

# electronics today

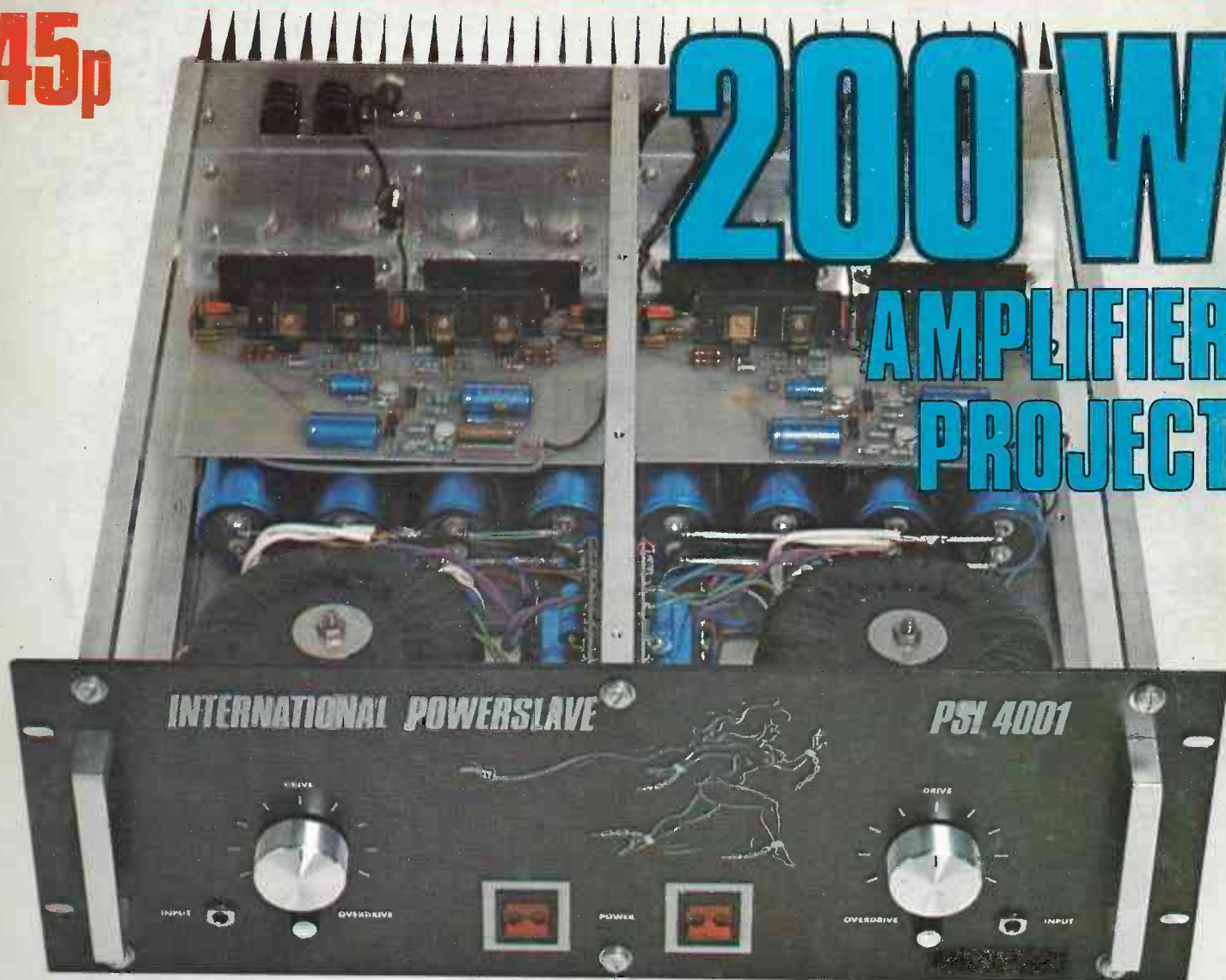
APRIL 1978

INTERNATIONAL

45p

# 200 W

# AMPLIFIER PROJECT



## — FREE TANDY CATALOGUE —

MOST BRITISH SALES ONLY

# PET HOME COMPUTER WHITE LINE FOLLOWER CASINGS SURVEY



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

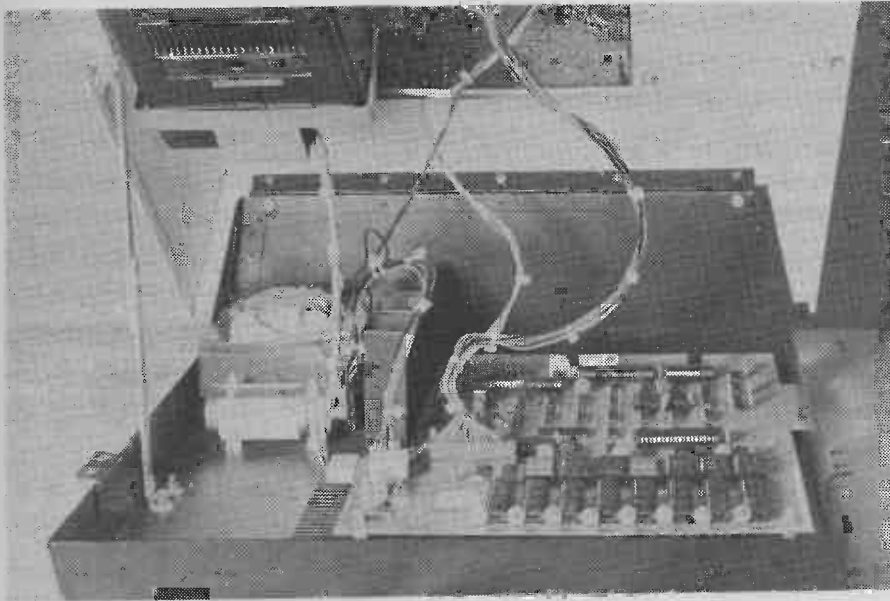


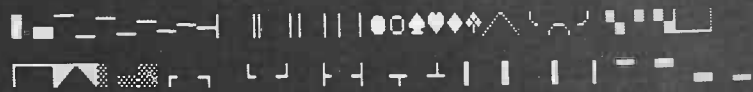
Fig. 2. Our first sight of the insides. It's a real pleasure to open up and discover a "prop" already in place to hold up the top. Notice neat cabling and connecting plugs, making for cheap efficient assembly and service.

Fig. 3. Here we've detached some of the parts from their mountings so we didn't have to draw a block diagram. Video monitor board is above.

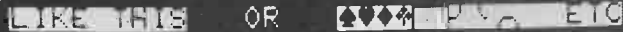
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HERE IS AN EXAMPLE OF THE TEXT THAT IS
POSSIBLE WITH THE COMMODORE PET DISPLAY
THERE ARE ALSO NUMBERS AND SYMBOLS:
1234567890 - = + * / ! " # $ % & \ | ~ ; ' > < [ ] ^ _
AND GRAPHICS:

```

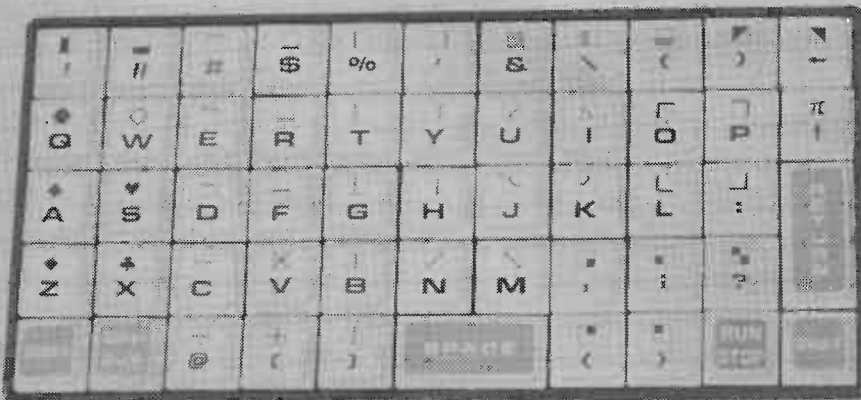


IN ADDITION ALL CHARACTERS MAY BE REVERSED:



THESE ARE ALL THE CHARACTERS NORMALLY AVAILABLE ON THE KEYBOARD.....

Fig. 4. The two PET keyboards. We found it quite handy to have a separate numeric pad.



unfair.

The keyboard arrangement has all the rows of keys lined up instead of offset as in a normal keyboard, which would appear to be a big disadvantage to experienced typists. However, one is unlikely to enter vast quantities

of text, and this turned out to be less annoying than anticipated.

To solve all these problems, it would be a simple matter to replace the main keyboard with a "proper" one. Since there are electronics inside, it would simply

be a question of configuring the switches the same way. How long will it be until some one comes out with a PET soup-up kit, come on, we've started counting . . . !

The video monitor appears to be quite standard, Fig. 4 is a view in the back. The 9 inch CRT provided is with high resolution for the twenty-five lines of forty characters. A brightness control is located at the rear.

## Electronics

For the electronics enthusiasts (well, you're reading this magazine aren't you?) we've got Fig. 2. Most of the important features are shown on this photo, from which a basic idea of the system configuration can be gleaned. All the big chips are plugged into sockets, something nice to see, especially for ROMs. (When's APL coming???)

The keyboard is accessed via a sixteen line Peripheral Interface Adapter (6520 like a 6820 for Motorola fans) which we expect uses eight outputs and eight inputs for decoding sixty-four keys, and then also a couple of the PIA "handshaking" lines for the rest of the work. In other words most of the keyboard decoding is done by software.

The cassette recorder as previously mentioned is a customised standard one, with a new PCB inside full of electronics suitable for data recording. In fact two cassette interfaces are included (second cassette recorder available later) with input, output, and motor on/off lines. This uses six lines of the sixteen on the second 6520 PIA (we assume) leaving ten lines, eight for parallel I/O and two serial, at TTL levels. Both cassettes record at 1 000 baud, but using built in software any program is recorded twice in series for reliability, cutting the effective rate of 500 baud. Thus an 8K program takes about two and a half minutes to load.

In addition, the PET is probably the first popular micro-computer to use the IEEE 488 bus for instrumentation communications, making it compatible with many existing and future digital instruments, printers etc.

A final note of the hardware. Unlike some of the early hobby computer equipment the inside of this machine looks like it's built for business, and for the manufacturer to stay in business. Constructed with quality electronics, and chassis and PCB arrangement for easy assembly and service.

## Software

As stated before, one of the beauties of the PET is its built in ROM — full of software. The 14K includes 8K BASIC, 4K Operating System, 1K Machine Language and 1K Diagnostic routine, according to Commodore's literature.

First there's 8K of "extended" BASIC. The correct term is "BASIC interpreter". In simple terms an interpreter is a machine language program which takes your BASIC program as data, "translates" it to machine language subroutines and then executes it. This process actually occurs in a line-by-line translate-execute manner. The term "extended" refers to the fact that many statements are included that are omitted in some versions of BASIC. Using BASIC means that programming can be conducted in a civilized manner, using statements that are almost readable in English, with base ten numbers. The machine does the work of converting to machine language and eight bit binary arithmetic. As

encouragement to skeptics we've included a description of the language and how (easy it is) to use it.

Commodore claim that their BASIC is significantly faster than anybody else's which we cannot attest to, but for general use the PET performed admirably as compared to the reasonably typical IBM 360 and 370 interactive, multi-user systems that the reviewers were familiar with. (But we do like APL 1/2).

The cassette I/O, keyboard, video, and other functions are handled by the 8K operating system. These together with the BASIC are provided in seven 2K x 8 ROMs.

Lacking documentation, we can only guess at the other two ROM items provided. The diagnostic routine we assume verifies the operation of the hardware, and uses a LED mounted on the main board as an indicator for this task.

The 1K machine language we guess refers to an assembly language ("machine language" is what the MPU uses, "assembler" is one step higher, using mnemonics for each instruction, and is generally more readable and useable). There is also a mention of next year's "assembler device", to be plugged into the expansion port for "machine language" (?) programming. The advantage of machine or assembler language programming is increased efficiency of programs over those "interpreted" from BASIC. This could be critical in case of a routine which runs several thousands times in a loop, or for a frequently used function.

## Basic Basic (interactive)

One can think of the PET as operating in one of two modes: "calculator mode" in which the operator asks the machine to execute and give the results of one statement; and "programmed mode" in which the programmer enters a series of statements, then has the machine execute the entire set at one go. The second mode requires a little more structure for "administrative" purposes.

### Calculator Mode

Known by this name because it is the process of getting a quick answer from a small formula, (similar to calculators), or telling the machine to do one thing.

Example: PRINT 3+4

The machine works out 3+4 and "prints" the result on the screen.

Another example: LOAD FRED

This causes the machine to obtain a program called "FRED" from the cassette, including giving you instructions about what buttons to push on the recorder.

### Program mode

**Problem: Figure out the sum of the integers zero to ten.**

**Program:** 10 J% = 0  
20 FOR 1% = 1 TO 10  
30 J% = J% + 1%  
40 NEXT  
50 PRINT J%  
60 END

The numbers down the side are line numbers which can be any integers, and they keep the lines in order. We have chosen multiples of ten as it makes for easy editing at a later date by inserting line numbers in between if necessary. The variables are J% and 1%. The % signs identify them as integers.

## Graphics

We suspect some pretty creative, intelligent people sat down and worked out the graphics character set on this machine. Figure 4 shows the keyboard and all the characters you can key in.

The display system is based upon 8x8 dot units, which may contain 5x7 dot upper case letters, or assorted symbols which are so designed to provide very versatile diagram and graphing capabilities. Because the 8x8 blocks fit together both horizontally and vertically, it means that adjacent lines of text look a little crammed together, but this can be avoided by judicious line spacing if necessary.

The "cursor" is a flashing "element" or character that can be moved about the screen, and it normally indicates the next space to be typed in. After typing in that space the cursor moves to the next adjacent spot and so forth. "RETURN" causes the cursor to move to the first position on the next line, just as a carriage return does on a typewriter. Additional cursor control is provided to move it quickly up, down or sideways. The cursor is useful also for editing and correcting programs already written on screen, with the facility for inserting and deleting characters. When the cursor attempts to move below the bottom of the "page", the screen "scrolls up". That is to say each line moves up one, with the top line disappearing.

In addition to the normal characters, each may be "reversed", that is appear as black on white, which can be used to advantage on some occasions.

Finally, here's our big surprise! If you're been counting keyboard characters, there are a lot less than the 256 possible with the character generator used in PET. Quite by accident we found a whole set of lower case letters! Very interesting. We're not quite sure what does it but check the pictures for yourself. That still doesn't add up to 256 characters, so there may be yet more we don't know about. In fact keyboards on early prototypes showed a set of graphic symbols that included assorted Greek letters, could they be inside as well? We don't know, but it all depends on what's in the character generator. We wonder if Commodore has lower case letters planned as a future "add-on option?" For that matter you could always burn your own PROM . . .

## Add-ons

Well that's the basic PET Commodore Systems to introduce a number of peripherals specifically designed for PET during this year. These include a 24K memory unit (thought to be dynamic) with its own power supply, a printer and floppy. The fact that PET has the IEE-488 bus and ready access to other data lines means that, with luck, we should see a wide range of add ons at reasonable prices from a wide variety of sources. Many pets (lower case for the furry kind) are bought in an initial burst of enthusiasm but are soon abandoned as some new copy comes along. More recently this fate has befallen many a TV game.

This phenomena is far less likely to apply to a versatile beast like PET but the User's Club Commodore Systems are to set up should go a long way to keeping interest in PET alive well beyond the initial purchase.

The club open to users and, for want of a better phrase, non-users, alike for an annual fee of ten pounds.

The club will produce a newsletter and provide a means of exchanging news, information and software on PET type subjects on an international scale.

Commodore Systems, although themselves running the club, hope that the driving force will be the many PET users throughout the world.

## What more can we say?

It looks like computers are starting their march into the homes of the masses, which sounds very science-fiction and scary to some. We hope that the familiarity with computers this may bring to the man/woman/child in the street will reverse the widespread fear of THE COMPUTER as an enemy. Perhaps man will once again feel master over objects. There was after all a time when the automobile was regarded as an evil fire breathing monster, until everybody got one.

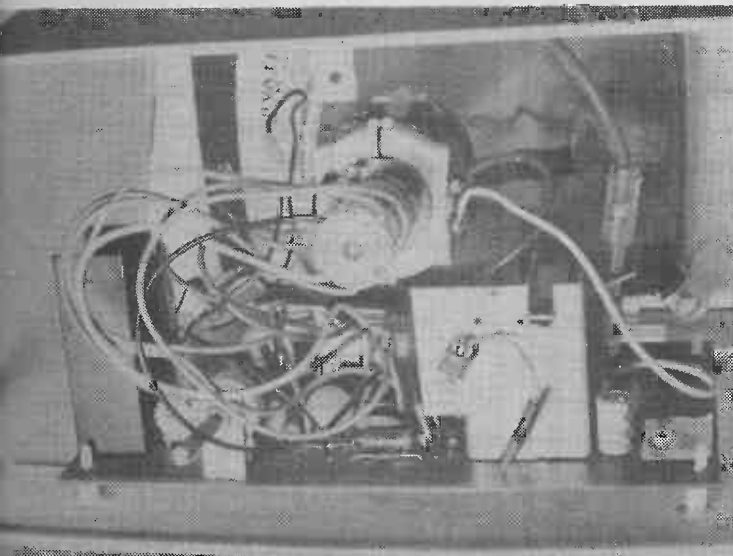



Fig. 5. Peeking in the back of the video monitor (left) reveals a fairly standard set of works.

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....ETI'S REVIEWERS DISCOVERED THAT
BY EXECUTING THE STATEMENT:
POKE 59500,72
you can have lower case letters
INSTEAD of graphics. You can't have
both on screen at once, but can
alternate them in one program.
    
```

# WHITE LINE FOLLOWER

ETI's Project Team present here a project for either the modeller who wishes to go electronic, or the electronic enthusiast who wants an excuse for crawling around the carpet all weekend . . .



THE IDEA OF A SLOT CAR that doesn't need a slot is not new — in fact, sophisticated systems based on inductive loops have been used in large factories for some years. This project is at the other end of the complexity scale, and uses a simple light/photocell combination to follow a white line. The electronics involved make up a simple feedback control system — as soon as one photocell sees more light than the other, the differential amplifier applies a correcting voltage to the steering servomotor and so the model steers itself back on to the line.

We are not sure whether to class this project as a toy or as a serious experimental project. Certainly, the basic project makes a great toy, but there is tremendous scope for experimenting and 'tuning' the control circuitry. Like all control systems, this one displays a characteristic called 'damping' — if the system is overdamped, the car will steer sluggishly and will have difficulty following anything except the smoothest curves. If the control circuitry is under-damped, the car

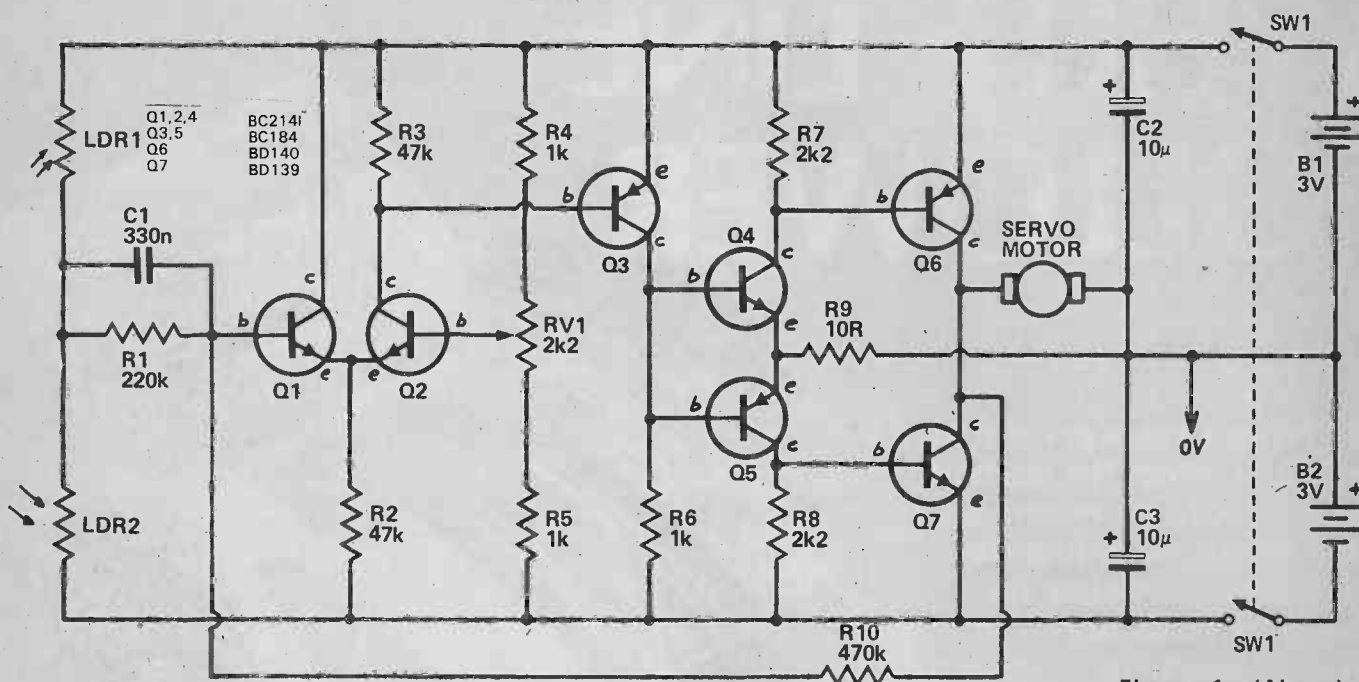


Figure 1. (Above) Circuit diagram of the white line follower unit.

## HOW IT WORKS

The sensor used to look for the white line is a pair of light dependent resistors (LDRs) which are aimed at either side of the line so that each sees half white half dark. The line is illuminated by a bulb to ensure that the LDRs have a relatively low resistance. If the car is moved off the centre line one LDR will see more 'white' and its resistance will fall. The two LDRs are connected in series across the supply voltage and so the voltage at the junction will vary as the car moves in relation to the line.

This voltage is compared with that set on RV1 by Q1 and Q2, the error signal driving the servo motor in the correct direction to try to eliminate the error. Negative feedback is provided by R10 to reduce the 'open loop gain', and dynamic feedback is provided by C1 which is used to reduce overshoot.

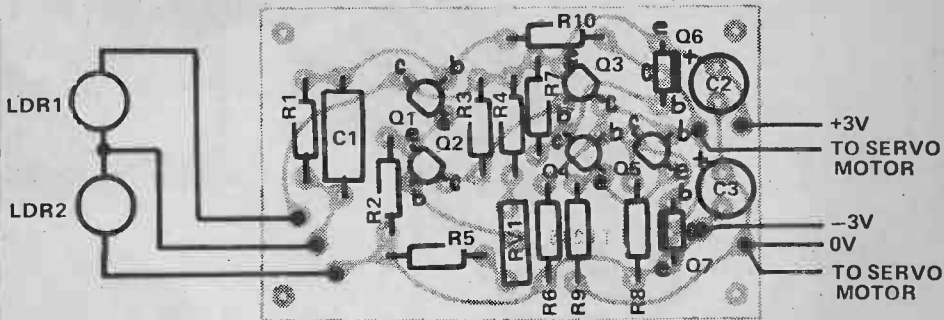


Figure 2. Component overlay. See text for details of mounting the board and servo motors within the model.

will oscillate from side to side on curves — this may also be set-off by small deviations on the straights.

The ideal situation is to have a 'critically damped' system, which has just the right combination of characteristics to respond quickly on curves without oversteering. This can be achieved by theoretical analysis, using techniques like Nyquist's Criterion, but it's more fun to tune by trial and error. The damping is a factor of the photocell spacing, the amplifier gain and the servomotor characteristics.

You can have a lot of fun racing these cars, especially since there is quite a bit of scope for tinkering and tuning them. The layout of your race track should include both smooth and tight curves — you may have problems with figure-8's that cross at anything but right angles. And of course you can time races with your ETI stopwatch!

### Construction

The mechanical side of constructing the car we must leave to the individual reader. As we were more

interested in the electronics side of the project we tended to take short cuts as far as the mechanics go. The car we used was a Tamiya Porsche 935 Turbo, a model specifically designed for radio control applications but ideal for our application. No doubt the model enthusiasts amongst you will know of many other models that would prove suitable.

