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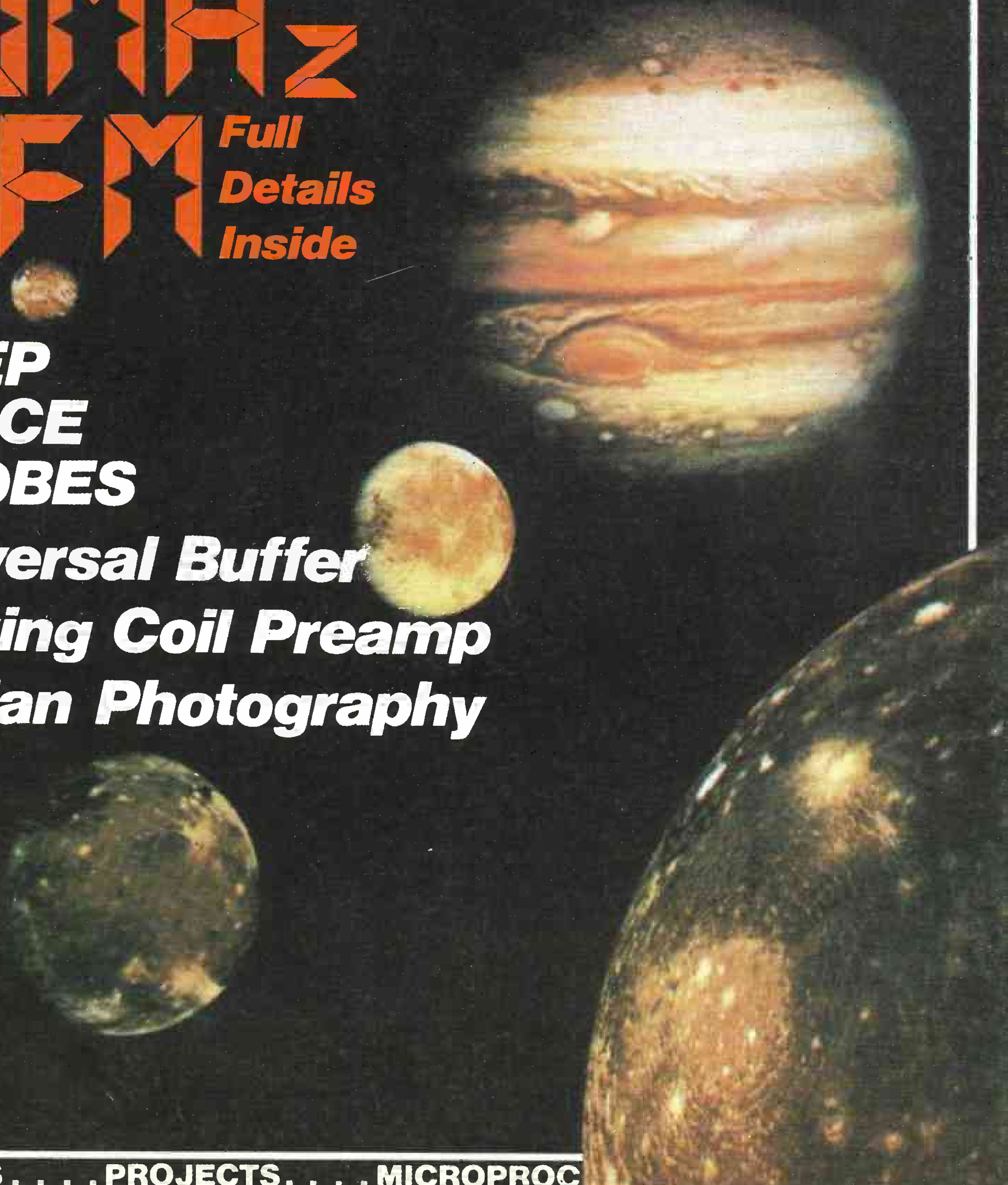
10MHz DFM

Full Details Inside



DEEP SPACE PROBES

Universal Buffer

Moving Coil Preamp

Kirlian Photography

. . . NEWS . . . . PROJECTS . . . . MICROPROC published by Edmund Scientific Company, Barrington, New Jersey, USA in 1975 provides circuitry details.

Many different arrangements of film and object position have been used. The film speed number — the ASA or DIN rating — is of little value as the energy exposing the emulsion is quite different from that for which the film-speed rating is assessed. Different films produce different results.

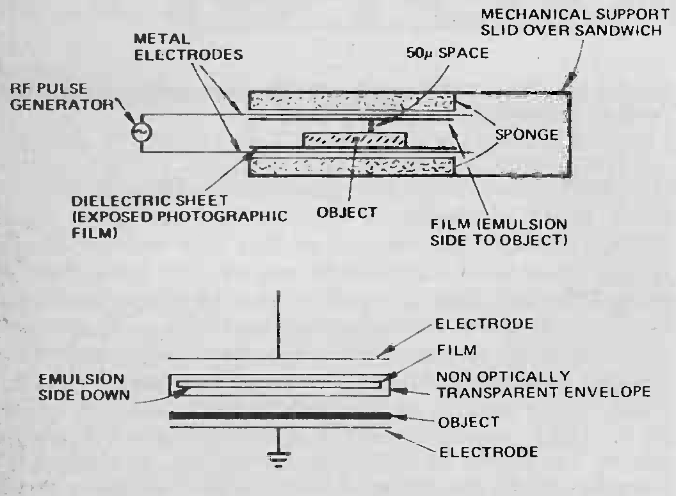


Fig. 3. Two methods of enclosing film to produce Kirlian photographs in a lighted room.

Defined Effects

Many variables exist to alter the characteristics of a Kirlian effect photograph. Even so, certain effects appear to have been established, giving electrophotography an intriguing nature.

It is said that live leaves and small animals produce a much clearer image, of higher contrast, than when they are dead — the energy image is said to reduce as the leaf looses its life.

Another claim is that a piece torn from a leaf still shows as present in a photograph of the remainder. This is termed the phantom or cut-leaf effect. (This is not be be lightly dismissed, for in the image storage method of holography the hologram plate can be broken and any piece from any position will still produce the same complete 3-D image).

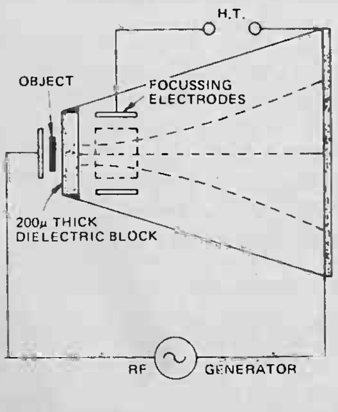
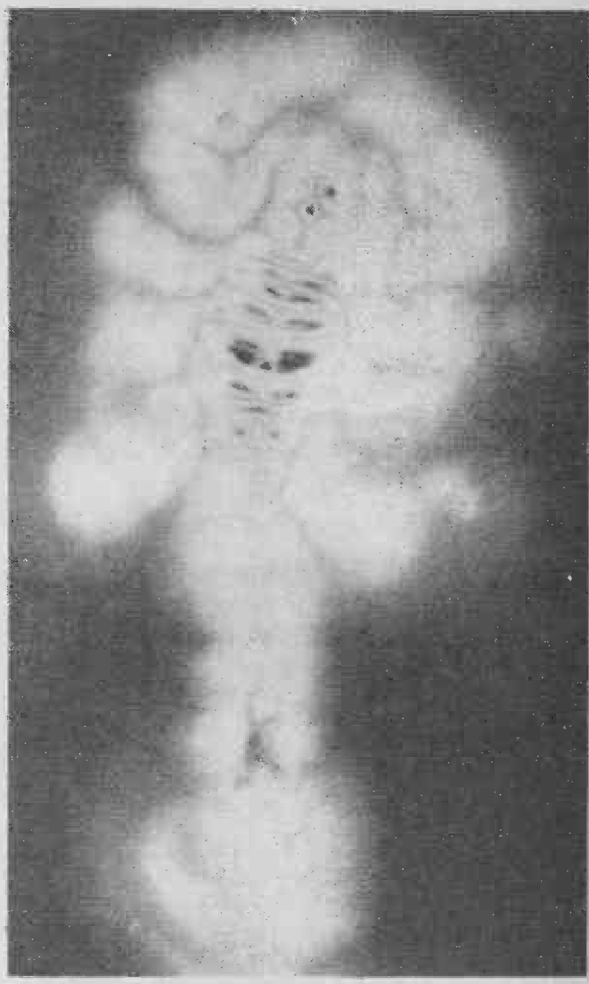


Fig. 4. A cathode ray tube arrangement for displaying a picture of the field around the object being examined.



The Kirlian aura of a live scorpion. The live parts in the centre of the outline are portions of the arachnid's abdomen in contact with the photographic plate.

It is also said that psychic healers' finger pads produce a more brilliant image when healing is in process compared with when it is not. As Johnson states: "Do the images show an energy transfer between healer and subject? Is there some informational exchange going on, resulting in the different energy representation of the finger pads."

This also is quite plausible for we accept that information can only be transferred in a physical system when an energy (or mass) carrier exists to convey the data.

Evidence, in the form of Kirlian photographs, has been obtained implying that people with "green-thumbs" have properties that assist repairing damaged plant tissue.

Electro-photographs are certainly artistic and often pleasing to behold. Perhaps they do demonstrate some form of energy unknown to man.

Acupuncture

What in the world have electro-photography and acupuncture in common? Why stage an international conference on this joint theme? The first Western Hemisphere Conference on "Kirlian Photography, Acupuncture and the Human Aura" was held in New York City in 1972. Papers were read by authors from the Soviet Union, Canada, France, Japan, United Kingdom, Eire and the United States. Letters were received from Czechoslovakia and other countries.

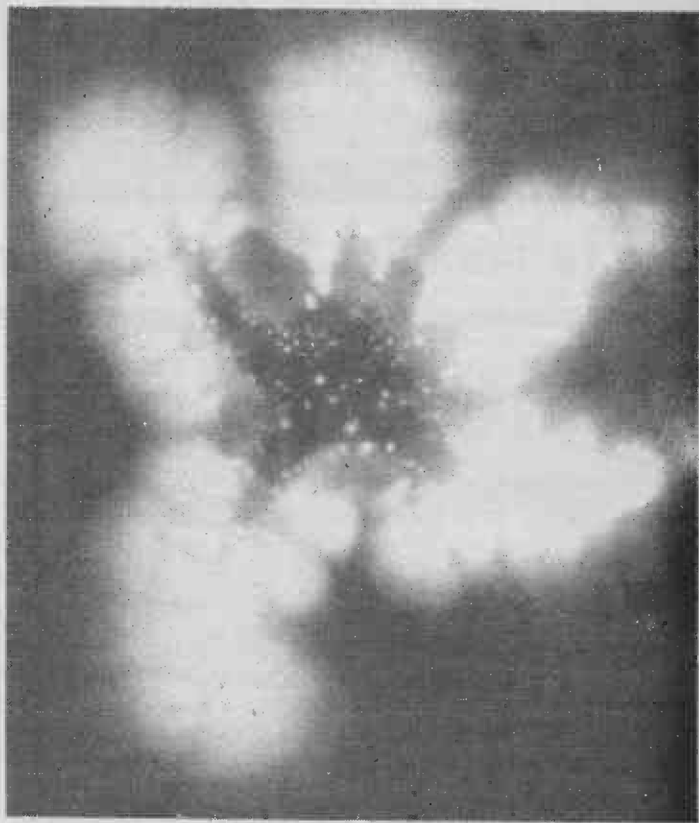
Kirlian photography is concerned with the properties of objects to modify and transmit energy fields — which are certainly of electro-magnetic kind — but may also be of some other, yet unexplained, information-linking nature.

Acupuncture is a Chinese art of healing, using needles inserted into the body at certain places called acupuncture points. It is a very ancient art and has been continuously practised, with effect, in the Asian regions.

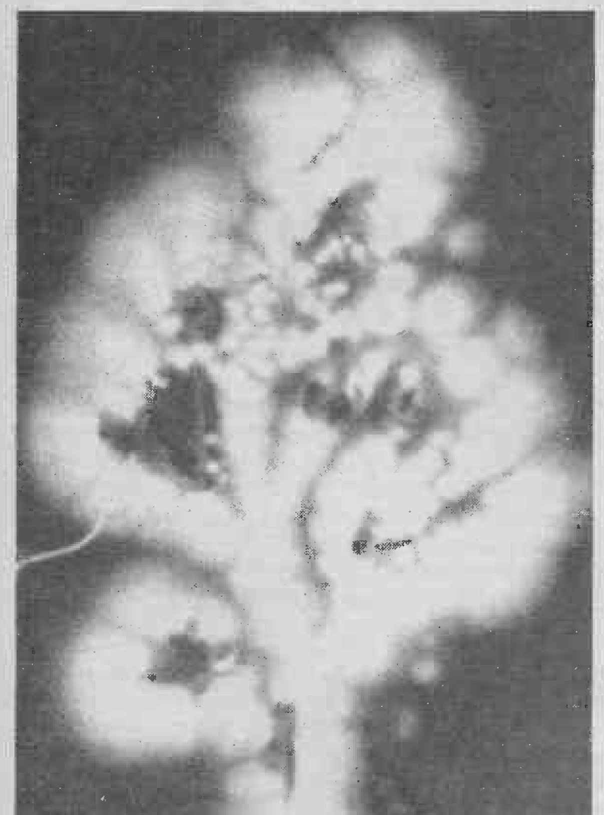
The Western attitude to medicine and healing has, until recently, been sceptical towards acupuncture because it cannot be adequately explained by Western science. Considerable evidence now proves that there is much about the body that can be controlled. Yogis are able to perform quite amazing variations of bodily function. Somehow the insertion of needles, in various numbers, places and depths can cure many ailments.

Bio-feedback is an apparently 'understandable' technology. Brendan O'Regan, of the Design Science Institute, Washington DC., wrote in 1973:

"Presumably, we in the West believe our senses only as their impressions are verified by the machines we create." It is in this light that Kirlian photography relates to acupuncture as well as to many other subjects.



Radiation field of a 'Jewel of the Ocean' starfish. Fine structure of the field is evident at the extremities of the creature.



The Kirlian aura of a seafern.

Several workers have reported that Kirlian effects are especially intense over known acupuncture points. Furthermore, some people have built probes — called tobiscopes — that indicate their position.

It is claimed that acupuncture can be established by moving electrodes over the body and observing the signal processed by an electro-physiological high-gain amplifier. The extent of the reading is said to also indicate the energy level of that particular acupuncture energy circuit. A 1971 Russian tobiscope, by Adamenko detects skin resistance changes that are claimed to drop from around the normal 1M down to 50-100 kilohm at an acupuncture point.

Related Reading

"Psychic discoveries behind the Iron Curtain" S. Ostrander and L. Schroeder, Prentice Hall, 1971.

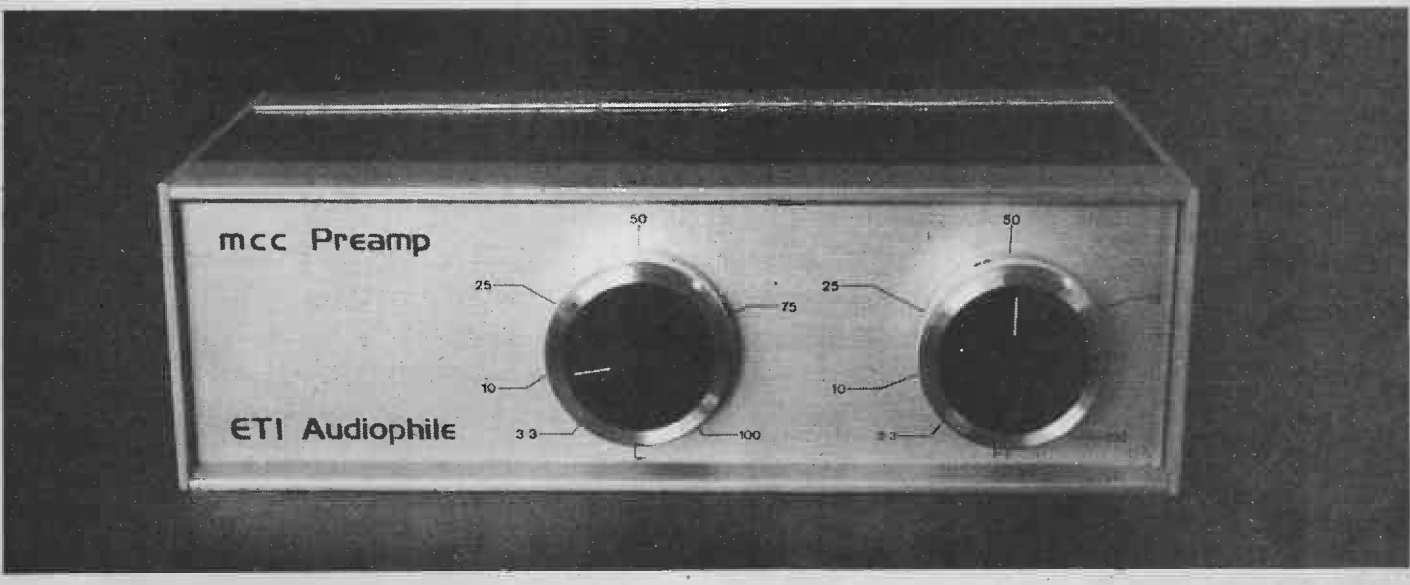
"Galaxies of life — the Human Aura in Acupuncture and Kirlian photography" S. Krippner, Interface, New York, 1973.

"Photography records electrical phenomena." Electrical Construction and Maintenance" Volume 75, 86, 1967.

"Instant imaging of electric, radio and acoustic fields" W. G. Hyzer, Optical Engineering, Volume 17, SR-3, 1978.

"Handbook of Unusual Natural Phenomena" W. R. Corliss, Sourcebook Project, Glen Arm, USA, 1977. ETI

MOVING COIL PREAMPLIFIER



A design of the highest fidelity, styled to match our amp, which is capable of bringing the best from those mobile windings.

Over the last several years there has been a dramatic increase in the number of moving coil cartridges released. The design of this type of cartridge results in a number of advantages which works on a moving magnet princple.

The pick-up coils are reduced drastically in size and weight compared to the coils used in moving magnet cartridges. This results in a total cantilever weight that is much smaller than in the typical moving magnet cartridge. Since the weight is greatly reduced the ability of the stylus to react to transients is increased and an overall improvement in signal accuracy results. Moving coil cartridges generally have superior frequency response characteristics and improved phase response at high frequencies. But they also have disadvantages.

The small pick-up coils have a very low impedance resulting in much lower signal levels than available from normal phono cartridges. In fact, the voltages present on the typical moving-coil cartridge at a recording velocity of 10 cm/sec can be in the order of 150µV! This is generally insufficient to drive an amplifier to anything like full power. Furthermore, since the output level is some 30 dB below that expected by the amplifier then a great reduction in the signal-to-noise ratio will result. An amplifier with a short circuit signal to noise ratio of 80 dB for example, which is quite a good figure, will end up with a signal to noise ratio of about 50 dB — which is distinctly *bad*.

The internal impedance of moving-coil cartridges is around 5 ohms and to achieve the low recommended load impedance required it is clearly not satisfactory to simply load down the input of the average phono input with a resistor since this does nothing to overcome the signal-to-noise ratio problems.

The solution to these problems is to insert some voltage gain between the output of the cartridge and the phono input. This can be done in two ways. Firstly, it is possible to use a transformer to boost the voltages up to the desired level and they are capable of very good results. But, transformers are still limited to transient performance and noise. To obtain the necessary voltage gain the turns ratio must be relatively high. Since the impedance ratio is related to the square of the turns ratio, the output impedance must, of necessity, be high also — usually around 30 k for a 50Ω input impedance. This is substantially higher than the output impedance of normal phono cartridges and degrades the noise figure of the phono input stage. A solution to this is to use a pre-amplifier instead of a transformer to achieve the necessary voltage gain. ▶

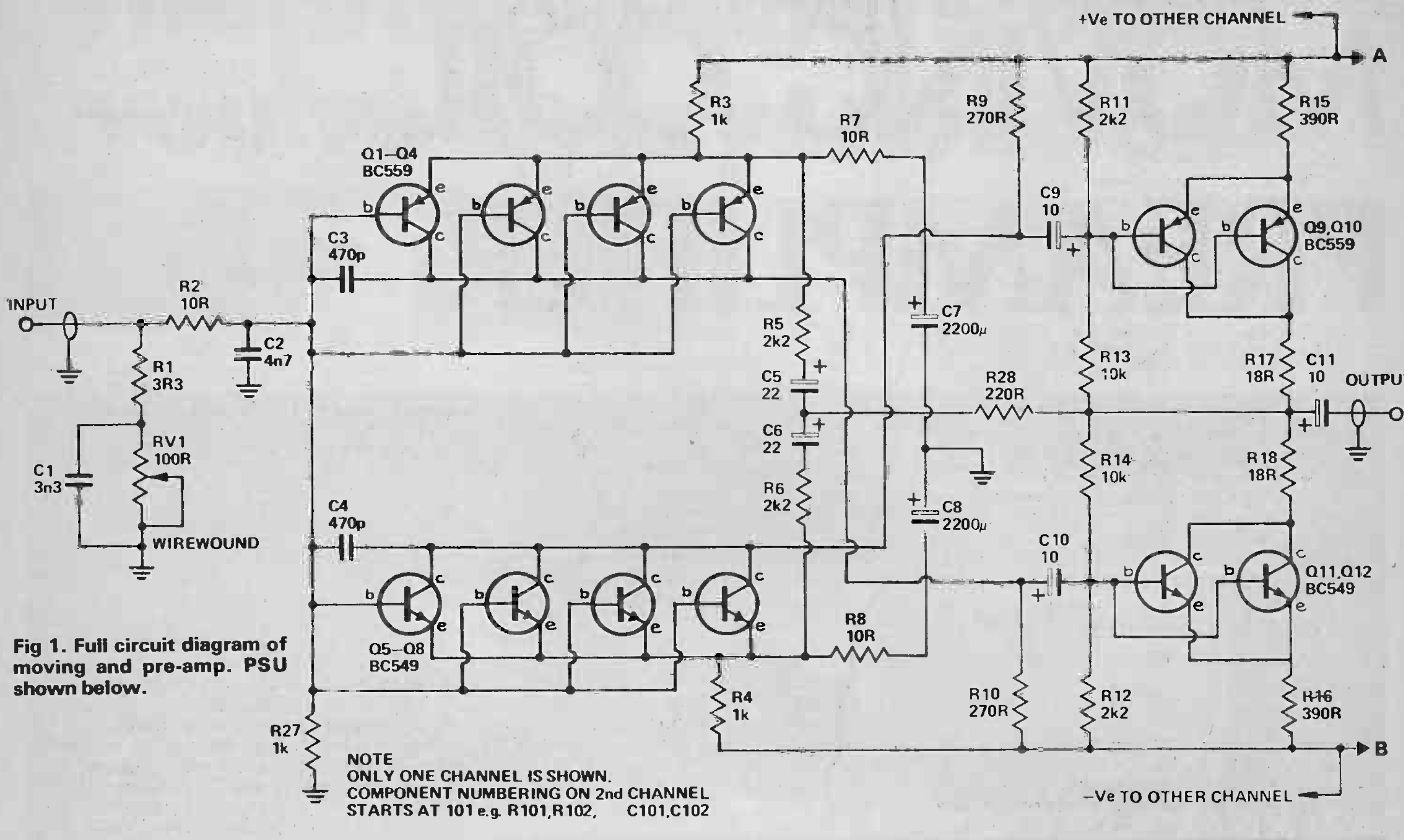
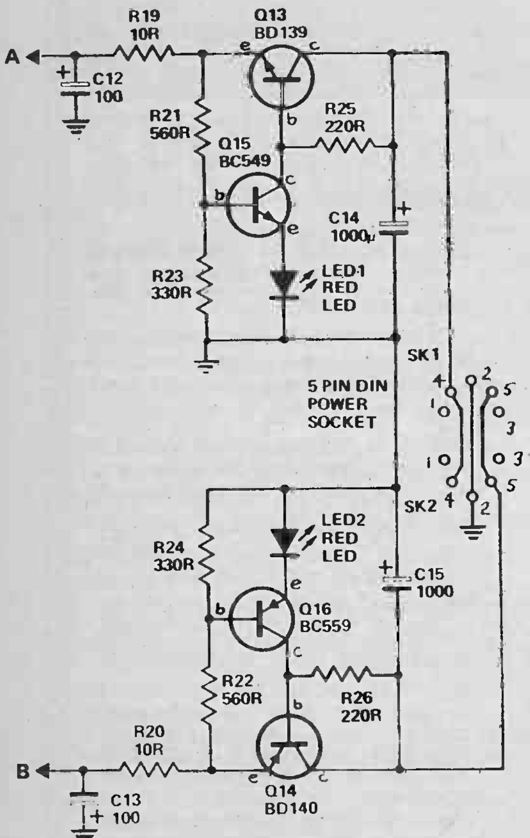
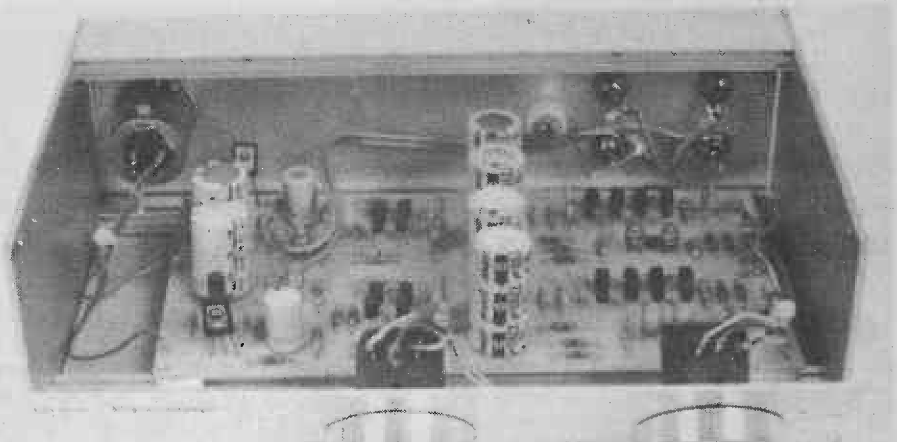


Fig 1. Full circuit diagram of moving and pre-amp. PSU shown below.





