electronics today

JANUARY 1978 INTERNATIONAL

40p

Electronics In Surveying

Wireless Show Report

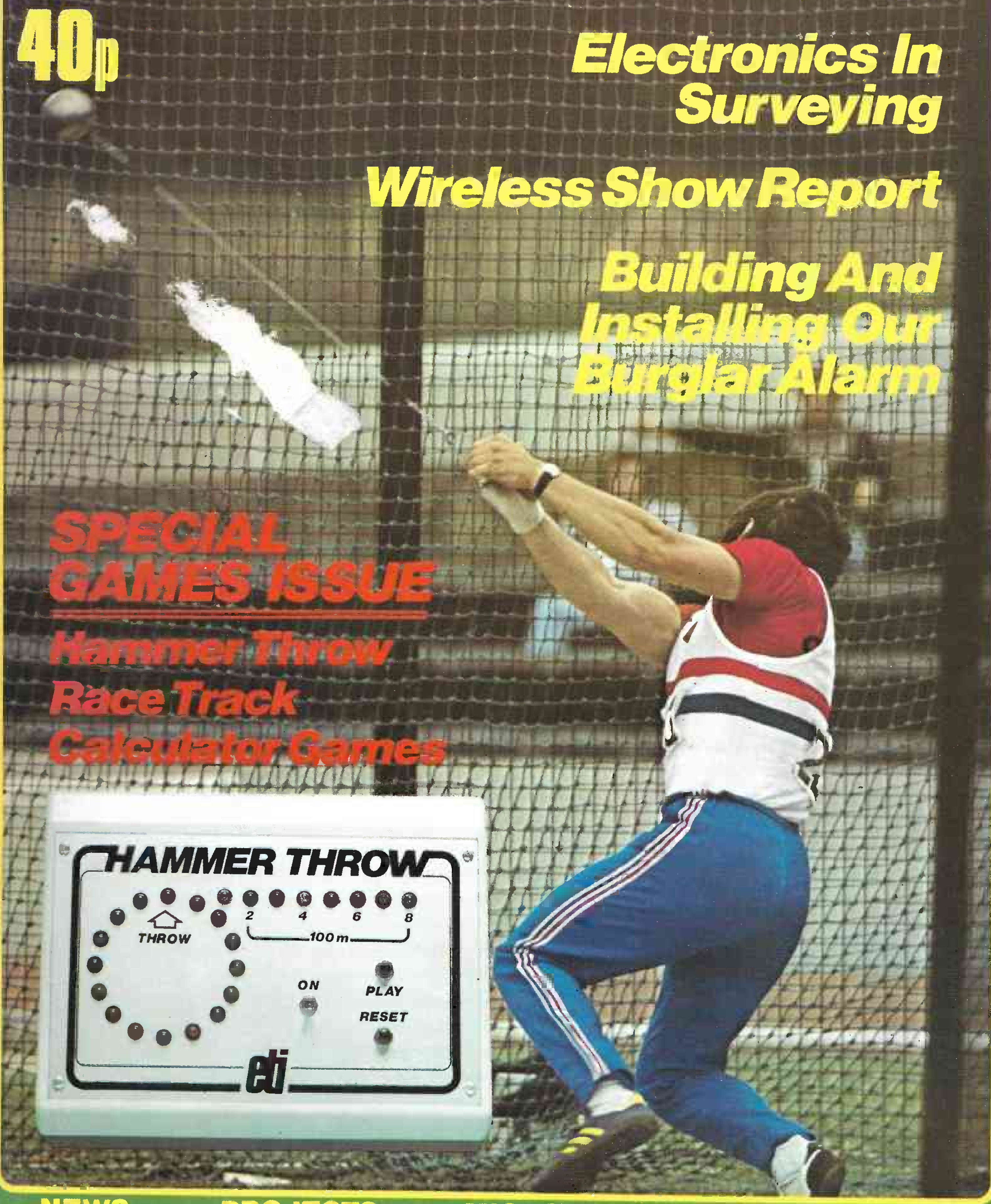
Building And Installing Our Burglar Alarm

SPECIAL GAMES ISSUE

Hammer Throw

Race Track

Calculator Games



. . . NEWS . . . . PROJECTS . . . . MICROPROCESSORS . . . . AUDIO . . .

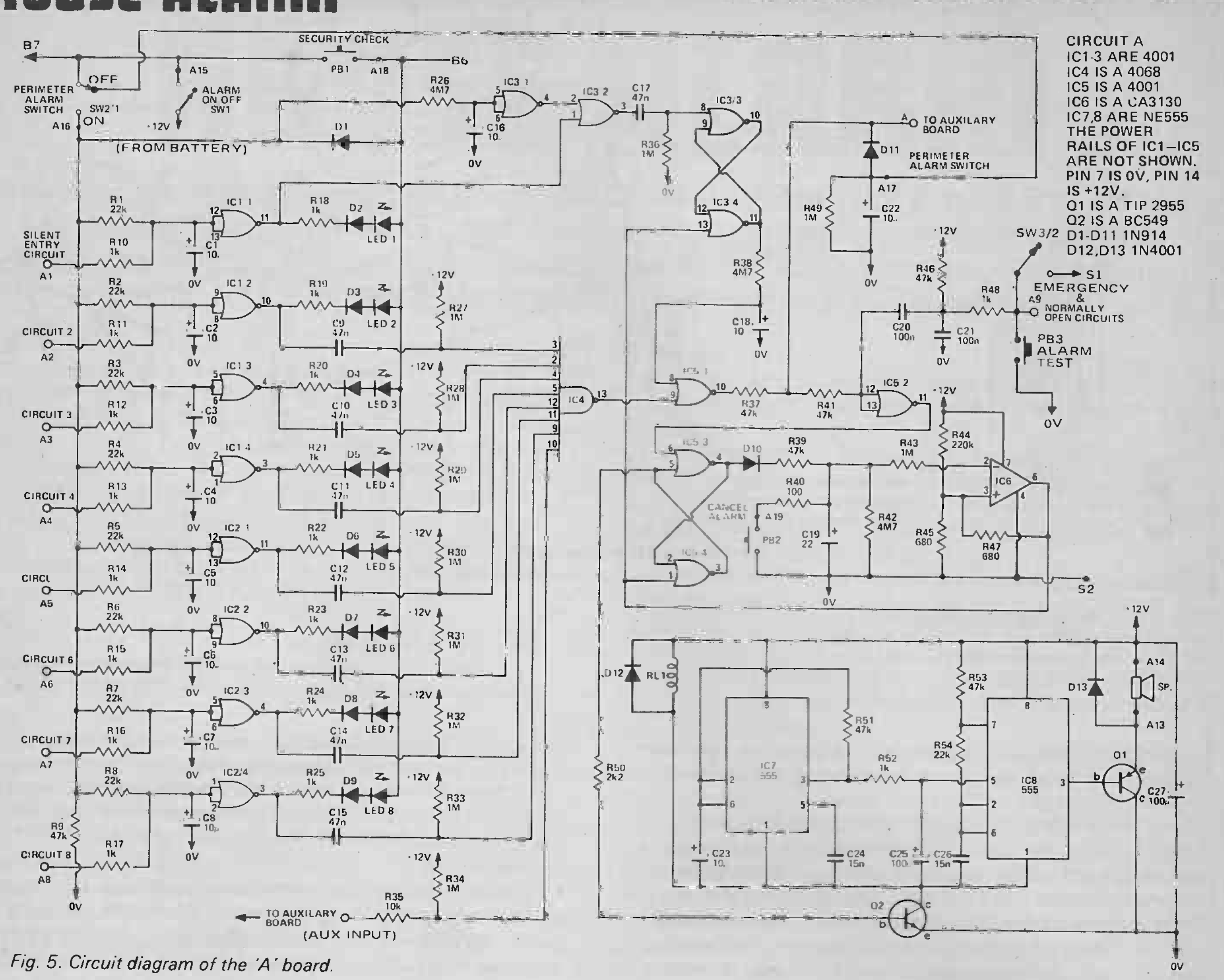


Fig. 5. Circuit diagram of the 'A' board.

run. The wires should be concealed from view.

We strongly recommend that a seperate 12 V battery be used in any burglar alarm. This should be checked at regular intervals to ensure it is still in good condition and should be replaced as a matter of course when it has been in service for a period of one year.

Alarm Unit

The specification of our alarm unit is shown in Table 1. From this one can see that the alarm has seven 'normally closed' circuits (A2-A8) plus a silent entry circuit (A1) which allows about 30 seconds on entry to turn the alarm off. This feature also gives a 30 second delay between turning the alarm on and the sensors being armed, this allows time to leave the house.

It is possible to connect two or more alarm switches in series for each external circuit but if so doing ensure that any such series-connected switches are grouped together.

The reason for providing a number of seperate alarm circuits is to do with the problems involved with resetting a triggered alarm mentioned above. Most alarms work on a system where all the windows and doors have normally closed reed switches all wired in series so that opening any one breaks the loop and sets the alarm off. The alarm then rings for ten minutes and

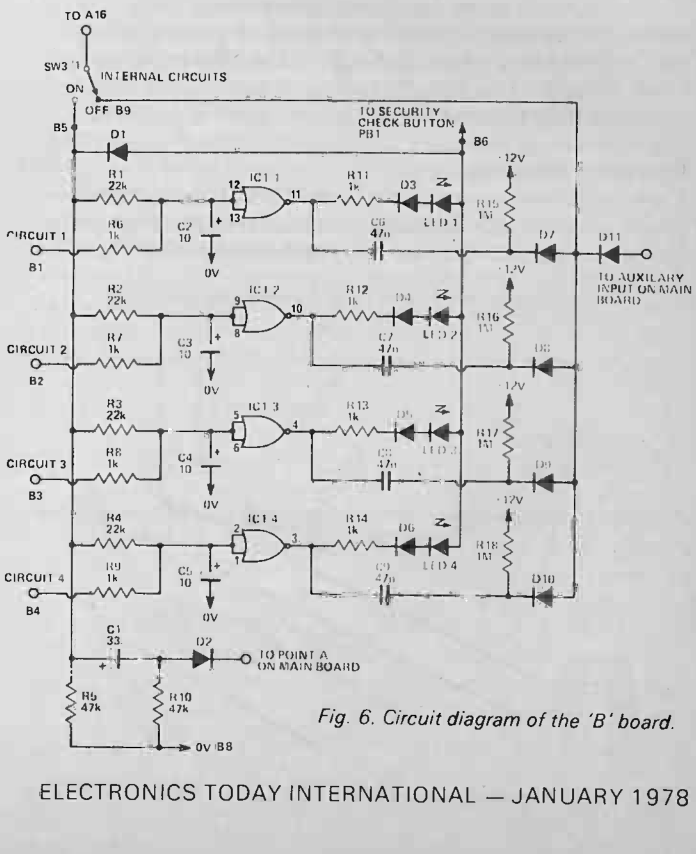


Fig. 6. Circuit diagram of the 'B' board.

HOW IT WORKS

UNLIKE SOME ALARMS that use a single sensing loop with all the switches wired in series, this design features a number of different alarm groups. These are broken down into two groups designed for normally closed (N/C) switches – Perimeter Group (inputs A_1-B_8) and Internal Group (inputs B_1-B_4m) — together with one group for normally open (N/O) switches (inputs to A_9).

The inputs to each of the circuits described above have their own input circuitry.

PERIMETER CIRCUIT

The normally closed sensors associated with the perimeter circuit (inputs to A_1-A_8) are connected to the circuitry around IC_1 and IC_2.

These ICs are Quad NOR gates which, in this application are configures as inverters. The sensors are connected to the inputs of these gates via the resistors R_{10}-R_{17}. With the sensor switch closed the output of the associated IC will be high. If the switch is opened the output will go low as the inputs to the gates are then tied high via resistors R_1-R_8. R_9 is included to ensure that the inputs to the CMOS ICs are terminated under all conditions. The capacitors C_1-C_8, together with the resistors R_{10}-R_{17}, provide a filter to ensure that transients on the input lines do not trigger the alarm.

In each output of IC_1 and IC_2 there is a LED which is connected to the Security Check Button (PB_1). Upon operation of this button power is supplied to the LEDs which will light if the IC they are connected to has a low output, ie the input is triggered. The diodes in series with the LEDs are necessary because of the low reverse voltage breakdown of the LEDs. Diode D_1 supplies power to the input circuitry during the security check. The input A_1 provides the silent entry feature and is described below.

The other sections A_2-A_8 have their outputs fed via an RC network, which generates a negative pulse upon triggering, to one of the inputs of IC_4. Thus if any of the inputs are triggered a positive pulse at the output of IC_4 will result.

SILENT ENTRY CIRCUIT

With the silent entry circuit a 30 second delay due to R_{26}, C_{16} and $IC_{3/1}$ overrides the output of IC_1, immediately after the alarm has been energised. After this time if the input is triggered the output of IC_3, will go high, having been inhibited from doing so until now by the high output of $IC_{3/1}$, and will toggle the RS flip flop formed by $IC_{3/3}$ and $IC_{3/4}$, taking the output of $IC_{3/4}$ high. After another 30 second delay due to R_{38}, C_{18} the input to $IC_{5/1}$ will be high and its output low.

TRIGGERING CIRCUIT

The same output results if one of the other inputs is triggered and the output of IC_4 goes high momentarily.

This output is used to toggle, via $IC_{5/2}$, the RS flip flop formed by $IC_{5/4}$ which is used to control the alarm and resetting circuitry described below.

$IC_{5/2}$ also has two other inputs. The first, consisting of the network R_{49}, C_{22} and D_{11}. This circuitry disables the alarm function when the Perimeter Switch is in the off position and for a short period of time after the switch is moved to the on position by holding the input of $IC_{5/2}$ high. This prevents spurious triggering.

The second input to $IC_{5/2}$ is from the normally open input (A_9), as well as the emergency and alarm test switches. If any of these switches are taken low a negative going pulse is coupled to $IC_{5/2}$ to trigger the alarm. These functions operate even if the perimeter sensors are off. This input can be used for emergency inputs such as fire alarms.

OUTPUT

The positive going pulse at the output of $IC_{5/2}$ sets the RS flip flop $IC_{5/3}$, $IC_{5/4}$ and in this triggered state $IC_{5/3}$ output is low and $IC_{5/4}$'s high.

The delay circuitry uses a CA3130 (IC_6) configured as a comparator. C_{19} is normally charged to +10V until the flip flop is triggered allowing it to discharge via R_{42}. When the voltage on C_{19} has fallen to about 20mV (the level set by R_{44} and R_{45} on the non-inverting input of IC_6). The output of the IC will go high resetting the flip flops formed by $IC_{5/3}$, $IC_{5/4}$ and $IC_{3/3}$, $IC_{3/4}$. R_{47} is included in the feedback loop to provide some hysteresis.

The output device can either be a relay or siren circuit. We have provided for both options. The siren output is formed by two 555s, one operating at a high frequency and driving the speaker via driver transistor Q_1 and the other at about 2Hz which is used to modulate the frequency of the first.

The relay and 555s are energised when Q_2 is turned on by the high output of $IC_{5/4}$ as the flip flop is set.

Addition circuits can be added in blocks of four at a time (as Board B) and connected to the Aux. input.

AUXILIARY BOARD

The circuitry of board B is almost identical to that of Board A. The main difference is that the negative going outputs of each IC are ORed using diodes D_7-D_{10} as opposed to a logic gate.

This board can only be energised if the perimeter board is powered up. The capacitor C_1, together with R_{10} and D_2, provide a short positive going pulse upon switch on to disable the main alarm for a brief period of time.

---

resets. If, however, the window, as is likely, is still open, the alarm must be turned off completely to prevent it continuing to ring.

This is the reason that our alarm does not use a single loop but has a number of alarm groups. Further, the alarm is triggered only by a change of state in any of its alarm loops. Thus if the alarm is triggered by the change of stage in any of its sensing loops when a window, say, is open, it will not be retriggered when after a period of time it resets and the window is still open. This affords some protection to the premises under these conditions.

We have provided a test button so that a check on the security of the house can be made before the alarm is set, indicating immediately which window or door is open.

As well as the external circuits the system has provision for connecting a number of internal circuits. These may be actuated by normally closed switches — in which case they should be connected to B1-B4 — or by normally open sensors connected to A9.

It may well be worth considering installing a series of emergency push buttons. Such switches should be mounted on the architraves of the front and rear doors or in a readily accessible position near the doors. They enable the occupant to set off the alarm if a caller forces his way into the house when the door is opened.

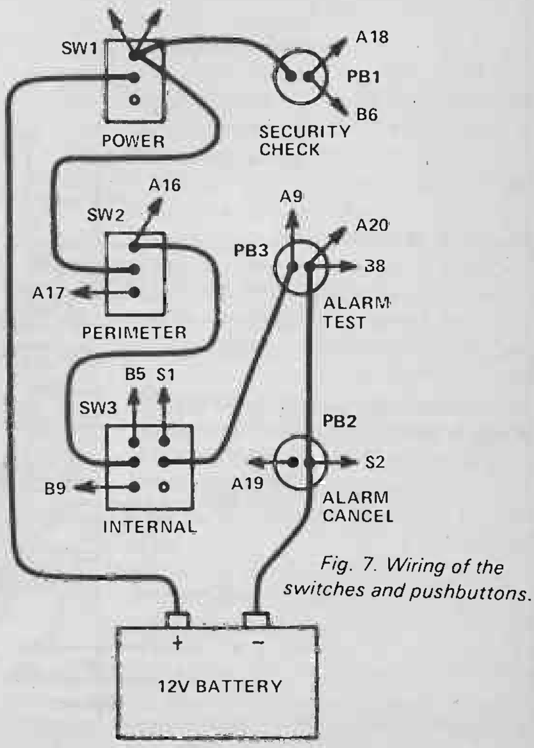


Fig. 7. Wiring of the switches and pushbuttons.

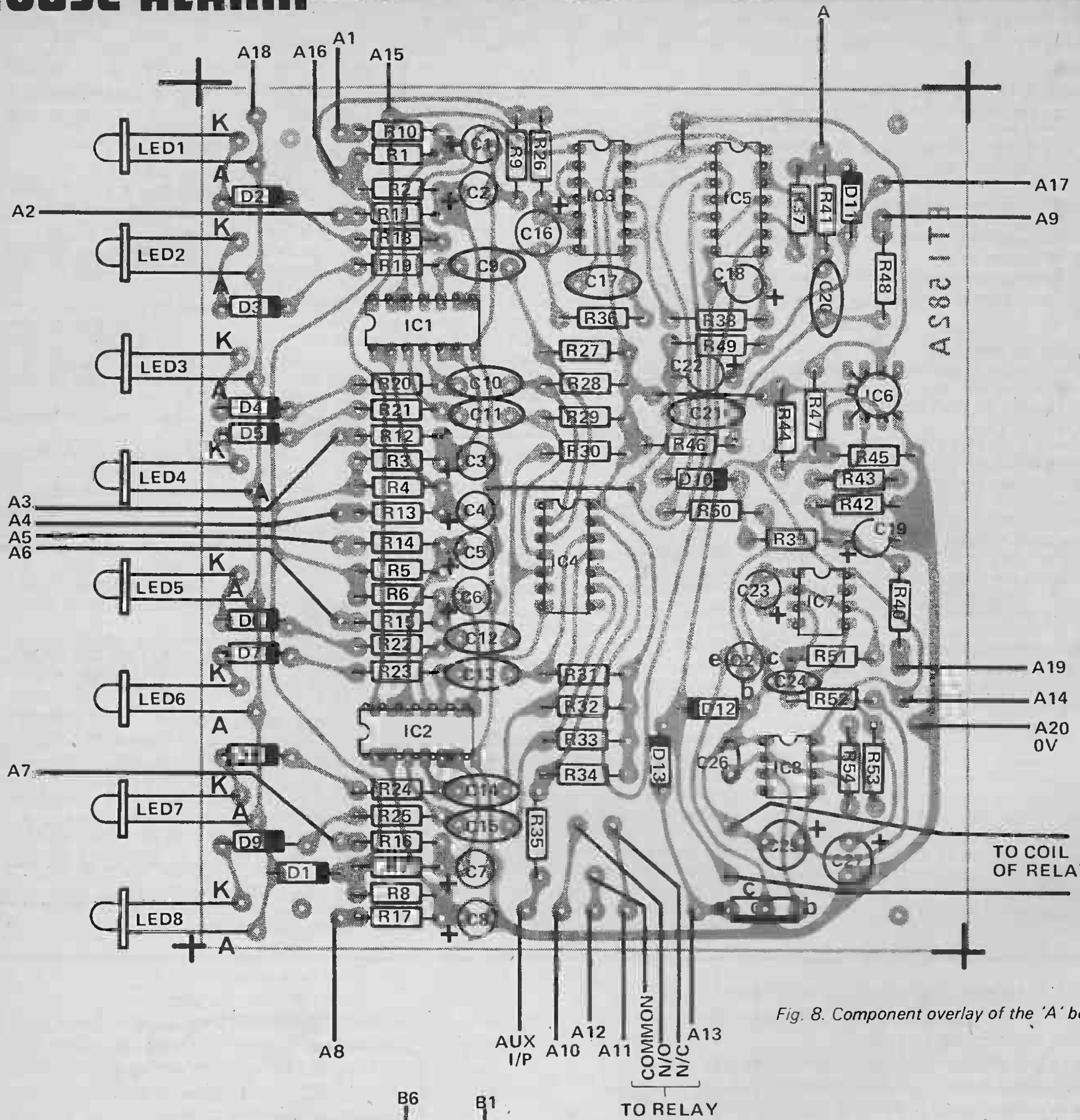


Fig. 8. Component overlay of the 'A' board.

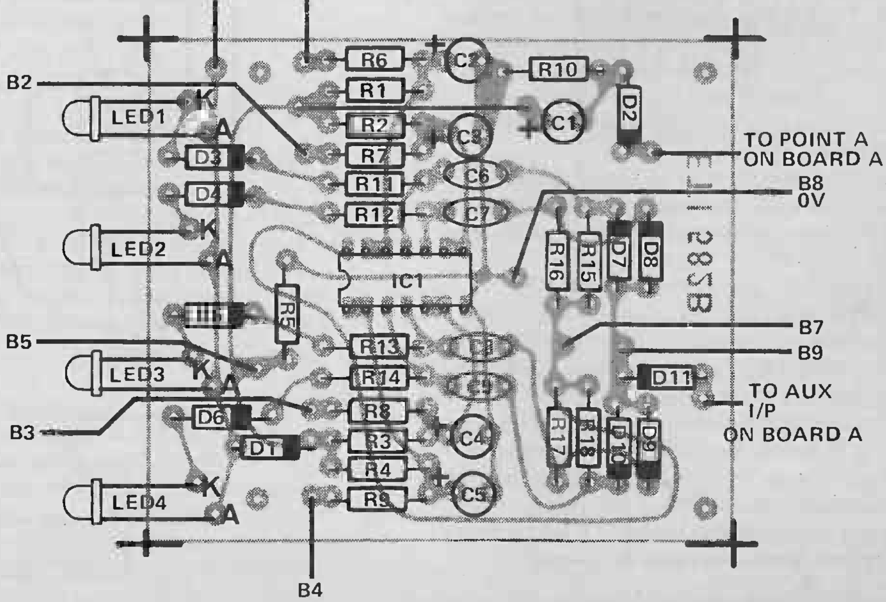


Fig. 9. Component overlay of the 'B' board.

Although this is not a common event, emergency switches provide elderly or timid people with a feeling of security.

Use good quality bell pushes for these circuits and connect them to the A9 inputs on the circuit board.

Fire Alarms

Fire sensors may be wired across the A9 input. The actual fire sensors should be mounted in the ceilings of rooms in which there is a fire hazard — kitchen, living room, rooms with electrical or heating applicances or where people smoke (don't forget the bedroom if you've a habit of smoking in bed!). Sensors should also be installed in the roof of the garage especially if this is attached to the house — the laundry, workshop etc.

Construction

Due to the number of components, it is recommended that the unit should only be built using the PCBs shown here.

Assemble the components, watching the connection of all the polarised components. Also solder the CMOS ICs last and then solder pins 7 and 14 first. This allows the protection diodes inside the IC to be effective. The LEDs should be mounted parallel to the PCB as shown in the overlay as these have to protrude through holes in the chassis.

Boxing of the alarm unit is largely a matter of choice. Our layout can be seen in the photographs. Note that we did not fit a key switch to our alarm, but installed it in a locked cupboard which could also be used for the storage of valuables.

Security Sense

May we say again that the installation of an alarm should only be part of a co-ordinated campaign to dissuade burglars. Details of the various preacutions that can be taken were detailed in our feature last March. Your local Crime Prevention Officer will also be prepared to give help on most matters of security.

ETI

PARTS LIST

BOARD A

RESISTORS all ½ W 5%

R1-8,54	22k
R9,37,39,41,46,51,53	47k
R10-25,48,52	1k
R26,38,42	4M7
R27-34,36,43,49	1M
R35	10k
R40	100R
R44	220k
R45,47	680R
R50	2k2

CAPACITORS

C1-8,16,18,22,23	10u 16 V tantalum
C9-15,17	47n polyester
C19	22u 16 V tantalum
C20,21	100n polyester
C24,26	15n polyester
C25,27	100u 16 V

SEMICONDUCTORS

IC1-3,5	CD 4001
IC4	CD 4068
IC6	CA 3130
IC7,8	555
LED1-8	.2" type LED
Q1	TIP 2955
Q2	BC109
D1-11	1N914
D12,13	1N4001

MISCELLANEOUS

PCB as pattern, 12 V 185R relay.

BOARD B

RESISTORS all ½ W 5%

R1-4	22k
R5,10	47k
R6-9,11-14	1k
R10	47k
R15-18	1M

CAPACITORS

C1	33u 16 V electrolytic
C2-5	10u 16 V tantalum
C6-9	47n polyester

SEMICONDUCTORS

IC1	CD 4001
D1-11	1N914
LED1-4	.2" type LED

MISCELLANEOUS

PCB as pattern.

GENERAL FOR BOARDS A & B.

SWITCHES

SW1	SPST toggle switch
SW2	SPDT toggle switch
SW3	DPDT toggle switch
PB1-3	single pole press to make push type.

MISCELLANEOUS

Case to suit, 12 V battery (HP1 or 2 X 991) terminal strip.

SPECIFICATION

Types Of Inputs	Silent entry Perimeter circuits Internal circuits Emergency circuits
Silent Entry	Single circuit, 30 s exit delay, 30 s entry delay.
Perimeter Circuits	7 circuits, N/C contacts, can be expanded in units of 4.
Internal Circuits	4 circuits, N/C contracts, can be expanded in units of 4. Any number of N/O circuits.
Emergency Circuits	Any number of N/O circuits. These circuits are active even if perimeter and internal circuits are switched off.
Current Drain And Battery Life (Type HP1 or similar)	
Emergency only	2.5 mA (4000 hours)
Alarm active	9 mA (2000 hours)
Alarm sounding	500 mA (10 hours)
Alarm Time	12 minutes.

HOUSE ALARM

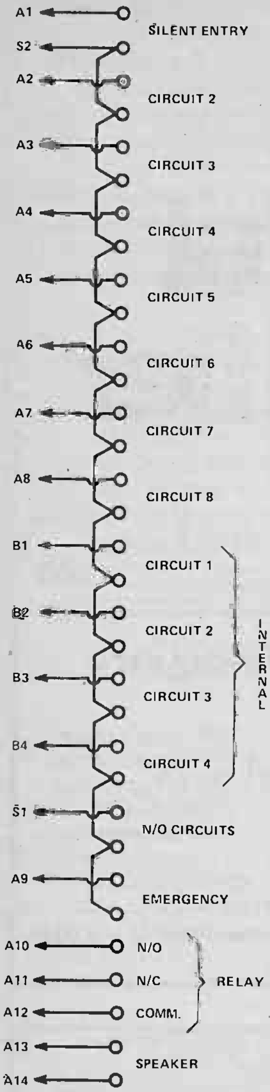


Fig. 10. Connection of the rear terminal block.

BUY LINES

The components for this project should be available from most suppliers, Watford, Marshalls, Maplin etc., or, probably, from most local shops. The Siren used is a matter of choice, but please make sure it's up to the job.

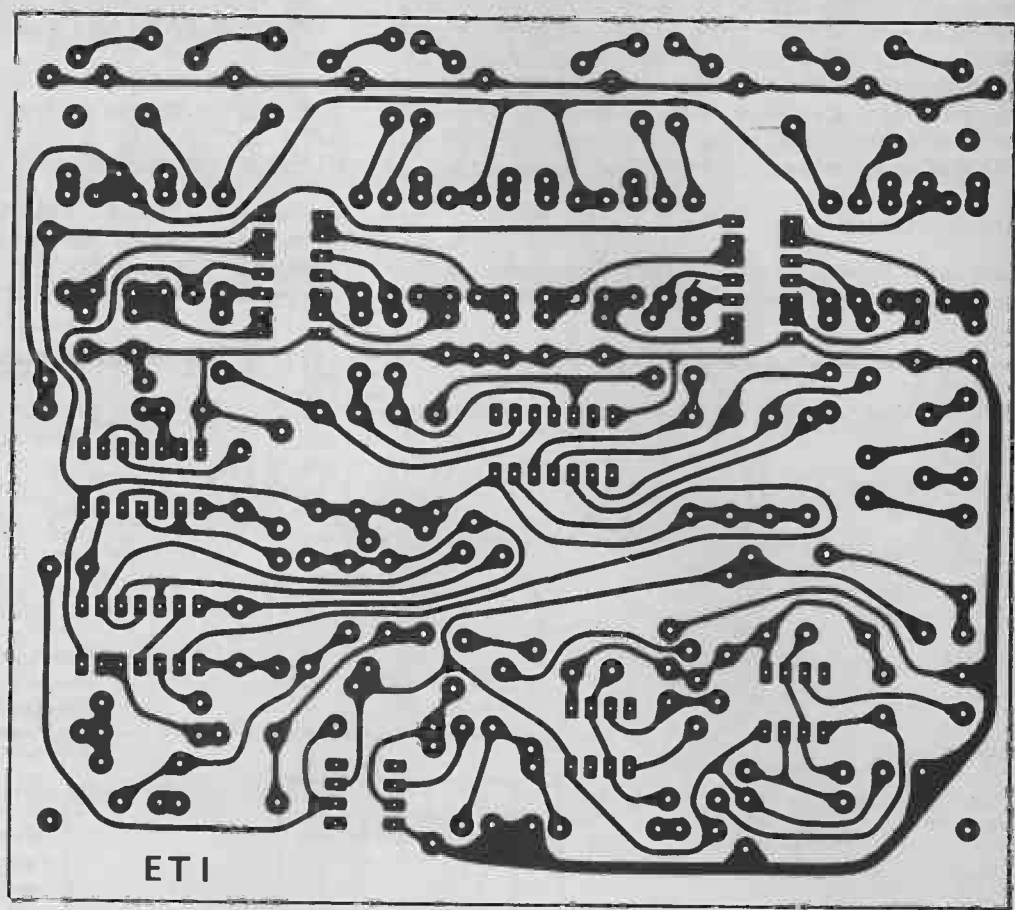


Fig. 11. PCB foil pattern of 'A' board shown full size (130 x 115mm).

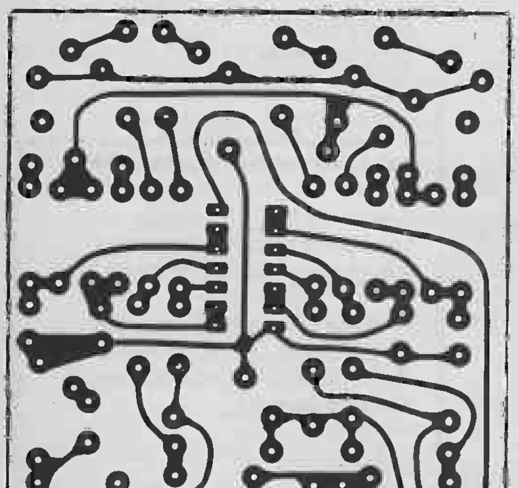
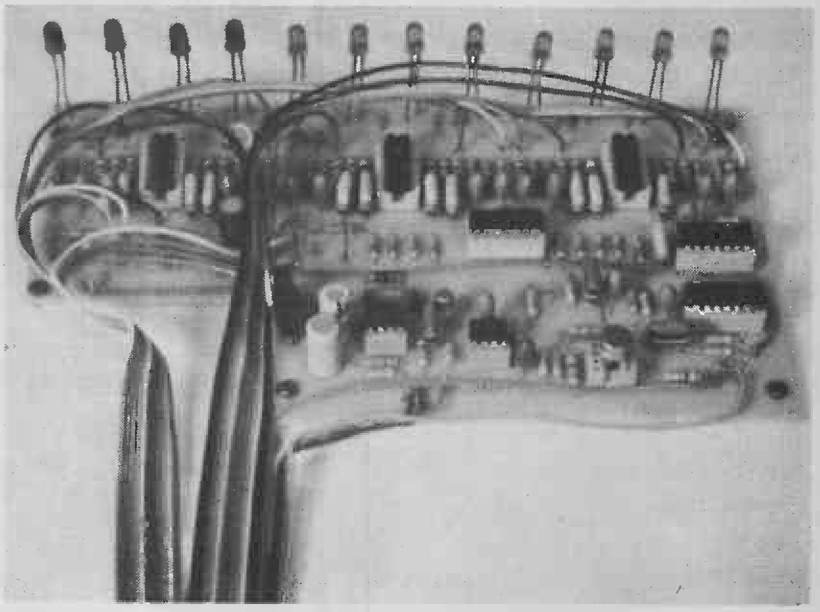


Fig. 12. PCB foil pattern of 'B' board shown full size (75 x 65mm).



ELECTRO IN SURVE

THE PRACTICAL ASPECT of a professional surveyor's job requires measurement of the size, shape and position (relative to other such defined shapes) of pieces of land ranging from the small household plot to the size of a country. It may also involve the application of the same methods for the measurement of large manufactured objects, such as buildings, bridges and other engineered structures. Such tasks commonly require measurement of distances and lengths ranging from a few metres to thousands of kilometres to precisions as small as a millimetre and angles to precisions down to less than an arc second.

Combinations of length and angle measurements, on a basis of measurement using triangles, are used in various ways to define shape and size. Definition of direction, with respect to North, and with respect to a level surface or a vertical plane, also enters into a surveyor's daily needs.

In many cases, for reasons of convenience, the measurements made are not *quite* those actually needed: conversion or correction is required and, as the mathematical process must be performed within 5 to 7 decimal figures of precision, the calculations needed can become tedious. As an example, when measuring the distance between two pegs in sloping ground it is the horizontal distance to a point vertically above the pegs that is often needed. The distance measured in practice is more often than not the slope distance between the actual position of the pegs.