We cheated with the steering mechanism as well by using a commercial servo motor stripped of its electronics to provide control of ▶

## PARTS LIST

### RESISTORS

R1	220k
R2,3	47k
R4,5,6	1k
R7,8	2k2
R9	10R
R10	470k

### LIGHT DEPENDENT RESISTORS

LDR1,2	ORP12
--------	-------

### POTENTIOMETER

RV1	2k2 min vert
-----	--------------

### CAPACITORS

C1	330u Polyester
C2,3	10u 10 V Electrolytic

### SEMICONDUCTORS

Q1,2,4	BC214
Q3,5	BC184
Q6	BD140
Q7	BD139

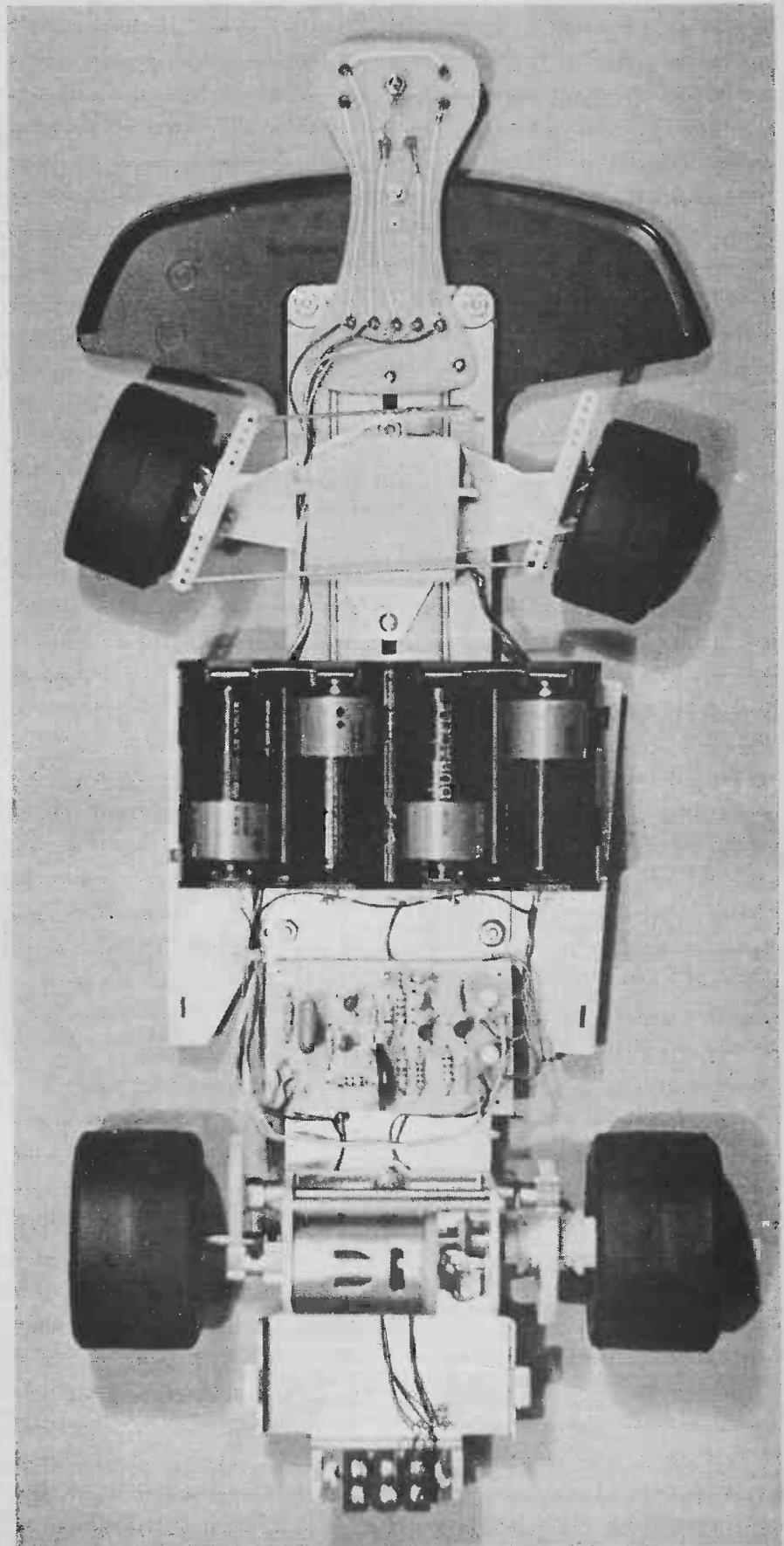
### MISCELLANEOUS

PCB as pattern, 3V bulb, 2-pole on/off switch, servo motor and car (see text)

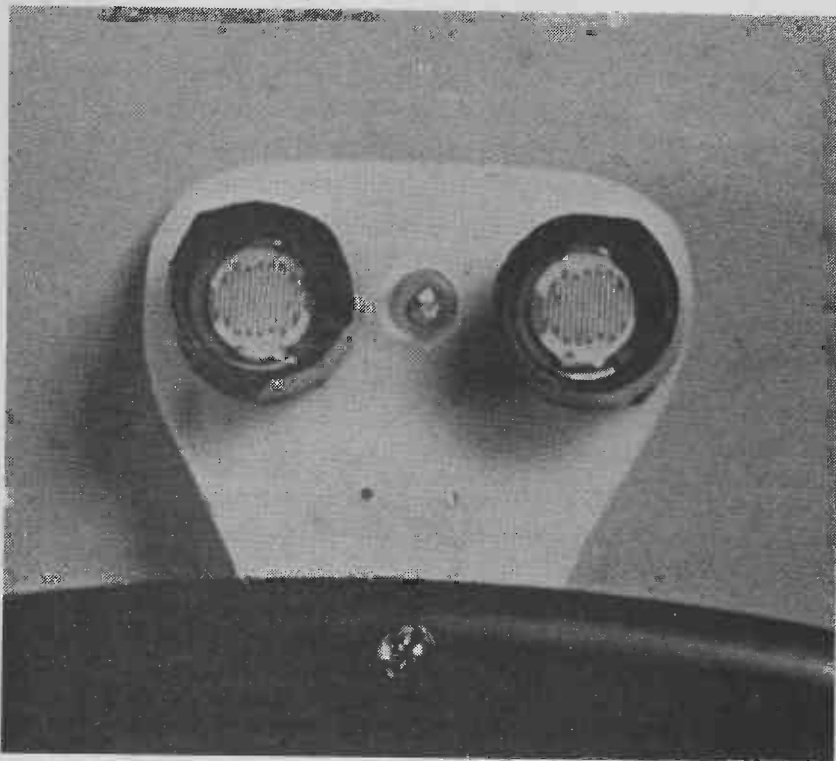
On the right the Porsche with its lid off. The PCB is mounted behind the drive motor, which is sitting between the rear wheels. The servo is sited between the front wheels, and the board upon which we put the LDRs and bulb can be seen on the front of the chassis.

## BUYLINES

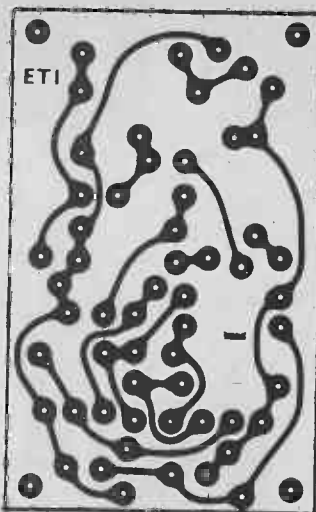
Purchasing the electronic components should prove straightforward. The mechanical parts are, as we say in the main text, a matter for the individual constructor.



## PROJECT:Line Follower



Above: the eyes of the animal. The bulb lies right between the LDRs. On the right: the foil pattern for the white line follower circuit, shown full size.



the steering. Again for those with a mechanical bent, a standard model motor (one that will operate reliably on 1.5V) driving the front wheels via suitable links is probably the best bet.

Ideally the sensors should be mounted in front of the wheels and should move with them so that when the wheels turn to the right the sensor does likewise and visa versa (another test of mechanical ingenuity).

The LDRs were housed in short lengths (about 10 mm) of cardboard tube to act as a shield and were spaced about 15mm apart (we used a 12 mm wide line) with the bulb mounted between them.

Electrically the components can be built onto the PC board described which can be mounted somewhere in the car. We used separate batteries for the electronics and ran the bulb off the main batteries, to keep the electronics supply more constant.

### Experimenting

Using different motors/gear ratios some changes to the electronics will probably be found necessary. These would mainly involve C1, R1 and R10. Increasing R10 or reducing R1 increases the DC gain, while increasing C1 increases the dynamic damping to reduce overshoot. Track width may also be experimented with as well as LDR spacing.

ETI

# THE NORTH'S PREMIER AMATEUR RADIO & ELECTRONICS EVENT!

Northern  
Radio Societies Association

## RADIO & ELECTRONICS EXHIBITION

BELLE VUE—  
MANCHESTER

SUNDAY, 2nd  
APRIL, 1978

Doors open at 11 a.m.

- ★ INTER-CLUB QUIZ
- ★ CONSTRUCTION CONTEST
- ★ RSGB BOOKSTALL
- ★ GRAND RAFFLE
- ★ AMATEUR COMPUTER CLUB STAND
- ★ RADIO SOCIETIES STANDS
- ★ CLUB STAND TROPHY
- ★ HOME OFFICE & RAYNET EXHIBITS
- ★ TRADE STANDS FEATURING RADIO EQUIPMENT, MICRO-PROCESSORS, PERSONAL COMPUTERS AND COMPONENTS
- ★ AMPLE CAR PARKS AND LEISURE FACILITIES FOR THE FAMILY INCLUDING FUNFAIR!

Talk-in for FM mobiles via GB3NRS and G8NRS/A on 145 MHz chs. S22 SO & R6 and on 433 MHz chs. SU8 SU20 RB4 & RB14.

ENTER AT REAR OF BELLE VUE, OPPOSITE MAIN CAR PARK—OFF HYDE ROAD, A57.

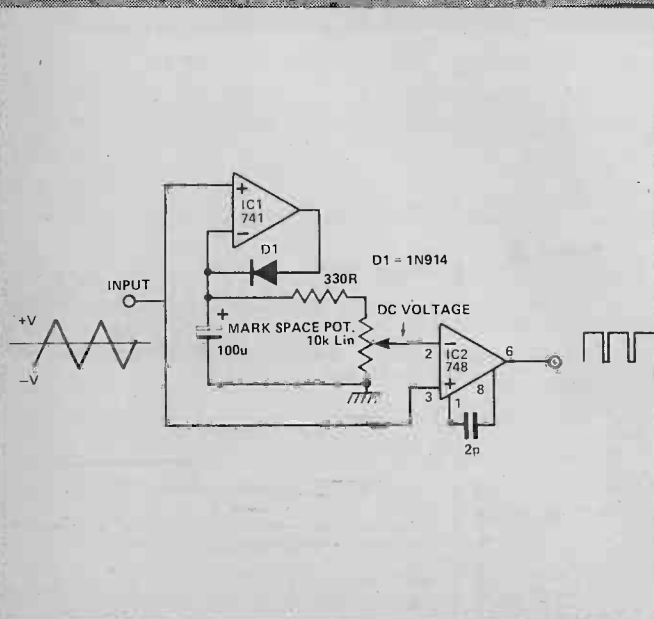
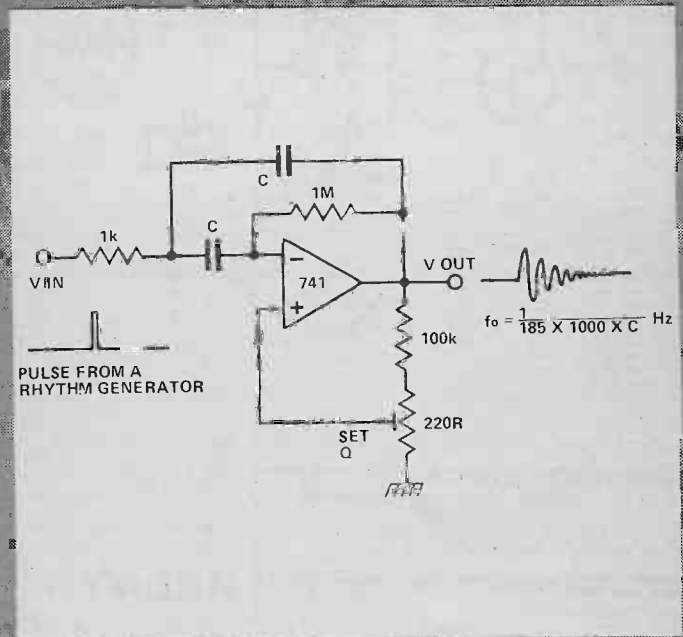


# OP-AMPS PART 3

Continuing along Tim Orr's circuit strewn path through op-amps

## Simple Musical Chime Generator

The circuit shown is that of a multiple feedback band-pass filter. The preset is used to add some positive feedback and so further increase the Q factor. The principle of operation is as follows. A short click (pulse) is applied to the filter and this makes it ring with a frequency which is its natural resonance frequency. The oscillations die away exponentially with respect to time and in doing so closely resemble many naturally occurring percussive or plucked sounds. The higher the Q the longer the decay time constant. High frequency resonances resemble chimes, whereas lower frequencies sound like claves or bongos. By arranging several of these circuits, all with different tuning, to be driven by pulses from a rhythm generator an interesting pattern of sounds can be produced. There may be some stability problems when high Q or high frequency operation is involved. To achieve better performance, an op-amp with a greater bandwidth than the 741 should be used. Alternatively, a different structure, such as a state variable filter could be used. Qs of up to 500 can be obtained with this latter circuit.

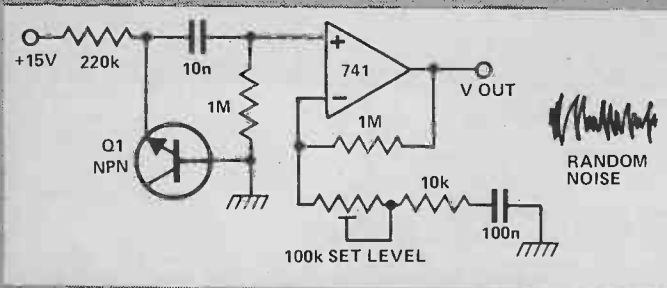
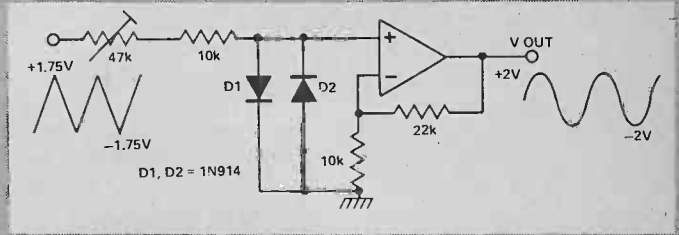


## Variable Markspace Squarewave Generator with Automatic Level Adjustment

By putting a triangle wave into one input of a comparator and a manually controlled DC level into the other, it is possible to generate a variable ratio markspace square wave. However, if the amplitude of the triangle varies then so will the markspace ratio. Alternatively, if you want the manual control to produce a very thin waveform at one end of its travel, then you will probably need a preset and a very stable triangle amplitude. However, this circuit solves these problems. The DC voltage is generated by a peak voltage follower, IC1, driven by the triangle itself. Thus the circuit tracks the peak voltage level. Secondly, only 97% of this voltage is ever fed to the comparator, IC2, and so at the end of the markspace pot, a 60:1 ratio square wave is generated. At the other end of the pot the ratio is 1:1. A 748 is used as the comparator because it has more bandwidth than the 741. As the frequency of the triangle increases, it may be necessary to use an even faster op-amp for IC2 or even a comparator.

### Simple Triangle to Sinewave Converter

A simple way of converting a triangle to a sinewave is shown. The logarithmic characteristic of the diodes is used to approximate to that of a sine curve. The distortion to be expected is of the order of 5%. However, the distortion may be tolerable if the sinewave is only used to generate audio tones.

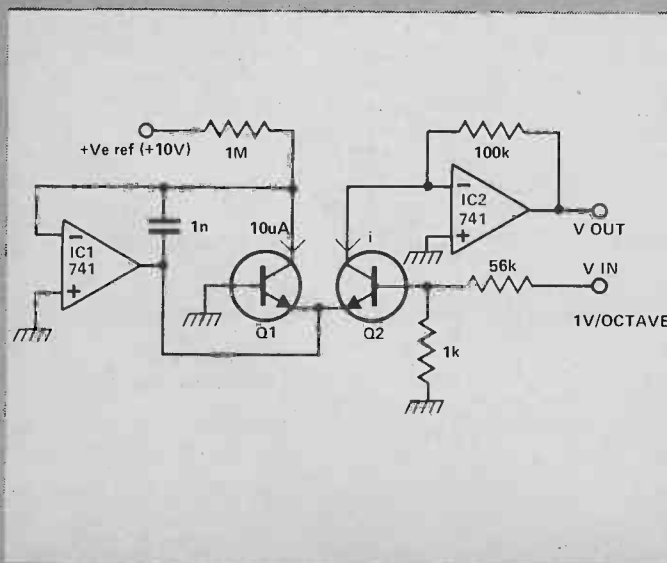
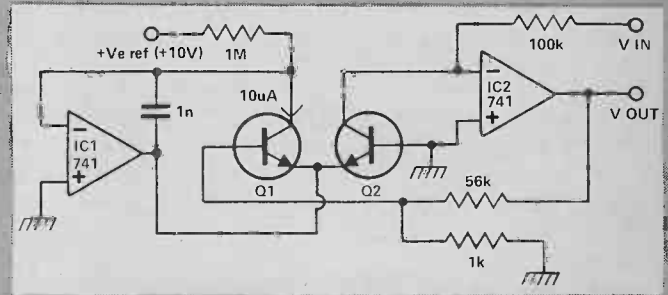


### Noise Generator

The zener breakdown of a transistor junction is used in many circuits as a noise generator. The breakdown mechanism is random and so generates a small noise voltage. Also this voltage has a high source impedance. By using the op-amp as a high input impedance, high AC gain amplifier, a low impedance, large signal noise source is obtained. The preset is used to set the noise level by varying the gain from 40 to 20 dB.

### Logarithmic Voltage to Voltage Converter

The output voltage is logarithmically proportional to the input voltage. The difference between this circuit and the previous is that the exponentiator is in the feedback loop of the op-amp and hence the mathematical function has been inverted. The circuit is useful for performing true logarithmic compression or for converting linear inputs into dBs.



### Exponential Voltage to Current/Voltage Converter

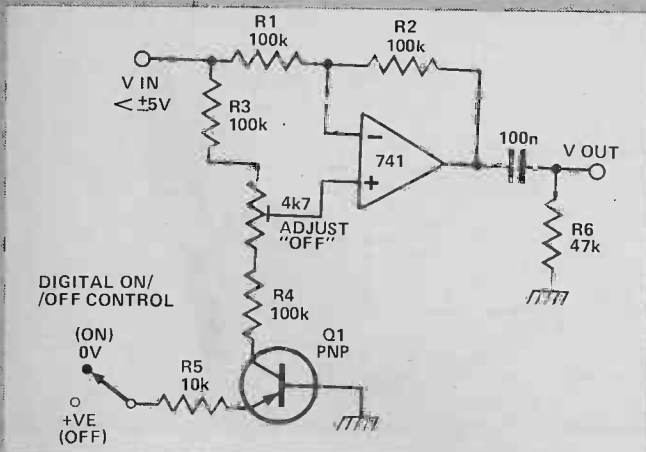
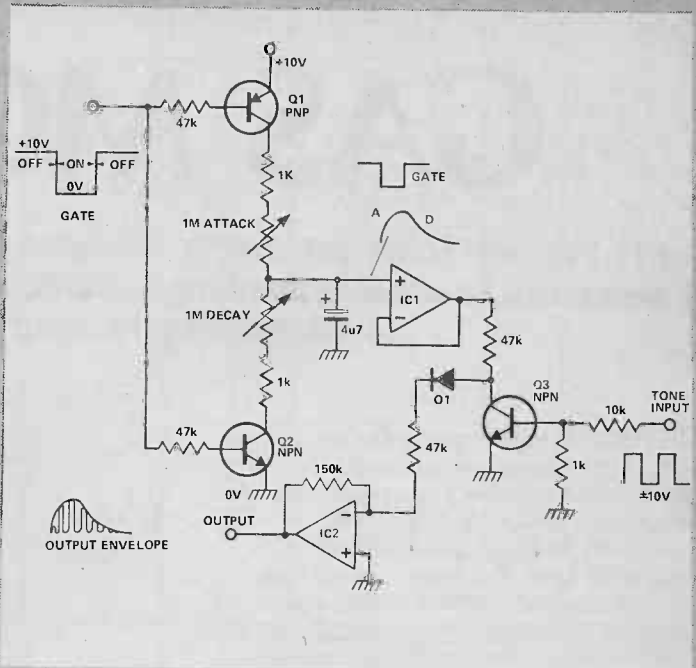
The circuit shown converts a linear input voltage into an exponential current or voltage. This type of circuit is used in music synthesizers to change linear control voltages into musical intervals. That is, if the circuit were used to control an oscillator, input increments of 1 V would change the pitch by one octave. The exponential characteristics of a transistor are employed to generate the correct transfer function. Q1 and Q2 are a matched pairs of transistors, preferably a transistor dual. IC1 maintains Q1 at a constant current. Thus, the op-amp serves only to bias the emitter of the second transistor Q2 into a suitable operating region. The purpose of Q1 is to generate this bias voltage. The base emitter junction of a transistor has a high temperature coefficient ( $-1.9 \text{ mV}/^\circ\text{C}$ ) and so the reason for using a matched pair is to use the first transistor, Q1, to provide temperature compensation for the second.

## Musical Envelope Generator and Modulator

A gate voltage is applied to initiate the proceedings. When the gate voltage is in the ON state, Q1 is turned on, and so the capacitor C is charged up via the attack pot in series with the 1K resistor. By varying this pot, the attack time constant can be manipulated. A fast attack gives a percussive sound, a slow attack the affect of 'backward' sounds. When the gate voltage returns to its off state, Q2 is turned on and the capacitor is then discharged via the decay pot and the other 1K resistor, to ground. Thus the decay time constant of the envelope is also variable.

This envelope is buffered by IC1, a high impedance voltage follower and applied to Q3 which is being used as a transistor chopper. A musical tone in the form of a squarewave is connected to the base of Q3. This turns the transistor on or off and thus the envelope is chopped up at regular intervals, the intervals being determined by the pitch of the squarewave.

The resultant waveform has the amplitude of the envelope and the harmonic structure of the squarewave. IC2 is used as a virtual earth amplifier to buffer the signal and D1 ensures that the envelope dies away at the end of a note.

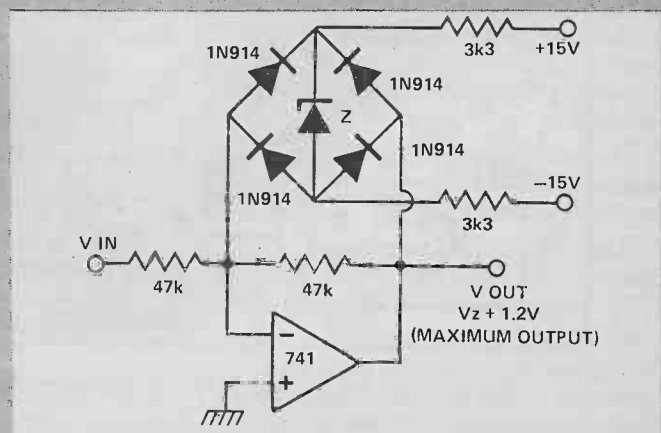


## Transistor Used To Turn An Op Amp On Or Off

When transistor Q1 is switched off, the circuit behaves as a voltage follower. By applying a positive voltage to the emitter of Q1 via a 10K resistor, the transistor is made to turn on and go into saturation. The circuit has now changed into that of a differential amplifier (see fig. 7), but where the voltage difference is always 0v. Now as long as the resistor ratios in the two branches around the op amp are in the same ratio then there should be zero output. A 4K7 preset is used to null out any ratio errors so that the 'OFF' attenuation is more than 60dB. The high common mode rejection ratio of a 741 enables this large attenuation to be obtained.

## Fast Symmetrical Zener Clamping

The problem with using two zeners, back to back in series to get symmetrical clamping are one, the knee of the zener characteristics is rather sloppy. Two; charge storage in the zeners causes speed problems and Three; the zeners will have slightly different knee voltages and so the symmetry will not be all that good. The circuit overcomes these problems. By putting the zener inside a diode bridge then the same zener voltage is always experienced. The voltage errors due to the diodes are much smaller than those due to the zener. Also the charge storage of the bridge is much less. Lastly by biasing the zener on all the time, the knee appears to be much sharper.

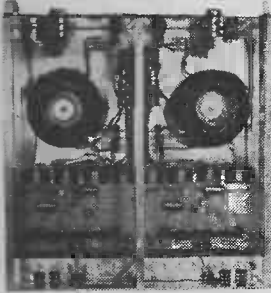


To be continued

# electronics today

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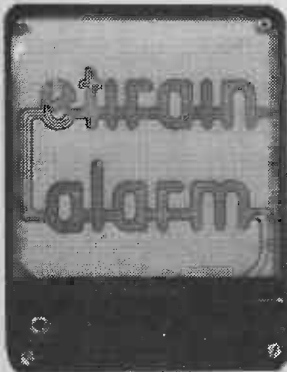
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# GAS MONITOR

**ETI Project Team present a machine which nose when you're fuming, and which can be suitably alarming. Particularly useful to boat owners, and of value to all needing to keep an eye on the gases.**

PETROL VAPOUR, closed space and electrical sparks are not ideal companions. Many a boat has been destroyed when the owner has switched on the ignition without realising there had been a petrol leak and the vapour content in the engine compartment is at a dangerous level. Unfortunately the circumstances also lead to injury and loss of life. Therefore any system which can prevent this is of great value.

This unit is designed to meet this requirement and uses a semiconductor gas detector (TGS cell) to monitor the atmosphere in the engine compartment and either prevent the engine being started or shut it down if a high vapour concentration occurs during operation.

## Construction

This is relatively easy if the printed circuit board is used and the wiring diagrams are followed. Some precautions should be taken if the unit is to be used in a boat to prevent corrosion. The rear side of the board should be coated with a cellulose spray (dope, nail polish, etc.) and the box, while having to be near the control panel, should be shielded from direct spray. Although we have used a separate box the unit can be mounted behind the control panel if desired.

A small heatsink (about 25 mm square aluminium) should be bolted on to IC1 to keep it cool.

The relay should be capable of handling up to 5A and should have a 12V coil with a resistance of over 100 ohms.

Obviously the sensor must be mounted in the engine compartment and while it must be in free air it must also be protected against mechanical damage.

## Installation and Adjustment

The sensor should be mounted in a position where vapour may be expected and should be mechanically protected against damage. The

connection to the sensor should be via a four core cable (on long runs use a shielded cable). Note that the sensor is symmetrical in layout and also the fact that it will fit into a standard seven pin miniature valve socket.



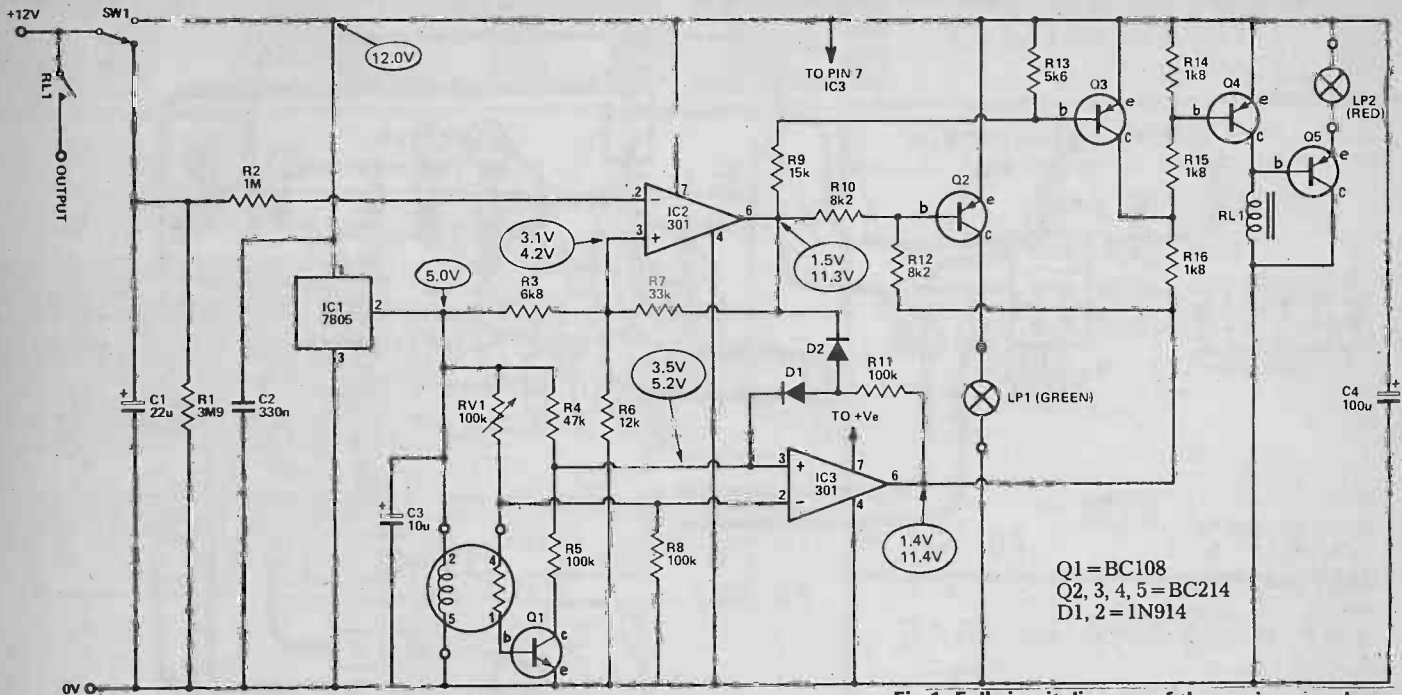


Fig 1. Full circuit diagram of the marine gas alarm.

