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JULY 82
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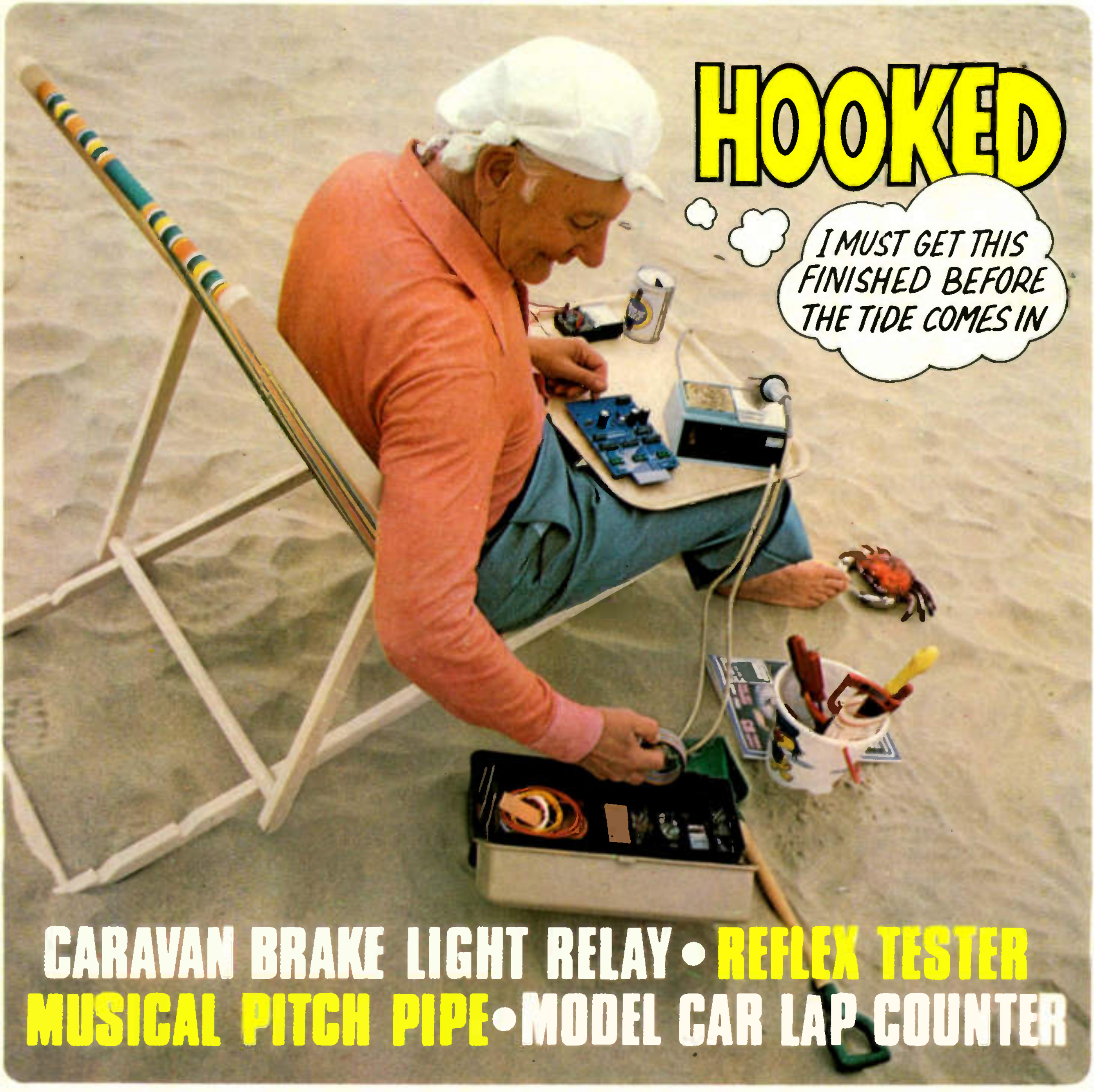

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VOL. 11 NO. 7 **JULY 1982**

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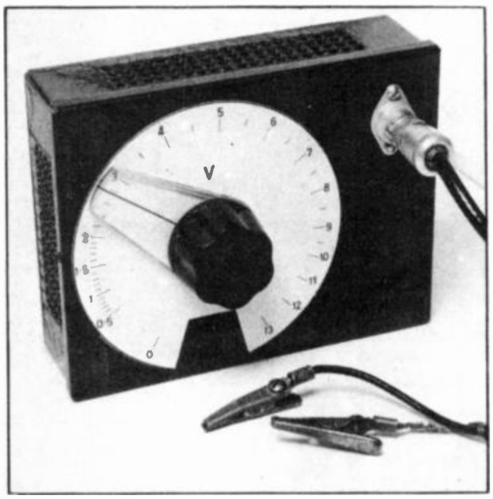

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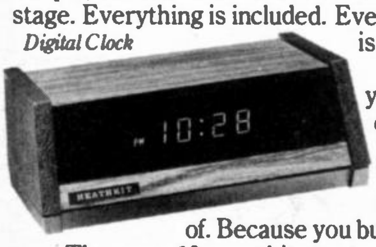

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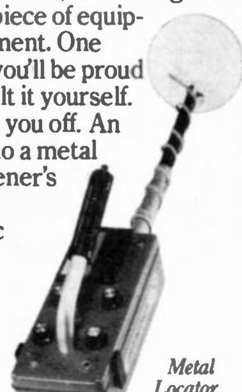
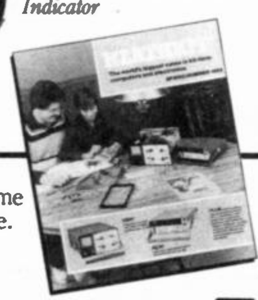


Metal Locator

Windspeed and Direction Indicator



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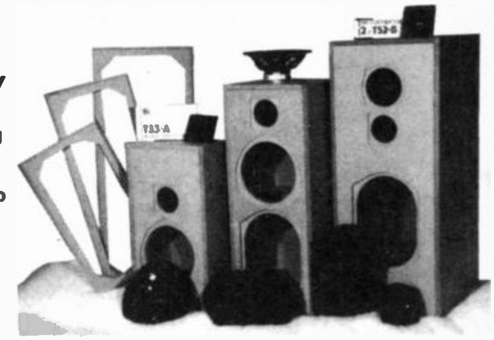

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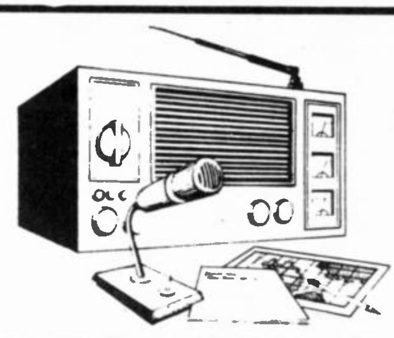

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MAKING CONTACT

Anyone wanting to try their hand for the first time at electronic circuit construction but who happens to be deterred by the need to make soldered connections will find a very simple method for wiring up components illustrated in the *Two-Way Intercom* project this month. Component and inter-wiring connections are made via screw terminal blocks and the only tools required are commonplace implements found in every home: a small screwdriver and something with which to cut wire.

The finished project, which is based around two transistors, is a perfectly practical system permitting speech communication over a distance of up to 25 metres, using a two-wire interconnecting link between the two units. So while demonstrating that some electronic circuits can be constructed without recourse to soldering, the completed equipment can be put to use within different areas of a house, or between house and outbuilding.

This is just one example of the kind of simple electronic circuits that may be assembled using solderless techniques. Various other projects can be built this way and we expect to publish more from time to time.

For the benefit of those not familiar with these things, it should be explained that there is nothing new about solderless techniques. Time was when every electrical connection was made by terminal screw, but that was in those far off days of wireless set construction in the 'twenties.

It has to be admitted that this method of construction has its limitations and is not universally applicable, nor suitable to all kinds of electronic circuits or components. We do not offer it as a serious alternative to conventional methods for hard-wiring using soldered joints. The attractiveness of the solderless method is that—within its limitations—it makes circuit construction very easy and something that can be tackled by anyone unfamiliar with electronics since it calls for no special skills, materials, or tools. It can be employed with advantage to assemble simple basic circuits quickly, as required for demonstration or experimental purposes.

We hope that anyone who makes a start in electronics by building this Intercom will be excited and pleased with the results and thus stimulated to pursue this hobby further. This will necessitate, in due course, acquiring the ability to use a soldering iron. But there is nothing frightening about soldering and articles explaining this in step-by-step fashion appear frequently in our pages.

Fred Bennett.

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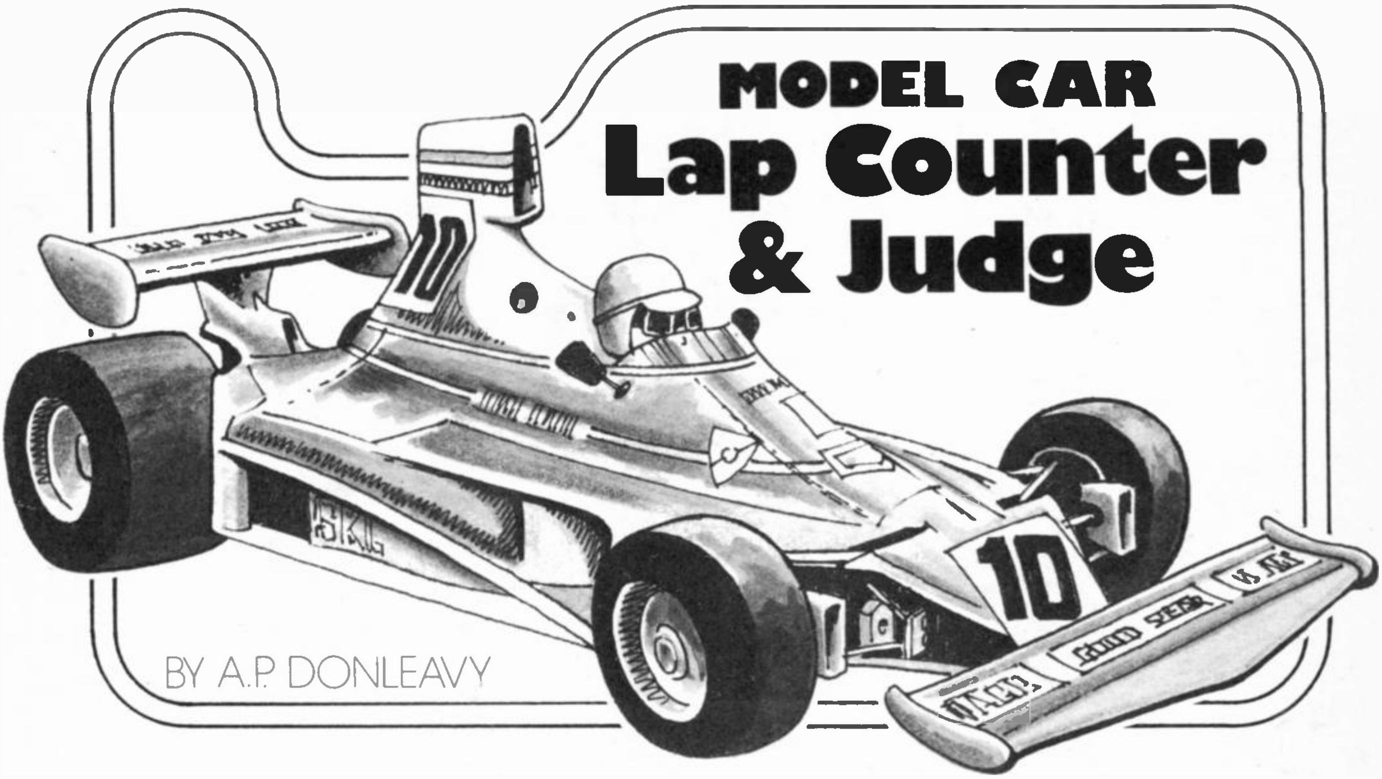
MODEL CAR Lap Counter & Judge



BY A.P. DONLEAVY

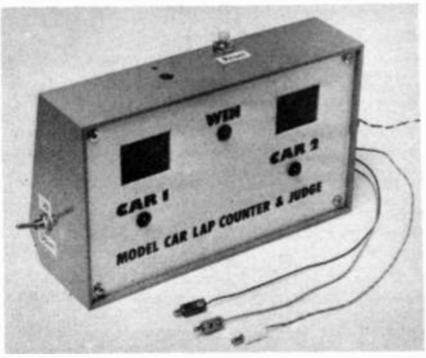
DESCRIBED here, especially for the slot car racing enthusiast, is an electronic lap counter for a two lane racetrack. Each track has its own counter circuit, able to count either up or down, and in the count up mode there is also a win indicator for the first car to pass the 100 lap mark.

The cars are detected by two phototransistors buried in the track and as the car passes overhead, it momentarily interrupts the ambient light falling onto the light-sensitive base region of the phototransistor, thus creating a pulse.

CIRCUIT OPERATION

The full circuit diagram is shown in Fig. 1. Each track has an identical counting circuit so only the first counter need be described.

Phototransistor TR1, mounted into the track, is the detector and under normal lighting conditions there is enough ambient light to hold the device on and the collector will be at nearly 0V due to volt drop across R1.



As the car interrupts the light, the current through TR1 drops and hence the collector voltage rises. This pulse is fed to pin 13 of IC1a, a CMOS NOR gate, which with IC1b, R2 and C1 forms a monostable multivibrator to provide a single clean pulse with a period of approximately 0·6 seconds. Once triggered, the monostable ignores any further voltage change at pin 13 for the duration of the timing period, thus eliminating any problems of jitter or multiple pulses from the detector and the car will have completely passed over it by the end of the 0·6 second period.

This pulse is connected to either pin 9 or 7 of IC2 via switch S1. IC2 is a 40110 CMOS decade up/down counter and display driver for a single seven segment display. With the input connected to pin 9, the counter will count up from 0 to 9, and down from 9 to 0 with the input on pin 7. This i.c. also has a latch facility but as this circuit does not use it, pin 6, the LATCH ENABLE input, is tied down to ground.

UP OR DOWN

So IC1 counts up or down one digit each time the phototransistor "sees" a car and displays the result on X1a.

Resistors R5 and R6 prevent the unused input from floating, which would lead to random counting.

When the count on IC1 goes from 9 back to 0 (in the count up mode, a short negative going pulse emerges from pin 10, the CARRY output, and this is connected to the count up input, pin 9, of another 40110 i.c. IC3, driving the second (most significant) digit, thus permitting the count to go from 09 to 10. In the count down mode, this negative pulse emerges from pin 11, the BORROW output, when the count goes from 0 to 9, and is connected to the count down input pin 7, of IC3.

In this way, the decade counter i.c.s can be cascaded in series to provide as many digits as required, in this case, only two.

Both counter circuits can be reset to zero by pressing S2, which momentarily connects all the RESET inputs to the positive supply.

WIN INDICATOR

The win indicator is based around IC6, a 4013 CMOS dual D-type flip-flop. Each flip-flop has a DATA and a CLOCK input and two outputs, Q and $\overline{Q}$. When a positive going pulse is applied to the CLOCK input, the logic state of the DATA input is transferred to the Q output, the $\overline{Q}$ output automatically taking on the opposite state.

On receipt of a high level on the RESET inputs of both flip-flops in IC6 (pins 4 and 10), the Q outputs will be returned to logic 0 and the $\overline{Q}$ outputs to logic 1. With IC6 wired as shown, that is the $\overline{Q}$ of the first flip-flop connected to the DATA input of the second and the $\overline{Q}$ of the second flip-flop connected to the DATA input of the first, both flip-flops are set ready for the $\overline{Q}$ outputs to go high upon receiving a clock pulse.

Hence the first counter to reach 100 laps will send a pulse from the CARRY output (pin 10 of IC3 or IC5) to trigger the relevant flip-flop and turn

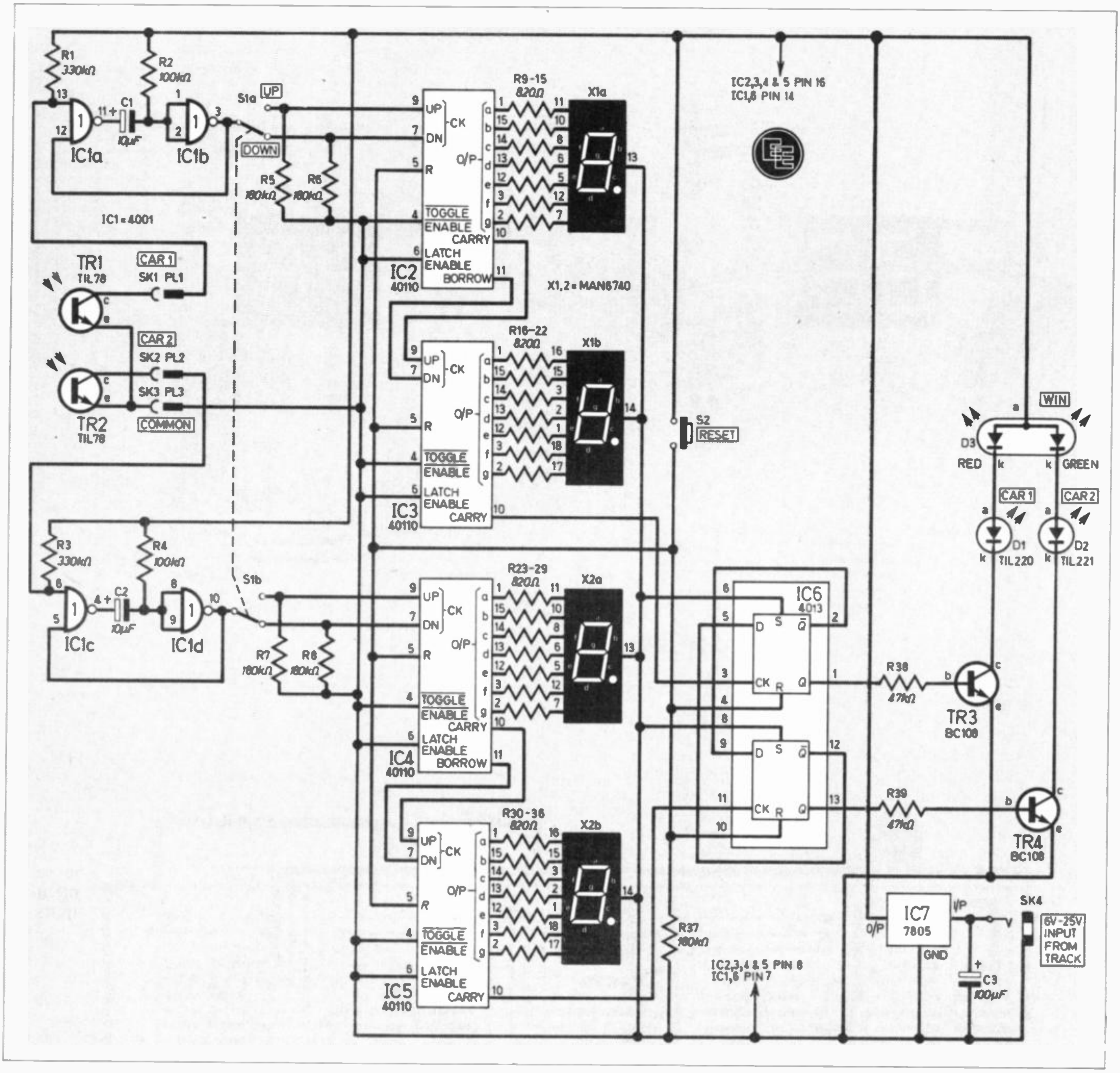


Fig. 1. Complete circuit diagram of the Model Car Lap Counter and Judge.

on the corresponding l.e.d., D1 or D2.

The $\overline{Q}$ output of the winning flip-flop (and hence the DATA input of the losing flip-flop) will now be at logic 0 resulting in no change at the Q output of the losing flip-flop when the losing counter circuit also reaches 100.

RESET

Thus only one l.e.d., the winner, will light and further pulses to either CLOCK input will not change the state of the outputs until the RESET button S2, has been pressed.

The win indicator can only be used in the count up mode, because the counters send their signal to the flip-flops at a count of 99 which would occur after only one lap in the count down mode!

The power supply of the Lap Counter uses a five volt regulator, IC7, enabling any power source from 6 to 25V to be used without any modification to the circuitry. The author used a nine volt calculator adaptor but a battery or the power from the track itself could also be used. The power input is via a 2·5mm jack socket, the tip being positive.

COMPONENTS

Resistors R5 to 8 and 37, the pull down resistors, are quoted as 180 kilohms but in fact are not critical and can be any value from 10 kilohms to one megohm.

The segment current limiting resistors, R9 to 36, were chosen to limit the total supply current to about 120mA, consistant with sufficient display brightness. If supply current is not restricted, then reducing the value of these resistors will give a brighter display. The specified regulator i.c. will supply 1A maximum.

Note that D3, the tri-colour l.e.d. is optional and can be omitted, the anodes of D1 and D2 must then be connected to the positive. The displays X1 and X2 can be any common cathode, two digit, seven segment display should the MAN6740 be difficult to obtain. However, in order to fit the p.c.b. the displays must be 18 pin d.i.l. packages on a 0·6 inch lead spacing.

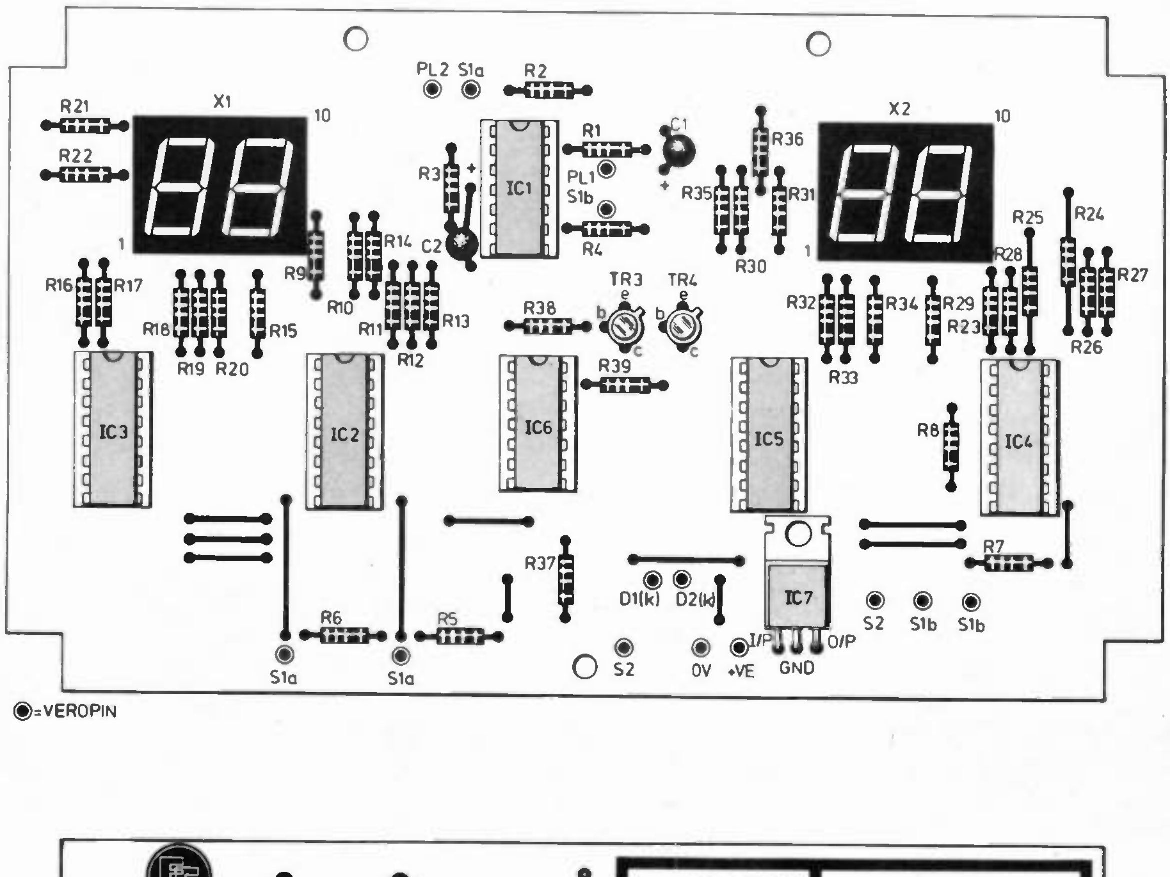
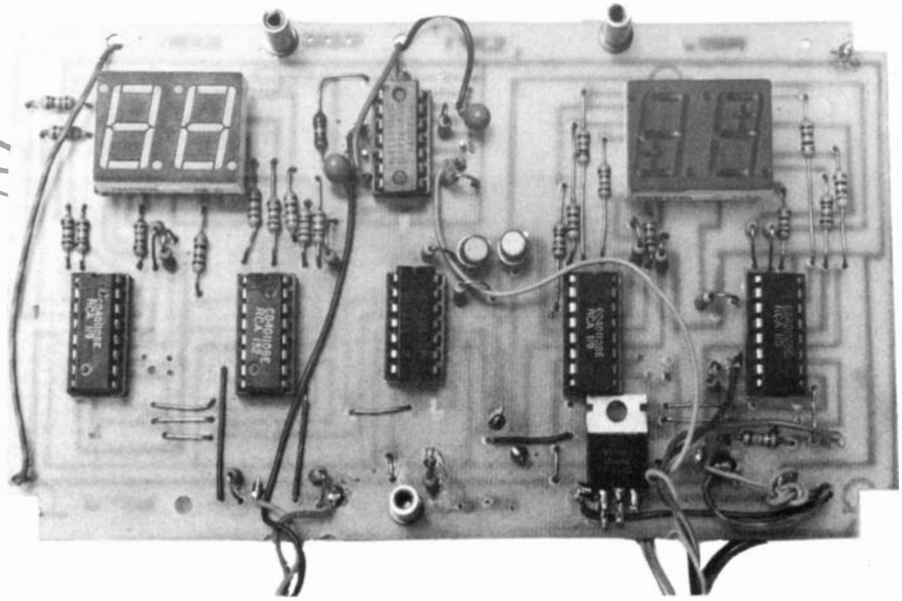


Fig. 2. Full size printed circuit board artwork and component layout for the Lap Counter and Judge.

CONSTRUCTION starts here



The assembled p.c.b. from the prototype.

CIRCUIT BOARD

The circuit was built on a printed circuit board and the track pattern for this is shown, full size, in Fig. 2 along with the component layout on the top side. The board measures 152 x 88mm and has the corners cut as shown, to fit into the console case.

The layout is considered to be suitable for production with an etch resist pen but etch resistant rub-down transfers will probably give a better result.

When it comes to assembling the p.c.b. holders are recommended for all i.c.s and the displays are mounted into Soldercon strip connectors, although they could be soldered directly to the board without any damage.

All other components should be soldered into place, observing the polarity of the capacitor and the orientation of the transistors. Links are to be kept as taught as possible and sleeved if there is any risk of them shorting out on an adjacent component.

All flying leads to be terminated on the board with a Veropin.

COMPONENTS

COMPONENTS approximate cost £25·00

Resistors

R1, 3	330kΩ (2 off)
R2, 4	100kΩ (2 off)
R5-8, 37	180kΩ (5 off)
R9-36	820Ω (28 off)
R38, 39	47kΩ (2 off)

All ¼W carbon ±5%

Capacitors

C1, 2	10μF 16V tantalum bead (2 off)
C3	100μF 40V elect

Semiconductors

D1	TIL220 0·2 inch red l.e.d.
D2	TIL221 0·2 inch green l.e.d.
D3	Tri-colour l.e.d. common anode
TR1, 2	TIL78 silicon *npn* phototransistor (2 off)
TR3, 4	BC108 silicon *npn* (2 off)
IC1	4001B CMOS quad 2-input NOR gate
IC2-5	40110B CMOS decade counter/driver (4 off)
IC6	4013B CMOS dual D-type flip-flop
IC7	7805 5V, 1A voltage regulator, TO-220 case
X1, 2	MAN6740 2 digit, common cathode seven segment display (2 off)

See Shop Talk page 455

Miscellaneous

S1	d.p.d.t. miniature toggle switch
S2	Push-to-make, momentary action switch
SK1	2·5mm banana socket, red
SK2	2·5mm banana socket, green
SK3	2·5mm banana socket, white
SK4	2·5mm jack socket
PL1	2·5mm banana plug, red
PL2	2·5mm banana plug, green
PL3	2·5mm banana plug, white

Single sided glass fibre p.c.b. 152 × 90mm; console type case 160 × 95 × 60 (rear) × 40 (front) with aluminium lid; 16-pin i.c. holder (4 off); 14-pin i.c. holder (2 off); Soldercon strip i.c. holder, 36 way; 5mm l.e.d. mounting clip (3 off); polarised red filter, 105 × 35mm; 7/0·2 p.v.c. sleeved equipment wire; 6BA spacers, 13mm long (3 off); 6BA screws, 6mm long (6 off).

CONSOLE

The unit is housed in an inexpensive console type case with the p.c.b. assembly mounted beneath the aluminium lid on three 13mm long 6BA spacers.

When marking the positions of these mounting holes and the two rectangular display windows on the lid, the p.c.b. may be used as a template (prior to any components being soldered into the board). The mounting holes are 3mm diameter and each window measures 22 x 28mm.

Three additional holes, 6·4mm diameter, are needed for D1, D2 and D3 and the approximate positions of these are shown in the accompanying photographs. Care should be taken here to ensure that these l.e.d.s do not foul any components on the board.

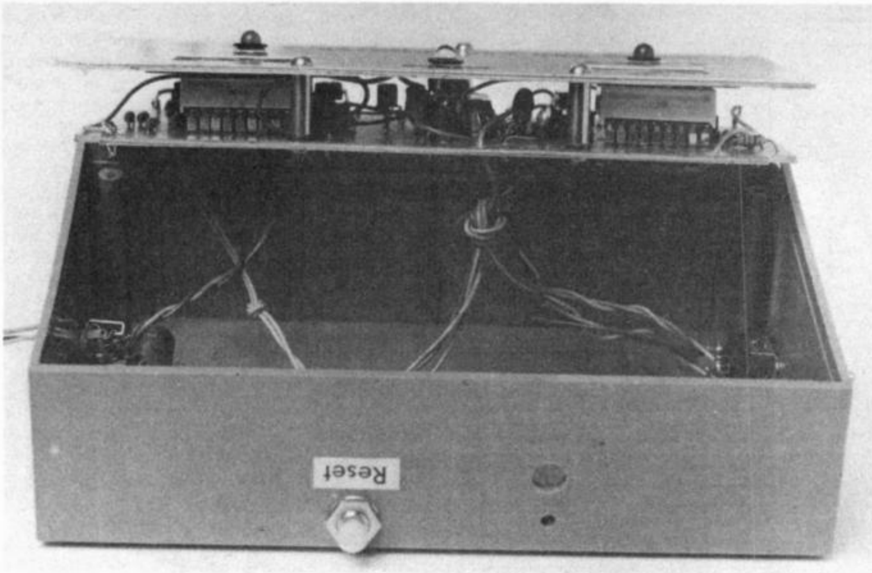
The two switches and jack socket SK4 are mounted in convenient positions in the sidewalls of the case and the three leads to the phototransistors mounted into the racetrack all pass through another hole in the case and will be terminated with the banana plugs PL1, 2 and 3.

The red polarised filter has to be cut into two pieces and glued in position behind the two window cut-outs.

