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MPF105	0.41	2G345	0.18	2N2219	0.22	2N3395	0.19	2N4286	0.19
OC19	0.39	2G371	0.18	2N2220	0.24	2N3402	0.23	2N4287	0.19
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OC42	0.27	2N388A	0.61	2N2904	0.19	2N3646	0.10	2N6021	0.75
OC44	0.17	2N404	0.22	2N2904A	0.23	2N3702	0.13	2S301	0.55
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OC72	0.16	2N598	0.46	2N2906A	0.20	2N3706	0.13	2S304	0.77
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BA126	0.24	BYZ12	0.33	OA91	0.07
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BA155	0.16	BYZ17	0.39	OA202	0.08
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BA173	0.16	BYZ19	0.31	SD19	0.06
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BY114	0.13	OA5 short leads	0.23	1N916	0.06
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BP945	0.30	0.28	0.25
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7423	0.40	0.39	0.38	7486	0.35	0.34	0.33	74174	£2.00	£1.95	£1.90
7425	0.40	0.39	0.38	7489	£4.00	£3.75	£3.50	74175	£1.40	£1.35	£1.30
7426	0.40	0.38	0.36	7490	0.74	0.71	0.64	74176	£1.60	£1.55	£1.50
7427	0.40	0.38	0.36	7491	£1.10	£1.05	£1.00	74177	£1.60	£1.55	£1.50
7428	0.45	0.42	0.40	7492	0.74	0.71	0.64	74180	£1.60	£1.55	£1.50
7430	0.18	0.17	0.16	7493	0.74	0.71	0.64	74181	£5.00	£4.50	£4.00
7432	0.40	0.38	0.36	7494	0.85	0.82	0.75	74182	£1.50	£1.45	£1.40
7433	0.42	0.40	0.38	7495	0.85	0.82	0.76	74184	£2.40	£2.30	£2.20
7437	0.45	0.42	0.40	7496	0.96	0.93	0.88	74190	£2.15	£2.10	£2.00
7438	0.45	0.42	0.40	74100	£1.50	£1.45	£1.40	74191	£2.15	£2.10	£2.00
7440	0.18	0.17	0.16	74104	0.70	0.68	0.66	74192	£2.15	£2.10	£2.00
7441	0.74	0.71	0.64	74105	0.70	0.68	0.66	74193	£2.15	£2.10	£2.00
7442	0.74	0.71	0.64	74107	0.44	0.42	0.40	74194	£1.90	£1.80	£1.70
7443	£1.20	£1.15	£1.10	74110	0.60	0.55	0.50	74195	£1.60	£1.50	£1.40
7444	£1.20	£1.15	£1.10	74111	0.95	0.92	0.90	74196	£1.73	£1.70	£1.65
7445	£1.98	£1.95	£1.90	74118	£1.10	£1.05	£1.00	74197	£1.73	£1.70	£1.65
7446	£1.20	£1.15	£1.10	74119	£1.50	£1.40	£1.30	74198	£3.45	£3.35	£3.20
7447	£1.10	£1.07	£1.05	74121	0.50	0.48	0.45	74199	£3.10	£3.00	£2.90

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Q21	4	AC127 NPN Germanium transistors	0.55
Q22	20	NKT transistors A.F. R.F. coded	0.55
Q23	10	OA202 Silicon diodes sub-min.	0.55
Q24	8	OA81 diodes	0.55
Q25	15	IN914 Silicon diodes 75PIV 75mA	0.55
Q26	8	OA95 Germanium diodes sub-min 1N69	0.55
Q27	2	10A PIV Silicon rectifiers IS425R	0.55
Q28	2	Silicon power rectifiers BYZ13	0.55
Q29	4	Silicon transistors 2×2N696, 1×2N697, 1×2N698	0.55
Q30	7	Silicon switch transistors 2N706 NPN	0.55
Q31	6	Silicon switch transistors 2N708, NPN	0.55
Q32	3	PNP Silicon transistors 2×2N1131, 1×2N1132	0.55
Q33	3	Silicon NPN transistors 2N1711	0.55
Q34	7	Silicon NPN transistors 2N2369, 500MHz (code P397)	0.55
Q35	3	Silicon PNP TO-5. 2×2N2904 & 1×2N2905	0.55
Q36	7	2N3646 TO-18 plastic 300MHz NPN	0.55
Q37	3	2N3053 NPN Silicon transistors	0.55
Q38	7	PNP transistors 5×2N3703, 2×2N3702	0.55

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U 5	60 200mA Sub-Min. Silicon Diodes	0.55
U 6	30 Sil. Planar Trans. NPN like BSY95A, 2N706	0.55
U 7	16 Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0.55
U 8	50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0.55
U 9	20 Mixed Voltages, 1 Watt Zener Diodes	0.55
U10	20 BAY50 charge storage Diodes DO-7 Glass	0.55
U11	PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0.55
U13	30 PNP-NPN Sil. Transistors OC200 & 2S 104	0.55
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U15	NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0.55
U16	10 3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0.55
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U18	8 6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0.55
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U21	30 AF. Germanium Alloy Transistors 2G300 Series & OC71	0.55
U23	MADT's like MHz Series PNP Transistors	0.55
U24	20 Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0.55
U25	25 300MHz NPN Silicon Transistors 2N708, BSY27	0.55
U26	30 Fast Switching Silicon Diodes like IN914 Micro-Min.	0.55
U29	10 1 Amp SCR's TO-5 can. up to 600 PIV CRS1/25-600	1.10
U32	25 Zener Diodes 400mW DO-7 case 3-18 volts mixed	0.55
U33	15 Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0.55
U34	30 Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	0.55
U35	25 Silicon Planar Transistors PNP TO-18 2N2906	0.55
U36	Silicon Planar NPN Transistors TO-5 BFY50/51/52	0.55
U37	30 Silicon Alloy Transistors SO-2 PNP OC200, 2S322	0.55
U38	20 Fast Switching Silicon Trans. NPN 400MHz 2N3011	0.55
U39	30 RF. Germ. PNP Transistors 2N1303/5 TO-5	0.55
U40	10 Dual Transistors 6 lead TO-5 2N2060	0.55
U43	25 Sil. Trans. Plastic TO-18 A.F. BC113/114	0.55
U44	20 Sil. Trans. Plastic TO-5 BC115/116	0.55
U45	7 3A SCR. TO66 up to 600PIV	1.10
U46	20 Unijunction transistors similar to TIS43	0.55
U47	10 TO220AB plastic triacs 50V 6A	1.10
U48	9 NPN Sil. power transistors like 2N3055	1.10
U49	12 NPN Sil. plastic power trans. 60W like 2N5294/5296	1.10

Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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50	0.05	0.06	IN4001	0.05	0.06	0.16	0.21	0.60
100	0.05	0.07	IN4002	0.06	0.10	0.17	0.23	0.75
200	0.06	0.10	IN4003	0.07	0.12	0.22	0.25	£1.00
400	0.08	0.15	IN4004	0.06	0.15	0.30	0.35	£1.35
600	0.09	0.17	IN4005	0.10	0.19	0.36	0.45	£1.90
800	0.12	0.19	IN4006	0.11	0.20	0.38	0.55	£2.10
1000	0.14	0.30	IN4007	0.12	0.25	0.48	0.65	£2.50
1200	—	0.35		—	0.30	0.58	0.75	£3.00

INTEGRATED CIRCUIT PAKS

Manufacturers' "Fall Outs" which include Functional and Part Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No. Contents	Price	Pak No. Contents	Price	Pak No. Contents	Price
UIC00=12×7400	0.55	UIC46=5×7446	0.55	UIC90=5×7490	0.55
UIC01=12×7401	0.55	UIC48=5×7448	0.55	UIC91=5×7491	0.55
UIC02=12×7402	0.55	UIC50=12×7450	0.55	UIC92=5×7492	0.55
UIC03=12×7403	0.55	UIC51=12×7451	0.55	UIC93=5×7493	0.55
UIC04=12×7404	0.55	UIC53=12×7453	0.55	UIC94=5×7494	0.55
UIC05=12×7405	0.55	UIC54=12×7454	0.55	UIC95=5×7495	0.55
UIC06=8×7406	0.55	UIC60=12×7460	0.55	UIC96=5×7496	0.55
UIC07=8×7407	0.55	UIC70=8×7470	0.55	UIC100=5×74100	0.55
UIC10=12×7410	0.55	UIC72=8×7472	0.55	UIC121=5×74121	0.55
UIC20=12×7420	0.55	UIC73=8×7473	0.55	UIC141=5×74141	0.55
UIC30=12×7430	0.55	UIC74=8×7474	0.55	UIC151=5×74151	0.55
UIC40=12×7440	0.55	UIC76=8×7476	0.55	UIC154=5×74154	0.55
UIC41=5×7441	0.55	UIC80=5×7480	0.55	UIC193=5×74193	0.55
UIC42=5×7442	0.55	UIC81=5×7481	0.55	UIC199=5×74199	0.55
UIC43=5×7443	0.55	UIC82=5×7482	0.55		
UIC44=5×7444	0.55	UIC83=5×7483	0.55	UICX1=25 Assorted 74's	£1.65
UIC45=5×7445	0.55	UIC86=5×7486	0.55		

Paks cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

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PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0.26	0.28	0.30	0.30	0.52	0.55	0.59	£1.27
100	0.28	0.37	0.52	0.52	0.55	0.64	0.70	£1.51
200	0.30	0.41	0.54	0.54	0.63	0.67	0.83	£1.70
400	0.48	0.52	0.62	0.62	0.74	0.83	£1.03	£1.93
600	0.58	0.63	0.75	0.75	0.85	£1.07	£1.38	—
800	0.70	0.77	0.85	0.88	0.00	£1.32	£1.05	£4.10

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VBOM	2A TO-5 £	6A TO 66 £	10A TO-48 £
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(Similar to 2N2060)

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news digest

Left: The Bowmar LED digital watch. Above: The Liquid Crystal digital watch available in kit form from Sintel.

THE CHANGING FACE OF WATCHES

What was moving and isn't and also wasn't moving but is now? Answer: Digital Watches. No moving parts is the answer to the first part, answer to the second part is that new models are appearing rapidly and things are really moving on this front.

Bowmar of 41 High Street, Weybridge, Surrey, are of course well-known for their calculators and as makers of LED displays and have now entered the top end of the digital watch market with a model costing about £200. Both the chip and display are made by Bowmar in Canada.