## HOW IT WORKS

This project is designed primarily to monitor the concentration of volatile gases inside the bilge of petrol-engined boats. The circuit provides an electrical cutout which prevents the engine from being started if fumes are present and also will remove all electrical power if fumes become present at any time.

The unit acts as a master switch and due to its warm up requirements, a two minute delay occurs on switch on. Two indicator lights indicate either "safe" or "fail" condition and in the initial warm up period both lights are on. The initial timing is performed by C1 and IC2. With the main switch off there is +12 V across C1. When it is switched on the

capacitor is allowed to discharge through R1. IC2 compares the voltage on C1 with that on pin 3 (about 3 V). During this period the output of IC2 will be about +2 V.

IC1 is a 5 V regulator and supplies the power for the heater of the sensor. The sensor's resistant element is in series with RV1 and this voltage is compared to the voltage set by R4/R5.

The transistor Q1 gives a fail safe operation and if the sensor is not connected this transistor will be off giving +5 V on pin 3 of IC3. Resistor R8 ensures that the voltage on pin 2 will always be slightly less than +5 V.

If vapour is present the sensor resistance will be low and the output of IC3 will be high. During the first two minutes the diodes D1 and D2 prevent the feedback loop (R11) operating. After two minutes if the output goes high the reference voltage on pin 3 of IC3 will go above 5 V and therefore the IC will latch in that position.

The relay is operated by Q4 and for it to close the output of IC3 must be low (no vapour) and also the output of IC2 must be high (more than two minutes after switch on). If the unit does switch off, or prevents initial switch on, it must be switched off and then on again (after clearing the fumes) and the two minute delay operates again.

The only adjustment is the sensitivity control and this is set by bringing a small container of petrol near the sensor and ensuring it operates. The adjustment should be as sensitive as possible without giving false operation.

### Other Applications

By suitable choice of sensor from the TGS range (see data sheet this issue) the basic electronics; with perhaps a few modifications, can be used for a number of other applications — for example switching on an extractor fan if the carbon monoxide level in a garage reaches a dangerous level. No doubt numerous other applications for this project will occur to you.

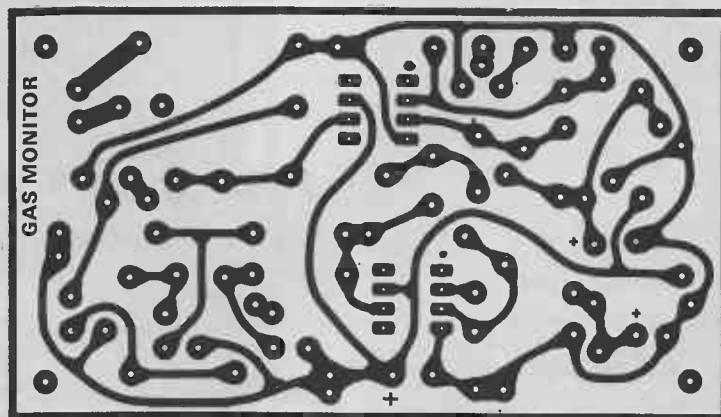


Fig 2. PCB pattern foil side shown full size (52 x 92 mm).

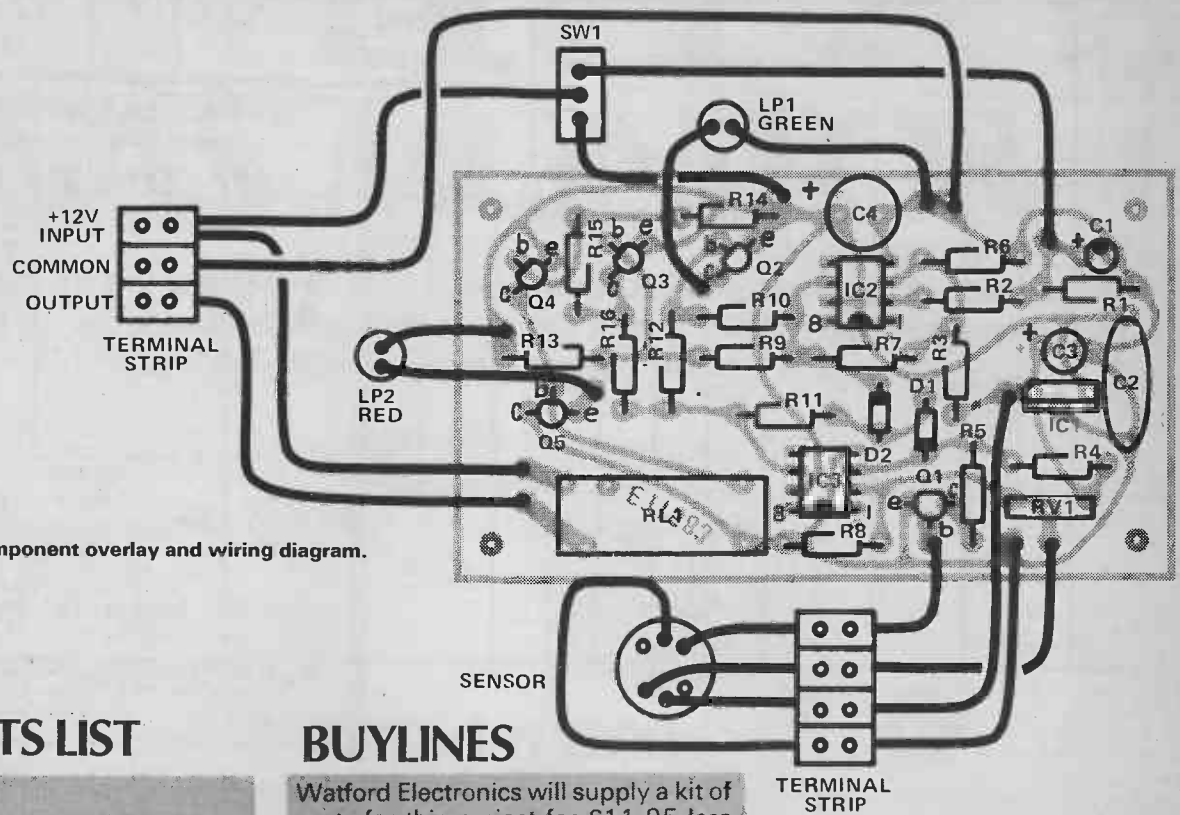


Fig 3. Project component overlay and wiring diagram.

## PARTS LIST

### RESISTORS

R1	3M9
R2	1M
R3	6k8
R4	47k
R5,8,11	100k
R6	12k
R7	33k
R9	15k
R10,12	8k2
R13	5k6
R14,15,16	1k8

### POTENTIOMETERS

RV1	100k vert. preset
-----	-------------------

### CAPACITORS

C1	22u 16V Tantalum
C2	330n Polyester
C3	10u 16V Electrolytic
C4	100u 25V Electrolytic

### SEMICONDUCTORS

IC1	7805
IC2,3	LM301A
Q1	BC548
Q2,3,4,5	BC214

### SENSOR

TGS	812 or 813
-----	------------

### LAMPS

LP1,2	12V 100mA
-------	-----------

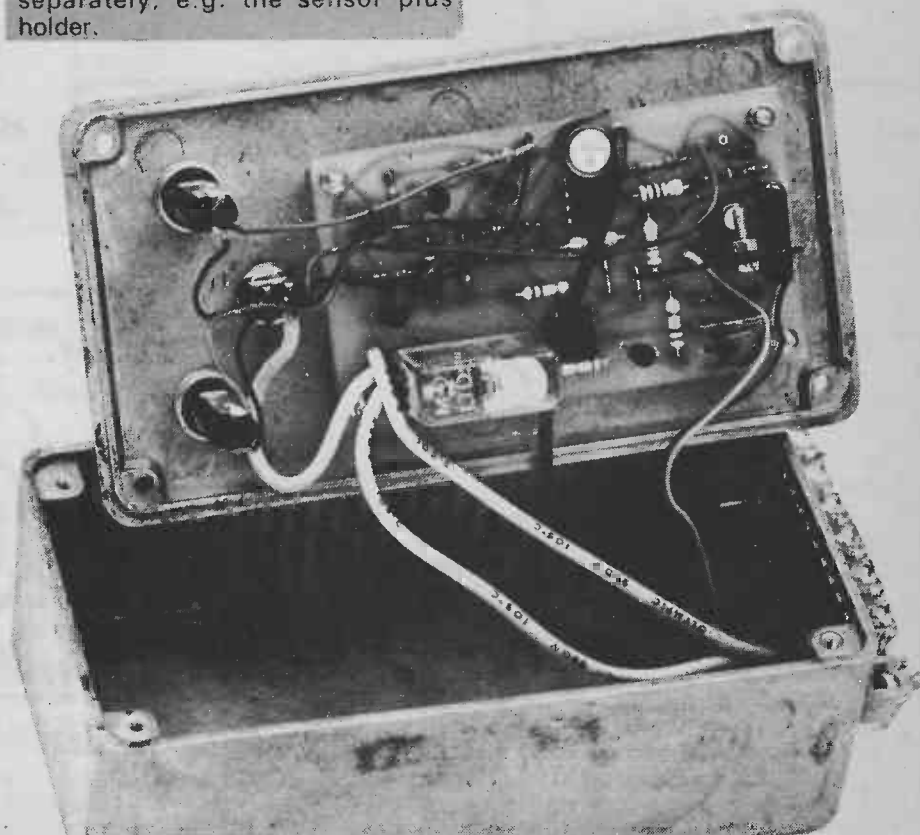
### MISCELLANEOUS

Relay to suit application (min res 100R),  
PCB as pattern, box etc.

## BUYLINES

Watford Electronics will supply a kit of parts for this project for £11.95 less box which should be selected to suit the constructor's particular application, i.e. the expense of a die cast box would not be warranted unless the device needs to be waterproof.

Watford will also supply all parts separately, e.g. the sensor plus holder.



# DIGITAL ELECTRONICS

THE 7490 DECADE COUNTER is a single-chip counter containing four flip-flops and various gates, which are arranged so that frequency division and decimal counting can be carried out. To make the counter more versatile, one flip-flop is separately connected so that it can be independently used as a scale-of-two counter, and the remaining three flip-flops are gates so that they act as a scale-of-five. The two sections of the counter can be connected together in different ways, either as a divide-by-ten circuit, or as a decimal counter with BCD outputs.

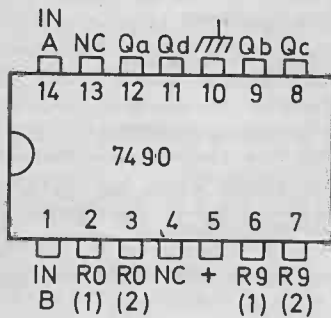


Figure 1. Pinout of 7490 Decade counter.

## Twos Into Tens

BCD — meaning Binary-Coded-Decimal — is a form of binary code which is particularly useful if decimal numbers have to be displayed. In a BCD count, each figure of a decimal number is represented by its binary equivalent, so that the number 85 (decimal) becomes 1000 0101, binary 8 and binary 5. Although more convenient, because each BCD counter can then drive a display unit, this form is longer than a pure binary number (binary 85 = 1010101, only seven figures), and BCD numbers are not so simple to add and subtract as pure binary numbers.

## BCD in Practice

Connect the power supplies to the 7490 with pin 10 to earth and pin 5 to +5 V. Pins 2 and 7 should also be

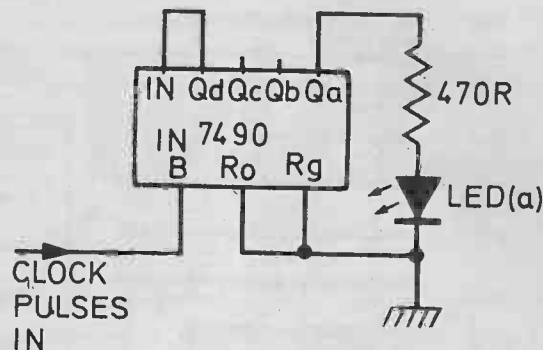
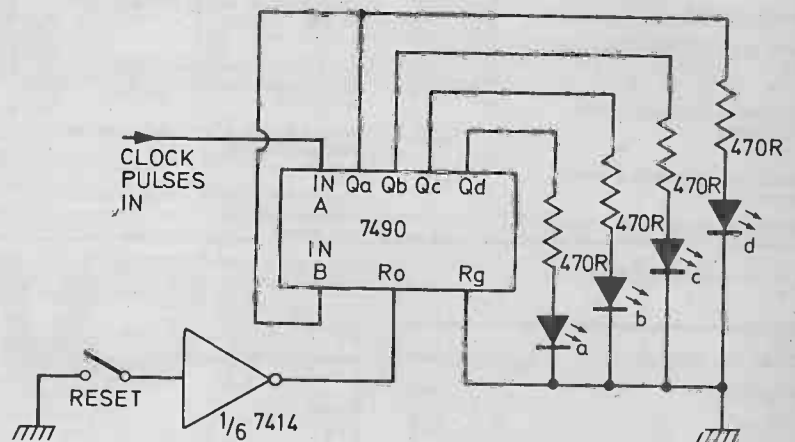


Figure 2. Connections for frequency division by ten — note that the symbol does not show the true pin positions. Figure 3. Connections for BCD counting, with reset switch. The reset pin must be kept at logic zero for counting, and taken to logic 1 for reset, so that an inverter must be used along with the push-button switch.



earthed for most of the experimental work in this section, although we may use pin 2 later for resetting to zero. Now connect LEDs and their limiting resistors, using the spare pads on the board, to Qa on pin 12 and Qd on pin 11. Connect the clock pulse from the slow oscillator to input A (pin 14) and by watching the clock LED and the LED connected to pin 12 (Qa), note the action of this section of the counter.

Switch off, transfer the clock pulse input to input B on pin 1, and switch on again, watching the clock LED and the Qd LED on pin 11. Note that the counter will operate only if the reset pins are earthed. There are two pairs of reset pins, each pair being inputs to an AND gate which operates the reset. Pins 2 and 3 are the reset to zero pins, and earthing either of them enables

the counter. If both are allowed to float to logic 1, or are taken to logic 1, the counter resets to zero. Pins 6 and 7 also act through an AND gate, but with both high the reset is to BCD 9 (1001) rather than to zero.

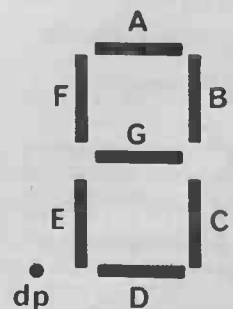


Figure 5. Arrangement of segments in a seven-segment display. The decimal point, which may be on the other side of the figure, is always energised separately, often from a range switch.



# BY EXPERIMENT PART 7

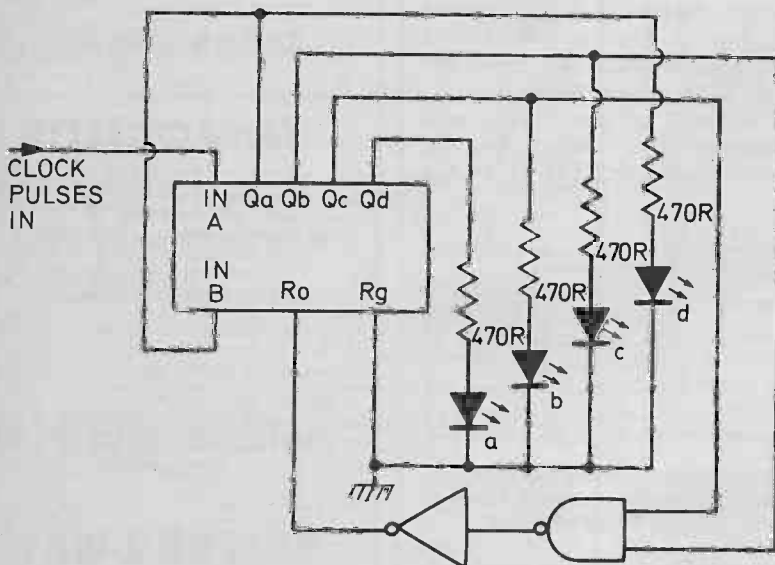


Figure 4. A terminated count. At some stage in the count, the gate will force the counter to reset. When does this happen?

Number/ Character	a	b	c	d	e	f	g
0	x	x	x	x	x	x	-
1	-	x	x	-	-	-	-
2	x	x	-	x	x	-	x
3	x	x	x	x	-	-	x
4	-	x	x	-	-	x	x
5	x	-	x	x	-	x	x
6	-	-	x	x	x	x	x
7	x	x	x	-	-	-	-
8	x	x	x	x	x	x	x
9	x	x	x	-	-	x	x
(10)	x	-	-	x	x	x	-
(11)	x	x	x	x	-	-	-
(12)	-	x	-	-	-	x	x
E (13)	x	x	-	x	-	x	x
E (14)	-	-	x	x	x	x	x
Blank (15)	-	-	-	-	-	-	-

x - lit  
- - unlit

	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0	0	0	0	0	0	0	1
1	1	0	0	0	1	0	0	1	1	1	1
2	0	1	0	0	0	0	0	1	0	0	1
3	1	1	0	0	0	0	0	0	1	1	0
4	0	0	1	0	1	0	0	1	1	0	0
5	1	0	1	0	0	1	0	0	1	0	0
6	0	1	1	0	1	1	0	0	0	0	0
7	1	1	1	0	0	0	0	1	1	1	1
8	0	0	0	1	0	0	0	0	0	0	0
9	1	0	0	1	0	0	0	1	1	0	0

Figure 6 (left) Truth table for figure and character displays. Figure 7 (above). Truth table for a common-anode display, figures only.

To use the 7490 as a frequency divider (Fig. 2), we connect Qd (pin 11) to INa (pin 14) and take the clock pulse to INb (pin 1). The output will appear at Qa, on pin 12, and the state of this output is monitored by an LED already. Connect up the clock pulse from the slow oscillator on the board, and by counting pulses, confirm that the correct division ratio is being obtained.

For a BCD count, the connections must be changed around (Fig. 3). We now need LED indicators on the Qb (pin 9) and Qc (pin 8) outputs as well

as on Qa (pin 12) and Qd (pin 11), and the cross-connections are different, with Qa connected to input B and the clock input taken to input A on pin 14. Label the LEDs as A, B, C, and D, and switch on, noting the values at each stage of the count. Use de-bounced switch as a clock supply if the oscillator is too fast to follow. Note that in the circuit of Fig. 3 a reset switch has been used; because we are using push-to-make switches, an inverter must be used as shown.

Because the 7490 is on a single chip it may be convenient to adapt it

for counts of less than 10, rather than use separate flip-flops. This is made easier by the arrangement of the reset lines, connected through AND gates. Ignoring the reset-to-nine pins, we can arrange for pin 2 to be driven by a gate whose output must be zero during the count, rising to 1 at the end of the count. Pin 3 must be kept high, or the count will not be interrupted.

Try the circuit of Fig. 4 — can you work out what the count figure will be? Connect up and try the circuit out.

## Displays

Though several other forms of display exist, the most convenient type for use with TTL circuits is the seven-segment LED display. The type used for this board, the BI-PAK DL747 (Jumbo) is one of the largest displays of this type available at the time of writing, and has been selected from the point of view of easy reading at a distance. If any other type is substituted, care will have to be taken with the pin connections, since there are several pinout standards for this type of display.

As the name suggests, the seven-segment display consists of seven LEDs made in one chip in the arrangement of a figure-of-eight, as shown in Fig. 5. The letters allocated to the strips are also shown (fortunately these are standardised).

Looking at the arrangement of the segments, we can draw up a table of the segments that will have to be activated (ON) for each number we want to display. Fig. 6 shows such a

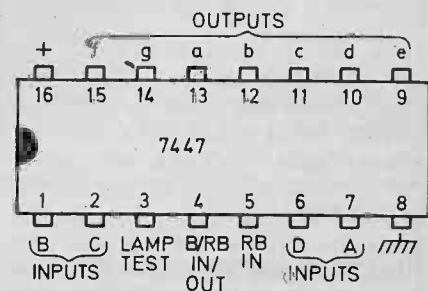


Figure 8. Pinout of 7447 BCD to 7-segment decoder-driver.

table for the numbers 0 to 9, and also some of the other characters which can be obtained. We now have to translate this ON/OFF table into terms of logic 1 and 0.

The next step depends on the type of display that is being used — common cathode or common anode. As the name suggests, the common cathode display has all of the LED cathodes connected together to logic 0, and each anode must be taken to logic 1 to be illuminated. To prevent excessive current flowing — because the normal forward voltage across the LED is less than the +5 V of the logic circuits — we must wire a limiting resistor in the connection to each anode. We cannot use one single resistor in the cathode lead, as this would cause the brightness of the display to alter according to the number of segments lit.

The other possibility is to connect the anodes of the LEDs together and take the cathodes out to separate pins. In this common-anode type of display, the segments will be lit when their respective cathodes are at logic zero, and once again limiting resistors must be used between each cathode and the TTL driving stage.

The type of display specified for this board is a common anode type, with several of the pins on the display connected to the common anode. Only one of these pins need be connected to the 5V line.

## Decoders

To obtain a decimal readout from the BCD output of the 7490 counter, a decoder stage is needed with the truth table shown in Fig. 7.

The type used here is the 7447 BCD-to-seven segment decoder/-driver, which has output stages of transistor collectors with no loads. In this way, the combination of LED and limiting resistor acts as load for the collectors of the output transistors in the 7447.

Care should be taken that the outputs of a 7447 are never connected directly to the +5 V line, as excessive currents could flow if the decoder were operated.

In use, the segment output pins of the 7447 are connected through the limiting resistors to the segment pins of the display. The values of the limiting resistors used will determine the brightness of the display. For the 7447 display we can use 150 R res-

istors, but 470R resistors have been specified on our board to ensure long life and to cut down current consumption. If other displays are used, 470R should also be suitable — in general the small displays need less current, and so larger values of limiting resistors should be used than with larger displays. If a common cathode display, such as the MAN-3 types, had been used, the 7448 decoder would have been needed.

Now connect up the display and the decoder on your board, noting the connection diagram of Fig. 9. In the

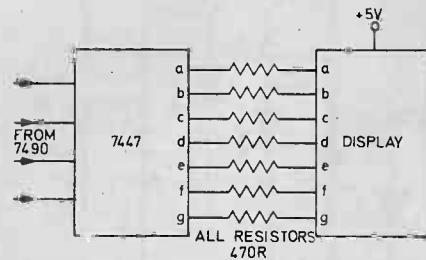


Figure 9. Connection of 7447 to display — not that the arrangement on the board is tidy as the diagram would suggest!

prototype boards, the very small resistors used for limiting could be passed under the body of the display, so avoiding long paths around it. The +5 V supply is taken to pin 16 of the 7447, and earth is taken pin 8. The outputs of the 7447, all on the side facing the display, and marked on the circuit diagram with small letters, are taken through the 470R limiters to the correspondingly lettered pins of the display. The inputs indicated by the capital letters A, B, C and D on pins 1, 2, 7 and 6 of the 7447 are for the BCD input from a 7490 and should be connected to the appropriate Q outputs from the 7490 counter.

## Testing and Blanking

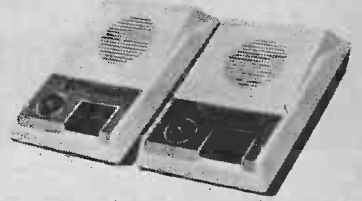
Note that pin 3 of the 7447 is labelled "lamp test." Taking this pin to logic 0 illuminates all segments of the display irrespective of what stage the count has reached, and is a useful check on the operation of the display. For example, an operator can check that a steady display of is not just with two segments faulty.

Pins 4 and 5 on the 7447 are for blanking, used mainly when the display is one of a set, to suppress zeros occurring before the first significant figures and after the last one. When pin 4 is low, the display is blanked out, though counting is unaffected.

To be continued

ETI

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# 200W AUDIO AMPLIFIER



NO LITTLE TIME AGO we published a project for a 100 W guitar amplifier. It has since proved to be our popular project *ever*, and shows no signs of lying down to die in a respectable manner.

The main complaint about this machine has been that it is not powerful *enough* — something which our burst eardrums have repeatedly failed to grasp. In an attempt to please all the people all the time (as usual) we decided to re-do a design completely, uprating the spec to 200W, and generally improving the quality as far as we could to make the amplifier suitable for high quality domestic usage.