Above right: Internal view of one of our prototype units.

SPECIFICATION

Gain	28dB (x25 approx)
Frequency response	29Hz to 48kHz ± 1dB
Input impedance	Adjustable 3.3 to 100 ohms
Noise	Total equivalent input noise 0.3nV/√Hz Over a 20kHz noise bandwidth −42nV Signal-to-noise ratio, with respect to an input level of 150μV: −71dB
Total Harmonic distortion	With respect to an input level of 0.2mV unmeasurable (below noise) Calculated to be 0.0015% (see text). Rising to 0.015% for a 30mV input signal at 1kHz
Channel separation	Better than 61dB
Input overload margin	Better than 80dB

HOW IT WORKS

The input stage consists of Q1 to Q8 plus associated circuitry. Q1 to Q4 and Q5 to Q8 are in parallel to reduce the current density providing a low input impedance stage having very low noise.

The required low input impedance can be achieved in several ways. Firstly, we can make the input stage a common base configuration. In this type of circuit the input is connected to the emitter of the transistor so that the input impedance is determined by the emitter resistor in parallel with the base-emitter junction of the input transistor, which can be quite low. However, this does not solve the problem of input stage noise.

The other possibility, and the one we elected to use in this design, is common emitter configuration. The impedance of the base-emitter junction of a bipolar transistor is a function of the amount of current flowing in the emitter of the transistor. This will be largely determined by the collector current and not by the base current, which will contribute only a small amount of the total emitter current. A study of base-emitter junction is approximately equal to:

$$\frac{26\beta}{I_e\ (\text{mA})}$$

where 'β' is the small signal current gain of the transistor, and 'I_e' is the current in the emitter of the transistor in mA.

So, to reduce the input impedance of the first stage it is simply necessary to increase the emitter current. But this increases the current density in the input transistors, increasing the noise generated by the input stage.

To understand why this happens it is necessary to look more closely at the causes of noise.

Noise

There are two main sources of noise in transistors: shot noise and I/F noise. Shot noise is the main cause of noise at middle and high frequencies and is generated when an electron attempts to cross a potential barrier. It is therefore directly related to the amount of charge flowing in the device. More specifically, it is given by the equation:

$$\overline{I_s^2} = 2qi_{dc}B\ (\text{amps})^2$$

(mean shot noise current)
where 'q' is the charge of an electron, in coulombs, 'i_{dc}' is the DC current in amps, and 'B' is the noise bandwidth in Hz.

I/f noise has a random amplitude like shot noise but its spectral density has a I/f characteristic. This means that the noise amplitude increases as frequency decreases and becomes the dominant source of noise at low frequencies. As with shot noise, its equation reveals that it is directly related to the current flowing in the transistor.

$$\overline{I_f^2} = K\frac{(I_{dc})^a}{f}B$$

where 'I_{dc}' is the DC current in amps 'K' and a are constants that are a function of the particular device. 'f' is the frequency in Hz, and 'B' is the noise bandwidth. Notice that as I_{dc} is increased, so too is the I/f noise (I_f^2).

It is clear from this that, in order to keep noise generated by shot and I/f noise to a minimum, it is necessary to keep the current density in the input stage low. But, as we saw earlier, to obtain the necessary low input impedance we have to increase the emitter current. The solution to this is to use several transistors in parallel to form the input device. This decreases the current density in each of the transistors since the necessary emitter current can be shared by all of the input devices. It also places the impedances of the base-emitter junctions in parallel, further decreasing the input impedance of the first stage. Furthermore, since each transistor is a completely independent noise generator their noise voltage will tend to reduce each other (a process too complex to examine in detail here).

This configuration works very well and the noise levels of this preamplifier rival any of the commercially available units.

To see just how difficult it is to obtain a satisfactory signal to noise ratio at these signal levels it is necessary to look at another form of noise called 'thermal noise'. This is caused by the agitation of charged particles in any conductor due to their temperature. Every passive component will generate thermal noise and short of dunking the whole thing in liquid helium to cool it off, there is simply no way of getting rid of it. Thermal noise is given by the equation:

$$\overline{e_R^2} = 4kTRB\ \text{volts}^2$$

where 'T' is the temperature in degrees Kelvin (K).
'R' is the value of the resistance.
'B' is the noise bandwidth
'k' is Boltzmans constant, equal to 1.38 x 10^{-23} W-sec/K.

From this equation we can calculate the theoretical noise that will be generated by the moving coil cartridge itself. This clearly is the absolute lowest noise figure that is possible with the input stage generating no noise of its own (which is very unlikely!).

If we let the temperature of the transistor be 300 Kelvin (i.e.: mean atmospheric temperature) and the noise bandwidth be 20 kHz (the hi-fi audio band), then since the DC resistance of the cartridge is about 5 ohms the equation becomes:

$$\overline{e_R^2} = 4 \times (1.38 \times 10^{-23}) \times 300 \times 5 \times (20 \times 10^3)$$

Therefore $\overline{e_R} = 4.07 \times 10^{-8}$ volts or 41 nV.

So, the thermal noise of the cartridge itself is 41 nV.

Actually, this calculation is not quite right since the noise bandwidth is defined as having a 'brick wall' response. An amplifier with 3 dB point of 20 kHz that is falling at a rate of 6 dB per octave will actually have a noise bandwidth much greater than 20 kHz. Furthermore, if we want to be able to quote noise figures to enable comparison between different input stages, it is valuable to quote noise voltages independently of noise bandwidth. This can be done quite easily by dividing the noise voltage by the square root of the bandwidth. The dimensions of this new figure will be "volts per root Hz", and our result for the thermal noise of a moving coil cartridge becomes:

$$\frac{41}{\sqrt{20\,000}}\ \text{nV}/\sqrt{\text{Hz}}$$

or 0.29 $\text{nV}/\sqrt{\text{Hz}}$

Now, if we are aiming at a signal to noise ratio of 70 dB with respect to a signal voltage of 150 nV (0.15 mV), which is the expected signal level at a recording velocity of 10 cm/sec., then the equivalent input noise of the amplifier will be given by the equation:

$$-70 = 20\log\left(\frac{N}{0.15 \times 10^{-3}}\right)$$

and is equal to 0.33 $\text{nV}/\sqrt{\text{Hz}}$.

The necessary equivalent input noise is in the same order of magnitude as the noise being generated by the cartridge itself!

The total equivalent input noise of this unit was measured at 0.3 $\text{nV}/\sqrt{\text{Hz}}$. With respect to a noise bandwidth of 20 kHz, this corresponds to an input noise of 42 nV, giving a signal to noise ratio with respect to an input signal of 150 nV (0.15 mV) of 71 dB. At this level, the noise generated by the cartridge itself will be one of the dominant noise sources.

Capacitor C1 and C2 fix the upper frequency roll-off characteristics as well as shunting the input with the desired load capacitance for the moving-coil cartridge. The configuration of R1 and R2, C1 and C2 was found to give the best loading for a variety of moving-coil cartridges.

The potentiometer RV1 allows the input impedance to be varied over the range most commonly recommended by cartridge manufacturers.

Negative feedback is applied via the network consisting of R28, capacitors C5 and C6 and resistors R5 and R6. Some degenerative feedback for the input stage is applied to the first stage by the emitter resistors R7 and R8. Capacitors C9 and C10 are coupling capacitors to the second stage while bias for this stage is determined by R11, R12, R13 and R14.

The power supply consists of a series regulator Q13 and Q14. The potential dividers R21/R23 and R22/R24 divide the voltage present at the output of the regulator and drive the transistors Q15 and Q16, and the LEDs. The transistor base-emitter junction in series with the LED will drop 0V6 + 1V65. Therefore, whenever the voltage present at the centre of the potential divider tries to increase above 2V3 the transistor increasingly, conducts decreasing drive to the pass transistors Q13 and Q14.

This is a relatively low noise regulator since the voltage reference is LED and not a zener diode which is a noisy device. Resistors R19 and R20, together with capacitors C12 and C13 form 6 dB per octave low-pass filters on the supply rails to further reduce noise that may be generated by the regulated supply. . .

PARTS LIST

Resistors All ½W, 5%

R1,101	3R3
R2,102,7, 107,8,108,19, 20.	10R
R3,103,4, 104,27,127.	1k0
R5,105,6, 106,11,112,12, 111.	2k2
R9,10,109, 110.	270R
R13,113,14, 114.	10k
R15,115,16, 116.	390R
R17,117,18, 118.	18R
R21,22	560R
R23,24	330R
R25,26,28, 128.	220R

Capacitors

C1,101	3n3 ceramic
C2,102	4n7 ceramic
C3,4,103,104	470p ceramic
C5,6,105,106	22u 16V tantalum
C7,8,107,108	2200u 25V electrolytic
C9-11,109-111.	10u 16V tantalum
C12,13	100u 25V electrolytic
C14,15	1000u 25V electrolytic

Semiconductors

Q1-4,101-104, 9,10,109,110, 16.	BC559
Q5-8,105-108, 11,12,111,112, 15.	BC549
Q13	BD139
Q14	BD140
LED1,2	TIL209

Potentiometers

RV1,101	100R linear (wirewound).

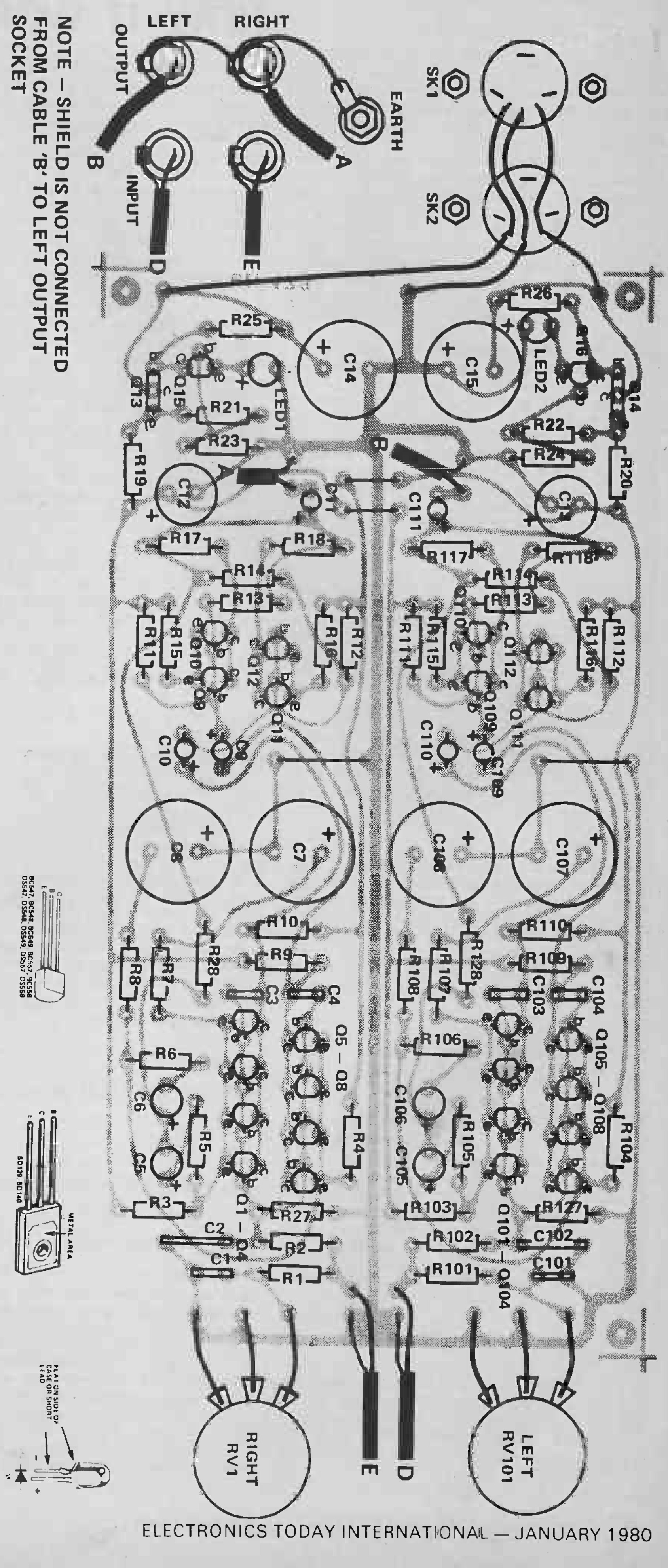


Fig 2. (Right). Component Overlay.

BUYLINES

The transistor types specified should not be substituted at all. In order to maintain performance keep to the parts list. The case used is in a matching style to our Audiophile amp, but probably a steel case would provide better screening. In practice ours worked well if properly sited (away from mains wiring). None of the components should prove troublesome to find. Case available from Boss Industries.

Preamp Requirements

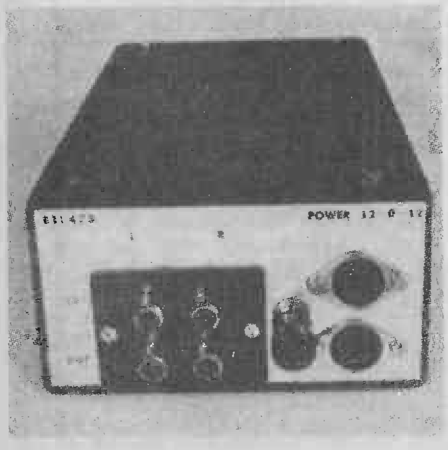
Preamplifiers have their disadvantages also. The biggest problem by far is the design of an extremely low noise input stage with the correct input impedance to load the cartridge according to the manufacturers' recommendations. The distortion must be kept to a minimum and the frequency response should be as flat as possible. These design goals are not unique to a moving coil cartridge preamplifier but they are difficult to achieve owing to the very low output voltage of the moving coil cartridge.

The required low input impedance can be achieved in several ways. Firstly, we can make the input stage a common base configuration. In this type of circuit the input is connected to the emitter of the transistor so that the input impedance is determined by the emitter resistor in parallel with the base-emitter junction of the input transistor, which can be quite low. However, this does not solve the problem of input stage noise.

The other possibility, and the one we elected to use in this design, is common emitter configuration. The impedance of the base-emitter junction of bipolar transistor is a function of the amount of current flowing in the emitter of the transistor. This will be largely determined by the collector current and not by the base current, which will contribute only a small amount of the total emitter current. A study of base-emitter turn-on characteristics shows that the impedance of the base-emitter junction is approximately equal to:

$$\frac{26\beta}{I_e\,(mA)}$$

where 'β' is the small signal current gain of the transistor and 'I_e' is the current in the emitter of the transistor in mA.



Performance Features

The total equivalent input noise of this unit was measured at 0.3nV/$\sqrt{}$Hz. With respect to a noise bandwidth of 20kHz, this corresponds to an input noise of 42nV, giving a signal to noise ratio with respect to an input signal of 150nV (0.15mV) of 71dB. At this level, the noise generated by the cartridge itself will be one of the dominant noise sources.

The circuit uses a symmetrical configuration with NPN and PNP transistors set up in such a way that asymmetrical distortions tend to cancel. Normally distortion products are generated differently for positive and negative signal excursions and this tends to produce second harmonic distortion products. The configuration used in this circuit results in very low second and third harmonic distortion. This has enabled a total harmonic distortion figure of around 0.0015% to be obtained.

The problem with quoting distortion figures of this order is that they are too low to be measured directly, being well hidden under the noise level. The only way a figure can be obtained is to remove the overall negative feedback, measure the distortion and then divide by the gain difference when the feedback is reapplied. Unfortunately, feedback does not affect all the distortion products equally, but the figure is still meaningful.

Another advantage of the symmetrical design of the input stage is that it does away with the need for an input capacitor. This is a definite advantage when dealing with low input impedances since the value of the capacitor would have had to be very large to obtain a flat frequency response at low frequencies.

The signal voltages present in the preamplifier are naturally extremely low and for this reason the power supply has been kept as a separate unit to reduce the possibility of 50Hz induction from the power transformer.

A voltage regulator supplies the necessary ±6V. As it is critical to achieve low noise it is important that the regulator does not put noise onto the supply rails which would degrade the noise performance of the unit. Normally the voltage reference used for regulators of this type is a zener diode but, as the zener is reverse biased, it generates a comparatively large amount of noise. In this design an LED was used as the voltage reference. A red LED operated in the forward-biased mode drops a constant 1V65 and generates very little noise.

Construction

Construction is relatively straightforward since most components are mounted on the board. Other construction methods are possible but performance will not match that of our prototype.

Mount the resistors and capacitors first, followed by the transistors. Cut the necessary lengths of shielded cables and solder them onto the board keeping the ends as short as possible. Solder the necessary lengths of hookup cable to the board and after checking all components mount the board in the chassis.

Use a steel box if you can, if not, just be careful where it is placed.

Once the board is mounted in the chassis, the pots and rear panel hardware can be mounted and the wiring completed according to the wiring layout diagram shown. The shielded cables coming from the outputs on the board have only one of their shields connected to the output sockets which are wired together and connected to the chassis at the ground terminal.

It is important that the sockets be insulated from the case and that the ground connection made to them is according to the wiring diagram. If the unit is going to be used with the recommended power supply there should be no hum problems. It is wired so that the 0 volt line is not connected to the chassis of the power supply. This is important, otherwise a hum loop around the units' mains grounds will result. Do not 'cure' the problem by disconnecting the ground wire at the 240 volt plug as this will remove any ground connection from the power supply chassis. This is dangerous.

Powering Up

Before turning the unit on make a final check of the board. Check the orientation of the transistors, electrolytic and tantalum capacitors and the LEDs. If all is right, turn down the volume control completely and switch the power supply on. The LEDs in the preamp's regulator should come on immediately.

Perhaps we are biased, but the sound quality of this preamp is extremely good! ETI

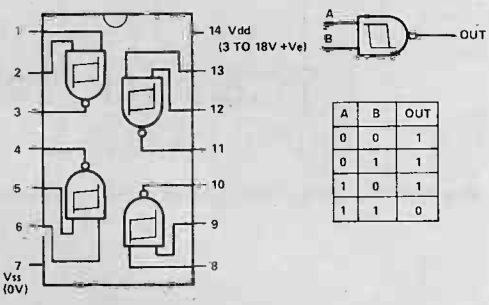
DESIGNER'S NOTEBOOK

In this month's 'Notebook' Ray Marston looks at applications of the ubiquitous CD4093B CMOS IC.

Regular readers of ETI and our sister magazine Hobby Electronics will have noticed that the project design team have a special affection for the CD4093B CMOS IC. This device is a quad 2-input NAND Schmitt trigger. It is a highly versatile package that can be used in a wide variety of wave-shaping, timing, logic and waveform generating applications. This month's 'Notebook' is devoted exclusively to describing applications of this uniquitous device.

Schmitt Applications

Figure 1 shows the functional diagram and truth table of the CD4093B. Each of the four gates is individually accessible and can be used as either a normal NAND gate or



A	B	OUT
0	0	1
0	1	1
1	0	1
1	1	0

Fig 1. Functional diagram and truth table.

an inverting Schmitt trigger by using the connections shown in Fig. 2. All unused inputs of the package must be tied to the positive or negative supply rails, as appropriate. ▶

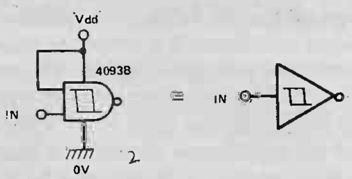


Fig 2. Method of connecting a NOR gate for inverting Schmitt use.

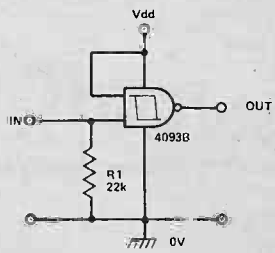


Fig 3. Simple Schmitt trigger with DC input.

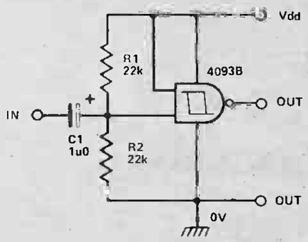


Fig 4. Simple Schmitt sine/square converter.

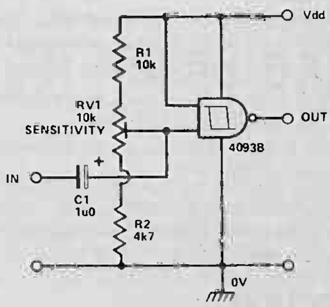


Fig 5. Improved sine/square converter.

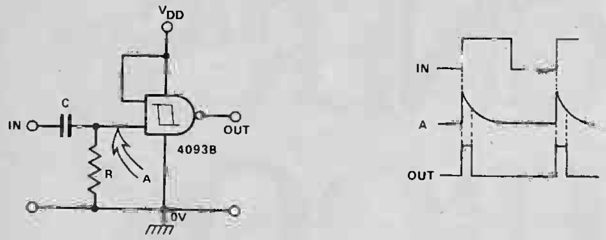


Fig 6. Connecting the 4093 as a rising edge detector.

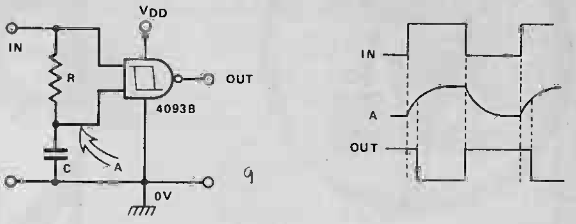


Fig 9. Leading edge delay circuit for the 4093.

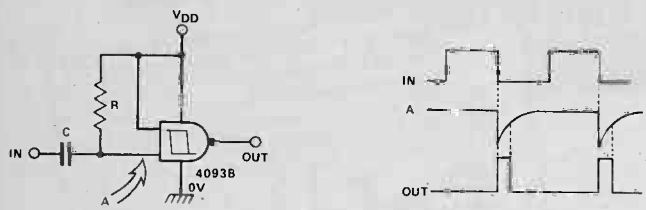


Fig 7. Rewiring Figure 6 to produce falling edge detection.

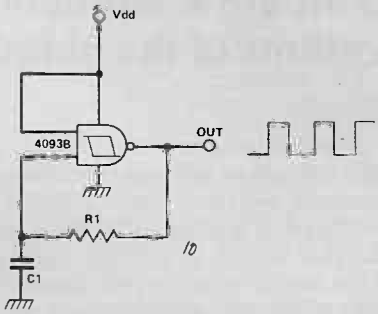


Fig 10. A basic astable multivibrator circuit.

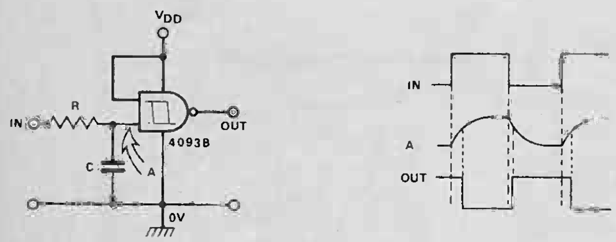


Fig 8. Pulse delay using a 4093.

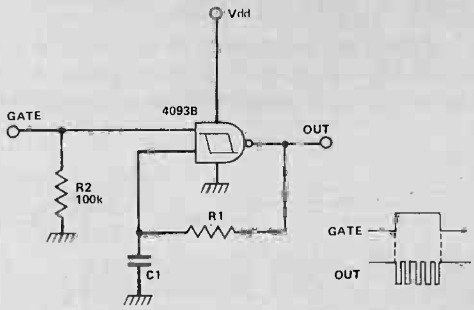


Fig 11. A variation giving gated astable multivibrator operation.

Figs. 3 to 5 show basic ways of using a CD4093B gate as a Schmitt trigger. Each gate has a typical hysteresis voltage (difference between the upper and lower trigger threshold voltages) of 2 V when powered from a 10 volt supply. In Fig. 3 the input signal is direct coupled to the gate input. In the Fig. 4 sine/square converter circuit the input signal is AC coupled and the input pin is biased at half-supply via R1 and R2. In the improved sine/square converter circuit of Fig. 5, the input pin bias can be adjusted to mid-way between the upper and lower threshold values, to give maximum sensitivity.

Edge Detection

Figs. 6 to 9 show a variety of ways of using the 4093 to detect or delay the edges of input pulse waveforms. The Fig. 6 circuit gives an output pulse on the arrival of the rising or 'leading' edge of an input pulse. The duration of the output pulse is determined by the C—R values. The Fig. 7 circuit produces an output pulse on the arrival of the falling or 'trailing' edge of an input pulse. The Fig. 8 circuit delays the entire input pulse by a period determined by the C—R values. The Fig. 9 circuit delays the leading edge only.

Clock Circuits

Figure 10 shows how a single CD4093B gate can be used as an astable multivibrator or 'clock' generator. This circuit gives excellent performance with very clean output edges that are unaffected by supply line ripple and other nasties. The operating frequency is determined by the C—R values and can be varied from a few cycles per minute to 1 MHz or so. The circuit action is such that C1 alternately charges and discharges via R1. C1 can be a polarized component.

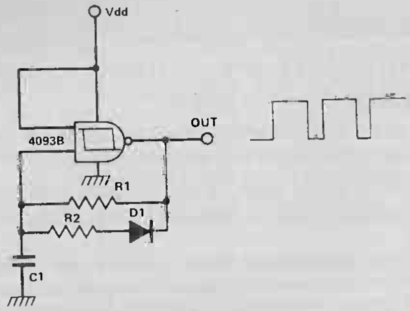


Fig 12. An astable with a non-symmetrical mark-to-space ratio.

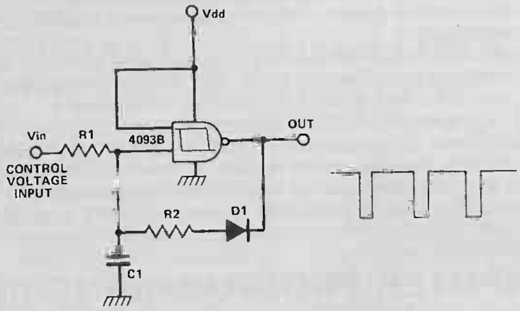


Fig 13. A special purpose astable. The voltage V_{in} has to rise above Schmitt (upper) threshold for operation. Frequency increases with V_{in}.

