keeping quiet about the technical details, walls have ears and all that. Suffice it to say that this is the design you've been waiting for. You have four weeks, starting from now to find your £30. It'll be money well spent, we promise you that.

Electronic Hand Grenade

You'll get a real 'bang' out of this new game. It's the electronic version of that old parlour game 'musical chairs'. The grenade is passed around a circle of players, the longer it is held the greater the chance it will go 'off'. The person that has it then leaves. This ingenious little circuit will provide hours of amusement at parties and can be built by even the most inexperienced constructor in just a couple of hours.

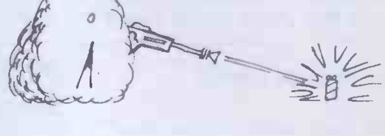


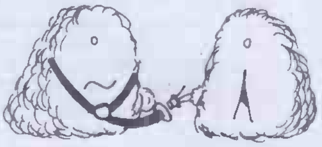
Guitar Sound Shaper

Gasp, shock, horror, you haven't heard of a Guitar Sound Shaper before. Shame on you. How can you ever hold your head up in decent company? People like you give our hobby a bad name, no wonder dogs cross the street when they see you. There's only one thing you can do, rush out and get next month's copy of HE or forever be a social outcast.

Battery Eliminator

This 35 kilowatt laser is guaranteed to instantly vapourise any battery from a HP7 to a PP9. Batteries are really becoming a nuisance. Stop their takeover right now. The HE battery Eliminator will forever remove the menace of the dry-cell. Just plug it into your local mains socket and laugh as you count all the money you'll save. Actually it's not really a 35 kilowatt laser but it will save you a few quid. Look out for it in next month's bigger-than-ever issue.



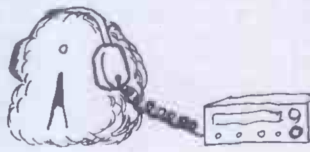


Transistor Tester

What can we say? Not a lot really, we don't have to tell you that this is the most advanced design ever to measure the collector current of a BC109, you know that already because it comes from Hobby Electronics!

Stereo

Now for the first time anywhere this century Hobby Electronics has commissioned that Master of the Microcircuit, the Baron of the Breadboard, that well known man of digits, Ian Sinclair (who?) to write the definitive lowdown on Stereo. What is it, how does it do it, what do I do with it? These are just some of the questions that will finally get answered next month in this exciting top-level feature.



The items mentioned here are those planned, but unforseeen circumstances may affect the actual contents.

Kitchen Timer

A cheap and simple circuit which is ideal for the newcomer to electronics.

THIS SIMPLE TIMER provides an audible alarm at the end of a preset timing period, which can be switch-selected in half-minute steps from one minute to six-and-a-half minutes. Although it's been designed for use in the kitchen it could of course be used in other applications such as photography.

The circuit uses a minimum of components and is based on the ever-popular 555 timer IC (what would we do without it?). The timer is automatically triggered when the unit is switched on and at the end of the chosen period a two-transistor oscillator is enabled. This generates an audible tone in a ceramic resonator, a solid-state device which produces quite a loud sound with little power consumption.

How it Works

The circuit is based on a 555 timer (IC1) used in the monostable mode. R13 and C2 provide a negative trigger pulse to IC1 at switch-on, so that the timing run automatically commences and the output at pin 3 goes high. The output returns to the low state when the charge on C1 reaches the same level as a reference voltage. This voltage can be "trimmed" using RV1, which is adjusted so that a timing period of one minute is obtained with SW1 set to the "1 minute" position, i.e. with C1 charged through R12 only. SW2 is used to switch in additional resistors, slowing the charge rate of C1 and increasing the delay time by half a minute for each additional resistor.

Q1 and Q2 are used in a straightforward astable multivibrator circuit operating at a frequency of a few kilohertz. Initially this is inoperative since the output of IC1 is high, and the transistors receive no significant supply voltage. At the end of the timing run the output of IC1 goes low, and the multivibrator then operates normally as it receives virtually the full supply voltage.

This produces an audio tone from the ceramic resonator which is driven from the collectors of Q1 and Q2. A ceramic resonator is not a low impedance device like an ordinary speaker, and needs little drive current. It does require a fairly high drive voltage though, and this is achieved by driving it from the antiphase signals at the collectors of Q1 and Q2. This effectively doubles the voltage swing across the resonator.

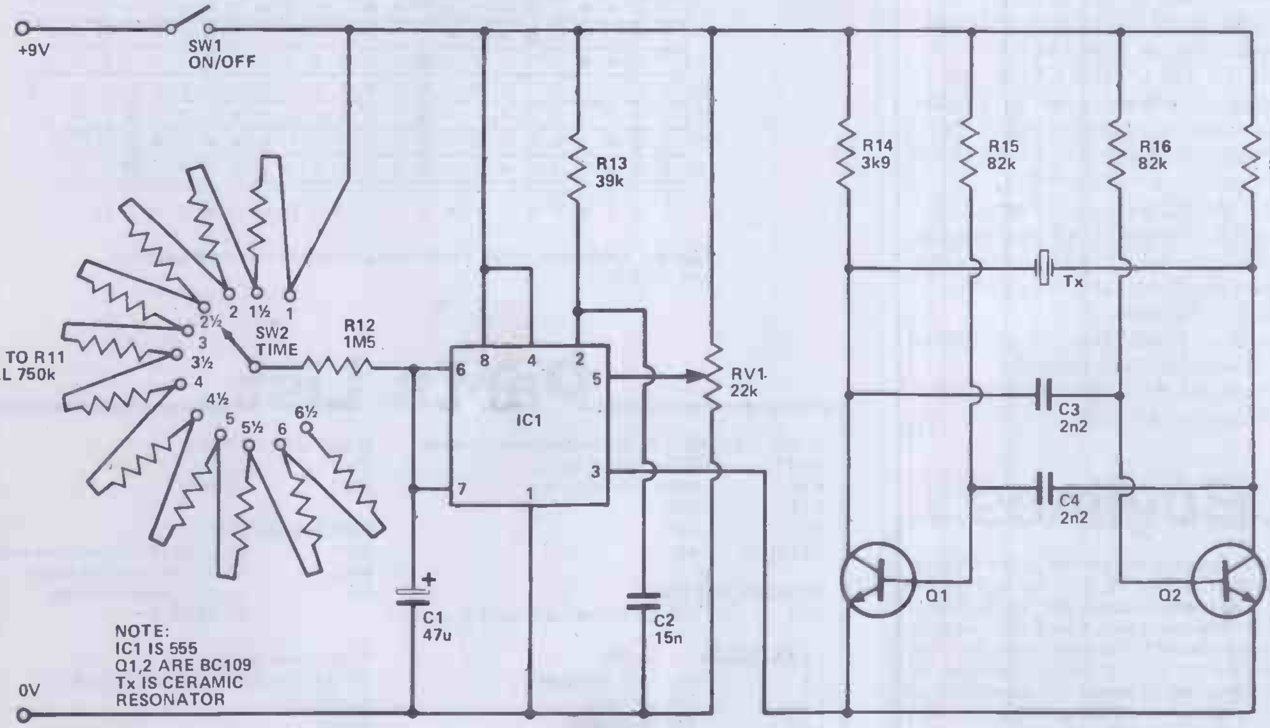
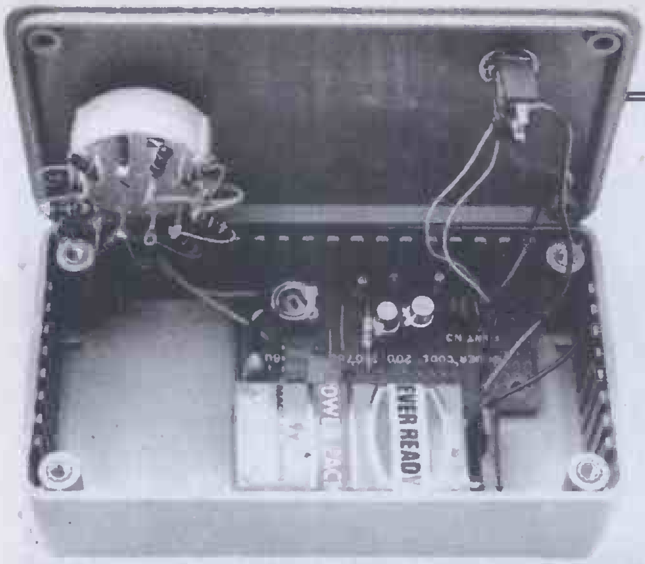


Figure 1. Circuit diagram of the HE Kitchen Timer.



This photograph shows the board and battery fastened to the box with sticky pads, and the controls mounted on the front panel. Note the resistors soldered to SW2.

Time And Time Again

The timing period of a 555 is determined by the values of the capacitor and resistor connected to pins 6 and 7; in fact, the formula used is $t=1.1RC$, where t is in seconds if R is in ohms and C is in Farads. By keeping C constant and changing R we can get different periods. In our circuit R is varied by connecting 11 resistors in series and using a twelve way switch to select a point in the chain. Fine adjustment of the timing period (to allow for errors due to component tolerances) is made with RV1 which varies the control voltage on pin 5 of the IC. This only needs to be done on one of the ranges.

Construction

The timer is built on our standard veroboard size of 10 strips by 24 holes, as shown in Figure 2. Be careful to connect IC1, Q1, Q2 and C1 the right way round as wrong connection could damage these components. All of the timing resistors except R12 are mounted directly on the terminals of SW2, as shown in the diagram and photograph. Try to solder these to SW2 very quickly, as overheating them could permanently alter their resistance and impair the accuracy of the unit.

Any small plastic box can be used to house this project. We fixed the veroboard and the battery inside with double-sided sticky pads.

HE

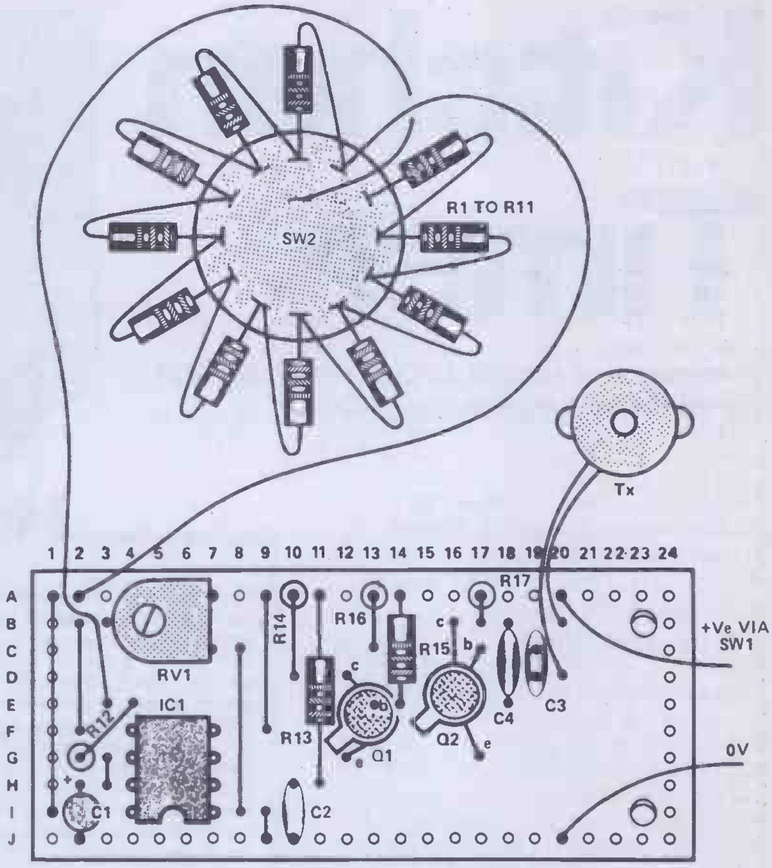


Figure 2. (Above) Veroboard layout and interconnection diagram.

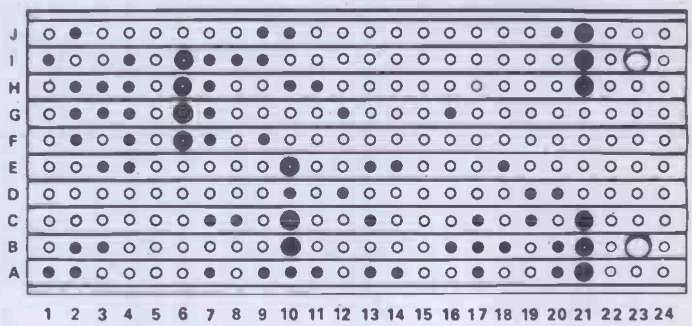


Figure 3. Underside of the Veroboard showing component positions and track cuts.

Buylines

The only unusual component is the ceramic resonator type PB2720, and this is available from Ambit International, 200 North Service Road, Brentwood, Essex, CM14 4SG. Satisfactory results should be obtained using 5% components for R1 to R12, but for optimum accuracy these should have a tolerance of 2% or better. Total cost of all components, excluding the case, shouldn't be more than £5.

Parts List

RESISTORS (All ¼ W, 5% except where stated)

R1-11	750k, 5% or better
R12	1M5, 5% or better
R13	39k
R14	3k9
R15,16,17	82k

POTENTIOMETERS

RV1	22k miniature horizontal preset

CAPACITORS

C1	47u 16 V tantalum
C2	15n ceramic
C3,4	2n2 ceramic

SEMICONDUCTORS

IC1	555
Q1,2	BC109

MISCELLANEOUS

SW1	single-pole, single-throw toggle
SW2	12-way, single-pole rotary
Tx	ceramic resonator (see BUYLINES)

Battery and clip
10 x 24 hole, 0.1" matrix veroboard.
Case to suit
Knob.

Into Digital Electronics

PART TWO

Down to practicalities this month. Ian Sinclair looks at the LS132 NAND gate and some of the the circuits we can build with it.

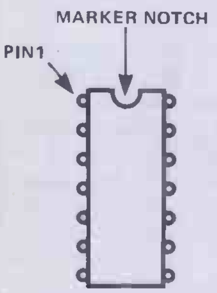
CHIP OF THE MONTH, folks, is one whose full number is SN74LS132; its full name is a quad two input Schmitt NAND gate. Either way, it's quite a mouthful, and we'll refer to it as the LS132. Since this is a strictly practical series, we'll start in a practical way by finding out what this particular IC does. (Note: Non 'LS' types are OK).

BOARD CONNECTIONS:
1A LED ANODE (4)
3A LED ANODE (3)
5A LED ANODE (2)
7A LED ANODE (1)
} CATHODE LEADS ON Y1

1k0 RESISTORS BETWEEN:
1A AND 1B
3A AND 3B
5A AND 5B
7A AND 7B
DIL SWITCH BETWEEN COLUMNS C AND D, LINES 1 TO 8
LINKS BETWEEN:
X1 AND X2
Y1 AND Y2

Fig.2.1. A reminder of the wiring round the LEDs — this must be completed, along with the switch wiring (shown in previous part) before any further work can be done.

Start by checking the connections of the switches and LEDs which you should have from last month. Figure 2.1 is a reminder, showing where each component is located and which lines are linked by wires. Remember to use only single core wire, 0.5mm diameter or so, because stranded wire will get caught up in the clips of the Eurobreadboard. If you're using a 4½ V battery (No. 1285) as a power supply, remember to get it the right way round, with + going to X1 (or X2) and — to Y1 (or Y2).



POWER SUPPLY LINKS
19B LINK X2 (+)
25A LINK Y1 (–)

Fig.2.2. How to find Pin 1 of an IC. The links shown are for supplying power to the 74LS132.

Disconnect the battery and find out where pin number 1 of the IC is. Figure 2.2 shows you how you find the pin 1 of *any* IC which is in this block form (the DIL package). There's an identifying notch cut at one end of the IC — the end which has pin number 1 and also the last pin (14 on the LS132, 16 on some others we'll use). Now if you place the IC legs down as it's shown in the drawing of Fig.2.2 the position of pin 1 is to the left of the notch. Some manufacturers also mould a little hollow next to pin 1. Don't be confused if there is what looks like a notch at each end — only the one which is sunk into the plastic is the true one!

Now that you've located pin 1, place the LS132 on the Eurobreadboard so that pin 1 is on line A19 and pin 14 is on line B19. You don't need to use tweezers to avoid handling the pins, because these are TTL ICs, not the CMOS ones which can be so easily damaged. When you've got the IC correctly placed, push it gently down, rocking it a bit from end to end, so that the pins go into the Eurobreadboard holes until the chip is right down on to the board. Check again that the pins are in the right holes, because all of the wiring instructions in this part, and all the following parts, assume that each IC is in exactly the place we've specified.

All You Need Are The Right Connections

We can now start making the connections which create a digital circuit. We're going to use just one of the four identical digital circuits which are on the LS132 chip, and we can make up the circuit by using just three wire links. One useful point about digital IC circuits is that most of them consist of just these links between ICs, with only a few odd resistors and capacitors to worry about. The only point to worry about now is, how do we know which connections to make? If you're building a circuit from scratch, to your own design, then you have to do it all the hard way, by tracing which pins you need to connect. For this series we'll use the easy HE way, using the Eurobreadboard line letters and numbers.

23B LINK 8C (SW1)
24B LINK 6C (SW2)
25B LINK 7B (LED1)

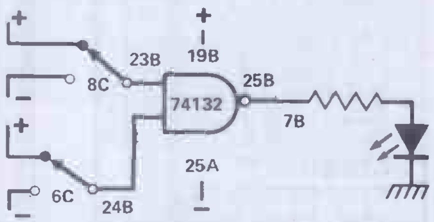


Fig.2.3. Link diagram (a) and circuit diagram (b) for a gate-test circuit. Only three wire links are needed to wire this up, because the switches and LEDs are already in place. This scheme assumes that the IC is in the correct place on the board.

Now there are two ways of showing how to make these connections, and Fig.2.3 shows both. One is a table of connections (Fig.2.3a) which shows which Eurobreadboard lines need to be linked with wires. The other way, which is a lot more useful, is to write the Eurobreadboard line numbers onto a circuit diagram. Why is it more useful? Because it gets you used to digital circuit diagrams, that's why. Once this series is finished you're on your own in the big bad world where there aren't any tables of Eurobreadboard connections, so we're training you to read the circuit diagrams and eventually to be able to fill in Eurobreadboard line numbers for yourself.

Fig.2.3(b), then, shows the circuit symbol for the digital device we're using. It's called a NAND gate, and this particular example has two inputs and one output. In the circuit shown, the inputs are connected to the switches 1 and 2, and the output is connected to LED 1. Since we have only two signal levels to worry about, a switch is all we need to provide an input. The way we've wired our switches, up causes the switch to provide logic 1, down provides logic 0; and the LED lights when the output is at logic 1.

The Truth Is On The Table

Now if this were a linear circuit, like an amplifier, we would probably want to measure some quantities like the voltage gain. We don't have to worry about such things when we use digital circuits, because the only quantities that exist are the two voltage levels 0 and 1. We can see what voltage levels we have at the inputs, because they're set by the switches, and at the output the LED shows whether we have a 1 or a 0. The only thing we need to know about a digital IC like this is what combination of inputs gives what output. Let's make that a bit clearer. If we had one input, we would want to know what the output was for a 0 at the input, and what the output was for a 1 at the input. With two inputs, there are four possible combinations of 0s and 1s which we could have at the inputs, and it's a bit easier to see what's happening if we write them down in the form of a table (Fig.2.4).

SW1	SW2	LED1
0	0	
0	1	
1	0	
1	1	

SWITCHES: UP FOR 1
DOWN FOR 0
LED: LIT FOR 1
UNLIT FOR 0

Fig.2.4. A blank truth table, ready for you to fill in.

We can now try out each combination of signals at the inputs, and find what output we get for each line of the table. This is now a 'truth table' for the digital IC — it shows what combinations of inputs produce 1 and which combinations produce 0. Showing this information in the form of a truth table is neater and simpler than describing what happens in words, though not so brief as the mathematical method called Boolean Algebra.

Come back, don't panic — we're not going to do any Boolean Algebra, I just mentioned it!

Now how do we go about finding the truth table for a circuit like the one in Fig.2.3? The obvious place to start is with both switches at zero (sliders down). If the LED is lit, then a 1 goes in-

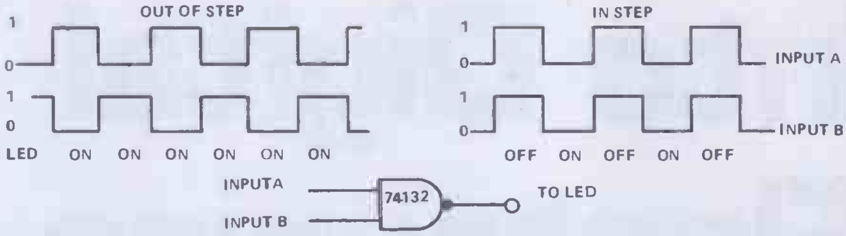


Fig.2.5. One possible use for the simple gate circuit.

to the output column on the line which has A and B inputs both 0; if the LED is not lit, then a 0 goes in the output. The next step is to try one of the switches at 1 (slider up), and we usually work from the right hand side, making A=0, B=1. Note the output for this one, then set A=1, B=0 and note the output for this, the third line of the truth table. Finally set both switches up so that the inputs are A=1, B=1 and see what the output is. Fill in this value, and your truth table is complete.

That really does tell you all you need to know about the way this gate works. The output is 1 unless both inputs are 1. When both inputs are 1, then the output is 0. That's all! It's called a NAND gate, for reasons we'll look at later.

Can you think of a use for this? Imagine that you have two oscillators, one supplying a signal to input A of this gate, and the other feeding its signals to input B. Could you tell when the oscillators were *exactly* in step? Yes, because the LED would be only dimly lit. When the oscillators are out of step, with one input of the gate high and the other low, the output is high, logic 1, keeping the LED shining reasonably brightly. When the oscillators are exactly in step, though, the LED is on when both signals are at their negative peak and off when both signals are at their positive peak (Fig.2.5), so that the eye sees the average brightness, somewhere between fully on and fully off.

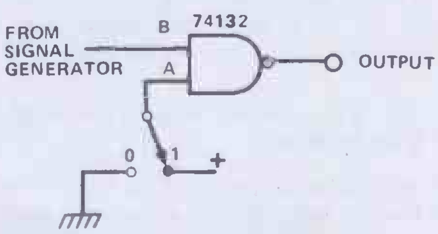
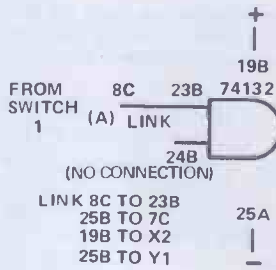


Fig.2.6. Using the gate as a signal relay.

Another application? Take a look at Fig.2.6. Here one input of the 74LS132 is from a switch and the other is from a signal generator. If the switch keeps input A at 0, then there is no signal output, because the output stays at 1. If the switch keeps input at 1, however, the output goes to 0 whenever input B goes to 1 (check the truth table to see that this is so), and the output goes to 1 whenever output B goes to 0. This is a typical gating action, opening or shutting a gate to let a signal pass or to prevent it.

Upside-Down Logic

That brings us to another very useful action of this gate. Suppose we use just one input, and forget about the other one? As it happens, we can't just forget about it, because if a TTL input is not connected, then it behaves as if it were connected to logic 1. Figure 2.7 shows the Eurobreadboard arrangement for trying this out, using switch 1 to set the remaining input, and LED 1 to indicate what the output is. The truth table for this is pretty simple, just two lines, one for A=0, the other for A=1. Try it for yourself, and fill in the output values.



A	Q
0	
1	

Fig.2.7. Using the gate as a signal inverter — another truth table for you.

Fig.2.8 shows a variation on this. Both of the inputs of the gate are connected to the same switch, so that we are using them as a single input. Try it out, and fill in the truth table.

By this time, you should be getting the hang of the simple Eurobreadboard method of connecting up, and we're going to use just the diagrams from now on. Remember that all the Eurobreadboard numbers and letters shown on one line of a diagram mean that these Eurobreadboard lines are linked by wire — that's all there is to building circuits this way.

Back to the digits. The action of the circuits of Fig.2.7 and Fig.2.8 is called

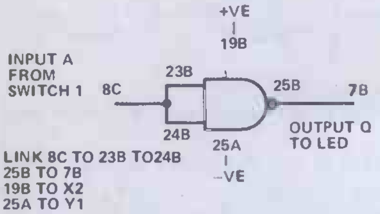


Fig.2.8. Another type of inverter connection.

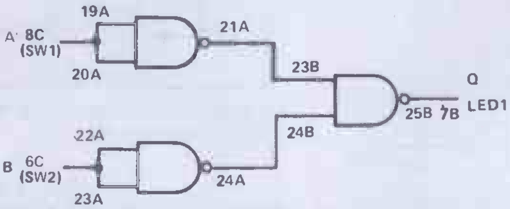
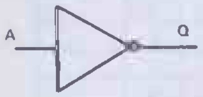


Fig.2.11. Another gate circuit. Does this one carry out the same action as the one in Fig.2.10?

inversion, and it's not hard to see why. For a 1 at the input, you get 0 at the output, and for a 0 at the input you get 1 at the output. The output is the inverse of the input, the other logic signal. Another name for this action is NOT, because NOT 0 must be 1 (there's nothing else) and NOT 1 must be 0 (same reason). A circuit which does this action only is called an inverter or NOT-gate, and its symbol is shown in Fig.2.9. The little circle at the output is what tells you that there is inversion, without the circle, the output of such a gate would be the same as the input. The same small circle occurs in the NAND gate symbol (Fig.2.8) which tells you that the NAND gate contains an inverter. More of that shortly.



A	Q
0	1
1	0

Fig.2.9. Inverter symbol and truth table.

Back to the board. Since we have a total of four NAND gates in one 74LS132, we can use more than one in a circuit.

Strip off all the links which go to the 74LS132, leaving only the switches and LEDs as they were. This clears the decks for the next circuit, and in future we'll assume that you've cleared the board before each circuit. Sometimes you'll find that the same links are used again but until you really get used to it it's always better to start with a clear board.

Try out the one shown in Fig.2.10. This has the circuit which you used before, with another gate used as an inverter at the output. Connect up and try it out, filling in the truth table for yourself. The action of this arrangement is on AND-gate, because the output is 1 only when both input A *and* input B are at 1. By using the second gate as an inverter, we have cancelled the inverting action inside the NAND-gate. Yes, that's right, NAND is short for NOT-AND.

Something a bit more ambitious now — making use of three of the four gates of the 74LS132. The circuit shown in Fig.2.11, with two gates used simply as inverters, but this time at the inputs rather than at the outputs. Does this have the same effect as the circuit of Fig.2.10? Try it out, filling in the truth table so that you can compare them. Not the same, are they? In fact the truth table of Fig.2.11 shows that the output is at 1 if A or B is at one, and it's the truth table of a type of gate called the OR gate (Fig.2.12).

Uses? Well just imagine you want a circuit to switch an LED on from either of two switches. If that's too simple, imagine this combined with a NAND gate, so that a signal can be stopped or passed using either of two switches.

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

Fig.2.12. The OR-gate truth table.

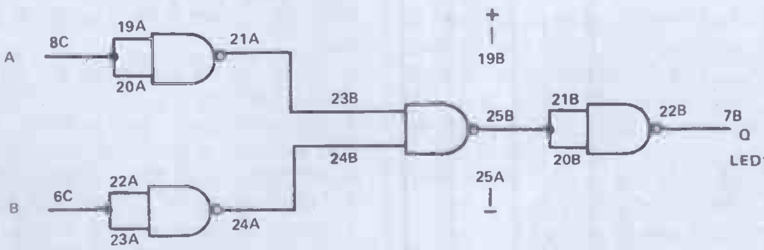


Fig.2.13. A circuit which makes use of all four gates of the 74LS132.

Nand Nanother Nthing

As a grand finale to this part of the work, add the last gate of the 74LS132, so that you have the circuit of Fig.2.13. Connect up, and fill in the truth table for this lot, which carries out the action of what we call a NOR gate. You should also be able to explain by now why it's called a NOR gate!