Enter electronics

Until the 1950s the most precise method for measuring long lengths used a steel-tape hung in catenary, this method having developed from the less accurate chain of iron links. Another optical method, called tacheometry, used the telescope of the theodolite

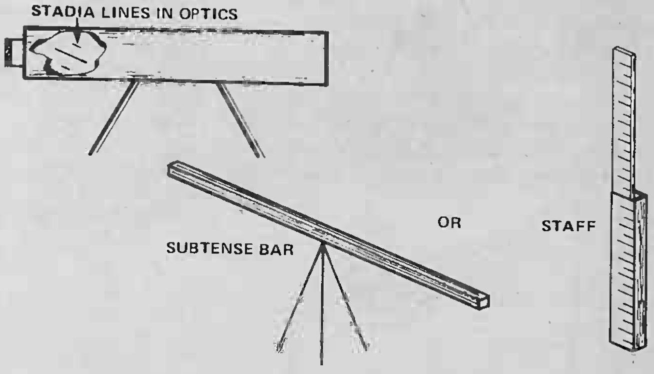


Figure 1. Using a telescope to determine range by tacheometry.

NICS
YING

A quiet revolution has taken place in the field with the advent of electronic methods. Dr. P. Sydenham explains how.

or level to determine range by observing a known length-interval of a measuring staff (placed at the far point) within a given observed angle defined by two lines in the telescope's field of view — see Fig. 1.

By the late 1950s the surveying instrument makers — traditionally they were then mainly from Europe — had acquired generations of skill with optics and fine mechanics, but little knowledge and experience with electronic technique. Because of this they were, at that time, understandably reluctant to develop and market electro-optical devices for surveying. However, by the mid-1960s the industry had built up its confidence in electronic methods and today we are in the midst of a quiet revolution.

This revolution began in earnest with the development and acceptance of an electro-optical method of long-range determination around 1945. It was called the Geodimeter and was made by AGA of Sweden to designs produced earlier by Dr E. Bergstrand. (History records the fact that Galileo proposed an optical method which was later tried unsuccessfully in the 1600's. At that time they lacked fast enough responding light sensors.) The AGA method could measure 20 km distances with only a few parts per million error.

After the Geodimeter came the Tellurometer, which made use of modulated UHF radio waves and could do better in range than the Geodimeter, with similar precision.

Figure 2. Tellurometer model MRAS, uses the microwave method to measure distance from 100 m to 50 km to an accuracy better than 1 in 500,000. Modern electronics have made it easy to operate. Readout is a 7-digit display of range.

What a Gaas

More development came about in the 1960s, the notable addition being shorter distance ranging apparatus based upon the easily modulated gallium arsenide Ga-As solid-state infra-red diode. This device was suited for the surveyor's needs in building and similar size tasks.

Simultaneously came the development of automatic theodolite scale-reading electronics. Observing with a second-of-arc scale instrument can prove tiring to the eyes, with the subsequent chance of a high error rate.

By 1970 electronic theodolites, as they became known, were being marketed by most of the large established surveying instrument makers. It was then just a matter of time to extend the automatic reading of scales to include straightforward conversion of angles and slope-distances into the required geometric parameter. These calculations were first done with separate electronic solid-state calculators; then the calculators were incorporated into the housing of the instrument itself. Today the latest machines use in-built microprocessors.

When automation can reduce the labour requirement at a cost less than the labour alternative, there is a case for its adoption.

That is why, in cases where extensive surveying work is needed, electronic methods have been used. For the same reason one instrument, that marketed by Hewlett-Packard, reduces the tolerances needed for initial levelling of the "theodolite" system by incorporating compensation measurement of the out-of-level existing at the time of measurement.

Let us now turn our attention to the detail of some of these developments.

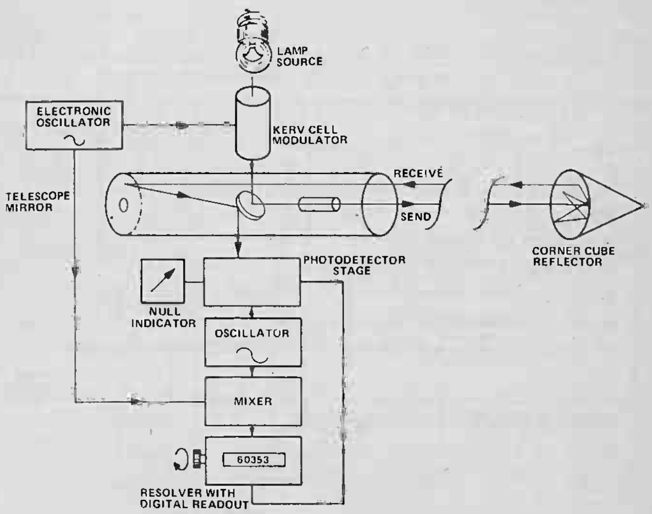


Figure 3. Much simplified schematic of Geodimeter model 6A distance meter. In this design electro-optical methods are used.

Ranging

Microwave methods: A continuously generated UHF signal, which is typically generated today by a Gunn diode oscillator, is sent from a small reflector or horn to a second unit placed at the other end of the distance to be determined. Phase difference between sent and returned signals provides a measure of distance in terms of the velocity of electromagnetic wave propagation in free-air conditions.

Accuracy is limited in all EDM (electronic distance measurement) methods by the knowledge of the refractive index of the air path. This limits all methods to around a 2 parts per million error in determining distances which range from 100 m to 50 km.

The first systems required the operator to learn a quite complicated procedure of use. Today the latest models provide digital readout, a voice channel to the person at the other station and, in some cases, an output compatible with digital data storage and processing systems. A modern microwave EDM unit is shown in Fig. 2.

The design and construction of microwave systems follow established radio communication practice using mixing techniques and special tone pattern generation. More detail on these methods is available in the "further reading" list given at the end of this review.

Electro-optical modulation: In these an optical carrier beam is modulated by altering the intensity of the carrier or its angle of optical polarization. The modulated beam is transmitted from a high-quality optical telescope to the far station where it is reflected back to the sender by one or more corner-cube reflectors. Fig. 3 shows the schematic of a Geodimeter model 6A.

Various sources of radiation are used in the models marketed. Originally a tungsten lamp or mercury discharge lamp was employed. Later improvements to range were provided by the use of helium-neon C.W. laser sources. Lasers also provided better utility in daylight conditions. The Mekometer method uses a pulsed Xenon gas source. The shorter distance modern units usually use a laser-diode source of infra-red radiation.

The kind of electro-optical technology involved in the manufacture of an I-R ranger is seen from the schematic of the optical system of the Hewlett-Packard 3820A, provided here as Fig. 4.

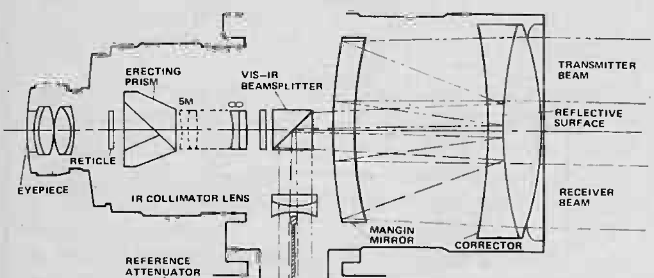


Figure 4. Electro-optical rangers require sophisticated manufacture to extreme provisions. This schematic is of an I-R laser diode instrument

Figure 5. The Wild DL10 Distomat is an I-R ranger that fits on to a conventional theodolite.

Tacheometry: Basically the angle subtended between a fixed interval bar of scale unit is used to determine range by redirecting the theodolite from end to end of the target interval. The alternative is to observe the interval of a graduated staff seen within the angle defined in the field of view of the telescope by two parallel lines appearing in that field of view.

A variation is possible in which the optics of the telescope are altered geometrically at the operator's control.

This method of ranging is simple in principle, but needs many geometric corrections in practice for the subtended interval is rarely geometrically square and central with the telescope. Corrections are needed to change slope to horizontal and vertical distances and to allow for the fact that the observed interval is not square to the observer.

Many of the new electronic methods are called "reducing tacheometers". These, it seems, are not true tacheometers in the traditional sense, but are in reality rangers to a point target.

Automatic angle measurement

The period 1950-65 was one in which extensive development of automatic angle measurement methods took place as part of numerically-controlled machine-tool development. Many methods of producing an electronic signal equivalent to angular rotation were invented.

Around 1960 several of the instrument designers in Europe began to apply these methods to surveying instruments so that the scales of a theodolite could be read automatically providing digital readout and automatic data reading.

Angular encoders for this task must provide circle subdivision to at least 21 600 increments (1 arc minute) in a small diameter.

Of the wide range of angular encoder types invented, optical methods have been adopted in electronic theodolites. Optical encoders may be of the incremental kind in which a pulse is produced and counted for each minimum resolvable increment of angular movement, the pulse being added or subtracted for the appropriate sense of direction. The alternative is to use a disk on which a digital code pattern is manufactured. This is called the absolute method, for there is no chance of pulse loss or gain due to noise,power-supply failure does not destroy the value.

Incremental methods use simpler to make measuring gratings because they need only identical lines ruled radially. A much higher density of lines is possible by this method than is economically available with the absolute scale. The absolute scale is more costly to make and read than the incremental version.

In practice experience has shown that a hybrid system is the best to use, one in which an absolute encoder disk scale provides the coarse-position component of the readout, a finer ruling incremental scale providing the less significant digits, usually by way of an analogue subdivisional method that interpolates between the rulings.

The future

In the world of large commercial manufacture, new ideas are slower to reach the market place than they are to realise. Over the next decade a number of improvements and alternatives should emerge.

Study of the time taken to set up a theodolite or level shows that the initial levelling procedure takes a significant time to achieve. Hewlett-Packard have recognised this and provided a partial solution to the user. Using electro-optic sensing of a plane surface, defined by a mercury pool, two-axis correction signals are produced that compensate for the not quite truly vertical central axis. The operator needs only to level the instrument within crude limits using a small circular bubbly level. The next stage must surely be to provide automatic levelling servos that set the instrument orientation regardless of gross misadjustment of the tripod top. This is straightforward to design — it is a matter of cost and time being available.

The next time-consuming task is to acquire the target and set the telescope fudicial mark on to it so that the angles can be read out. In many cases the target is identified by a special mark or pattern to make it easier to find. The next logical move is to have the theodolite or level automatically seek out the target, locking on to it. Once acquired, the scale values would be read automatically.

Another development that may replace the theodolite in many applications is a technique called chronometric angle measurement. In this method a rapidly spinning mirror causes a photo-detector to see established targets in sequence. The time between the sources is a measure of angle if the rate of rotation is known. Simple arithmetic establishes that the precision of timing available today is able to provide second of arc accuracy. There are no scales to read in the method. This concept was explored and an instrument built in Germany a decade ago. Perhaps the surveying instrument makers have a prototype ready to market now — such information is hard to establish in this highly competitive field of sophisticated instrumentation. ETI

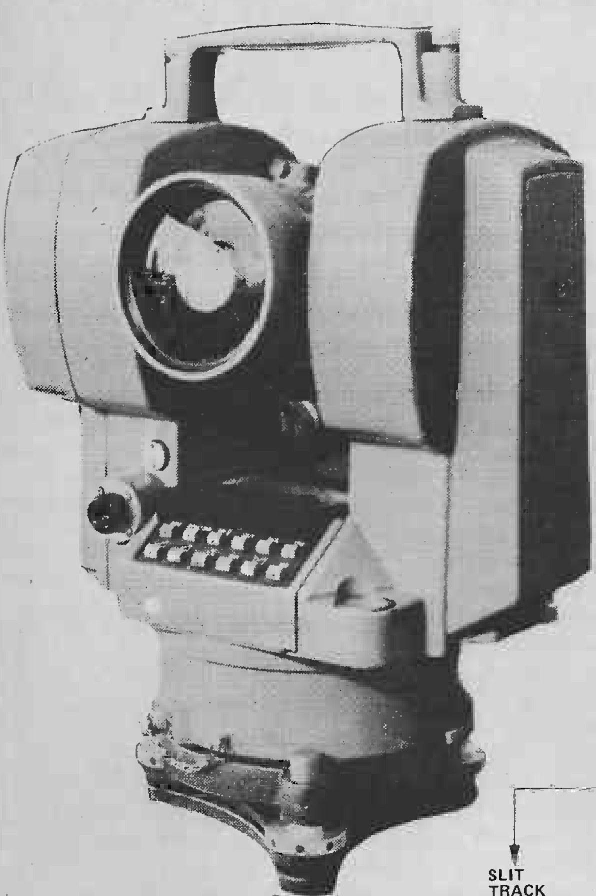


Figure 6. The 2820A electronic Total Station is an example of the more sophisticated electronic surveying instruments. Like some others, it contains a microprocessor that does the tedious calculations required, and the extra computing power available is used to correct readings for such variables as out-of-vertical of the instrument.

Further reading

"Surveying" by A. Bannister and S. Raymond, Pitman, 1977, contains a quite up-to-date chapter on electronic methods. It does not, however, discuss such concepts as electronic theodolites and instruments having micro-processors in them.

"Electromagnetic Distance Measurement" by C. D. Burnside Crosby, Lockwood Stapes, provides detail.

Hewlett-Packard Journal issues describe the theory, operation and construction of their Total-Station instrument in considerable depth. Most companies marketing this kind of equipment are able to provide reprints of papers describing the use of their products.

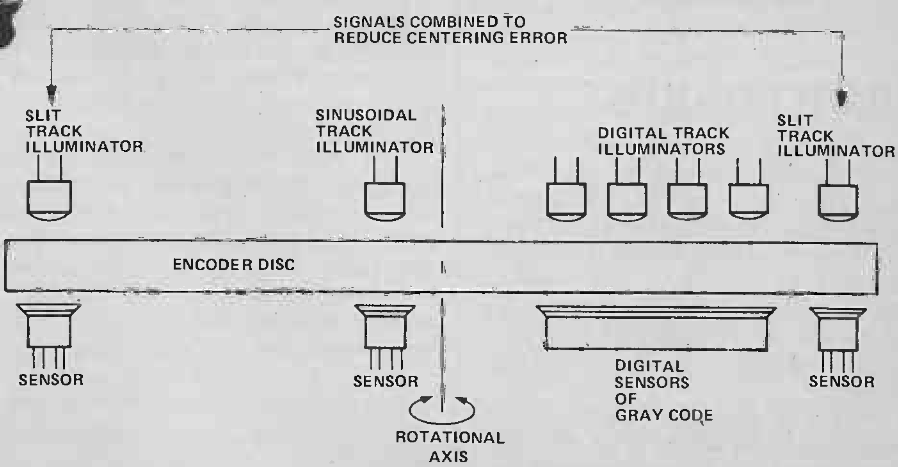
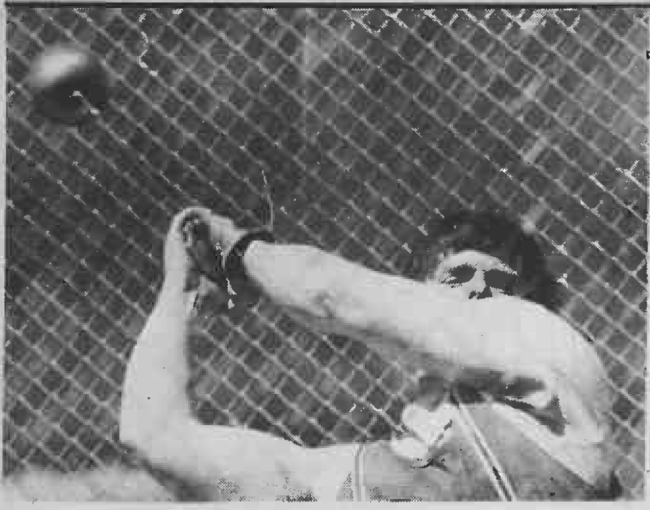


Figure 7. Cross-Section of reading heads that sense the angle in the HP 3820A Total Station.



HAMMER THROW

An exciting game of skill and luck that will help pass those long and lonely winter evenings.

IF, LIKE MOST of the ETI staff, you have more brains than brawn, and would not boast about the quality of either, it is likely that the mere thought of swinging a massive weight around your cranium is enough to strain your bodily systems. This probably means — and we are sorry if this comes as a disappointment — that your chances of selection for the Olympic hammer throwing team are, shall we say, nil.

Some may say that this is a pity as the sheer thrill of an event such as the hammer throw is probably very stimulating to those chunky brutes that are lucky enough to be able to take part. This is where we come to the rescue with our armchair version of the game. We think it has a number of distinct advantages over the real thing. One of these is that anyone, from an anemic sparrow upwards, can play the game. A second being that it is nowhere near as messy if, when playing in your lounge, you get things wrong.

The game, as can be seen from our photographs, has a front panel with a circle of sixteen LEDs together with a line of eight LEDs at a tangent to the circle.

To play, after pressing reset, firmly press the play button. The LEDs in the circle will light one at a time simulating a spot of light moving in a circle. At the same time a distinctive, not to say loud, sound will be generated.

The spot will at first travel slowly round the circle, but will soon begin increasing in speed until it is travelling quite fast.

The object of the game is to release the play button at the instant that the 'top' LED of the circle is lit. If sucessful the line of LEDs will light to indicate your score, the faster the spot was moving when you scored the more will be your score. If you miss, the cirle of LEDs will continue to rotate at the same speed as they were when you played.

Big Ones And Little Ones.

A game will consist of, say, eight rounds — the score from each being added to the last. At the end of a game the person who scored the most is the winner. The skill comes in deciding whether to go for a number of low scores that are relatively easy to get, or for a few big ones.

As befits the design of a project of this nature we were in convivial mood and pleasant surroundings when we first discussed the game. We produced the first design sketch (well a few lines on a beer mat — yes in the pub again) which used digital devices. Upon seeing this some likely person said that he thought most games featuring LEDs designed over the past few years should generically be called "spot the 4017".

Our initial reaction was to defend our design but a moment's thought showed that he had a point — the 4017 CMOS counter is over-used when it comes to games. At this stage we decided to rise to the occasion and produce the game using an all analogue approach.

The result can be seen in the circuit diagram. We are pleased with this circuit: It uses some unusual ICs and features a number of interesting circuit blocks — and of course there is not a 4017 in sight.

Construction

Construction of the game is greatly simplified if the PCBs are used. Three boards are required, one for the power supply, one for the display, and finally the main control board. Begin by building and testing the power supply. Take care to ensure that all components are mounted as shown in our overlay.

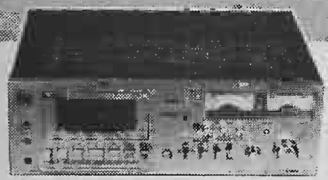
Next assemble the control and display boards. These carry a large number of components and mistakes made during assembly can be difficult to trace later — so take care at this stage. Do not insert the link between IC2/4 and IC9 at this stage.

It is best to test the boards before mounting them in the case, as it is difficult to get to some of the devices when the boards are in their final

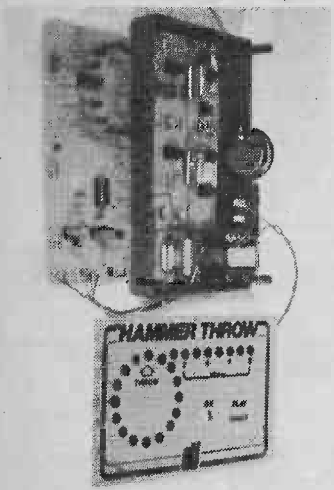
CONTAINS 100 PAGES

electronics today international

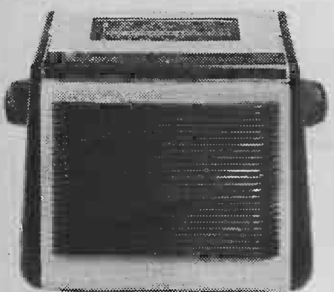
Vol. 7 No. 1



New AIWA deck does it all — p.72



You don't have to be strong, but you have to be quick — Hammer Throw game p.29.



Nostalgia trip '77 — but you don't have to be old — p.50.

FEATURES

ELECTRONICS IN SURVEYING **24** Looking around electronically
LETTERS PAGE **28** Readers make their points
WALLS HAVE EARS **41** How private is private?
WIRELESS SHOW REPORT **50** Down tube lane at the V&A
SOFTWARE GAMES **56** Fun and games with calculators
DIGITAL ELECTRONICS PART 4 **67** Flipping and flopping

PROJECTS

CMOS HOUSE ALARM **16** Building and installing to protect
HAMMER THROW GAME **29** Led into a throwaway
RACE TRACK GAME **36** Place yer bets here
DRUNKEN SAILOR PUZZLE **46** Can you solve it — sober?
SYSTEM 68 — CUTS CARD **61** Getting a bit taped

NEWS

NEWS DIGEST **11** Electronics news travels fast here
DATA SHEET **53** A new family of bi-fet op-amps
AUDIOPHILE **70** Class E sprays and a super-fi cassette
MICROFILE **74** The MPU mans news pages
ELECTRONICS TOMORROW **77** Games for soft tellys!

INFORMATION

WANT TO WORK FOR ETI? **14** Two jobs — one here one down under
ETI PRINTS **15** You asked it — and now you've got it
SUBSCRIPTIONS **39** Give yourself a treat!
NEXT MONTHS ETI **44** Preview of February ETI
ELECTRONICS TOMORROW **48** Our best special yet — got yours?

SPECIALS **52** All our wares on display
ETI CLOCK **55** Time to keep time
TECHNICAL BOOK SERVICE **64** Books from ETI
PANEL TRANSFERS **75** Finish it off professionally

INTERNATIONAL EDITIONS

AUSTRALIA Collyn Rivers Publisher, Les Bell Acting Editor
HOLLAND Anton Kriegsman Editor-in-chief
CANADA Steve Braidwood Editor, Graham Wideman
GERMANY Udo Wittig Editor

ABC

EDITORIAL AND ADVERTISEMENT OFFICE
25-27 Oxford Street, London. W1R 1RF. Telephone 01-434 1781/2 Telex 8811896

Halvor W. Moorshead — Editor
Ron Harris B Sc — Assistant Editor
Gary Evans — Editorial Assistant
Diego Rincón — Art Director
Brenda Goodwin — Editorial Secretary
Jim Perry — Specials Editor
Tony Alston, John Koblanski — Project Development
Paul Edwards — Technical Drawings
Sandra Cassar — Subscriptions
Margaret Hewitt — Administration
David Lake (Manager), Kim Hamlin, Tim Salmon — Reader Services
Mark Strathern (Manager), Tom Moloney — Advertising

PUBLISHED BY Modmags Ltd., 25-27 Oxford Street London W1R 1RF
DISTRIBUTED BY Argus Distribution Ltd. (British Isles)
Gordon & Gotch Ltd. (overseas)
PRINTED BY QB Limited, Colchester

Electronics Today International is normally published on the first Friday of the month prior to the cover date.

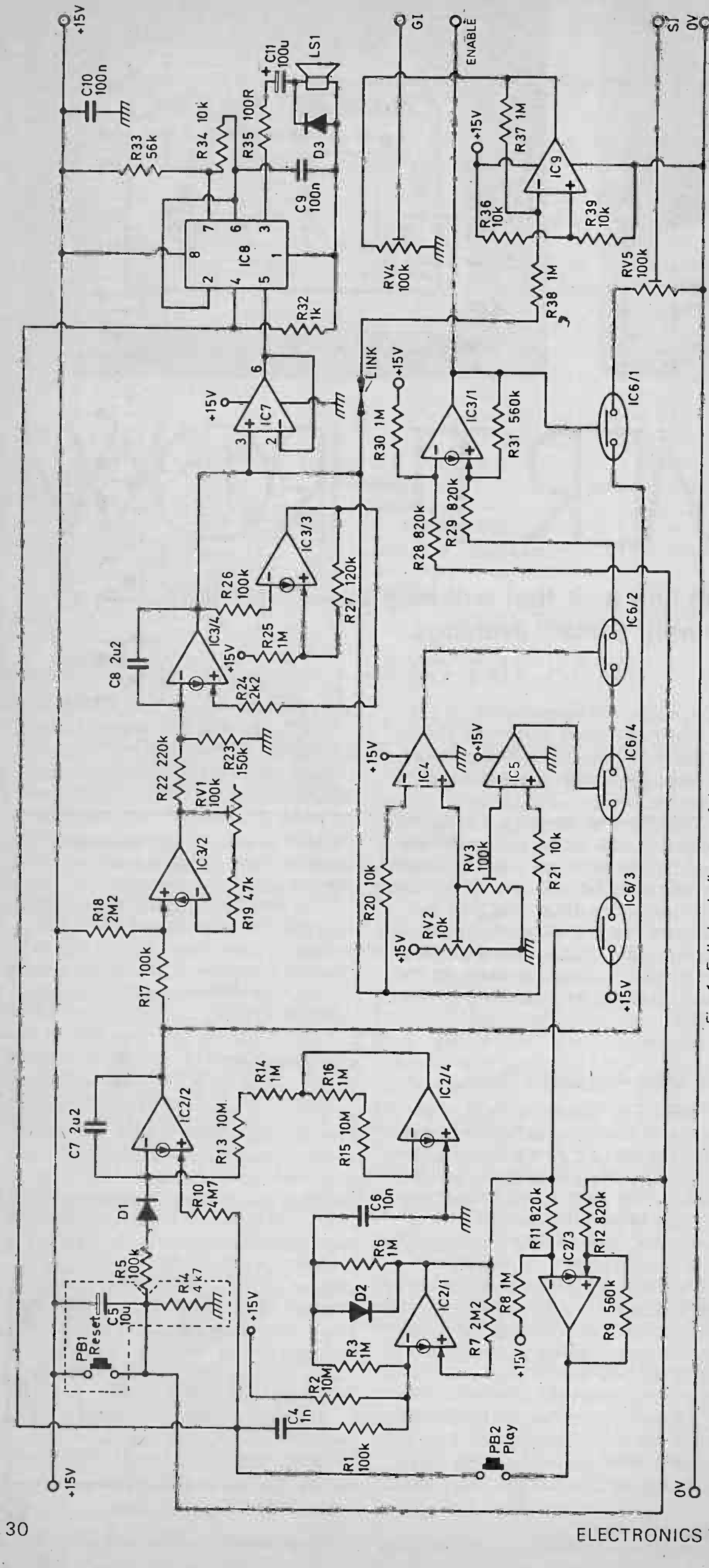
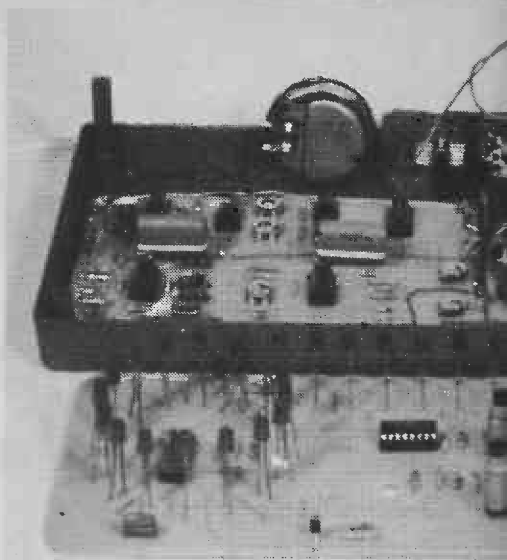


Fig. 1. Full circuit diagram of the hammer throw. For IC pin-outs see Fig. 10.



positions. We used a sloping front Vero box to house our game and the general layout adopted can be seen from our photographs.

Setting Up

There are five preset potentiometers on the board and all must be correctly set up before the game can be played.

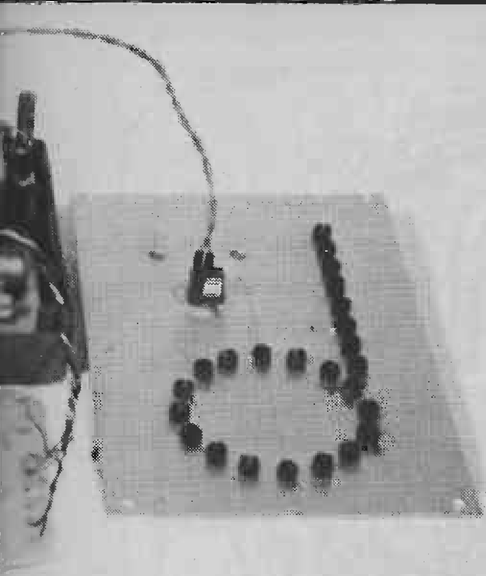
The first adjustment to be made is to RV4. To calibrate this control first press the reset button and then the play button for a few seconds. At this stage a sound should be heard from the speaker and the game display LEDs should be seen flashing. Adjust RV4 until the LEDs produce a continuously rotating spot of light. The speed at which the circle of light rotates can be adjusted by RV1.

The next operation is to set up the score display. To accomplish this, press reset and then operate the play button until the spot of light is rotating at maximum speed. Release the play button and enable the score display by applying a positive pulse (from supply) to the junction of R29 and IC6. RV5 should now be adjusted so that the seventh score LED is just extinguished and the eighth lit.

The final adjustments concern the 'window' discriminator. To make this adjustment R38 (the end remote from IC9) should be connected to the slider

BUY LINES

Some of the ICs used in this project may be unfamiliar but they are stocked by most of the larger component stores. Some of the high value resistors may also prove illusive, but again, if they are not available at your local shop try the advertisers in this issue.



of RV2. Adjustment of RV2 should illuminate successive LEDs of the game display. RV2 should be set to the point at which the top LED just extinguishes and the LED to the left just lights.

Now connect the input of IC9 to the slider of RV3. Adjust this pot so that the top LED just extinguishes and the LED to the right is just on.

This completes the adjustments and the link omitted during construction, should now be fitted.

Now is the time to get in training and, if you're good enough, you may yet make it to Moscow. ETI

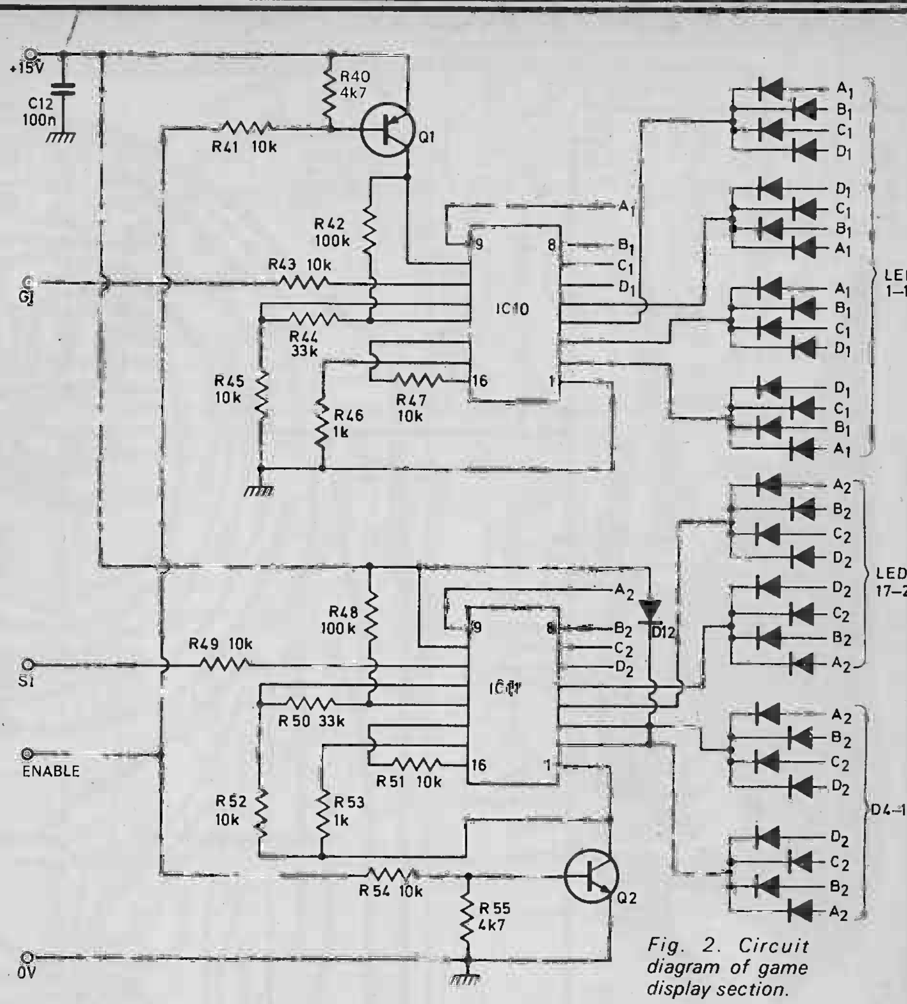


Fig. 2. Circuit diagram of game display section.

PARTS LIST

RESISTORS all ¼W 5% unless stated

R1,5,17,26,42,48	100k
R2,13,15	10M ½W 10%
R3,6,8,14,16,25, 30,37,38	1M
R4,40,55	4k7
R7,18	2M2
R9,31	560k
R10	4M7
R11,12,28,29	820k
R20,21,34,36,39,41,43 45,47,49,51,52,54	10k
R22	220k
R23	150k
R24	2k2
R27	120k
R32,46,53	1k
R33	56k
R35	100R
R44,50	33k
R19	47k

POTENTIOMETERS

RV1,3,4,5	100k min hor trim
RV2	10k min hor trim

CAPACITORS

C1	1000u	25 V electrolytic
C2	220n	polyester
C3	470n	polyester
C4	1n	polystyrene
C5	10u	25 V electrolytic
C6	10n	polyester
C7,8	2u2	polyester
C9,10,12	100n	polyester
C11	100u	25 V electrolytic

SEMICONDUCTORS

IC1	78L15A
IC2,3	LM3900
IC4,5,7,9	741
IC6	CD 4016
IC8	555
IC10,11	UAA 170
Q1	BC212L
Q2	BC184L
D1,2,3,4–12	1N914
LEDs 1–24	.2" type
BR1	4 pin DIL TYPE: 0.9 A 400 V (from R. S. Stockists)

TRANSFORMER

T1	240 V – 15 V 6VA

LOUDSPEAKER

LS1	G.P.O type insert

SWITCHES

PB1,2	Push to make
SW1	SPST toggle

CASE	Vero type 65–2523

MISCELLANEOUS
Flex, PCBs as patterns, LED mounting clips, fuse and holder to suit.

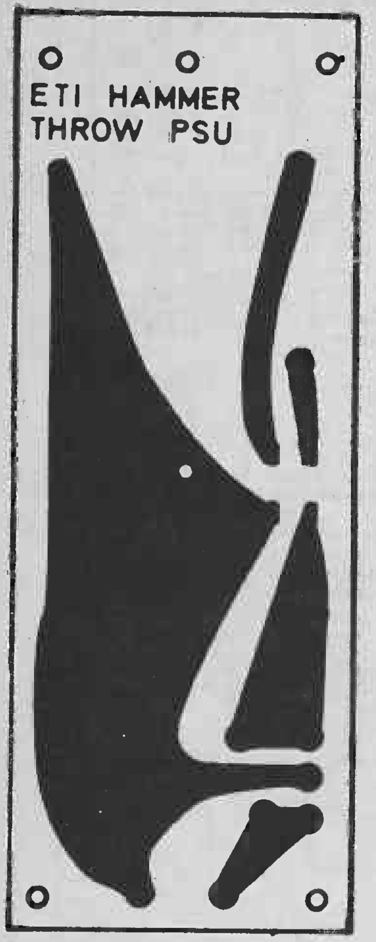


Fig. 3. Foil pattern of power supply board shown full size (120 x 45 mm).