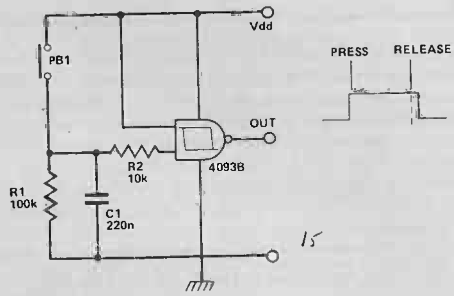


Fig 14. Using a 4093 to obtain a 'noiseless' push button switch.

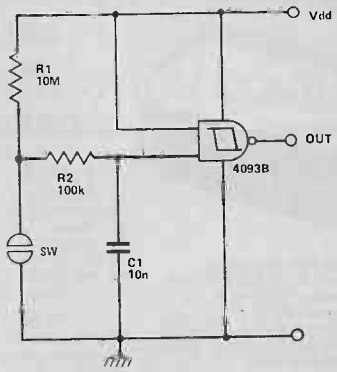


Fig 15. Touch switch giving output HIGH on operation. Reversing R1 and SW gives output LOW on operation.

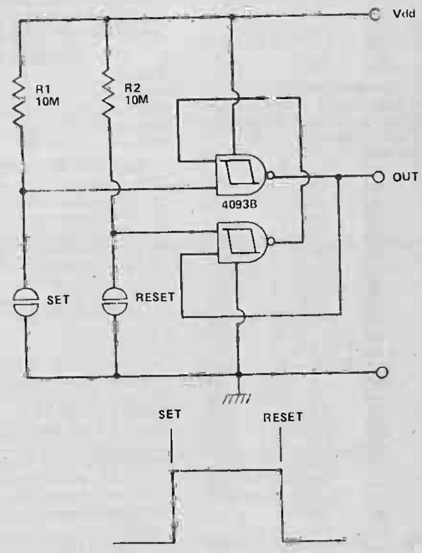


Fig 16. A latching or bistable touch switch circuit using two CD4093B ICs.

Figure 11 shows how the basic astable can be gated on and off via an external signal. Note that the circuit is gated ON by a high input, but gives a high output when it is in the OFF state.

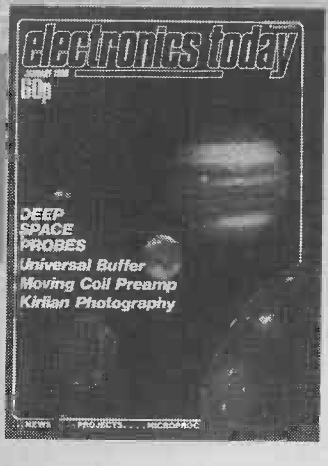
The basic astable circuit of Fig. 10 produces an inherently symmetrical output waveform. The circuit can be made to produce a non-symmetrical output by providing the timing capacitor with alternate charge and discharge paths, as shown in the circuits of Fig. 12. The Fig. 12 circuit produces a fixed M/S (mark-space) ratio output.

Figure 13 shows a special-purpose voltage-controlled astable which operates only when V_{in} rises above the upper Schmitt threshold: the operating frequency then rises as V_{in} is further increased.

Miscellaneous

Fig. 14 is the circuit of a 'noiseless' push button switch, which produces a clean output pulse each time PB1 is operated. C1 charges up rapidly when PB1 is closed but discharges slowly (with a period that is long relative to normal noise spikes) via R1 when PB1 is released.

The output of the Fig. 15 circuit goes high when the input contacts are touched. Fig. 16 shows the circuit of a latching or bistable touch-activated switch. ETI



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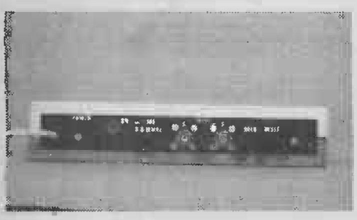

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EPROM PROGRAMMER

Once you've developed and debugged a program for your trusty Triton, transfer it to tape or into EPROM using the latest addition to Triton's hardware - an EPROM Programmer.

THE EPROM programmer is constructed on a single sided PCB. As there are not many components on the board construction is quite straightforward. Start by inserting the wire links into their respective holes. There are five of these. Bare tinned copper wire can be used. Then insert pins for all of the connections to Triton and for the transformer outputs. Now solder the normal IC sockets into position (leave the zero insertion force socket for now). Solder one socket to the board at a time in order to ensure that all of the pins are connected. As usual, start with the largest socket and work down to the smallest. You can now solder the resistors, capacitors, diodes and transistors into position. Take care to insert the correct value component into each position and to ensure that the transistors, diodes and electrolytic capacitors are the right way round. Lastly insert the socket for the EPROM and solder it. The control lever is adjacent to pin 1.

It is now time to make up the connecting cable for the board. The programmer is intended to be plugged into the end of the Triton motherboard and derives most of its power from here. However, it could be run directly from the extender socket on the main board with some care. More on this later. Using the wiring diagram of figure 5, attach the wires to the 64 way socket and to the PCB. If you are using a cover on the socket, remember to pass the wire through it before soldering both ends! Take care when connecting the wires to ensure that none of them become crossed on their journey from the socket to the circuit board or you will end up with a data encrypter! When the job is complete and checked, insert all of the ICs into their relevant sockets and check their orientation.

The unit can now be mounted into a box and the transformer connected. Firstly, cut a hole in the lid of the box for the zero insertion force socket. Also cut a slot at the join of the lid and base of the box for the cable entry. The board should be mounted with stand-off pillars to the box lid so that the programming socket is flush with the front panel. The connecting cable emerges via the slot cut between the lid and base of the box.

Firm Commitment

The programmer is now ready for use. Connect the 64 way socket to the end of your motherboard and switch the Triton system on. Now apply 240V to the programmer. If you are using the Level Six firmware, you are ready to go. Otherwise it is necessary to key in the program given. Having keyed it in, save it on tape. Now enter the program that you want to burn into EPROM. This can either be done using the monitor or TRAP. Normally the program is loaded from a cassette tape having been previously developed and debugged in RAM. When an object code form of the program is ready in RAM, you can start to program the EPROM with Level Six type Z. With other monitors, load the tape which you dumped earlier into RAM and type G1600. In response to the START: prompt type the address in RAM where the 1K byte block of data for the EPROM starts. After typing the carriage return, the program will start to load the data into the EPROM. Before each programming pulse occurs, the data is read from the EPROM and checked against the new data for the location to ensure that a 0 bit is not trying to be programmed to a 1. If this test fails a PROGRAM ERROR is reported on the VDU and programming is halted. On the last programming cycle, the data in the EPROM is read again and tested to see if it is the same as the data being programmed into that location. This test is used to verify that the data has been correctly

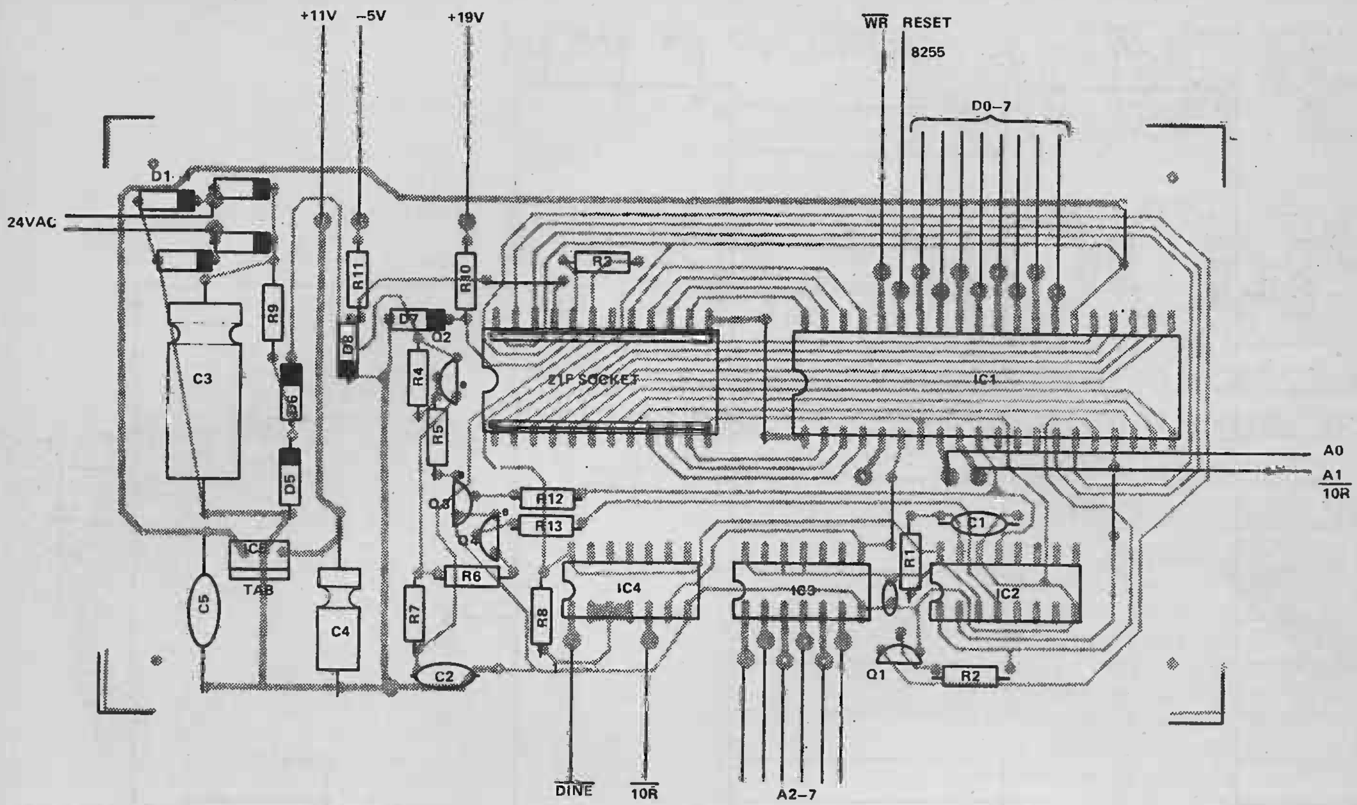


Fig 1. Component overlay for the Triton EPROM programmer

PARTS LIST

RESISTORS all ¼W 5%		SEMICONDUCTORS	
R1	22k	IC1	8255
R2,8	4k7	IC2	74LS123
R3,4	10k	IC3	74LS30
R5	33k	IC4	74LS33
R6	47R	IC5	7805
R7	180R	Q1,3,4	BC548
R9	560R	Q2	BC558
R10	100R	D1–4,6	1N4001
R11	130R	D5	27V 1W zener
		D7	12V 400 mW zener
		D8	5V1 400 mW zener

CAPACITORS	
C1	100n ceramic
C2	10n ceramic
C3	220u 63V electrolytic
C4	47u 25V electrolytic
C5	470n ceramic

MISCELLANEOUS
12-0-12 V 50 mA transformer, 100 mA fuse and holder, 64 pin Euro Socket (straight), 40 pin IC socket, 16 pin IC socket, 14 pin IC socket (2 off), 24 pin zero insertion force socket, case to suit, PCB (Transam Components Ltd).

transferred and if it fails, a READ ERROR is reported. When an EPROM is successfully programmed, typically after about 100 seconds, the FUNCTION prompt reappears. Using the Level Six monitor and the tone oscillator facility will cause a bleep to be sounded.

Banishing The Bug

Having successfully programmed an EPROM and plugged it into the Triton, some new bug in your program may well decide to rear its head! Fortunately with EPROMS this is no problem. Having traced the bug and decided how to correct it, turn your Triton off and remove the offending EPROM. Place it in an eraser for about 30 minutes. The eraser is just a source of ultraviolet light so if you do not own one of these (relatively expensive) machines do not worry. If you have a sun lamp, it is a good source of UV light. Put the EPROM on a piece of conductive foam or aluminium foil and place it under the lamp. Remember — DO NOT LOOK DIRECTLY AT THE SOURCE OF ULTRAVIOLET LIGHT — IT WILL DAMAGE YOUR EYES. If you do not possess a sun lamp, a UV tube can be purchased for a few pounds. Connect it up with a choke and fit it into the lid of a small lightproof box. Place the EPROM in the box about one inch from the tube, close the lid and switch on. After about half an hour you have an erased EPROM. While waiting for the EPROM to clear, load the program back into RAM from tape and modify it. When the EPROM and program are ready, reprogram the EPROM.

If you do not have a motherboard it will be necessary to wire up the 64 way connector to suit the expansion socket on the Triton main board. This has different connections and these can be obtained from the Triton manual. It is also necessary to provide the power supply voltages. This can be done with a small transformer or from the existing Triton power supply rails. In the latter case do not use the −5V rail directly. Instead use the −12V rail and a Zener diode and resistor so as not to overload the existing circuit. ▶

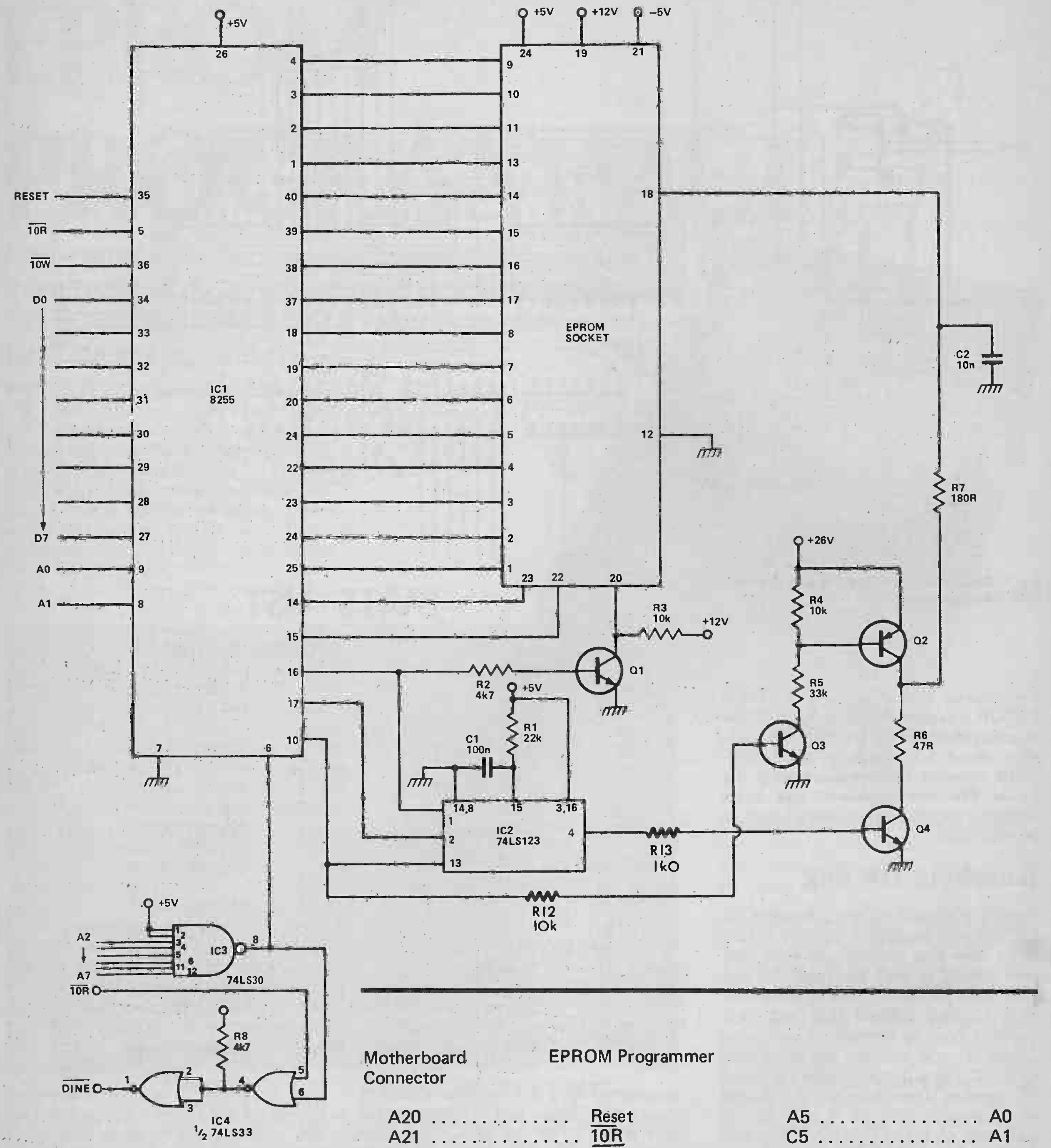


Fig 2. (Above) Main current diagram for the EPROM programmer.

Fig 3. (Right) Connection table for hooking into Triton.

Motherboard Connector	EPROM Programmer		
A20	Reset	A5	A0
A21	$\overline{10R}$	C5	A1
A18	$\overline{10W}$	A6	A2
A22	$\overline{DINE}$	C6	A3
A23	D0	A7	A4
C23	D1	C7	A5
A24	D2	A8	A6
C24	D3	C8	A7
A25	D4	A1,2, C1,2	0V
C25	D5	A32, C32	+11V
A26	D6	A31, C31	−11V
C26	D7	A3, C3	+19V

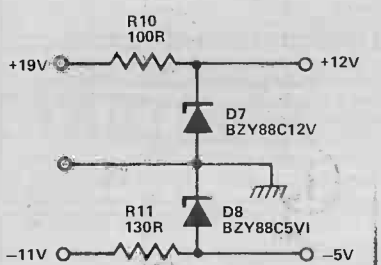
HOW IT WORKS

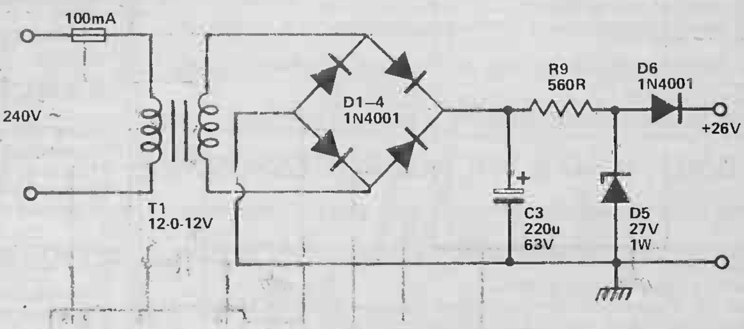
When an EPROM is fully erased all of the bits are set to a one so that each location reads FFH. Programming the EPROM sets selected bits to a zero level. To program the device, the address has to be set up on the address pins and the data for that location has to be set up on the data output pins. Then a 20 V pulse is applied to the program pin. Each location has to be programmed for 100 mS. As there are 1024 locations, the programming operation should take about 103 seconds. However life is not as simple as applying one 100 mS pulse for each location to be programmed. The programming pulse duration must be between 0.1 mS and 1 mS. In this design a pulse of 1 mS is used. Hence each byte must be programmed 100 times. We are using Triton to carry out all of the work so this is not a cause of concern.

The main work in the programmer is done by IC1 and IC2. IC2 is a TTL monostable producing pulses with a 1 mS duration. This pulse could have been generated directly on one of the output port pins using a software timing loop. However, this approach has two disadvantages. Firstly, if the Triton's clock speed is altered, the software must be changed to compensate for this. Secondly, and more importantly, if an interupt or reset occurred whilst the programming pulse is in an active state, it will remain active for longer than the maximum permissable time, 1 mS and damage the EPROM. The Q and Q outputs are used to drive Q2–4 which generate the 20 V pulse at pin 18 of the EPROM. Q4 is used to provide an active pull down, since the EPROM sources a few mA of current when the program pulse is low. If a resistive pull down were used then the pulse would not reach 0V. R8 and C2 provide the necessary shaping of the pulse. The communication between the Triton and the EPROM is provided by an 8255. This is a device with three programmable eight bit I/O ports. Pin 6 is the CS and this is enabled by IC3 for port addresses FC–FFH. The C5 signal is NANDed with IOR to provide the DINE signal required by the motherboard during port read operations. The 8255 contains four registers which are selected by A0 and A1. Three of these are the port data registers and the other is a control register. The 8255 is used in mode 1. In this mode it provides three simple I/O ports and port C can be used as two four bit ports. For circuit port A is used as the data bus to read data from the EPROM or to send data to it. Port B is used as an output port for the lower eight address bits. The lower half of port C is used as an output port. The bottom two bits are used for the remainder of the address bus and the upper two bits are used to control the generation of the program pulse. The upper half of port C is used as an input port to monitor the state of the program pulse so that Triton can keep a track of the programmer's operations.

While the data and address information is being set up, port C bits 2 and 3 are set to 1 and 0 respectively. This inhibits the monostable and holds the CS of the EPROM active (at 0V). When the busses are ready, bits 2 and 3 of port C are toggled. Now the CS is set to +12V to enable programming and the monostable is triggered to generate the program pulse. This sequence of events is repeated for each program cycle.

No buffering was provided on the busses as it is felt that the programmer will not be connected to the bus for much of the time and it does not present a load of more than one gate on any of the address or data lines. This has allowed the cost to be reduced.





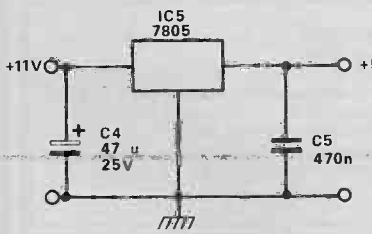
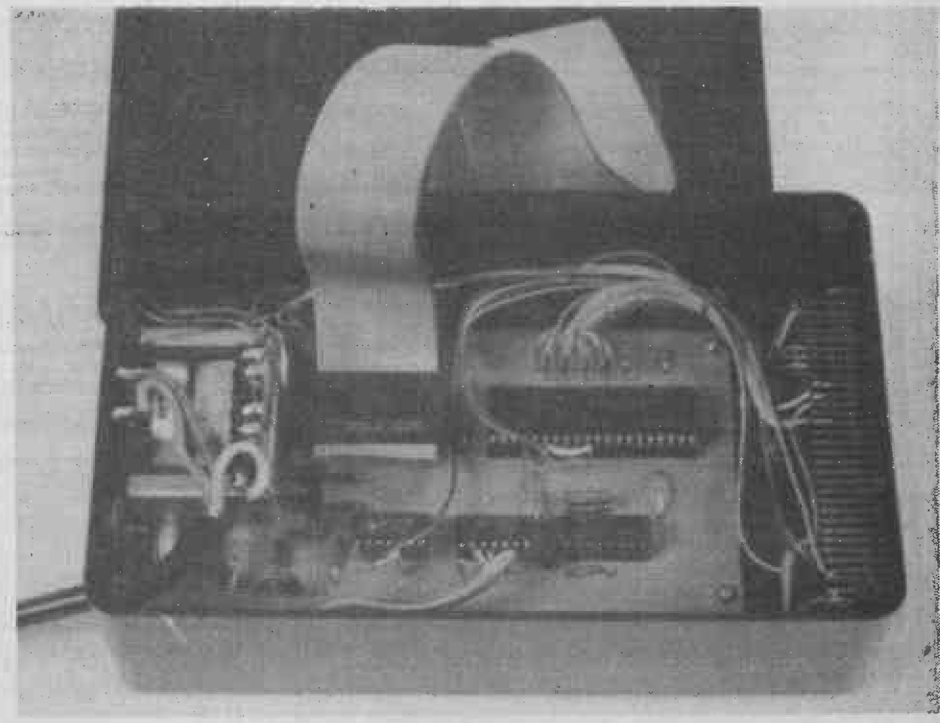


Fig 4. (Above) PSU circuits for the TRITON EPROM card.



BUYLINES

Transam Components are producing a kit for the Triton EPROM programmer for £29.50 excluding the case. Another £2.50 brings you the case as well. Transam Components Ltd, 12 Chapel Street, London NW1 5DH.

ELECTRONICS IN THE STUDIO

Tim Orr - the man of a thousand circuits - takes us on a tour around the cables of a recording studio.

The last decade has seen an enormous growth in the quantity of electronic hardware that is used in recording studios. The list of equipment now available includes 24 track tape recorders, 48 channel mixers, computer assisted mixing, spectrum analysers and a whole host of electronics effects gadgetry. These high technology solutions have made the job of producing recordings much easier but the tasks now demanded of the studio engineer have increased.

It is sobering to remember that the early Beatles' albums were produced in one day on a four track recorder. No matter how hard we try, technology cannot produce music; it can only provide the 'tools for the job'. In fact technology has in some ways, had a detrimental effect on music production with the idea that if you have sufficient recording tracks to spare you can get it right on the final mix down.

A Typical Studio

A typical recording studio is split up into two working areas: the performance area and the control room — containing all the electronics and associated hardware. The performance area is soundproofed to provide about 80dB's of acoustic isolation from the outside world. The walls, floor and ceiling are all made from very dense materials to absorb sound. The room itself is usually acoustically flat, having little or no reverberance or resonances. Often there are mobile acoustic baffles, (vertical sheets of board), that can be positioned in between musicians to provide some amount of acoustic isolation between them. These are often used for drums. There is a studio talk back system so that the control room can talk to the musicians or play them recordings. The microphones plug into floor or wall sockets and are connected directly to microphone amplifiers in the control room. A large double glass window separates the two halves of the studio.

The control room houses all the electronic equipment needed to produce the recording. All signals pass through a multi-channel mixer which is used to provide control over the volume, tone and any special treatments that need to be performed on a particular sound. The usual approach for producing a recording is to build it up track by track so that the music is broken down into its basic ingredients, (i.e. bass line, melody, vocals, strings, drums), which are stored on a multi-track tape. This can then be mixed down by the producer to get the required overall balance. The mixer can be used to fade in and out various tracks and to provide equalisation.

Graphic Equaliser

A Graphic equaliser is a very flexible tone control operating over the audio spectrum. This spectrum is broken up into segments, each being controlled by a slider which can provide up to 12dB of cut or lift. Thus it is possible to draw out, using the sliders, an overall frequency response which ▶

will be imposed upon the audio signal. The position of the sliders graphically display the frequency response curve.