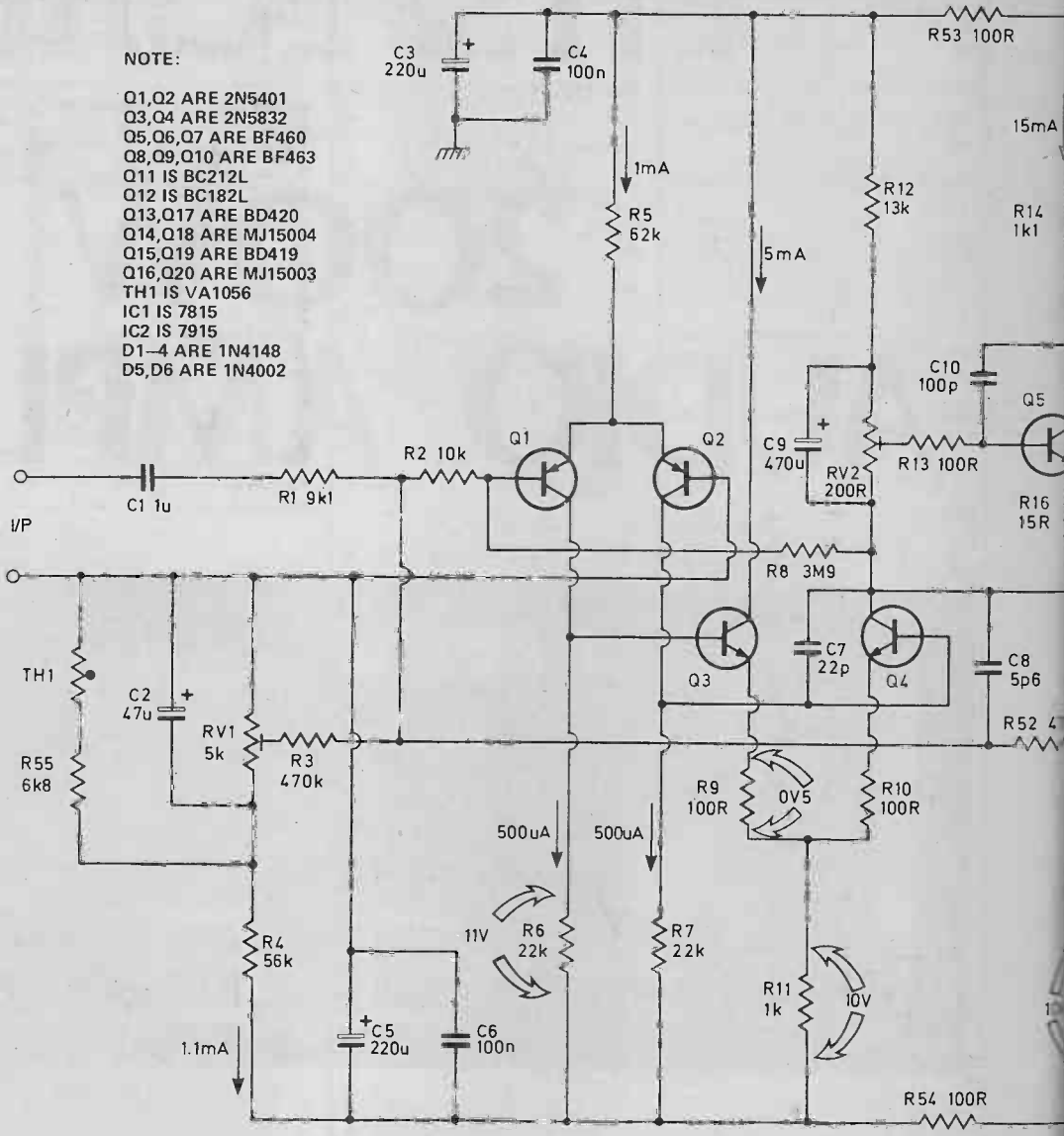
The subjective quality of the design is such that it will not be out of place in the highest of hi-fi set-ups, and its power enables it to drive the more inefficient monitors which seem to dominate such spheres.

## SPECIFICATION

<b>Output power</b>	<b>200 W</b>	
<b>Input sensitivity (for rated output)</b>	<b>.775 mV (0 dB)</b>	
<b>Distortion at 200 W</b>	1 kHz	<b>0.031 %</b>
	10 kHz	<b>0.073 %</b>
<b>20 W</b>	1 kHz	<b>0.025 %</b>
	10 kHz	<b>0.060 %</b>
<b>2 W</b>	1 kHz	<b>0.027 %</b>
	10 kHz	<b>0.042 %</b>
<b>Signal to noise ratio (CCIR weighted)</b>	<b>-101 dB</b>	
<b>Frequency response (-3dB)</b>	<b>10.2 Hz — 70.0 kHz</b>	
<b>Slewing rate</b>	<b>20 V/u sec</b>	

**NOTE:**

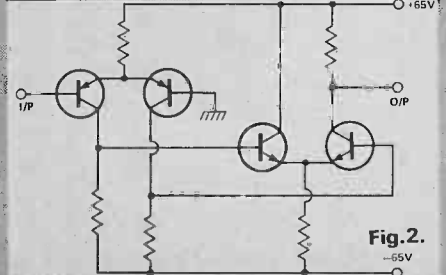
- Q1,Q2 ARE 2N5401
- Q3,Q4 ARE 2N5832
- Q5,Q6,Q7 ARE BF460
- Q8,Q9,Q10 ARE BF463
- Q11 IS BC212L
- Q12 IS BC182L
- Q13,Q17 ARE BD420
- Q14,Q18 ARE MJ15004
- Q15,Q19 ARE BD419
- Q16,Q20 ARE MJ15003
- TH1 IS VA1056
- IC1 IS 7815
- IC2 IS 7915
- D1-4 ARE 1N4148
- D5,D6 ARE 1N4002



**HOW IT WORKS**

**USE OF DIFF. PAIRS**

Extensive use is made in the design of the 'long-tailed' or differential pair. The basic voltage amplification stage is shown in Fig.2. The symmetrical operation of the long-tailed pairs run with equal current in each arm affords the stage low distortion. Differential operation also possesses high linearity, as any non-linearity in  $V_{BE}$  for either transistors is compensated for by the other.



It is normal to operate differential pairs with a constant-current source in the tail, i.e.

Q8, D2 and R22-24 supply Q9 and Q10, and Q7, D1 and R18-20 supply Q5 and Q6. However, at the input of the amp (Q1 and Q2), only very small changes in tail current occur due to the small voltage swings, and a fairly 'large' value resistor, i.e. R5 will suffice. Similarly for R11 and Q3 and Q4. In the output driver stages very large voltage swings will be present and thus a current source is essential to correct operation.

**OPERATION**

For the purposes of operation the amplifier can be considered in four blocks: Two low gain, low distortion voltage amplification stages formed by Q1 and Q2 and by Q3 and Q4 output drivers Q5 and Q6 with Q9 and Q10 and finally the fully complementary output stages which consist of paralleled darlington. Discrete devices are employed for their better operating characteristics and speed 2MHZ. Q15 and Q16 are paralleled with Q19 and Q20 to form in effect a single output 'transistor'. Q13, Q14, Q17 and Q18 constitute

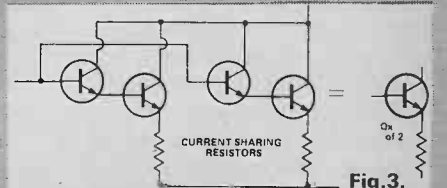
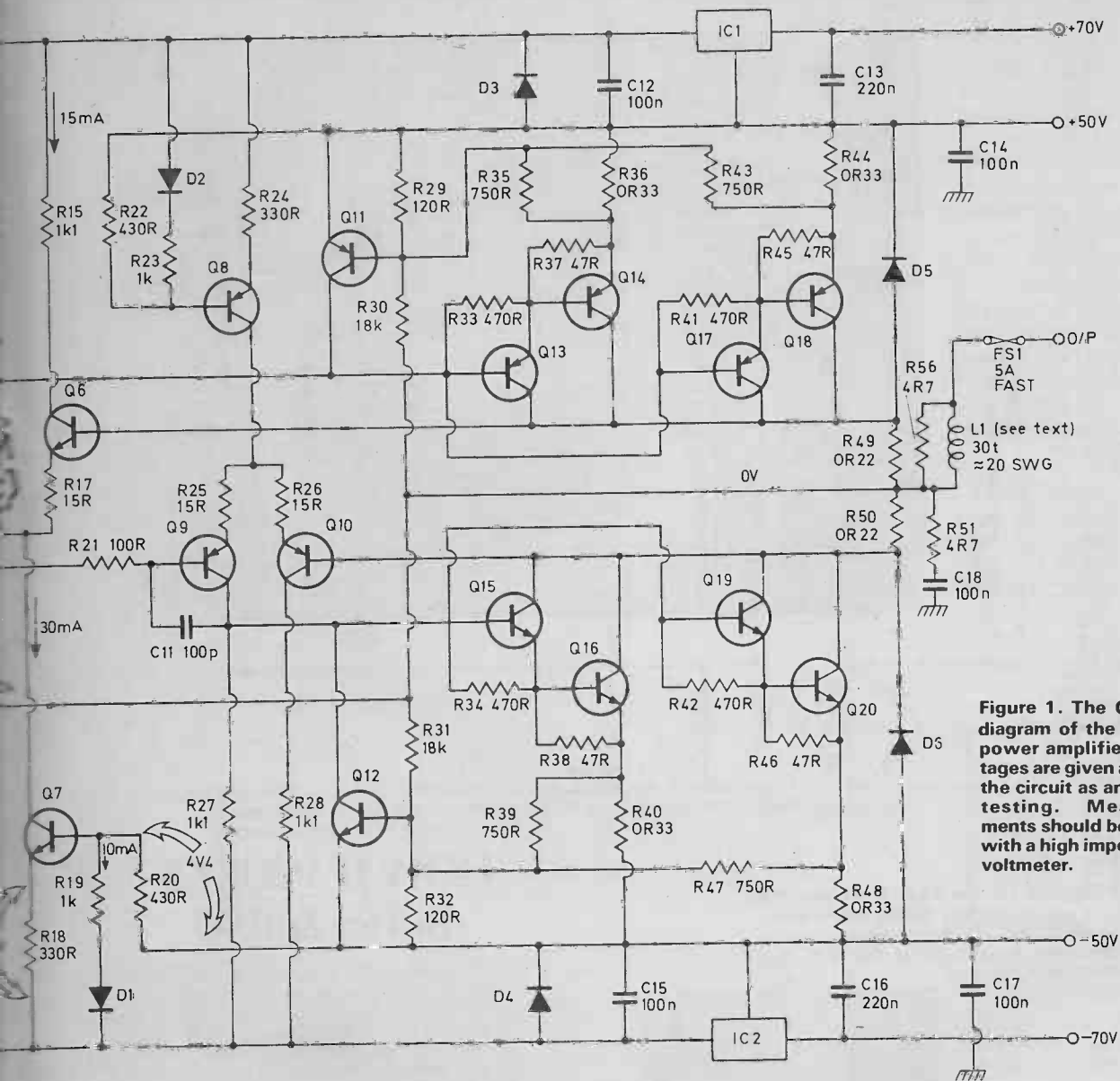


Fig.3.

an identical configuration for the other half of the cycle. Fig.3 shows how the four may be combined into 'Qx'.

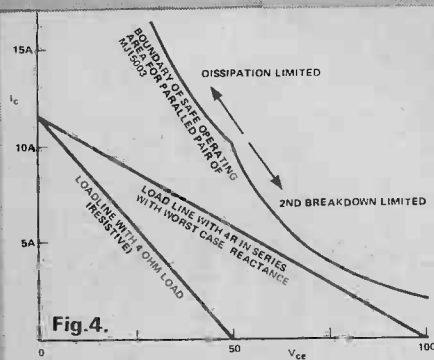
**OUTPUT TRANSISTORS**

The output types themselves are 250 watt devices, since for reliability the load line of these transistors must lie within the "safe operating" area (Fig 4). This is simply achieved with a pure resistive load, but not with the reactive component of a loudspeaker added. For a 4R load instantaneous dissipation in this design has a max of 144W, but with a reactive load dissipation can rise to 288 W. For these reasons lower power



**Figure 1.** The Circuit diagram of the 200W power amplifier. Voltages are given around the circuit as an aid to testing. Measurements should be made with a high impedance voltmeter.

## WORKS - Main Amp



devices are not recommended for use, unless more are paralleled to share the load. Because the amp employs low overall feedback (14 dB) the bias current for Q1 is not obtained via the feedback resistor R52 since this would result in a large DC offset at the output. An independent supply is provided, consisting of RV1, R55 and R4. Temperature compensation is provided by TH1.

### QUIESCENT CURRENT

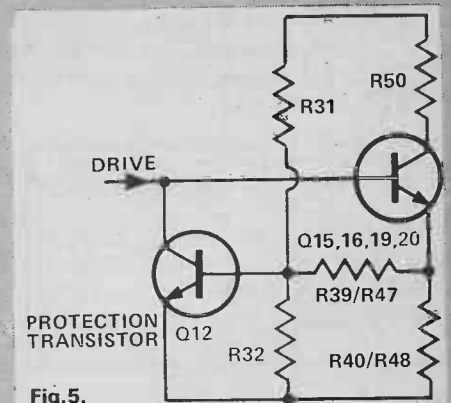
With the employment of long-tailed pairs, setting of quiescent current in the output 'switches' QX is somewhat different to a 'normal' design. The function is affected by RV2, which varies the DC between Q5 and Q6 bases. Q5 base will follow the base of Q6 by differential pair action, and similarly Q9 and Q10 this means that the voltage across R49 and R50, which is proportional to  $I_q$  will be 'referred back' to RV2. Temperature effects can be removed by keeping Q5 and Q6 as well as Q9 and Q10 at the same temperature, and to ensure this pair is thermally connected to a (different) heat sink.

Regulators IC1 and IC2 are employed to stabilize the 50-volt rails with respect to the 65-volt rail for the constant current sources supplying driver stages Q5 and Q6 and Q9 and Q10.

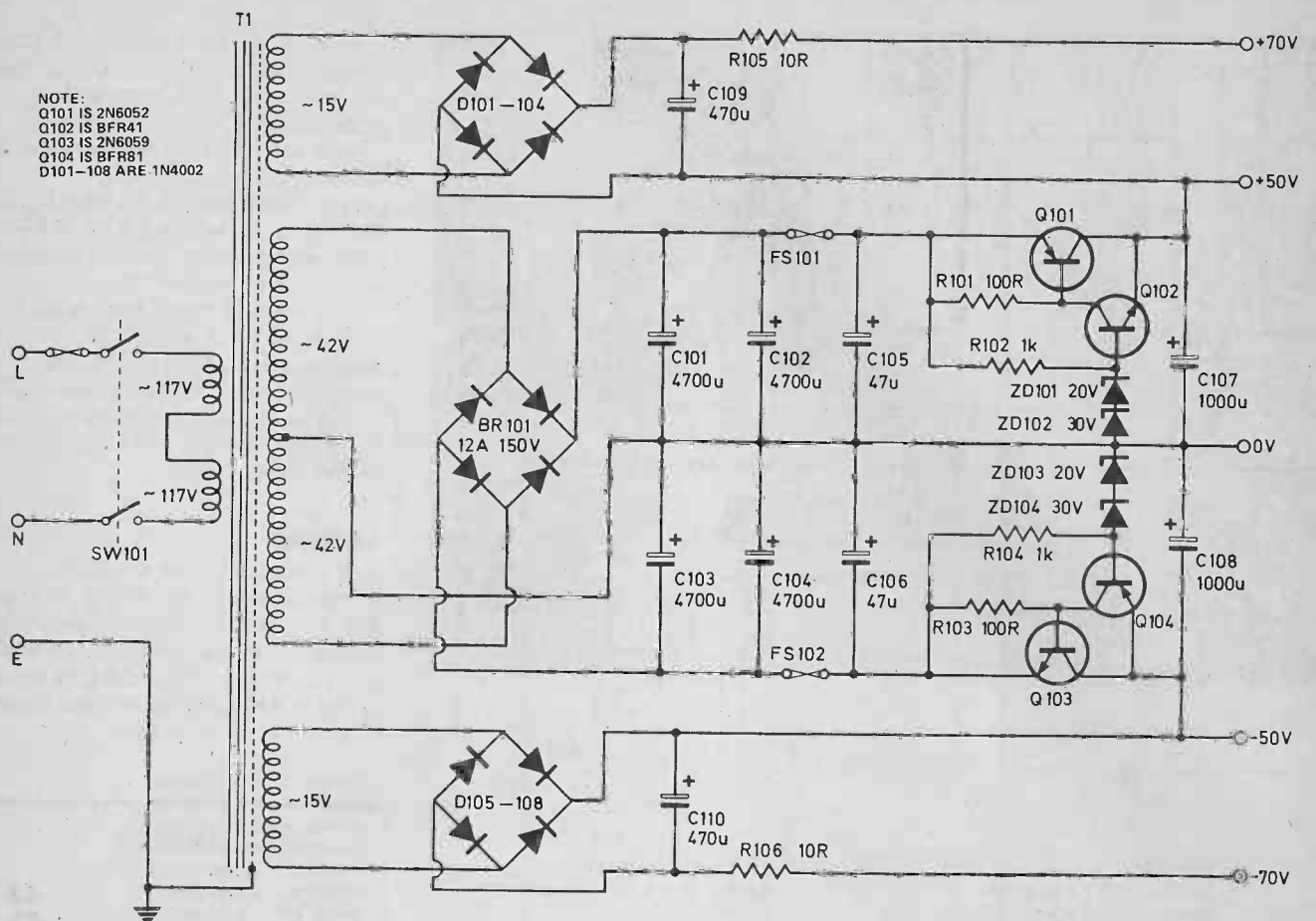
Diodes D8 and D4 protect IC1 and IC2 from any reverse voltages that might be present at switch on.

### OUTPUT PROTECTION

Conventional short circuit protection is employed, using load-line limiting, i.e., refer-

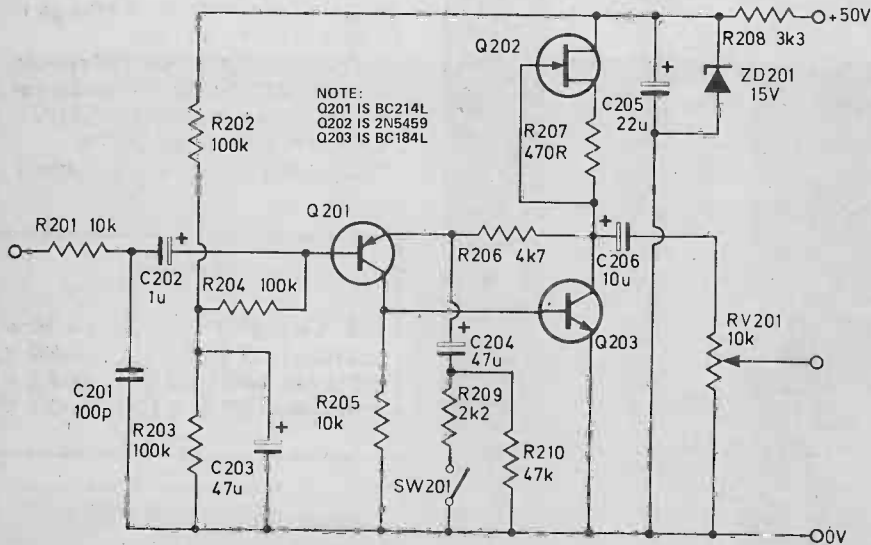


**Fig. 5.** The current through R31 will voltage limit the output, and the current through the parallel combination imposes a current limiting function. If either limit is exceeded, Q12 switches on and closes down the drive signal.



NOTE:  
 Q101 IS 2N6052  
 Q102 IS BFR41  
 Q103 IS 2N6059  
 Q104 IS BFR81  
 D101-108 ARE 1N4002

Figure 6. (Above) Circuit diagram for the PSU. Note that the transformer is a special unit wound for the 200W amplifier by Powertran Electronics. Figure 7. (Below) The circuit diagram for the buffer to increase the input impedance of the unit, and provide variable input sensitivity if required.

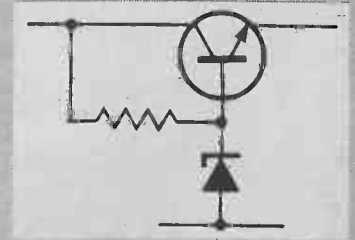


NOTE:  
 Q201 IS BC214L  
 Q202 IS 2N5459  
 Q203 IS BC184L

## HOW IT WORKS ~Buffer & PSU

THE power supply is a conventional series pass circuit. The basic circuit elements are shown below. The circuit is essentially an emitter follower, the voltage at the base of the transistor being some 0V6 below that set by the zener in the base. The final circuit shown in Fig. 6 shows that Q101 forms the pass element in the +50v rail while Q103 forms the complementary device in the negative rail. Q102 and Q104 provide increased drive to the pass elements.

The  $\pm 70V$  rails are derived from a simple bridge rectifier circuits.



### THE BUFFER

The buffer is a straightforward circuit formed by Q201-203. The buffer provides a high input impedance and allows for two gains, with RV201 at maximum, +0dB with SW201 open and +10dB with R209 in circuit. Changing the value of R209 to 470R will give a 20dB boost when SW1 is operated.

The buffer is powered from the +50V rail with ZD201 included to provide a 15V rail.

# news digest.

## strike me

Straight out of Star Wars is a 'Strike Sight' computer from Ferranti.

The further away from the target a tactical aircraft can release a bomb load the greater chance the pilot has of returning safely. In particular, when releasing bombs equal to thousands of tons of TNT, unless the load can be released from an aircraft flying at very high altitudes (most tactical aircraft are not built for this), the only way is to release the load at some distance from the target.

The strike sight computer enables the pilot to do just that. The computer receives signals from and transmits signals to the range and doppler radars, the master reference gyro, and the altimeter. It guides the pilot on the approach to the target. At a specific time from the target the pilot selects whether to release the bomb or to abort the attack and pull out. At a precise interval thereafter, having selected to make the attack, the pull out begins and the computer takes over — the bomb is released automatically.

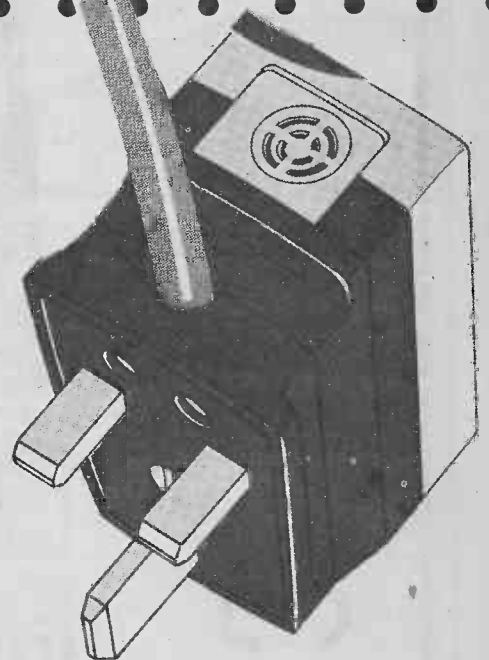
The only direct decision required by the pilot is whether or not to release the bomb. When he has made the selection the computer computes the release times and the pull-up process is initiated.

## getting a buzz

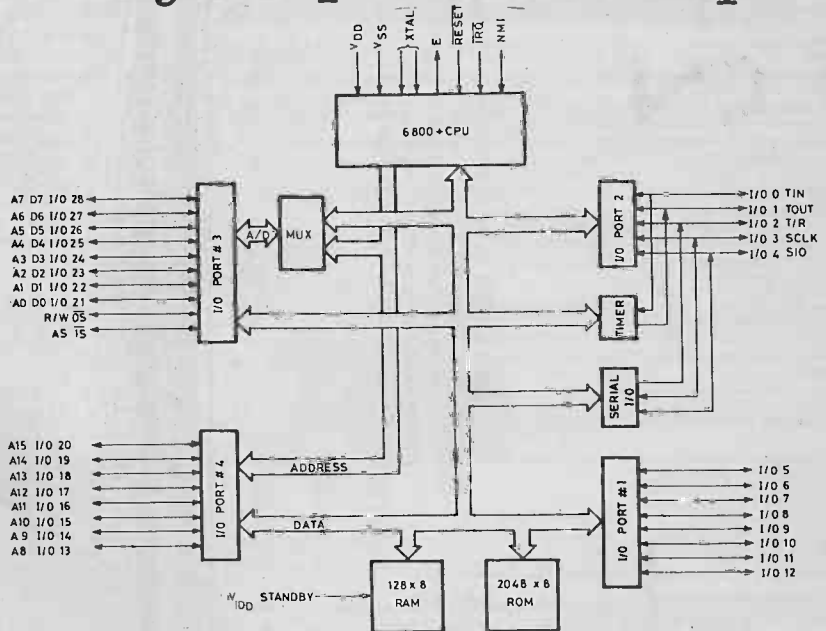
Wired like an ordinary plug and looking not much larger, the BUZZ PLUG may be fitted as a direct replacement for a standard plug.

The slightly thicker top actually contains some newly designed microcircuitry which continuously monitors the mains supply. In the event of a power failure (due to accidental switch-off, power cut, blown fuse) the plug produces a loud instantaneous warning which will persist until some action is taken.

The plug is powered by a single inexpensive battery which will give up to 60 hours warning. Typical applications include use with freezers, fridges, incubators and equipment which must run constantly or would require recalibration. Abbatal is the manufacturer, and further information is available from Ian Jones on Basingstoke (0256) 56417.



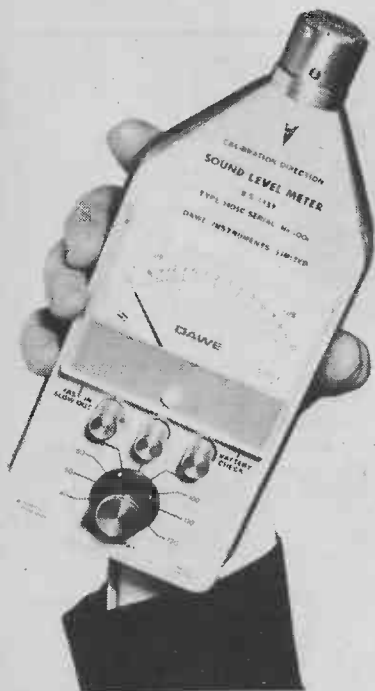
## all yer mpus in one chip



Motorola, manufacturers of the 6800 MPU has announced the introduction of a new one chip microprocessor in May. The chip, the MC6801 includes 2K-bytes of ROM, 128 bytes of RAM, a 16-bit timer, clock, serial output and 31 input/output lines.

The MC6801 is not a cut-down low end microprocessor but a very large scale integration MPU with an equivalent of 40,000 devices on the chip. The 6801 implements the full 6800 instruction set with the execution time of many key instructions reduced.

## level out



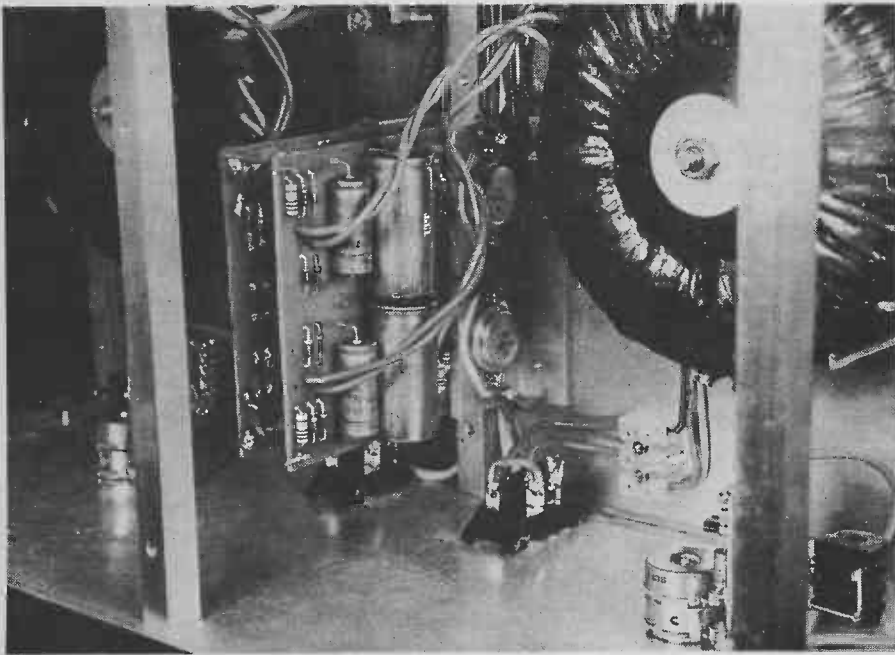
Pictured here is the Dawe Sound Level Meter 1405C. This device has a very wide dynamic range, from 34 to 130dB — from a whisper to well above the loudest shouting. Dawe Instruments Ltd, Concord Road, Western Avenue, London W3 05D.