You should have a fair collection of truth tables by now, and they are all important. We can make AND, OR, NOT, NAND and NOR gates in IC form, and Fig.2.14 shows a reminder of the truth tables for these gates when only two inputs are used. We've used just one type of gate to make these circuits, though, and that's one of the interesting things about digital electronics. A collection of NAND gates can be used to carry out any action we like, including the action of other types of gates, so that we could build up digital circuits using only NAND gates, if we liked. We do, in fact, use NAND gates very extensively simply because they are so useful; we could equally well use NOR gates. We couldn't use AND or OR gates for so many useful purposes, because they don't invert signals. We can, for example, produce the action of an AND gate by using two NAND gates (Fig.2.10) but we could never produce the action of a NAND gate by using any number of AND gates, unless we could also make use of an inverter.

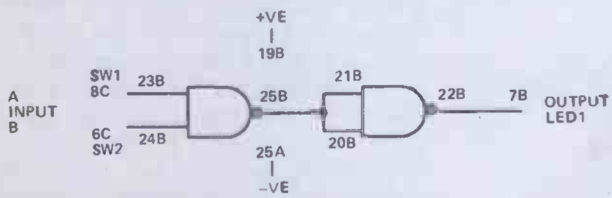
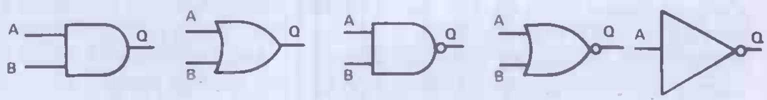


Fig.2.10. A circuit using two of the gates on the 74LS132. Construct your own truth table!



A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

A	Q
0	1
1	0

Fig.2.14. Gate types, symbols and truth tables summarised.

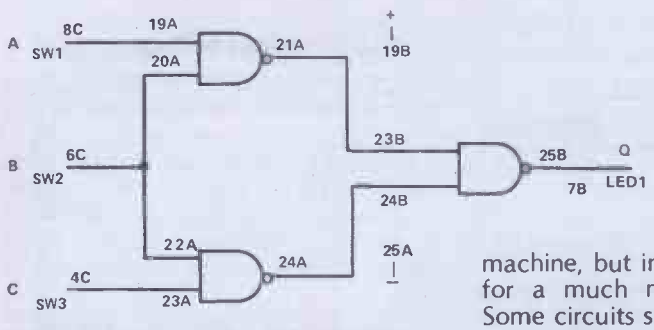


Fig.2.15. Find the truth table for this gate system.

Let's go practical again. Fig.2.15 shows a circuit which makes use of three NAND gates, and has three inputs. Now this extra input makes a big difference to the truth table, because it means eight lines instead of four. The general rule is that the number of lines of the truth table for a gating circuit has to be equal to 2 multiplied by itself as many times as we have inputs. For two inputs we need 2x2 lines, for three inputs we need 2x2x2 (which is eight). Mathematicians write this as 2^n (2 to the power n), where n is the number of inputs.

A	B	C	Q
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Fig.2.16. Blank truth table to fill in.

The blank truth table is shown in Fig.2.16, so you can fill in the output for each of the combinations of inputs which are shown. This one does not form any named type of gate, but its action is quite a useful one. Take a long hard look at that truth table. Notice that the output is always zero if B is zero and one or more of the other inputs is zero, and the output is 1 if B and more of the inputs are at 1. This is a simple form of a 'majority voting' circuit, so called because the output will be of the same polarity (0 to 1) as the majority of the inputs. It could, for example, be the basic of a simple voting machine, but in engineering it is used for a much more serious purpose. Some circuits simply are so important that no failure must ever happen, even if the circuit cannot be repaired. The simplest way of doing this is to make many identical circuits, and use a 'majority voting' gate at the output. If all the circuits are operating perfectly, then all is well, but if some fail, then the output will still be decided by the majority. It can be a great comfort if you're 250,000 miles away from Earth!

Now for one last bit of practical work, try the circuit in Fig.2.17. This uses all four gates of the 74LS132, with three inputs and one output. Because there are three inputs, there must be eight lines in the truth table, which you can complete for yourself by experiment. What sort of gate is this?

Gate circuits like this can be used as the basis for 'combination lock' circuits, which give a 1 at the output only for some particular combination of inputs. For this reason, the gate circuits are sometimes known as combinational logic — it's the combination of signals at the inputs which decide what what the output will be. As it happens, we can make the circuit entirely from NAND gates if we like. The circuit of Fig.2.17 produces the effect of a three-input AND gate, though we have used only two-input NAND gates in the circuit.

How can we find what a gate circuit does? One way is to try it out on the Eurobreadboard, but another way is just by writing truth tables. We need a truth table with lots of columns, one for each input, of course, but also one for each place where the output of one gate is connected to the input of another. Figure 2.18 shows the circuit of Fig.2.17 labelled and a truth table drawn up in this way. If we now write in the usual collection of inputs (2^n, remember), we can fill in the rest of the columns simply because we know the truth table for the gates we are using. Figures 2.19 to 2.21 show this particular truth table being filled in bit by bit in this way. The final result is the output column, which shows the action of the whole circuit. In this case it's a 1 when all the inputs are 1, a three-input AND in fact.

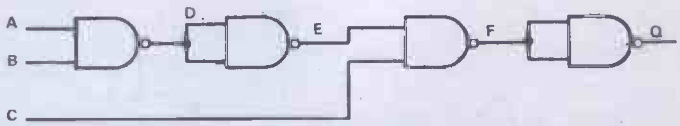


Figure 2.18. Marking out a gate circuit so that you can draw up its truth table *without* experiment.

A	B	C	D	E	F	Q
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

Figure 2.19. Filling in the truth table — the first step. Each possible A,B,C input has been entered.

A	B	C	D	E	F	Q
0	0	0	1	0		
0	0	1	1	0		
0	1	0	1	0		
0	1	1	1	0		
1	0	0	1	0		
1	0	1	1	0		
1	1	0	0	1		
1	1	1	0	1		

Figure 2.20. The next step — the E and D columns can be filled in because you know the truth table for the NAND gate and inverter.

A	B	C	D	E	F	Q
0	0	0	1	0	1	0
0	0	1	1	0	1	0
0	1	0	1	0	1	0
0	1	1	1	0	1	0
1	0	0	1	0	1	0
1	0	1	1	0	1	0
1	1	0	0	1	1	0
1	1	1	0	1	0	1

Figure 2.21. The table can now be completed, once again because the truth tables for NAND gate and inverter are known.

The important point is that gate circuits can be designed to give a 1 output for any combination of inputs we like. A lot of machinery can be controlled just by an ON(1) or OFF(0) signal, so that gate circuits are the ones we use to make control circuitry. The more complicated the control action has to be, the more suitable digital gates are to carry it out, because mechanical switches and relays are suitable only for comparatively simple circuits. HE

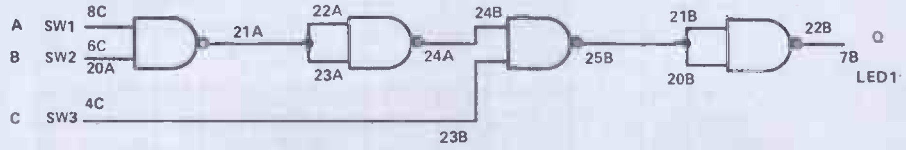


Fig.2.17. Another gate system to investigate — try it out.

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1950	Iron coated bit 1/8" for 1948	£0·58
1951	Iron coated bit 3/16" for 1948	£0·58
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163	4in	2¼in	2in	£0·87
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400	TR12A/400	£0·82	400	TR110A/400	£1·29

6 amp volts			10 amp volts		
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IS924 300V	£0·12	IN5406 600V	£0.24
		IN5407 800V	£0.29
		IN5408 1000V	£0.35
1 Amp		**10 Amp**	
IN4001 50V	£0.05½	IS10/50 50V	£0.22
IN4002 100V	£0.06	IS10/100 100V	£0.24
IN4003 200V	£0.07	IS10/200 200V	£0.26
IN4004 400V	£0.08	IS10/400 400V	£0.40
IN4005 600V	£0.09	IS10/600 600V	£0.48
IN4006 800V	£0.10	IS10/800 800V	£0.59
IN4007 1000V	£0.12	IS10/1000 1000V	£0.69
		IS10/1200 1200V	£0.79
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IS020 100V	£0.12	IS30/100 100V	£0.79
IS021 200V	£0.13	IS30/200 200V	£1.07
IS023 400V	£0.15	IS30/400 400V	£1.44
IS025 600V	£0.16	IS30/600 600V	£2.02
IS027 800V	£0.18	IS30/800 800V	£2.33
IS029 1000V	£0.23	IS30/1000 1000V	£2.66
IS031 1200V	£0.29	IS30/1200 1200V	£3.31
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IS70/50 50V	£0.86	IS70/400 400V	£2.01
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		IS70/1000 1000V	£3.45

THYRISTORS

600ma Volts	TO 18 Case No.	Price	7 amp Volts	TO 48 Case No.	Price
10	THY600/10	£0.17	50	THY7A/50	£0.55
20	THY600/20	£0.18	100	THY7A/100	£0.59
30	THY600/30	£0.23	200	THY7A/200	£0.66
50	THY600/50	£0.25	400	THY7A/400	£0.71
100	THY600/10	£0.29	600	THY7A/600	£0.90
200	THY600/200	£0.44	800	THY7A/800	£1.06
400	THY600/400	£0.51			

1 amp Volts	TO 66 Case No.	Price	10 amp Volts	TO 48 Case No.	Price
50	THY1A/50	£0.30	50	THY10A/50	£0.59
100	THY1A/100	£0.32	100	THY10A/100	£0.66
200	THY1A/200	£0.37	200	THY10A/200	£0.71
400	THY1A/400	£0.44	400	THY10A/400	£0.81
600	THY1A/600	£0.52	600	THY10A/600	£1.14
800	THY1A/800	£0.67	800	THY10A/800	£1.40

3 amp Volts	TO 66 Case No.	Price	16 amp Volts	TO 48 Case No.	Price
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100	THY3A/100	£0.35	100	THY16A/100	£0.67
200	THY3A/200	£0.38	200	THY16A/200	£0.71
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200	THY5A/200	£0.58	200	THY30A/200	£1.87
400	THY5A/400	£0.66	400	THY30A/400	£2.06
600	THY5A/600	£0.79	600	THY30A/600	£4.03
800	THY5A/800	£0.93			

5 amp Volts	TO 220 Case No.	Price	No.	Price
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1w-1·5w Plastic and metal encapsulated. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z13 18p**

10w Metal stud type SO10 case. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z10 44p**

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200v RMS	BR1/200	£0·29	200v RMS	BR2/200	£0·60
400v RMS	BR1/400	£0·41	400v RMS	BR2/400	£0·67
			1000v RMS	BR2/1000	£0·78

SILICON 10 amp Type	No.	Price	SILICON 25 amp Type	No.	Price
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200v RMS	BR10/200	£1.96	200v RMS	BR25/200	£2.53

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MITRAD LM40 Four button gentleman's alarm. Continuous display of hours, minutes and seconds plus selectable month, date, day. PM flag. Alarm, settable anywhere in 24 hour period, is activated for full 60 seconds. Back light. Closely woven adjustable stainless steel strap. Case thickness 10mm.
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MITRAD LM39 Ladies auto LCD dress watch. Continuous display of hours, minutes and (pulsating) seconds. Month and date with auto calendar. Back light. Integral watch and strap with sugar frosted finish in gold or silver. Spring clip clasp for comfortable fit. Case thickness 8mm. **£10.25 + 85p p&p.**

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Tug O'War Game

Play an old game a new way with this design from HE — eliminate sweat, mud and sore palms. The HE Tug O'War is the ideal game for the less energetic who only wish to exercise their fingers — a genuine digital circuit in more ways than one!

HERE AT HE we are basically very lazy (who said 'hear hear'?). So we're always looking at ways to turn the physical excesses of the sporting life into games that we can play with one finger, in the comfort and privacy of our own armchairs. Our latest venture into this field (or rather off the field) is the Tug O'War game, which does for this sport what Shark did for swimming and the Scalextric Lap Counter did for motor racing.

In our version the game is not a trial of strength, (strain gauges are not readily available to the hobbyist!) but rather a contest to see who's finger is fastest on the button. The display consists of a line of LEDs, of which only the centre one is lit at the start of the game. A single flashing LED is provided and when it comes on the first player to press his button causes the light on the display to move towards him. The more often a player reacts first, the further the light moves. The winner is the person who gets the light to his end of the display. All of this is accompanied by the usual bleeps and buzzes that we know and love so well.

Our office philosopher once said that most electronic games could be reduced to just one, 'Spot the 4017'. You might think that the same is beginning to apply to the LM3914 — and why not? Like the 4017, it is a very useful and versatile chip which can be used for many different applications. Here we use it as a bargraph voltmeter in the 'dot' mode, so that only one LED in the display is lit up at any one time.

Construction

We recommend the use of our PCB. Solder the resistors, capacitors, diodes, transistors, and IC sockets to the board, taking care that polarised components are fitted the right way round. We mounted the display LEDs in clips on the front panel. The anodes were linked together by a length of tinned copper wire which was then wired to the PCB, while the individual cathodes were wired to the corresponding pads on the PCB. If you hate interwiring, then it is possible to solder the LEDs directly in position on the PCB — however you will have to use 0.125" LEDs or the more expensive square type as the size we used won't fit.

Wire up the switches, indicator LED, loudspeaker and battery clip and insert the ICs into their sockets. Now fasten the PCB inside the case. We simply stuck it to the bottom with double-sided sticky pads. The loudspeaker is glued to the base of the box; but don't forget to drill a few holes there first or the sound will be somewhat muted!

How it Works

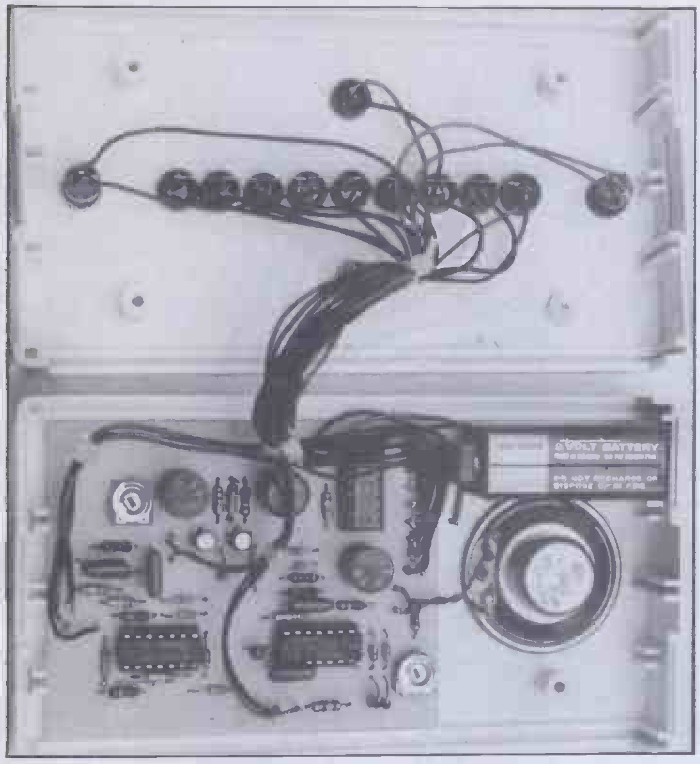
A player has to push his button first to move the light on the display towards him — the circuitry around IC1 detects who is first. A new chance to beat the other player is provided once a second, when IC3a resets IC1. IC3a is connected as an astable (oscillator) operating at one Hertz. When its output (pin 9) is high, IC1a and b are reset via D2 and D4. When pin 9 goes low again IC1a and b are enabled and LED1 lights to indicate this. The degree of difficulty of the game can be varied by altering the mark-space ratio of IC3a (time that it is on and off). This is done by adjustment of RV2.

IC1 contains two D-type flip-flops, or bistables, one for each player. In this type of bistable a pulse on the clock input causes the logic level (high or low) at the data input (D) to be transferred to the output (Q). Clock pulses are generated when a player presses his button, and the inclusion of C1 and C2 ensures that a player cannot cheat by holding his button down; a new pulse must be provided every time LED1 turns on. The reset pulse from IC3a forces the outputs of IC1a and b low and both D pins are held high by R3 and R5, so the faster player will send his Q output high.

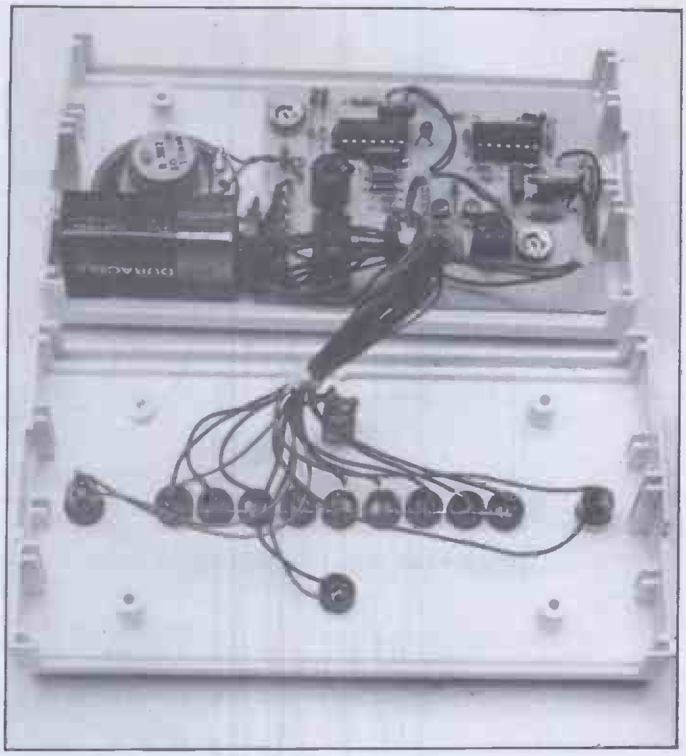
Each output is coupled to the reset pin of the other bistable via D1 and D3. Thus the faster player's high output disables his opponent's bistable for the remainder of that 'play' period. One of the transistors Q1 or Q2 will be turned on via R9 or R10, depending on who was first.

IC2, an LED voltmeter, senses the voltage at the junction of C3 and C4 via RV1. Normally this junction is charged to half supply voltage, and RV1 adjusted to light the middle LED of the display. If Q1 turns on, the voltage at the junction will rise as C3 discharges and C4 charges. Similarly the voltage will fall if Q2 turns on. IC2 responds by lighting LEDs further up or down the scale. This provides the game display.

IC3b is connected as audio oscillator, normally off because its enable pin is grounded (pin 4). When either output of IC1 goes high, IC3b is enabled via D7 or D8 — the pitch depends on the control voltage applied to pin 3 via R20 and R21. The tone shows which player reacted first.



Inside the case, note position of the loudspeaker and battery.



Close up of the interwiring of the LEDS. A cable tie keeps things neat.

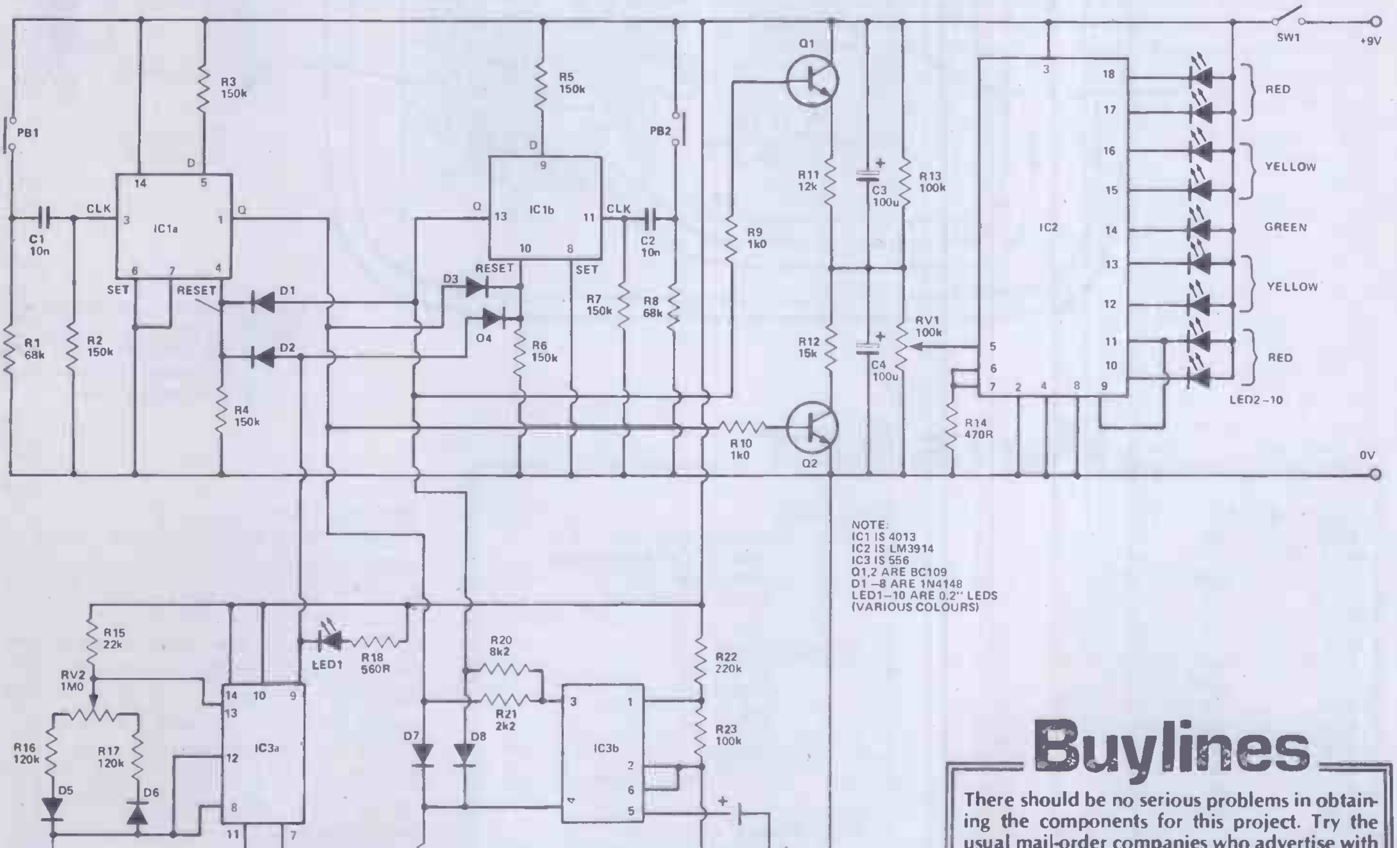


Figure 1. Circuit diagram of the HE Tug O'War

Buylines

There should be no serious problems in obtaining the components for this project. Try the usual mail-order companies who advertise with us if you have trouble. Component cost should be about £12, but remember that this price is exclusive of case and printed circuit board.

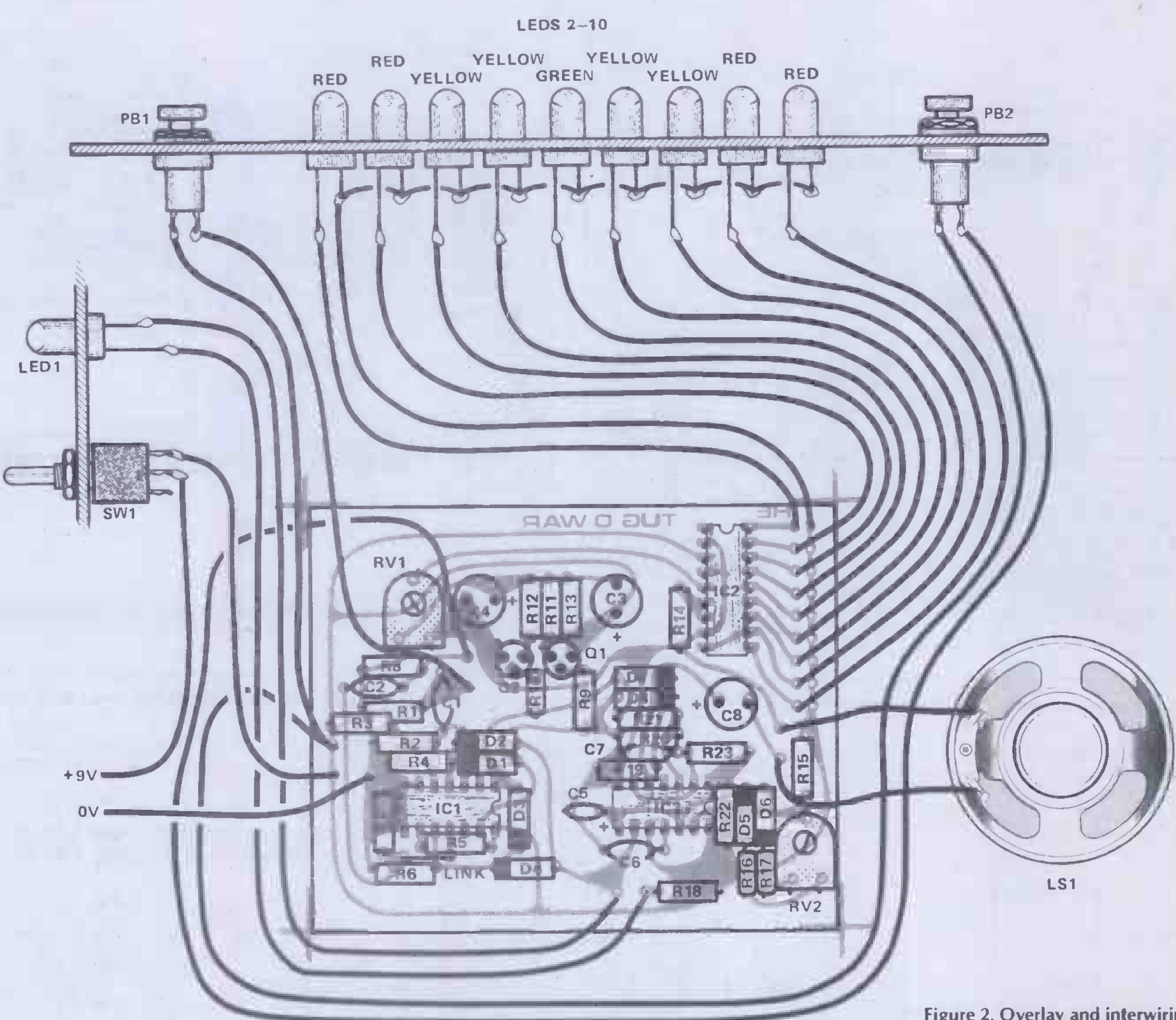


Figure 2. Overlay and interwiring diagram for the HE Tug O'War game. LED1 and SW1 mount on the front panel as well but we've drawn them as separate for clarity

Parts List

RESISTORS (all ¼ W 5%)

R1,8	68k
R2,3,4,5, 6,7,19	150k
R9,10	1k0
R11	12k
R12	15k
R13,23	100k
R14	470R
R15	22k
R16,17	120k
R18	560R
R20	8k2
R21	2k2
R22	220k

POTENTIOMETERS

RV1	100k linear horizontal miniature preset
RV2	1M0 linear horizontal miniature preset

CAPACITORS

C1,2,6,7	10n polyester
C3,4,8	100u 16 V PCB-mounting electrolytic
C5	1u5 35 V tantalum

SEMICONDUCTORS

IC1	4013
IC2	LM3914
IC3	556
Q1,2	BC109
D1-8	1N4148
LED1-10	0.2", various colours

MISCELLANEOUS

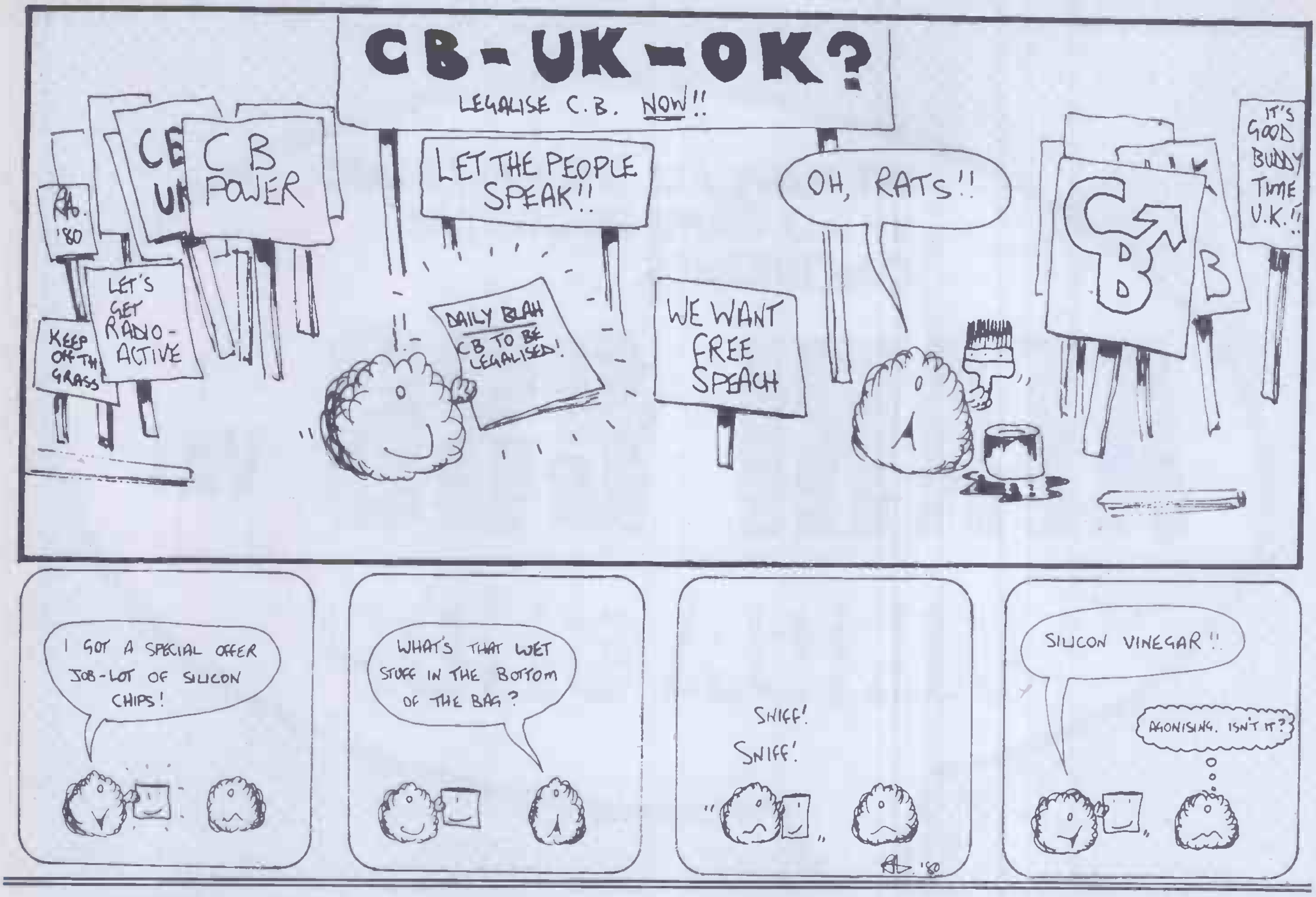
SW1	Single-pole, single-throw toggle
PB1,2	Push-to-make non-locking
LS1	Miniature 8R0 speaker

PCB, IC sockets, 9 V battery and connector, verocase, clips for LEDs.