The watch uses as a standard a 32768Hz crystal and is claimed to be accurate to within a minute a year. Using the push buttons, the watch displays hours, minutes, seconds and the date. A special screen enables the display to be read even in bright sunlight. Power is derived from two mercury cells; when these need replacing, the display flashes four times a second. The batteries will last about a year.

Shopertunities, the mail-order company are now advertising a liquid crystal watch for £57.95, the lowest price we have yet seen, but advertisements for several watches using either liquid crystal or LED readouts are now appearing.

Mike Fischer, one of our friends from Sintel, 53a Aston Street, Oxford dropped in to see us recently sporting a digital watch with LC display which had been built up from a kit that they hope to market for about £55. Anyone interested should contact Sintel.

A combination calculator/watch has just been introduced in the USA by the US Fondiller Corp. of New York. The unit is called the Calcron and is a full scientific calculator. It is a 40-function device including Trig, Logs, exponential, square roots etc. Time is shown on the digital readout.

Nickel-cadmium batteries power the unit for some 20,000 calculations. The selling price in the United States is reported to be as low as £200.

UK 5 NOW ARIEL V

UK 5, Britain's latest scientific research satellite is now in its designed 550km orbit and the spacecraft is in A1 condition and working perfectly.

Now that the £2.5 million satellite is in orbit it will be known as Ariel V. The all-British satellite, which carries both American and British experiments, is to carry out the most comprehensive investigataion yet initiated into X-ray sources in deep space including such phenomena as 'black holes' (see last month's ETI).

ERNIE'S SISTER 'IRENE'

The Central Bank of the Philippines has just ordered a new premium bond number selection equipment to be named 'IRENE' – Indicating Random Electronic Numbering Equipment – a twist on the initials 'ERNIE' which was the name given to the United Kingdom machine.

'IRENE' is made up of a number of complex modern electronic units controlled by a small but powerful computer. The Premium Bond numbers are generated at random by electronic circuits at high speed and stored in the memory of the computer. The computer ensures that numbers which belong only to a previously specified valid range are stored. These are then recorded simultaneously on two magnetic tape machines for security. The contract has gone to a division of Plessey Telecommunications.

BRITISH TECHNOLOGY X4 SPACECRAFT 'MIRANDA'

The picture shows the launch of the British Technology Spacecraft X4, known as MIRANDA. Among the experiments on board is an experimental star sensor, designed and built at the Royal Aircraft Establishment, Farnborough, and using a specially designed EMI photomulitiplier tube (type D119 NMA).

At present MIRANDA is in a circular sun-synchronous orbit of approximately 759 km and will provide a space platform for the testing of new types of sensors and attitude control systems for future space applications. It is expected to have a six months operational life before going into eclipse.

LAUNCHING MIRANDA

Now Miranda is in orbit carrying new sensors to give us information we will need for future space experiments.

SEMICONDUCTOR NEWS

It's some time since we heard of a company entering the transistor field but International Rectifier have done just that. IR are of course the world's largest manufacturers of thyristors, diodes and rectifiers but have now launched 12 discrete and 15 Darlington power transistors.

Market research by IR of Hurst Green, Oxted, Surrey indicated an expected long term volume increase for high voltage transistors.

A feature of the new range is the use of glass passivation, normally associated with thyristors. This gives better voltage ratings, long term stability and improves production yields. This technique effectively provides 'on-the-junction' hermetic sealing, preventing the ingress of moisture and impurities.

The discrete transistors are rated up to 700V V_{CBO}, 7A I_C and the Darlingtons 600V V_{CEO}, 20A I_C.

Typical applications are for switching for power conditioning, electric motor speed control, car electronic ignition systems and for horizontal scanning circuits for c.r.t's.

Semicomps of Wembley, Middx have available Signetics double-diffused MOSFETS. This manufacturing process, known as DMOS, ensures that the devices have a better performance in the range 500MHz to 1GHz. They feature low capacitance, high power gain and low noise.

The range includes both single and dual-gate n-channel enhancement mode devices, all of which have built-in gate protection.

General Instrument (UK) Ltd, Cock Lane, High Wycombe, Bucks have introduced a new family of low-cost plastic MOSFETS, which because of their moulded packages represent cost savings over metal can types.

Left: The General Instrument (UK) plastic MOSFETs.

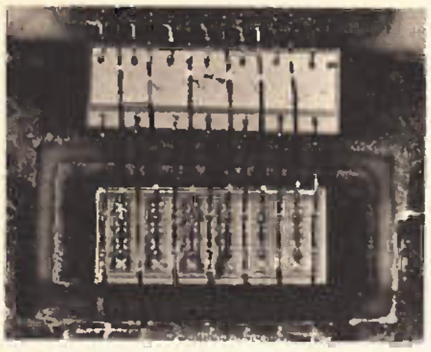
Initially there are four types: MEM630, MEM631, MEM632 and MEM712.

The MEM630 is intended for use in high frequency r.f. amplifiers of FM radios, the MEM631 for use in VHF amplifiers such as TV tuners and i.f. amplifiers. The MEM632 is for use in h.f. and VHF mixers and its high conversion gain makes it suited for TV or VHF mixer applications.

The MEM712 is an n-channel MOS transistor which has a low threshold limit of 2.0V making possible direct drive from TTL logic levels. The low ON resistance, low feed-through capacitance and low cost make it ideal for high speed analogue switching.

Motorola, York House, Empire Way, Wembley Middx, have announced sweeping price cuts on all their CMOS devices. These price cuts average about 25% and are the second to be made by Motorola within six months.

The same company have also announced price cuts for their popular MRF619 and MRF620 UHF power

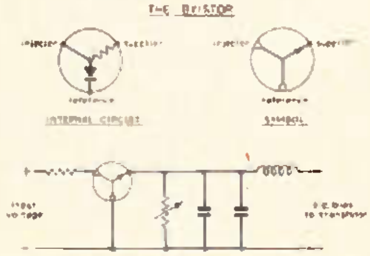


transistors. These devices designed for 25W and 35W operation use internal matching (controlled Q) to raise the base impedance, thereby increasing the bandwidth and simplifying circuit design.

Another price reduction is that of Signetics CMOS devices. The 4001, 4002, 4011 and 4012 have been cut substantially in price. Ten further devices are going to be reduced in the next few weeks.

Available from Walmore Electronics of 11-15 Betterton Street, Drury Lane, London WC2 is a device known as a *Byistor*. This has been developed by the Communications Transistor Corporation (CTC) of America to enable the best possible performance to be obtained from silicon r.f. power transistors without the risk of thermal runaway.

THE BYISTOR



TYPICAL R.F. TRANSISTOR BIAS CIRCUIT

The Byistor consists of a special diode and resistor within a single package. Use of the device ensures that the bias current applied to an r.f. transistor is automatically adjusted to exactly the right value whatever the operating temperature and the need for a power wasting emitter resistor to stabilise d.c. conditions is eliminated.

The Byistor depends on its thermal characteristics being an accurate inverse thermal match to the power transistor. As the temperature of a power transistor increases, the collector current also increases leading to runaway. The byistor reduces the bias current applied as the temperature increases, maintaining the collector current at a steady level.

To obtain the accurate match, CTC manufacture the diode within the bysitor using exactly the same material, device geometry and diffusion process used by the manufacturer of silicon r.f. power transistors. To improve the thermal match still further, the internal resistor is also made of silicon.

The byistor is intended for mounting on the same heat-sink as the power transistor and as close to it as possible. As the temperature increases, the silicon resistor increases in value and the voltage across the diode decreases. The diode acts as a voltage source with an impedance of 0.3 ohms and the silicon resistor contributes a further 0.7 ohms, giving an apparent source impedance of about 1 ohm.

For class AB operation about 350mA is applied to the injector terminal from any convenient voltage and the desired static collector current in the power transistor is set by adjusting the variable resistor. Increasing the value of the variable increases the V_{BE} and also the collector current.

IBA TECHNICAL REVIEW

The series of engineering texts under the title of 'IBA Technical Review', published by the IBA, has been expanded by the recent publication of Volume 4 'Television Transmitting Stations' and Volume 5 'Independent Local Radio'. These fully illustrated books are intended for professional broadcasting engineers, for technical and other educational centres and for libraries. If you want to read one tell your librarian that copies can be obtained from: IBA Engineering Information Service, Crawley Court, Winchester, Hants SO21 2QA.

Volume 4 describes recent designs for high-power stations and for low-power, all-solid-state local relays; control systems for unattended stations; aerials and aerial-combining equipment; power supplies; station buildings; and the planning and control of construction programmes. All articles are contributed by engineers of IBA's station design and construction department.

Volume 5 includes papers on the engineering planning of ILR services; design of MF and circularly-polarized VHF sound transmitting stations; control equipment; directional MF aerial arrays; and the design and operation of an ILR studio centre.

NEW HOPE FOR B & W TV

Good news for fans of black and white television. Tubes for their sets will still be available because Edicron Limited (who have been importing black and white TV picture tubes from Czechoslovakia for some years) is planning to increase its supplies. So the news that manufacturers may be stopping production does not mean that black and white sets, many of which are rented, will immediately become obsolete.

WALKIE-TALKIE MESSAGE SENT 50,000 MILES

With an antenna fashioned from an umbrella, an engineer beamed a walkie-talkie message more than 50,000 miles to demonstrate the dramatic potential of space satellites for search-and-rescue missions. The long-distance transmission, originating from a walkie-talkie with a typical range of only five miles, showed that simple radio gear and a collapsible antenna could enable persons in distress to summon help from any point on earth, using a space satellite.

The demonstration was given by an American engineer using a five-watt radio identical to the walkie-talkies carried by law enforcement officials, firemen and foresters. For the demonstration, however, its transmitter and receiver had been tuned to the satellite's broadcasting frequencies. Two other items where needed: a special antenna, constructed on the frame of a golfer's umbrella, and the services of a geostationary space satellite orbiting at an altitude of 22,300 miles over the Amazon River in Brazil.

In the demonstration, by means of the 'press-to-send' key on the walkie-talkie, a message in Morse code was transmitted from NASA headquarters in Washington DC to the ATS-3 geostationary satellite, which then relayed the signals to GE(USA)'s Radio-Optical Observatory near Schenectady, New York - a total distance greater than 50,000 miles.

After receiving the message, Observatory personnel transmitted voice signals back through the satellite to the engineer's radio. This showed that downed pilots, the survivors of shipwrecks, and others in need of help could readily receive a voice reply from a search-and-rescue station, acknowledging the SOS and providing rescue information.

A global search-and-rescue system would require only six geostationary satellites to cover all but the polar regions. The satellites could be monitored by three ground stations using range measurements to locate

 Continued on page 70.