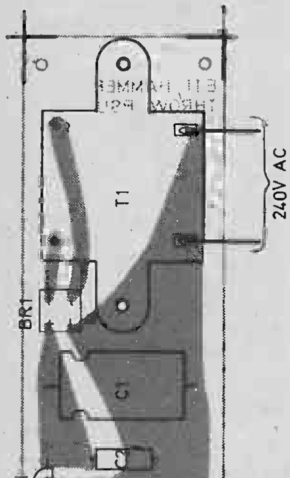


Fig. 4. Component overlay of PSU mains earth is connected to TI by a solder tag under the mounting bolt. The transformer's screen should also be connected to earth.

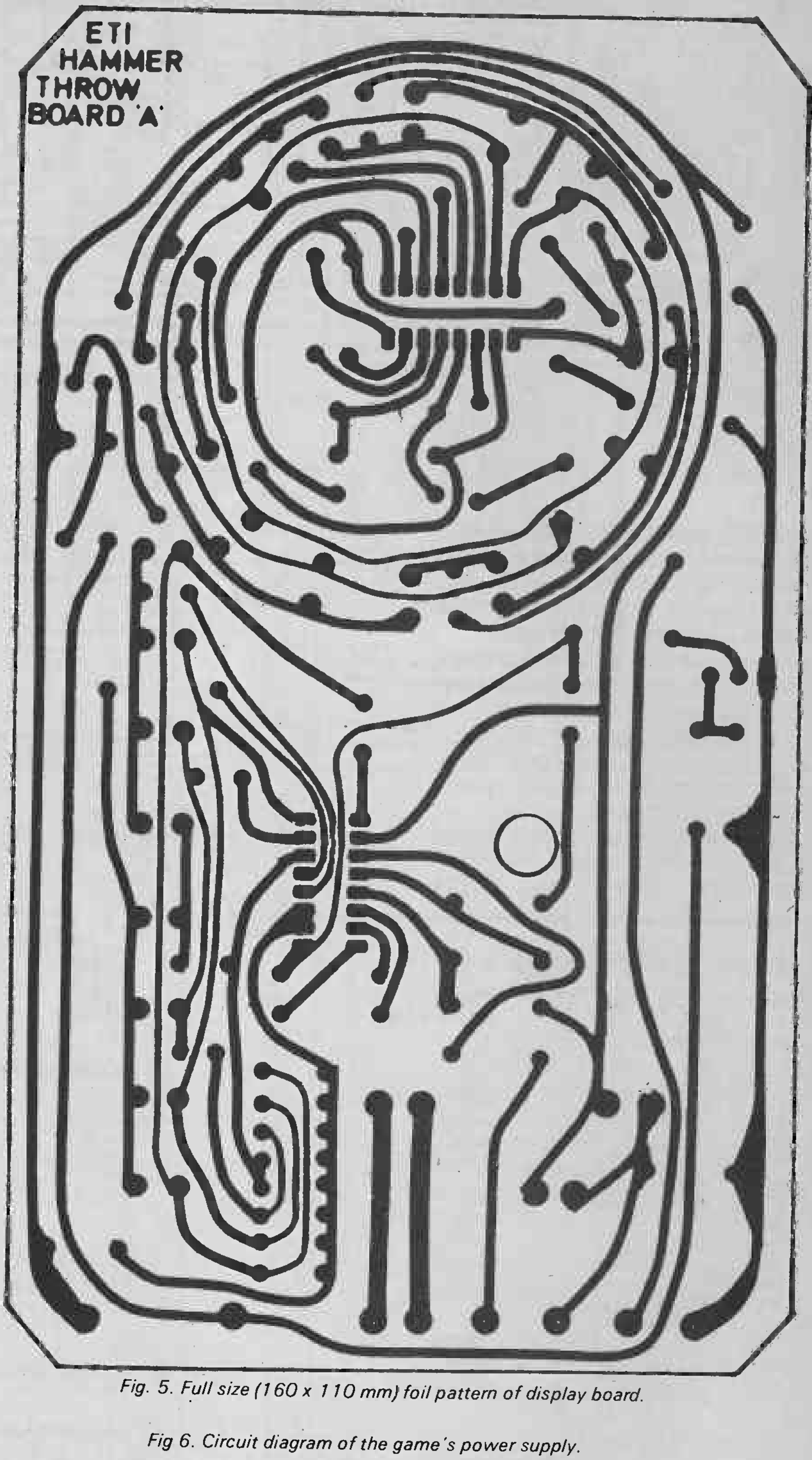
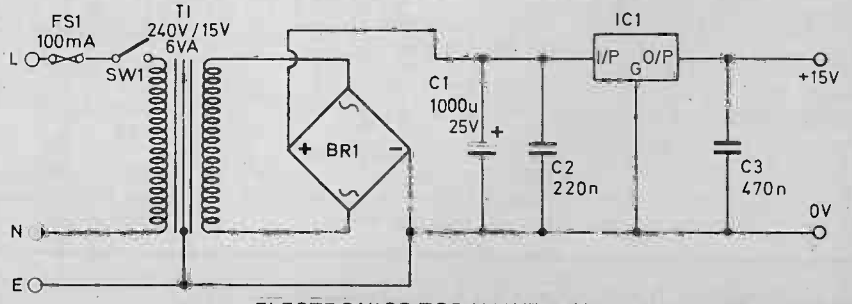


Fig. 5. Full size (160 x 110 mm) foil pattern of display board.

Fig 6. Circuit diagram of the game's power supply.



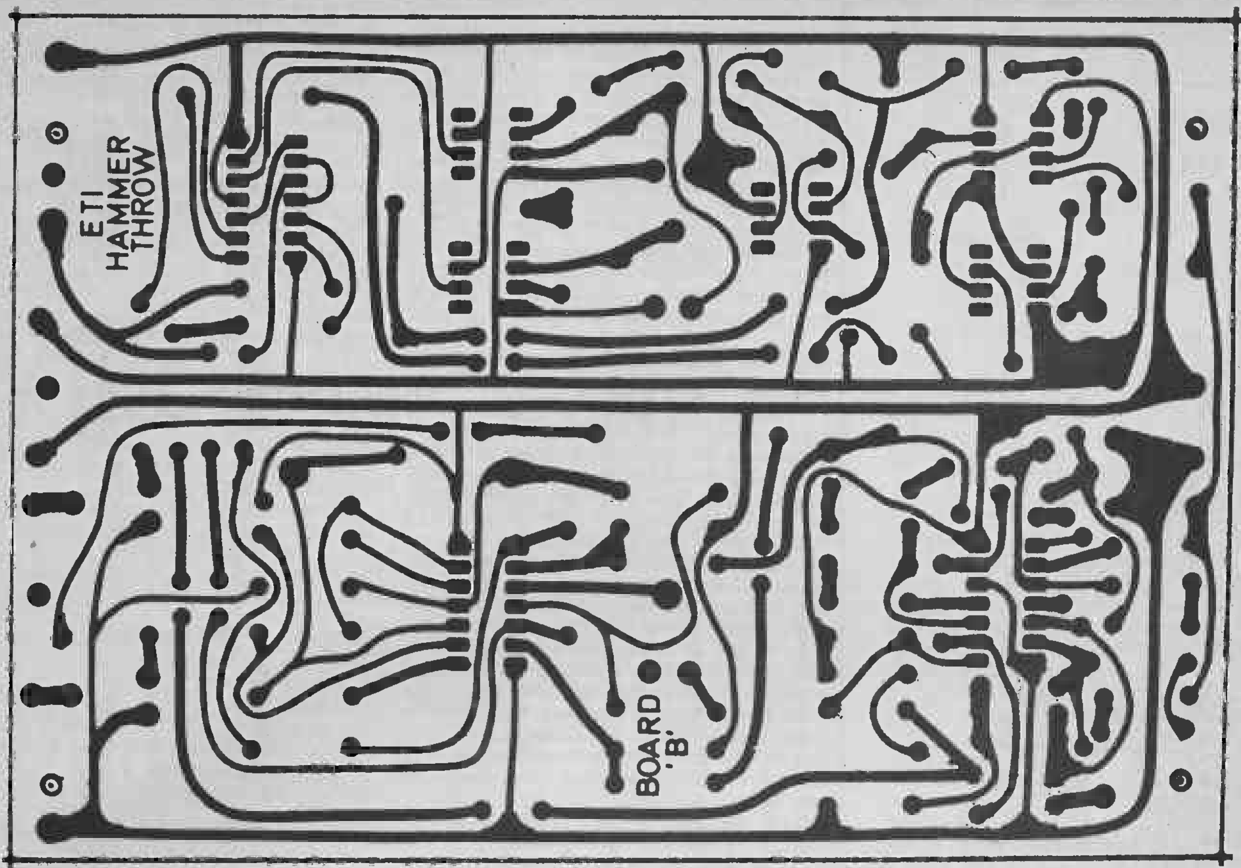


Fig. 7. Full size foil pattern of main control board (160 x 110 mm).

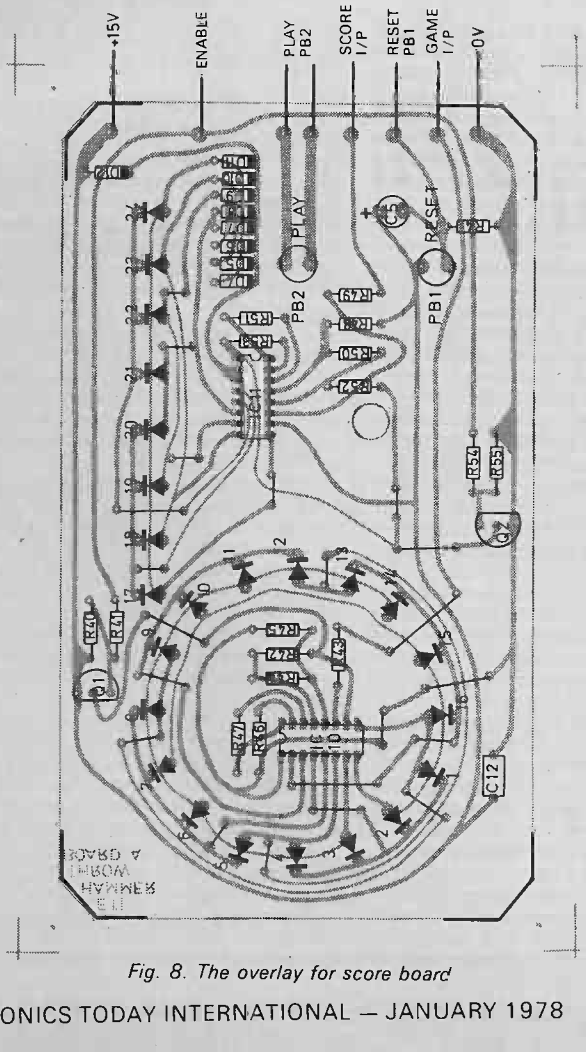


Fig. 8. The overlay for score board

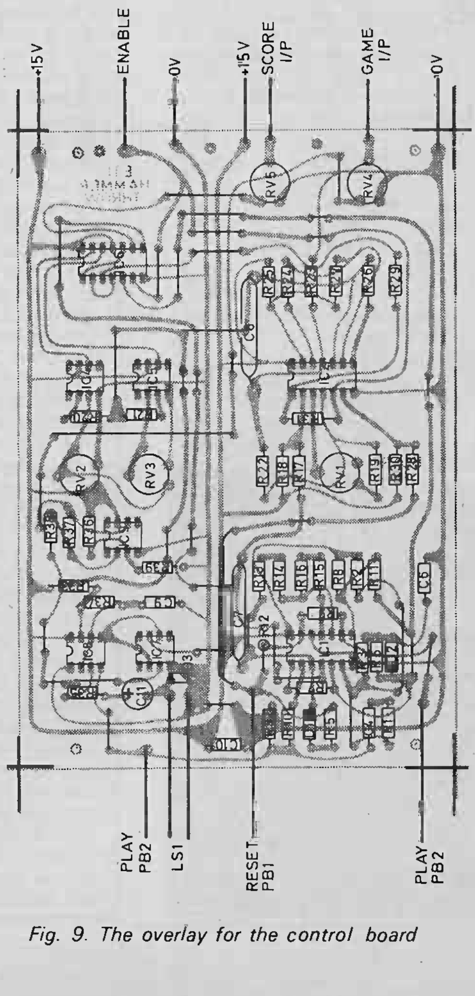


Fig. 9. The overlay for the control board

HAMMER THROW — HOW IT WORKS

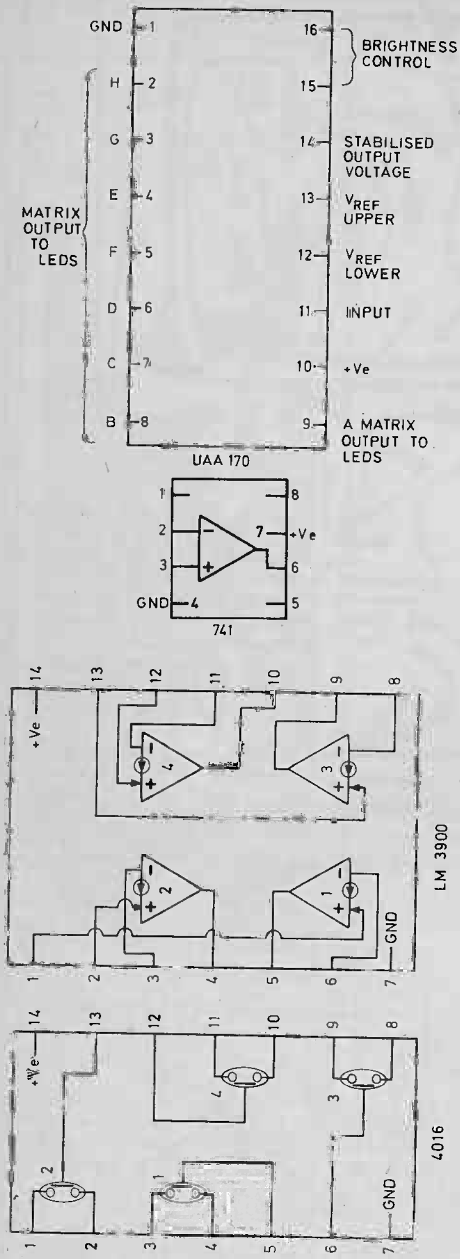
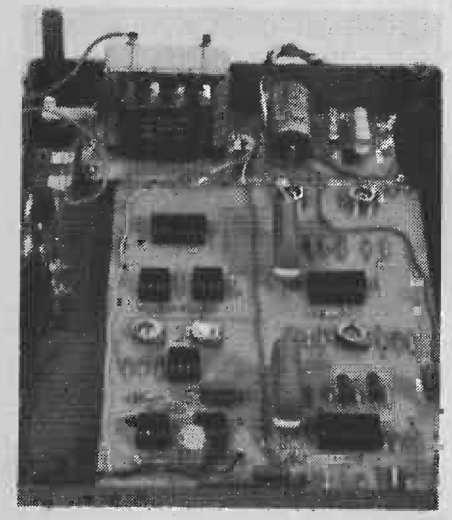


Fig. 10. Pinouts for the integrated circuits used in the hammer throw.



The circuit may be broken down into a number of major blocks — viz the display sections for both game and score, a voltage controlled oscillator, a ramp and hold circuit whose output controls the oscillator, a 'window' discriminator, a sound generating circuit and finally a power supply. As well as these major blocks there are also a number of latches, buffers and switches that are necessary for circuit operation.

The block diagram shown in Fig 11 shows most of the circuit blocks and, together with the circuit diagram, should be read in conjunction with this how it works.

SYSTEM OPERATION

The game display is based on a UAA 170 IC. This device is for driving LED displays and when connected to a line of sixteen LEDs will illuminate any one of these depending on the magnitude of the analogue voltage applied to its input. For the game display we need to produce the effect of a spot of light moving in a circle. To achieve this we arranged the sixteen LEDs in a circle and feed a sawtooth waveform into the UAA 170. A moments thought will show that this will produce the desired effect.

In order to make the display rotate slowly at first, but speed up as play proceeds, we made the sawtooth generator voltage controlled. The control voltage is produced by a ramp and hold circuit which is reset to zero at the start of play, but begins to ramp up, thus increasing the sawtooth's frequency as play continues. When the play button is released, the voltage reached is held by the ramp and hold configuration until it is reset. This voltage is used for score purposes as described below.

The game requires that if, at the instant of releasing the play button, the 'Top' LED of the game display is lit, a score is indicated, the magnitude of the score being proportional to the speed at which the circle of LEDs was moving at the instant of release. From the description of the game display it will be seen that in order to light a specific LED the voltage input to the display driver must lie within a specific voltage range, thus in order to detect whether or not the 'top' LED is on we must look at the output of the sawtooth generator (this is input to UAA170) and decide whether it lies within the range that will light the specific LED at the instant the play button is released. The circuit that accomplishes this is the 'window' discriminator.

This is formed from two voltage comparators together with two analogue switches. Detailed action is described below, but briefly the circuit, when fed with the sawtooth output, will provide an indication whenever this waveform passes through an (adjustable) 'window' voltage range.

At the instant that the play button is released a short pulse is produced from a monostable. If this pulse is coincident with an indication from the window circuit that the top LED is on we must arrange to indicate a score.

The score must be proportional to the speed of the LED circle which is in turn proportional to the voltage level reached by the ramp and hold circuit. Thus, to produce a score, we feed the output from the ramp and hold, via an analogue switch, to a second UAA 170. This second display consists of eight LEDs in a line.

This completes a brief description of circuit action; we shall now deal with each block in more detail.

RESET CIRCUITRY

The game is initiated by operation of the reset button (PB1). This zeros the ramp and hold circuit described below, as well as setting latch 1 IC2/3 and resetting latch 2 IC3/1. Latch 1 enables the play button when its output is high (set) — latch 2 enables the score display when low (reset), the game display when high (set)

Each latch is based on two of the amplifiers of an LM 3900 Quad Norton amplifier package. This device is unusual in that instead of amplifying the difference in voltage applied to its input terminals, it amplifies the difference in input current.

The + and — inputs of these Norton amplifiers are both clamped to one Diode-Drop above ground and thus all input voltages must be converted to currents (by resistors) before being applied to the inputs. This is the basis for the current-Mode (Norton) type of operation.

In operation the current flowing into the + input must equal that flowing into the — input, the difference between the current demanded and the current provided by an external source must flow in the feedback circuitry.

Operation of both latches is the same and we shall only describe the action of latch 1.

Assuming that the latch output is low (the latch is reset) the current injected into the — input of IC2/3 will ensure that the output remains low. If now sufficient current is injected into the + input the output voltage will rise as the device attempts to reduce the input current differential to zero. Positive feedback via R9 will enhance this action and cause the amplifier to latch high. This is because the current injected into the + input via R9 in this case is greater than that into the — input due to R8. A positive pulse via R11 to the — input will however once again bring the output low.

C5 and R4 ensure that when power is first applied the game is reset.

RAMP AND HOLD

The ramp and hold action is provided by IC2/2 and IC2/4. A positive voltage via R5 and D1 causes the output to ramp down while a similar voltage via R10 causes the output to ramp up. The reset button causes the downward ramp while play causes an upward ramp.

In any sample and hold application a very low input bias current is required if the hold period is to be stable. The existence of matched amplifiers within the LM3900 allows one amplifier to bias another.

In operation the LM 3900 requires a bias current to be applied to its — terminal. IC2/4 has its + terminal grounded and feedback applied via R15 and R16. The output voltage of this device will attain a level such that the current fed back via these resistors is equal to the bias current demanded by the input. This same current will flow via R13 and R14 into the — input of IC2/2 reducing the effective bias current of this amplifier to almost zero. D1 isolates this bias current from the rest of the input circuitry.

If now a positive current is injected into the — terminal, the output voltage will fall as it attempts to feedback a current of this value in order to reduce the input current differential. This constant current across C7 results in a Linear voltage ramp appearing across C7. Input to the + terminal causes a positive going ramp, to the — terminal a negative going ramp.

The rate at which the voltage across C7 changes is proportional to the value of the constant current supplied which is in turn proportional to R5 and R10. As R5 is some 40 times larger than R10, the ramp down (reset) is far quicker than the ramp up.

The output from the ramp and hold circuit is fed, via IC6/1 to the score display and via IC3/2, a non-inverting scaler, to the sawtooth VCO.

NON-INVERTING SCALER

The scaler is required because the output from the ramp and hold configuration can vary over nearly the whole supply voltage wheres the VCO requires only small voltage swing to provide the required frequency change.

The scaler is based on another Norton amplifier arranged as a non-inverting amplifier feedback is applied via RV1 and R19 and output is fed to a potential divider formed by R22 and R23 and thence to the VCO.

VOLTAGE CONTROLLED SAWTOOTH OSCILLATOR

The VCO is formed by IC3/3 and IC3/4. Action of IC3/4 is much the same as that of IC2/2 described above. The special input bias circuitry is not required as there is no hold requirement.

IC3/3 acts as a comparator and circuit action is as follows: while to output of IC3/4 is high and ramping down (input to — terminal) the current into the — input of IC3/3 due to R26 is greater than that to its + terminal due to R25 – its output is thus low.

As the output of IC3/4 ramps low however, there comes a point where this situation is reversed. The output of IC3/3 goes high. This state being maintained by positive feedback via R7 and injects a large current into the + input of IC3/3 as R7 is much smaller than R25.

The output if IC3/4 thus goes high, restoring current flow via R26 and starting the cycle again.

By varying the current injected via R22 the time taken for the output of IC3/4 to ramp down to the point at which the comparator triggers is lessened. This results in an increase in the frequency of the sawtooth.

The output from the VCO is fed to the game display section R??, to the 'window' discriminator formed by ICs 4 and 5 and via IC7 to the sound generator *IC8.*

WINDOW DISCRIMINATOR

The window discriminator is formed by two comparators IC4 and IC5 and two of the analogue switches in IC6.

Operation is as follows: If we assume that the output of the sawtooth VCO is high and ramping down the voltage on the – input of IC4 will be higher than that on the + input (a reference level established by RV2) and its output will be low. The output of IC3 will be high as the input to its + terminal is higher than that to its – input.

As the voltage ramps down, a point will be reached where the output of IC4 goes high as the voltage at its – input falls below that set by RV2 at its + terminal. At this stage the outputs of both IC4 and IC5 are high, as IC5 has not switched. As the voltage continues to ramp down, however, the voltage on IC5's + input falls to a point below that on its – input and the output of this IC goes low.

Thus the outputs of both ICs will be high for a small range of input voltages (the window) defined by the difference in voltage between the sliders of RV2 and RV3.

The outputs of these ICs are fed to the inputs of two analogue switches. A positive voltage applied to these switches turns them "on".

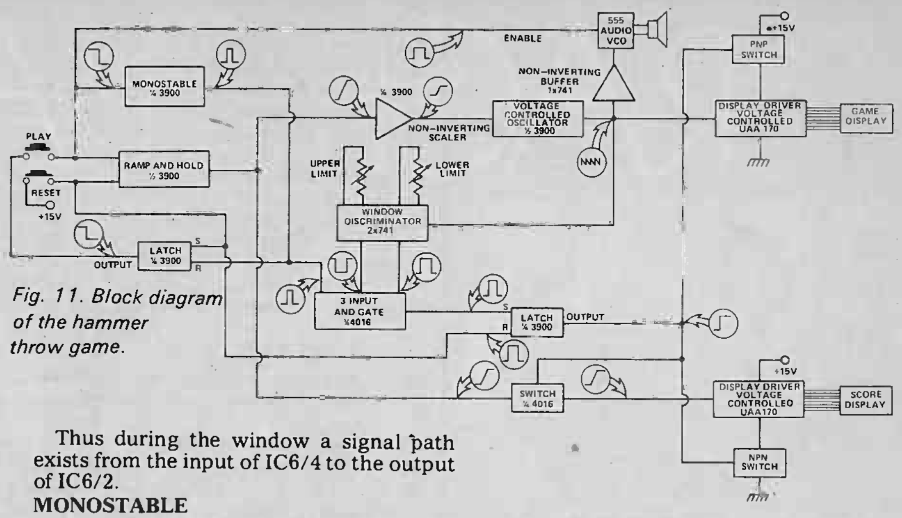


Fig. 11. Block diagram of the hammer throw game.

Thus during the window a signal path exists from the input of IC6/4 to the output of IC6/2.

MONOSTABLE

The monostable is formed by IC2/1 this produces a short positive going pulse upon receipt of a negative spike produced by the release of the play button.

Current injected into the — terminal via R3 will normally hold the output low, however a negative pulse applied via C4 and R1 will "rob" this current from the input and causes the output to go high.

R7 latches the gate in this state after the negative pulse is removed. At this stage C6 begins charging, feeding back an increasing amount of current to the — input as the voltage at the junction of R6 and R3 rises.

There comes a point when this current is greater than that fed back via R?? and the output returns low. Diode D2 rapidly discharges C6 to provide reliable re-triggering.

The leading edge of the output pulse is coincident with the release of the play button. This pulse is used to turn on analogue switch IC6/.3 It will be remembered that if the voltage of the VCO is within the 'window' at this point — switches IC6/4 and IC6/2 will also be on. This allows the supply voltage input to IC6/3 to set latch 2 and thus initiate the required actions, ie, blank game display, enable score display, etc.

The monostable also resets latch 1 IC2/3 to remove supply from the play button, this prevents cheating.

GAME DISPLAY

The output of the sawtooth VCO is fed via an inverting fuffer, IC9, and a potential divider, RV4, to the input of IC10 a UAA170. The input circuitry of this device consists of a series of differential amplifiers with one input of each connected to the input terminal (pin 11) via an emitter follower. The other input of each is connected to a point in a potential divider chain consisting of equal value resistors. The differential amplifiers thus operate as analogue voltage comparators and as the input exceeds the reference voltage of a particular comparator, the output of that comparator will change state.

To reduce the package pin-out the LEDs of the display are not driven individually but are arranged in a four by four matrix pattern controlled by the row and column outputs of the UAA170 (A-D and E-F respectively). By enabling the appropriate row and column output any one of the sixteen LEDs may be selected. The matrix outputs are controlled by the internal logic of the UAA170.

The resistor chain R42, R44 and R45 sets up the reference voltage inputs of the device. The voltage on pin 12 establishes the lowest voltage to which the UAA170 will respond. If the input voltage is below this point the first LED of the display remains lit. As the voltage rises above this level the first LED is turned off, the second on — as the input rises the spot moves up the chain, until the voltage reaches that set on pin 13. This is the maximum voltage to which the display responds and if the input is taken above this level the last LED remains lit.

In addition to defining the indication range the voltage between pins 12 and 13 determines the abruptness of transition between any two LEDs. With this difference set to 1V4 the light point glides smoothly along the scale, with increasing voltage difference the passage becomes more abrupt until at 4V the light spot jumps from one LED to the next. We have set this voltage to a point between the two extremes.

The resistors R46, R?? and R47 control the brightness of the display. Q1 supplies power to the display and is driven from latch 1 IC2/3. This, you will recall, is reset, ie, its output is low, at the start of a game. A low voltage applied to Q1 via R41 turns this transistor on and enables the display. The latch is returned high at the end of a game, this turns Q1 off and blanks the display.

SCORE DISPLAY

The score display is formed by a second UAA170 (IC10). Much of the circuitry is the same as that of the game display except that we only wish to display eight LEDs. The diodes from unused outputs to the +VE supply act as 'dummy' LEDs, restricting the display to eight LEDs, you could use LEDs for extended scoring — but a larger box is needed. This display is powered by Q2 which is again fed from the output of latch 1 (1C2/3. This time, however, the display is blanked, Q2 off, when the latch is low and enabled, Q2 on, when the latch output is high.

SOUND GENERATOR

The sound is generated by IC8 an NE555 operated in its astable mode.

The reset pin(4) is normally held low by R32 and hence circuit action is inhibited. A positive voltage applied from latch 1 via the play button enables the sound during the game.

The output is frequency modulated by applying the output of the sawtooth VCO, via buffer IC7 to provide the necessary low impedance drive, to the voltage control input (pin 5) of IC8.

RACE TRACK

WE BET YOU'LL HAVE FUN WITH THIS GAME

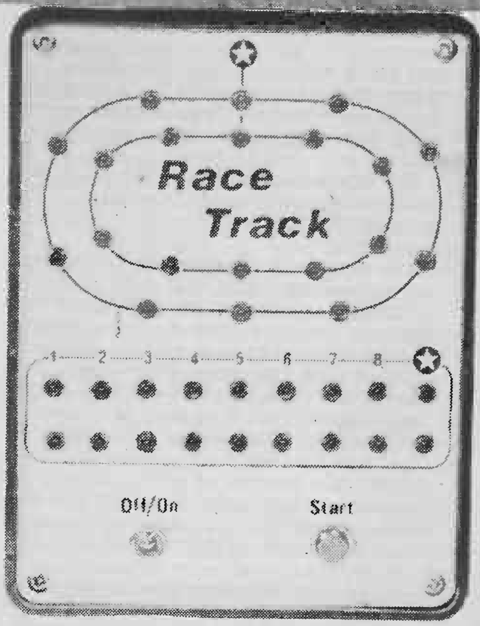
THE DESIRE TO place bets upon almost any event, from the outcome of the big race at Newmarket to the likelyhood of life on other planets, is a deep seated one in many of the inhabitants of these islands. That old joke about the guy who bet his friend a couple of quid that he can give up gambling for a week would not be amusing, but for the fact that it were so near the truth.

Three Way Bet

Bets fall into a number of different categories. They may be made on disagreements of fact ('I bet mine's bigger than yours'), about events capable of being modified by skill or lack of it ('I bet I can get mine further than yours'), or bets made upon random events (The mind boggles!).

It is this latter type of bet, the toss of a coin, cut of a card or spin of a roulette wheel, that is probably the most popular form of gambling amongst groups of people, our race track game provides an exciting means of indulging in this type of activity.

The game is really a development of the well known 'heads or tails' type of game, but whereas most games of this sort are visually unexciting, the race



track game more than makes up for any shortcomings in this area!

They're In The LED

When the game's reset button is pressed all the LEDs are off and the 'horses' line up at the starting post. Now is the time to choose a horse and place bets if you wish.

Releasing the button starts the action with the circles or LEDs representing the 'horses' starting to flash as first one horse then the other takes the lead. As each horse completes a lap the appropriate lap LED lights. The first horse to cross the finish line lights his 'win' LED and halts the racing horses. If lady luck did not smile on you this time, pressing the reset button gives her, and you, another chance.

Construction

Mount all the components on the PCB as indicated in our overlay diagram. We recommend that sockets are used for ICs 1–6 as these are CMOS devices and should not be placed in circuit until all constructional work is complete. The LEDs are hard wired to the PCB and the interconnection information is given in Tables 1 and 2. Note that LEDs 37 and 38 have their cathodes taken to 0 V via R6 and R7 and not directly to ground as the rest.

The value of R1 sould be selected to give the best display on the race track. A value somewhere between 4M7 and 10M should suit.

Now is the time to turn on, place your bets and probably loose your shirt.

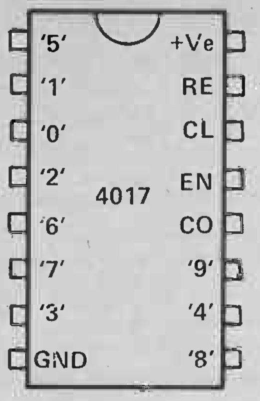


Fig. 1. Pin-out for 4016 IC

The photograph of the game shown left shows the general method of construction used in the prototype. Connection details for the wires between the board and front panel are shown in Tables 1 and 2.

HOW IT WORKS

The circuit uses two oscillators each based on two of the NOR gates in the 4001 Quad NOR CMOS packing. One of these (IC1/3 and IC1/4) runs at a high frequency and its output is fed to the input of one half of a 4013 Dual D type flip-flop. The device devides the output of the high speed oscillator by two and provides two signals that are 180° out of phase at its Q and $\bar{Q}$ outputs. These signals enable either IC3 or IC5, the ICs being enabled if their enable input is held low.

The second oscillator based on IC1/1 and IC1/2 runs at a lower speed and is arranged to provide a non-unity mark space ratio, in fact a very short "high" output followed by a much longer "low". This non-unity mark space ratio is achieved by the inclusion of D1 in the oscillator's timing network. This second oscillator can be gated on and off by signals to be described below.

Circuit action is as follows. PB1 is closed and this resets all the counters to zero as well as inhibiting the slow running oscillator. Upon releasing PB1, IC3 or IC5 will be clocked as the first positive pulse is generated by IC1/1 and IC1/2. Which counter is incremented will depend upon the state of IC2's outputs.

In general as the two oscillators are out of phase the counters will appear to be clocked in a random manner. A further random element is introduced because while a 4017 is normally clocked with positive going pulses at the clock input with enable held low, it is possible for it to be clocked with a negative going pulse at enable while clock is high. Thus occasionally IC2 will act as a clock.

At the end of a lap a pulse is generated from the carry out (CO) output of either IC3 or IC5 and is used to advance the lap counters (IC4 and IC6).

The game ends on the ninth lap when the '9' output of either lap counter goes high. This turns on either Q1 or Q2 and in turn lights the appropriate win LED. The signal from either '9' output is ORed by diodes and this signal used to halt the game by disabling the slow running oscillator.