Setting Up

Double check the position of all the components and wiring, then insert a PP3 into the battery connector. Switch on and check that the move indicator LED is flashing. The ratio of 'on' to 'off' times can be adjusted by RV2 to set the level of difficulty you require. Now rotate RV1 until the centre LED is lit. Check that pushing either button causes the light to move in that direction and a tone to sound (different for each button). If the light moves the opposite way, swap over the connections to the pushbuttons.

If all is well, snap the case together and the game is ready for use. All you have to find is a friend and two armchairs. HE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LEGALISE C.B. NOW!!
CB POWER
LET THE PEOPLE SPEAK!!
OH, RATS!!
IT'S GOOD BUDDY TIME U.K.!!
LET'S GET RADIO-ACTIVE
KEEP OFF THE GRASS
DAILY BLAH
CB TO BE LEGALISED!
WE WANT FREE SPEACH
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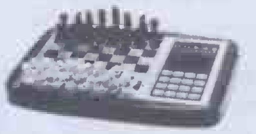

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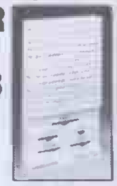

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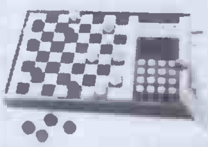

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electronics today INTERNATIONAL

Look out for the November issue — on sale October 3rd.

SPACE INVADERS

In the past few months we've seen all manner of Space Invaders games — from enormous pub machines to programs on tape cassette for home computers. We've spent many a long hour researching the game in pubs and clubs from Land's End (Watford) to John O' Groats. Next month we present the ETI Space Invaders game for you to build. ☐ Plug the lead into the back of your telly and sit back with the box of tricks on your lap. Off you go — blasting aliens out of existence (with full sound effects, of course). ☐ World War III's OK, but there's nothing like the real thing — ETI Space Invaders — a computer game with a trick or two up its sleeve, as you'll find out next month.

Photos courtesy of Twentieth Century Fox.

FREE PCB

As we finish printing each issue of ETI with our John Bull set, we're sticking a free, gratis, no-more-to-pay printed circuit board on the cover. It has a million and one uses — you can prop up a wobbly coffee table, make a shower for the budgie . . . OR build the five projects we've designed for your free PCB. There's an RIAA equalised preamp, a 2 W amplifier, a touch doorbell, a light switch and a metronome. ☐ We give you the PCB; we give you the project designs . . . it couldn't be easier.

RADIOACTIVITY

Know your alpha, beta, gammas? If it's all just radiation to you, you could learn a thing or two from A.S. Lipson's excursion into that fantastic, frazzling, phenomenon of modern physics — Radioactivity. What makes something radioactive? What exactly is radioactivity? All will be revealed next month.

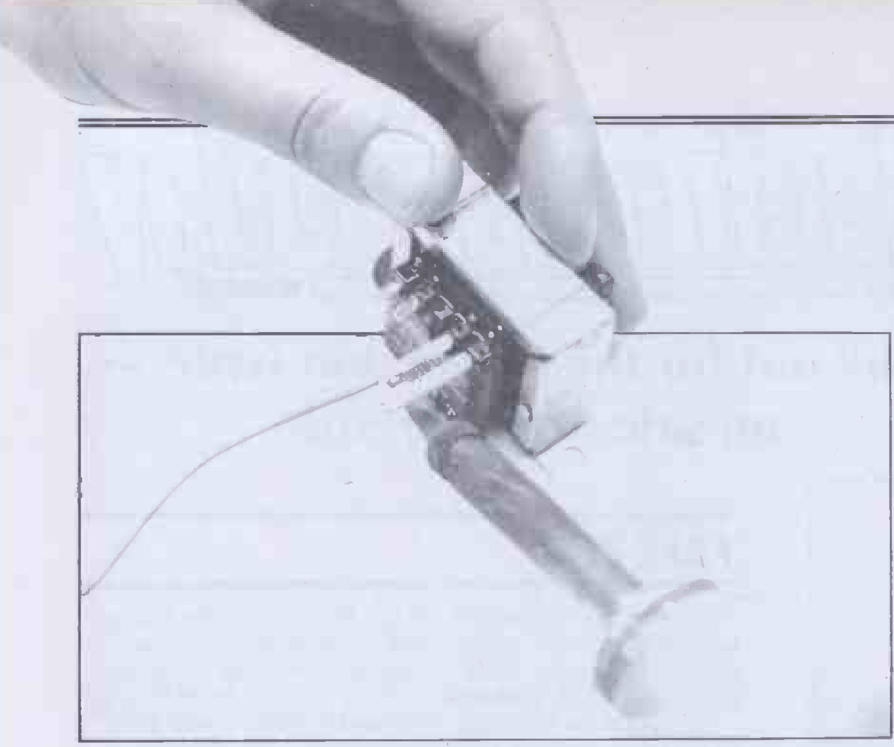
EVEN MORE PROJECTS

Not satisfied with bringing you our amazing Space Invaders game and FIVE projects for your free board, we've also got a doorbell with a difference (it plays tunes) and a straightforward, no frills Bench Amplifier for your test bench. It's all in ETI November.

AND THAT'S NOT ALL

Data Sheet puts in an appearance with all you need to know about a family of monolithic switched capacitor filter chips and a speech generator chip (a very clever little block of plastic). ☐ Talking of blocks of plastic, voltage regulators this time — we look at a very simple discrete component regulator design (for when you don't have the necessary chip to hand then and there). ☐ We know now that the Space Shuttle launch has definitely been postponed until at least next March. Astrologue explains why.

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.



Building Site

Although the National Grid, courtesy of the Electricity Board, provides us with a useful source of energy to power our projects, you won't be surprised to learn that it can also be dangerous if proper care is not taken. Keith Brindley offers a few suggestions as to how the mains can be safely harnessed.

SOME INTERESTING problems arose with three of this month's projects — the Freezer Alarm, the Light Dimmer and the Temperature Controlled Soldering Station, all of which are connected to the mains power supply.

Now, nobody can deny 220-240 V AC mains is exceptionally useful as an easy way of obtaining power for your projects and furthermore, running costs are minimal. But the problem still remains of the potential shock hazards encountered with its use. A mains shock will at best give you a painful jolt, leaving your arm quite numb for a few minutes. In the worst case, mains voltages are lethal. It all depends on which route the current takes to earth — it will automatically take the easiest path — so if *you* are the easiest path — BANG. For instance, if your left hand is resting on a good earth point eg. the earthed case of your project and you inadvertently touch a live point with your right hand, then the easiest current path is up your right arm, across your chest and down your left arm. Your heart suffers a bit in this sort of case, being in direct line with the current and you may find (or rather the first person to come across you after your shock may find) that it has stopped altogether.

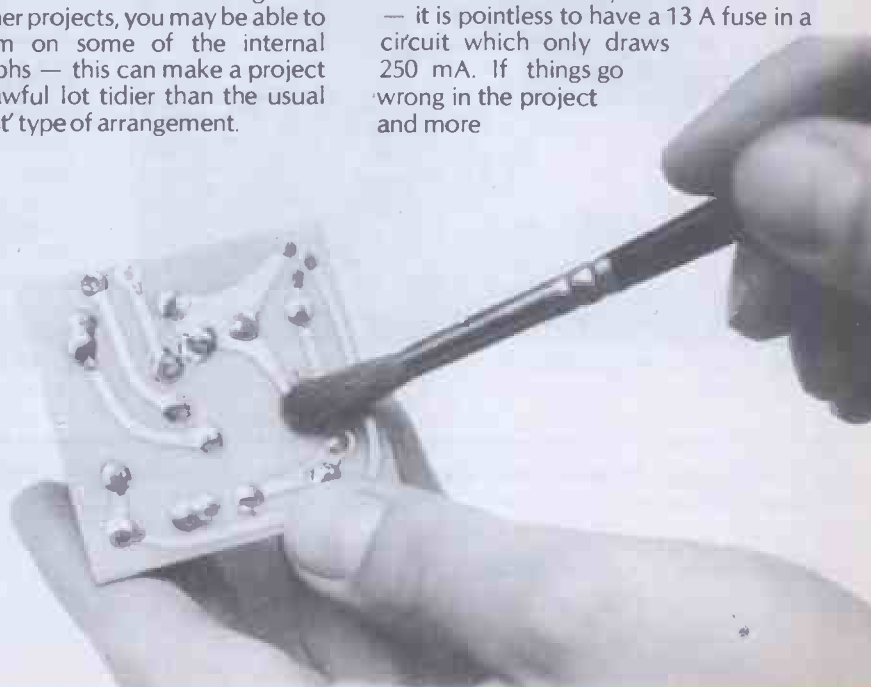
Don't Lose Heart

All joking apart, it cannot be stressed strongly enough that you should take care when dealing with mains voltages. If you must probe around inside equipment which is connected to the mains, keep one hand in your pocket, not because you are mean and want to keep a firm grip on your money but simply to avoid setting up a path through your heart.

Mains powered projects can be designed with certain safety precautions built in. Take the HE Freezer Alarm for example, the constructional method is ideal for hobbyist purposes as a number of precautions having been taken. The first is the use of a grommet and some form of cable clip to prevent the mains cable from being pulled out or its insulation from being worn. Various forms of cable clip are available that do the job satisfactorily, the type we mostly use is a simple tie-clip. The tie-clips have a non-release ratchet lock action (ie. pull them as tight as you can and simply cut off the long flying end), which holds the cable securely. They are very cheap, around 2 or 3 pence each. Tie-clips are also used to tie together all the interconnecting wires on the other projects, you may be able to spot them on some of the internal photographs — this can make a project look an awful lot tidier than the usual 'bird's-nest' type of arrangement.

Figure 2 shows the use of a very convenient method of mains connection known as European-style chassis connectors. None of this month's projects actually have this sort of plug and socket arrangement fitted but it is such an important method that it is shown here for your future reference. Connections to the inside of the circuit can be made using standard ¼-inch push-on tab connectors or they could simply be soldered on. An advantage of this type of chassis connector is that you will only need two or three made-up leads with the corresponding line plug, as they are readily interchangeable.

Another sensible precaution in the mains circuit of the Freezer Alarm is the fuse and fuse-holder. A fuse should usually be inserted in the live lead to protect the project itself. You should always ensure that a correctly rated fuse is used — it is pointless to have a 13 A fuse in a circuit which only draws 250 mA. If things go wrong in the project and more



current is drawn, then it is unlikely that the 13 A fuse will blow and your project may well suffer irrepairable damage.

A terminal block can be a useful addition to a project because it provides a convenient way of 'commoning' any necessary points in the circuit. The photograph of the Freezer Alarm shows the terminal block method in use.

The Light Of Your Life

Space restriction in the HE Light Dimmer precludes these connecting methods. Without them the whole unit becomes small enough to fit into a standard sized wall box, in place of the existing on/off type light switch. Once fitted you would be unlikely to take the dimmer out again, so possible hazards are avoided, and it is safe. Nevetheless, we coated the back of our printed circuit board (ie. the copper track side) with insulating varnish just to be on the safe side and advise that you do the same. In fact, it's a good idea to do that to any PCB which carries mains voltages so it may just save a life — yours!

Most mains powered equipment uses a transformer to reduce the high mains voltage to a more manageable level (e.g. 12 V). It is only pure coincidence that two out of this month's three mains projects do *not* have a transformer in the circuit.

The mains transformer has a secondary purpose (pun? what pun?) which is every bit as important. The structure of a transformer is such that it has two *mechanically* joined coils of wire which are *electrically* isolated. This electrical isolation is the key to a project's safety. At no point (usually) is the low voltage side of the transformer joined to the high voltage mains side, with the possible exception of earth (i.e. zero potential). This may or may not be joined depending on the circuit.

The Light Dimmer and the Temperature Controlled Soldering Station do not have a mains isolating transformer in circuit. So due care must be taken — two measures are advised — varnish the copper track side of the board before use and do not case the devices in such a way that prying fingers can get at the insides.

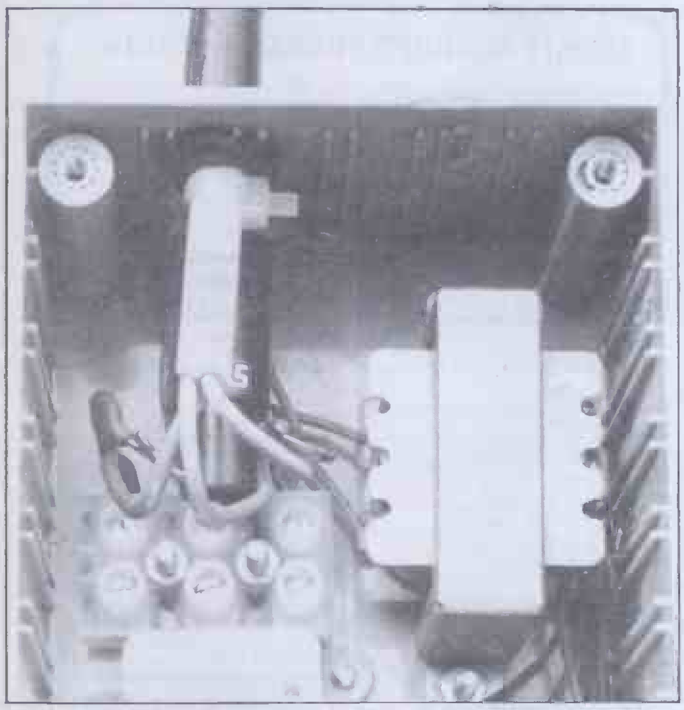


Fig.1. Internal photograph of the mains connection circuitry of the Freezer Alarm, from this you can see the grommet, cable clip, fuse and fuseholder and terminal block.

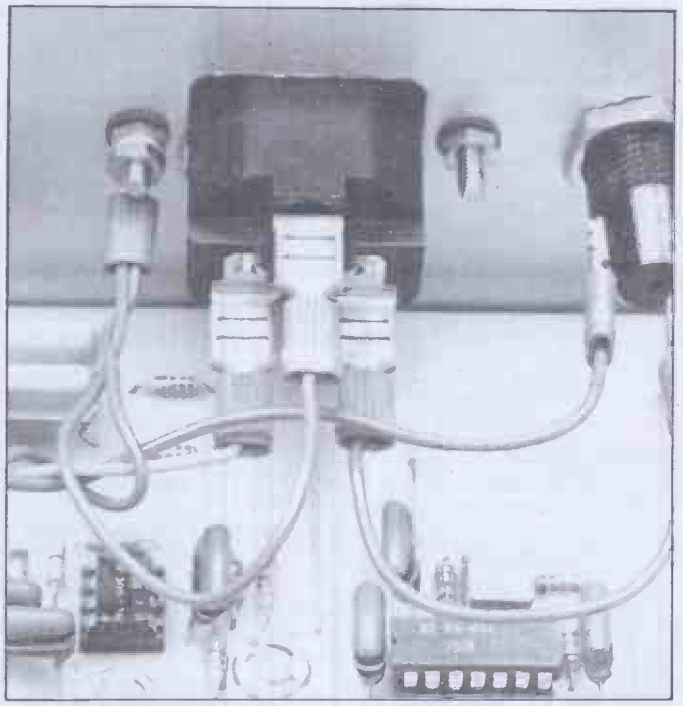


Fig. 2. A European style chassis connector. Quarter inch tab connectors were used to make connections.

The Heat Is On

One precaution that we often take when building projects in the HE Projects Lab is to use Heat Shrink Sleeving. This is a very effective method of covering up and, therefore, insulating any connections which may carry dangerous voltages. The sleeving is made from a polyolefin material which possesses the remarkable ability to shrink to about half its original diameter when heated. It's simple to use, just slip a short length (about 20 mm) over the lead and connection and then heat it up. The heat can be applied from a proprietary hot air blower (similar to a hand-held hair dryer but much hotter), a gas or match flame, or, as we use, a hot soldering iron held close to *but not touching* the sleeving. Picture 1 shows such an operation. The sleeved joint on the left has already been heated and you can see how the sleeving has shrunk to tightly cover the joint. The one on the right is just about to be heated by the soldering iron. This is a good precaution to take on any project, not just mains powered ones, as it protects two or more close connections from ever short circuiting.

Use Your Loaf

The important thing to remember if you build your own mains powered equipment is to take your time. Double check and triple check everything before you switch on. Use your common sense!

From that harmless-looking socket on the wall you have three leads, coloured green/yellow (earth — safe), blue and brown (neutral and live — DANGEROUS). When you touch that live connection — if you're lucky, it'll hurt — if you're unlucky, you won't feel a thing!

Next month I'm planning to talk to you about how to make your own PCBs, as quite a few readers have written requesting more information on the subject. Well, next month you'll see how we do it and pick up a few hints on how to make really first class PCBs yourself, so don't miss it! **HE**

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Light Dimmer

For those of you who are romantic, this project will let you set the right mood. If you're not, think of the saving on your electricity bill!

LIGHT DIMMERS are always a popular project. They are cheap, simple, and easy to build — furthermore they are useful things to show friends who wonder what on earth electronics is good for as a hobby. Our design is probably the simplest and smallest mains lamp dimmer possible — just eight components on a PCB two inches square. As we've used an MK blanking plate for the 'front panel' of this project it's also easy to fit. All you do is remove the existing light switch from the metal wall box and replace it with the HE Lamp Dimmer, soldering the two mains leads in position on the board first.

The single active component in this circuit is a combined triac and diac (trigger diode) which is cheaper than using two components and also takes up less space. Radio frequency interference, always a problem with this type of circuit, is suppressed by L1 and C1. L1 is not a critical coil and can easily by wound by hand. Details of this are given below.

Construction

All of the components, including the switched pot, are soldered directly to the PCB. Start by mounting RV1. The switch terminals on the back are soldered to the PCB and the pot terminals connected to the corresponding pads on the board by means of short lengths of insulated wire. Now solder all the other components. The only polarised component is SCR1 — make sure you get it the right way round. Its leads should be bent at right-angles to match the pattern of the PCB pads, so that it lies flat against the board. Leave a slight gap to allow air circulation for cooling.

L1 is made by scramble-winding about 50 turns of 22 SWG enamelled copper wire on a ⅜ inch former. The finished coil should be about one inch long. Scrape the enamel off the ends and solder it in place. Now the whole board can be fastened to the MK blanking plate by means of RV1.

The HE Lamp Dimmer can control a load of about 250 W. We suggest that for safety you varnish or lacquer the track side of the board before use, and make sure that no part of the circuit is touching the metal mounting box.

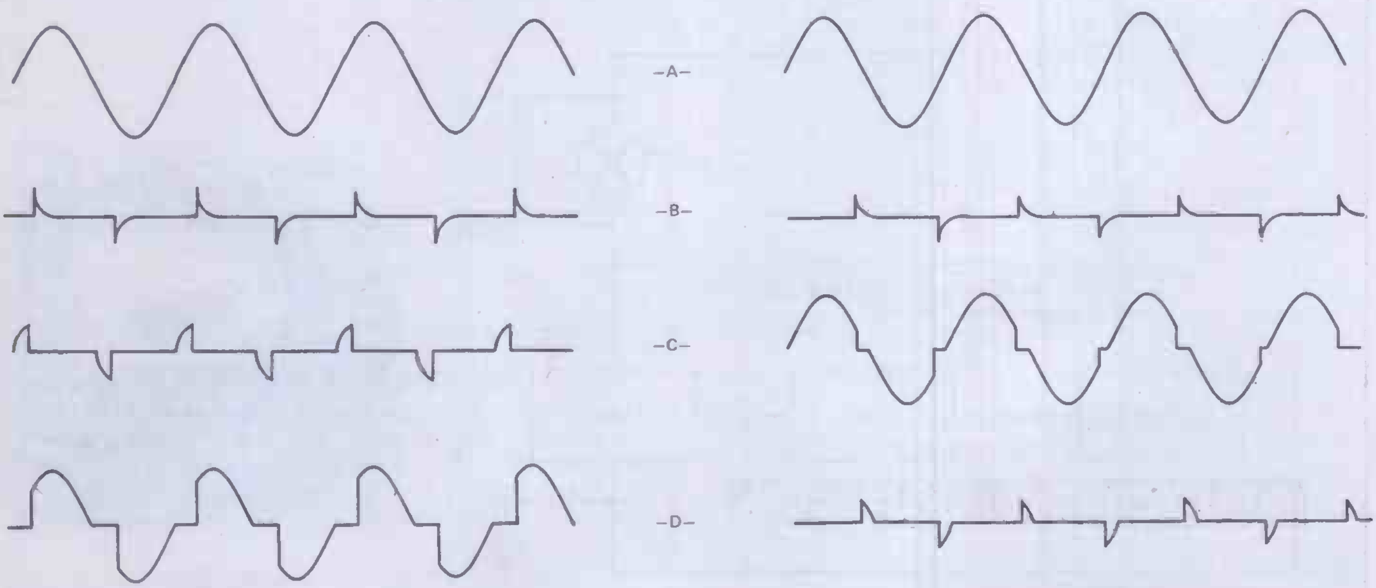
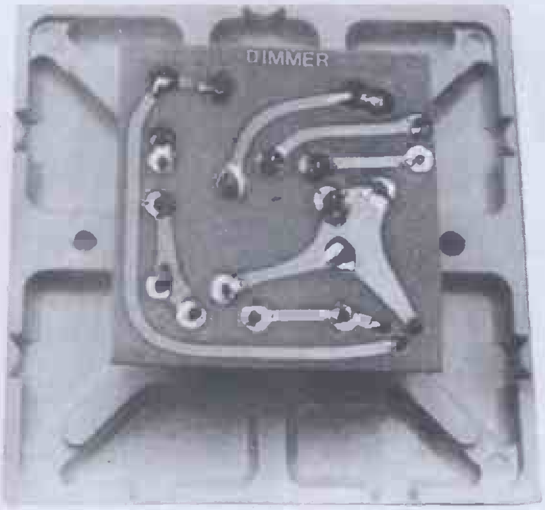


Figure 1. The waveforms on the left occur when the dimmer is set near maximum brightness, those on the right near minimum brightness.



A view of the completed PCB mounted on the MK blanking plate. This gives you some idea how small it is.

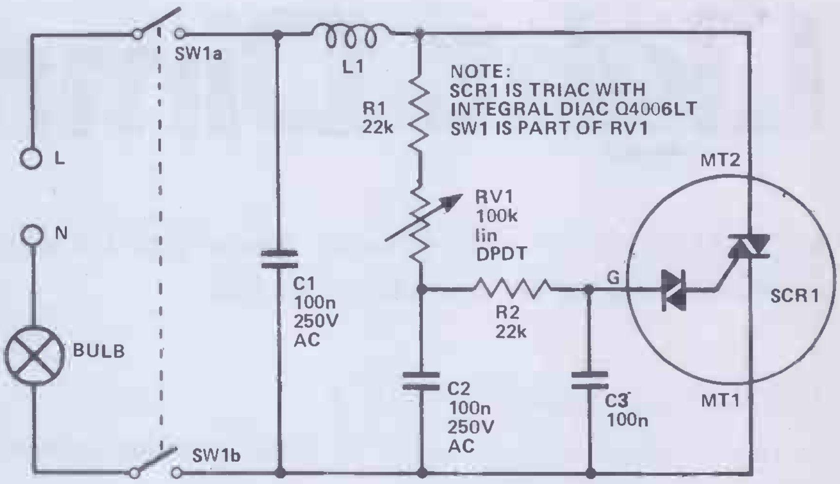


Figure 2. Circuit diagram of the Light Dimmer

Buylines

We used an MK blanking plate to mount our dimmer, this particular variety has a punch through hole in its centre allowing insertion of the pot spindle. Any good electrical hardware store should stock them.

SCR1, the Q4006LT triac with integral diac is available from TK ELECTRONICS, who advertise with us. As far as we know they are the only stockists.

None of the other components should cause problems. Total cost including the blanking plate should be around £4.

How it Works

The basic block diagram of the HE LIGHT DIMMER is shown in figure 2. (Figure 2 shows the waveforms within the circuit when approximately 4/5 power is applied to the load (the light bulb) and when approximately 1/5 power is applied.

A triac is, essentially, a power switch which can operate on either the positive or the negative half cycle of an applied AC waveform (waveform A in figure 1). The triac in the HE LIGHT DIMMER is in series with the lamp and so current cannot flow through the lamp until the triac is turned on. This is done by an internal trigger diode (more commonly called a diac) which provides a pulse to the triac gate. This "fires" the triac into conduction (waveform B illustrates this). The triac stays on for the remainder of the half cycle of applied power, ie. until the voltage across it reaches zero. This is shown in waveform C. At this point it switches off until a further pulse is applied to its gate.