WHEN WE USE OUR eyes to look at any scene, there are two features in particular which the eyes convert into signals to pass to the brain. These are hue and brightness.

The hue is what we can describe as the colour; the eye not only detects this but also the degree of *saturation* of the colour, how pure it is or how mixed with white to make a pale colour.

The brightness information is more important, for it tells us more about the shape of the object, and can operate at lower light levels. All this information is received by the eye as light waves which come in diverging paths from any object.

What happens to the light rays inside the eye is of considerable interest, not only to specialists in the eye but also from the point of view of the electronic engineer, since television systems operate in ways which must match the action of the eye.

In each case, there has to be an imaging system — a lens, which makes the diverging light rays from an object *converge* to form an image. That image must be formed on some sensitive layer which can convert the light intensity and hue into electrical signals for transmission.

In the eye, this is done in the retina, and the signals are transmitted along countless nerves to the brain.

In a television system, the job of converting image to signal is done in the camera tube, but we cannot have countless channels; the information must eventually end up as one electrical signal to be transmitted. It is because of this last restriction that the camera tube is so unlike the eye in detail.

PICTURE TO SIGNAL

IAN SINCLAIR TELLS HOW TODAY'S TV CAMERAS WORK

BREAKING UP THE SIGNAL

To transmit picture information in any way other than as light, involves splitting up the picture into pieces. There is always more information than we can cope with.

Even light is itself not a continuous wave but stops and starts irregularly in groups called *quanta*, but these bits are too small for our purposes; we must break up the picture into a number of bits which we can handle.

The eye does this by having the retinal surface made of sensitive fibres, the 'rods and cones', so that the number of rods and cones determines the number of bits into which the picture is broken. Each sensitive portion has a 'wire' (the nerve) linking it to the brain, so that an image is broken into bits, and the hue and brightness information on each bit is taken to the brain at the same time.

As we said earlier, we cannot have a separate channel for each piece of information, so we cannot transmit all the bits of our picture at the same time. The only way in which we *can* transmit all the pieces of a picture is by transmitting them in sequence: this is the process of scanning.

If the picture is scanned in sequence at the transmitter and each piece of information transmitted as it is scanned, then a similar sequence at the receiver should reconstruct the picture. This is the heart of the television system, and a television transmitting tube must therefore be able to convert an image into an electrical signal and then to scan it so that only one bit of information at a time is transmitted.

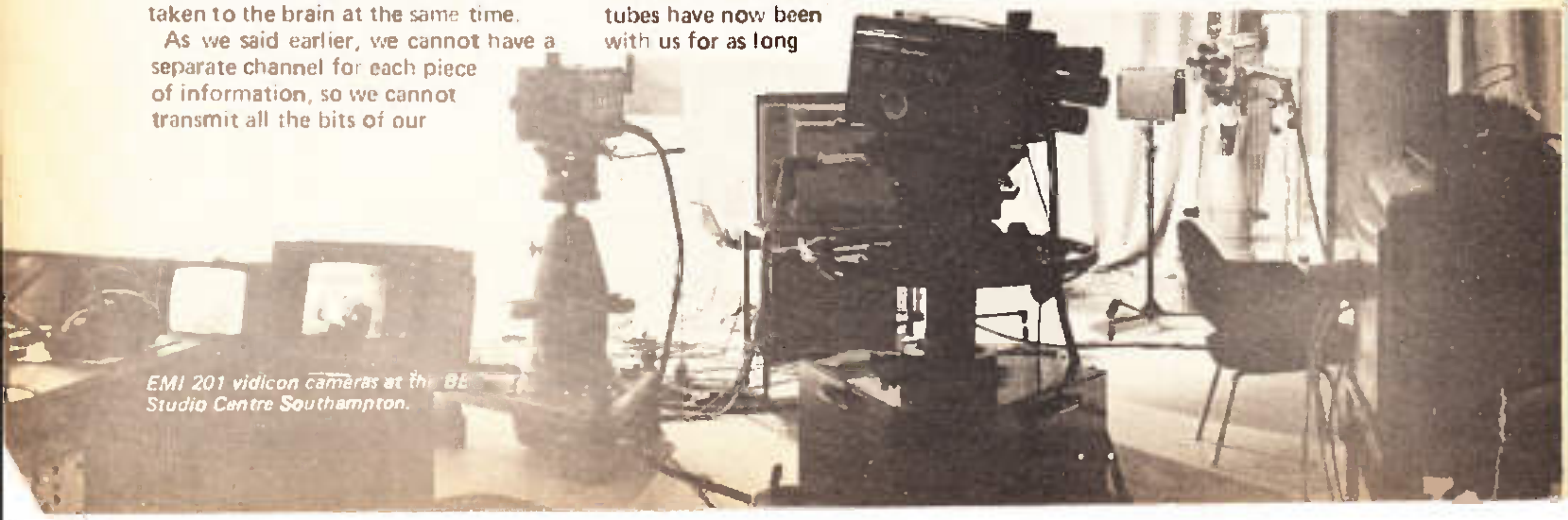
PICTURE TUBE PROBLEMS

The early mechanical systems of television carried out the scanning by means of perforated wheels, but totally electronic television camera tubes have now been with us for as long as high definition television.

High definition means that the picture is broken into a large number of pieces, so that fairly fine detail can be seen, not simply the outline of shapes.

The development of such tubes has occupied men of great inventiveness and intellect and has resulted in the remarkable achievements which we take for granted today, but in every case the operation of these tubes involves a number of compromises in order that the system as a whole can work.

For example, the number of bits into which the picture can be broken, which determines the resolution of the picture, is affected by several parts of the whole television system. The normally favoured scanning system is into lines, and the resolution of the



EMI 201 vidicon cameras at th BB Studio Centre Southampton.

picture is affected by the number of lines. But we cannot simply decide to have more lines so that we may have more resolution. The scanning spot of the receiver cathode ray tube may be too large to show a number of closely spaced lines as separate parts, as also may the scanning spot of the transmitting tube. In addition, the greater number of lines means taking up more channel width, so that we can have fewer transmissions. Similar conflicting factors affect every part of a television system, so that the camera tube must be tailored to fit the remainder of the system, and be at least of a comparable performance.

On the face of it, we need only two sections in a camera tube, one to convert the image on the face of the tube into an electrical signal, another to scan the electrical signal and "read out" the information on each picture bit to the transmitter. This we find to be insufficient.

The conversion of light image to electrical signal is not an efficient business, and the materials used convert only a small fraction of the energy of the light into electrical energy – with different efficiencies at different colours. What is more, the signal coming out carries no colour information. The result is that using the electrical signal direct from the conversion of light to electrical signal gives us insufficient energy, so that early television worked only under lighting of ferocious power. For this reason, all camera tubes incorporate the idea of storage.

At each part of the picture, light energy is converted into electrical energy, but the electrical energy is stored, and built up until it is scanned and removed. The electrical output is not therefore that present during the microsecond or so that the scan spent on that part, but the amount built up between scans, which is a very much longer time, several thousand times longer.

The use of this principle has resulted in the high sensitivity obtainable today; but materials are still not available to enable the scanned signal to carry colour information, though some ingenious recent tubes have achieved colour coding inside the tube. In most cases, the colour information has to be gathered by having separate tubes working on separate colours, and we are fortunate that only three 'primary' colours, red, blue and green, are needed to re-create any colour found in nature, (and a large number which are not). Since the colour information does not involve any difference in the camera tube (except in the case of the specialised tubes mentioned), we need not mention it further, but will look at the types of

The portable version of the most advanced broadcast television camera, the Marconi Mark VIII. The camera is designed to produce high quality pictures which can be inter-cut with pictures from other studio cameras without degredation of picture quality. The Mark VIII Portable, which can be connected to a standard camera control unit, retains the features of automatic alignment and colour balance, particularly important for portable cameras which are subjected to very rugged treatment.

Below: Shooting a demonstration of a diamond grinding wheel for the BBC's 'Know How' engineering series.

PICTURE TO SIGNAL

tubes used in television camera work.

THE VIDICON

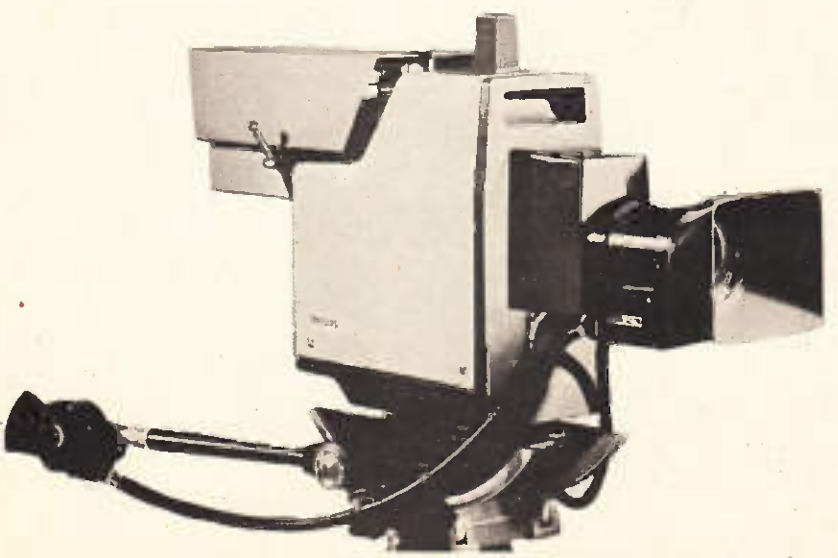
This tube is considerably smaller than other types, and exists in a number of types according to the material used for light sensitivity. Since the tube works in the same way, we need not bother too much about this at the moment, but the differences are of importance later.

The conversion of light information into electrical signal is performed by a photoconductive material, whose electrical resistance changes with the amount of light falling on it. It is very high (in the region of megohms) in the dark, and low when illuminated, the amount of the resistance depending directly on the light level.

In the "traditional" vidicon, this material is antimony trisulphide, in the more modern type of vidicon, a form of lead oxide is used. This material has a dual role, since it acts also as the means of storing the electrical information. These substances will polarise in an electric field, meaning that if they are sandwiched between conducting plates with a voltage across them their molecules will charge so that one part is negative and the other end positive. This is the familiar action of a capacitor, and normally we use insulators for this job; there is no reason for not using conductors except that they would lose the charge too quickly. If we use poor conductors, then the charge will be lost only slowly, and as it turns out, this is ideal for our purpose.

