Easy to build projects for everyone

Everyday ELECTRONICS

JAN. 81
60p

Australia $1·00 New Zealand $1·10 Malaysia $4·50

POPULAR KITS AND PARTS

TRANSMITTER SURVEILLANCE
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox—all electronic parts and circuit. **£2·30.**

RADIO MIKE
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. **£6·90.**

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

LIGHT CHASER
Gives a brilliant display—a psychedelic light show for discos, parties and pop groups. These have three modes of flashing, two chase-patterns and a strobe effect. Total output power 750 watts per channel. Complete kit. **Price £16.** Ready made up **£4 extra.**

FISH BITE INDICATOR enables anglers to set up several lines then sit down and read a book. As soon as one has a bite the loudspeakers emits a shrill note. Kit. **Price £4·90.**

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13·5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit. Includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy, if you have an amplifier to connect it to on a pair of high resistance headphones. Price **£11·95.**

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price **£2·30.** Crystal earpiece **65p.** High resistance headphones (give best results) **£3·75.** Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find—start at the aerial and work towards the speaker — when signal stops you have found the fault. **Complete kit £4·95.**

INTERRUPTED BEAM KIT
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components—relay. photo transistor, resistors and caps etc. Circuit diagram but no case, Price **£2·30.**

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. **The kit comprises:** 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. **Price £11·50 + £2·50 post.**

G.P.O. HIGH GAIN AMP/SIGNAL TRACER. In case measuring only $5\frac{1}{4}$in × $3\frac{1}{4}$in × $1\frac{1}{4}$in is an extremely high gain (70DB) solid state amplifier designed for use as a signal tracer on GPO cables etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard $4\frac{1}{2}$v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp. cueing amp, etc. **An absolute bargain at only £1·85.** Suitable 80 ohm earpiece **69p.**

VU METER
Edgewise mounting, through hole size $1\frac{3}{8}$" × $\frac{1}{2}$" approx. These are 100 micro amp f.s.d. and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. Price **£2·88p.**

BALANCE METER
Edgewise mounting 100 UA centre zero. Price **£2;30p.**

$1\frac{1}{2}$" SQUARE PANEL METER
Eagle full vision plastic front, 50 UA. Price **£4·60p** 1 mA Price **£4·03p.**

WATERPROOF HEATING WIRE
60 ohms per yard. This is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses—around water pipes, under grow boxes in gloves and socks. **23p** metre.

DIAL INDICATOR
As used in tool making and other precision measuring operations, the famous John Bull accurately shows differences of 0·1mm. A beautifully made precision instrument, price in most tool shops would be £12-£15. We have a fair quantity. Price **£9·20p.**

COMPONENT BOARD Ref. W0998.
This is a modern fibre glass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including four 3 amo 400v types (made up in a bridge) 8 transistors type BC 107 and 2 type BFY 51 electrolytic condensers, SCR ref. 2N 5062 25 Ouf 100v DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at **£1·15.**

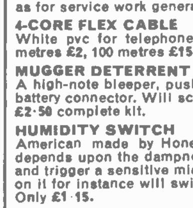
FRUIT MACHINE HEART. 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot." **£9·95 + £4** carriage.

DESOLDERING PUMP
Ideal for removing components from computer boards as well as for service work generally. Price **£6·35.**

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

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. **£2·50** complete kit.

HUMIDITY SWITCH
American made by Honeywell. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch. Very sensitive breathing on it for instance will switch it on. Micro 3 amp at 250V a.c. Only **£1·15.**

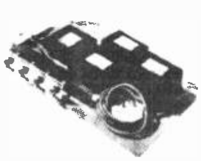


MINI-MULTI TESTER
Deluxe pocket size precision moving coil instrument, jewelled bearings—2000 o.p.v. mirrored scale.
11 instant range measure:
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0-100 mA.
Continuity and resistance 0-1 meg ohms in two ranges. Complete with Test Prods and instruction book showing how to measure capacity and inductance as well.
Unbelievable value only **£6·75 + 50p** post and insurance.
FREE Amps ranges kit to enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini-tester and would like one, send **£2·50.**

SUPER HI-FI SPEAKER CABINETS.
Made for an expensive Hi-fi outfit—will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price **£6·90** per pair (this is probably less than the original cost of one cabinet) carriage £3 the pair.

CHASSIS BARGAIN
3 wave band radio with stereo amplifier. Made for incorporation in a high-class radiogram, this has a quality of output which can only be described as superb. It is truly hi-fi. The chassis size is approximately 14". Push buttons select long, medium, short and gram. Control are balance, volume, treble and bass. Mains power supply. The output is 6 + 6 watts. Brand new and in perfect working order, offered at less than value of stereo amp alone, namely **£6·90.** Post £2·00.

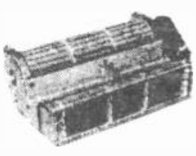
MULLARD UNILEX
A mains-operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about **£30**—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£16** including V.A.T. and postage.
FREE GIFT—Buy this month and you will receive a pair of **Goodman's** elliptical 8" × 5" speakers to match this amplifier.



THIS MONTH'S SNIP We all know how especially in the cold weather p.v.c. leads lose a lot of their flexibility, in fact some poor grade p.v.c. can be quite stiff and awkward and will not stay put. We recently purchased a quantity of an extra flexible twin cable. This is highly suitable for lead lamps, vacuum cleaners, in fact any portable device which does not need an earth. The regular price of this very flexible cable which is suitable for up to 7·5 amps is 30p per metre, and that is buying 1,000 metres at a time. However, this month you can buy 50 metres for **£6·35** or 250 metres for **£28·00.**

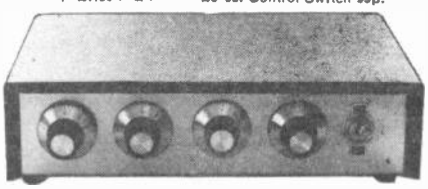
WALL MOUNTING THERMOSTAT,
Danfoss, a handsome 2 tone this is intended for living rooms but is just as efficient in a greenhouse or store. It is suitable for normal air temperature range 32F-80F—price **£4·60.**

TANGENTIAL HEATER UNIT



3 KW Mode
£6·95
+ £1.50 P & P

A most efficient and quiet running blower-heater by **Solatron**—standard replacement in many famous name heaters—comprises mains induction motor—long turbo fan—split heating element and thermostatic safety trip—simply connect to the mains for immediate heat—mount in a simple wooden or metal case or mount direct into base of say kitchen unit. **Price £5·95,** post £1·50. Control switch to give 2kw, 1kw, cold blow or off available 60p **extra.** 3kw model **£6·95.** Control Switch **95p.**



3-CHANNEL SOUND TO LIGHT KIT
Complete kit of parts for a three-channel sound to light unit controlling over 2,000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by $\frac{1}{4}$" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is **£14·95** in kit form or **£19·95** assembled and tested.

TERMS: Cash with order—but orders under **£10** must add **50p** to offset packing, etc.

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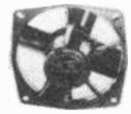
IT'S FREE
Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

DUE TO THE HIGH & RISING PRICES OF FUEL many companies and probably many householders are looking around for ways of saving some of this cost. One Company bought a number of fans from us and fitted these on the ceiling of their workshops where the hot air tends to collect and they blow this hot air downwards. Another Company has bought fans from us to suck the exhaust from their oil fired central heaters through a zig zag of asbestos pipes, the asbestos pipes being in a separate chamber which becomes a hot air chamber, the hot air from this is blown through ducting to where ever it is needed. Basically, they have cut out the normal chimney and replaced this with one of our high power extractor fans. If you have any other good ideas on heat cost saving, let us know and we will pass it on to other readers.

EXTRACTOR FANS
Ex-Computer made by Woods of Colchester, ideal also as blower; central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 r.p.m. but quiet running. Choice of 2 sizes, 5" **£5·50, 6" £6·50;** post **£1** per fan.



PING PONG BALL BLOWER-UPPERS Have you got to organise a Christmas Party or Charity Fund-Raising Event? Then one always popular way is to have ping pong balls going up and down and being caught. We have some powerful blowers and these should be ideal for this, and of course for more serious purposes. They are 4 stage blowers, coupled to synchronised AC mains motors of approximately $\frac{1}{8}$ h.p. They have a terrific suction as well as a high velocity blow. Ex computers, price **£26·00.**

TWO MORE BLOWERS Both 'snail' type, one very small and compact and suitable for cooling projectors or other equipment. Impeller size 2" × 1", coupled to mains voltage induction motor, outlet size approximately $1\frac{1}{2}$" × $1\frac{1}{4}$". **Price £5·50 + 68p.** The other is a larger **FLANGED BLOWER** for direct coupling to ducting, outlet size $3\frac{1}{4}$" × $2\frac{1}{4}$" + 1" flange, holed for easy fixing to trunking. Impeller size $5\frac{1}{2}$" × $1\frac{1}{2}$". Powered by 1/12 h.p. mains motor. **£11·75.**

RECHARGEABLE SOLID GEL BATTERY 12v 5 AH new and unused made by or for Elpower Corporation of California. Dimensions, 6" long, $3\frac{3}{4}$" high and $2\frac{1}{2}$" wide. Regular price of similar batteries, R.S. Components is **£26·00.** Limited quantity available at **£15·80.**

DUAL DIGITAL TIMER Short delay, left timer adjustable 0-2 secs, right timer 0-9·9 secs. Made by Techno Instruments Ltd., catalogue no. 010 18/1. We have very little information on these, but they are battery operated, to use you simply set the digital switches in the desired position, turning the rotary indicator to the chosen time. The lamp will light up when the right timer is in operation. Periodic or single action possible. This is a precision instrument $4\frac{1}{2}$" wide, $1\frac{1}{2}$" high and $5\frac{1}{4}$" deep. We understand that these cost over £60·00 from the Makers, limited quantity only at **£23·00.**

SOLID STATE VARIACS By Lewis and Holtzman Ltd—their "Elvar". 230-240v AC in and out. 10 amp model is cylindrical approximately $3\frac{1}{4}$" diameter $4\frac{1}{4}$" deep. Price **£13·80.** 5 amp model, again cylindrical, $2\frac{1}{4}$" diameter, $4\frac{1}{2}$" deep. Price **£9·20.**

E.H.T. UNITS One of our specialities has always been E.H.T. transformers, and we probably have bigger stocks than most of our contemporaries. It is surprising what uses these high voltages can be put to—killing flies and weeds, lighting central heating boilers, lifting paper, extracting dust, etc. etc. A new one this month is 14·5 KV. (dc) 0·5mA—made by ADVANCE ELECTRONICS—this unit is completely enclosed and has input and output sockets—size of the unit is approximately 6" × 3" × $3\frac{1}{2}$", price **£15·38** post £1.
To remind you of the E.H.T. Transformers we stock, here is a list:

3–4 KV	3 mA	ex equipment	**£2·90**
5 KV	5 mA	ex new equipment	**£7·15**
5 KV	5 mA	with outer casing and E.H.T. outlets	**£9·45**
8·5 KV	10 mA	totally enclosed with E.H.T. outlets	**£13·50**

LEDS are used increasingly and are now being recommended for nearly all indicators and for games and novelties. Due to a fortunate purchase, this month we are able to offer 10 red led's for **£1.** These are the small ones equivalent to the TIL 209. Bulk price **£60·00** per 1,000 + V.A.T.

FIG. 8. FLEX is always in demand, especially when doing the Christmas decorations. We are able to offer white Fig. 8 5 amp type on 50 metre roll for **£2·80,** ditto but dark grey with tracer lead, suitable for speaker extensions. 50 metres **£3·38.**

500 WATT MERCURY VAPOUR LAMP Mazda, ref. 90-5104 MAT/V blended. These give a really powerful light but, of course, have to be used with the correct control gear. We are expecting to get this control gear early in the New Year. Price of the lamp is **£3·38** + 38p. Post 50p.

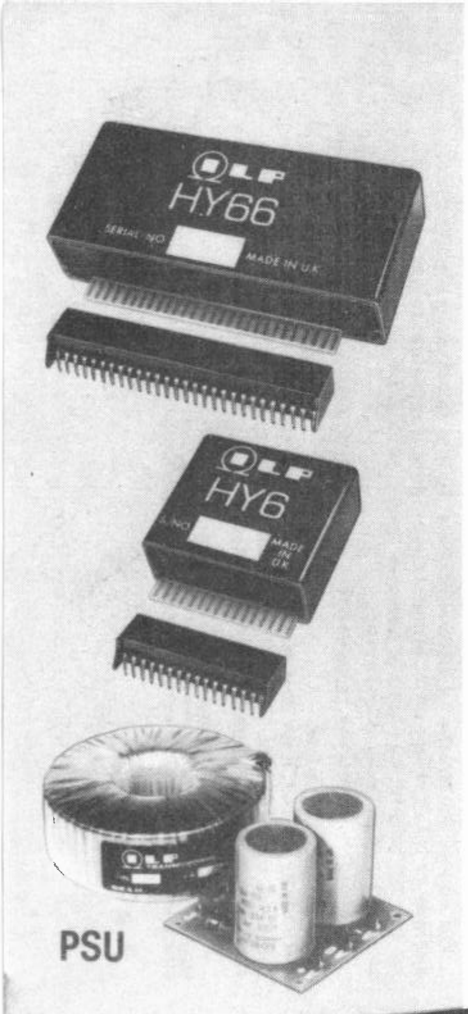
ANTI FROST THERMOSTAT The normal refrigerator type thermostat, switches off as the temperature falls and so is not suitable for anti-frost devices. However, we have the *ice stat*—this switches on as the temperature falls and is set to switch on just above freezing point. It is a skeleton stat so would require boxing, but the price is modest at **£1·10.**

THIN CONNECTING WIRE 500 metre drums, 7 stranded copper core p.v.c. covered available in 10 different colours. Price **£7·15.**

OCTOBER/NOVEMBER CONSTRUCTOR'S SNIP. Here's a super bargain for you, 100 twist drills, regular tool shop price over £50, yours for only **£11·50.** With these you will be able to drill metal, wood, plastic etc from the tiniest holes in P.C.B. right up to about $\frac{1}{4}$". Don't miss this snip—send your order today.

SUPER BREAKDOWN PARCEL with free gift of a desoldering pump, perhaps the most useful break-down parcel we have ever offered. Consists of 50 nearly all different computer panels on which you will find: over 300 ICs, over 300 diodes, over 200 transistors and many hundred other parts, resistors, condensors, multi turn pots, rectifiers, SCR etc. etc. for only **£8·50,** which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel, + **£1·27** VAT + £2 post (it's a big parcel).

TIME SWITCH BARGAIN Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs **£2·50.**



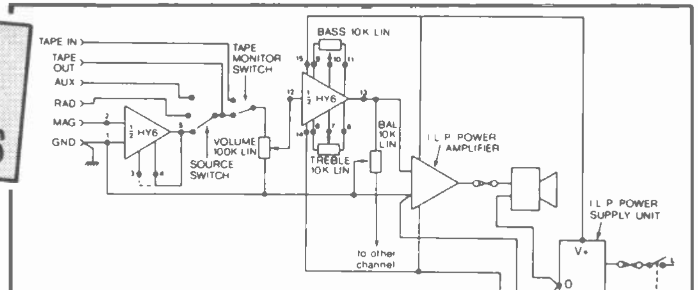
NEW PRE-AMPS

HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

Sizes – **HY6** – 45×20×40 mm. **HY66** – 90×20×40 mm.
Active Tone Control circuits provide ±12dB cut and boost.
Inputs Sensitivity – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + £1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE AMP. WITH STEREO CONNECTION SHOWN

- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO – 90dB (Mag. P.U. – 68 dB)**
- **38 dB overload margin on Mag. P.U.**
- **LATEST DESIGN HIGH QUALITY CONNECTORS**
- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ±15 to ±60v**

NEW POWER SUPPLY UNITS

IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

PSU30 ±15V at 100mA to drive up to 12 x HY6 or 6 x HY66	**£4.50** + 0.68p VAT
● *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*	
PSU36 for use with 1 or 2 HY30's	**£8.10** + £1.22 VAT
● *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*	
PSU50 for use with 1 or 2 HY60's	**£9.75** + £1.46 VAT
PSU60 for use with 1 HY120	**£9.75** + £1.46 VAT
PSU65 for use with 1 MOS120	**£9.75** + £1.46 VAT
PSU70 for use with 1 or 2 HY120's	**£13.61** + £2.04 VAT
PSU75 for use with 1 or 2 **MOS120**	**£13.61** + £2.04 VAT
PSU90 for use with 1 HY200	**£13.61** + £2.04 VAT
PSU95 for use with 1 **MOS200**	**£14.75** + £2.21 VAT
PSU180 for use with 1 HY400 or 2 HY200	**£23.02** + £3.45 VAT
PSU185 for use with 1 or 2 **MOS200**	**£24.20** + £3.63 VAT

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Projects... Theory...
and Popular Features...

HAPPY AND PROSPEROUS

The customary form of greeting will have a hollow ring about it when voiced at the close of 1980. Those millions who have lost employment and those thousands of school leavers who have been denied the chance to make a start in paid employment will, like all the rest of us, HOPE for prosperity in 1981. But pronouncements from the government and independent authorities alike provide little cheer.

In simple terms, we are told things must get worse before they get better. The patient will be all the better for the current bloodletting. He will arise (in 1981, 2, 3 or 4?) lean, hungry and rearing to go. That's the official belief.

The idea behind the government's policy is beautifully simple. Once inflation has been conquered the prevailing high interest rates will be cut —thereupon new industries will start to arise phoenix-like from the ashes of those factories forced into closure during the treatment. Britain will then enter a new era of industrial prosperity, with the whole world clamouring for her products.

But what is happening in the real world in the meanwhile? Take electronics. This technology will not sit back and wait passively until the UK has recovered. In electronics and allied fields, changes and developments are constantly happening. If we fall out of the race, even for one year, it may be impossible to recover the ground lost to our competitors.

Even at this time leaders in the electronics industry deplore the shortage of top class circuit designers and computer programmers—key people in the development of new i.c.s. This shortage is handicapping development work, even in this present quiescent state of the industry.

The need for computer programmers extends beyond just the electronics industry. These skilled operators will be shock troops in a revitalised economy. No area of industry or commerce (or indeed life itself) will escape the expanding mesh of computer control.

Today we should be training school leavers (and others) for these vital roles. Not cutting back on education. It will be too late on revival day.

Our readership constitutes a good cross-section of the population, for an interest in electronics knows no bounds, whether trade, profession, class or age. Some readers will have already become victims of recession. A large number are in the younger age group and under normal conditions many of these would be looking forward to a career within the electronics area.

No one can insulate him or herself from the effects of the recession. For the vast majority of us, hope is the only thing we can do while waiting for the medicine to have its effect. We hope "they" have got the prescription right.

Fred Bennett

Our February issue will be published on Friday, January 16. See page 47 for details.

ELECTRONICS

VOL. 10 NO. 1 JANUARY 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Back Issues

Certain back issues* of EVERYDAY ELECTRONICS are available worldwide price 80p inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.

* *Not available:* October 1978 to May 1979.

Binders

Binders to hold one volume (12 issues) are available from the above address for £4·40 (home and overseas) inclusive of postage and packing. Please state which Volume.

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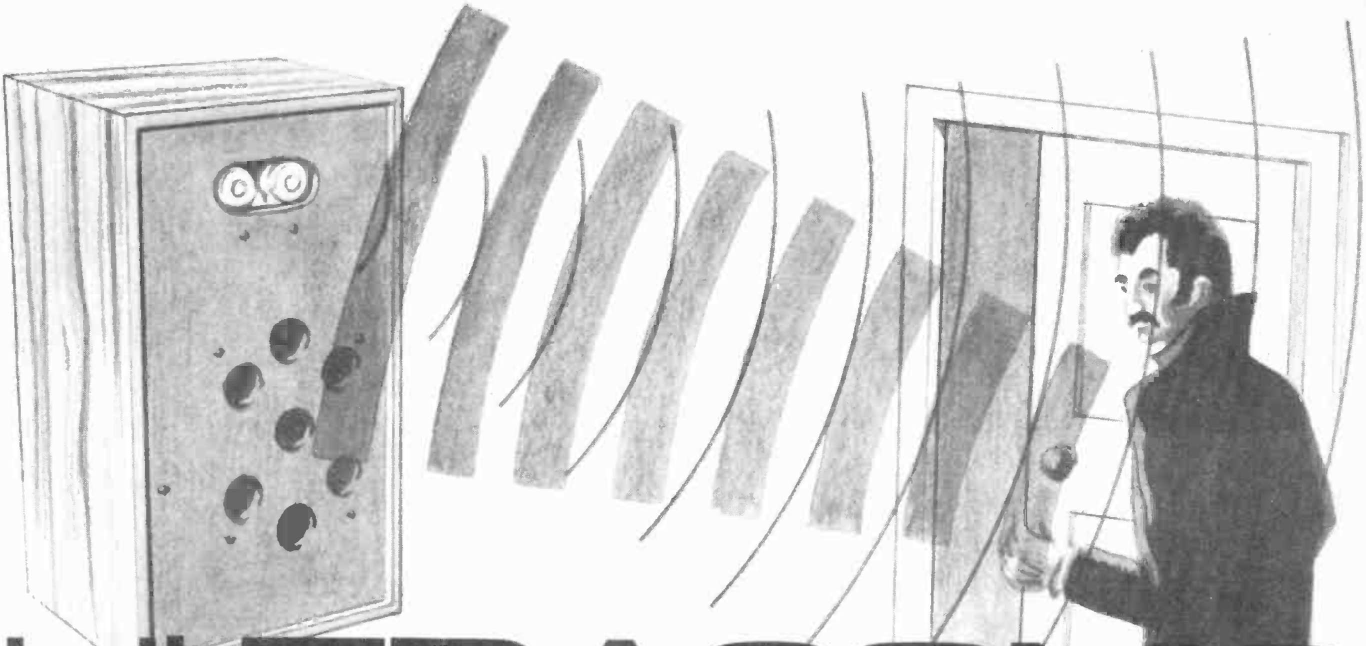
Seasonal Greetings TO ALL OUR READERS



ULTRASONIC INTRUDER DETECTOR

BY E. M. TERRELL

A FACTOR that deters many people from installing a conventional type of home security system (one that relies on the closing or opening of a switch to activate the alarm) is the need for extensive runs of wiring around the house. In modern houses this is difficult to conceal easily due to solid flooring.

Added to this is the requirement that all doors and windows fitted with a switch must be closed before the unit is switched on, unless of course zone switching is designed into the system. Also, every possible entry into the house should be included in the protection loop(s).

For maximum protection the switches themselves need to be concealed which usually means embedding them in door frames and the like. The system is thus permanent and not readily moved from one house to another should the need arise for example when one moves home.

PRINCIPLE OF OPERATION

The unit to be described here operates on an entirely different principle, requires no loops and is easily transportable.

The system is often referred to as a Doppler shift system. Here a fixed frequency ultrasonic signal is fed into an area, the one to be protected, and after bouncing around the room is picked up by a receiver section in the system. Any object moving in the area will by the Doppler effect produce a second and different frequency source which is detected.

The transmitter and receiver are located in the same cabinet, which here takes the form of a small speaker cabinet in an effort to disguise its identity.

The security device to be described here has the following features.

(1) Initial turn-on delay. This enables the unit to be switched on and remain inactive for a set time and allow the operator to leave the area without triggering the alarm.

(2) Once activated a further time delay occurs before the alarm begins to sound. This allows the operator to return and turn off the unit without sounding the alarm.

(3) The alarm sounds for a set time which the internal logic resets and re-instates the ready situation.

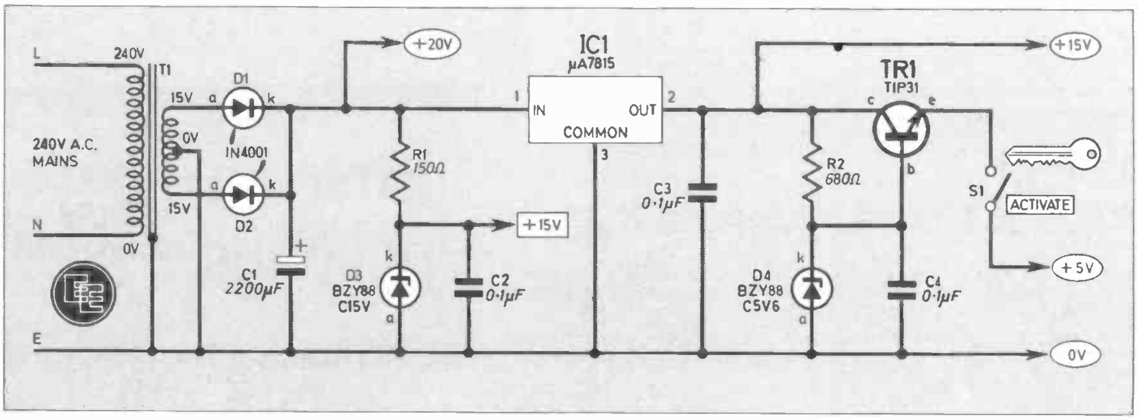


Fig. 1. The mains derived multi-output power supply section of the Ultrasonic Intruder Detector. All supplies are stabilised with the exception of the alarm supply line.

(4) Integral alarm having a modulated piercing tone produced in an internal loudspeaker.

(5) Outlet for remote loudspeaker.

CIRCUIT DESCRIPTION

The circuit diagram of the power supply section of the unit is shown in Fig. 1. Mains voltage is applied across the primary of T1 and is stepped down to 30 volts across the centre-tapped secondary. This a.c. voltage is full-wave rectified by D1 and D2 and smoothed by C1 to produce a d.c. level of about 20 volts across C1. This voltage is used to supply the alarm power output stage.

Resistor R1 and D4 form a simple Zener stabilised voltage supply (15V) which is used to supply the transmitter section.

IC1 is a voltage regulator i.c. and reduces the 20 volt d.c. input to a stabilised 15 volts which supplies the receiver and detection sections of the system. This supply rail is also used to derive the 5 volts required by the TTL i.c.s in the timing, control and alarm circuitry.

R2 and D5 produces 5·6 volts which is applied to the base of TR1 biasing it into conduction. The usual 0·6 volt is dropped across the base/emitter junction leaving 5 volts at TR1 emitter at currents up to 500mA which is more than adequate.

THE TRANSMITTER

The transmitter consisits of IC1 and local components feeding ultrasonic transducer X1, see Fig. 2. This has a resonant frequency of 40kHz. IC1 is wired as an astable multivibrator with D6 and D7 functioning as steering diodes in the charge and discharge paths of C5. They are used to obtain an approximate 1:1 mark:space ratio output at pin 3. VR1 allows adjustment of the oscillator frequency which must be fixed at the resonant frequency of X1. In the prototype a multiturn preset was used to allow fine tuning at the critical point.

THE RECEIVER

X2 is an ultrasonic receiving transducer matched with X1 and usually sold as a pair. Received signals are passed to IC3, an operational amplifier connected with R7, C10, C11, VR2 and R8 to form a bandpass filter with high gain at and near the resonant frequency i.e. 40kHz. VR2 allows fine adjustment of the filter resonance point.

The use of a bandpass filter reduces the likelihood of triggering by extraneous ultrasound sources such as the ringing telephone set in or near the protected zone.

The amplified sinewave signal reaches the next stage, a diode pump composed of C12, D7, D8 and C13. This acts as a voltage doubler/detector.

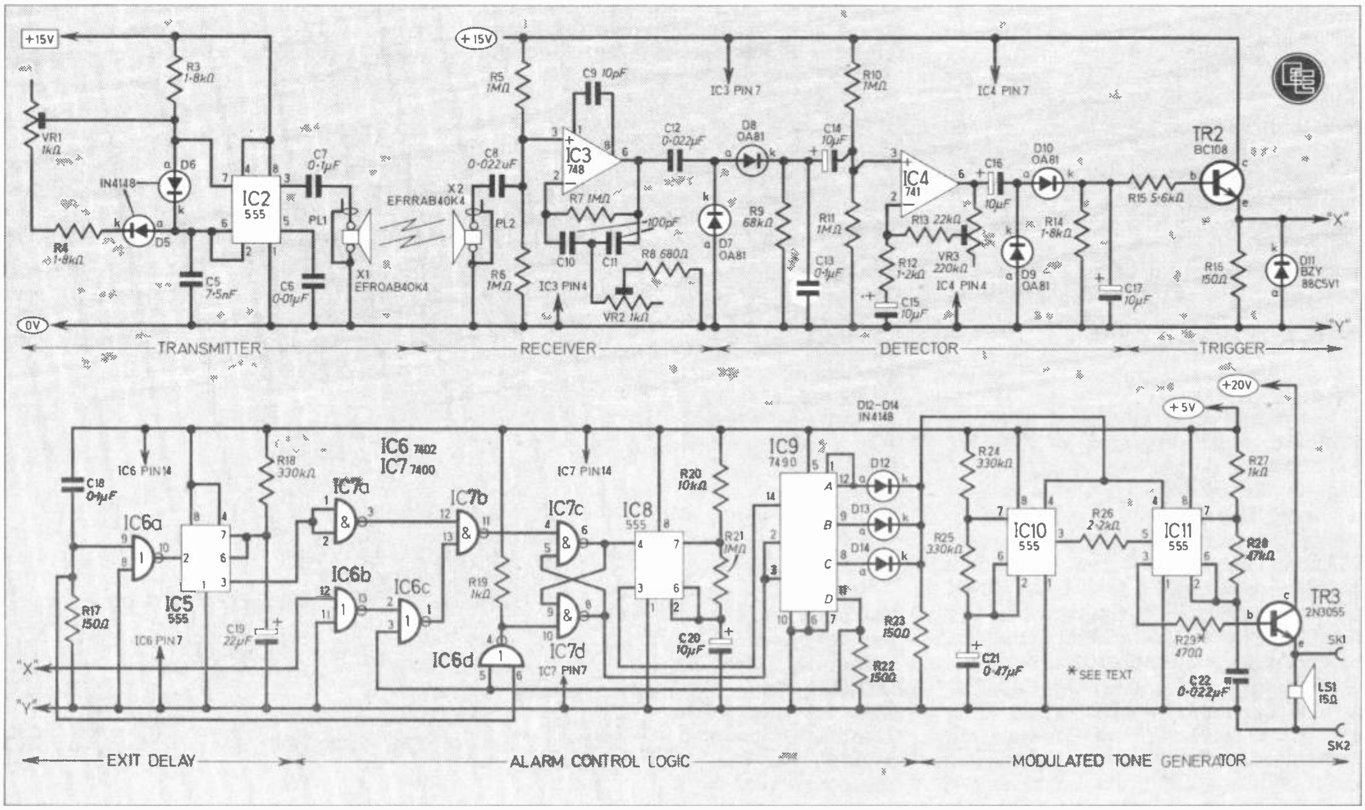
Under "static" conditions, the voltage level across C13 soon reaches the peak-to-peak level of IC3 output. This voltage is a steady d.c. referenced to 0V. Any movement in the guarded zone will by the Doppler principle be equivalent to a signal source with a frequency related to the "standing" transmitter frequency and the velocity of the moving object.

This second frequency is picked up by X2 and appears amplified at IC3 together with the standing frequency. The two interact to produce sum and difference frequencies. The latter results in an a.c. signal being developed across C13. This is passed to IC4 via d.c. blocking capacitor C14. IC4 and local components form a variable gain a.c. amplifier with the gain fixed by the ratio (R12 + R13 + VR3)/R12. Capacitor C15 determines the lower frequency turnover point. The gain is varied by preset VR3 and is the system sensitivity control.

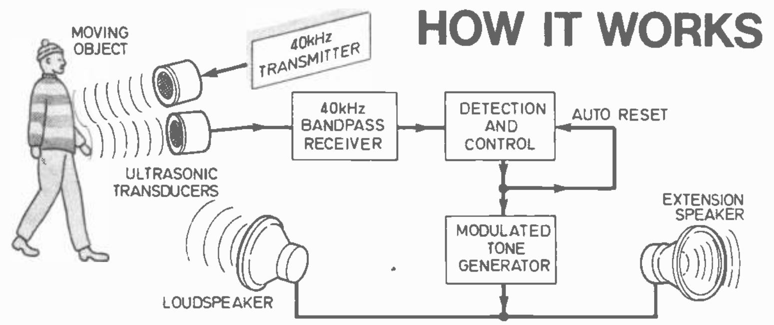
SECOND DIODE PUMP

Under static conditions the voltage across C13 is steady and so no signal is presented to IC4, A detector stage similar to that after IC3 is connected to IC4 output but the voltage across C17 is extremely low in the absence

Fig. 2. The circuit diagram of the Ultrasonic Intruder Alarm. Any 40kHz ultrasonic transducers may be used.



HOW IT WORKS



The 40kHz transmitter feeding the ultrasonic transducer introduces waves into the room to be guarded which are reflected off walls and other stationary objects to reach the receiver transducer. The received 40kHz produces no trigger signal and the alarm is quiet.

A disturbance (moving object) in the room will in effect generate other frequencies, close to 40kHz, and these will be detected by the receiver section to trigger the alarm. After a preset period, an auto reset signal is generated to mute the alarm and place the unit in a ready condition to detect further disturbances.

of any a.c. input to pin 3. This condition exists for all amplitudes of received transmitter frequency. Thus re-arrangement of furniture in the protected area will have no effect (and therefore require no adjustments). Similarly, the unit may be re-positioned without adjustment except perhaps for rotation of the transducer heads for maximum sensitivity. This is a distinct advantage over the "broken beam" type detectors.

Returning now to a disturbance in the area, the interacting frequencies produce an input signal to IC4 and a voltage rise on C17. When this level exceeds a certain threshold, TR2 is biased on. This results in its emitter voltage rising from 0V, the amount depending on the speed of the moving object. A human being moving at less than 1 m.p.h. caused sufficient output to trigger the alarm control circuits. The output at TR2 emitter is limited to +5 volts by the action of D11.

ALARM CONTROL

The step voltage produced when S1 is closed is differentiated by C18/R17 to produce a positive going spike. This is routed to IC6d whose output is forced low (logic 0) to set the bistable (constructed from IC7c and IC7d) output at pin 6 low. The other bistable output, pin 8, is of course high (logic 1), and this is connected to the reset "0" pins of IC9, a binary counter, to hold it in a no-count condition.