If pulses are applied at the beginning of the AC cycles then the triac is on for the greater part of the time — therefore the bulb has current flowing through it most of the time (approaching maximum brightness).

If, however, the pulses are delayed for a time after the beginning of the cycle then the current only flows through the bulb for a small amount of the time (approaching minimum brightness). This time delay is provided by R1, RV1 and C2. The use of variable potential divider RV1 makes the time delay completely variable, allowing complete control from minimum to maximum brightness. RV1 has a built in switch, allowing the power to the dimmer and the lamp to be switched off completely.

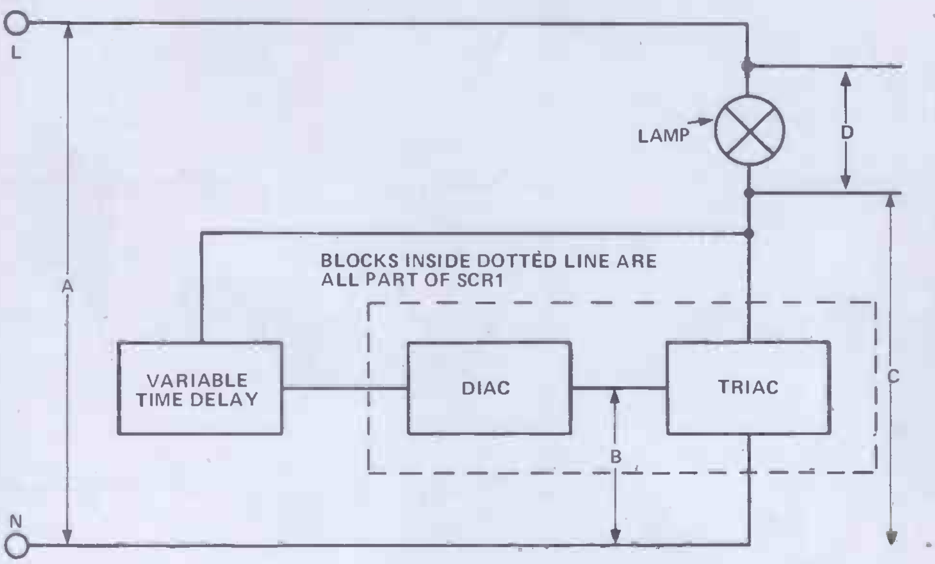


Figure 3. Block diagram of the Light Dimmer

This photograph shows the PCB with the components in place ready for mounting on the blanking plate.

Parts List

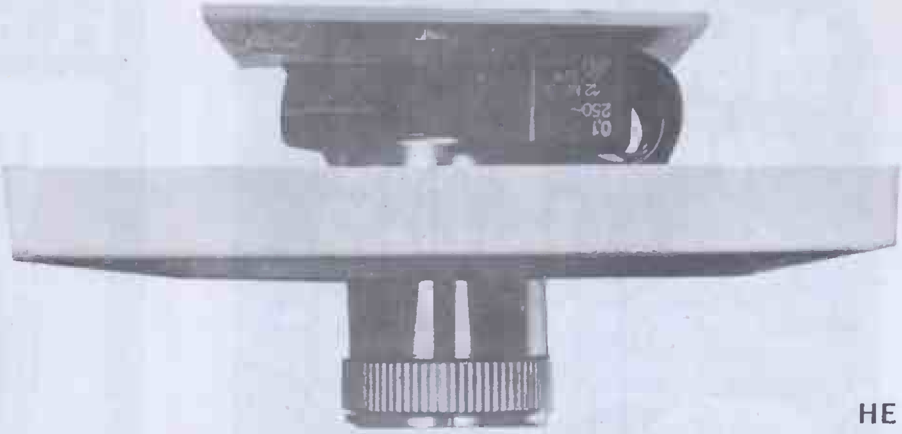
RESISTORS (¼W 5%)
R1,2 — 22k

POTENTIOMETERS
RV1 — 100k linear with built-in DPDT switch

CAPACITORS
C1,2 — 100n 250 V AC polyester
C3 — 100n polyester

SEMICONDUCTORS
SCR1 — Q4006LT

MISCELLANEOUS
PCB, coil L1 (see text), MK blanking plate, knob.



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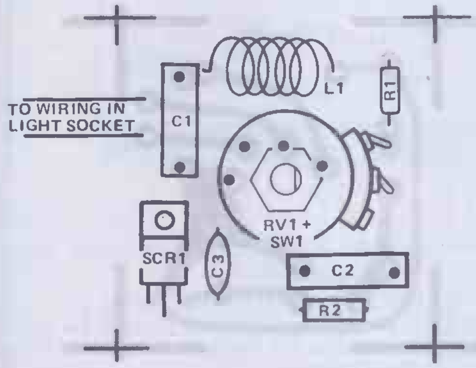

Figure 4. Component overlay of the Light Dimmer

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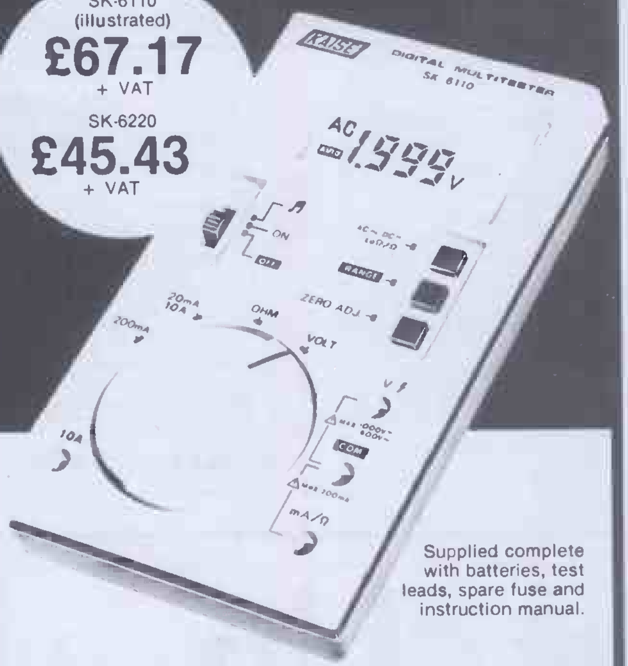

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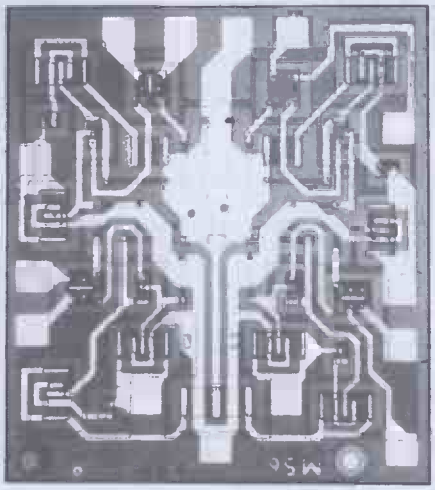
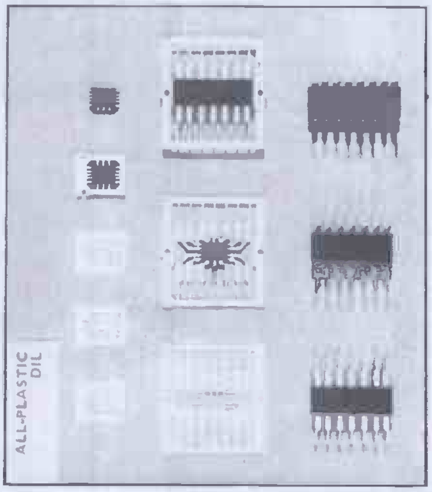
What's In a Name

The Integrated Circuit is probably the most used and least understood of all the semiconductor devices. Rick Maybury looks at the remarkably short history of the 'chip' and what it may hold for the future.

FEW INVENTIONS or discoveries ever *really* change the way we live, the human race could continue without the delights afforded by non-stick frying pans and sliced bread. Our subject this month is altogether in a different league, possibly having consequences as far reaching as the wheel did five thousand years ago.

The name Integrated Circuit belies the importance of a family of electronic devices first developed some twenty-two years ago. Jack Kilby is the man generally reckoned to have produced the first IC, that was back in 1958 whilst he was working for Texas Instruments in Dallas USA. He perfected a photographic technique that allowed a number of active semiconductor devices to be built onto a single, minute piece of semiconductor material.





The infamous 'chip' in close up (left). The layered construction can be clearly seen. The picture on the right shows the various stages of encapsulation.

Photographic Technique

Kilby's research was directly related to work already underway, attempting to find a way of producing transistors to a given specification. Early transistors were made by artificially growing a semiconductor crystal and the characteristics of the crystal were unpredictable, to say the least. The method Kilby developed involved depositing layers of semiconductor material, layer by layer, onto a semiconductor base or substrate. After each layer had been formed it was coated in a photographic resist and exposed to light. A mask between the light source and semiconductor layer had a pattern that corresponded to that part of the circuit, rather like making a multi-layer printed circuit board. After exposure the unwanted portions could be washed away.

Computer Chips

During the early sixties little was heard of integrated circuits, most devices were relatively crude. The growing computer industry was the first to benefit. Computers are actually very simple devices, most of the circuitry is based upon our old friend the multivibrator, a basic electronic switch. Even the most basic computer might need several thousand identical circuits, however, and computer manufacturers turned to the IC for help.

Initially the IC was just a convenient method of producing simple circuits in great quantity. The need for ever faster operation led to smaller and smaller circuits, (even the distances between components is considered critical these days). The decision to make a single type of device led to problems quite early on. Obviously some circuits would be needed more than others, typical examples include the AND and NAND gates which were produced in their millions. As the photographic methods improved, more and more single devices were put onto 'chips'. Around the late sixties things were getting out of hand. Literally thousands of separate devices were available and the designers started to look around for a 'universal' IC that could fulfill all their customers' needs but without having to keep re-designing their equipment. The answer came in 1969 with the now legendary microprocessor. It was in effect a programmable IC. Once it left the manufacturer it was up to the customer to program it.

Computer Design

The development of the integrated circuit is a relatively short story. The basic techniques evolved during the late fifties are still in use today and IC manufacture is still a photographic process. Today, the IC manufacturer can put something like 500,000 active devices on a one square millimetre chip and this will continue to increase for some time. The materials used allow more advanced devices to be duplicated in greater quantity. From the early TTL devices (Transistor-Transistor Logic) to the latest generation of LSI CMOS devices (Large Scale Integration, Complementary Metal Oxide Semiconductors) marks one of the most dramatic periods in our history. ICs are everywhere, not only replacing old technology but creating new sciences that will ultimately dictate the way we live. Perhaps one of the most sobering aspects of this new era is the fact that nowadays the designs for new ICs are usually made by computer, itself a collection of ICs. The complexity of these devices is such that a mere human could never hope to do anything more than instruct the computer. 1984 is only four years away! **HE**

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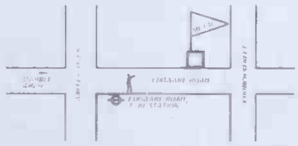

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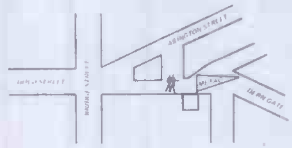

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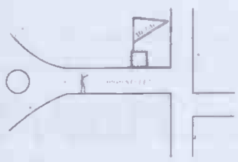

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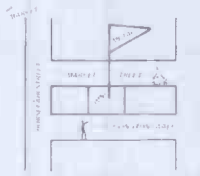

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Freezer Alarm

When the temperature starts to rise you'll be glad you built the HE Freezer Alarm to protect your frozen food!

AFTER CENTURIES of complaining about the daily drudgery of their lives, it seems that women are finally getting a better deal. Manufacturers are finding more and more ways of applying technology in the home, from motors in the can-opener to microprocessors in the washing machine. One of the most useful items for a working woman (or bachelor, come to that) is a freezer. Not only does it remove the need for daily shopping trips, but meals can be prepared weeks in advance, in bulk, and simply heated up when required.

Finding Fault

Unfortunately we don't live in a perfect world and the convenience of a freezer can become a great inconvenience should anything go wrong. A failure can be very difficult to detect as the pilot neon on the front will only tell you that the mains is connected. Any other fault may only become apparent the next time you open the door and find a messy heap of defrosted food. Despite the fact that a freezer is designed to stay cold without power for long periods (in case of power cuts), it is not a very good idea to rely on this and hope you'll spot something wrong next time you use it. It might be too late.

Fault Finding

Prevention is better than cure, even if you are insured, and the obvious answer is to fit a temperature monitor that sounds an alarm if the temperature inside the freezer starts to rise above normal, towards the point of no return. This gives you a chance to get the freezer fixed before the contents are ruined.

The HE Freezer Alarm uses an LM3911 temperature controller IC as a sensor. This is placed inside the freezer, connection to the rest of the circuit is made by a thin cable. This can pass under the rubber door seal without affecting the insulation. The alarm we used is the now-familiar solid-state buzzer.

You might think it strange that the circuit is powered from the mains but this is OK. It means that you can't forget to replace the battery, and in any case, as mentioned above, freezers are

How it Works

The heart of the alarm is the LM3911 — an integrated circuit specifically manufactured for use in temperature control equipment, although we have adapted its use slightly for this project. The IC itself has three main sections as seen in Figure 1, a zener diode, a temperature sensor and an operational amplifier.

The zener diode is used with R2 in the circuit diagram to provide a stable reference voltage of 6V8 which supplies the temperature sensor and the internal op amp. The op amp is connected as a voltage comparator — ie. when the voltage at the non-inverting (+) input rises above that at the inverting (−) input, the op amp output goes high. The voltage at the inverting input is set by potential divider chain R3, RV1 and R5. The voltage at the non-inverting input is set by the output of the temperature sensor — and this falls as the temperature increases.

RV1 is adjustable to allow for a temperature setting of approximately −25°C to 0°C. Different resistors in the potential divider chain will alter the turnover temperature of the op amp to allow the IC to be used as a room thermostat, say. In fact the LM3911 can be used to measure temperatures of −25°C to +85°C. Power is provided via mains transformer T1 to isolate the circuit from mains voltage. BR1 is a bridge rectifier which changes the AC from the transformer to DC and C1 filters the voltage to give a smooth DC supply of about 16 V.

The output of the internal op amp of the LM3911 drives Q2 via R4. As long as the temperature is below the present level, Q2 is turned on and prevents base current flowing into Q1, which is therefore held off. When the op amp swings low, Q2 is turned off and current can now flow into Q1 base via R1. Q1 turns on and sounds the alarm.

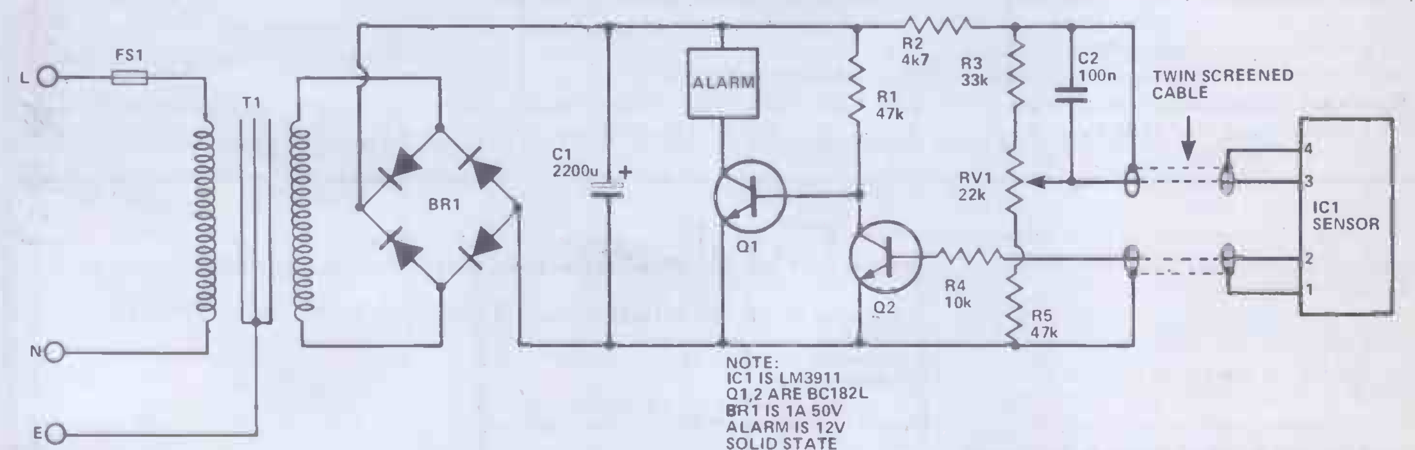


Figure 1. Circuit diagram of the HE Freezer Alarm

Parts List

RESISTORS (all ¼ W, 5%)
R1,5 — 47k
R2 — 4k7
R3 — 33k
R4 — 10k

POTENTIOMETER
RV1 — 22k linear

CAPACITORS
C1 — 2200u 16 V PCB-mounting electrolytic
C2 — 100n polyester

SEMICONDUCTORS
Q1,2 — BC109
IC1 — LM3911
BR1 — 1 A, 50 V bridge rectifier

MISCELLANEOUS
9 V, 100mA transformer, fuse (500mA) and fuse-holder, 10 x 24 hole veroboard, twin screened cable, solid state buzzer, socket for mounting IC (see text).

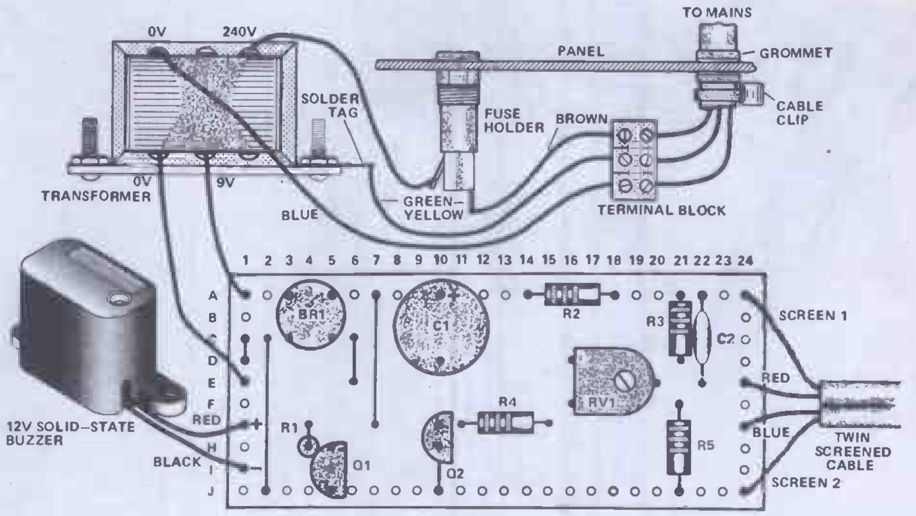


Figure 2. (above) Overlay and interwiring diagram.

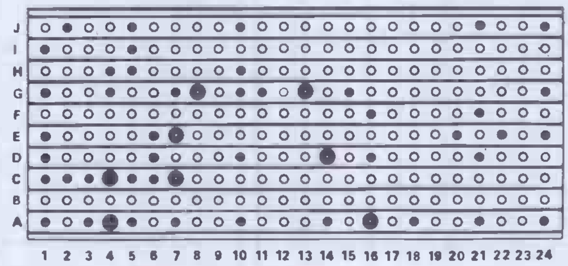


Figure 3. Veroboard layout showing component positions and track cuts.

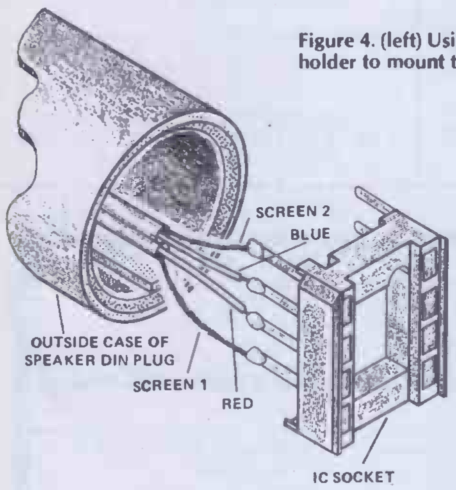
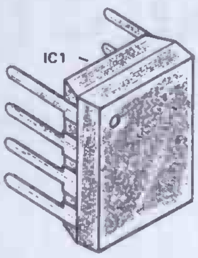


Figure 4. (left) Using an IC holder to mount the LM3911



designed to cope with power cuts provided you don't keep opening the door.

Construction And Setting Up

Nothing unusual here apart from the mounting of the sensor. We soldered a length of twin miniature screened cable to the pins of an IC socket and encased the socket in the plastic cover from a DIN speaker plug. The drawing and photograph should make this clear. The LM3911 is then fitted into the socket. We only used a socket to make a tight fit in the plastic cover — if you choose some other method of construction there is no reason why you cannot solder directly to the pins of the IC (provided you do it quickly).

Take the usual precautions when building the rest of the circuit, making sure that transistors and electrolytic capacitor are the right way round.

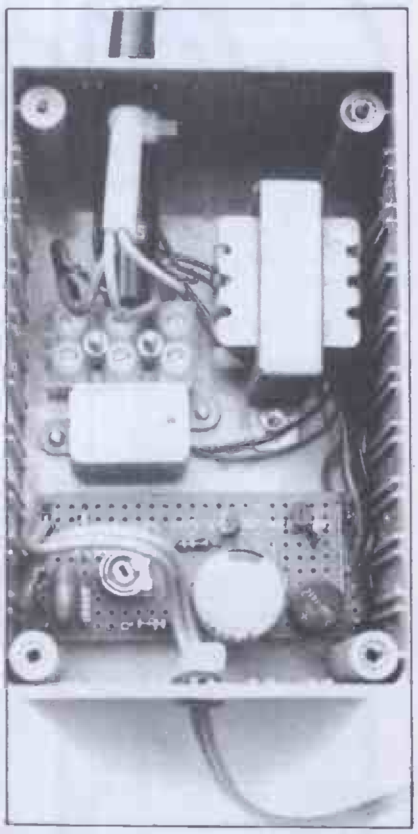
Please be careful with the mains circuitry — we would hate to lose any of you!

To set up the unit, switch the freezer to its highest working temperature and leave the sensor inside to cool down. Adjust RV1 until the buzzer sounds, then back it off slightly to turn the buzzer off. The alarm is now ready for use.

Buylines

Nothing which will cause any trouble here — all parts should be easily obtainable at your normal component stockist or most of the usual mail order companies.

All parts (excluding the case) should total approximately £7 — not much to pay to protect the contents of your freezer.



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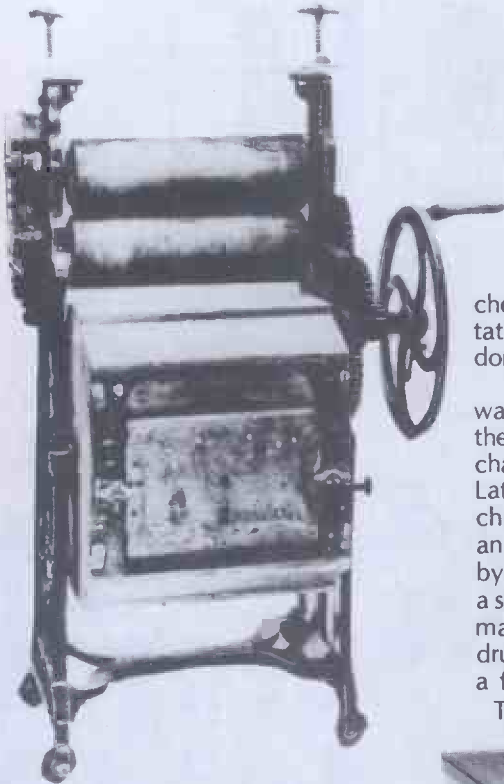


Electronics

Are you keeping up with the Joneses or have you been le

Tina Boylan examines the history of th

THERE WAS A TIME, not so long ago when home life was a simple matter, filled with simple pleasures and simple menial tasks. Entertainment consisted mainly of songs sung around the family piano or the occasional visit to the local Music Hall. Heating meant lighting a coal fire, and food was cooked on the coal-fired kitchen range. Cleaning was done with a dustpan and brush, and gas and oil lamps needed to be trimmed to keep them working efficiently. Any household wishing to eat fresh meat and vegetables, had to buy them daily for immediate consumption, as the only methods of preservation were stewing, tinning, bottling and salting.

Today electronics are not only making life easier for the housewife, they are also making life more interesting and varied for the rest of us.

Where It All Began

From an historical point of view, domestic electrical appliances first began to appear during the 1920s, a time considered 'great' for Britain, just recovering from the effects of the First World War. Electricity had originally been introduced into the average household at the turn of the century, at which time it was used purely as a luxury form of lighting, as gas was then far cheaper — the relatively high price dictating that it was not greatly exploited domestically.

The first electrical device to appear was the cooker, and it is safe to say that the basic concept of this item has changed little since those 'roaring' 20s. Later during the 1940s washing machines were being sold for home use, an example of which was manufactured by Hoover, a company still maintaining a strong grip on the domestic appliance market. Their machine consisted of a drum-like 'washer', impeller driven, with a folding manual wringer on the top. The switch which controlled the washing program was motor driven, and the machine really did nothing more than wash! The wringer was entirely manually operated, it was only there because it was more convenient to have it attached to the washer.

During this period the radio was being slowly introduced into British homes, and was finding its place at the centre of family entertainment. Television made its debut in Britain in 1935 when the BBC was experimenting with it. The Alexander Palace Transmitting station was opening in 1936, and by 1937 when the coronation of King George VI was televised, though, still relatively few people owned television sets — it seemed to be just an expensive gimmick as the picture quality was exceptionally poor.

The Spoils Of War

It was not until the Second World War had ended that electronic devices for the home really began to make an impact. Television transmissions and receiving apparatus were greatly improved thanks to the advances made in radar defence systems used by the British during the War. Even so, it was as late as 1953/4 that the BBC opened its Sutton Coldfield transmitting station and this heralded the ultimately high level of television ownership we know today, it was at last an indication that television was here to stay.

In The Home

ehind by the developments in the electronic gadget market?
abour saver and takes a look into the future.

In 1950 it was again the BBC who experimented with the concept of stereo. It first appeared as a way of demonstrating records in record shops. Of course it was not true stereo, as only mono recorded discs were available at the time, but this certainly prompted the record industry to begin producing stereo discs. Another form of now popular entertainment is the tape recorder. These were first introduced in 1954 for use as office dictating machines. The recordings were made on a 4" disc and quality was extremely poor. It wasn't until ferrite tapes were introduced around 1960 that recorders for music were considered a reasonable possibility. At this time the transistor revolution was beginning to take effect. Thermionic valves needed huge cases, and the eventual influx of small Japanese transistor radios brought home entertainment into the portable age. Miniaturisation was the name of the game — far more electronic capabilities could be included in each small device, many items became more sophisticated; radios, recorders, record players and televisions all became smaller and cheaper, indeed the way was well and truly paved for the beginning of the electronic era.

We Have Lift Off...

The next great step forward in electronics was brought about by research carried out on the American Space Program during the late sixties and early seventies. The lunar modules used by the Astronauts had to be computer controlled, space was considerably limited, (sorry about the pun!), even transistors were not small enough, so ultimately the Integrated Circuit was developed. When we consider the specialised application of the IC in its original form, it is quite incredible to consider the extent of the impact it has made on each one of us. Its invention led to the computerisation of many devices, helped introduce remote control into the home, and made fuel injection possible in motor cars, something that was difficult to do by purely mechanical means. Today even the humble washing machine has had its chips and is truly programmable!

Yesterday, Today, Tomorrow

Just imagine what the Victorian housewife would say with her washboard in one hand and her wooden spoon in the other, as she gazed round the treasure trove of 'domestic electrical appliances' which can be found in any local department store. There seems to be a labour saving device for virtually everything these days. They can cook your toast, boil your kettle, make your coffee, sharpen your knife, heat your water, dry your clothes, preserve your food, clean your teeth, dispense your loo paper..... dispense your loo paper?