Imagine then, a glass plate which has been treated with stannous chloride at a high temperature. This treatment makes the glass a conductor along the treated surface, so that it transmits light and can have an electrical contact made to it. On the conducting side there is now deposited a thin film of photoconductor, antimony trisulphide or lead oxide (Fig. 1).

Suppose now that we make contact with the photoconductor, and connect the glass to a positive voltage of about 40 V. With no light falling on the glass, the photoconductor does not conduct, so that the glass side remains at 40V and the other side remains at zero volts. If some light now shines on this sandwich, the photosensitive material conducts, and some of the 40V present on the glass appears on the other side. How much? It depends on the resistance of the connection we have made, which can be kept constant, and on the level of light. What is more, the material will act as a capacitor, and the voltage will build up with time, giving us the storage which we need. The whole assembly acts as a capacitor shunted by a resistor whose value depends on the light intensity.



This model LDH 20 colour TV camera from Philips is equipped with three + 25 mm plumbicon tubes — adaptors enable it to be used with vidicons if required.

SCANNING

Reading the information from this sandwich is done by a scanning electron beam. The beam must have a very small spot size, since this directly affects the resolution. Fortunately this is not difficult to achieve, but some care has to be taken that the beam current is not cut down too much to achieve a small spot, otherwise the signal out will be very small, and the signal-to-noise ratio will be poor.

The beam has then to be made to scan so that it arrives at the sandwich structure, the target just described, at right angles to the surface and scan across and down in the familiar TV pattern. This task is made easier by the small size of the vidicon; it is always easier to achieve precise scanning of a small area than of a large area. As it scans the target, hitting the surface of the photosensitive material, it acts as a high-resistance contact connecting the target surface with the electron-gun cathode wherever it touches. As it does so, any voltage built up on the surface of the target at that point is discharged, as would be a capacitor.

This action does not depend on the resistance of the material; it is the action of a capacitor, and it causes an equal amount of current to flow in the contact to the glass (Fig 2). The amount of current is that needed to charge the target up again to its original level (zero volts on the gun side, 10 V on the glass side), and is proportional to the amount of charge, which in turn is proportional to the amount of light which discharged the target between scans. The current which flows to the glass contact in this way is the signal current, and it can be amplified in the usual way.

THE COMPLETE ACTION

Consider now the complete cycle of action at any piece of the target while a scan is being televised. An image of some scene is focused on to the glass side of the target, so that some areas are brightly lit, and others are darker. Imagine one portion, neither fully lit nor totally dark. On the glass side of the photoconductor, the voltage is maintained at +40 V by the power supply. Assuming that the scan has just passed, the action of the photoconductor is to allow the voltage on the electron gun side to rise towards 40 V.

The rate of rise depends on the capacitance between the two sides of the photoconductor, which is fixed by the type of material and the thickness of the layer, factors which remain constant after manufacture, and also on the resistance, which depends on the light level.

The portion which we are looking at is therefore rising in voltage at a rate which depends on the light level. If there were no scan, it would continue to rise (though not at a constant rate) until it reached +40 V. Because of the scan, however, it rises only part of the way when the beam scans across, the capacitance is discharged down to zero volts, the current flows in the glass contact, and the action of that part of the target starts again.

The vidicon relies so heavily on the properties of the material and for its target that it is not surprising that the choice of material is very critical to its operation. When antimony trisulphide is used, the main problem is "vidicon lag", which is a problem of storage, causing a changing picture to appear smeared, as if the previous image were not wiped clear before the next one appeared. This is, in fact, exactly what is happening, and it is most troublesome when the vidicon is operated at low light levels with moving subjects.

This problem became acute with the advent of colour television. The cameras used had three vidicons, one for each colour, and each individual vidicon thus dealt with less than at the total light.

As a result, development of lead oxide surfaces was speeded-up, and this work, due to Philips, has resulted in much improved vidicon behaviour. Nowadays the lead oxide type of vidicon is used almost in all colour cameras.

Work on vidicon target materials is not complete, and the most promising recent reports have been on silicon photodiode arrays. A sheet of dots of silicon, each a miniature photodiode, forms the target for this type of vidicon. The construction follows the familiar methods used for integrated circuit construction, and the advantages spring from the greater control over the process, and from the fact that each miniature diode is isolated from its neighbours rather than being part of a sheet of material. So far, the difficulty has been that of creating a sufficiently large target surface free from defects, since one faulty diode can be detected as a spot in the final picture.

IMAGE ORTHICONS

Despite the large number of lead oxide vidicons in use in colour cameras, the image orthicon is still the most used camera tube world-wide.

The principles of the image orthicon are totally different from those of the vidicon; it is a tube which has "grown up" with television itself, as it can trace its ancestry back to the earliest types of camera tube.

The image orthicon can be divided, for the sake of understanding its action, into three distinct parts. These are the image section, (Fig. 5), where the light image is turned into an electrical signal, the target section (Fig 6), where the electrical signal is stored in the form of charge, and the scanning section, where the charge signal is scanned and the information extracted from it and amplified within the tube.

THE IMAGE SECTION

This part of the tube consists of a thin film of photo-emissive material deposited on a glass plate. The film is made from a complex mixture of materials, the metal caesium and the semiconductor antimony being the most prominent. When light shines on

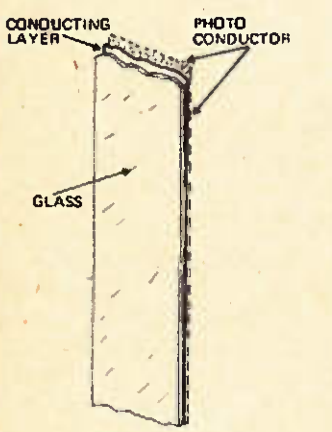


Fig. 1. Magnified cross-section of Vidicon target.

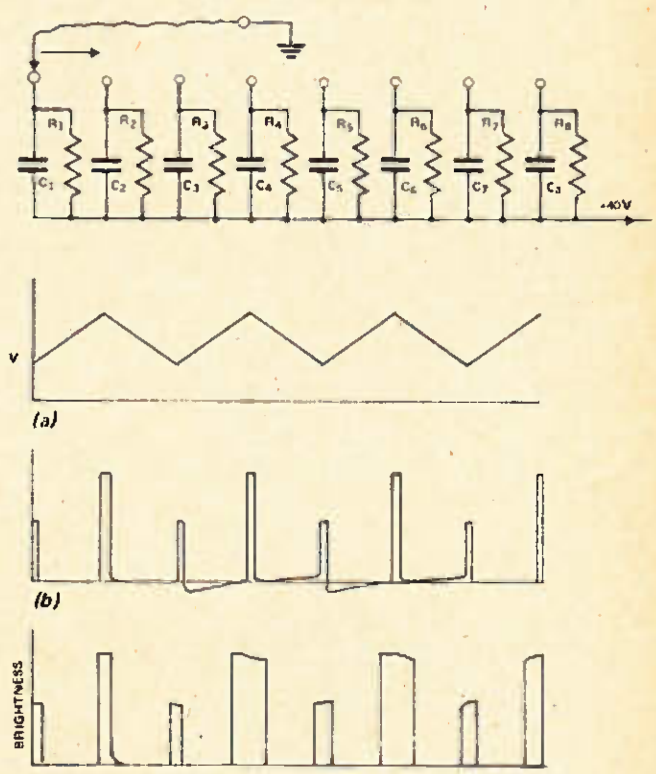


Fig. 2. Action of target. The equivalent circuit is of a set of capacitors with variable resistors (controlled by light intensity) in parallel. The beam scanning action is to earth one side of each capacitor in turn and then disconnect. As each capacitor is scanned, its beam-side plate is clamped to zero volts. The voltage will rise as the capacitor discharges through the resistor in parallel. The amount of the rise achieved in one scan time depends on the value of the resistor. (a) Typical voltage waveform for light and dark areas. (b) Current flowing in common circuit as capacitors are discharged. (c) Brightness pattern on the tube face.

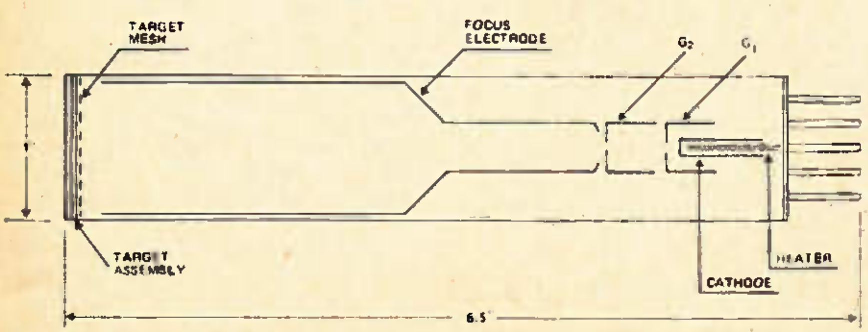


Fig. 3. Complete vidicon assembly. The target mesh exists to act as an anode for electrons which do not land on the target.

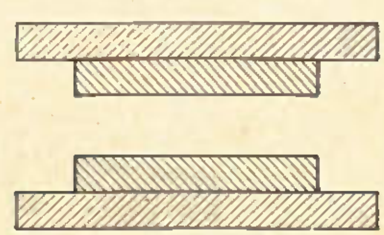


Fig. 4. Scanning/deflection coil cross-section. The coil assembly fits over most of the length of the vidicon.

PICTURE TO SIGNAL

such a material (which must be formed and kept in a vacuum), electrons are released, and the current which can be drawn from the surface depends on the intensity of the light. To draw this current, an accelerating voltage must be used, and this must be in the region of 1000 V. By using electrodes of carefully designed shape, the electrons leaving the photocathode, (as the film of photoemissive material is known) can be made to keep the relative positions which they had as they left. In this way, an 'image' of electrons exists at any plane parallel to the photocathode, and electrons landing on any surface on such a plane should recreate an image in the form of electric charge, since each electron is a unit of electric charge.

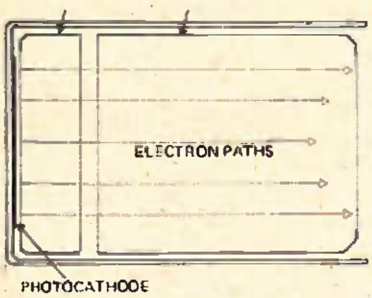


Fig. 5. Image section of Image Orthicon. The photocathode releases electrons in numbers which depend on the light level, and the electrons are accelerated by the G6 and target cup towards the target.