FINAL ASSEMBLY

Insert l.e.d.s D1, 2 and 3 into the lid with the special mounting clips and solder to the corresponding flying leads from the p.c.b. as shown in Fig. 3. The board can now be mounted to the lid using the 6BA screws and spaces.

Solder the correct leads from the p.c.b. to the switches and jack socket, and the three leads to the phototransistors can now be threaded through the relevent hole and clamped tightly with a ratchet type cable tie



View inside the console showing the p.c.b. mounted beneath the lid.

to prevent them being pulled through. The banana plugs can now be added, taking care to get the colours right as the red plug (PL1) corresponds with the red l.e.d., (D1) win indicator.

Note that C3 is soldered directly to the terminals of jack socket SK4.

The lid can now be secured.

PHOTOTRANSISTORS

To mount the phototransistors TR1 and TR2, drill holes in the track such that they will be a tight fit and secure with glue. It is necessary to choose the position of these devices such that the car will obscure the light from the cell when passing over it.

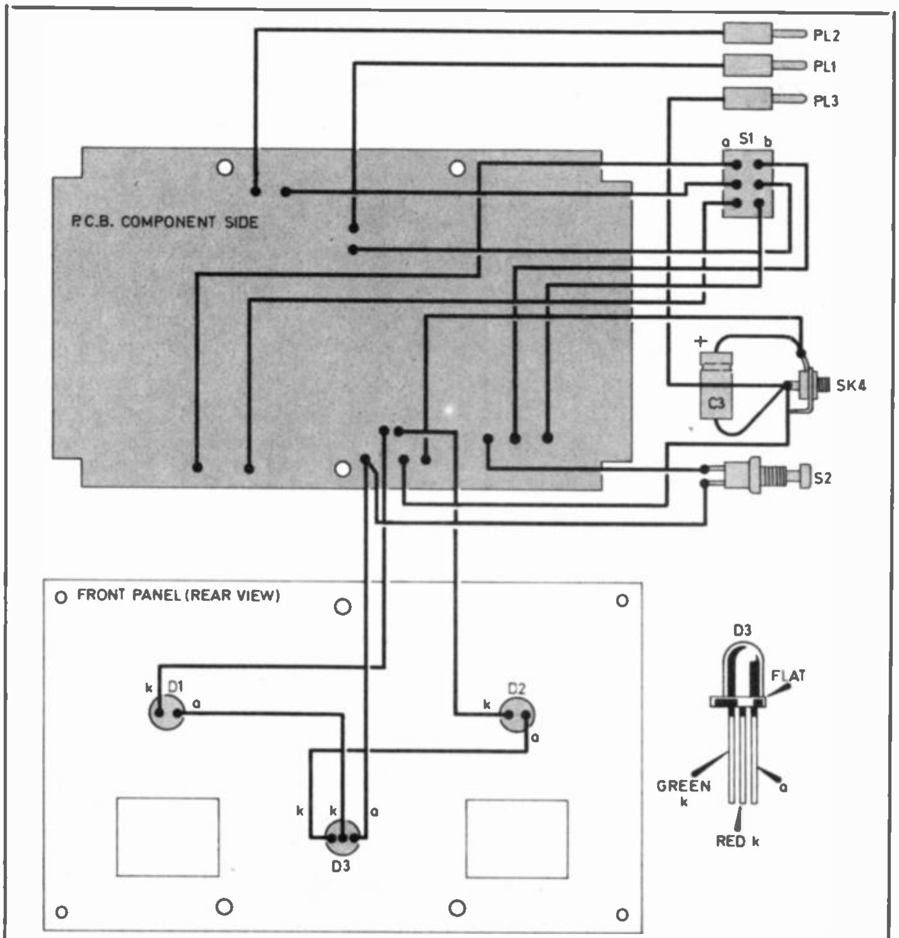


Fig. 3. Interwiring diagram. Attention must be paid to the routing of the wires and this will depend upon the positions of the switches, l.e.d.s and sockets.

The 2·5mm banana sockets are mounted on the edge of the track. Choose a straight piece of track for the cells and sockets otherwise a car skidding round a corner may hit them.

TROUBLE SHOOTING

If the p.c.b. has been accurately reproduced then any malfunctions of the circuit will almost certainly be wiring errors or faulty components.

Should one or both of the counters not function then the fault may be due to reversed connections to the phototransistors. The functioning of the phototransistors can be checked by measuring the voltage at the collector with light falling on, and absent from, the light sensitive face. These should be 0·2 and 4·8V respectively.

The function of the monostable can also be checked by measuring the voltage at IC1 pin 3. On interrupting the light to the photocell, the voltage at pin 3 should rise to approximately five volts for half a second and then fall back to zero.

Voltages at pins 10 and 11 of IC2 to IC4 should be five volts, if not then suspect a faulty i.c. Check also the pins tied to ground are in fact at zero volts and if not then there is probably a bad soldering connection.

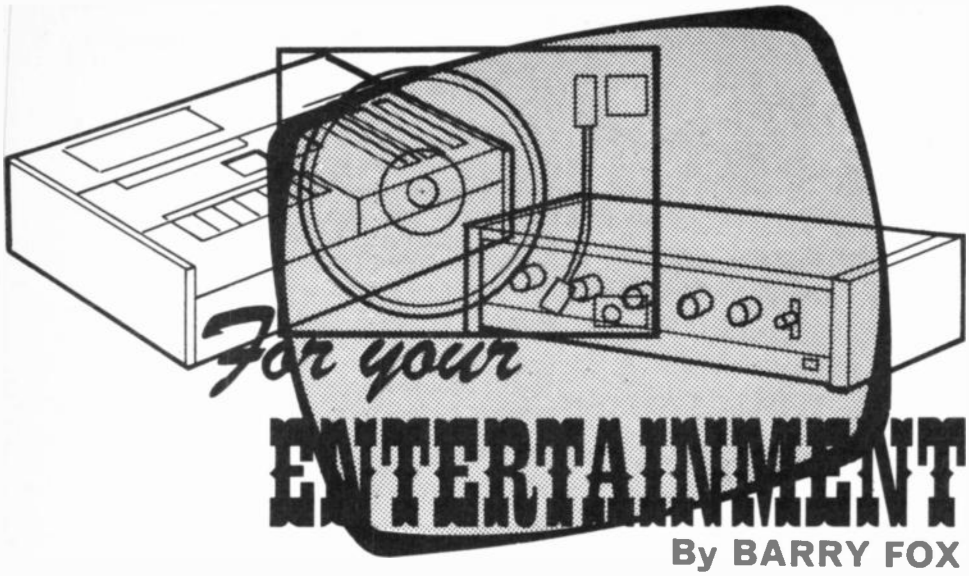
If only one counter circuit is working, it is possible to transpose all the i.c.s from the faulty counter, one by one, to the good counter and thus isolating the malfunctioning i.c. when the fault itself is transferred. This highlights one of the many advantages of using i.c. holders.

IN USE

In most situations, the ambient lighting will be sufficient to trigger the phototransistor. If difficulties arise, locate the track piece containing the detectors near to a light or window. If this proves to be impractical then a table lamp placed in the proximity of the track will give sufficient light for the sensors.

If the counters increment continuously, this indicates that the light level is on the threshold of being too low.

Finally a shorter race, or even a handicap race can be arranged by putting the counter in the COUNT DOWN mode and passing your hand over each sensor until the required starting point is reached for each track. Then switch to the COUNT UP mode and start the race.



For your ENTERTAINMENT

By BARRY FOX

Cable Shock

Publication of our feature on optical fibre technology coincided not only with British Telecom's plans for more fibre 'phone links across the country, but also publication of an official report on the future of cable TV systems in Britain. These will rely, in part, on optical fibres. But note well those words "*in part*".

The cable TV report was prepared for the Prime Minister by the Information Technology Advisory Panel, set up in July 1981 "to ensure that Government policies and actions are securely based on a close appreciation of market needs and opportunities". The Panel was charged with keeping the Prime Minister and her colleagues up to date on "all aspects of information technology".

Essentially the ITAP report proposes that Britain should have a private enterprise cable TV system by the mid-80's. This would tie in with the proposed inauguration of a direct broadcasting satellite system to be run by United Satellites (the consortium of British Telecom, British Aerospace and GEC-Marconi). The panel proposes that Britain should be cabled with main trunk lines of optical fibres capable of carrying very wide bandwidth signals, and thus as many channels of video and digital data as are likely to prove necessary for the 1990's and even 21st century.

Unfortunately, the panel makes the potentially disastrous recommendation that these optical fibre links should *not* extend right into the home. Instead these will terminate at switching stations, probably at the end of each street, each handling fifty or one hundred homes.

These switching stations will receive all channels through the optical fibre link but connect with local homes through a coaxial link of greatly restricted bandwidth. According to the panel this will be adequate because "each subscriber (whether in a home or business) only needs simultaneous access to, at most, a few channels (so) there seems little need to provide all channels down the final links all the time".

This seems a terribly short sighted view point, especially bearing in mind the fact that the links won't be laid until the mid or late 80's. Also the panel is recommending that the cable system will be useful for business applications because it "enables information to be exchanged between computers and word processors".

The inescapable conclusion is that the proposed coaxial links are likely to be inadequate even before they are laid!

Short Sighted

The reasoning behind this short sighted proposal is even more disturbing. The panel compared the cost of laying optical fibre inter-active links into each home, with that of laying coaxial links.

The panel only asked British Telecom for an estimate on the cost of the opto-electronics necessary. This produced a minimum cost per home of between £1,500 and £1,700. The panel believes that it will only cost £200 or £300 to provide a coaxial link with the necessary command switching for the local sub-station.

Even if these estimates are correct (which seems unlikely) they are at today's prices. By the mid or late 80's when the system is being laid, opto-electronics will be commonplace and cheap.

In Japan it is already possible to buy a complete laser diode and photo receptor unit, the Taos made by Olympus, for between 40,000 and 50,000 yen, which is around £100. These units are still being made only in a small quantity, but the optics are formed as a single integrated unit. So the price will drop dramatically over the next few years.

By the mid 80's, when Britain is ready for cabling, they could cost only a few pounds each. What a pity the ITAP committee didn't talk to Olympus before publishing its report.

Obsolete System

If the Prime Minister and Government go along with the panel's proposals, we could end up with an obsolete cable system based on obsolete coaxial technology, which actually costs more than a full bandwidth system based on optical fibre technology.

Music For Pleasure

Music for Pleasure, the budget EMI record label, puts out some interesting re-issues. One does get the feeling, however, that there's a budget interest on the part of MFP. For instance, the wonderful André Previn, Shelly Manne, Leroy Vinegar jazz trio recording of songs from *My Fair Lady* is a very welcome re-issue, even though it's clearly motivated by a more recent Previn recording on the EMI label which is plugged on the MFP sleeve.

A string of Previn trio recordings were made in the Contemporary Studio in Los Angeles between 1956 and 1958. Although most of these recordings were made before the RIAA standardisation on disc stereo (in March 1958) they were all taped in stereo, using AKG C12 condenser microphones, an Ampex recorder and Reeves Soundcraft tape. Roy DuNann was the engineer.

What a pity therefore that the MFP recording has been reissued with *Mono* stamped on the disc centre label and no mention on the sleeve of the fact that it is one of the earliest jazz stereo recordings. To confuse things further the mono disc is packed in a sleeve labelled Stereo. It is, by the way, cut in stereo.

Live Performance

Another MFP re-issue is the Beach Boys *Live in London*. Here the sleeve note explains how in the days of *Good Vibrations* "many critics wondered aloud whether the group were capable of reproducing anything even vaguely resembling their recorded sound when making live in-person appearances".

Most of The Beach Boys recorded material was, of course, meticulously polished in the studio with re-mixing and over-dubs. "But," continues the sleeve "the group reached a level of polished stage performances . . . (and) this album, recorded at the peak of the group's prowess encapsulates the atmosphere of one of their live concerts".

Well, if my memory serves me well, the Beach Boys concert encapsulated on the MFP label was taped at the London Paladium on December 1, 1968. The group, fresh from recording in Californian studios, insisted on an 8-track system for their live concert taping in London.

Two 8-track recorders were rustled up, one dismantled from a fixed mount in Chappell's Studios, and the concert was duly multi-tracked. The tapes went back to California for re-mixing where all the sound of the London pit band had to be lost for Union reasons.

The group then spent so long on cleaning up their vocal and instrumental tracks that in the end the only untouched original material on the tape was a track of audience atmosphere and applause. The final result, which you can hear on the MFP record, is superb.

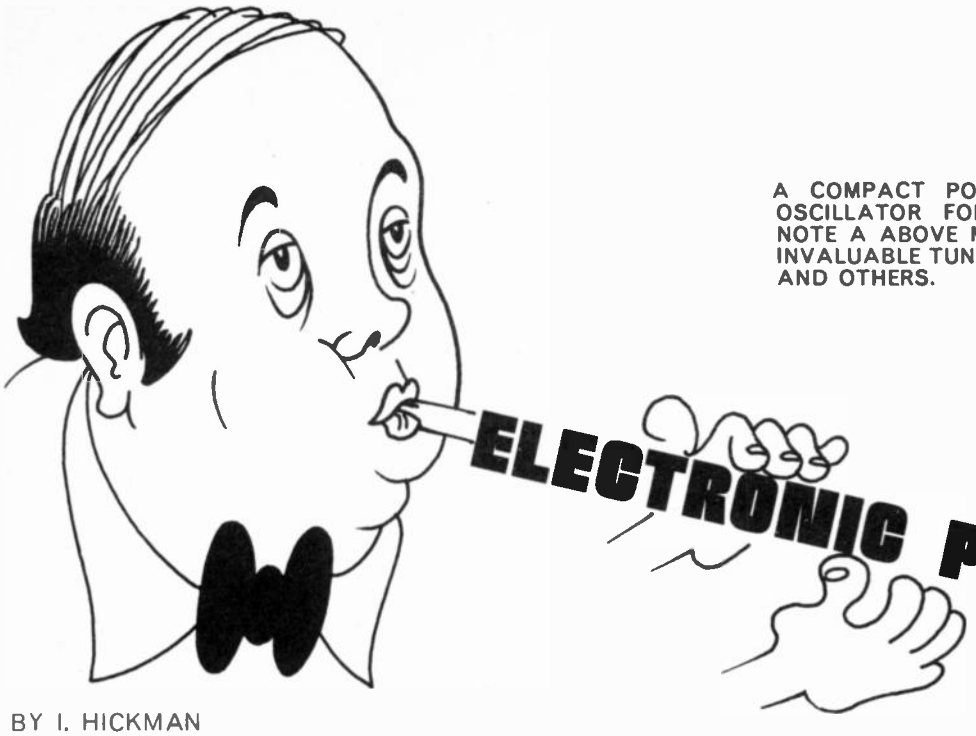
Closed Shop

The biggest problem with buying an MFP record can be finding it. They are sold in shops like Woolworths whose assistants often know next to nothing about what's available. Other record shops have a rather snobbish attitude.

I asked at my local specialist record shop for the Classics for Pleasure re-issue of Stokowski's version of *Carmina Burana*, which is interesting both for Stokowski's treatment of the music and as an example of early stereo (it was recorded soon after RIAA standardisation). "We don't have it" they told me.

"Why? Because it's out of stock or you don't stock budget labels?" I asked. "Because it's not very good" they told me and returned to the more important job of talking amongst themselves.

The shop is now closed I note.



ELECTRONIC PITCH PIPE

A COMPACT POCKET-SIZED CONSTANT PITCH OSCILLATOR FOR THE MUSICIAN. GENERATES NOTE A ABOVE MIDDLE C (440Hz) MAKING IT AN INVALUABLE TUNING AID FOR THE VIOLIN PLAYER AND OTHERS.

BY I. HICKMAN

For the accurate tuning of musical instruments, particularly the violin, some source of accurate pitch, usually the A above middle C, is required. Many homes have a piano, which solves the problem for the violinist at home, but when no piano is at hand (and the group of players does not include an oboeist) the usual solution is a "pitch pipe", or sometimes a tuning fork.

In these modern technological times it is easy to produce an electronic device to replace pitch pipes and tuning forks, and in fact the author has done just this for his violinist daughter. The electronic pitch pipe was built into a very small radio case, just large enough to include a 2in speaker, and fits easily into one of the pockets in her violin case.

Any small plastic box will do, though as the photographs show, if it is possible to obtain a suitable small radio case it looks more professional, making an unusual talking point at orchestral rehearsals!

BATTERY POWER

The case shown is rather compact inside; the original circuitry (which was missing) was to have been powered from two 1·35V mercury cells. However, this voltage is too low to enable a simple audio oscillator with the necessary frequency stability to be designed, so a higher voltage battery was necessary. Because of its small size, an Ever Ready B154 15V battery was chosen. This is used in certain flash guns and is obtainable at any good photographic chemists store or camera shop.

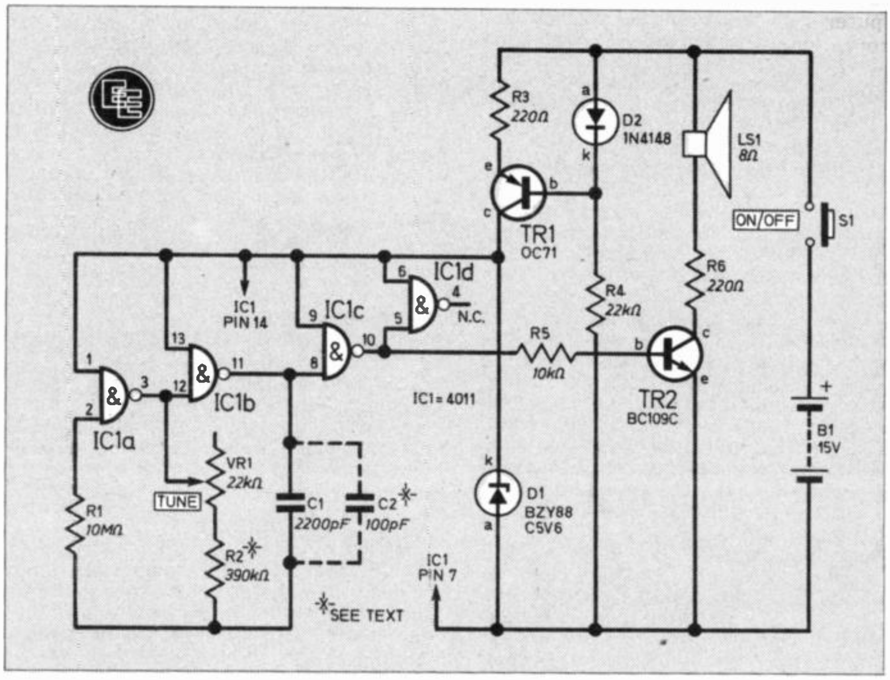
However, the frequency of the tone produced by the electronic pitch pipe is independent of supply voltage down to just over six volts, so if a little more space is available in the box, the ubiquitous 9V PP3 can be used.

CIRCUIT DESCRIPTION

Fig. 1 shows the circuit diagram of the electronic pitch pipe. IC1 is a 4011 CMOS quad two input NAND gate, with two of the gates (IC1a and b) being used as a squarewave oscillator, and a third (IC1c) as a buffer stage. The fourth is unused. Note, however, that the inputs of the unused gate (IC1d) should not be left floating, but connected as shown.

To obtain a constant pitch regardless of the state of the battery, the supply to the oscillator is stabilised at 5·6V by means of zener diode D1, which is fed from a current source. The latter consists of TR1 and D2, and works by virtue of TR1 being a germanium transistor whilst D2 is a silicon diode; different types should not be substituted here.

Fig. 1. Pitch Pipe circuit diagram.



The buffer stage, IC1c, drives the output transistor, TR2, the base current being limited by R5 and the collector current by R6. To provide maximum volume and to avoid loading the stabilised supply, the output stage is run directly from the battery. It might be thought that with R6, a 220 ohm resistor, in series with an 8 ohm speaker, nearly all the output would be dissipated in the resistor and that the output sound level from the speaker would be quite inadequate. However, the figure of 8 ohms refers to the resistance of the loudspeaker at d.c. and very low frequencies. At 440Hz (concert pitch A)

there is also the very substantial impedance due to the speakers voice coil, so that a fair proportion of the limited output power available does appear in the loudspeaker. The result is a very pleasant clear tone of more than adequate loudness, with no trace of "chirp" at switch-on.

The ON/OFF switch, S1, is a momentary action push-button, so there is no danger of the electronic pitch pipe being accidentally left on and running down the battery. With normal use, the life of the battery should be almost as long as its "shelf life", say 18 months or more.

STABILITY

Of course an electronic pitch pipe must produce as accurate and stable a pitch as an ordinary pitch pipe if it is to be useful, so consequently the finished prototype was tested for consistency of pitch with variation of both battery voltage and ambient temperature.

From fifteen down to about six and a half volts, and over the maximum range of temperature that a violinist would care to play in, the pitch did not vary by more than a couple of cents or so. (A cent in this context is a frequency difference of one per cent of a semitone.) This is barely discernable, even if two notes, one cent apart are played simultaneously.

To obtain this excellent performance, good quality components should be used throughout, and for preference VR1 should be a cermet type, and R2 should be a high stability resistor. If you build the circuit and wish to temperature test it to check that the pitch doesn't change, make sure that it is heated or cooled evenly as a complete unit, blowing a hair dryer at the circuit can heat some components more than others and is thus *not* representative of a normal change in ambient temperature.

COMPONENTS

Resistors
- R1 10MΩ
- R2 390kΩ (see text)
- R3, 6 220Ω (2 off)
- R4 22kΩ
- R5 10kΩ
- all ¼W carbon ±5%

See **Shop Talk** page 455

Capacitors
- C1 2200pF
- C2 100pF (see text)

Semiconductors
- D1 BZY88 C5V6 400mW, 5·6V Zener diode
- D2 1N4148 silicon signal diode
- TR1 OC71 germanium *pnp*
- TR2 BC109C silicon *npn*
- IC1 4011 CMOS quad 2 input NAND gate

Miscellaneous
- VR1 22kΩ miniature vertical cermet preset
- S1 push-to-make, momentary action
- LS1 8 ohm miniature loudspeaker
- B1 15V battery (Ever Ready type B154)

0·1 inch matrix stripboard, 21 strips by 21 holes; case to suit (approx 70 × 50 × 25mm); Veropins (5 off); 7/0·2 equipment wire, 14 pin d.i.l. holder.

Guidance only Approx. cost £5 excluding case

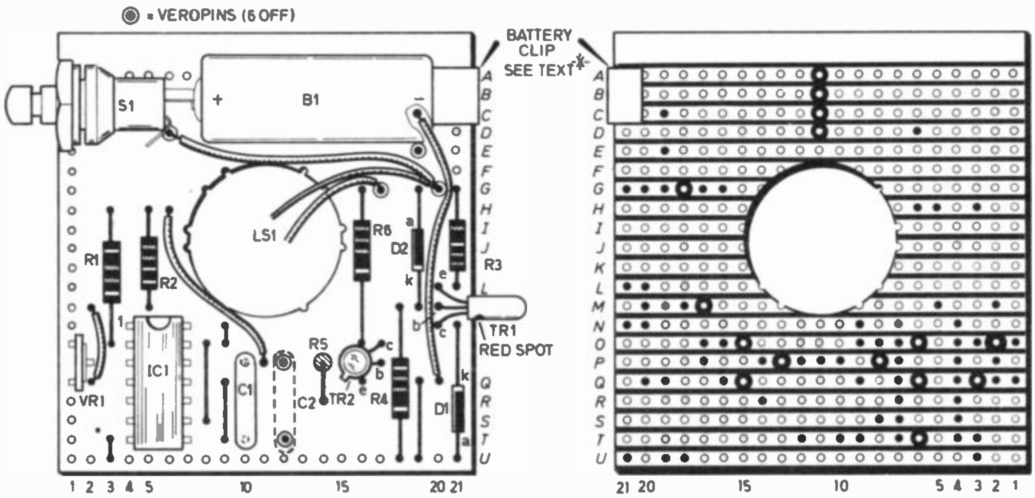


Fig. 2. Stripboard layout for the Pitch Pipe housed in the small transistor radio case shown in the photograph above. Note that this model employs the 15V battery (B1) and also has the speaker hole in the board. If a larger case is used, the layout may need to be modified accordingly to accommodate the larger PP3 battery and the new speaker position.

CIRCUIT BOARD

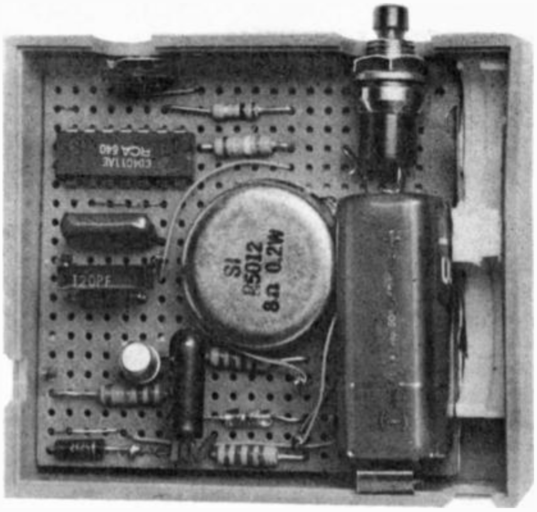
The prototype circuit board was constructed on a piece of stripboard, 21 strips by 21 holes, with a hole, 22mm in diameter, to fit over the loudspeaker magnet. This hole is actually centred on a matrix hole, reference *I*11 (see Fig. 2), but this will largely depend upon the type and size of both speaker and case used by the constructor.

As discussed earlier, the case used on the prototype was a surplus stock miniature transistor radio enclosure of Russian origin, which regrettably, may be difficult to obtain. However, a similar radio case, more likely to have originated from the illustrious regions of Hong Kong, could easily be salvaged from a defunct tranny and modified to suit the project. This type of case is recommended as it not only readily accepts the miniature loudspeaker (more often than not it will have its own already!) but also houses a battery in a purpose-built compartment.

So bearing in mind that the layout shown in Fig. 2 is for a specific case and may require modification, assembly can commence. S1 and VR1 were positioned so as to line up with holes in the case and one of the terminals of S1 is actually used as the positive battery connection, the negative battery connection is formed from a strip of brass soldered to tracks *A*, *B* and *C* on the board and then folded upwards to make a spring clip. This is only necessary if the smaller 15V battery is used.

S1 is then anchored down with a piece of solid wire, bent around it and soldered into the board. The other switch terminal is then bent away from the battery and soldered to a Veropin.

C2 should not be added at this stage, but two Veropins inserted into the positions shown to facilitate including this component should it be required when calibrating the pitch.



Full size prototype of the Pitch Pipe.

CALIBRATION

To set the pitch to A above middle C (440Hz), VR1 is adjusted as necessary. If the pitch is still too high even with VR1 at maximum resistance, C2 should be added, about 100pF should suffice. If, however, the pitch is too low even with VR1 at minimum resistance, change R2 to 360 or 330 kilohms and proceed as above.

The pitch should be adjusted by sounding the electronic pitch pipe at the same time as a known accurate A, for example, a piano at concert pitch or the tuning note on the oboe at the beginning of a broadcast concert.

If neither of these is available, a 440Hz tone is broadcast for a four minute period on the hour during BBC2 test card transmissions. It may be worth noting that the BBC2 test card goes out at 4pm until the first evening programme Monday to Friday and from 9am between programmes on a Saturday.

Finally, this project should be well within the capabilities of most constructors, and the finished article will be a treasured possession for any musician. ⌑

COUNTER INTELLIGENCE

By PAUL YOUNG

Hot Recipe

I always make a point of answering every reader who is kind enough to write to me, but recently I had a letter from a lady, and although I replied to it, I am still not quite sure whether it was a leg-pull. She asked me if I had a microwave oven and a spectrometer.

It seems the good lady had taken three rather strange ingredients and cooked them in a microwave oven and she estimates that the resulting amalgam is copper gold and silver!! Would I check the results for her? If I remember rightly, when I worked under the sign of the three spheres, the usual test for gold was nitric acid.

I did explain to her that I am very anti microwave ovens, even more so, since a friend of mine pointed out that you might even be at risk if the chap next door has a leaky one and places it against the adjacent wall. The waves can pass right through the brick wall and damage you! All the same I wish her every success with her discovery, and if she is having me on, well I forgive her because she raised a smile, and that is quite a feat in these hard times.

Good Publicity

I was once told that if you invented a better mousetrap, the world would beat a path to your door in order to buy it. I regret to say, there is no truth in this statement at all. You might invent the finest mousetrap in the world and offer it at a very low price but unless you could back it with good publicity, you would still get no customers.

I was reminded of this the other day when I was asked if my Tabletop Workbench was still available. Although I abandoned it when my old friend Burt Malme died (he made all the wood work) it never really took off. Contrast this with the "Work Mate" which was a portable woodworkers bench, the man who dreamed this up made a fortune, because it was taken up by Black and Decker who were able to give it the necessary publicity.

I still think of the Tabletop Workbench as a viable proposition, but in order to keep down the cost, it needs to be turned out in one piece as a plastic moulding. This would need complicated tooling and today this would be extremely expensive.

New Experience

I have always been keen to try new experiences, and when a friend of mine who runs a car hire firm, told me one weekend that two of his drivers had gone down with flu and could I help him out, I jumped at the chance.

Now for the interesting part. All the regular drivers are equipped with two-way radios. I had no such luxury, so my friend said "you can use the portable", and handed me a small box measuring about eight inches by three by two and a half inches. It had a small rod projecting from one end about six inches by half an inch in diameter, which I took to be the aerial.

I kept my thoughts to myself, though I couldn't for the life of me see this tiny object working satisfactorily. However, after dropping a passenger I stood on the pavement and called up my base. Immediately back came the reply loud and clear. Surprise number one.

After my next trip the controller said, "You are not leaving your radio switched on!" I replied, "Surely it won't work inside the car being completely screened, including the aerial?" "Oh! yes it will" and it did! Surprise number two.

During a lull in the proceedings I decided to examine this little marvel more closely. I was curious to know where it was made. Although I had already decided it must be Japanese, the biggest surprise of all was number three. Clearly marked on the side in small letters were the words, *Made in Ripley, Derbyshire.*

Most of the drivers use a code partly derived from the old RAF jargon, such as "Roger out" and "My E.T.A. is 12.15". I fully expected it to crackle into life and a voice say, *"Bandits, Angels One Five, Tally Ho!"

* Enemy aircraft at fifteen thousand feet, attack!

EE TEACH-IN 82

PART 10

BY O.N. BISHOP

BASIC ELECTRONIC THEORY WITH EXPERIMENTS

OSCILLATORS

THE ASTABLE MODULE that forms part of *Minilab* is an example of the class of oscillators known as **relaxation oscillators.** You can think of them working by a gradual building up of tension followed by a sudden release, or relaxation. A capacitor is gradually charged up to a certain level. When that level is reached, a transistor or other device switches on and discharges the capacitor rapidly. The frequency of oscillation depends mainly on the time required to charge the capacitor.

UNIJUNCTION TRANSISTOR OSCILLATOR

Another type of relaxation oscillator, is shown in Fig. 10.1. It uses a single active device, a **unijunction transistor** (u.j.t.) see Fig. 10.2a.

Current flows through VR3 and R23 gradually charging C8. The potential at the emitter gradually rises. When it is close to zero the junction is reverse-biased and only a small leakage current flows.

After a while the potential rises and the junction is forward biased. Current flows and holes are injected into the bar and these move toward base 1. This causes increased conductivity (= decreased resistance) in the lower part of the bar.