Seriously though, amongst these relatively simple gadgets, one can spot some of the most sophisticated machines which the electronics industry can produce, and all widely available to the general public, if, of course, you have the money in your pocket, and can decipher the pidgin English of the instructions.

Common As Muck

Washing machines with programs as long as your arm are capable of turning your dirty linen into clean, dry items without you having to do more than set the dial and put in the washing. The timers used today are electronically pulsed, moving to the desired heat and speed setting, taking in water, washing powder and pumping it all out again when necessary. Never again will a rainy Monday mean five days of dripping washing in the bathroom.

Food processors now mean that the aspiring 'Cordon Bleu' cooks can whip up exotic meals at the touch of a button — no more amputated fingers in the Goulash, and no need for muscles like a shot-putter in order to finely dice, grate or whisk your desired recipe into shape.

Cooking the food itself has also been quite drastically changed by the invention of the Microwave Oven. It must surely be the snack enthusiast's dream, as everything is cooked incredibly quickly, so not too much time elapses between deciding to eat and actually eating. You simply put into it whatever you want to cook, set the timer and stand well back. Of course they're not dangerous, but the concept used to heat the food is certainly revolutionary. The oven works on the principle of producing an electromagnetic field of very short wavelength. This causes rapid molecular movement which generates heat cooking the food, but neither heats the dish nor browns the food, the latter being perhaps a slight disadvantage, except to the American lady who put her poodle in it to dry it after a bath. The effect this process has is to cook the food from within, instead of conventionally heating it on the outside and waiting for the heat to penetrate the mass. Therefore food is cooked in a fraction of the normal time. Among its less obvious advantages are that it runs cold, is very clean, and is useful for defrosting and cooking frozen foods quickly. Unfortunately if you happen to be one of the people who likes his roast chicken to look like roast chicken, you'll be disappointed, though an ordinary electrical heating element may soon be added to the microwave ovens, although the browning process may take up to four times as long as it takes to actually cook the chicken.

The question now must be 'what do the Englishmen of the 1980s do in their castles while their washing is being done and food prepared?'

More than likely they will be listening to their hi-fi radio/cassette/record deck, or relaxing in the comfort of an armchair, remotely switching on the colour telly, while keeping one eye on the quartz controlled LED/LCD alarm clock/radio waiting for the microwave oven to cook the dinner.

1984 And All That

So where does all this leave us. True, it's an easy and effortless life we lead these days, but with any luck it could become even easier. The future trends almost certainly lie in this direction. After all, we know there is no mechanical motion that can't be controlled electronically, and one step forward from this idea leads to computerisation and control systems, which are currently enjoying great popularity with researchers and manufacturers alike.

From a personal viewpoint I would eventually like to see homes completely controlled by a central computer, the type that will ensure that when I get home from work I could open the door to a perfectly clean house, punch out my instructions on the computer keyboard, then sit down while the hi-fi selects my favourite record, the robot prepared my meal, the bath was run and the coffee maker poured my coffee, sheer bliss!

With the way electronics are moving at the moment that might well be a dream which will materialise. After it happens someone will have to develop an exercising machine that can keep you totally fit — preferably in the comfort of your computerised home. **HE**

Temperature Controlled Soldering Iron

Tame your soldering iron with this ingenious temperature controlled soldering station

A MAJOR FACTOR in the art of soldering concerns the ability of your soldering iron to do its job. For instance, if the iron is a high wattage type, say 100 watt, it obviously shouldn't be used to solder sensitive ICs into circuit (you may even find it lifts the track from the board because of the intense heat — never mind damaging the ICs!). Likewise, if the iron is only a 15 watt job, then it won't have the necessary power to solder components on to a hefty earth bus.

There are two ways in which an efficient level of soldering can be obtained — either use a specific iron for a corresponding job (which means you need a selection of three or four irons) or use a temperature controller which heats the iron to the correct temperature for any chosen use. It is a well documented fact that good control over soldering tip temperature not only improves the quality and integrity of soldered connections but also greatly increases efficiency and extends tip life, whilst reducing troublesome oxide buildup on the tip.

Now, all this sounds great, all you have to do is rush out and buy yourselves one of these tremendous gadgets and then you can solder away to your heart's content, whatever the job. But here's where you will hit a slight problem. A complete soldering system will cost you quite a few weeks' pocket money.

One simple alternative to holding up the local High St. bank is the HE TEMPERATURE CONTROLLED SOLDERING STATION, which will enable you to convert any 15-100 W soldering iron to a fully controlled iron, capable of intermittent hobby use to full time production use, as well as providing a convenient soldering stand. (If you have a choice most electronic soldering applications are best handled using a 40 watt to 60 watt iron with this controller).

The 4000 series CMOS ICs were selected for their cheapness and versatility and to give the electronics enthusiast some insight into just how versatile these ICs are. The design has incorporated zero voltage switching which eliminates radio frequency interference (RFI) caused by phase control of line voltage and the potentially destructive spikes created by thermostatically or 'magnetically' controlled soldering irons. The soldering iron temperature can be varied from full off to full on whilst the iron is in use. A visual indication of controller operation is also provided.

The output waveform consists of controlled burst of pulsating DC and is, therefore, suitable for resistive element soldering irons only. (Soldering irons or guns that use transformers cannot be used with the project). This waveform was selected to simplify power supply design, reduce internal power by dissipation and eliminates costly, sensitive gate triacs which would be required for direct interface with CMOS logic.

Construction

Construction is reasonably straightforward — start with the PCB. Nothing special here, just remember to mount R1 and 2 (along with Rx if used) about three or four mm from the board, to help heat dissipation.

Remember that IC1 and 2 are CMOS and we advise the use of IC holders (not essential but helpful). Next, mount the spring and holding bolt, neon and RV1 on the front panel and follow the wiring diagram of figure 3 to connect up your soldering station.

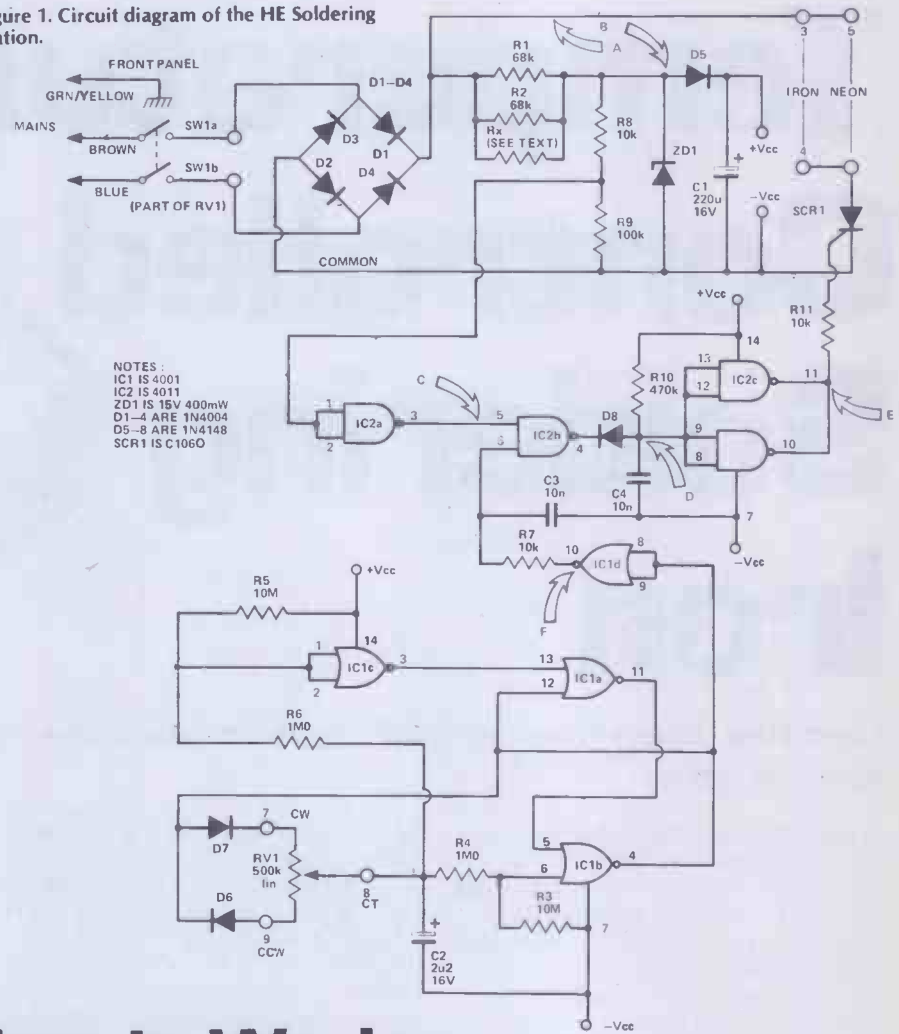
The cable ties at the mains input and iron output grommets are necessary to avoid strain on the cable connections. The PCB simply slides into one of the grooved slots in the case eliminating the use of special fixing procedures. Finally, make sure that the earth connection on the front panel is a good one.

Testing and Setting Up

Plug the controller into 220-250V AC mains. Advance the temperature control clockwise until the power switch clicks on. Advance the control further clockwise until the neon lamp just begins to flash. This is the lowest temperature setting of the controller. At this setting the soldering iron tip will be barely warm to the touch. Advance the control further clockwise. You will note that the on-off ratio of the neon lamp will slowly change as the control is advanced fully clockwise. Whenever the neon lamp is lit, power is being applied to the heating element. At the maximum clockwise position of the temperature control the neon lamp will remain on continuously and the soldering iron will produce full output.

The controller takes advantage of the 'thermal mass' of the soldering iron in maintaining a reasonably constant temperature at the tip (the larger the iron, the better the regulation). Any fluctuations in tip temperature due to increased or decreased loading can be easily compensated by adjusting the temperature control as required. If the neon lamp comes on at full intensity at the full counter-clockwise position and does not flash on and off, the wires to the 100 k potentiometer (R3) are probably reversed.

Figure 1. Circuit diagram of the HE Soldering Station.



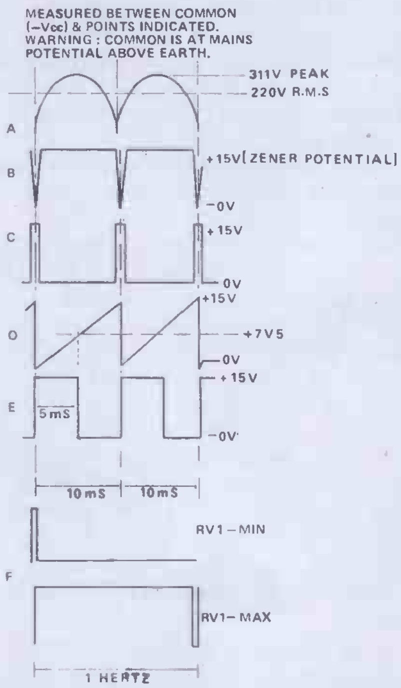
How it Works

The incoming mains voltage is switched via SW1 which is integral with the temperature control RV1. The mains voltage is then full wave rectified by D1-D4. The resulting pulsating DC (illustrated in waveform 'A') can deliver the same heating power to a resistive element as 220-240V AC mains. The pulsating DC will heat the soldering iron element and illuminate the neon whenever the silicon controlled rectifier SCR1 is gated on by the combined logic of IC1 (1 hertz variable duty cycle multivibrator) and IC2 (zero voltage cross-over detection and SCR gate driver). Without gate drive SCR1 will cease to conduct each time the pulsating DC returns to 0V.

The mains potential pulsating DC is dropped via R1 and R2 and clamped to a pulsating +15V via ZD1. Waveform 'B' which is produced by the clamping action of ZD1 also pre-regulates the supply voltage for the integrated circuits. D5 prevents the power supply filter capacitor C1 from filtering out the sync pulses.

IC1 and the associated components form a variable duty cycle astable multivibrator with a frequency of 1 Hz.

At the fully counter-clockwise position of RV1, the output of this astable is low (logic 0) for 99% of the 1 second period. At the fully clockwise or maximum setting of the RV1, the astable output is high (logic 1) for 99% of the period. Waveforms 'F' show these two modes. Mid-positions of RV1 produce outputs which vary between these two extremes. In summary, the setting of RV1 will vary the ratio between the logic '1' state and the logic '0' state (duty cycle) without appreciably altering the period of the complete cycle.



The line synchronisation signal illustrated in waveform 'B' is coupled to the input of IC2a via voltage divider R8 and R9 which protects IC2a from the sync signal which is slightly higher in potential from IC2's operating supply. IC2a inverts the line sync signal shown in waveform C and improves the transition between the logic levels. IC2b, c and d serve as a logic AND gate i.e. only when its two inputs (pins 5 AND 6) are at logic 1, will the output (pins 10 and 11) be at logic 1.

Therefore, whenever the line sync pulse is at 0V (logic 0 inverted to logic 1 by IC2a) and the output of the proportionally controlled astable is at logic 1, a pulse is applied to the gate of the SCR. This applies power to the soldering iron element in fully controlled bursts.

The combination of all sections described above results in SCR1 being gated on only near zero crossings of the mains voltage. This eliminates RFI. The on-off ratio and therefore the soldering iron temperature is proportional to the setting of the temperature control RV1.

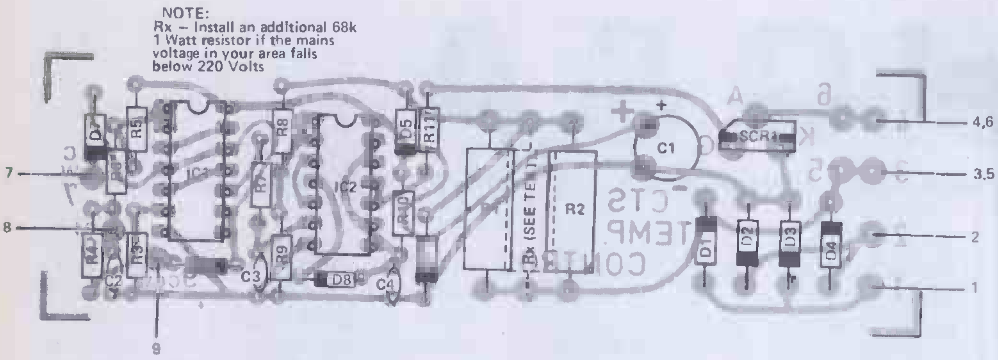


Figure 2. Overlay diagram for the Soldering Iron controller.

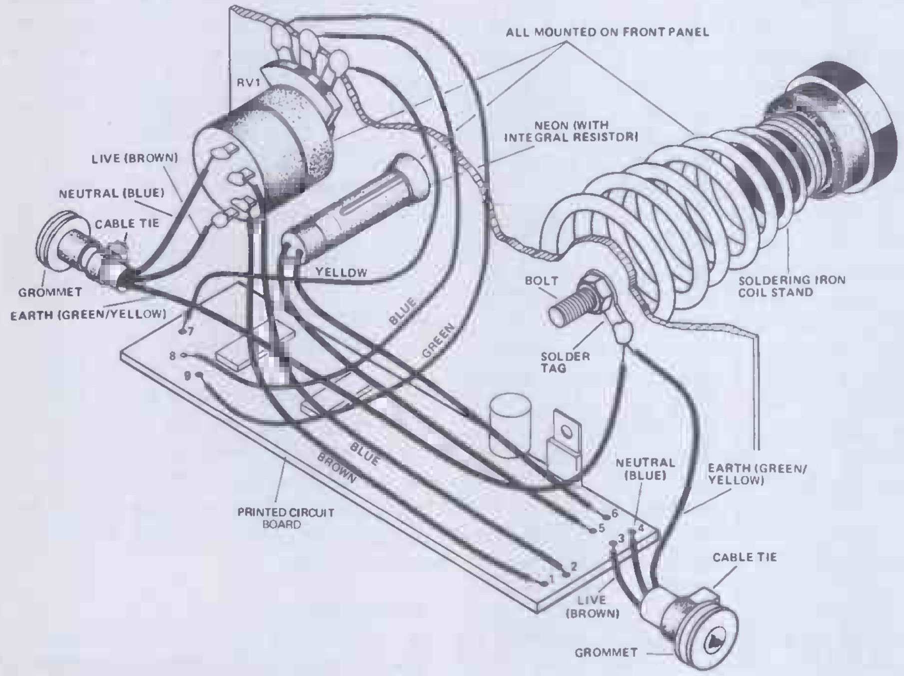


Figure 3. (Above) Wiring and interconnection diagram. To ensure safe operation you must follow this diagram closely. Remember, mains voltages are lethal!

Warning

The circuit described here does not use an isolation transformer and therefore all sections of the circuit must be considered dangerous.

It is advisable not to operate the device without its case.

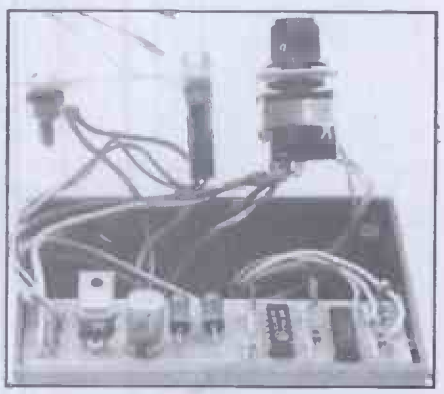
Parts List

RESISTORS (All ¼W, 5%, except where stated)	
R1, 2, x	68k 1 watt
R3, 5	10M
R4, 6	1M0
R7, 8, 11	10k
R9	100k
R10	470k
POTENTIOMETERS	
RV1	500k lin with double-pole, single-throw switch
CAPACITORS	
C1	220u 16 V printed circuit mounting electrolytic
C2	2u2 16 V tantalum
C3, 4	10n ceramic
SEMICONDUCTORS	
IC1	4001 quad NOR gate
IC2	4011 quad NAND gate
ZD1	15V 400 mW zener diode
D1-4	1N4004
D5-8	1N4148
SCR1	C106D

MISCELLANEOUS
Spring mount for soldering iron
Neon with integral resistor
Knob for potentiometer
Case to suit
Grommets and cable clips
Heavy weight (for bottom of case)

Buylines

A complete kit for this project (including PCB, all PCB mounted components, a silk-screened case and all case components) is available from Compu-Tech Systems for £11.95, all inclusive. All you have to find is the mains plug and soldering iron. Compu-Tech will also supply the copyrighted PCB separately.
Compu-Tech Systems
Gaymers Way
Laundry Loke Industrial Estate
North Walsham
Norfolk



HE

O Level Q & A

Nick Walton, our tame teacher now looks at some of the units and quantities we shall be using throughout this series.

THIS MONTH we will take a look at some of the basic concepts of electricity. Once these have been established (or you have been thoroughly confused!) we will relax and consider the energy sources that help to make electricity and how that electricity gets to us by means of the National Grid.

The little beast around which it all centres is the electron, one of the three most important particles that make up the atom. The other two are the neutron and the proton and they live in the centre of the atom, called the nucleus. Everything and everybody around us is made up of atoms and there are slightly over one hundred different stable varieties; hydrogen, oxygen, copper and silicon to name but four. Of course most substances contain combinations of many different elements. Atoms are so small that approximately five million would fit across the full stop at the end of this sentence. Atoms have been thought about of since ancient times but it was not till a bright New Zealander, Lord Rutherford, arrived in 1911 that they came to be regarded at tiny "solar systems" with electrons (which carry negative charge) buzzing in their orbitals round a central part called the nucleus, rather like our planets move in their orbits round the Sun.

Big and Small

The nucleus, which is about a ten thousandth the diameter of the atom, contains protons which carry a positive charge and neutrons which do not carry any charge at all, together with various other subatomic particles we need not worry about. So, for example, the carbon atom illustrated in Figure 1 has six electrons round the nucleus which itself contains six protons (whose six positive charges balance the negative charges of the six electrons) tucked together with six neutrons.

Relative sizes when playing with atoms can sometimes be a bit mind-bending. For instance, if we look at it the other way round and magnify our nucleus up to the size of a full stop, then the atom will be five metres across, (i.e. about ten thousand full stop diameters) and our original full stop, which if you remember was five million atoms across, will now have grown to a blob twenty five million metres across; this is twenty five thousand kilometres across, or approximately twice the diameter of the earth and rather a lot of printing ink!

The Coulomb

In fact for electrical purposes all we are concerned with is the electron and the negative charge it carries. Charge is measured in units called coulombs (named after a French scientist) and one coulomb is the charge of about six million million million electrons. This can be written as 6×10^{18} electrons. When electrons start to flow in an electrical circuit we get a current. It is measured in amps or amperes (named after another French scientist, Monsieur Ampère, the architypal absent-minded professor. He once forgot a dinner date with the Emperor Napoleon — and got away with it; his father was guillotined during the French Revolution).

If those units are too big you can always subdivide amps into thousandths and call them milliamps (nothing to do with Ampère's daughter) or mA for short. If you could sit in the wire and watch the electrons going past, then a coulomb's worth of electrons (i.e. 6×10^{18} of them) passing you every second would constitute a current of one amp.

The Volt

Our next problem is to consider what is pushing this charge round the circuit. Whatever it is that causes this to flow is measured in volts (named after Volta, an Italian scientist). If it is a battery then the term electromotive force can be used (though strictly it is not a force in the purely scientific sense). We might for instance talk of a battery having an electromotive force (or EMF for short) of 9 volts, this being the total voltage it can offer. Note that a voltage can be present even when there is no flow of charge — a battery has an EMF of 9 volts even when it is not connected to a circuit. As the voltage is *potentially* available to push charge around, the word "potential" has come to mean voltage, and we can refer to the difference in voltage between parts of the circuit as a "potential difference".

Volts pushing charge round a circuit implies that the charge has been given some energy. Energy is measured in joules (named after an English scientist this time: a Manchester brewer in fact who is reputed to have spent his honeymoon, well some of it, measuring the temperature difference between the water at the top and the bottom of waterfalls in Switzerland). The more joules you supply to your coulombs of electricity (or they supply to you) the greater the voltage, or in other words the greater the quantity of joules per coulomb. Incidentally the units of your electricity bill (which are in fact kilowatt-hours) are no more and no less than units of energy — lumps of 3,600,000 joules at a time.

While on the subject of British scientists, we should not forget our Scottish friend James Watt who did great things with steam engines. He gave his name to the unit of power which is the rate at which energy is being used up or provided. Thus a watt refers to one joule being used every second (1 joule per second).

Summary

If all that was new to you and you got it first time, you're either a genius or you're kidding yourself. Anyway, let's summarise it.

Units of electric charge are coulombs. 1 coulomb is the charge of about 6×10^{18} electrons.

Units of current are amperes, amps or milliamps. 1 amp is the flow of 1 coulomb of electric charge per second.

Units of voltage are volts (Surprise!) 1 volt is 1 joule per coulomb.

Units of energy are joules (or kilowatt-hours. 1 kWh = 3,600,000 joules).

Units of power are joules per second. 1 watt is 1 joule per second.

Battery voltage (total) can be described as electromotive force (EMF).

Voltage between two points can be described as potential difference (PD).

AC/DC

Having now established the idea of a steady voltage driving a steady current, we need to be aware of the existence of a commonly occurring form of voltage that is by no means steady. This is called alternating voltage (giv-

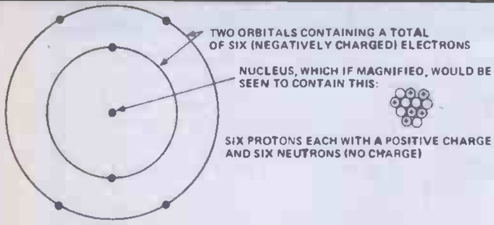


Figure 1. Simplified structure of a carbon atom showing the positions of the electron orbitals and nucleus.

ing rise to alternating current or AC) and we have all met it in the form of our 240 volt mains supply (not literally I hope!) This rises smoothly from zero to a peak of about 340 volts and then drops again to zero and goes on dropping till it reaches −340 volts at which point it smoothly turns round and comes back to zero. This cycle is repeated fifty times every second which is why we talk about mains frequency being 50 cycles per second, or 50 Hertz or Hz (a German scientist this time, who discovered radio waves). All this to and fro motion gives out the same amount of energy as we would get from 240 volts direct which is where the figure of 240 comes from.

Power Problems

Our coal resources are not going to last forever — I have seen estimates which range from 100 to 300 years and oil is going to run out during the lifetimes of most of us. Estimates range from 15 years if you are a pessimist to about 30 if you are an optimist. Whatever your personal feelings about nuclear power, the fact is that it is the only form of energy capable of fulfilling our expanding needs. The technology exists and so do the risks and unless a series of governments take active steps to fund research into alternative sources at a scale that can meet our needs, the more certain it will become that you will be powering your HE project or home computer from electricity generated by energy unlocked from that little nucleus I mentioned at the beginning.

Other forms are interesting and promising. Solar energy in its present form can help us reduce our hot water bills but no sane person in this country seriously reckons it can do more than make a small contribution. Then again there is wind power; windmill sails or rather propellers could well enjoy a comeback and waves and tidal energy may help too. Areas in Italy, Iceland and New Zealand are fortunate in being able to tap energy from naturally occurring steam, but these are just not capable of supplying energy in the required quantities.

Supposing we do solve our energy problems we will still need power stations and the huge network of pylons to distribute all the power they produce. This network is known at the National Grid and it carries electricity at very high voltages (132,000 volts, i.e. 132 kV is typical). The reason for the high voltage is that the electrical power is multiplied by the current. So a high voltage allows you to get away with having a small current, and it is the size of the current which determines how much power is wasted in heating up the transmission lines. Actually the power wasted depends on the square of the current, so for instance, if you could reduce the current to a third of its original value you would have reduced the wasted power to a ninth.

So much for the difficult stuff; but don't forget it as we shall be needing it over and over again. Next month it will be resistors and capacitors and meters which hopefully will bring us a little nearer to the real world of HE projects. Meanwhile happy soldering and keep thinking! **HE**

Talking Design

Pulse Width Modulation is a phrase you'll be hearing more and more. This important control technique looks set to revolutionise digital electronics.

THIS MONTH we are going to delve into the realms of digital control. The particular technique involved is pulse width modulation. This technique is likely to become more and more common in audio amplification and power supplies, especially now that high speed switching devices are becoming widely available.

To understand the principle, look at the simple circuit of Fig. 1d. Here a transistor, used in the common emitter mode, has a square wave of equal mark space ratio as an input. The transistor is in saturation or cut off for equal periods, so the average voltage at the collector, as measured with a multimeter will be half the supply voltage (Fig. 1a). If the mark to space ratio is increased as in Fig. 1b then the average voltage will rise. Conversly if the mark to space ratio is decreased (Fig. 1c) then the output voltage will fall. Taken to extremes the transistor would be either in saturation or cut off for the whole time and the output voltage would either be zero or supply voltage.