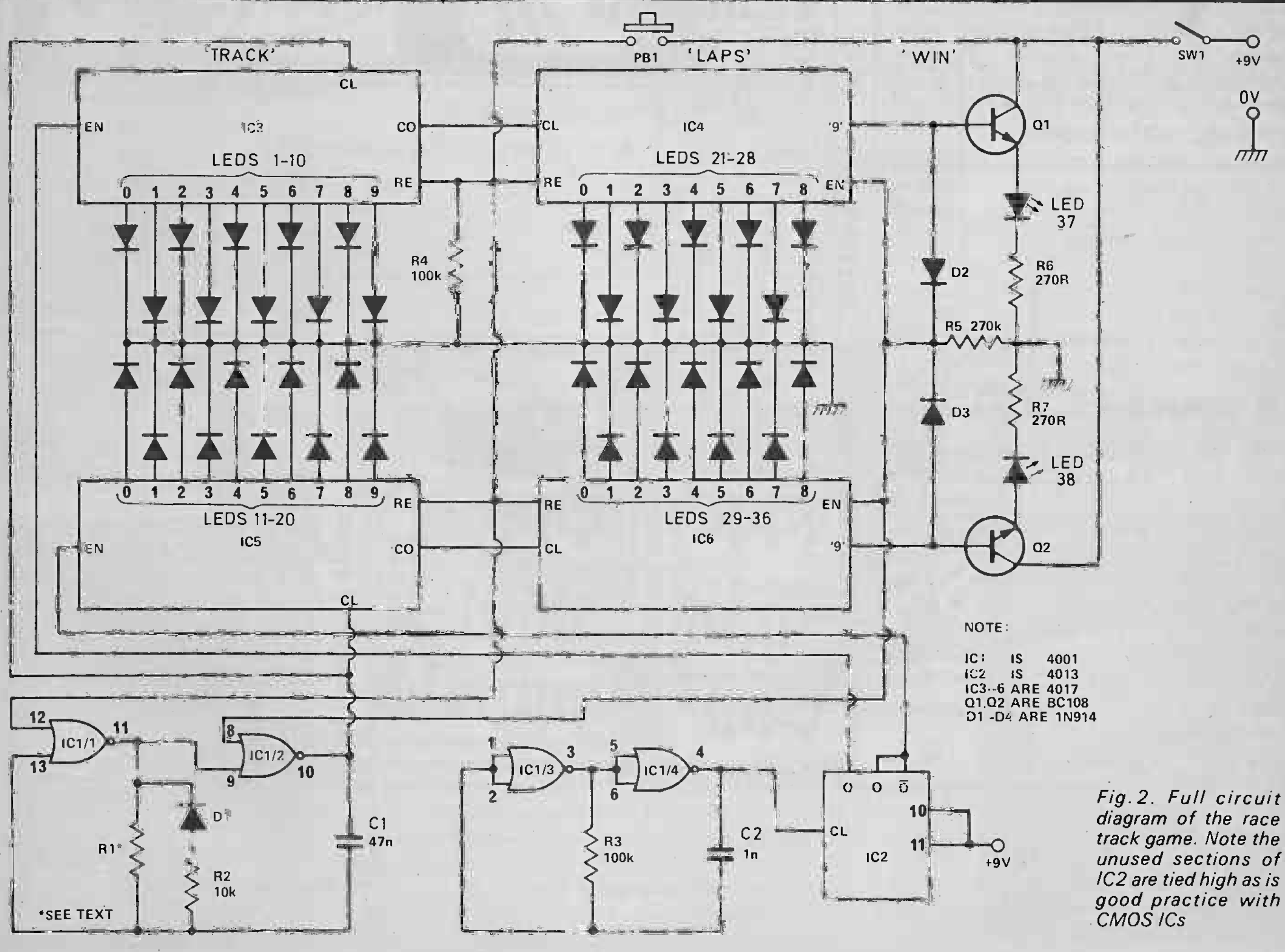


Fig. 2. Full circuit diagram of the race track game. Note the unused sections of IC2 are tied high as is good practice with CMOS ICs

TABLE 1
CONNECTIONS TO IC3 (5)

PIN	LED (ANODE)
1	6 (16)
2	2 (12)
3	1 (11)
4	3 (13)
5	7 (17)
6	8 (18)
7	4 (14)
9	9 (19)
10	5 (15)
11	10 (20)

TABLE 2
CONNECTIONS TO IC4 (6)

PIN	LED (ANODE)
1	25 (33)
2	21 (29)
4	22 (30)
5	26 (34)
6	27 (35)
7	23 (31)
9	28 (36)
10	24 (32)

BUY LINES

There should be no problem getting any of the components for this project. The ICs should be available from people like Lynx, Maplin, Watford and Marshalls. The main thing is to try and get a quantity discount on the thirty-eight LEDs needed.

PARTS LIST

RESISTORS (all ¼ W-5%)

R1	* see text
R2	10k
R3,4	100k
R5	270k
R6,7	270R

CAPACITORS

C1	47n polyester
C2	1n ceramic

SEMICONDUCTORS

IC1	4001
IC2	4013
IC3-6	4017
Q1,2	BC108
D1-3	1N914
LED1-38	TIL209 red

SWITCHES

PB1	Push to make type
SW1	SPST toggle

MISCELLANEOUS

Battery clip, flex, PCB as pattern, case to suit.

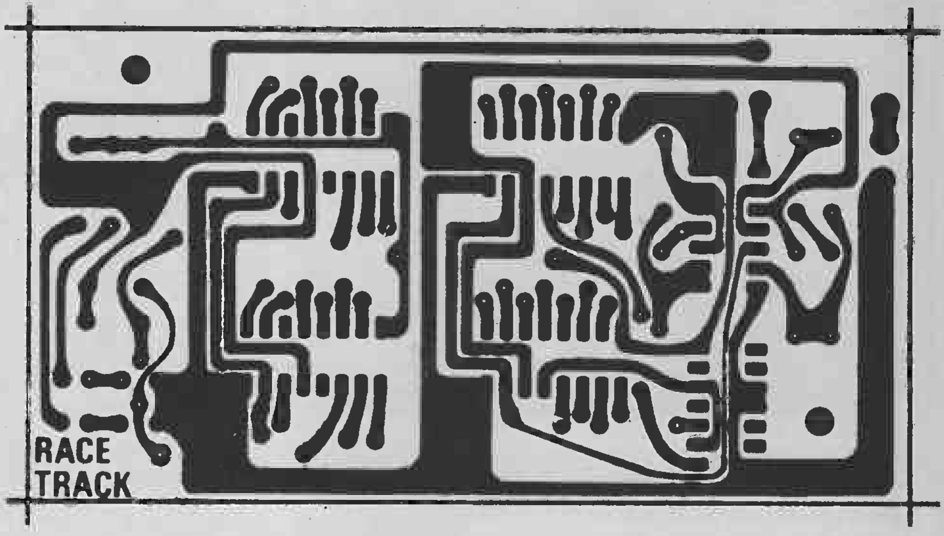
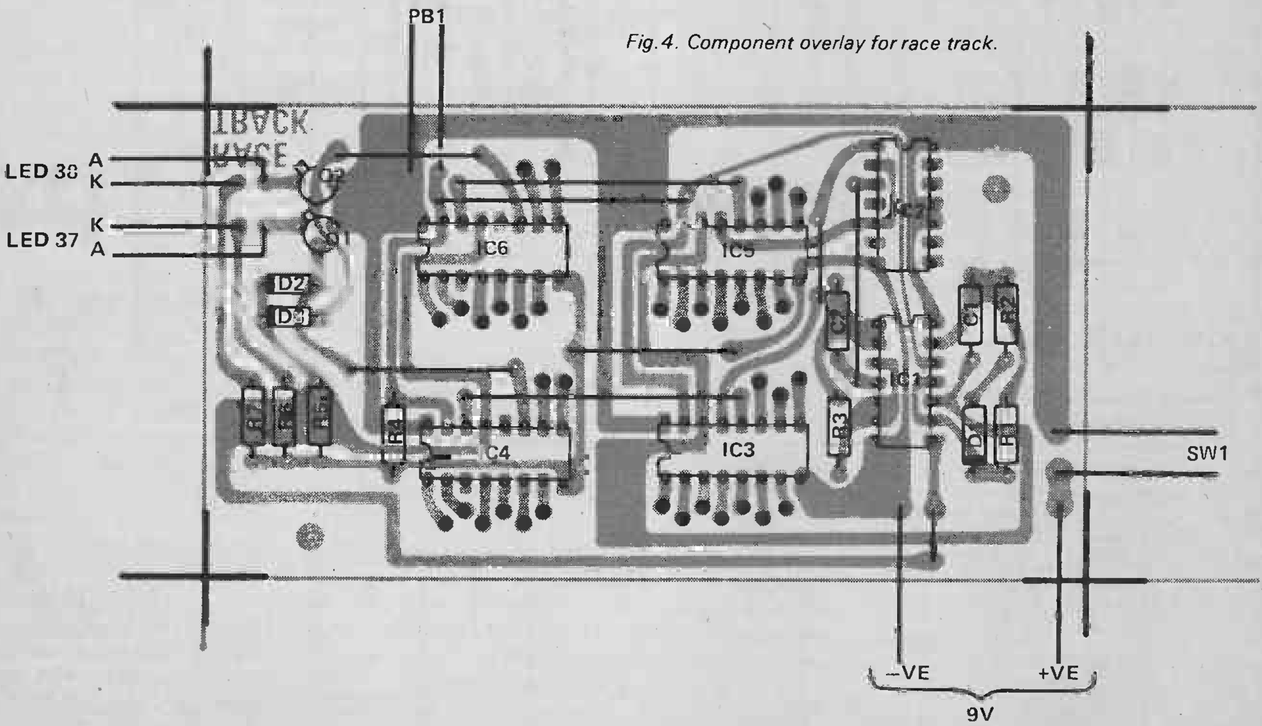


Fig.3. Full size (115 x 62mm) foil pattern

Fig.4. Component overlay for race track.



You may think your conversation is private but

WALLS HAVE EARS

There appears to be little control in Britain over the manufacture and sale of bugging devices. ETI has been investigating the current situation.

IT WILL COME as a big surprise to most readers that bugging is **not** in itself a criminal offence. Plant an RF bug in an office during working hours, listen in on highly confidential discussions and the worst that you'll be got for — if you're caught — is operating a transmitter without a licence. Technically you could also be had for listening to 'an unauthorised transmission' but we know of no such prosecutions.

The Younger Committee on Privacy which reported in 1972 quite rightly recommended that bugging in any form should be an offence, in itself, but it has not yet been acted upon.

How serious is bugging?

In researching this feature we found ourselves continually coming up against stony silence — few people are prepared to discuss the subject and none would agree to having their comments personally attributed. Try to talk to a company that's advertising bugs and ten-to-one he'll tell you he's now stopped, but he will supply you with equipment to 'sweep' your office (the technical term for finding other people's bugs).

It is possible to get some idea of the scale of things however. There are about ten companies in Britain openly advertising bugs — most of them appear to be very small. Even so this indicates that sales are unlikely to be worth less than £100,000 a year and since bugs are cheap, literally thousands are sold every year.

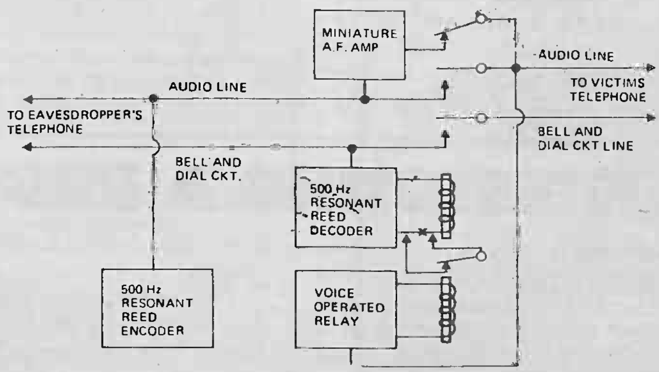
Most technical publications (this includes ETI) refuse to accept advertisements for these devices on the grounds that they are undesirable, not because we are not allowed to.

Where are these bugs used then? We suspect that the overwhelming number are bought as toys and not for any devious purpose but this still leaves probably several hundred that are bought for their stated purpose: of listening in on other people's business.

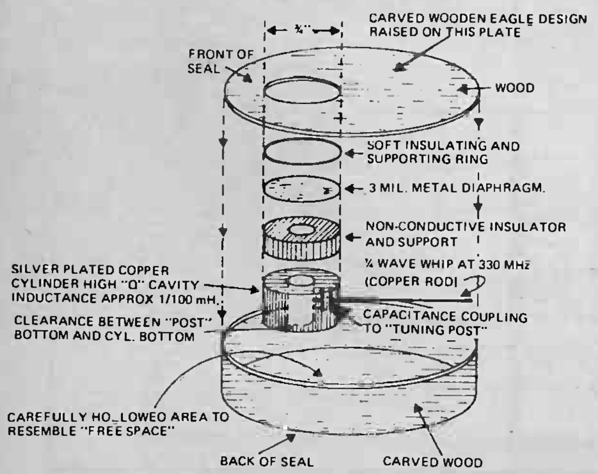
The vast majority of businesses are operated decently and honestly but in every sphere it is very useful to know about your competitor's business. There are several ways of finding this out, the commonest is to head-hunt a senior employee but his information is quickly out-of-date once he has left. Even knowing what's going on in R&D has serious limitations since even the staff in these departments don't know if their work will eventually get into production.

Bribery has been tried but you run the very serious risk of meeting one of the 95% of employees who would report it to their boss.

Bugging is anonymous. Even if the bug is found, it's almost impossible to find out who planted it and since the



Arrangement of an infinity transmitter used to eavesdrop on sounds in a room thousands of miles away using the telephone as the microphone.



Exploded view of the US Great Seal presented to the American Embassy in Moscow in 1945. This ingenious device was passive in operation and could not be detected by most of today's anti-bugging equipment. When you appreciate that this was devised 33 years ago it makes one wonder how sophisticated modern-day intelligence equipment must be.

. . . news digest . . . . .

show-offs

Aiwa have become the third Japanese hi-fi company to open showroom facilities in London. The new premises are at 56-58 Brunswick Centre, just off Russell Square – which itself is pretty close to Tottenham Court Road (Just turn right at Laskys and keep going, you'll walk right into Russell Square).

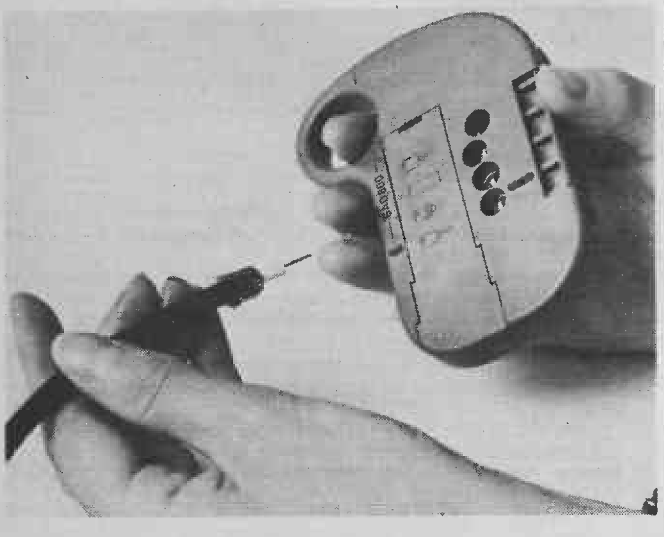
The idea of such a place is to allow people to inspect the goods without the usual hi-fi shop hard sell. Sony started the idea in Regent Street some time ago, but to get a place the size of Aiwa's on Regent Street would cost a fortune. It is massive! Certainly worth a look around if you are wandering the length of Tottenham Court Road in search of some hi-fi. In addition to displaying the entire range, the showroom sells the specialised Aiwa accessories which might not be available elsewhere.

Also from Aiwa is the brand new cassette deck which to us represents the endstop (at present!) in cassette technology. The machine is designated the 6800, and can be adjusted to obtain the optimum from any brand of tape by the user within 10 seconds! Simple procedures align the heads and set the bias, via a special test head. The machine is far too complex to describe here, we're looking at it in more detail elsewhere in this issue! Aiwa Sales and Service, Brunswick Centre, Bloomsbury, London WC1.

coping with cables

A new hand operated coaxial cable stripper has been introduced by AB Engineering Company under the model number COAX-1. Simple hand pressure ensures accurate stripping of television, telecommunications and other coaxial cables up to 7.5 mm diameter. The tool incorporates four apertures offset to a common cutting blade which provide: Aperture one–Strips to outer insulation: aperture two–cuts through the screen and strips the insulation leaving a 7 mm or 12 mm length: aperture three–strips the dialectric: aperture four–cut through the cable.

Further details may be obtained from AB Engineering Company, Apem works, St. Albans Road, Watford, Herts.



LCD on the panel

Lascar Electronics have introduced a 3½ digit DPM fitted with 0.5" liquid crystal display. The new meters have the features of auto-polarity, auto-zero, 0.1% accuracy etc. (available with an F.S.D. of –1,999 mV or – 199.9 mV). The new types operate from a single supply rail between 5-12 V DC The low power consumption (typically 1 mA current drain) makes them ideal for use in portable instruments.

It is claimed that a PP3 battery would give several months' operation in normal use.

Calibration is set by an on-board (20-turn) preset with over-range input indicated by suppression of the last three digits. Programmable LH decimal point and input impedance greater than 10 Mohms. Bezels are also available.

Lascar Electronics Limited, P.O. Box 12, Module House, Billericay, Essex. CM12 9QA.

WALLS HAVE EARS

This telephone insert looks pretty standard. In fact it contains an FM radio transmitter with a range of several hundred metres.

risks to a company initiating bugging are enormous, middlemen are almost always used.

● Superbug, not just another bug, high stability FM transmitter, with 20 mile range. [redacted] Minibug, tinier than matchbox, 5 miles range. [redacted] (not kits, ready for use), best value available, sae for details. [redacted]

Sweeping

Many, if not most of the companies selling bugs will also supply sweeping equipment — after all a radio signal is easier for someone close to the transmitter to pick up than it is for someone a hundred metres away — or is it? First you don't know what frequency it's operating on. It could in theory be from 50 kHz (though the antenna would be a problem) up to several hundred megahertz. OK, use an untuned circuit but then what do you do about regular radio and TV broadcasts? If you set the frequency of the bug close to that of a powerful FM station it's difficult to sort out the two.

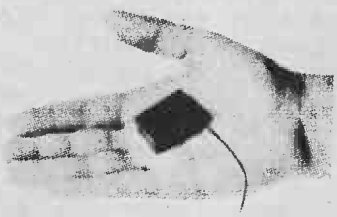
The makers of the equipment are highly secretive about their techniques and not one would discuss technicalities; they claimed, perhaps with some justification, that if you know how the sweeping is done, its all the easier to use a technique which won't be picked up. We believe many of them employ a howl-round technique — put a receiver near a bug and you'll set up an audio/RF loop which will go into oscillation.

● Micro transmitters, receivers, electronic stethoscopes, etc., complete range of professional equipment available, send 6½p stamp for fully illustrated catalogue, local agents in many areas. [redacted]

International Espionage

Although companies will normally keep quiet about attempts to bug them, Governments delight in exposing the failed attempts.

The American Embassy in Moscow recently announced that they were being subjected to extremely high power, high frequency radio signals. It was of such a magnitude that it was even suggested that it was an attempt deliberately to make the staff ill. It is now thought far more likely that the RF signals were being used to recharge batteries in bugs within the building.



A small bug openly advertised in Britain. Claimed to have a range of 200 metres with a 50-hour battery life, it retails for under £40.

The size of this bug can be judged from the PP3 battery plug. It is claimed to have an output of 300 mW which the makers claim is good for 5 miles and can be supplied with any frequency in the range 84-150 MHz. We have no way of verifying these claims; price is about £16.

In 1945, as a gesture of good will, the Russians presented the US Embassy in Moscow with a beautiful wooden carving of the US Great Seal. After several years it was discovered that that this had built into it a wonderfully simple bug. Inside the seal was a copper cavity coupled to an antenna; one end of the cavity was covered by a thin metal diaphragm.

The bug was activated by an external RF signal (in fact 330 MHz)— this made the cavity resonate but the diaphragm caused the reradiated signal to be modulated and this to relay conversations near the Seal. This could still have been in operation

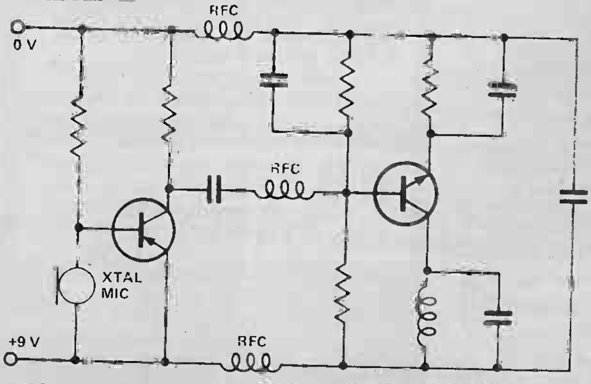
DISSECTING A BUG

THE RF BUG shown in the photograph is a home-brew one that came into ETI's possession. The circuit was openly published in a British book a few years ago — we show the circuit as well although we have not, nor will we, provide any component values. (Since there are several variables we do not suggest you 'suck-it-and-see'.)

Although a DIY circuit, it would seem that virtually all the smaller or simpler bugs are of similar complexity or even similar circuitry.

This bug operates anywhere in the 87 MHz-108 MHz range and despite the simplicity and low battery drain (only a few milliamps) it will transmit a fair quality signal for several hundred metres in most areas and at least 30 metres even in heavily built-up areas with steel-frame buildings like city centres.

The microphone will pick up normal speech at 10 metres quite easily. The performance, frankly, is worrying — because of the effectiveness — and the unit can be built for about £3!



Complete circuit of a VHF bug which can be built for only a few pounds.

if some British technicians had not stumbled across the signal by accident. A thorough subsequent 'sweep' of the US Embassy brought to light no less than 60 other devices!

It is hardly surprising that British Intelligence Services are involved as well. The Russian Embassy in London moved a year or so ago and when access to the building became possible it could be seen the lengths to which the Russians went to prevent eavesdropping, even to having built a room within a room. Various bits of information have leaked out that Intelligence Services were directing a low power laser at the window glass; this would then have been slightly modulated by the sound inside the room and the reflection picked up could detect this.

One of the techniques which has recently come to light is that of 'RF flooding' of a telephone. Even when the phone is on the hook, the RF can 'jump' the contacts. This is then modulated by the microphone and can be picked up. As it can only be used with single lines, a switch-board defeats this technique.

The other phone tapping technique, the 'infinity transmitter' is also made useless with a switch-board. Many company executives use direct lines for security whereas the switch-board itself is a pretty good defence against some techniques.

Equipment Available

Laws in many countries have failed to keep pace with technology but it is ironic that most of the really sophisticated equipment being made originates in the US — the very place with the strictest laws against bugging and phone tapping. This could be because the problem there is greater but no amount of legislation is going to prevent the availability of equipment — the profits are too great.

The range of equipment is so varied and the interest so keen that in the Spring of 1977 a full scale exhibition of both bugging and anti-bugging devices was held in West Germany — a country which incidentally bans sales . . . except if it is marked as 'Export Only'. It's surprising how many retail outlets regard themselves in this field!

The Future

However superior anti-bugging equipment becomes, the number of ways of eavesdropping electronically is so varied and the techniques developed for keeping the devices undiscovered so ingenious, it seems that bugs and bugging are not likely to become any less of a problem.

Legislation may not stop bugging but it can raise the risk factor to such a level that those practising it will think carefully. **ETI**

ARE YOU BEING BUGGED?

THE BIGGEST PROBLEM facing someone wishing to bug another is gaining access. Breaking and entering is obviously criminal but a bug can be installed literally in one minute if some risk of the device being discovered is acceptable. Unless the villains have access to a building during building or decorating work, problems in siting the bug are real — well-concealed hiding places are usually bad for picking up sound. Favourite sites reported to us are in low-pressure air-conditioning vents and behind radiators — another one is on sticky pads under a desk, somewhere which would not be noticed for years.

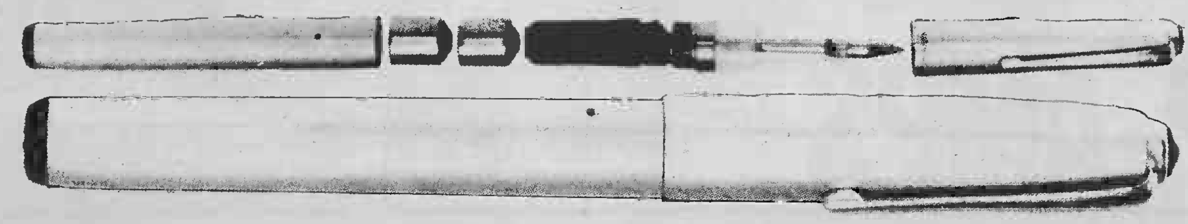
A simple search is best and most bugs will be discovered unless a true expert has been employed.

The extent of telephone bugging is unlikely to be high — access is so difficult that only the Intelligence services will be able to handle this. In any case electronic telephone scramblers can overcome this.

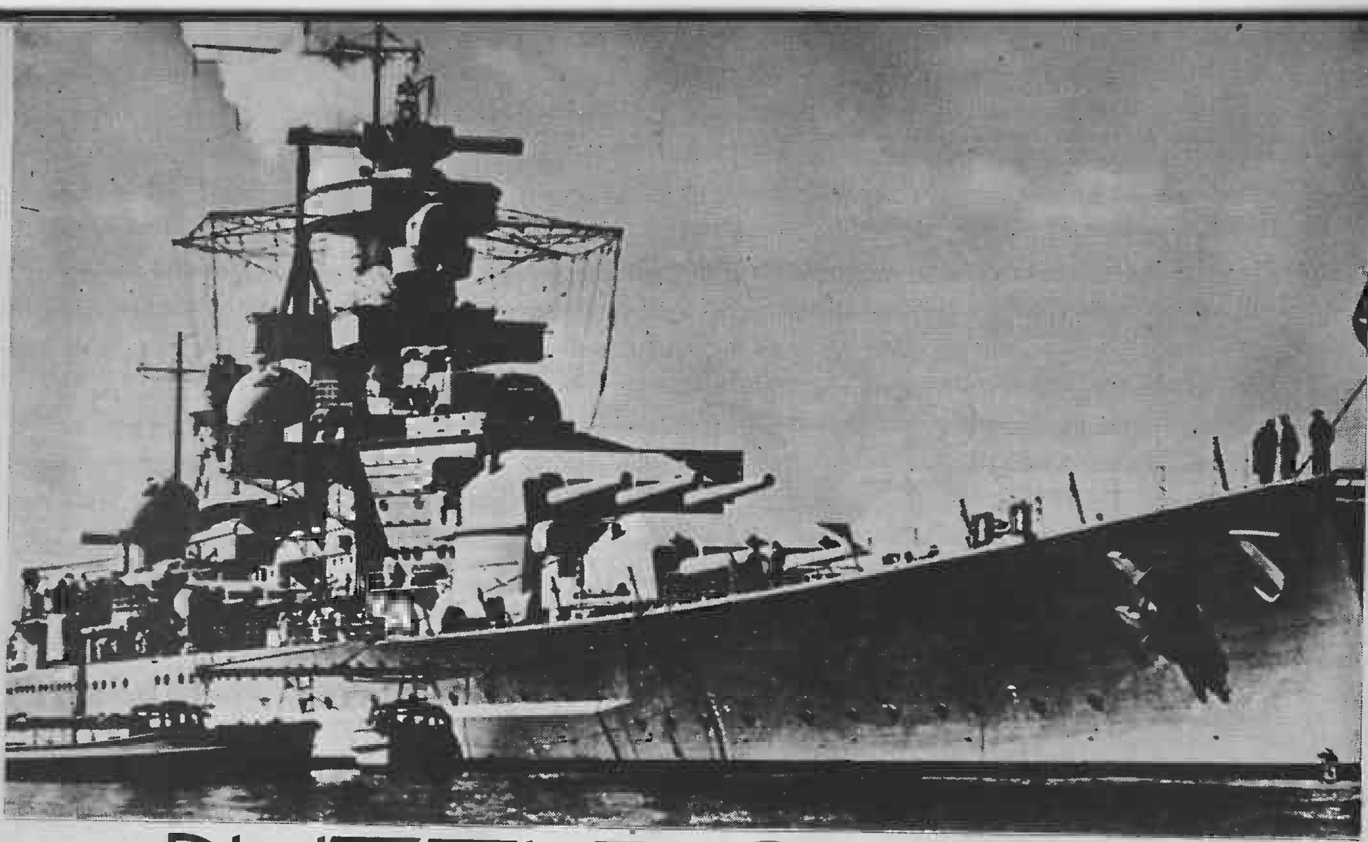
If you regard yourself as a candidate for bugging, check the credentials of Post Office engineers if you haven't called them in yourself. But don't be fooled by the novelists who seem to insist that 'two ominous clicks' after the telephone is lifted is a certain indication that there is an unwanted listener on the line.

A real spy kit advertised for 'the professional'. A 6-channel transmitter operating on VHF or short wave is supplied — there is a matching receiver. Also included is a cassette recorder mains operation facilities.

ETI is not prepared to answer any queries, for whatever reason, on the circuit components or as to the availability of the equipment shown in this feature.



At first sight an ordinary pen but look closer. Despite its size it has everything incorporated and will put out a signal over 100 metres for three days on one set of batteries.



PUZZLE OF THE DRUNKEN SAILOR

THE MODEL REPRESENTS a ship which has four navigation lights on the port (left) side and four on the starboard (right) side. Unfortunately, a drunken sailor installed 4 green lights in the sockets on the port side and four red lights on the starboard side — which, as everybody knows, is the wrong way round. Everybody knows too that you don't have four navigation lights on each side — but never mind that, this is a puzzle.

And the puzzle is to get all the green lights on to the starboard side, and all the red lights on to the port side — where they belong. That would be easy if you just unplug them and swop them around, but the rules of the game are that:—

a) only one lamp can be moved at a time;
b) a lamp can be moved only along the black line and must be put into a vacant socket at the end of the move,
c) a lamp can be moved as far as desired on any move, including going round corner;
d) a lamp cannot jump over another lamp.

Well that's the puzzle. If you think it's easy — try it. Just draw the lines on a sheet of paper, use dots for the sockets and use 4 5c and 4 2c coins as lamps.

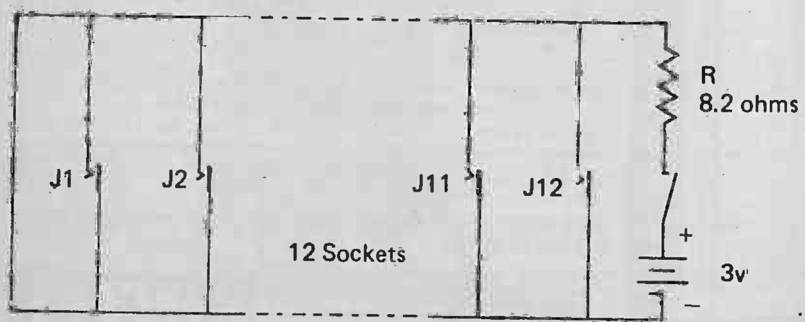
Actually that's all you really need for the puzzle, but to make it more attractive and electronic we used red and green LEDs which light up in the sockets.

Construction

The circuit of course is simple — just 12 audio sockets connected in parallel, a 3 volt battery, a current limiting resistor, a switch and 8 LEDs which can be plugged in.

The prototype was constructed in a plastic box measuring 140 x 100 x 75 mm with an aluminium panel. Any box about that size would do; construction is not critical.

Circuit diagram Fig 1: The value of current limiting resistor R should be found by trial to keep total battery drain to about 100 mA.



PARTS LIST

RESISTOR
8R2 ½ W (see text)

LEDS
4 Red (TIL 209 or similar)
4 Green (TIL 209 or similar)

MISCELLANEOUS
2.5mm jack socket (12 off)
2.5mm jack plugs (12 off) (see text)
On/off switch (any type)
Hook-up wire
Box to suit
Battery (3 V)

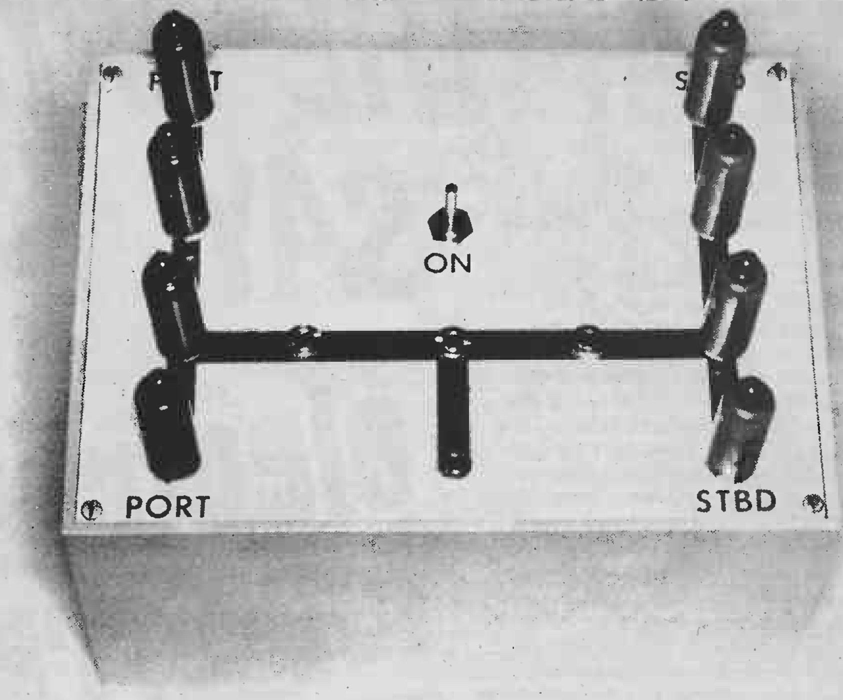


Photo 1: The finished puzzle

The lamps are 4 red and 4 green LEDs soldered straight on to the terminals of 2.5 mm audio plugs. Care must be taken that all LEDs are soldered in the plugs the same way round, so that the positive side of each LED is connected to the centre contact of the plug. There are available several lengths of 2.5 mm plug but the best for this project has a 'handle' measuring 22 mm and a hole in the top which is just right for a LED. The plugs should have colours to match the LEDs if possible — red and green — or at any rate red and black. Take care to get all LEDs protruding by the same amount.

The sockets mounted in the panel must all be wired the same way round too so that in every one the positive wire is connected to the contact which meets the centre contact of the plug. In this way any LED will light up in any socket.

The resistor R in the prototype was chosen to limit the current drain on the battery to a reasonable value — 100 mA, and still give adequate brightness to the LEDs.

The battery comprised two D cells soldered together in series and to the wiring on the panel. They were held in the box with suitable packing, but a clip could be made instead.

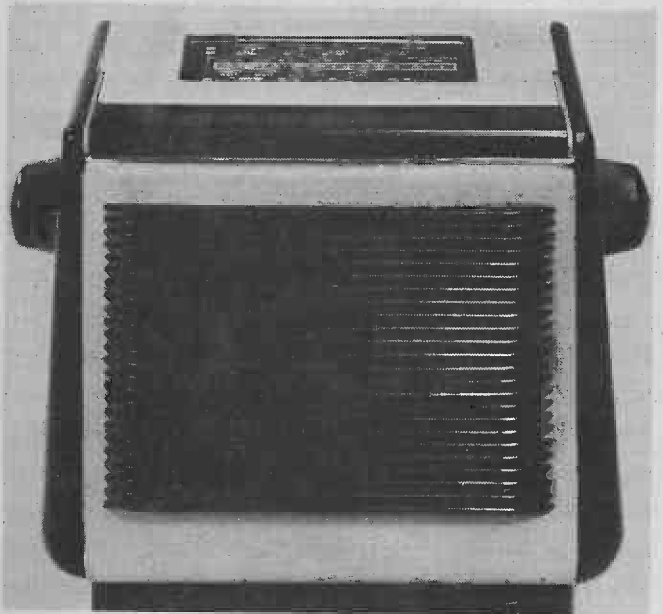
The black line on the panel was made by cutting a strip from a sheet of black contact which was on hand. Scotchcal, paint or drawing ink would do instead.