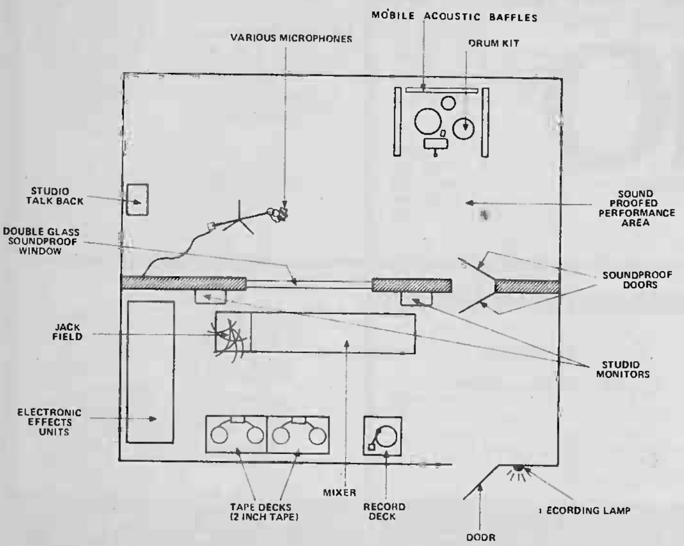


Fig 1. A typical studio layout.

Compressor/Expander

Two problems that are ever present are noise and overloading. To prevent overloading of equipment you can simply operate at a low signal level but this results in a poor signal to noise ratio. To obtain a good signal to noise ratio you should operate at a higher signal level but this will probably result in overloading and distortion!

An enormous amount of programme material is listened to on radio sets which typically have a reception signal to noise ratio of between 40 to 55dB and which are used in noisy environments. Thus the programme sound level must be very tightly controlled. If the signal level is too large then the radio transmitter will be over modulated causing gross distortion; if it is too small the signal will be lost in noise. Generally broadcasting companies try to limit their programme material to a range of about 16dB. Also when records are cut the dynamic range must be tightly controlled as a disc can only provide 60dB (usually less) signal to noise ratio.

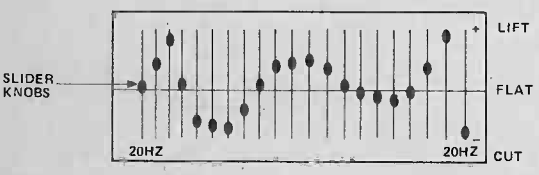
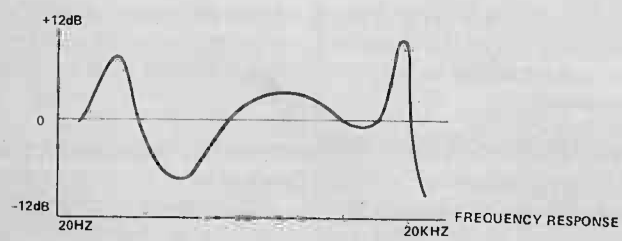


Fig 2. A graphic equaliser and response.



If the signal level is too large the cutting will break through into its neighbouring grooves. Even if it doesn't actually break through it can cause a material deformation of the master disc that produces a noticeable pre and post echo. When a disc is cut the general brief for the disc cutter is to get as large a cut as is possible without producing any cross talk and to do this the recorded material should not have any nasty signal peaks.

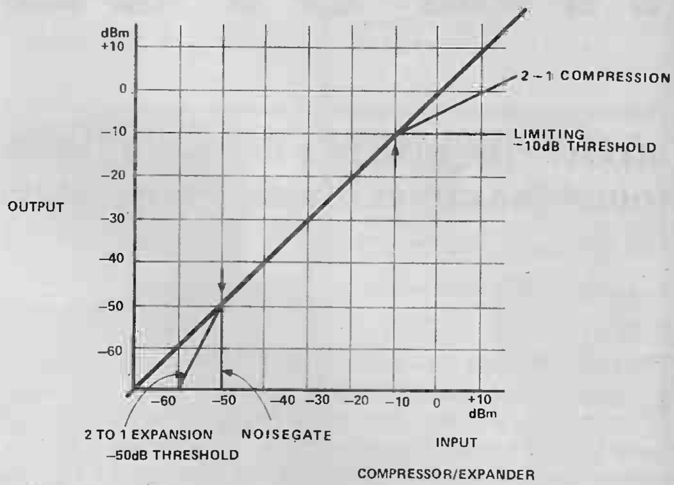


Fig 3. Compander limits and response

Level Control

There is a large selection of equipment available to control the signal level of programme material and these are known as compressors, limiters and expanders.

A typical device will have controls that set the threshold points, the compression and expansion ratios and the response times.

A limiter is a device that prevents the output signal from rising above a set threshold. As the input signal attempts to do this, a voltage controlled attenuator turns the signal level down. The effects of limiting are rather harsh and are usually only used to prevent overloading in some other pice of equipment. Compression is also used to reduce overloading but it is more subtle.

If say, a two to one ratio has been selected then as the signal level exceeds the threshold the output will increase by only 3dB for every 6dB increase of the input. By using both a compressor and a limiter at once it is possible to run at 6dB below the maximum operating signal level for a system and still handle signal excursions of a further 18dB without noticeable distortion.

When the input signal is very noisy as for example, a telephone news report, or an old film sound track, an expander can be used to clean up the sound quality. An expander is a device that attenuates the signal when it falls below a pre-set threshold. A two to one expansion ratio reduces the output signal by 12dB when the input signal falls by 6dB. A more dramatic effect is a noise gate which has an expansion ratio of about 20:1 or even more.

The speed with which compression or expansion occurs is controlled with switchable attack and decay times. This allows the user to select the best time constants for the job in hand.

Another but more specialised type of signal level controller is the voice over or ducking unit. This enables a DJ to automatically fade the music down to a preset level every time he speaks. When he stops the music rises back to its original level. The attack and decay times for the ducking are adjustable.

Above: an Audio Design compander.

Above: an Audio Design voice over unit.

Noise Reduction

The signal to noise ratio of a professional tape recorder is about 60dB, which is mainly due to the limitations of the tape. This is not good enough for professional recordings, particularly when many sound tracks have to be mixed together. What is needed is a system for improving the perceived signal to noise ratio. An expander does this but it distorts the natural dynamics of the signal in that the signal dies away abruptly after it falls below the threshold. A system that overcomes this problem and which is widely used in studios is the Dolby A system. The signal to be recorded is pre-processed with a low level compression. That is, low level signals are selectively made larger whilst the high level signals are unaffected. The signal is then recorded on tape and in doing so tape noise is added.

When the tape is replayed a low level of expansion exactly complimentary to the compression previously mentioned is performed. This reduces the effect of the tape noise in the periods of silence but does not corrupt the signal dynamics because of the complimentary compression and expansion.

Also, the process is performed in four independent frequency bands so that ''breathing'' effects are reduced. The advantage of using low level compansion is that the distortion caused by it appears only on low level signals and is thus not very noticeable. Also low level compression makes very little difference to the maximum signal level. An improvement of 10dB is obtainable using the Dolby A system.

Echo And A D T

Electronic delay lines are often used to produce a wide range of effects such as flanging, chorus, automatic double tracking and echoes. There are two methods of implementing time delays, one is with bucket brigade delay lines which are useful for short delay (1 to 40 mS.) low cost units, and the second is with digital delay lines. These are best used for 10 mS to 1 S. delay times in high quality units, (usually costing £500 upwards).

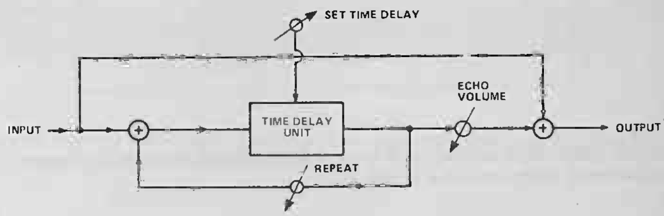
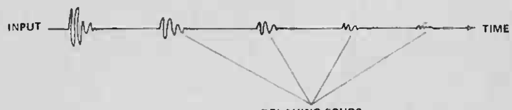


Fig 4. (Above) Block diagram of an echo unit.
(Below) The resulting outputs.



Automatic double tracking (ADT) simulates the sound of a second instrument playing along with the original. A time delay of 10 to 40 mS is generally used and the delayed voice is mixed in with the original so you effectively get two musicians or singers for the price of one. To improve the naturalness of ADT the time delay is slowly modulated, thus generating very slight timing errors. Another effect similar to ADT is 'chorus' where one or more delays lines are used with a slightly shorterdelay time, (5 to 10 mS) thus creating a richer, more complex sound structure.

Echo is often obtained using a digital delay line. The input sound is converted into a binary word with an ADC, stored in a large RAM and then converted back sometime later into an analogue voltage using a DAC. The memory size is often very large. Take, for example, an echo unit which has to have a 60 dB dynamic range, a 10 kHz bandwidth and an echo length of 1 second. The system must be 10 bits wide and have a clock speed of 25 kHz, thus the number of bits of memory needed is 25K x 10 = 250,000 bits, which would be 250 1K RAMs costing about £1 each!

Flanging

Flanging is a popular effect that is implemented using a comb filter. The comb filter response is produced with a short delay line, (1 to 10 mS) where the original and delayed signal are mixed together. This generates a frequency response which has a series of linearly spaced notches, the spacing of these being inversely proportional ▶

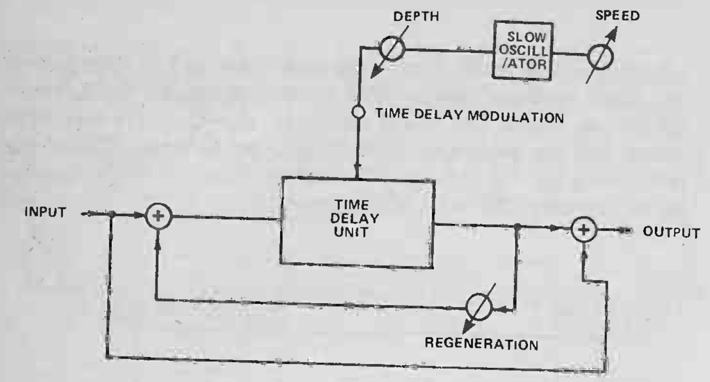
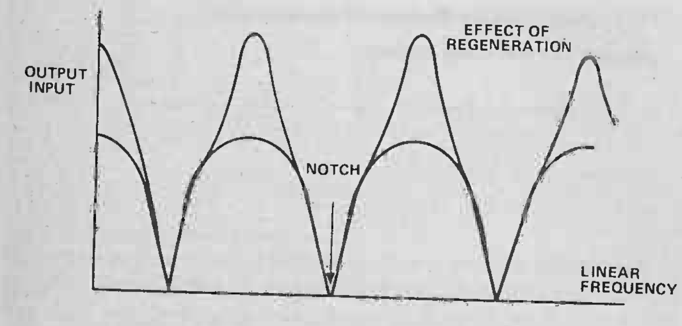


Fig 5. (Above): Flanging and how it is obtained. Below is shown the frequency response of a comb filter.



to the delay time. By applying feedback around the delay line, the comb becomes more peaky and so provides more colouration of the sound. The delay time is slowly modulated and this produces an interesting mobile colouration of the sound. Flanging and phasing are often confused as they are both produced by comb filtering. Flanging uses a time delay and generally has lots of notches, sometimes as many as 50, whereas phasing uses phase delay and usually has only 2 or 3 notches.

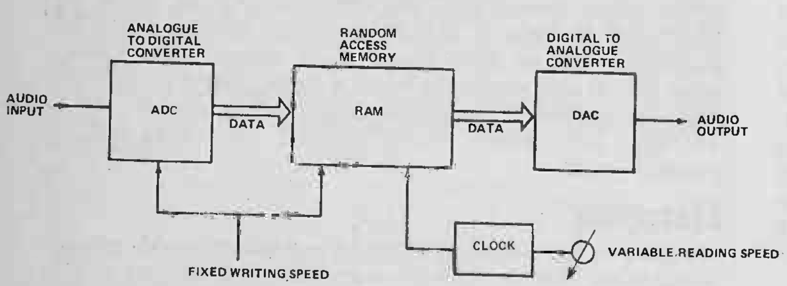


Fig 6. Digital pitch shifting techniques.

Pitch Shifting

It is now possible to transport the pitch of an instrument using a pitch shifting device. The shifting is not perfect, but it is good enough to produce useable harmonies. The operation is as follows. The input signal is converted into a binary code and written into memory. At the same time the memory is read, but at a different speed and this data is converted into the audio output using a DAC. If, say, the reading speed is twice that of the writing speed then the output will be transposed up an octave in pitch. There are many problems to be overcome. First, the output must not be significantly delayed. Second, the time varying information of the output must rapidly track the input, that is, the melody should be the same, but the pitch transposed. To satisfy these conditions the memory size should be relatively small (20 to 40 mS). Take the case of the up transposition of one octave. If the reading speed is twice as fast as the writing speed then each segment of sound will have to be played twice, otherwise gaps would appear. However, when the transposition is down by one octave,

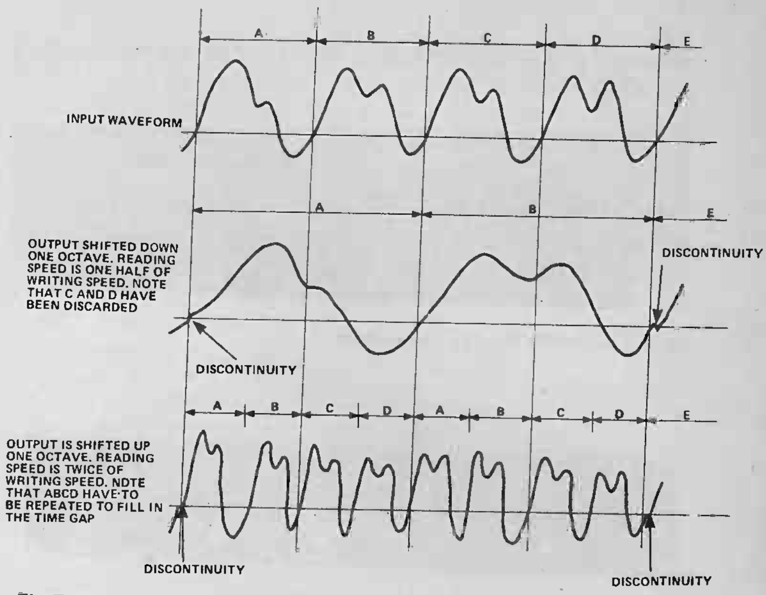


Fig 7. Pitch shifting in practise.

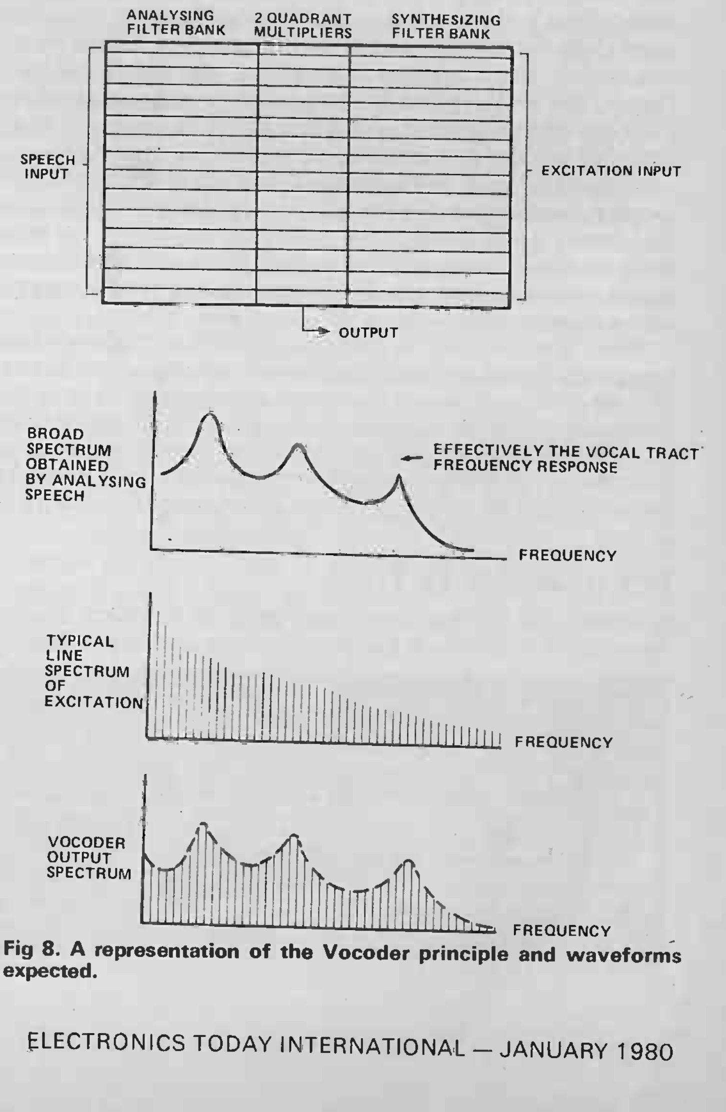
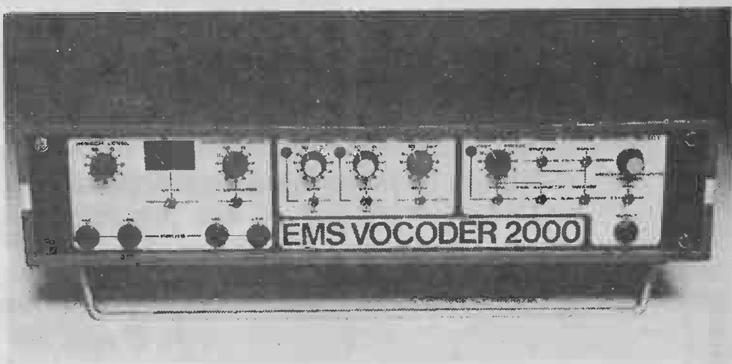


Fig 8. A representation of the Vocoder principle and waveforms expected.

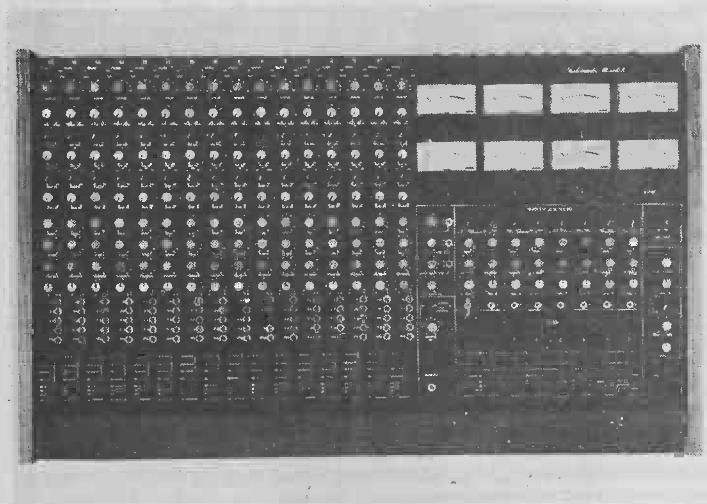
then half of the information cannot be read in time and so has to be discarded. Pitch shifting units are usually continuously variable over the range of plus or minus one octave.

Vocoders

A vocoder is a device for producing a cross product of two sounds. If the two sounds are speech and an electric organ, then the resultant sound output is a talking organ. When we speak we produce a buzz in our vocal chords that is acoustically filtered by our vocal tract. The buzz becomes articulate, it speaks. The vocoder uses a filter bank to analyse the speech so it can determine the time varying frequency response of the vocal tract. It then synthesises a model of this frequency response using a second filter bank plus some multipliers. The excitation signal (the electric organ), is then filtered by this model and so becomes articulate. The vocoder output has the melody and harmonics of the excitation signal, but the time varying broad spectrum (the articulation) of the speech.



Above: the EMS Vocoder 2000, a very popular unit and one which the author helped to design in his days at EMS.



Above: a typical portable mixing unit. This one is produced by Studiomaster and will mix sixteen channels into eight.

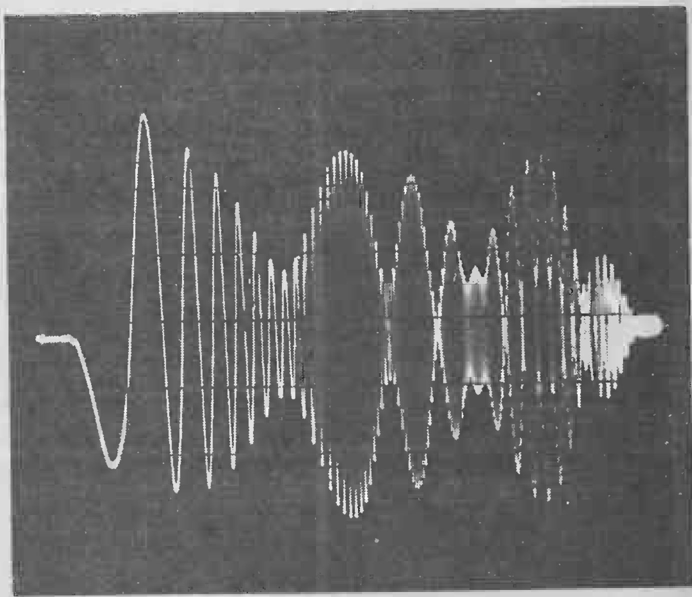


Fig 9. The frequency response of a chorus unti which employs three flanging units without regeneration. The scope picture was obtained using a swept sine wave oscillator set to run the audio band.

Mixers

There is a wide variety of mixers on the market today, ranging in price from £20 to £20,000. Basically, the more you pay, the better the product. A mixer is composed of input and output channels; for example a 16 into 8 device has 16 inputs and 8 outputs. A typical input channel has the following controls. An input gain switch so that low level signals from microphone sources up to high level studio signals can be accomodated. An overload lamp or a VU or PPM is usually provided so that the signal level may be monitored. Next is a tone control section, perhaps consisting of Bass, Middle, Treble and sometimes a few parametric control functions. Many mixers also have an echo send control so that reverb may be added to that channel. A foldback control is often included. This is an internal mixing system so that a few tracks can be grouped together and fed back via head phones to the musicians.

A pan control enables that channel to be sent to either of the left and right output groups. Routing switches are used to connect a particular channel to any output group. A level slider, always at the bottom of the channel allows the operator to fade in and out the sound from that channel? You might get a nasty surprise! You won't if you have got a prefade listen switch. This connects the signal at the top of the slider to some monitoring device, so that the operator can have a sneak listen to a channel before fading it up and perhaps ruining the output.

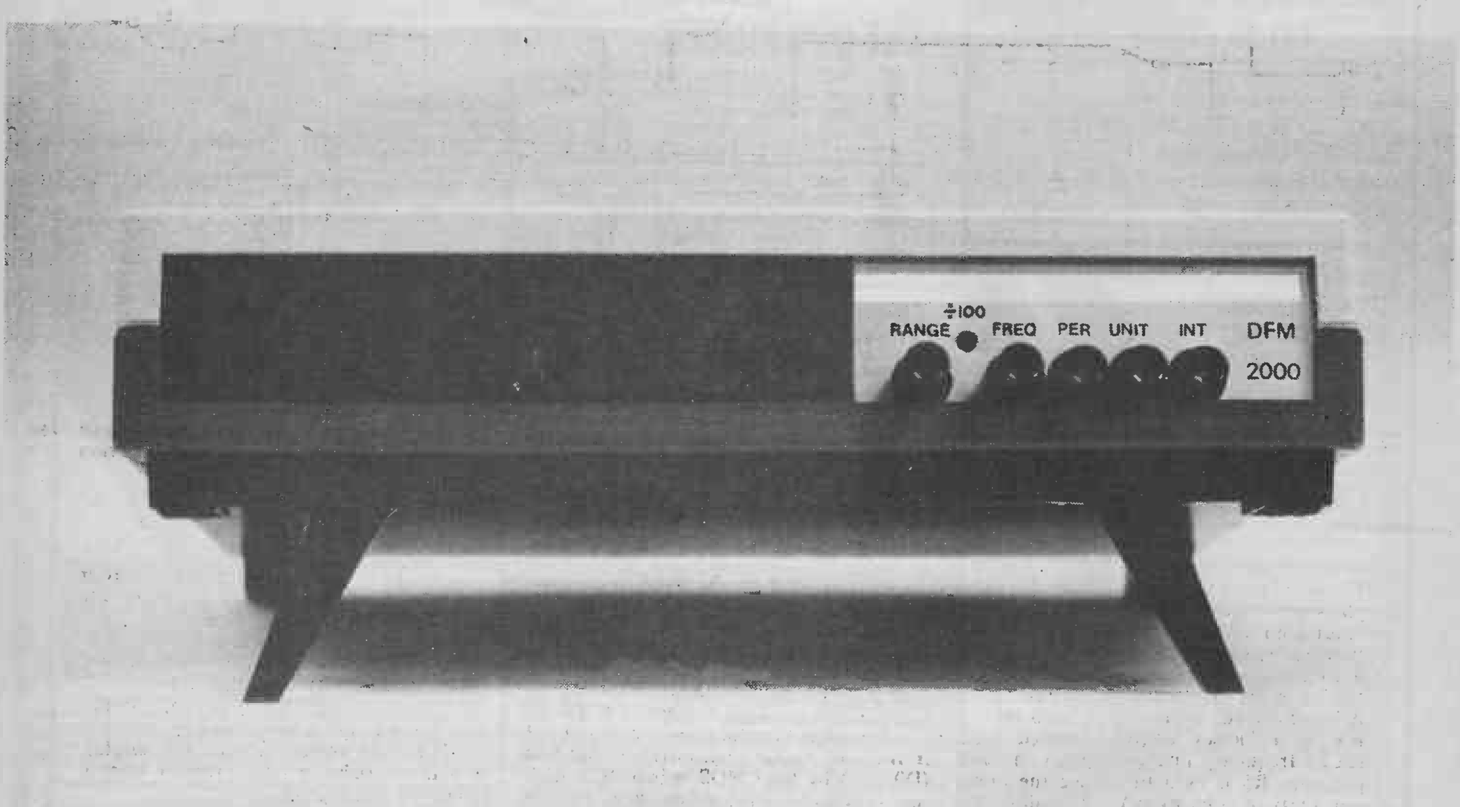
To produce a controlled mix down the operator will need to be very skilled and possibly he will need ten pairs of hands!