The effect of this is to lower the potential in that part of the bar (think of it as a potential divider, as in Fig. 10.2b, with R2 suddenly being made smaller). The junction becomes even more strongly forward-biased, causing greater emitter current, more holes and further drop in potential in the bar.

The result is a sudden burst of current, which almost instantly discharges the capacitor. When it is discharged, the process starts again.

We can obtain two kinds of waveform from this oscillator, a sawtooth at the emitter and a series of spikes at base 1. The frequency depends on the values of *R* and *C* (VR3 + R23 and C8).

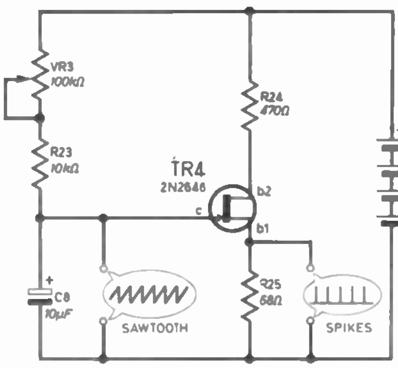


Fig. 10.1. Relaxation oscillator based on a unijunction transistor.

EXPERIMENT 10.1
CMOS oscillator

It is even simpler to build a relaxation oscillator from CMOS logic gates, see Fig. 10.3. The two gates are wired as inverters (NOT gates), the only other components required being a capacitor and a resistor, C8 and R24.

If the output of IC3b suddenly goes high, the sudden increase in voltage is passed across C8, giving plate *B* a high potential. IC3a has a high input, so it has a low output. The low level at point *X* causes current to flow from *B* to *X*, through R24. When potential at *B* has fallen sufficiently, IC3a changes state. Its output becomes high, causing IC3b to change state and its output to become low.

Now plate *B* is pulled low, causing current to flow from *X* to *B*. This continues until the potential at *B* has risen sufficiently to switch IC3a back again. The switching back and forth continues indefinitely.

Resistor R23 is not essential for operation of the oscillator. Its effect is to make frequency less dependent on supply voltage. R23 should be at least twice the value of R24. Fig. 10.4 shows how to build this oscillator on *Minilab*. Note that a single i.c. can be the basis for two independent oscillators.

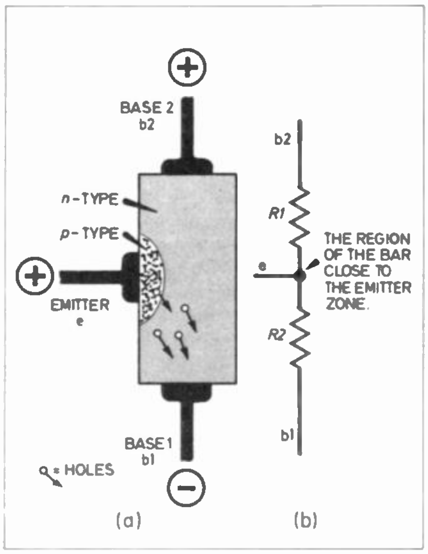


Fig. 10.2. (a) Construction of a unijunction transistor (b) equivalent circuit of a unijunction—it acts as a potential divider.

CRYSTAL OSCILLATORS

The frequency of relaxation oscillators is generally dependent on the time constant, *RC*. In practice, *R* and *C* vary with temperature, so frequency is temperature dependent. There is also the problem of obtaining components with exact values needed to produce a required frequency.

A much more precise control of frequency can be obtained by using a quartz crystal. A crystal is cut to vibrate mechanically at a precisely determined frequency. It is made to vibrate by applying an oscillating p.d. to it. As it vibrates, an oscillating e.m.f. is generated across it. It can therefore be connected into a circuit which supplies it with the energy to keep it vibrating and in which the e.m.f. from the crystal keeps the circuit oscillating at the required frequency.

Temperature stability is much better than with a simple *RC* circuit, yet crystals are cheap. Most digital watches base their timing on a crystal oscillator. Typically,

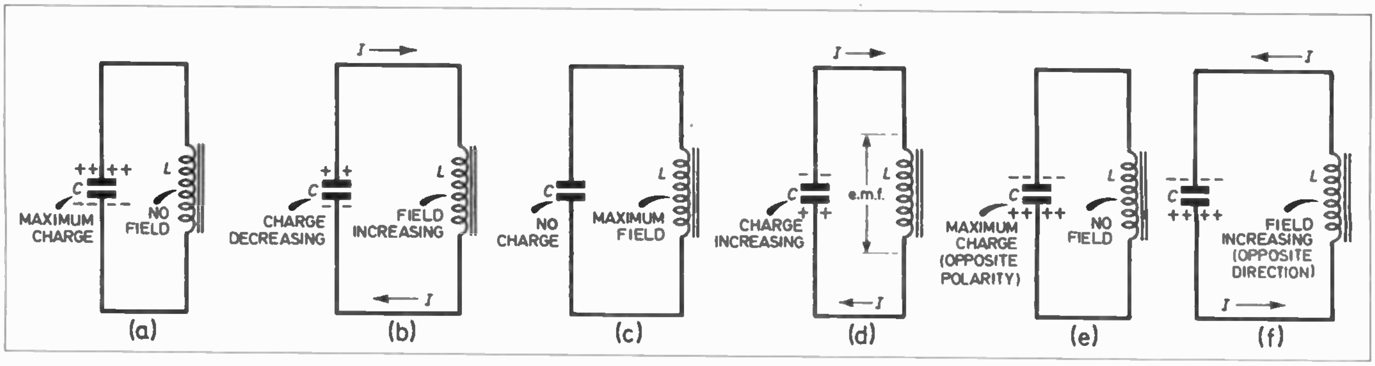


Fig. 10.5. An *LC* oscillator in various operational stages.

the crystal has a frequency of 32·768kHz. This is divided by 2^{15}, using a 15-stage binary counter, to give a frequency of 1Hz.

RESONANCE

A pendulum is an oscillator and, has long been used as such in timekeeping. Left to swing, its amplitude of swing gradually decreases as it loses energy, mainly by creating currents in the air around it. Note that though the *amplitude* may decrease, the *frequency* remains unaltered.

In a pendulum clock, the mechanism keeps it swinging indefinitely by giving it a small "kick" at each swing. The kicks must be provided at the right time, just as we must give a person on a swing a push at the right time if they are to be kept going. The supply of energy must be timed correctly—it must be in **resonance** with the natural period of swing of the pendulum.

Fig. 10.5 shows a circuit which oscillates. At (a) the charged capacitor *C* is discharging through the inductor *L*. At (c) it is discharged and the magnetic field of *L* is at its maximum. Now the current stops and the field collapses.

As explained last month, inductors *oppose* changes in magnetic field. An e.m.f. is induced to maintain the field. This causes a current to flow (d), recharging the capacitor, but with opposite polarity (e).

Energy has been transferred from the capacitor to the inductor and back to the capacitor again. Now the capacitor discharges again (f) and the cycle is repeated. This occurs at a frequency given by $f = 1/2\pi LC$.

In time, oscillations die away as electrical energy is converted to heat. But, just as with the pendulum, the frequency remains unchanged. If we replace the lost energy from outside, the circuit can oscillate indefinitely. This is the basis of the second main class of oscillator, the **harmonic oscillator.**

A pendulum swings with simple harmonic motion. If we could trace the motion of the bob on a sheet of steadily moving paper (Fig. 10.6) without stopping it swinging, we should obtain a sine curve.

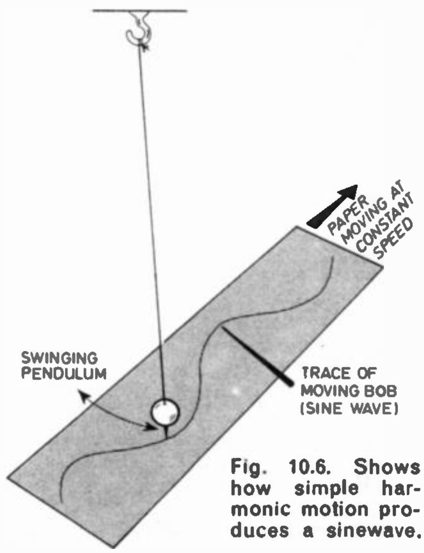
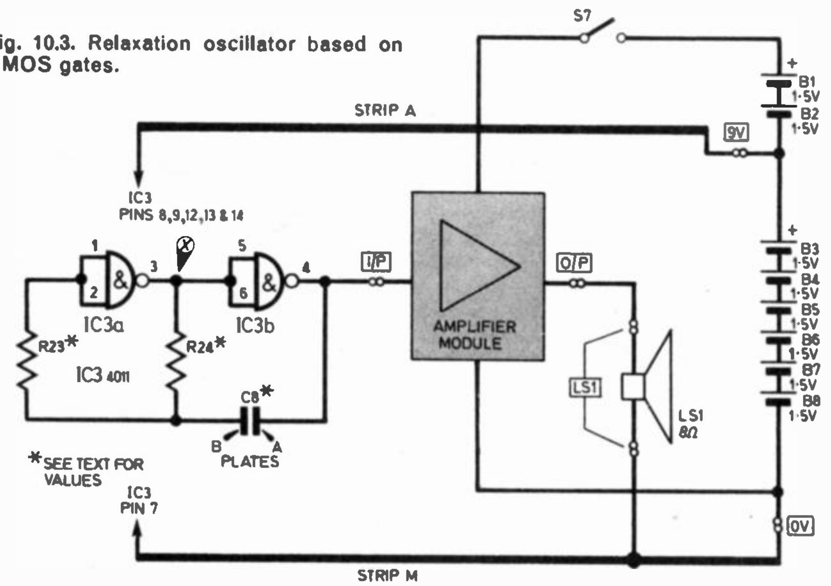


Fig. 10.6. Shows how simple harmonic motion produces a sinewave.

EXPERIMENT 10.1

Fig. 10.3. Relaxation oscillator based on CMOS gates.



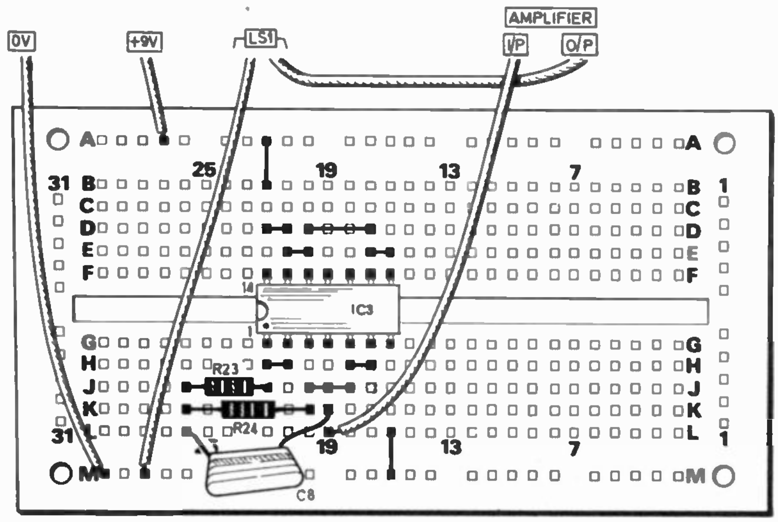


Fig. 10.4. The circuit of Fig. 10.3 wired up on the Verobloc.

Similarly, if we measure the potential at any point in the *LC* circuit and plot it against time, we obtain a sinewave.

Harmonic oscillators are therefore very useful for making pure sinewaves.

LC OSCILLATOR

The Hartley Oscillator (Fig. 10.7) has an *LC* oscillator (C1, L1) in its collector circuit. The base potential is held very steady by C8. The *LC* circuit oscillates at its natural frequency and needs to be supplied with energy to maintain these oscillations.

The coil L1 is tapped a short distance from one end. The p.d. across this portion alternates in step with the oscillations. This alternating signal is fed back through the coupling capacitor C9 to the emitter of TR4. The signal alters the base-emitter p.d., and hence controls collector current.

Feedback is positive. As C1 is charging, decreasing current through L1 brings reduced potential at C9. This causes emitter potential to fall, increasing the base-emitter potential, so increasing collector current. The p.d. across the oscillator is increased and additional charge is given to C1. This replaces energy being lost from the oscillator. Output is taken from this circuit by a second coil L2 wound on the same former.

EXPERIMENT 10.2
Hartley Oscillator

Fig. 10.8 shows how to assemble the oscillator on *Minilab*.

To wind L1, first prepare a paper collar for the ferrite rod as you did for last month's radio circuit. Wind 20 close turns of 28 s.w.g. enamelled copper wire over the collar.

At this point scrape the enamel from 5mm of the wire and firmly twist the bare end of a short length of wire around this region. This is the "tap". Continue winding the coil to make 80 turns in all. The output coil L2 is not needed, for we can detect the output by other means.

EXPERIMENT 10.2

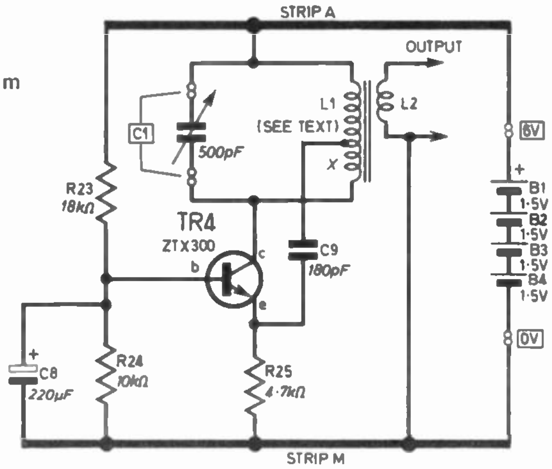


Fig. 10.7. The circuit diagram of a Hartley oscillator.

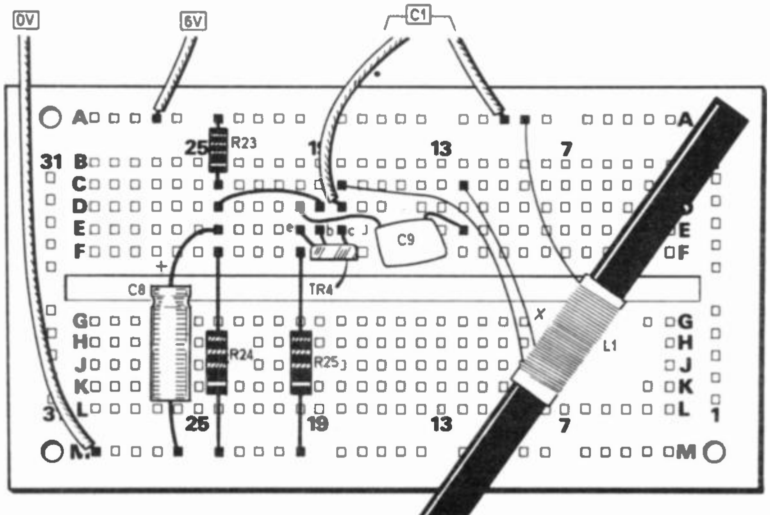


Fig. 10.8. The layout of the components on the Verobloc for the circuit of Fig. 10.7.

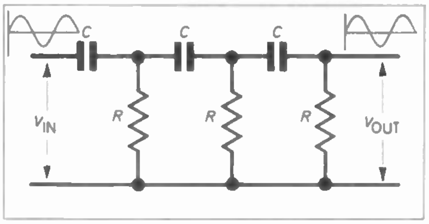


Fig. 10.9. A phase-shift network made up from three high pass filters connected in series.

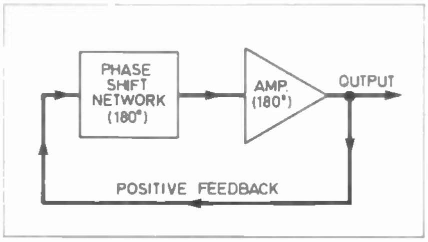


Fig. 10.10. Principle of a phase-shift oscillator.

Connect the battery. Set C1 to about the middle of its range. Now place a radio set beside the oscillator. Tune it to the medium waveband where no station is being received. You will hear a loud rushing sound which stops when you disconnect the battery from the oscillator.

Capacitance is only about 250pF and inductance is only a few millihenries, so the frequency of the oscillator is high.

The frequency of oscillation depends on the values of C1 and L1. The frequency of one oscillator built in this way was tested by winding L2 (20 turns) and connecting it to an oscilloscope. The frequency was 500kHz, which is well into the radio frequency band.

Naturally you cannot hear such a high frequency with the radio set, but it reacts with the radio circuits producing interference frequencies in the audible range. The radio set merely indicates that something is happening!

COLPITT OSCILLATOR

The Colpitt Oscillator works in a manner very similar to the Hartley oscillator. Instead of a tap on the coil, there are two capacitors in series in the oscillating circuit. Feedback is taken from the junction between these. In effect, the capacitative side of the oscillator is being tapped.

Once again use is made of positive feedback to maintain the energy level in the oscillating circuit.

PHASE SHIFT OSCILLATOR

Fig. 10.9 shows three high-pass filters in series. These constitute a high-pass filter with very sharp cut-off. Each filter causes some slight shift of phase between input and output signals.

For sinewave signals of one particular frequency the total phase shift is exactly 180 degrees. Input and output are exactly *out of phase*. The output has the same frequency as the input, but when V_{IN} is increasing V_{OUT} is decreasing, and the other way about.

In Fig. 10.10 we see how this network is used in a phase-shift oscillator. Part of the output signal is fed back to the phase shift network. It passes through the network and enters the amplifier. This is an inverting amplifier, which shifts phase by another 180 degrees. Total phase shift of the loop is 180 degrees + 180 degrees = 360 degrees. In other words, the output signal is *in phase* with the signal originally fed back from the output.

Oscillations of precisely the right frequency produces positive feedback. The circuit steadily oscillates at that frequency.

An oscillator of this type was used last month to generate sinewaves for the experiments on filters. The amplifier was a Darlington pair, which gives 180 degrees phase shift.

If output is tending to swing more widely than it should, this makes the average current through VR3 and LP1 higher than normal. The filament is heated above its normal temperature and its resistance increases. An increased resistance in this section of the potential divider causes a rise of potential at the inverting input, resulting in a reduction in output level.

If output is lower than it should be, the reverse applies and output is increased.

EXPERIMENT 10.3
Wein Bridge Oscillator

Fig. 10.13 shows how to set out the components. The output from IC3 has enough amplitude, but by connecting a loudspeaker to it the operation of the oscillator is upset. For minimum effect on the oscillator we use an amplifier with very high input impedance. This is a good demonstration of the use of a **source-follower amplifier.**

This is similar in principle to the emitter follower amplifier described in Part 7 (Fig. 7.2). The source follower uses an f.e.t. and, as we are using a VMOS f.e.t. (TR4), its input impedance is virtually infinite.

As with the emitter follower, gain is approximately unity (actually about 0·9) but, since the original signal already has sufficient amplitude, there is no need for further increase. The potential at the source follows the oscillations of the amplifier and

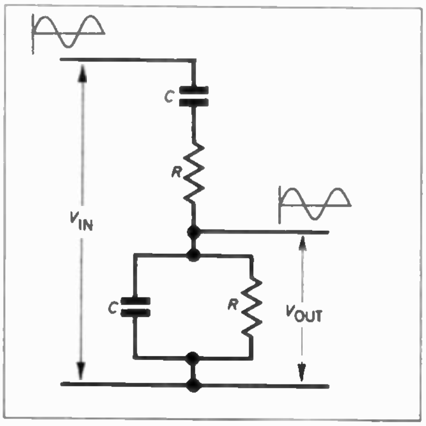


Fig. 10.11. A Wien bridge network.

WEIN BRIDGE OSCILLATOR

The Wien Bridge Oscillator is based on a different design of filter than those discussed so far (Fig. 10.11). For a sine wave of the correct frequency, this network has zero phase shift. Input and output signals are exactly in phase. In addition, V_{OUT} is exactly one third of V_{IN}. To use this network in an oscillator, we need an amplifier with a gain of at least ×3, and with zero phase shift.

Fig. 10.12 shows how an op amp may be used. Output from an op amp is always in phase with signals at the non-inverting input. The output from the network is fed to this input, giving positive feedback.

It is essential that the gain of the amplifier is carefully controlled. If it is more than ×3, positive feedback causes it to oscillate with ever increasing amplitude until the output is swinging violently to +6V and −6V, giving a clipped waveform or even an almost square wave. If gain is less than ×3, the oscillations gradually die out.

Gain is controlled by the negative feedback resistor VR3, which can be adjusted as required. Since gain is to be low, VR3 has a low value.

Gain is stabilised in an unusual way. VR3 and the filament of the lamp LP1 form a potential divider between output and the 0V rail.

EXPERIMENT 10.3

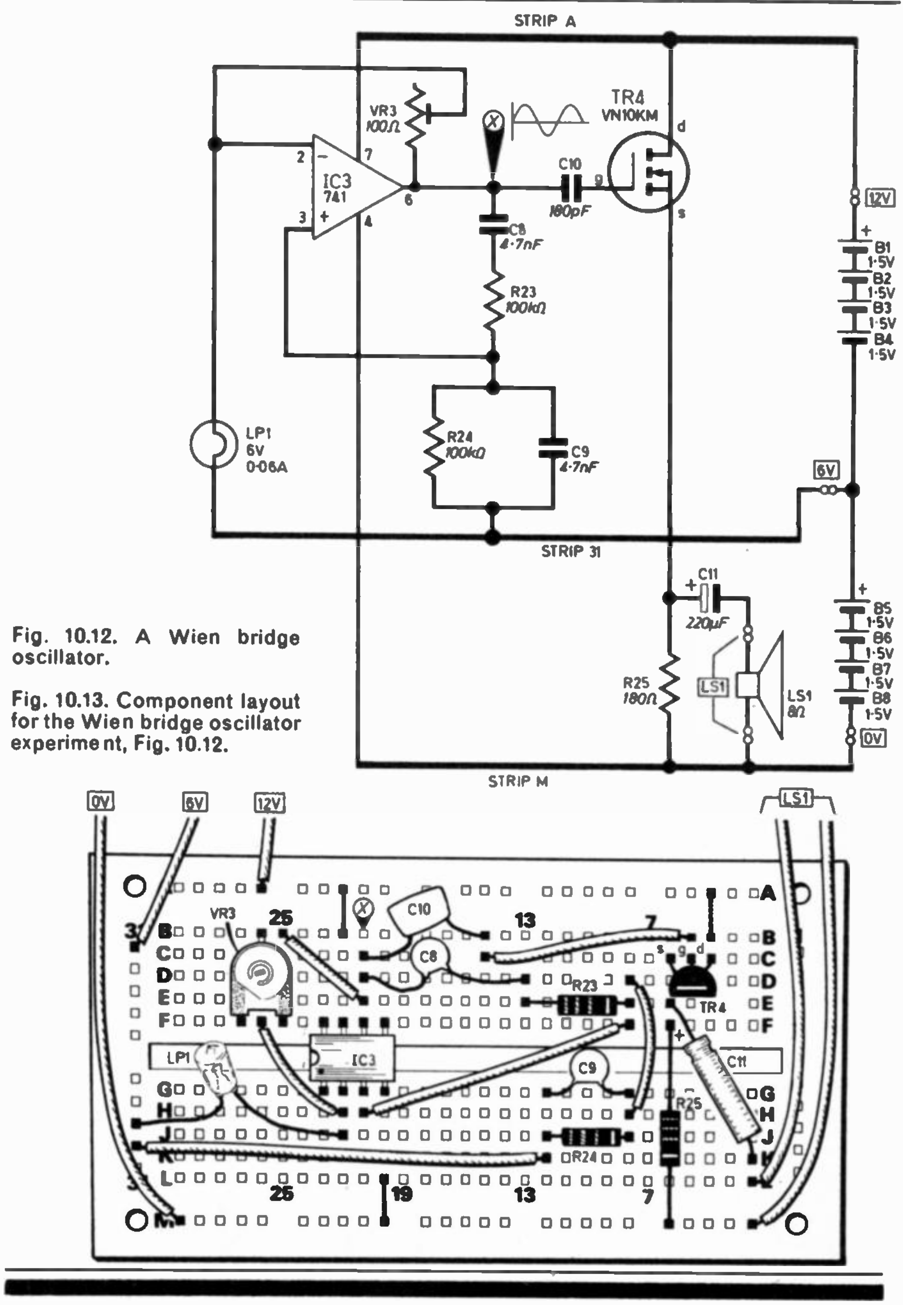


Fig. 10.12. A Wien bridge oscillator.

Fig. 10.13. Component layout for the Wien bridge oscillator experiment, Fig. 10.12.

QUESTION TIME

10.1. What type of oscillator is needed to produce a sine-wave?
10.2. What kinds of waveform can be obtained from a u.j.t. oscillator?
10.3. What is the advantage of a crystal oscillator?
10.4. Name a radio frequency oscillator?
10.5. How much is the gain of the amplifier in a Wein bridge oscillator?
10.6. What type of feedback is needed to keep a harmonic oscillator running?

is coupled to the loudspeaker circuit though C11.

For the reasons given in the previous section, VR3 must be carefully set. When the right position is found a loud note at about 340Hz will be heard. This has a much smoother sound than the harsh square waves we have heard before. It is a pure sine wave.

If C8 = C9 = C and R23 = R24 = R, the frequency $f = 1/2\pi RC$. Try other values for R23 and R24 (10kΩ, 1MΩ) and for C8 and C9 (0·1μF). With some combinations, f is below audio frequency.

With 1MΩ and 0·1μF, f = 1·6Hz. To observe this, remove C11 and connect the voltmeter (10V f.s.d.) to the −6V rail and to the source of TR1 (sockets *M6* (+ve) and *E6* (−ve). The needle oscillates steadily around 6V.

To be continued

Answers to Part 9

9.1. At the start.
9.2. At the start.
9.3. The product of the resistance and the capacitance.
9.4. 0·33 seconds.
9.5. 37 per cent of 12V = 4·44V.
9.6. A quarter.
9.7. 1693 at 200Hz; 1·69 at 200MHz.
9.8. 106kHz.

By Dave Barrington

Catalogues Received

We have just received the latest edition of the TK Electronics shortform catalogue.

This new 20-page edition contains over 100 new items and all components under the memories and microprocessor sections have been reduced in price. As well as popular components, the catalogue also carries goods that have sometimes proved difficult to locate, such as ultrasonic transducers and remote control devices.

Among the kits listed is an excellent selection of infra-red controllers for many applications, including a programmable receiver. Also available are a range of home lighting kits which includes a touch dimmer that can also be controlled remotely by an infra-red transmitter.

Now available from Verospeed is the fourteenth edition of the company's comprehensive components catalogue, featuring more than 300 new product lines. In total, it covers some 2500 products from over 50 suppliers.

New items in the latest edition include an ultra-miniature range of digital panel meters and a selection of dry-reed and mercury-wetted relays. Other products featured for the first time are a static-safe work station kit, range of analogue panel meters, Zeners and CMOS integrated circuits from Motorola and a range of "flat-pack" cases.

Valid until the end of August, copies of the Verospeed components catalogue can be obtained from Verospeed, Dept EE, Stansted Road, Boyatt Wood, Eastleigh, Hants, SO5 4ZY.

If ever a title was a true reflection of its contents then the latest Ambit International's component catalogue "The World of Radio & Electronics" says it all.—Many's the time they have "saved our bacon" for those hard to locate devices.

This third edition contains 96 pages covering the whole gambit of components from coils to radio receivers and draughting aids to microprocessor development systems. Each page carries the goods price, less VAT, and is valid for the currency of the catalogue.

Available from newsagents or direct from Ambit for the sum of 70p, the catalogue contains three £1 redeemable vouchers. These are valid until July 31 and may be used with each order totalling £15, excluding VAT.

Pastures New

London's loss is Glasgow's gain, with the announcement from Marshalls that they have closed their head office at Kingsgate House, London, and moved all their business transactions, mail order and industrial sales, to their Glasgow operation at 85 West Regent Street.

Running the business since her late husband died has been quite a task for Mrs June Marshall, especially so since she remarried. Therefore, unable to devote as much time in the business, Marshalls have disposed of their Bristol and London retail outlets to their respective managers.

In charge of the Glasgow operation is Gavin Briggs, nephew of the late Alex Marshall, and he will be pleased to hear from all Marshalls customers. Gavin informed us that he now considers that the Regent Street set-up holds the largest stock and widest range of electronic components and accessories in Scotland.

CONSTRUCTIONAL PROJECTS

Reflex Tester

Although the components list for the *Reflex Tester* calls for a miniature single-pole single-throw (s.p.s.t.) slide switch, the double-pole versions are more commonly stocked and can be used here. However, the single-pole miniature type is certainly stocked by TK Electronics and also available through most Tandy stores.

The "Start" switch S3 used in the model was part of a non-latching 2-pole, 2 way switch block. Any 2-pole changeover momentary action push switch can be used.

Model Car Lap Counter & Judge

The only source of supply we have been able to trace for the 40110 CMOS decade counter/driver used in the *Model Car Lap Counter & Judge* is Maplin and Watford Electronics.

The only stockist we have found for the specified 2-digit, common cathode, display is Maplin. Indeed, they list all the components for this project (except p.c.b.), including common anode tri-colour l.e.d.; stock no. YY61R.

Brake Light Relay

The dry-reed switch used in the *Brake Light Relay* is a RS Components device. It is listed as type 6-RSR-A, stock number 338-147, and should be available from any RS supplier.

Public Address System

The *Power Amplifier* output transformer T1 is the same as the mains transformer T2, except that it has a centre-tapped primary. Both transformers are obtainable from ILP Electronics Ltd., Dept EE, Graham Bell House, Roper Close, Canterbury, Kent. Quote the two type numbers given in the components list last month.

The meter ME1 is obtainable from Maplin Electronic Supplies.

Two-way intercom

The terminal blocks used in the *Two-Way Intercom* should be 2A types with 8mm spacing between "ways". This is so that they may be placed directly on the template drawing.

Electronic Pitch Pipe

The case used in our prototype for the *Electronic Pitch Pipe* was from an old discarded radio set.

The components are rather crowded in this size of case and we suggest that a larger one be used. This can be any plastics case with suitable dimensions.

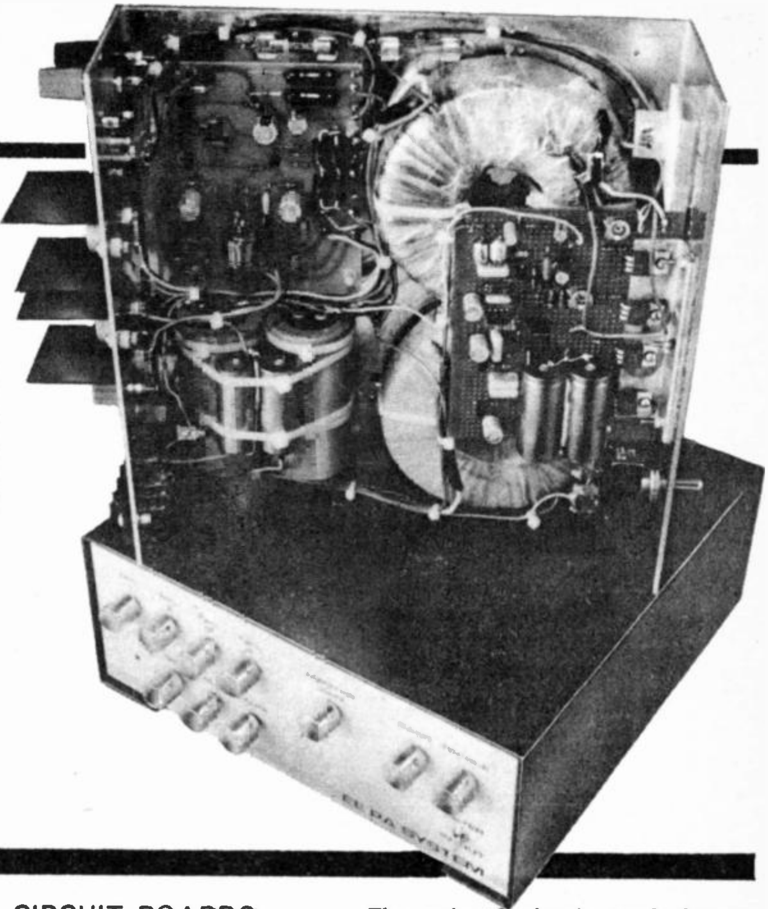
Comparator Voltmeter

When ordering components for the *Comparator Voltmeter* be sure to specify a wirewound type for the calibration control VR1. This component is stocked by most component suppliers and should not cause any problems.