## right hook

In a historic ruling, the US Supreme Court has confirmed that private individuals have the right to buy or make their own telephone equipment and connect it to the US telephone network.

Under the ruling it will be legal to hook

up as many devices as the user wishes — computer controlled systems, 'phone diverters, memory diallers, picturephones etc, etc. The only restriction is that the various bits must meet the relevant FCC requirements.



The PSU can be seen above. The layout of all the major components can be seen with the buffer (in close up below) just appearing at bottom right.

In addition the bodies of diodes D1 and D2 should be in contact with the heat sink of the appropriate group transistors.

The coil L1 is formed by winding thirty turns of self-fluxing polyurethane covered wire (about 26 SWG) around resistor R56 (4R7), soldering the wire to the leadouts at either end of the resistor.

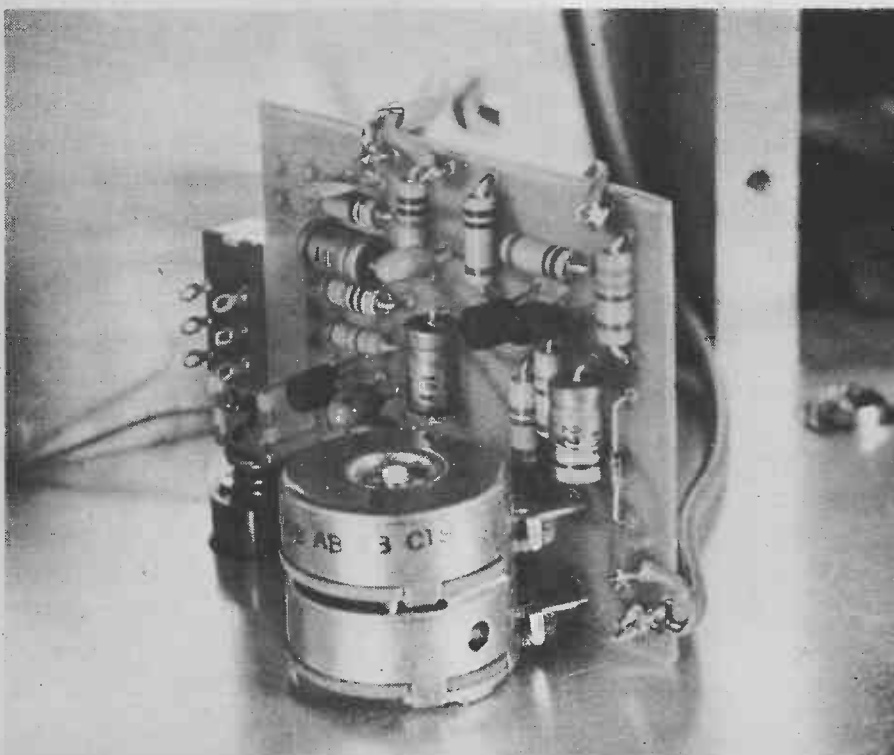
The interwiring of the various completed units should be undertaken by referring to the overlays and the various views of the amplifier chassis designed to show the layout that should be adopted in the completed unit.

## Testing

Test of the amplifier should commence with satisfying yourself that the power supply is operating correctly before connecting it to the main amplifier. The voltages shown in Table 1 should be present upon switching on the mains.

TABLE 1

C102+ to 0 V	62 V
C103- to 0 V	-62 V
C109- to C109+	22 V
C110- to C110+	22 V



If all is well switch off and — please — discharge the four hefty capacitors via a resistor before doing anything further or else you will be in danger of having a lot of energy make its way to earth via you.

Next connect a 1k5 1W resistor between Q101c and 0V and a similar resistor between Q103c and 0V. Switch on and hopefully the voltages will be shown in Table 2.

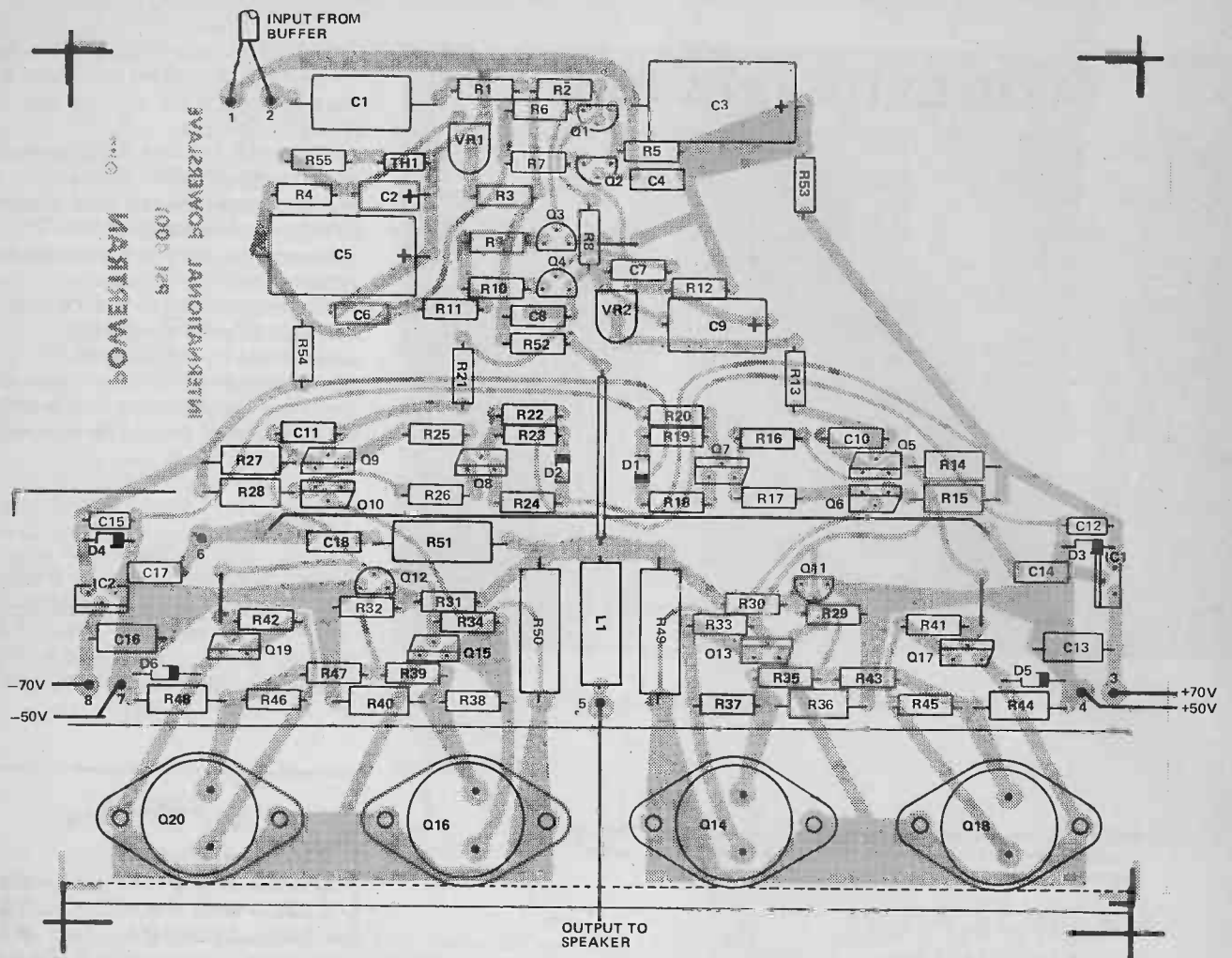
TABLE 2

Q101c to 0 V	+50 V
Q103c to 0 V	-50 V
PSU pin 101 to 0 V	+72 V
PSU pin 106 to 0 V	-72 V

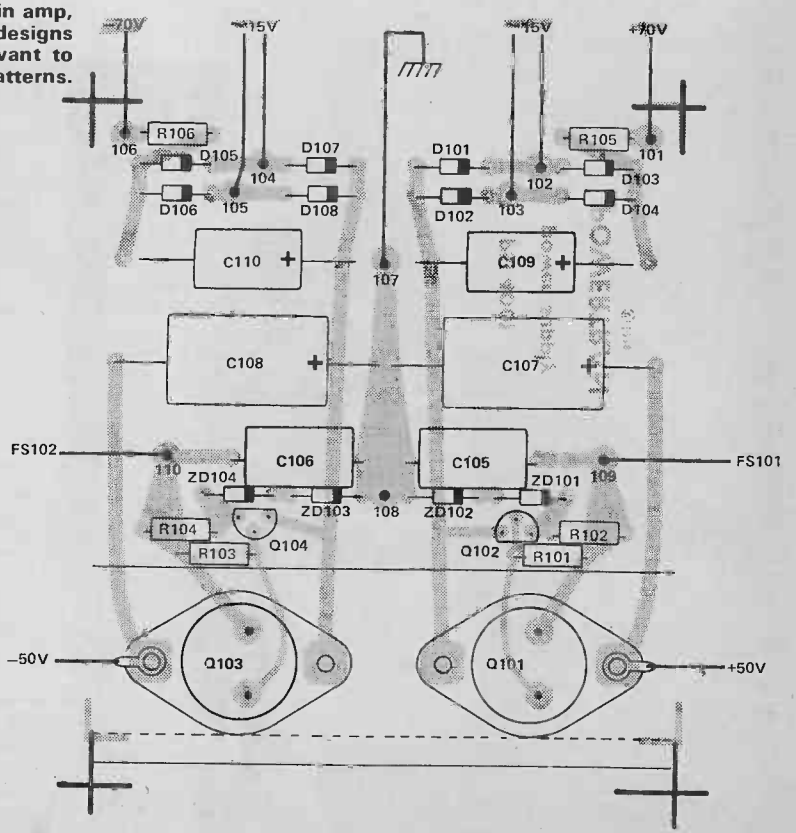
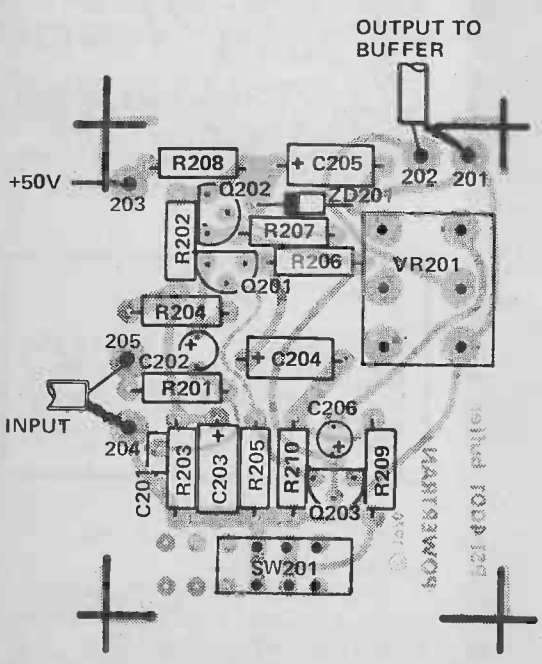
Again if OK, switch off and discharge those Cs.

Next replace the 5A PSU fuses with a 12V 2W4 light bulb in series with a 47R ½W resistor. This





On this page are gathered together overlays for the main amp, the power supply and the buffer. Please note the board designs are copyright Powertran but for those of you who want to produce your own an SAE to us will secure you the foil patterns.



## PARTS LIST~Buffer & PSU

### POWER SUPPLY PARTS LIST

RESISTORS (allows 2% metal oxide unless stated).

R101, 103 100R  
R102, 104 1k  
R105, 106 10R

### CAPACITORS

C101, 102, 103 4700u 63 V electrolytic  
104  
C105, 106 47u 63 V electrolytic  
C107, 108 1000u 63 V electrolytic  
C109, 110 470u 25 V electrolytic

### SEMICONDUCTORS

Q101 2N6052  
Q102 BFR 41  
Q103 2N 6059  
Q104 BFR 81  
D101-108 1N4002  
BR1 12A 150 V bridge  
ZD 101, 103 20 V 400 mW  
ZD 102, 104 30 V 400 mW

### TRANSFORMER

T1 see text

### MISCELLANEOUS

PCB as pattern, fuses.

### BUFFER

RESISTORS (All 2% OW5 metal oxide unless stated).

R201, 205 10k  
R202, 203, 204 100k  
R206 4k7  
R207 470 R  
R208 3k3  
R209 2k2  
R210 47k

### POTENTIOMETERS

RV20 1 10k

### CAPACITORS

C201 100p polystyrene  
C202 1u 16 V tantalum  
C203, 204 47u 10 V electrolytic  
C205 22u 25 V electrolytic  
C206 10u 16 V tantalum

### SEMICONDUCTORS

Q201 BC214L  
Q202 2N5459  
Q203 BC184L  
ZD1 15 V 400 mW

### MISCELLANEOUS

PCB as pattern.

## Construction

With a project of this type, while attempting to keep construction as straightforward as possible, the sheer physical size of many of the components precludes mounting them on a PCB. This inevitably leads to more constructional work and hence to a greater scope for error. Care taken during assembly and careful checking at each stage can save time and (plenty of) money later on. With this in mind please read this section thoroughly and study the photographs of the finished unit before starting constructional work.

The first stage in building up the amplifier is to mount all the passive components and links on the three PCBs according to the appropriate overlay. Needless to say all soldering must be or the highest standard and checks should be made to ensure that there are no solder bridges present.

## Power And Its Place

The four power transistors associated with the amplifier and the two required for the power supply are mounted on cooling brackets as shown in our photographs. Care should be taken to ensure that there are no burrs around the holes in the heat sink that might damage the mica washers that must be fitted to all six transistors. In order to aid heat flow from the transistors silicon grease should be smeared on both sides of these mica washers.

Note that solder tags are required to connect to the cases of the two PSV transistors but not on the main amp's devices where connection is made via the PCB.

## Bracketed Cooling

The thermal cutout is also fitted to the cooling bracket on which the amplifier's output devices are mounted.

As can be seen in the photos of the amplifier board the following groups of transistors are thermally connected

Q5 Q6 and Q7  
Q8, Q9 and Q10  
Q13 and Q17  
Q15 and Q19

## PARTS LIST~Main Amp.

### 200 W AMP PARTS LIST

RESISTORS (all 2% OW5 Metal Oxide unless stated)

R1 9k1  
R2 10k  
R3, 52 470k  
R4 56k  
R5 62k  
R6, 7 22k  
R8 3M9  
R9, 10, 13, 21, 53, 54 100R  
R11, 19, 23 1k  
R12 13k  
R14, 15, 27, 28 1k1 1W Carbon Film  
R16, 17 15R  
R18, 24 330R  
R20, 22 430R  
R25, 26 15R  
R29, 32 120R  
R30, 31 18k  
R33, 34, 41, 42 470R  
R35, 39, 43, 47 750R  
R36, 40, 44, 48 OR33 2W5 Wire Wound  
R37, 38, 45, 46 47R  
R49, 50 OR22 5W Wire Wound  
R51, 4R7  
R55 6k8  
R56 4R7 2WG Wire Wound

### POTENTIOMETERS

RV1 5k Cermet  
RV2 200R Cermet

### THERMISTOR

TH1 VA1056

### CAPACITORS

C1 1u polyester  
C2 47u 10 V electrolytic  
C3, 5 220 63 V electrolytic  
C4, 6, 12, 14, 15, 17, 18 100n polyester  
C7 22p 160 V polystyrene  
C8 5p6 63 V polystyrene  
C9 470u 6V3 electrolytic  
C10, 11 100p 160 V polystyrene  
C13, 16 220n polt ester

### SEMICONDUCTORS

Q1, 2 2N5401  
Q3, 4 2N5382  
Q5, 6, 7 BF460  
Q8, 9, 10 BF463  
Q11 BC212L  
Q12 BC182L  
Q13, 17 BD420  
Q14, 18 MJ15004  
Q15, 19 BD419  
Q16, 20 MJ15003

IC1 7815  
IC2 7915

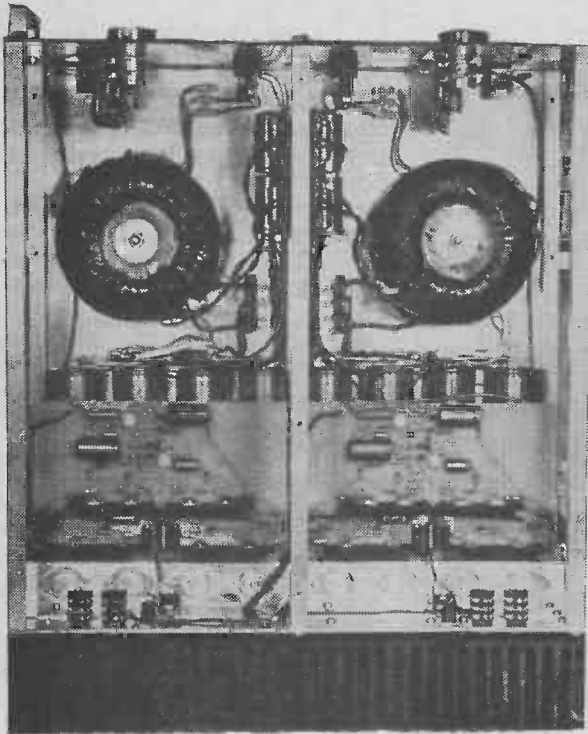
D1-4 1N4148  
D5, 6 1N4002

### INDUCTOR

L1 see text

### MISCELLANEOUS

PCB as pattern, thermal fuse, mica washers, connecting wire, etc.



Below can be seen the main circuitry. The heatsinking arrangements of the various output devices can be seen as well as the mounting of C101-C104. Above — an overall view of the amplifier.



The photograph above shows a version of the amplifier built with power level meters. The circuitry required to provide this facility is shown below.

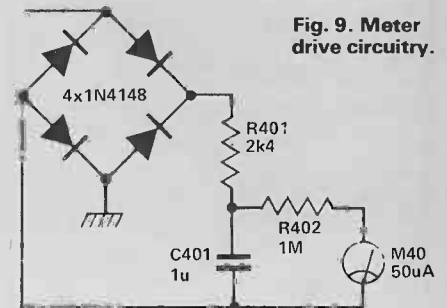
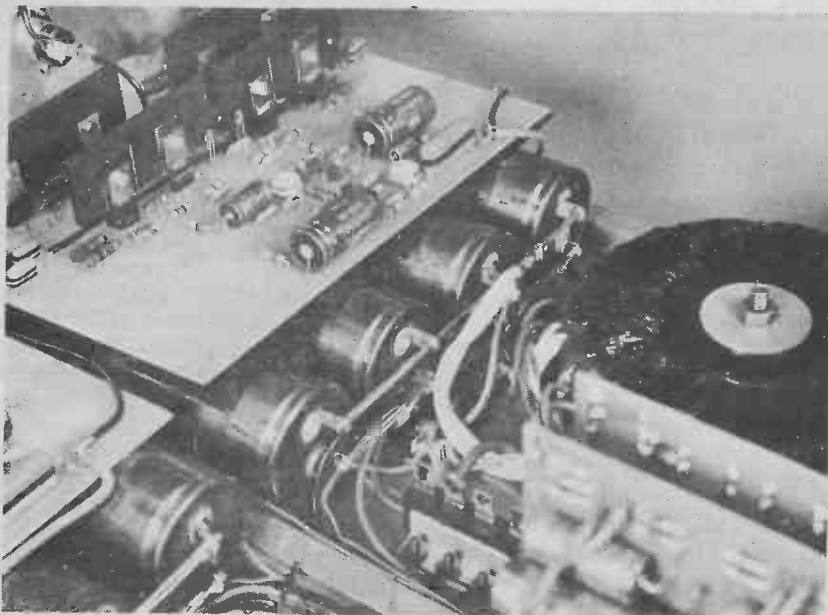


Fig. 9. Meter drive circuitry.



## BUYLINES

Powertran are to provide a complete kit of parts for this project. For prices and further details see their advert on the inside front cover.

provides a convenient method of monitoring and limiting the current drawn by the amplifier. Note that if the main amplifier is working correctly you will see an initial surge of light from the bulb which should then die away.

Before connecting power to the amplifier set RV1 to its centre position RV2 fully clockwise and RV201 fully anti-clockwise.

Switch on and check that the voltage between 0V and the R56 and R51 junction is near zero. RV1 should be adjusted until this voltage is exactly zero.

Next RV2 should be rotated until the lamps in the power supply lines start to brighten.

If everything is still going according to plan, replace the power supply fuses and adjust RV2 until the voltage between Q14c and Q16c is 20mV. Resetting the output to zero volts with RV1 completes setting up.

Leave the amp on for about half an hour and recheck all voltages, making any necessary adjustments connect a speaker to the output and 'test drive' the amp for about an hour. A final check of all voltages and your amplifier is ready to go into service.

# data sheet

## TGS 812/813 GAS SENSOR

FIGARO

THE TGS 812/813 are semiconductor gas sensors suitable for general purpose combustible gas detection.

The sensor consists of a ceramic tube onto which is deposited a layer of the semiconductor (mainly tin dioxide) and the electrodes.

In fresh air the resistance of the semiconductor is constant, but as the concentration of the detectable gases increases and comes into contact with the sensor's surface, the resistance of the semiconductor changes.

In order to increase the response time of the device, the sensor is heated to a temperature between 200 and 400°C by a heated coil in the ceramic tube.

The sensitivity characteristics of the TGS sensors are altered by changes in atmospheric temperature and humidity. The detection principle of the sensor is based on chemical absorption and desorption of gases on the sensor's surface, and because these reactions are temperature dependent and water vapour can be considered a gas, the effects of temperature and humidity changes cannot be eliminated from the sensor. These effects can, however, be reduced by suitable circuit design (see Fig 7).

The TGS812/813 sensors are available from:  
**Watford Electronics**  
 33-35 Cardiff Road Watford Herts.

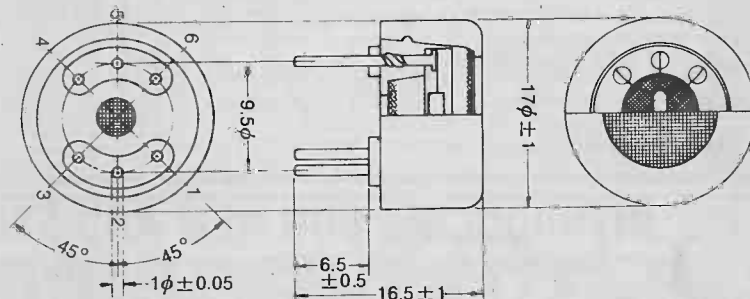
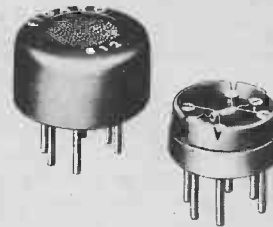
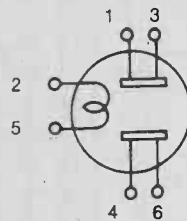
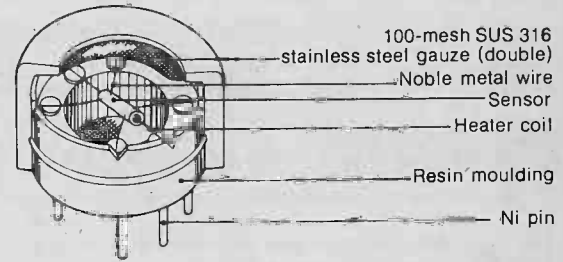


Fig 1. Mechanical structure of types 812 & 813 sensors, in mm.

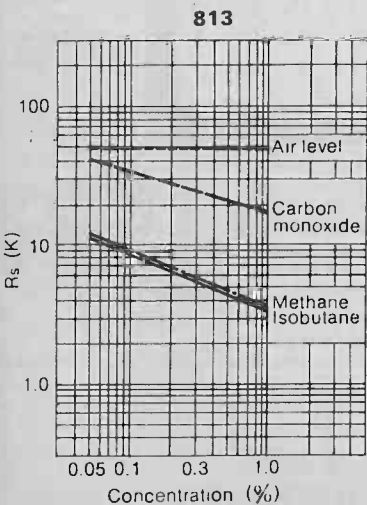
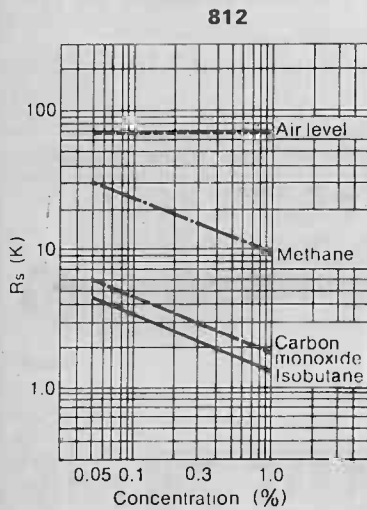


Fig 2. Sensor resistance ( $R_s$ ) changes with different concentrations of gas.

TYPE NO.	TGS 812/813
<b>TEST CONDITION</b>	
(A) Circuit Voltage (Vc)	10V (A.C. or D.C.)
(B) Heater Voltage (VH)	5.0V (A.C. or D.C.)
Heater Power	
Dissipation (PH)	Approx. 650mW.
(C) Load Resistance (RL)	4K
<b>WARM-UP TIME</b>	Approx. 2 min.
<b>HEATER RESISTANCE (RH)</b>	38±3
<b>SENSOR RESISTANCE (RS)</b>	1~10K in Isobutane 1000ppm/air
<b>RATIO OF RESISTANCE</b>	$\frac{R_S \text{ in Isobutane } 3000\text{ppm/air}}{R_S \text{ in Isobutane } 1000\text{ppm/air}} = 0.63 \pm 0.05$

Fig 3. Sensor characteristics.

Sensor type	Electrical ratings	Applications and Features
812	V <sub>C</sub> : (Max.)24V V <sub>H</sub> : 5.0V	General purpose combustible gas detection. Carbon Monoxide detection. High CO sensitivity enables most types of smoke to be detected.
813	V <sub>C</sub> : (Max.)24V V <sub>H</sub> : 5.0V	General purpose combustible gas detection. Methane detection. High CH <sub>4</sub> sensitivity makes it suitable for Natural Gas detectors.

Fig 4. Differences in sensitivities between 812 & 813.