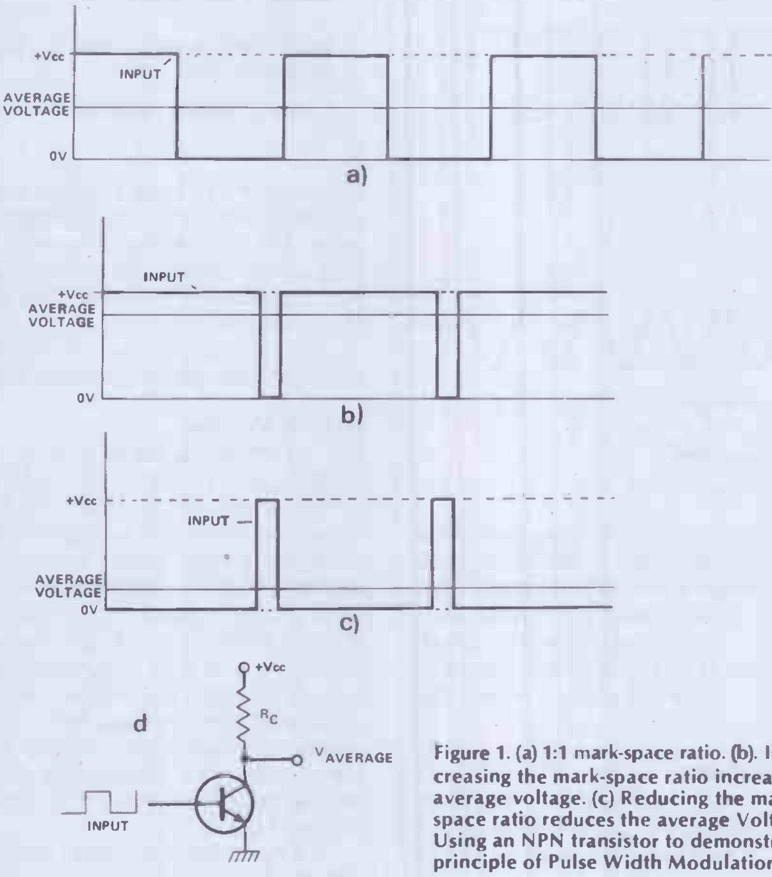


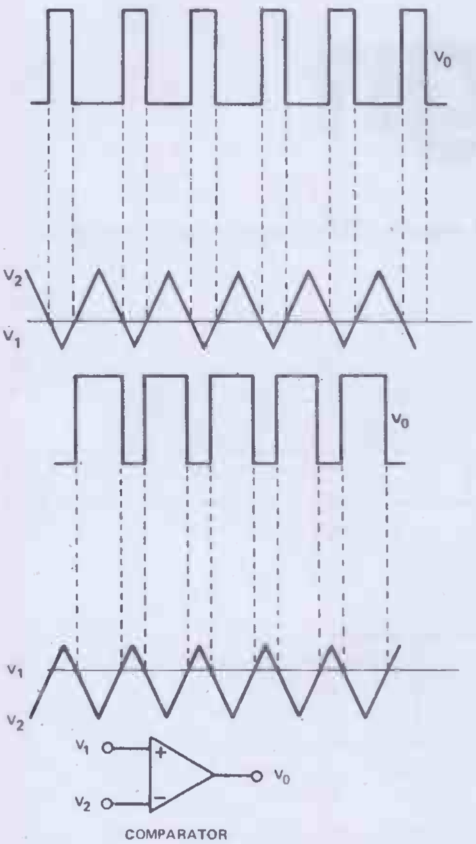
Figure 1. (a) 1:1 mark-space ratio. (b). Increasing the mark-space ratio increases the average voltage. (c) Reducing the mark-space ratio reduces the average Voltage. (d) Using an NPN transistor to demonstrate the principle of Pulse Width Modulation.

Well, you say, so what? The simple answer is that, unlike an analogue design, a current can be delivered to a load with hardly any power loss or dissipation in the driving device. For instance, look back to the circuit of Fig. 1 and assume that we have a supply voltage of 9 V and a collector resistance Rc of 100R. To maintain a voltage of 4.5V across this resistor there must be a current flow of 45 mA. The power dissipated in the transistor and the resistor is found by multiplying the voltage drop by the current flowing. In this case 4.5 V x 4.5×10^{-2}A, = 0.2025 W. In the switching circuit a 1:1 mark space ratio square wave would be used to set the required voltage across the resistor. Ideally the voltage drop across the transistor would be zero when it was in saturation, and the current through Rc is then 9 V ÷ 100R = 90 mA. So the power dissipated would be V x I, i.e. 0 V x 90 mA, zero! When the transistor is cut off the full supply voltage would appear across it and the power dissipation would again be equal to V x I, 9 V x 0 mA, again zero! In reality there will always be a small saturation voltage across the transistor of a few hundred millivolts, and even when the transistor is cut off there will still be a small leakage current flowing, although this will only be in the order of a few microamps.

Although transistors are imperfect devices, you can see that the square wave circuit is many times more efficient than an analogue one.

Square Waves

Before the idea can be used practically, a means must be found of generating a square wave with an easily adjustable mark space ratio. A simple method of doing this is to feed a triangle wave of known amplitude into one input of a comparator, and a control voltage into the other. For those unfamiliar with comparators, a quick description is probably in order. A comparator has two inputs, an inverting and a non-inverting, like an op amp. It also has a high voltage gain but unlike an op amp is operated without negative feedback. It functions as a switch — the output is at zero potential when the non-inverting input is more negative than the inverting while the output is fully positive when the non-inverting input is more positive than the inverting one. Because the gain of the comparator is very high a voltage difference of a few millivolts at the inputs will be sufficient to ensure switching. Comparators, as the name im-



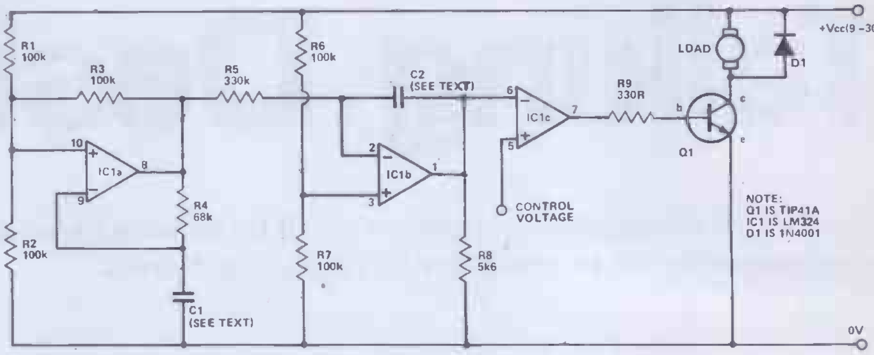


Figure 2. (left) Using a comparator to produce square wave from a triangle wave and a variable DC level.

Figure 3. (above) A practical circuit using Pulse Width Modulation to control a motor.

plies, are used for detecting and comparing voltage levels. If one input is fed with a triangle wave and the other with a variable voltage level the output consists of a square wave whose mark space ratio depends upon the voltage at the input. Figure 2 should make this clear.

Practicalities

The practical application is shown in Fig. 3, a pulse width modulator that will deliver in excess of one amp to a load (such as a motor or lamp) that can be simply adjusted by a control voltage.

The circuit is an excellent power saving device with an efficiency of 90% and is ideally suited to battery operated equipment.

To keep the circuit simple whilst providing maximum flexibility, a low cost quad op amp is used as the active device. The type chosen, the LM324, contains four op amps that are similar to the good old 741 but with the advantage that the output can go down to ground even when operated from a single supply voltage.

IC1a is used as an astable multivibrator that produces a 1:1 mark space square wave at its output. These are input to an integrator, which converts the square wave into a linear triangle wave suitable for the pulse width modulator, IC1c. IC1c is used as a comparator with the triangle wave at one input and the control voltage at the other. The resulting square waves at the output of IC1c are used to drive the output transistor, a TIP41A which is used in the common emitter mode.

Having outlined the circuit we can consider its operation in more detail.

How It Works

The non-inverting input of IC1a is connected to the junction of R1,R2 and R3. IC1a is being used as a comparator and its output must either be high or low.

When power is first applied C1 is discharged. Thus the voltage at the inverting input is held lower than that of the non-inverting input, and the output of the op amp is at supply voltage. C1 starts to charge up via R4 and when the voltage at the inverting input exceeds that at non-inverting input the output of the op amp goes down to 0 V. Now C1 discharges through R4 and the op amp's output stage.

The non-inverting output is held at a potential that depends on the values of R1,2 and 3. When the output is high R1 and R3 are effectively in parallel whilst when the output is low R2 and R3 are in parallel. Since R3 is connected from the output to the non-inverting input a positive feedback loop is obtained. In practice this ensures that the output of the op amp changes from high to low state and vice versa very rapidly. If all three are made equal in value then the potential at the non-inverting input will oscillate between 1/3rd and 2/3rds of the supply voltage.

The frequency at which the circuit runs is determined by the values of R4 and C1 and can be calculated from the formula

$$f = \frac{1}{1 \cdot 4\,R4\,C1}$$

To operate small motors and lamps from the pulse width modulator the actual frequency employed is not critical. The lower limit for reliable operation seems to be 100Hz. At the upper end this particular circuit is limited by the rate at which the output of the op amp can change. This is known as the slew rate and you will find it quoted on op amp data sheets. For the LM324 the slew rate is 0.5 V/microsecond. Another measure of this same effect is the full power bandwidth, also quoted in data sheets. For the 324 this is 6kHz. Within these limits the values of R4 and C1 can be whatever happens to be at hand. In the prototype an operating frequency of 1kHz was chosen. A 10n capacitor was available for C1 and so the equation was rearranged thus

$$R4 = \frac{1}{1 \cdot 4fC1} = 1 \div (1 \cdot 4x10^3x10^{-8})$$

68k is the nearest value.

Our square wave must now be converted into a triangle wave by a circuit known as an integrator. The output of this circuit is directly proportional to the integral of the input. The integral of a square wave is a linear triangle wave. A positive voltage level at the integrator's input produces a negative ramp at the output. If a negative voltage level is input, a positive-going ramp comes out. Since our square wave consists of alternate high and low levels the triangle wave at the output will resemble that shown as V_2 in Fig. 2. To calculate the values that we require for R5 and C2 we use the following formula,

$$V_0 = \frac{Vcc}{4RCf}$$

Again a large range of values can be employed and by simply rearranging the equation one can easily calculate the required values. An example of the procedure follows. To get a large adjust-

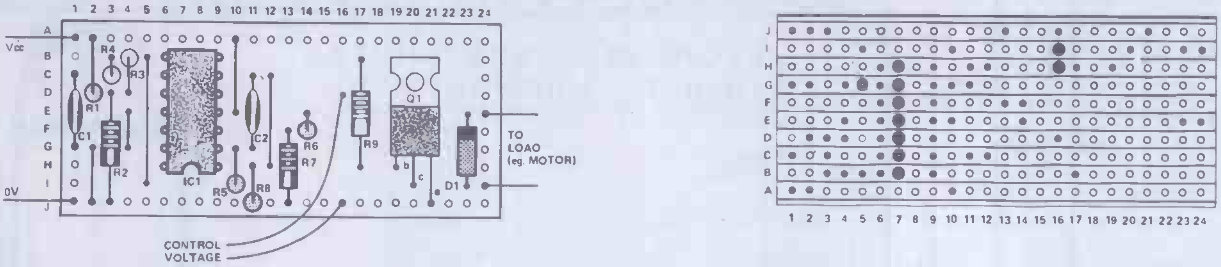


Figure 4. Veroboard layout for the circuit in Figure 3.

ment range a fairly large signal swing is required. Assuming that the circuit will be employed over a range of supply voltages it is necessary to ensure that an undistorted and unclipped signal is available. For this reason a peak-to-peak voltage of 7 V was chosen and the required component values were calculated as follows. Choose an arbitary value for C2, say 100nF. The value of R5 can be calculated by rearranging the above equation thus:

$$R = \frac{Vcc}{4V_0Cf}$$

$$= \frac{9}{4 x 7 x 10^{-7} x 10^3} = 3 \cdot 2 x 10^5$$

The nearest value is 330k.

Note that 9 V was taken for the supply voltage. This calculation does not need to be repeated for other voltages as the amplitude of the triangle wave will be in direct proportion to the supply voltage used.

The last part of the circuit is built around IC1c. This is the pulse width modulator proper and its function has already been described. The output square wave drives the power transistor, a TIP41A. Base current is limited by R9.

D1 is included to protect Q1. When a current is fed into an inductive load, for instance, a motor winding, energy is stored in the magnetic field that builds up around the wire. When the supply is interrupted the field collapses and as it does so the magnetic flux produces a large reverse polarity voltage spike.

This spike can have sufficient amplitude to destroy the driving transistor. The diode will short any such spikes to the positive rail thus protecting the transistor. If you glance through any projects in HE where transistors are used to drive relays, for example, you will notice this feature has been included.

Layout

A simple stripboard layout for the circuit is given in Fig. 4. The TIP41A does not require a heatsink. As it stands the circuit has many applications. A typical application would be a model train speed controller.

HE

Intruder Alarm

Banish burglars, vanquish villains and thwart thieves! The HE Watchdog is a steal at only £10.

CONVENTIONAL BURGLAR alarm circuits show up in electronics magazines with disturbing regularity — we say disturbing because it's a sad reflection on the state of society that such projects are made popular by necessity. Generally these circuits involve concealed switches in doors and windows which can be connected in one of two ways — all of them wired in series and normally closed, so that opening one switch breaks a circuit and sounds the alarm, or all of them wired in parallel and normally open, so that closing one switch completes a circuit and sounds the alarm. It is also possible to mix the two systems, for example you could have normally-closed switches on the doors and windows combined with normally-open switches in the form of pressure mats under the carpets.

The problem with such systems is that, although they will deter (or trap) the amateur housebreaker or the kids looking for cash and kicks, a professional burglar is quite another matter. The normally-closed switch system can be disabled by shorting the wires, and the normally-open by cutting them. A professional could have the knowledge and experience to make a guess about your system and risk tampering with it. Three courses of action are possible. You can make it impossible for anyone to get at the wires by burying them in the plaster or running them under the floorboards — this requires lots of hard work and extensive redecoration. Or you can opt for a different system altogether, using infra-red beams or ultrasonic movement detectors, but these are more expensive and more complex, and complex burglar alarms have a nasty habit of giving a high proportion of false alarms.

The third possibility is to devise a circuit in which the wires are tamper-proof. This is the approach we have used in our latest design.

This burglar alarm is based on a window comparator. Note that this is *not* a device that compares open windows with closed ones! In its basic form a window comparator is a device whose output is in one logic state unless the voltage it is monitoring moves outside certain limits (the 'window'), in which case its output changes state. The window comparator in our circuit is slightly more complex than this, as we need to indicate whether the input voltage is above or below the 'window' in the event of an alarm.

The external wiring of the alarm is made as follows. Each protected point has a concealed switch fitted which is normally closed, and each switch has a resistor soldered in series. Each of these switch/resistor combinations is then wired in parallel with the others. Figure 1 should make this clear. The total resistance of this chain is therefore equal to the parallel sum of the individual resistors, and this value is used in one arm of a potential divider that is monitored by the window comparator. Any change in the value of this resistor chain will trigger the window comparator and set off the alarm.

This solves the problem of tampering with the wiring. If a door or window is opened the corresponding resistor is taken out of circuit and the alarm sounds, as it will if the wires are cut, or a short or resistance of any value connected between them. This means the wiring can be run anywhere in complete safety, even along the outside wall of the building if you want. It also allows you some flexibility in use — since the threshold can be adjusted with a potentiometer, you can leave a protected window open (on a hot night for example) and alter the setting to allow for the changed circuit resistance. An 'alarm' LED is included in the circuit so that you can make these setting-up adjustments without the bell or siren going off — this avoids the need to assist several large members of the constabulary with their enquiries.

Burglar alarms should always be battery-powered, as power cuts provide good cover for those with nasty intentions towards your belongings, so we've used a new CMOS op amp, the ICL7611. This only draws 10 *microamps* quiescent current, less than that through the resistor chain, so your PP3 should last for months. The external alarm should also be battery powered, preferably a high-capacity, heavy-duty type. A mechanical bell is probably still the best choice for an alarm — being resonant it can produce vast quantities of decibels with only a small current drain. You might consider making the bell circuit self-latching, so it rings for a long time even if the PP3 gets drained by the relay. This is left as an exercise for the reader!

Construction

Nothing unusual here; the controls and the LEDs fit on the front panel and everything else fits on the printed circuit board. Use sockets for the ICs and don't touch the pins of any of them when inserting them — the op amps are CMOS and therefore static-sensitive too. If you can't find a relay whose pins fit the PCB, just mount it off the board and wire it to the pads. We made the external connection via a jackplug and socket, as shown in Fig. 3, but if you're worried about the plug being pulled out you can make a direct solder connection to the board.

It is possible to use microswitches in the alarm circuit but we aren't that keen on them — they are prone to give false alarms if the door vibrates in a strong wind or if the woodwork warps. Reed switches are a better bet, mounted in the doorframe with the magnet let into the door.

The resistors associated with the switches should be of equal values — the correct value depends on the number of switches and is chosen to give a total parallel resistance of about 50k. For example, if you have 12 switches each resistor must be about 12 x 50k i.e. 600k. The nearest preferred value is 620k. Solder the resistor close to one of the switch terminals. It might be an idea to sheath it in heat shrink sleeving for protection (see this month's Building Site for details).

To set up, close all the doors and windows that you want closed, disable the relay, switch on the unit and adjust RV1 until the alarm LED stays off when the reset button is pushed. Then switch the relay back in.

Some final points about protection against theft; a burglar alarm is no substitute for proper locks on your doors and windows, nor for forgetting to lock up when you 'just pop round the corner'!

How it Works

IC1 and IC2 are two op amps with no feedback connection between output and input i.e. they function as comparators (for more information on comparators, see this month's 'Talking Design' feature). In this circuit the two comparators are connected together to form a window comparator, one to monitor the upper limit of the window and one for the lower limit.

The reference voltages for IC1 and IC2 are applied to pin 3 (non-inverting input) and are set by resistors R1, R2 and R3. R1 and R3 are equal and have large values compared to R2 so the reference voltages are approximately at half the supply level. R2 sets the reference voltage for IC1 and IC2 slightly above and slightly below half-supply voltage respectively. The monitored voltage is fed to pin 2 of the two ICs.

This input voltage is taken from point XX of a divider chain consisting of RV1 and the resistors associated with the door and window switches (see Fig. 1). When all the switches are closed, the resistors are connected in parallel and the total resistance is therefore given by $R = R_A/n$ where n is the number of resistors and R_A is the value of each resistor in Fig. 1 (all equal). If RV1 is now adjusted to equal this resistance, the voltage at point XX will be half the supply voltage (i.e. inside the window). Hence the output of IC1 will be high and the output of IC2 will be low.

The outputs of the two comparators are taken directly to the inputs of NAND gate IC3a, and to the inputs of IC3b, another NAND gate, via inverters IC4a, IC4b. Both NAND gates have one input high and the other low, so both their outputs are high. This holds LEDs 1 and 2 off.

Suppose a door or window switch is now opened or the alarm wiring cut. The corresponding resistor will now be out of circuit and the total resistance of the external chain increases. This causes the voltage at point XX to drop below the lower window threshold and the output of IC2 goes high. This has no effect on the state of IC3b since its inputs will both be low, maintaining its high output. However, both inputs of IC3a will be high and its output switches low, turning on LED1 to indicate an open door.

However, if the external wiring is shorted at any point, the voltage at point XX is taken above the upper threshold and IC1 output goes low. IC3a is now unaffected (both inputs low) but IC3b will have both its inputs high. Its output goes low and turns on LED2, indicating a short.

The two remaining NAND gates IC3c and IC3d are connected as a set-reset latch. Normally its 'set' input is held high by R6. If either IC3a or IC3b goes low, the associated diode (D1 or D2) pulls this input low and sets the latch (pin 11 goes high). The outputs of the inverters IC4c-IC4f go low and turn on LED3 (alarm indicator) and the relay. The inverters are connected in parallel to increase their drive capability. Pressing PB1 resets the latch and turns off the alarm.

The relay contacts may be used to operate any external bell, siren etc. SW1 is included to disable the external alarm while setting up the threshold control. D3 prevents any voltage spikes from the relay damaging LED3.

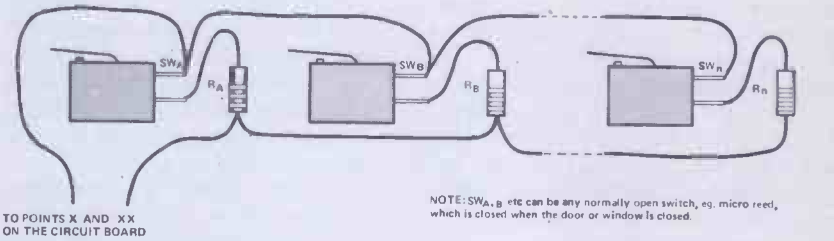


Figure 1. This drawing shows how the resistors and alarm switches are wired in the external circuit, one pair for each protected door and window. You can use any convenient twin-core cable (e.g. speaker cable) and loop it from one installation to the next. We have shown the switches as microswitches (easier to draw!) but reed switches and magnets are probably more reliable. Resistors R_A to R_n should all have the same value; see text for details of how to calculate the values.

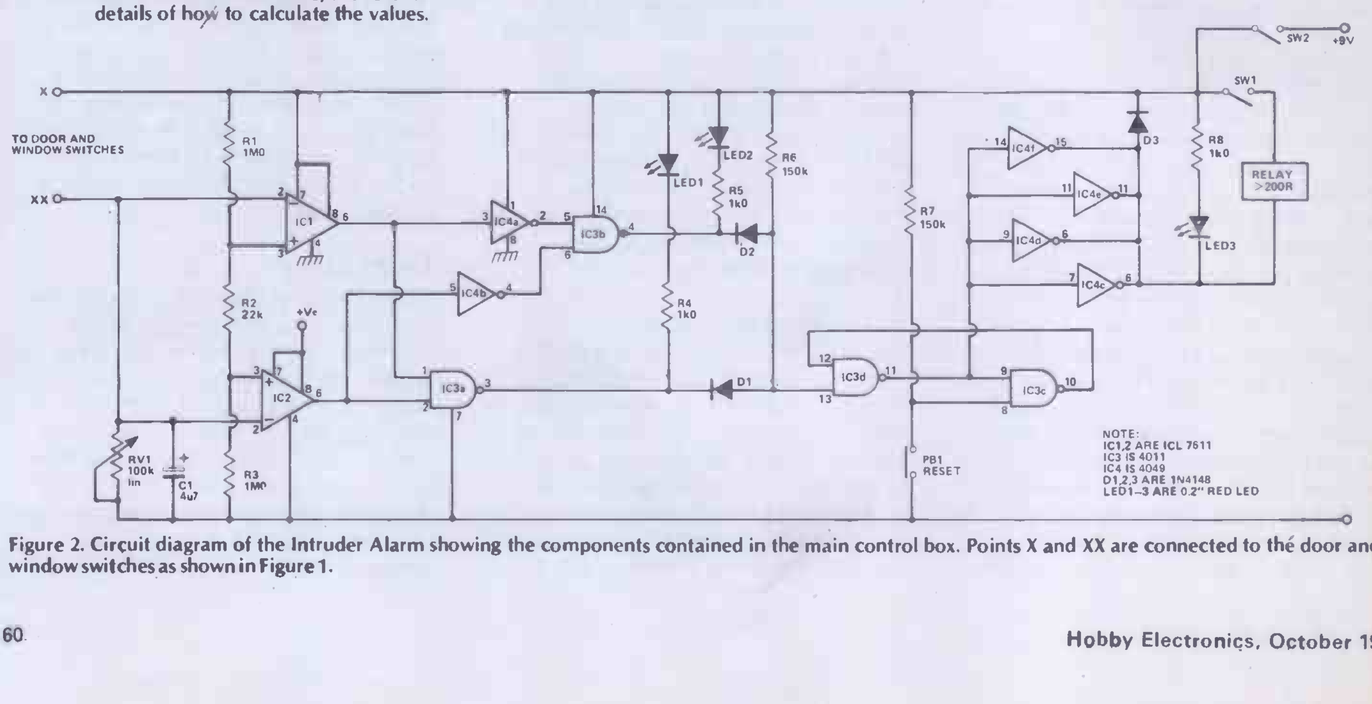
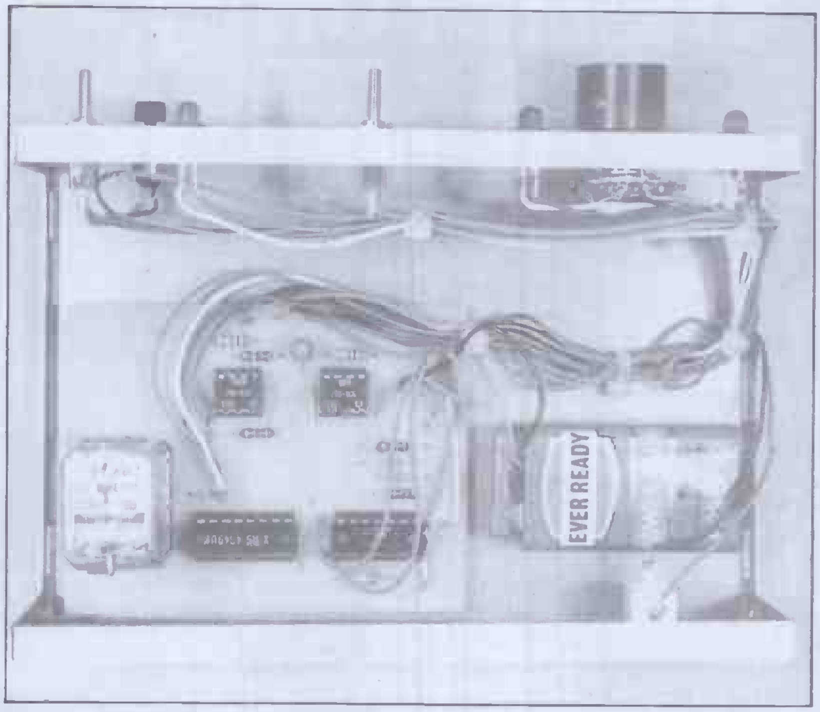


Figure 2. Circuit diagram of the Intruder Alarm showing the components contained in the main control box. Points X and XX are connected to the door and window switches as shown in Figure 1.

Buylines

The components for this project, excluding case and PCB will amount to around £10. The window and door switches will cost extra and their total price will depend upon how many and what types you use — we estimate that microswitches should be available for about £1 each, reed switches and magnets should be somewhat cheaper — shop around, you will probably find a great deal of difference from one place to another.

The only hard-to-come-by components may be IC1 and 2. They are from a new family of integrated circuits and at the moment may be slightly difficult to find. Any of the mail-order companies will, no doubt, advise you if you have trouble.



Photograph showing the internal layout of the Intruder Alarm control box. Follow the interwiring diagram (Figure 3) and you should have no problems. Cable ties keep the wiring neat and tidy.

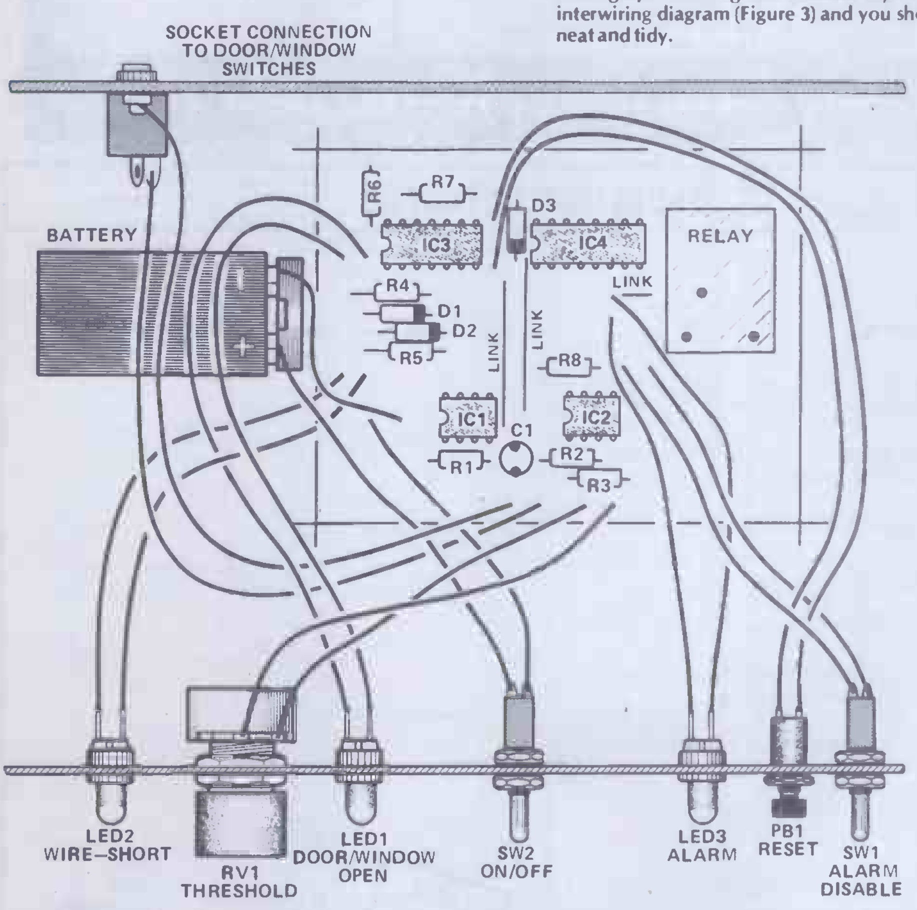


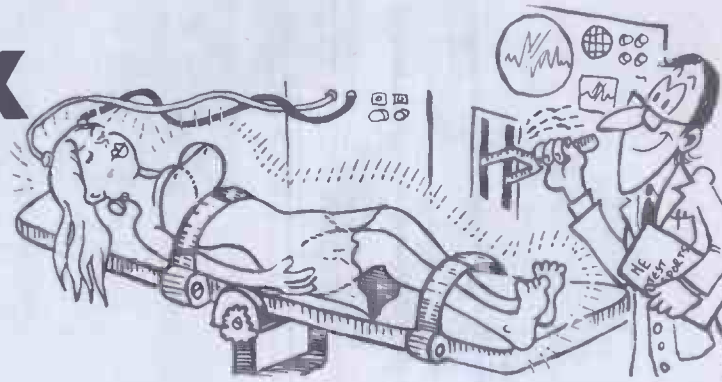
Figure 3. Component overlay and interwiring diagram for the main control box, showing the controls fixed to the front panel and the input jack socket on the back panel. If you think a jack plug might get pulled out, you can leave it out and solder the wires from the alarm switches directly to the printed circuit board.