PUBLIC ADDRESS SYSTEM

PART 3

By E.A.Rule



THIS month's article deals with the construction of the power amplifier. The circuit diagram, technical description and components list for this unit were given in Part 2.

METALWORK

The chassis is made in a similar fashion to the control unit chassis and the general remarks concerning the material to be used and the drilling and bending operations given in Part 2 should be referred to.

Drilling and bending details are given in Fig. 3.1.

As with the control unit, the cover for the power amplifier is made after the chassis has been completed, when the actual dimensions required can be ascertained by measuring the completed chassis. Refer to Fig. 2.4 for overall form of the case.

HEAT SINKS AND BRACKET

The two heat sinks are made from aluminium as shown in Fig. 3·2. It is very important that the middle section which is for mounting the transistors is *completely* free from burrs and also *flat*. File the front and rear surfaces with a suitable flat file to ensure freedom from "bumps" or indentations.

When completed these heat sinks should be painted matt black.

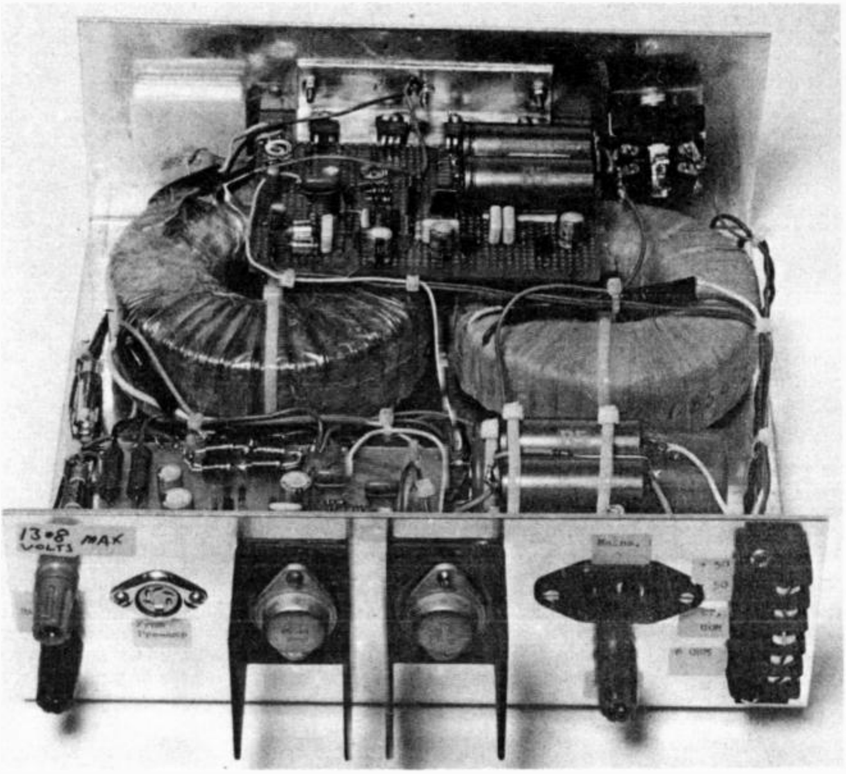
The mounting bracket for the invertor Darlington transistors is shown in Fig. 3.3a and, again, the surfaces should be free from burrs and any "bumps".

PRINTED CIRCUIT BOARDS

There are two printed circuit boards in the power amplifier unit: (1) the main (power amplifier) p.c.b. and (2) the inverter p.c.b.

The printed circuit track layouts are shown in Fig. 3.4 and Fig. 3.6 and the component layouts in Fig. 3.5 and Fig. 3.7, respectively.

Completed power amplifier viewed from rear. Note method of securing transformers and electrolytic capacitors with plastic cable ties.



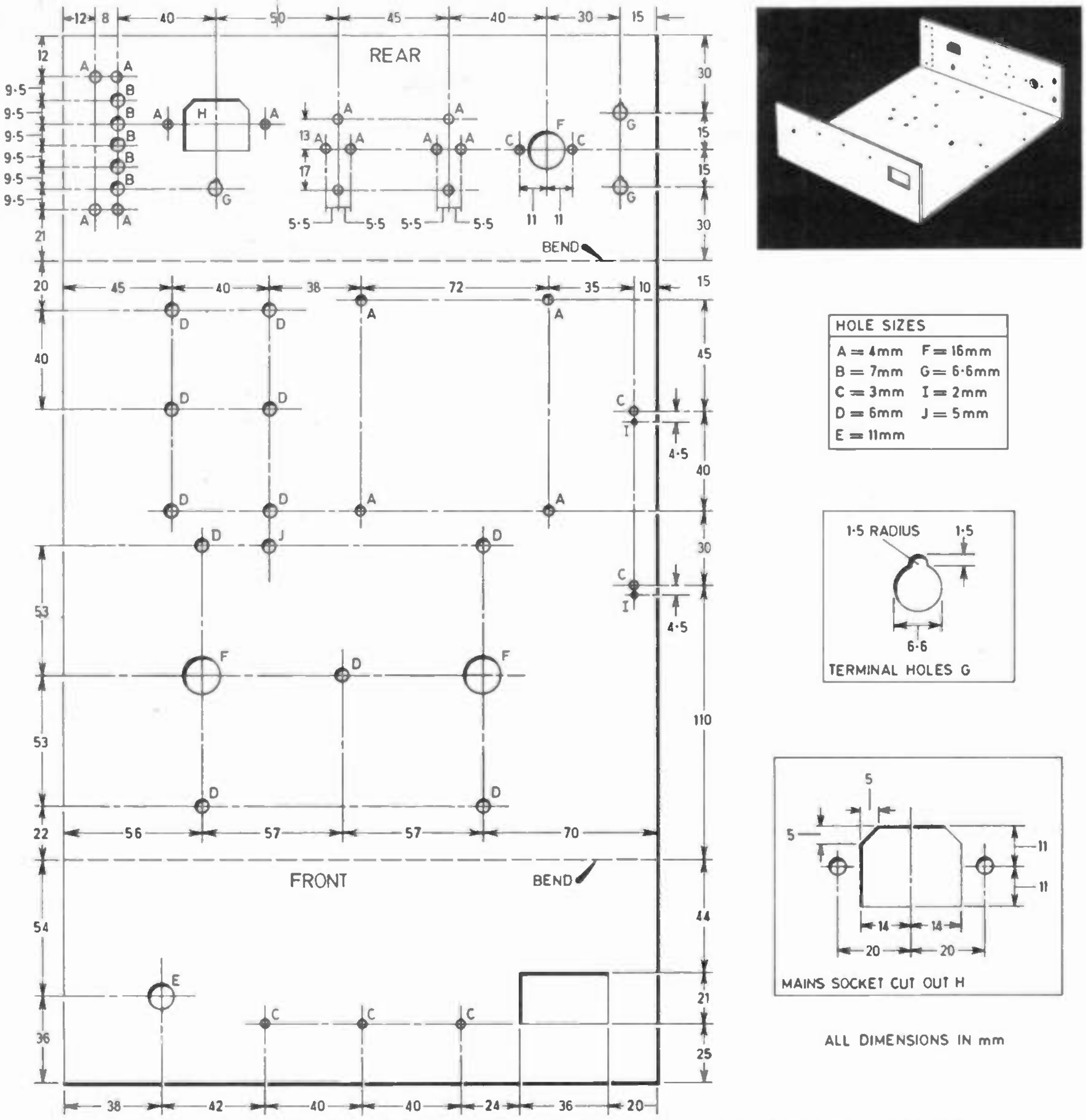


Fig. 3.1. Public Address System: Power Amplifier chassis drilling and bending details.

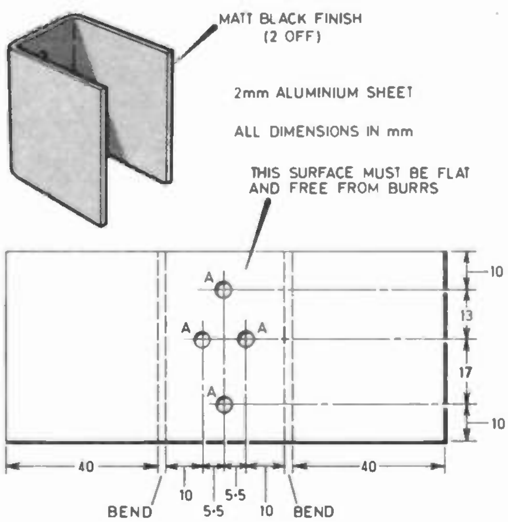


Fig. 3.2. Heat sink constructional details.

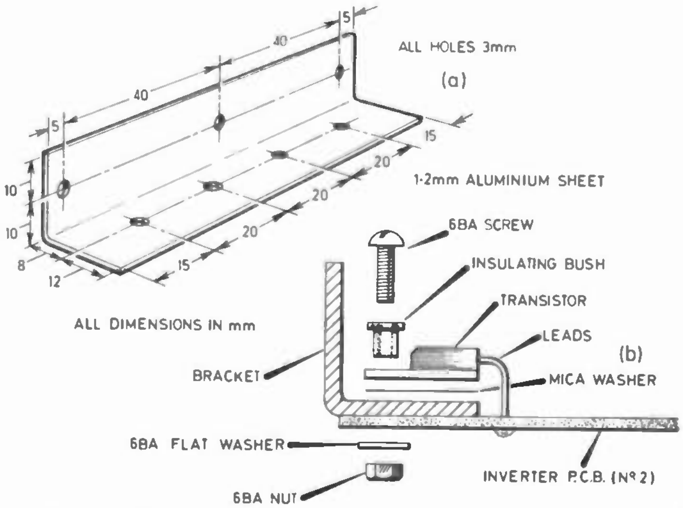


Fig. 3.3. Mounting bracket for inverter p.c.b. (a) constructional details (b) cross section showing method of mounting the Darlington transistors which also provides the means for securing bracket to board.

MAIN AMPLIFIER BOARD (PCB1)

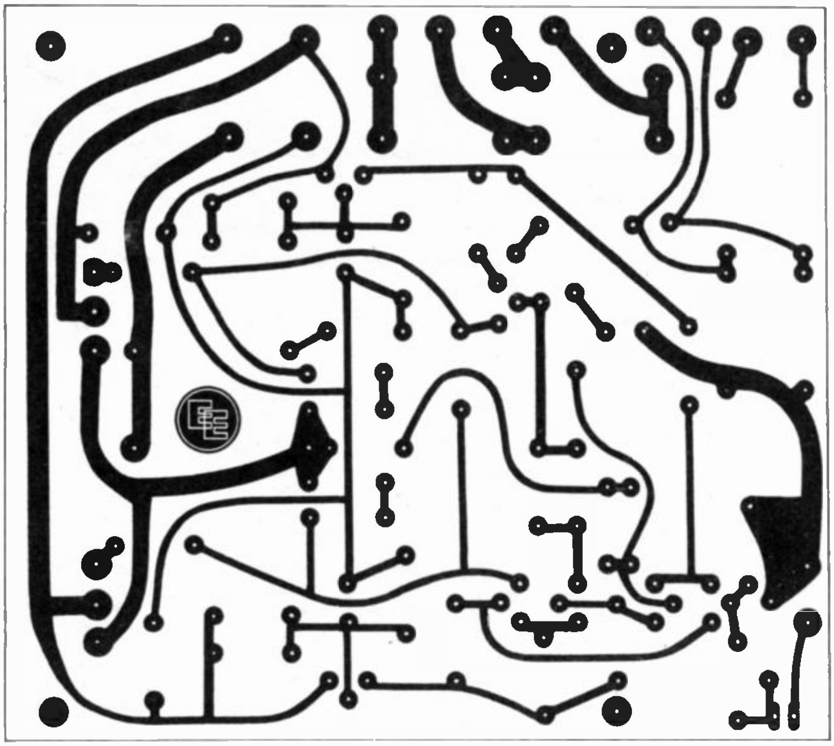


Fig. 3.4. Public Address System: Power Amplifier printed circuit board No. 1 (Main Board), actual size. *NOTE:* One side of C13 goes to terminal pin 14 (0V line), not to 12 (−42·5V line) as shown on circuit diagram.

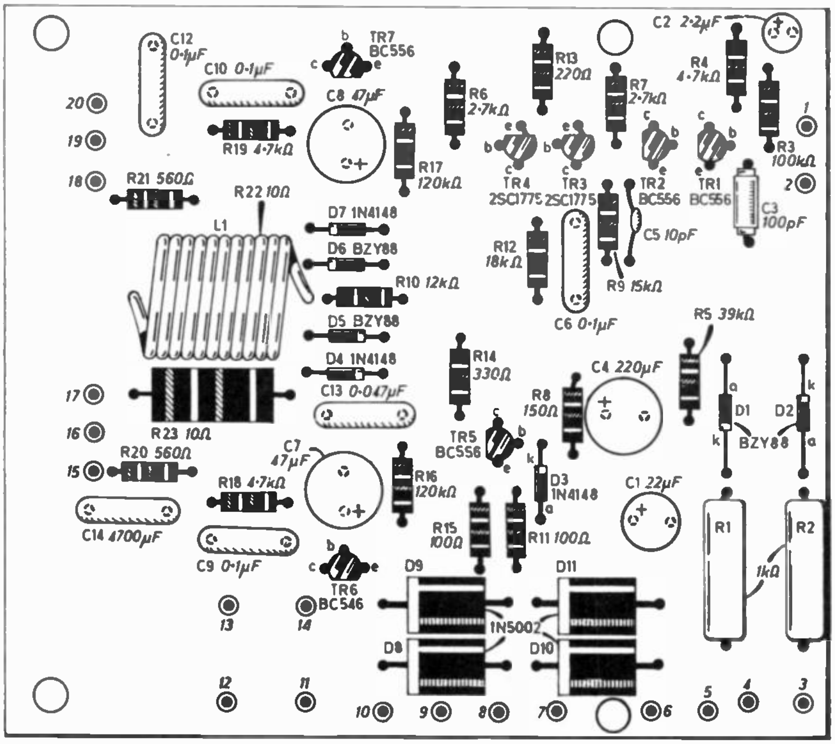


Fig. 3.5. Public Address System: Power Amplifier printed circuit board No. 1 (Main Board), topside with components in position.

L1 COIL ASSEMBLY

Before assembling the power amplifier p.c.b., the coil assembly shown in Fig. 3.8 should be constructed; it consists of L1 and R22 shown on the circuit diagram.

The coil is wound with 30 turns of 18s.w.g. enamelled wire with three layers of windings. The first has 11 turns, the second has 10 and the third has 9. Between each layer is a layer of masking tape and this will help to keep the turns in place while winding. The internal diameter of the first layer is 8mm.

After winding, the 10 ohm 2 watt resistor is fitted inside and soldered as shown. The finished ends are then "pre-formed" to 22·5mm centres to fit the p.c.b. It will be necessary to scrape the enamel insulation from the 18s.w.g. wire before soldering.

P.C.B. ASSEMBLY

Assembly of the printed circuit boards should start with the terminal pins which are inserted from the track side of the p.c.b. and lightly

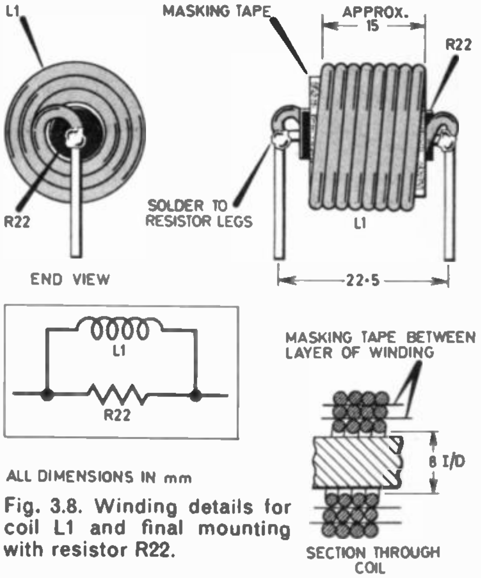


Fig. 3.8. Winding details for coil L1 and final mounting with resistor R22.

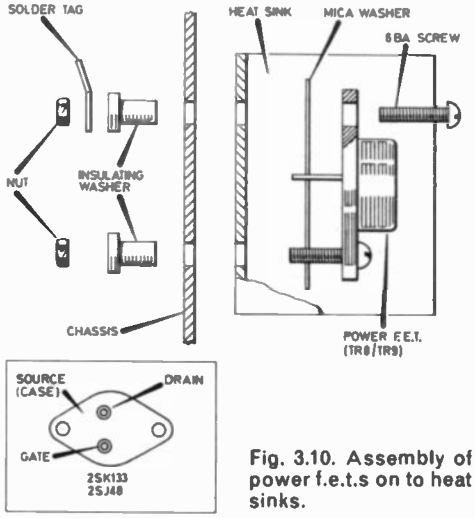


Fig. 3.10. Assembly of power f.e.t.s on to heat sinks.

hammered into place so that they are a firm fit but not overtight. The pins are then soldered into place. The p.c.b. should be supported from behind to avoid damage to the board.

After the pins are in place the suggested order of assembly is resistors, small capacitors, transistors, then electrolytics. In other words, the smaller components first, as this will enable the components to be inserted and the p.c.b. turned over onto a foam pad which will hold the components in place while they are soldered in.

Be very careful to mount all electrolytics and semiconductors the correct way round as indicated on the p.c.b. overlay; in particular watch the polarity of diodes and the position of pin 1 on the IC1. A socket may be used for the i.c. as this will be an aid to rapid servicing in the field in the event of failure.

A number of components may need to be pre-formed and details of these are given in Fig. 3.9. Pay special attention to the leads of transistors type 2SC1775e.

WINDING DATA FOR L1

Inside diameter	8mm
Length	15mm
Windings	3 layers of 11, 10 and 9 turns (30 total)
Outside diameter	18mm approx.
Wire	18 s.w.g. enamel covered copper
R22	10Ω 2W carbon resistor

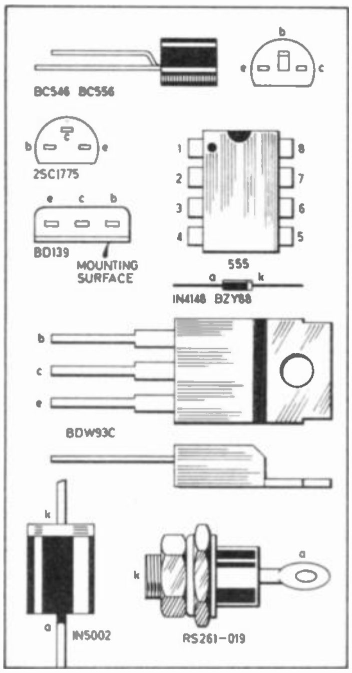


Fig. 3.9. Details of semiconductors used in power amplifier (for power f.e.t.s see Fig. 3.10).

INVERTER BOARD (PCB2)

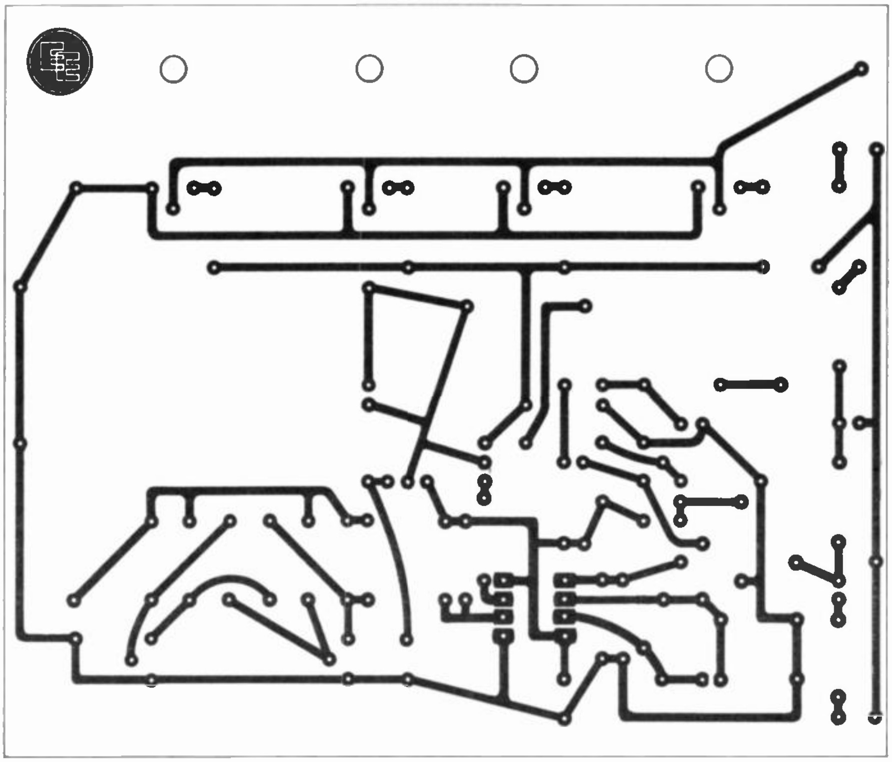
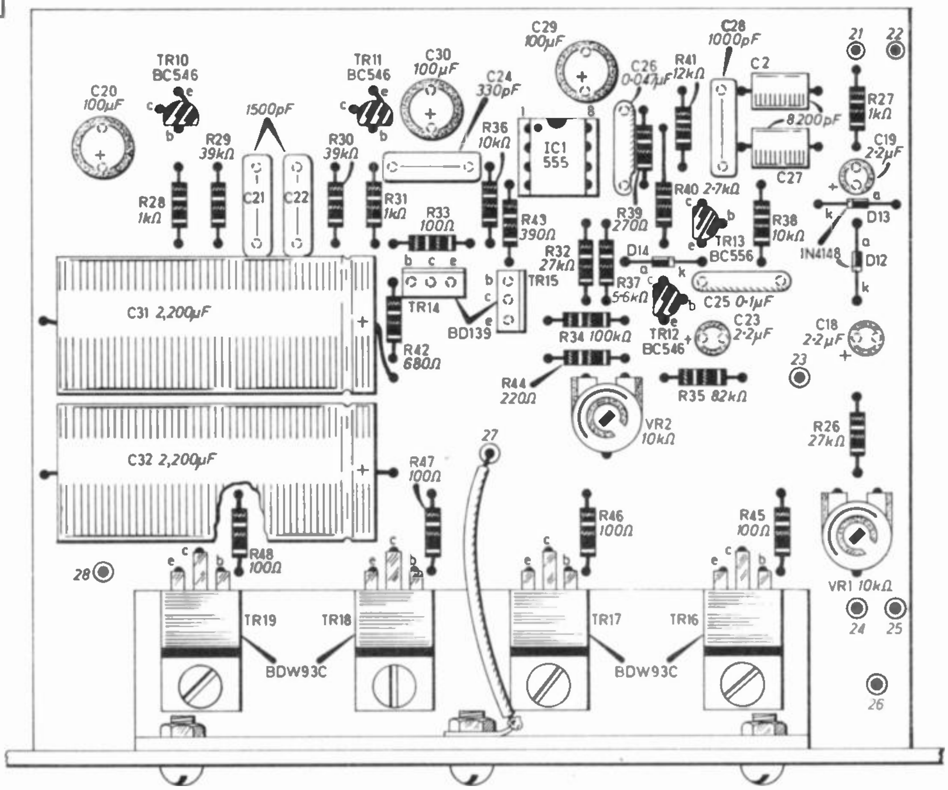


Fig. 3.6. Public Address System: Power Amplifier printed circuit board No. 2 (Inverter Board), actual size.

Fig. 3.7. Public Address System: Power Amplifier printed circuit board No. 2 (Inverter Board), topside with components in position.



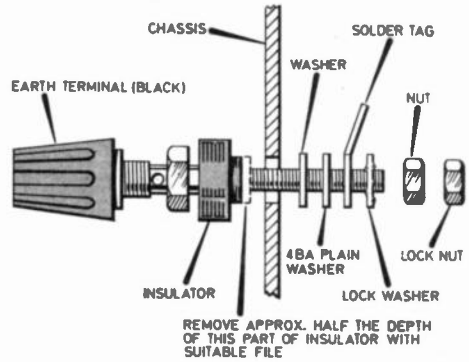


Fig. 3.11 Modification required to Earth terminal X1 (black).

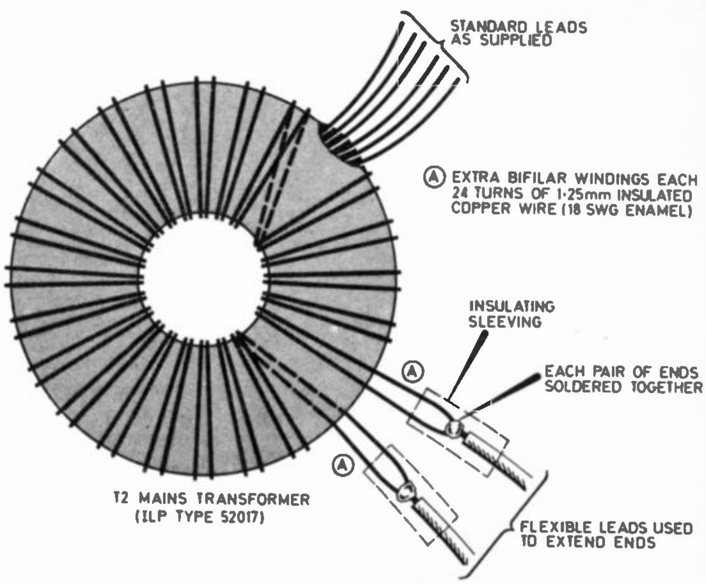


Fig. 3.12 (right). Modified transformer T2. Two additional windings each of 24 turns are wound side by side (bifilar) over the normal transformer core as shown. See text.

GENERAL ASSEMBLY

Once the printed circuit boards have been assembled and carefully checked for good soldering and absence of solder "bridges" between tracks and components the general assembly can be started.

Fig. 3.10 shows how the power f.e.t.s are assembled onto the heat sinks. It is important that the insulating bushes used are the Hitachi type as these are longer than the more common types and will be long enough to come through both chassis and heat sink thickness; the more common shorter type will only come through the heat sink and may permit the screws to touch the metal chassis, causing a short circuit. This point may be checked out by an ohm meter.

The earth terminal is modified and assembled as shown in Fig. 3.11.

MODIFIED MAINS TRANSFORMER

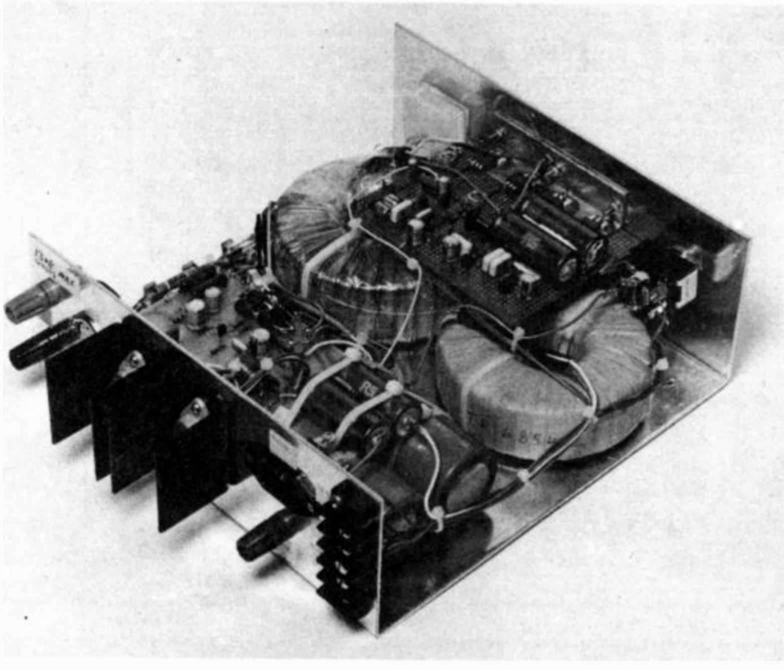
Two transformers are required if the full unit is being constructed: one for the line output and one for normal mains power supply. These are basically the same type of transformer: ILP type 5X017; which is the 160 VA type with a 30 volt plus 30 volt secondary. For the T1 line output order with a centre tapped 240 volt mains winding, ILP type 53017.

The transformer used for the power supply (T2) ILP type 52017 will need an extra winding if the battery powered version is being constructed. This extra winding is wound by the constructor as is not difficult to do. Full details are shown in Fig 3.12.

Two windings are wound side by side (bifilar) each of 24 turns. These are wound with 18s.w.g. enamel insulated wire and the ends joined as shown. (The number of turns required is based on the ILP design and may not be suitable for other makes using a different turns/volt ratios).

The length of wire for each winding (before winding) is approximately 4 metres including ends. This should be measured off and any kinks removed before winding. The two windings should be wound evenly around the core as shown and care should be taken to avoid the wires "crossing over" each other.

After winding a layer of insulating tape should be wound over the winding to hold it in place and insulate it from contact with the chassis when mounted into position.



FINAL WIRING

The final wiring layout is shown in Fig. 3.13. All wiring for the battery power supply and power f.e.t.s as well as the 8 ohm output should be done with at least 16/0·2mm (0·5mm²) conductors and preferably 32/0·2mm (1·00mm²) if possible. Currents as high as 12 amps can flow in these leads and the thicker wire will avoid voltage drop and power losses.

The remainder of the wiring can be carried out with 7/0·2mm p.v.c. covered equipment wire. These wires are available in many colours and different ones can be used as an aid to circuit identification.

Although the wiring layout is not critical in itself, the actual point of connections is, and these must be followed carefully.