Well, there you are, that's the puzzle and nothing else need be said about its construction.

Its solution is another matter. The answer will be published next month. Suffice it to say for the present that it requires several moves! ETI

wireless show

Pete Scott, our visiting Australian hi-fi editor, took a wander through the hallowed halls of the Victoria and Albert Museum to cast his eyes over the vintage radios displayed therein and bring us this report on the ancestors of the 'trannie'.



Decca Deccette 1953. A 4-valve battery portable, using miniature valves of superhet design and with (detachable) mains eliminator base.

THE NOSTALGIA TRIP of 1977 is undoubtedly the 'Wireless Show' at the Victoria and Albert Museum until December 11. The show, which consists of a fine collection of British radio receivers from a period which could loosely be called the 'valve era' is the most comprehensive survey of historical radio receiving sets ever compiled.

Scope

The 130 classic receivers have been chosen as a representative selection of equipment produced between the early 1920s — when regular public broadcasts commenced in Britain — to 1956, when the era could be said to have ended with the introduction of the first British transistorised portable radio.

The show is necessarily restricted in scope by the available space and so does not attempt to give a completely balanced view of the thirty years it covers. Items such as the combined radio-gramophone, or the larger combined radio-TV, are not included. It is also obvious that the exhibits of the larger floor-standing consoles have been limited to allow a greater overall diversity.

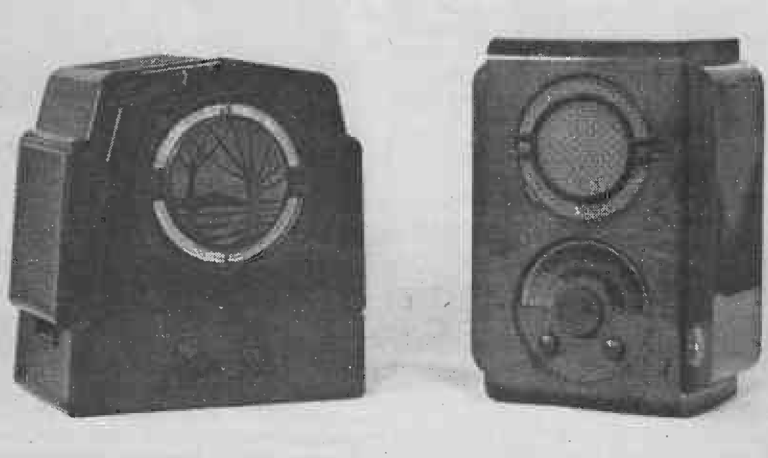
Table-standing valve sets — every home used to have one — form the dominant section of the show, but older visitors will have their memories stirred by the earlier units with their free-standing horn speakers.

Background

The choice of 1922 as the starting point is not random, even though a great number of the major innovations in the wireless field had already taken place by that time. Marconi had filed his first world patent in 1896, transmitted over the Atlantic in 1901, and speech had been broadcast by Fessenden in 1903.

The first broadcast of speech across the Atlantic had been achieved in 1916, using a transmitter comprising some 300 valves, and the first practical use of superhet techniques for speech broadcast across the Atlantic was made in 1921.

About this time wireless was being used only by experimenters and enthusiasts, who tended to construct their own receivers, although it was estimated that there were some 500 companies manufacturing components in Britain alone.



Left: Ekco model SH25 from 1932, and on the right the UAW78, five years older.

Left to right: A 1948 GEC, a Marconiphone Personal (would you believe) set (1947), our

Wireless at this stage was not used for 'passive entertainment' in Britain, although America was being served by several hundred transmitters — largely unregulated. However, with the formation of the British Broadcasting Company, set up in 1922 to organise regular entertainment programmes through a network of eight transmitting stations, wireless began to have a less esoteric appeal.

So the starting point for the Wireless Show represents the time at which radio started to become a popular commodity. The growth rate in the industry from this time was extremely rapid, as was public acceptance.

The Technical Side

For those interested in the changing technology the show is an interesting aid to tracing technical developments through the thirty years preceding Britain's first transistor radio.

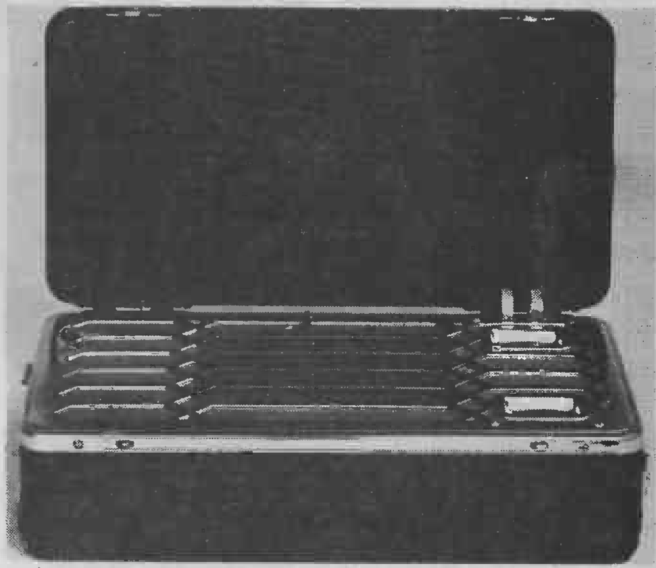
Immediately obvious features include the rapid improvement in tuning facilities, the fight for higher selectivity as the number of transmitters escalated, and the move from battery operated sets (or combined battery/ac) to ac only as more houses were wired up, and and then the move back to battery power as portability became a desirable feature.

Even the gimmicks and convenience features, such as the 'magic eye', introduced as technological advances slowed in the late thirties, prove fascinating.

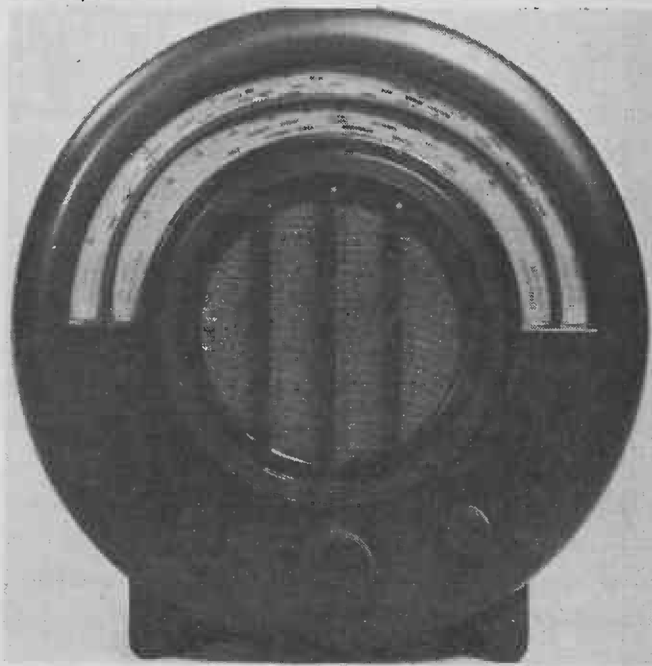
Stylistically

The main purpose of the exhibition at the Victoria and Albert, however, is to show the changing styles in the presentation and appearance of radio receivers through the chosen period. Styles that moved from the ornate — almost ornamental — crystal sets of the very early days, through to the receivers with intricate wooden cabinets, and then to the architect-designed, sculpted-plastic 'creations' which eventually proved too much for the woodworking craftsmen, but which were dropped in post-war austerity.

The show, produced by the V&A in association with the British Vintage Wireless Society, is well worth a visit by anybody who ever built a crystal set. It will revive many memories for older visitors and gives a fascinating insight into the background and formative years of radio in this country. ETI



The vastly expensive (£15 19s 5d) Marconiphone personal receiver in close-up.



Superhet from 1932 and Ekco, 3-valve design, could be battery run.

friend the Decca again, and a 1950 design by Lawrence Griffin.

Marconiphone 1932 model 42 on the left of the Pye 'MM' from the same year.

TL080 Family Bifet Op Amps

Texas

The TL080 family of BIFET operational amplifiers, provides an ideal combination of high-impedance JFET inputs with a low-distortion bipolar output circuit. Quality performance in the TL080 family is achieved without complex circuitry.

TL080 family circuit description

The following sections should be read in conjunction with Fig 1, the basic schematic for one channel.

Bias circuits

EFT Q16, zener D2, transistors Q14/Q15 and resistor R6 establish the bias currents for the input differential amplifier and the second gain stage. Epitaxial FET Q16 provides a fixed current to D2 establishing 5.2V on the base of Q15. The resulting 317uA collector current of Q15 flows through Q14 and sets the current levels in Q1 and Q9.

Resistor R1 causes 196uA current in Q1 that is divided between the input stage JFETs Q2 and Q3. The second-gain-stage bias current, about 600uA, is derived from E9.

Input circuit

Input JFETs Q2 and Q3 operate into the active load circuit consisting of Q4, Q6, and Q7. Current imbalance and input offset voltages may be adjusted on the TL081 and TL083 through connections to the emitters of Q6 and Q7. External offset controls for the TL080 connect to the collectors of Q6 and Q7. The C1 compensation capacitor is internal on the TL080, TL082 and TL083, and TL084. For the TL080 connections for external compensation are provided which allow user adjustment of AC characteristics.

Ion-implanted input devices provide very high input impedance, controlled pinch-off voltage for maximum common-mode input range, and matched characteristics for control of the input offset voltage. JFET inputs also allow adequate drive to the second stage resulting in maximum output peak-to-peak capability and wide power band widths.

Output stage

Q10 and Q11 provide Class AB bias to the output transistors Q12 and Q13. This allows near zero crossover distortion and produces a low total harmonic distortion at the output. The simplicity of the output circuit results in minimum silicon area requirements keeping manufacturing cost down while maintaining quality performance. R2, R3 and R4 form the output short-circuit protection network.

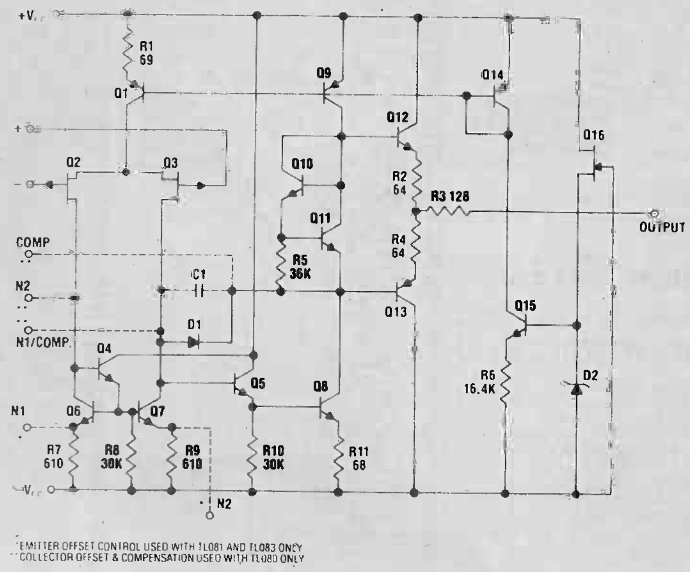
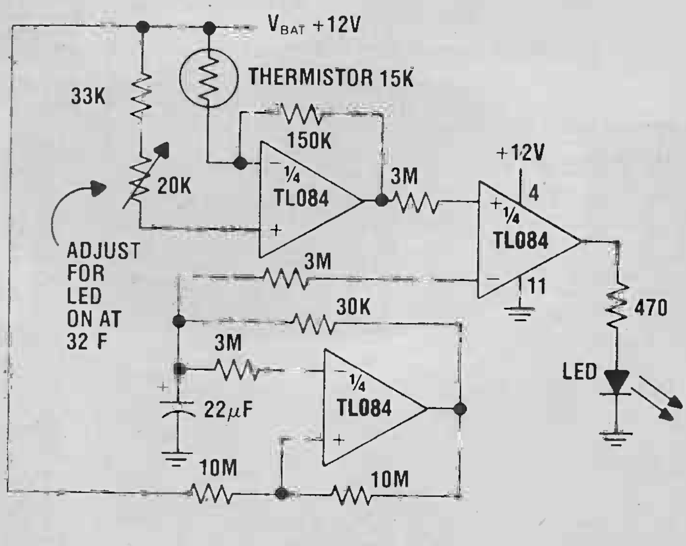


Fig 1. Schematic diagram for TL080 family.

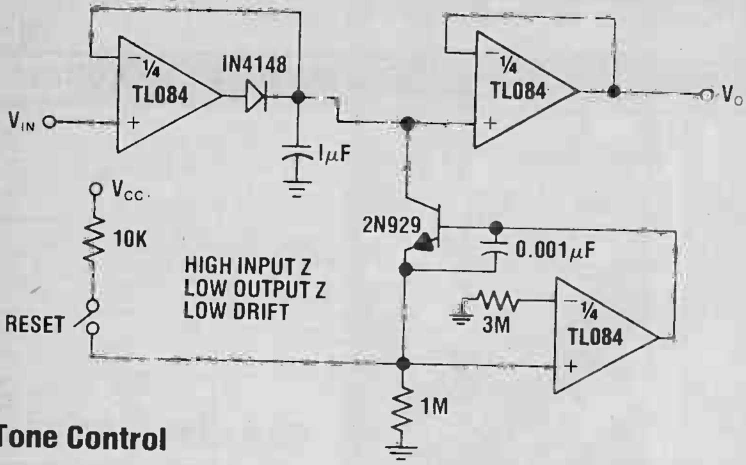
Second stage

Drive from the input stage is single-ended from the collector of Q7. D1 provides a clamping action across Q5 and Q8 preventing saturation of Q8 and excessive current in Q5. Q5 and Q8 form the high-gain second stage. The second stage output, collector of Q8, drives the output stage consisting of bias transistors Q10 and Q11, and output drivers Q12 and Q13.

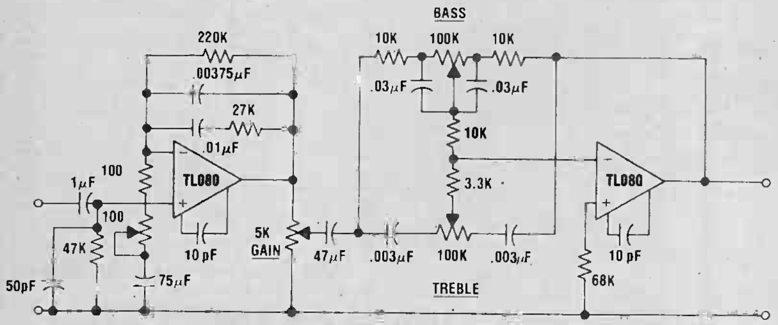
Icy Road Warning Indicator



Peak Detector



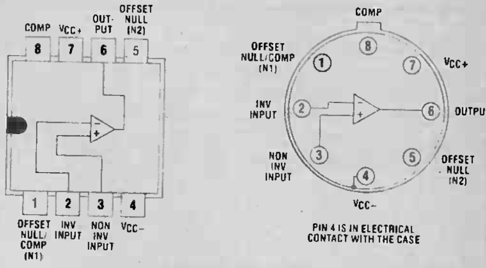
Tone Control



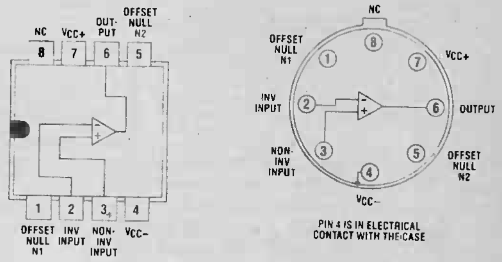
FEATURES	ADVANTAGES
● HIGH INPUT IMPEDANCE	Minimum loading effects allow efficient use with high impedance transducers.
● HIGH SLEW RATE	Provides the desired response characteristics required in audio frequency active filters and quality sound systems.
● LOW DISTORTION	Minimized crossover distortion yields very low total harmonic distortion for maximum performance in critical music systems.
● CONTINUOUS SHORT CIRCUIT PROTECTION	No damage resulting from accidental shorts or operation into low impedance loads.
● LOW POWER CONSUMPTION	Only 2.8 mA per operational amplifier. Less system power required and battery operation is practicable.

PIN OUTS

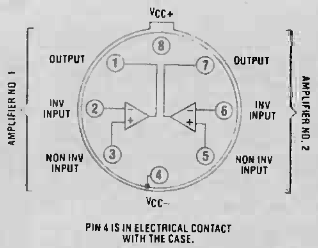
TL080



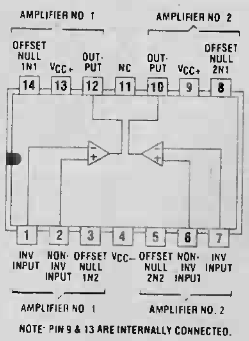
TL081



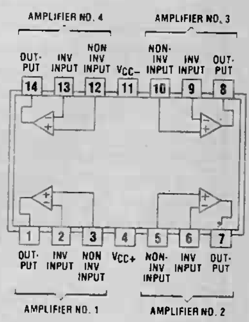
The TL082



The TL083



The TL084

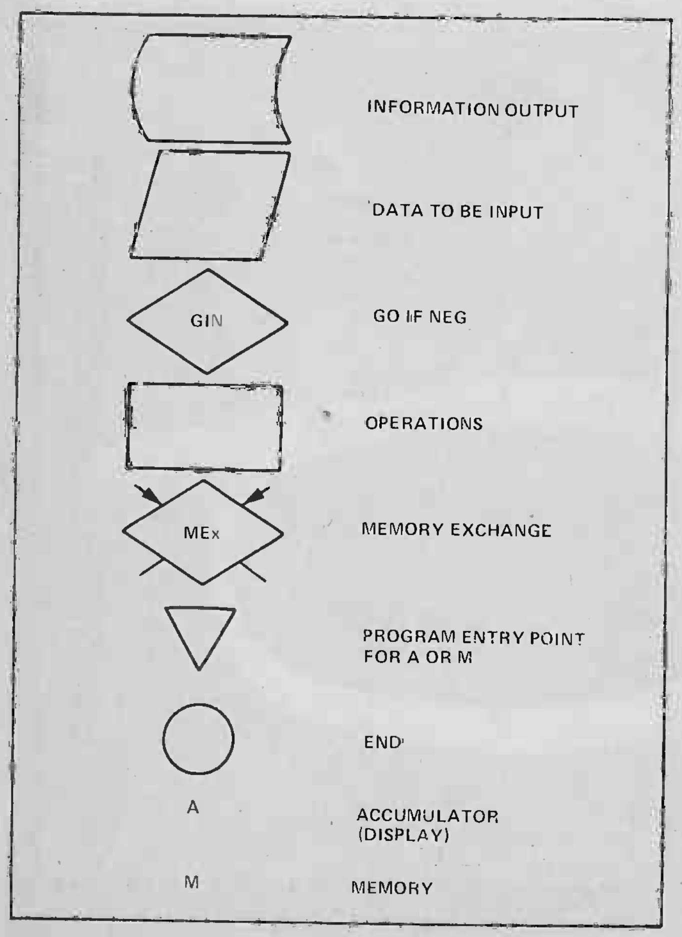


absolute maximum ratings		TL08_C TL08_AC TL08_BC
Supply voltage, V_{CC} (see Note 1)		18 V
Supply voltage, V_{CC} (see Note 1)		−18 V
Differential input voltage (see Note 2)		±30 V
Input voltage (see Notes 1 and 3)		±15 V
Duration of output short circuit (see Note 4)		Unlimited
Continuous total dissipation at 25°C free-air temperature	J,JG,N, or P Package	680 mW
	L Package	625 mW
Operating free-air temperature range		0 to 70°C

NOTES:
1. All voltage values, except differential voltages, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC+} and V_{CC-}.
2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.
3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.
4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

SOFT WARE GAMES

These games for the Sinclair Programmable were submitted by Mr P Cornes of Crewe in Cheshire. A flow chart is given with each listing, so that owners of different machines have a head start in producing a program for their machines.



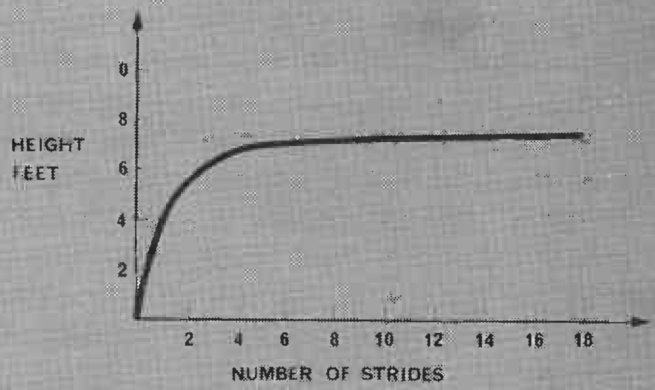
Object — To simulate a show jumping course in such a way that:—

1. The player enters a guess as to how many strides of acceleration he thinks will be required by a horse to clear a fence H feet high.
2. The player is given an indication of right and wrong guesses.
3. The players total score is made available to him at the end of the game.
4. The players score is made dependent on the value of his guesses and on his successfully clearing the fences.

Execution —

0/▲▼/sto/▲▼/▲▼/goto/0/0/
input H fence 1/RUN/input strides/RUN/right-wrong
input H fence 2/RUN/input strides/RUN/right-wrong
input last H/RUN/input strides/RUN/right-wrong
▲▼/Rcl/score.

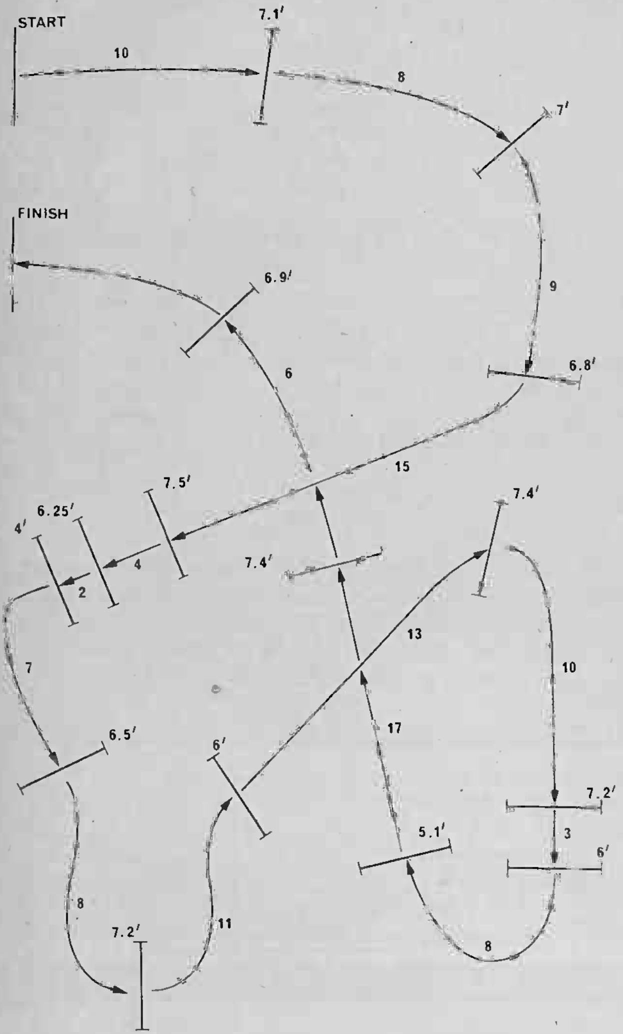
The biggest problem with this program was trying to find a realistic relationship between the number of accelerating strides input and the height that these strides would enable a horse to jump. The following curve shows the sort of relationship that is required.



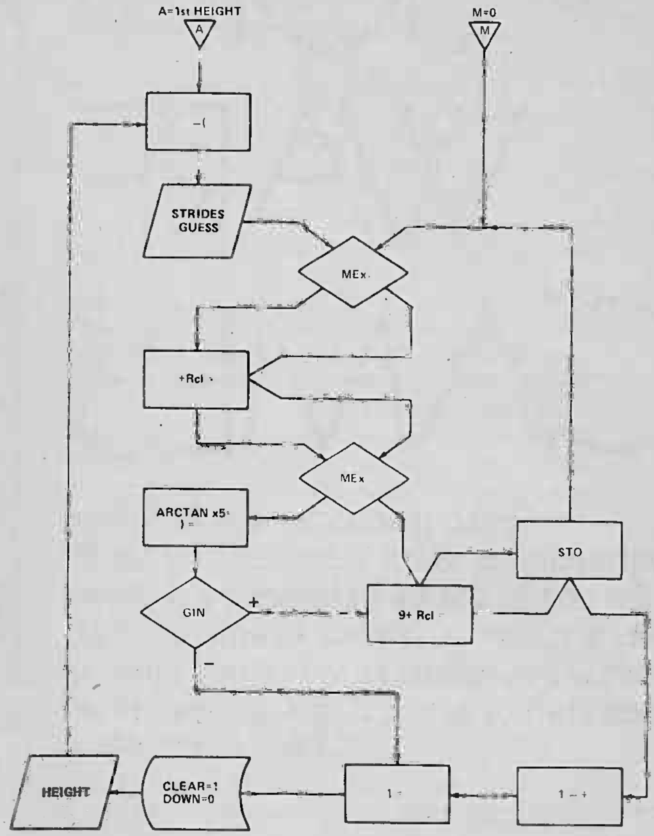
As you can see from the curve the extra height that the horse can jump decreases as the number of strides increases, such that after a certain point no increase in height is gained by increasing the number of strides. This is the sort of curve you would expect in reality. I have simulated this curve by using the arctan function. The tan of an angle can take any value between zero and infinity so the arctan of any number between zero and infinity has a radian value between 0 and 1.57 and you will find that taking the arctan of any number greater than about twenty gives approximately 1.57 as an answer. The only thing to be done now is to scale the arctan values up to give a reasonable range of heights, to do this we multiply by five.

Looking at the plan of the course you will see the path connecting the fifteen fences together. The number alongside each fence is its height (H) and the numbers on the paths between the fences are the distances in strides to each fence. If you input these numbers as your guesses

HORSE JUMPING GAME



Above: a suggested course for the horse race game. All the fence heights are given in feet, and the number of strides between the fences.



then you are guaranteed to clear the fences but you will find that it is possible to clear most of the fences in less strides than shown.

Your score is calculated by totalling all your guesses round the course and by adding a penalty of nine points for each fence you do not clear. You should consider yourself to be disqualified if you knock down more than four fences.

If you clear every fence in the minimum number of strides you will end with a score of ninety-five but you should consider a score of one hundred and ten or less as good.

When you master this course it is a simple matter to change the heights of the fences and this creates your own course but remember that no fence should exceed 7.5 feet in height or you will not clear it.

		–	F	00
		(	6	01
	INPUT STRIDES	Stop	0	02
VALUE –VE FOR FENCE CLEARED +VE FOR FENCE DOWN	UPDATE SCORE WITH STRIDES INPUT	▼	A	03
		MEx	5	04
		+	E	05
		Rcl	5	06
		=	–	07
		▼	A	08
		MEx	5	09
	CALCULATE HEIGHT FROM STRIDES INPUT	▼	A	10
		arctan	9	11
		x	.	12
		#	3	13
		5	5	14
		=	–	15
		)	6	16
		=	–	17
		▼	A	18
		GIN	1	19
		3	3	20
		2	2	21
	UPDATE SCORE WITH FENCE DOWN PENALTY	#	3	22
		9	9	23
		+	E	24
		Rcl	5	25
		=	–	26
		Sto	2	27
	FENCE CLEARED/ DOWN DISPLAY 1 = CLEARED 0 = DOWN	#	3	28
		1	1	29
		–	F	30
		+	E	31
		#	3	32
		1	1	33
		=	–	34
	INPUT HEIGHT	Stop	0	35

...news

game attempt ....

The first Commodore TV game is titled TV 3000H, and can be used by up to four players. The usual four games are available:—

Football (Two or four players);
Tennis (Two or four players);
Squash (Solo or two players);
and:
Target Shooting.

Other Features:

On-Screen Scoring shows the score after every point and three realistic sounds help to add realism to the game. (To save battery costs, a mains adaptor is provided, included in the price).

The game is colour, and auto speed up of the ball is also included. The TV 3000H is covered by a one-year guarantee and is available at a RRP of £39.95 (including VAT and adaptor). A pistol, which can be assembled into a rifle for use with two target games is available as an optional extra at £12.95 (including VAT). Commodore Business Machines (UK) Ltd., 446, Bath Road, Slough, Berks. SL1 6BB.

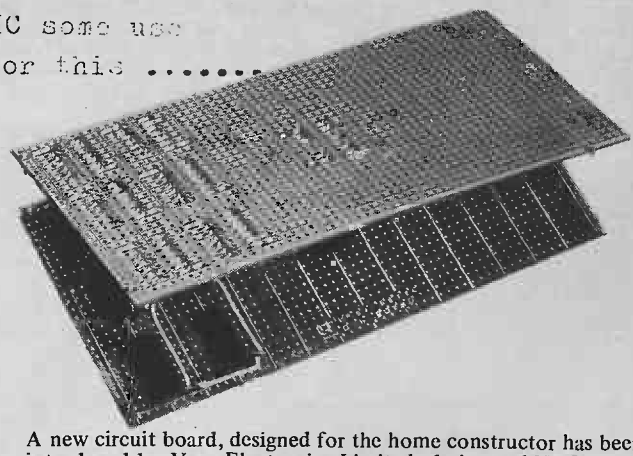
caught red (hot?) handed ....

A new Passive Infra-Red Intruder Detector is now available from Photain; The unit consists of a solid state passive infra-red sensor which views an area through a seven facit optical system. When the sensor detects an infra-red emission (eg. the human body) passing across the optical system a relay action is obtained to trigger any type of alarm system. Two conditions must be complied with before the relay operation takes place (ie. heat, emission and movement) and therefore false alarms will not occur from static hot bodies such as radiators, electric fires etc.

The unit is normally fitted on a wall some 3 metres above ground level. (The area of coverage is up to a distance of 12 metres).

The main use for the device is to protect specific high risk areas of a building and as the unit does not emit any signal (such as ultrasonic or microwave detectors do) it can be used in areas with large glazed surfaces or lightweight partitioning without suffering problems. Photain Controls Ltd., Unit 18, Hanger no. 3, The Aerodrome, Ford, Arundel, W. Sussex.

IC some use for this ......



A new circuit board, designed for the home constructor has been introduced by Vero Electronics Limited, designated V–Q (Vero Quad).

Primary design considerations were to produce an economical board capable of accepting any component, but especially integrated circuits – regardless of pin spacing. V–Q has a 0.1" matrix, and a layout sheet with a 1:1 copy of the copper pattern is packed with every board. Up to twenty-one 14 or 16 pin ICs can be accomodated on the board, which measures 147 mm (5.82") x 73 mm (2.90").

The order code for V–Q is 01-0044C and it is available from retail shops and mail order houses at around £0.90. Vero Electronics Limited, Retail Dept., Industrial Estate, Chandler's Ford, Hampshire. SO5 3ZR.

UNIVERSAL RANDOM NUMBER GENERATOR — FOR GAMES

Object — To generate a random number of any required length up to eight digits in such a way that each digit can take any value from N to M.
OR generate single random numbers with values from K to L.
OR play an ESP game such that the player has the opportunity of entering a single digit number before the calculator generates a random number, both digits being displayed at the end of the run for comparison and statistical purposes.

Execution 1 —
Any number between 0 and
1/▲▼/Sto/▲▼/▲▼/goto/0/0/^{C}/ce/
RUN/random digit/ if you require a two digit random number then press RUN again and a second random digit will be displayed alongside the first, a three digit random number, press RUN a third time etc . . . .
When you have a random number of the required length and wish to generate another number press the clear button followed by RUN/random digit/ etc. . . .

Execution 2 —
Any number between 0 and
1/▲▼/Sto/▲▼/▲▼/goto/0/6/^{C}/ce/
RUN/random number/
RUN/random number/
RUN/random number/ etc . . . .

Execution 3 —
Any number between 0 and
1/▲▼/Sto/▲▼/▲▼/goto/0/0/^{C}/ce/
Your guess/RUN/random number and your guess
Your guess/RUN/random number and your guess
Your guess/RUN/random number and your guess

With the program as it stands the variables take the following values:—

N = K = 1
M = L = 6

Obviously with these values the program can be used to simulate the throwing of dice with executions 1 or 2.

When you come to change the variables you should do it in the following way:—

Executions 1 and 3
Chose a value for N between 0 and 10 (integer).
Chose a value for N and 9 (integer).
Replace lines 9 and 10 with the value of M − N.
Replace lines 29 to 31 with the value of N − 1 (including sign).
Run as per execution instructions.

Execution 2
Chose a value K between 0 and 10 (integer).
Chose a value L between K and K + 99 (integer).
Replace lines 9 and 10 with L − K.
Replace lines 29 to 31 with K − 1 (including sign).
Run as per execution instructions.

With a moments thought you will see that there are one hundred and one uses for this program, a few of these are given below.

Slot Machine

Use execution 1 with N = 1 and M = 4 and score wins according to the following table.

Display	Win
111	10
222	10
333	10
444	10
221	5
331	5
441	5
11–	4
1–	2

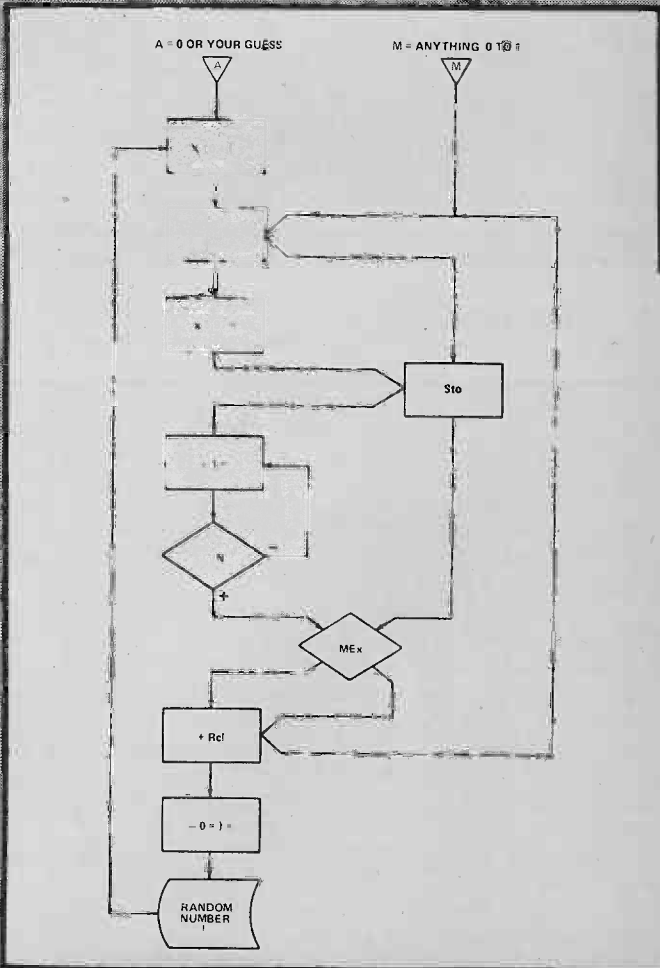
With the values of win shown, the program gives a 95% pay-out.