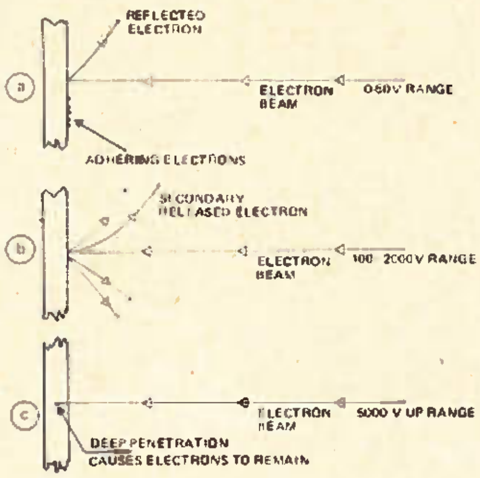


Fig. 7. Secondary emission. (a) At low accelerating voltages, the electrons stick to the surface or reflect. (b) At higher accelerating voltages, more electrons come off the surface than reach it, so that an insulator surface becomes steadily more positive as the electrons hit it. It cannot become any more positive than the most positive electrode near it. (c) A very high accelerating voltages, electrons penetrate so deeply that there is no return, and an insulator becomes steadily negative.

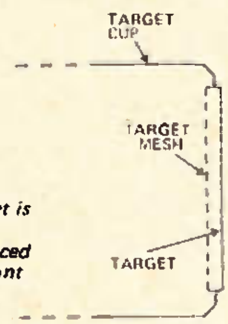


Fig. 6. The target assembly. The target is of glass, the target mesh of copper spaced about 0.001" in front of the glass.

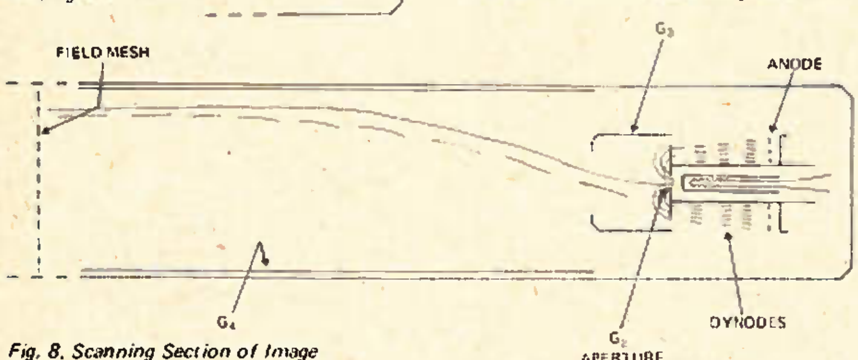


Fig. 8. Scanning Section of Image Orthicon. The electron gun is inside the dynode assembly, and projects a beam towards the target. The beam is focused and scanned by the coil assembly. The electrodes, particularly the field mesh, are arranged so that the beam approaches the target at a low speed and at right angles to the target surface. The return beam hits the G_2 surface, which is also the first dynode, releasing large numbers of electrons, which are then multiplied in turn by the remaining dynodes. The final signal is obtained from the anode connection.

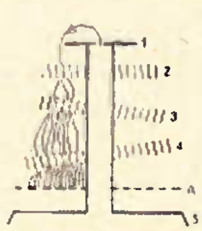


Fig. 9. Dynode assembly. The dynode consists of fine metal vanes and mesh coated with the metal Caesium, which is a good secondary emitter.

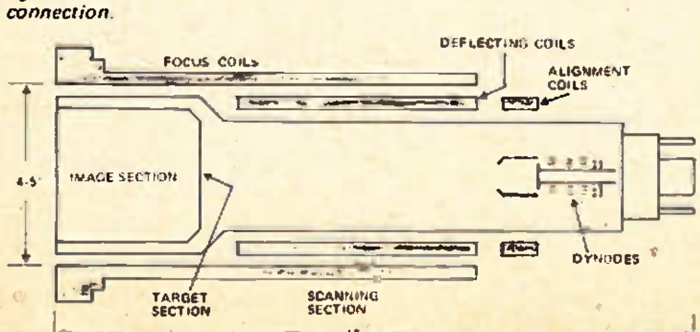


Fig. 10. Overall section of Image Orthicon. Note the complexity of focus, scan and beam alignment coils.

THE TARGET SECTION

The target of the image orthicon is a thin film of glass which is slightly conducting. This is no ordinary glass, but a material which is able to conduct by flow of electrons through it, and it is made as a very thin film, less than a thousandth of an inch thick.

Two properties of this material are used. One is the now-familiar idea of charge storage, using the glass as one plate of a capacitor to store charge, the other plate being the target mesh. The second property is 'secondary emission', a property of all substances but little known outside this field of electronics.

When a surface is hit by electrons, the way in which it is affected depends on the speed of the electrons. Very slow electrons, accelerated by only a few volts, simply remain on the surface or bounce off. The electrons which remain cause the surface to be charged negatively, unless there is a conducting path to discharge it. When faster electrons are used, accelerated perhaps by several hundred volts, the energy of the electrons can cause the target material to release some of its *own* electrons. For each electron that surfaces, there may be more than one released, so that the surface, if it is an insulator, charges *positively*, as it is losing *negative* electrons.

The voltage which exists between the photocathode and the target is enough to ensure that this condition exists, so that the electrons striking the target from the photocathode leave more than their fair share of charge behind them. If the electrons from the photocathode have retained their relative positions so as to form an image, they will leave an image of charged areas on the target after the secondary emission process has taken place. The formation of a true charge image can take place only if no electrons return to the target; as the target is positively charged by the secondary emission process, this is likely to happen unless there is a more positive surface to attract the electrons. This, however, must be able to distinguish the secondary emitted electrons which must be trapped from the electrons from the photocathode, which must be allowed to pass through with as little impediment as possible. This rather difficult task is performed by a metal mesh of very fine texture (750 lines per inch in each direction) which is spaced close to the target on the photocathode side and which also acts as a capacitor plate. The rapidly moving electrons from the photocathode pass through the holes in the mesh, though a rather large fraction (about 40 per cent) is intercepted. The mesh is held at about 2 V positive, and the slow-moving secondary electrons are readily trapped.

This established the charge image on the target, it only remains to scan it and take the signal out.

THE SCANNING SECTION

One of the peculiar advantages of the image orthicon, over earlier tubes, is that the target is scanned from the opposite side from the photocathode, so that there is some degree of isolation between the photocathode imaging magnetic fields and the scanning fields. This is possible because the target is made of a glass which conducts slightly through the thickness of the film, but very little across the surface. Because of this, the positive charge which appears on the photocathode side appears also on the scanning side of the target. The resistance of the glass is so high though that we cannot make use of a beam current to the target to form a signal.

Instead, the beam which scans across the target from the electron gun is made to strike the target at such a low speed that the main part of the beam returns down the tube to the gun. How much of the beam will return depends on the conditions at the target. If the beam is scanning over a positive portion of the target, the electrons of the beam will land on the positive target until the surface is discharged. If the beam is scanning over a more negative portion of the target, most of the beam will return, as there is much less charge to replace. The return beam therefore carries the charge information, being dense where the beam has scanned a more negative target area (low light level at the photocathode) and thin where the beam has scanned a more positive area (high light level at the photocathode). Unfortunately, because the spot size of the beam must be small, the beam current is very low, and amplification of such a small signal would be difficult and would give signals of very poor signal-to-noise level.

The solution is to amplify the beam current variations noiselessly within the tube itself.

On the way back to the gun, the return beam strikes a surface called the first dynode; a surface of metal at a high voltage (about 500 V) and coated with a material which is a good secondary emitter. Four or five secondary electrons are released, for each electron of the return beam landing on the first dynode. This represents an amplification of the beam signal four or five times.

This does not finish the process, though, for the secondary electrons can be accelerated in turn to a second dynode so that each one releases another four or five, and the process may be continued to five dynodes before the final anode at which the total current of the amplified beam signal is available. Because no other electrons are involved, this process of multiplication, as it is called, adds practically no noise to the signal, and enables a usable signal output to be obtained from a beam signal too small to be used at the light levels now common. Each dynode must, of course, be run at a voltage rather higher (several hundred volts) than the previous one to ensure that the electrons released from one dynode are attracted to the next.

OVERALL ACTION

The overall action is as follows; assume an image of half light, half dark across one line. The image on the photocathode causes electrons to be emitted — in large numbers on the bright side, very few on the dark side. These electrons are accelerated, without changing positions, to the target. The electrons from the bright side of the photocathode cause the target to have a voltage of several volts positive (relative to the gun cathode) and the electrons, few in number, from the dark side leave the target at its natural voltage close to the voltage of the gun cathode. Because of the conductivity of the cathode, the voltages appear also on the other side of the target. On this other side, the electron gun scans with a fine-spot beam across the target. As the beam scans across the half which is positive, (corresponding to the bright side of the photocathode), the beam lands, and very little of the beam returns. On the other half of the scan, where the target is at low voltage (corresponding to the dark portion of the photocathode), the beam is almost totally reflected. The return beam, whose current depends on the state of the target, has its fluctuations amplified by the dynodes. Finally the signal emerges as a current signal at the final anode. Note that the action of scanning has left the target on the scanning side at a uniform voltage, and the time between the scans is available for charging up the target again, so giving the storage action required.

PROBLEMS AND DEVELOPMENTS

The target action has proved to be the greatest headache in image orthicon design and used for the conductivity of the target is most critical.

If the conductivity is low, then the scanning beam will be unable to wipe off the signal from the photocathode side, and the target will be 'sticky', meaning that a scene will remain, giving an output signal after the tube has been pointed at another scene or capped up; this, of course, makes the tube useless for scenes having movement.

If the conductivity is too high, the charges may move sideways on the target and so cancel each other out, giving a low signal output.

Before the invention of the electronically conducting target, due mainly to Peter Banks of E.E.V., problems of this sort were endemic, and it was accepted that the life of an image orthicon would be a short one due to target deterioration.