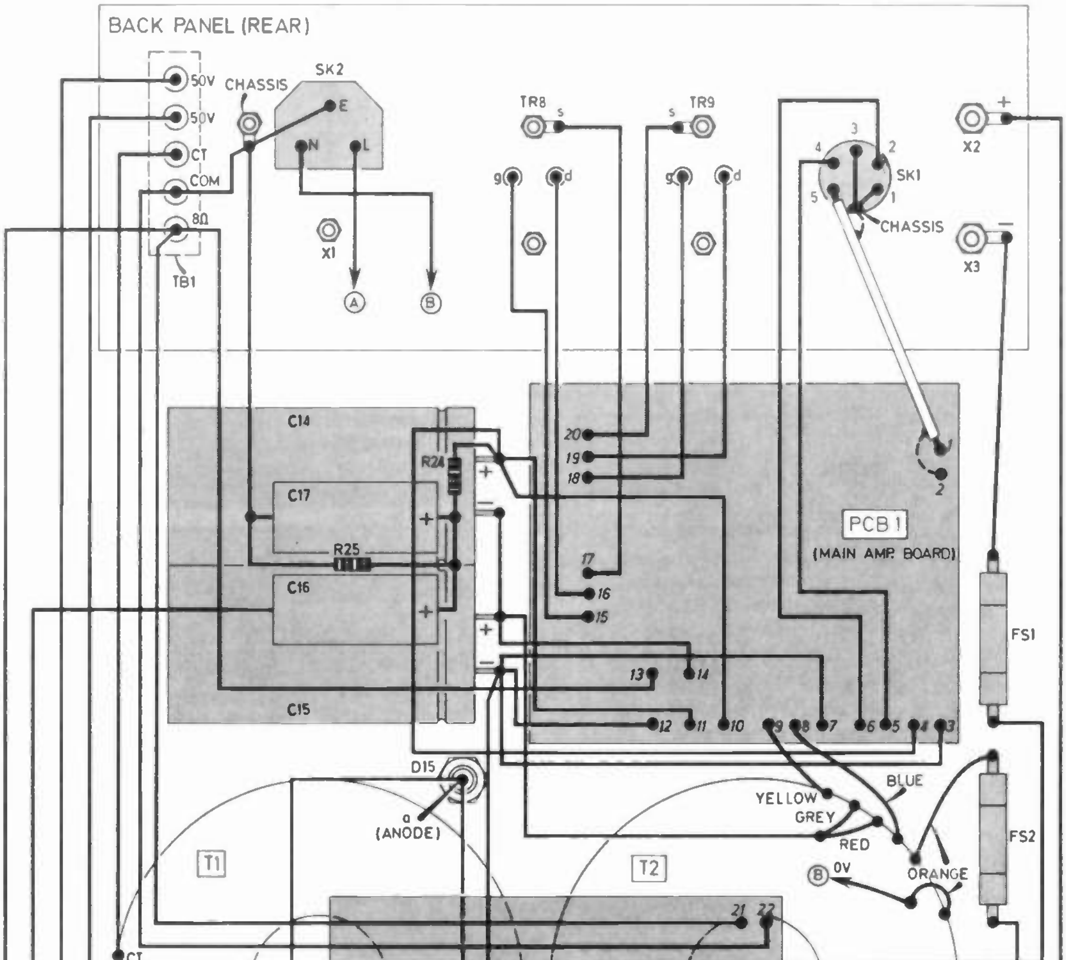


Fig. 3.13. Public Address System: Power Amplifier final assembly and wiring details.

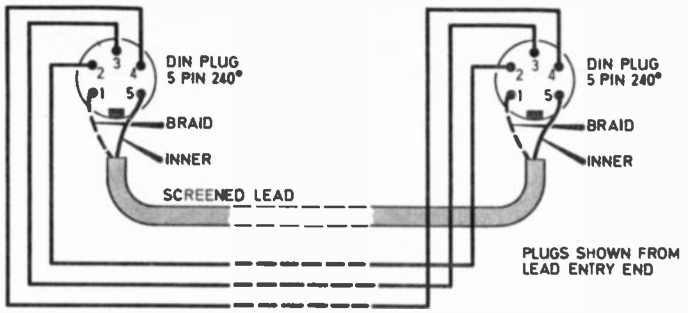


Fig. 3.14. Public Address System: Interconnecting lead.

Failure to follow as shown will result in increased background noise and/or distortion. This is particularly important with regard to the power supply circuits and the method shown for inter-connecting the two 4,700μF capacitors to the other parts of the circuit must repeat MUST be followed.

Do not be tempted to simply link (*for example*) terminal pins 3 to 7 to 12 to C15 thinking it will save wire and time, because it will greatly increase hum, noise, and distortion if you do.

With high power and sensitive inputs the actual method of wiring interconnections is vital to obtaining the full specification which the amplifier is capable.

The technical reason for making C15 the common point (in our example) is because the capacitor acts as the lowest impedance path to earth for *all* signals flowing in the supply line. At the high peak currents involved in power amplifier and battery supply circuits it only takes a fraction of a ohm impedance common to two circuits to inject considerable amounts of unwanted signal into one of the circuits from the other one.

At the output from the bridge rectifier there would be a high ripple voltage and current present. Now, if the supply lead was taken direct from pin 12 to the early stages, the ripple voltage drop between C15 and pin 12 would be injected straight into these early stages. If we consider that the peak current could be several amps and the impedance of the wire 0·1 ohms we would in practice be injecting several hundreds of millivolts of ripple into the early stages power supply rail.

A similar thing happens with audio signals. By making C15 the actual common point, this unwanted signal is kept to the minimum possible.

CONTROL UNIT—Part 2

Certain matters relating to the Assembly and Wiring (page 396) and Fig. 2·5 (page 398) need some further clarification.

1. Although the wiring layout is not critical in itself, the actual point of connections is, and these must in all cases be in accordance with the diagram Fig. 2·5.

2. Note that some screened leads do not have the braiding connected at both ends but only at *one* end and this is important. Where the two screened leads join behind the potentiometers the braiding must *NOT* be allowed to touch the chassis or rear metal case of the potentiometer. Note the way any earthing is carried out on input and power sockets and follow exactly.

The performance of the equipment may be impaired if these instructions are not adhered to.

COMPONENT FIXING

The two transformers* and the large electrolytics are held in position with large type plastic cable ties. Small type cable ties are used for holding cable runs. The RS types 543-428 and 547-717 respectively will be found suitable. C14 and C15 are held with additional ties once C16, C17 have been fitted.

Diode D15 will require its surplus stud cut off once mounted

The VU meter ME1 is held in position on the front panel with double sided Cellotape.

The two battery terminals are mounted in a similar way to the earth terminal (Fig. 3.11), but WITHOUT modification.

*The ILP Ltd mounting kit is not used for the transformer fixing, although the foam washer is used between the transformer and chassis.

INTERCONNECTING LEAD

An interconnecting lead is required between the two units to carry the power supply to the control unit and the audio signal to the power amplifier. The wiring details for this lead are shown in Fig. 3.14. As the output impedance of the control unit is reasonably low the lead may be several metres long without loss of high audio frequencies, however in practice it is best to keep it as short as possible. Note that the DIN plugs are 5 pin 240 degree and NOT 180 degree types.

ALTERNATIVE VERSIONS

There are a number of options which the reader may like to consider before starting to construct the amplifier.

1. It may be constructed with an additional socket (5-pin 240 degree DIN) on the power amplifier chassis. This will enable audio signals to be fed into extra slave amplifiers. To do this, move the existing socket higher by 20mm and also drill holes for a second socket with centres 20mm below the first. Wire the new bottom socket as before and link pins number 1 and 5 between the two sockets, (pin 1a to pin 1b; pin 5a to pin 5b). This will put an audio take-off on the top socket to drive another power amplifier. The d.c. power supply leads are NOT wired to the extra socket.

2. If Battery supply operation is not required, the mains transformer will not need the extra winding and only the VU meter section of the inverter p.c.b. need be assembled. The mains toggle switch can be changed for a standard two-position one and both live and neutral leads switch in the normal way. A standard 3 amp rated switch will be suitable. (Note that if battery power is intended the switch must be rated at *15 amps d.c.*

3. The line output transformer T1, C15, R24 can be omitted if 100 volt line operation is not intended. The output at 8 ohms impedance is not effected.

4. The fitting of an "ON" indicator to the power amplifier chassis. A suitable hole to take an extra l.e.d. can be drilled below the on/off switch and an l.e.d. wired with a resistor of 3·3 kilohms 2 watts rating in series, is fitted and wired between pin 11 (+50) and pin 14 (com). The current through the l.e.d. will be approximately 15 milliamps.

SLAVE AMPLIFIERS

Additional amplifiers can be constructed when extra audio power is required. The main power amplifier construction is simply repeated with whatever options are needed. Each amplifier must drive separate load systems as they must not have their outputs commoned in any way. When used with battery supplies a separate battery should be used for each amplifier, if possible, to avoid earth loops in the power supply wiring.

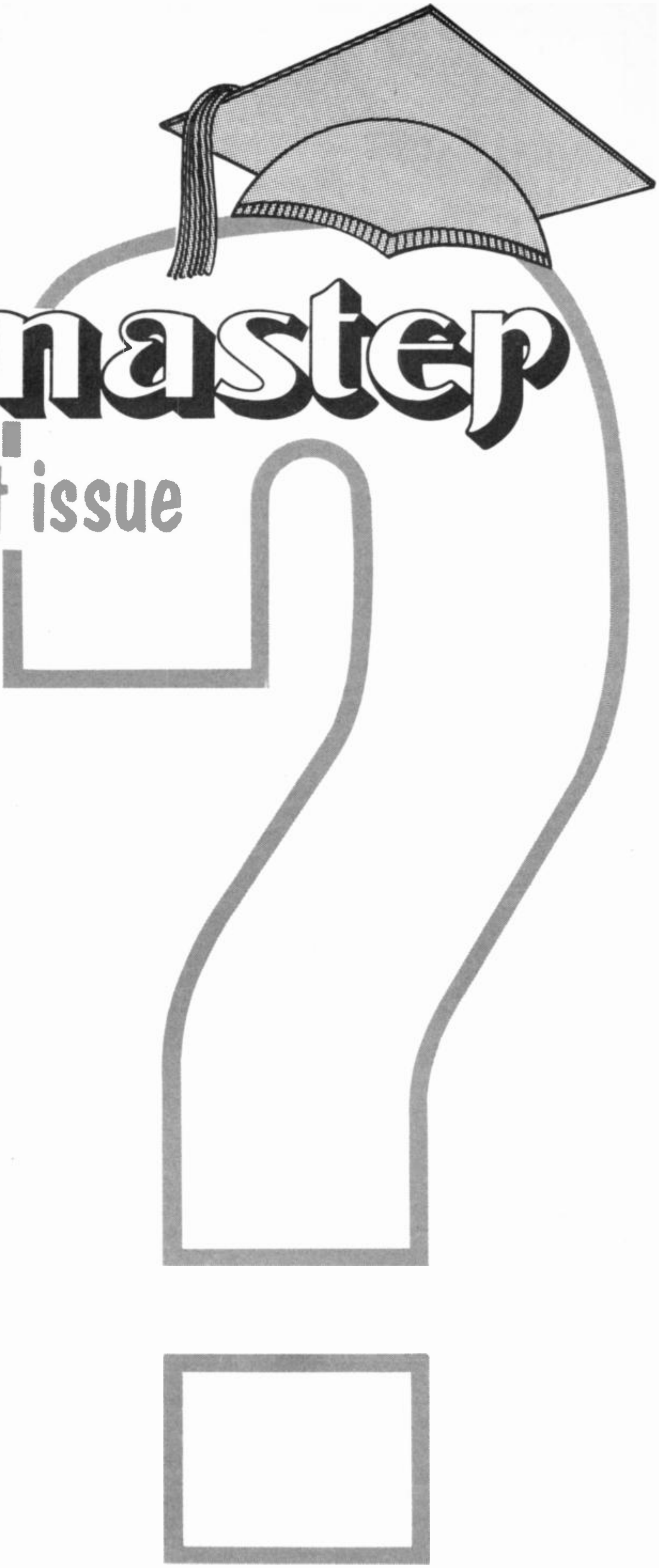
To be concluded next month

Everyday ELECTRONICS

Presents

Quizmaster

in the August issue



"Who was ready to answer first?" No doubt at all if this versatile machine is used during quiz competitions.
A novel form of construction caters for various numbers of teams with various numbers of members.

ROGER BLEEPER

An add-on unit for any citizen's band transceiver without the facility of an audio tone produced at the end of each transmission.

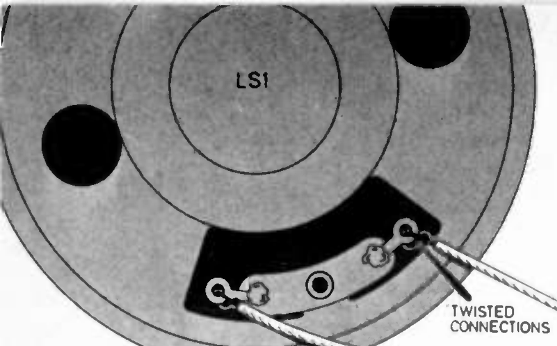
TWO - TONE DOORBELL

A simple and effective unit for the front door. Has other uses wherever a distinctive audible alarm is needed.

Temperature Interface Unit for the Tandy TRS - 80 Microcomputer

Computes and displays on the screen of the TRS-80 Model I Microcomputer, the temperature of a remote sensor. Simply plugs into the expansion port of CPU console.

AUGUST 1982 ISSUE ON SALE FRIDAY, JULY 16



two way

USING THE EE SOLDERLESS TEC

THIS article describes the construction of a simple two-way intercom that has been successfully operated at distances up to 25 metres between base and remote stations. It should also work effectively at double this distance but with reduced volume. It draws its power from a PP3 9V battery.

Other battery voltages may be used up to 16V, which allows operations from a car battery if required. A higher supply voltage leads to an increase in volume thereby extending its range capability.

SIMPLE CONSTRUCTION

The project and its construction technique were developed following a request for a simple, easy to construct project for the novice which did not require any special skills or tools such as those associated with soldering. Also, component cost had to be low.

The choice of screw terminal blocks in the construction allows the unit to be assembled using only a few tools: a screwdriver, a means of stripping the insulation from a wire, and a wire cutter (scissors?), In fact there are screwdrivers available that have a wire stripper built into the handle which could also be used for cutting wire.

CONSTRUCTION starts here

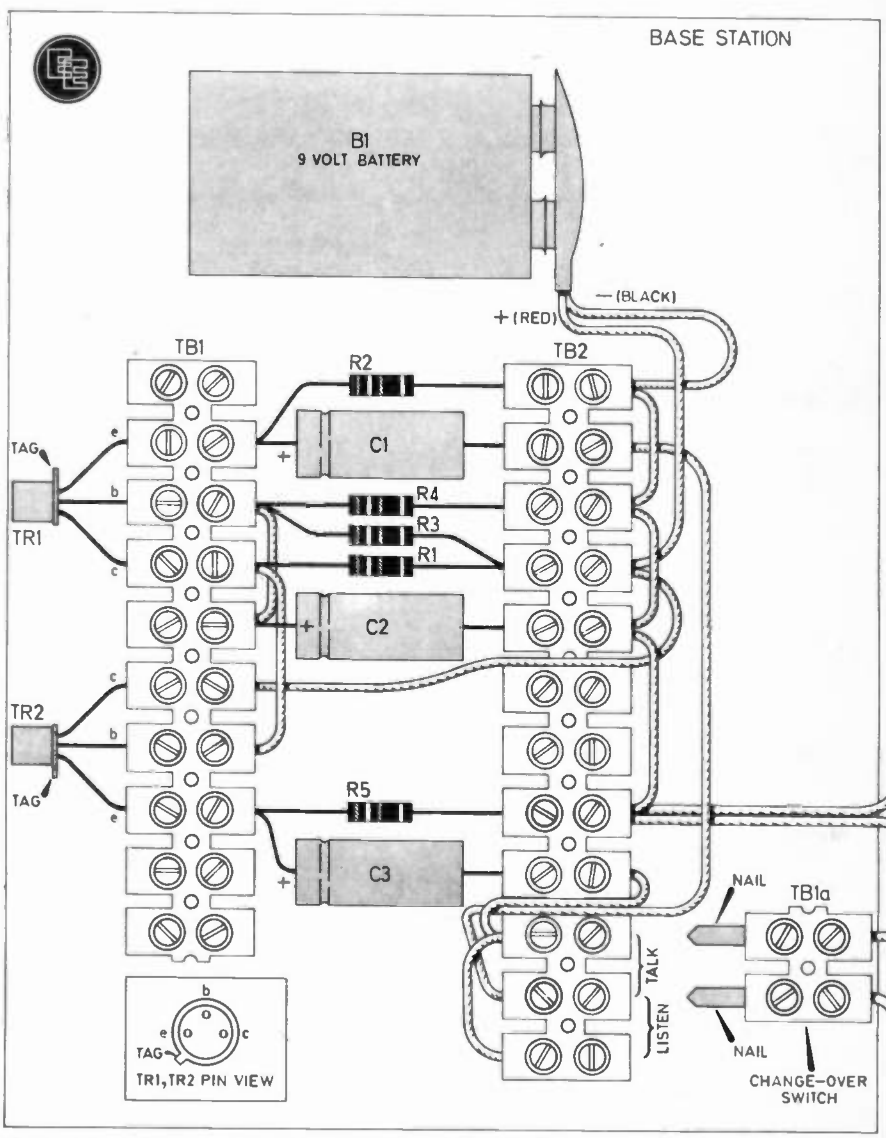


Fig. 1. Actual size layout and interconnection diagram of the Two Way Intercom. This may be used as a template.

COMPONENT IDENTIFICATION

The components are to be interconnected according to Fig. 1. First of all, identify each of the components. The values of the capacitors are printed clearly on the body of the component. Note that these have an indentation around the body at one end. This is the positive (+) terminal and must be connected as shown in Fig. 1.

The resistors have their values printed on the body in the form of a coloured-band code. For those not familiar with this coding system, refer to Fig. 2 for identification details. Resistors may be connected either way round.

INTERCONNECTION TEMPLATE

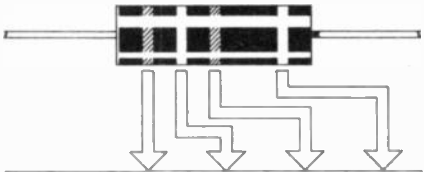
The interconnection diagram, Fig. 1 is drawn actual size which allows it to be used as a template during assembly. First of all, cut off the end two-ways from one of the blocks. This will be used later for constructing the changeover switch.

Place the now 10-way terminal block (TB1) over its position in Fig. 1, and then working from top to bottom, connect the components to TB1 by feeding the component lead(s) into the holes in the brass inserts in

ntercom

AS SEEN ON T.V.*

HNIQUE BY E.M. TERRELL



REF	VALUE	BAND 1	BAND 2	BAND 3	BAND 4
R1	27kΩ	RED	VIOLET	ORANGE	
R2	2·2kΩ	RED	RED	RED	GOLD OR SILVER
R3	150kΩ	BROWN	GREEN	YELLOW	
R4	18kΩ	BROWN	GREY	ORANGE	
R5	1kΩ	BROWN	BLACK	RED	

Fig. 2. Colour code identification of the resistors R1 to R5.

COMPONENTS

See Shop Talk page 455

Resistors
R1 27kΩ
R2 2·2kΩ
R3 150kΩ
R4 18kΩ
R5 1kΩ
All ¼W carbon ±5%

Capacitors
C1, C2, C3 47μF 16V elect. axial leads (3 off)

Semiconductors
TR1, TR2 BC109 silicon *npn* (2 off)

Miscellaneous
B1 9V type PP3
LS1 LS2 miniature 3 inch diameter moving coil speaker (2 off)
TB1, TB2 2A 12-way screw terminal block (2 off)
Equipment wire: stranded insulated 7/0·2mm, 50cm; battery clip with leads for PP3; 2A bell or speaker wire, length as required.

Approx. cost Guidance only £4.50 excluding battery

the block and then tighten the appropriate screw to securely grip the component lead. When all components (not the transistors yet) have been fitted, trim the leads on the other sides of the components so that they are of approximately equal length.

Next form these leads so that they align with the appropriate positions on the other terminal block (TB2) and then manoeuvre this over the component leads and tighten the screws as before. Check all connections before proceeding.

The next step is to connect all the linking wires between the various terminal block positions. Cut the wires to the correct length to comfortably span the positions they are to link, and then remove about 1cm of insulation from each end. Twist each end to form a solid core. Where more than one wire is connected to the same terminal block position, twist together both ends to form one before inserting in to the block. Tighten the screws onto the wires as before to securely grip them, see Fig. 3. Attach the battery clip leads to their positions.

TRANSISTORS

The transistors may be fitted next, but pay particular attention to their orientation for they may be permanently damaged if connected otherwise. Refer to the inset in Fig. 1 which shows details of the BC109 lead-outs. Note that the emitter lead-out is closest to the body tab. Make sure also that none of the leads are touching or in contact with the case of the transistor, for this is internally connected to the collector(c).

Two 25mm long wire nails (with heads cut off) should next be fitted to the remaining terminal block. This arrangement will function as a d.p.d.t. switch and allow communications in both directions.

CONNECTING SPEAKERS

It only remains for the speakers to be wired in before testing. Twin bell wire or speaker wire is ideal. Remove about 1cm of insulation from each of the eight ends, separating the twinning at each end for about 10cm. Twist all the ends as you did with the linking wires. Feed the appropriate bare wire ends through the eyelet connectors on each speaker and twist to form a closed hook tightened on the eyelet. Finally wire the remaining four ends of these wires to the terminal blocks (TB2 and TB1a).

In the prototype intercom, the base station assembly was glued to thick card with the battery held in place with Sellotape. Alternatively it may be housed in a plastics box, with or without its speaker.

* Freetime, Thames Television, Friday, 4th June, 1982, 4.45pm.

Some form of enclosure must be used to house the speakers, for both best results and protection. The cardboard boxes in which the speakers were packed made quite effective enclosures once cut-outs were made.

IN USE

Place TB1a in the TALK position on TB2. Connect the battery. A click will be heard in the remote station speaker. Get someone to speak into the base station speaker, and if you have carried out the assembly correctly, you will hear their message in your speaker when positioned fairly close to your ear.

Now move TB1a to the LISTEN position to allow the person at the base station to receive your message.

As there is only one-way communication at a time, the speaker should, when he/she has finished his/her immediate message sign off with the word "over". "Over and out" would mean the conversation has ended. The base station should normally be left in the LISTEN mode for incoming messages.

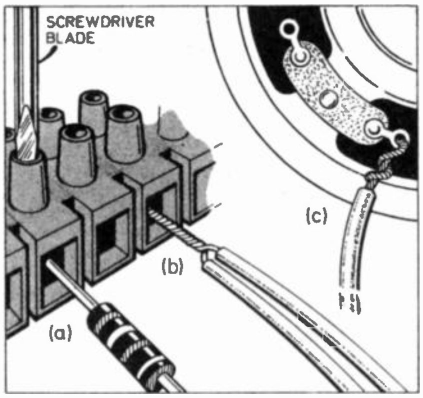
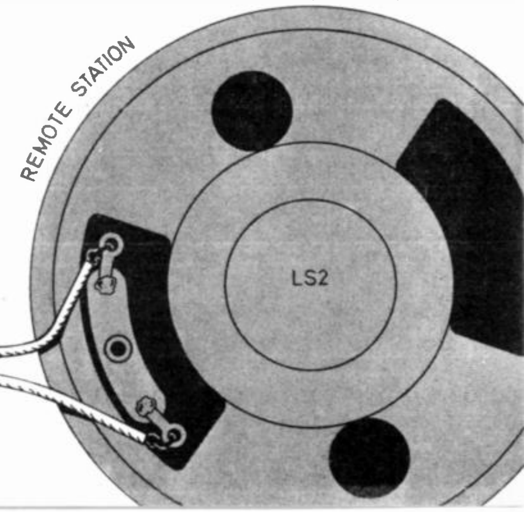


Fig. 3. Fixing component lead and two wire links to one block position (a) and (b); (c) shows wire connection to speaker eyelet.



CIRCUIT DESCRIPTION

The circuit diagram for the Intercom is shown in Fig. 4. The two speakers, LS1 and LS2 are used both in the normal loudspeaker mode, and in "reverse" as microphones according to their connection through the changeover "switch" arrangement.

When using a loudspeaker as a microphone, the pressure waves from the voice cause the speaker cone to vibrate in sympathy. Thus the coil connected to the cone moves in the field of the speaker magnet. This alternating motion causes an e.m.f. to be generated in the coil windings. The generated voltage follows the frequency and amplitude of the pressure waves reaching the cone. The amplitude however is very small, typically less than 1 millivolt.

AMPLIFIER

Transistor TR1 is configured in a common-base mode which has very low input impedance and is capable of very high voltage amplification. To a first approximation the gain is given by the ratio of the value of R1 to the impedance of the microphone, that is 27000/8=3300 approx. (Loading of the second stage affects this figure).

The small a.c. signals developed in the "microphone" reach TR1 emitter via a.c. coupling capacitor C1 where they affect the base current flowing. The small base current variations cause much larger collector current variations (basic transistor action) resulting in a fairly large voltage change across R1. These voltage variations are available at the collector of TR1, the output of the voltage amplifier.

This voltage cannot be used directly to drive a loudspeaker as the output impedance is high and consequently output current low. The function of TR2 (wired as an emitter follower) is to multiply this current by the gain factor of TR2 (typically 200) to produce a level suitable for driving an 8 ohm loudspeaker. The voltage is slightly reduced by this stage of the circuit. The signal has thus received voltage and current amplification, the power being taken from the battery. ◻

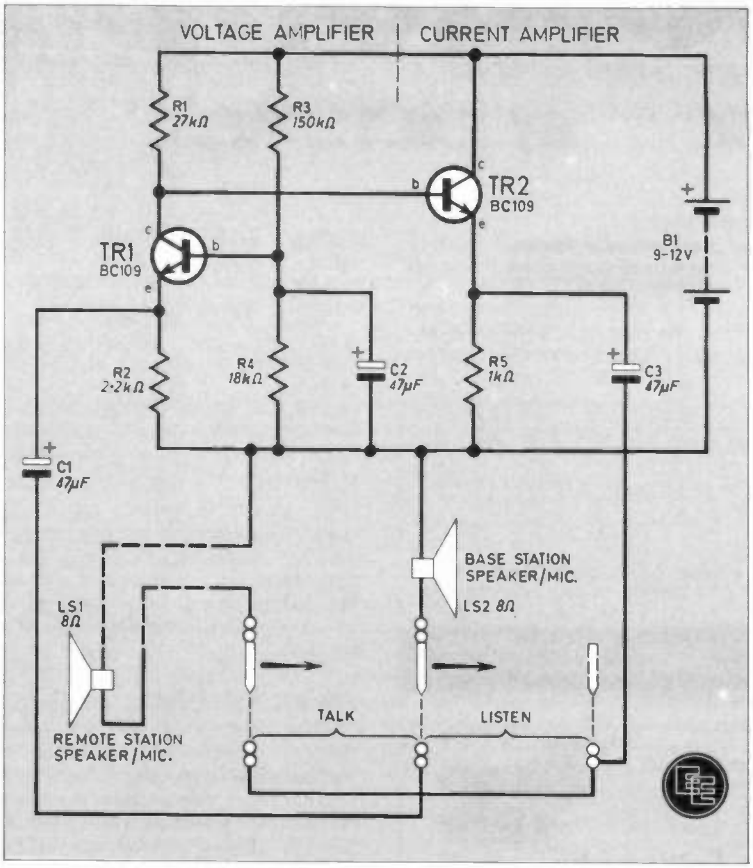
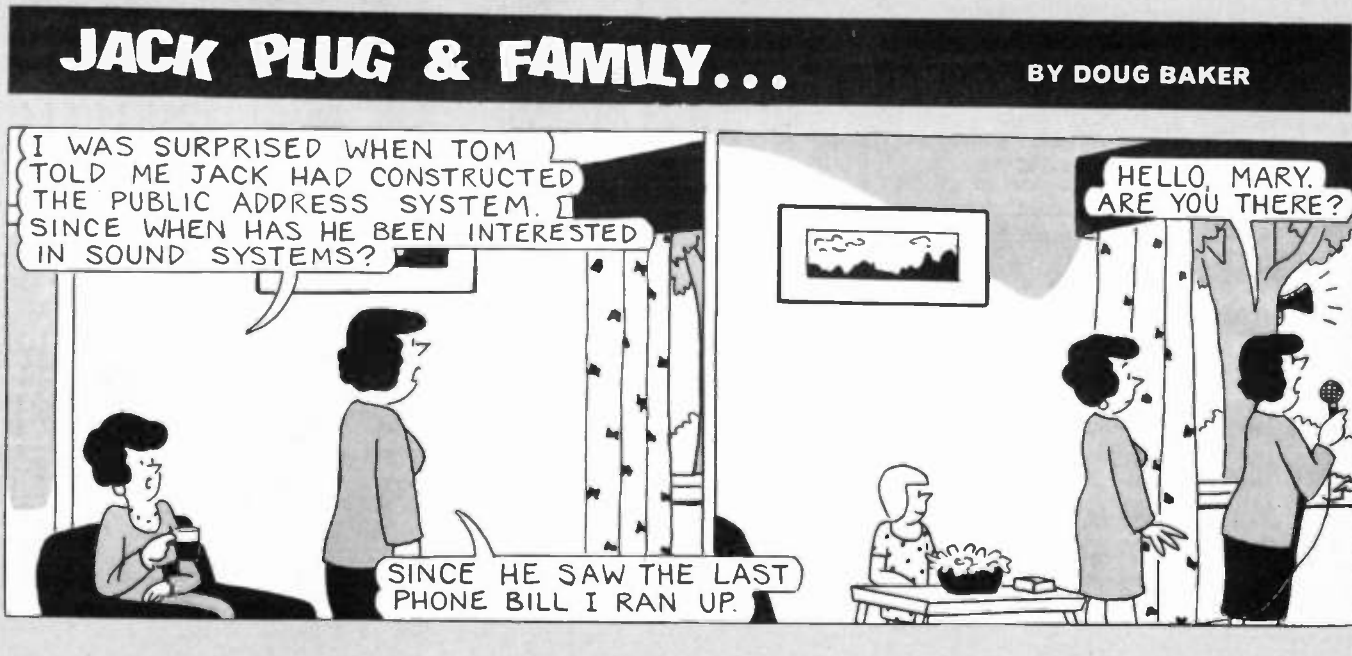


Fig. 4. Circuit diagram of the Two Way Intercom.



RADIO WORLD

By Pat Hawker, G3VA

Museum Pieces

During the past few years there has been increasing interest in "antique radio and television" and many of the domestic receivers of the 1920s, 1930s, 1940s and even 1950s are now being eagerly collected and restored. Surprisingly there is no really good permanent collection of such sets in any of the London museums.

A few years ago an excellent display of "wireless sets" covering 1922-1956 could be seen for some weeks at the Victoria & Albert Museum and attracted a large attendance. For this exhibition The British Vintage Wireless Society produced three wall-posters and a set of these on my office wall continues to arouse the interest of visitors. More recently this museum staged an excellent display of the original pen and ink drawings from early issues of the Radio Times.

The Science Museum brought together early television sets for its special "50 year" television exhibition in 1980—the Science Museum also has its permanent "Telecommunications" gallery though this provides more formal history and rather less nostalgia. For several years there has been talk of setting up a television museum at Alexandra Palace, and of course there are several "private" museums in the UK such as those run by Ron Ham and David Byrne.

Texas Broadcast Museum

During a recent visit to the annual National Association of Broadcasters convention and exhibition in Dallas, Texas, I took the opportunity of visiting *The Texas Broadcast Museum* which claims to be the "world's largest broadcast museum". It emerged from the private collection of Bill Bragg (a video engineer at a Dallas television station) who as a youngster began collecting anything which involved broadcasting and gramophones; equipment, receivers, autographed photographs, magazines and literally almost any other broadcast memorabilia.

A few years ago, with his home overflowing with hundreds of items, the Bragg family "went public" and with a start-up fund of just $25 moved their collection into shop premises in the main central area of Dallas—it has been growing ever since. Very far from being a formal history of broadcasting and the amateur radio bug, it really is the most fascinating "attic" of long discarded bits and pieces—with tapes and "78s" discs of famous American stars of yesteryear adding to the atmosphere.