Parts List

RESISTORS (all ¼ W, 5%)	
R1,3	1M0
R2	22k
R4,5,8	1k0
R6,7	150k
R_A-R_n	see text
POTENTIOMETERS	
RV1	100k linear
CAPACITORS	
C1	4u7 35 V tantalum
SEMICONDUCTORS	
IC1,2	ICL7611
IC3	4011
IC4	4049
D1-3	1N4148
LED1-3	0.2" red LED
MISCELLANEOUS	
PB1	Push switch (non-locking)
SW1,2	Single-pole single-throw toggle
Relay	Coil >200R
PCB	
IC sockets	
Case	
9 V battery and connector.	

HE

Clever Dick



Worried about hard-to-get service manuals, troubled by ultrasonic record players? Your worries are over as Clever Dick attempts to answer some of your weird and wonderful questions.

OUR FIRST LETTER this month comes from a Welsh Flasher. Mystified? Well read on:

Dear Seedy,
A few questions:
1. Will the Flash Trigger project (July issue) work on the external trigger socket of the motor drive unit of my Nikon FE?
2. Could you design a Time-Lapse photography project? The Nikon Intervalometer is rather prohibitive at £325.
3. How about a slide projector dissolve unit?
4. And a tape/slide synchroniser to work with the dissolve unit.
Thank you for reading/publishing this letter and also for the excellent mag.
P.S. Thanks also for the Binder.

P K Roberts
New Quay, Wales

Seedy?? Well, it's original. Now, about your Nikon, I've checked the office Brownie only to discover it doesn't have a motor drive. We're not rich enough to afford a Nikon so at a guess I'll have to say no. The Flash Trigger was designed to operate an electronic flash gun. I assume you want the camera to wind on after each exposure. This may or may not involve mucking about with the motor drive unit's innards so unless you want to take a chance on ruining it I'd leave it well alone. If anyone else has some thoughts on this matter we would be pleased to hear from them.

Your idea for a time-lapse unit sounds most interesting, it has been passed on to the project department. The slide projector dissolve unit is easy, how about a large tub of very strong Sulphuric acid, no? OK that was just a little joke (very little), that idea and your suggestion for the synchroniser have all been passed on. One last point, you must be extremely rich to own a Nikon so you can buy your own Binder, the cheek of this man!

David Clark starts his letter in a much more promising manner, a definite candidate for the Binder of the month.

Dear Richard-The-Intellectual,
I am planning to build the Car Booster and Equitone but as my cassette player has a rather insensitive volume control I am wondering if I could modify the booster with a pot in series with R1, if so what value would you suggest?
A quick point concerning the CB monitor offer in the August issue, I seem to remember that it was illegal to monitor transmissions on 27 MHz, if this is not the case how about a circuit for a converter?

David Carle
Strathaven

Your problem with the insensitive volume control should disappear with the Booster in circuit. You could put a pot in series with R1 but I suspect that you won't need to. The CB monitor is technically illegal if if is used to monitor illicit transmissions, listening to Police broadcasts also comes under this heading. If you use it to monitor Radio Control or foreign CB you should be OK. We have actually got a circuit for a CB monitor but the parts alone would come to more than £11.50!

Do you remember Adrian Hallas's letter in the August CD? He wanted to know if ultrasonics could be used to replace the mechanical stylus on a record player. We asked for comments, here's one from Paul Fletch.

Dear CD,
Concerning Adrian Hallas's letter about playing records by ultrasonics, I'm sorry to put the damper on it but the resolution of a system using normal ultrasonic sound would be far too low, for the following reasons:
Say 100kHz (and that's rather high) and the speed of sound around 300 metres per second.
Now:
velocity = frequency x wavelength.

$$\text{So wavelength} = \frac{300}{3000} = 3\,\text{mm}$$

The resolution of a wave system (eg light in an optical microscope) is always less than the wavelength. So the smallest distance that can be judged is larger than 3 mm — which is far too large. A higher resolution can only be obtained with impractically higher frequencies, sorry.

Paul Fletch
Watford

That sounds like fairly logical reasoning, we have heard of ultrasonic microscopes though the frequency is into the megahertz and gigahertz region. it looks as though the Ultrasonic Record Player idea is doomed to failure.

As you can imagine we get hundreds of letters each month, and many good ones have to go unanswered. We'll finish off with some abbreviated versions of the more urgent questions but please try to keep your letters as short and to the point as possible.

Where do you get those 'chunky' PP3 battery clips?

Steven Turner
Gwynedd

Any of the larger mail-order companies, Watford, Maplin, Stevenson etc.

Where can I get a service handbook for a Single Beam Oscilloscope Model MSB 100?

Jim McMahon
Manchester

Try Austrec Ltd, 76 Church Street, Larkhall, Lanarkshire ML9 1EH. Send an SAE for their list.

Where can I get a IR106 thyristor or equivalent?

Robert Ewing
Coventry

The IR stands for International Rectifier, any 106 device will do, eg. C106 etc, these are obtainable from any of the mail order companies previously mentioned.

That's it again for another month, thanks for your letters, see you in four weeks. **HE**

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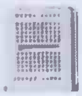

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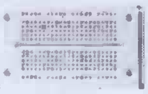

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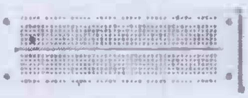

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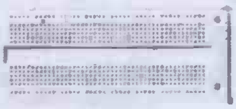
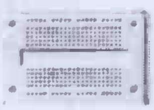


EXP 650 £3.60 Has ·6" centre spacing so is perfect for MICROPROCESSOR applications.



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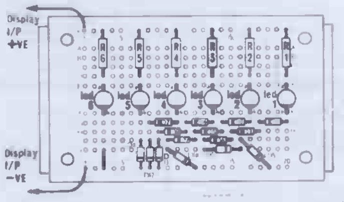

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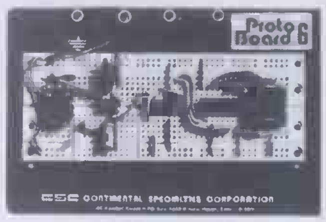

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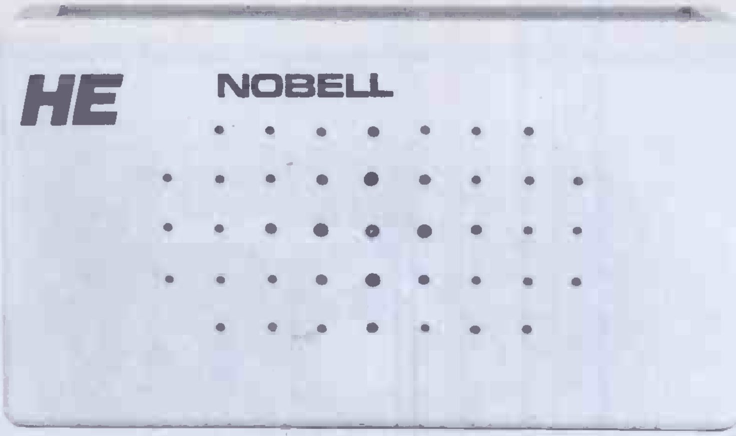


Nobell Doorbell

Ring in the changes with this revolutionary design that faithfully reproduces the noise of those old time door knockers.

GLANCE THROUGH THE newspapers and it seems that almost every day another field of human activity has been taken over by the relentless march of the microprocessor. It's obvious that there's no limit to man's ingenuity for computerising anything and everything, no matter how trivial. Not even the humble doorbell has escaped, and you can now have the arrival of a visitor brought to your attention with a blast of almost any popular tune you fancy.

Knock Knock ...

Although we at HE don't exactly disapprove of this electronic takeover bid (it keeps us employed), we feel a bit nostalgic for the good old days when you made your presence known to a householder by banging away on a huge brass knocker. So we've combined the past and the present in the form of the HE Nobell, an electronic doorknocker. The Nobell's a prize-winning design that won't leave you in peace (OK, don't turn over the page, we promise not to do it again).

The audio generator is built around a single transistor oscillator. When it receives a trigger pulse it produces a 'boing' noise which can be tailored to resemble a knocking sound. Other sounds are possible as detailed in the setting-up procedure below. The sound is amplified by a standard LM380 audio power amp IC, a chip which should be familiar to regular readers of HE.

The rest of the circuit is there to provide a set of five triggering pulses for the audio generator from the single pulse caused by pressing the push switch on the front door. This is done by a tone burst generator, a fairly standard electronic circuit. Two 555-type timer/oscillators are connected together, one wired as a monostable (i.e. it produces only one output pulse of fixed length) and the other as an astable (it produces pulses as long as it is turned on). The push switch turns on the monostable which then turns on the astable. This results in a burst of pulses at the output. Normally the frequency of the tone is in the audio range and it is used for testing amplifiers and loudspeakers. In this project we use a very low frequency to generate our set of knocks.

Power can be obtained from any AC or DC supply in the 6 V to 12 V range. If a DC supply is used it may be connected either way round because of the steering action of the bridge rectifier D3 — D6.

Construction

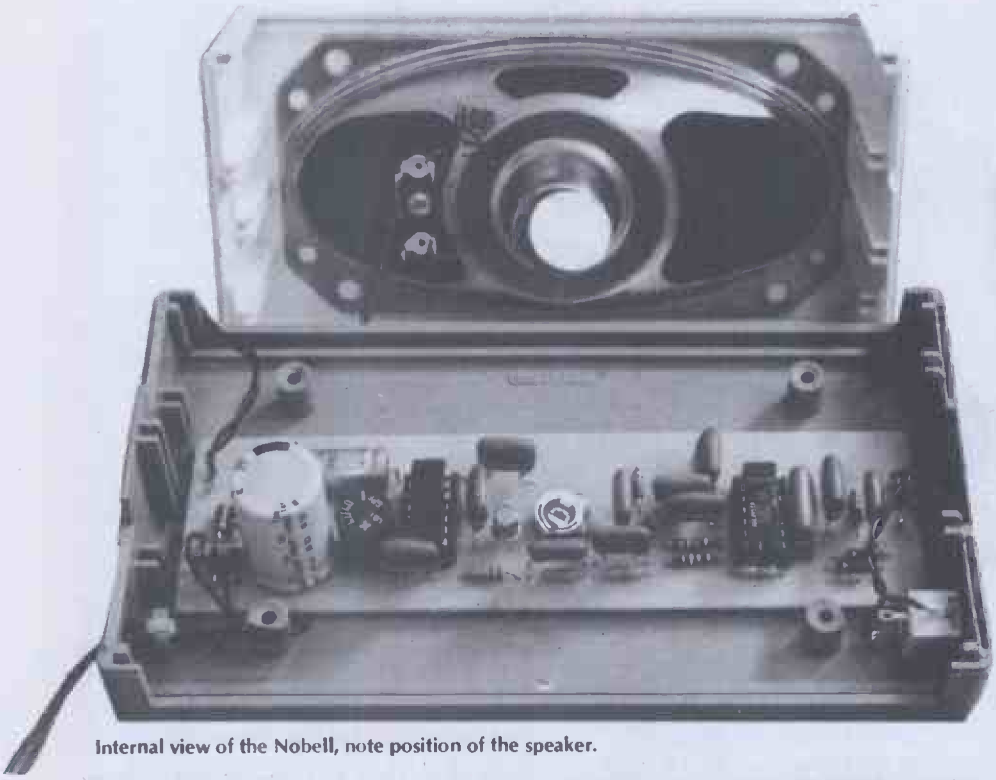
Construction of this project is straightforward, especially if you use our printed circuit board. Make the usual careful checks to ensure that the ICs, electrolytic capacitors and the transistor are soldered in the right way round. How you case the project is largely up to you. As the photographs and overlay show, we mounted the PCB and loudspeaker in a verobox and connected the input leads to a miniature jack socket. The wires from the push switch were terminated in a matching jack plug. Connect up the power and you're ready to set up the circuit. If you are using this project to replace your existing doorbell then you can make use of the existing bell transformer and push switch.

Setting Up and Customising

RV1 is adjusted to set the correct operating point for the Q1 oscillator, and should be turned until oscillations occur only when a trigger pulse is received. However, the exact position depends on your own personal taste. The sound can be varied from a short, sharp tick, through a sound resembling a knock, to an extremely good impersonation of a bongo drum.

Further alterations can be made by changing component values. As already mentioned, the number of knocks depends on the time period of the monostable and the frequency of the astable. In our circuit, these are set at half a second and ten Hertz respectively, so there will be five knocks. The monostable period is set by R3 and C2 and increasing either of them lengthens the time of operation. The astable frequency is set by R5, R6 and C5 and if one or more of them is decreased the 'knocks' will come faster.

If you decide to use the bongo sound, then you can vary the pitch by altering the values of C7, C8 and C9 in the twin-T filter. The same approximate ratios between the capacitors should be maintained — for example if you halve their values (to 4n7, 4n7 and 10n) then the pitch of the bongos will be doubled.



Internal view of the Nobell, note position of the speaker.

Parts List

RESISTORS (all ¼W, 5%)	
R1,2	8k2
R3	2M7
R4	10k
R5,6	680k
R7,11	15k
R8	22k
R9,10	47k
R12	2R7
POTENTIOMETERS	
RV1	100k linear horizontal miniature preset
CAPACITORS	
C1,7,8	10n polyester
C2	220n polyester
C3,4,5,10, 11,12	100n polyester
C6,9	22n polyester
C13	47u 25V PCB-mounting electrolytic
C14	1000u 25V PCB-mounting electrolytic
C15	100u 25V axial electrolytic
SEMICONDUCTORS	
IC1	556
IC2	LM380
D1,2	1N4148
D3-6	1N4001
Q1	BC109
MISCELLANEOUS	
PCB, push switch, loudspeaker (≥8 ohms), Verocase.	

How it Works

When the push switch on the door is pressed, the brief pulse that is generated must be stretched out to operate the rest of the circuit. This is done by one half of IC1, a dual 555-type timer/oscillator. This half (pins 1-6) is connected as a monostable multivibrator i.e. a pulse of fixed length appears at the output (pin 5) whenever a trigger pulse from the push switch is received at the input (pin 6). The length of the output pulse is determined by the values of C2 and R3.

The other half of IC1 (pins 8-13) is wired as an astable multivibrator, or oscillator. It produces a square wave at pin 9 whenever the output pulse from the monostable forces pin 10 (enable input) high. The frequency of the square wave is determined by the values of R5, R6 and C5. The square wave passes to the sound generator via C6 and D2.

The sound generator circuitry is a 'twin-T' type sine-wave oscillator. Q1 is an amplifier with a twin-T filter in its feedback loop (R9, R10 and C9 form one 'T' and C7, C8 and RV1 form the other). If the loop gain of this circuit is greater than one, oscillation occurs at the resonant frequency of the filter. RV1 is adjusted so that Q1 is just on the verge of oscillation — a pulse via D2 will force the oscillations to start but they quickly die away. This makes a 'bong' type of sound.

The signal is amplified by audio amplifier IC2, and LM380, and fed to the loudspeaker.

The power supply is not at all critical. An AC supply rectified by diodes D3 — D6 and these same diodes mean that a DC supply can be connected either way round. The supply is smoothed by capacitor C14 and additional decoupling of the supply to IC2 is provided by C12 and C13.

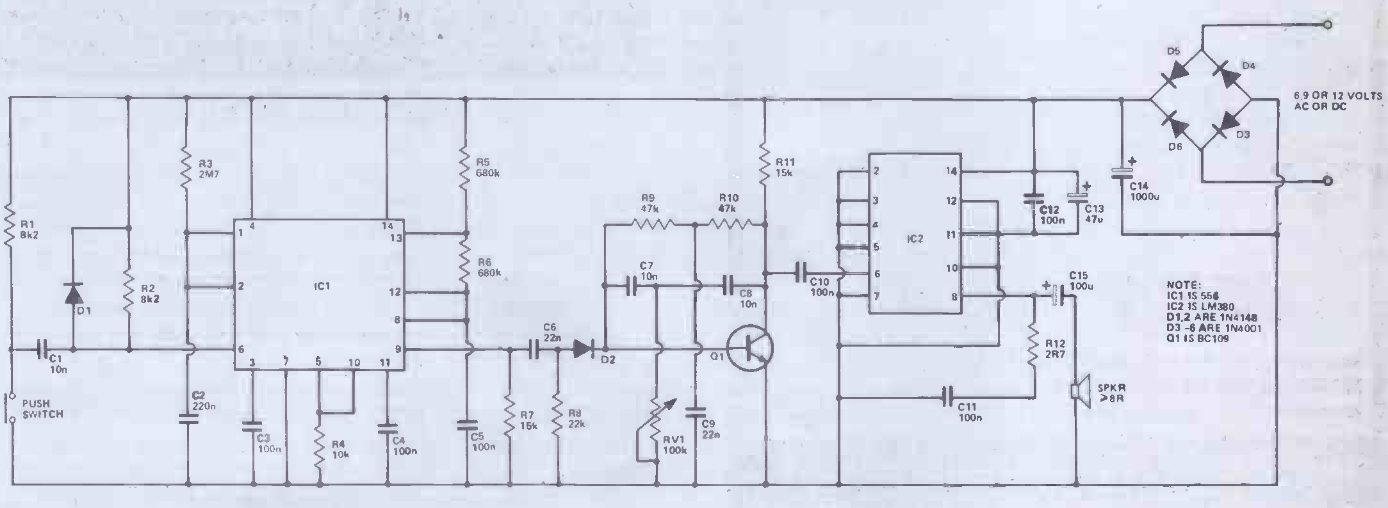


Figure 1. Circuit diagram of the HE Nobell

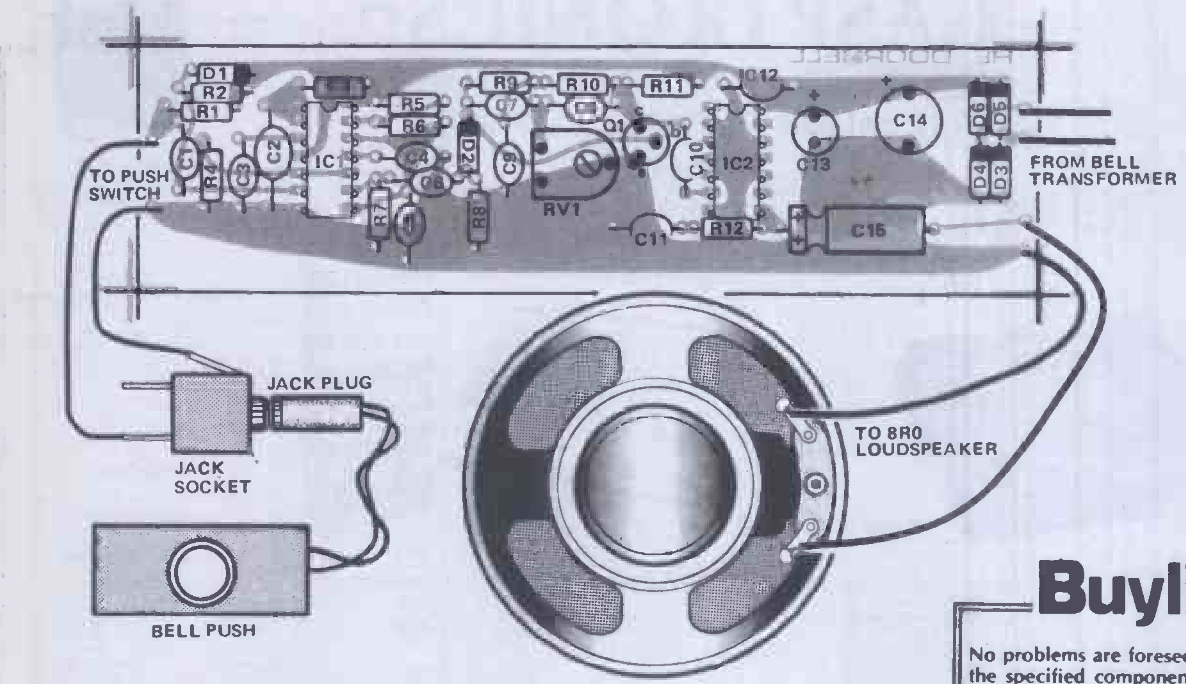


Figure 2. Component overlay and wiring diagram.

Buylines

No problems are foreseen in obtaining any of the specified components at your neighbourhood electronic supermarket. An approximation of the cost of components (with the usual exception of case and PCB) comes to £7.50.

HE

CBH-5

CASPTRONICS

IMPORTER AND DISTRIBUTOR OF MURA PRODUCTS FOR U.K & IRELAND

CBS-44

MP-100/101

£65

MP-300/301

HERE IT IS! THE BEST SELLING, BEST VALUE CORDLESS TELEPHONE SYSTEM IN AMERICA.

Range depends on conditions

£99.95

The MP-100/101 Is packed with outstanding features that include ■ An effective range of 900 feet ■ A remote that operates up to 12 hours on its built-in rechargeable nicad battery ■ 2 or 3 party intercom and paging capabilities ■ Telephone privacy control ■ Automatic line release if MURAPHONE is left 'off hook.'

A MURAPHONE MP-100/101 System consists of (1) The MP-100. A rechargable battery powered portable unit which operates up to 12 hours on a single charge. This portable phone Is rugged, lightweight (only 10 oz) and compact. It can be clipped onto your belt or slipped into a pocket (2) The MP-101. An AC powered base station. The base unit is easily attached (do it yourself) to the phone system through standard phone jacks. The standard telephone instrument may be connected to the phone system through the MURAPHONE base station. In addition to the intercom control, the base station has a line release button which can be used to disconnect the portable unit to assure telephone privacy. (3) A battery re-charging cord and a complete, easy-to-follow owner's manual.

The system is handsomely finished in cocoa brown and wood grain with brushed aluminum accents. Packaged in an eye-catching, self-display carton.

This deluxe system (at a very affordable price) permits the used to both receive phone calls and originate phone calls from anywhere within its 900 ft range.

The MP-300 301's stylish beige and wood grain finish and outstanding features are sure to capture the attention of the rapidly expanding cordless phone market that MURAPHONE has been so instrumental in creating.

MP-300/301 individual features and controls include: The MP-300 Remote Unit ■ Operates 12-15 hours on a rechargeable nicad battery ■ Slide type volume control ■ A great convenience is the automatic 'last number recall' memory. By simply pressing a button the MP-300 automatically redials the last number dialed ■ The remote weighs 14 oz and easily slips into a pocket or clips onto belt. The MP-301 Base Station ■ Incorporates a 3 LED display (yellow, red, green) to indicate 'Charging,' 'Power' and 'In Use' modes ■ Built-in remote charger ■ A 'Line Release' button to assure telephone privacy and an 'Intercom' button for paging the remote unit.

The system is smartly styled to complement any home or office decor. Attaches to the phone lines and AC power.

Owner's Manual that completely and clearly describes installation and operating procedures.

The MP-300 301 system is compatible with either rotary dial or touch button telephone systems.

Beautifully packaged.

MURAPHONE MP-100 REMOTE & RECHARGER

An extra MP-100 remote enables the owner of any MURAPHONE System to have available at all times a fully charged remote. No more down time waiting for a remote to charge. The system is now operational 24 hours a day.

Completely compatible with all MURAPHONE Systems, though it cannot be used to dial out over the MP-301 full function base unit.

Individually packaged with recharger.

90 days limited warranty.

£25

MURAPHONE MP-300 REMOTE & RECHARGER

Compatible with any MURAPHONE System, the MP-300 remote permits around-the-clock operation in the system because a fully charged remote is always available. The addition of an MP-300 remote to an MP-100 101 system will not upgrade that system by giving it a 'call out' capability. Dial capability requires both the MP-300 remote and the MP-301 base.

Individually packaged with recharger, owner's manual and 90 day limited warranty.

£45

CBM-10 Dual-Function CB Meter

The two functions most critical for tuning and checking CB antennas are combined in this one-low cost unit. The CBM-10 measures Standing Wave Ratio (SWR) and Field Strength (FS) on an easy-to-read meter with D'arsonval precision movement. The CBM-10 is provided with its own antenna for relative field strength measurement.

The unit can be left in a coax line permanently with no appreciable signal loss, comes with detailed instructions for use, and is covered by Mura's 3-month limited warranty.

SPECIFICATIONS—SWR Scale: 1:1-1:3 VSWR • FS Scale: 0-5 relative scale • Frequency Range: 3.5-150 MHz • Impedance: 52 Ohms • Antenna: 5-section telescopic • Dimensions: 6"x2½"x2½".

CBM-20 3-Function Meter

The versatile CBM-20 measures transceiver RF output power on two scales, as well as measuring SWR and relative field strength.

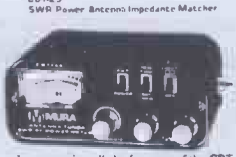
The unit is equipped with a telescopic antenna for field strength measurement and can be left permanently in the coax line with negligible signal loss.

A highly useful feature of the CBM-20 is a switchable impedance setting for testing twin antennas.

The CBM-20 is provided with 2-foot connecting cable permanently attached, complete instructions, and Mura's 3-month limited warranty.

SPECIFICATIONS—SWR Scale: 1:1—3:1 VSWR • Power Scales: 0—10; 0—100 Watts • FS Scale: 1—10 relative scale • Frequency Range: 1.5—55 MHz • Impedances: 52, 75 Ohms • Antenna: 2-section telescopic • Dimensions: 6"x2½"x2½".

CBT-25 SWR Power Antenna Impedance Matcher



Incorporating all the features of the CBT-8 and CBT-15, the CBT-25, in addition, offers an RF power scale for measuring transceiver output power.

The RF power scale enables the user to achieve the lowest possible SWR while maintaining optimal transceiver output.

Other features of the CBT-25 include a backlit meter scale for each night-time viewing, and a 2-foot connecting cable pre-wired to the unit.

SPECIFICATIONS: Impedance Matching Range: 25-140 Ohms • SWR Scale: 1:1-3:1 VSWR • Power Scale: 0-10, 0-100 Watts • Dimensions: 5"x2⅛"x2½".

CBT-35 Dual Scale Meter Antenna Impedance Matcher

This deluxe unit feature separate scales for simultaneous measurement of SWR and RF power. Used in conjunction with the antenna tuning controls, the twin meters allow a greater degree of tuning precision. A new feature of this model is a % Voice Modulation Scale. This scale is located on the SWR meter face.