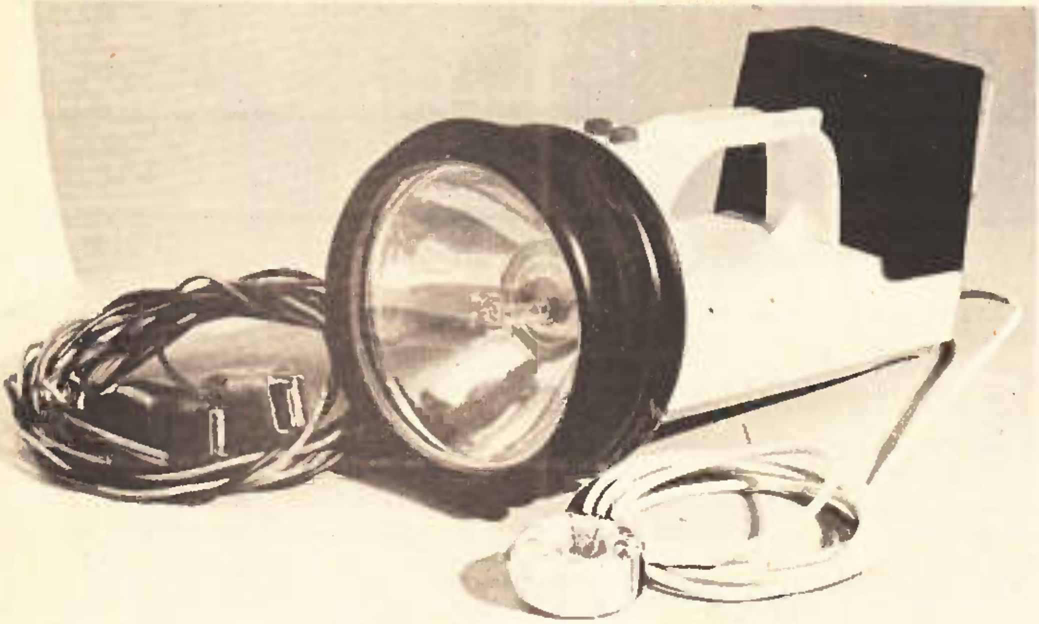
The new types of target have changed this dramatically, and excellent working is achieved provided that the target is run at the correct temperature — since its conductivity varies with temperature. Cameras for image orthicons have always incorporated thermostatically controlled heaters and blowers to keep the target of the tube at a constant temperature.

The main development of recent years concerns the use made of the beam. It is rather illogical that the return beam should be most dense in the part of the target corresponding to low light, for a large return beam density means greater noise in the signal just where the signal is small and can least afford greater noise. The image isocon is a development of the image orthicon, which makes use of the different type of reflections of electrons at the target to separate the signal-carrying electrons from the remainder which make up the steady beam current. This gives an enormous increase in signal-to-noise ratio, enough to enable the isocon to be used in applications where the light level is too low for normal vision. Such tubes are even more of a precision job than the image orthicon, and so are not in quantity production, but have undoubted applications.

SUMMING UP

The camera tubes used for television purposes are remarkable achievements in electron beam technology, and at the moment there seems nothing likely to replace them from the "solid-state" stable. The scanning operation is the most difficult to replace, an operation which is comparatively simple to carry out on an electron beam presents most formidable difficulties in a solid array; the problem is not impossible, and has been solved after a fashion for low definition pictures, but its extension to the high-definition picture to which we are accustomed is fraught with difficulty. It seems likely that we shall be living with the vidicon and its larger cousin, the image orthicon, for a long time to come. ●

TACHO TIMING LIGHT



PROJECT 311

Extended circuitry allows timing check over full speed range.

Our September issue described a project for a single timing light with a xenon flash lamp. Now we describe a more advanced instrument which will facilitate updating of the earlier design. This instrument incorporates a calibrated delay which gives a meter indication of the exact advance of the ignition in degrees — at any engine speed. It has a built-in tachometer so a serious enthusiast could check the complete distributor advance curve.

The use of such an instrument will allow checks on the correct operation of the distributor particularly with respect to mechanical and vacuum advance with increasing RPM.

CONSTRUCTION

The layout and construction of the timing light will vary depending on the housing.

We purchased a cheap torch which takes four HP2 batteries.

Our layout and method of construction can be seen from the illustration but this can readily be varied to suit the housing used.

Most of the electronic components are mounted on a printed circuit board which can be assembled with the aid of the circuit diagram and the component overlay, Fig. 2. Check the polarity of diodes, capacitors and transistors etc before soldering. All external wiring to the PC board is numbered and interconnections from the PC board to external components should be made with the aid of the circuit diagram, note that C4 is mounted on the back of the meter and C12 on the rear of the reflector.

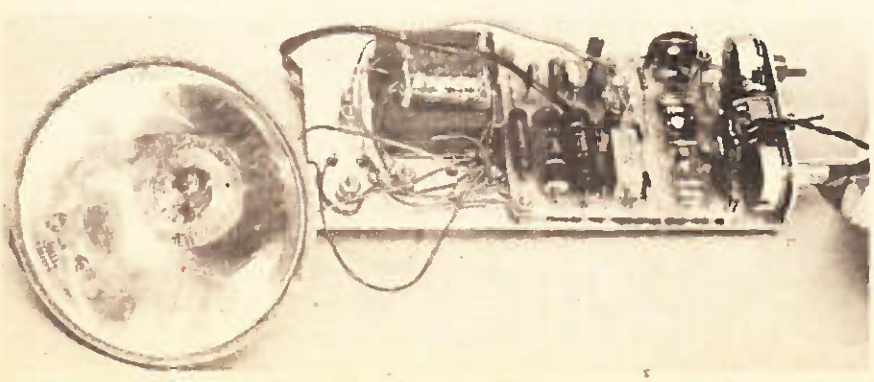
The inverter power transistors should be mounted on, but insulated from, a heatsink made from aluminium sheet of at least 40 square centimetres area.

If the unit will not oscillate, (you will hear a 2 kHz whistle when it is oscillating) try reversing the feedback winding.

The secondary voltage is around 350 volts and care should therefore be taken to insert insulation as specified in Table 1, between the primary and secondary windings in the transformer, and to keep the windings separate on the matrix board.

The reflector of the torch may be modified to house the flash lamp in the following manner.

Remove the existing socket, using a pair of pliers or cutters, and file the



Assembly of the unit may be seen from this photograph.

WARNING

On some cars the fan blades rotate close to or at a multiple of the crankshaft speed. When strobed by the timing light, the fan may appear to be stationary or rotating slowly.

This is common to all strobe light timers and failure to remember this can result in serious personal injury, or a wrecked timing light.

ALWAYS — keep well clear of the fan, or remove the fan belt whilst timing the engine.

opening until it is large enough to accept the flash lamp with about one millimetre clearance all round. Insert the lamp from the front and use modelling clay at the rear of the reflector to hold the lamp and seal the opening. Then pour quick-dry epoxy cement into the reflector until there is sufficient around the base of the tube to secure it in place. Be careful not to get epoxy elsewhere on the reflector. When dry, remove the clay and use more epoxy to fill any recesses in the rear.

If and when the tube is to be replaced a hot soldering iron may be used to destroy the epoxy thus permitting removal.

The discharge capacitor C12 should be mounted on the rear of the flash-tube/reflector assembly as shown in the photograph.

The pick-up coil is wound on a toroidal ferrite core, as shown in the photograph, using screened audio cable as follows. Remove about 0.8 metres of the inner cable from its shield and wind 20 turns of this around the ferrite core. Then solder the end of the inner conductor to the screen thus creating a complete loop.

The coil should also be shielded to prevent the magnetic field around nearby spark-plugs (other than number one plug) from triggering the timing light. To do this we cut strips of aluminium foil about 10mm wide and sandwiched them between two layers of 12mm wide cellulose-tape to produce a continuous strip of insulated foil 1 metre long. A length of wire should be connected to one end so that the strip may be connected to the screen of the coaxial cable. The foil is wrapped around the coil, in a similar manner to the coax, except that the ends of the foil must not touch. Should the ends touch, a shorted turn would be created which would prevent the transducer from operating at all. The coil should be completely covered and will appear as shown in the photograph.

CALIBRATION

Two different methods may be used to calibrate the timing light. In method A, the preferred method, you will need an oscilloscope with a triggered and calibrated time base, and an accurate tacho. In method B you will have to prevail on the local garage to allow you to calibrate your unit against their accurate (?) unit.

Method A.

1. Connect the unit to the engine with the transducer over number 1 spark lead.
2. Switch the timing light to "tacho" mode.
3. Start the engine and adjust the sensitivity control to the minimum setting that allows the meter to move smoothly as engine revs are increased.
4. With the CRO monitor between the common line and the collector of Q4, the voltage should swing from zero to +9 volts and back to zero each time the number one plug fires.
5. Adjust RV2 such that the pulse width at Q4 collector is 1.67 milliseconds.
6. Remove the CRO leads and set the engine revs to 3000 with the aid of the accurate tachometer.
7. Adjust RV4 such that the meter reads 3000 RPM. This completes the calibration.

Method B.

1. Connect both your timing unit and the garage unit to the car.
2. Switch the unit to "timing" mode.
3. Start the engine and set the RPM to 3000.
5. Now using your own unit adjust the sensitivity control as in step 3 method A.
6. Adjust RV1 until the timing marks coincide.
7. Adjust RV4 such that the same reading is obtained on meter M1 as on the garage unit.
8. Switch to tacho and adjust RV2 to read 3000 RPM.

Note that the engine must be held at constant speed throughout this process.

USING THE UNIT

The workshop manual for most cars contains details of the timing changes with respect to engine RPM and vacuum. If an engine is to perform at maximum efficiency these characteristics need to be checked and corrective measures taken if out of tolerance.

To check mechanical advance:

1. Remove vacuum line to distributor.
2. Fit transducer over number 1 spark-plug lead.
3. Switch timing light to "TACHO"
4. Start engine and switch on timing light.
5. Adjust sensitivity such that meter indicates correct RPM over full range without undue jitter.
6. Set the idle speed as specified in manual.
7. Switch to TIMING and set "timing adjust" potentiometer until the flywheel mark corresponds with TDC mark on the crankcase. (If some other mark than TDC is used, simply add the number of degrees the mark is BTDC (before top dead centre) onto the meter reading). If this is less than 2° advance (minimum obtainable with delay) switch SW3 may be used to remove all delay.
8. Switch back to tacho and increase speed to next calibration point as detailed in the manual.
9. Whilst holding engine revs steady at this setting, switch back to "TIMING" and set "TIMING ADJUST" until the marks again coincide. The meter now indicates the number of degrees of advance. Note that engine revs must not change otherwise the reading will be in error.
10. Repeat 8 and 9 for all other specified calibration points.

To check vacuum advance:

The only points on vacuum advance that need checking are the maximum advance with vacuum and that a vacuum is held, ie no leaks in the distributor.

1. With the motor idling check the timing with the vacuum line disconnected.

2. Draw a vacuum in excess of the normal vacuum (sucking the line by mouth will be sufficiently effective) and check the timing advance against that specified in the manual.