Race

Use execution 2 with K = 1 and L = number of players (say four). Run the program and each time a number comes up enter a one in the table shown, in the next empty square down, underneath the number displayed. The first player to fill the column below his number is the winner.

Battle

Use execution 3 with N = 0 and M = 5. Each player takes it in turn to enter his own number (one to five) and run the program. When the display appears subtract the smaller digit from the larger and then add the larger digit to this answer. The player with the highest number at the end of the round wins the round. The first player to win five rounds wins the game.



ATOMIC DECAY GAME

Object — To simulate the decay of B grams of a radioactive material with a half-life of D seconds in such a way that:—

1. The player has the opportunity of guessing how much of the material (plus or minus C grams) is left after each second.
2. The player is given indications of right and wrong (hit and miss) guesses.
3. A running total of the player's score is displayed after each guess.

Execution —

1/0/0/▲▼/sto/▲▼/▲▼/goto/0/0/0/RUN/ score (0) /
Your guess/RUN/Hit-Miss/RUN/ score/
Your guess/RUN/Hit-Miss/RUN/score/ etc . . .

With the program listing and execution sequences given the variables take the following value:—

B = 100 grams. D = 10 seconds. C = 1 gram.

Should you wish to change the variables (When you get used to playing the game) then:

To change B — Put the new value in place of the 100 at the beginning of the execution sequence.

To change C — Change lines 21 and 22 in the program to your new value (any 2 key-stroke number between .1 and 99)

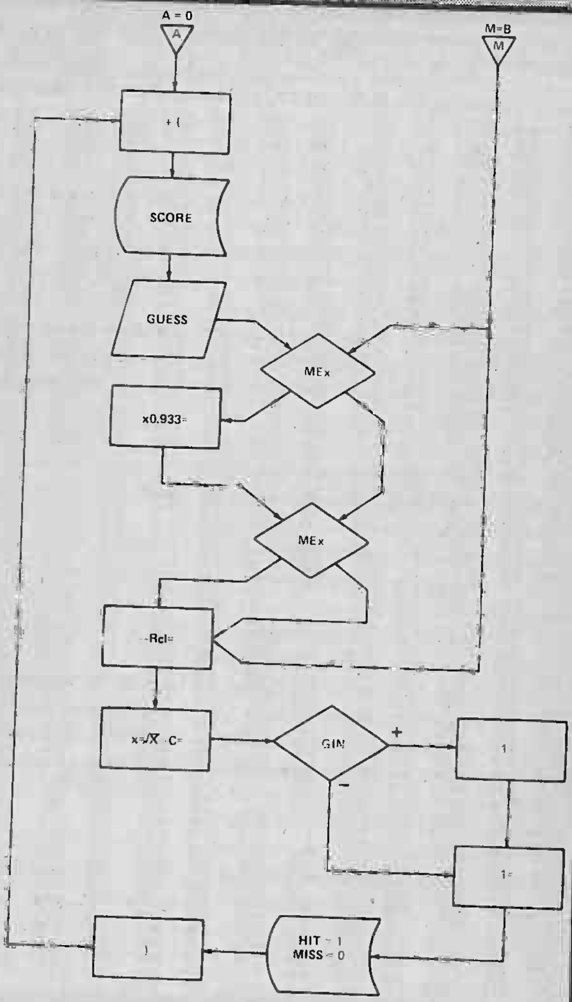
To change D — This variable is the most difficult of the three to change as it requires calculation thus:—

2/▲▼/1n x/÷/New D/=/▲▼/▲▼/e^x/÷/=

If the answer is less than one, then replace lines 08 to 10 with the three most significant digits after the decimal point. If the answer is greater than one then replace lines 07 to 10 with the four most significant key-strokes.

e.g. If answer is 0.9330114 then put 933 into lines 08 to 10.

N.B. The only way the answer to this sequence can be greater than one is if your value for D is —ve in which case you are no longer working with a radioactive decay curve but with an exponential growth curve.



SCORE DISPLAYED (steps 01–02)
CALCULATES NEXT VALUE OF DECAY CURVE (steps 03–13)
COMPARES GUESS WITH VALUE CALCULATED PLUS OR MINUS C GRAMS (steps 14–23)
FINAL VALUE OF BRACKETS ADDED TO TOTAL RUNNING SCORE
CALCULATES HIT/MISS FIGURE 1 = HIT 0 = MISS (steps 24–33)
HIT/MISS DISPLAY (step 34)

+	E	00
(	6	01
Stop	0	02
▼	A	03
MEx	5	04
x	.	05
#	3	06
.	A	07
9	9	08
3	3	09
3	3	10
=	–	11
▼	A	12
MEx	5	13
–	F	14
Rcl	5	15
x	.	16
=	–	17
√x	1	18
–	F	19
#	3	20
0	0	21
1	1	22
=	–	23
▼	A	24
GIN	1	25
3	3	26
1	1	27
#	3	28
1	1	29
–	F	30
#	3	31
1	1	32
=	–	33
Stop	0	34
)	6	35

FINDS NEXT RANDOM NUMBER (steps 05–32)
DISPLAYS RANDOM NUMBER (step 35)

x	.	00
#	3	01
1	1	02
0	0	03
+	E	04
(	6	05
Rc1	5	06
x	–	07
#	3	08
0	0	09
5	5	10
.	A	11
9	9	12
7	7	13
=	–	14
Sto	2	15
–	F	16
+	E	17
#	3	18
1	1	19
=	–	20
▼	A	21
GIN	1	22
1	1	23
7	7	24
▼	A	25
MEx	5	26
+	E	27
Rcl	5	28
–	F	29
#	3	30
0	0	31
=	–	32
)	6	33
=	–	34
Stop	0	35

START

1	2	3	4

FINISH

Above: the score sheet for the battle game and left are the listing and flow chart for the overall game.

CUTS CARD

Designed by John Miller-Kirkpatrick

LAST MONTH WE completed the description of the System 68 TTY card and described a simple cassette interface circuit that could be used in conjunction with this card. This month we begin describing what is probably the most popular means of encoding data in a form suitable for storage on magnetic recording tape — the CURS format. CUTS stands for Computer Users Tape System and is also sometimes referred to as Kansas City Format.

CUT Above The Rest

Figure 1 shows the basic specification of the CUTS system. From this it can be seen that a serial data stream of eight bits has a number of control bits added to it, much as a TTY has similar control information added to its output. The reason for these additional controls were dealt with in the first part of the TTY interface published in November last year.

Figure 1 also shows that the CUTS specification calls for a logic '1' to be recorded as eight cycles of a 2 400 Hz tone and a logic '0' as four cycles of 1 200 Hz. These tones have been selected as being suitable for recording on most tape systems and are also easily derived from the master 4 800 Hz clock present in standard UART systems.

The circuit diagrams of the decoder are shown in Figs. 2 and 3. These two circuit blocks replace the equivalent sections of the TTY interface circuitry to provide a complete CUTS encoder/decoder, all memory decoding and UART configuration being identical to that of the TTY card.

Next month we shall deal with the construction of the CUTS card as well as dealing with the necessary software. We shall also deal with means of providing additional RAM and PROM for the System 68.

Before winding up this month however, may we go on to discuss an interesting area of software.

Assemblers and Disassemblers.

An assembler is a program which allows instructions to be entered in a coded form which are converted by the program into a machine code form. Large programs cannot be written without an assembler or similar program to help with address and branch decoding. A disassembler works the other way round, if you feed it with a machine code program it will attempt to convert this back into the coded form used by the assembler. This is useful for documenting programs which have been written originally in machine code.

Mr. G. L. Evans of South London (not our G. Evans) has sent us an example of a routine written in Assembler for use in a disassembler. We hope that Mr. Evans will send us further details of his Disassembler as it progresses. If anybody has a small Assembler we would be very interested in that as well.

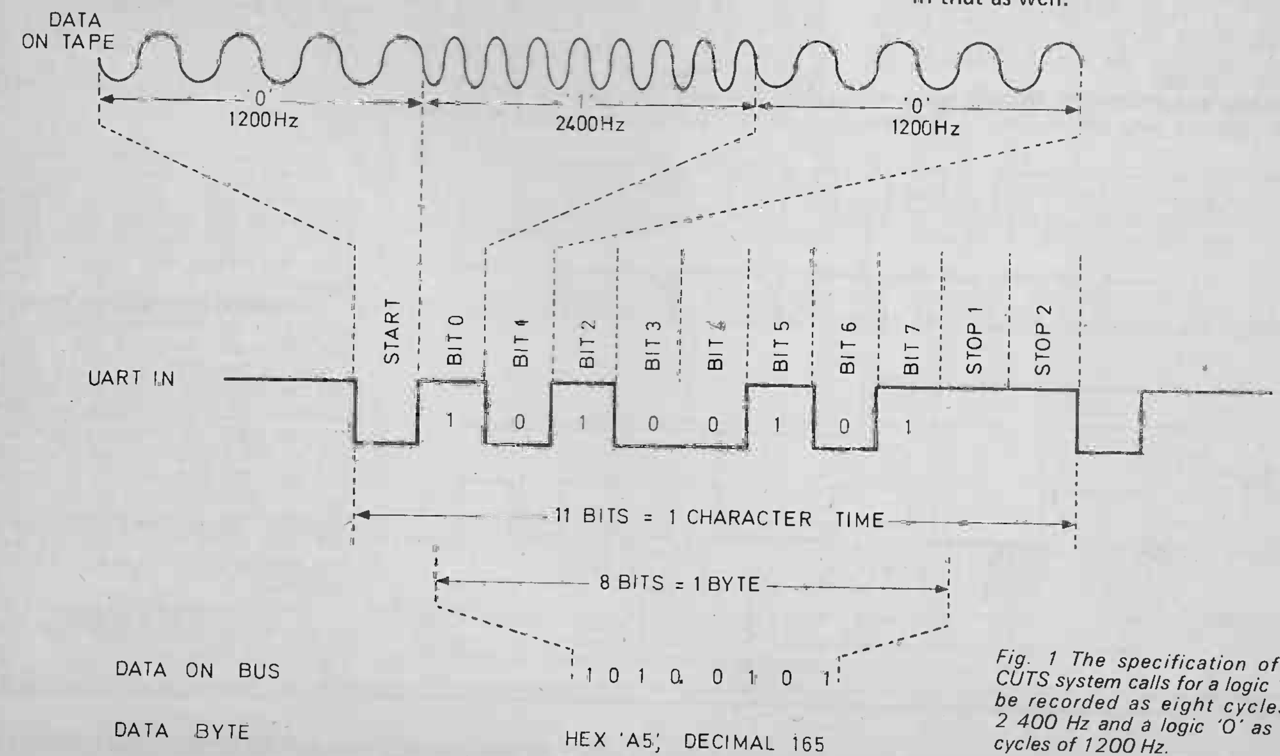


Fig. 1 The specification of the CUTS system calls for a logic '1' to be recorded as eight cycles of 2 400 Hz and a logic '0' as four cycles of 1200 Hz.

CUTS CARD

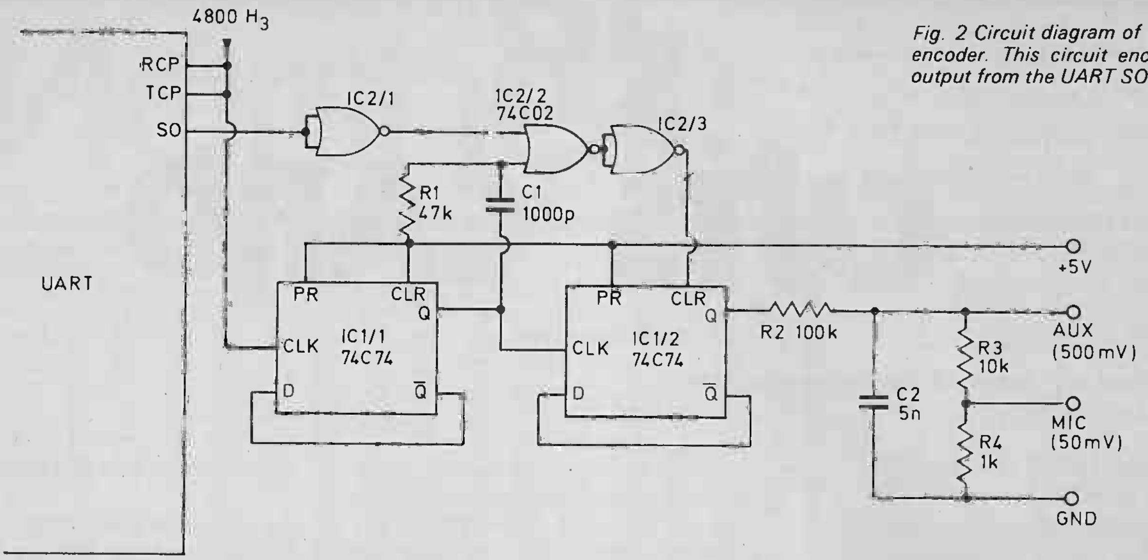


Fig. 2 Circuit diagram of the CUTS encoder. This circuit encodes the output from the UART SO output.

HOW IT WORKS

Much of the circuitry of the CUTS encoder is exactly the same as that used for the TTY interface described in the November 1977 copy of ETI.

The CUTS format calls for a byte of data to be recorded as a START bit (logic '0') followed by eight data bits with the end of a word being signified by two STOP bits (logic '1'). The setting up of the UART's control registers to conform to this specification was dealt with in the December issue of ETI.

With a data rate of 300 baud each bit time will be equal to sixteen pulse times of the UART transmit clock (4 800 Hz). We require that a logic '1' be recorded as eight pulses of 2 400 Hz and a logic '0' be recorded at four pulses of 1 200 Hz.

ENCODER

The circuit of the encoder is shown in Fig. 2. As mentioned above, this circuitry replaces the circuitry associated with the SO output of the UART shown in the TTY interface.

The 4 800 Hz TCP clock is input to one half of the 74C74 Dual D flip-flop where it is divided by two to provide a 2 400 Hz signal with a 50% duty cycle.

This signal is fed to the clock input of the second half of the 74C74 and, via C1 to the input of IC2/2 a 74C02 NOR gate.

Circuit action is as follows. When SO is low and we require a 1 200 Hz signal, the inverted SO output is fed to IC2/2. A glance at the truth table for a NOR gate will show that the output from this gate must then be low. This output is inverted by IC2/3 and the resultant high applied to IC1/2's CLR input. This input is active low and the clear is thus disabled. This means that IC1/2 will act as a divide by two element producing the required waveform.

If now SO goes high, a low is input to IC2/2 after inversion. Reference should be made to Fig. 4 to make the following description easier to follow.

The signal at the C1/R1 junction consists of a series of negative spikes co-incident with the trailing edge of the 2 400 Hz signal at IC1/1's Q output. With a low applied via the inverter, to the other input of IC2/2, the output of this gate will be a series of short positive going pulses, which after inversion, are used to reset IC1/2.

As the 74C74 clocks on the positive edge of the clock input from IC1/1's Q output but is reset on the negitive edge of the same signal, the output of this IC becomes the required 2 400 Hz signal.

The 2 400 Hz or 1 200 Hz output from IC1/2 is fed via a filter formed by R2 and C2 to the AUX output and via an attenuater, R3 and R4, to the MIC output.

The filter is necessary to convert the square wave logic signal to a waveform more suitable for recording on tape.

DECODER

Figure 3 shows the circuit of the decoder, which again, is used to replace the equivalent circuit block on the TTY card.

The output of the recorder is squared up and brought to TTL levels by Q1 and IC2/4. It is then applied to IC3/1, one half of a 74123 dual retriggerable monostable. This device has its astable period set to a time that is longer than the period of a 2 400 Hz signal, about 550 uS is the best.

If we now assume that the signal from the tape is of 2 400 Hz, when the first pulse reaches the 74123 its output goes high for 550 uS. As the input is 2 400 Hz however, after some 417 uS, the device is retriggered. Therefore with an input of 2 400 Hz the Q output will remain high.

If, however, the signal is replaced by a 1 200 Hz output from the recorder, the Q output will still go high for 550 uS, but as retriggering will not take place for at least 830 uS, the Q output will consist of 550 uS, logic '1' pulses with logic '0' pulses in-between.

The output from the monostable is input as data to the D flip-flop IC4/2. The clock signal for this device is the 1 200 Hz or 2 400 Hz input to the 74123. The D flip-flop is triggered from the low to high transition of this waveform and thus if the signal is 2 400 Hz implying that the Q output of IC3/1 is at '1', the ouput of IC4/2 will also be at logic '1'. If however the input is at 1 200 Hz, at the moment of clocking, the Q output of IC3/1 will be low, thus the Q output of IC4/2 is also low. The waveforms shown in Fig. X help explain this action.

The Q output of IC4/2 is fed to the SI input of the UART thus completing the recovery of data.

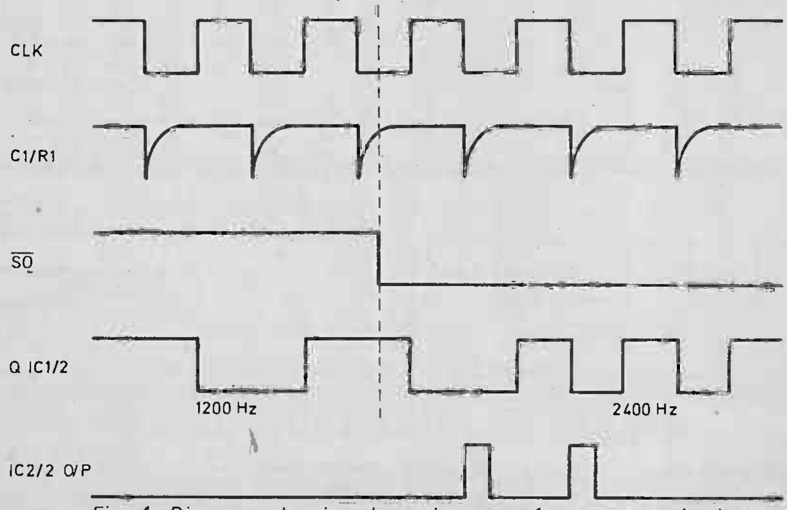


Fig. 4. Diagrams showing the various waveforms present in the encoding circuit.

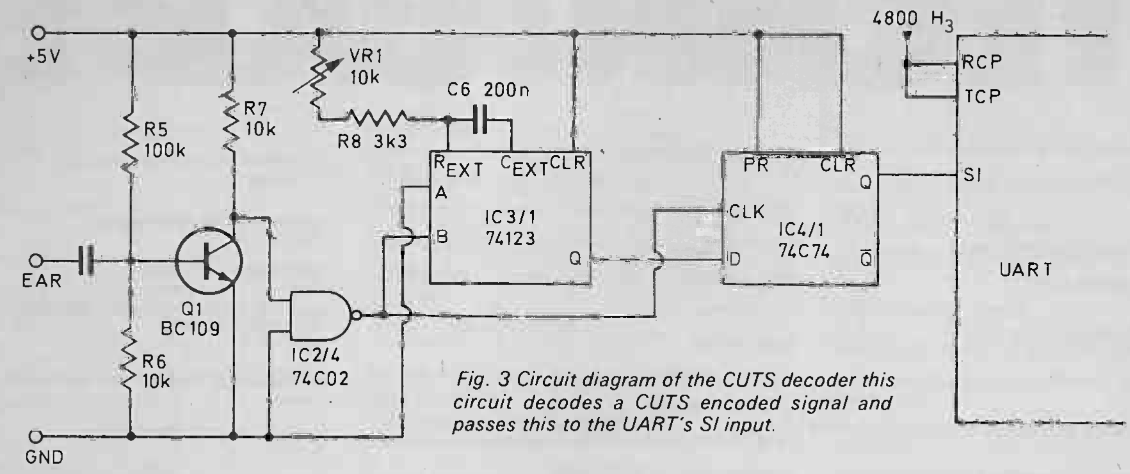


Fig. 3 Circuit diagram of the CUTS decoder this circuit decodes a CUTS encoded signal and passes this to the UART's SI input.

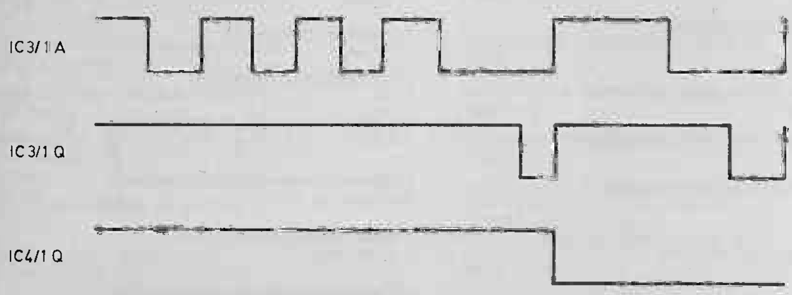


Fig. 5. Diagram showing the various waveforms present in the decoding circuit.

SYSTEM CLOCKS

The receive clock pulse RCP used in the decoding operation is the same as that used in the transmit mode (TCP). In order to justify the use of the same clock for both operations we need to study the operation of the UART and do some straightforward arithmetic. (For a full explanation of the terms used below see the UART data sheet published in November 77's ETI).

Figure 6 shows the timing of the UART in receive mode, the data presented to the UART by the CUTS decoder is shown as SI. If we assume that the UART is looking for a START bit then it will recognise the transition of SI from high to low as a possible START bit. It now waits for eight pulses of its 4 800 Hz clock and then samples the SI line at what should be the mid-point of the START bit. If SI is high at this time then the START bit logic is reset and the UART waits for another high to low transition of SI. If SI is low at the sample time then the UART accepts this as a valid START bit and procedes to sample the SI line every sixteen pulses of the 4 800 Hz clock. After inputting the correct number of data bits the UART looks for a valid STOP bit (logic 1) at which time it transfers the data and any error conditions to the output registers and signals DAV (Data Available) to the MPU. The MPU accepts the data and status words and resets the DAV line to indicate acceptance to the UART which by now is looking for the next valid START bit.

The ideal sampling pulse is shown as Fig. 6A, two worst cases are shown as Figs. 6B and 6C. In these worst case conditions it is assumed that the 4 800 Hz clock used as TCP is also being used as RCP and thus the only variations possible are phase change and frequency change. The phase change problem is overcome inside the UART and thus does not concern us here. The frequency change can only be due to changes in tape speed between recording and playback at the 555 timer used as a 4 800 Hz oscillator is independant of voltage variations in the power supply. If we examine sample pulse train B we can see that the data is being input at a faster rate than expected and as a result the sample pulses end up very close to the end of data bit seven time. As the sample pulse is set during the START bit as being the eighth pulse and in data bit seven is during the fifteenth pulse time of the input data it must change by seven pulses in eight bits (8 x 6 pulses). This can be worked out to an error variation of:–

$$\frac{7}{8 \times 16} \times 100 \text{ percent}$$

= 5.46%

On a tape recorder of a reasonable specification this level of tape speed tolerance will not occur and thus the 4 800 Hz TCP can also be used as the RCP clock.

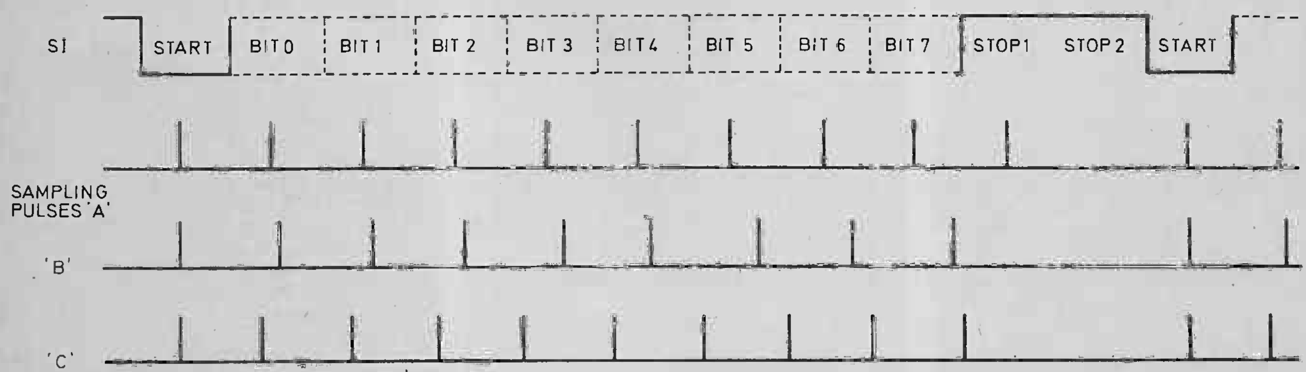


Fig. 6. Diagram showing the effect on the sampling pulses generated by the UART with a difference between TCP and RCP. 'A' shows the ideal sampling pulse (TCP = RCP), 'B' shows TCP < 'RCP while 'C' shows TCP > RCP.

DIGITAL ELECTRONICS BY EXPERIMENT PART 4

IN THIS PART of our series we shall look into sequential logic by using the 7400 IC.

Set the IC up on the board to make a circuit using two of the logic gates as shown in Fig. 1. The gate with its output taken to the LED should have its spare input marked R, while the spare input to the other gate should be marked S.

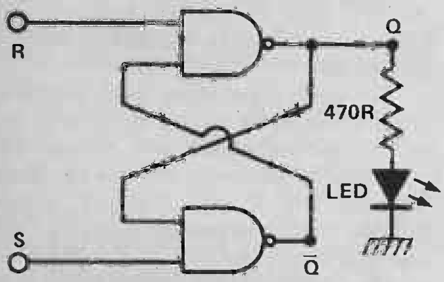


Fig. 1. Cross-coupled NAND gates forming an R-S flip-flop.

This circuit is a flip-flop, as you may have guessed from the cross-section of inputs and outputs. Complete the table shown in Fig. 2, and note that the output for R = 1, S = 1 is *not* the same in each case.

Sequential Logic

The R-S flip-flop, as this is called, is an example of a sequential logic circuit, in which the output depends on the *sequence* of signals at the input — in other words, the state of the output depends on the previous signals as well as the present ones. Strictly speaking this circuit is more of a *latch,* a circuit which temporarily stores an output while both inputs are high. Note that in normal use, we want two outputs Q and $\overline{Q}$ to be complementary ($\overline{Q}$ is always the inverse of Q) so that the input R = 0, S = 0 must not be used, since this gives Q = $\overline{Q}$ = 1.

In logic circuits, clocked flip-flops are much more common. A clocked flip-flop changes state only when a

R	S	Q
0	1	
1	1	
1	0	
1	1	

Fig. 2. Part truth table for R-S flip-flop. When you complete the table, taking readings from your blob-board circuit, be sure to work through each state in sequence.

timing, or clock pulse is received. This is done by combining the flip-flop action with gating so that the signal inputs have no effect until the gating (clock) pulse arrives.

One type of clocked flip-flop is the D-type, and a typical truth table is shown in Fig. 3. In this type of circuit the signal (0 or 1) which is present at the D (for Data) terminal is transferred to the output at the clock pulse, and remains unchanged until the data changes *and* the clock pulse arrives.

Clocked Flip-Flop

The type of flip-flop chosen for this board is the J-K flip-flop. This is a more versatile device which combines clocking with gating to achieve a wide range of actions. On the type we have chosen, the SN7476, the action is the type known as "Master-Slave", which means that the input signals are accepted on the leading edge of the clock pulse, but the outputs do not change until the trailing edge comes along. This avoids problems which would occur if outputs were connected back to the inputs, as we shall see later.

The J-K flip-flop has five inputs and two outputs. The inputs are labelled J, K, Clock, Set and Reset (the Reset is sometimes called clear, and the Set terminal is sometimes called preset). The outputs are Q and $\overline{Q}$, with $\overline{Q}$ always the inverse of Q. We shall check the action of the J-K flip-flop using signals generated on the board.

From previous work you should have available one section of the 7414 connected as a low speed oscillator. This provides an ideal slow clock pulse, and you should already have an LED connected to the output of the 7414 to monitor this pulse.

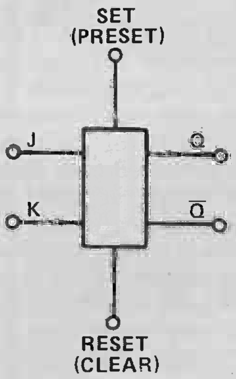


Fig. 4. J-K flip-flop symbol.

Double Flip-Flops

The connection diagram of the 7476 is shown in Fig. 5. From this you will see that the 7476 contains two J-K flip-flops which are completely independent. For the first series of practical exercises we shall use only one half.

Solder connections from pin 13 of the 7476 to earth, and from pin 5 to the +5 V line. Now solder an insulated wire connection from the clock oscillator output to pin 1 of the 7476, so that flip-flop number 1 is activated.

Connect pins 4 and 16 to earth so that J = 0 and K = 0, and connect switches so that the reset pin (pin 3) and the set pin (pin 2) can be connected momentarily to earth as needed. The

D SIGNAL	Q BEFORE CLOCK	Q AFTER CLOCK
0	0	0
0	1	0
1	0	1
1	1	1

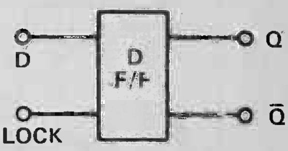


Fig.3. D-type flip-flop and truth table. Note that, unlike the R-S flip-flop, changes take place only when the clock pulse arrives.

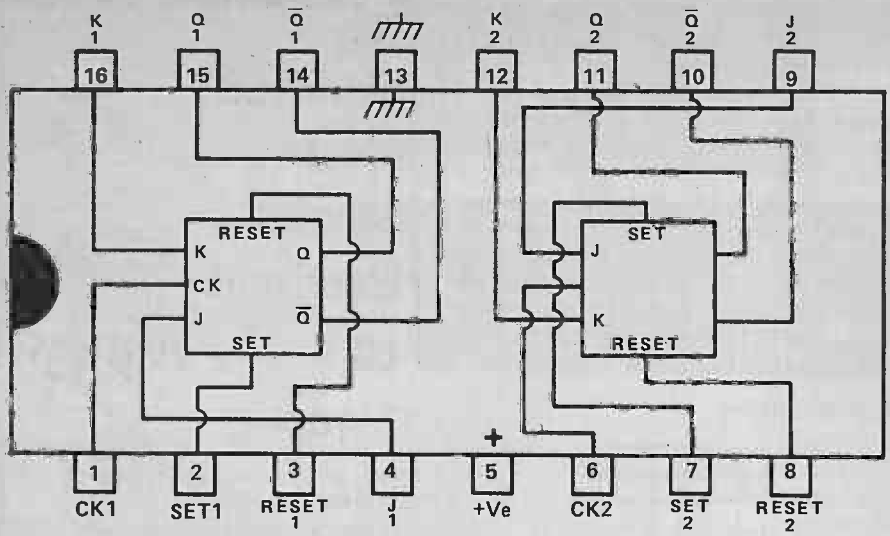


Fig. 5. Pinout of the SN7476 dual master-slave J-K flip-flop.

circuit is now as Fig. 6, and the appearance of the board is shown in Fig. 7.

Now connect a resistor from pin 15 (Q) to a spare pad, and an LED from the spare pad to earth. This LED will indicate the state of the output from the flip-flop at Q.

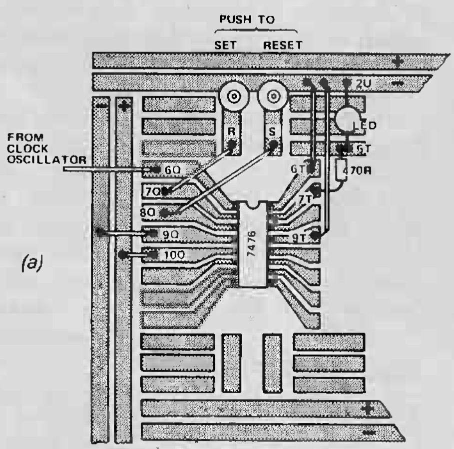
Switch on, and look at the LED. Using the SET switch, set the output to give logic 1 (This happens when the SET switch is returned to 0, whatever the clock pulse is doing at the time). When the switch is changed back again, does the output change at once? Or when a clock pulse arrives?

These changes and others to follow may be easier to observe if the clock pulse is very slow, and a 1 000 uF, or greater, capacitor may be used in the oscillator circuit. Later, a "debounced" switch will be used.

Complete the sequential truth table, in which Q_{n-1} is the value of Q just before the clock pulse arrives, and Q_n is the value of Q just after the end of the clock pulse (the 1 to 0 change). Can you decide when the change, if any, occurs? Is it on the leading or the trailing edge of the clock pulse?

Now switch off, and disconnect one end of the link between K pin (pin 16) and earth, so allowing K to float to 1. Now we have J = 0 and K = 1. Switch on and observe the output. Change the output by using a switch (which one will you use SET or RESET?). Does the clock pulse affect the output after the switch has been returned to normal?

(a)



(b)

J-0
K-0

Q_{n-1}	Qn
0	
1	

Q_{n-1} – STATE OF Q (0 OR 1) BEFORE CLOCK PULSE

Qn – STATE OF Q (0 OR 1) AFTER CLOCK PULSE

Fig. 7. (a) The layout on the board, with the LED in position.
(b) Form of part truth table.

Switch off again and reverse the connections so that J = 1 and K = 0, and repeat your readings. Enter all the readings on the sequential truth table of Fig. 8.

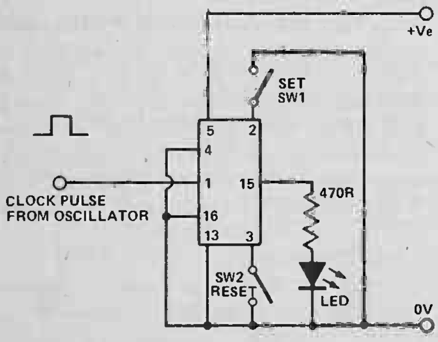


Fig. 6. Circuit for checking J-K action, see text for details.

J=0
K=1

Q_{n-1}	Qn
0	
1	

J=1
K=0

Q_{n-1}	Qn
0	
1	

J=1
K=1

Q_{n-1}	Qn
0	
1	

Fig. 8. Remaining truth tables for J-K action.

From these exercises you will have found that the action of the J-K flip-flop can be controlled by the J and K inputs, which act to force the output to either 1 or 0 when the clock pulse arrives. The SET and RESET pins act independently of the clock, making the output go to 0 or 1, and holding it there until the reset or set voltage rises to 1 again, when the next clock pulse will cause whatever output is forced by the J and K voltages.

Toggling

With the power off, disconnect the wires from both J (pin 4) and K (pin 16). Switch on again, and observe both the output and the clock LEDs. Now complete the truth table of Fig. 8 (c). In this arrangement the J-K flip-flop is acting as a divide-by-two stage, for there is one complete output pulse for each two complete input pulses – we say that the flip-flop is *toggling*. At any time during this action, the ouput may be forced to 1 or 0 by the action of the SET or RESET pins, but it will revert to the toggling action when the SET or RESET is released.