Collector's Items

A couple of bulky broadcast transmitters, 40 working Edison phonographs, listening booths, Edison's microscope, Bill Haley's guitar, Walter Cronkite's farewell microphone, old scripts, early wire and tape recorders, are all on display. While set names, such as Atwater Kent, Paragon, Grebe, Philco "Cathedral", may be unfamiliar to British readers—they represent an important slice of the domestic history of our age.

I noted the 1940s Hallicrafters small-screen television receiver with a strong likeness to that firm's then current range of communications receivers. Similarly, I welcomed the opportunity to browse through a varied selection of old magazines and booklets including a description of amateur radio at the 1933 Chicago World's Fair.

The museum by no means adopts a rigid "hands off" policy and it seems to be run by the Bragg family on a very informal basis that adds to the attraction—not only to those who recall the days when the equipment was in many homes but also, I noted, to a party of schoolchildren who seemed to be vastly enjoying the records of the Boswell Sisters, early Bing Crosbys and the big band era.

American A.M.

When from time to time I have been in the USA I have always admired the extremely well-organized way in which their medium wave a.m. broadcasting works, at least from a technical point of view. In Europe we have been conditioned to accepting an appalling amount of co-channel interference, particularly during the hours of darkness when the ionosphere reflects back signals from stations several hundreds of miles away.

On many of the low power stations one now accepts that night time coverage, far from being greater after dark, is in reality only a small fraction of the daytime coverage. Some channels, occupied by very high power stations attempting to broadcast to other countries, are virtually only useful for a single station over the whole of Western Europe.

In the USA, once the chaos of the early days of broadcasting was overcome, the system has been well planned. Many a.m. stations are "daytime only" closing down as darkness falls to leave "clear channels" for others, and even these clear channel stations are limited to a maximum of 50kW.

Directional Aerials

For many years, very good use has been made of highly directional aerial arrays using up to about a dozen masts, carefully designed to produce "nulls" of minimum radiation towards other stations using the same frequency. It is all a giant jig-saw pattern but it means that listeners in the cities, both during the day and night, can tune to many different stations, each coming through clearly enough to give reasonably good quality reception.

This year, at Dallas, I found a good deal of anxiety. Many of the a.m. broadcasters are worried that the present situation may deteriorate rapidly due to the intention of Cuba to build many more a.m. stations, not using directional aerials, and with at least two 500kW transmitters. Calculations show that if the Cubans go ahead with their plans—they recently walked out of an international planning conference—a considerable number of American stations will lose between 90 to 99 per cent of their interference-free night time coverage.

To be fair to the Cubans, part of the problem has arisen from the intention of the Americans to broadcast on medium waves to Cuba. Up to now the radio propaganda "war" has been waged on short waves—including a period when the CIA operated an anti-Castro station on Swan Island in the Caribbean.

A.M. Stereo

Another problem is facing the American a.m. broadcasters. Many of them are keen to introduce stereo on medium waves and for several years the FCC has been trying to decide which a.m. stereo system would be best. Now it has given up and ruled it must be left to the marketplace to decide.

There are still four aggressively-competing systems: Magnavox, Motorola, Harris and Kahn/Haseltine. Unfortunately the systems are not compatible and American anti-trust laws make it illegal for the broadcasters to agree among themselves on which system to use. So listeners may find their new a.m. stereo set can only be used on a few stations, or more likely it will delay the widespread use of any system unless it proves possible to design a universal decoder; difficult and very expensive.

Broadcasting in the States shows much rivalry between AM and FM stations and is based on 10kHz channel spacing. For these and other reasons it may be some considerable time before there is any move to start a.m. stereo in Europe.

"Faulty vertical hold, I'd say".

Everyday News

ROYAL AWARDS FOR THE

. . . FROM AIDS FOR INDUSTRY TO AIDS FOR THE DISABLED . . .

Electronics figured prominently in this years 1982 Design Council Awards

For the first time a CHIP was given an award. LUCY, Mullard's teletext decoder chip was the happy recipient!

THE 1982 Design Council Awards were presented to 34 British companies by HRH The Duke of Edinburgh at a ceremony at the Barbican Centre, London.

The awards were given for a wide range of products. Among five motor awards there were two commendations for prototypes.

Engineering products and components award winners, eight and four awards respectively, came from the agricultural, aviation, robotics and micro-electronics fields. Four awards were made in the medical area for laboratory aids, surgery equipment and a mobility aid for handicapped children.

We regret that we are unable to mention all winners by name, but have selected a few to give some idea of the formidable task in winning one of these highly prestigious symbols of excellence.

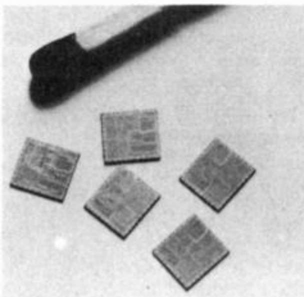
HRH The Duke of Edinburgh presenting an award to Ivor Cohen of Mullard for the company's LUCY chip (left), used in viewdata decoders.

Lucy the Chip

It is fitting in 1982, designated Information Technology Year, that LUCY, a customised i.c. designed by Mullard for viewdata-type applications should win an award.

It has been designed specifically as part of a decoder used in TV terminals suitable for viewdata-type applications, where coded alphanumeric and graphic information is transmitted from a computer data base down the telephone line.

The function of the chip is to act as a general interface between various data sources and the microprocessor in the decoder. The circuit density of LUCY is so high that it combines the functions of the many conventional peripheral integrated circuits previously used in viewdata decoders. The result is a more compact, cheaper and more sophisticated decoders for viewdata systems.



Marine Call

Brookes & Gatehouse is the first marine electronics company to win two consecutive awards. This year the award has been given for the Homer 5 marine radio receiver.

The major advance in the design is that it is controlled by a microprocessor and has brought low cost sophisticated reception to a wide range of craft.

Mobile Aid

An award in the Medical Equipment section went to Malden Care for their Rally Special Go-Kart, a stylish vehicle for disabled children that provides them with a greater freedom of movement outdoors. The judging panel commended the obvious consideration that had been given to safety factors.

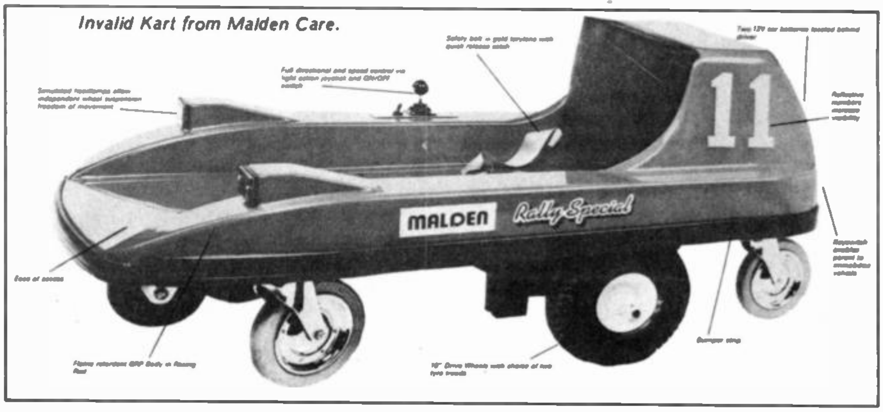
An electronic controller gives full directional and speed control from a joystick that can be mounted right or left of the driver. By gently pushing the stick halfway forwards, the vehicle moves forward at half-speed; fully forward provides a speed of not more than 2·5mph.

The speed is controlled so that it will not increase on a downward slope. A key-switch at the back enables parents to immobilise the Go-Kart so that children, disabled or able-bodied, cannot go for unintended joy rides!

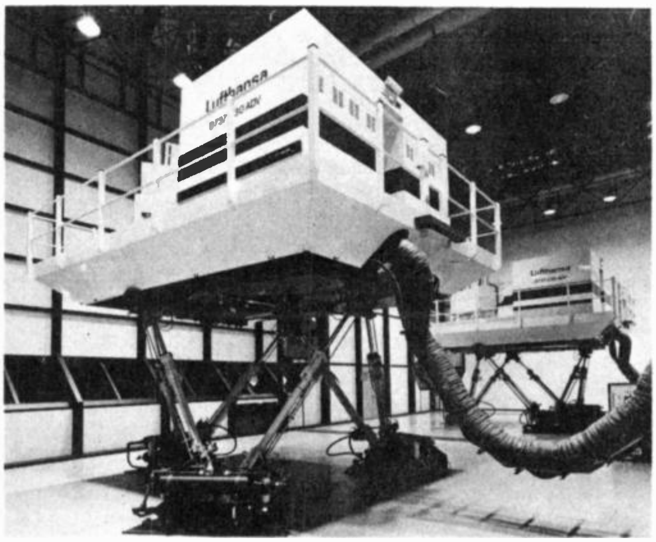
Additional features for the Go-Kart include a detachable "bonnet" to protect legs, and a remote control for children who cannot drive the vehicle themselves.

The Homer 5 marine receiver.

Invalid Kart from Malden Care.



INNOVATORS



Advanced technology flight simulator from Rediffusion Simulation was an award winner in the engineering section.

Flight Simulator

Two and a half tonnes of fuel is burned up every time a jumbo jet takes off. Increasing fuel prices, coupled with ever-tightening flight schedules means that fewer aircraft can be made available for essential crew-training.

A British company, Rediffusion Simulation Ltd from Crawley, has provided the answer to this world-wide problem, with the development of an advanced technology flight simulator for training crews in the most realistic conditions on the ground.

The main design criterion was to create a totally realistic training environment in terms of both the physical and performance characteristics of a particular aircraft. This has been achieved physically by fully reproducing the aircraft flight deck, making maximum use of original intruments, flying controls and furnishings.

Sensory cues of motion, control feel, vision and sound are provided through separate systems and co-ordinated by a central 32-bit computer programmed with flight data relating to each specific aircraft simulated.

Robotics

In the area of robotics, the CompArm robot manufactured by Hall Automation is one of the leading examples designed to provide fully automatic spraying, previously carried out by operators in paint booths.

The arm is controlled by the HAL 90 computer control system with a solid-state, non-volatile memory with separate modules of 10 minutes capacity, and which can contain up to 63 separate spraying programmes.

Computers

We leave readers to guess who took the computer award? But when last seen, not on the BBC, he had the full spectrum of expressions on his face and was using the code name ZX81.

The Future

As this year's winners celebrate their success The Design Council begins its search for the 1983 Design Council Award winners and invites submissions for its five Awards categories—Engineering Products, Engineering Components, British Motor Industry, Medical Equipment and Consumer and Contract Goods, both decorative and durable.

TELETEX

By international agreement the term Teletex is to be used for high-speed message transfer (electronic mail) in the UK and overseas networks.

Not to be confused with teletext, a term used to describe broadcast viewdata services such as Oracle and CEEFAX. UK Teletex starts on a pilot scale almost immediately with full implementation of domestic and international service by 1984.

A new industrial robot developed by Fujitsu is said to have such delicacy and accuracy of touch that it can be used to assemble small electronic components and watch parts.

World leader in semiconductor sales, Texas Instruments, is forecast to lose the championship in the coming year to challenger Motorola who has been Number Two for many years. Both companies have world sales of more than a billion dollars with TI currently leading at 1·3 billion against Motorola's 1·2 billion.

—ANALYSIS

ZERO-ONE

Digital technology has become so dominant in recent years that many of us imagine it is not only fashionable but also something completely new. The fundamental idea is a binary system in which the basic operational component is a two-state device which can be either "on" or "off". In electronics, diodes or transistors can be used as switches in circuits whose signal paths always have one or other of two possible voltage levels or, in the terminology, logic level zero or logic level 1.

The principle of two-state signalling is nothing new. It was well-known to the ancients and has been practiced throughout recorded history. Perhaps the earliest examples were fire beacons recorded in the literature as early as 500 BC. Fire out, level zero. Fire lit, level 1.

An extended system of this type was used in 1588 between Plymouth and London to signal that the Spanish Armada had been sighted. The beacons were spaced some eight miles apart over 200 miles and it took 20 minutes for the message to reach the capital, the delay being the time it took to light each beacon in succession along the chain. But this was still very must faster than relays of riders on horseback.

The drawback of simple on-off signalling is its low information content of only one "bit". London was informed of the sighting but still knew nothing of the size of the Armada or its intention. It was also necessary to know in advance that beacon lit meant Armada sighted.

The electric telegraph was the big breakthrough in long-distance signalling, became faster, more private and independent of visibility. The two-state on/off principle was still used but the invention of a dot/dash, mark/space code by Samuel Morse (1791-1872) made it possible for alphanumeric messages of any complexity to be transmitted and received. The principle was as before but the information content was now virtually infinite.

By 1862 Britain had 15,000 miles of installed electric telegraph. The peripheral equipment was a Morse key for sending and headphones for receiving. Some sixty years ago those peripherals were updated to keyboard entry and printer read-out for commercial use.

The modern "digital revolution" is merely an extension of an old principle. The difference today is in sheer speed and handling capacity of very large quantities of logic states, in their marshalling, manipulation and storage. Zero and 1, the simplest of all signals, remains the operating principle of all digital computers, digitally controlled machines and processes.

Brian G. Peck

BRAKE LIGHT RELAY

BY T.R. de Vaux-Balbirnie

WHEN fitting a trailer or caravan to a car, one important point is often overlooked. This is to provide some assistance to the brake light circuit to relieve the load when the additional lights are operated.

The usual solution is to simply wire the caravan brake lights in parallel with those on the car, which will work but the switch will now pass *twice* the normal current and this can cause premature failure. Where the switch is of the type directly operated by the brake pedal, replacement is straightforward, but if it is of the pressure-operated type placed in the hydraulic brake line replacement is much more costly. This is because air will enter the system when the old unit is removed and "bleeding" will be necessary when the new switch is fitted.

Apart from it being illegal to drive a car with defective brake lights, such failure will endanger other road users.

The answer is to install a relay circuit which will operate the additional brake lights while imposing negligible load on the existing system and some commercial units employ a mechanical relay, but here we have used a power transistor to do the actual job of switching.

In designing this project, it was also thought worthwhile to add a special safety feature. This is an indicator light placed on the car dashboard which warns the driver that one or both trailer brake lights have failed.

As well as indicating "blown" bulbs, the warning light will also operate if there is a poor electrical connection; at the socket on the towbar, for example.

CIRCUIT OPERATION

The circuit diagram is shown in Fig. 1. When the brake pedal is pressed, the brake light switch closes as the car brake lights operate in the usual way. A small current also flows through R1 into the base of transistor TR1. This turns it "on" and as TR1 is directly coupled to TR2, as a Darlington pair, this is also turned "on".

TR2 is a power transistor capable of carrying the current needed for the trailer brake lights which are connected in its emitter circuit.

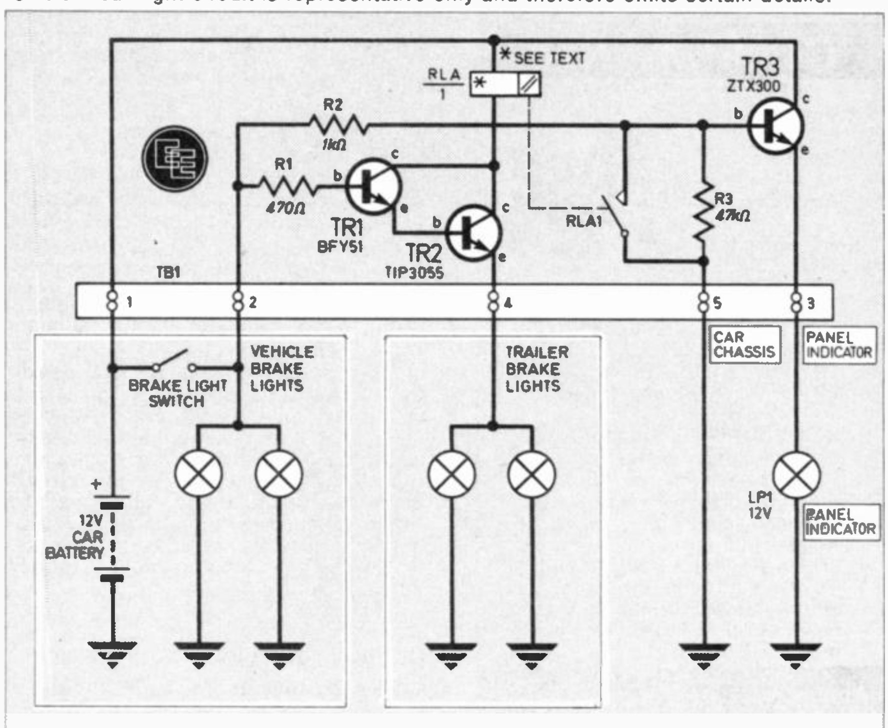
The collector current for TR1 and TR2 flows through a coil of wire (RLA/1) wound around the body of a miniature reed switch (RLA1). This will be operated by the magnetic field generated by the current flowing through the coil.

When construction is complete, the number of turns of wire on the coil will be adjusted so that the current for *two* lamps will be sufficient to operate the reed switch but the current for *one* will not. Thus, if one or both lamps fail or if there is a poor electrical connection, the reed switch contacts will fail to close.

WARNING LIGHT

The reed switch contacts could be used to operate the warning light, LP1, directly but then this light would operate each time the brake pedal was pressed in normal operation. This is unsatisfactory; the warning light should stay *off* in normal use and only operate in cases of failure.

Fig. 1. Circuit diagram of the Brake Light Relay unit. Note that the inset diagram of the vehicle break light circuit is representative only and therefore omits certain details.



One method of achieving this would be to use a reed switch with *normally closed* contacts but these are uncommon. So as most reed switches have *normally open* contacts and are cheap and readily available, one of these was used along with TR3.

When the brake light switch is made, current also flows into the base of TR3 via R2, turning it "on". However, before there is time for LP1 (connected to the emitter of TR3) to light, the reed switch contacts close, earthing the base of TR3, turning it firmly "off".

BRAKE LIGHT FAILURE

If a brake light fails, then the reed switch contacts will remain open since there will be insufficient current through RLA/1, and the warning light will operate. The purpose of R3 is to ensure that TR3 is "off" during the time when the brake pedal is not pressed.

From the foregoing it can be seen that the warning light will operate each time the brakes are operated whilst *not* towing a trailer, because, as far as the circuit is concerned, there is "failure" of the trailer brake lights. It is necessary to either disregard this or to fit a small switch on the dashboard to cancel the indicator when not towing. To preserve the safety feature it is, of course, necessary to remember to switch on again when towing.

CONSTRUCTION

The prototype was built in a metal "throat lozenge" tin 85×65×22mm. This not only provides mechanical strength but also acts as a heat sink for TR2. For this reason a plastic box should not be used.

COMPONENTS

Resistors
R1 470Ω
R2 1kΩ
R3 47kΩ
All ¼W carbon ±5%

See Shop Talk page 455

Semiconductors
TR1 BFY51 *npn* silicon
TR2 TIP3055 *npn* silicon
TR3 ZTX300 *npn* silicon

Miscellaneous
TB1 5A, 5 way terminal block
LP1 12V panel mounting indicator
RLA 6-RSR-A miniature reed switch, normally open contacts with six turns of 1/0·6mm wire (see text)

0·1 inch pitch strip board, 13 holes by 16 strips; case to suit; grommet; transistor mounting kit; 4A auto type stranded wire; auto type spade connectors; auto type bullet connectors; board mounting hardware.

Approx. cost Guidance only £5 excluding case

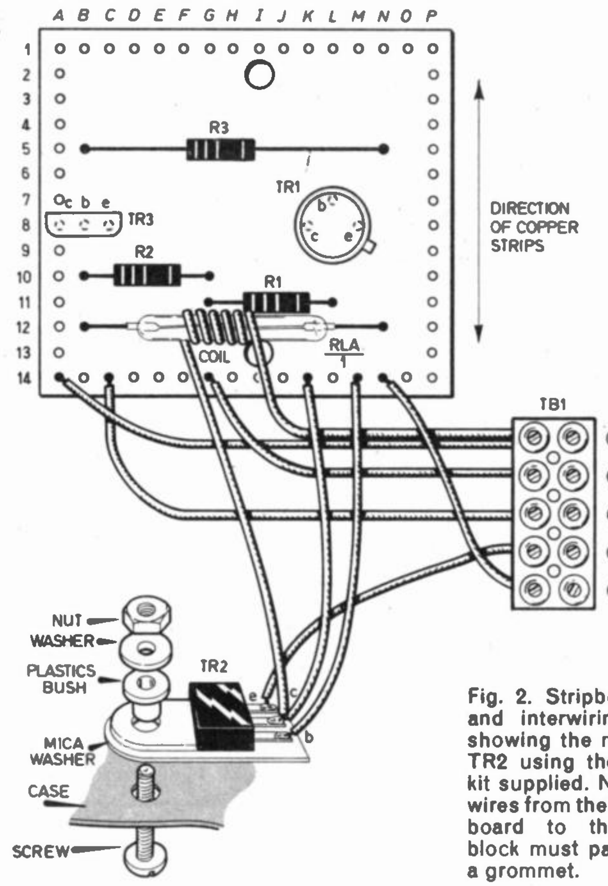


Fig. 2. Stripboard layout and interwiring diagram showing the mounting of TR2 using the mounting kit supplied. Note that all wires from the component board to the terminal block must pass through a grommet.

Most of the circuit is built on a piece of 0·1in pitch stripboard, 16 strips by 13 holes as shown in Fig. 2, with the exception of TR2 and the terminal block.

When fixing TR2 into the case, the mounting kit supplied must be used to electrically isolate it. The kit consists of a mica washer and a plastic bush and is assembled as shown in Fig. 2

REED RELAY COIL

To begin with, the coil RLA/1 should consist of six turns of ordinary 1/0·6mm single core insulated equipment wire. This will be approximately right for the reed switch specified. There are differences between reed switches of the same type, so it is possible that some adjustment will be required later.

The circuit panel is secured inside the box using nuts, screws and stand-off insulators. These stand-offs may be made from two short pieces of plastic wall-plug. They are essential to ensure that the copper strips on the circuit panel do not touch the metal box and cause short circuits. Where wire connections pass through the box to the 5-way terminal block on top, a rubber grommet must be used.

INSTALLATION

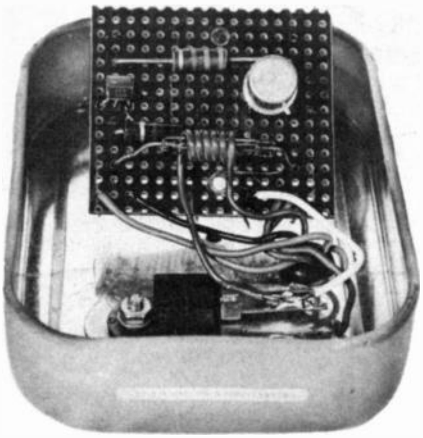
The finished unit may be mounted in the boot of the tow-car. It can, perhaps, be concealed behind a trim panel but it is best to leave it free for the time being since final adjustments may be necessary.

Locate a fuse which is "live" only when the ignition is turned on with the aid of a 12V test lamp and run a length of wire from this fuse to TB1-1 on the unit. This wire *must* be of the stranded variety and be rated at 4A minimum. An automotive type connector must be used at the fuse end and if all available outlets from the fuse have been used, a "piggy-back" connector may be obtained from a car accessory shop to turn one outlet into two.

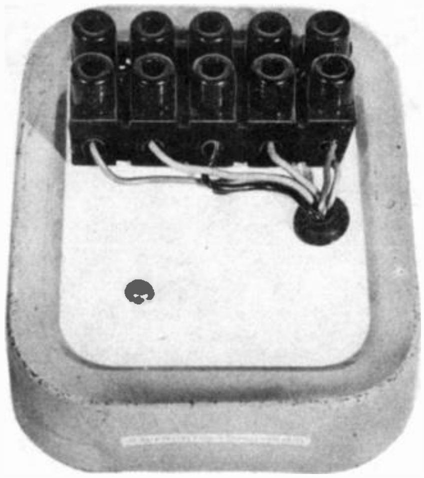
Wherever wire must pass through a metal panel in the car, a hole should be drilled and a rubber grommet fitted. Now run a wire from the indicator light LP1 on the dashboard to TB1-3 on the unit. This may be light-duty wire but must still be of the stranded automotive type.

BULLET CONNECTORS

Using a little detective work, locate the wire which leads from the existing car brake light system to the socket on the tow-bar. This wire should be broken at a convenient place and insulated "Bullet" connectors inserted to extend both free ends to the position of the unit. These connectors should allow the two ends to be joined together again so that "conventional" operation is once more possible in the event of the unit failing or, perhaps, when selling the car.



View inside the finished prototype showing the circuit board and power transistor mounting.



The terminal block is mounted onto the base of the "lozenge" tin as shown.

The free wire leading to the existing brake lights should go to TB1-2 whilst that leading to the tow-bar socket should go to TB1-4 on the unit. Finally, TB1-5 on the unit should be connected to an earth point. One may already exist nearby or alternatively, a small hole may be drilled in the metal and an eyelet and self-tapping screw used. Ensure that the paint is scraped away from the area of contact.

MOUNTING

An ideal way of securing the finished unit to the bodywork is by means of two self-tapping screws through the lid. In this way, the entire circuit may be "snapped" into position and removed just as easily.

The indicator light LP1 is mounted in the dashboard. One terminal is "earthed" and the other connected directly to TB1-3 or via the panel switch described earlier.

FINAL TESTING

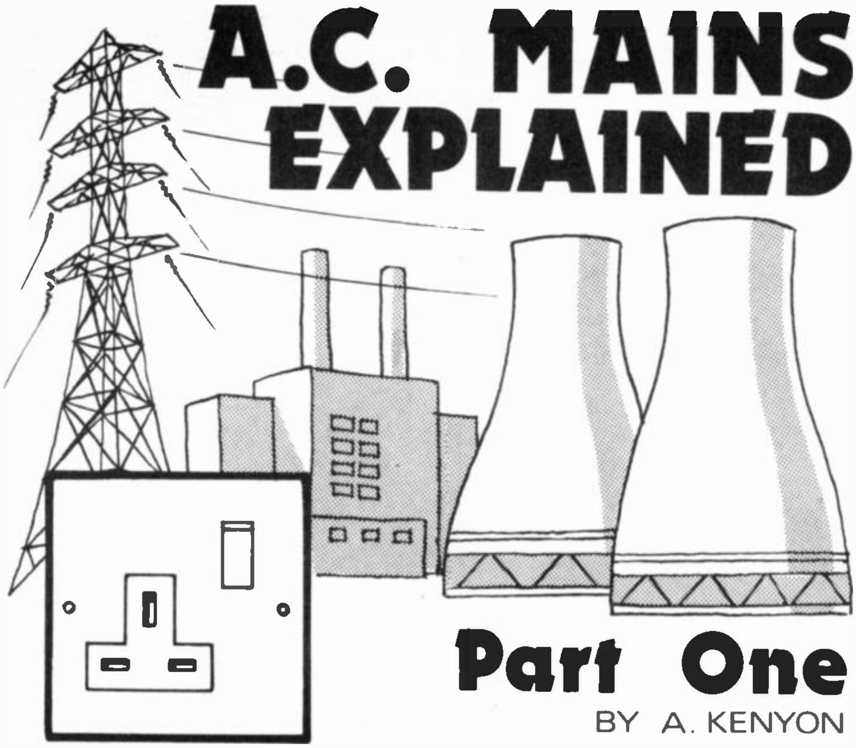
The circuit is now ready for final testing. The caravan plug should be connected to the car and the rear covers removed from the light clusters on the caravan. With the ignition switched on and the brake pedal operated, all four brake lights should operate and the panel light should remain *off*. If the panel light comes on when the lights are working, a few extra turns of wire should be added around the reed switch.

When one brake lamp is removed from the caravan the panel light LP1 should now signal a fault when the brake pedal is pressed. If LP1 stays *off* then there are too many turns of wire around the reed switch and a few should be removed. With both bulbs removed from the rear of the caravan, or with the caravan uncoupled, the indicator should again light.

When the correct number of turns have been found for RLA/1 it is advisable to "lock" them with a little adhesive. Check that everything works with the engine running.

All being well, the trim panel can be replaced and the unit left to do its job. As this circuit works along the lines of the old maxim that "prevention is better than cure", the extended life of the brake light switch is unlikely to be noticed. However, one day, when the dashboard indicator warns you of a failed bulb, you will bless the day you built this project!

A.C. MAINS EXPLAINED



Part One

BY A. KENYON

THE STANDARD method of transmitting and distributing electrical energy throughout the world is by Alternating Currents (a.c.), so called because the generated voltage is in the form of a sine wave and being a continuous wave, it has a frequency. The mains frequency used throughout the UK is 50 cycles per second or hertz (Hz) and in other countries is usually either 50 or 60Hz.

How therefore can the voltage of a sinusoidal wave which varies between zero and some peak value be classified? This can be achieved precisely because the a.c. voltage is *always* sinusoidal.

DETERMINATION OF AN A.C. VOLTAGE

If a 12 volt, 24 watt lamp is first connected across a car battery and then across the output terminals of a suitable 12 volt transformer, it will be seen that the lamp lights with the same brilliance even though the former voltage source is d.c. and the latter, a.c. So what are the characteristics of the sine wave which will give the same power output as a direct voltage? The easiest way to investigate this, is to compare each voltage on a Cathode Ray Oscilloscope (c.r.o.).

Set the time base frequency to measure 50Hz (5ms per division) and connect the battery to the c.r.o. input terminals noting the 12 volt calibration height (see Fig. 1.1a). Next observe the 12 volt a.c. waveform from the transformer output (with the lamp still across it) and note the detail of the voltage sine wave which is equivalent to the 12 volts d.c. (See Fig. 1.1b).

Upon examination it can be seen that this sine wave oscillates between a maximum of 16·97 volts positive and 16·97 volts negative in order to produce a voltage equivalent to 12 volts d.c. (The fact that the voltage goes negative during one half cycle does not matter since reversing the lamp across the battery terminals gives the same brilliance).

The ratio of the peak a.c. voltage to the equivalent d.c., is equal to:

$$\frac{16 \cdot 97}{12} = 1 \cdot 414$$

and this is a constant for all sinusoidal waveforms.

It is also true that:

$$\frac{\text{peak voltage}}{1 \cdot 414} = \text{equivalent d.c. voltage}$$

This equivalent is known as the r.m.s. value (Root Mean Square) of the a.c. voltage. All voltage referred to on an a.c. network are the voltages in terms of their r.m.s. value (their equivalent d.c. value).

For instance, the 240V single phase output from a domestic mains socket varies sinusoidally between plus and minus 339V (240V × 1·414) at a frequency of 50Hz.

MEASUREMENT OF A.C. CURRENT

An inspection of Fig. 1.1b shows that at any instant, the a.c. voltage is either zero, positive or negative and if this voltage is applied to a resistance (for example, the filament of the 12V lamp) the resulting current (I) will vary in accordance with Ohm's law, $I = V/R$.

It follows therefore that the current will also be a sine wave and its equivalent d.c. (r.m.s.) value will be:

$$I_{r.m.s.} = \frac{V_{r.m.s.}}{R}$$

From the power taken by the lamp we know that the current will be the power in watts divided by the voltage which equals 24W ÷ 12V = 2A, and that this is the r.m.s. current. The peak current taken from the transformer will therefore be 2 × 1·414 = 2·828A.