3. Hold the vacuum in the line and check that the timing does not shift (due to leak in distributor vacuum mechanism).

If a more accurate check is required the above checks can be done in conjunction with a vacuum gauge.

(Note — refer to September 1974 issue re capacitor life)

SPECIFICATION

Energy per flash	0.2 joule
Maximum flash rate	>50/sec (6000 rpm)
Trigger method	current transformer on No 1 spark lead.
Input voltage	10-14 volts dc
Timing meter range	$0-50^{\circ}$
Minimum delay 0° is switchable	$<4^{\circ}/1000$ rpm
Maximum delay 50° maximum	$>40^{\circ}/1000$ rpm
Tacho meter range	0-5000 rpm

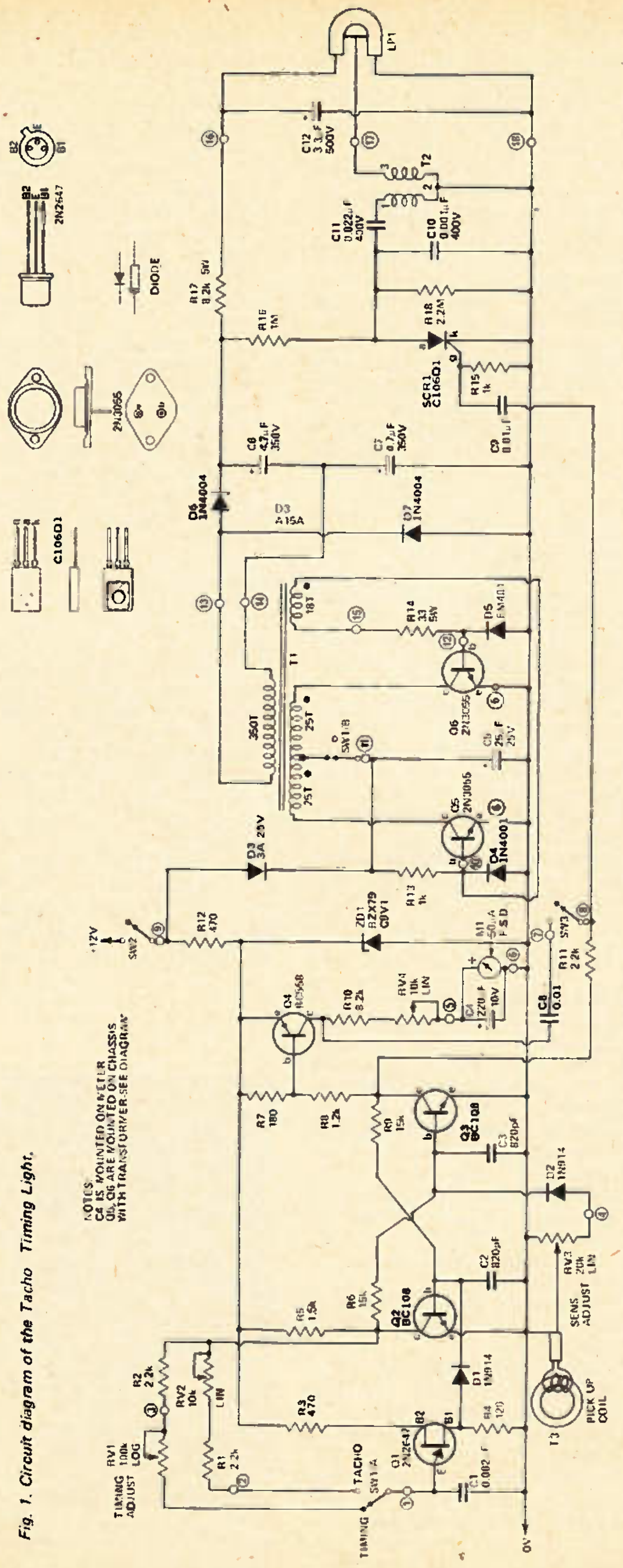
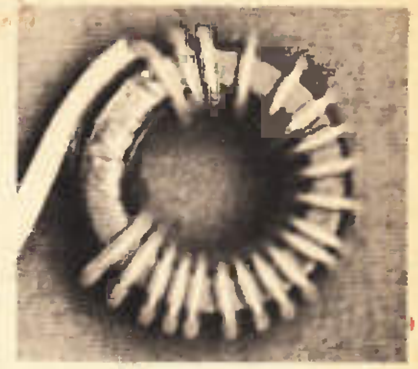


Fig. 1. Circuit diagram of the Tacho Timing Light.



This picture shows how the transducer is wound with the inner core of screened cable. Aluminium foil shielding is wound over the completed coil as detailed in the text.

PARTS LIST
TIMING LIGHT
ETI 311

R14	Resistor	33 5W	5%
R4	"	120 ¼W	"
R7	"	180 ¼W	"
R3	"	470 ¼W	"
R12	"	470 ½W	"
R13,15	"	1k ¼W	"
R8	"	1.2k ¼W	"
R5	"	1.5k ¼W	"
R1,2,11	"	2.2k ¼W	"
R10	"	8.2k ¼W	"
R17	"	8.2k 5W	"
R6,9	"	15k ¼W	"
R16	"	1M ¼W	"
R18	"	2.2M ¼W	"
RV1	Potentiometer	100k log rotary	
RV2,4	"	10k trim type VTU or similar	
RV3	"	20k lin rotary	
C2,3	Capacitor	820pF ceramic	
C10	"	0.001μF 400V polyester	
C11	"	0.022μF 400V polyester	
C8,9	"	0.01μF polyestor	
C1	"	0.082μF polyestor	
C12	"	3.3μF 500V electrolytic	
C6,7	"	4.7μF 350V electrolytic	
C5	"	25μF 25V electrolytic	
C4	"	220μF 10V electrolytic	
Q1	Transistor	2N2647	
Q2,3	"	BC108	
Q4	"	BC178	
Q5,6	"	2N3055	
SCR1	SCR	2N6240 C106D1	
D1,2	Diode	1N914 or eouivalent	
D3	"	3A, 25V.	
D4,5	"	1N4001	
D6, 7	"	1N4004	
ZD1	Zener diode	BZX79C9V1 (9.1V 400mW)	
T1	Transformer	see text	
T2	Pulse Transformer	"	
T3	Pickup coil	"	
LP1	Flash tube		

PC board ETI-311
M1 meter 0.50μA FSD
SW1 Switch 2 pole 2 position.
SW2,3 switch single pole on-off.
(There were already incorporated in the torch housing used in our prototype)
reflector, heatsink, housing for electronics.

HOW IT WORKS ETI 311

The flash tube used requires a supply of 300 to 400 volts. This is obtained by stepping up the vehicle 12 volts supply by means of an inverter.

Transformer T1, together with transistors Q5 and Q6 form a self oscillatory inverter. The frequency of operation, about 2 kHz on a 12 volt supply, is primarily determined by the core materials, the number of primary turns and the supply voltage. Protection against reversed-polarity supply leads is provided by diode D3.

The output from the secondary of transformer T1 is voltage doubled by D6, D7, C6 and C7 to provide about 400 volts dc which is fed to the flash tube via R17. Capacitor C12, in parallel with the flash tube, charges to this voltage and thus stores the energy needed for the flash.

Capacitor C11 is also charged up via R16 and the energy stored in this capacitor is used to trigger the flash as follows. When the SCR is triggered by a pulse on its gate it conducts and rapidly discharges C11 through the primary of pulse transformer T2. The pulse of current through the primary of T2 induces a 4000 volt pulse in the secondary winding which fires the flash tube.

When C11 is fully discharged the current through R16 is not sufficient to hold the SCR on and it turns off. Thus the flash is fired at a time determined by timing of the trigger pulse to the SCR.

The pulse from number one spark-plug lead is picked up by transducer T3 and used to trigger a monostable consisting of Q1, 2 and 3. Each time a spark-plug pulse occurs Q3 turns on and Q2 turns off, and remains off for a predetermined time before resetting. Whilst Q2 is off C1 charges via RV1/R2 (or RV2/R1) and when the voltage across it reaches about 6 volts the unijunction transistor Q1 fires, discharging C1, producing a pulse which resets the monostable. By varying the setting of RV1 the time duration of the monostable pulse can be altered.

Transistor Q4 simply inverts the output pulse train from Q3 and drives the meter M1. When Q3 is on Q4 is on and its collector is at +9 volts, and when Q3 is off Q4 is off and its collector at zero volts. Thus capacitor C4 will charge to a voltage which is proportional to the average of the on/off ratio, and this voltage is read by the meter. Zener diode ZD1 stabilizes the supply to Q4 at 9.1 volts.

The output of Q3 (Q4 in the no delay mode) is used to trigger the SCR. Since the SCR requires a positive pulse to trigger it, it will fire when Q3 turns off, that is, at the end of the delay period produced by the monostable. Since the output of Q4 is "inverted", when this output is selected the SCR fires the instant Q3 turns on, that is without any delay.

In the timing mode the delay period is adjustable by means of RV1 so that the timing mark on the flywheel is aligned with that on the block. The meter M1 will then read the number of degrees of spark advance. In the tacho mode the inverter is disconnected to disable the strobe and a preset delay of 1.66 msec is selected. The meter now reads RPM with full scale of 5000 RPM.

The picture shows how the transducer is wound with the inner core of shielded cable. Aluminium foil shielding is wound over the completed coil as detailed in the text.