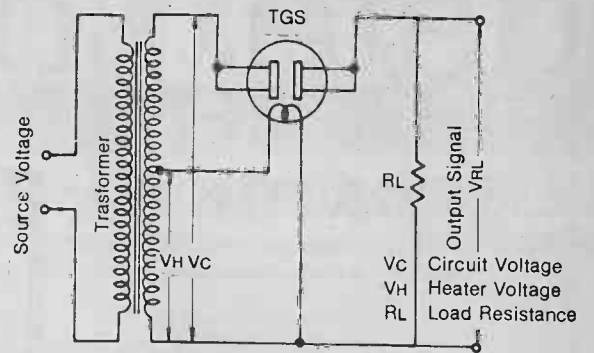


Fig 5. Basic test and measuring circuit.

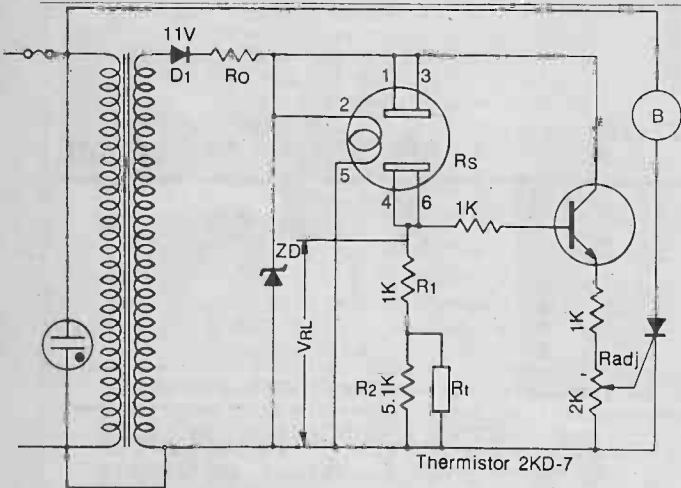


Fig 6. Circuit for use as a gas leak detector.

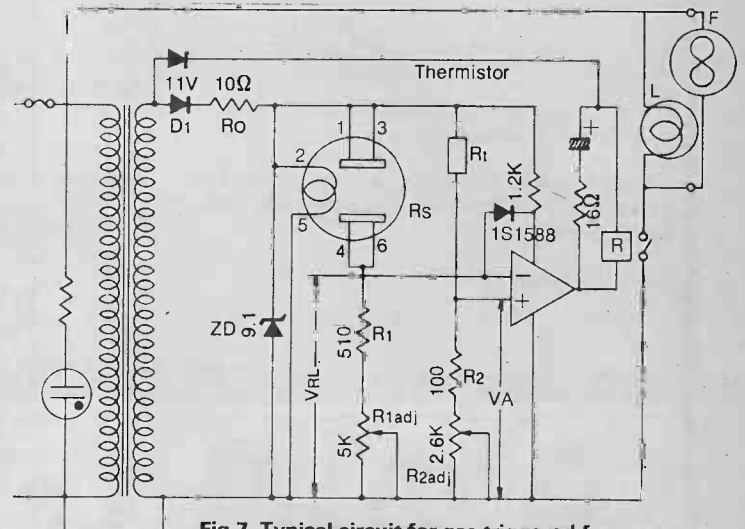


Fig 7. Typical circuit for gas triggered fan.

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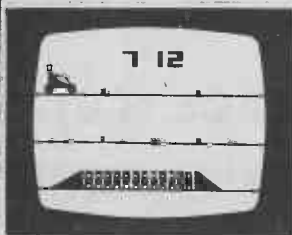
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\* Super Stunt (illustrated), Bus Stunt, Moto-cross, Drag Race.

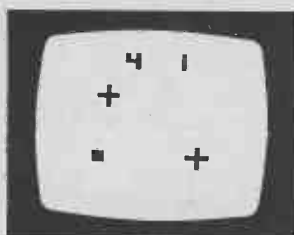
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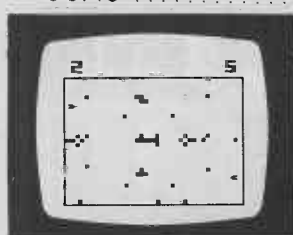
\* Shoot 2—no rifle required! (illustrated). Shoot 1, Football, Hockey, Solo, Basketball, Gridball, Tennis, Squash, Basketball Practice.

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- ★ Tanks controlled by toggle switches or joystick and fire button.
- ★ Realistic tank, shell burst and explosion sounds through TV speaker.
- ★ Three speed tank control.
- ★ Exploding mines and terrain barriers.
- ★ Guided missile shells
- ★ Single 9v supply.

All kits include full instructions LS I, PCB, pre-tuned UHF and sound modulators, etc., fully guaranteed. Cases and controls not included. UHF and Sound Modulators, pre-tuned, £5.50 (pair). Joysticks for AY-3-8600 £3.50 (pair). Joysticks for AY-3-8710 (TBA) colour encoder module, pre-tuned £6.60. Regulated mains adaptor £3.50.

\* All prices include VAT and P&P

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# RAIN ALARM

MARCH WINDS AND APRIL showers bring forth May flowers — not exactly poetry, more accurate reporting of activity on the weather and horticulture fronts at this time of year. Additionally the bit about April showers is likely to bring forth more than the odd May bud if one of these periods of intermittent precipitation disrupts a busy housewife's washday by relegating her almost dry laundry to the ranks of the wet behind the eiderdown brigade.

## It May Rain!

It's here that the good guys of the ETI project team come to the rescue with their Rain Alarm. This little fellow might well upstage any canine companion as a housewife's best friend, at least on washday, by giving a warning at the first sign of rain, giving plenty of time to get the washing in before it gets too wet.

The rain alarm should be placed out in the open and a length of two core wire run between it and an eight ohm speaker. We used an old

intercom sub-station to provide a home for our speaker but a car extension speaker or indeed any suitably boxed eight ohm device would be fine.

Any rain falling on the sensor track, formed as part of the PCB (neat innit?), will set off the alarm and produce a distinctive, intermittent bleep-bleep.

## Construction

Construction is straightforward if the PCB layout shown is used and in the case of this project we would recommend that the PCB is used, as this adds to the attractiveness of the project.

Assemble the components according to the overlay, ensuring that the tantalum capacitor is connected the right way round. If you do not use a socket for IC1, solder pins seven and fourteen before the others (this allows the device's internal protection circuitry to function).

In our prototype we used a value of 4M7 for R1 which acts as a sensitivity adjustment. This value leads to a 'hair trigger' alarm and the value could well be reduced according to the level of sensitivity required.

When construction is complete and the alarm has been tested the area of the PCB that holds the components should be covered with some suitable non-conducting potting compound — epoxy resin should do — to render it waterproof.

## Power To Your

Power consumption of the unit is so low when the alarm is not triggered that it was not thought necessary to provide an on/off switch.

While this unit is not as effective as a device to control the weather — still working on that one — it should at least prevent some of those washday blues.

ETI



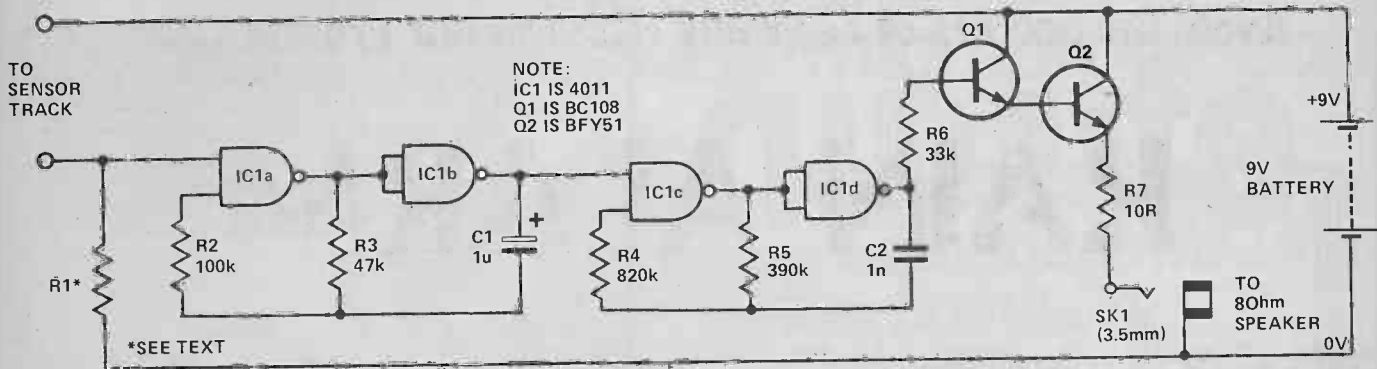
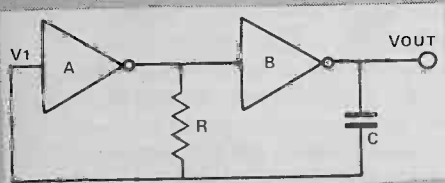


Fig. 1. Circuit diagram of Rain Alarm.

## HOW IT WORKS

THE rain alarm is formed by two gated CMOS oscillators and an audio output stage.

The basic CMOS oscillator is shown in Fig. 2. Upon switch on, with C discharged, the output of inverter B will be low, the input to A low and its output high. Capacitor C will now commence to charge towards supply, the voltage level at A's output, via resistor R.



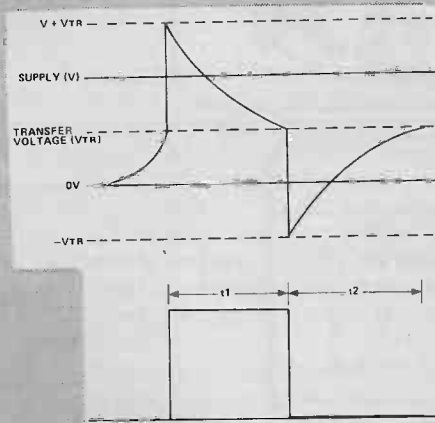
We can consider a CMOS gate to be a comparator that will change output state when the level of voltage at its input reaches a specified value, the transfer voltage ( $V_{tr}$ ), usually about half supply. Thus as the voltage on C increases due to the charge current being supplied by R there will come a point when the voltage on the input of A will pass its transfer voltage and the output of B to go high.

At this point the charge on C corresponds to a voltage level of approximately half supply.

As the inverters A and B change states the end of C that was held at 0 volts is now at

supply and the end of C that was connected to supply via R is now returned to 0 volts via the same resistor.

These changes together with the charge stored on C mean that the potential across C is now supply plus the transfer voltage of gate A. This is shown in Fig. 3.



Capacitor C will now discharge via R until once again the transfer voltage of A is reached whereupon the outputs of the inverters will assume their original states.

The conditions are not quite the same as at

switch on because, as can be seen in Fig. 3, the Potential across C is now a negative value equal to A's transfer voltage.

From this point C charges via R again to repeat the cycle.

The output is shown in Fig. 3 where  $t_1 = t_2 = 1.1 RC$  (the time taken for C to charge (discharge) via R to two-thirds of the maximum value of voltage across it).

In practice, due to the protection networks associated with modern CMOS devices, it is necessary to include a resistor in series with the input of A in order to ensure that the voltages across C are allowed to reach the values shown in Fig. X.

The final circuit diagram (Fig. 1) of the Rain Alarm shows that the inverters are in fact formed from the four NAND gates of a 4011 package. In each oscillator, while one gate is configured as a straightforward inverter, the other has one input that can act as a control input, oscillator action being inhibited if this input is held low.

The first oscillator (IC1a and IC1b) has this input tied low via a high value resistor (R1) that acts as a sensitivity control. Thus this oscillator will be disabled until the control input is taken high. Any moisture bridging the sensor track will so enable the output which is usquare wave at about 10 Hz. This in turn will gate on and off the 500 Hz oscillator formed by IC1c and IC1d.

This latter oscillator drives the loud-speaker via R6, the Darlington pair formed by Q1 and Q2 and resistor R7.

## PARTS LIST

### RESISTORS (all 1/4W 5%)

R1	See text
R2	100k
R3	47k
R4	820k
R5	390k
R6	33k
R7	10R

### CAPACITORS

C1	1u0 16 V tantalum
C2	1n0 polyester

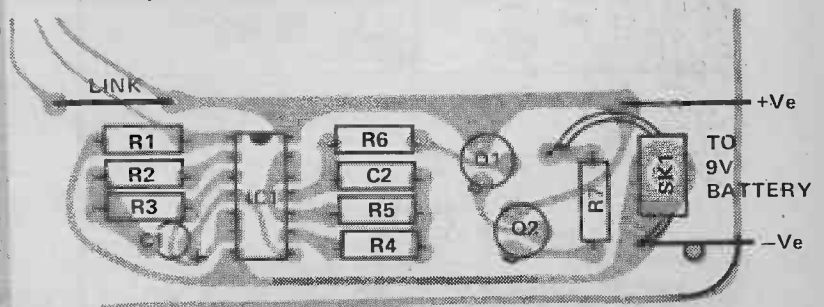
### SEMICONDUCTORS

IC1	4011
Q1	BC 108
Q2	BFY 51

### MISCELLANEOUS

PCB as pattern, 3.5mm jack socket, 8R speaker, battery.

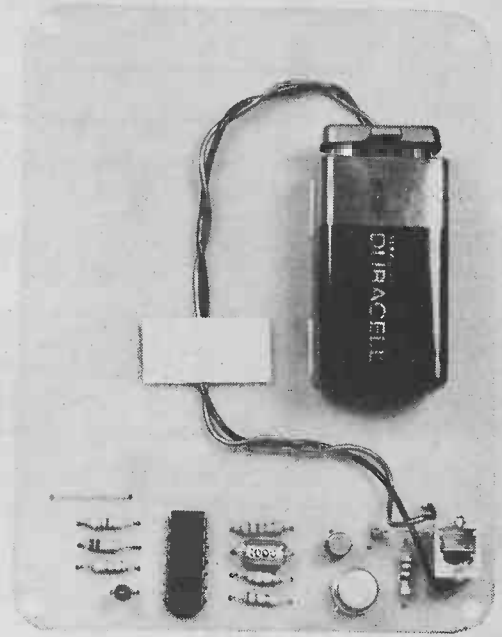
Fig. 2. Overlay of the section of the Rain Alarm PCB that holds the components.



# PROJECT: Rain Alarm

## BUYLINES

The PCB will be available from any of the usual suppliers that advertise in ETI. C1 must be a low voltage tantalum but this component should be widely available. All of the other components are likewise obtainable from most electronic retailers:



## WIREWRAP

### PRECUT WIRE

Why buy wire on rolls?

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100 pcs of 6" at 1.06 = 2¢/ft.  
Wire Kit 1 at \$6.95 = 2 1/3¢/ft.

#### Bulk Wire

50 ft. roll at \$1.99 = 4¢/ft.  
100 ft. roll at 2.95 = 3¢/ft.

\* 30 Kynar stripped 1" on each end. Lengths are overall Colors: Red, Blue, Green, Yellow, Black, Orange, White. Wire packaged in plastic bags. Add 25¢/length for tubes.

	100	500	1000	5000
2 1/2 in.	.78	2.40	4.30/K	3.89/K
3 in.	.82	2.60	4.71/K	4.22/K
3 1/2 in.	.86	2.80	5.12/K	4.55/K
4 in.	.90	3.00	5.52/K	4.88/K
4 1/2 in.	.94	3.21	5.93/K	5.21/K
5 in.	.98	3.42	6.34/K	5.52/K
5 1/2 in.	1.02	3.65	6.75/K	5.85/K
6 in.	1.06	3.85	7.16/K	6.19/K
6 1/2 in.	1.15	4.05	7.57/K	6.52/K
7 in.	1.20	4.25	7.98/K	6.85/K
7 1/2 in.	1.25	4.45	8.39/K	7.18/K
8 in.	1.29	4.65	8.80/K	7.53/K
8 1/2 in.	1.32	4.85	9.21/K	7.84/K
9 in.	1.36	5.05	9.62/K	8.17/K
9 1/2 in.	1.40	5.25	10.03/K	8.50/K
10 in.	1.45	5.51	10.44/K	8.83/K
Add'l. In.	.10	.41	.82/K	.66/K

### WIRE WRAP SOCKETS

	1-9	10-24	25-99	100-249	250-999	1K-5K
8 pin	.41	.38	.35	.31	.29	.27
14 pin	.42	.39	.36	.32	.29	.27
16 pin	.46	.43	.39	.35	.32	.30
18 pin	.63	.58	.54	.47	.44	.41
20 pin	.84	.78	.71	.63	.59	.54
22 pin	1.30	1.20	1.10	.95	.90	.84
24 pin	.91	.84	.78	.68	.64	.59
28 pin	1.25	1.15	1.08	.95	.89	.82
40 pin	1.65	1.55	1.42	1.25	1.15	1.09

Gold 3-level Closed Entry Sockets  
End & Side Stackable All prices include gold  
7m sockets and 2-level sockets available

### WIRE WRAP TOOLS



**\$34.95**

HOBBY WRAP

Model BW 630

With Free Wire Kit 1

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WSU 30 Hand Wrap-Unwrap Strip Tool

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WSU 30M, for Modified Wrap

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BT 30 Extra Bit

2.95

### WIRE KITS

# 1	\$6.95	# 2	\$19.95
250 3"	100 4 1/2"	250 2 1/2"	250 4 1/2"
250 3 1/2"	100 5"	500 3"	250 5"
100 4"	100 6"	500 3 1/2"	100 5 1/2"
		500 4"	1 250 ft. Roll Bulk

Choose One Color or Assortment

### INTERCONNECT CABLES

Ribbon cable connectors for connecting boards to front panels, or board to board.

#### SINGLE ENDED DOUBLE ENDED

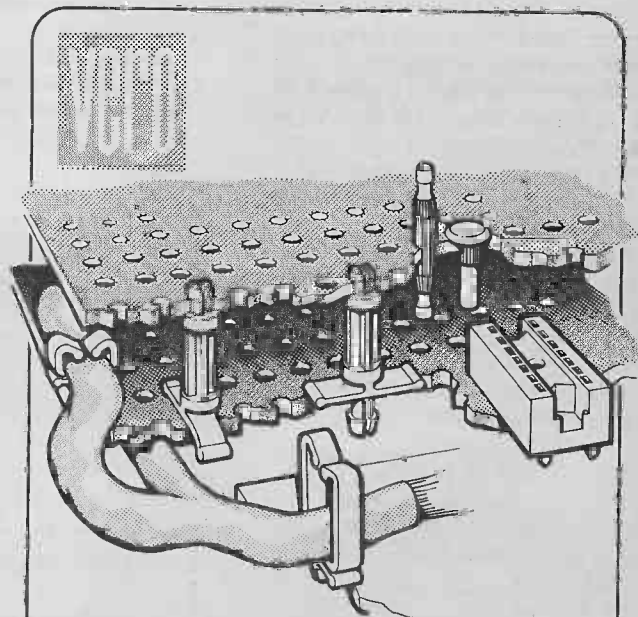
	14 pin	16 pin	24 pin	14 pin	16 pin	24 pin
6"	1.24	1.34	2.95	2.24	2.45	3.37
12"	1.33	1.44	2.24	2.33	2.55	3.92
24"	1.52	1.65	2.63	2.52	2.76	4.31
48"	1.91	2.06	3.40	2.91	3.17	5.08

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# PROJECT CASINGS SURVEY

**Built a project recently and don't know where to put it? William King has been looking at some of the vast range of project cases available to the amateur constructor to enable him to add the finishing touches to his latest creation.**



UNLESS YOU ONLY go in for the assembly of commercial electronic kits which come complete with a ready drilled case and all the nuts, bolts and washers required to produce a project with an almost professional finish, you may never have realised that amateur "electronics" is more than just soldering neatly and knowing the difference between a pretty "C280" series capacitor and a liquorice allsort, but that a little "metal bashing" is also required.

## Casing The Joints

Electronics can often be a very uninteresting subject and a PCB full of the latest chips is not going to be as interesting to a friend (with little or no electronic knowledge) as would be a (say) simple electronic dice built in a nice neat plastic box. Although some people seem to believe that so long as their latest high power electronic rat exterminator works it doesn't matter if it is housed in a tobacco tin held together with insulating tape and chewing gum. Needless to say this is not the attitude we expect from ETI readers.

A little extra money spent on a few basic tools (small drill and assorted bits, files, nuts, bolts, washers) is really essential (making holes in plastic boxes with your soldering iron is not a good idea). This coupled with a little time spent selecting a case, can turn a mediocre run-of-the-mill project into an impressive piece of electronic sophistication that you won't feel embarrassed to have lying around when the friends/relatives drop in unexpectedly.

Although there are many different cases in a multitude of shapes and sizes, the daunting prospect of choosing a suitable case is eased by the parameters governed by the project itself — is screening required? Will it take a PP9 battery, will it fit in your pocket?

Once a box has been chosen the work begins. The first essential is a layout of all the controls, sockets cable exits and any other holes which need to be made. Careful attention should be made to details such as not mounting audio switches near mains switches to avoid hum pick up.

Once satisfied that the panel has been designed to be both aesthetic and functional, drilling can begin. This successfully completed leaves only one more stage before the project can be fitted into its housing, this is inscribing legends for the controls.

This can be done in a variety of ways (typed labels glued on, dymo type labelling strips . . .) but the method which gives the most professional appearance is rub down lettering transfers (a set of transfers suitable for panel marking, including potentiometer scales (rotary and slider) is available from ETI — see the advert in this issue.

If using transfers it is best to either use a clear varnish spray or self adhesive plastic film to prevent the lettering from rubbing off with use.

All that remains then is to secure the project in its case, stand back and admire . . .

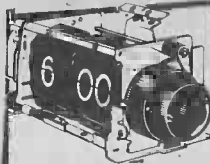
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Input 50/80 M/V. Into 500K  
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Input 300 M/V. Into 100Kcs  
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BURROUGHS 9 digit Panplex calculator display, 7 segment 0.15" digits, neon type, with red bezel, socket and instructions. £3.50. 10 for £30. 100 for £250.

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AVO meter movements for a military version of the Avo 8. Precision 3/5 micro Amp 50 µA with integral shunt movement. Electronic voltmeter circuit available on request. £8.50.

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VITALITY 12V 0.15 amp. MES Bulbs. 100 for £5. 1,000 for £40.

BECKMAN 500KHz triggerable clocking oscillator for use with calculator chips etc. 5V supply. 25x10x12mm £1. 10 for £8. 100 for £65.

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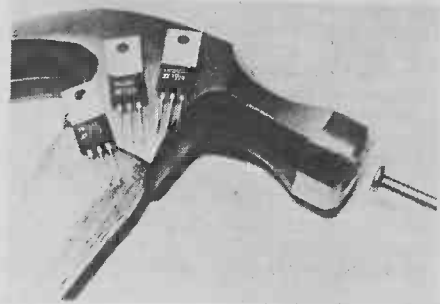
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# news

## hammer fet-ish



A new range of low cost VMOS power FETs in plastic have been introduced by Siliconix. These devices are aimed at replacing conventional bipolar transistors in a great many applications. This development in VMOS technology has cut the price of such devices by a third enabling them to compete directly with bipolar devices.

The direct interfacing with most logic families makes VMOS ideal for use in computer peripherals, micro- and mini-computer

systems, process control, etc. In addition to the many existing applications, VMOS should open up many new areas in telephone switching, analogue switching, and unlike conventional FETs or bipolar devices, VMOS transistors are inherently linear and ideally suited to use in linear power amplifiers from audio right through to VHF.

Siliconix Ltd.,  
Llanllienwen Close  
Morrleston,  
SWANSEA SA6 6NE

## digital dialing

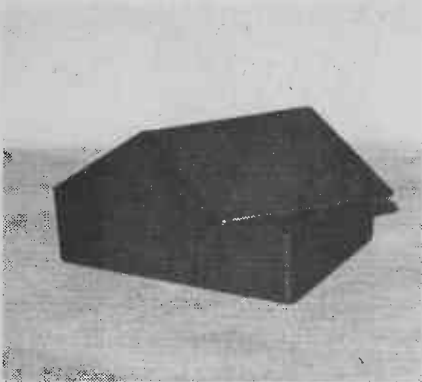
Unilever have recently had a new computer controlled telephone system installed in their Rotterdam headquarters. The system comprises a Philips computer controlled exchange with electronic switching and the latest pushbutton keyphones installed throughout the building. Now each phone has its own 'switchboard' capability and supports many new facilities such as short code dialling, automatic call back and 3-way conversations.

The new system should make telephoning quicker, easier and more effective (in 1976 the phone bill came to over £200,000 — more than £200 per person!).

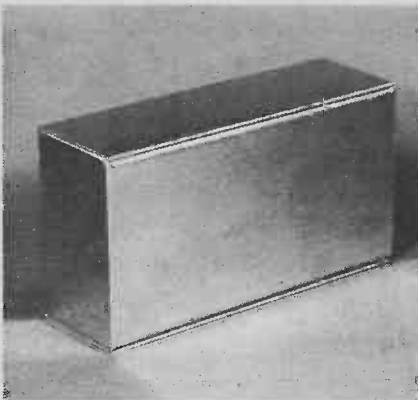
A similar system will be installed in their London offices in the future.

## bbc get it taped

The BBC and 3M have collaborated to develop a new tape recording system claimed to provide 90 dB noise figure. The system will accommodate 32 tracks on one-inch tape at an undisclosed tape speed.



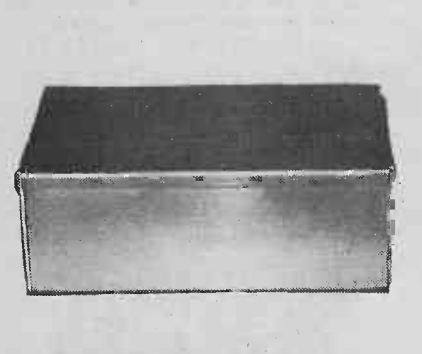
All-plastic 'Gemini' box and lid in black, grey or white. 110x70x30 at 71p. Supplier B.



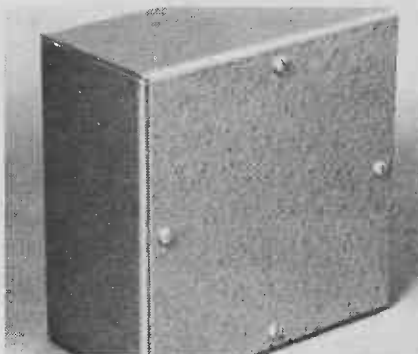
Aluminium plate box in two parts. 6 sizes available. Supplier B.



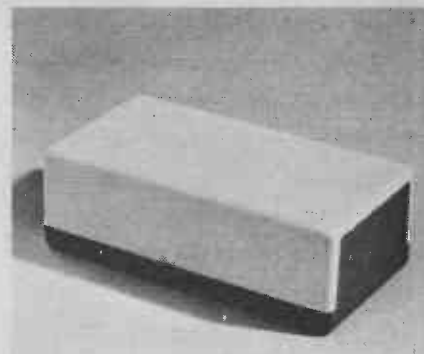
"Eddystone" die-cast aluminium boxes in 1.5mm thick walls. 8 sizes available from 89x38x32 to 222x146x108. Prices from £1.13. Suppliers B & C.