The spike (or pulse) at C18/R17 is also inverted by IC6a wired as a NOT gate (inverter) to produce an instantaneous low pulse to the trigger input of IC5, a 555 timer i.c. arranged in the monostable mode. Its output is inverted by IC7a to reach IC7b pin 12. While this is low, the effect of a high input at the trigger point "X" has no effect. After a time interval determined by the values of R18/C19, IC5 output (pin 3) drops to 0V and stays there. IC7b pin 12 goes high which enables IC7b to be triggered by a high at "X" via IC6b (inverter) and IC6c. Thus a high at "X" resets the bistable; IC7c pin 6 goes high and removes the inhibit condition from IC8 which is a second 555 timer i.c. connected as a low frequency astable multivibrator whose output is linked to the counter input, IC9 pin 14.

At the same time IC9 is put in the count mode by the bistable output IC7d pin 8 going low. The binary outputs of IC9 are forced high on the falling edge of the clock pulse arriving at pin 14. So once the alarm control has been triggered, a delay of almost one cycle of IC8 (high mark: space ratio output pulse) occurs before the binary count of 1 occurs and *A*, pin 12, goes high.

The outputs of all the binary digits up to the count of seven are ORed by D12-D14 and R23. Thus for counts 1 to 7 and up to count 8, a high is fed to the commoned reset pins of IC10 and IC11 (natural frequency about 1·5kHz) to produce a frequency modulated squarewave tone at IC11 pin 3. This is coupled to the emitter follower power stage and heard in the loudspeaker.

When the count of IC9 reaches 8, the *D* output goes high and is fed back to IC6d which forces its output low to reset the bistable. One bistable output forces pin 4 of IC8 low, which resets and inhibits any output, while the other resets IC9 and returns it to a no-count condition. This takes low the discrete OR gate output which resets and inhibits IC10, and IC11 turning off the alarm generator. The unit is once again in an armed state ready to repeat the above operations if "X" again goes high.

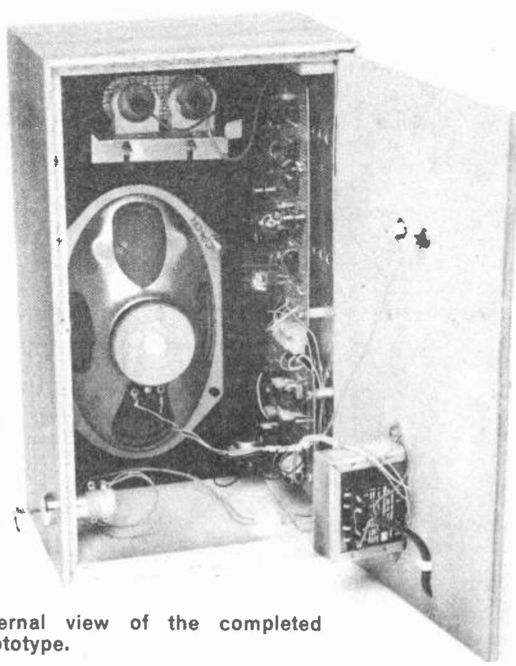
DELAY TIMES

The initial key-operated turn-on delay can be set independently of the second delay and alarm time by choice of R18 and C19 values according to $t_1 = 1{\cdot}1 \times C19 \times R18$ seconds.

The second delay and alarm "on" time are related by the frequency and mark:space ratio of the pulses from IC8. The pulse interval is given by $t_2 = 0{\cdot}7\ (R20 + 2 \times R21) \times C20$ seconds with a mark to space $= \frac{R20+R21}{R21}$.

A longer second delay (shorter alarm on time) may be realised by omitting D12.

When the operator returns to the unit, S1 must be turned off immediately to prevent the alarm sounding. Also, the mains supply should be disconnected by wall switch or plug. When next setting the unit, the mains must be reconnected before S1 is switched on.



Internal view of the completed prototype.

CONSTRUCTION starts here

CIRCUIT BOARDS

For convenience of handling, testing and versatility, the circuitry has been assembled on two circuit boards. There is no reason why a larger single board layout could not be employed.

Board *A* accommodates the power supply stage (with the exception of the +5V rail) the transmitter, and modulated tone generator with power output stage.

Begin construction with this board. The layout of the components on the topside of the board and the necessary breaks on the underside of the stripboard are shown in Fig. 3. Make these breaks followed by the three board fixing holes and TR3 heatsink fixing hole. Position and solder in place all the i.c. sockets and link wires; 20 s.w.g. tinned copper wire was found suitable. To produce taut straight links, solder in one end first and then pull the other end through its location hole using a pair of pliers so that the wire is slightly stretched, and then solder this end.

ASSEMBLY

Secure and solder the Veropins and then assemble the resistors, capacitors and semiconductors in this order. Capacitor C1 should be left until last to allow easier assembly of the other components. With TR3 secured to its heatsink (no insulation bushes or mica washer required in specified location) TR3 can be wired to the board. Attach the short lengths of flying leads to reach the terminal block, and secure in position.

The two speaker wires and screened cable terminated in a phono plug are required next. The signal wire (inner) must be connected to the phono centre terminal. Set VR1 to its midway position.

In the prototype unit, the internal height of the speaker cabinet was 30cm and the boards were bolted to the same length of aluminium which forms the chassis. The width of this is equal to the depth of the cabinet. Fix board *A* to the chassis. Threaded spacers were used for this to keep the board well clear of the chassis and prevents the possibility of shorting. Alternatively, a couple of nuts could be used for spacing. Do not insert the i.c.s at this stage.

RECEIVER AND LOGIC BOARD

Board *B* holds the receiver section and alarm control logic. The layout of the components on the topside of the board is seen in Fig. 4 together with the breaks to be made on the underside. Make these breaks and then drill the three fixing holes.

All of the i.c.s on this board are held in d.i.l. sockets. The two sections are completely separated on the board to allow two-stage construction and testing.

Begin by fixing the sockets (these act as reference points for other components) and solder in the link wires. Where long links run close to each other, sleeving is recommended on one link. Assemble the components in the same order as before leaving TR2 and its heatsink until last. As long as this heatsink is not allowed to come in contact with any other component, insulating washer and bush are not necessary.

Attach short lengths of flying leads to reach the screw terminal block *A*,

COMPONENTS

Resistors

R1	150Ω	R11	1MΩ	R20	10kΩ
R2	680Ω ½W	R12	1·2kΩ	R21	1MΩ
R3	1·8kΩ	R13	22kΩ	R22	150Ω
R4	1·8kΩ	R14	1·8kΩ	R23	150Ω
R5	1MΩ	R15	5·6kΩ	R24	330kΩ
R6	1MΩ	R16	150Ω	R25	330kΩ
R7	1MΩ	R17	150Ω	R26	2·2kΩ
R8	680Ω	R18	330kΩ	R27	1kΩ
R9	68kΩ	R19	1kΩ	R28	47kΩ
R10	1MΩ			R29	470Ω

All ¼W carbon ± 5% except where stated otherwise

Potentiometers

VR1,2 1kΩ multiturn preset (2 off)
VR3 220kΩ vertical skeleton preset

Capacitors

C1	2200µF 25V elect.	C12	0·022µF ceramic or plastic
C2	0·1µF ceramic or plastic	C13	0·1µF ceramic or plastic
C3	0·1µF ceramic or plastic	C14	10µF 16V elect. radial
C4	0·1µF ceramic or plastic	C15	10µF 16V elect. radial
C5	7500pF ceramic or polystyrene	C16	10µF 16V elect. radial
C6	0·01µF ceramic or plastic	C17	10µF 16V elect.
C7	0·1µF ceramic or plastic	C18	0·1µF ceramic
C8	0·022µF ceramic or plastic	C19	22µF 6V elect. tantalum
C9	10pF ceramic or polystyrene	C20	10µF 6V elect. radial
C10	100pF polystyrene	C21	0·47µF 6V tantalum
C11	100pF polystyrene	C22	0·022µF ceramic or plastic

Semiconductors

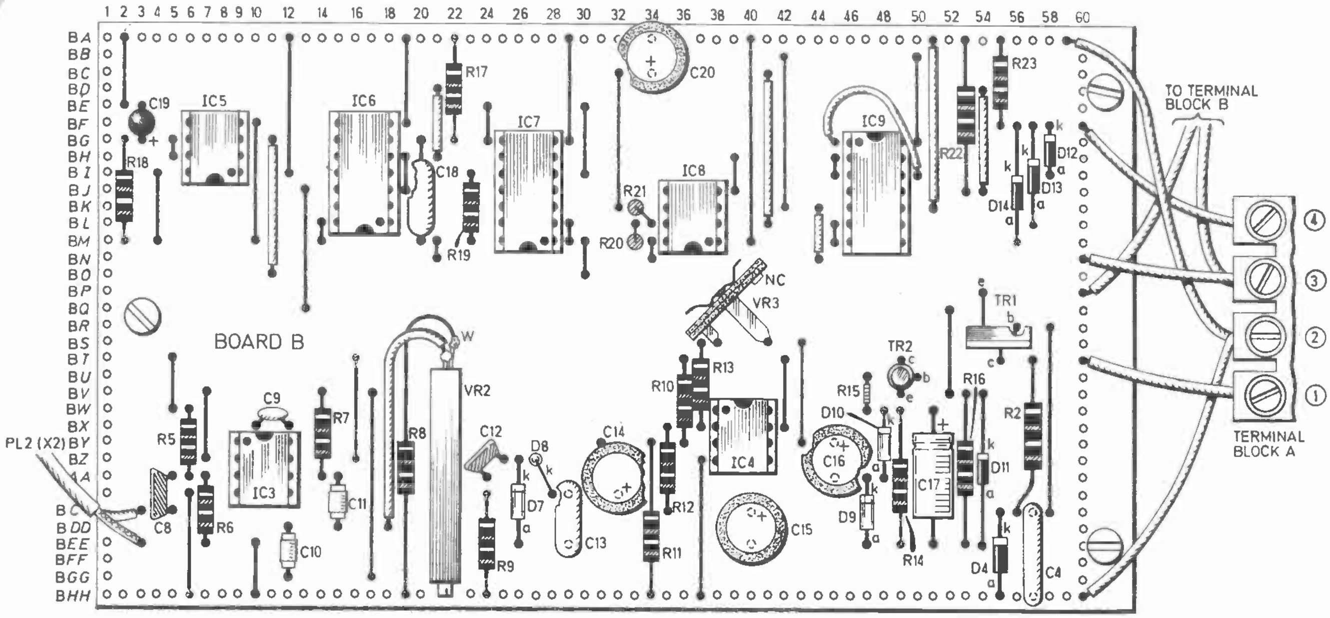
D1,2, 1N4001 50V 1A silicon (2 off)
D3 BZY88C15 400mW 15V Zener diode
D4 BZY88C5V6 400mW 5·6V Zener diode
D5,6 1N4148 (2 off) small signal silicon
D7-10 OA81 or OA91 germanium diode (4 off)
D11 BZY88C5V1 400mW 5·1V Zener diode
D12-14 1N4148 (3 off)
TR1 TIP31 *npn* silicon
TR2 BC108 *npn* silicon
TR3 2N3055 *npn* silicon
IC1 µA7815 15V 1A voltage regulator i.c. plastic power package
IC2,5,8,10,11 555 timer i.c. (5 off)
IC3 748 operational amplifier i.c. 8-pin d.i.l.
IC4 741 operational amplifier i.c. 8-pin d.i.l.
IC6 7402 TTL Quad 2-input NOR gate
IC7 7400 TTL Quad 2-input NAND gate
IC9 7490 TTL decade binary counter

See **Shop Talk** page 20

Miscellaneous

T1 mains primary/15-0-15V 500mA secondary
S1 double-pole on-off key operated switch
SK1,2 4mm sockets (2 off)
PL1,2 phono plugs (2 off)
LS1 moving coil, 15 ohms, size to suit
X1 EFR-OAB40K4 ultrasonic transmitting transducer
X2 EFR-RAB40K4 ultrasonic receiving transducer
Stripboard, 0·1 inch matrix: 34 strips × 60 holes, 38 strips × 35 holes; threaded spacers and bolts/washers; aluminium for chassis; screened cable; heatsinks for TR1, TR3 and IC1; mains cable; 4-way 2A screw terminal block; Veropins (3 off); BA fixings; aluminium for transducer mounting bracket; plastic pipe clips.

COMPONENTS approximate cost £38 excluding cabinet



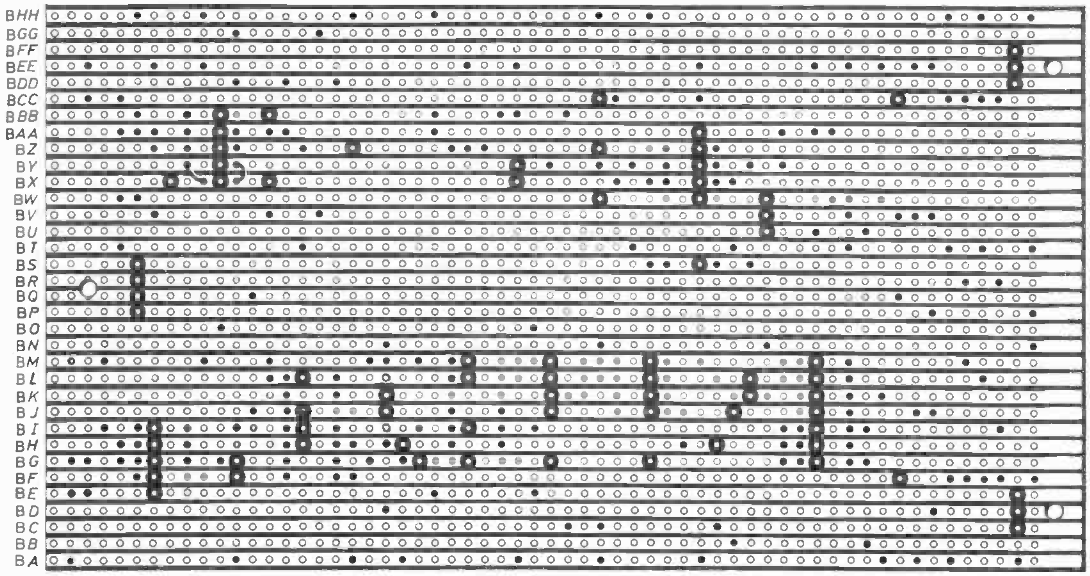
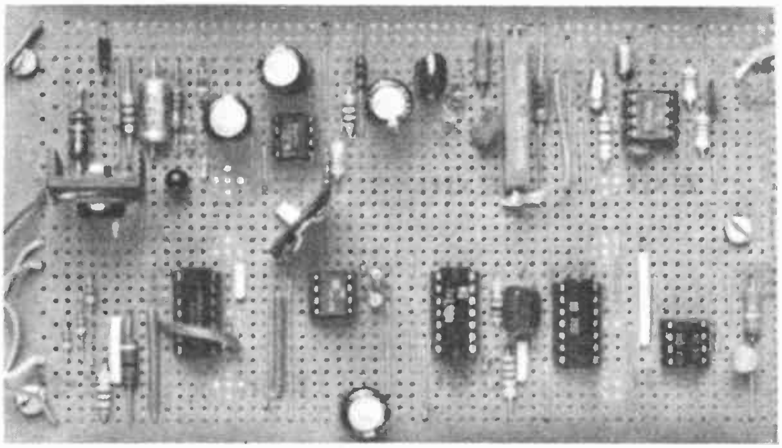
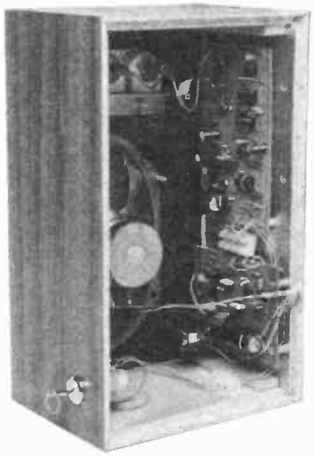


Fig. 4. The layout of the components and the breaks required on board *B*. This contains the receiver, detecting and control logic circuitry. VR2 is glued in position.

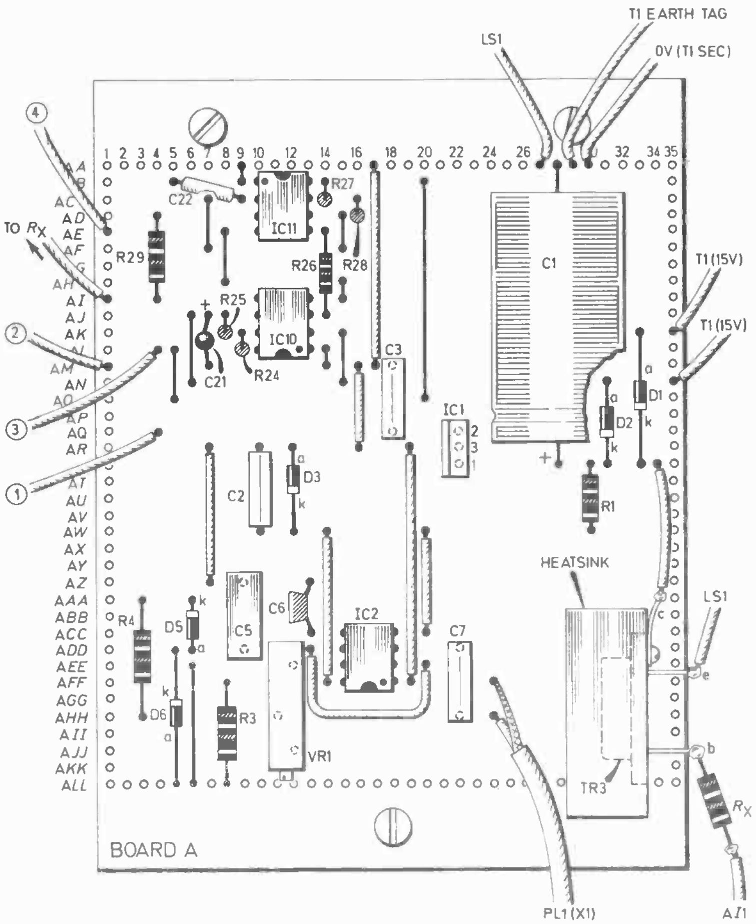


Layout of the components on the completed receiver/detector/control board.



The circuit boards mounted to the vertical aluminium chassis fitted to the side of the enclosure.

ULTRASONIC INTRUDER DETECTOR



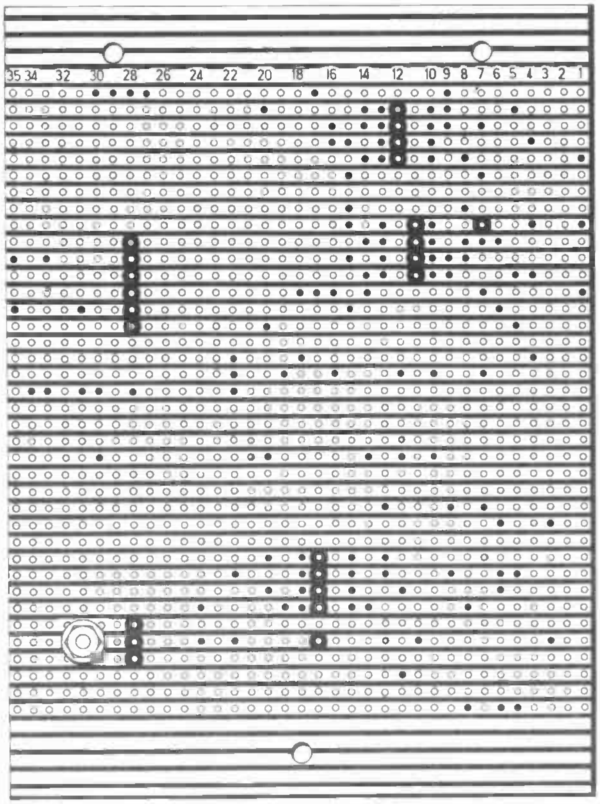
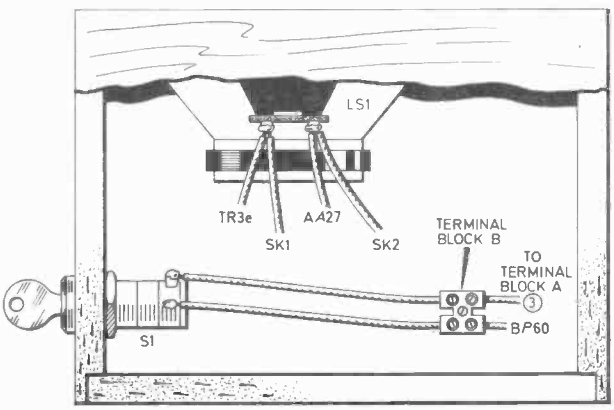


Fig. 3. The layout of the components on board *A* and the breaks (top right) to be made on the underside of the board. This board contains most of the power supplies, the transmitter and alarm circuitry. R_x is added to reduce the loudness of the alarm. If not used connect the wire from A/1 direct to TR3 base. IC1 should be fitted with a heatsink.



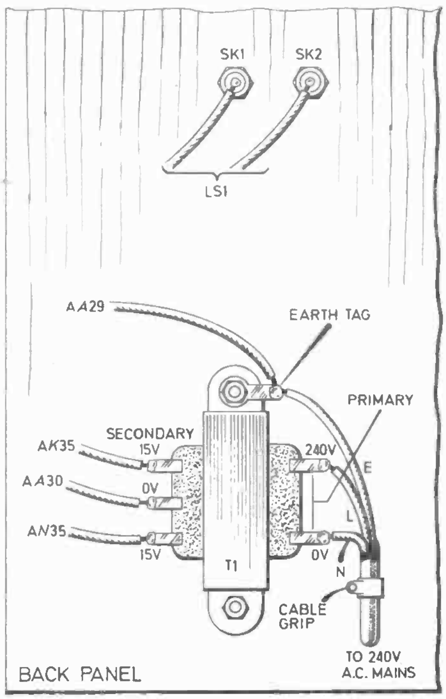
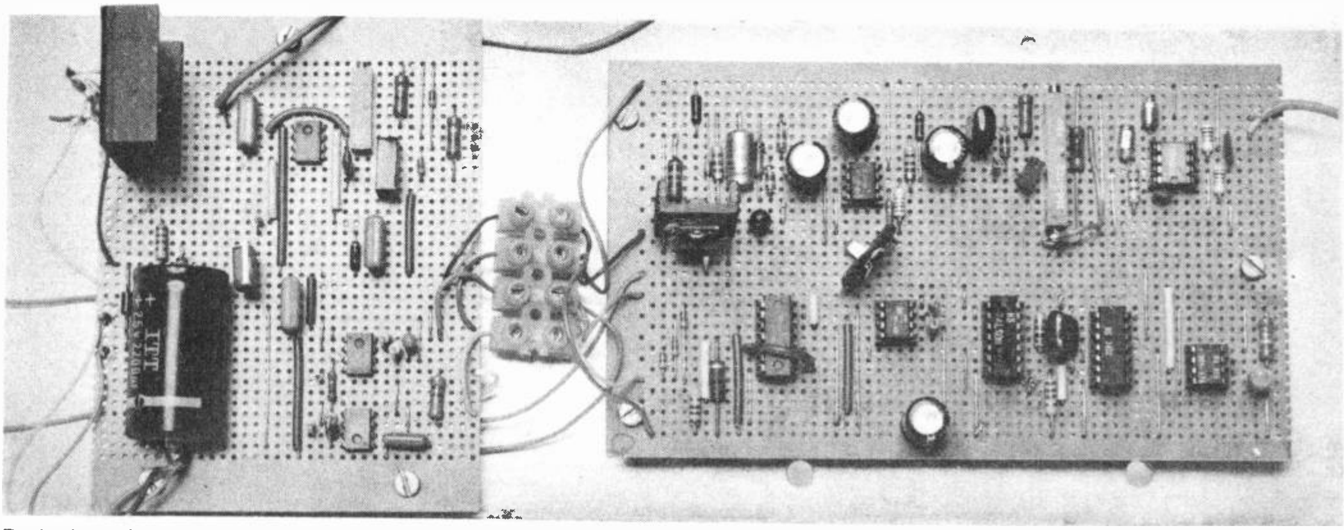


Fig. 5. Above and right, shows wiring of loudspeaker, mains transformer, keyswitch and outlet sockets. Final positions of these components will vary according to enclosure chosen.



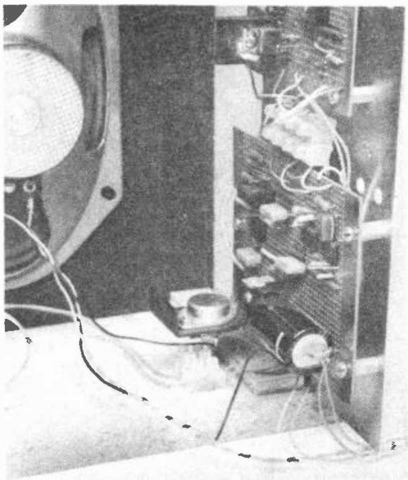
Both circuit boards and interconnecting terminal block fitted in place on the chassis. A smaller assembly can be realised by mounting one board on each side of the chassis.

and one lead long enough to reach terminal block *B* connecting to the key switch. A length of screened cable terminated in a phono plug wired as before completes the wiring on this board. The assembly can now be fitted to the chassis using spacers as with board *A*. Do not connect board *B* to the terminal block just yet. Wire up the keyswitch to terminal block *B* and this to the other terminal block and board *B*, location. *B*P60. Ensure S1 in the off position. Do not insert the i.c.s in their sockets just yet.

TESTING

Ideally an oscilloscope or d.v.m. is required in the setting up although it can be carried out with a high impedance multimeter having an a.c. millivolt range. A power supply would be helpful.

If a power supply unit is available, set this to 20 volts and place this across C1. Alternatively wire the transformer T1 to the board as indicated in Fig. 5.



Before inserting IC2 in its socket check that the transmitter supply, pin 8, and pin 4 are at +15 volts and that the output from IC1, terminal block position 1, is +15 volts. Repeat checks with the transformer connected to board (if not already). Fit IC2 and the transmitter transducer to its plug and tape face to face with the receiver transducer fitted with a spare phono lead. Connect the free end of this lead to a sensitive a.c. voltmeter or 'scope. Adjust VR1 for maximum reading.

RECEIVER

Switch off and connect the lead *B*T60 to terminal block position 1, and the leads from *B*A59 and *B*HH60 to terminal block position 2. Separate the transducers and tape them facing each other about 15cm apart. Check that the voltage at pin 7 on both IC3 and 4 is +15 volts. If so insert these i.c.s. Attach your a.c. voltmeter between IC3 pin 6 and 0 volts. Switch on and adjust VR2 for maximum reading.

Remove the meter +ve probe, set the meter to read d.c. volts and check that the level at D8 cathode (k) is steady until the beam between the transducers is interrupted. Move the +ve probe to C17 +ve plate. The reading here should be near 0 volts. Any movement, e.g. waving hand, should cause the level to rise, the amount depending on the speed of movement and the setting of VR3. Anticlockwise rotation of VR3 should increase sensitivity.

Now move the positive probe to D11 cathode. The reading should be 0 volts until movement sends this to +5 volts maximum. This is point "X" shown on the circuit diagram. These results indicate that the receiver is functioning satisfactorily.

Check that the voltage level at TR1 emitter is +5 volts and that this level appears on the appropriate socket pins for IC5 to IC9 with S1 turned on. If so insert these i.c.s. With S1 in the off position, set the meter to 10 volts d.c. f.s.d., ensure that TR1 emitter is 0 volts which moves to +5 volts when S1 is closed. Turn off S1.

LOGIC AND ALARM

Connect the +ve probe to IC5 pin 3 and switch on at S1. The reading should stay at +5 volts for the time period set by R18/C19 (see earlier). Turn off at S1 and place the +ve probe on D14 cathode Switch on at S1, and after the delay of the previous check, any movement around the transducers will result in the meter reading to change to about 4·5 volts after the second (entry) delay period discussed earlier. It will remain at this level for about 90 seconds (with values specified) and then return to 0 volts. Any movement at or after this time will result in a repeat performance after the entry delay.

While checking it may be required to remove the entry delay. This can be done by temporarily connecting a diode between IC9 pin 14 and R23, thereby extending the discrete OR gate to a 4-input gate.

Switch off at S1 and at the mains and connect the two leads from *B*N60 and *B*F60 to terminal block positions 3 and 4 respectively. Next check the supply voltages on IC10 and IC11 before inserting these i.c.s in their sockets. Connect the loudspeaker, turn on at the mains followed by S1. The alarm should sound for about 90 seconds after the two delays (or the initial delay if the second is by-passed as mentioned earlier) when any movement is made around the transducer.

If all the above results have been obtained, the assembly is ready for fitting in the cabinet. The loudness of the alarm may be decreased by increasing the value of R29. This is easiest carried out by connecting a resistor in the lead to TR3 base. This is in fact shown in Fig. 3 and labelled R_x.

CABINET AND ASSEMBLY

The cabinet used by the author was a small speaker enclosure with modified baffle board, but this is by no means essential. The speaker in the prototype is larger than necessary and was used because it was at hand. Smaller types, e.g. 3-inch diameter, are suitable.

It may be preferred not to have an integral alarm. This allows a much smaller unit to be constructed. Some ideas for "disguise" without integral speakers are: (1) a hi fi amplifier case with the transducers made to look like control knobs and sited among other similar knobs; (2) made to resemble one or more books and reside in a bookcase or (3) use a pair of loudspeaker cabinets, one containing the electronics, the other the speaker.

Numerous other housing arrangements will no doubt be designed by constructors to suit their own particular requirements and taste.

The external speaker sockets are connected in parallel with the primary speaker and the remote unit should have an impedance of 15 ohms for equal alarm volume.

TRANSDUCER APERATURE

In the prototype, a rectangular aperature was cut in the baffle board to accomodate the transducer pair. These are mounted in plastic pipe clips fitted to an L-shaped bracket located immediately beneath the aperature. This arrangement allows the transducers to be rotated in a horizontal plane.

Short lengths of wood are glued to the top and bottom inside faces of the cabinet to form runners for the chassis which then requires no further fixing. For security reasons, S1 is a key-operated switch to be fitted in the most convenient position for the user and the location of the unit.

Fit and wire up the transducer assembly. The mains transformer is bolted on the enclosure rear panel with the mains cable fed through an adjacent hole drilled in the panel. An internal or panel mounted fuse may be inserted in the live wire if not fitted in the plug. A terminal block may be required to connect mains to T1 depending on the transformer connections.

FINAL ASSEMBLY POINTS

The position of the remote alarm take-out point and key switch will be decided by the final position and mounting of unit. Probably the best place for all "exit wires" is on the rear panel (where they will not be visible) with the cabinet mounted on a wall and hinged on one vertical edge. This will allow it to be swung and provide access to the rear panel.

For final setting up purposes it would be useful to override the entry delay. This can be done by connecting another diode (1N4148), cathode to location BF59 and taking a lead from its anode, and a second lead from BB59 (IC9 pin 14) to a two-pin connector (e.g. miniature jack socket) mounted on the front panel. Inserting a shorted connector (jack plug with wire link across its terminals) will complete the circuit and remove the entry delay.

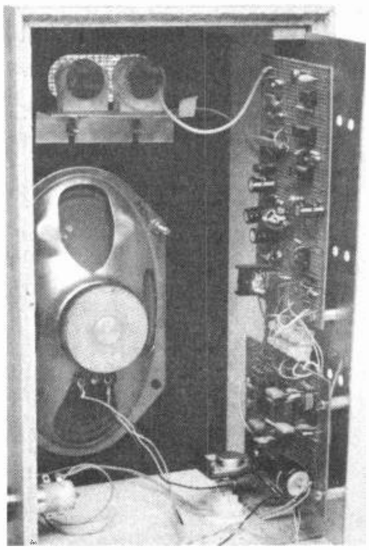
SETTING UP

It is recommended that for maximum coverage the unit be mounted above the floor in the area to be guarded. The exact placing of the unit within the house will vary according to the layout of the rooms and their use. It is summised that open-plan dwellings will be afforded more protection from a single unit. The room with the most doors into it (this could be the hall) may be the best place to site the unit, on the assumption that an intruder is unlikely to confine his search to one room and will have to pass through the guarded area to reach other rooms.

Immediate partial protection will be given to rooms adjacent to that containing the unit if adjoining doors are left open.

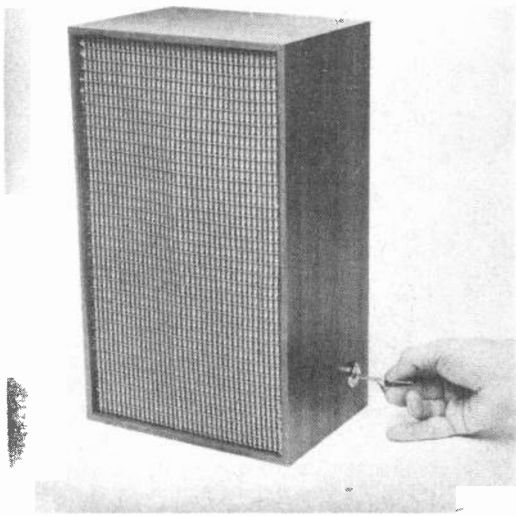
Having arrived at the optimum position, the unit and its transducers should be orientated in conjunction with the setting of VR3 to give maximum coverage without being oversensitive. This is determined by switching on and standing at strategic places within the room(s) and making some form of movement. Also any doors and windows may be opened from "outside" adjusting the set-up for the required sensitivity. This is more easily accomplished with the entry delay overridden as discussed above using the linked plug. When satisfied the linked plug should be removed and the speaker facia replaced. Finally, for obvious reasons the mains cable and remote alarm wires should be concealed.

In use, the unit is first switched on at the mains and then by the key switch. You then have a short time in which to leave the room without triggering the alarm. When returning, a further delay occurs before the alarm sounds enabling you to turn off the unit before this happens. ⌘



Mounting of the transducers and chassis arrangement.

Cut-outs required in the baffle board for loudspeaker and transducers.



The completed unit disguised as a conventional loudspeaker cabinet.

By Dave Barrington

Using the time of year as an excuse we should like to suggest some more unusual items that would make possible gifts.

Translator

Why not let the lady of the house converse with the holiday waiter or the new found "foreign guest" with an electronic translator?

Similar in size to a pocket calculator, the Sharp IQ 310 translates English, German, French, Spanish and Japanese with Italian and Portugese expected soon.

English is preprogrammed in to the translator with other languages added from plug-in modules. It holds two modules at any one time so three languages can be translated simultaneously. Each module is claimed to contain 152 sentences and between 1,800 and 2,000 words.