As with the voltage, all currents referred to on an a.c. network are given in terms of their r.m.s. value. This is sometimes referred to as the "Virtual Value", that is the value of the a.c. waveform which is *virtually equivalent* to a d.c. voltage or current of the same value.

SINGLE PHASE AND THREE PHASE SUPPLY SYSTEMS

Generators of a.c. voltages are known as Alternators and the best way to understand the generation of a three phase system is to first examine how a single phase voltage is produced and to avoid confusion, a single conductor rotating in a magnetic field will be considered.

Referring to Fig. 1.2, the conductor (shown here looking "end on") is rotated in a uniform magnetic field created between the two poles of a permanent magnet.

If the conductor moves across the magnetic field in one direction as

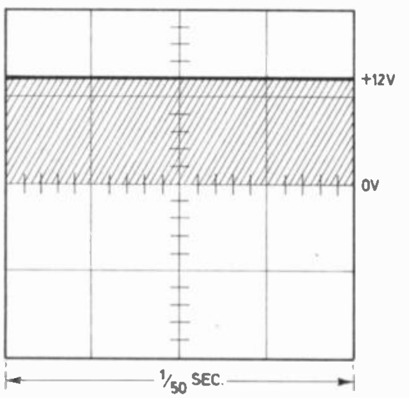


Fig. 1.1a. C.R.O. display for the 12 volts d.c.

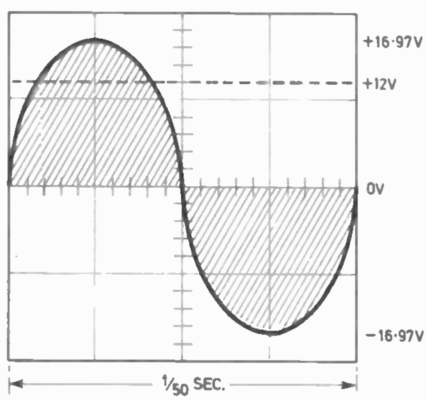


Fig. 1.1b. C.R.O. display for the 12 volts a.c.

shown (from point *A* to point *C*), a voltage is generated between the ends of the conductor. When the conductor moves back across the same magnetic field in the opposite direction (from point *C* back to point *A*), the polarity of the induced voltage is reversed. When the conductor moves parallel to the path of the magnetic field in either direction (at *A* or *C*), no voltage is generated in the conductor.

Three things now determine the amplitude of the generated voltage.

1. The speed at which the conductor moves across the magnetic field.
2. The strength of the magnetic field.
3. The length of the conductor.

Assume now the ends of the conductor to be connected to two slip rings (see Fig. 1.3) with carbon brushes connected to the input of an oscilliscope. The speed of rotation of the conductor is now set to fifty revolutions per second (3,000 r.p.m.) and the strength of the magnetic field adjusted to generate a peak voltage of 339·41V alternating from positive to negative between the slip rings. This is a standard 240V r.m.s. supply.

Now connect one slip ring to an Earth point; this will be the Neutral. This slip ring will always be at Earth potential while the other slip ring will alternate from 339V above earth potential to 339V below.

This slip ring is the Live terminal and the generated supply will be the same as the single phase 240V supply of Live and Neutral as supplied to domestic premises. Fig. 1.3 also shows how the output voltage sine wave that would appear on an oscilloscope, the frequency being 50Hz.

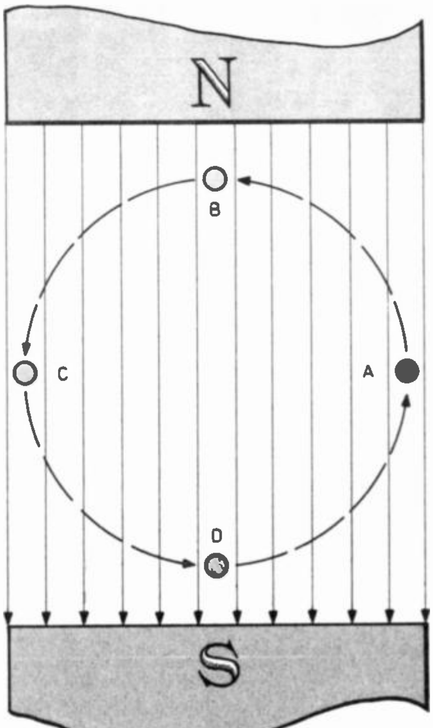


Fig. 1.2. Simple a.c. alternator. Magnetic field shown as parallel lines.

THREE PHASE A.C. SUPPLIES

A Three Phase supply differs from the single phase system in that three voltages, each equal to the single phase supply, are simultaneously generated within the same magnetic field. (See Fig. 1.4).

This is similar to that shown in Fig. 1.3 but instead of having only one conductor rotating in the magnetic field, there are three, equally separated by 120 degrees. Each conductor will generate 240V at 50Hz as before but their respective peaks will occur at 1/150 of a second intervals.

QUESTION TIME

1.1. The single phase Line to Neutral voltage of a three phase system measures 115 volts. What is the three phase Line voltage?

1.2. A three phase transmission system is 33,000 volts. What is the peak voltage of any Line conductor to Earth?

1.3. Examine Fig. 1.3. Can you suggest any way in which the voltage could be increased two-fold whilst keeping the same magnetic field strength and the same frequency?

The three commoned ends of the conductors are joined to one of the slip rings as shown. This slip ring will be permanently at Earth potential, and again called the Neutral while the three other slip rings will each have a separate 240Vr.m.s. voltages alternating above and below Earth potential. The resulting output waveforms are also shown in Fig. 1.4.

The voltage from any slip-ring to neutral is referred to as the single to neutral is referred to as the single phase voltage and the voltage across any two of the three live slip rings is referred to as the three phase Line voltage, that is, between rings one and two, two and three or one and three.

It can be shown that the Line voltage or the voltage between any two of the live slip rings on the three phase power system is √3 times greater than the single phase Live to Neutral voltage. Now as √3 (the square root of three) is approximately equal to 1·73, we can say that for a distribution system of 240V, the three phase voltage is 240V × 1·73 = 415V.

To be continued

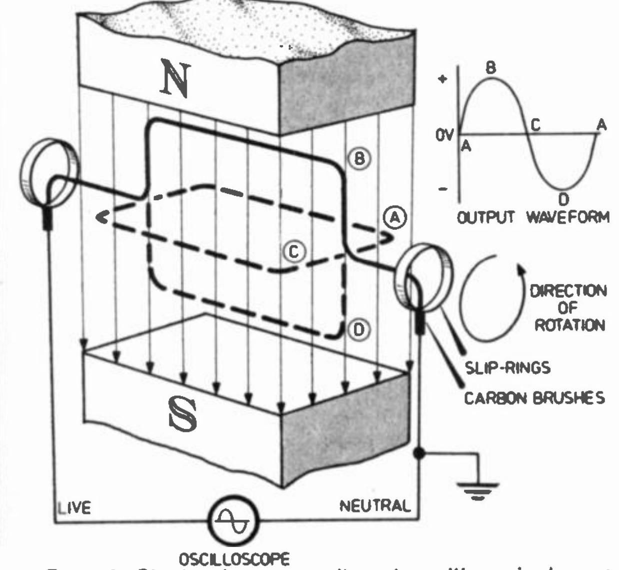


Fig. 1.3. Single phase a.c. alternator with a single conductor rotated in a magnetic field.

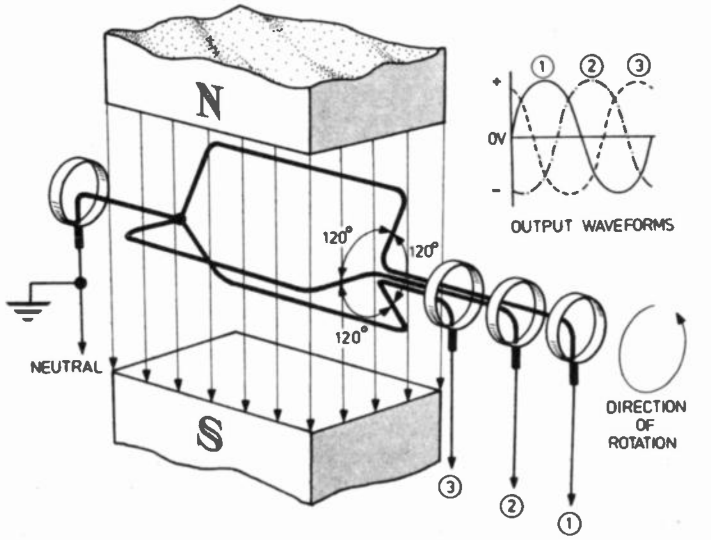


Fig. 1.4. Three phase a.c. alternator with three conductors, equi-spaced 120 apart, rotated in the same magnetic field.

SQUARE one FOR BEGINNERS

THIS months subject deals with tools for the construction of electronics projects. Having the proper tools for the job certainly makes work a lot easier and will in general result in a better made projects.

As with most things in life you get what you pay for—and tools are no exception. Quality tools cost more (obviously) but in the long term will be more cost effective than a number of lower grade (cheap?) tools.

SOLDERING IRON

Virtually all projects involve soldering so a soldering iron is essential and should be at the top of your list. The majority of EE projects can be comfortably assembled with the aid of a 15 to 20W iron fitted with a 1·5mm diameter bit. A larger bit size could also be in stock for bigger jobs, for example, soldering to large tags on potentiometers, transformers and the like. An iron clad bit will last longer.

Choose a mains powered iron unless you have a specific reason for choosing a lower voltage type. The lower voltage types can be used with the mains via a suitable transformer which will provide isolation. Hooks are fitted to most irons for hanging purposes during use, but a stand is much better and safer.

WIRE CUTTERS

Wire cutters are necessary for trimming component leads to the required length, either before or after soldering, and for cutting interconnecting wire to length. The latter may be cut using a pen-knife, but cutters are preferred. The two sections of the cutter can either be (a) lap-jointed, where the sections are laid one on the other and rivetted together to pivot at this point, (b) box-jointed, where the two sections are machined to inter-lock about a machined pivot. The latter will provide longer service.

Cutting edges can be obtained with and without a bevel, the latter providing a very close cut. Other variations are size, for light, medium and heavy duty use, and with and without spring loaded handles, see Fig. 1.

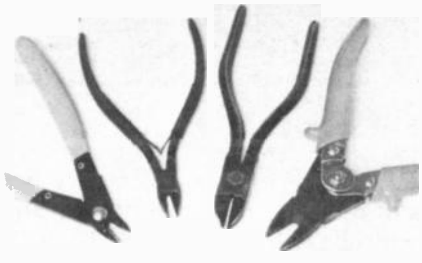


Fig. 1. A selection of wire cutters (these are also referred to as side cutters). The pair on the left are lap-jointed, the others all being the box-jointed type, the heavy duty pair in fact having two joints for extra leverage.

Fig. 2. Wire strippers. The pair on the left are of superior quality but as such, can be considerably more expensive. Both types are adjustable for different size wires.

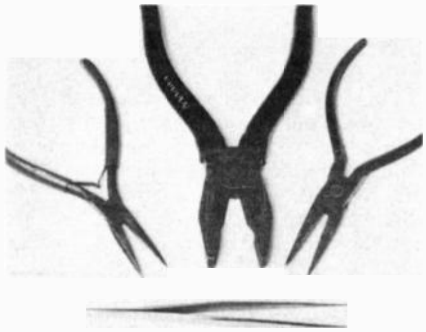


Fig. 3. A range of pliers with the electricians pliers in the centre, flanked by two pairs of long-nosed pliers. A pair of fine tweezers are also shown.

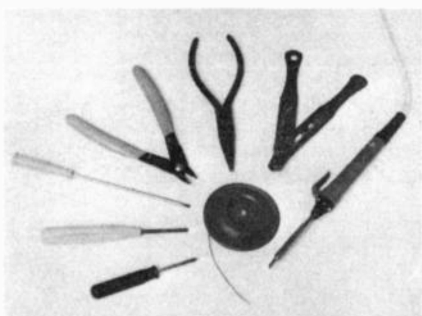


Fig. 4. The basic tool kit with, clockwise left to right, small cross-head screwdriver, spot-face cutter, small plain screwdriver, wirecutters, long-nosed pliers, wire strippers, mains soldering iron and in the centre, a reel of solder.

Lightweight sprung handle cutters without bevel have been found most useful in the workshop. Heavier cables could be cut with a pen-knife.

WIRE STRIPPERS

Wire strippers are needed for removing the insulation from wire. Basically, there are two versions as shown in Fig. 2. Both shown are adjustable and spring loaded. The adjustment does allow the strippers to be also used as cutters.

There is quite a difference in the cost of these two versions and we have found that the cheaper type in (b) to still function well after several years of use. Cable strippers can also be bought, but their expense is not justified for hobbyist use.

PLIERS

A selection of different pliers are seen in Fig. 3 and one or more different pairs will be regularly required during construction. The pair shown top centre in Fig. 3 are known as electricians pliers which are also usually equipped with a centre cutter for heavy cables and wire, and a side-slot-cutter for heavy wire gauges. The jaws are serrated for gripping purposes, useful for holding nuts/bolts.

The smaller pairs of pliers are long-nose pliers. These will be useful for bending component leads and linking wires, as heatshunts, picking up and placing components on boards; tweezers are useful for the latter.

SCREWDRIVERS

A small selection of screwdrivers are an essential part of any electronics toolkit. You can buy inexpensive screwdriver sets, conveniently packed in a plastics case with two or three different shaped heads of different sizes which are satisfactory for the hobbyist.

The kits we have in mind are for general purpose use and also contain a pointed blade and a threaded blade, for making holes in wood.

STRIPBOARD

Stripboard is rarely obtained in the size you require for a particular project and so has to be cut. A Junior hacksaw is ideal. A smooth file is required to clean up the edge and remove any jagged copper track ends that could possibly produce shorting bridges between the tracks.

To make breaks at positions along the tracks, a drill bit about 3mm diameter makes a clean cut but is a little difficult and soon tires the hand especially if there are a large number of breaks to be made. There is a tool called a "spotface cutter" made specially for this purpose and is recommended.

Multicore makes soldering easy fast & reliable

Ersin Multicore

Ersin Multicore, solder contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required.
Comes in handy dispensers and tool box reels in two different alloys 40/60 tin/lead for general purpose electrical soldering and 60/40 tin/lead ideal for small components and fine wire soldering.

Size PC115 60/40 tin/lead
£1.38 Handy pack 0 028mm dia

Size 3 40/60 tin/lead
£4.37 Per reel 1 6mm dia
Size 10 60/40 tin/lead
£4.37 Per reel 0 71mm dia

Size 19A 60/40 tin/lead
£1.15 Handy pack 1 22mm dia

Multicore Savbit

Multicore Savbit, solder increases the life of your soldering bit by 10 times, for better soldering efficiency and economy.
Comes in two handy dispensers and tool box reels.

Size 5 Savbit
£1.15 Per pack 1 2mm dia

Size 12 Savbit
£4.37 Per reel 1 2mm dia

Size SV130 Savbit
£1.73 Per pack 0 048mm dia

Multicore Alu-Sol

Multicore Alu-Sol, solder contains 4 cores of flux, suitable for most metals especially aluminium.
Comes in handy dispensers on tool box reels.

Size AL150 Alu-Sol
£2.07 Per pack 048mm dia

Size 4 Alu-Sol
£7.82 Per reel 1 6mm dia

All prices inclusive of VAT.
Available from most electrical and DIYs stores. If you have difficulty in obtaining any of these products send direct with 50p for postage and packing. For free colour brochure send S.A.E.

Multicore Solder Wick

Multicore Solder Wick, absorbs solder instantly from tags and printed circuits with the use of a 40 to 50 watt soldering iron.
Quick and easy to use, desolders in seconds.

Size AB10 Solder Wick
£1.43 Per pack

Multicore Tip Kleen

Multicore Tip Kleen, soldering iron tip wiping pad.
Replaces wet sponges.

Size 2 Tip Kleen
£0.92 Per pack

Bib Wire strippers and cutters

Wire strippers and cutters, with precision ground and hardened steel jaws. Adjustable to most wire sizes. With handle locking-catch and easy-grip plastic covered handles.

Size 9 Wire Strippers
£2.69 Per pair

Bib Audio/Video Products Limited
(Solder Division), Kelsey House,
Wood Lane End, Hemel Hempstead,
Hertfordshire, HP2 4RQ.
Telephone: (0442) 61291
Telex: 826437

NEW · NEW · NEW · NEW
PRODUCTS
NEW · NEW · NEW · NEW

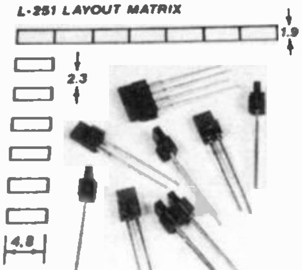
STACKABLE LEDs

A new design of rectangular l.e.d. has recently been introduced by Zaerix Electronics enabling end or side stacking.

Available in red, yellow or green, the L-251 series couple the advantage of full area illumination with the facility of producing continuous unbroken lines in the end stackable direction, enabling a wide range of bar type displays to be generated.

Having a maximum power dissipation figure of 105mW, the l.e.d.s have a typical luminous intensity figures of up to 2·8mcd at 20mA.

Zaerix Electronics Ltd, Dept EE, Electron House, Cray Avenue, St Mary Cray Orpington, Kent BR5 3QJ.



HIGH RESOLUTION

Owners of VHS and Beta format video machines will welcome the new video cassette tapes from the renowned Bib range of audio and video products.

This new top grade, high resolution tape, specially made for Bib in Japan, is claimed to provide the most realistic colour quality current technology can offer.

The E180(VHS) and L750 (Beta) Bib video cassettes should be available from most video shops and stores. The recommended retail price for the tapes is £9·98.

Bib Audio/Video Products Ltd, Dept EE, Kelsey House, Wood Lane End, Hemel Hempstead. Herts HP2 4QR.

DIGITAL MULTIMETER

Introduced to meet the market demand for a portable digital multimeter for the "field" service engineer, Salford Electrical Instruments pocket meter incorporates two design features.

The input terminals are at the top, enabling the operator to probe the circuit under test whilst holding the instrument in one hand. The 3^1_2 digit LCD display is at the base, and is sloped for easier reading.

The meter covers a resistance range of 0 to 20MΩ, with diode test facility, and a voltage range of 0 to 1kV (max) d.c. and 0 to 750V (max) a.c. Current range is 0 to 2A, both a.c. and d.c., which is protected by a 2A fuse. Short duration transient protection is included and will withstand 250V r.m.s. fed into any input, on any range indefinitely.

The SEI D1000 Digital Multimeter is powered by a PP3 battery and comes complete with case and probes.

Salford Electrical Instruments Ltd, Dept EE, Barton Lane, Eccles, Manchester, M30 0HL.

WORLD FIRST

For the princely sum of £2,500 plus VAT (someone must pay for development) you can own the world's first truly portable, flat-screen, liquid crystal display, digital storage oscilloscope. And it's British.

Claimed to be the first of its type in the world, the Scopex Voyager oscilloscope uses a flat-screen liquid crystal display in place of the conventional cathode ray tube. It has thus proved possible to have a portable, battery operated, digital storage scope with a front-to-back depth of less than 100mm and weighing only 2.5kg.

This unique instrument was the result of work undertaken by British Scientists at the Royal Signals and Radar Establishment, Malvern, Dr. Ian Shanks together with Paul Holland who were responsible for the method which is used in addressing 32,000 odd points which comprise the display.

Incorporated in the instrument is a function called "save memory" which maintains the information stored in a RAM device even when the instrument is switched off, enabling waveforms to be held for future reference. When switched on again the trace stored is shown as clearly as when first recorded. Comparison of signals sequentially coming from the same or different sources, and by use of the compare and store functions in the dual-trace mode, single and dual-trace storage over the entire screen area is possible.

Another feature which comes out of the digital storage method employed is the ability to have a pre-trigger function. This effectively enables the user to look back in time to see what occurred before the event which triggered off the recording. This ability to look back can be made to give various amounts of pre-trigger information and is exceedingly useful in detecting random and occasional faults.

The digital storage system is controlled by six slide switches together with an indicator display which shows the mode of operation.

Other brief technical details are as follows. Vertical Systems — Bandwidth: d.c. coupled, d.c. to 150kHz at 8 samples per cycle; a.c. coupled, 3Hz to 150kHz at 8 samples per cycle. Sensitivity: 10mV/cm to 5V/cm in 9 calibrated ranges. Accuracy is claimed to be ±1·5 per cent. Risetime: 800ns single trace; 1·6μs dual-trace or compare. Maximum input voltage: 250V (d.c. +pk a.c.). Input impedance: 1MΩ±3 per cent and 22pF.

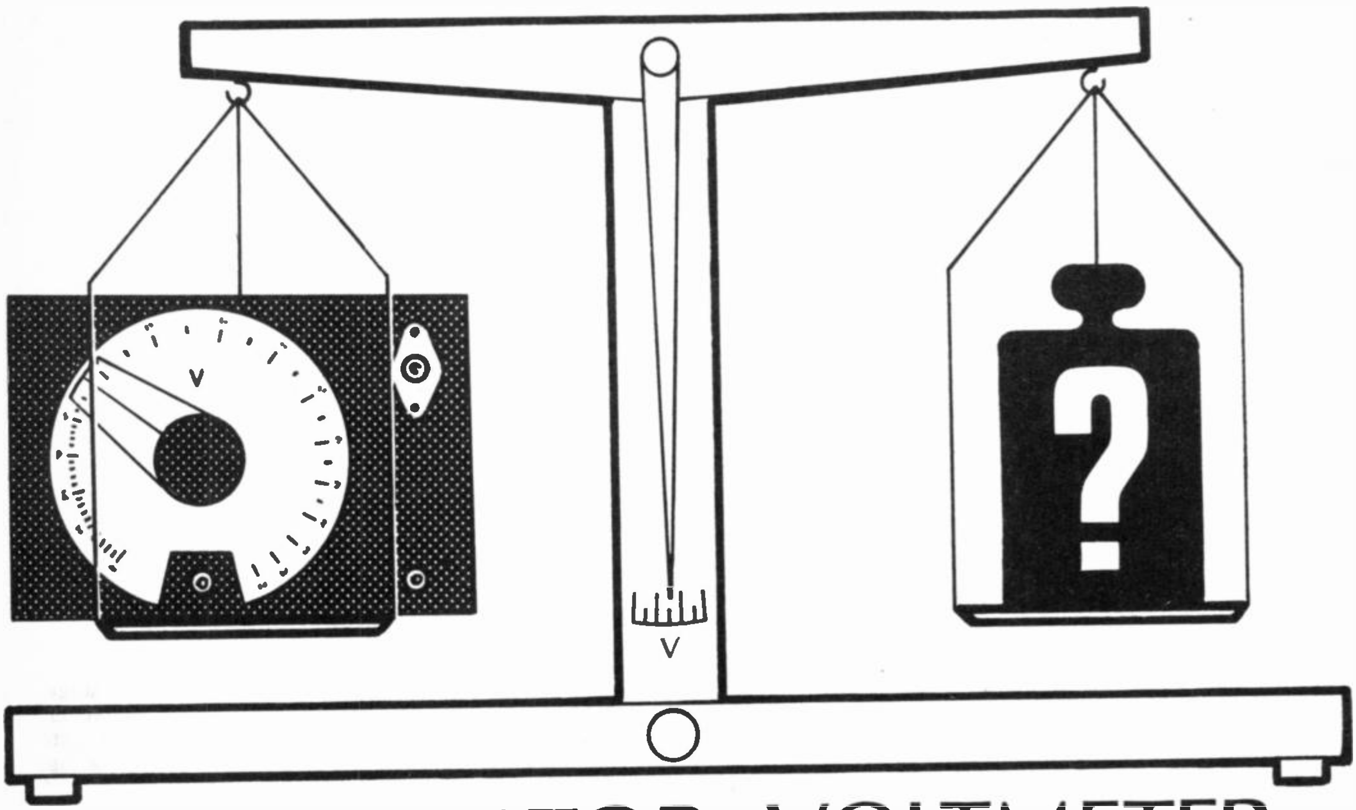
Horizontal system—Timebase sweep speeds: 20μs/cm to 50s/cm in 20 calibrated ranges. External input: 1·25MHz maximum, no lower limit; +4·75V ±0·25V. Minimum pulse width 100ns. Accuracy is claimed to be 0·01 per cent internal: External; determined by external timebase source.

The trigger sensitivity internal: 2mV d.c.-150kHz; External: 100mV d.c.-150kHz. Sample rate is 1·25MHz. The flag display indicates aliasing, low battery, store saved, store, triggered and armed.

The internal battery supply consists of 6 nickel cadmium rechargable cells which give upto 5 hours continuous use. The low battery indicator operates approximately 15 minutes before the display drive safety circuits finally cut out.

The Scopex Voyager with its low voltage display and operation enables it to be used in many semi-hazardous environments where oscilloscopes have been banned.

Scopex Instruments Ltd, Dept EE, Pixmore House, Pixmore Avenue, Letchworth, Herts SG6 1HZ.

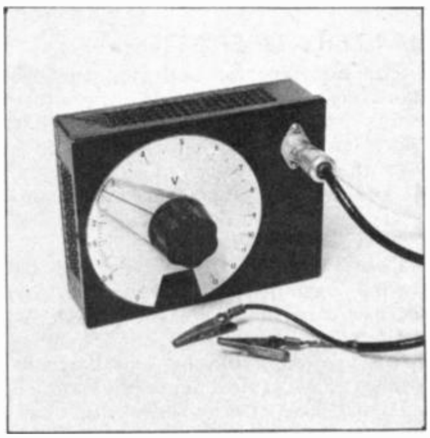


COMPARATOR VOLTMETER

By N. P. Naughton

MANY a precariously positioned multimeter has come to an expensive end in numerous garages and, indeed, workshops. The simple electronic voltmeter described here has no delicate meter movement to damage. It extends a technique widely used in the computerised testing of semiconductors.

An ordinary testmeter operates magnetically to indicate the value of an unknown voltage. But the same measurement can be made by comparing the unknown voltage with a known reference voltage. This reference voltage is varied by means of a potentiometer until it coincides with the unknown voltage so when the test probe is applied to the unknown voltage, a pointer knob on the potentiometer is turned until an l.e.d. goes out to indicate coincidence. The voltage can then be read off from a calibrated scale. This is the principle of the comparator voltmeter.



Although this single range meter was originally meant for testing in fairly high current circuits, it has also been used for checking out low voltage circuits such as TTL. But the meter has a low input impedance and therefore loads a circuit somewhat more than a conventional type and the readings in such cases may be inaccurate. However, they will be accurate enough for most purposes.

CIRCUIT DESCRIPTION

Three silicon *pnp* transistors are employed in the complete circuit shown in Fig. 1. Zener diode D1, TR1 and R4 form an emitter follower voltage regulator which develops a stabilised voltage across potentiometer VR1 in such a way that any selected voltage at the slider is always negative with respect to point *A*. The probe input is always positive with respect to this point.

Whenever a negative voltage at VR1 slider coincides in value with a positive voltage at the probe, the voltage at point *B* will be equal to that at *A*. Transistor TR2 detects this "null" condition by turning on when it occurs. It does so because its base becomes 0·6 volts negative relative to its emitter when the null occurs. This voltage derives from an offset voltage developed across preset VR2 which acts as the SET ZERO control of the meter.

When TR2 turns on, TR3 turns off since TR2 collector voltage is now too low to allow TR3 to conduct. The NULL INDICATOR l.e.d., D2, therefore goes out when coincidence occurs.

HALF WAVE

A single diode is used to provide half wave rectification of the 18 volts a.c. from the mains transformer, T1. This simplifies construction and assists Zener regulation by avoiding the voltage drop of two diodes which would happen with a full wave bridge. In fact, a small voltage drop does occur at VR1 slider when TR2 turns on, but since this discrepancy is constant throughout it is absorbed in calibration.

Electrolytic capacitor C1 provides smoothing and D3, a green l.e.d., provides POWER ON indication.

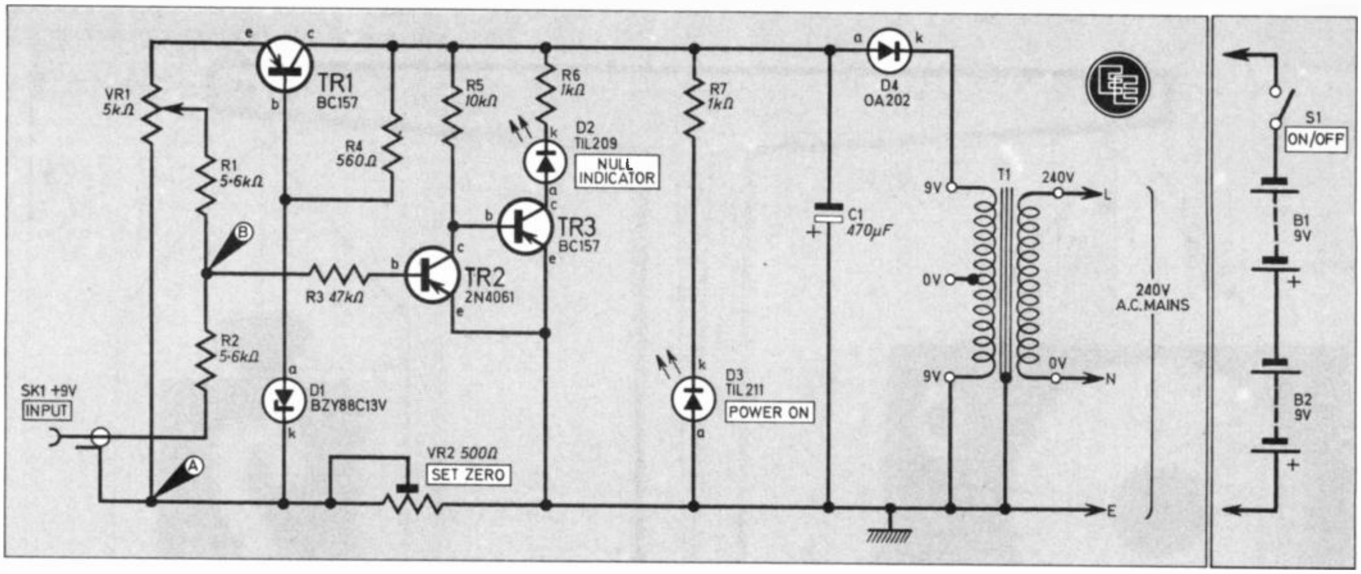


Fig. 1. Circuit diagram for the Comparator Voltmeter

CONSTRUCTION starts here

CIRCUIT BOARD

Most of the components are assembled on 0·1 inch matrix stripboard 28 holes by 17 strips and the layout is shown in Fig. 2. Ensure that the transistors, capacitor and diodes are correctly orientated before soldering and that foil breaks are made exactly as shown. Insert the resistors and links, made from component lead off-cuts, into the board and solder in position. VR2 should be accessible from the top.

Many constructors assemble stripboards as instructed but have their own ideas regarding boxing and finish. However, for this particular project, the following points should be noted. It is strongly recommended that the box selected be a metal one, as this will act as a heat sink for the transformer which, in most cases, will be a miniature, warm running type. The case used in the prototype was an AB10 aluminium box 101×103×38mm, and finished with a black crackle paint. It is essential that the box be well ventilated so drill plenty of small holes in the sides, otherwise it will become something of an oven and the calibration may drift.

FINAL ASSEMBLY

The circuit board is mounted in the base of the case on spacers as shown in Fig. 3. T1 is also secured to the case alongside the board and on one of its mounting screws is placed a 3-way tag strip to accommodate the main input wires.