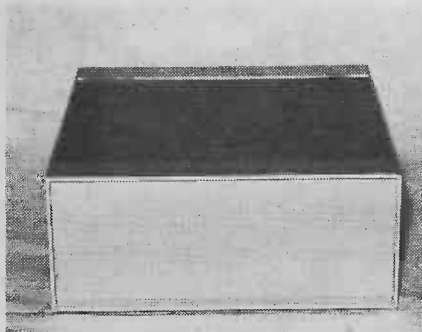
Folded aluminium boxes with lid and screws. 20 sizes from 76x51x25 to 304x203x76. Prices from 49p to £2.27. Supplier B



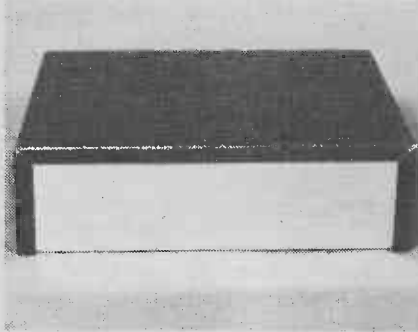
16 SWG aluminium, silver hammer finish cubical boxes. Type N in 3 sizes from 102x102x51 to 203x152x51. Prices from £1.90. Supplier A.



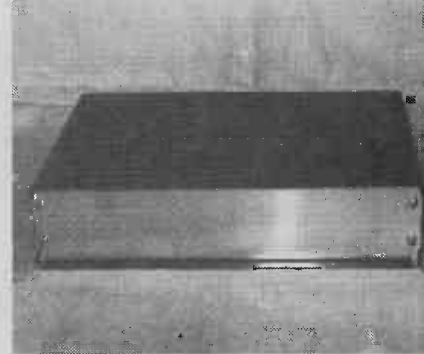
65 series plastic two-piece rectangular cases in white/grey. Sizes from 100x50x25 at £1.80. Supplier G.



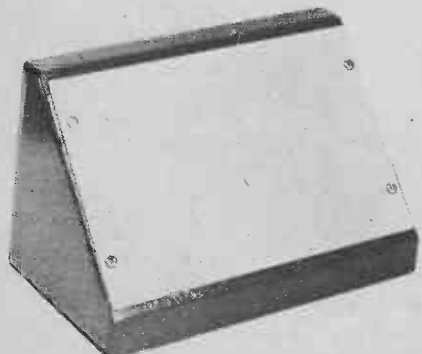
"Classic" instrument case. Satin-finished anodised aluminium with textured vinyl-coated steel top & bottom plates. 6 sizes from 216x127x63. Price from £7.94. Supplier B.



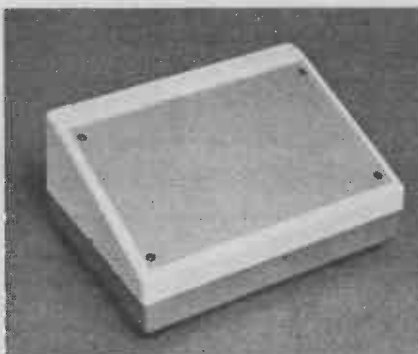
Aluminium two part construction case (type PJ) with front and rear vinyl covered. 7 sizes available from 127x63x57 to 305x158x133. Prices from 65p. Supplier B.



'Opal range', steel cases with aluminium panels, in 3 sizes from 65x58x210 to 65x160x210 with price from £9.67. Supplier B.

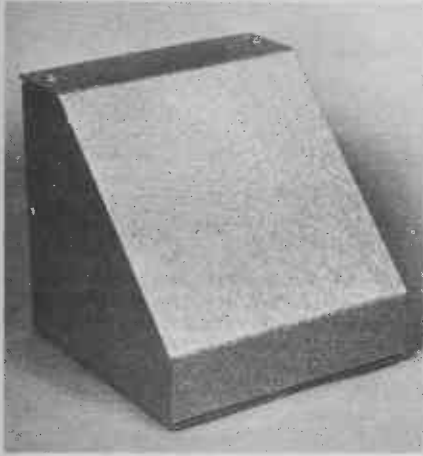


Steel cases with 45° sloping aluminium panels available in 3 sizes, from 150x95x95 with 150x100 front panel. Price from £2.10. Supplier E.



Two colour plastic case with sloping aluminium panel with mounting points for EUROCARD board. Size 171x121x75. Type 75-1798K at £4.53. Supplier G.

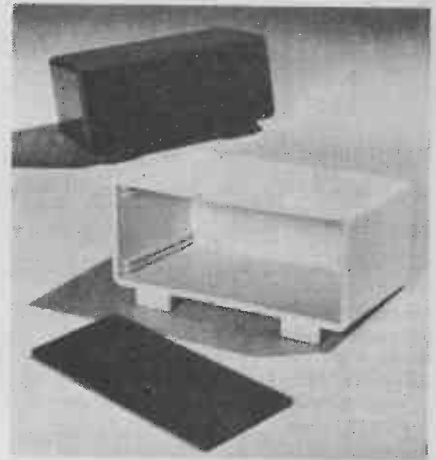
A key to the supplier codes is printed at the end. All dimensions are in millimetres. Prices include VAT but not postage and packing and should be used as a guide only.



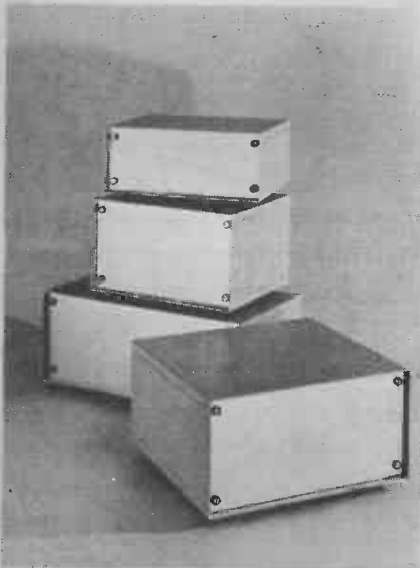
16 SWG aluminium, silver hammer finish. 3-piece construction. Type U case in 8 sizes from 76x76x76 to 381x229x229 from £1.50. Supplier A.



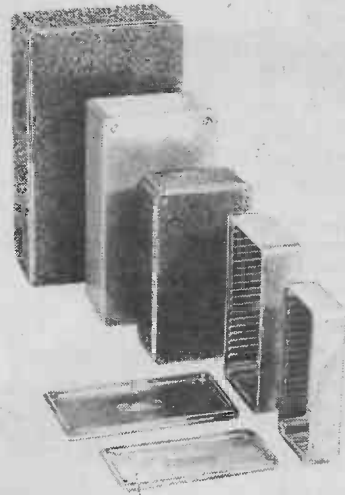
Flip-top polypropylene boxes with aluminium alloy panels in black or yellow. Two sizes 130x75x34 and 196x127x51 at approx £2.05 and £2.70. Supplier G.



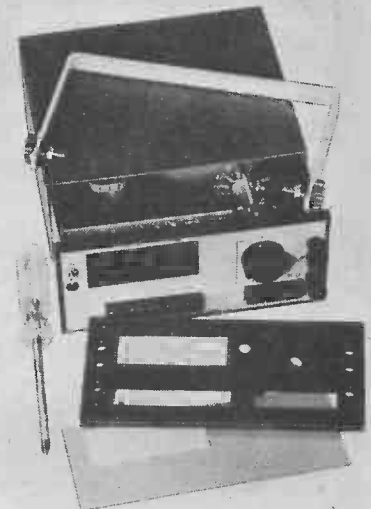
"Time box" for digital clocks in antistatic ABS. Slots for two PCBs available in white, red, orange or blue. Price £2.22. Supplier C.



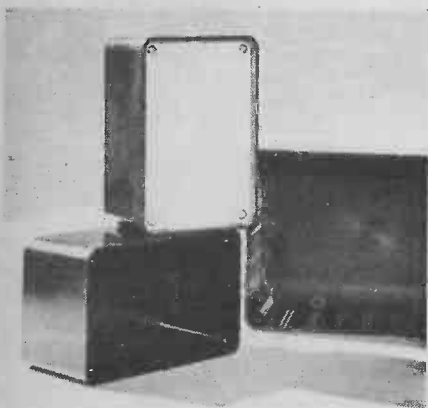
Veropak 49 series cases made of heavy gauge PVC clad steel in 5 sizes from 277 x 113 x 219 with prices from £9.70. Supplier G.



5000 series boxes in die-cast aluminium in 5 sizes with slotted guides for 1.5mm PCBs. Sizes from 100x50x25 with natural or hammertone. Price from £1.05.



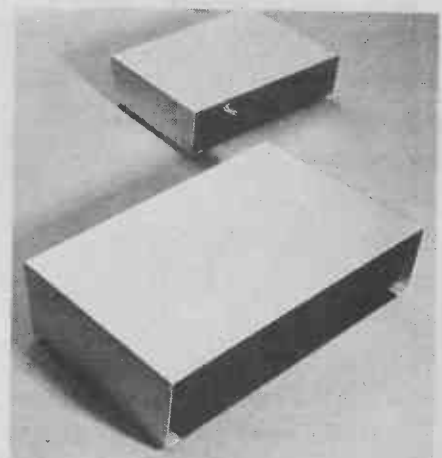
Amatek PDS instrument case system in PVC-coated aluminium with ready drilled front panel. Accepts push button switches, digital displays, meters. Size 178x80x152. Price £9.18. Supplier D.



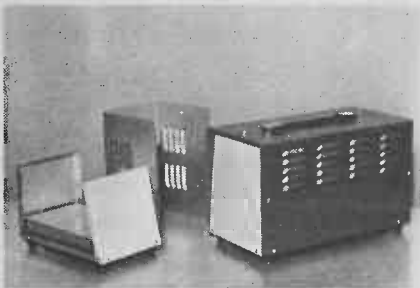
Miniature "Minos" cases in black or white ABS with aluminium panels. Guides for PCBs. 4 sizes from 65 x 100 x 50 to 130 x 200 x 54 at prices from 52p. Supplier C.



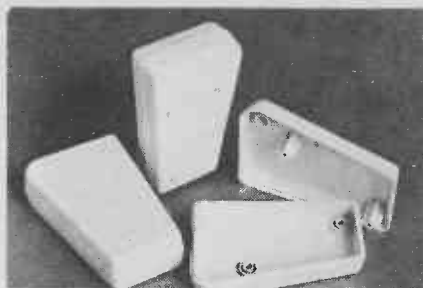
Two vacuum formed cases in black ABS with aluminium panels supplied, for mounting keyboards. Sizes 220 x 276 (about £8) and 550 x 340 (price TBA). Supplier G.



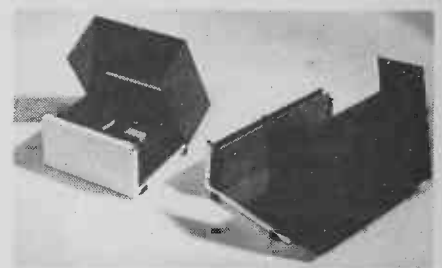
"G range" cases with sloping visor, in 3 sizes with slide on cover. 3 sizes from 44x134x123 from £4.86. Supplier G.



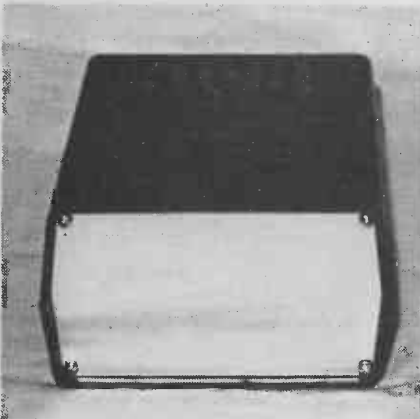
Hammered finished 20 SWG zinc-coated mild steel cases in two colours and 4 sizes, from 101x101x155 to 177x152x307. Supplier E.



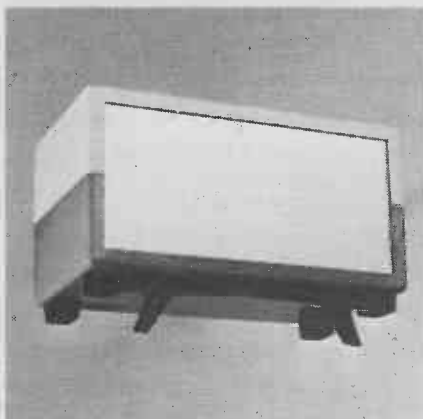
Hand held plastic control boxes approx. 61x94x27 type 75-1799E, in white high impact ABS. Price approx 70p. Supplier G.



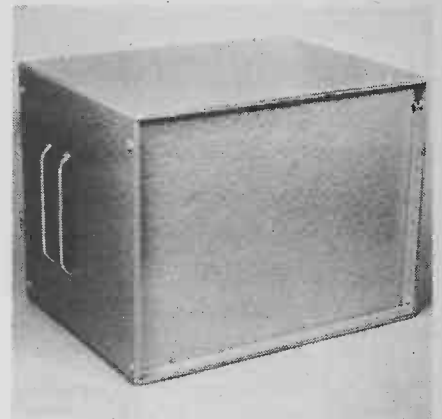
Samos miniature cases in 7 sizes. Two part construction, holds up to 4 PCBs with special PCB feet. Sizes from 50x50x100 to 75x200x125. Prices from £1.47. Supplier C.



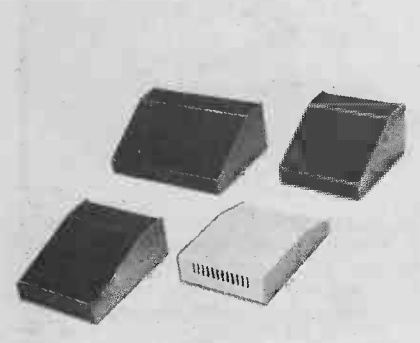
Alfa range plastic cases in 3 sizes. Aluminium panel front & rear. Sizes from 173x130x35 to 173x130x70 with prices from £3.46. Supplier B.



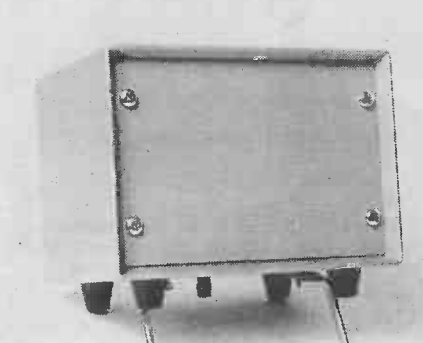
A range of cases in two colours. Plastic with aluminium front & rear panels with provision for tilt leg. Sizes from 85x40x154 at £2.76. Supplier G.



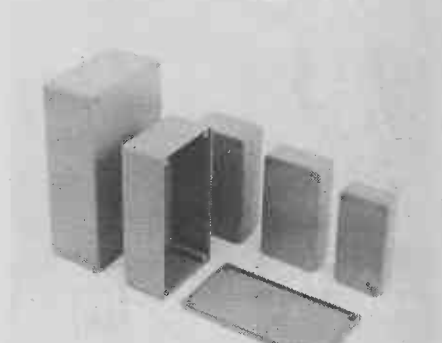
16 SWG aluminium case, silver hammer finish (type W). 4 sizes from 203x152x152 to 381x228x203 with prices from £4.55. Supplier A.



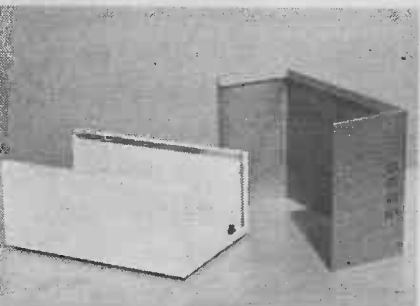
7000 series consoles of all-metal or ABS/metal construction with sizes from 102x28x140 to 356x33x287. Prices from £10.18. Supplier F.



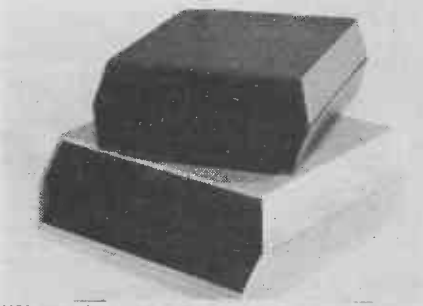
Minicases in mild zinc coated steel sheets with hammertone finish. Sizes from 165x114x114. Supplier E.



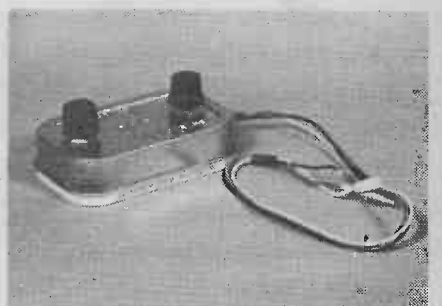
2000 range of boxes in ABS moulded in four colours with slotted guides for 1.5mm PCBs. 5 sizes from 100x50x25 from £1.03. Supplier F.



Zinc-coated mild steel case with vents in blue/light grey. Available in 8 sizes from 127x69x101 with price from £2.64. Supplier E.



"Nuova" enclosures in anti-static abs. Transparent red front panel is inclined at 70°. Contains pillars for PCBs. Four colours and three sizes available, from 120x50x90 at £1.72. Supplier C.



One size boxes in tin-plated steel popular with some constructors. Boxes come with free contents which should be burnt before use. Price varies.

# microfile.....

## Gary Evans tip toes through the micros

THE MICROPROCESSOR WAS a boon to those people who like organising conferences. Here was a device about which many people felt a keen "need to know."

News of conferences/seminars/lectures came thick and fast, one could have flitted from one event to the next without drawing breath.

A lot of these activities were aimed at the professional but a fair few were designed to appeal to the amateur. With the initial deluge behind us now it is interesting to note that not only are there fewer events but that the nature of those that take place, at least those aimed at the amateur, is changing.

In the early days the subject matter was almost solely concerned with details of the internal architecture of the MPU, max speeds of operation, PSU requirements etc. However, most amateurs, from the word go, thought of the MPU in terms of home computer systems. In this light, a lot of the details presented at these conferences were, essentially, boring. After all, whilst the LSI technology that gave birth to the MPU was essential if any low cost computer was to be envisaged, in essence, a good PSU is just as important to the operation of the overall system and we didn't see many talks on the detailed operation of power supplies — interesting as they might have been.

The realisation that what most people are interested in is personal computing means that today we are seeing more and more conferences dealing with this aspect of things.

Early February saw Microsystems 78, a three day event with one day devoted to Personal Computing.

With Dr Chris Evans (must be O.K. with a name like that — Chris I mean) in the chair, delegates were treated to a day of talks on all aspects of personal computing — talk of accumulators accumulating and stacks stacking was not to be heard.

Later in the year we have the second of the DIY Computer Shows organised by Online (more of that later) and no doubt there are many other events of this nature in the pipe line.

### Initial PCW

Early February also saw a new magazine on the market. Personal Computing World is a welcome addition to the ranks of titles that appear on our newsagents shelves every month. Dealing, as it does, almost exclusively with personal computing it should act as some sort of focus for this new hobby — something we need.

While we at ETI hope we have been, and intend to remain with for instance our personal computing supplement in June, involved with personal computing — after all the American magazine Popular Electronics has a regular computing section in spite of the Plethora of computing mags — we acknowledge that with the greater space available to them, PCW fill a long felt need in these Islands.

We wish PCW luck.

For further information on the magazine contact:

PCW  
62A Westbourne Grove London  
W2

It should however be available from your local newsagent.

### Video Writer

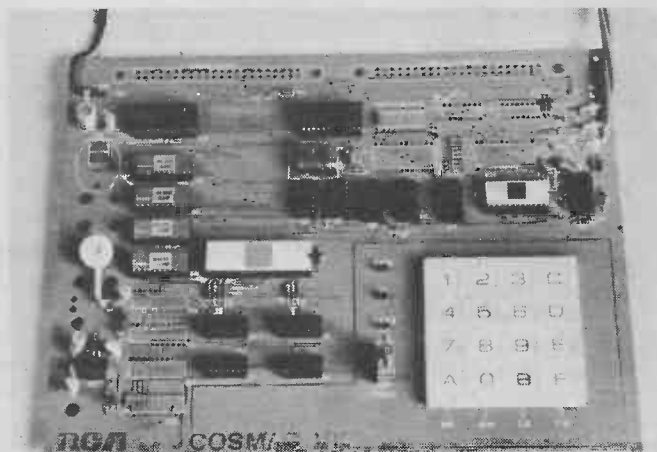
The COSMAC VIP (Video Interface Processor) pictured is a new computer kit from RCA.

Featuring the CDP 1802 MPU the VIP is specifically designed to allow easy generation of TV graphics and games. The VIP offers a versatile 4K operating system with facilities for storing and retrieving programs developed in the system's 2K RAM on cassette tape.

Using an interpretive language known as CHIP-8, 2 byte instructions entered via the VIP's hex keyboard, allow patterns to be generated on the screen, the generation of random bytes, the sounding of tones and allow subroutine nesting.

Expansion is possible and the hobbyist manual contains detailed information on use with music synthesizers, relays, printers and ASCII keyboards as well as program listings for twenty video games.

At present available only in a NSTC monochrome standard soon a PAL interface chip and programmable sound capability will be available. Further details from:  
RCA Solid State-Europe  
Sunbury-On-Thames  
Middlesex  
TW16 7HW



### Be Rat-ional

If I hear the words Womp Rat once more I think I shall become an intergalactic hermit.

The response to my offer to provide a BASIC listing of a game program last month has been overwhelming.

I thought that I might, if lucky, get a few requests for the game and so did not bother to ask for an SAE. The result — to avoid being lynched by an overworked reader services department — I had to address a good few envelopes myself. A short Microfile this month because writer's cramp has set in.

It was impossible to give personal replies to the letters — no Microfile if I had, no eating or sleeping either — but please anybody who offered us game programs of any sort — take this as a blanket request to send them in to me at ETI.

ETI

# tech tips

## Proper Identification for T.V. Game Chip

E. Parr

Many of the T.V. game circuits, whether ready built or as a magazine project, use the popular GI 8500 chip. The standard circuit gives white players, ball and court on a black background. The circuit described below gives a grey background, one white and one black player and a white ball and court. This is aesthetically more pleasing and has the advantage of making the squash game less confusing.

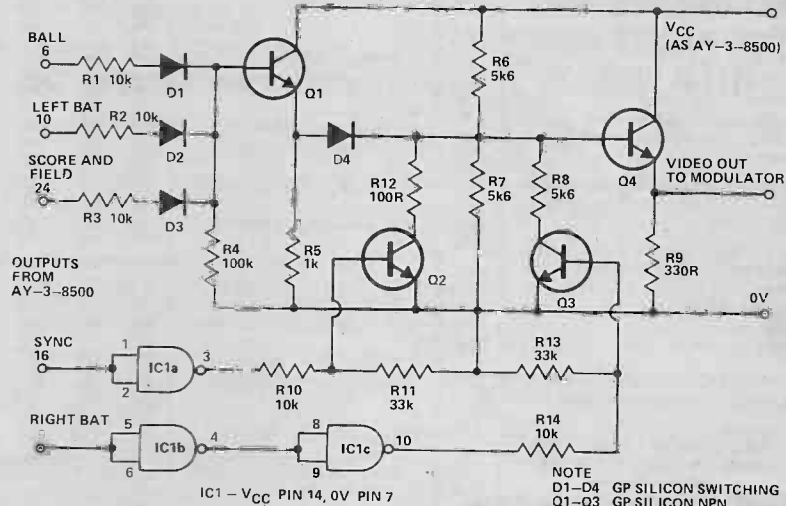
The modifications are shown below. The output on Q2 emitter spends the majority of the time at a "grey" level, and this "grey" voltage is defined at the junction of R6 and R7.

The three signals from the 8500 requiring a white output are Ball (pin 6), left player (pin 10) and the score and field (pin 24). These are "Or'ed" together by Q1 to produce a white level defined by the ratio of R1-R3 and R4. The white level on Q1 takes the output on Q1 to white via diode D4.

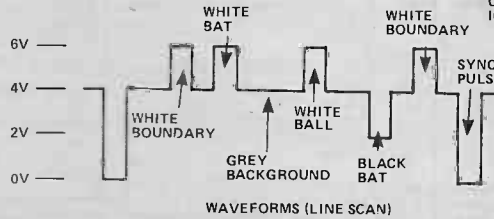
The one black signal is the right bat (pin 9). This is buffered by two stages of a CMOS 4011 chip, and turns on Q4. This takes the output to a black voltage defined by R6, R7, R8. If a white and black signal occur together

(as happens when the bats cross in squash) the white from Q1 will predominate.

The sync output from pin 16 is inverted and turns on Q3 pulling the output down to sync level, 0V.

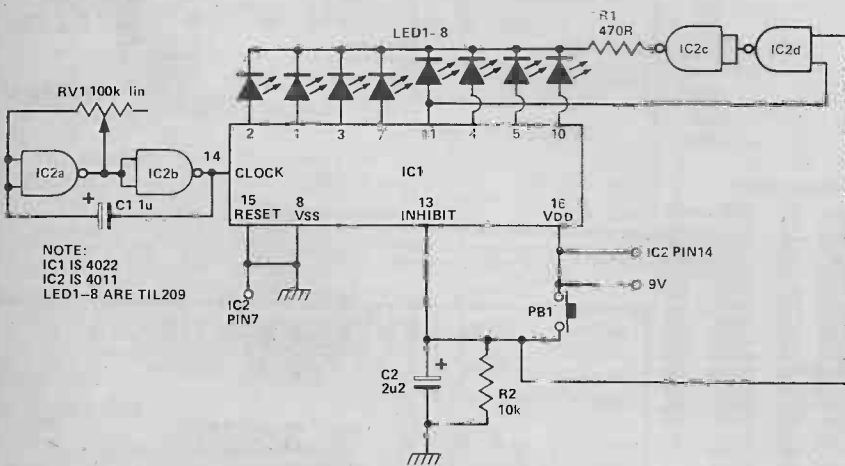


NOTE  
D1-D4 GP SILICON SWITCHING  
Q1-Q3 GP SILICON NPN  
Q4 2N3053  
IC1 4011 CMOS



WAVEFORMS (LINE SCAN)

With the values shown and a supply of 9V the open circuit output voltages are White 6V, Grey 4V, Black 2V and sync bottom 0V. The output is positive going video.