A feature of the machine is its search function which, it is claimed, will find appropriate sentences instantly from 14 categories, indicated by easily recognisable keyboard symbols, such as aeroplane for transportation and knife and fork for dining phrases. Using this function will, it is claimed, fulfil most general conversation needs.

The Sharp IQ310 translator is expected to retail for just under £100 and each language module less than £20 each. Sharp Electronics (UK) Ltd., Dept EE, Thorp Road, Manchester, M10 9BE. **Phone 061.205 2333.**

Computer Chess

If you're looking for something exotic for the man of the house, then why not the latest Voice Sensory Chess Challenger.

The Voice Sensory Chess Challenger does away with the keyboard and display window type move-programming. Instead it has a touch sensitive playing surface on the chess board, with l.e.d.s on each square which illuminates to show to and from positions.

It has nine levels of play and is claimed to respond faster and "think" more comprehensively than any of its predecessors, while chatting with its opponent. It speaks all its own moves as well as the opponents, relates the positions of all the pieces on demand and calls out every capture.

It has a repertoire of 64 book openings, each of varying difficulty and averages 15 moves in the game. It also allows the player to participate in any one of 64 world classic games, giving points for a correct move and flashing lights for a wrong one.

The Voice Sensory Chess Challenger carries a recommended price tag of £279·95. An optional extra is a hard copy printer for studying moves at a later date.

For local stockists contact Computer Games Ltd., 214/221 Maybank Road, South Woodford, London, E18 1EX. **Phone 01.504 2255.**

Musical Calculator

For the young and most important members of the household, we have chosen the Casio MG-880 calculator with a game and music function.

It is an eight-digit calculator with the usual four basic calculations, three memory functions and a percentage facility. When switched to the music function the machine becomes an 11-note melody maker. The calculator keyboard doubling as the note keys.

The game facility is a version of the well established "Space Invaders" and the object of the game is to shoot down as many incoming invaders as possible as they travel across the display. This is accomplished by pressing a "fire" button when the same digit appears on both sides of the display. With each new encounter the speed of the invader increases necessitating rapid firing.

If that doesn't help to keep the children amused for hours and you find they have a musical "bent", then there is always one of the new Casio microchip electronic keyboard instruments.

The Casiotone M-10 is a polyphonic instrument with piano, organ, violin and flute voicing and spans 2½ octaves.

Both the MG-880 Calculator and the M-10 instrument are available from Tempus, Dept EE, 164-167 East Road, Cambridge, CB1 1DB. **Phone: 0223 312866.**

Finally, one of the new beginners constructional hampers from Home Radio, **Phone: 01.543 5659,** would be most useful. This pack, price £14 plus VAT, contains over 60 assorted components that the constructor is likely to need when building a project.

This hamper does not include semiconductor devices, but semiconductor packs can be obtained from Bi-Pak Semiconductors. **Phone: 0920 3182.**

CONSTRUCTIONAL PROJECTS

Returning now to the more pressing problems of component buying, there are one or two small items that could cause concern.

Phaser Sound Effects

The LF351 f.e.t. input op-amps called for in the *Phaser Sound Effect* may cause readers some problems, these are available from Maplin, Magenta and Marshalls. The CMOS timer i.c., type ICM7555 is listed by Magenta and Watford Electronics.

The photocell type RPY58A should be available from most advertisers, but is certainly available from Maplin.

Aquarium Lamp Protector

The only component in the *Aquarium Lamp Protector* that is likely to be in short supply is the thermistor VA1026. This is available from Electrovalue although the RS equivalent may be supplied.

Automatic Slide Changer

The ICM7555 device used in the *Automatic Slide Changer* is available from Watford and Magenta Electronics.

Ultrasonic Intruder Detector

The 40kH ultrasonic transmitter/receiver transducers used in the *Ultrasonic Intruder Detector* are available from Watford, Maplin and Arrow Electronics. The transducers may be supplied with two-pin or phono plug connections. Either device is suitable: it will only necessitate changing the fixing arrangement to suit.

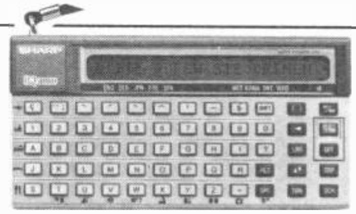
Ice Alarm

This month's *Uniboard* project is an *Ice Alarm* and there are some components that, although not "specials", may be difficult to locate.

The Darlington transistor type MPSA65 is available from Maplin and the MPSA66, available from the same source, can also be used in the circuit. We notice that Electrovalue list a MPSA63 and it is quite possible that this could be used, although we have not tried this device.

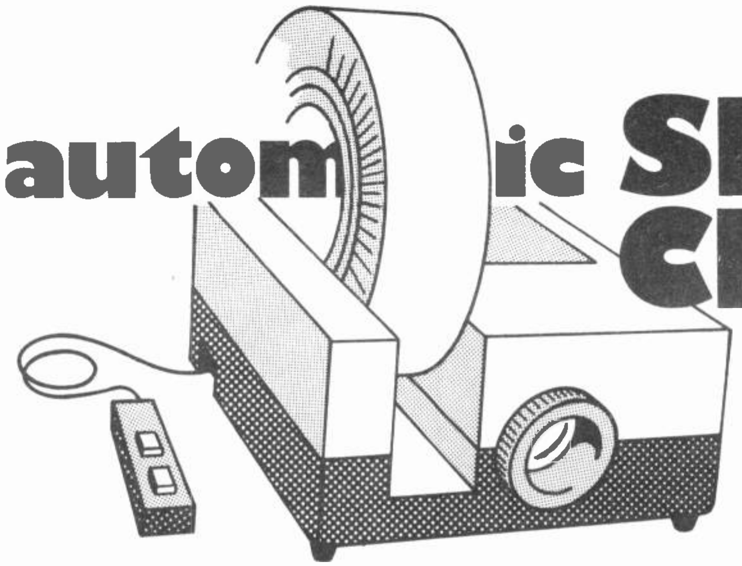
The indicator lamp, type MR, would appear to be only available from Electrovalue. If an l.e.s. bulbholder is used it is better to use a 6V 0·06A bulb with a 100ohm resistor, to prevent overheating. A 12V 1W bulb is likely to generate too much heat.

Computer Games Voice Sensory Chess Challenger



The Sharp IQ3100 translator.

Casio MG-880 calculator from Tempus.
Beginners Hamper from Home Radio.



automatic SLIDE CHANGER

by R.A.PENFOLD

SOME of the more sophisticated slide projectors have an integral timer unit that can be used to automatically change slides every few seconds, the interval between slide changes usually being variable from about five seconds to half a minute.

This useful facility can be added to automatic projectors which do not have a built-in timer, provided the projector has a remote control socket to which an external timer can be connected (or a suitable socket can be added to the unit). The subject of this article is a very simple and inexpensive add-on unit to provide automatic slide changing.

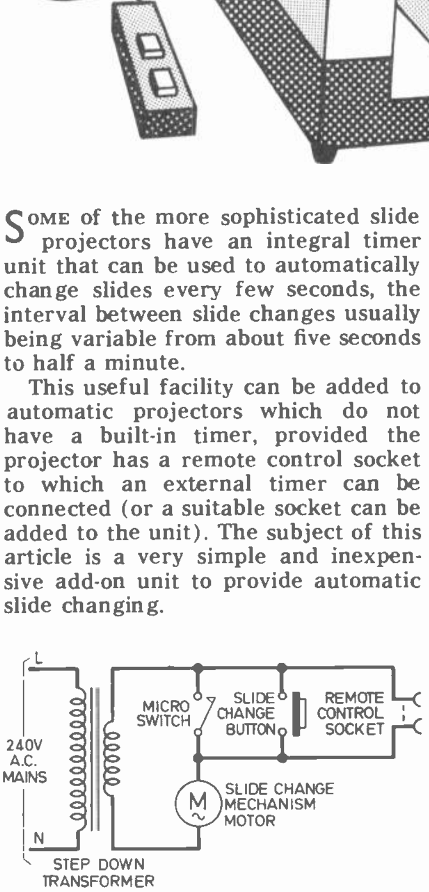


Fig. 1. Basic slide changing circuit of an automatic projector.

SLIDE CHANGING

Slide changing in automatic projectors is normally by means of a mechanism which is driven by a small electric motor, and the basic electrical arrangement is shown in Fig. 1. The motor is switched on if the slide change button is depressed, or if a switch connected across the remote control socket is closed.

The microswitch is part of the slide change mechanism, and is closed almost as soon as the motor starts to operate. It then provides the supply to the motor when the push button is released, and it maintains the supply until the slide change has been completed, whereupon it automatically opens and switches off the motor.

The Automatic Slide Changer briefly closes a pair of contacts (connected across the remote control socket) at regular intervals and therefore simulates manual operation of the remote slide change button.

THE CIRCUIT

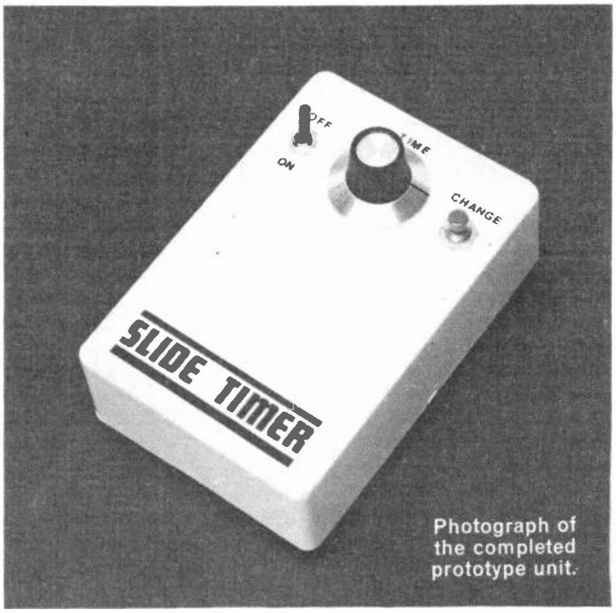
Fig. 2 shows the complete circuit diagram of the Automatic Slide Changer. The circuit is based on an ICM7555 i.c., and this is a CMOS version of the popular 555 timer i.c. The CMOS version has the advantage of a far lower current consumption than the standard bipolar device, the typical current consumption of about 80μA actually being about one hundred times less than the standard 555. This gives very low running costs in a battery powered circuit such as the one described here.

IC1 is used in the standard 555 type astable (oscillator) circuit. The circuit oscillates by timing capacitor C2 charging up to two - thirds the positive supply voltage by way of timing resistances, VR1, R1, and R2. When this charge level is reached, it is sensed by a voltage detector circuit within IC1 which has its input at pin 6 and an internal transistor connected from pin 7 to the negative supply rail is then switched on. C2 then discharges through R2 and the internal transistor until its charge equals one-third the positive supply rail.

This charge level is sensed by an internal voltage detector of IC1 which has its input at pin 2 of the device. This second voltage sensor returns the circuit to its original state, and C2 charges up once again and the above process repeats. Thus the circuit oscillates indefinitely with C2 being first charged and then discharged.

OUTPUT PULSES

The main ouput of IC1 is at its pin 3 terminal, and this assumes the high state while C2 is being charged, and the low state while it is discharging. Since C2 charges through the combined resistance of VR1, R1, and R2, but only discharges through the relatively low resistance of R2, the output at pin 3 only goes into the low state for comparatively short periods.



Photograph of the completed prototype unit.

AUTOMATIC
SLIDE CHANGER

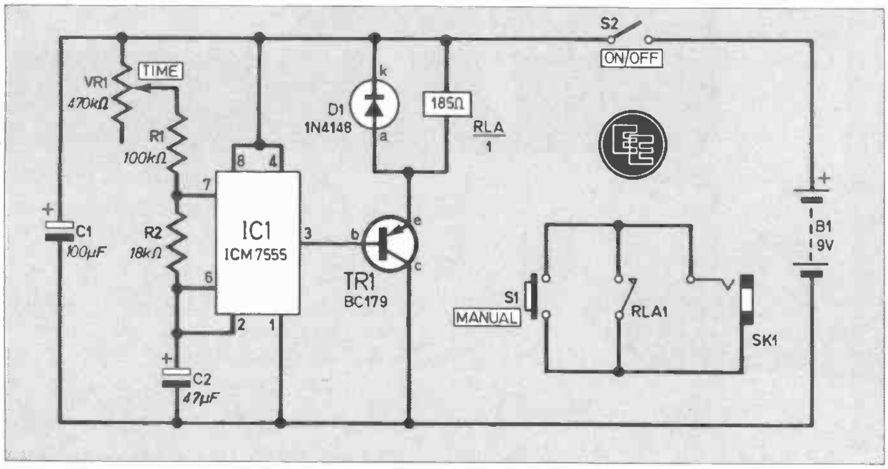
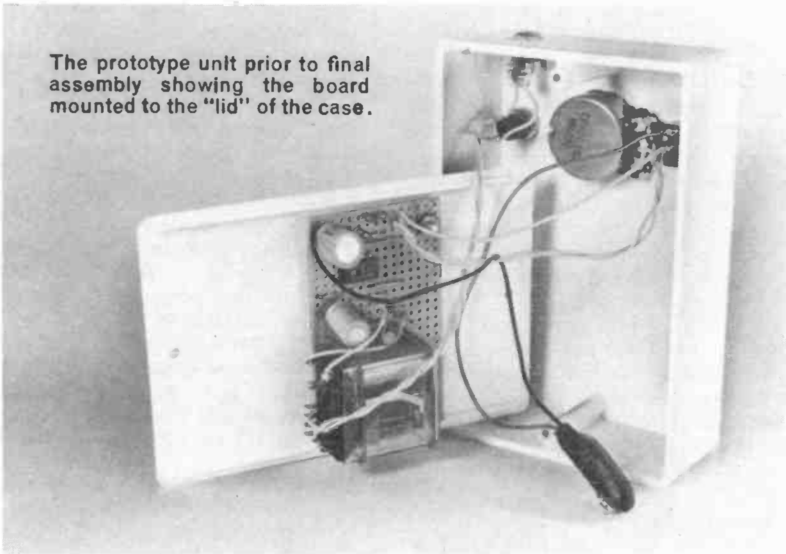


Fig. 2. The complete circuit diagram of the Automatic Slide Changer. Capacitor C2 should be a low leakage type for consistent results.



The prototype unit prior to final assembly showing the board mounted to the "lid" of the case.

COMPONENTS

See **Shop Talk** page 20

Resistors
R1 100kΩ
R2 18kΩ
Both ¼W carbon ± 5%

Capacitors
C1 100µF elect. radial leads
C2 47µF 10V elect. radial leads, see text

Semiconductors
IC1 ICM7555 CMOS timer i.c.
TR1 BC179 *pnp* silicon
D1 1N4148 small signal silicon

Miscellaneous
VR1 470kΩ carbon lin. potentiometer
S1 push-to-make, release-to-break push button type
S2 s.p.s.t. miniature toggle type
B1 9V battery type PP3
RLA miniature 12 volt relay, 185 ohms minimum coil resistance with at least one set of normally open contacts
SK1 3·5mm jack socket
Stripboard: 0·1 inch matrix size 15 strips × 26 holes; PP3 battery connector; plastic case approximately 114 × 76 × 38mm (e.g. type PB1); control knob; case feet (4 off).

COMPONENTS approximate cost £8·50 excluding case

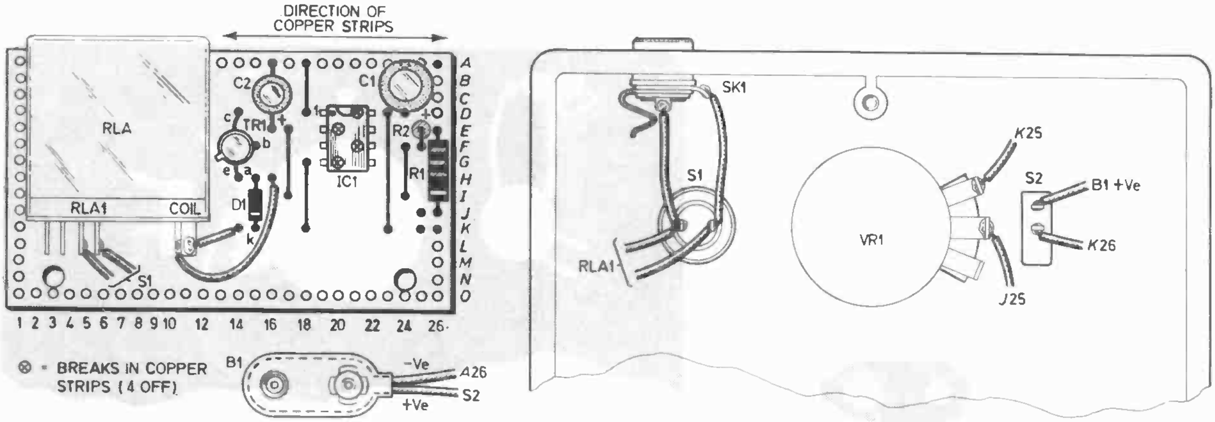


Fig. 3. The layout of the components on the topside of the stripboard. Note there are four breaks to be made on the underside indicated by the key. Also shows complete wiring between board and case mounted components.

A relay coil is driven from the output of IC1 via an emitter follower buffer stage, TR1. When IC1 output is high, the voltage across the relay coil is virtually zero and it is not energised. During the brief period when IC1 output goes low, virtually the full supply potential is supplied to the relay coil, and it is activated. A normally open relay contact, RLA1, is then closed, and operates the projector.

VARIABLE INTERVAL

The values of R2 and C2 set the "on" time of the relay at about 0·6 seconds, which is long enough to ensure that the slide change mechanism latches properly, but is not so long as to cause a double operation of the mechanism.

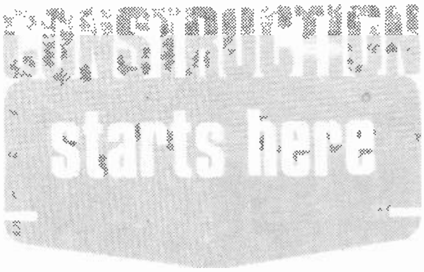
The time between slide changes can be varied by means of VR1 from (theoretically) about 4·5 seconds to a little over 20 seconds. However, due to the imperfections of electrolytic capacitors (such as timing capacitor C2), in practice the maximum interval is likely to be somewhat higher than 20 seconds. Of course, the exact timing range obtained is not critical in this particular application.

Note that C2 must be a good quality component, and ideally a tantalum bead component should be used here, although most ordinary electrolytics should be satisfactory.

Push button switch S1 enables the unit to be used as a simple remote control unit when the unit is switched off (using on/off switch S2). This switch is also useful when initially viewing slides as it can be used to immediately move on to the next slide if a completely failed slide appears.

Diode D1 is used to protect the semiconductor devices in the unit against the high reverse voltage pulse which would otherwise be generated across the relay coil as it de-energised. D1 limits this spike to a peak amplitude of about 0·65 volts, and thus prevents any damage from occurring.

The current consumption of the unit is about 100μA when the relay is switched off, and approximately 35mA when it is switched on, giving an average current consumption of only about 2mA.



CIRCUIT BOARD

Most of the components are mounted on a piece of 0·1 inch matrix stripboard having 15 strips by 26 holes, the layout of which is shown in Fig. 3 which also shows the wiring to the switches, battery clip, VR1, and the relay. The mounting holes in the prototype board are 3·5mm in diameter and take M3 or 6BA bolts. There are just four breaks in the copper strips, and these can either be made using the special tool or a small hand-held drill bit. It is advisable to use a modern miniature cased relay and this can then be mounted on the component panel. It can either be held in place using two tight wire tethers soldered to the board, or it can simply be glued in place.

CASE

The case used for the prototype was a small plastic box having outside dimensions of 114 x 76 x 38mm, although any similar case could be used. However, it should not be significantly smaller as there would probably be insufficient space for all the components.

VR1 and the two switches are mounted at one end of the top panel of the case, as can be seen by referring to the photographs. The component panel is mounted on the base panel of the case, in a roughly central position, so as to leave sufficient space for the PP3 size battery at the opposite end of the case to the controls.

On the prototype the output of the unit is taken to a 3·5mm jack socket, SK1, mounted at one end of the case. The timer is then connected to the projector via a twin cable fitted with a 3·5mm jack plug at the end which connects to the timer, and a plug of the appropriate type at the end which connects to the projector.

The author's projector is a Hanimex Rondette 1500A to which a 3·5mm remote control socket was added, but most automatic projectors already have a suitable socket.

You should only add a remote control socket to a projector if you are perfectly sure that the slide change mechanism is powered via a step-down and isolation transformer, and is not a type where the mechanism is powered direct from the mains. Adding a remote control socket to a direct powered type would be dangerous.

When the unit has been completed, check the wiring before fitting the case together and trying the unit out.

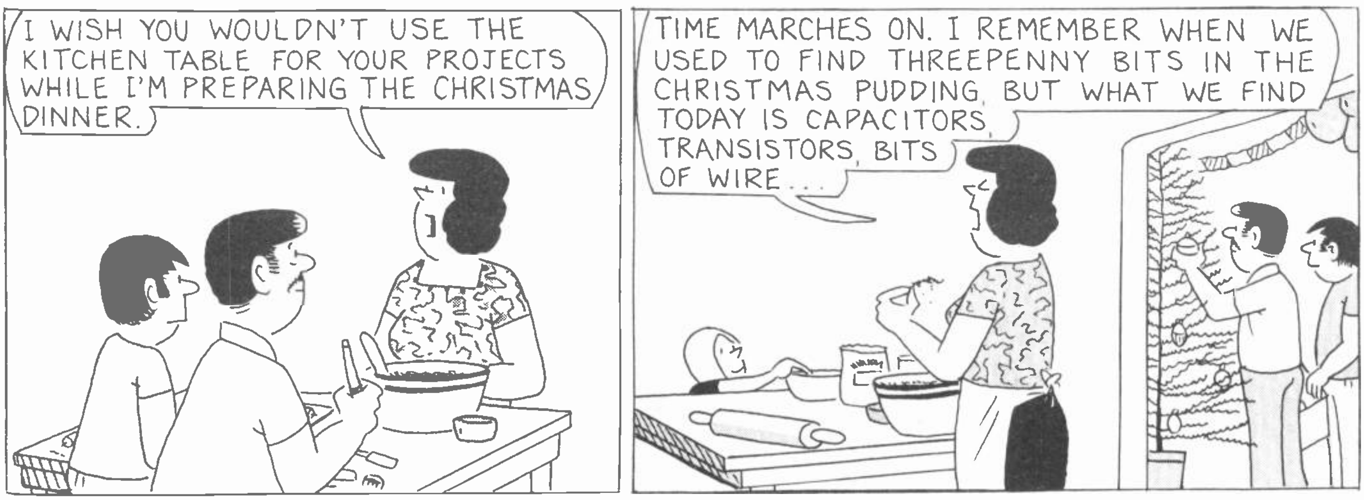
Initially test the unit with VR1 set for the minimum interval between slide changes (set fully anticlockwise). If all is well, adjust VR1 for a much longer interval, and check that the unit still functions correctly.

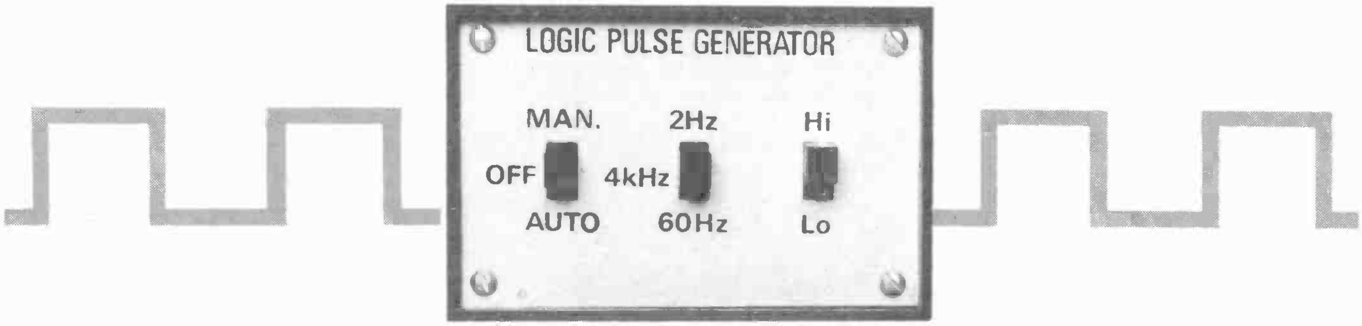
If the maximum interval is much more than about 30 seconds, or the unit does not operate at all at higher settings, C2 is of inadequate quality and should be replaced with a lower leakage type.

Rubber feet fitted to the case underside will enhance the appearance of the unit and afford protection to its mounting surface. ⌑

JACK PLUG & FAMILY...

BY DOUG BAKER





LOGIC PULSE GENERATOR

F.G.RAYER

THIS TESTER helps locate faults in binary display equipment, whether fitted with Nixie or seven segment displays, in binary dividers used in earlier non-display sections, and in harmonic frequency markers and similar apparatus. The pulser has automatic output rates of approximately 2Hz, 60Hz and 4kHz, and a non-bounce manual high-low optional output.

The 2Hz rate is useful for operation of a binary input i.c. which is connected to the decoder-driver and numerical display actually to be observed, or where input is required to a divider in turn driving this i.c.

Operation is slow enough for all numerals to be observed. Where one is absent, or imperfect, the equipment can be set to this state manually, and meter tests will then show if the divider binary outputs are correct, the decoder-driver inputs are correct, or the decoder-drive outputs are correct, or the numeral inputs correct.

The fault is thus localised to one i.c., the numeral, or connections between two of these items.

HIGHER RATES

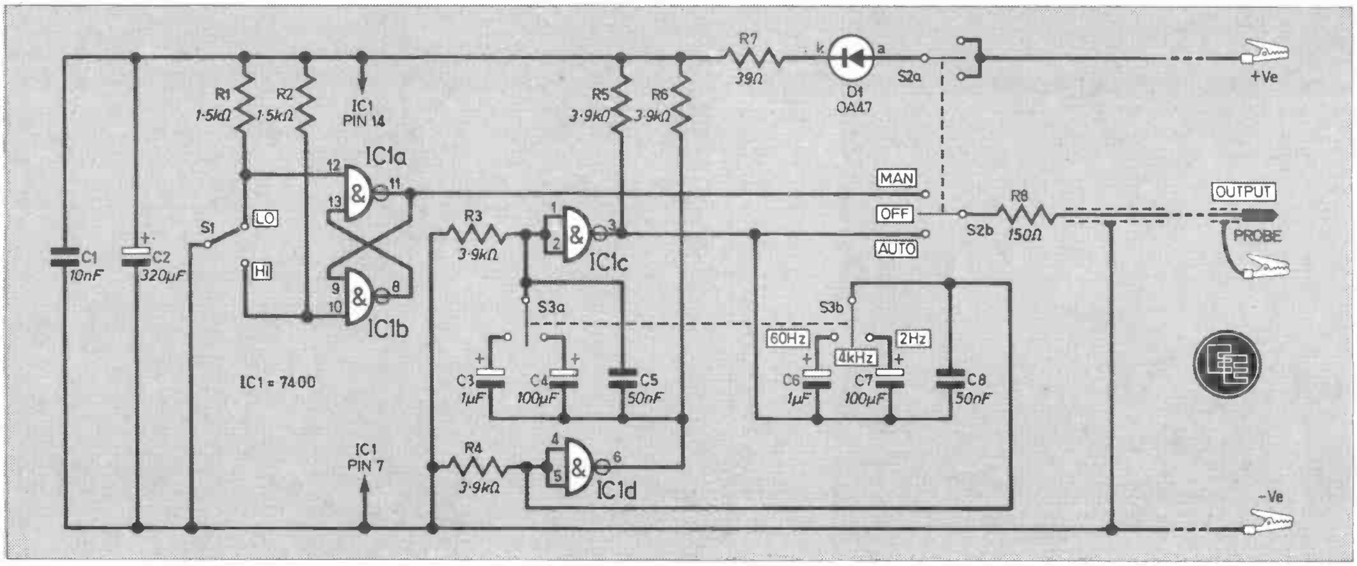
The higher automatic rates are useful for providing input for earlier dividers, from where large division factors will often exist before any display is obtained. Also for the quick run through of displays of several figures, since units, tens, hundreds, thousands and higher numbers can be checked progressively in a relatively short time, by using 2Hz for the first check of units, 60Hz for tens and hundreds, and the 4kHz rate (units, tens and hundreds being too rapid to observe) for thousands, thus checking a newly made or serviced counter section with input at units only.

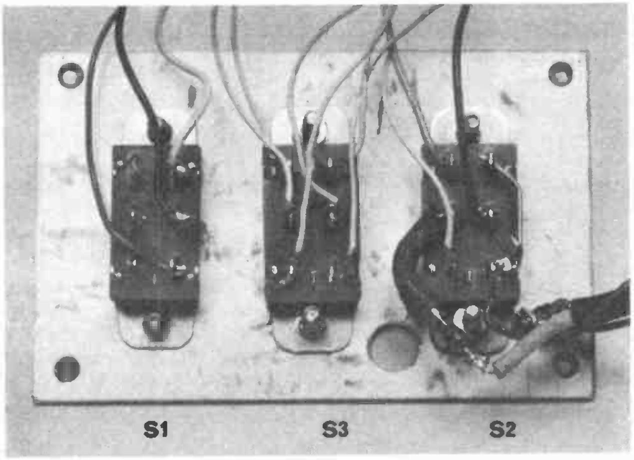
There is also provision to apply a single pulse to the equipment under test and also hold the unit output at logic one or logic zero so that detailed examination of the sequence of operations in the counter can be checked.

SINGLE I.C.

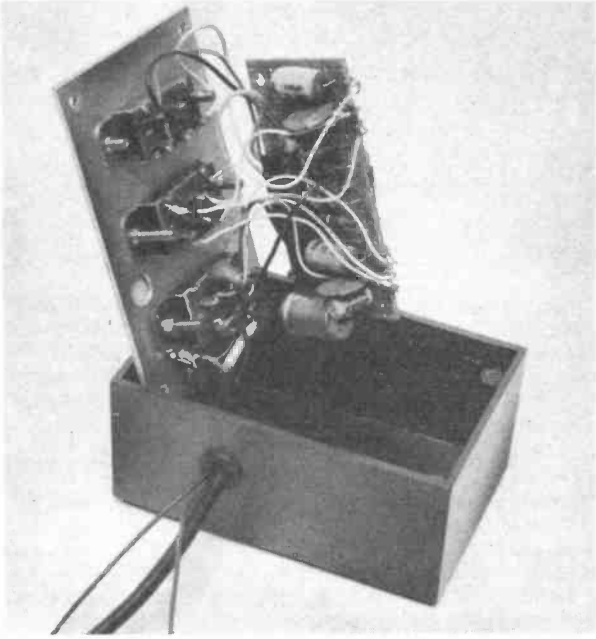
The full circuit of the Logic Pulse Generator is shown in Fig. 1. The complete circuit is based on a single 7400 TTL logic i.c. Manual operation is provided by S1. If a mechanical switch is used to provide an input to a counter, multiple contacts during closure generally result in more than a single count.

Fig. 1. Full circuit diagram of the Logic Pulse Generator.





Positioning and wiring of the slider switches. Note also the common earth connection attached to the fixing screw of S2.



View inside the completed unit showing wiring between circuit board and switches.

COMPONENTS

See **Shop Talk** page 20

Resistors

R1	1·5kΩ
R2	1·5kΩ
R3	3·9kΩ
R4	3·9kΩ
R5	3·9kΩ
R6	3·9kΩ
R7	39Ω
R8	150Ω

All ¼W carbon ± 5%

Capacitors

C1	10nF disc ceramic
C2	320μF 6V elect.
C3	1μF 6V elect.
C4	100μF 6V elect.
C5	50nF disc ceramic
C6	1μF 6V elect.
C7	100μF 6V elect.
C8	50nF disc ceramic

Semiconductors

IC1	7400 TTL quad two-input NAND gate
D1	OA47 germanium signal diode

Miscellaneous

S1 s.p.d.t. slider switch
S2, S3 d.p.d.t. slider switch with centre-off position (2 off).
Piece of perforated s.r.b.p. board, 0·1 inch matrix, size 24 by 14 holes; case, 85 × 60 × 30 mm, Bimbox BIM4003 or similar; crocodile clips (3 off); test probe; length screened cable; two lengths flexible stranded wire, one red, one black; light interconnecting wire.

COMPONENTS approximate cost £5·50

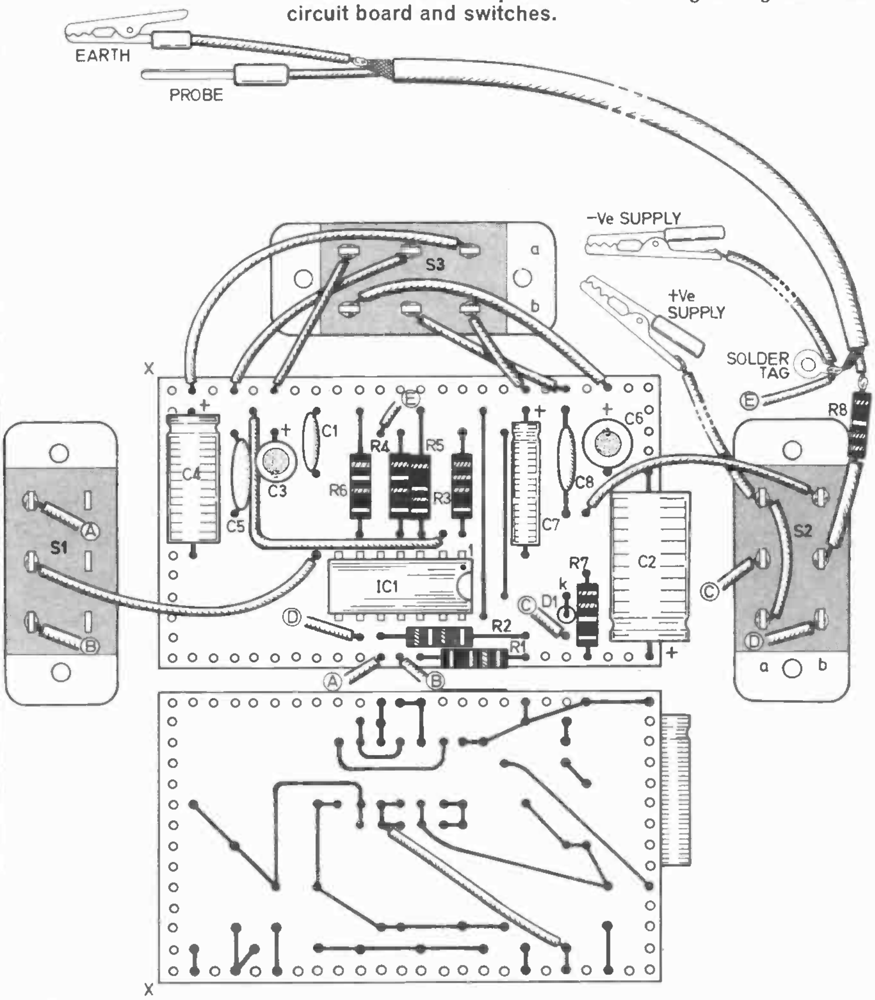
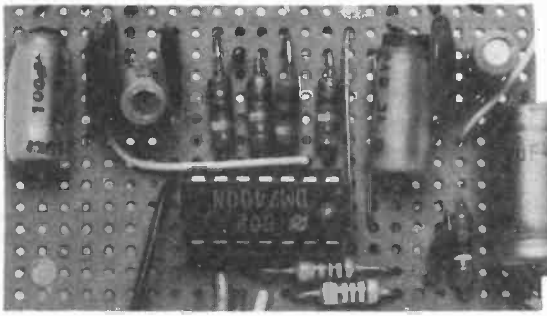


Fig. 2. Circuit board layout and switch interwiring. The three slider switches are shown spread out for clarity and their final positions in the case can be seen in the photographs.