Computer Mixdown

To ease the burden of mixing down 32 channels, Neve Electronics has produced the NECAM computer assisted mixdown system. The computer can remember several mixdowns and replay them. The sliders are servo driven and so they provide a visual indication of what is actually happening. The slider knobs have promity switches so that the operator merely has to touch them to regain control.

This system is however, 'slightly expensive'! ETI

DIGITAL FREQUENCY METER



This 0-150 MHz DFM design from Watford Electronics features frequency, period, unit counter and time interval functions. A highly stable crystal timebase ensures accurate measurement.

The heart of this instrument is the Intersil ICM7216A, which contains all the timing, timebase oscillator and control circuitry. Input A is the main signal input. Input B is used with the time interval function and has a five volt TTL input characteristic. Pressing the ÷100 button switches in a prescaler. To obtain the correct result the display reading should be multiplied by 100.

A double-sided PCB is used. To save the cost of plated through holes, pins are used to connect the two sides. Start by soldering in the pins, resistors and capacitors, but do not insert the power supply test link yet. The PCB is fixed to the rear panel with right angle brackets. When all the components are mounted on the board, clean it with meths or thinners. Check that diodes, electrolytics, etc, are the right way round and that there are no solder bridges between tracks.

SPECIFICATION

Input A	0.3 to 20 Volts 0–10 MHz (20–150 MHz ÷ 100 in)
Input B	5 V TTL.
Sample Rate	5 Hz (all ranges)
Supply	240 V AC.
Accuracy	± 1 digit
Overflow indicator	Left hand digit decimal point.

DIGEST

Blonde Bombshell

Now be honest with yourself — aren't there times during those long cold winter days when you could do with one of these in your office. No, unfortunately I don't mean Blondie in the white pants. The blonde bombshells here are the brushed aluminium boxes of ITT Terryphone's new solid state intercom units.

The intercom, which doubles as a security and alarm system, consists of a master unit and from one to nine sub-units. The system is easily installed in many configurations.

Simple press-button-to-talk operation is featured on the master and sub-units. Each sub-unit can be called independently from the master unit, or all sub-units can be called simultaneously. Pressing the self-latching security button allows noises from children, equipment, burglars, etc to be picked up and transmitted to other parts of the premises. So, the intercom can be used as a security system in small businesses of a baby alarm at home.

Each sub-unit comes complete with cable and cable fixing pads for £20 each. The master unit costs £85 and comes with a mains plug and a screwdriver. Talking of Blondie — she can install an intercom in my office any time.

Further details of this system is available from ITT Terryphone, Station Approach, London Road, Bicester, Oxon OX6 7BZ.

Near Thing

If you find yourself in one of those situations where you need to know how near the knuckle something is, arm yourself wiith a proximity switch.

The Omron TL series from IMO Precision Controls is a series of low cost, inductive, proximity switches, which now includes AC operation types TL-XY 5mm and 10mm and TL-YS 10mm. All examples of the series offer reliable sensing of ferrous material. Flush-mounting and flat-mounting types are available. All the switches are available from stock and typical prices to the OEM would be under £20.

You can get further details of the Omron TL series from IMO Precision Controls Ltd, 349 Edgware Road, London W2 1BS.

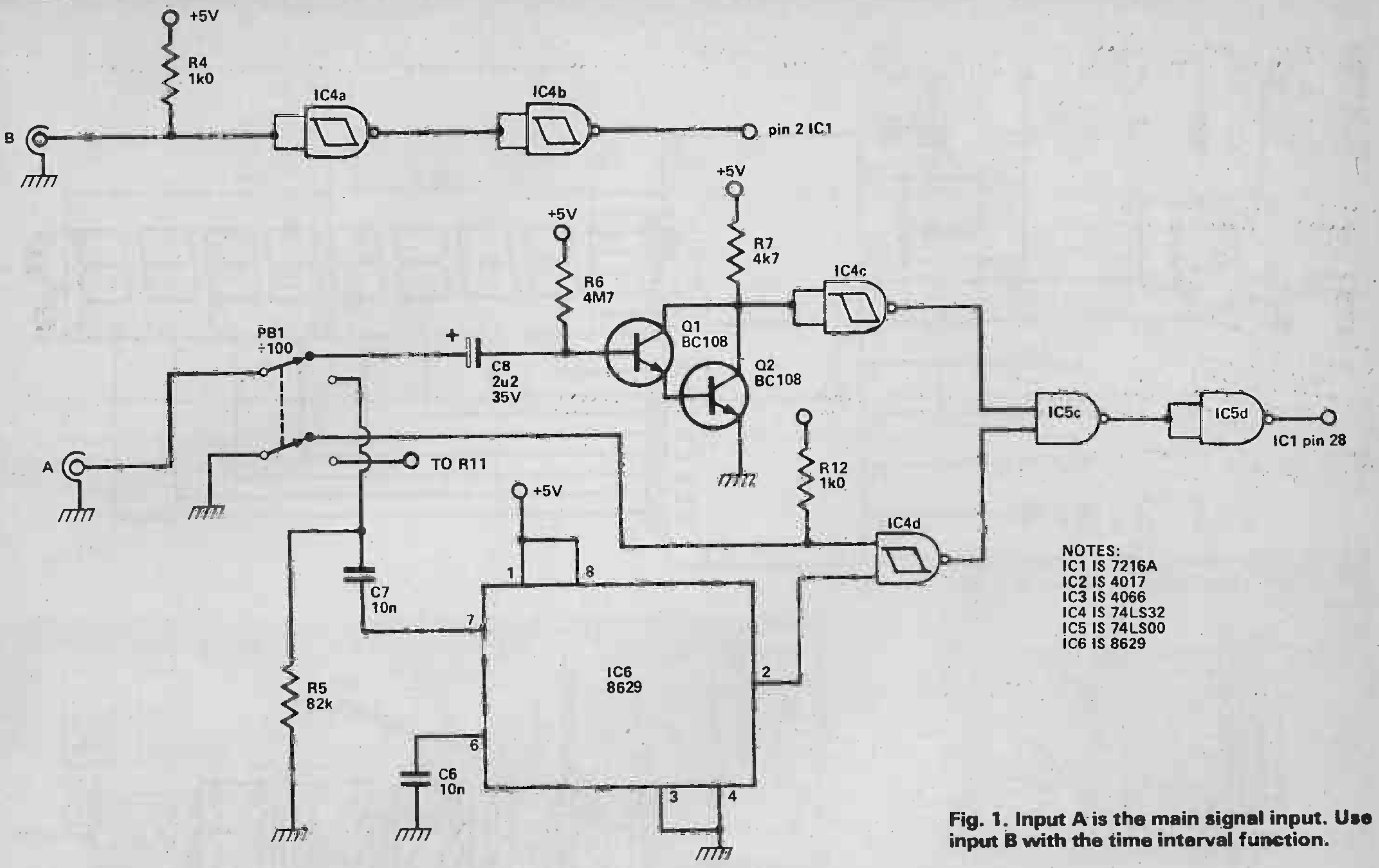


Fig. 1. Input A is the main signal input. Use input B with the time interval function.

HOW IT WORKS

IC1 does most of the work. The two displays are driven directly by IC1, so they require no additional drive circuitry. The timebase is formed by the crystal with C8, 9 using the onboard oscillator.

When the ÷100 switch is pressed, input A is connected to the input of IC6 via C7. IC6 is a Plessey emitter coupled logic (ECL) frequency divider with an onboard pre-amp. R5 is used to reduce the input sensitivity in order to increase stability.

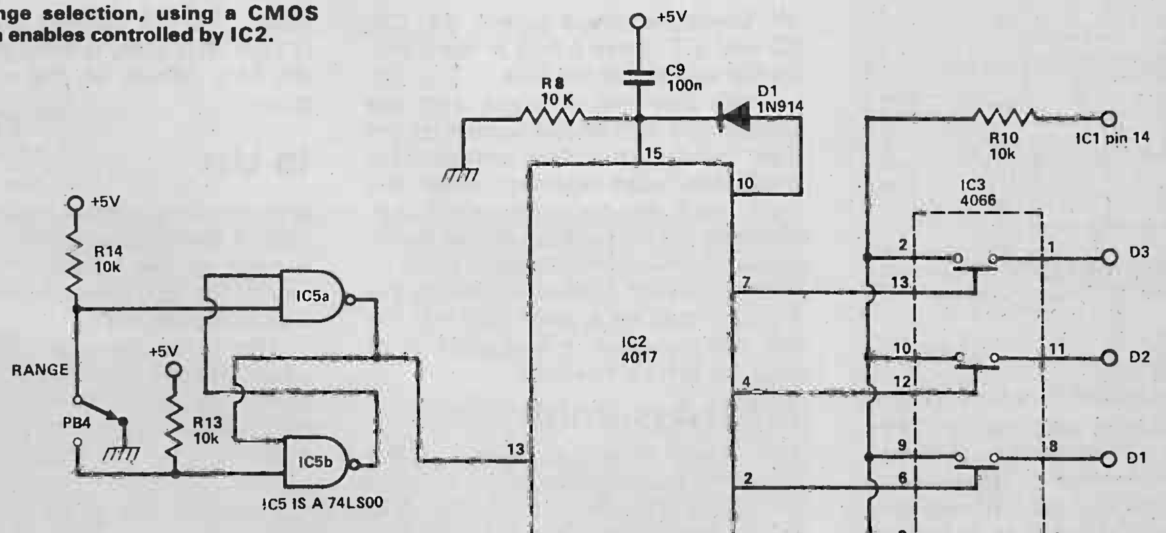
When PB1 is in the 0–10 MHz position, input A is connected to the pre-amp formed by Q1,2 with C8, R6 and R7. Input B is a Schmitt TTL gate. Why TTL? TTL is used in preference to CMOS because the maximum input frequency for the CMOS equivalent is around 2 MHz.

The range selection pin (pin 14) of IC1 is switched to the appropriate strobe line (D0–D3) by the CMOS switch, IC3, with the enables controlled by IC2. PB4 is debounced by IC5 and cycles the four position ring counter IC2. C9 resets the counter when power is applied.

For function selection, pin 3 of IC1 is connected to the appropriate strobe line (D0,D3,D4,D7) by switches 6,9. R9, 10 are used to increase noise immunity in the multiplexed inputs, pins 3 and 14.

The Hold switch 'freezes' the display to make it easier to take a reading from a rapidly changing input.

Fig. 2. Range selection, using a CMOS switch with enables controlled by IC2.



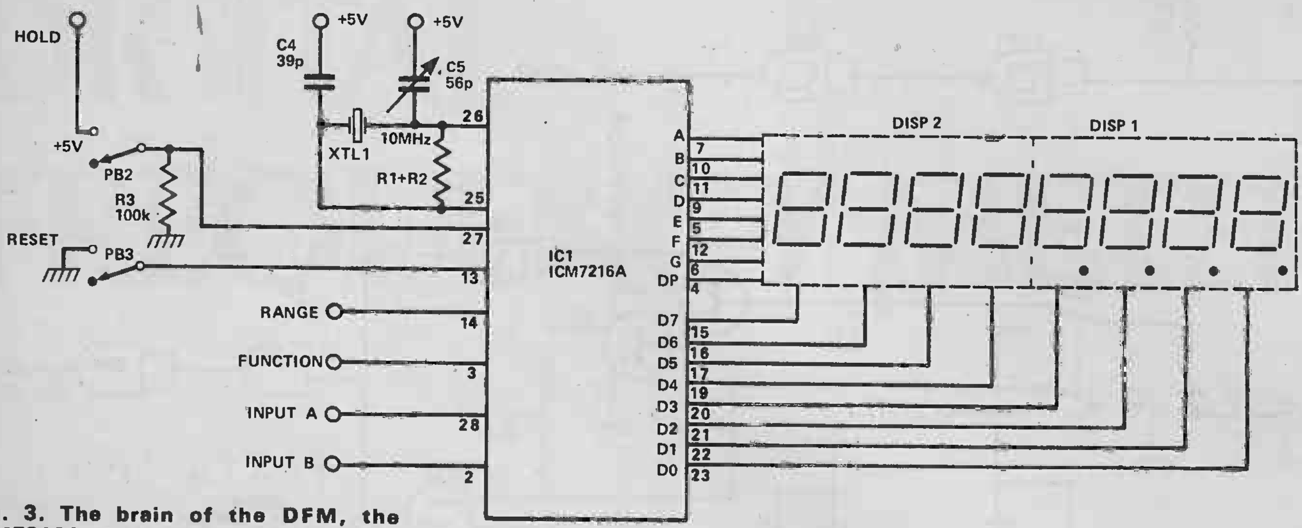


Fig. 3. The brain of the DFM, the ICM7216A chip. It even drives the displays.

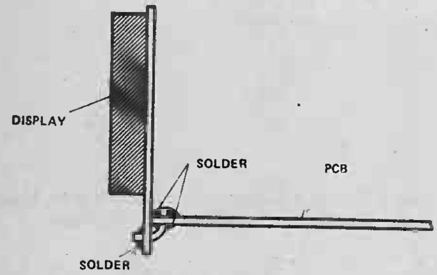


Fig. 4. Fixing the display board to the main PCB.

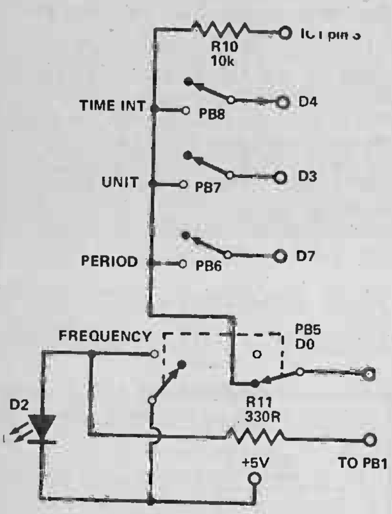


Fig. 5. Switch wiring for the time interval, unit, period and frequency functions.

Testing

Fit a 1 A fuse in the holder and apply power. Check for grey smoke. If all is well, attach a multimeter (on the 10 V DC range) across C2. Take care — remember, parts of the PCB are live. If the reading is about 5 V, switch off, discharge C1 and solder in the test link. If the reading is wrong, switch off, check the mains switch, C1, C2, C3 and IC7. Have a look at the transformer and check the fuse.

With the link in place and the power on, a zero should appear on the right hand digit (unless unit counter mode has been selected, when the right hand decimal point will light). With the ÷100 button out, connect a signal of known frequency to input A. Note: to obtain a reliable reading the signal should be at least 300 mV. To test the prescaler, a frequency of at least 10 MHz is needed.

Final Assembly

The plastic mounting pillars in the bottom of the case should be removed with a hot knife blade or cutters. Slot the PCB with panel into the case bottom and drill out the fixing holes (6 BA clearance). Bolt the board into place. The red perspex display filter (113×28½ mm) is held in place by the two halves of the case when closed.

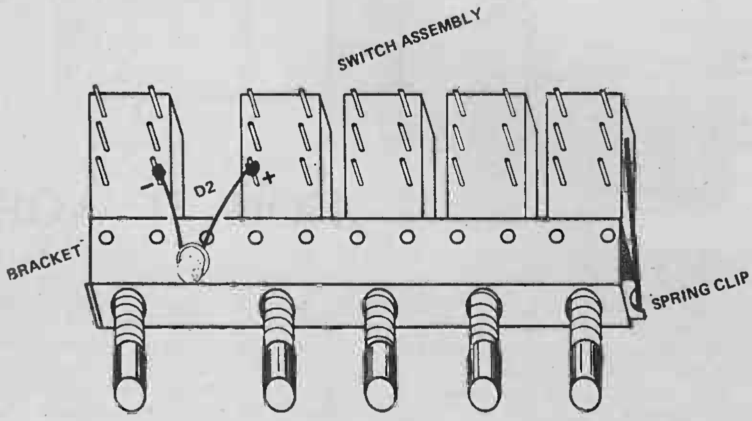


Fig. 6. Make sure you get the polarity of the frequency switch LED right.

In Use

With the time interval mode selected, input A starts the count and B stops it. A must go low before B to stop the count. On repetitious signals this occurs automatically.

The instrument can be used to count items on a moving conveyor belt or to measure the speed of a model plane prop. The prop can be made to interrupt a beam of light.

The speed is then given by:

$$\frac{\text{No of pulses (Hz)}}{\text{No of blades}} \times 60 = \text{RPM}$$

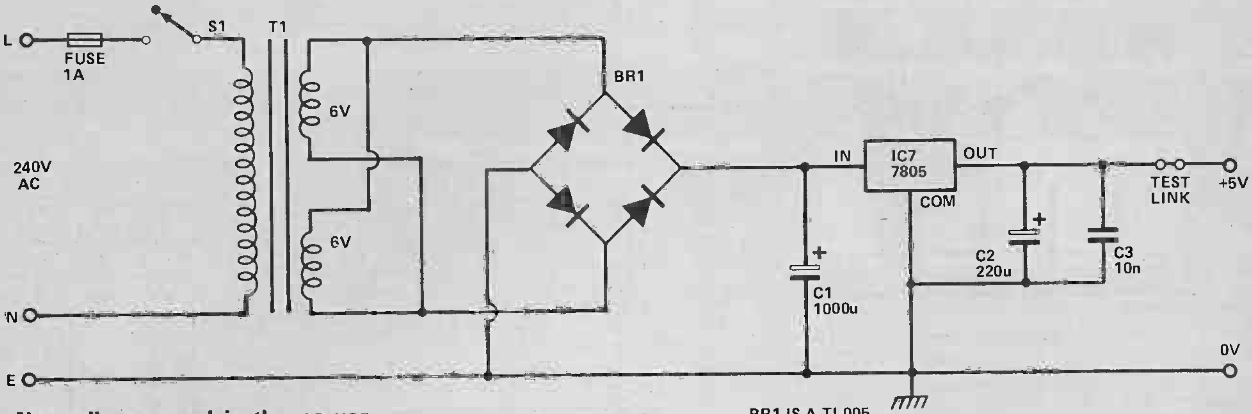


Fig. 7. Now all you need is the power supply to start DFMing. See text for details of the test link.

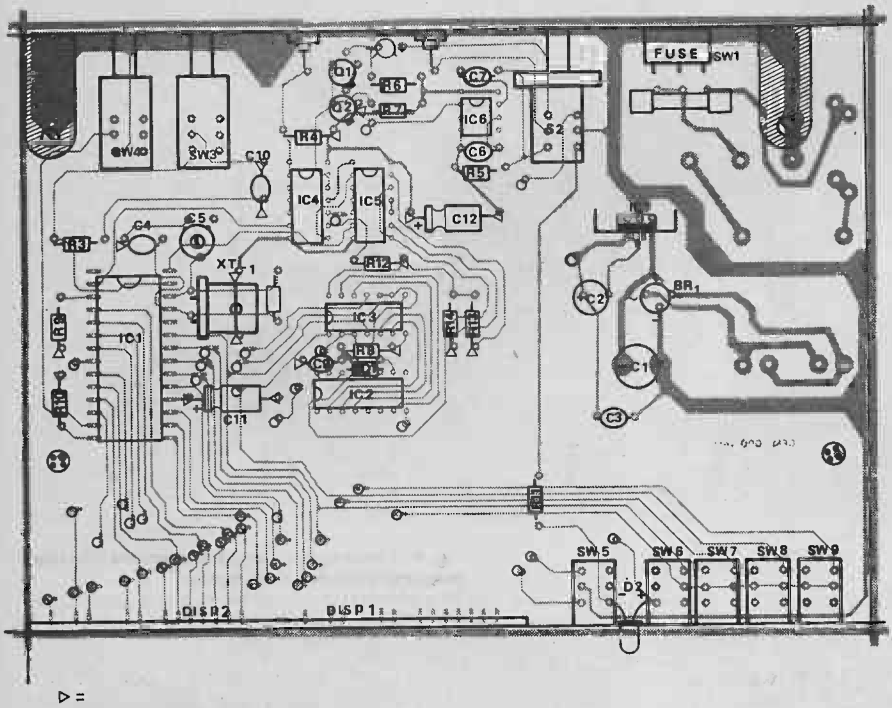


Fig. 8. Component overlay.

PARTS LIST

RESISTORS all ¼W 5%

R1,2	10M
R3	100k
R4,12	1k0
R5	82k
R6	4M7
R7	4k7
R8,9,10,13, 14	10k
R11	330R

CAPACITORS

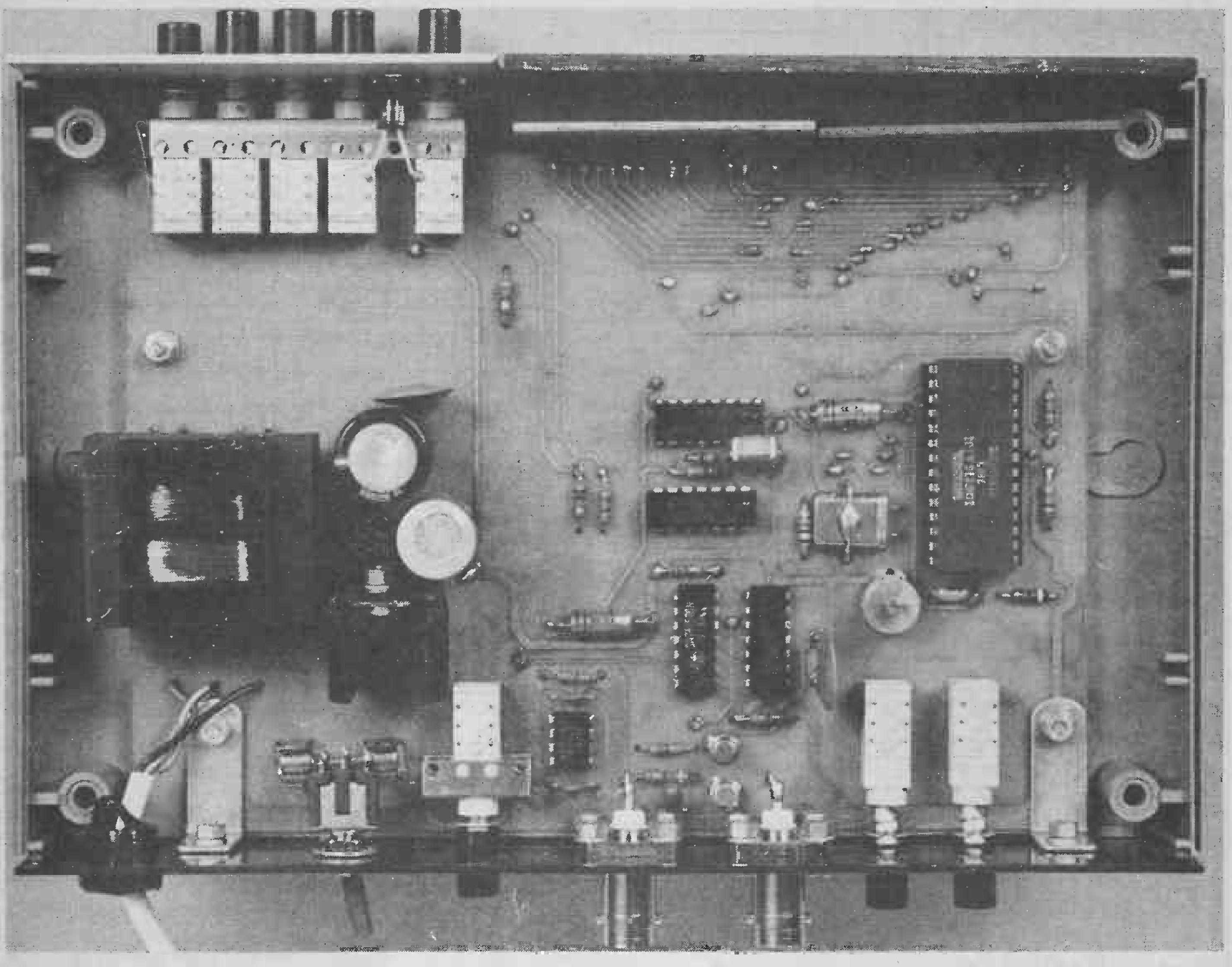
C1	1000u 16V PC electrolytic
C2	220u 25V PC electrolytic
C3,8,9	100n polycarbonate
C4	560p polystyrene
C5	56p trimmer
C6,7	10n ceramic
C8	2u2 10V tantalum
C9,10	100n polycarbonate
C11,12	10u 35V electrolytic

SEMICONDUCTORS

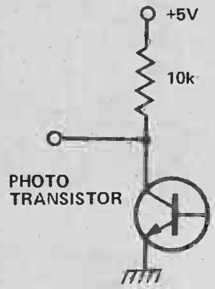
IC1	ICM7216A
IC2	4017
IC3	4066
IC4	74LS32
IC5	74LS00
IC6	SP8629
IC7	78M05
Q1,2	BC108
D1	1N914
D2	TIL211
BR1	TL005
Disp 1,2	4 digit common anode display

MISCELLANEOUS

DPDT push button switches (PC mounting) and buttons (8 off), 6way mounting bracket, one way mounting bracket, SPST toggle switch, BNC sockets (2 off), 1 A fuse (20 mm) and PC clips, 6-0-6 3VA PCB mains transformer, 10 MHz crystal, case, cable clip, PCB.



. . . And when you put it all together, this is what you get. Nice innit!
This photo shows the completed prototype PCB, installed in the case.



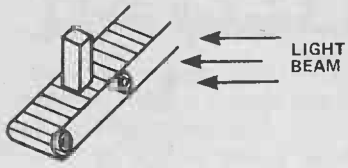
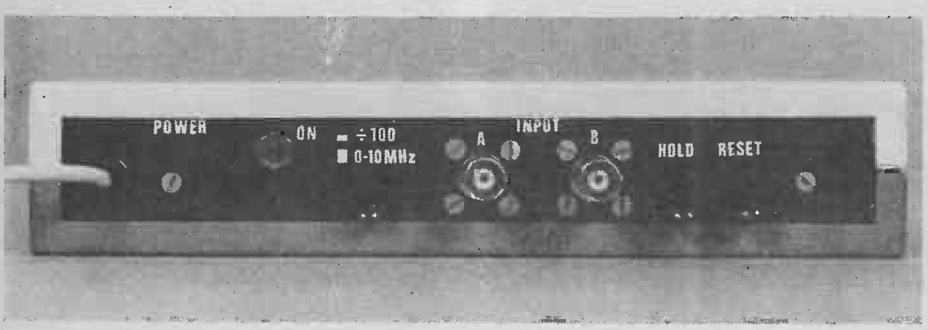


Fig. 9. If you have a conveyor belt handy, you can count things running along it (gremlins, etc.) with this arrangement.