## Pot Shot

A. Kenny

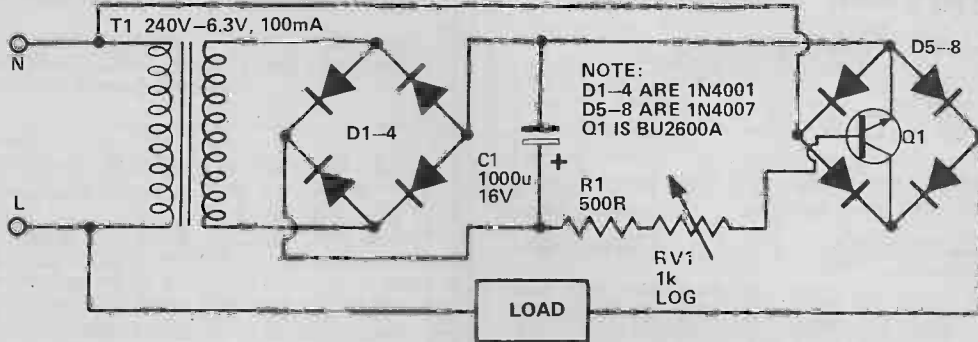
This is a circuit for a game of the shooting gallery variety. IC2a and b form an astable multivibrator clocking IC1 which causes LEDs 1-8 to flash in turn LED 5 is the "target" LED and the object of the game is to depress PBT1 just as LED 5 comes on. If this is done, the whole display is blanked for a few seconds signifying a hit. Otherwise, the LED which was lit remains lit. When the push button is released, C2 discharges through R2 taking 8 pin 13 low again and the LEDs will start to flash again.

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

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

### Speed Controller

J. Harris



Some AC motors judder badly at low speeds when controlled by triacs, using phase control. This circuit gives very smooth operation with no RFI.

Q1 acts as a 'variable resistor' in the mains supply, with diodes D5-8 ensuring unidirectional current flow through the transistor.

Bias to the transistor is supplied by the mains transformer and controlled by RV1. Q1 must be able to withstand peak mains voltage ( $\sim 350V$ ).

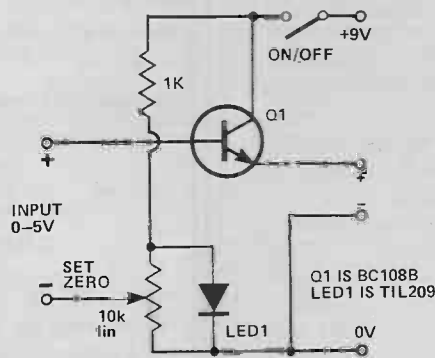
### Increasing Regulator Outputs

D. Self

It is often necessary to arrange an integrated circuit 3-terminal voltage regulator to give a higher output voltage than that set by the regulator alone. The normal way of doing this is to connect the "common" terminal to the mid-point of a potential divider hung between the regulated output and ground. The regulator voltage now appears across the top divider resistor; hence, if for example equal divider resistors are used, the output voltage is twice that maintained by the regulator between its common terminal and output.

The problem with this method is that most IC regulators (eg the 78-series) have a small quiescent current (approx 10mA) flowing out of the common terminal to ground. The magnitude of this current is not closely controlled, and hence the total output voltage becomes somewhat unpredictable due to this extra current flowing in the bottom half of the divider. Low divider resistor values help, but there are likely to be the complications of heat dissipation and inefficiency.

The circuit above avoids the problem by using transistor Q1 to generate a low impedance at the regulator common terminal by emitter-follower action, while trans-

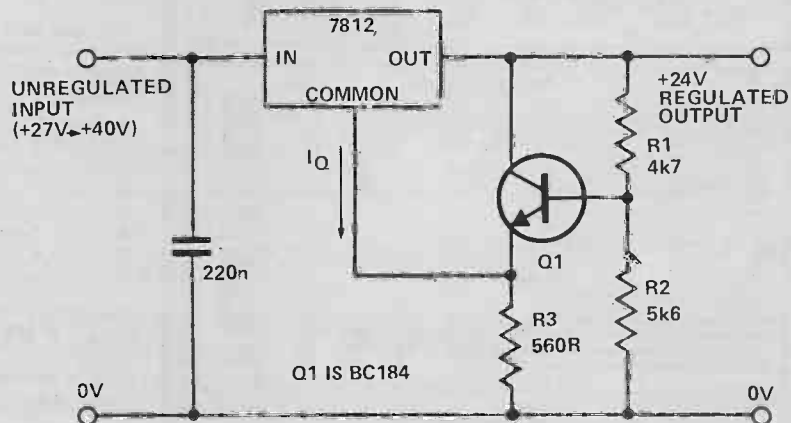


### More Ohms Per Volt

R. Soar

This circuit is designed to improve the performance of a low cost 1k/volt multimeter on the 0.5V DC range.

The BC108 emitter follower provides an impedance transformation with a gain of 250 or more, so that the effective input impedance of the multimeter is now 250k/volt. The LED provides a fixed reference voltage for the set zero control, which compensates for the voltage drop across the transistor.



ferring the voltage derived from a relatively high-resistance divider network. The value of R3 is not critical, but must be low enough to accept the

highest likely quiescent current without causing Q1 to turn off.

The circuit shows a practical 24 Volt supply using a 7812 regulator.



### Car Voltage Regulator

C. Gibbons

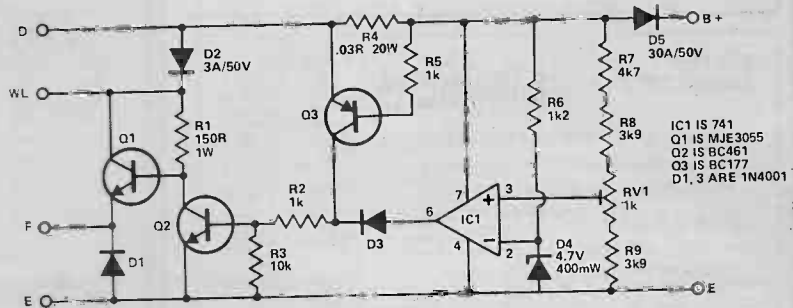
This circuit provides solid state control of battery charging. The field winding of the dynamo is initially energized via the ignition light as in a conventional system. Current flowing down the WL lead passes through Q1 to the F lead then to the field coil. Once the engine has started, current from the dynamo passes through D2 to Q1. The ignition light goes out because the WL lead rises in voltage to that of the battery. Current also passes through D5 to the battery. The battery voltage is sensed by IC1, which is wired as a comparator, once the voltage of the non inverting input, rises above that of the inverting input (Held at 4.6 volts by D4) the output goes high. Current then flows through D3 and R2 to the base of Q2 turning it on. This then pulls down the base of Q1 turning it off and cutting off the current to the field winding. The output from the dynamo then drops bringing down the battery voltage. This holds the battery voltage con-

stant. The battery voltage is adjusted by RV1 to approximately 13.5 volts.

Under cold weather starting the battery voltage drops very low. Once the engine has started the internal resistance of the battery is also very low, which would draw excessive current from the dynamo causing possible damage. To limit the current R4 is inserted in the main power lead from the dynamo, the resistance of R4 is chosen so that at maximum current

(Typically 20 amps) 0.6 volts is developed across it, this then turns on Q3. When Q3 turns on current flows from the power rail through R2 to the base of Q2 turning it on, which in turn, turns off Q1 and cuts off current to the field winding. The output from the dynamo then drops.

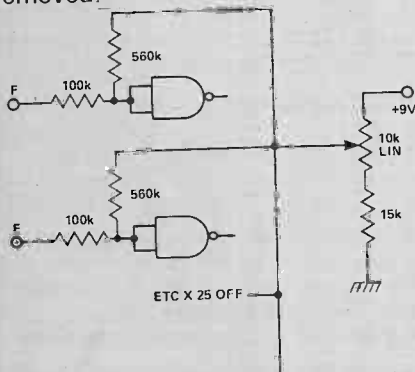
No changes have to be made to the existing wiring. The circuit can be housed in an old regulator box, Q1, Q2 and D5 should be mounted on a heat sink.



### Organ Modification

I. Cole

One of the problems with the ET1 Touch Organ (December 76) is that peoples skin resistance varies enormously and with the 4M7 pull up resistors as specified, when a person with moist skin touches the keyboard the note is sustained for several seconds even when the finger is removed.

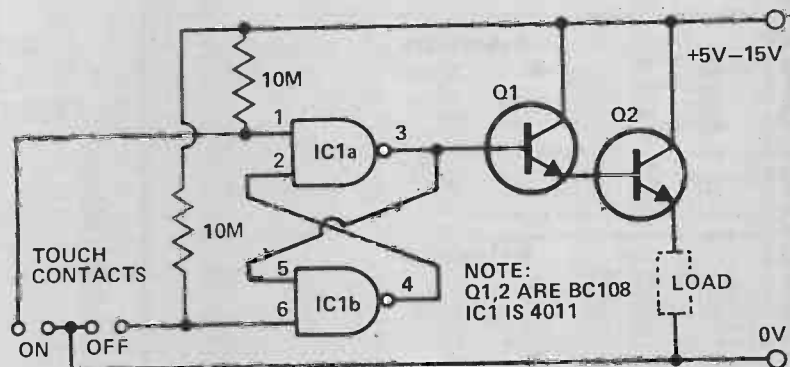


This modification provides a solution in the form of a sensitivity control.

The pull up resistors are removed and replaced by 560k resistors stood vertically on the board. The free ends of the resistors were then joined with a piece of rigid wire and connected to the wiper of the "sensitivity" pot.

### Low Current Touch Switch

D. Ian



The cost of many CMOS ICs is now lower than a mechanical on/off switch. Using only one half of a 4011, plus a couple of general purpose transistors, a touch operated switch can be constructed which is ideal for many battery powered projects.

Assuming that the inputs to the remaining half of the 4011 are tied low, the current drawn in the off state

is almost negligible and battery life is hardly affected.

Touching the 'on' contacts with a finger brings pin 3 high, turning on the darlington pair and supplying power to the load (transistor radio etc). Q1 must be a high gain transistor, and Q2 chosen for the current required by the load circuit.

# electronics tomorrow.....

by John Miller-Kirkpatrick

## 6800 Update

RECENTLY RECEIVED from a Motorola distributor is an M6800 series shortform catalogue entitled 'Microprocessor News — September 1977'. This catalogue lists Motorola's MPU products ranging from integrated circuits to EXORcisers and Polyvalent Development System components.

In the area of chips Motorola have announced some interesting new goodies. Their 1024 x 4 MCM6614, static RAMs come in 200, 300 and 450ns versions. Motorola's 128 x 8 bit static RAM, the MCM6810 is now also offered in 250, 360 or 450 ns versions. On the subject of memories there is the MCM68708 10 24 x 8 EPROM (basically a 2708) and the pre-announcement of the 2716 product, the MCM68716.

## New Interfaces

Motorola have not been any slower than other MPU manufacturers in getting onto the LSI interface chip bandwagon. LSI technology allows many functions to be integrated on one chip to give high density, low cost interfaces to I/O devices which would otherwise require multi-TTL chip solutions. An example is the MC6843 Floppy Disk Controller which performs the complex interface between an M6800 system and a range of Floppy Disk drives.

The MC6845 is Motorola's CRT controller chip which performs the 6800 to CRT interface with so many programmable options that one set of options is bound to fit your requirements. It features programmable dots per character, lines per character, characters per row, rows per screen, sync generation and cursor generation. It even features an on-chip light pen register to allow the use of presumably some form of photo diode or transistor to recognise a particular character location on the CRT. This would allow the use of a non-keyboard entry device for a low cost MPU system. If the MPU is programmed to display its complete character set at the bottom of the screen whenever it expects a keyboard entry then the light pen can be used to choose the input character from those displayed — System 68 VDU revisited?

Continuing through the catalogue we pass the various auxiliary circuits which include a GPIA General



New Total Development System M68 TDS from Motorola.

Purpose Interface Adaptor, Modems, DMA Controller, Bus transceivers and a thing called a 'Triple Bi-directional Bus Extender/Switch' (TB-DBES?) or MC6881/3449. After this it becomes simple to understand the new two-chip M6800 (MC6802 + MC6846) and the two-board computer (MEK D2 kit).

By now you are prepared for the Polyvalent Development System (PDS) which fills the gap between low-cost and on-a-board microcomputers, and the sophisticated aids for designing microprocessor systems. As its name suggests the PDS is really a family of sub-systems that can be selected to provide the required options and can then be used to analyse the system. This is Motorola's description of their PDS, which looks to me like a rich man's System 68. One version of the PDS is called the Autonomous Development System (you guessed it — ADS for short) which includes the PDS master board interfaced to a keyboard and 5 inch CRT monitor, the kit with monitor is the M68ADS1 or M68ADW1 without the CRT. I am not sure that I could recommend these kits as cost effective MPU tools at over £900 if System 68 costs about £300! But congratulations to Motorola for seeing the problem of high-cost TTYs and trying to overcome the problem.

On page 16 of the catalogue you are introduced to the MC68CIM1 (CIM stands for Audio-Cassette Interface Module). This is used to interface any ordinary audio-cassette recorder with any of the PDS configurations (SAC, MEB, ADS). The data is recorded on the cassette according to the Kansas City Standard (CUTS), in the playback mode the clock is recovered from the signal and used to clock the receiving ACIA in the PDS, this feature copes with cassette speed variations of up to 30% without producing errors. The MC68CIM1 is a module consisting of several chips on a PCB (isn't it about time someone produced a single chip CUTS interface to plug on to any 8 bit data bus?), if anybody knows of one please let us know.

ETI

# digest...

## lcd giving a hand

A Scottish company, Murrell Dynamics, has designed an LCD watch with an analogue-type 'dial'. The main problem which Murrell has overcome is reducing the number of connections required to address the segments which comprise the 'hands'.

The 100 mm diameter prototype (which Murrell claims can readily be reduced to 25 mm) utilises two concentric rings of 60 radial lines — the inner ones are addressed uniquely for the hours indication, the two rings together for minutes, and the outer one for seconds.

## hp in the day

Hewlett-Packard have announced red and yellow seven-segment displays which can be viewed in direct sunlight or in ambient lighting as bright as 10,000 foot-candles.

## planer sailing

Planer instruments have introduced a new hand-held digital voltmeter using a 3½ digit display with 11mm high digits. The device has an input

sensitivity of 10M and four ranges from 0.1999 volts to 199.9 volts. Price is around £50. Planer Products Ltd, Windmill Road, Sunbury-on-Thames, Middlesex.



# ETIPRINTS

In case you have missed out on ETIPRINTS thus far, they are a complete PCB pattern already to rub down in seconds. The patterns are produced from our original artwork so that the results they produce are nice and sharp.

We think that ETIPRINTS are such a good idea that we have patented the system (Patent numbers 1445171 and 1445172).

ETIPRINTS 005 is now available, and joins 001-004 as part of the regular system.

Details of ordering the ETIPRINTS are shown below.



*Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!*

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**ETI MAGAZINE,**  
**25/27, OXFORD STREET, LONDON. W.1R. 1RF.**

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- 001** With patterns for skeet, clock board A, and the compander from Nov 77 plus the spirit level, three-channel tone control, and the digital thermometer from Oct 77.
- 002** With patterns for the burglar alarm from Jan 78 plus clock board B and the rev monitor from Dec 77.
- 003** With patterns for hammer throw and race track from Jan 78 plus the freezer alarm from Dec 77.
- 004** With patterns for the ultrasonic transmitter-receiver, metronome, 1B metal locator and porch light from Feb. '78 plus 51 w stereo amplifier Mk. 2 from Jan. '77.
- 005** March 77 issue projects, including howround, suppressor, RMS voltmeter, LCD panel meter

Readers please note that in earlier ads the contents of 002 and 003 were reversed. Would you please indicate when ordering from which issue the patterns you require were taken.

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# ... news

## gambling on

By Gerald Chevin  
Videocraft Ltd.

WINTER CONSUMER ELECTRONICS  
SHOW 5th-8th January 1978

The WCES at its new Las Vegas home, utilised 350,000 square feet and boasted over 550 exhibitors, with products ranging from Television through to Automobile sound. The new East Hall at the Las Vegas Convention Centre housed 350 exhibitors, the remaining 200 occupied the Pavilion Exhibition Hall and Grand Ballroom of the adjacent Las Vegas Hilton.

On the American VCR/VTR front, we have an alignment of manufacturers, opting for either the Sony Betamax or the V.H.S. (video home systems) format.

The sales forecasts estimated for 1977 by RCA is approximately 250 000 Video machines. This gives some indication of the kind of market penetration that the Video revolution is beginning to generate.

A number of Television large screen projectors are also on show, judging by the number of enthusiastic onlookers a very attractive unit the "Network 2000" from Magna-Vision, selling for less than £1,200 and including such features as Digital TV Channel read-out and cordless remote control, could be an indication of a new trend in large screen TV.

New Video games were not introduced at this winter show, but plenty of new programme cartridges, some with strange sounding onomatopiac titles like "Zzz ap," "Scribbling," "Acey-Deucey," "Bingo Math," "Indy 500" and "Draw Poker" to name a few were introduced by Atari, Bally and Coleco. Fairchild have introduced five more Video Carts.

These will interest anybody with a Videoplay TV Game, as the Video Carts, are totally compatible with the European version of the Fairchild game.

Microprocessor orientated games, included the GAMMONMASTER II Backgammon Computer (which is now available in the U.K.). COMPU-CHESS, at £100. A hand held game with six different levels of skill. One and Two are utilised for teaching purposes. Players familiar with the game, use levels three to five, but due to the number of algorithms, at level five, it could take the game nearly seven hours to reply to your move, and at level six, could take nearly two days!! For only £190, "BORIS" is available, whose features include programmable starting position, handicapping, autoqueening, en passant, editing, castling, timer and an eight digit alphanumeric read-out that flashes "congratulations" should you defeat it.

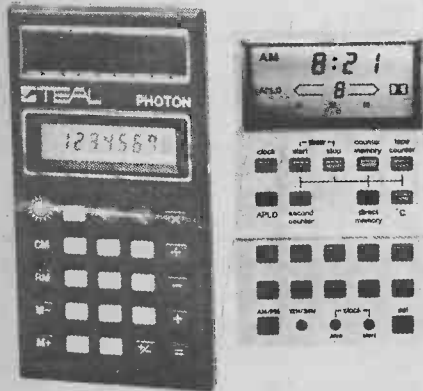
Parker Bros (who brought us Monopoly) are now micro-orientated with their code name sector. Two opponents command destroyers, trying to destroy a computer controlled submarine, which may be at any of the 4,800 locations. Digital read-out of speed, depth, headings, and range are included. Collisions may throw the players off course, and if one misses the submarine, it then adopts a secret course.

Apart from most of the now familiar statistical scientific and programmable calculators, calculator alarms and calculator watches, the main interest in this sec-

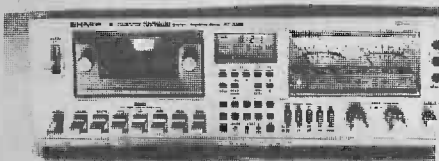
# digest...

## new development

tion was the photon by teal. It's features do not include an on-off switch, batteries, or a charger unit. It operates on pure Solar power, even under "LLL" low light levels.



Audio-wise, we saw a nice combination between the Micro processor and cassette deck by Sharp/Optonica. Some of its features include *auto programme locate* which



can skip ahead or backwards, up to 19 songs, and automatically play your choice. *Counter memory* will stop or play at your own number selection on the counter. An LCD display indicates the function in use, or real time, which may also be used to turn the machine on and off. Approximate price £250.

Fisher offer on their model CR 4025 a cordless pause control with accompanying LED indicator on the deck. Price approximately \$250.

Blank tape is also a potential money spinning market. Not just the audio cassette field, but the video boom means a prime market place for both types of video cassette formats. One Company who likes to show its products to the full intermagnetics, emphasise their mechanical qualities by utilising transparent housings.

Radio sets has taken a turn for the better. With improved audio (maybe even soon stereo A.M.!) and arrays of digital read-outs for almost everything. Even "Star Wars" R2 D2 and CP30 are now available as radios.

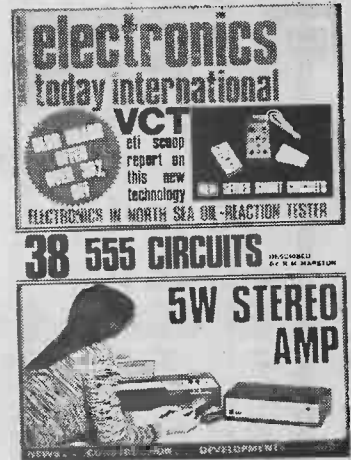
Finally a brief look at the up and coming Autosound industry, which is expected to top the billion dollar mark in '78.

We now have a 150 watt per channel power amplifier from AUDIOMOBILE INC. A seven channel stereo graphic equaliser from PYRAMID INDUSTRIES coupled with a multitude of goodies like digital read-outs, ultra small, heavy sounding loudspeakers and a claim most manufacturers make that performance levels are comparable to home audio systems.

The best quote from the show by Nolan Bushnell, the Chairman of Atari TV Games; "Only after you've experienced the sheer joy of slaughtering your best friend, will you know the true meaning of fun."



# Gaps?



# Gaps?

It can be a nuisance can't it, going from newsagent to newsagent? "Sorry squire, don't have it - next one should be out soon."

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# THE CBM PET ~ IS IT HOUSE TRAINED?

Gary Evans, in conjunction with Graham Wideman and Mark Czerwinski of our Canadian offices, takes a look inside the machine that might do for 1978 what the TV game did for 1977.



Fig. 1. The version of PET that is as far as we know the version that will be available in the UK.

WE FIRST SAW the Commodore PET as long ago as last April and reported on the fact in the July 1977 Microfile. It's taken until now for the final prototype we saw then to be translated into a production model, investments in production facilities completed and at last we have seen the official UK launch of the long awaited machine.

We have been dying to get our hands on a PET for some time and between our Canadian and British offices have now managed to put in some time on various PETS. Before getting down to a detailed description of the hardware just a few words about what will be available, at what price, when and from whom.

Commodore have set up a new division specifically to market PET and associated products (notably KIM 1 A 6502 development kit). Commodore Systems plan to mount a direct marketing operation to retail PET. They hope to locate suitable London showrooms very shortly.

The model available in Britain will initially be assembled in Germany and will feature 8K or user RAM (the 4K version sold in the States is not to be made available in the UK) and will retail for £695 (inclusive).

At the launch in early February Commodore Systems were quoting delivery times of about thirty days but expected these to lengthen to perhaps sixty days as demand increased. It might be worth mentioning however that the backlog of orders in the states has meant waits of up to one hundred and twenty days. The thirty or even sixty days quoted by Commodore Systems might be a little optimistic until production reaches target levels. ▶

## The Machine Itself

The machine shown in Fig. 1. is as close to the final production version as makes no odds.

What you get for your money is what you see (CRT, cassette mechanism, calculator style keyboard) all packaged in a neatly styled case, plus the innards (6502 MPU, 12K or REM containing all that is necessary to operate the hardware plus a fast BASIC interpreter, 8K or RAM plus other assorted bits shown in Fig. 2.)

## How did we like it

There is no doubt that this package of micro-pieces is well thought out, and designed with the idea that the user needs to know very little about computers to get "into" the PET. Remember the increased popularity of tape recording when cassettes came out? Make it simpler to use, easier for the human being. Same philosophy at work here, and that is what will sell it. Needless to say in spite of the fact we had very little documentation, we were highly impressed.

First of all there is no wiring up to do. When you plug in and switch on the PET, after only a couple of seconds it's ready for action. No BASIC to load from tape, it's already in there. This is one great headache reliever if the program you've written bombs out and writes all over memory in selected vital (of course) locations. No waiting for a 20 minute BASIC reload. 14K of built-in software is worth ten times its weight in silicon.

So after "power up" you can start programming, (more about that under SOFTWARE) or load from a cassette the software you want. Presumably in the future, tapes for various useful software packages will be widely available, so you will infrequently need to write your own, but it's lots of fun so you'll actually want to.

## Taped

Upon entering the LOAD instruction, the machine tells you to stick the tape in and press the "PLAY" button. Here's where a compromise has been made. Although the PET can switch the transport motor on and off, it tells you to do the muscle work. Commodore have saved money by using a standard (cheap) cassette recorder, which is sensible for the consumer market they are aiming at.

The cassette feature worked quite well, although a couple of demonstration tapes did not load properly (we suspect over-worn tapes due to heavy use). One feature we would have liked, (which could not have been included without a large extra cost) would be a fast forward search. Without it the machine took a long time to find a program if the tape was started at the beginning and the program happened to be near the end. For this reason it seems most economical (time wise) to only use C30 cassettes (these are thicker and stronger anyway) and then record only one or two programs near the start of each side, unless programs are recorded in some long sequence in which they are to be used, or for storage of little used data etc.

## BASIC

Commodore claims that their full floating point BASIC is the fastest yet implemented on a microcomputer. Here are the statements and features included.

**Standard Dartmouth BASIC Statements:** LET, READ, PRINT, DATA, IF, THEN, FOR, NEXT, DIM, END, GOTO

**Extended BASIC Statements:** RESTORE, REM, GET, GOSUB, DEF, RETURN, STOP, STEP, INPUT, FN, ON . . . GOTO, ON . . . GOSUB

**Scientific Functions:** SGN, INT, ABS, SQR, RND, SIN, COS, TAN, ATN, LOG, EXP, PI

**Logical Operators:** AND, OR, NOT

**Operation Commands:** RUN, NEW, CLR, LIST, CONT, FRE

**Formatting Functions:** TAB, POS, SPC

**Machine Level Statements:** PEEK, POKE; Allow the user to examine and store at specific memory locations. USR, SYS; Link BASIC to machine language subroutines with parameter passing or developmental subsystems. WAIT; Monitors status of a memory location such as an I/O port until specified bits are set.

**String Functions:** LEFT\$, RIGHT\$, MID\$; Returns substrings (of specified length and position) of string acted upon. CHR\$, ASC; CHR\$ returns a character, given a numeric code. ASC returns a numeric code corresponding to a character. LEN; Returns the length of a string. VAL, STR\$; Convert decimal values to numeric strings and vice-versa.

**Extended I/O Statements:** OPEN, CLOSE; Control association of a logical file number to a physical device and, optionally, a file name on the device. SAVE, LOAD, VERIFY; Store and retrieve a program, with optional file name, on a physical device. Load allows for program overlay, VERIFY compares contents of memory to stored program. PRINT#, INPUT#, GET#; Allow communication with logical device numbers other than keyboard or screen. GET# inputs one character. CMD; Permits communication with multiple devices simultaneously.

### Variables

TYPES: Real, Integer (%), String (\$)  
NAMES: Variable names are uniquely given as a letter or a letter followed by a letter or digit.

### Special Variables

TI, TIS: Time of day. ST: Status word for I/O operations.

## Key features

Another cost saver is the keyboard, being of calculator type construction and feel. All our reviewers disliked the feel (no feedback, you have to look at the screen to see your entry). On the other hand these reviewers were all