Close up view of circuit board. Note the i.c. holder for the 7400 logic i.c.

So two gates are arranged that the first contact of S1 sets one or other in conduction. Output at pin 11 of IC1 can thus be switched "high" or "low" by S1 without these multiple contacts. With S2 set at MANUAL, the output can be switched high or low by means of S1.

This can be held at the required logic level for as long as necessary to enable logic level tests in the counter to be made before moving S1 to the other position. In this way the actual binary coded output or counter output can be followed exactly to localise a fault.

PULSE GENERATOR

The remaining two gates form an automatic pulse generator, its rate depending on the capacitors selected by S3. The central position is approximately 4kHz (C5, C8), one outer position about 60Hz (C3 and C6 added) and the other outer position about 2Hz (with C4 and C7).

The unit does not have its own power supply but is connected to the power supply rails of the equipment under test. A diode, D1 protects the unit against being connected up the wrong way round and S2a switches the power on and off.

CIRCUIT BOARD

The complete unit is built on a single piece of perforated s.r.b.p. board. Both sides of this are shown in Fig. 2. The i.c. should be positioned as shown in the diagram and the use of a socket for this component is recommended.

Under the board, the wire ends of resistors can be bent over, cut to length, and soldered to the required points. Elsewhere, 22 s.w.g. or similar wire may be used.

Flying leads of thin flexible wire are provided for the switch connections, and can afterwards be cut to length and soldered to the switch tags. Note that S2 and S3 have a central off position.

The board is wired to the switches as in Fig. 2, but is then placed so that it lies in the bottom of the case with the switches on the panel above the board. Note that all the earth connections are gathered together and soldered to a tag fastened to the front panel by one of the switch securing screws.

PROBE

The probe consists of a length of miniature screened cable which is terminated with a suitable metal probe for the inner core and a crocodile clip for the screen or earth.

Similarly the two supply cables are colour coded and terminated with crocodile clips. These are made up from flexible stranded wire.

TESTING

Connect a 5V supply or 4·5V battery, and set S2 to MANUAL. A multi-range meter set to any suitable range should show "high" and "low" at the output, according to the setting of S1.

The best way to check the output is to observe it on an oscilloscope. Each setting of S3 should be observed in turn. Failing that, the 2Hz rate may be observed with a meter set to a low votage range, whilst the other two ranges can be checked by connecting the output to any appropriate audio device such as a loudspeaker.

Once this check has been successfully completed the unit is ready for use. The actual values of the outputs are approximately 3·75 volts for logic high and 0·1 volt for logic low, although naturally there is some latitude here.

---

in My Class

by T.R. de Vaux-Balbirnie

THE FUSE in Stephen's power supply had "blown". He replaced it with another fuse of the same value but it just "blew" again. I told him that there must be an underlying *cause* — either the power pack was faulty or the fuse was incorrect.

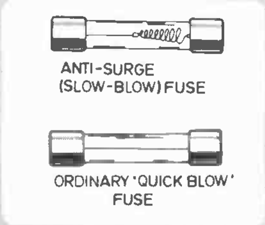
I asked him to bring over the original fuse and his replacement. It was easy to see that they were not the same. "When I looked at the original fuse there was a sort of spring inside—I couldn't find another one like it so I used an ordinary 2 amp fuse" Stephen said.

"This is called an 'anti-surge' or 'slow-blow' fuse", I told him, pointing to the original. "It blows a little slower than the ordinary kind—perhaps with a delay of about 1/10th second.

If a circuit has one of these fuses fitted then it is essential to replace it with one of the same type. If this is not done, the fuse is likely to just blow again."

Stephen looked puzzled, "Why should you want a fuse to blow *slowly?*", he asked. "Surely the idea of a fuse is that it blows as *quickly* as possible".

I explained that certain circuits pass a very high *surge* current for a fraction of a second after switching on. This high current would blow an ordinary fuse instantly. A slow-blow fuse delays the blowing time so that it copes with the surge.



Circuits which are particularly vulnerable to this effect are those containing motors, filament lamps and charging capacitors. The filament of a cold lamp has a low resistance so, on first switching on, there will be a high current until the temperature rises. Electric motors pass an unusually high curent until they reach operating speed.

I went on to say that slow-blow fuses did not seriously sacrifice safety due to the relatively short delay. I passed Stephen a slow-blow replacement fuse. He fitted it in the power supply and everything worked correctly.

YOUNG ENGINEER OF THE YEAR

Once again it is our privilege to report on the Young Engineer for Britain 1980 awards. It was interesting to note that this year over two-thirds of the entrants were electronics based projects.

In addition to the Young Engineer for Britain trophy and title for the overall winner there were awards in each of three age classes for both individual and group entries. Prizes donated by industry included overseas visits, scholarships, industrial visits and cash awards totalling several thousand pounds.

Open to students and apprentices aged between 14 and 19 who compete with mechanical, electronic or chemical projects which have commercial potential, benefit industrial production, cut waste, make better use of energy resources or improve an existing process. This year's competition attracted a record entry of over 200 projects, an increase of 50 per cent, and following regional finals this was reduced to a final 42 projects.

It is regretted that space only allows us to mention the various category winners and we can only offer our praise to all participants and hope they have better fortunes next year.

1980 Young Engineer Trophy winners Martin and Richard French and Kevin Teasdale with their Valve Refurbishing Machine.

Distress Alarm

For his design of a Distress Alarm for the severely handicapped, Carlton Evans from Brentwood School, Essex, took the individual prize in the Class A (14 to 15 years) prize.

This alarm employs the theory that increased heart rate and lower skin resistance result from the ill health or anxiety of a patient both of which are being investigated. The unit will display either heart rate or minute changes in skin resistance on a meter, with an alarm being triggered if the level exceeds or drops below present levels.

The group entry winners in the Class A group were Clifford Brown and Alan Thomson from Archbishop Holgate's School, York. Their project was a Warning System for Potato Storage.

Cassette Tape Programmer

The individual winner in the Class B (16 to 17 years) and also recipient of the best practical electronics application was Glen Middleton of the Bosworth College, Desford, for his Cassette Tape Programmer.

Particularly for use in schools and colleges where computer usage is limited, 256 characters of a program are typed via the adapted calculator keyboard into the internal memory of the machine. They are then transferred to the cassette as an audio signal.

Kitchen Balance for the Blind

For their efforts in designing a Kitchen Balance for the Blind, Michael Allin and Jonathan Elvidge of Longcroft School, Beverley, took the group title in Class B.

To measure out a certain weight the respective rotary switches are turned through the required number of clicks. The substance to be weighed is then added into the pan.

The amount of weight added is indicated by three tones, a low if below, a high if above and an intermittent tone if the weight is correct.

Diagnostic Aid

For her efforts in producing a Diagnostic Aid for the measurement of the disability in a patients' leg, Susan Redpath of the Friends' School, Lisburn, Northern Ireland, was awarded the individual prize in Class C (18 to 19 years).

Refurbishing Machine

The Class C (18 to 19 years) and *Young Engineer of Britain for 1980 trophy* went to Martin French, Richard French and Kevin Teasdale of the Darlington College of Technology for their Valve Refurbishing Machine project.

This machine has been designed primarily for carrying out renewal work on valves on site.

Class C individual winner, Susan Redpath with her Diagnostic Aid.

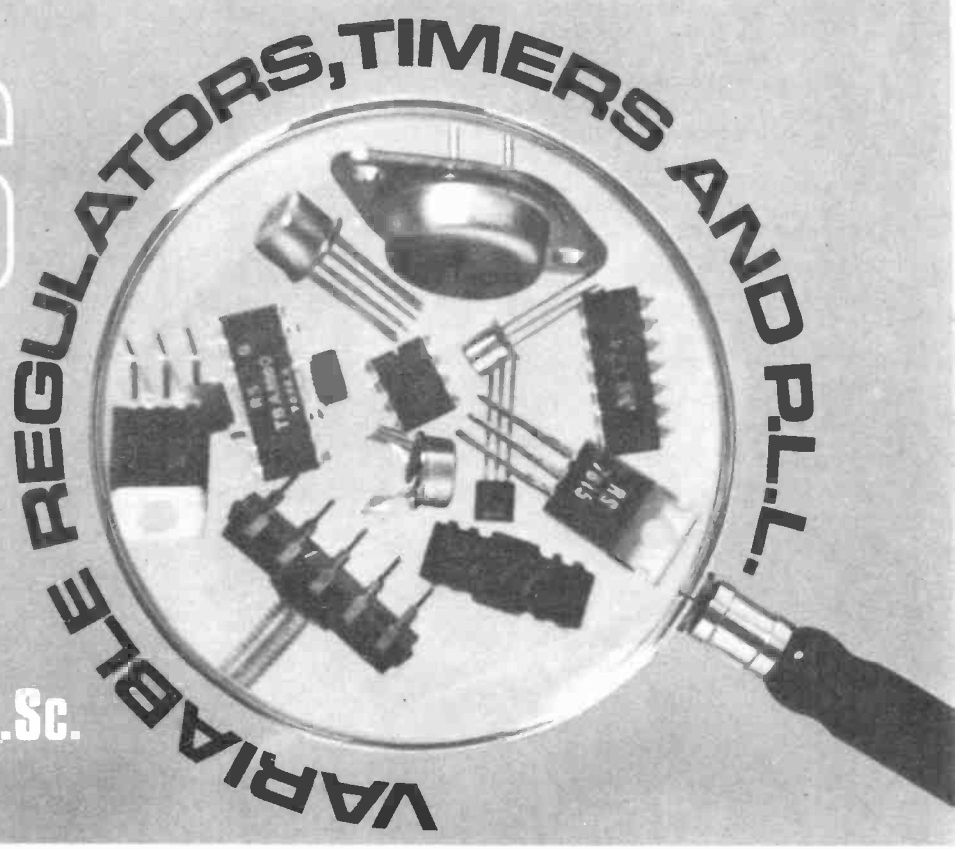
The Distress Alarm designed by Carlton Evans won the Class A individual title.

The best electronics application and Class B individual winner Glen Middleton demonstrates his Cassette Tape Programmer.

Class B group award went to Michael Allin and Jonathan Elridge for their Kitchen Balance for the Blind.

Potato Storage Warning System won the Class A group award for Clifford Brown and Alan Thomson.

I.C.s EXPLAINED PART 4



by J.B.DANCE M.Sc.

LAST month we saw how extremely simple regulator circuits could be used to provide a fixed output voltage. We now look at devices designed to provide a variable output voltage, but some of the circuits are just a little more complex.

VARIABLE REGULATORS

One of the best known variable regulator devices is the 723 type which is produced by many manufacturers under slightly different type numbers, including the LM723 (National Semiconductor), μA723 (Fairchild and Signetics), MC1723 (Motorola), SN72723 (Texas Instruments), SF.F2723 (Thomson-CSF) and L123 (SGS-ATES). It can deliver an output current of up to 150mA over a range of 2V to 37V, but different circuits are required for the 2 to 7V output range and the 7V to 37V range.

The circuit of Fig. 4.1 shows the use of a 723 device to provide a regulated output of 7V to 37V (provided that the maximum 40V input is used if the maximum output voltage is required). A reference voltage of +7·1V from pin 6 is applied to the input of a voltage comparator at pin 5. The other input of this comparator at pin 4 is kept at about the same potential as pin 5 by the feedback action of the circuit, so the output voltage has a value of $V_{ref}(VR1+R2)/R2$. The value of R2 may be 5 kilohm and VR1, 20 kilohm or a smaller value if the maximum output voltage is not needed.

The maximum output current is determined by the value of R_{sc}. When the output current produces a voltage of 0·65V across this resistor, an internal transistor is switched to conduction and the output voltage falls. If R_{sc} is 10 ohms, the output current will be limited to around 65mA. This protects both the device and any external circuits to which the output is fed.

The 723 device is best regarded as a versatile building block for which the user can design a circuit to meet his own particular requirements.

78/79 TYPES

During the past few years quite a number of variable regulator devices have appeared which can be used in much simpler circuits than the 723. One of these devices, the Fairchild μA78MG, can be used in the circuit of Fig. 4.2 to provide any output voltage from +5V to +30V at currents of up to 500mA. A similar device, the μA78G, can provide outputs of up to 1A in the same type of circuit.

Both the μA78MG and the μA78G incorporate thermal shutdown and output current limiting protective circuitry; they are available in various types of package. Similar devices for negative output voltages are available under the type number μA79MG and μA79G.

THE LM317

Another popular variable regulator, the LM317, has only three connections. It is available in various types of package and may be used in the very simple circuit of Fig. 4.3 to provide any output voltage from 1·2V upwards. Only the voltage across R1 (=1·2V) is applied to the LM317 and not the full output voltage, so the maximum output voltage is not limited by the characteristics of the regulator device. The maximum input to output potential is 40V.

The LM317 contains thermal shutdown circuitry to prevent damage from overheating and current limiting circuitry. The maximum output current is 0·8A with some types of encapsulation, but others can supply at least 1·5A (typically 2·2A).

The LM350 is a similar device which can provide a 3A output and the LM337 is a similar 1·5A device for providing negative output voltages.

The regulator circuits discussed so far have all been series regulators in which the output voltage is controlled by a series device which limits the current passing to the output. Such devices cannot provide a higher output voltage than the applied input.

SWITCHING REGULATORS

Recently there has been much interest in the somewhat more complex switching regulator circuits which require an inductor, but which can provide outputs greater or less than the input voltage or even of the opposite polarity. A further advantage of switching regulator circuits is that their efficiency can be very high and about 75 per cent of the input power appears at the output. Apart from their greater complexity, switching regulators have the disadvantage that they generate a switching frequency which can cause interference.

The circuit of Fig. 4.4 shows the use of a TL497 device to step up an input voltage of perhaps 5V or 10V to an output of +16·2V. The output voltage is equal to (1+R1/R2) times the internal reference voltage of 1·2V. The maximum output current is determined by the value of R_{sc}.

OSCILLATORS AND TIMERS

The 555 timer device created great interest and has proved to be very versatile indeed. It is now available from many manufacturers both as a single device and as dual (556) and quad devices. Although other timer devices are normally used for periods of over about ten minutes, the 555 is still very widely used.

The timing of a 555 device depends upon the time taken for a capacitor to charge through a resistor. Although the time taken for the capacitor to charge to a given voltage is dependent on the supply voltage to the resistor, the circuit of the device is arranged so that the end of the timed period occurs when the potential across the capacitor has reached a certain fraction of the supply voltage; this renders the timed period almost independent of the supply voltage. The normal supply voltage range is +5V to +15V.

555 CONTROLLED RELAY

A simple time delay circuit for controlling a relay is shown in Fig. 4.5. When the start switch is closed, the output voltage at pin 3 rises and the relay closes. The capacitor *C1* now charges through the resistor *R1* and when the potential across *C1* reaches two-thirds of the supply voltage, the circuit is switched so that the potential at pin 3 falls and the relay opens. In addition, the capacitor *C1* is discharged into pin 6. The circuit is now ready to perform another timing operation.

DELAY PERIOD

The length of the timed period is approximately equal to $1{\cdot}1 \times R1 \times C1$. In order to obtain a long time delay, both *R1* and *C1* should be large, but *R1* cannot exceed 20 megohms, since the current flowing through this resistor to pin 6 would otherwise produce too large a voltage drop across *R1*. When *C1* is 1μF and *R1* is 20 megohm, the timed period is about 22 seconds. The optional reset switch can be used to terminate a timed period. *D2* protects the 555 against damage from the transient peak voltage occurring when the current in the relay coil ceases to flow. The current required to trigger the 555 at pin 2 is only 0·5μA, so it is easy to use this

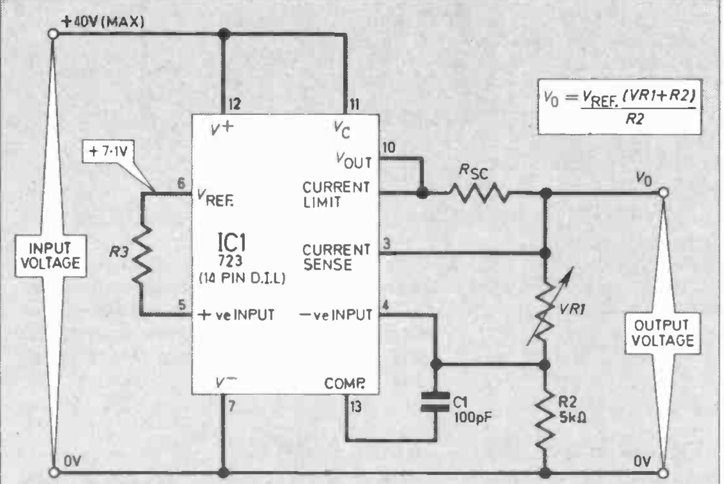


Fig. 4.1. A voltage stabilising circuit providing outputs from 7 to 37V.

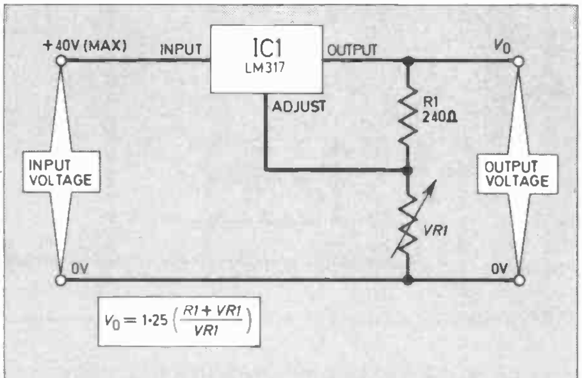


Fig. 4.3. A three terminal LM317 regulator is used in this versatile circuit.

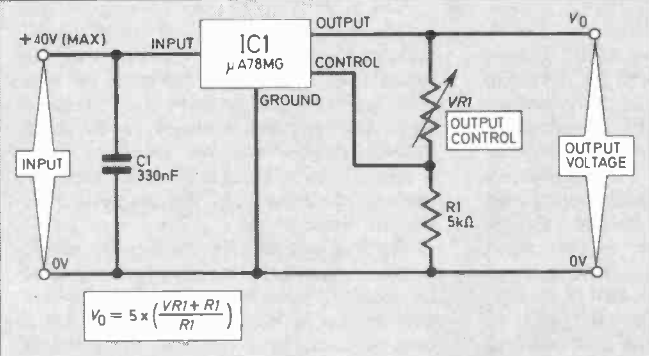


Fig. 4.2. A circuit providing +5V to +30V at currents up to 500mA.

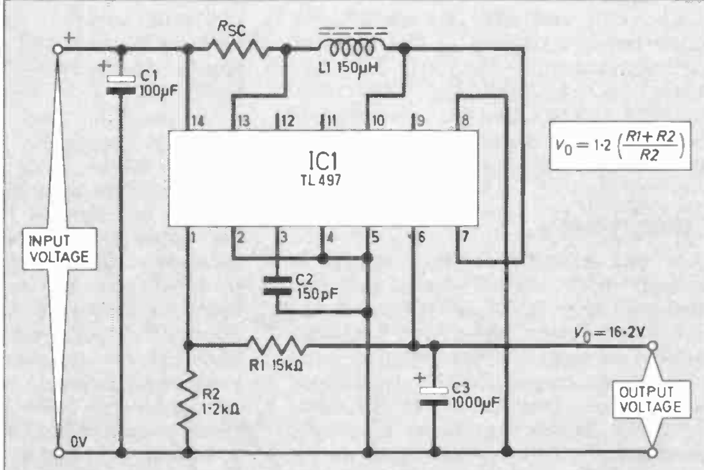


Fig. 4.4. A switching regulator voltage step-up circuit.

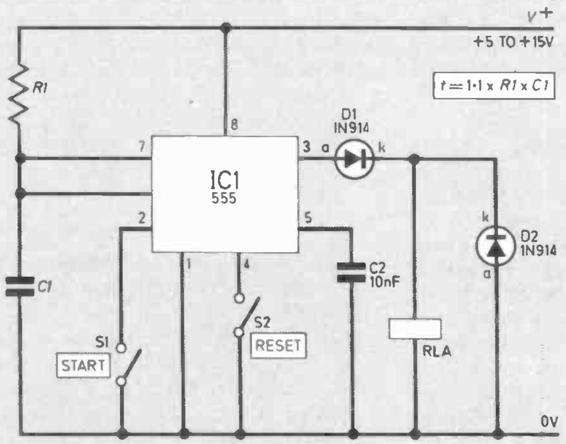


Fig. 4.5. A 555 interval timer used to close a relay.

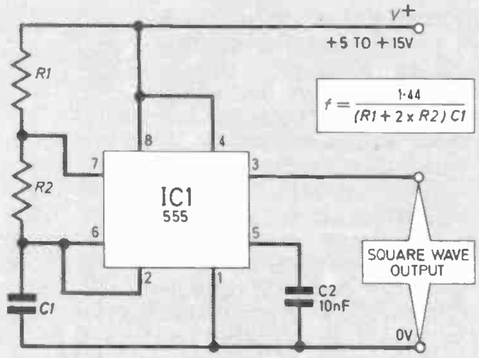


Fig. 4.6. A 555 astable circuit.

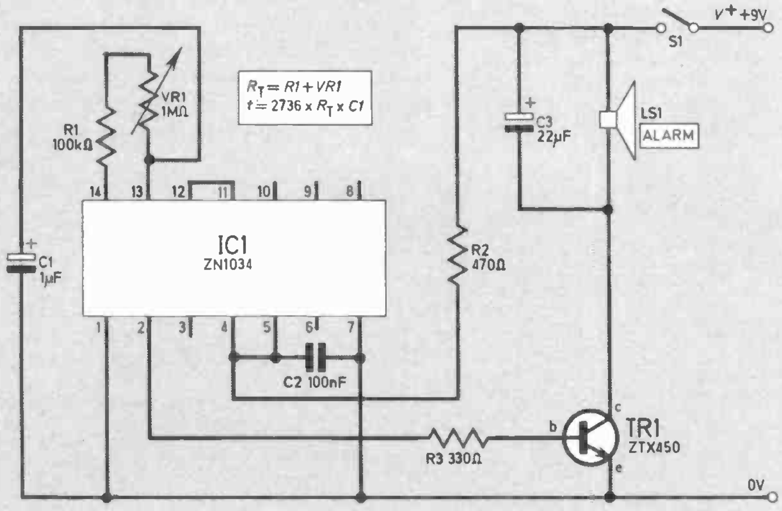


Fig. 4.7. A ZN1034 long period timer.

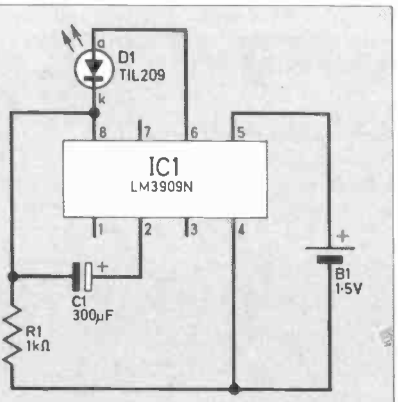


Fig. 4.8. A LM3909 flasher circuit.

terminal in a touch switch arrangement which is triggered by a person's finger.

The 555 can also be used as a squarewave oscillator in the type of circuit shown in Fig. 4.6. The frequency is approximately $1{\cdot}44/(R1 + 2 \times R2)C1$. The capacitor $C1$ charges and discharges between one-third and two-thirds of the supply voltage.

LONG TIMES

If one requires a time which is longer than that which can be obtained from a 555 circuit, one may use an oscillator and count the oscillations so that the timed period ends after a certain number of oscillations have been counted. The Ferranti ZN1034E device has been especially designed for this application.

In the circuit shown in Fig. 4.7, the output from pin 14 is a 2·5V reference voltage which drives a current through R1 and VR1 to charge the capacitor C1. This capacitor is then automatically discharged when the potential across it reaches a preset value. Charging and discharging continues to provide the oscillations required.

If pins 11 and 12 are joined together, the timed period is $2736 \times R_t \times C1$ where R_t is the total resistance between pins 13 and 14. Thus if VR1 is set so that R_t is 1 megohm, the timed period will be about 2736 seconds or over 45 minutes. When C1 is 100µF and R1 is 2·2 megohm, a delay of over one week can be obtained. Even longer delays can be obtained by connecting a 300 ohm resistor from pin 12 to ground instead of connecting pins 11 and 12. The timed period is then $7500 \times R_t \times C1$.

In the circuit of Fig. 4.7 timing starts when the switch S1 is closed. The alarm sounds at the end of the timed period and continues to sound until S1 is opened. It is possible to cascade the counter circuits in two ZN1034E timers to produce delays of over a year or to use two devices to produce oscillations with a period of over a week.

LED FLASHER

The National Semiconductor LM3909 device can be used in very simple oscillator circuits such as those in which it causes a light emitting diode to emit a short flash of light every few seconds.

Although a light emitting diode requires a potential of at least 1·7V before it commences to conduct and emit light, the simple circuit of Fig. 4·8 can be used to drive a light emitting diode from a single 1·5V cell; indeed, flashes will be obtained from a supply as low as 1·2V, but the frequency decreases as the applied voltage is reduced.

The circuit shown flashes at about 2·6Hz, but pins 1 and 8 may be linked to obtain a frequency of 1Hz. The current drain of the circuit in Fig. 4.8 is only 1·2mA, but if C1 is reduced to 100µF, the mean current is about 0·3mA and the intensity of the flashes is lower.

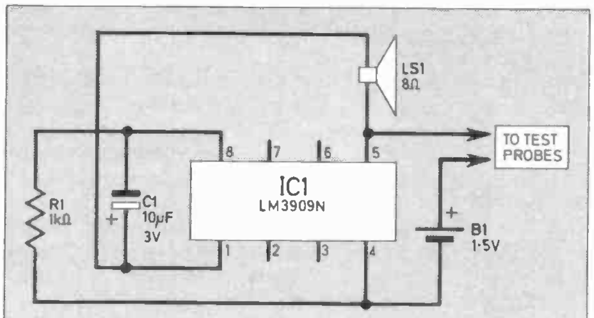


Fig. 4.10. A continuity tester which produces an audible note.

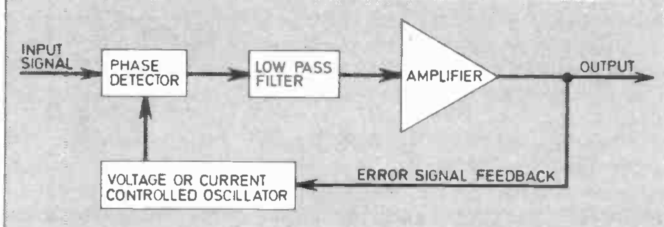


Fig. 4.11. The basic phase locked loop circuit.

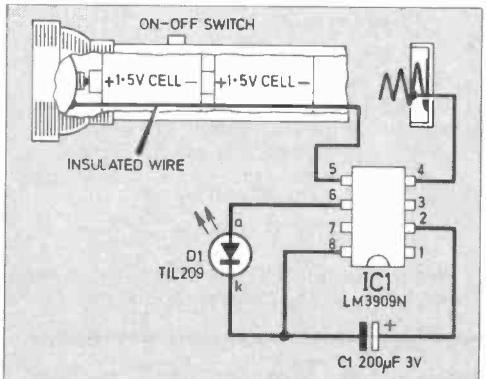


Fig. 4.9. A circuit for a torch finder.

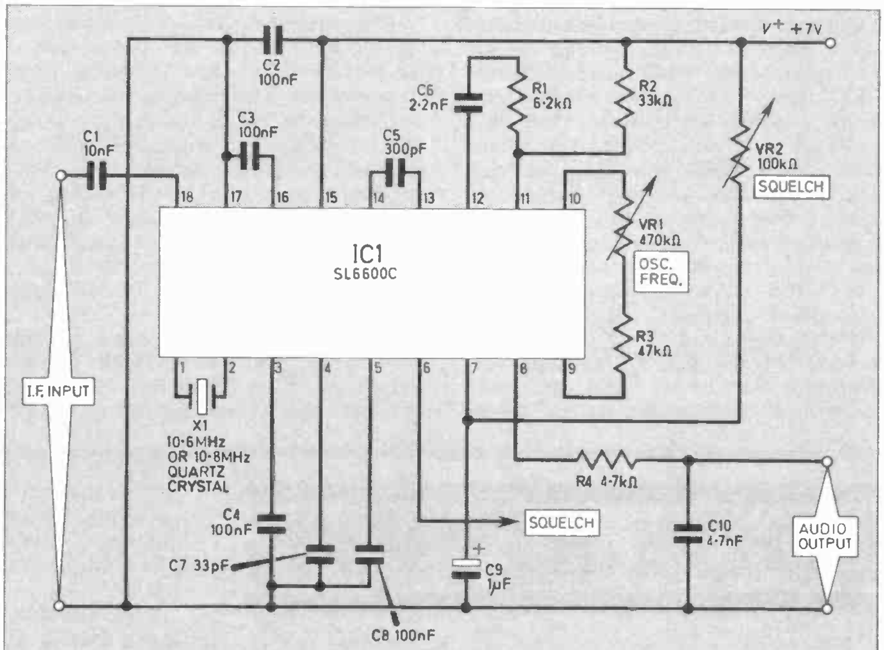


Fig. 4.12. A phase locked loop demodulator for narrow-band f.m. signals.

A useful application of the LM3909 device involves the fitting of the circuit of Fig. 4.9 in the base of a torch. The light emitting diode D1 emits flashes at all times when the torch is switched off so that one can find the torch easily in complete darkness. The current consumption is so small that the life of the torch batteries is almost unaffected, but a transparent cap must be fitted to the torch base.

Fig. 4.10 shows a further use of the LM3909 as a continuity tester. The loudspeaker emits a note when the test probes are joined together, but if the resistance between the probes is increased to only a few ohms, the frequency of the note changes enough to be detected.

PHASE LOCKED LOOPS

Phase locked loops (PLL) are somewhat complex circuits which can be conveniently made using one or more integrated circuits so as to minimise the number of components. Basically an input frequency is fed into the loop and the frequency of the oscillator in the loop will automatically change to the frequency of the input signal or to a frequency closely related to the input frequency.

Phase locked loop circuits are found in a wide variety of applications, such as f.m. and a.m. demodulator circuits, frequency synthesisers for use in digital tuning systems, quartz crystal control circuitry for the rate of revolution of record player turntables, circuits for setting a clock accurately using a radio signal, frequency-shift-keying decoders for data reception, some metal detectors, voice scrambler circuits and the control of the speed of electric motors.

PLL BLOCK DIAGRAM

The basic circuit of a phase locked loop is shown in Fig. 4.11. An input signal is fed to one of the inputs of a phase detector circuit and the other input signal comes from an oscillator whose frequency is controlled by a voltage or current fed into this oscillator. Let us consider how the process of locking occurs.

If the input signal which is slightly different from the free-running frequency of the oscillator is applied to the circuit, the phase detector compares the phase and frequency of the two signals and generates an error signal related to the difference between the two signals.

The error voltage is passed through the low-pass filter which attenuates high frequencies so that the output consists of the error signal and little else. The error signal is fed back to the voltage or current controlled oscillator and causes the frequency of the latter to be brought closer to the frequency of the input signal. After a very short time the oscillator frequency becomes locked or synchronised to the input signal frequency.

The oscillator signal is now identical in frequency to the input signal, but there is a difference in phase between the two signals which is needed to provide the error signal which maintains the loop in lock. If the frequency of the incoming signal varies within a limited range known as the "locking range", the oscillator frequency will track the signal frequency variations and keep the loop in lock.

Let us suppose that the input signal to the loop circuit of Fig. 4.11 is an f.m. radio signal. As the frequency of the input signal varies at the audio modulation frequency, the error signal will vary at this audio frequency. Thus the output of the circuit of Fig. 4.11 will be the demodulated audio signal.

DEVICE TYPES

Quite a number of monolithic phase locked loop devices are being manufactured which enable a complete phase locked loop circuit to be constructed using little more than the single device and about ten other components. The available devices may be classified into high frequency phase locked loops which can operate at frequencies of over about 5MHz and low frequency devices which can operate only at lower frequencies.

Signetics produce one of the earliest series of high frequency devices, the 560, the 561 and the 562 which are all rather similar and can be used at frequencies up to about 15MHz (30MHz in a typical device). They can be used as f.m. demodulators, but the signal-to-noise ratio does not meet modern high fidelity requirements (typically it is 35dB).

A 563 device was produced by Signetics for high fidelity f.m. receivers, but is no longer available, while the 564 is a 50MHz device using low-noise techniques.

Low-frequency loops include the 565 and a 567 tone decoder which produces an output when the loop is in lock. The CMOS 4046 devices are also low-frequency loops.