Try applying a clock pulse obtained from a switch, as in Fig. 9 (a). Wire the switch to the board and replace the connection between the 7414 clock generator and the flip-flop with a connection from the switch output to the flip-flop clock input. Turn on the 5 V supply, and use the switch as a slow clock generator. You will probably find that the output is erratic, sometimes seeming not to change the output when the switch is operated.

This is caused by switch contact bounce.

De-Bounce De Switch

With power off, rewire the switch with a resistor and a capacitor to one of the spare sections of the 7414, as shown in Fig. 9 (b). This is a simple de-bouncing circuit.

Solder a resistor and an LED to the output of the 7414 in the usual way to show the state of the clock pulse, and connect the output also to the clock input of the 7476. You should find that the action is perfect, and the very slow clocking which is now possible will show that the changes which take place at the output do so when the clock pulse goes low, that is, from 1 to 0.

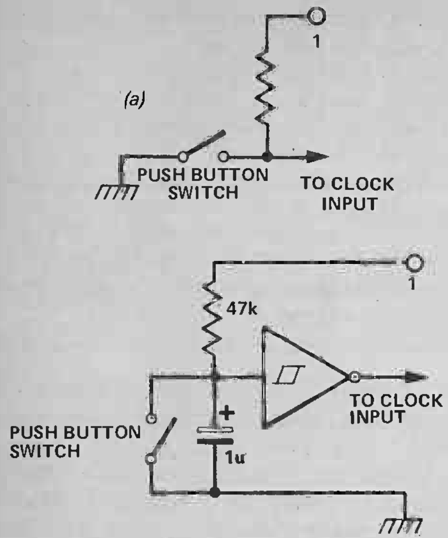


Fig. 9. (a) Using a push-button switch as a clock pulse supply.
(b) A debounced switch circuit.

Note that other flip-flop types may not have the same sequence of actions. Some, for example, are edge triggered, meaning that all the flip-flop action takes place on the leading edge of the clock.

When you are using flip-flop circuits, you must be careful to use the same type of flip-flop as that specified, since circuits which suit one type may not suit another. In particular, the 7476 "Master-Slave" type of flip-flop has a particularly complex action.

In essence, the action is that on the leading edge of the clock, the information which is present (1 or 0) at the J and K inputs is stored and once the clock pulse has reached its 1 value, these inputs are locked out, meaning that changes in J and K will now have no effect. At the trailing edge of the clock pulse, the flip-flop action takes place to change the output. The reason for this construction is that several types of circuits, some of which we shall build in this series, use feedback connections between the output of the flip-flop and its J or K inputs.

If all the action of the flip-flop happened at the leading edge of the clock, such feedback would cause indeterminate action — any change in Q would cause a change in J or K, which might cancel the effect on Q, and the flip-flop would probably oscillate at the high frequency. Because of the Master-Slave action, this does not happen — the changes in Q happen at the trailing edge of the clock pulse, by which time the J and K inputs are locked out and their voltages cannot affect the action until the leading edge of the next clock pulse.

Investigation

You should already have one section of the 7414 set up as a high frequency oscillator with earphones, or similar, to detect the output note. What is the effect of leading the output of the 7414 oscillator to the clock terminal of the 7476 with J = 1 and K = 1? Listen to the output wave from Q and compare it with the signal from the oscillator.

Can you now design an "octave" oscillator? This circuit will use a single oscillator, but its output will be alternately at oscillator frequency, then at half oscillator frequency (one musical octave below) according to the input to the gate. The gate input could then be obtained from another slow oscillator.

Finally, Fig. 10 (a) shows the complete truth table for the 7476. Fig. 10 (b) shows a changes truth table, in which the settings of J and K to produce certain changes (or non-changes) are listed. In the last table, X means "don't care", signifying that the value may be 1 or 0, and the action will be the same. Check that this last table agrees with the full table of Fig. 10 (a).

You may want to copy these tables, since we shall refer to them several times in Part 5 of this series. ETI

READERS FOLLOWING THIS SERIES SHOULD REFER TO THIS MONTHS LETTERS PAGE FOR DETAILS OF SOME APPARENT CHANGES TO THE BOARD USED IN THESE ARTICLES. WE APOLOGISE FOR ANY CONFUSION THIS MAY HAVE CAUSED.

To be continued.

Fig. 10. Truth table for J-K flip-flop.
(a Complete truth table.

J—K FLIP—FLOP

INPUTS		OUTPUT	OUTPUT
J	K	Q BEFORE CLOCK	Q AFTER CLOCK
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

(b) Shortened truth table for changes only.

J	K	Q_{n-1}	Qn
0	X	0	0
1	X	0	1
X	1	1	0
X	0	1	1

AUDIOPHILE

If you have any problems relating to hi-fi, choosing equipment, compatibility between units, weird occurances etc. we might be able to help. Audiophile is to have its own readers queries service, for which there will be no charge - just an SAE please - and mark the envelope 'AUDIOPHILE' so that it gets to where it should be.

A RECENT heated discussion between several hi-fi enthusiasts here brought to light several interesting points. The first was the number of similarities which exist between the fairer sex and hi-fi equipment!

Think we're joking eh? Well consider: both tend to dominate the room they're situated in. Both are capable of generating very high sound levels, but will stay absolutley silent if turned off or ambient conditions are not favourable to smooth operation. Upkeep on both is horrendously expensive, and requires constant purchase of software (wear) and cleaning materials.

In fact the only major difference detectable occurs when the specimen blows a fuse. One variety refuses to make a sound, while the other demonstrates incredible slew-rate and reaches 200 dBA in a microsecond.

Class E Birds?

Be that as it may, our German edition has sent us news of the missing E amplifier configuration. We shall assume here that you've all read the article on class G in the last issue. If you haven't . . . go directly to jail, do not pass GO, do not collect £200. As you now know then Hitachi attempted to call their Dynaharmony circuit class E when it first appeared, but found that classification already reserved.

And now we know who by; Arcus. Their DPA 320, shown in Fig 1, is a 200 W RMS per channel power amplifier—class E. Basically this configuration would appear to be a digital system, using pulse width modulation to control the output transistors.

A 100 kHz square wave is generated within the amplifier by means of a crystal-locked oscillator, and integrated to produce a triangular wave.

This wave is then superimposed on to the incoming music signal, this being put through a very fast A-D convertor, the end result of all the logic circuitry producing a pulsewidth modulated square wave. Fig 2 shows a sine wave with the square wave produced by the logic alongside. The square wave is now used to switch the output transistors on and off very rapidly, the on time depending on the widths of the incoming pulses.

In this manner the music signal is reproduced, but theoretically without the inherent faults of the transistors affecting it. Using the output stage like a switch is not new — Quad's 405 current dumper does this , but in a different manner.

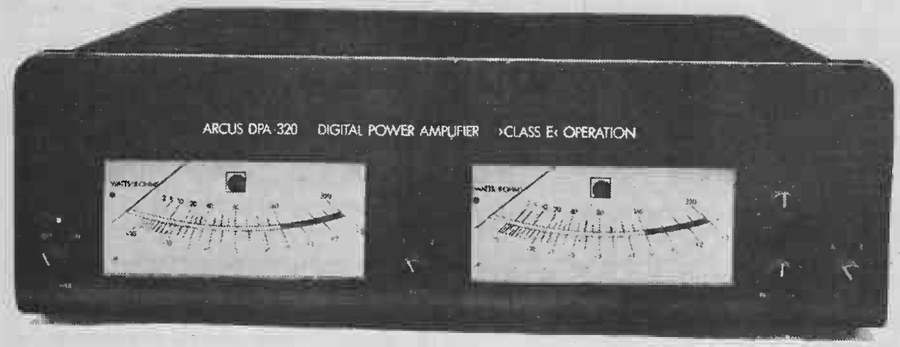


Fig. 1. The Arcus DPA 320 power amp. Producing some 200 W per channel, this digital design is claimed to be totally free of crossover distortion, TID, and all other bipolar amp vices!

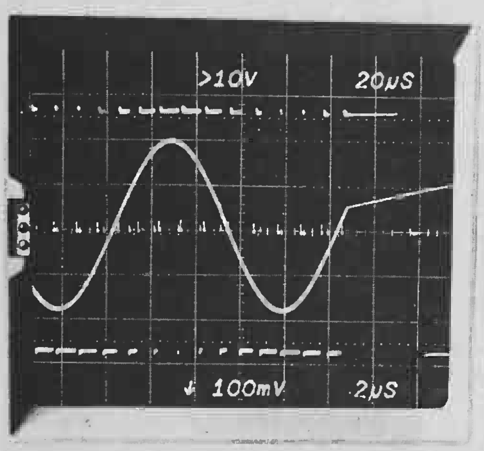


Fig. 2. A sinewave and its equivalent pulsewidth modulated squarewave. In a class E power amp this would hopefully induce the output stages to reproduce the sinewave!

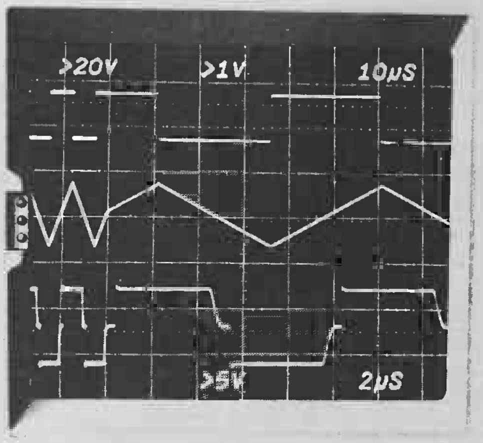


Fig. 3. The middle trace is the triangle produced by integration of the 100 kHz squarewave signal within the DPA 320. This triangle is then superimposed on the digitised music signal to control the power switch output pair.

Spray now, play later — Sound Guard takes your highs to a ripe old age.

To keep operation symmetrical the transistors are not pushed totally into saturation and this allows 'recovery' from each switching operation to occur more rapidly. Contrast this to class D switching amps which operate by completely saturating the output pair in turn. Class E is 10 times faster to 'recover'.

Those interested in further details can look up the patent on the process (No 1444201) or contact Arcus direct in Germany (*Don't* mention the war!) at:-
Elektroakustik GmbH, Teltower Damm 283, 1 Berlin 37, Postfach 370 370.

Don't Wear It — Spray It!

An interesting spin-off from the space programme is to be marketed in Britain by Pyser Ltd. Called Sound-Guard the product is a spray preservative for LPs. (Just around this point in the proceedings all the usual spectres of gunged-up records and glue-ridden styli ploughing through seas of dust attracting *substances* should leap into the enthusiast's mind. They don't? . . . . Sorry!)

The compond was originally produced by NASA as a dry lubricant for use in conditions of hard vacuum and high temperatures. Development has now taken it into the form of a liquid spray.

This is applied to the LP surface, and immediately polished up. A coating five millionths of an inch thick is apparently formed across the record and groove walls. The basic property of Sound-Guard is that it will not bond to itself, so that once applied a build-up on the surface is just not possible, thus alleviating the horrors associated with such an occurance.

Benefits claimed are a cancellation of increase in harmonic distortion due to wear, reduction of surface noise generated by stylus wear,and a preservation of high frequency response by protection of the delicate groove modulations for those frequencies.

To The Test

To test these assertions, we decided to set up an A-B comparison on a Sound-Guard treated LP. This was achieved by purchasing from our local record emporium two (different) LPs in as good a condition as could be managed (after several return trips to dispose of copies with extra radial grooving) and recording these at 15 ips.

One LP was then treated with the fluid, simply by spraying on and rubbing well in with the pad provided. No trouble here — once buffed up properly no audible deterioration could be detected, and certainly the noise level was not affected. Nothing appeared round the stylus either!

So far, so good.

Both records now went into the collection as normal, and were played over a period of about a month, no *special* care being taken to differentiate them from any other LP other than noting when each was put under the needle.

The test was called to halt when we ran out of time on this report. Things were evened up so that the test side of each had been played the same number of times, thirty-one in fact. Yes we *do* play a lot of records.

Masterful Comparison

Each could now be compared with the master tape made at the time of purchase, and the by now obligatory listening panel was assembled to haggle over results. This time however no haggling was necessary, and the results could be unanimously agreed. The Sound-Guard treated LP had definitely 'held' the high frequencies better than the untreated record.

On direct comparison with the tape, there was no doubt whatsoever that the treatment had preserved the frequency response to a clearly audible degree. Most people do not realise how quickly extreme high frequencies are worn off an LP, even at low tracking weights. Our tests were conducted at 1.2 g, and so heavier weights would presumably show benefits earlier and to a greater extent.

For The Record

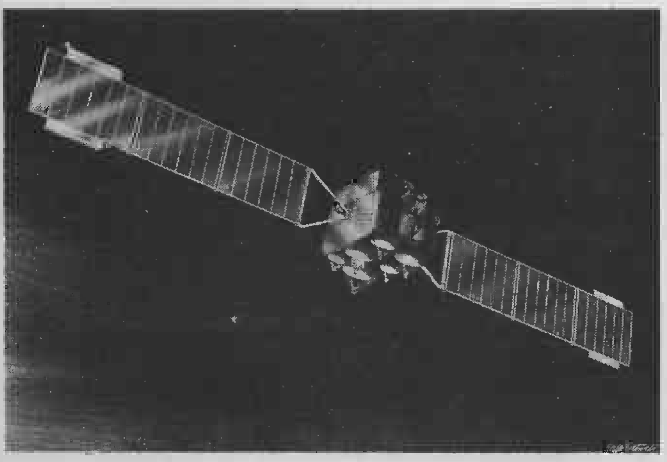
No conclusions could be drawn, however, as to whether Sound-Guard had achieved a favourable result with regard to surface noise—both LPs were still in excellent condition. As it is, we have no hesitation in recommending Sound-Guard as a worthwhile addition to the audiophile's armoury, it's worth its cost if it only prolongs the life of two LPs after all, and one bottle does 25.
Price: Full kit (see photo) £4.99. Refill £3.25 (inc. VAT).
Pyser Ltd., Fircroft Way, Edenbridge, Kent.

digest...

Europe in orbit ....

An initial release of funds totalling £3.74 million for the full development of the initial ECS (European Communications Satellite) has been made by the European Space Agency.

ECS will be a fully operational European regional satellite communications system and will be capable of carrying a significant proportion of future European telephone, telex and TV traffic. The first ECS will be placed in geo-stationary orbit in 1981 by the European Ariane launcher and it is planned that this should be followed by three more between then and 1990. The launches will be made from the equatorial site at Kourou in French Guiana. M.K. Hird, Hawker Siddeley Dynamics Ltd., Manor Road, Hatfield, Herts.



taking stock of a cat ....

We have just received our copy of Watford Electronics latest stock list. It's not really a catalogue but it is very comprehensive, and would certainly have counted as such with us if no-one had told us otherwise!

Active component stock is particulary good and the prices bear comparison with the best. Watford are working on a 'proper' catalogue which will be around soon apparently. In the meanwhile the stock list makes a very useful addition to the bookshelf.
Watford Electronics, 33 Cardiff Road, Watford, Herts.

Aiwa The Lads

And so to our main news this month, a cassette deck with several important differences. Recent models from such noteworthy manufacturers as Nakimichi, Sony, Technics and Aiwa have shown a search for something other than that last few kilohertz at the top of the range. And now Aiwa have come out with the AD 6800, which they themselves consider "as far as one can go with cassettes," and have equipped the machine with the facilities to let you know just how far that is!

Bias Your Opinions

With all the various tape formulations on the market today, the age old compromise inherent in not optimising a particular machine's bias for a particular brand is becoming ever more irksome. While being fairly satisfactory in general there is no flexibility in this system at all, and no user control since such adjustment has always had to be done by a dealer. All the user could do was to set a single three position switch to 'Fe-Cr', 'CrO2' or 'LH'.

What has been needed, and Aiwa have now provided (else we would not be rambling on about it) is some simple user controlled system to set up the machine for any brand of tape desired, and obtain the maximum fidelity from it. Let's face it at 4.8 cm/sec and ¼in wide we need all the help we can get. Too high a bias current results in high frequency roll-off and increased distortion, and a balance has to be achieved.

On the 6800 the facilities to optimise bias are: built-in oscillator, test head, switched meters with filter, azimuth adjustment and two three-position switches for bias and equalisation, backed up by the three 'fine adjust' bias controls. All this must add a considerable amount to the cost of the machine, and shows how seriously Aiwa take the cassette. (Wonder if they'll come up with an Elcaset?)

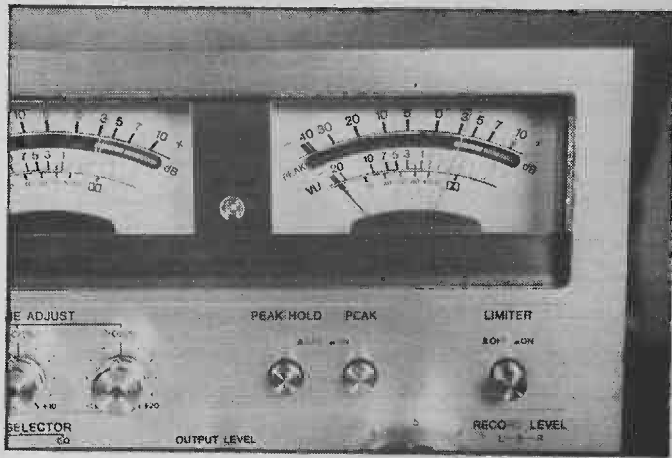
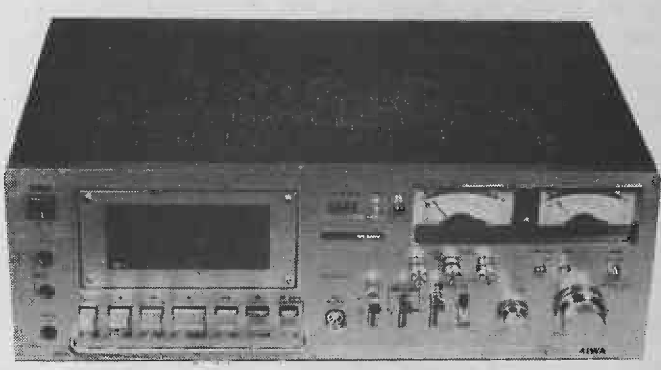


Fig. 1. The twin needles meters show clearly the peak facility is on here, and the reading is thus of the highest level which passed through the circuit on the last segment.



Self Satisfied Unit

Before we move on to show how the bias adjustments are made, and what effect they have on performance, let's consider the rest of what the AD-6800 has to offer. The finish is superb, and the controls are smooth and positive. Everything about it looks — and probably is — very expensive.

The meters are a revelation in themselves. Two needles, peak and VU reading, are provided for each channel with excellent ballistics. The peak reading facility really *is* peak reading, not some cheap approximation, and is switchable from peak reading to peak hold, or even to off if you feel like.

The hold facility makes setting up to record very easy. Just lock the hold on, and advance the record level until the needles move onto the level you want to set at. No getting eye-jump trying to watch cavorting little needles avoiding 0 VU, and much improved recording as result.

Even loading this animal is different. In short *you* don't — it does it itself. Press the open key and the door swings up and over in an almost seductively damped manner. Facing you now is the cassette carrier. Put the tape in and give it a gentle push (or close the door) and the machine jumps to life, takes the carrier out of your hand and locates the cassette itself, all with a mechanical whirr of efficiency. Now I know it's only a little motor set to activate upon movement of the carrier, and I know it's silly and probably a gimmick — but it's still beautiful!

When the 6800 arrived here for review it was hours before we could actually play anything on it, since the entire office staff from receptionist to technician insisted on having a play with the loader. On a practical note, the auto-load does mean that the tape itself is less liable to be mishandled, and the drive mechanism can be mounted further into the case with all the attendant advantages of dust avoidance. A conveniently placed head cover makes cleaning easy.

Reviewing Review

Another very useful facility is the "review/cue" mode. With the 'FWD' key depressed, operating rewind reverses the tape direction as normal, but leaves the head in contact with the tape so that an audio signal, at reduced level, appears at the output. Very handy for locating the end of tracks on recordings. The fast 'FWD" keys work in a similar manner to allow you to 'CUE' up quickly to the end of a piece. If used continually no doubt head wear would be accelerated, but Aiwa contend that for the amount of use the facility will see in terms of playing time such additional wear will be negligible and well worth the facility. In our opinion a fully justified contention.

Finding Your Type

Using the bias tuning is simplicity itself. Let the machine load a cassette (don't fight it — use it) put it into the record mode, with input selector at Test and Dolby off.

Fig. 2. The azimuth adjust control within the cassette compartment. This is used in conjunction with the 8kHz oscillator and the right hand meter in obtaining maximum level and hence correct alignment.

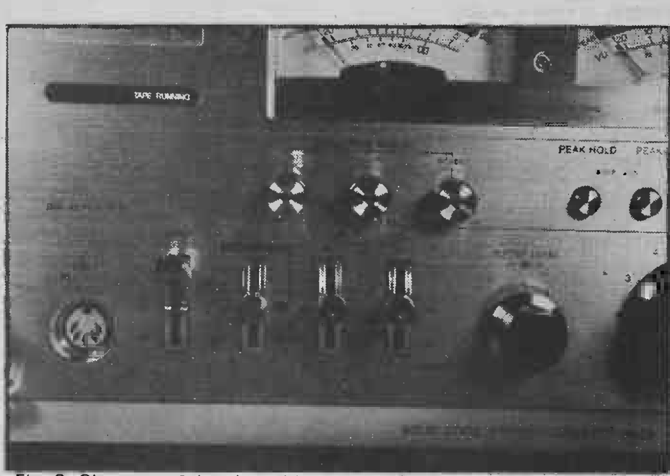


Fig. 3. Close-up of the clever bits. Above the general input controls can be seen the bias fine adjust control which allow tuning up for each tupe formulation available. The control ito be used is illuminated once the input is set to 'Test'.

This allows the internal oscillator to put its signal onto the cassette. Both meters now deflect. The right channel meter indicates 8 kHz level, and the left 400 Hz. The test head itself is aligned by adjusting the slider inside the cassette compartment for maximum 8 kHz level.

To optimise the bias set the coarse control to the correct formulation, and adjust the fine control until both meters read as equal as possible. It takes longer to describe all this than it does to do it, and just to make it even easier, the fine control you should be using is illuminated as soon as the coarse bias is set. CrO_2 switching is automatic.

Aiwa intend all this to be used to obtain a flat frequency response by setting equal levels at 400 Hz and 8kHz. Of course, if the tape type in use sounds a little 'dead' at the top end, you can always leave a few dB extra on that meter . . . .

We tried the 6800 on a whole range of cassette types from TDK SA to BASF LH Super, taking in CrO2 and FeCr on the way. Results with all tape types were first class, but even using the fine tuning, the 6800 seems to display a preference for TDK Super Avilyn. Results with this tape were the best we have ever heard from a cassette deck, the sound displaying a clear and open nature with little of the usual stricture associated with the medium.

Ferry Chrome Carried?

With FeCr tape it was necessary to 'tune' considerably from brand to brand, but once achieved the correct setting delivered a very good recorded performance. The results with CrO2 tapes were frankly disappointing. The sound never approached that of the SA recordings, and some difficulty was experienced in following through the setting-up procedure. We feel this is a minor drawback however, in view of the outstanding qualities displayed with both FeCr and Super Avilyn, and the excellent LH results.

Without doubt, the bias controls of the AD6800 added considerably to the unit's versatility, and allowed wide variety of cassette tapes to give of their best. The variation in sound quality with 'tuned' settings is surely to be expected, after all some tapes are better than others! If you are looking for a machine that takes cassettes seriously, and are prepared to pay for it (in the region of £400) then this unit merits top place on the shopping list. It costs a great deal of money, but has much to offer in return.

Manual Labour

In conclusion this month, one parting shot across the bows of the Japanese giants — Aiwa included. The standard of the instruction manual with the AD 6800 is typical of such publications — abominable! Production and layout are nicely done, but the English — oh the English! It's been said before, and now we've said it again. Please please please someone somewhere convince the powers that be and get the instructions up to the unimpeachable standards of the hardware.

ETI

SPECIFICATION

Frequency Response:	According to DIN 45 500	
	LH tape:	25–15,000 Hz
	CrO2 tape:	25–17,000 Hz
	Fe–Cr tape:	25–18,000 Hz
SN Ratio:	According to DIN 45 500	
	64 dB (Fe–Cr tape DOLBY NR ON)	
Wow & Flutter:	According to DIN 45 500	
	0.1%	
Tape Speed:	4.8 cm/sec (1–7/8 ips)	
Rewind time:	90 sec. (C–60)	
F. FWD Time:	90 sec. (C–60)	
Bias Frequency:	100 kHz	
Motor:	38 pulse FG Servo Motor	
Tape Head:	Ferrite Guard Head (FGH)	
Distortion:	0.9% (400 Hz, 0 VU, Fe–Cr tape)	
Input levels:	Microphone:	sensitivity: 0.25 mV
		impedance: 200R to 10 k
	Line:	sensitivity: 50 mV
		impedence: over 50 k
	DIN:	sensitivity: 0.1 mV/k
		impedance: 3 k
Output levels:	Line:	0.775 V (0 VU)
	optimal load impedance: over 50 k	
	DIN:	0.775 V (0 VU)
	optimal load impedance: over 50 k	
	Headphones:	
	load impedance: 8R to 150R	
Power Consumption:	20 Watts	
Dimensions:	450 W, 162 H, 335 D, (mm)	
Weight:	10 kg	

microFile

This month Gary Evans takes the hard work out of finding a way of producing cheap hard copy, at some new educational items from Heathkit and how to nobble your AGC which can give trouble with digital signals.

May I begin this month by asking you a question? Yes? — No, hold on, that was not the question that comes next.

Heath CUTS

If I were to ask you if you would be interested in an impact printer that produced copy with a thirty-six alpha-numeric character set on eight-inch-wide paper with sixty characters per line and five lines per inch for less than a hundred pounds, what would be your answer? If it's No then suppose I threw in a keyboard which was capable of generating seven bit ASCII codes with parity? Still No? Well, let's also throw in a UART making the terminal TTY or CUTS compatible. If you're not yet sold on this device what about reducing the price to less than ninety pounds? If having read this far and still not become very interested in the specification evolving I can only assume that you mistook this column for news about a new item for your tool-box (shades of needle file?).

Why have I dreamt up this machine that would answer most micro users' prayers? Well, the answer is that it is no dream. I have been sent details of just such a device, the DTS 77 data terminal. I shall try to get hold of one of these beauties and tell you all about it when I do. In the meantime further details may be obtained from: —

Heath E & M,
26 Broad Street,
Lyme Regis,
Dorset.

Heath Kits

A few months ago I mentioned that Heathkit had launched the H8, a personal computing system, in the US. This interesting piece of hardware is yet to make it across the great divide but rumours have it that the middle of next year should see its UK launch. Microprocessors do, however, have a foothold in the range of kits that Heath offer on the UK market. The microprocessor flag is being waved (set) by Heath's microprocessor course and computer Trainer package (Heath references *EE-3401* and *ET-3400* respectively).

These follow the lines of their, by now familiar to connoisseurs of the Heath range, continuing Education Series. The format of these courses follows the same basic pattern of providing a 'learning program' which is a comprehensive set of notes dealing with the theory of the subject to be covered — in addition practical experiments are described in the text. These experiments can be carried out with the "trainer" that is designed to complement each learning program. These trainers incorporate a breadboard area together with all the components necessary to carry out the experiments described.

At the end of each section a self-evaluation quiz allows one to assess the progress that one has made during each unit of study. Until recently the courses covered basic AC and DC theory plus Semiconductor Principles and a Digital Techniques course.

The MPU course is the latest addition to the range and looks as if it could be a good way of getting to grips with Micros. I have not yet managed to get my hands on one, but from the photos and description shown in the new Heath catalogue, it looks good.

Based on the good old 6800 supported by a 1K ROM monitor, with 256 byte RAM plus other components and breadboard area, Heath say it should prove a valuable teaching aid. It should provide a means of gaining familiarity with machine language programming, hardware I/O interfacing, micro theory, and design applications.

With data input via a hex keyboard, and display of data plus address on seven segment LEDs, to use the trainer is easy. It is an expensive item and has limited applications — in that it cannot be easily expanded to form part of a larger system. It was not designed for this latter role however, and should together with the learning program provide very valuable hands-on experience. For further details of these new items from Heath see their new catalogue. For a copy of this contact Heath at: —

Heath (Glous) Ltd
Gloucester
GL2 6EE

A Corrupting Influence

Referring to a past microfile last month I mentioned the SERT MPU lectures at Kent University during late September. Lack of space last month prevented me from saying much about it — and it looks as if much the same thing has happened this month! So just another titbit from the event.

The idea came from R. A. Smith of Essex University and concerns the use of low-cost cassette recorders

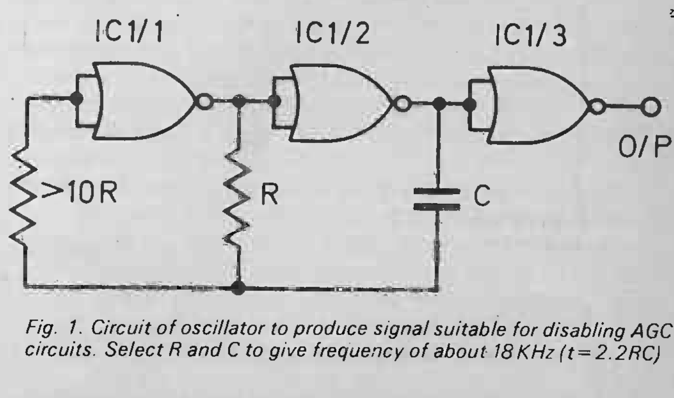


Fig. 1. Circuit of oscillator to produce signal suitable for disabling AGC circuits. Select R and C to give frequency of about 18 KHz (t = 2.2RC)

when recording data output from a micro system. It is a technique to overcome one of the problems often associated with this type of recorder — namely unwanted action of AGC circuits.

In the less costly recorders these AGC circuits, ideal for recording speech, often cannot be switched out of the signal path. When recording any form of digital data the action of such a circuit will be to corrupt it. Consider for example a gap in the recording. The AGC will increase the gain of the input signal, thus increasing the likelihood of noise or transients upsetting the recording.

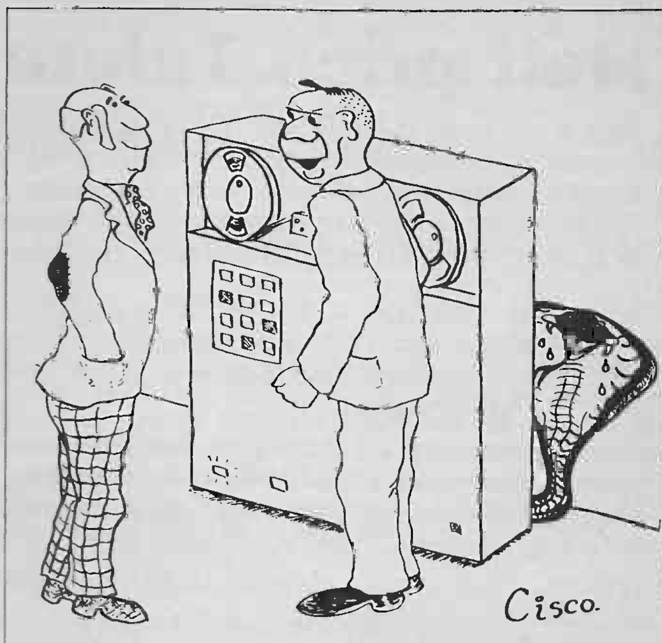
Now we get to the clever bit, by superimposing a continuous HF signal on the, usually, LF data signal the action of the AGC can be nullified. How? Well, we arrange for the HF signal to be outside the response of the tape, usually not much more than a few KHz on the cheaper machines, but within the response range of the AGC processor.

Thus the AGC circuits 'think' that there is a continuous high level present at the input, and keep the recorders gain constant.

A simple CMOS oscillator can provide the required bias signal, and be mixed with the data just before being fed to the recorder.

A simple idea that should improve the performance of these low-cost storage systems.

ETI



This computer has a unique security system. Make like you're going to tamper with it.

ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

JUST A COUPLE of weeks to Christmas and you haven't yet thought what you would like Father Christmas to bring you in your stocking this year? Its time to leave extra large hints lying around, if you feel like dabbling with your TV games unit try leaving this article in a place where 'Father Christmas' is sure to find it!

Christmas Colouring Kit.

If you have one of the black and white TV games based on the GIAY-3-8500 TV games chip you can now upgrade it to colour. Watford Electronics have a kit to upgrade this type of unit to give effects such as a green court, red boundary and score, yellow left bat and blue right bat. The kit includes a UHF modulator so that you can plug the game into the aerial socket of your TV. If your game was built from a kit which never quite worked then this add-on might be just the excuse to dig it out of the 'not quite completed' projects pile. If you still don't feel like trusting your ability to build such a unit you will be pleased to hear that Watford can supply it built, tested and even installed in your own game. For details see their advertisement.

Other Upgrades and add-ons

Another way to improve your TV games unit is to change the chip for the AY-3-8550 which gives additional horizontal bat control together with a few other improvements. The chip is pin compatible with the AY-3-8500 and requires only an additional potentiometer in each hand control to complete the modification.

Alternatively you could st art almost from scratch with the AY-3-8600 chip which gives a total of eight games including Gridball, Hockey and Basketball. The AY-3-8550, AY-3-8600 and PCBs, kits, etc are available from Telecraft, for further details see their advertisement.

Add-on Music.

If you already have enough of the above modifications or think that they will only cover Christmas day and you are looking for something to occupy you on Boxing Day then how about making out a list of components for 'Father Christmas' to enable you to experiment with this idea?

The TV games chips described use something like a 2MHz oscillator to generate all of the timing signals including sync. If this oscillator were also divided by about 4 and gated so that it was enabled only inside the 'court' or visible signal time of a TV game then it should be possible to divide up the court into several horizontal sections. If the sync signals are counted (and reset during court) then the court can be similarly broken up into several vertical sections. A little additional logic will allow you to display several 1in. or so squares on your TV screen. With your colour modulator kit you can also define the colours of the squares and define how the colours are allowed to change.

Now all you need is an audio signal, a bit of filtering, a few BC109s and suddenly you have your own multi-option fourth TV channel. For additional mind-bending experiences try adding the TV games signals and your generated 'music' signals to give a multicoloured court!

1978......

1978 will bring some pleasant surprises in the TV games business, with some cassette or cartridge units already available. At first there will be a great divide in the market between GRAPHICS games such as those already available and BASIC games played in question and answer form. Eventually these will become combined in some really interesting TV games units — stay tuned to ETI for more information!

Software Made Simple

I have been involved in writing a lot of software for various applications over the past few months and I thought that some of the techniques I use might be of interest.