BUYLINES

Watford Electronics are producing a complete kit of parts for this project, with everything you need down to the last nut bolt and knob.

Your Watford Electronics Digital Frequency Meter kit will cost £64.50 + VAT.



The back panel, which carries the inputs, input attenuator and hold and reset buttons . . . and power switch, of course.

MICROFILE

This month Henry Budgett takes the plunge into the language war and brings you the latest Triton news.

A strange month this one and no mistake. There have been lots of little snippets of information drifting in on the wind, varying from general interest to specific details, but with the proliferation of trade shows that always occurs at this time of year much has tended to be "come and see". As I have mentioned in the past, the majority of Personal Computer shows in this country have tended to become carbon copies of each other so I hope to bring a little difference to this month's proceedings by not mentioning any!

Television's Epitaph

It was with a great deal of personal sadness that I learnt of Dr Chris Evans' death last month. The return of ITV with their series "The Mighty Micro", taken from his recently published book and presented by him, will probably be a fitting epitaph. I was fortunate enough to work with him for over four years prior to joining Computing Today and, from the first couple of the episodes that have been shown so far, I think that his prime skill of presenting complex information simply is going to make the series a great success.

Although the series will break no new ground with anyone familiar with the micro as a tool, it already has the appearance of being the "Working Man's Guide to New Technology". If it succeeds in getting over the fact that the microprocessor is by no means the weapon that certain areas of the popular Press tend to scream about then it will have achieved what I believe is its main aim.

Chris had not been in the best of health for nearly a year, but his sudden and untimely death has removed a great source of energy and interest from the computer world. I hope that the rest of the series maintains the level of interest that it has already set.

Program Or Language

A raging controversy is taking place at the moment in the personal computer pages of many publications. The subject under the spotlight is what will replace BASIC as the next computer language for the home computer.

Claims have been made in support of everything from Pascal via LISP to FORTH. In fact the vast majority of these claims reveal one simple fact — not too many people in the home computer market know as much as they would like us to think!

Before you think that my head is expanding at an alarming rate, let me explain.

Your average computer doesn't really give a proverbial monkey's about what language you use because all it knows about is a series of binary digits that conform to either its internal instruction set or are data for it to process. The only reason that computer languages were invented was to save us mere mortals from going mad over vast quantities of binary. The next logical stage up from the actual binary language, machine code as it is generally called, is Assembly Language. This consists of mnemonics, or short groups of letters, that remind one of what the binary code does. It is obviously easier for someone who talks in a complicated language like English to understand something written in letters than as a string of ones and zeroes. Most assembly languages follow roughly the same format and it is not too difficult to convert from say SCMP to Z80.

At this stage in the game we find what are called High Level languages, or as I prefer to call them Specialist Languages. These become more like the language that is spoken by the people who use them and this is the real point of this little discourse. It is a strange fact that this country is about the only one to have any expertise at machine code level in the home environment. The Americans, who are supposed to have invented everything from the wheel up, and indeed did produce the micro, seem to disappear whenever the words Machine Code are mentioned. Why we are happy with it is a total mystery to me (answers on the back of a blank chqeue please) but there must be some reason. I wasn't allowed near BASIC until I had some knowledge of machine code and I suspect that there are many others like me. ▶

Any bets for the next home computer bingo.

The reason for the popularity of BASIC at the moment is because it is a well proven language, easy to write, many systems support it and, above all, it is easy to understand. Try taking a program written in say Z80 assembler, another in BASIC and a third in APL. It is fairly certain that the BASIC program will be the easiest to understand, the easiest to convert to your system and the easiest to change. I well remember being asked at an interview which I would prefer to alter, a program in BASIC or one in machine code, I replied "BASIC, because I'm more familiar with it." My interviewer replied "Right answer, wrong reason." I'll leave you to work out why!

The language which most people are touting to replace BASIC is Pascal, and this is in my opinion similar to buying a two litre car where a one litre one would do. The point to be made here is that both perform exactly the same job but in a different way. If you were offered a choice of BASIC or FORTRAN you would look at the problem in a different way, say, as a choice between a car and a lorry. Why, because they do different jobs. So the prime objective in the choice is to select the right language for the task that you wish to perform and, without any doubt in my mind, the choice for the general purpose user is BASIC.

As a final parting shot in this argument I would further endorse the suggestion that any microcomputer sold without decent access to it's machine code isn't worth much. Whilst being harder to write it does give such a vast speed improvement that it can be the only way to solve some programming problems.

Try It On

A couple items of interest to those who have Tritons. You can now get a Pascal compiler for the system. It's a 20K version that plugs into the motherboard but it was developed from a CP/M original which will also become available soon, so those of you with a CP/M system can have it too. I'm digging my fingers in at the moment and will let you have a report as soon as I can.

The second item is that disks are on the way very soon, again with the CP/M operating system. Both 5½ and 8 inch will be available and you can have up to four in double sided, double density format, which is a tidy number of bytes of store. Keep your ears on for more details soon.

And finally two items, again both concerning Triton. The first is just about the dirtiest trick in the book and I take the blame for it. I wanted to hang our printer on our Trion (we have 5.1 so it's really easy), but I was a trifle worried about speed problems. The fact was that our printer uns at 300 Baud. I'm too lazy to change the switch and it looked as though the delay in the software wasn't going to belong enough to cope with the carriage return. Well, being hardware biassed I looked around for a solution, and I found it! On the original Triton drawings you will see a dotted push-button on IC4, that's the master clock, labelled PAUSE. Well, I thought, why not stick the printer's busy signal on there, after all it does the job. Even so sorry Mike and all you at Transam but it does the job perfectly!

The final item this month before I go off to a couple of exhibitions, drat I gave the game away, again concerns our little machine. Having been dragged through the rigours of the disco, as seen in the papers, it has been banished of all places to Mount Etna, allegedly to control the temperature of the police chief's bath water. ETI

PROCESS CONTROLLER

This controller has myriad applications in electronic and photographic work. It features an LED display which 'counts down' and is easily visible in darkroom or daylight.

Various processes in fabricating electronic projects require timing a chemical reaction or process — developing photoresist in making printed circuit boards being a prime example.

The Technique

The easiest way of producing a time delay is by using a 555 timer IC, but a glance at the data sheets shows that it should not be used for periods in excess of 100 seconds. By using the 555 as an oscillator and feeding its output into a 4017 counter/decoder IC the maximum timing period can be increased ten fold. The unused decoded outputs can then be connected to a column of LEDs which will give an indication of elapsed time.

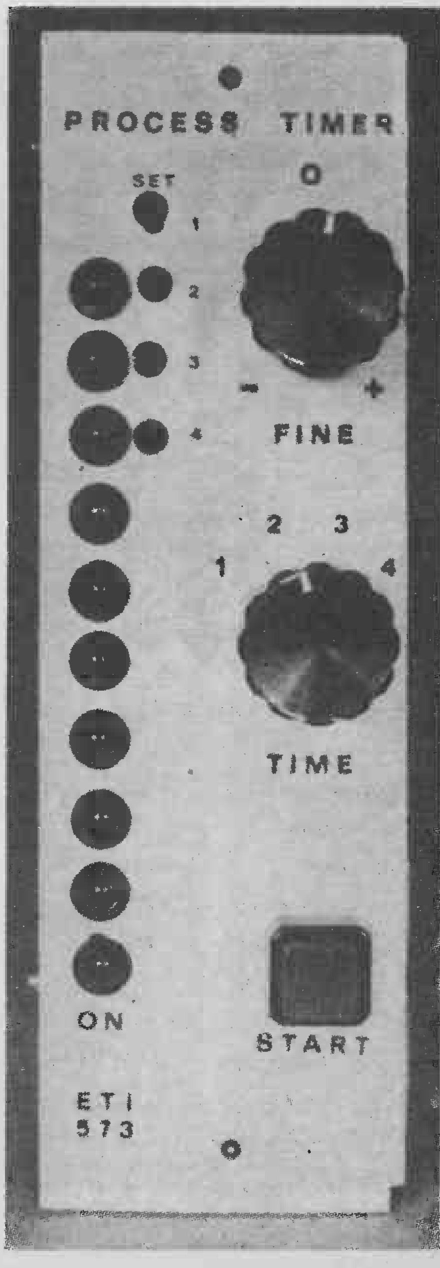
Each pulse from a 555 clocks the 4017, moving a high level along its ten decoder outputs, lighting each of the LEDs in turn. When the high level reaches the last output it is used to operate the relay and thus the time delay has been multiplied by ten.

A permanently-lit LED has been included at the bottom of the row to show when the unit is on. This also gives a better indication of elapsed time in a darkroom, as the LEDs can be seen to step towards a reference light.

Four time ranges have been provided with a trim pot on each one for easy adjustment. The table gives the values for each trim pot and C1, for a variety of times. The minimum time is limited by the time taken for the relay to operate, maximum time by the limitation of the 555. In practice, times from 100 mS to twenty minutes can be achieved. For very short times the time elapsed indication will not be much use and the LEDs can be left off the board.

Fine adjustment of the timing is achieved by adjusting the threshold voltage on pin 5 of the 555. When the voltage on pin 5 reaches a set value, the output (pin 3) of the 555 goes 'low' (i.e: the 555 triggers). This voltage is normally set at two-thirds the value of the supply rail, fixing the time during the charging cycle of C1 when the 555 triggers.

If the threshold voltage is increased, the time taken for C1 to charge to the required value increases, and the frequency of oscilla- ▶



SPECIFICATION

Maximum time delay	1 sec	10 sec	100 sec	1000 sec
value of C1	1uF	1uF	10uF	100uF
value of RV (1–4)	200 k	2 M	2 M	2 M

Table of values for C1 and RV1–RV4 required for differing time delays.

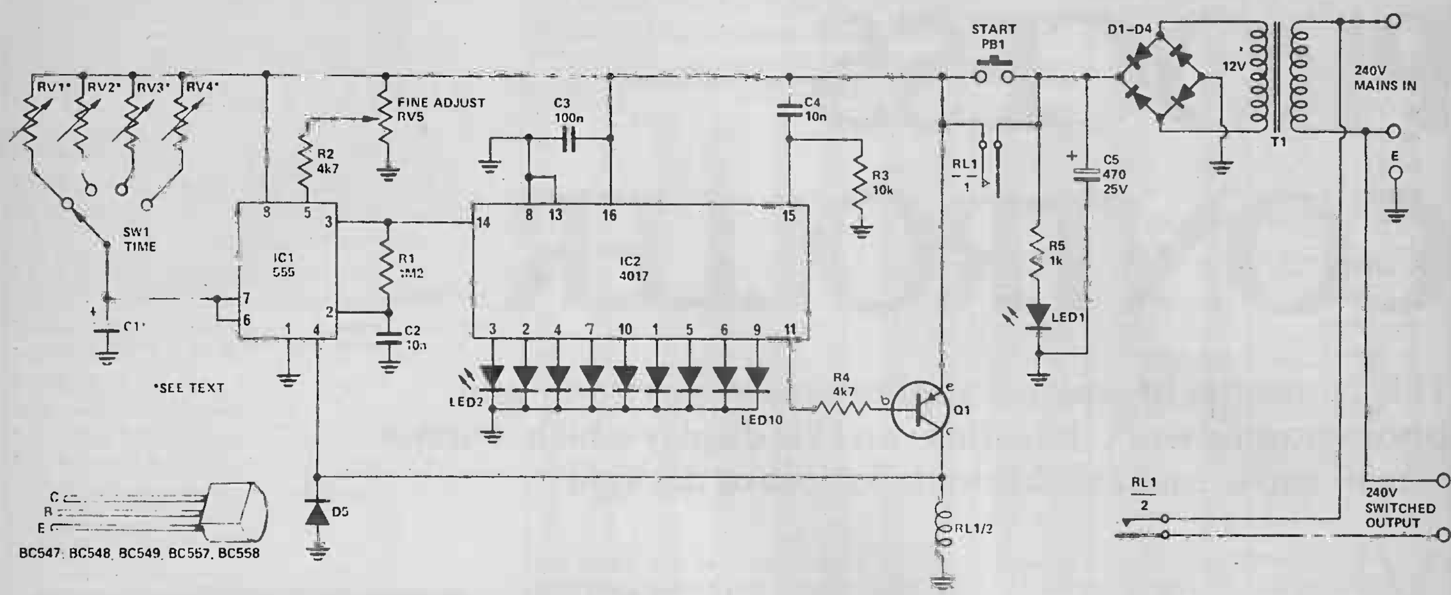
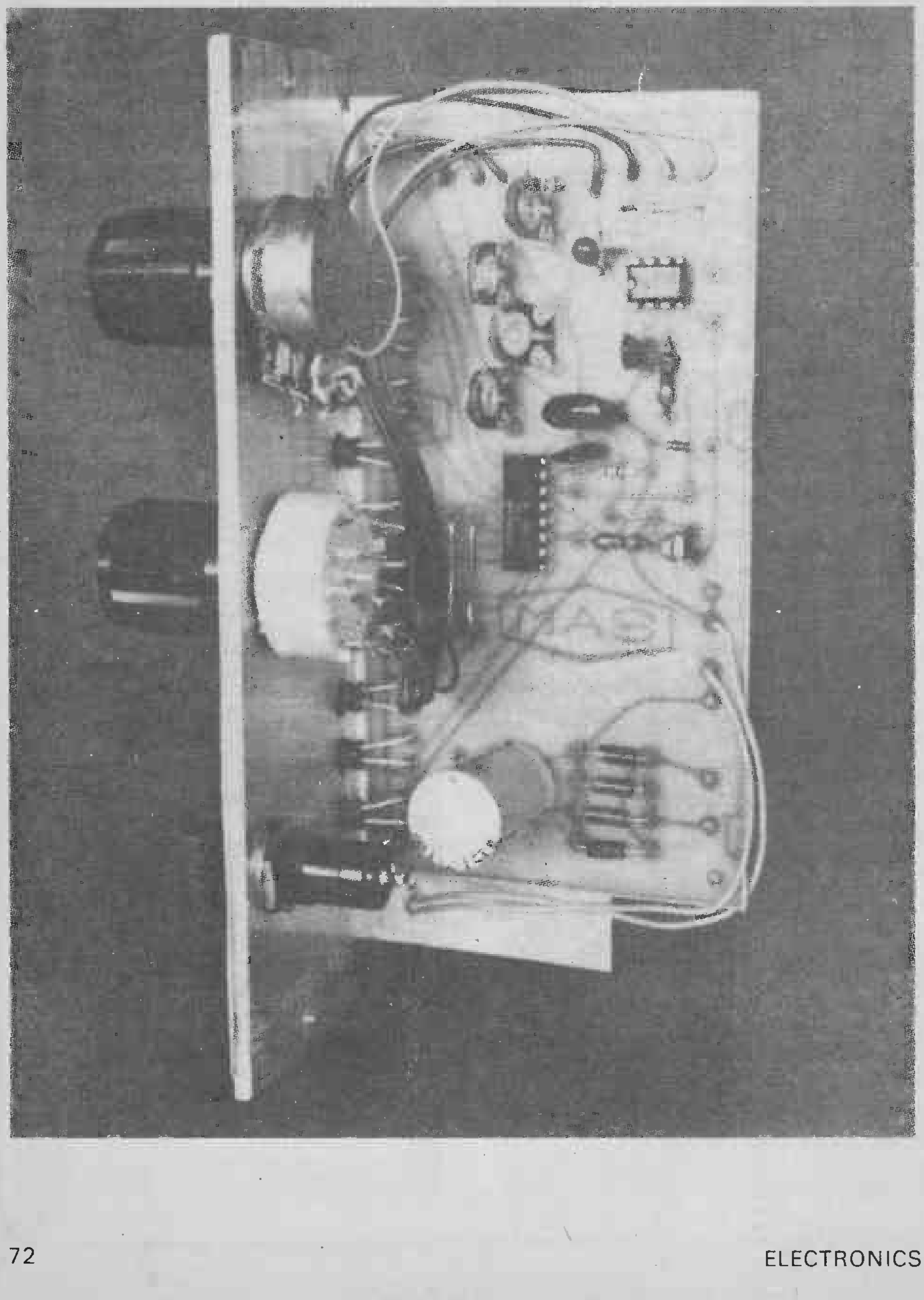


Fig 1. Full circuit diagram of the controller



HOW IT WORKS

The timer consists of a 555 timer IC used as an oscillator driving a 4017 counter/decoder IC, the decoded outputs being used to drive a row of LEDs and switch a relay.

The timing period is set by the frequency of oscillation of IC1. This is dependent on the time constant of RV1-RV4 and C1. As either of these components are increased in value the time constant will increase and the frequency adjustment is provided by RV5 which adjusts the threshold voltage on pin 5 of the 555. This voltage is normally set at two thirds of the supply voltage, but here it is adjusted varying the required voltage across C1 to the 555.

Output from the 555 is fed to the clock input of the 4017. After each pulse a different decoded output of the 4017 goes high, lighting each LED in turn. After the tenth clock pulse the output on pin 11 of the 4017 goes high. We shall come to what that does shortly.

When power is first applied, the relay contacts RL1/1 are open and the bottom LED (LED 1) is lit. When the 'start' button is pressed the 4017 is reset to zero by a positive pulse applied to pin 15. This pulse is provided from R3 and C4. Pin 11 goes low, turning on the PNP transistor Q1, and the relay operates. The now closed relay contacts (RL1/1) short out the start button and sustain the power after the start button has been released. The transistor also drives the reset line of the 555 (pin 4) which commences to oscillate. This ensures accurate timing of the first cycle.

On the tenth pulse from the 555 pin 11 of the 4017 goes high, turning off Q1, stopping the oscillator, and the relay is de-energised. The contacts RL1/1 open removing the supply to the timer returning it to its original condition, ready for the next sequence.

During the timing period, the second set of contacts RL1/2 close and can be used to switch up to 5 A using the relay specified.

tion decreases. Thus, the total timing period is increased.

What device you want to control with the timer will determine the type of relay you use. This unit is capable of driving quite large relays, however, we used a commonly available type having contacts rated at 10A.

Construction

First, you will have to determine from the table the correct values of RV1-RV4 and C1 to provide the times you want for your application.

Next, mount all the components taking care to correctly orientate the semiconductors. The LEDs are best mounted by inserting them into their holes and bending them over flush with the edge of the PCB. The photo shows the way we mounted the LEDs.

The completed unit can be mounted in a variety of ways to suit individual applications. Either in a box, together with its relay and a mains female output socket for the switched output, or on a panel with a remote transformer and relay.

To mount the unit against a front panel, drill a row of ten holes for the LEDs and four holes to line up with the trim pots for screwdriver adjustment of the timing. The start button, timing switch and fine adjustment pot can be mounted anywhere convenient. The board should be mounted against the panel so the LEDs protrude through the holes.

Setting Up

Having assembled the unit, all that remains is to calibrate the ranges. This is easily done with the aid of the second hand of a watch. For shorter times, say under five seconds an oscilloscope is best.

Monitor the positive supply after the relay contacts RL1/1 and measure the time the contacts operate. For other purposes it may be best to set the ranges by trial and error, such as when the it is being used for a PCB development timer. In either case, the fine adjustment control should be set in its mid position when calibrating.

ETI

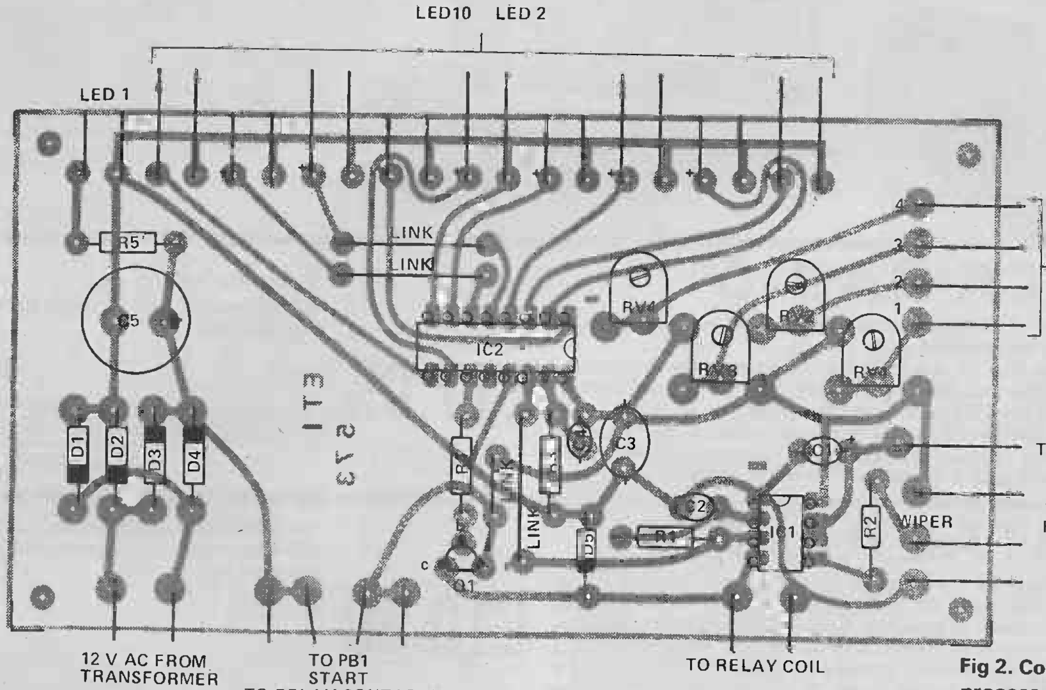


Fig 2. Component Overlay for the process controller unit

PARTS LIST

Resistors All ½W, 5%

R1	1M2
R2,4	4k7
R3	10k
R4	4k7
R5	1k0

Potentiometers

RV1-RV4	See text
RV5	10k lin pot

Capacitors

C1	See text
C2,4	10n polyester
C3	100n polyester
C5	470u 25V electrolytic

Semiconductors

D1-D4	1N4004
D5	1N914
Q1	BC558, BC178
IC1	555
IC2	4017
LED1-10	TIL220R or similar

Miscellaneous

SW1	One pole, four position switch
PB1	Momentary Push Button
T1	12V, one amp transformer
RL1	12V relay with two changeover contacts

BUYLINES

The switch SW1 can be any 'break before make' rotary type. Suitable units are sold by Watford and Maplin. The 12 V relay is not a critical type and so readers should experience no difficulty in obtaining one suitable from their local component shop.

AUDIOPHILE

This month Ron Harris has news of a vanishing thump, a speaker which comes with ribbons on and a cartridge which has a golden future. Videotone, Goodmans, JVC and Goldring get themselves involved.

IT is 6.30 am Monday morning and it is cold and dark on Charing Cross Road. ETI's editor walks through the still air, ignorant of the frost gathering on his extremities and the shuffling uncertain glares of the tramps in the doorways.

Far away a burglar alarm rings unheeded, disturbing no one not even the rat munching happily on a crisp bag which skips away with a snarl as the editor passes, eyes unseeingly fixed on infinity.

Dawn was gathering its strength behind Centrepoint (and the rubbish piles) as he reaches the office doors. He stops suddenly and a mugger swinging an iron bar down at where the editorial head would have been, misses his mark, stumbles and falls down a flight of stairs into a cellar, stunning himself.

Head still in clouds, musing on the ill fortunes of life, ETI Ed turned the key and meandered into the building, closing the door just as a hungry cat leapt at him from the hall, catching it in mid-flight with the door.

"Rotten. That's what is is. Rotten. Everything has a flaw in it," he mused to the ringing walls. "Rotten luck is what we got. Rotten. Take for example that Coral H 300 headamp I reviewed last month. Lovely sound, neat construction and well matched to the excellent MC81. But is it perfect? Alas no. Rotten luck. Rotten. The de-thump relay doesn't work on switch off. Sends the speaker cones heading for the far wall with no regard for any ear-drums that may be in the way. Rotten luck."

By now he was entering the offices, edging in as the semi-sentient cleaning staff pushed out, demolishing a wall fitting on the way. As their communicative grunts echoed away down the stairs the editor walked to his office passing the Art Director slumped unconscious across his desk on the way. Cause unknown.

Just as he takes his place in the Editor's Throne, but before he can doze off, the phone rings. It is Coral. They put the designer of the H300 on the line. The unit is no longer possessed of a thumping switch-off. The relay has been rewired on all current models so that no nasties escape. All thumps are de-thumped good and proper. The flaw is rectified. All is well. . . . Perfection at last.

The Editor flings the phone high in the air and runs yelling from the room, awakening some of the staff in his uncaring unbounded joy.

Life is good after all. Nice one Coral.

Heed ye all the vision before thine eyes. Felicity Kendal. You must have been expecting this for a long time. Mr N. Ashford of Leicester had the good sense to point out that although I have continually referred to the beautiful lady, I have never actually published a photograph of her to prove the point to heathens like him.

Well Mr Ashford, my thanks for the idea (excuse?) and I only hope you are suitably repentant. Ignorance is no excuse.

Casio Long Life

With the introduction of the F-8C from Casio, the age of the disposable watch is upon us. The F-8C is fitted with a lithium battery, which should last for three years. When you feel it's about time for a new watch, your battery will be on its last legs. You can strap a new F-8C on your wrist for only £12.95, complete with its three year lithium battery. If the prices of watches keep coming down and batteries become more sophisticated, more efficient and long-lived *and* more expensive, it can't be long before you really do throw away your watch when the battery goes to the great recharger in the sky.

Meanwhile, back to the F-8C — this new Casio ticker (with a silent tick) gives continuous LCD readout of hour, minute, second, AM (or PM), date and day of the week. It's accurate to within 20 seconds a month and has an automatic calendar, needing adjustment only once in four years — on February 29th. There's also a micro-light, of course. The stated battery life takes into account five seconds of micro-light use every day.

The F-8C is made by Casio Electronics Co Ltd, 28 Scrutton Street, London EC2A 4TY. The recommended retail price is £12.95, so you should be able to get hold of it for a little less. Moral: bargain-hunting is the best policy.