F.M. DEMODULATOR

The circuit of Fig. 4.12 shows the use of the Plessey SL6600C device as a narrow band f.m. amplifier and demodulator. The input signal (usually 10·7MHz) is fed to pin 1 after which it is amplified by 20dB before being fed to a mixer circuit. The local oscillator operates at 10·6MHz or 10·8MHz and is stabilised by the crystal connected between pins 1 and 2. The difference frequency of 100kHz is passed to the phase locked loop circuit.

The free running frequency of the loop is set close to 10·7MHz by the value of the capacitor connected between pins 13 and 14, but the exact frequency of the oscillator can be set by VR1. The loop filter is connected between pins 11 and 12.

The "squelch" level resistor VR2 can be used to adjust the threshold level below which weak signals produce no audio output. This prevents excessive noise as one is tuning the receiver.

Although the SL6600C has been designed specifically for narrow-band receivers, it can be used in high fidelity f.m. receivers provided that a crystal frequency is chosen which produces a difference frequency of about 800kHz rather than the 100kHz used for narrow band work. Thus, for a 10·7MHz input frequency, the crystal resonant frequency should be about 9·9MHz or 11·5MHz in high fidelity receivers.

CONCLUSION

It is hoped that the circuit examples given will whet the appetite of constructors and convince them that linear circuits are fairly easy to use—always provided that one is careful to avoid unwanted feedback which can produce oscillation.

Next month. *In Part 5 of this series, the digital i.c. will be introduced.*

BOOK REVIEWS

PRACTICAL HI-FI SOUND: THE COMPLETE GUIDE TO PERFECT LISTENING IN THE HOME

Author	Roger Driscoll
Price	£6·00 Hardback
Size	245 × 175mm 176 pages
Publisher	Hamlyn
ISBN	0 600 34627 7

THIS book contains more information than its title suggests and should appeal to a large readership from layman to the hi-fi "technicrat".

The author, Dr Driscoll is a consultant in the audio world and a lecturer in acoustics. His abilities in the latter are evident in the presentation of his material. The text is concise and well written and supplemented by over 100 illustrations and photographs.

A brief history of sound reproducing equipment with photographs of early commercial equipment is followed by a section on the properties of sound, containing graphs, tables and relevent photographs with formulae. Even drawings of the inner ear are included showing the "mechanics" of reception. This is the pattern for the remainder of the book. Graphs and tables in our opinion are considered extremely useful, economical and generally unambiguous.

An interesting section is one on musical instruments which explains the production of the sounds from string, wind, brass and electrical musical instruments, and the human voice, each with acoustic spectra graphs.

The longest chapter in the book is devoted to loudspeakers, including special types and the many different enclosure geometries, and ending with construction details for a high quality enclosure specially designed for this book.

The two chapters dealing with complete systems, choosing a system (three suggested), and room acoustics with suggestions for domestic room arrangements are both informative and useful.

B.W.T.

RECORD REVIEW

Title	Practical Hi-Fi Sound
Label	Philips (Phonogram) 6840 010
Format	12 inch LP 33⅓ r.p.m.
Price	£6·00

THIS record, sponsored by *Practical Hi-Fi Magazine*, has been produced to complement the above book, *Practical* Hi-Fi Sound. One side of this disc contains six tracks of popular titles by six different well known artists with the flip-side containing three classical tracks.

The main purpose of the record however is for test and demonstration, and will help you to evaluate your equipment, or that perhaps which you are contemplating purchasing. The inner sleeve contains information for each track dealing with recording aims, musical content and what to listen for. In some cases, the likely cause of unwanted sounds or discrepancies is pin-pointed.

A lot of care has gone into the production of this record in which rumble, surface noise and distortion have been kept as low as possible.

This is a test record with a difference and makes a refreshing change to the highly technical "tone types" and has the advantage of being a source of entertainment after its initial use.

B.W.T.

SQUARE ONE FOR BEGINNERS

ELECTRONIC circuits depend upon semiconductor devices for their operation.

Semiconductors are solid state components. They have no moving parts, and their external appearance is not in any way distinguished, other than for the two or more wire leads with which they are equipped.

Yet these small devices are the heart of electronics.

The simplest kind of semiconductor is the diode. This was discussed on this page in November 1979. This month we shall consider the most important of all semiconductor devices, the transistor.

THE TRANSISTOR

The transistor is most valuable and important because it will amplify small electric currents. It is the solid state version of the triode valve.

Transistors intended for dealing with low powers, and small signal levels, are characteristically enclosed either in a metal can or encapsulated in plastic. They have three wire leads. These are connections to the three essential parts of a transistor: base, emitter and collector. Typical transistors are illustrated in Fig. 1 and the symbols used in circuit diagrams are given in Fig. 2.

Note there are two kinds of transistor, the *npn* and the *pnp*. They have different polarities. The arrow in the symbol points in the direction of conventional current flow. Thus for *npn* transistors the positive side of the battery must be connected to the collector and negative side of the battery to the emitter. This is illustrated in Fig. 3 and Fig. 4.

For *pnp* transistors the battery connections are reversed, so that the negative side of the supply goes to the collector. Consequently the currents circulate in the opposite direction to that for a *npn* type.

TRANSISTOR ACTION

The action of a transistor can be explained in simple terms as follows.

Refer to Fig. 3. A small signal applied between base (b) and emitter (e) will cause a small current to flow around that circuit. Suppose a second circuit is connected between emitter and collector (c) and this is supplied by a battery B1. The small current through base and emitter will affect the conductive properties of the transistor, and so will in turn affect the second circuit. In short, a small current flowing between base and emitter controls the much larger current flowing between emitter and collector.

(The name transistor comes from "transferred resistance" which very concisely explains what it's all about.)

The larger current will always be a faithful reproduction of the smaller, but magnified (or amplified) in scale. The two circuits are separate, even though they share the emitter. A transistor connected in this fashion as an amplifier is known as operating in the *common emitter mode.*

SIMPLE AMPLIFIER

This property of amplification is the basis of many electronic circuits. A simple example is the amplification of small signals, such as from a microphone, so that they become powerful enough to operate a loudspeaker.

This is shown in Fig. 4 where a microphone is connected at the input of the circuit (base/emitter) and a loudspeaker in the output or collector circuit.

A bias current is applied from the battery B1 to the base of the transistor TR1 via resistor R1. This is to establish the best working point for the transistor. The capacitor C1 prevents this direct current from flowing through the microphone.

The capacitor C2 allows the audio signal currents in the collector/emitter circuit to by-pass the battery.

DIFFERENT APPLICATIONS

Instead of the microphone, we could use some other type of transducer, or sensor. For example a photo-diode, which is light sensitive, or a thermistor which is heat sensitive. The output circuit could incorporate an audible warning device, or perhaps an electro-mechanical relay suitably wired up to activate some other device or machinery.

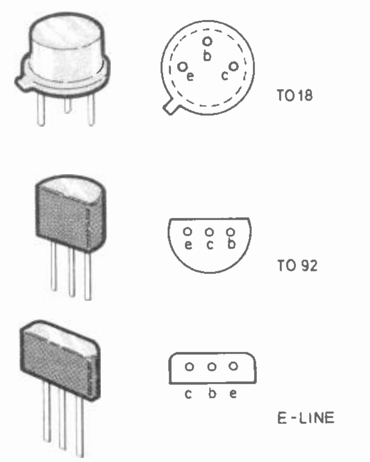


Fig. 1. Small transistors. Three different styles are illustrated, together with their lead identification as viewed looking at the underside of the device.

The topmost transistor is metal cased, the others are plastic encapsulated.

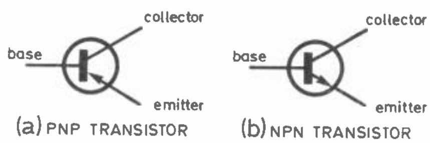


Fig. 2. Circuit symbols for transistors. The arrow head points in the direction of conventional current flow, positive to negative.

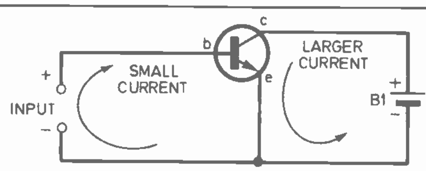


Fig. 3. Basic transistor action (*npn* type—the popular BC108, for example). For a *pnp* type (see Fig 2b) the battery is reversed and the two currents circulate in the opposite direction.

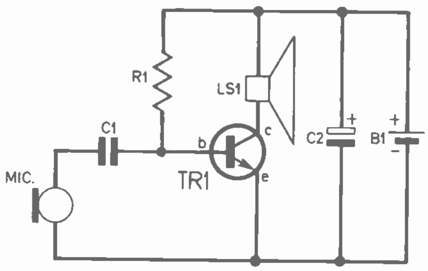
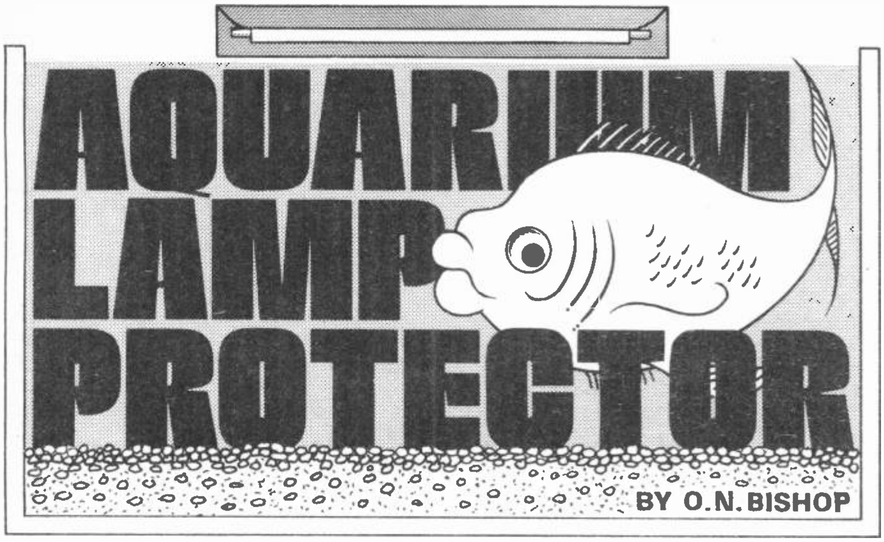


Fig. 4. A simple audio amplifier circuit using a *npn* transistor (as in Fig. 3). The microphone provides the small input current, and a loudspeaker LS1 is connected in the collector/emitter circuit. A d.c. bias is applied to the base via resistor R1. The capacitor C1 blocks this bias voltage from the microphone, but passes the alternating current from the microphone to the base of the transistor. C2 is an electrolytic capacitor of large value and allows the audio signal currents to by-pass the battery.



Tropical aquariums are often lit by a tubular filament lamp, operating from the mains. It was found by the author that the lamp usually lasts only three months before burning out. Since these lamps are considerably dearer than ordinary lamps (over £1 each) a way of making the lamps last longer was investigated and the simple circuit to be described here was found to increase the lamp life.

As with all filament lamps, failure usually occurs at the moment the lamp is switched on. When running, a 240 volt 30 watt lamp takes a current $I=P/V=30/240=0\cdot125$ amps. A further simple calculation shows that its resistance must be $R=V/I=240/0\cdot125=1920$ ohms. The clue to the trouble is that the resistance of metals has a positive temperature coefficient. In other words, the resistance of the filament is much lower when it is cold.

INITIAL SURGE

A testmeter measurement shows that the resistance of the cold filament is only 200 ohms. The effect of this is that when the lamp is first switched on the current flowing through the lamp is $I=V/R=240/200=1\cdot2$ amps. This is almost ten times its normal operating current.

Lamps are designed to withstand this initial surge but, when the lamp has been in use for some time the filament becomes weaker and eventually fails at switch-on.

LIMITING RESISTANCE

Some models of 8mm film projectors have a series resistor which limits the current to the lamp when it is first switched on. The lamp becomes warm and is then switched to full brightness by switching the resistor out of circuit.

A simpler method of protection is to use a thermistor. This consists of a rod or disc of a semiconductor material. Like most semiconductors its resistance has a negative temperature coefficient. The type used in this lamp protector has resistance 380 ohms when at 25 degrees Celsius (room temperature) but, as it becomes hotter, its resistance falls to about 50 ohms.

With two thermistors in series with the lamp, as shown in Fig. 1, the total initial resistance of the circuit is $200+380+380=960$ ohms. The initial current is now $I=V/R=240/960=0\cdot25$ amps. This is only double the normal operating current and is insufficient to damage the lamp until it is very old. When the lamp is first turned on it glows dimly for a few seconds but gradually gets brighter as the thermistors become hotter and their resistance falls. After 10 to 20 seconds the resistance of the thermistors has fallen to 50 ohms each, or less, which is negligible in comparison with the 1920 ohms resistance of the hot filament. The filament now glows at almost its full brightness. Actually its brightness is imperceptibly less than when thermistors are not used and, since it is now being very slightly under-run, this is another factor in prolonging the life of the lamp.

GROUP BOARD ASSEMBLY

The thermistors are mounted on a small piece of group-board, which is supported by two bolts from the wall of the metal case, see Fig. 2. The reason for using two bolts is to prevent tension on the wires from rotating the board, and bringing exposed metal parts of the circuit into contact with the metal case.

A few small holes drilled in the case allow ventilation, but these should not be so large that small children can push their fingers through the holes. Usually it will be easy to find a safe place for the device, tucked well out of sight behind the aquarium.

When the current is switched off the thermistors take several minutes to cool. If the current is switched on during this period, protection will be less than normal. It is recommended that current should not be switched on until at least 5 minutes after it has been switched off.

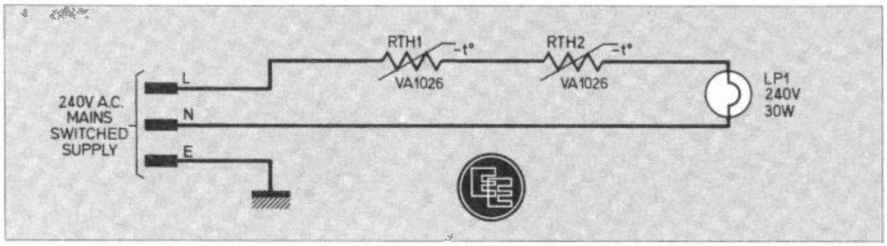


Fig. 1. The complete circuit diagram for the Aquarium Lamp Protector.

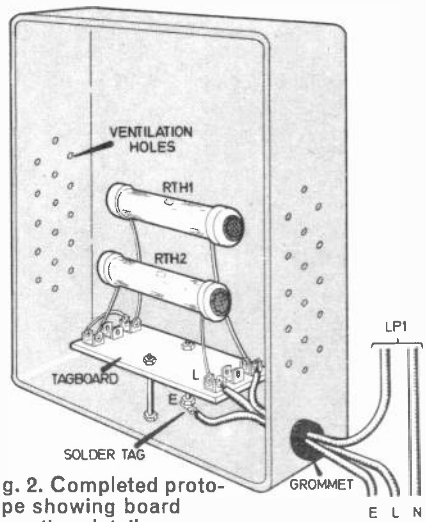


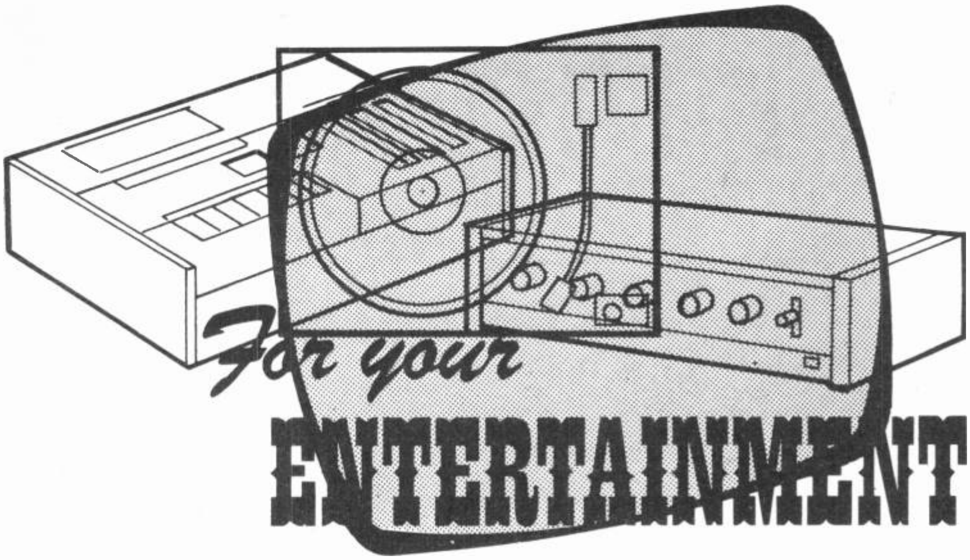
Fig. 2. Completed prototype showing board mounting details.

COMPONENTS

Thermistors
RTH1, RTH2 VA1026 rod types n.t.c. (2 off)

Miscellaneous
Miniature group-board 3-way; mains cable—length to suit; 6BA fixings and 15mm long spacers (2 sets); rubber grommet; metal case approx. 100 × 70 × 40mm diecast type recommended; 6BA solder tag.

Approx. cost £2·20 excluding case



For your ENTERTAINMENT

By BARRY FOX

Lack of Knowledge

It's my bet that the top brass of many large Japanese companies would be horrified if they knew how little the British trade press and public knew of their companies' activities.

It's easy to think of Matsushita only as the manufacturer of National Panasonic and Technics television sets and audio and video equipment. Likewise it's easy to think of Sanyo, Hitachi and Toshiba only as manufacturers in the same restricted field. All these companies, in fact most Japanese firms whose names we think of only in connection with audio and video equipment, manufacture a wide range of consumer and industrial electronic gear.

I have caught a glimpse of this once or twice when travelling in Japan and reading trade information which originates from the companies' homeland. But I can't think of a single Japanese company which has a really efficient system of advertising its full scope of interest outside Japan.

Some Japanese companies are represented in the UK by associated firms or subsidiaries whose lack of knowledge and interest in the parent company's activities and achievements has to be encountered to be believed. In fact, woe betide the British electronics industry if ever the Japanese moved into top gear over here and publicised the full scope of their technological achievements!

Japanese Scene

Althouth the UK press normally only gets to see and hear what the Japanese firms are doing by visiting the country or by reading information which originates from Japan, once in a while something filters through UK channels, almost by mistake. Hitachi, for instance, recently ran a dealer seminar at Belvoir Castle in Leicestershire. Although much of the technology shown related to audio and video, the company took the welcome initiative of releasing a folio of data sheets on other Hitachi developments.

Here then is a brief mention of just a few of the mouth-watering novelties which Hitachi offers in addition to "routine" audio and video. Remember that Hitachi is just one of many companies with a similarly broad scope of interest, and you'll see what I mean about the Japanese electronic "threat" being still in relatively low key.

Energy Conservation

For energy conservation Hitachi engineers have devised a carpet which radiates heat. No special installation is involved, you simply plug it into the mains and use it like an ordinary carpet.

It's waterproof as a protection against spilled drinks and has the obvious advantage that you can have warm feet even in a relatively cold room. And warm feet usually mean a warm body. So the carpet cuts heating costs.

As anyone who has used a microwave oven knows, it's difficult to obtain even heat distribution. A rotating table is useful but too difficult to clean. A stirrer system, which disturbs the microwave pattern is easier to clean but less effective.

The Hitachi answer is a microwave oven with a rotating antenna rather like an aircraft or ship radar system. This creates a continually changing radiation pattern which is claimed to offer more uniform cooking.

Recording and Listening

A miniature keyboard instrument incorporates a microcomputer and memory which will store your favourite musical piece and then automatically reproduce it. An edit function enables the player to add or alter some parts of the "recording", and thereby build up a perfect performance.

Up to 287 steps can be memorised with the basic 2K byte memory but this can be increased to two thousand steps with the installation of added memory capacity.

The Hitachi ASLC (Automatic Sound Level Control) is used with a car stereo system. As anyone who listens to In-Car Entertainment well knows, it can be very difficult to set the sound level so that it is loud enough when the car is running fast but not too loud for slow-moving traffic jams.

The ASLC unit senses the ambient noise level in the car and adjusts the ICE sound level accordingly.

Talking Clock

Speech synthesis circuitry is now all the rage and needless to say Hitachi have their own proprietory circuit. This is now built into a clock radio which quite literally tells you the time at pre-set intervals.

The clock also serves as an alarm, uttering announcements such as "Good morning, it is time to wake up", "Good night, it's time to go to bed" and "Now it's time for your appointment". The neatest touch of all however is the provision of an automatic warning facility which announces "The battery is nearly dead. Please change it".

Audio Visuals

Hitachi, like Matsushita, have developed an audio visual aid which can generate colour video pictures from an ordinary audio cassette tape.

Although details are sparse the Matsushita device (which I've seen working) uses a modified helical scan system, similar to a domestic video cassette recorder, operating on a narrow extra track squeezed in between the audio tracks. But Hitachi records the picture signal information on one track of the tape and the sound on another track.

With either system, however, it is obviously impossible to store video pictures on audio cassette tape in "real time" i.e. twenty-five different pictures a second. So digital signals are fed into a frame memory which is read out to produce a frozen full frame picture as soon as there is enough information in the memory.

Soundtrack

As the tape runs there is a continual soundtrack of music and speech. Simultaneously a series of still colour TV pictures are displayed on the screen, in perfect synchronism with the soundtrack.

In many respects the device is a logical extension of viewdata and teletext technology, where data signals are transmitted by radio or phone line at relatively slow rate, stored in a memory at the receiver and then read out to produce a full page of text information. But whereas the stored teletext and viewdata information is used to control the *generation* of graphics, the Hitachi and Matsushita systems use the stored data to *recreate* a full-colour freeze frame picture, similar to a colour transparency. The potential for education and audio visual displays at exhibitions is obvious. Less obvious perhaps is the pointer to the future which such systems offer.

Hitachi, although cagey over the time it takes to decode each individual picture, claims that a picture of 49,152 elements (192 vertical × 256 horizontal) is stored in a memory of 16K bytes under the control of a single 8-bit micro-computer. If this claim is accurate some remarkable storage techniques are being used. As a guide line, for a full broadcast quality video frame store you normally need a memory capacity of 2M bits.

MAKING PRINTED

STAGE BY STAGE PICTORIAL GUIDE

Look inside virtually any piece of modern, factory made electronic equipment and you are bound to see at least one printed circuit board. Ever since the first transistor saw the light of day this method of mounting and interconnecting electronic components has become more and more popular with manufacturers until nowadays it is more or less universal.

The reason for this is not difficult to see when you consider the advantages it offers in production, not to mention great reliability in use. A printed circuit board (p.c.b. for short) makes construction extremely simple, which means fewer mistakes and it doesn't take a great deal of imagination to realise how important this would be to many constructors.

Indeed p.c.b.s are featured regularly in E.E. projects (such as the E.E. Radio Control System). Many readers however are put off by the seemingly complicated process necessary to produce the finished board. In fact making a printed circuit board is quite a straightforward matter—certainly nothing to frighten the average constructor.

DOWN TO BASICS

One question that is inevitably asked is, "What is a p.c.b.?" Put simply a p.c.b. is a sheet of glass fibre or s.r.b.p. (synthetic resin bonded paper) board onto which is bonded a copper pattern designed to connect all the components together according to the circuit diagram.

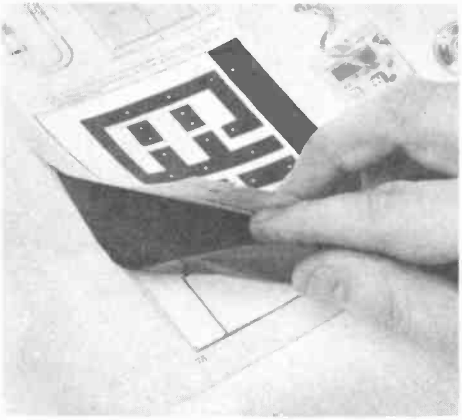
The production of a p.c.b. falls into two stages. The first involves taking a piece of copper clad board and masking off those areas of the copper that will form the foil pattern. This masking material is known as the etch resist and can take many forms. The second stage involves immersing that board in a chemical solution which etches away the unprotected copper leaving behind the final design.

Some care is needed in this second part as the chemicals involved could be dangerous if misused. The board must then be finished off after etching and such things as mounting holes have to be drilled.

SELF ADHESIVE RESIST

Self adhesive plastic such as Fablon or Contact makes a very good etch resist. Choose a light coloured material so that any marks made on it are clearly seen. The board should first be cut to size and the copper side covered with plastic.

When you have finished, make sure that the edges of the remaining resist are rubbed down very firmly otherwise the edges of the copper areas in the final board will turn out ragged.

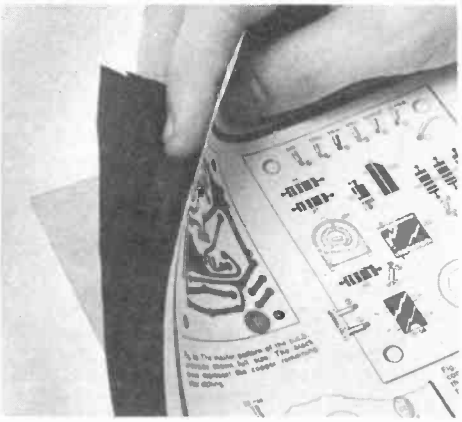


A sheet of carbon paper is placed on top of the plastic and the board is placed directly underneath the drawing.

ETCH RESIST PAINT

A useful alternative to self adhesive resist is to use a special resist paint. Proprietry brands of resist paint can be obtained but simple enamel or nail varnish will do the job just as well. It is also possible to obtain felt-tip pens with etch resist ink.

The copper surface of the board should be thoroughly cleaned before starting.

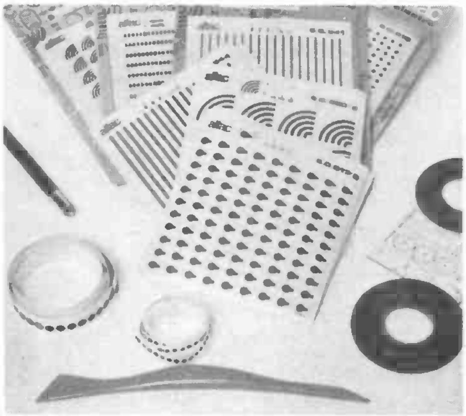


The pattern is transferred onto the copper-clad board exactly as before.

TRANSFERS

The two preceding methods are best suited to foil designs where large areas of copper are left unetched. However as more intricate lines become necessary rub-down transfers are much more suitable. It is possible to obtain these in a variety of shapes and designs and very thin tape is also available for long thin strips.

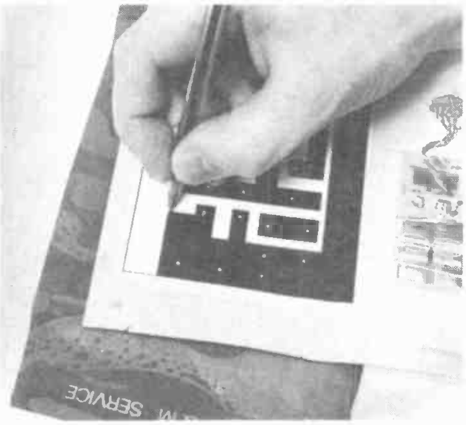
Again the board should first be cleaned and the design transferred using carbon paper.



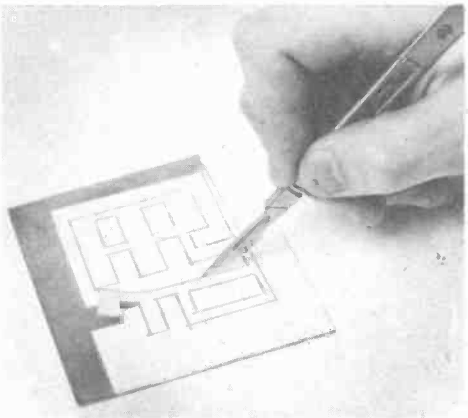
A selection of transfers, including pad groupings, curves and other various shapes. Note also the plastic spatula and etch resist pen.

CIRCUIT BOARDS

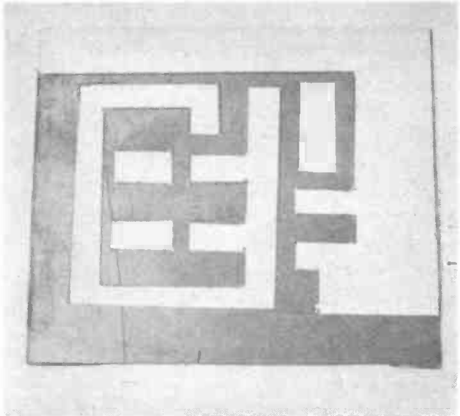
BY S. DOLLIN



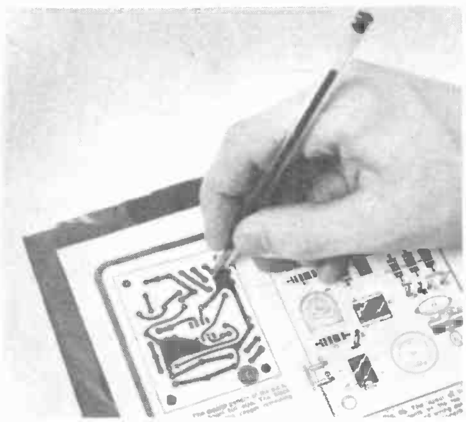
Draw carefully over the pattern so that it is transfered onto the plastic etch resist underneath.



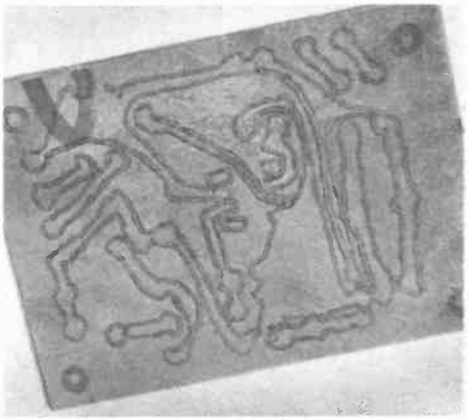
It is now a simple matter to remove the unwanted areas of plastic with a sharp knife.



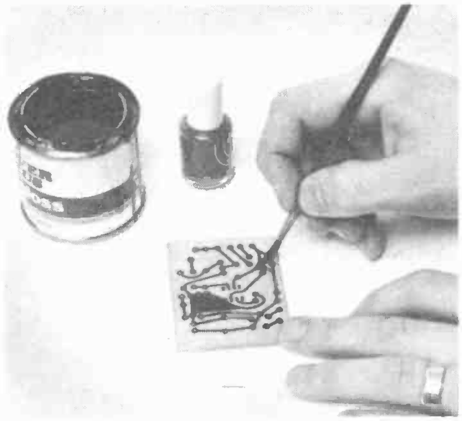
The board is now ready for etching.



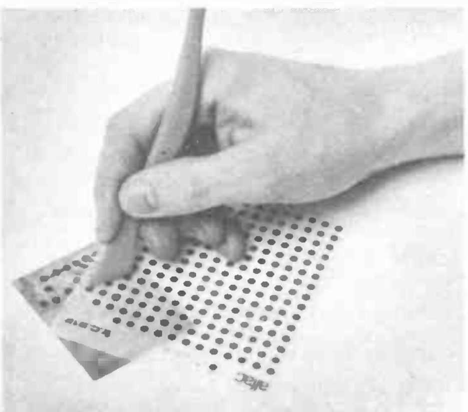
Extra care must be taken when going round the design and it is necessary to press hard in order to transfer the design.



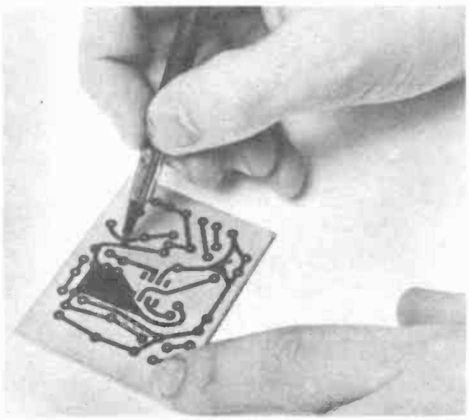
The carbon imprint goes straight onto the copper surface.



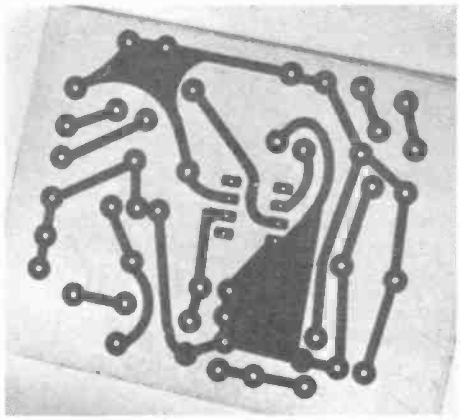
The etch resist paint is then applied directly to the copper with a fine artist's brush.



The shapes are rubbed down onto the copper surface, carefully following the foil pattern.



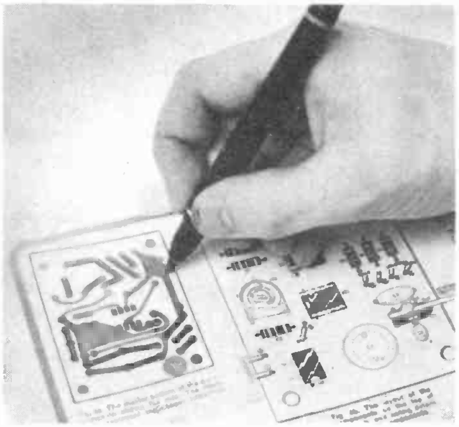
The etch resist pen is used to fill in any irregularities and as an alternative to transfers for large areas and long thin lines.

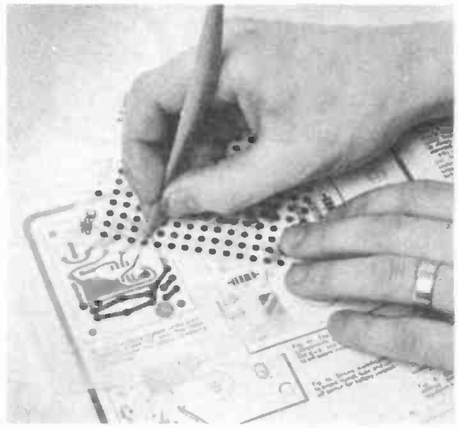


The completed board ready for etching.