Like CBT-15 and CBT-25, this model is equipped with backlit meter scales a 2-foot coaxial connector. An additional feature of the CBT-35 is a special mounting bracket supplied with the unit for easy attachment above or beneath the transceiver.

SPECIFICATIONS: Impedance Matching Range: 25-140 Ohms • SWR Scale: 1:1-3:1 VSWR • Power Scale: 0-10, 0-100 Watts • Dimensions: 6¼"x2⅛"x2¾".

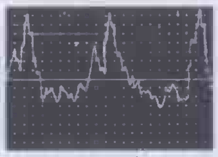


FIGURE 1 Input signal before amplification: note asymmetry and sharp peaks.

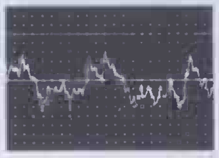


FIGURE 2 same signal after PRM processing.

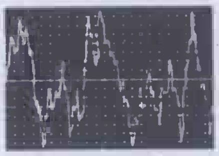


FIGURE 3 Amplified PRM processed signal, with more of signal at higher energy levels.

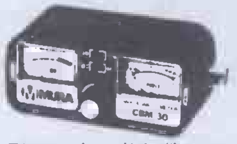
PRX-100 Variable Gain Power Microphone

Without PRM — Unlike test instruments that generate the clean audio signals known as sine waves, the human voice, when transformed by a microphone cartridge into electrical energy, produces a signal that is asymmetical — that is, a signal with sharp excursions (peaks) in only one direction. This type of signal prevents uniform amplification, since the peaks will exceed the clipping point (causing audio distortion) while the less-modulated areas of the signal are just reaching audible levels. Ordinary CB microphones do nothing to correct this signal imbalance.

With PRM — Mura engineers tackled the problem by developing a way to electronically redistribute the peak portions of the signal to less modulated areas. This peak-redistribution modulation (PRM) effect is made possible by delaying peak components for minute amounts of time before being passed on to the amplifier stage of the transceiver. This process effectively creates symmetry in the signal and lessens the average energy levels of the peaks. The evenly distributed input signal can now be amplified to maximum (preclipping) level with a significantly greater portion of the signal at close to total modulation. Result: a tremendous increase in modulated power — more than twice the talk powers of conventional equipment, with far less distortion (since clipping is not required to produce high overall modulation).

The final product — Six of the finest CB mikes ever made, including three old favourites and three brand new additions to the line.

CBM-30 Twin-Scale Meter



This meter is provided with separate power and SWR scales, allowing for simultaneous monitoring of SWR and RF output power functions.

The wide, easy-to-read scales are matched with a precision-built D'arsonval movement for accurate readings of both functions.

The CBM-30 is provided with a 2-foot connecting cable permanently attached for easy installation. The unit comes with a detailed instruction booklet.

3-month limited warranty.

SPECIFICATIONS—SWR Scale: 1:1—10:1 VSWR+5% • Power Scale: 0—100 Watts +20% • Frequency Range: 3.5—55 MHz • Impedance: 52 Ohms • Dimensions: 6"x3"x2".

CBT-15 SWR Antenna Impedance Matcher

Ease of operation, convenience and accuracy distinguish the CBT-15, an antenna impedance matcher with a built-in SWR meter.

Since the SWR meter is an integral part of the unit, everything necessary for precise tuning of the antenna system is in one compact cabinet.

Like the CBT-8, the CBT-15 incorporates a wide impedance-matching range, facilitating accurate adjustment under all conditions and for all channels. For night-time use, the SWR meter scale is backlit —a Mura innovation. A 2-foot connecting cable is prewired to the unit.

SPECIFICATIONS: Impedance Matching Range: 25-140 Ohms • SWR scale: 1:1-1:3 VSWR • Dimensions: 5"x2⅛"x2½".

CBC-24

Required to connect CB transceivers to test equipment.

This 24-Inch coaxial cable is fitted with standard PL-259 connectors.

PRX 100	£22.95
CBM 10	£13.95
CBM 20	£18.50
CBM 30	£20.95
CBT 15	£23.50
CBT 25	£25.95
CBT 35	£29.95
CBC 24	£2.95
CBH 5	£6.95
CBS 44	£6.95
PL 259	.65
QDK 18	£3.95
WMS 49	45.00

All prices include VAT.

SPECIAL OFFER ON HI-GAIN ANTENNAS AM/FM/CB WITH SPLITTER BOX DISGUISE £20.95
570 TRUNK OR ROOF MOUNT £9.25
All prices include VAT.
Post and Packing phones and antennas £1.50
meters and speakers £1.00
all other items .50

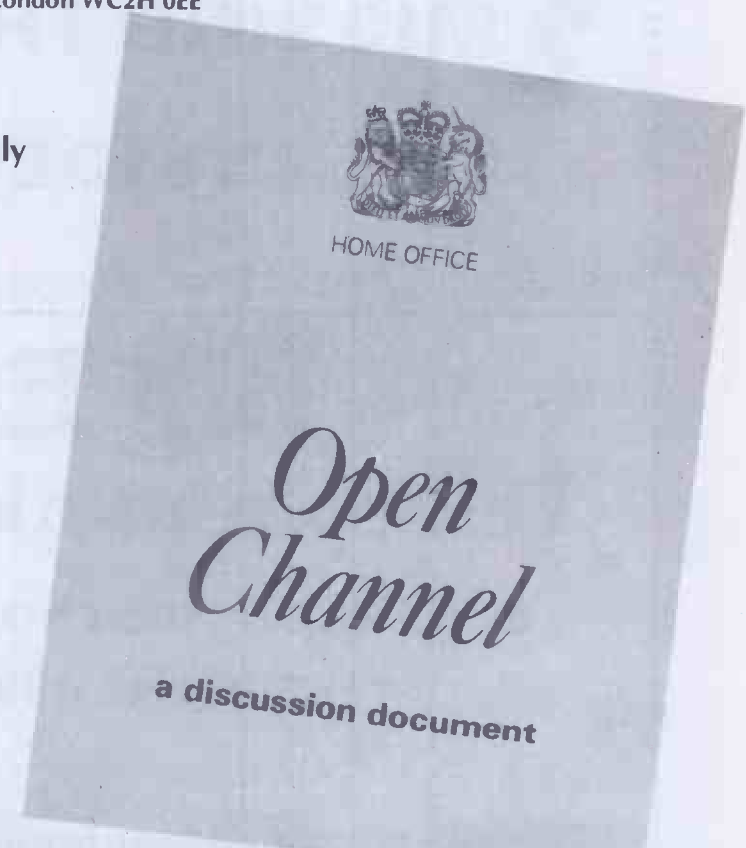
CASPTRONICS

CATHEDRAL ROAD,
ARMAGH,
NORTHERN IRELAND,
TEL: 0861 523914.

Trade and retail enquiries welcome.
Selected items available from Motor and Sport, Donegal Pass, Belfast.
Phones and WMS 49 not licensable in UK.

CB Breaker One Four

Send any news, comments or information you have to: Breaker One Four, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE



Has this got anything to do with CB?

Now that the Open Channel Green Paper has finally appeared we have a chance to air our views. Rick Maybury reports on the latest happenings on the CB scene.

TWO OUT OF THREE, that's our rating. The Government Green Paper published on the 5th of August made interesting reading. We wholeheartedly agree with the suggestion that 40 channels would be needed. Even the inference that 25 watts would be the optimum power level sounds reasonable, it was the choice of frequency that spoilt an otherwise interesting document.

Looking at it rationally 928 MHz is a strange figure, how on earth did they decide upon it? (We reckon it was scientifically chosen with a sharp pin and a shakey hand). In setting out their arguments the Government have made two serious errors of judgement. The first is the mood of current CBers. When asked what would the Government do about the thousands of illegal operators Timothy Raison MP replied 'Well, they'll just have to stop doing it ...' Optimism in Government employees must be at an all time high. Not one single Breaker is going to dump his rig in his dustbin and wait for the glorious day when he can spend an unspecified amount of money on equipment that might or might not work as well as cheap and readily available gear will.

Their second mistake is the choice of 928MHz, over and over again tests have proved that high frequencies are not suitable for short range urban communication, even less so for open country where a leaf on a tree is an effective barrier to any RF signal above 700 MHz.

Do Something About It

As soon as the document was published we had dozens of phone calls from people complaining that 928 MHz was no good and asking what we were going to do about it. The simple answer is we can't do much, but you can. The Green Paper is meant to promote discussion and comment, in fact it invites it. Every single one of you has the opportunity to tell the Government exactly what you think about it. If you haven't already seen a copy then you can obtain one by writing to: The Officer in Charge, Home Office, Supply and Transport Branch, Royston Road, Caxton, Cambridge CB2 8PN (natty post code!) and ask for 'Open Channel — a Discussion Document'. Read it carefully then send your comments no later than the 30th November to: Radio Regulatory Department, Home Office, Waterloo Bridge House, Waterloo Road, London SE1 8UA. We won't tell you what to write but we will say that if enough people make a fuss something may be done about it. Don't moan, do it.

Big Ears

Earlier this month we took the M1 north to meet the famous Big Ears, CB accessory dealer extraordinaire. The journey itself was something of an advertisement for CB, the almost perpetual roadworks and numerous accidents took some three hours to negotiate. Even when we arrived the rather vague directions had us looking everywhere but the right place. Eventually we found the shop, where Terry (Big Ears) assured us that a day earlier you couldn't move for stock, we could hardly get in that day so you can guess what sort of trade he has. Just about every conceivable accessory was on show and prices were as good as (and in some cases cheaper than) any we've seen. After a diabolically hot curry Terry showed us around Leicester, it turned out to be an eventful journey as you'll see from the picture. A young police constable tailed us for some five miles before pulling the Big Ears van over. One of the Big Ears employees is seen here telling the constable his rights (more of that later). After some 20 minutes he actually managed to persuade the Constable to give up. That man could talk the hind legs off a donkey, (and then convince the donkey it didn't need them in the first place). The next day we heard from Big Ears, apparently the shop had another visit just after we left, this time from the Home Office and Customs & Excise. Again they found nothing.

Your Rights

The question of right of entry by police, Post Office, Home Office etc. is an old one. Recently a document came into our possession. It is a general guide to the authorities on how to handle a situation involving use of an unlicensed transmitter. It starts off with an interview. The questions are fairly straightforward:

'Are you the owner of this equipment'?
'Where did you get it?'
'What call-sign do you use?'........

This is interposed by the usual cautions, *'You are not obliged to say anything ...'* etc and details of test transmissions made giving frequency (isn't that illegal?) and channels. The second part of the document goes on to tell the interviewer what the law allows. The most interesting part comes at the end of the second page:

'It is emphasised that there is no power under the Wireless Telegraphy Acts for the Police, Post Office or Customs & Excise to detain apparatus for evidential or any other purpose. Apparatus may only be removed with the owner's consent'.

Before you get too smug, the Police *may* detain the equipment under the Customs and Excise Management Act but

He got away with it too!

The Big Ears Shop

this must be with prior agreement from the C&E. In practice this can be almost impossible to do. So now you know your rights but try arguing that with half-a-dozen burly policemen!

Club Scene

It didn't take long for a new club to be born from the disquiet generated by the Green Paper. In fact as we go to press no less than four organisations are about to or are already looking for members. The first one we have any firm details of is the Campaign for British Citizens Band (BCB). The inaugural meeting was held on the 14th of last month. For further details of the club's activities contact our old friend Keith Townsend at:

CBCB
1163 Yardley Wood Road,
Birmingham, B14 4LE
(Love the postcode Keith!)

Telford CB Radio Club
Chairman: P. McGuiness,
192 Bishopdale,
Brookside,
Telford.

Glasgow CB Club,
President: Ian Patterson,
147 Trassachs Road,
Rutherglen,
Glasgow.
(Phone 041-647-6923)

South Birmingham CB Club (SBCBC)
Secretary: R.A. Smith,
14 Delreme Road,
Solihull,
West Midlands B90 2HH.

South Coast Area Breakers,
Telephone Worthing 62929.

Circle City Breakers (CCB)
Leeds: (Call Breaker Channel for details)

The South Birmingham Club have been very active during their relatively short existence, already they boast over 100 members and a regular monthly meeting. Whilst we're on the subject of well organised clubs the North Birmingham group have also been doing well. Already they are printing a well thought out newsletter with masses of local information for their members. We would like to see any newsletters from any of the other clubs, we might even print the bits that are of national interest.

Thanks too to all those of you that have sent in newspaper clippings, again we would like to see any reports of CB in your local papers especially if it is out of the ordinary, emergencies, stolen cars, dramatic busts, etc.

CB VIP

TERRY (BIG EARS) NEWELL

Big Ears is our CBVIP this month, as you'll see he has had a very full and interesting life. We asked him for his views on Open Channel, we think he's not alone with some of his observations! By the way, he asked us not to publish his picture, the gentleman on the right is a good friend of Terry's.

BOF. OK Terry, tell us your life story.

TERRY. I was born at a very early age, in 1948 to be precise.

B. What were you doing before you got involved with CB?

T. I was heavily involved with the Rock and Roll business as a 'Rodent' for some years.

B. Rodent, what's that?

T. I was a go-getter.

B. How long did you do that?

T. Fourteen years.

B. That's a long time, were you involved with any big bands?

T. Yeah, Black Sabbath, PFM, Magma, Pretty Things.

B. You must have travelled quite a bit then?

T. Four countries in as many days, and that was taking it easy!

B. So when did you first come across CB?

T. In the States, I was a truck driver for a while.

B. How long?

T. Not long, New York to LA and you know all about it, 3000 miles non-stop. I've had white line fever, you can stop the truck and the road is still moving.

B. So when did you come back to the UK?

T. I never really left.

B. No, I mean when did Big Ears and you start, was it when you returned?

T. Big Ears as a company began on the 1st of January this year, I was involved in the CB scene for the past two years though.

B. I hear you've got a shop in Wales.

T. That's right, and maybe one in London soon.

B. What are your printable interests?

T. Horse riding, radio control modelling, I've got a Stock car at the moment that I race.
(The rest of Terry's interests are most certainly not printable but are common to most red-blooded males)

B. Do you race seriously?

T. Oh yes.

B. Are you any good?

T. Not yet.

B. Do you get any interference from CB?

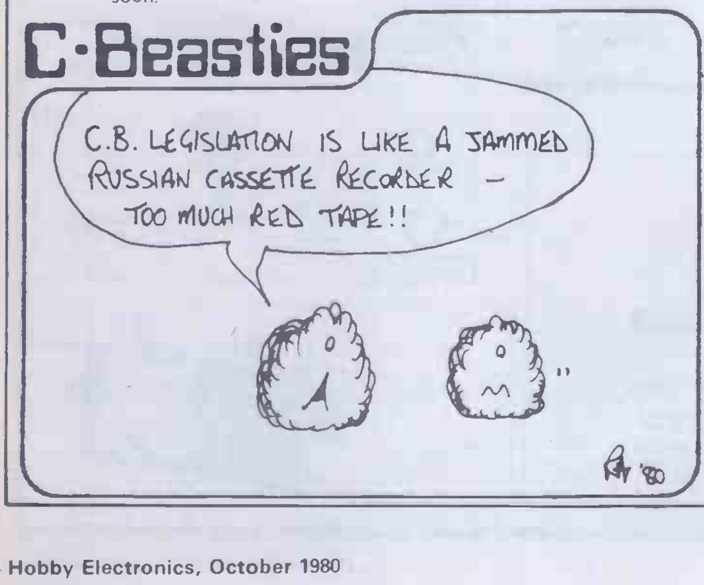
T. Believe it or not, no.

B. So how do you see the future?

T. The number of 27 MHz rigs in this country is grossly underestimated, I've got reliable figures that show at least 250,000 rigs in operation. The Government have left it too late. All the people I've spoken to are not prepared to accept the Open Channel system with all its limitations and probable cost.

B. What are you going to do about it?

T. Well, we've formed the National Association for the Legalisation of 27 MHz and we'll be starting our campaign of action very soon.



B. Would you like to tell us exactly what you'll be doing?

T. No Comment, you'll see soon enough.

B. Is this organisation backed by any big names?

T. No, just the people who matter, the Breakers, but it's not a Breakers' organisation as such. We want to totally divorce ourselves from the UBA, UKCBC and all the other publicity-seeking organisations. We're not interested in getting our faces on TV, just getting CB legalised and preferably on 27 MHz.

B. I can see your point but what will you say to those who claim 27 MHz CB interferes with other electronic equipment?

T. The evidence is pretty slim, I do accept that aero modellers can suffer but the recent announcement by the Home Office that R/C is to get another channel should take care of that.

B. How about hospital paging systems, I hear that the Breaker Channel in Leicester is 19, isn't that because of a paging system on 14?

T. Exactly, it interferes with CB, not vice-versa. There are 39 other channels, there is no need to use 14. There are several reasons the Government do not want CB to exist in this country. For instance, and I want you to print this, the situation at Grunwick could have been far worse if only half a dozen stewards had CB sets, and the same applies to the recent Steel dispute. The Government sees CB as a social/political menace, all forms of communication, except word of mouth, are controlled by the Government. Open Channel is a con, they are putting it into a prohibitive price bracket and limiting the number of sets, if it ever happens. The whole point is that 27 MHz is available, it works, people like it and want it, we can have it now. The constitution is surely Government for the people by the people. The people say they want 27 MHz so the people should have 27 MHz. If enough people get together then they will have to do something about it. The benefits are well known, if you were on a motorway and you had five miles warning of an accident you could do something about it.

B. That's right, we could have got here an hour earlier.

T. Right, if you had a CB in the car you might have avoided taking an hour to find my shop, you could have put out a 'Break' and I would have helped you straight away. A three minute call dialled on your own rig costs nothing.

B. So what do you think will happen?

T. The Government have got one thing working for them, apathy. If enough people get off their backsides we can do something about it, everyone must make their views known.

B. Thank you very much and good luck with the campaign.

The CB Trouble Tape available from Wintjoy Ltd — see Odds and Ends below.

National Directory of Handles

At last, the Directory is ready. Problems with distribution are forcing us to offer the Directory on a mail-order only basis. Each handbook-sized issue contains thousands of registered handles all with an individual number and location, all the addresses of the national and local clubs, hundreds of hints and tips to make your life easier and the chance for you to register your handle in the second edition that, hopefully, will be appearing on a regular basis. Full details next month.

Odds and Ends

Two items of interest from the accessory dealers this month. The first comes from Big Ears and is an automatic antenna matching unit. This motor-driven device will automatically SWR the antenna every time the channel is changed. There are only three connections, the rig plugs into one side, the antenna into the other and a connection is made to positive 12 volts. Installation is kept to an absolute minimum as the unit is held in place with a hefty magnet, a quick twiddle to set it up and your antenna will forever remain perfectly SWRed. Big Ears has a limited supply of these devices, they're called Sylvania Automatch and can be yours for £45.00.

Our second item this month comes from Glyn Hall at Wintjoy, it's called 'CB Trouble Tape'. Basically it is an American cassette with recordings of all of the most common types of interference. There are sections on identifying the cause of the trouble and eliminating them, all easy to understand. Wintjoy are currently offering them for around a fiver, a mite pricey, but then how valuable is your time?

Missing Child

Cast your minds back to the beginning of last month. You may remember the story of the two year-old child Elizabeth Peck who decided to have a stroll around a forest near her home for a couple of days. Happily she was found, none the worse for her ordeal. The news reports at the time said that local radio amateurs were helping with communication to the search parties. What the media failed to report was the help given by some 60 local Breakers who turned up in response to a plea from the local Fire Brigade. They set up an impressive communications network complete with mobiles and base station, under the supervision of the local constabulary. The Police are now (understandably) reluctant to acknowledge the help given by the CBers. A spokesman from the club said:

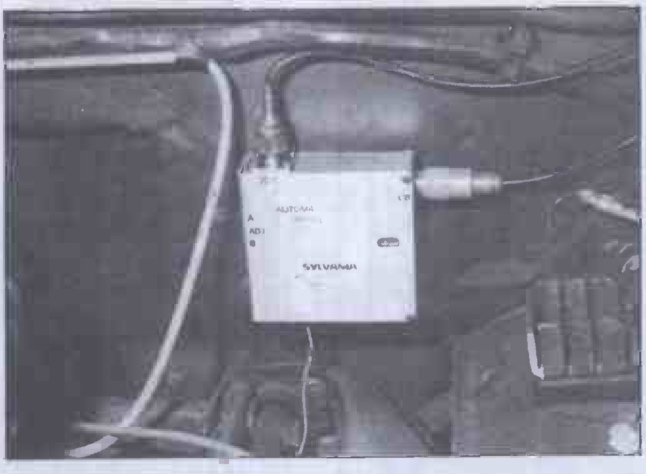
'Our main concern was to help find Elizabeth, not to publicise CB, but the authorities' flat denial of our assistance prompted us to make the truth known'.

We would like to thank publicly Moonraker, Wallaby, Green Turtle, The Mole and all the other members of the South Coast Area Breakers for their prompt and selfless help.

NATCOLCIBAR

Our last item this month concerns the latest meeting of the Technical Sub-Committee of the National Committee for the Legalisation of Citizens Band Radio. As you may or may not know BOF has been attending these meetings for the past six months. The meeting on the 22nd of August was held to discuss the Green Paper and finalise the alternative specifications that NATCOLCIBAR hope the Government will adopt. To cut a long story short the National Committee have investigated all the possibilities and deduced that an area around 42 MHz is sufficiently free, (remember cheap equipment is available for this frequency).

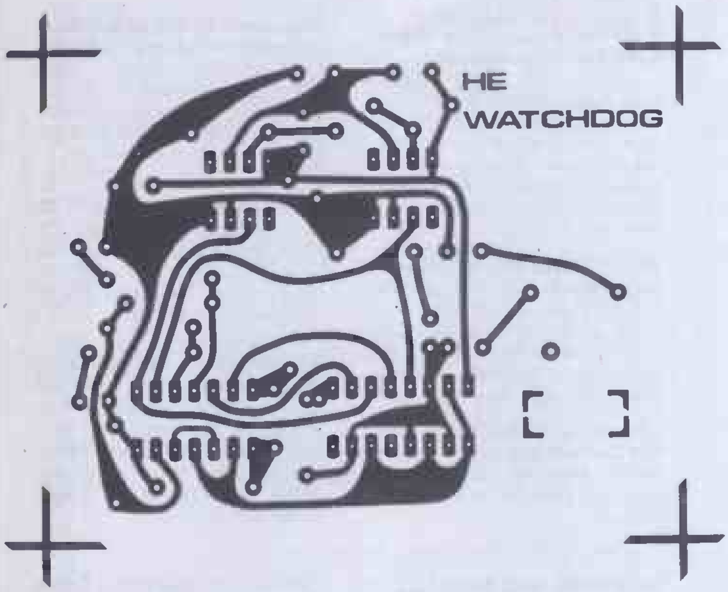
Their final comment was: the Government Green Paper has absolutely nothing to do with CB. That just about sums it up really! Stay Lucky and see you next month.

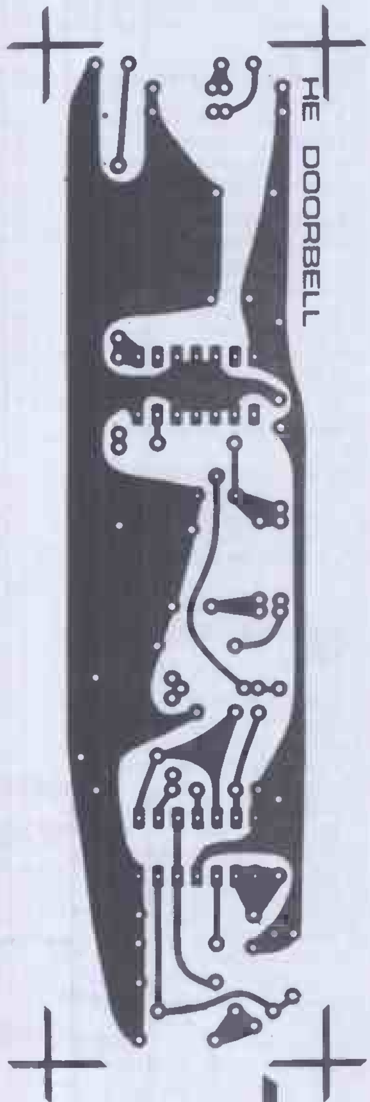


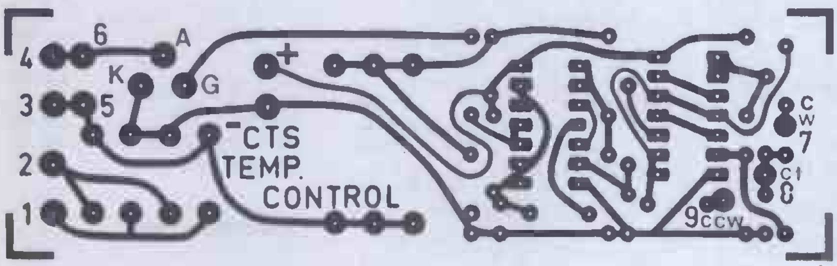
The Sylvania 'Auto SWR' in position

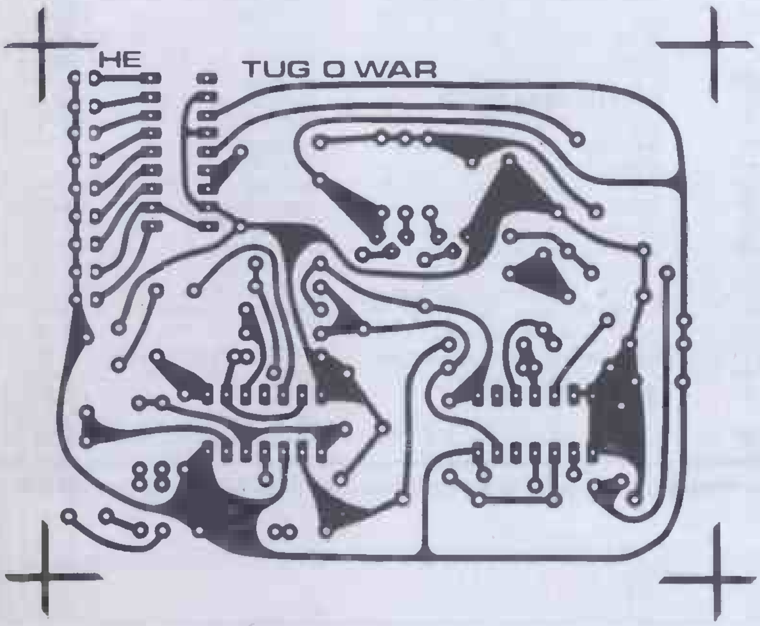
HE

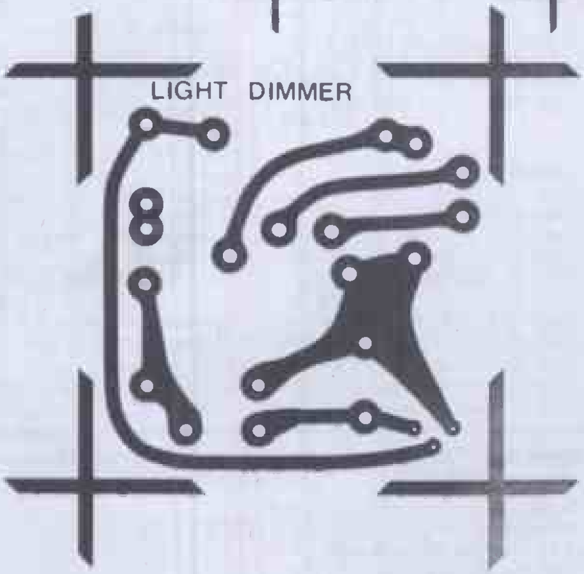
PCB Foil Patterns











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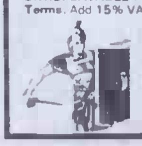

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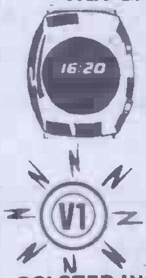

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