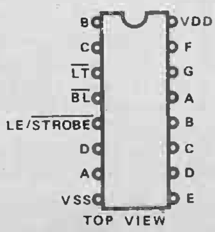
Touch Switch

This month, in our regular mistakes mention, we feature the Touch Switch (ETI December). The component overlay on page 94 looks a bit odd. To put things right, turn the foil pattern round through 180°.

Reaction Timer

We've a had a few inquiries about the display used in this project. The original design was Australian and unfortunately there does not appear to be a UK equivalent for the SEL 521 displays used.

However, all is not lost. Many of you have been keen to use alternative displays, but were unable to do so, as neither the display nor the driver pin functions were identified. With the aid of the 4511 driver pin-out shown and any suitable common cathode, seven segment display, you should be able to start timing your reactions in a flash (not literally, we hope). Common cathode, seven segment displays are available from most of the major mail order component suppliers.



Corals H300 head amplifier which can now be wholeheartedly endorsed because the one fault — a de-thump relay which didn't work on switch-off — has been dealt with by the manufacturer and all is now well.

Apart From All That

Yes, well, I'm back from unbounded joy — all too soon. It would take Felicity Kendal's smile to keep this cynical soul in Nirvana longer than a brief moment or two. All else is but dross after all. 'Music to sooth the savage editor', etc, etc.

Some nice things have happened this month in the realms of things hi-fi. Two new sets of loudspeakers are worth a mention for starters. Goodmans launched the XB

The entire Goodmans XB range — all three of them! Prices vary from £95 for the 25 up to £139 for the considerably larger XB45 lurking away at the back of the photo. Stands are considered essential by Goodmans and are always a good thing anyway. All three are specified for 10-60W RMS and a sensitivity of 9W (DIN).

range shown in the photo and on the initial listen in they have a crisp sound to them with a particularly clear upper bass. Good value for your diminishing pound.

JVC also have some new speakers to follow last month's tuners, and their claim to fame and notice is the use of a ribbon tweeter unit, the principle of which is of interest. For once even my own stubborn nature does not tell me I could improve on the company's own explanatory verbiage. So

Getting Ribbed

In the ribbon tweeter the diaphragm is a piece of thin film (12u — poly resin) of which the voice coil (18u — aluminium foil) is an integral part. This single unit has a moving mass of 0.048g — which is between 5% and 20% of the moving mass of a conventional tweeter.

The diaphragm is stressed to ensure constant surface tension and sandwiched between two sets of magnets of high efficiency and linearity.

Current entering the tweeter flows through the coil bonded onto the resin film and, with minimal transmission loss in the coil, the diaphragm can produce movement with high efficiency.

Transient response is excellent, since the entire surface of the driver is driven to displace air and a (cast aluminium) horn is used to aid sound dispersion.

Intriguing, eh?

There are three models in the new Zero range, a Three, Five, and Nine floor standing version which I would very much like to get a listen to somehow. I will have to hope JVC can help. At £375 each they are a little over the top to stop a shop and try one.

JVCs new Zero-5 loudspeaker incorporating the new ribbon tweeter unit of which they are so proud. Sounds Isodynamic to me.

If you're about to buy a pair of headphones for anything under £35 — then don't. Instead, hang onto your money until you've read next month's Audiophile. A little box with MDR-3 written on it, which arrived here very recently, could make you regret doing anything rash. Let me be sneaky and refuse to reveal anything other than that if you want your phones to be comfortable, compatible with any amp, have an excellent transient response and cost £17 then anything you do now might be a mistake.

It is a safe prediction for me to make that the MDR-3 will completely change the headphone market place upon their release. You have been warned! ▶

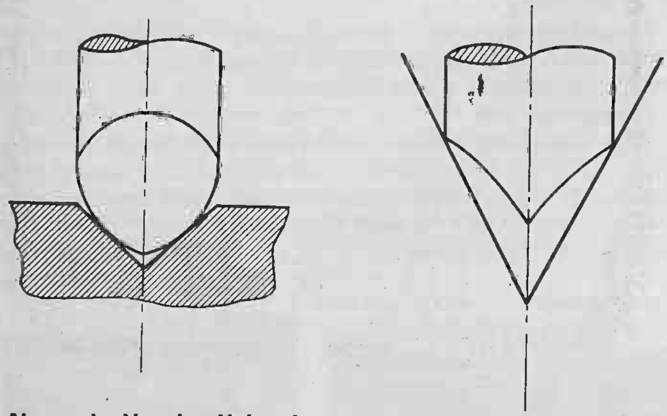
Goldring G900IGC

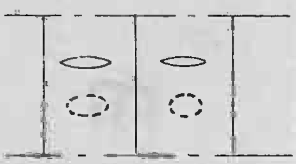
Whatever next. Gold plated ABS plastic boxes, containing gold plated cartridges. How to make an impression in one easy lesson and lots of pounds sterling.

The precious metal approach was adopted by Goldring to enhance the presentation of their new IGC (Improved Groove Contact) cartridge. This is basically a G900SE II body with a whole new, highly expensive, stylus assembly.

Called a Van den Hul point, the stylus is of the 'Gothic Arch' type such as employed in the Shibata type, but with a completely redesigned profile to further improve groove contact and better recreate the cutter head profile.

Goldring have taken an amazing amount of time, trouble and money out of the bank over this stylus. The shape itself is computer designed, the work having been done by the Dutch physicist after whom it is named, and the company spent a long long time searching for a supplier for the very high grade of diamond employed.





Above: the Van den Hul stylus profile from the side (left) and the front (right) showing the close approximation to the cutter head shape.
Right: comparative groove contact for the Van den Hul and the elliptical type of stylus.

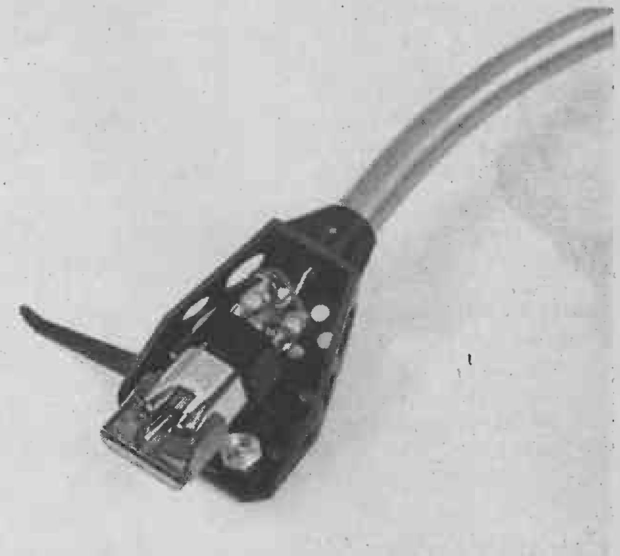
Finally it has all come together at once, and here we have the result — a cartridge with claimed attributes of reduced intermodulation distortion due to its line of contact with the groove being straight and perpendicular, better detail (especially at HF) due to its minor radius of 4.5 microns as compared to 7 microns for an elliptical point and reduced record and stylus wear due to reduced friction between the two.

As my one faithful reader may well recall I value the G900SE II as one of the best examples of a moving magnet cartridge around and here they've been and gone and changed it. It's enough to drive a man to bacon butties and bromide in his tea (almost).

It is with trepidation and wonder that one should open a golden (Pandora's?) box. Beware of Greek postmen bearing gifts and all that.

Making An Entrance

It certainly entranced *me* seeing that bright gold body clasped firmly to the bosom of the SME. Setting up the unit proved to be no trouble at all, but that mounting bracket looks as wrong now as it did on the first G900 I tried. Alright, so I know it only looks that way and I cannot fault it technically but that don't quiet the vague rumblings of discontent somewhere south of what passes for my conscious mind.



I ran the cartridge through a series of response and distortion tests which only went to prove how pointless it is to publish a graph which is to all intents and purposes a straight line and from which not one jot of information about the cartridge's performance — other than that it has a textbook frequency response — is to be gleaned.

At 1.3g it passed every tracking test I could put in its way and sailed unconcerned over 99% of the 'murder music' I fed it later. An almost incomparable tracking ability then (good improvement here). As a guideline I'd say the IGC is a better tracker than the VI5 IV — but only just!

What A Set-Up

As part of their 'blurb' Goldring make the astounding assertion that 'due to the IGC's inherent ability to follow the record grooves exactly it will obviously pick up record blemishes also. In order to extract the best from the cartridge, therefore, we recommend that ONLY records of the highest quality (such as Enigma Supercut series) should be played.

Include that ONLY and discount nine-tenths of your market, Goldring. I must say that I found the IGC as tolerant of bad software as any top quality cartridge. It did not emphasise 'blemishes' in the slightest, much as that text would have led me to expect it to. I can see what they're getting at but instead of giving the impression of a superb performance, fit for Superdiscs, in my opinion they are needlessly accusing their own product of a touchiness it does not possess.

Detail,Detail

To be able to form a valid opinion of any piece of hi-fi, one needs a reference against which to compare performance and in this case that role was filled by the Coral MC81 moving coil cartridge. In addition I was interested to see how the new 900IGC gared against its predecessor, the G900SE II.

In a direct comparison with the Super-E, the IGC was at first listen little different. However, the two were *at once* distinguishable and as the minutes ticked by the virtues of this new point began to make themselves apparent.

The sound is a beguiling one which leads you deeper into the music the more you listen. It has a considerable ability to portray that elusive thing called detail, and the treble is a good deal better than either the G900SE II or that Decca device, being smoother and more accurate. Cymbals sound more like cymbals (rather than a burst of metallic white noise).

The difference is not one which leaps from the loudspeakers but is of the kind that makes hi-fi livable with for a long long time as opposed to until the gloss wears off the power switch.

It will also build a following devoted to the IGC I think.

Bass quality is simply very very good and little changed over the two models.

Having stayed ahead of the competition this far the Coral beckoned confidently, and the SMEs were appropriately armed.

Coral In Deep Water

Let me say now that the Coral is a more expensive cartridge and one which I feel gives a performance which is worth a great deal more than its purchase price. It was no disgrace therefore for the 900IGC to fail to better it subjectively. Indeed the comparison did it proud indeed.

The main difference is one of those things difficult to explain but immediately audible. The MC81 sounded at ease with whatever music it was playing and somehow less like a hi-fi cartridge. I avoid the word colouration deliberately as being inappropriate.

One area where the IGC did take the decision, and all but unanimously too, was the bass. It just goes down further — reaching the parts which moving coils cannot refresh, and with good control to boot. To put it bluntly windows rattled more with the Goldring!

The only thing we could find to criticise was that the IGC is on the bright side of neutral, being characteristically very clinical in its approach. The rendition is excellent although I fear some of the "valve brigade" may find it a little cold. A small thing to hold against such radiance.

Summary

Overall then the Goldring is a very fine moving magnet device and one which many people — including me — preferred to such moving coils as the 777EX and even (shock horror) the Entré 1. It easily bears comparison with the best of current moving magnet cartridges and indeed, in my opinion, has no peer in this realm.

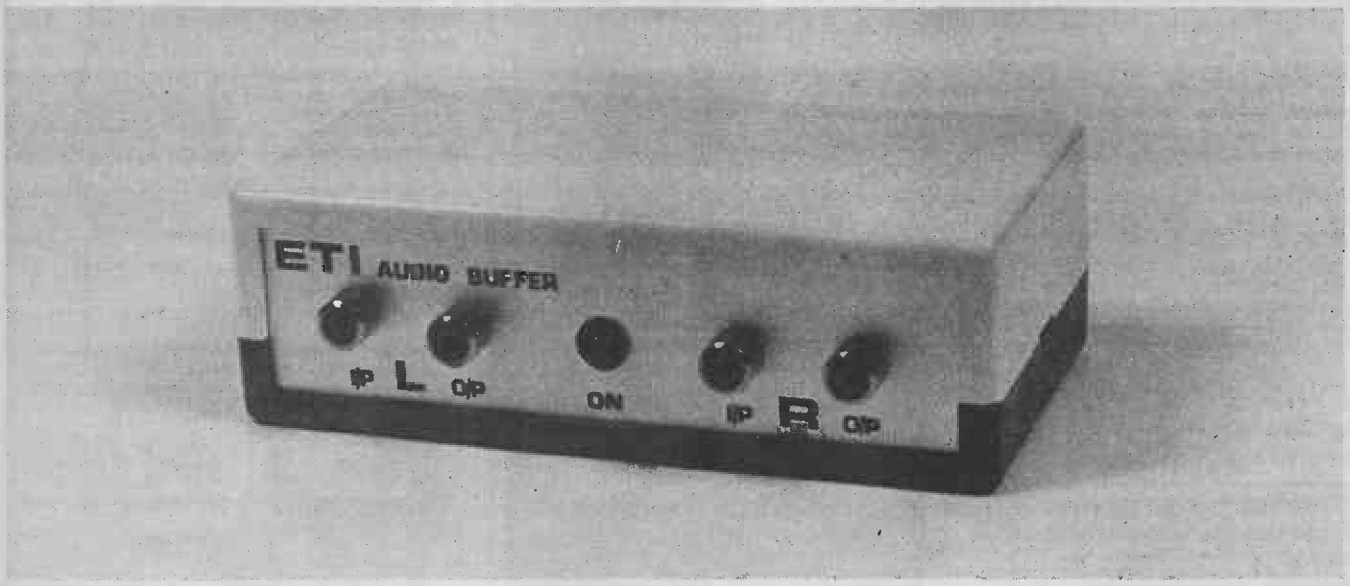
It is difficult to find anything remotely detrimental to say about the cartridge and very easy indeed to go on praising it I shall thus refrain from both and finish by congratulating Goldring for improving an already worthy product.

All they have to do now is to convince people to listen to something other than the 'revered few' repeatedly fawned over by the more 'partisan' press.

ETI

The 900 descends. Even the stylus assembly is posh! The carrier is in a translucent green if you please. If this lot doesn't get in the Design Centre they must be all mad blind twisted and dead.

AUDIO MATCHING CIRCUIT



Make sure you and your hi-fi are well matched with ETI's universal buffer.

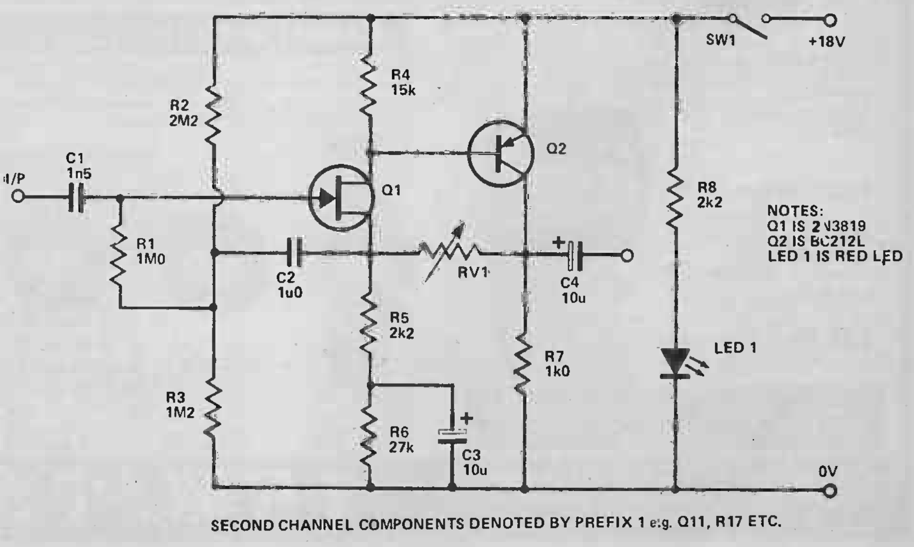
A FAIR proportion of problems in audio set-ups can be due to mismatched output and input impedances, when connecting equipment. If a relatively high output impedance source is fed to a low impedance receiver, distortion can occur mainly because of the overloading of the output stages of the source. We can understand how this can occur by looking at Ohm's Law (this is a simplification of the situation, but nevertheless a useful analogy can be drawn). Ohm's Law states that the current through a resistor is proportional to the voltage across it and inversely proportional to its own resistance.

ie. $I = V/R$

Impedance

It can be appreciated that if the resistance is lowered with the same voltage, then the current must increase. Likewise if the I/P impedance of a receiver of a signal falls below that of the O/P impedance of the source then more and more current will be drawn from the source. The O/P stages can become overloaded, distorting the signal and, if the impedance is too low the O/P stages can be permanently damaged.

Fig. 1. Circuit diagram of the buffer.



SECOND CHANNEL COMPONENTS DENOTED BY PREFIX 1 e.g. Q11, R17 ETC.

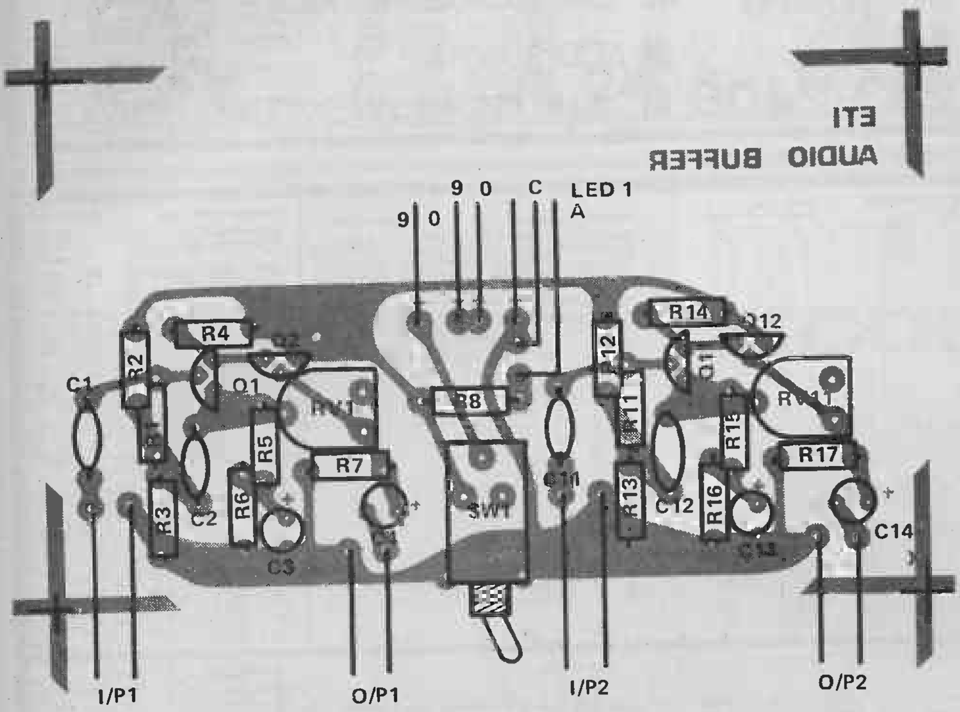


Fig. 2. Component overlay.

PARTS LIST

RESISTORS All ¼W, 5%		**SEMICONDUCTORS**	
R1,11	1M0	Q1,11	2N3819
R2,12	2M2	Q2,12	BC212L
R3,13	1M2	LED 1	TIL220
R4,14	15k		
R5,8,15	2k2		
R6,16	27k		
R7,17	1k0		
POTENTIOMETERS		**MISCELLANEOUS**	
RV1	20k preset	SW1	SPDT PC mounting switch.
CAPACITORS		Phono sockets	4 off
C1,11	1n5 polystyrene	Box	Vero type 202-21048D.
C2,12	1uF polycarbonate		
C3,4,13,14	10uF tantalum 16V	Battery clips	2 off type PP3

HOW IT WORKS

The high input impedance of a field effect transistor is utilised in the input stage to the buffer. This is further increased by "bootstrapping" the amplifier, by inserting C2 (referring to the circuit diagram) between the source and R1. The capacitor is chosen to be large enough to act as a virtual short circuit at the lowest frequency under consideration. This gives the effect that if one end of R1 changes in voltage, the other end of R1 moves through the same voltage change. R1 is "pulled up by its bootstraps". (A typical American term).

RV1 allows a certain amount of gain because the overall voltage gain is given approximately by the equation

$$A_v = \frac{R5 + RV1}{R5}$$

In our circuit R5 = 2k2 and RV1 = 20k, allowing a gain of approximately 10. RV1 can be further increased if required.

The opposite, however is not the case — if the receiver stage has a higher impedance than the source, no distortion will occur.

Currently In

The ETI Audio Input Buffer provides the facility of an impedance converter. Because of the inherently high input impedance (in the order of Megohms) the buffer is basically a high impedance source follower (ie. whatever signal is connected to the I/P will appear at the O/P). The O/P impedance is low and therefore will drive virtually any amplifier.

The ideal buffer should give the outward appearance that there is nothing there, ie. it should introduce no distortion, no matter what frequency or amplitude of signal is being buffered, the only effect should be impedance matching. To this end the frequency response of the ETI buffer is quite wide, 20 to 200KHz (adequately covering the audio range) and it can accommodate signals up to about 10 volts pk. to pk. without clipping.

Although essentially a unity gain device we have included a preset resistor whose adjustment will give a maximum gain up to approximately 10: overall making it a most useful and versatile device (we hope).

Construction

Construction is straightforward if our PCB design is used. Both channel components are mounted on the printed circuit board along with the ON/OFF switch SW1, to reduce interwiring. Use screened lead for all I/Ps and O/Ps and keep them as short as possible.

C2 must be non-electrolytic — we used polycarbonate for size restrictions, and would recommend that you do likewise.

Although a Verobox such as employed here is perfectly adequate, in hum fields such as are found next to mains transformers etc, a steel box might improve noise performance.

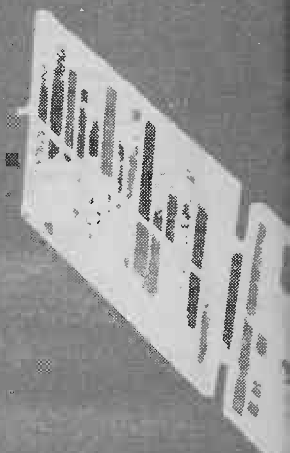
In use ours gave no problems at all if sited sensibly. ETI

BUYLINES

All parts used in this design are standard types which should be available at your local stockist, without much ado.

DEEP SPACE PROBES

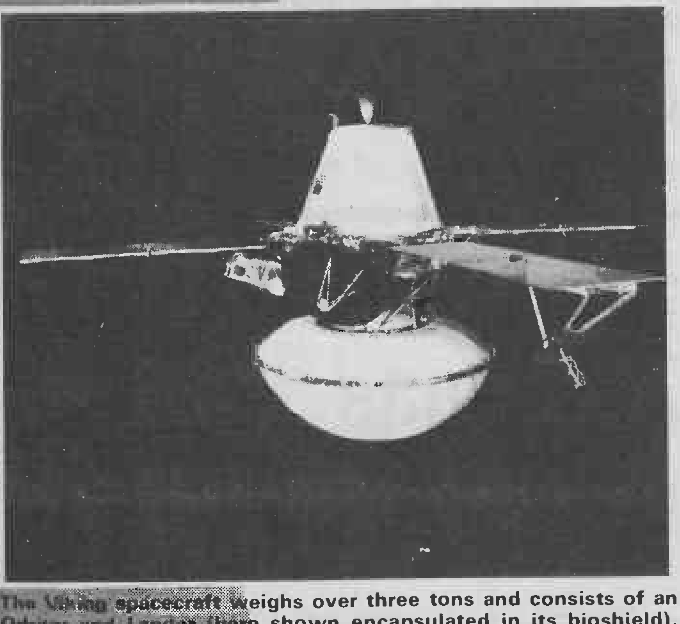
This month Ian Graham tracks down the interplanetary superstars – Viking, Voyager and Pioneer.



Until recently, unmanned spaceflights have been overshadowed by the glamour of manned missions, especially the Apollo series. However, in the hiatus between the last Apollo flight in December 1972 (hard to believe it's almost seven years ago) and the long-awaited re-useable shuttle, unmanned space probes have come into their own.

In the foreseeable future men are likely to visit only Mars, so any on-the-spot study of the planets must be done by unmanned probes. Our first close-up view of the surface of another world came from the Soviet Luna-9 in January 1966. Since then, spacecraft have crashed into, soft landed on or flown by Mercury, Venus, Mars, Jupiter and Saturn. Soviet motorised 'wheelbarrows' have even trundled across the Moon's surface, picked up rocks and returned them to Earth.

The recent stars of stage, screen and now ETI are Viking, Voyager and Pioneer. Although the Mariner spacecraft sent back impressive photographs of Mars, Viking made the headlines. Viking was special, because it was sent to look for evidence of life on Mars, the most Earth-like planet in the Solar System. In addition, it would study the atmosphere and geology of the whole planet. Each of the two Vikings launched in 1975 was a double spacecraft. While the Orbiter circled Mars, photographing the surface and studying the atmosphere, the Lander carried its payload of instruments down to the surface.



The Viking spacecraft weighs over three tons and consists of an Orbiter and Lander (here shown encapsulated in its bioshield). When the Lander is sitting on the surface of Mars, it radios data back to earth via an aerial on one of the Orbiter's four solar panels.

The Lander, although less than ten feet across, contained the equivalent of two power stations, two computer centres, a TV studio, a weather station, two chemical labs, three incubators, a scoop and hoe to dig trenches and collect soil samples, an Earthquake (Marsquake?) detector and miniature railway wagons to deliver the samples to the labs and incubators.

Landing Snaps

Viking-1 orbited Mars for a month while the Orbiter carried out a detailed photographic reconnaissance of the proposed landing sites. Apparently smooth sites, photographed by Mariner-9 showed up as cratered, rocky spacecraft killers under Viking's cameras. Finally, the Lander was committed to a landing at a site in the Plains of Chryse. A month later, Viking-2 came down to a successful touchdown in the Plain of Utopia.

The two sites were found to be quite different in nature. Chryse featured exposed bedrock, a large variety of rock types and sand dunes. Utopia featured more abundant, more uniform, generally vesicular rocks, but no sand dunes.

Viking-1 was not the first spacecraft to stand on the Martian surface. As in so many space activities, the Soviet Union did it first, but did not follow up its lead. Mars-3 successfully soft-landed in 1971, but stopped sending back data after only 20 seconds.

The most striking feature of the first photos received from Viking was the colour of the Martian landscape and sky. The first colour pictures showed a pink sky. As scientists had expected to see a blue sky, a few knobs on Earth were twiddled to make the sky blue. However, we now know that Mars has a pink sky, caused by particles of the red surface dust being carried into the atmosphere by strong winds.