PHOTO RESIST

The photographic method can be broken into three stages. First a transparency of the foil pattern is made. Second, a piece of pre-sensitised board is put behind the transparency and exposed to strong U.V. light. Board can be bought ready coated or a coating applied from an aerosol. Third, the exposed part of the coating is dissolved in a solution of caustic soda leaving a resist coating corresponding to the p.c.b. pattern.


Making the transparency using drawing ink and tracing paper.

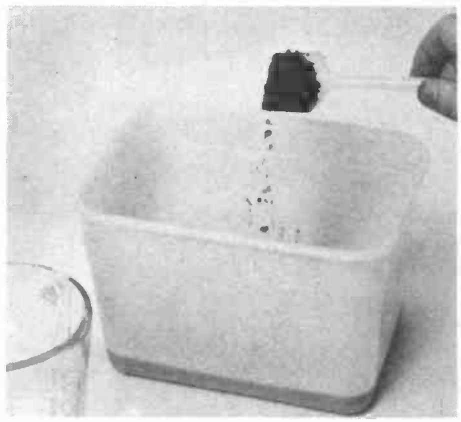

Making a transparency using rub down transfers. The base material may be tracing paper or some other translucent material.

ETCHING

Removing the unwanted copper from the board involves dissolving away the unwanted areas with a chemical solvent. This process is known as etching and the method is the same whichever form of etch resist is used.

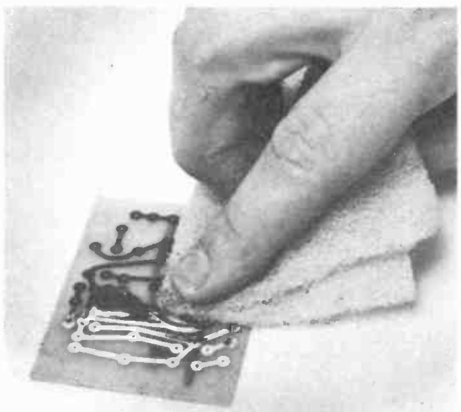
The most common copper solvent is ferric chloride solution. *Beware—this is highly corrosive and very poisonous.* **It is usually sold in the form of tiny brown crystals.**


Glass and plastic vessels are essential when handling this material.


Making up the solution. You must follow the manufacturers instructions exactly.

FINISHING OFF

Once the etching process is complete and the finished board has been rinsed, there are several operations to carry out before the board is completed. The etch resist must first be removed, although certain photo resist materials can be left in place as they form a flux for soldering. Holes should be drilled for both component wires and mounting bolts and the copper surface thoroughly cleaned.


Removing the etch resist using an abrasive pad. Sticky back plastic can simply be peeled off.


Drilling component and mounting holes. A diameter of 1mm is adequate for most components.

PATTERN TRANSFER

Generally there are two ways of transferring the published foil pattern onto the board in the form of an etch resist. One is to do it directly, the other photographically.

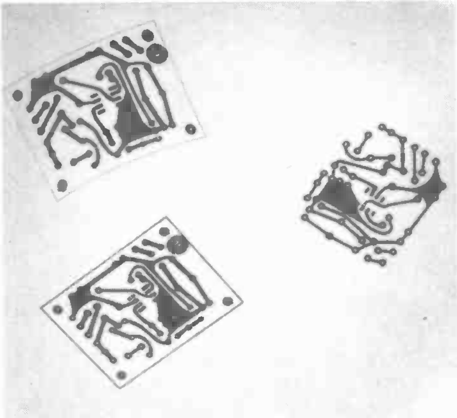
Direct methods, as the name implies, involve the direct application of a physical barrier to the surface of the copper and can take the form of self-adhesive plastic, transfers, or paint.

Generally speaking, the paint or plastic is used for simple patterns and transfers are reserved for more complicated designs.

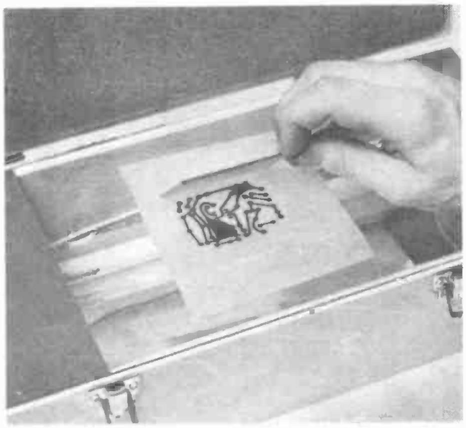
The photographic method involves coating the copper surface with a light sensitive chemical resist, exposing the board to a transparency of the foil pattern and developing away the exposed resist, rather like a photographic plate.

Of course this method is much more precise than direct transfer methods and identical boards can be produced in as large a quantity as you wish. All commercial boards are made this way (or with a silk screen).

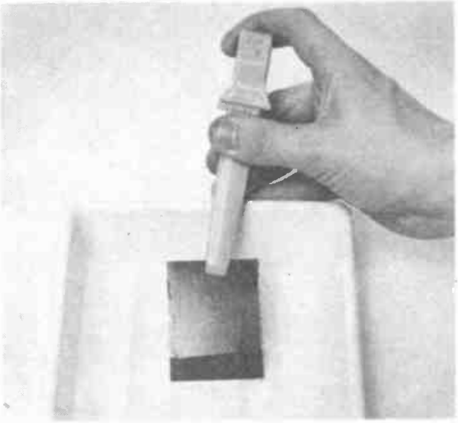
To the amateur this may seem rather daunting but in practise is



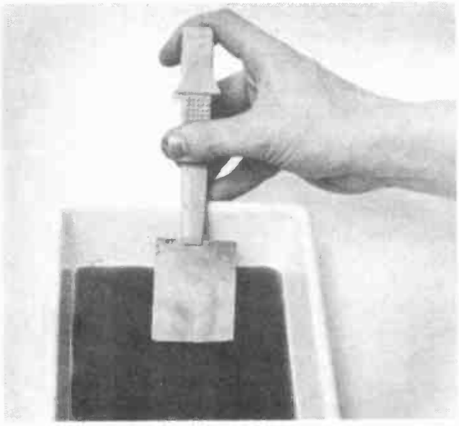
Completed transparencies using a combination of these methods.



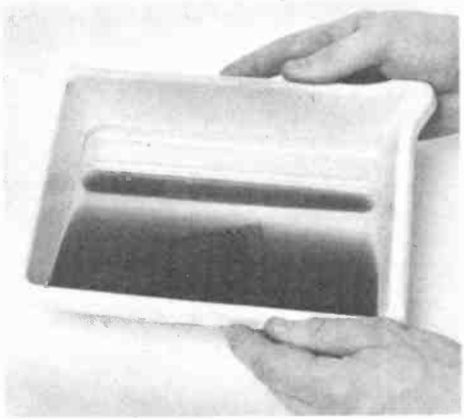
Placing the transparency and the board, coated side face down, in the U.V. light box for exposure. This takes about 20 minutes.



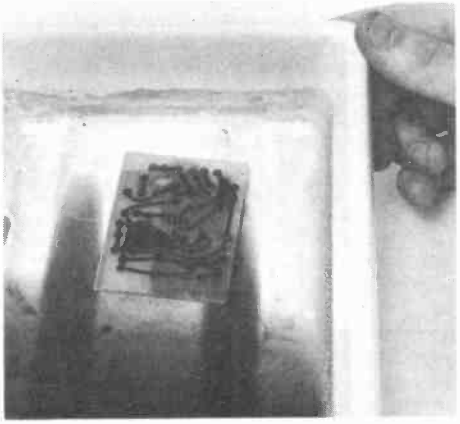
Developing the board. The solution is tinted blue and unwanted copper areas can be seen when the board is ready.



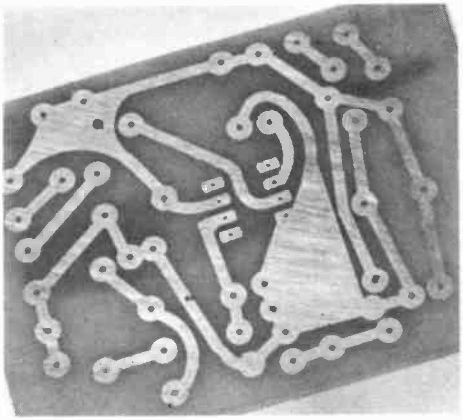
Using a pair of plastic tweezers immerse the board in the solution. A depth of about 15mm should be sufficient.



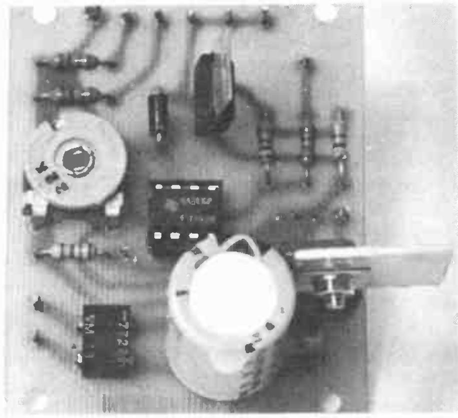
Leave the board in the solution for about 20 minutes, agitating every so often.



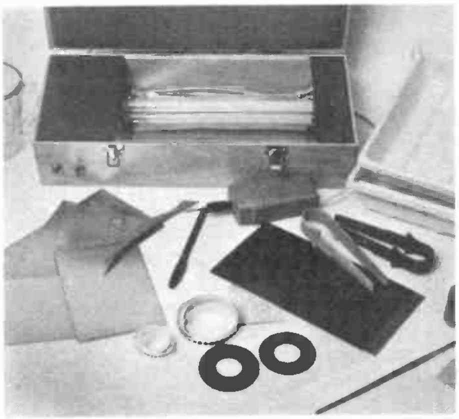
Once all the unwanted copper has disappeared, the board can be removed from the solution and rinsed under the tap.



The completed board before components are mounted.



The final result with all components in place.



Some of the materials needed to make a finished p.c.b.

quite simple and certainly worth considering if you intend to make a lot of p.c.b.s.

DOUBLE SIDED

Usually the copper pattern is on one side of the board only but in certain applications you may see a board with a pattern on both sides. These "double sided" boards are used where a great number of connections are required such as in computers and really need specialist manufacturing techniques.

Often the holes are "plated through" which means that there is a direct connection between the patterns on top and on the bottom of the board.

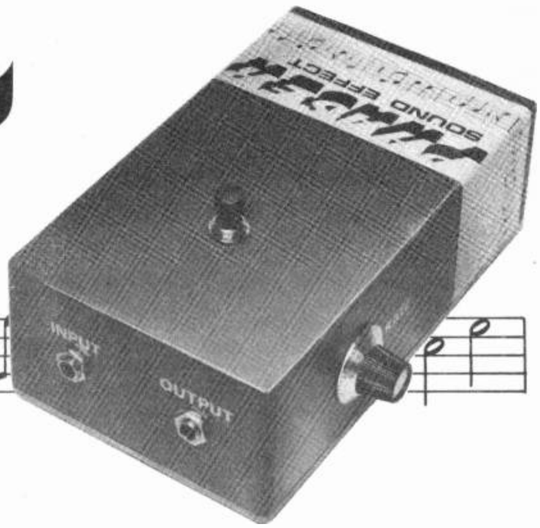
SOME PRACTICALITIES

Assuming you've worked out the foil pattern (and in all p.c.b. based E.E. projects it has already been done for you), the first problem is to decide which particular form of etch resist you are going to use.

Once this has been done, it is a simple matter to follow the step-by-step instructions to produce a board.

PHASER
SOUND EFFECT

R.A. PENFOLD



THERE ARE a large number of electronic effects units in use today, and the phasing effect is one of the most popular of these. It is an effect which is difficult to describe properly, but it will probably be well known to those interested in electronic music anyway.

The effect is produced using a filter that provides one or more notches (narrow bands of very high attenuation). The notch or notches are tuned slowly up and down over the greater part of the audio spectrum in order to produce the effect, and this tuning is normally achieved automatically using an oscillator which can be set to the desired speed.

Usually a slow phasing speed of less than one Hertz is used, although a higher speed can be used. However, this gives a very different, and tremolo like effect.

For the best possible effect, a phaser should provide a number of notches, but quite a good effect can be obtained from a one or two notch circuit, and in the interests of simplicity and economy most phasers are of the single or double notch variety.

The circuit described here is a double notch type, and it generates negligible levels of noise and distortion due to the use of modern bifet devices in the design. Low distortion is also aided by the use of opto-isolators in the phase shift networks, rather than the more usual Jfets.

OPERATING PRINCIPLE

The diagram in Fig. 1 shows in block form the basic arrangement used in the unit. The input signal is applied to a preamplifier which gives the unit a high input impedance, and also gives a small amount of voltage gain to compensate for the losses through the mixer circuitry at the output of the circuit.

This gives the unit an overall voltage gain of approximately unity. Some of the output from the preamplifier is fed through a series of four phase shift networks.

PHASE SHIFT

Each phase shifter is based on an inverting amplifier which gives 180 degrees of phase shift, and has a voltage gain of unity. In other words, the output voltage is equal to that fed to the input, but is opposite in polarity.

Each stage has additional circuitry that modifies its performance, so that the amount of phase shift decreases with increasing input frequency, and is zero at very high frequencies.

If we first consider the action of the circuit at these two extremes, with 180 degrees of shift through each section, the signal appears in its original form at the output of the last phase shifter.

This is because the inversion through the first section is counteracted by a further inversion through the second section, and the inversions through the third and fourth stages similarly cancel out one another.

The output from the final phase shifter is mixed with some of the output from the preamplifier, and as the two signals are identical they do not modify each other in any way. The unit then simply acts as a unity gain buffer amplifier.

The same is true when there is zero phase shift through each of the four sections since, as before, the signal emerges unchanged from final phase shifter.

ATTENUATION

A very different situation arises at certain intermediate levels of phase shift. For example, at the frequency where there is 45 degrees of phase shift through each section, the signal undergoes a total of 180 degrees of phase shift through the four sections, and emerges inverted at the output from the final stage.

Thus this signal will be equal in value to the signal direct from the preamplifier, but of opposite polarity, and when the two are mixed together they precisely cancel one another out. The circuit therefore provides infinite attenuation at this frequency.

There will also be a high level of attenuation at frequencies close to this one, as the two signals fed to the mixer partially, although less than

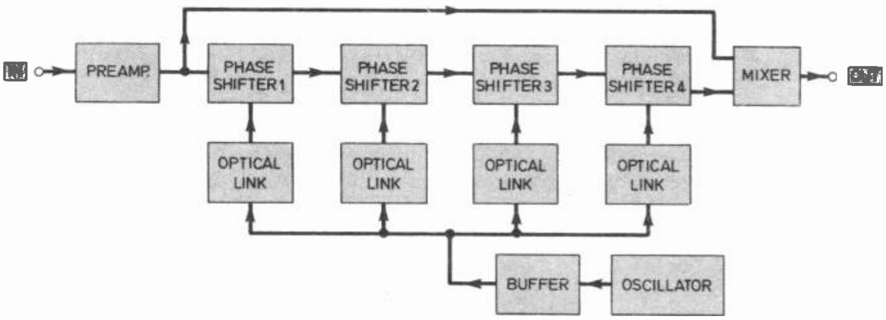


Fig. 1. Block diagram of the Phaser.

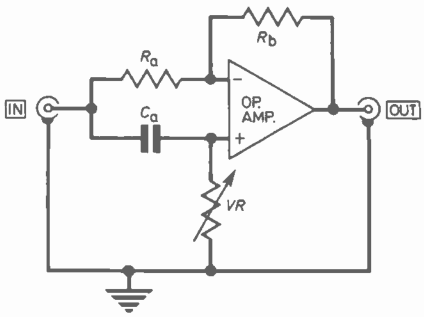


Fig. 2. Basic circuit of one of the phase shifting elements.

totally, counteract each other. This gives one of the required notches of high attenuation.

The other notch occurs at the frequency where there is 135 degrees of phase shift through each section. This gives a total shift of 540 degrees, and the first 360 degrees of shift merely brings the signal back into phase with the input. The next 180 degrees of shift then inverts the signal so that the cancelling effect is produced at the mixer.

It is possible to vary the frequencies at which the 45 and 135 degree phase shifts are produced by altering the value of a resistance in each phase shifter.

This resistance is varied electronically by a low frequency oscillator having a buffered output, and this gives the required sweeping of the notches over the audio spectrum.

where impedance of C_a is equal to that of VR, the circuit will be half way between the two extremes and will give 90 degrees of phase shift.

The voltage gain is always unity, regardless of the degree of phase shift provided. Obviously the frequency at which a particular phase shift is obtained can be varied by means of VR, and it is by controlling this resistance that the frequencies of the notches are varied.

COMPLETE CIRCUIT

The full circuit diagram of the phaser is shown in Fig. 3. The first i.c. IC1 is used in the preamplifier, and it is employed in the conventional inverting mode. As only a single supply rail is used, R2, R3, and C2 have been used to provide a centre tap on the supply to which the non-inverting

This is important because such noise spikes could easily enter the signal path, and would be very noticeable if the unit was to be used with a low level source such as a guitar.

A second advantage of the ICM7555 over the standard device is its far lower current consumption (only about 80μA as opposed to 8mA for the standard device).

The circuit operates by letting timing capacitor C13 charge up by way of R15, VR1, and R16 until a charge voltage of two-thirds supply is achieved The i.c. is then triggered, and exhibits a very low resistance from pin 7 to the negative rail.

Capacitor C13 then discharges through R16, VR1, and IC6 until its charge drops to one-third supply and IC6 then reverts to its original state and C13 commences to charge again. The circuit continuously oscillates in

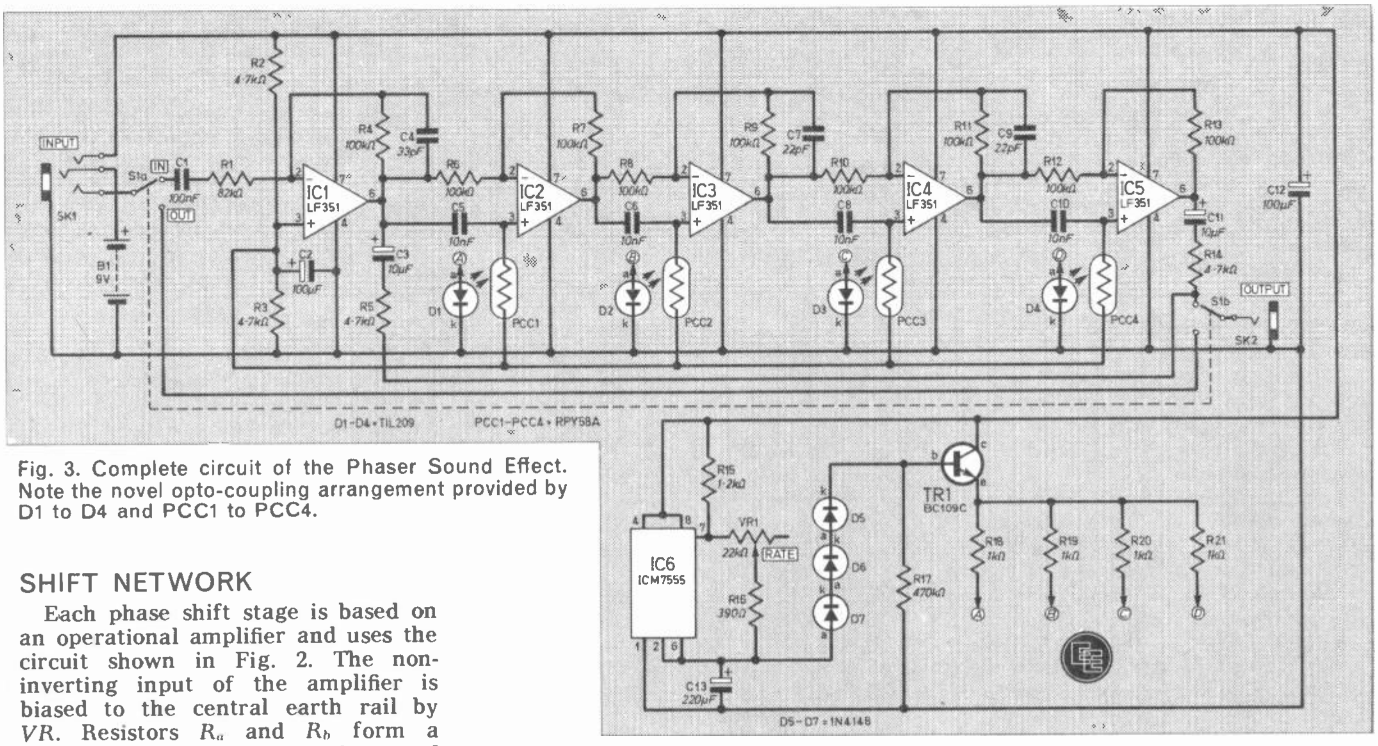


Fig. 3. Complete circuit of the Phaser Sound Effect. Note the novel opto-coupling arrangement provided by D1 to D4 and PCC1 to PCC4.

SHIFT NETWORK

Each phase shift stage is based on an operational amplifier and uses the circuit shown in Fig. 2. The non-inverting input of the amplifier is biased to the central earth rail by VR. Resistors R_a and R_b form a negative feedback loop and are of equal value so that the required unity voltage gain is obtained.

At low frequencies where the impedance of C_a is high in relation to that of VR, no significant signal is coupled by C_a to the non-inverting input of the amplifier. The circuit then acts as a straight forward inverting amplifier, giving 180 degrees of phase shift.

At high frequencies the circuit provides a phase shift of zero as all the input signal is coupled to the non-inverting input of the amplifier through the relatively low input impedance of C_a.

At intermediate frequencies the circuit operates in a combination of both modes, and gives an intermediate level of phase shift. For instance,

inputs of the five operational amplifiers are biased.

The four phase shifters are based on IC2 to IC5, and are all of the type already described. Capacitors C7, C9, and C4 are used to roll off the r.f. response of the circuit in order to prevent instability. The mixer is a simple passive type and is comprised of R5 and R14.

OSCILLATOR

The oscillator uses IC6 in a standard 555 type astable circuit. The ICM7555 is actually a CMOS version of the popular 555 device, and in this application has the advantage of not injecting noise spikes of significant proportions into the supply lines.

this way, producing a roughly triangular signal across C13. The normal rectangular output at pin 3 of the IC6 is not used in this application.

TRIANGULAR OUTPUT

The triangular output from IC6 is fed via D5, D6, and D7 to an emitter follower buffer stage which uses TR1. This uses four l.e.d.s and their series current limiting resistors as its emitter load.

Due to the voltage drop across D5 to D7 and the base emitter terminals of TR1, when the output from the oscillator is at its minimum level there will be just insufficient voltage across the l.e.d.s to turn them on.

COMPONENTS

Resistors

R1	82kΩ	R5	4·7kΩ	R16	390Ω
R2	4·7kΩ	R6-R13	100kΩ (8 off)	R17	470kΩ
R3	4·7kΩ	R14	4·7kΩ	R18-R21	1kΩ (4 off)
R4	100kΩ	R15	1·2kΩ		

All ¼W carbon ± 5%

Capacitors

C1	100nF polyester type C280	C8	10nF polyester type C280
C2	100μF 25V elect.	C9	22pF ceramic plate
C3	10μF 25V elect.	C10	10nF polyester type C280
C4	33pF ceramic plate	C11	10μF 25V elect.
C5	10nF polyester type C280	C12	100μF 25V elect.
C6	10nF polyester type C280	C13	220μF 25V elect.
C7	22pF ceramic plate		

Semiconductors

IC1-IC5	LF351 f.e.t. input op-amp (5 off)
IC6	ICM7555 CMOS timer i.c.
TR1	BC109C *npn* silicon
D1-D4	TIL209 3mm red l.e.d. (4 off)
D7-D9	1N4148 small signal silicon diodes (3 off)

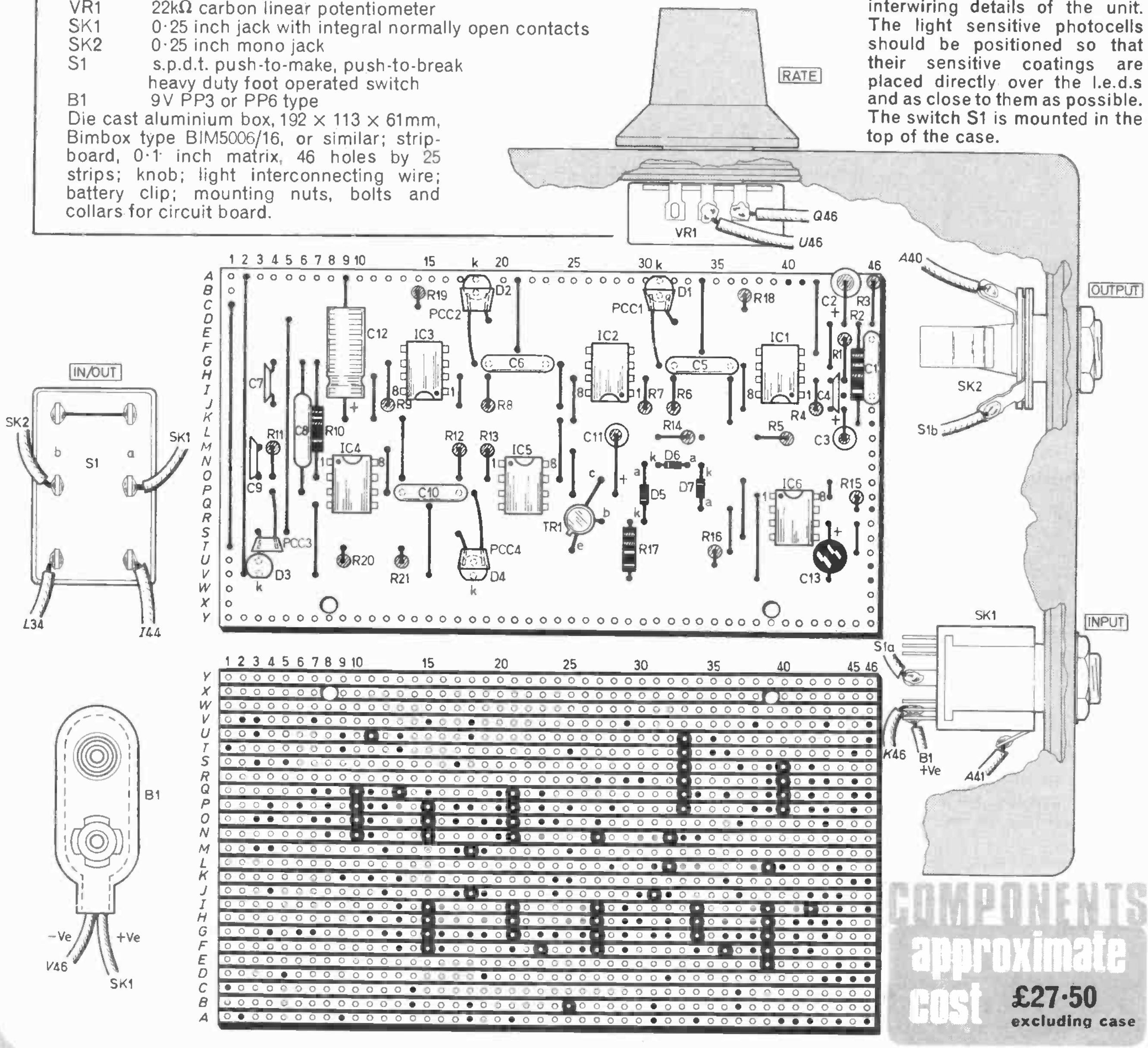
See **Shop Talk** page 20

Miscellaneous

PCC1-4	RPY58A cadmium sulphide photocell (4 off)
VR1	22kΩ carbon linear potentiometer
SK1	0·25 inch jack with integral normally open contacts
SK2	0·25 inch mono jack
S1	s.p.d.t. push-to-make, push-to-break heavy duty foot operated switch
B1	9V PP3 or PP6 type

Die cast aluminium box, 192 × 113 × 61mm, Bimbox type BIM5006/16, or similar; strip-board, 0·1 inch matrix, 46 holes by 25 strips; knob; light interconnecting wire; battery clip; mounting nuts, bolts and collars for circuit board.

Fig. 4. Circuit board layout and interwiring details of the unit. The light sensitive photocells should be positioned so that their sensitive coatings are placed directly over the l.e.d.s and as close to them as possible. The switch S1 is mounted in the top of the case.



COMPONENTS approximate cost £27·50 excluding case

At higher output voltages there is sufficient voltage across the l.e.d.s to switch them on to some degree, and so the l.e.d. brightness varies in sympathy with the output voltage from the oscillator.

The light output from D1 to D4 is directed at PCC1 to PCC4 respectively. The latter are cadmium sulphide photocells which have a resistance of at least 200 kilohms in total darkness, but less than 1 kilohm when the l.e.d.s are at maximum brightness. Thus, as the brightness of the l.e.d.s vary, the two notches are swept up and down in frequency.

OPTO ISOLATOR

This opto-isolator arrangement may seem to be a little unusual in this type of equipment, but it has the advantage over the Jfets which are normally used, of introducing no significant distortion. Also, no setting up adjustments are required.

The switch S1 can be used to bypass the phaser circuitry when the phasing effect is not required, and this is a foot operated, sequential push button type.

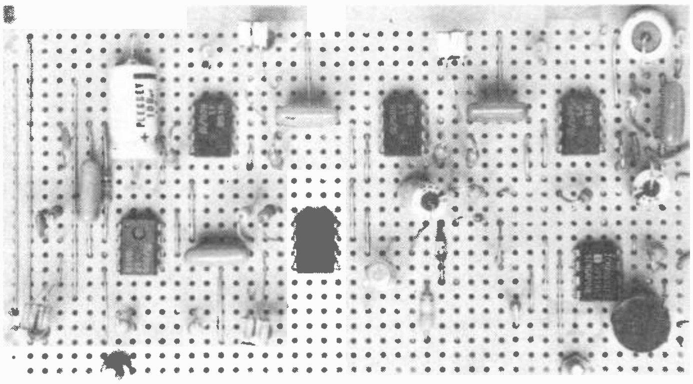
The on/off switch, is made from one set of contacts on the input socket, SK1, and the unit is automatically switched on when a plug is inserted into SK1.

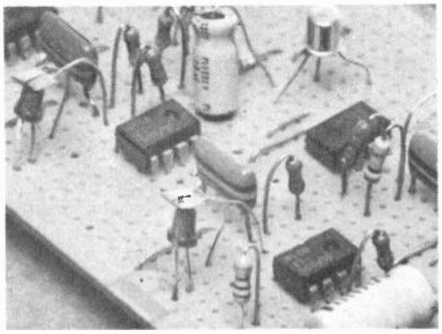
A separate switch can, of course, be used if preferred. The average current consumption of the unit is only about 18mA.

METAL CASE

The unit must be housed in a strong metal case, and a diecast aluminium type is ideal. The case for the prototype is a diecast box having approximate outside dimensions of 192×113×61mm, but this is slightly larger than is absolutely necessary. The sockets, switches, and VR1 are mounted on the case in the positions shown in the photographs.

Photograph right shows a close-up view of the completed circuit board. The photocells and l.e.d.s can be seen in position. A better view of these can be seen below. Note that the photocell is positioned horizontally over the l.e.d. with a spacing of about 2mm.





Next the circuit board can be produced, and details of this are provided in Fig. 4. This has dimensions of 46 holes by 25 strips and is carefully cut down from a larger piece using a hacksaw. The two 3·3mm diameter mounting holes are then drilled and the numerous breaks in the copper strips are made.

BOARD

The board is then ready for the components and link wires to be mounted and soldered into place. Although IC6 is a CMOS type, the normal special handling precautions are rendered unnecessary by its internal protection circuitry.

The other i.c.s do not require any special precautions either, because they have Jfet and not MOSFET input stages. The four l.e.d.s are mounted vertically on the board, and then the photocells are connected and position over their respective cells, as close to them as possible. Then the sensitive surface of each cell must be aimed down at its l.e.d., and this is the surface to which the leadout wires do not connect.

Finally, the board is completed by connecting flying leads of adequate length at the appropriate places, and connecting the negative battery clip lead. It is then mounted on the base panel of the case using two 6BA or M3 screws. The board itself can be used as a template when marking the position of the two mounting holes on the case.

Be careful to position the board where it will not be obstructed by the controls or sockets when the base panel is fitted into position. 6·3mm spacers are used over the mounting bolts to hold the component board clear of the metal casing. The remaining wiring can then be completed, and this is illustrated in Fig. 4.

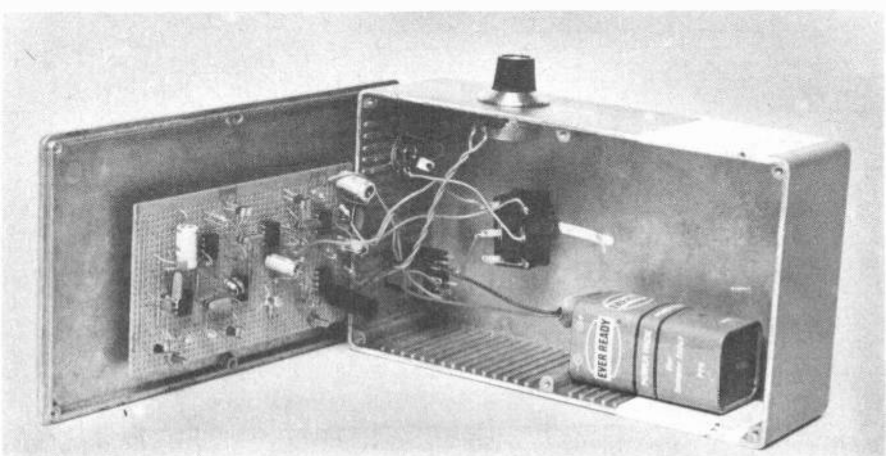
TESTING

After a final check for mistakes the unit is then ready for testing. Note that the unit will not produce a full effect unless the case is closed and the photocells are shielded from the ambient lighting. If the unit is working correctly, the phasing effect should be clearly audible on virtually any input signal.

It will be most apparent on a signal containing a wide range of frequencies though, such as a guitar fed first to a treble boost or fuzz unit, a noise source, or a tone generator having a squarewave output.