The mains cable enters through a grommet and is firmly held in place with a "P" clip. The EARTH wire (yellow/green) is soldered to the earth point on the tag strip, the live and neutral wires must be soldered to isolated tags.

The case lid holds VR1, l.e.d.s D2 and D3, and the probe socket, SK1 a u.h.f. coaxial connector, and these are mounted in the positions shown.

All interwiring is done with the p.v.c. sleeved 7/0·2 wire, Fig. 3.

A suitably drilled and scribed Perspex strip glued to the bottom of the knob makes an excellent pointer. If this is made 50mm long, effective scale length will be about 250mm.

CALIBRATION

Before setting up the meter for the calibration procedure, a disc of paper no greater than 100mm in diameter must be temporarily stuck to the box lid, its centre on that of the potentiometer, VR1. It is on this that the calibration marks can be made with a sharp pencil. The suggested graduations are the zero point, 0·5 to 2V in 0·1V steps, up to 3V in 0·2V increments, from 3 to 10V in steps of half a volt and finally up to the maximum of 13V in 1V steps. Less than 0·5V was not thought to be necessary and, since the meter is not intended as a precision instrument, no more calibration marks are needed.

The zero control is best set with the test probe or clip floating. Simply turn VR1 to minimum and then carefully adjust SET ZERO potentiometer, VR2 until the NULL INDICATOR, D2, just lights up. The pointer now marks 0 volts.

A variable voltage source and an accurate conventional voltmeter are necessary for calibration. The variable source could be a pair of 9 volt batteries wired across a low resistance potentiometer, however, a variable power supply would be ideal.

With the calibration voltage source correctly connected to the probe, set the voltage to the first point, that is 0·5V, and rotate VR1 from the zero position in a clockwise direction. When l.e.d. D2 goes out, mark the position of the pointer on the scale with the sharp pencil. Return VR1 to the zero position and set the calibration voltage to the next value.

It will be noticed that when rotating VR1 back again the l.e.d. comes on again at a lower point on the scale. This Schmitt trigger effect is due to altered circuit conditions occurring the instant TR2 conducts.

The scale markings will be semi-logarithmic but the long scale length compensates for some crowding at the higher voltage end. The completed instrument should read from about 0·5 volts to just over 12 volts.

BATTERY OPERATION

The high cost of batteries and the relatively low cost of miniature mains transformers make mains operation the obvious choice, however if battery operation is desired, T1 and D4 will be deleted, and in the interest of low power consumption remove D3 and R7.

Two 9 volt PP3 batteries will be needed and it will, of course, be necessary to fit an ON/OFF switch as indicated in Fig. 1. When the measured voltage differs significantly from a known reference, for example, a $1\frac{1}{2}$ volt cell, the batteries will need to be replaced. ⌑

COMPARATOR VOLTMETER

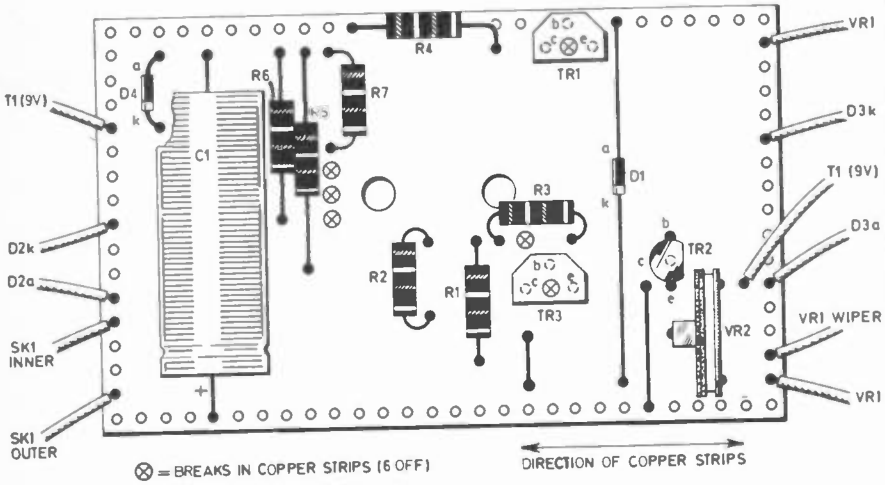
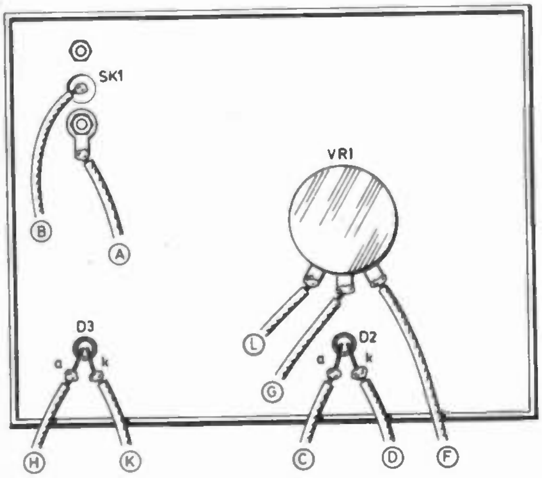
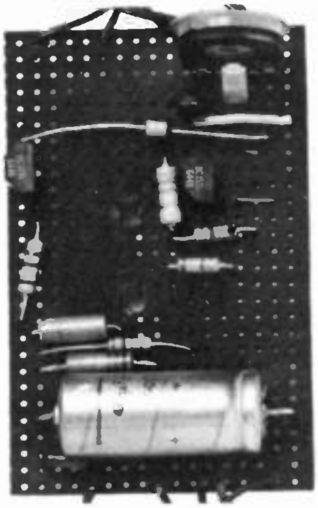
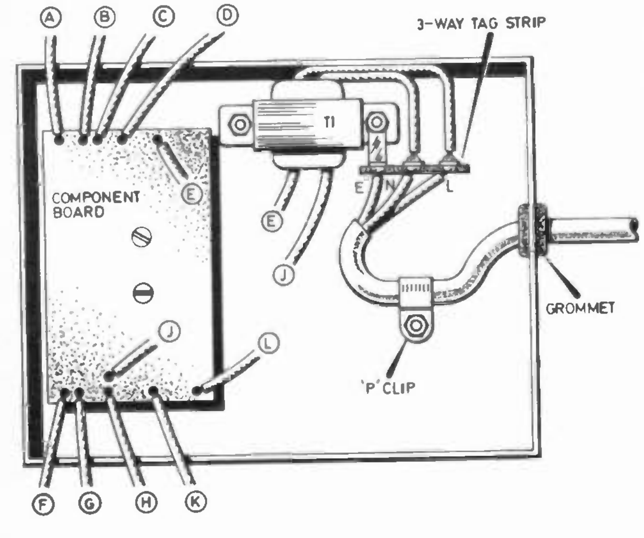


Fig. 2. Stripboard layout for the Comparator Voltmeter. Note the positions of the six track breaks.







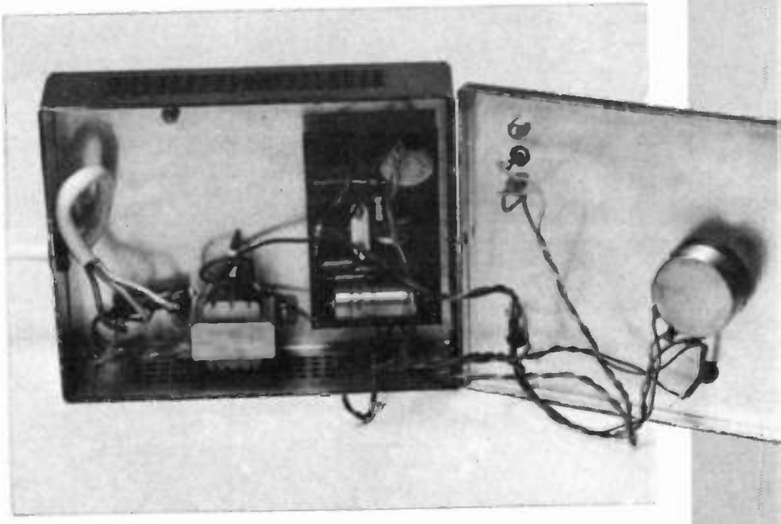


Fig. 3. Wiring diagram showing view inside case. Transformer and case must be earthed via the earth point on the tag strip.

View inside the finished prototype unit. Note that the mains cable "p" clip is not shown, however it is important that it is included.

COMPONENTS

Resistors

R1, 2	5·6kΩ (2 off)
R3	47kΩ
R4	560Ω
R5	10kΩ
R6, 7	1kΩ (2 off)

All ¼W carbon ±5%

See **Shop Talk** page 455

Capacitors

C1	470μF 25V electrolytic

Semiconductors

D1	BZY88 13V, 400mW Zener diode
D2	TIL209 red l.e.d.
D3	TIL211 green l.e.d.
D4	OA202 general purpose silicon
TR1, 3	BC157 silicon *pnp* (2 off)
TR2	2N4061 silicon *pnp*

Miscellaneous

VR1	5kΩ lin w/w control potentiometer
VR2	500Ω lin carbon vertical preset
T1	Miniature mains transformer, 9V-0-9V, 100mA secondary
SK1	Co-axial socket, surface mounting
PL1	Co-axial free plug

Stripboard, 0·1 inch matrix, 17 strips by 28 holes; aluminium case 101 × 133 × 38mm (type AB10); 3-way tag strip with earth point; grommet; P-clip; l.e.d. mounting clips (2 off); control knob with long pointer; mains plug; crocodile clips (2 off); 7/0·2 equipment wire; mains lead (approx 2m); screened co-ax cable (approx 1m); mounting hardware for T1 and circuit board (M2·5 or 6BA).

Approx. cost Guidance only £8.70

REFLEX TESTER

by D. J. EDWARDS

So you think you've got fast reactions? Would you really have been the fastest gun in the West? The speed at which people react to a stimulus is dependent on many factors. Age is one—as neurons die and nerve pathways deteriorate, the speed of impulse is delayed.

It is of course well known that alcohol affects reaction adversely.

Can you make up a composite definition of someone with good reactions? Will a tall person have slower reactions than a small person? Does it depend on fitness? All in all a reaction tester can be fun to have around.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1 and can be seen to be a good example of classic transistor action. It consists of two bistables (one for each contender) and the time variable "trigger" around TR5 and TR6 that gives the signal for the players to trip their respective switches.

Let us first look at the bistable around TR1 and TR2, bearing in mind its action is identical to the one comprising TR3 and TR4.

In the normal un-triggered state TR2 is off, therefore its collector is high and D1 is also off. The high voltage at TR2 collector is coupled to TR1 base via the potential divider of R2 and R3, keeping TR1 on. TR1 collector is therefore low and this is coupled back to the base of TR2 via R7 keeping TR2 off.

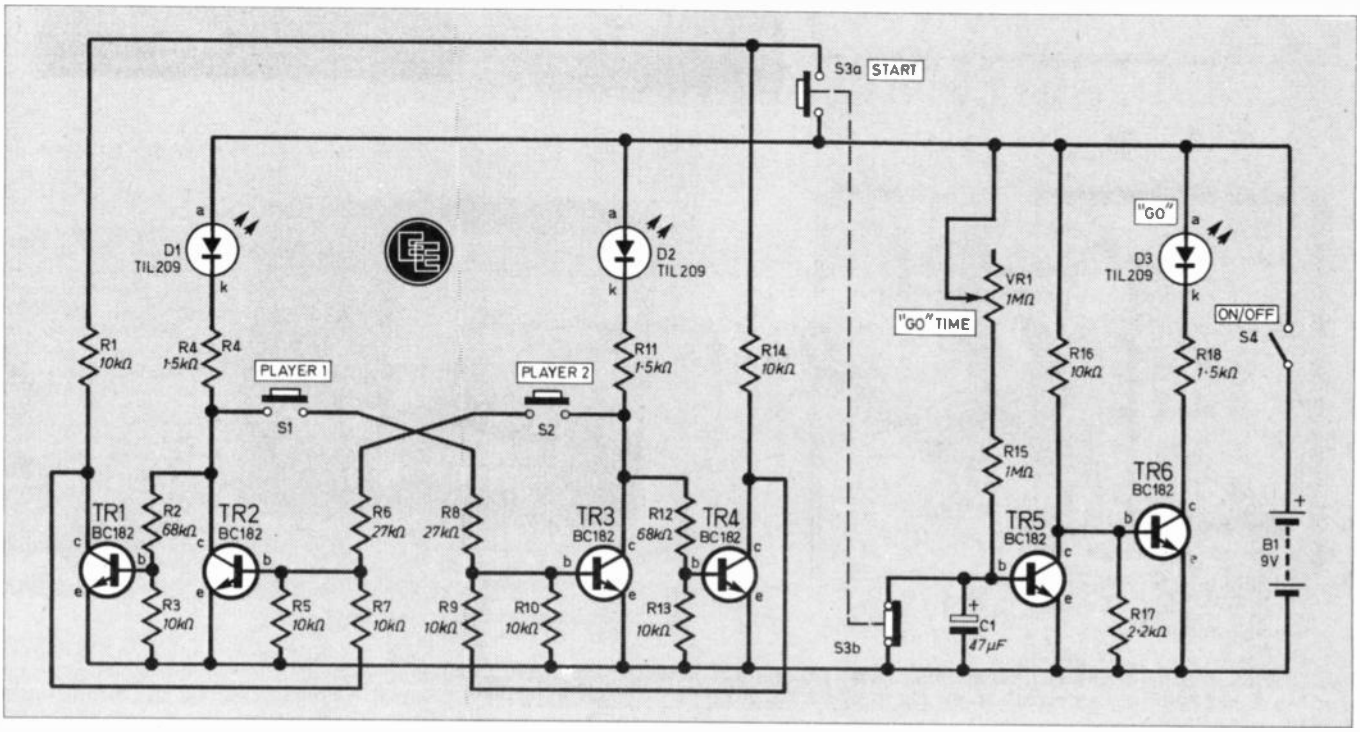
If a pulse is now applied to the base of TR2 by depressing S2, TR2 goes on. Its collector goes low, D1 lights up. The voltage at the junction of R2 and R3 is now insufficient to keep TR1 on, so its collector goes high. This is again fed back to TR2 base via R7, keeping TR2 on even if S2 was only operated for an instant. Because TR2 collector is now low there is insufficient current for the other player to trigger his bistable by pressing his switch, S1.

This description applies equally well for either bistable and ensures that the first player to hit his switch in response to the signal automatically cuts out his opponent.

Let us now turn our attention to the circuitry that initiates this action.

Initially C1 is uncharged and TR5 base is at 0V. TR5 is thus off, which

Fig. 1. Complete circuit diagram of the Reflex Tester.



keeps TR6 on and D3 alight. As C1 slowly charges up via VR1 and R15, the voltage at TR5 base gradually rises. When it reaches approximately 0·6V TR5 switches on. TR5 collector goes low, TR6 goes off and D3 is extinguished. The time it takes for this process to be executed can be varied by VR1.

BOARD ASSEMBLY

All the components with the exception of the switches, the l.e.d.s, and the potentiometer, are mounted on a piece of 0·1 inch matrix stripboard size 24 strips by 12 holes. The layout of the circuit board is shown in Fig. 2 together with details for the breaks to be made in the copper strips.

Leave the inclusion of the transistors until last. There are a number of flying leads which should be attached to the board at this stage. Notably the four leads to D1 and S2 should emerge from the copper side of the board that is to be soldered directly to their appropriate track positions without being passed through a hole on the board topside.

CASE

There is not a great deal of room in the case specified, but there is sufficient if care is taken, and a compact, convenient unit is the result. The case used measured 120×66×40mm with internal slots for vertical board mounting hardware. This negates the need for mounting hardware.

Drilling details for the l.e.d.s and switches are given in Fig. 3. The arrangement, however, is quite simple. D3 is situated in the centre of the panel with the on/off switch (S4) and reset button (S3) positioned either side. S1 and S2 are placed as near to their respective ends of the panel as possible.

The fixing centres of D1 and S2 are equidistant from the horizontal axis of the panel, as are D2 and S1. VR1 is mounted in the centre of a long side. The battery and the circuit board are placed either side of the centrally mounted switches and l.e.d.

IN USE

When the unit is first switched on, all l.e.d.s should light. After a short period D3 will go out (the time this takes being dependent on the position of VR1) as C1 charges to 0·6V. If S3, the reset switch, is now briefly depressed D1 and D2 will be extinguished and D3 will light again. The unit is in the "play" state where the aim is to "hit" your switch first when D3 goes out.

VR1 is included in the circuit to add some unpredictability as to when D3 goes out, so that "veterans" cannot anticipate this. As such VR1 should have an unmarked knob and should preferably be twiddled between bouts by a third person.

Some people are also better on a short delay than a long one, and vice versa. But after saying this, remember that it's not to be taken too seriously and all results should be treated with a healthy amount of conjecture! ⌑

COMPONENTS

Resistors

R1	10kΩ	R10	10kΩ
R2	68kΩ	R11	1·5kΩ
R3	10kΩ	R12	68kΩ
R4	1·5kΩ	R13	10kΩ
R5	10kΩ	R14	10kΩ
R6	27kΩ	R15	1MΩ
R7	10kΩ	R16	10kΩ
R8	27kΩ	R17	2·2kΩ
R9	10kΩ	R18	1·5kΩ

All ¼W carbon ±5%

See Shop Talk page 455

Capacitor

C1 47µF 10V elect.

Semiconductors

TR1-TR6 BC108 *npn* silicon (6 off)
D1-D3 TIL220 0·2 inch red l.e.d. (3 off)

Miscellaneous

VR1 1MΩ linear carbon potentiometer
B1 9V type PP3
S1, S2 s.p.s.t. normally open momentary action push switch (2 off)
S3 d.p.d.t. momentary action push switch
S4 s.p.s.t. slide switch
Stripboard: 0·1 inch matrix size 24 strips by 12 holes; battery connector; plastic case, size 120 × 66 × 40mm (ABS 2004); control knob—no markings; fixing clips for l.e.ds (3 sets).

Approx. cost Guidance only £4·75

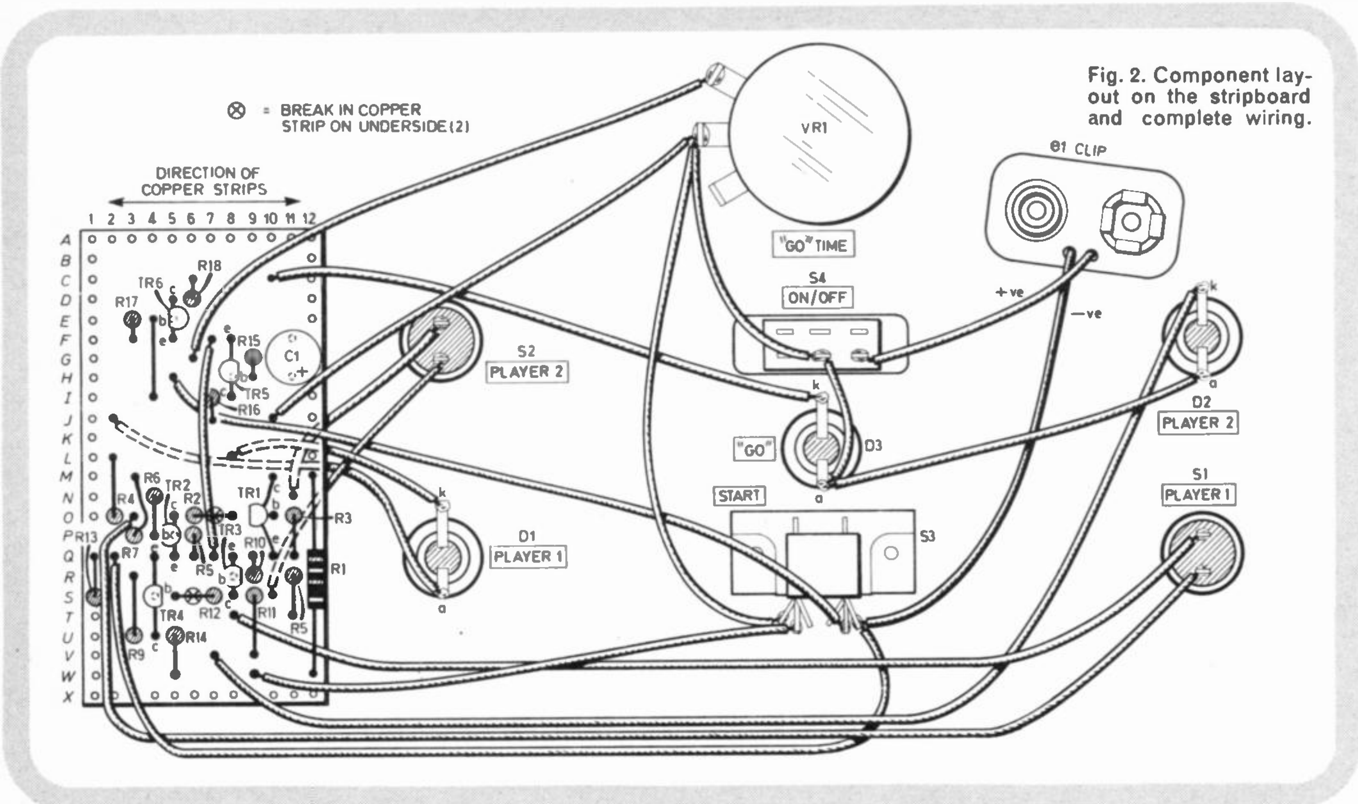


Fig. 2. Component layout on the stripboard and complete wiring.

Sinclair ZX81 Personal Comp
the heart of a system that grows with you.

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

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

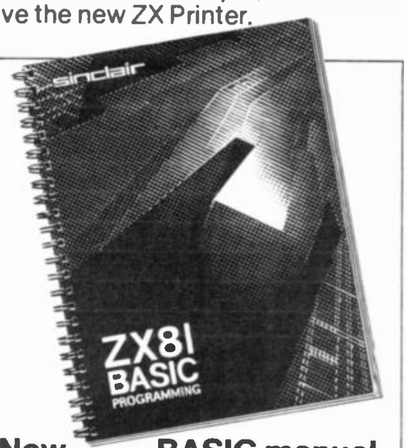
Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability

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

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

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



New BASIC manual

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

Kit: £49.95

Higher specification, lower price – how's it done?

Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

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

New, improved specification

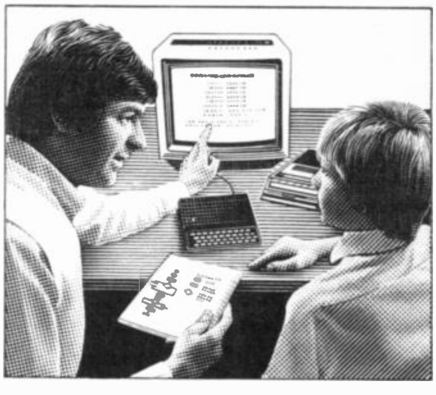
- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes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

Built: £69.95

Kit or built – it's up to you!

You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 700 mA at 9 V DC nominal unregulated (supplied with built version).

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



uter-

Available now- the ZX Printer for only £59.95

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

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

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

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

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

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

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

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

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

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

How to order your ZX81

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

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

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

To: Sinclair Research Ltd, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (700 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	29.95	
	Sinclair ZX Printer.	27	59.95	
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sinclair ZX81

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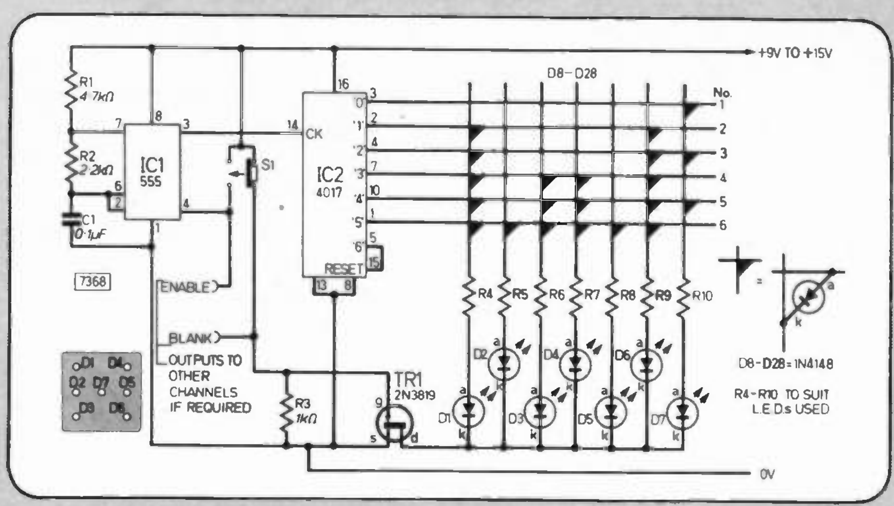
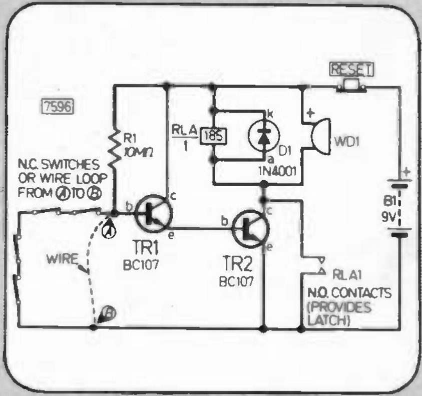
CIRCUIT EXCHANGE

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

Payment is made for all circuits published in this feature.

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





BURGLAR ALARM

I enclose a circuit of an ultra-low quiescent current burglar alarm. I cannot read the current on my 500µA f.s.d. meter. The current, I estimate at 0·5µA. In use, my unit consumes 70mA, though it depends on the alarm device and RLA.

The alarm is designed for a closed loop alarm system; when the loop is *broken* the alarm sounds. This has obvious applications as a bike alarm; a wire being run through the spokes, which if broken or unplugged from unit sounds the alarm. Far cheaper than even the EE Bike Alarm.

Brian S. Craigie,
Edinburgh,
Scotland

ELECTRONIC DIE

I enclose the circuit diagram of an Electronic Die which I have designed.

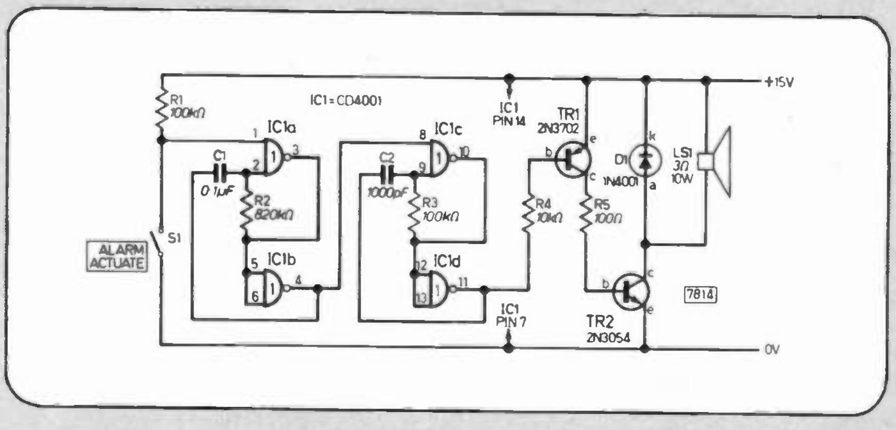
The display consists of seven l.e.d.s arranged in an "H" formation. These are connected to the outputs of IC2, a 4017 decade counter, via a diode matrix which ensures that only the l.e.d.s wanted are lit.

When S1 is pressed resistor R3 pulls the gate of TR1 negative, thus turning it off and blanking the display. It also enables the 555 oscillator IC1 which clocks IC2 at a frequency of about 10kHz with the values shown.

When S1 is released it disables the oscillator and turns on TR1, allowing the display to light at a number dependant on which output of IC2 is high. Due to the high frequency used the output is virtually a random number. The diode matrix can be changed to suit the display wanted.

The circuit can be modified so that two or more die operate in "parallel", each having a different clock rate.

G. Foote,
Woodford Green,
Essex.



SIMPLE SOUND GENERATOR

I have just finished reading a book on simple sound generator circuits. I came to the conclusion that there was not an alarm generator that produced more than 2W output. I set about improving a design and have come up with this alarm which gives a full 10W from a 15V supply. It also has one other feature, the alarm is a pulsed tone alarm which is a more attractive sound than a normal tone generator.

P. Linforth,
Solihull,
W. Midlands

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- Instant inverse video.
- Switching inverse video on and off gives flashing characters/numerals etc.
- Video pages can be superimposed by software switching.
- Access to video page is similar to plot and unplot commands in BASIC.

The pack comes in an elegant aluminium case, anodised black and styled to fit onto the back of the ZX81, allowing more add-ons (Memopak RAM, Sinclair printer, etc) to be connected without a further power supply. It contains a 2K EPROM monitor, holding a full range of graphics subroutines which can be called by the BASIC USR function or by machine code.

Unique 3 month trade-in offer!

For your future needs, we'll allow you £10 against your purchase of our 64K model if:
you return your 16K pack within 3 months of receipt;
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*We reserve the right to reject, for discounting purposes, units which have been either opened or damaged in any way.

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It is a fact that the ZX81 has revolutionised home computing and coupled with the new Memopak 16K it gives you a massive 16K of Directly Addressable RAM, which is neither switched nor paged. With the addition of the Memopak 16K your ZX81's enlarged memory capacity will enable it to execute longer and more sophisticated programs, and to hold an extended database.
The 16K and 64K Memopaks come in attractive custom-designed and engineered cases which fit snugly on to the back of the ZX81 giving firm, wobble-free connections.

MEMOTECH ADD-ON £68.70 plus VAT

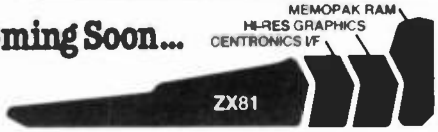
Memopak 64K Memory Extension

The 64K Memopak is a pack which extends the memory of the ZX81 by a further 56K, and together with the ZX81 gives a full 64K, which is neither switched nor paged, and is directly addressable. The unit is user transparent and accepts BASIC commands such as 10 DIM A(9000).

BREAKDOWN OF MEMORY AREAS

0–8K . . . Sinclair ROM **8–16K** . . . This section of memory switches in or out in 4K blocks to leave space for memory mapping, holds its contents during cassette loads, allows communication between programmes, and can be used to run assembly language routines. **16–32K** . . . This area can be used for BASIC programmes and assembly language routines. **32–64K** . . . 32K of RAM memory for BASIC variables and large arrays.
With the Memopak 64K extension the ZX81 is transformed into a powerful computer, suitable for business, leisure and educational use, at a fraction of the cost of comparable systems.

Coming Soon...



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LOW RADIO INTERFERENCE fully suppressed supply and absence of inverter 'spikes' on the output reduces interference to a minimal level.

DESIGNED IN RELIABILITY an inherently more reliable circuit combined with top quality components – plus the 'ultimate insurance' of a changeover switch to revert instantly back to standard ignition.

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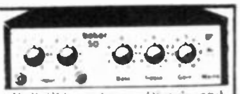

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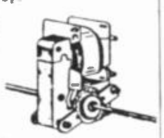

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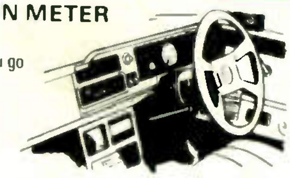

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