Even though the Martian atmosphere is less than a hundredth of the density of the Earth's atmosphere, Viking found several similarities in the weather of the two planets. On one day in 1976, the atmospheres of both planets reached their maximum temperatures at 3 pm local time, although the terrestrial maximum temperature was some 150°F higher than that on Mars. (The daily Martian temperature ranges from −122°F just after dawn to −20°F in the middle of the afternoon). Even the wind behaviour over the Plains of Chryse matched winds blowing over the Great Plains of midwest USA.

Although the Martian air has only a thousandth the water content of terrestrial air, cloud and fog are to be found on the Red Planet. In the valleys and deep in craters, atmospheric water freezes during the cold night, appearing as white fog in the early morning. It vaporises again, however, in the low atmospheric pressure (about 8 millibars) when the Sun climbs high in the sky.

One meterological feature not found on Earth is an enormous seasonal variation in atmospheric pressure. In one month, the Viking Lander recorded a drop of 5%. It may be that, in winter, carbon dioxide, which forms 95% of the atmosphere (compared to 0.03% on Earth), was freezing out onto the southern polar cap.

The second most common element (by weight) found in the Martian soil, silicon being the most common, was iron. However, only a small fraction of the soil was found to be magnetic, suggesting that there must be more than one mineral of iron, not all of which are magnetic. In general, the soil was similar to terrestrial and Lunar basalt lava. Weathering and contact with the water-rich atmosphere make it more Earth-like than the dry, unweathered Lunar soil.

Look Lively

Before you can design instruments to look for life on an alien world, you must decide what you're looking for. Viking's experiments were based on two assumptions — that life on Mars would be Earthlike in carbon-based and secondly, that as on Earth, some form of bacterial life would exist almost everywhere on the planet.

The Lander's incubators provided a warm, nourishing environment for the sought-after organisms. Instruments studied the samples for any chemical activity. One experiment provided a radioactive carbon dioxide atmosphere and looked for radioactive compounds produced by any organism present. In another experiment, the gas above the soil sample was analysed for anything which might result from biological activity. A third experiment added radioactive nutrients to the soil, while instruments looked for radioactive carbon dioxide exhaled by any organisms in the sample.

After processing several samples in each Lander's laboratories, the results are inconclusive. The experiments did, indeed, record some form of chemical activity in the soil, but it's not clear if this was due to living organisms or the unusual chemical make-up of the soil itself. Despite the positive results from these experiments, no trace of the carbon molecules that make up terrestrial living organisms were found. The depth of analysis necessary to find out what is going on in the Martian soil is beyond the capabilities of Viking, so the question of life on Mars is unlikely to be resolved until samples can be returned to Earth by an automatic probe or until man lands on the planet. Although the latter is technically possible, there remains the question of the so-far unknown effects of deep space missions on the human body. It is by no means clear yet whether manned spaceflights as we know them today, but lasting several years, are possible.

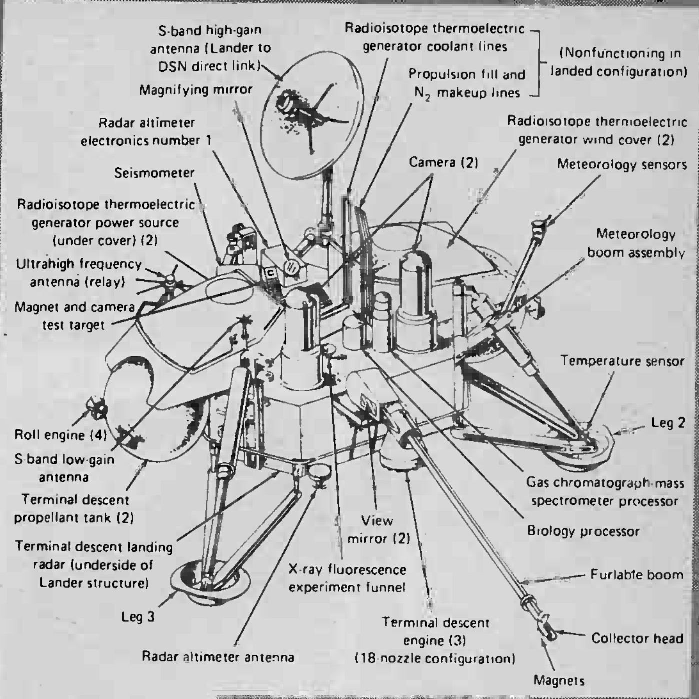


Fig. 1. The Viking Lander is an automatic laboratory designed to study the structure, surface and atmosphere of Mars and to look for life forms.

This artist's impression shows the Viking Lander heading for touchdown after a year in space. The aeroshell is descending on a parachute in the distance.

IO

EUROPA

GANYMEDE

CALLISTO

In March 1979, Voyager-1 took these photographs of the four large Galilean satellites of Jupiter. Ganymede and Callisto are bigger than Mercury. Io and Europa are about the same size as Earth's Moon. The reflectivity of the satellites varies according to the nature of their surfaces. Io may be covered with sulphur and salts (63% reflectivity), Europa with water ice (46%), Ganymede with ice and rock (43%) and Callisto with rock-covered ice (17%).

The interiors of the satellites showed similar diversity. Io and Europa have rocky interiors, while Ganymede and Callisto contain a lot of water or ice.

Voyager-1 took this photograph while still 28 million miles from Jupiter. Bright cloud in the equatorial region north of the Great Red Spot appears to be where bright clouds originate from, streaming westward. However, the bright ovals south of the Great Red Spot appeared about 40 years ago and have remained relatively unchanged ever since.

By Jove!

Jupiter is a strange, massive and totally un-Earthlike world. The Earth would comfortably fit inside Jupiter more than 1300 times. The main constituents of the atmosphere are hydrogen and helium. The planet itself is largely composed of liquid hydrogen. Its core is six times hotter than the surface of the Sun. Although a very distant world (a mean distance from the Sun of 800 million kilometres), one prominent feature seen from Earth as early as 1664 is the Great Red Spot — the biggest storm in the Solar system. It constantly blows its way over 40,000 square kilometres and reaches 8 kms above the surrounding clouds.

Bon Voyage

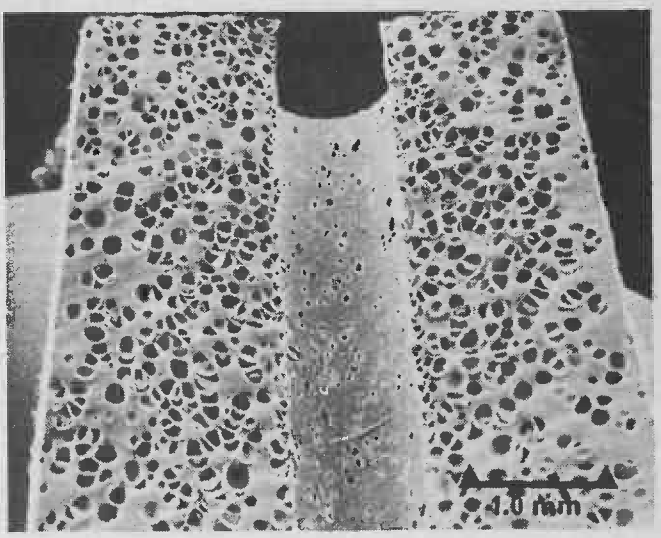
Two Voyager spacecraft left Cape Canaveral in August and September of 1977 on their way to the outer planets. Voyager-1, launched after Voyager-2, flew a faster, shorter route to Jupiter, to arrive ahead of Voyager-2.

The spacecraft receded from Earth at nearly nine miles a second. They took ten hours to cross the Moon's orbit (Apollo took three days). Voyager-1, while testing its optical navigation and video systems, captured both mother Earth and its solitary Moon in one picture from more than 7½ million miles away, the first time it had ever been done.

Between them, the two Voyagers were designed to investigate the atmosphere and magnetospheres of Jupiter and Saturn and survey in detail five Jovian and six Saturnian satellites. At 60 million kilometres from Jupiter, the spacecraft's narrow angle camera turned to face the planet. During the 80 days until closest approach, the narrow angle and then the wide angle camera took hundreds of colour photographs of the disc. Closer to the planet, the narrow angle camera was used to pick out individual features, like the Great Red Spot. In addition to the white light photography, ultraviolet, infrared and polarimetric observations were made to provide more information on the structure and composition of the planet. A radio astronomy experiment monitored powerful radio bursts from the planet's surface and spectrometers scanned the atmosphere and brilliant cloud bands to determine their composition.

Exciting as the Viking photographs of Mars were, the detailed photographs of the brilliant red, swirling storms on the surface of Jupiter have, I believe, been the most beautiful images received from space to date.

Tiny, red Amalthea orbits Jupiter every twelve hours. Voyager-1 took this photograph of Amalthea, only 100 kms across, from over a quarter of a million miles.



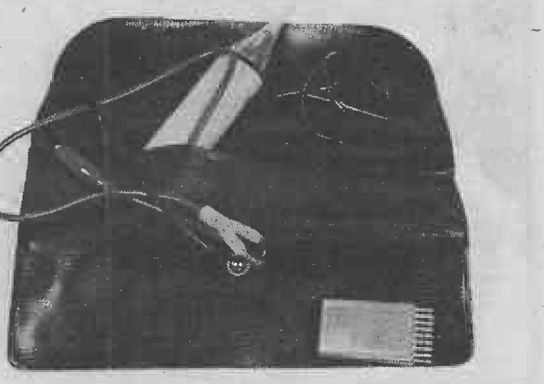
Holy Messages

Before vicars all over the country start sending me details of forthcoming church bazaars and bring and buys, we have *not* started a religious corner in News Digest.

The holes are microscopic perforations in polyethylene cable insulation and the messages are telephone calls. BICC Ltd are using millions of microscopic holes in cables to improve the quality of telephone calls. For their next trick . . .

The holes in the insulation help to reduce the loss of signal strength and also make the cables lighter and easier to handle. They can't be any old holes; they must be of the right size and properly distributed within an impermeable outer layer. A greater concentration of smaller holes is located next to the wire itself.

During research and development of the system and commercial production techniques, BICC have been using a stereoscan scanning electron microscope from Cambridge Instruments. The photograph shows the cell distribution in a cellular polyethylene telephone insulation.



Wat Probe

What do you give the man who has everything? If he's an electronics nut, you could solve your present problems with this month's special offer from Watford Electronics.

They are offering ETI readers the 3300A logic probe kit at the give away price of £14.50 + VAT — but only during the month of December.

As you can see, the probe, with its protective cover, comes complete with power leads, a 16 pin IC test clip and a push-on spring hook. They even supply a smart pouch to tuck the trusty tester away in.

The 3300A logic probe kit is available at the special offer price, only to ETI readers and only during December, from Watford Electronics, 30/35 Cardiff Road, Watford, Herts. Mention ETI in your order.

Pocket Companion

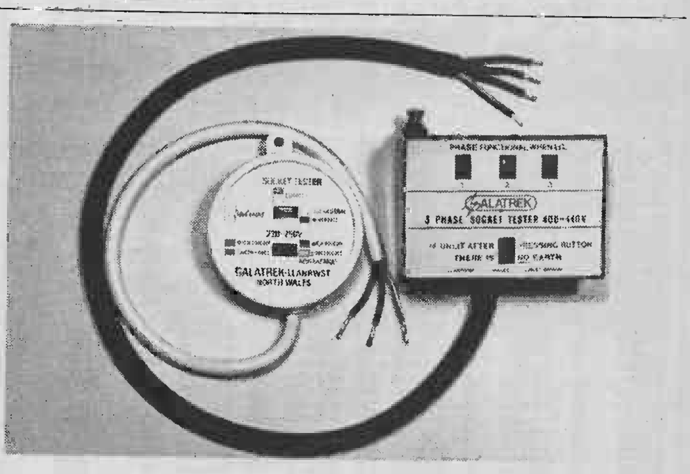
Not just an electronic dictionary or a translator or an appointments diary or an encyclopedia, but something of all these rolled into one, the 'Brainbank' is hailed as the world's first pocket information centre and language laboratory.

Brainbank is programmed via a series of interchangeable, plug-in memory cells, so you have virtually unlimited information storage possibilities (armed with a bucket full of memory cells).

Each language cell, which contains 32K of ROM holds about 1200 of the most common words, stored individually and in groups of up to fifty in categories such as travelling and food. The program also includes short phrases, automatically corrects spelling errors and explains words with double meanings (with its double entendre chip?).

The information centre's heart is a Mostek 3870 microprocessor. Memory cells are currently available on diet and nutrition, first aid, taxation and a thesaurus. New cells will become available every month. A custom cell service is also available.

Brainbank will cost around £150 plus £20 or less for each additional cell. We will tell you more about this little marvel, when we can get hold of one to play with.



The Thinking Man's Plug

Galatrek's 13 Amp Socket Tester, introduced in 1978, has been such a success that they have just introduced two new models. The first is a six function socket tester for any type of socket. Fit your own plug and see from a neon display immediately if the socket is alright or has a live fault, neutral fault, no earth, live earth reversed or reverse polarity. The second newcomer is a three phase tester which instantly indicates if phases are functional and if there is an earth.

Both testers are available from the manufacturer. The six function 13 ampSocketTester is £4.50 and the three phase model is £8.95. Both prices include VAT and UK mainland postage.

For further details contact Galatrek Engineering, Scotland Street, Llanrwst, Gwynedd LL26 0AL, North Wales.

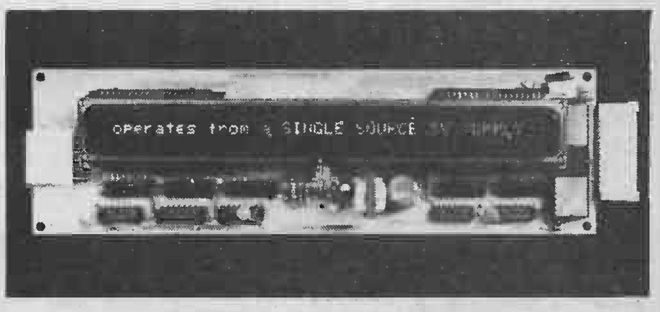
Gloss in A Box

Elcometer proudly presents the Gardner Glossard II, a gloss meter to let you compare shiners with one hand-held instrument, which holds the optical system, digital display, circuitry and rechargeable battery.

The Glossgard II is available in the popular geometries — 20°, 45°, 60°, 75°, and 85° — for matt to high gloass applications. Testing is to international standards. The meter has a hold button, which, guess what, holds the last reading on the liquid crystal display until you release the button. There is also a battery recharge light to warn you that the battery is somewhat lacking in oomph.

The instrument comes in a zip-up vinyl case, which also holds the new precision, self-locating gloss standard, and comes complete with a small plug-in mains charger.

For further details of the Gardner Glossgard II, get in touch with Elcometer Instruments Ltd, Edge Lane, Droylsden, Manchester M35 6BU.



Flip Flory

New from Perdix is the IEE "Flip" vacuum fluorescent display. It has a single line of 40 characters and needs only a single five volt supply. The high brightness, 7×5 dot matrix character is 0.2 in high and has an editing cursor.

The display is controlled by an on-board dedicated processor and interfaced via an 8-bit bi-directional data bus for parallel TTL ASC11. The unit will also accept serial data.

A unique feature is the ECMA 7 character font set that supplements the standard 96 character ASC11-7 set to include European characters plus upper and lower case letters, numerals and symbols.

The use of an on-board processor allows useful control functions such as backspace cursor, carriage return, line feed, horizontal scroll, read data at cursor, read data at a specified address, etc.

The unit is designed for limited-space, front panel applications. In fact, the entire assembly is less than one inch deep (by 3" high and 10.6" wide).

For further information please contact Perdix Components Ltd, 98 Crofton Park Road, London SE4.

KIRLIAN PHOTOGRAPHY

Unexplained phenomena on the fringe of established science have attracted a great deal of interest this century, but there is still no plausible theoretical framework to explain the observed events.

Two groups of phenomena that have come closer to explanation than most are first the observations and photographic records of mysterious lights and radiations around people and objects — called variously, radiation field photography, electrophotography, Kirlian effect, Human aura, St. Elmo's fire plus other names — and second acupuncture.

The Kirlian effect and acupuncture would seem as related as monkeys to stones but, as will be shown, they do seem to be complementary concepts. Belief in the existence of the human aura is very ancient. Medieval people distinguished four kinds of aura: 'Nimbus' and 'Halo' that stream from the head, 'Aureola' that issues from the whole body and 'Glory' which is both kinds combined. These were often featured in paintings. Others divide the aura into health, vital, Kharmic, aura of character and aura of spiritual nature.

Some people (clairvoyants particularly) claim to be able to see these effects without aids. The colours of the aura indicate the person's emotional and physical state.

The Old Testament bible relates how Moses was involved with a burning bush. Similar flames appeared as the "tongues of fire" that came upon the twelve apostles on the day of Pentecost.

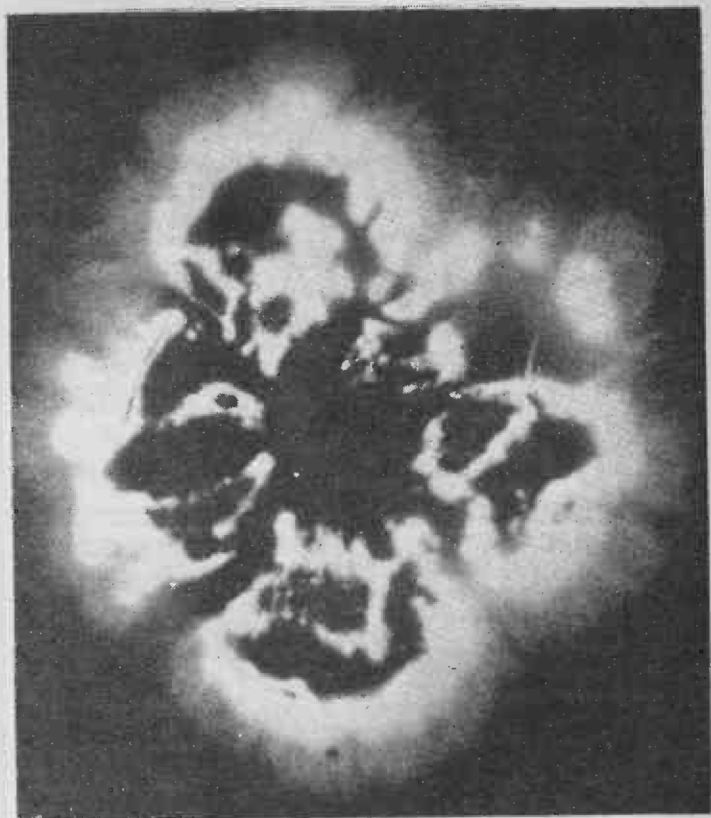
Sharp ends of extended objects — ships masts, yardarms, church steeples, airplane wingtips — in free air often exhibit this mysterious fire. This became known at St. Elmo's Fire after the martyred Italian bishop who became patron saint of sailors. Other names used include Castor and Pollux, Dioscuri, Corpusant and Fermie's Fire.

Recently this is said to be static electric discharge — corona discharge. A bluish glow was photographed around Pete Conrad the astronaut, when he landed on the Moon from Apollo 12 in 1970.

We all have, no doubt, experienced being charged-up on dry days. There are recorded instances of people who have the ability to deliver powerful electric charges who also have electro-magnetic properties enabling them to suspend magnetic materials.

Electrical storms have been known to produce images, (a rainbow in one case and pictures of people in others) semi-permanently formed in glass window panes. This is called lightning photography.

In psychic photography, photographs of people, sometimes of people long departed, have appeared on plates. It is suggested that there exists another energy form to electro-magnetic radiation. It is usually called bioenergy, the name coined by Czechoslovakian parapsychologists.



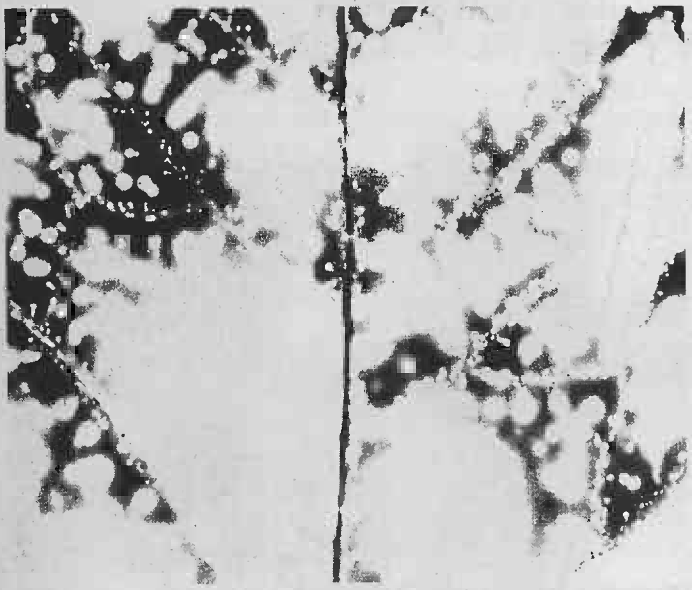
Kirlian photograph of an oleander flower. The flesh of the flower in contact with the photographic film is indicated by the dark portions.

Electro-photography

Electro-photography is as old as the availability of photographic emulsions that could record the existence of radiations. A case dated 1842 is the oldest. Yakov Narkevich-Todko showed photographs taken using electrical discharges in 1898. A 1926 book by C. Hall "Triumphs of invention," contains "A photograph of the Eiffel Tower taken during the dispatch of wireless time-signals. The ultra-violet radiations, although invisible to the naked eye, appear luminous on the photographic plate."

This kind of detection has become known as Kirlian photography after release of the work, in 1958, of the Russians Semyon and Valentina Kirlian. At first, interest in the Western World was minimal but it gained followers especially from 1970 onward.

In the West, one man responsible for assisting this interest to flourish is Kendall Johnson, who, it seems, was the dominant person in the US to obtain Kirlian pictures of objects. ("The Living Aura" by K. Johnson, Hawthorn Books, New York, 1975, is a *must* to read.) There were some earlier accounts of success in the US — one was published in 1938.



Kendall Johnson's first radiation field photograph, taken in 1971 using surplus electrical parts. The subject was a leaf.

Having accepted that there is little mysterious in Kirlian photographs, researchers are now concentrating on trying to resolve whether or not the pictures have recorded more than mere electro-magnetic radiation effects. Do they contain evidence of bio-energy? Does some new form of energy exist to be explained?

The Practice of Kirlian Photography

In the simplest form of electrophotography, an unexposed photographic film is placed on top of an electrode plate with the emulsion uppermost. Onto this is placed the subject to be photographed — a coin, leaf or person's finger or hand. High voltage is applied to the top of the object and discharged through the object and photo-emulsion to the other plate. Clearly the high voltage source must not be of lethal extrent if used directly on the body.

Body-part photographs can be made using the static charge built up on a person who shuffles around on a synthetic carpet in a dry room. The use of any other active voltage source for bodypart pictures can be a most dangerous practice. It is strongly advised that you experiment with objects such as leaves, coins, flowers, metal shapes and liquid drops, unless you know about the safe use of electrical sensing equipment in electro-medical applications.

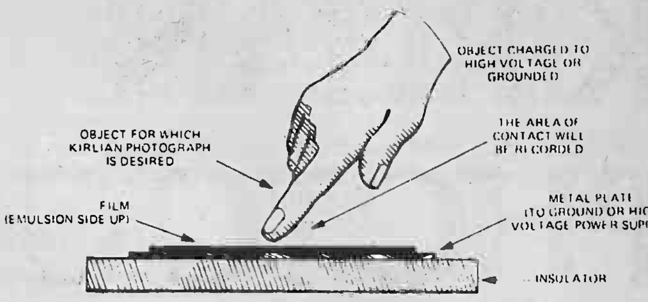


Fig. 1. A simple method for making Kirlian photographs of fingertips using static charge built up on the body.

Photographs can be obtained using DC charge, a burst of audio frequency high voltage or a single short pulse. Just about every combination appears to have been tried. Finding the right combination of film type and speed and source characteristics apparently can be time consuming as each object will need different settings. Results have been obtained using Tesla coils without and with spark-gaps (in which case RF is generated), Van de Graaf generators, charged capacitors and the charge of a person. Wei, in a paper in the Journal of Applied Physics, Volume 47, p. 4437-4441 reported using a proprietry electric photography set made by Edmund Scientific. This provides voltages up to a maximum of 20W in the frequency range 3-50 kHz. The set allows the user to vary voltage, frequency, pulse width, pulse repetition frequency, and time. He also found that a spring-release piezo-electric generator, which supplies a 10 uS pulse of 19 kV, was suitable as a source for his work with metal grids. It is likely that the larger style piezo-electric gas lighters might suffice. Wei used ASA 3000 film (Polaroid 87) in his work.

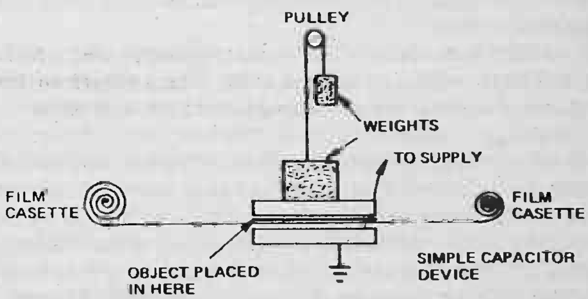


Fig. 2. Roll film can be used to record a Kirlian image. This method requires complete darkness to make the exposure.

Boyers and Tiller (J. Appl. Phys., Volume 44, 3102-3112, 1973) typically used 100 uS pulses of bipolar 1 MHz signal having amplitudes varying from 20 to 100 kV. They derived this by driving an Oudin resonator coil (details given in their book) from a modified radio transmitter. They found that each pulse produced different streamer configurations, these tending to expose the film uniformly when a string of pulses was used as excitation. They also established that the surface composition, smoothness, topography, inter-electrode spacing and parallelism of electrodes were each important factors having bearing on the results obtained. They also experimented with colour films, effects produced depending very much on the method of use and the type of film used.

A description of how to build a simple set of equipment is given in Johnson's book "The Living Aura." Another work "High voltage photography" by H. S. Dakin, ▶