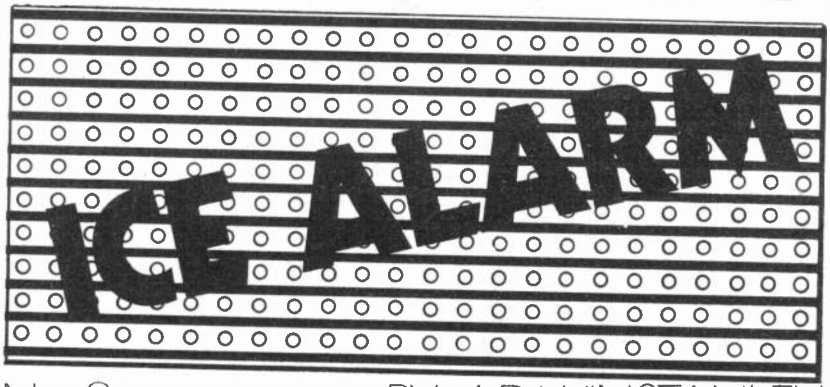
The RATE control, VR1, should give a sweep rate of about one every 7·5 seconds at maximum resistance to about 3·5 per second at minimum resistance. Some constructors may feel that the sweep covers an excessive range of frequencies, and a narrower sweep can be obtained by increasing the distance between each photocell and its l.e.d. ⌑

A view inside the completed unit. The circuit board can be seen mounted in position on the base to the left and the controls mounted in the upper part of the box to the right.



I.C. UNIBOARDS

SIMPLE INTEGRATED CIRCUIT DESIGNS



No. 2

BY A.R. WINSTANLEY

AT THE time of writing, winter is upon us once more, and with it come the traditional problems of black ice and treacherous driving conditions for motorists.

This Ice Alarm warns the driver when possible conditions exist for the formation of black ice. It does this by monitoring the temperature outside the car. When this drops to about two or three degrees Celsius, slightly above freezing, the unit flashes a warning lamp on the dashboard, thereby alerting the driver.

Normally, however, this lamp is continuously alight to indicate that the unit is in operation. The device can be switched off when it is not required.

CIRCUIT DESCRIPTION

The unit employs a CMOS integrated circuit, and the full circuit is shown in Fig. 1.

The heart of the unit is IC1, a CMOS multivibrator which has been wired up as a gated astable. This means that the device oscillates only when pin 5 is high, otherwise it is inoperative.

There are three outputs, pins 10 and 11 are the Q and $\overline{Q}$ outputs, and pin 13 is the oscillator output. Of these, pins 10 and 13 are not used in this design. The Q and $\overline{Q}$ outputs simply go high and low alternately. At all outputs a square wave is generated, the period (or time for one cycle) of which is determined by values of C2 and R3.

At pins 10 and 11 the period is equivalent to roughly $4{\cdot}4 \times R3 \times C2$. Thus the period at pin 11, the only output used, is approximately 0·5 seconds, giving a frequency of 2Hz. The frequency of the square wave at pin 13 is always double this.

Ignoring TR1 for the moment, when pin 5 is grounded, the i.c. is disabled and does not oscillate. In fact pins 10 and 12 go low and pin 11 goes high. The outputs remain like this until pin 5 goes high again, when the i.c. will once more oscillate.

DETAILED OPERATION

The Ice Alarm operates in detail as follows. The sensor, RTH1, consists of a thermally sensitive resistor, or thermistor. Its resistance decreases as its temperature rises. It has a negative temperature coefficient. At 3°C it has a resistance of roughly 11 kilohms.

Along with R1 and VR1, the thermistor forms a potential divider, the output of which is connected to the base of TR1. This transistor is a *pnp* Darlington transistor. It is really two transistors in one, so connected as to form a very high gain unit.

If TR1 is on, pin 5 is high and so the i.c. oscillates freely. If the transistor is off, however, the reset pin is grounded through R2 and so the i.c. is disabled. In this case pin 11 goes high and remains like this until the transistor TR1 turns on again.

Under warm conditions TR1 is off. Pin 11 then delivers a constant drive signal to TR2, which switches on. This means that the indicator lamp LP1 is constantly alight.

As the temperature of RTH1 decreases towards 0°C, its resistance will increase and the voltage at TR1 base will be reduced. Eventually a point is reached where the base terminal is 1·2V less than the emitter and so TR1 must turn on. Pin 5 of IC1 goes high, permitting it to oscillate normally; pin 11 then presents a square wave signal to TR2 and this causes the indicator lamp to flash.

Note that the lamp is normally fully alight to show that the Ice Alarm is on, but it flashes when RTH1 detects a low temperature.

PRESET

The preset VR1 permits a certain amount of adjustment to be made to the "switching point" of TR1, that is the instance at which TR1 will start to conduct and cause IC1 to flash the lamp.

The two main factors affecting this switching point are the 20 per cent tolerance on the thermistor, and also the actual voltage of the supply rail. The tolerance on RTH1 may cause either premature or late operation of the flasher circuit.

Fig. 1. Full circuit diagram of the Ice Alarm.

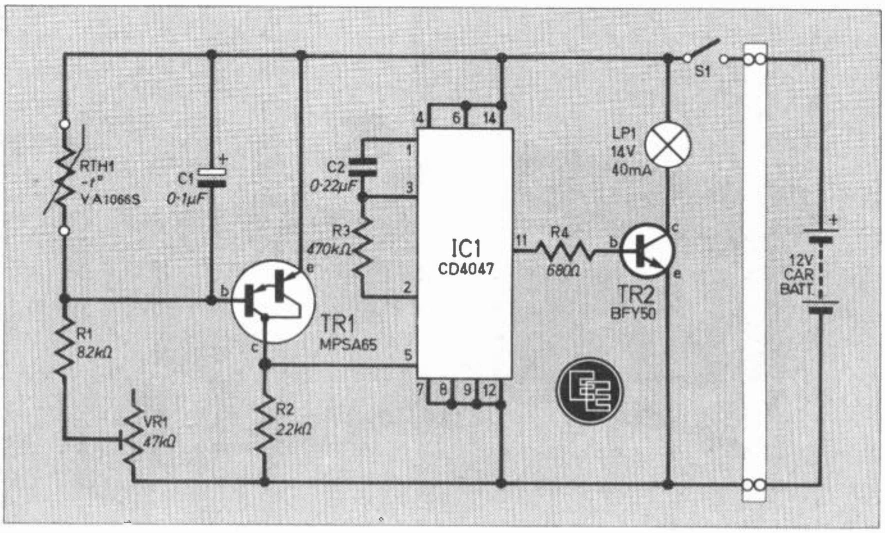
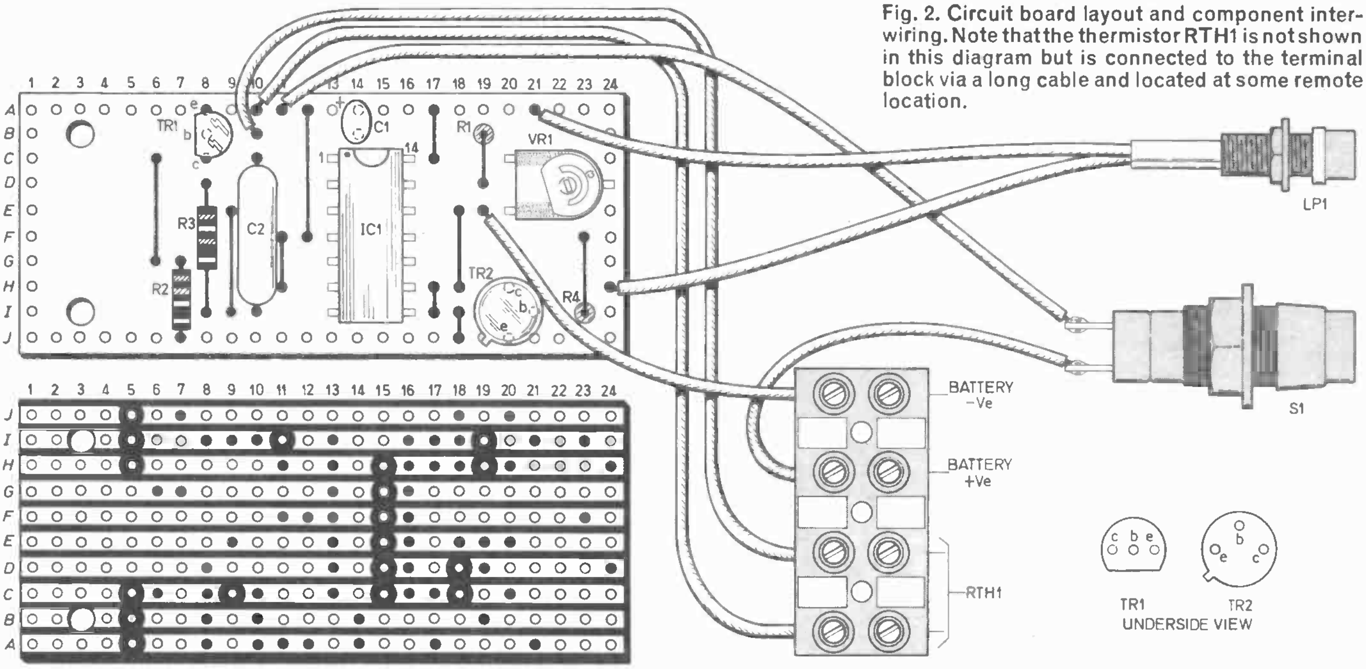


Fig. 2. Circuit board layout and component interwiring. Note that the thermistor RTH1 is not shown in this diagram but is connected to the terminal block via a long cable and located at some remote location.



CIRCUIT BOARD

The layout of the components is shown in Fig. 2. These are all mounted on 0·1 inch matrix stripboard which measures, of course, 10 strips × 24 holes.

It is usually best to commence by drilling the two holes needed to take the mounting hardware and then make the breaks in the copper strips. There are eighteen of these.

It is strongly advised that a 14-pin dual-in-line (d.i.l.) socket be used to carry IC1, and the socket should next be soldered into position. Do not insert IC1 yet but keep it in its anti-static package for the moment.

Complete construction by soldering in the resistors, capacitors and then the transistors.

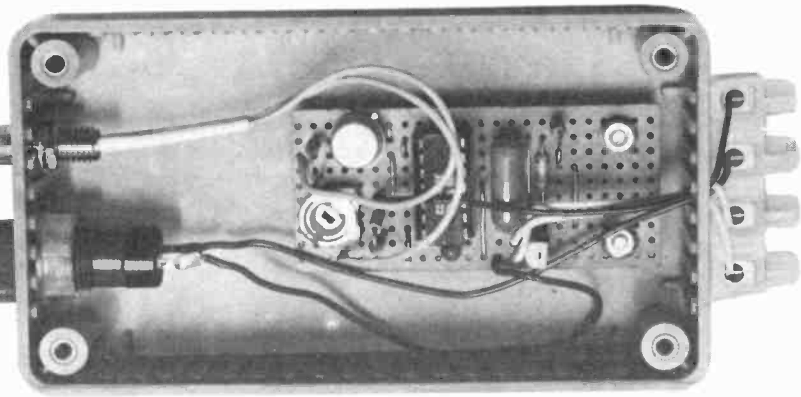
With the assembly of the component panel completed, the i.c. can now be inserted into its socket. Some precautions are necessary however because CMOS devices are sensitive to static electricity.

The circuit board is mounted with 6BA hardware within a plastic box roughly 110×60×30mm. Any case, either metal or plastic, of suitable dimensions can be used, although a Bimbox type BIM2003/13 was used in the prototype.

FINISHING OFF

The push switch, S1, and the indicator lamp were mounted on the box but there is no reason why these could not be extended to a suitable location on the dashboard. In its present form the Ice Alarm is fixed by brackets under the dash, with the lamp and switch facing forward.

Connections for the power feed and thermistor are taken by flying leads from the stripboard, through the case to a four-way screw terminal block mounted outside the case.



Inside view of the unit showing the position of the circuit board and interwiring to other off-board components.

COMPONENTS

Resistors
- R1 82kΩ
- R2 22kΩ
- R3 470kΩ
- R4 680Ω

page 20

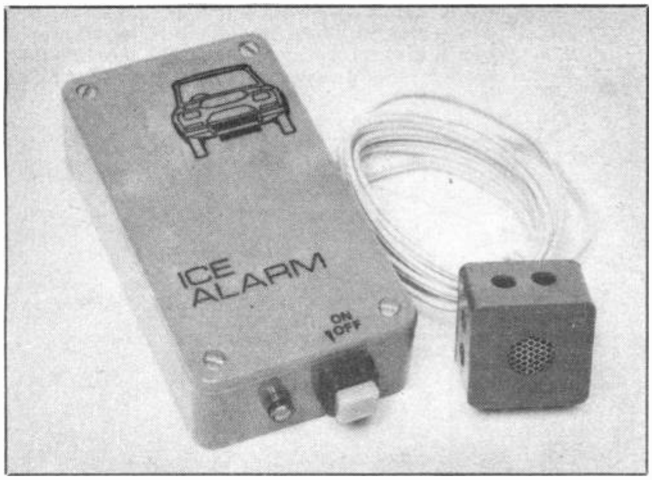
Capacitors
- C1 0·1μF tantalum bead 35V
- C2 0·22μF polyester C280

Semiconductors
- IC1 CD4047 CMOS mono/astable multivibrator
- TR1 MPSA65 *pnp* silicon Darlington
- TR2 BFY50 *npn* silicon

Miscellaneous
- VR1 47kΩ miniature horizontal preset potentiometer
- RTH1 VA1066S negative coefficient rod thermistor
- LP1 14V 40mA integral type MA lamp (amber)
- S1 push-on, push-off single pole switch

Case, 110 × 60 × 30mm, Bimbox type 2003/13 or similar; stripboard, 0·1 inch pitch, 10 strips × 24 holes; 14 pin d.i.l. socket for IC1; four-way screw terminal block; piece of tagstrip for mounting RTH1; twin core flex; mounting hardware for circuit board; lamp holder for LP1.

Guidance only Approx cost £7·50 complete



Outside view of the completed unit. The thermistor is mounted in the small container shown on the right. It is important to keep RTH1 dry but at the same time it should not be unduly insulated from the outside environment. This means that the container should be adequately ventilated.

The indicator lamp recommended for the design is a 14V 40mA "MA" integral type. This fits into a $\frac{1}{4}$ inch dia hole and has convenient flying lead connections which solder straight to the stripboard.

The thermistor, in the prototype, was soldered to a small piece of tagstrip with one mounting lug being used to secure this assembly inside a small plastic box measuring about $30 \times 30 \times 20$mm.

This box must be well ventilated so that the thermistor within can measure the temperature of the air around it. Cheap twin core flex can be used to connect up the thermistor to the main unit.

INSTALLATION

It is of prime importance that the power supply is wired up the right way round; +12V and 0V are taken to the appropriate terminals of the connecting block on the case.

You should ascertain whether the car chassis is positive or negative earth and connect this to the positive of negative terminal on the terminal block. The other supply wire should come from an ignition-controlled circuit (possibly at the fusebox), so that the Ice Alarm is not inadvertently left switched on should the ignition be switched off.

The position of the thermistor module may be rather a trial and error affair The unit is obviously not waterproof and so it must not be exposed to spray or road filth. Furthermore it needs to be placed away from the car's exhaust system and cooling system—parts which get hot during normal operation.

Final positioning must vary from car to car. A suggestion is behind (i.e. inside) the front bumper.

Readers with component embedding resin available may like to try potting the thermistor inside a small box. This would weatherproof the module, and is a much better alternative than the assembly described in this article.

With installation completed there is little left to do except wait for a frosty night! Check for correct operation (the lamp flashes) when the thermistor has detected freezing temperatures.

Some adjustment of VR1 may prove necessary but initially start with the preset to mid-position. Once you have finalised the setting, the preset should be secured with a dab of glue or paint. ⌑

BOOK REVIEWS

A GUIDE TO ELECTRONIC MUSIC

Author	Paul Griffiths
Price	£2·95
Size	200 × 135mm 128 pages
Publisher	Thames and Hudson
ISBN	0 500 27203 4

IT IS OFTEN forgotten that electronic music is not much more than thirty years old and yet the electronic revolution has had a profound effect on composers, opening up a whole new range of creative possibilities.

At the same time this area of music is still a mystery to most people. How many can honestly say that they have heard of such composers as Pierre Schaeffer, Edgard Varèse and Herbert Eimert?

Using clear, non-technical language, Paul Griffiths gives us an introduction to some of the most exciting music of today. The main strength of the book is its readability, something not easy to achieve when there are a lot of different achievements to cram into a modest space.

Indeed the book is remarkably comprehensive, covering the early days in Paris and Cologne right up to the Punk Rock of the late seventies. However it must be said that the author has concentrated entirely on the aesthetic to the exclusion of any technical detail.

Surprisingly, the rock world is given comparatively little coverage, especially when it is given credit for a great deal of cross fertilisation to the so-called "art" music sector, but as the author says, "only the composer's background can be used to determine whether his music should be classed as rock or art." S.E.D.

TOWERS' INTERNATIONAL MICROPROCESSOR SELECTOR

Author	T. D. Towers
Price	£14·95
Size	250 × 175mm 244 pages
Publisher	Foulsham
ISBN	0 572 01037 0

AN ENORMOUS amount of work must have been carried out in the preparation of this book which lists with parameters, over 7,000 devices, consisting of microprocessors, memories, interface chips with other related l.s.i. circuits. The sheer volume probably accounts for the rather high price.

The specifications listed are: Function, Word length, Description of the device, Family, Manufacturer, Package, Technology, Temperature range, Supply voltages, Quiescent power consumption, Compatible I/O levels, and Substitutes where applicable.

These specifications occupy about 80 per cent of the content, the remainder being devoted to ten Appendices containing lists of names and addresses of the manufacturers, a glossary, codings and Microprocessor "Families" (the CPU and support chips) to mention a few.

For those interested in microprocessor "development systems", a section is devoted to this where the CPU is listed with makers name and address. One other Appendix to mention is a bibliography of books and magazines available on the microprocessor and programming. Over 200 titles are mentioned.

This book certainly gives you a lot of relevent information in one package, but it is questioned whether the tabulated data is of the best arrangement. The devices are listed in alphabetical order. This is fine for Diodes, Transistors and Op-amps—the subject of earlier books in the "Selector" series by the same author, but is it the best approach for micros and support chips? B.W.T.

NEXT MONTH

A Splendid Mix

Stereo Mixer

A simple 3-channel transistor design with options for further expansion.
Can accommodate a variety of inputs.

Driveway Light

A light operated switch that responds to a predetermined number of headlamp flashes. It will keep the exterior light on long enough to let the user leave the car and enter house, and then switch itself off automatically.

Signal Tracer

A quick means of locating faults in radio receivers and amplifiers. This unit can be used in both r.f. and a.f. circuits and has enough sensitivity for low signal levels.

4 Band Radio

Superhetrodyne radio for added performance. Covers M.W. and L.W. as well as shortwave up to 15MHz. Features a b.f.o. for c.w. and s.s.b. resolution.

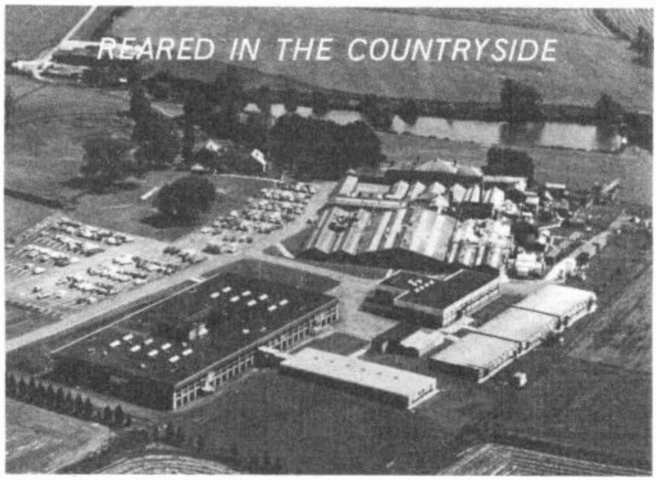
To make sure of your copy place a firm order with your newsagent.

Everyday ELECTRONICS

FEBRUARY 1981
ISSUE ON SALE FRIDAY, JANUARY 16

Everyday News

NEW BREED OF MICROELECTRONIC DEVICES



Gallium arsenide semiconductor devices will predominate in microwave systems of the future. The potentially superior performance of GaAs (compared to silicon) as a semiconductor substrate material has been recognised since the early 1960s. This discovery arose through work at the Allen Clark Research Centre, Caswell, Northants.

Named after the founder of the Plessey Company Limited, this is the company's microelectronics "back room." Today, a large organisation has grown up around the country house that was the original research centre, set up in the Northamptonshire countryside in wartime, forty years ago, to escape bombing.

It is now one of the foremost research establishments in the U.K., and has gained worldwide reputation for its work on the frontiers of electronic technology.

Here, in a pastoral setting, solid state physics is exploited to develop new technologies and microscopic devices for application to future sophisticated electronic systems.

GaAs Devices

Much of the work with GaAs analogue integrated circuits is geared to military requirements, particularly in the field of radar and communications at millimetre wavelengths (frequencies above 30GHz). But it is suggested that a possible civil application for this new gallium arsenide technology will be in receivers for the direct reception of TV via satellite.

High-speed digital circuits in GaAs are also being investigated at Caswell. These devices could find application in the computer field, where the possible speed of 4GHz and above will help meet the continual demand for yet more faster and more powerful computers.

Another material developed for microwave applications is indium phosphide (InP). This work, in collaboration with M.o.D. establishments, has lead to a world leadership position in the development of high efficiency pulsed Gunn oscillators. InP Gunn devices will operate at higher frequencies than GaAs and work is now in progress at Caswell to develop InP devices for the 100-200GHz band.

Piezoelectric Plastic Transducers

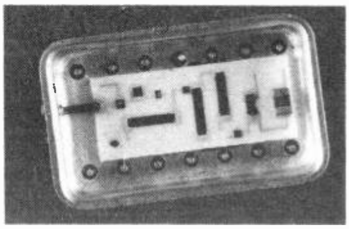
Carbon microphones in telephone handsets may be replaced by piezoelectric devices based on a plastic film, polyvinylidene fluoride (PVDF). The new devices are of simple lightweight constructions, wide frequency range and have linear relationships in mechanical/electrical response. A piezoelectric microphone designed at Caswell is currently being evaluated by British Telecom.

Fibre-optics

The important contribution to improvement in the telephone service is further illustrated by the Centre's work on fibre-optic components.

This includes the integration of electronic and optical functions on a single chip of GaAs using l.e.d.s, lasers and pin photodiodes in a monolithic configuration with GaAs f.e.t.s, film resistors and overlay capacitors.

Plessey engineers using the company's central integrated circuit CAD facility.



This hybrid receiver module uses a 1.3 micron sensitive Gallium Indium Arsenide PIN diode and Gallium Arsenide MESFET as front-end components for a high sensitivity fibre optic receiver preamplifier.

MICROELECTRONICS COME HOME

In a Design Centre exhibition to be held in London, January 7 to March 7, the public will be able to see and try out microelectronic products for the home and have a glimpse of the shape of things to come.

If any designers or manufacturers of British microprocessor-based products feels their "wares" are worthy of the public interest they should write to the Exhibition Manager, The Design Council, 26 Haymarket, London, SW1Y 4SU.

Billion Bit Disc

Two RCA scientists have developed a 12-inch diameter disc claimed to be able to store one billion bits of information. The disc is of plastic coating with tellurium.

A laser beam records information by burning microscopic "pits" in the surface coating. Retrieval of information is by a second laser and a light detector to catch the reflected illumination from the "pits".

The system is said to be theoretically capable of storing all the information of an encyclopaedia on both sides of a single disc.

. . . from the World of Electronics

ANALYSIS

THE ELECTRONIC JOURNAL

Most of us are now familiar with the idea of data banks stored in computers and capable of access through a computer terminal or, with an appropriate Teletext/Prestel decoder, through our home TV set. And we are all familiar with dissemination of information through the written and printed word of which this issue of EVERYDAY ELECTRONICS is but one example.

A logical development is the all-electronic journal which would dispense with ordinary printing and distribution methods, thereby saving both money and time. We are already half-way there with data banks and all the technology is available for a system in which not only does the user have access to the particular information he requires but also the preparation of articles, their refereeing when necessary by specialists, their editing and publishing are all computer-aided at the input end.

We can imagine a communications network in which authors, editors and readers are all interconnected and, to a large extent, interactive. Publishing of new material would be almost an instant process and the only "printing" would be by subscribers who decide to output a hard copy of text and diagrams at their own terminal. Publication could be continuous rather than in monthly "packets" of information.

How would an electronic journal work out in practice? To find out, the British Library has awarded grants of £122,000 and £134,000, respectively, to Birmingham and Loughbrough Universities. Researchers at Birmingham will supply all the hardware and software facilities and Loughbrough will conceive and "publish" the electronic journal.

The problems, if any, are seen not in the technology itself but in the way it can be best used by human beings and whether, in fact, the electronic journal would be easier to use and cheaper than a conventional printed journal. The title will be *Computer Human Factors*, reflecting the work of those engaged directly in the research plus contributions from other interested parties.

The grants extend over a period of three years to November 1983—just in time to meet the fateful Orwellian deadline, year of grace, 1984!

Brian G. Peck

Testmex 80

To the amateur constructor, the conception of test equipment probably runs to no more than a multimeter, signal generator and oscilloscope.

However the needs of industry extend way beyond these few items and the range and sophistication of exhibits on show at the recent *Testmex 80* exhibition indicate just how diverse this market has become.

For example, automatic p.c.b. assembly has become so complicated that manual checks are too time consuming or costly so a computer based autochecker is required. Other processes require similar automatic testing equipment and there was certainly no shortage of microprocessor based testing systems on display all crying for attention.

Of course this exhibition, held in the plush surroundings of the Wembley Conference Centre, was a trade only affair. Even our old favourites the oscilloscope and multimeter are now far more sophisticated to cope with superior component performances and whilst most test equipment on show was recognisible, its capabilities and performance far outstripped anything the amateur would ever need.

Even the familiar Avometer is being supplanted by a more modern and no doubt superior digital version.

In all there were nearly one hundred exhibitors at the exhibition and these were supplemented by a series of seminars on various topics related to electronic testing.

CB Hazards

A scare campaign that the proposed 928MHz band for *Open Channel* CB radio might be a health hazard for operators is virtually sure to be ignored by the Home Office. There is no evidence that the low field strengths from CB at such frequencies would be harmful.

Present illegal operation on 27MHz is damaging the CB cause through interfering with model aircraft remote control systems. The Society of Model Aeronautical Engineers has protested to the Home Office on public hazards of radio-controlled aircraft losing control through CB interference.

Computerised Metro

Behind the launch success of the new Austin Mini Metro car was 10 man-years of design of the production control system.

This involves 23 shop-floor computers and over 200 terminals located on the production lines, in stores and in offices. These are all linked by more than four miles of co-axial cable.

The control system is geared to production of a car every 40 seconds despite the fact that with different body colours, trims, accessories etc, there are theoretically 2×10^{21} possible versions.

Optimists

The recent Internepcon *exhibition of electronic production equipment was the biggest and best ever. It showed electronic manufacturers to be confident of a quick climb out of recession. It also confirmed that machines designed for high productivity are cheaper than people. Either way it indicated continued optimism in electronics as a continuing and fast-growing industry.*

Disc-processing is reported as having started on a pilot scale at Philips Blackburn plant. The Philips optical disc system is expected to have its launch during 1981 in the UK, the first country in Europe, with some 120 titles in conjunction with Magnetic Video Corporation.

The Marconi "Master Gunner", a realistic classroom artillery training aid with computer-controlled visual and audio effects, is being supplied to the United States 7th Army in Western Germany.

Seven complete systems are on order after extensive evaluation by the United States Army Field School at Fort Sill, Oklahoma.

Electronic Oilman

This year's Faraday Lecture, now touring the country is "The Electronic Oilman". It is presented by BP and describes in vivid detail with visual and audio effects how electronics is involved in every stage of oil production from exploration onwards.

Captain of Industry

This year's Captain of Industry Award from the Livingston Industrial and Commercial Association was won by Ernie Harrison, Chairman and Managing Director of the Racal Electronics Group.

The award is made to the person the Association considers has made the most outstanding contribution to British industry over the previous year.

RADIO WORLD

By Pat Hawker, G3VA

Open Line

One has only to listen to the amateur "nets" on the 3·5MHz band, or the many "phone-in" radio programmes, or note the continuing pressure for CB or Open Channel facilities to appreciate that, whatever may be the officially declared aims and intentions of the participants, in reality most people enjoy talking to others with the semi-anonymity conferred by a microphone, recreating the casual conviviality of an old-time pub or the traditional village green.

This type of informal social contact and semi-public forum, from which one can break-off without causing offence, appeals to a wide section of the public, and not only, as sometimes suggested, the lonely.

Now there is a very old saying in the telecommunications world, where the shortage of radio frequencies has long been recognised: "never use wireless when wire will do".

I was reminded of these two concepts by learning that the French are experimenting, at two places in the south of France, with a form of conference telephone arrangement that provides a "convivial" meeting house for the communities. In Montpellier and Lozère, by dialling a specific telephone number you can find yourself linked to from two to perhaps ten similarly minded callers.

A sociologist has been carefully checking up on how local subscribers are reacting to this experimental facility; she finds (as in the amateur radio "nets") that new micro-societies are being established, with their own rites, rules and self-elected leaders. The service, it appears, not only serves to reunite old friends and acquaintances and members of the same professions and occupations, but also bringing together people who to begin with may be complete strangers.

The use of surnames is rare, callers identifying themselves by first names and districts; as in radio phone-in programmes it is a case of "Mary of Mitcham" or "Charles of Croydon". In Montpellier, the "telephone societies" often adjourn their open line conversations for what the amateurs call "eyeball-to-eyeball" meetings, and one gathers that picnics, street-dances, card playing groups are again flourishing in that part of France.

The conviviality phone also seems to be proving an effective substitute for the computer-dating bureaux, and there is nothing in the reports I have read to suggest that any of the problems that might be anticipated are in practice arising in these small provincial towns. So perhaps, if the Home Office drags it feet on Open Channel, then British Telecom could step in with an Open Line.

World Radio Club

Since 1967, the BBC World Service has broadcast (three or four times each week) the 15-minute "World Radio Club" programmes for short-wave listeners, radio amateurs or indeed anyone with an interest in the technical aspects of broadcasting, radio communication or radio physics. Well over 700 weekly programmes have been produced, without breaks, first by John Pitman, then by Joy Boatman and most recently by Reg Kennedy.

A retired BBC engineer, Henry Hatch, G2CBB, has been connected with the programme since the earliest days. During the 13 years, more than 40,000 listeners have taken the trouble to write in and register themselves as "members" of the club. But come 1981 and, at least for a time, those regular "club meetings" are due to vanish from the World Service programme schedules, though whether this is a permanent closure has yet to be decided. As a regular listener, and an occasional contributor, perhaps I should spend next year outside Bush House with a placard "Bring back WRC"!

Collectors' Items

The rapid growth of interest during recent years in the collection of ancient radio and television sets and early gramophones is spreading out well beyond the old domestic equipments. Old telegraph apparatus, redundant in gleaming brass, early valves and components are now eagerly sought after or being brought down from attics, even though there is not a lot of early radio equipment that really deserves the "vintage" label.

Surplus military equipments that a few years ago could be bought for a bob or two off the pavements in Lisle Street, London are now being carefully restored even though some of them did not work too well when first made in the hectic rush to expand the production of radio equipment in 1940-41.

Among the collectors' favourites are the well-made suitcase transmitter-receivers, such as the B2 and B2 Minor, made for the Special Operations Executive (SOE) for use in clandestine links with the European Resistance movements, though I wonder if some of the present owners appreciate the agony of mind some of the original users went through every time they switched the equipment on in enemy occupied territory. Not only were the German direction-finding teams extremely skilled in tracking down the transmissions, but at times were also able to locate the "pianists" from the radiation of the local oscillator in the receivers.

Very rare, not only in this country but also on the Continent are items of German military equipment, although these were often of outstanding mechanical construction and included some of the best "straight" (i.e. non-superhet) communications receivers ever built, as well as transmitter-receivers with stable variable frequency oscillators that could be set accurately to a given frequency using the large clearly calibrated dials. One Dutch amateur, Arthur Bauer, PAoAOB of Amsterdam has gathered together some 100 items of this rare equipment and most of it, in full working order, is in regular use in his amateur station.

The reason for the scarcity of this well-built and sturdy equipment is that at the end of World War II, the Allies decided first to destroy all German military radio equipment apart from a few samples for examination in their research establishments, and then subsequently to halt the destruction but instead to dismantle what remained to provide components for domestic radios as post-war production restarted. Thousands of these "vintage" sets ended under the crash hammer.

800MHz Mobile Radio

One can understand, and have sympathy for, the vocal Open Channel (CB) lobby that objects to the proposal to locate this on the ultra high frequency of 928MHz. But some of the objections being made seem a bit exaggerated, including the notion that the range would be little better than what could be achieved with a good strong voice or a whistle.

In Tokyo, for example, a new high-capacity mobile telephone service was inaugurated by NTT (the official Japanese telecommunications agency) just about a year ago and using an 800MHz band that would have virtually identical radio propagation characteristics to 928MHz. With some thousands of vehicles now equipped, this system is being claimed as the world's first "cellular" mobile service, with a number of base stations placed regularly throughout the city and suburbs.

The coverage of each base to mobile station represents a radius of 5 to 10km and the whole system is arranged so that a vehicle driver linked to the ordinary telephone network can continue a conversation uninterrupted as he crosses "cell" boundaries.

Another feature of the system is that the vehicles automatically transmit location registration signals which are then stored in the memory of the electronic switching (mobile exchange) system so that the vehicle need be selectively "called" or paged only in the appropriate "cell" area.

Most of the normal telephone services are available to a driver, including the ability to make emergency police and fire calls. The base stations have a power of 25 watts while vehicle equipment is rated at 5 watts. The radius of each cell in the urban centre is 5km, and in the suburbs 10km. Initially the service covers 23 wards in Tokyo.

Eliminate TV?

A review of a recent book "Four Arguments for the Elimination of Television" by Jerry Mander delivers the following blast at the box: "Television threatens the person, society and the planet with dangers mental, physiological, ecological, economic, political. It inhibits thought. It disorientates viewers from a sense of time, place, history, nature. It encourages passivity, is anti-democratic and a seed-bed for autocracy. It limits and confines human knowledge within its own restricted capacity for transmitting information. It standardises people, accelerates the destruction of nature by increasing their alienation from it."

Gosh, seen any good programmes lately?