First of all get yourself a hardback or loose-leaf notebook of a reasonable size to write down all of your attempts — there is nothing worse than having to rewrite a routine from scratch because you have lost the cigarette packet which had the original notes on the back.

Decide roughly what the routine will do, a rough flowchart plus an idea of any fixed stack assignments, sub-routines, etc. Convert this to a first draft machine code listing with notes and labels but leave plenty of room for additional, insertions and changes. Looking at some of my roughs and comparing them to the finished product it seems that nearly every other line has alterations.

Having decided what you think the machine code should be sit down at your MPU and try it. For most sub-routines you will probably have to set up a calling routine to test it, this routine simply sets up any parameters used by the sub-routine and then calls the routine. Do not bother to enter more than about 10 instructions at a time because the likelihood of having to shift them all is very high. At a convenient point enter an instruction to generate a Software Interrupt so that the MPU will perform the code entered so far and then return to a routine which will allow the results so far to be checked, in most 6 800 systems this will be a '3F' instruction.

If the results so far are those expected then another 10 instructions can be entered and another '3F' instruction inserted, etc, etc. Any changes to the original coding should be made to your original notes immediately after the change has been verified on the MPU.

Branches to parts of the routine which are not yet coded are easily handled by branching to a '3'F' instruction or back into a loop until the condition changes, this allows one side of the branch to be coded before attempting to do the other. ETI

tech-tips

Digital Echo Unit

J. A. Murdie

The Digital Echo Unit described below may be constructed on standard Euro-card PCBs with 31 way connectors, and utilizes the cheap 2102 1K static RAM, of which from any amount from (say) 32-64K may be used to achieve a (continuously variable) delay of up to a second. The delay time is of course directly proportional to the amount of memory used. There are three PCB designs used: Fig. 1: Input/Clock board (1 off), Fig. 2: Output/Control board (1 off), Fig. 3: 8K Memory Board (max. 8 off).

Dealing with the input board first, it may be seen that the 555, 7476 and 7408 constitute a non-overlapping two phase clock whose outputs are 'Enable Read' (ER), and 'Enable Write' (EW). During the write phase a bit is taken from the digitized input and fed to the 'Data Write' (DW) line. The AD convertor used is the FX209 which was featured in the ETI June 1976 Data Sheet. The bits created are placed in the memory location addressed by the 12 bit counter ('Bit Address'), on this board and the 4 bit counter on the Output/Control board ('Block Address').

When the ER line goes high a bit is taken from the memory address pointed to by the counters with the 4 bit value produced by the Hexadecimal Priority encoder (Delay Switches) being added to the block address. Thus the 'distance' between the write and read 'heads' may be altered to place them any number of blocks apart, and thus create a choice of 16 basic delay lengths. The bit read is placed on the DR line and is then converted to an analog value by the DA convertor. Note that some of the output may be fed back to the input ('Regen') to create multiple echo effects.

After this sequence of a write and a read cycle the bit/block address is incremented by one so a succession of bits may be placed in memory by input, and read from the memory by the output. The rate at which this sequence occurs is controlled by the clock rate of the 555 astable, and thus this not only controls the delay time as do the delay switches, but also the quality of the sound reproduced as this independent on the number of samples taken per second in the digitizing process. The device may be set up to digitize the analog input at a maximum of 125 K bits/second — which is quite adequate for (say) an electric guitar which requires a bandwidth of some 10 KHz.

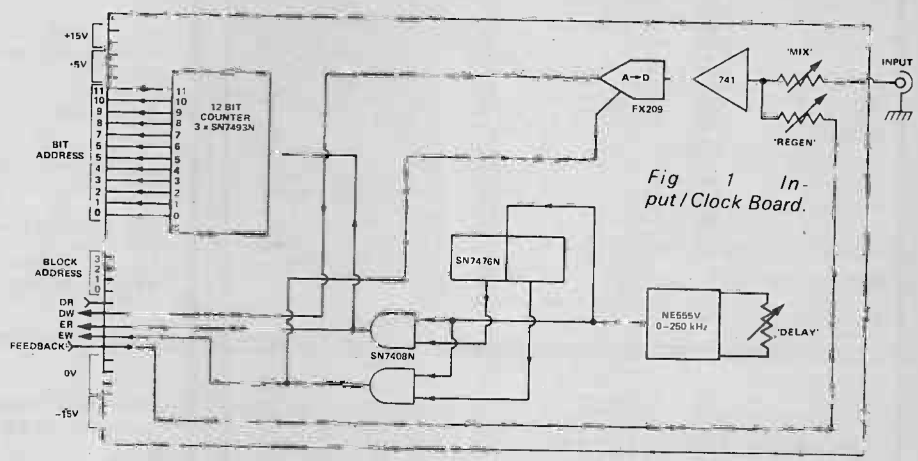


Fig 1 Input/Clock Board.

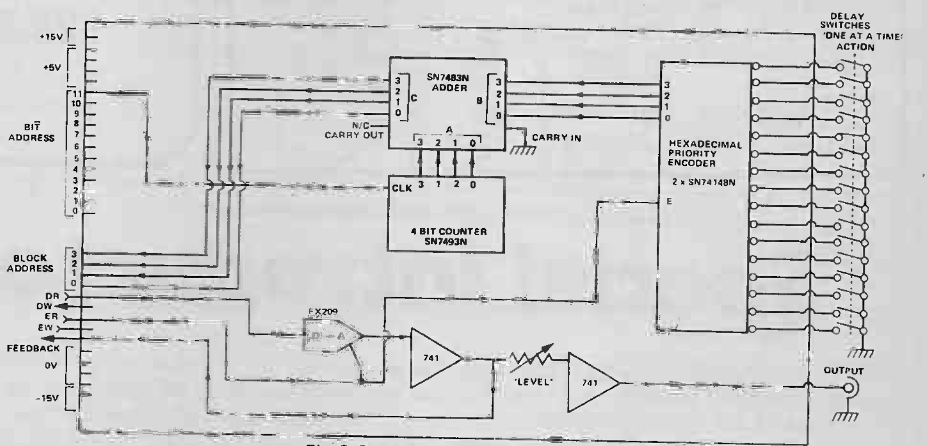


Fig 2 Output/Control Board.

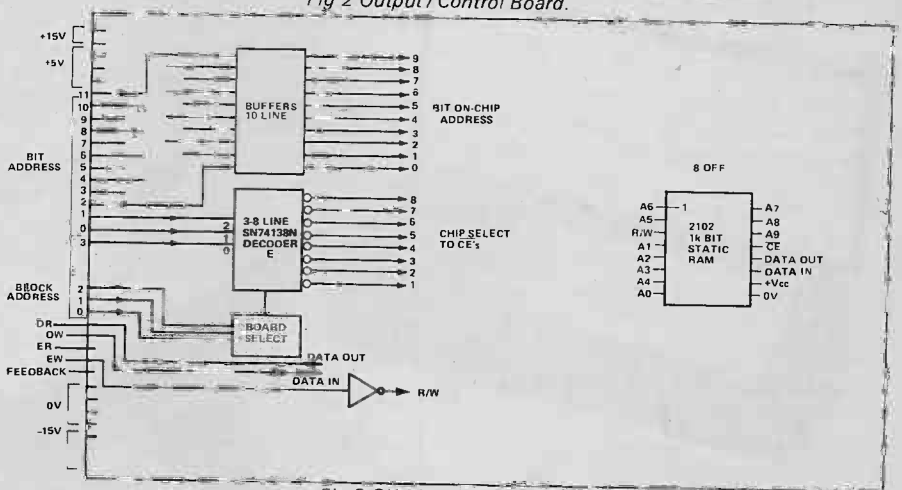


Fig 3 8K Memory Board.

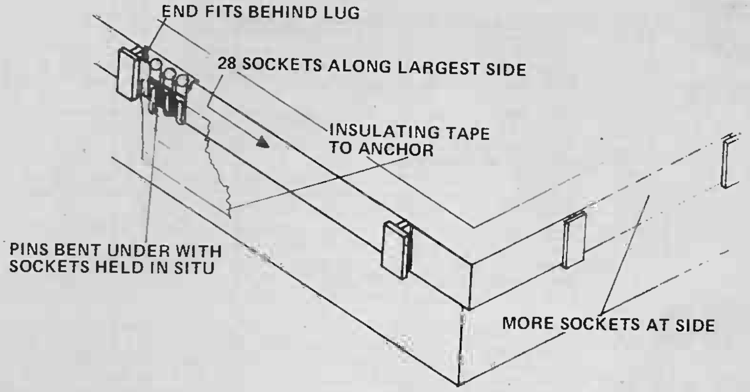
Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.

tech-tips

Dec-ed Out

D. F. Tranter



When using S-Decs to test circuits, one often finds that several groups of the Dec contacts are taken up for one common connection, particularly the contacts which run to the battery connections.

In order to extend the capacity of a single S-Dec I fit a row of sockets along each of the two Dec sides which have lugs for connecting to other Decs, using the lugs as end fixing points.

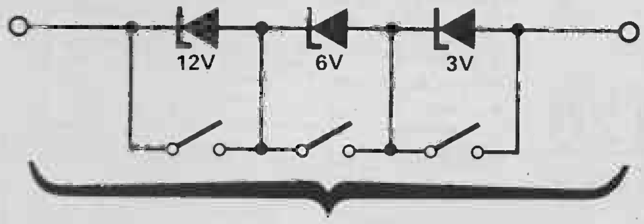
If the sockets are bent and a strip of insulating tape used to anchor the lower ends, one gets a reasonably robust fitting which greatly extends the capacity of the Dec.

The lug recesses along the other two sides can also be used for attaching more rows of sockets.

The Multi-zener

R. N. Soar

This is an application of zener diodes based on the binary system. In the example shown three zener diodes are used 3 V, 6 V and 12 V (ie. 3.0 V, 6.2 V and 12 V) plus three S.P.S.T. switches. In the "on" position of a switch the diode is short circuit. In the 'off' position the diode is in circuit. Thus the effective diode by suitable operation of the switches is 3, 3+6, 3+12 etc. ie. 3,6,9,12,15,18,21 volts By the addition of the next in the series 24 V and another S.P.S.T. switch the range is 3,6,9,12,15,18,21,24,27, 30,33,36,39,42,45 volts.

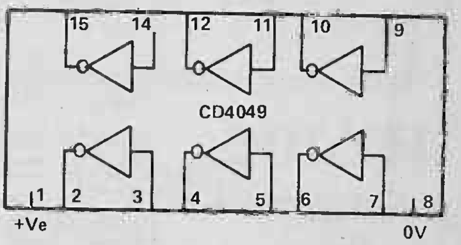


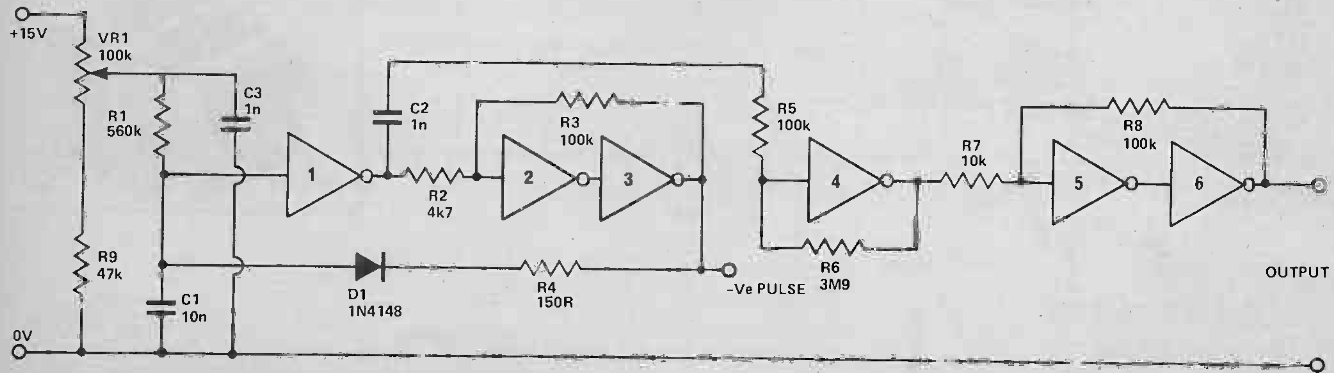
EFFECTIVE ZENER

Cheapo VCO

A. J. Richardson

This circuit provides a cheap solution to a non precision voltage controlled oscillator. C1 charges towards the voltage set on VR1 until inverter 1 output goes low whereupon the output of inverter 3 goes low and discharges C1 via D and R4. Inverters 2 and 3 form a Schmitt trigger circuit with positive feedback supplied by R3. Inverter 4 forms a linear amplifier with its gain set by the ratio of R5 to R6 which squares up the signal appearing on inverter 1 output. The signal is further squared up by the Schmitt trigger action of inverters 5 and 6 to provide a square wave of approximately 50% duty cycle at the output of inverter 6. With the values shown a frequency range of at least 100 Hz to 15 kHz is guaranteed with VR1 but other ranges can be covered with suitable values of R1 and C1. The circuit works well at lower supply voltages but the frequency range covered for a given set of components may be slightly less. If a square wave is not required a negative pulse of approximately 200 nS is available at the output of inverter 3 thus enabling two VCOs to be built with one chip.





tech-tips

Phaser Mod

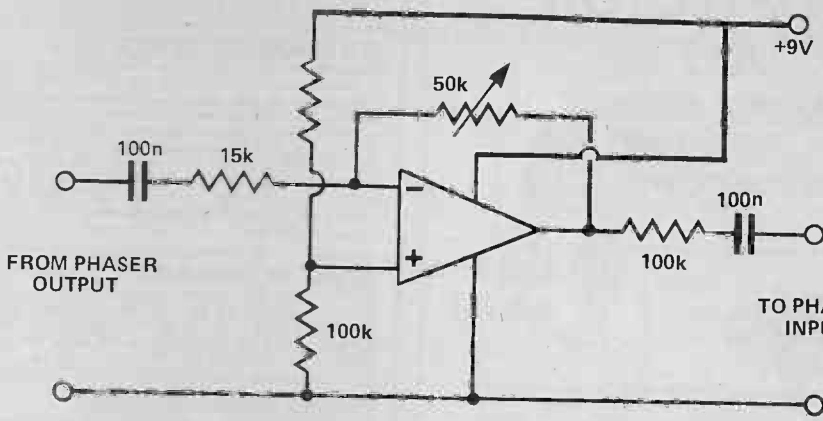
M. Headey

I constructed a simple variable gain op amp inverter and connected it between the output and the input.

When the feedback amp was switched into circuit the effect was dramatic. The phaser sounded much deeper.

The modification is simple enough and though can be adjusted to feedback (audio) level, sounds very good if the gain is kept down.

The circuit as shown gives very good results although you may be able to suggest some component value changes.

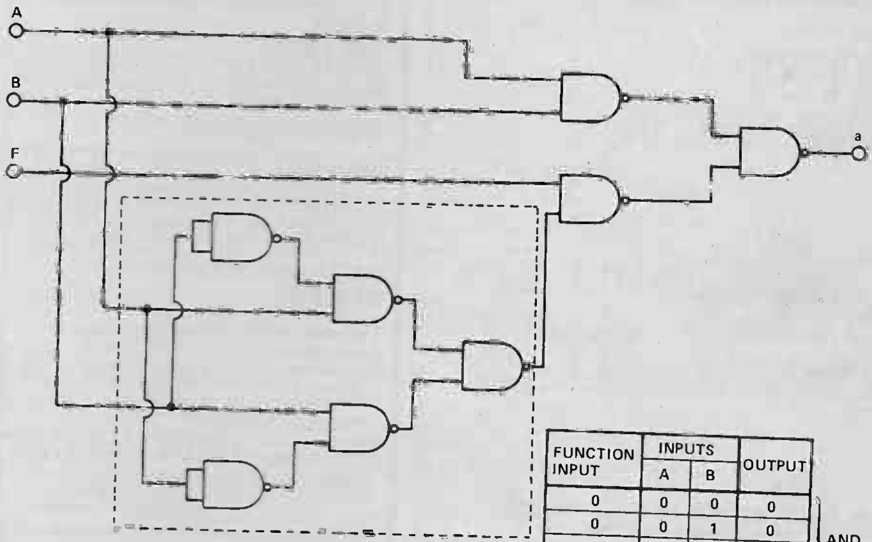


Programmable Gate

P. Mead

The Programmable Gate is a gate which converts an AND gate to an OR gate by applying a logic '1' on the function input.

The logic design uses 8 x 2 input NAND gates. The number of gates may be reduced by replacing the 5 NAND gates enclosed by the dotted line, with a 2 input exclusive OR, such as the TTL 7486.



FUNCTION INPUT	INPUTS A	INPUTS B	OUTPUT	
0	0	0	0	AND FUNCTION
0	0	1	0	
0	1	0	0	
0	1	1	1	
1	0	0	0	OR FUNCTION
1	0	1	1	
1	1	0	1	
1	1	1	1	

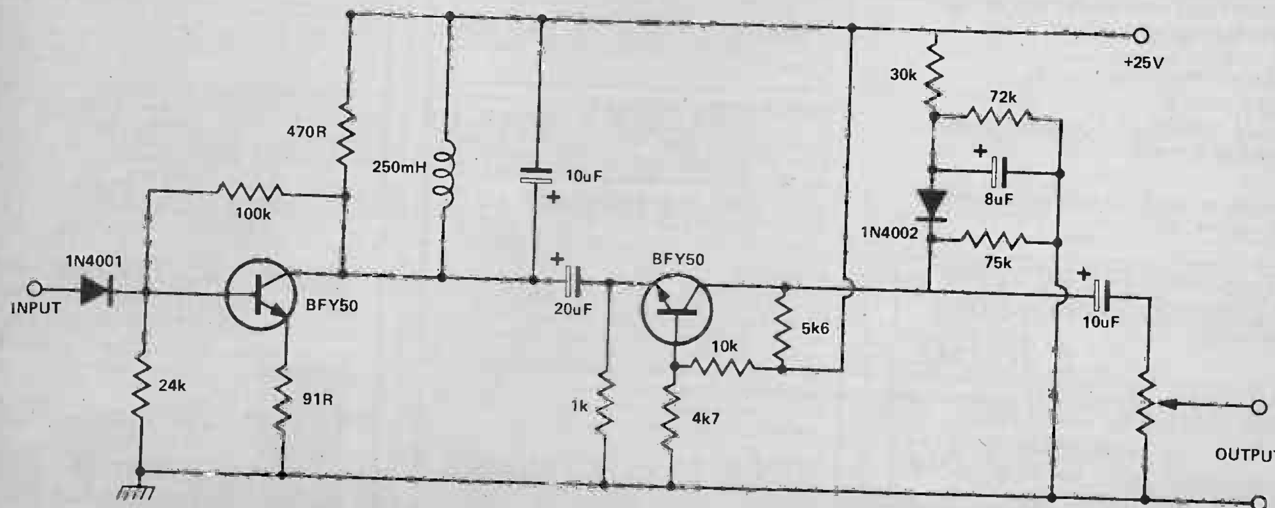
5mS Delay Unit

C. S. Rushton

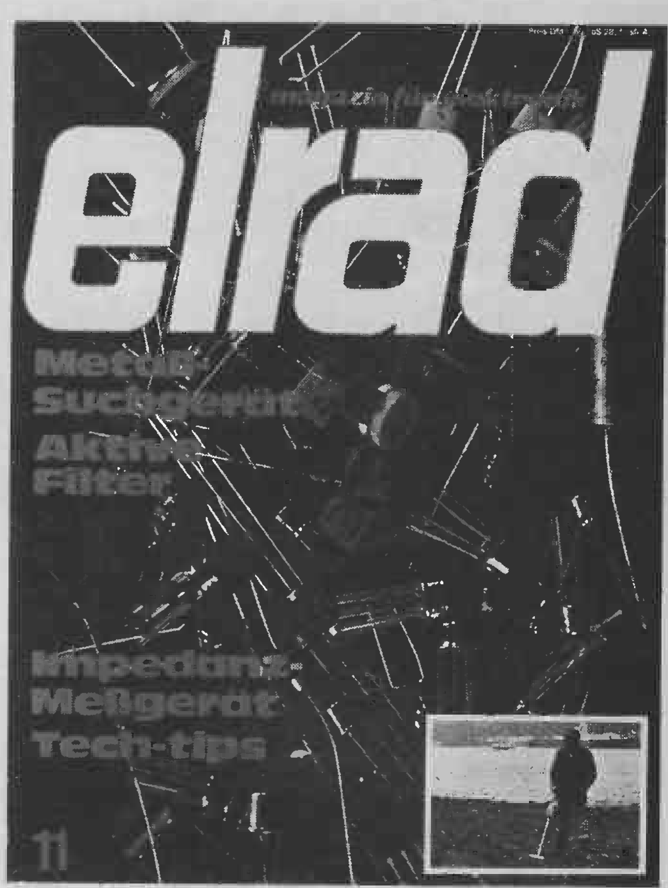
The circuit shown will produce a delay of 5 mS from input to output with good correlation between amplitudes over a dynamic range of approximately 40 dB.

The circuit consists of four main sections: an input buffer, a damped resonant RLC circuit, a non-inverting amplifier and a clamping circuit.

The delay can be modified within reasonable limits by adjustment of the RLC network.



.....news



Staff Vacancies

ELECTRONICS TECHNICIAN

We need someone for the ETI Project Team. Applicants must be capable of, and enjoy, firstly bread-boarding up prototypes from supplied circuits and then converting the proved circuit into a well-built prototype.

Skills necessary are a good standard of workmanship, both electronically and mechanically and examples of previous work must be available for examination. Ability to design PCB layouts would be an advantage though limited experience in this area should not preclude candidates from applying.

The majority of the work is in building but it will be necessary to co-operate with the other editorial staff both with design and with the paperwork needed to present the project in the magazine.

The job is in our workshop at our Oxford Street premises. Salary will depend upon skills and experience but will be in the range £2,800 absolute minimum to £3,600 for someone bringing additional skills to the team.

EDITORIAL ASSISTANT FOR ETI-AUSTRALIA

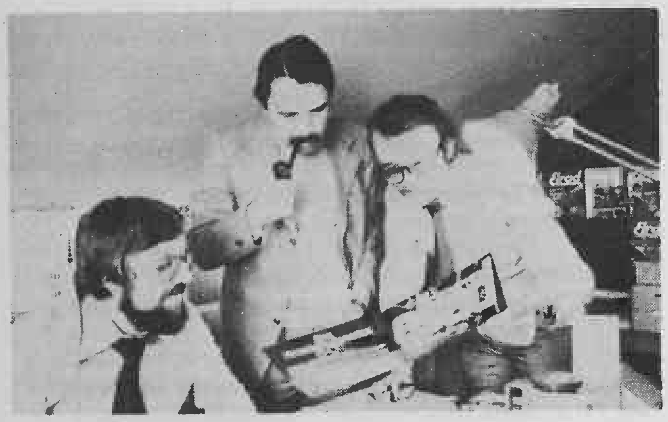
An additional staff member is needed in Sydney, Australia, to work on ETI-OZ: this position is *only* being advertised here at

digest....

Elrad: ETI Germany...............

A new edition of ETI starts this month — Elrad in Germany. The name Elrad itself means nothing and is simply an amalgamation of electronics and radio. It is being published by Heinz Heise in Hanover and is edited by Udo Wittig shown with pipe in the photograph examining a publicity leaflet with the advertising and production managers.

Following German tradition, the first issue is numbered zero and given away. This came out in November and the front cover is shown on the left.



with ETI

this stage so we are serious about seeking applicants.

We are seeking a young person — probably under 25 — who is genuinely interested in electronics. We are not specifically seeking someone with journalistic experience as this is far easier learnt than for a journalist to learn electronics. The work is extremely varied but much of the work is preparing the work of others for the magazine; some writing is also involved. Formal qualifications in electronics are not as important as interest in the field.

Initially the successful applicant will work on the British edition for 'initiation' and work experience. After a satisfactory trial period, the successful applicant will go to Sydney: it is a permanent position. Australian is a language similar to English liberally dotted with certain Anglo-Saxon words. Salaries in Australia are considerably higher than those prevailing in the UK.

For both positions apply in writing to Halvor Moorshead, Editor, ETI-Magazine, 25-27 Oxford Street, London W1R 1RF, giving details of education, knowledge, experience, age, current salary and any other relevant information. Applications should reach us as soon as possible. Interviews will be held in London in early January.

HOUSE ALARM

IN these days of increasing crime and vandalism an alarm system for the home can add greatly to ones peace of mind. To be effective however, not only must the alarm circuitry be well designed, it must also be correctly installed. This article describes a sophisticated alarm system and how best to commission it.

OUR MARCH ISSUE last year carried a feature going under the title "Burglar Proof Your Home". The item dealt with the various methods by which householders could make their domiciles more secure and thus less attractive to the burglar. A wide variety of means by which the security of the home could be improved were described in some detail, from simple common sense precautions like locking all doors even when "popping out for a few minutes", to the use of non-drying paint and the installation of burglar alarms. The feature did not however include any circuits of suitable alarm systems.

Since last March we have had a number of requests to design an alarm suitable for domestic or small business use and as a result have developed the design we present here.

We cannot emphasize enough though, that any alarm system — no matter how sophisticated — can only be of use if it is installed correctly. Further the installation of an alarm should only be considered as part of a general awareness of the need for greater attention to be paid to security. For this reason, before going on to describe the alarm in detail, we shall deal with domestic security in general, the installation of alarms and how the specification of our alarm evolved.

How They Get In

Nearly 30% of all burglaries are committed by thieves entering via unlocked doors or windows. A further 24.4% are committed via forced door locks, and about the same percentage via forced windows.

Thus nearly four out of five potential breakins can be avoided by installing adequate door and window locking mechanisms.

Use 'deadlatch' locks on all external doors. These can only be opened with a key — even from the inside — so that even if a thief enters via a window he cannot remove any large items as the doors remain locked and few thieves will risk passing out items through a window.

Do have locks fitted by an experienced locksmith unless you have experience in this field — and do not fall for the door-to-door lock salesman — it is not unknown for such people to retain a duplicate key.

Consult a security expert about window locking devices. Innumerable types are available for metal, wood framed and sash windows. A burglar might break glass but few will risk climbing through a window frame with broken glass in it.

The precautions outlined above will reduce your chances of being burgled by about 80% — the remaining 20% can be reduced to almost zero by installing a good burglar alarm. The emphasis must be on the word good, a poor alarm may go off erratically, or worse, not at all.

Sensors

For most premises, it is necessary to install sensors to protect front and rear doors, windows and garage entrances.

A few forced entries are made through the walls or roof or very occasionally via the floor. Although rare, such forced entries may be guarded against by placing sensors in a strategic passage or area through which any intruder is likely to pass.

The simplest and most reliable switching device for alarm installations is the magnetic reed switch. This consists of a pair of ferromagnetic contacts in a small hermetically sealed glass enclosure. The switch contacts are cantilevered from the ends of the glass tube and overlap slightly at the centre, with a small air gap between them.

When a magnet is brought near the reed switch, the attracting forces increase and overcome the stiffness of the reeds, bringing them into contact. When the magnet is removed, the contacts open. The relative distance for pull-in is less than for drop-out, a valuable feature as small movements of doors and windows will not cause false triggering.

Reed switches purchased for alarm installations must be of a type specifically intended for the purpose — standard reed switches will not do.

Many professional security companies install reed switches and magnets encased in plastic mouldings. Whilst these are neat and simple to fit, it is better to conceal both reed and magnet within the framework of the door or window to be protected.

In Figs. 3 and 4 we show just two of the various methods of fixing the reeds and magnets (note that the magnet is to be fitted to the moving part of any door or window).

Window glass may be protected by glueing on a loop of aluminium foil tape (or using a self-adhesive type of foil). The foil is quite thin and breaks if the glass is fractured. Foil will deter all but the most determined of burglar. After all why risk being caught when next door does not seem to be protected by an alarm.

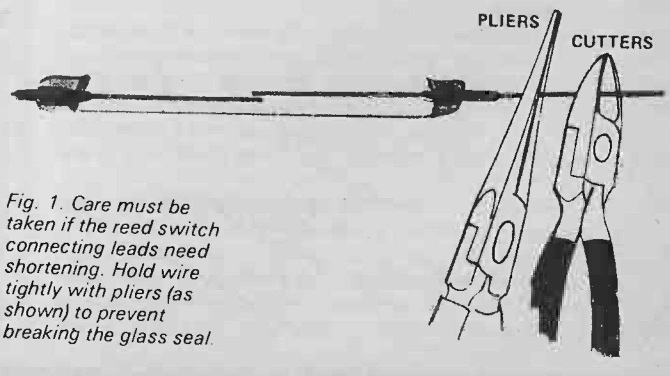


Fig. 1. Care must be taken if the reed switch connecting leads need shortening. Hold wire tightly with pliers (as shown) to prevent breaking the glass seal.

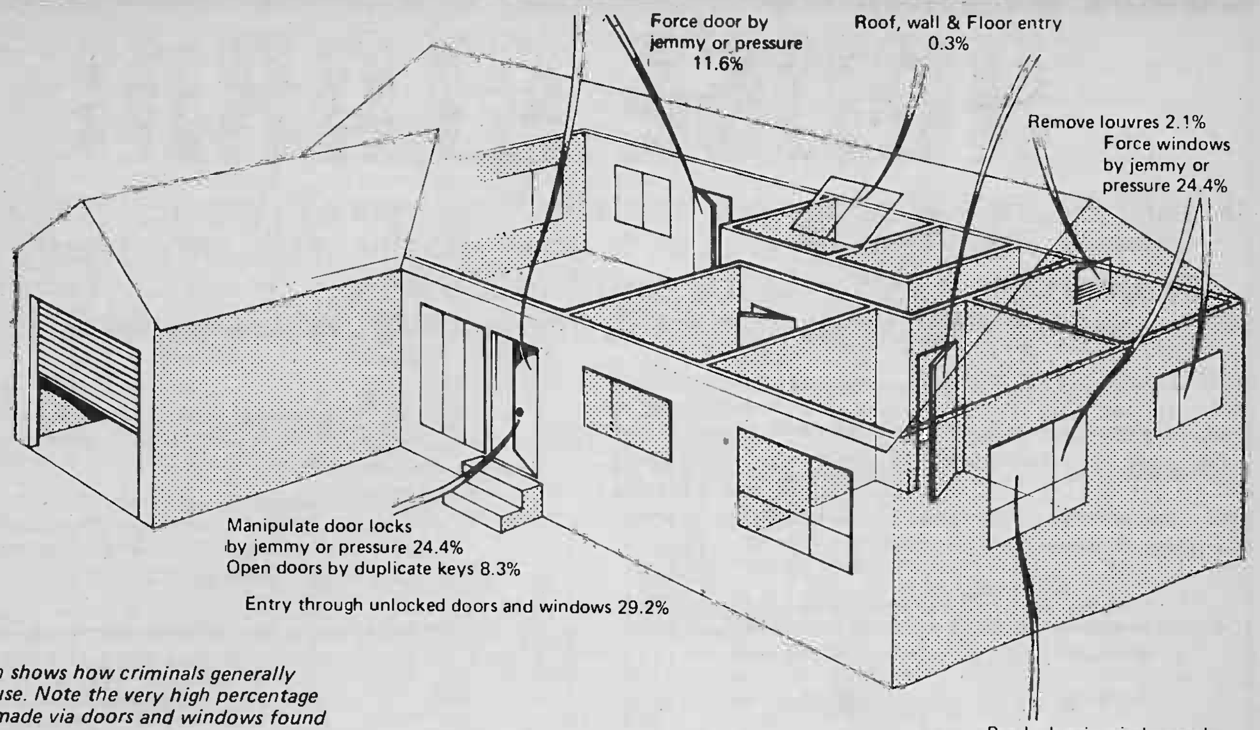


Fig. 2.
This sketch shows how criminals generally enter a house. Note the very high percentage of entries made via doors and windows found unlocked.

Vibration sensors may be used to protect large areas of glass but these are prone to false triggering during thunderstorms etc.
Many other types of intruder sensing devices may also be included in the system. Pressure mats for example can be placed under carpets in strategic passageways — or even under the door mat. The mats contain a large number of normally open contacts some of which will be closed when the mat is trodden on. The system can also include more sophisticated intruder detectors such as infra-red type sensors.

The intruder alarm itself should be reasonably accessible to people entering and leaving the premises via a 'silent entry' door, but will hidden from the sight of an intruder. The alarm's output stage should be a relay which latches when an alarm signal is received.

Warning Devices

For household use a good quality 12 Volt bell should prove an adequate warning device. Being mechanically resinant, bells have a very high conversion efficiency; in fact, the average bell draws less than 500 mA at 12 V yet can be heard several hundred metres away.

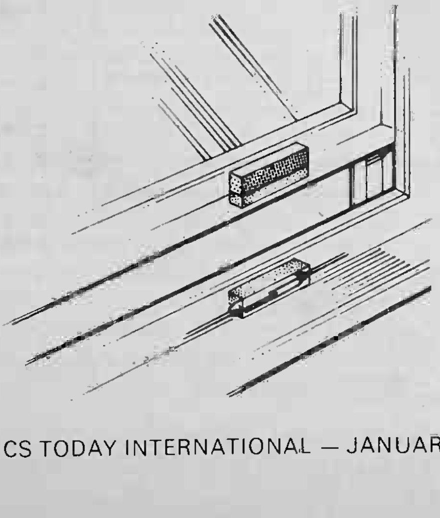
Good sirens can be heard well over a few kilometres away, but they draw a lott of current and cost more than a good bell. Small cheap sirens cannot be recommended.

If at all possible, householders should make mutual arrangements with neighbours to contact the police if the alarm is heard. Similar arrangements should also be made so that neighbours can switch off the alarm when the police arrive.

An alarm which resets after a period of time, silencing the bell or siren, is a useful device that will be much appreciated by the neighbours. Care must be taken to ensure however, that the alarm when triggered and reset, still provides some measure of protection to the property.

Whatever the warning device chosen, it should be mounted unobtrusively high up in an inaccessible place. The leads to the device should be of an adequate gauge to avoid any voltage drop associated with a long

Fig. 3. Set the reed switch into the window frame and the magnet into the moving part.



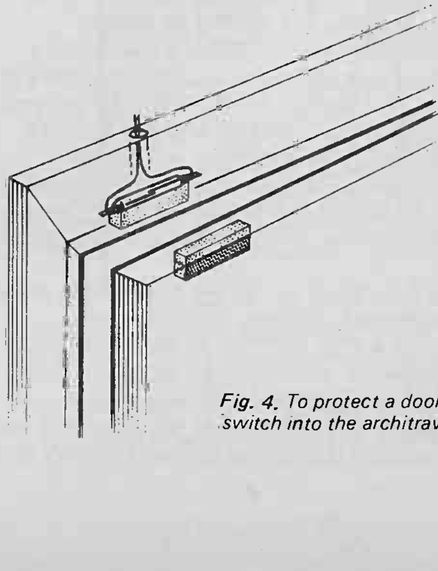


Fig. 4. To protect a door set the reed switch into the architrave.