Memory Bag

Writing what I call my Christmas number is always a special pleasure because I can dip into my memory bag and my good Editor is even more indulgent than usual.

At this stage, I like to think it is perhaps Christmas afternoon and your breathing is slightly short circuited by that second helping of Christmas pudding. As you sit in your armchair in front of a roaring fire, you will soon nod off, but before you do, you might do a spot of reading, and all you require is a modicum of entertainment.

So where do I begin? Last year I remember telling you about some of my more unfortunate electronic experiments, resulting in temporary loss of eyebrows and my early experience with crystal sets.

However, I left school at fifteen and started to work for a firm of Meat and Canned Food importers in the City. At this point a slightly older cousin who was a steward on a P and O liner, returned and fired my imagination with tales of foreign travel, and I had to go and do likewise.

Foreign Parts

It was after returning from a trip to Australia that my father asked me if I would like to take up radio as a career. About this time Marconi had joined forces with H.M.V. and I was very happy working for them, but about two years later, when I was a top technician, I was being paid the magnificent sum of sevenpence ha'penny an hour.

I decided that a change would be beneficial so I then took a job in the service department at Ultra, and all I remember here is that I could look out of the window in front of my bench and see Kensal Green Cemetery.

Soon after I was lucky enough to find a job with Alexander Black, the Wireless Doctor. This particular work was great fun but something right outside my experience to date.

Variety

In those days Variety was all the rage, and we used to provide microphones, amplifiers and records of sound effects. I might be needed to provide a microphone for a crooner, but unfortunately it tied me up for the whole performance of perhaps ten acts.

In those days amplifiers were big and clumsy and had to be sited in the wings so I could see when to switch on and turn up the volume. That wasn't all. The entrance to the stage was usually quite narrow and all these shows started and finished with twenty or thirty high kicking chorines.

Just imagine my dreadful embarrassment at having twenty or more lovelies literally squeezing by me twice nightly wearing little more than a vacuous smile, talcum powder and a top hat.

Aeroplane

We did have our problems, of course, as for example when I put my microphone cable adjacent to a mains cable and when I turned up the volume, it sounded like an aeroplane flying through the theatre.

There was also that nerve racking performance when the whole play depended on our sound effects. My amplifier broke down and I repaired it with two seconds to spare. All in all I remember this period as a happy one as I found the theatre folk nice to work with and they really did work hard to scrounge a living.

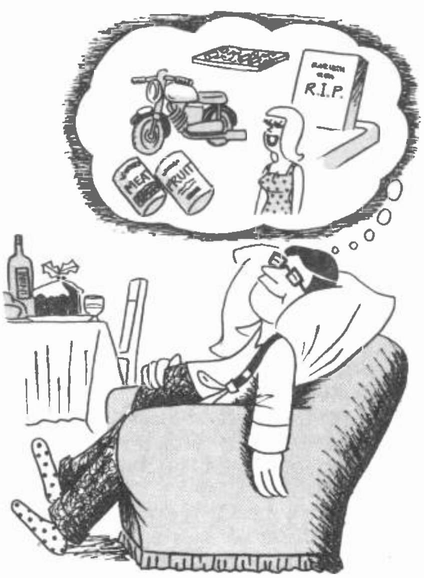
It was shortly after that that I had a job with Selmers, the musical instrument firm in Charing Cross Road. They had two brilliant designers, and I remember they made an amplified piano which could be used with earphones or fill the Albert Hall. My job was servicing these things.

Dead Reckoning

It was a few years later, after various jobs, that I found myself working for H.M.V. again. At this point through a slight miscalculation on my part, the war came and I became a pilot. For most of the war my only contact with radio was through my wireless operator. His main job was to give me bearings to steer back to base.

A splendid chap he was. When the sky was so clear you could see a hundred miles he would produce bearing after bearing. When you came back in a pea-soup fog, he couldn't come up with a single one.

I would then have to fall back on the method used for the last two hundred years called "dead reckoning". In fact, if no dramatic wind changes took place, it was fairly reliable. Needless to say I'm still around.



CMOS TAKE CARE

E. DOWDESWELL

HAVE you handled any good CMOS devices lately? If you've built a project recently using these you were probably just a bit vexed to read the author's casual note saying something like "handle the CMOS i.c.s with the usual care".

What usual care? Will they break if I drop them, you may well ask. It's all right for the author, he's got all the manufacturer's bumph! But why not share the info around with those "wot don't know"!

Of course, you are quite right. So let's have a look and see what it's all about. First of all, CMOS, what's it mean.

Well, discrete metal oxide semiconductors (MOS) have been around for quite a time and one popular type is the f.e.t. (field effect transistor) and its derivatives. But only in the last few years have production techniques made it possible to produce i.c.s having both n- and p-channel complementary types on the same chip. Hence CMOS.

STATIC CHARGES

The input gates on these devices exhibit very high values of resistance so that if a quite small static charge is applied to a gate inadvertently then the voltage developed can greatly exceed the voltage required to puncture the extremely thin layers of silicon oxide employed in the construction of the i.c.

This "puncture" voltage is round about 60V to 100V but some measure of protection is built into the gates, using diodes, which may have normal or Zener characteristics.

We can all generate static electricity ourselves quite easily, unknowingly most of the time. Taking a nylon shirt off in the dark will produce a nice lot of crackling sparks which are easily seen. Thick artificial fibre vests are an even better source of fireworks! If there is a transistor radio nearby it will sound as if there is a thunderstorm overhead!

So you walk across the nylon carpet in your nice plastic insulating slippers and sit down to get on with that CMOS project, taking with you a static charge of several thousand volts!

You pick up an i.c. and fiddle with it and bang, you've written it off. Unfortunately you are not likely to be aware of this until you find that the thing doesn't work. So, life can't really be as difficult as all that, there must be an answer somewhere.

CONDUCTIVE FOAM

There is. When you get your CMOS i.c.s either by post or from a shop they should be supplied "plugged" in to a piece of conductive foam that shorts all the pins of the i.c. together. LEAVE THEM THERE! Don't pull them out just to have a look at them, there're just like any other i.c.

The conductive foam is generally black and about ¼ inch thick and if you take a piece about 1 inch square and put your ohmmeter prods across opposite sides you will get a reading of 1·5 kilohm or so. This is pretty low as far as CMOS gates are concerned so while the i.c.s are in the foam they are being protected, and must not be removed until they are about to be fitted to the p.c.b. or stripboard.

The circuit board should be finished completely in every other respect because if the author has done his design work properly, he will have arranged for all the sensitive gates to be connected to the other i.c. elements via a d.c. path of some kind, usually a resistor. No pin of the i.c. should be left floating in any case.

POLYSTYRENE FOAM

By the way, don't plug CMOS i.c.s into ordinary polystyrene foam as it is an excellent insulator and almost certainly will be holding a substantial and dangerous charge.

Before handling CMOS devices discharge yourself by touching some earthed metalwork because the chances are these days that you will be wearing some clothing made from artificial fibres. If you can arrange to have an earthed sheet of metal on your workbench so much the better.

It's not a bad idea to have a lead handy, with a crocodile clip on each end, to connect the "earth" or "ground of the circuit board to the metal plate or other known earth.

THE SOLDERING IRON

This concludes the precautions you need to take if you are using i.c. holders on the circuit board but if you are going to solder the i.c.s directly to the board then we have another problem on the horizon. The soldering iron!

Being connected to the mains supply, usually, there is always the chance of leakage currents passing through the tip of the iron unless due precautions are taken.

Make sure that the earth wire of the iron is really connected to the earth pin of the mains plug. Why not check yours NOW? You may not have bothered with it in the first flush of excitement when you fitted the plug!

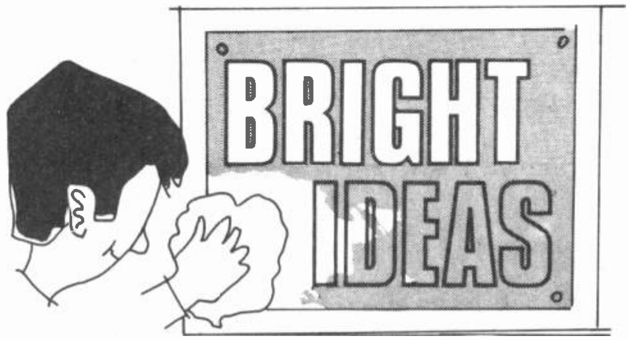
To make quite sure a separate wire should be taken from the soldering iron tip itself to earth. It is not unknown for the tip to be electrically isolated from the rest of the body of the iron.

Personally speaking, I always cheat in this matter of soldering irons and CMOSs. I make sure that the iron is properly hot then I unplug it from the mains and dab it on something earthed and make a couple of joints quickly on the i.c., then plugging the iron back into the mains again.

FINALLY, SWITCH OFF!

If the foregoing has frightened the life out of you, I'm glad! That was the idea! In fact, the precautions to be taken when handling CMOS i.c.s are few and simple: but it is important that they are understood. Then, if the project doesn't work when you have finished it, the chances are that the fault lies elsewhere than with the i.c.s—and that is some consolation!

Finally, and possibly most importantly, NEVER plug a CMOS i.c. into its socket, or remove it, when the power supply is on. Some would also add that signals should not be applied to the gates of a CMOS device when the power is off since the protective diodes may not be effective then. ⌑



Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

I.C. STORAGE

I have found an excellent substitute for the foam plastic which is used to store i.c.s. The material is called "Oasis", comes in a large green block used for flower arranging and is obtainable from any florist. It can be cut to shape using an old eating knife and it accepts i.c.s more easily than conventional foam.

This, of course, should not be used with CMOS i.c.s which require a special conductive black foam for static protection.

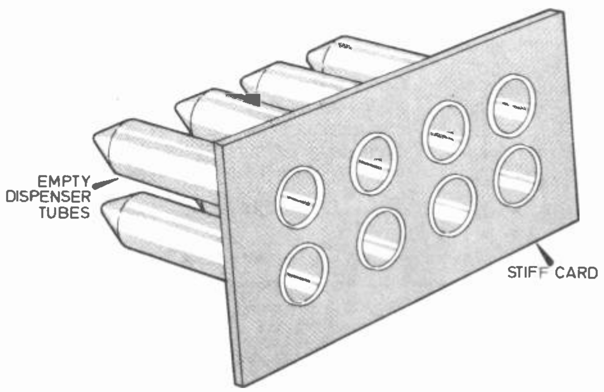
R. Easto,
Reigate,
Surrey

COMPONENT STORAGE

After a few years of constructing projects, a pile of empty solder dispenser tubes accumulates. These can be used to store components.

Holes are cut in a sheet of thick card the diameter of the tubes. These are then inserted through the holes and the whole card can then be suspended in front of the work-bench for easy component selection.

D. O'Connor,
Dumfries,
Scotland



EASY WAA-WAA

When constructing the *Waa-Waa Pedal* (EE March 1976) I found two short cuts to constructing the foot pedal.

The first consists of replacing the recommended pivot with a simple brass hinge. This needs to be split in two by removing the centre pin before the pedal can be assembled.

The second gets rid of the need for a spindle coupler and associated parts by simply bending the potentiometer spindle.

A plastic spindle can be easily bent by holding it above a candle flame at the required point. After a few seconds the plastic softens and it is then easy to bend it around any 90 degree former.

Once it is in the required position the plastic can be cooled in water. A few rubs with emery cloth removes any surface charring.

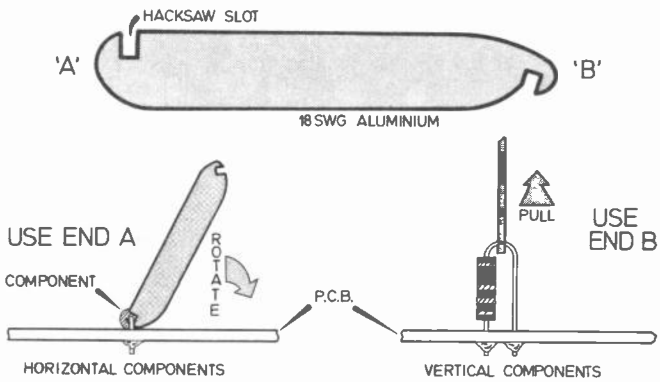
T. Taylor,
Barnsley,
South Yorkshire

COMPONENT REMOVER

Nowadays many constructors use components that they remove from old circuit boards. Unfortunately resistors that are mounted horizontally are very difficult to remove without burning ones own fingers or causing damage to the components.

I have designed a simple but effective tool to assist in removing resistors and any similar components. I made it from a small piece of 18 s.w.g. aluminium sheet as shown in the diagram. I recommend that it is made about six centimetres long.

David Green,
Bury St. Edmunds,
Suffolk



SLIDING TRAYS

I have recently discovered that the cardboard tubes inside toilet rolls form useful component trays.

Take two of these cardboard tubes and cut one of them lengthwise in half, so you have two curved pieces. Now slide one half into the uncut tube. Flatten out the other half and then trace the semicircular shape of the curved half tube onto the flat half (twice). Cut these semicircles out and stick them onto the end of the curved half. This tray piece should now be able to slide in and out of the uncut tube. Several of these glued together form a storage cabinet.

Christopher Muten (aged 15),
Crowborough,
East Eussex.

SPEAKER ENCLOSURE

I have recently discovered a cheap and attractive cabinet for mounting miniature speakers up to 335mm in diameter.

It is an Airbal air freshener container. Where the scented refill is situated there is an ideal holder for a speaker. All that is required is to drill a hole in the base for the leadout wires.

The ready-made slits in the top allow the sound to escape and the sliding, removeable top becames a simple volume control and enables you to direct the sound. It also found that a semi-circular cut-out in the removable top enables it to move further back and improve the acoustics.

Paul Ramsden,
Blackburn,
Lancs

LETTERS

Sound Sense

May I congratulate you on producing a fine channel separator in the Sound-To-Light project in the November issue. When I built it this was all I used.

I found that using the rectifier would only have added to the cost of the unit and of bulbs. We all know that heating a bulb of any sort from cold to full does it no good at all and this is precisely what is being done here! Just using thyristors saves the bulbs, but if you do want full brightness why not use triacs which conduct on both halves of the a.c. cycle? Though you do in fact mention that there is little gate current available, I successfully used an SC41D triac on each channel producing a much better effect.

If you do want to keep the bulb filament warm it can be done by use of complicated electronics, or by connecting from mt1 to mt2 of each triac the primary winding of a transformer. Though very crude it does save on bulbs but will only pay for itself if used for a very long time.

The r.f. interference circuit was not employed as interference was neglible on radios and the TV.

The actual channel separation is excellent considering the circuit's simplicity and for me it is certainly a step up from the one channel device in the September '78 issue of EVERYDAY ELECTRONICS.

A. Boulton (aged 14),
Stoney Stanton, Leicester

Our contributor J. R. W. Barnes answers the points raised.

1. The choice of thyristors was primarily made on the grounds of gate sensitivity. Whereas an average triac requires a gate current of about 20mA to sustain conduction, many triacs have a specified requirement of 50 to 80mA. The gate current requirement of the C106D used in the 3-Channel Sound-to-Light unit is a mere 0·2mA. Because of the simple passive filters used, loading greatly affects channel separation.

2. The use of full-wave control was carefully considered. Experience has shown that more bulbs are "lost" through (a) Handling whilst hot (b) During transportation (c) Carelessness, than during functioning in the unit.

The thermal shocking you describe is not as large a factor as at first appears, only the initial shock is significant as the bulbs remain quite warm between flashing. In short, one has to balance between using half-wave control and risk breaking twice as many bulbs, or using full-wave control minimising the number of bulbs lost in operation.

3. The inclusion of a filter for r.f. interference is essential not only as a legal requirement but a moral obligation to your neighbours.

Batteries vs Mains

I have decided to make the *Microchime* doorbell project featured in an earlier issue, but I have found one problem concerning the power consumption. Batteries do cost a lot of money (about 50p for a PP3). Do you think a suitable mains power supply (9V + 9V) could be employed in this circuit without causing damage to the i.c. or any other part of the circuit?

I have designed a p.s.u. 9V + 9V at 100mA. Do you think this would be suitable? Thank you for an excellent magazine. I have already successfully completed many of your projects.

K. Patel,
Fosse Estate,
Leicester

On the question of battery prices we agree with you entirely and believe these to be exhorbitant. One would think that in this "electronic age", with so many battery powered devices, there would be sufficient volume of battery sales to keep the selling price down.

Wherever possible, one should for reasons of long and medium term economy, consider the use of a mains derived low voltage supply. This is recommended for battery powered units which are permanently fitted in one location and the simplest answer is to use a commercial battery eliminator. Even with portable equipment, it is a good idea to fit a switched socket across the battery clip to allow a battery eliminator to be used wherever possible.

Another possibility is the use of rechargeable cells. Admittedly these are not cheap, but even when their cost is added to that of a suitable charger, the system will probably be more cost effective in the long term than battery replacement.

Provided your power supply can give about 18 volts and there is no danger of this value being exceeded under any circumstances, for example, if there is a component failure in the p.s.u., then it can be used with confidence. A p.s.u. rated at 100mA is more than adequate for powering the Microchime doorbell project.

Baffling Buffers

I was most impressed to see some excellent projects in your October issue and was very interested in the *Bicycle Alarm*. A very good idea! I noticed that it used the CD4011 CMOS device. Now in my Maplin catalogue it is listed as "4011BE, buffered outputs"; and "4011UBE, unbuffered outputs". As a relative beginner in electronics, I do not know which type to order.

Tim Mottershead (aged 14 years),
Uxbridge, Middlesex

In the circuit for the Bicycle Alarm *it does not matter whether the buffered or unbuffered CMOS i.c. is used, as both types will function in the circuit arrangement. It is recommended however that the buffered version be used since these are not so easily damaged by static electricity as the unbuffered types.*

Humans walking on nylon and other man-made fibre carpets for instance, are a potential danger to CMOS devices, especially in dry weather. If precautions are not taken during handling (which incidentally should be kept to a minimum), such as earthing yourself before picking up the i.c.s, they could become permanently damaged.

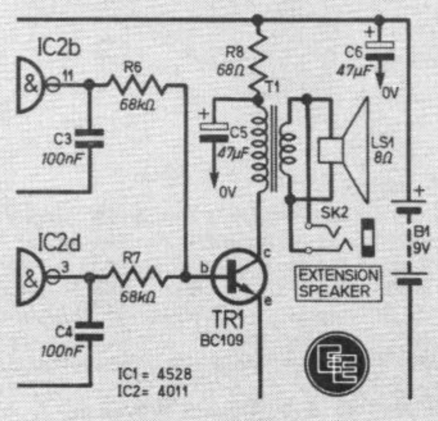
Whether to use buffered or unbuffered types is important in some circuits. For instance, in the Two-Tone Door Chime *last month, the author discovered the unbuffered types would not allow the circuit to function correctly. Perhaps some readers can offer an explanation for this. Here, OR gates were being used to construct an oscillator in the normal way.*

Where we find a necessity for unbuffered types this will be clearly indicated in the components list. RCA, probably the largest manufacturer of general purpose CMOS devices, distinguish between the two by a suffix A- unbuffered, B- buffered.

PLEASE TAKE NOTE

Two-Note Door Chime *(September 1980)*

Readers may experience some distortion of the chime note. This may be caused by an unusually low inductance in T1 primary or low batteries and can be alleviated by fitting decoupling components as shown in the diagram. Capacitors C5 and C6 are tantalum bead types.



I Can't Do Maths!

BY GEORGE HYLTON

DON'T DESPAIR. THIS FOUR-PART SERIES PROVIDES A GUIDE TO BASIC CONCEPTS

3 - LETTERS AND FIGURES

YOU HAVE to go on a shopping expedition to buy components for your latest project. What will be the cost? There is the price of a component by itself, as marked in the shop. But that's not all. There is usually some sort of sales tax such as VAT.

If the components you buy need to be mounted in some way there's the added cost of fixing clips, nuts and bolts, tag boards, and so on. And you have to get to the shop and back, which may involve a bus or train ride, so there are fares to pay as well.

Suppose you buy ten components, at 16p each plus VAT at, say, $12\frac{1}{2}$ per cent; plus fixing clips at 5p each on which the VAT is only 10 per cent; and suppose the fares cost 12p each way. What is the total cost of one component? Let's work out the real figure:

10 components at 16p	£1·60
VAT at $12\frac{1}{2}$ per cent	20
Fixing clips; 10 at 5p	50
VAT on clips at 10 per cent	5
Fares	24
Total	£2·59

$$\text{Cost per component} = \frac{£2\cdot59}{10} = 25\cdot9\text{p}$$

Now, all this is a bit tedious, but it's quite straightforward. Just simple arithmetic. But if you were to ask a mathematician to show you how to work out the cost per item he'd probably produce something like this:

$$C = \frac{n[P_c(1+T_1) + P_f(1+T_2)] + 2F}{n}$$

What on earth does it all mean? Nothing, unless you know what the letters stand for and what the brackets mean. Here's what the letters stand for:

C = real unit cost or real cost of one component
n = Number of components
P_c = shop price of one component
P_f = shop price of one fixing clip
T_1 = tax at first rate ($12\frac{1}{2}$ per cent) expressed as a decimal
T_2 = tax at second rate (10 per cent), similarly expressed
F = single fare

The first problem is how to express VAT as a decimal fraction.

It's quite easy, really. A tax rate of 10 per cent means that you have to add 10 per cent to the shop price.

This means that you have to add one-tenth to the price because 10 per cent is one-tenth of 100 per cent. So if the shop price is 10p and VAT is 10 per cent the price you pay is $10\text{p}+10\text{p}/10=11\text{p}$.

So a VAT of 10 per cent, expressed as a decimal would be 0·1, and as we've seen, a VAT of $12\frac{1}{2}$ per cent is 0·125. So what?

Well, to get the price plus VAT you have to add the price and the VAT, obviously. But instead of first taking the price of an item, then working out the VAT on it, then adding the two together it is quite possible to do the job another way.

First add 1 to the VAT rate in decimals. For a 10 per cent VAT (which equals 0·1) this comes to 1·1. To find the total of price plus VAT for any item all you have to do is multiply the shop price by 1·1. In the case of the clips the shop price was 5p.

The price including VAT is therefor 1·1 times 5p, which is 5·5p. Ten clips then cost ten times 5·5p=55p.

The advantage of multiplying by 1·1 instead of first working out the VAT then adding it to the price is that it is very easy to do with a calculator. Suppose the price were 78p. Then with 10 per cent VAT it becomes 78 times 1·1=85·8p. No addition needed.

Before you can finally break the mathematician's code there is one other bit of information needed. How to deal with the brackets.

Let's stick to real numbers to begin with. The expression, $8(3+1)$ will do. The first thing to learn is always to carry out the operation inside the brackets before you deal with anything outside.

In this example the inside job is to add 3 to 1. So inside the brackets we have 4. The 8 outside means "multiply what's inside by me". So we have 8×4 and the answer is 32.

When you have brackets within brackets, as in the mathematician's formula, the thing to do is to deal with the inner brackets first before attending to the other ones. Here's an example using numbers:

$$2[3(7-1)-2(4+1)]=?$$

Dealing with the inside ones first and the outside last this turns, step by step, into something very simple:

$$2[3(7-1)-2(4+1)]=2[3(6)-2(5)]$$
$$=2[18-10]=2[8]=16$$

Looking back to the mathematician's formula, it follows that the first thing to do, once the appropriate figures have been substituted for the letters, is to work out the values of the two expressions, $P_c(1+T_1)$ and $P_f(1+T_2)$.

I'll do the first one but leave the other to you. The expression P_c is the price of the component, which is 16p in our case; T_1 is the decimal equivalent of VAT at $12\frac{1}{2}$ per cent, which we know is 0·125. So in our example,

$$P_c(1+T_1)=16(1+0\cdot125)$$
$$=16(1\cdot125)=18\text{p}.$$

Just carry on. Deal with everything above the dividing line in the formula first. The "n" below means that when you've finished with the upper part you divide the answer so far by the number of components, here ten.

You'll find that you get the same answer as when we did the calculation the ordinary way. You may then ask what is the point of the formula.

There are two answers to that question. The mathematician's answer is that the formula is a neat, tidy, set of instructions and adaptable easily to numbers other than ten.

My answer is that it is just to give you practice at translating letters into figures and dealing with brackets.

WORKSHOP MATTERS

By Harry T. Kitchen

Workbench

In the last article we looked at the importance of good house keeping, and this month I want to expand on the theme with the central item being the workbench.

The workbench can take several forms. The ideal situation is a room allocated to the hobby, with the workbench made to measure, but we are not all that fortunate, so let us explore the possibilities. The first requirement must be that the bench (let us call it that whatever it may really be) is strong and rugged, and capable of taking some abuse and misuse.

Perhaps the first possibility is the ubiquitous kitchen table and this may have a surface of some form of laminate. This makes it easy to clean, but also "things" slip off more easily. So some form of restraint, perhaps half round beading, all round the edges could prevent accidents.

Another alternative is the ex-government or ex-works desk, available in wood or metal. Metal and electricity do not make a happy mixture, so my preference would be a wooden desk. But get it checked for woodworm first. Such desks are, in my experience, superior to the current crop of imitation X-Plan desks, and the drawers make useful storage compartments for all sorts of tools and components.

If room permits the desk can form the central console, with additions built on. You could end up with a large "U" shaped workbench with a vast working area allowing you to position your test equipment to best advantage, and with ample working room and storage space.

Custom made

Finally we come to the custom made bench. This requires possibly the greatest outlay of cash, and certainly some skill in woodworking. Also that the room is definitely allocated to the hobby since the workbench will be a permanent part of it.

The bench can occupy, for example, one side of a room, and this permits one to screw shelves behind the desk, and above it, to accommodate test equipment, books, components, and all the impedimenta of any enthusiast. Proprietory shelving, utilising aluminium brackets, and laminated wooden shelves is both neat and light, and has the advantage of being flexible, an essential requirement since rarely do we find the optimum siting first time.

If heavy books or equipment is involved the aluminium brackets should be placed close together or else the wooden shelves will bow, and in extreme instance may break. I speak from practical experience, having had the mortification of seeing shelves bow down steeply when loaded with heavy books. By taking all down and doubling up on the "bracketry" I achieved something close to the desired result.

Power supplies

Having sorted out a bench, we must now look to the power requirements that the equipment with which it is equipped will require, and how best to provide this.

However much equipment you have on your bench, it should all have its own power socket, and this should be the 13A type, though not necessarily equipped with 13A fuses. Sockets should be distributed evenly around the bench to avoid the tangle of leads that so often occurs when sockets are grouped together.

If the bench is of the kitchen table variety, it should be provided with a flying lead terminated in a suitable plug so that if necessary the bench can be tucked away in a corner. The distribution sockets can be on sub-panels screwed underneath the table, one per side.

Each piece of equipment should have a fuse appropriate to its power requirements, and rarely, in the case of the amateur, will this exceed 250 Watts, so that a 1A fuse will be adequate. Sometimes power surges may cause the fuse to blow though there is no fault and in this case the next value up can be used, but in general use the smallest fuse value that you can as this provides you with the maximum safety margin.

Lighting

No matter how good your eyesight may be, good lighting is essential for safe and pleasant working. Fluorescent lighting is popular and it does give a soft even spread of light, as well as being more efficient than incandescent bulbs.

For general lighting fluorescent lamps can be used, but for specific areas nothing beats a bulb in a lamp holder of the "Anglepoise" type. Such lampholders are not expensive, and can be bought with a weighted base or a clamp, and these can be positioned to cover quite a good radius.

The fluorescent lamp will probably be part of the room lighting, but the Anglepoise lamp should be part of the workbench.

Master switch

"Accidents happen". An old saying, but a true one.

If you are not experienced in wiring-up work benches, get a qualified electrician to do it. And as a precaution, fit a master switch in a position easily identified, and accessible, so that if you do plug yourself into the mains someone can cut off the power.

However you may decide to equip your own workbench, never lose sight of the safety factor. This also means using good quality plugs and sockets, and proper mains cable, not any old bit of wire you may have at hand.

Make sure that all mains cables are securely clipped under or around the bench and cannot be trapped or drop out and cause short circuits.

Ancilliaries

Under the somewhat vague term of ancilliaries come those items that cannot be allocated a paragraph heading to themselves.

Let's start with comfort. The first requirement is a chair, and although you can borrow one from the kitchen, you really ought to consider a permanent chair, and here an ex-office chair is ideal. It is adjustable for height, will swivel around, and can be bought quite cheaply particularly if a bit on the tatty side. In this case the ladies can rally round and recover it!

Heating is another item worthy of consideration, particularly if you are serious about your hobby and spend all available hours on it. Gas and oil heaters are undesirable, unless venting to atmosphere, for they give off large amounts of water vapour in which are dissolved various acids, and corrosion will result. This leaves electricity, of which the quickest acting are the fan heaters and thus they are also the most economical.

A good radio will help to pass the time more pleasantly. When I updated my hi-fi many years ago, my faithful Quad (valve, not quadraphonic!) equipment was moved into my room. This feeds good quality long throw, small diameter 'speakers in small infinite baffle cabinets, and the standard is acceptable.

Good quality hi-fi equipment can often be picked up fairly cheaply and will repay its cost in added pleasure. Be a Sybarite. Add pleasure to pleasure.

Why the Sinclair ZX80 is Britain's best-selling

Built: £99.95

Including VAT, post and packing, free course in computing, free mains adaptor.

Kit: £79.95

Including VAT, post and packing, free course in computing.

This is the ZX80. A really powerful, full-facility computer, matching or surpassing other personal computers at several times the price. 'Personal Computer World' gave it 5 stars for 'excellent value'. Benchmark tests say it's faster than all previous personal computers.

Programmed in BASIC – the world's most popular language – the ZX80 is suitable for beginners and experts alike. And response from enthusiasts has been tremendous – over 20,000 ZX80s have been sold so far!

Powerful ROM and BASIC interpreter

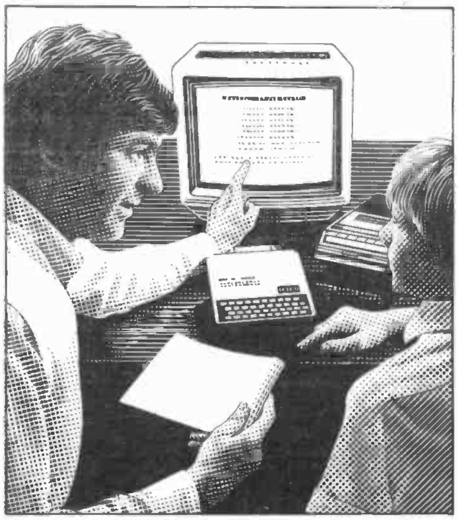
The 4K BASIC ROM offers remarkable programming advantages:

* Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
* Unique syntax check. A cursor identifies errors immediately.
* Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison).
* Up to 26 single dimension arrays.
* FOR/NEXT loops nested up to 26.
* Variable names of any length.
* BASIC language also handles full Boolean arithmetic, condition expressions, etc.
* Randomise function, useful for games and secret codes, as well as more serious applications.
* Timer under program control.
* PEEK and POKE enable entry of machine code instructions.
* High-resolution graphics.
* Lines of unlimited length.

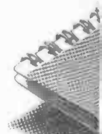
Unique RAM

The ZX80's 1K-BYTE RAM is the equivalent of up to 4K BYTES in a conventional computer – typically storing 100 lines of BASIC.

No other personal computer offers this unique combination of high capability and low price.



The ZX80 as a family learning aid. Children of 10 years and upwards are quick to understand the principles of computing – and enjoy their personal computer.



The Sinclair teach-yourself BASIC manual

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book (free with every ZX80). The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs.

Kit or built – it's up to you

In kit form, the ZX80 is pleasantly easy to assemble, using a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9V DC nominal unregulated. If not, see the coupon.

Both kit and built versions come complete with all necessary leads to connect to your TV (colour or black and white) and cassette recorder. Plug in and you're ready to go. (Built versions come with mains adaptor.)

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Right-angle mounting brackets. Ideal for mounting, PCB, panels et cetera into boxes and cases.
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in high insulation	WHITE	1982	£0.35
material available in a	BLUE	1983	£0.35
choice of colours ideal	YELLOW	1984	£0.35
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3 pole	4 way	1967	£0.55
4 pole	3 way	1968	£0.55

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1958	Iron coated bit ⅛" for 1948 iron	£0.58
1951	Iron coated bit 3/16" for 1948 iron	£0.58
1931	Highly popular X 25 25 watt quality iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3.5uA and another shaft of stainless steel to ensure strength	£5.12
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1932	Iron coated bit ⅛" for 1931 iron	£0.58
1933	Iron coated bit ⅛" for 1931 iron	£0.58
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Entirely new range of connectors for Discrete wire. Uniquely designed Wirepost is soldered to the P.C. Board. A pre-stripped wire is inserted into the connector and easily locked by pressing the housing down. The wire is alternatively removed by lifting the housing. Tin alloy plated contacts ensure good as gold performance.

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1¼in car inline type	508	£0.18
Panel mounting 20mm	509	£0.23
Panel mounting 1¼in	510	£0.37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1.5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2.5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2.5A	628
250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630

All 8p each

QUICK-BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 8p each

Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	4A	641
2A	637	3A	639	5A	642

All 7p each

NUTS AND BOLTS

BA BOLTS — packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50

Type	No.	Price	Type	No.	Price
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½in 0BA	840	£0.86	¼in 4BA	847	£0.29
1in 2BA	842	£0.75	1in 6BA	848	£0.46
½in 2BA	843	£0.52	½in 6BA	849	£0.24
¼in 2BA	844	£0.60	¼in 6BA	850	£0.29
1in 4BA	845	£0.51			

BA NUTS — packs of cadmium plated full nuts in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	855	£0.83	4BA	857	£0.35
2BA	856	£0.55	6BA	858	£0.28

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50

Type	No.	Price	Type	No.	Price
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2BA	860	£0.14	6BA	862	£0.14

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Type	No.	Price	Type	No.	Price
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2BA	852	£0.32	6BA	854	£0.25

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130	2 pin DIN plug to 2 pin DIN inline socket Length 5m	£0.78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 Length 1.5m	£0.95
132	2 pin DIN plug to 2 pin DIN socket Length 10m	£1.13
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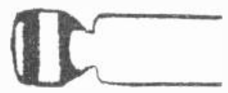

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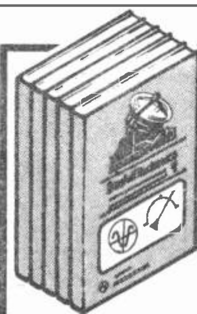

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