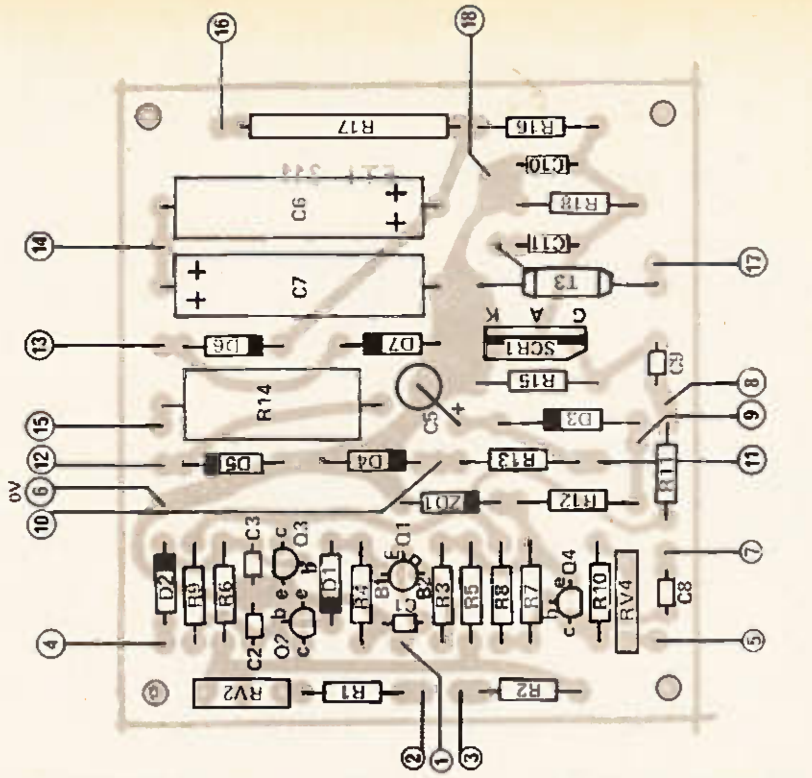


Fig. 2. Component overlay for the Tacho Timing Light (this drawing has been placed sideways on the page to simplify checking against main circuit drawing).

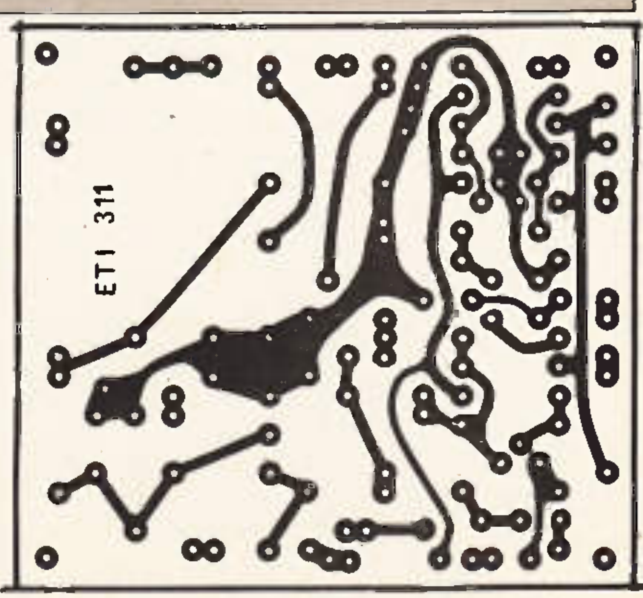


Fig. 3. Printed circuit board dimensions 74mm x 82mm (full size).

GETTING HOLD OF THE COMPONENTS

THE TRANSFORMER
This is available for £2.37 including VAT and postage from RCS, MCQ or Henry's. The RCS transformer will not fit the PCB mentioned below. Winding details were given in our September issue.

THE XENON FLASH TUBE AND TRIGGER TRANSFORMER
These can be bought from Henry's disco store or MCQ Entertainments for a special ETI readers' reduced price of £4.84 including VAT and postage. The ZFT-8Z tube is slightly different from the one in our prototype, but the same mounting method will work.

THE PICK-UP COIL
This is made from a ferrite ring with an inside diameter of 1". The Mullard FX1588 will do. Further details are given in the text.

THE PCB
PCB's are available for this project or the simpler version for £1.25 plus 15p P & P, from MCQ. However these are suitable only for the transformers from MCQ or Henry's.

RCS Products Ltd, 31 Oliver Road, London E.17.
Henry's Radio (Disco), 303 Edgware Road, London W.2.
MCQ Entertainments, 9 Greystoke House, Frensham Street, London SE15.

Now–two fascinating ways to enjoy saving money!

NEW! Sinclair Scientific kit £19.95 (INC. VAT)

Britain's most original calculator now in kit form
The Sinclair Scientific is an altogether remarkable calculator.

It offers logs, trig, and true scientific notation over a 200-decade range – features normally found only on calculators costing around £100 or more.

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Forget slide rules and four-figure tables!
With the functions available on the Scientific keyboard, you can handle *directly*

- sin and arcsin,
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- automatic squaring and doubling,
- $\log_{10}$, antilog_{10}, giving quick access to x^y (including square and other roots),
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So is the Scientific difficult to assemble?
No. Powerful though it is, the Sinclair Scientific is a model of tidy engineering.

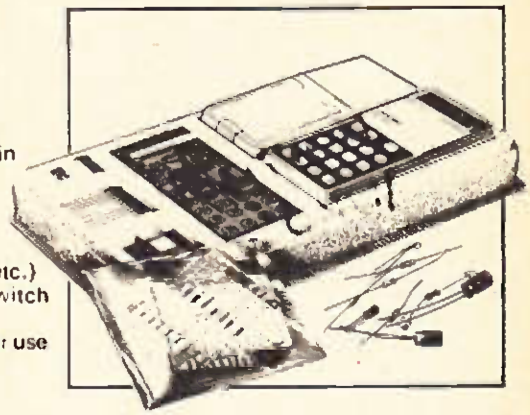
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our Service Department will back you throughout if you've any queries or problems.

Of course, we'll happily supply the Scientific or the Cambridge already built, if you prefer – they're still exceptional value.

Components for Scientific kit (illustrated)

1. Coil
2. LSI chip
3. Interface chips
4. Case mouldings, with buttons, windows and light-up display in position
5. Printed circuit board
6. Keyboard panel
7. Electronic components pack (diodes, resistors, capacitors, etc.)
8. Battery assembly and on/off switch
9. Soft carrying wallet
10. Comprehensive instructions for use

Assembly time is about 3 hours.



Features of the Sinclair Scientific

● **12 functions on simple keyboard**
Basic logs and trig functions (and their inverses), all from a keyboard as simple as a normal arithmetic calculator's. 'Upper and lower case' operation means basic arithmetic keys each have two extra functions.

● **Scientific notation**
Display shows 5-digit mantissa, 2-digit exponent, both signable.

● **200-decade range**
10^{-99} to 10^{+99}

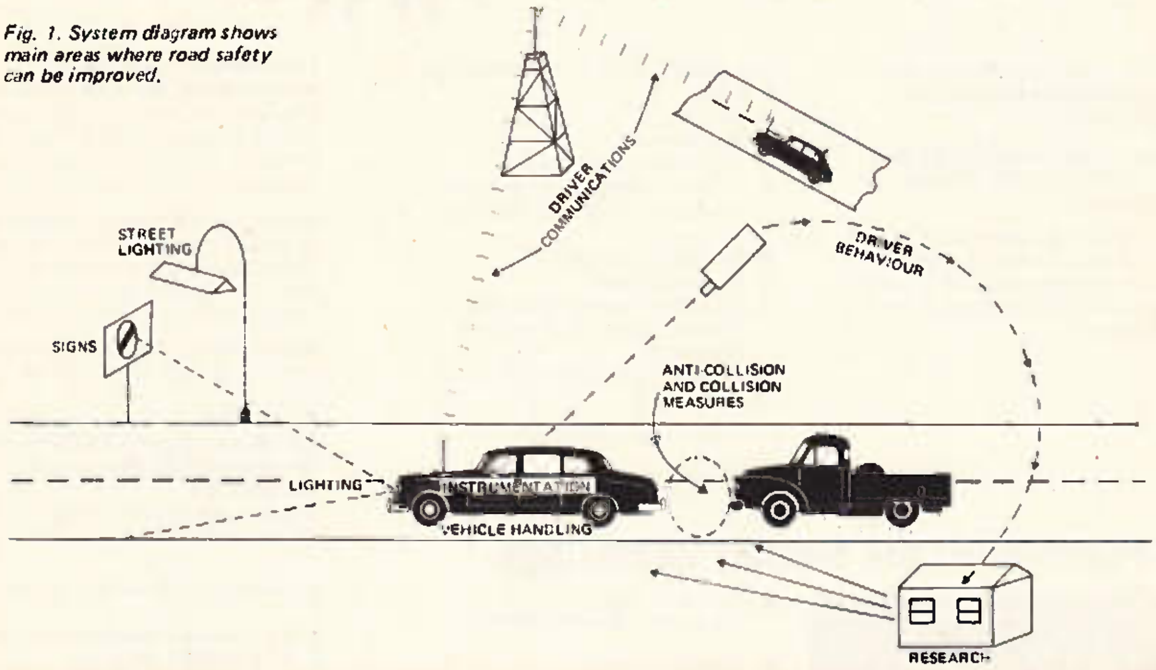
● **Reverse Polish logic**
Post-fixed operators allow chain calculations of unlimited length – eliminate need for an = button.

● **25-hour battery life**
4 AAA manganese alkaline batteries (e.g. MN 2400) give 25 hours continuous use. Complete independence from external power.

● **Genuinely pocketable**
4 1/3" x 2" x 11/16". Weight 4 oz. Attractively styled in grey, blue and white.

ROAD SAFETY -an electronics

Fig. 1. System diagram shows main areas where road safety can be improved.



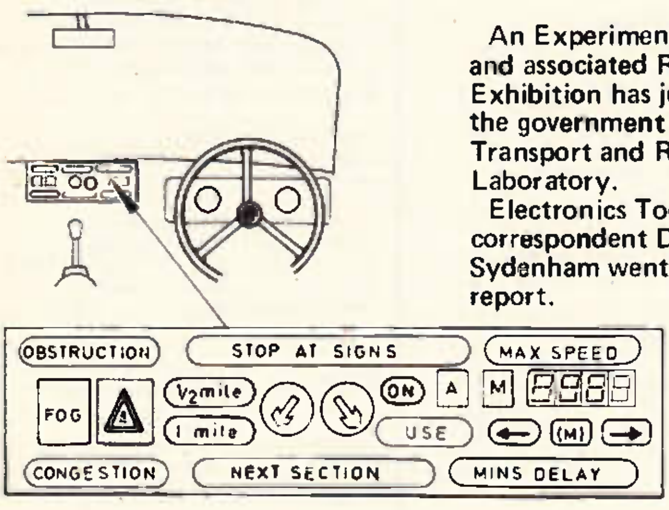


Fig. 2. Indicating panel of advance warning equipment 'AWARE'.

An Experimental Safety Vehicles and associated Road Safety Exhibition has just been held at the government sponsored Transport and Road Research Laboratory.

Electronics Today's special correspondent Dr. Peter Sydenham went along to report.

SOME road accidents may well be inevitable, believe many road research workers.

A driver has to make too many virtually instantaneous decisions as his vehicle progresses through a seething mass of hopefully well-controlled movement. Too often speed and the number of events are beyond his capability to react correctly and in time — and accidents occur.

Hence, any economic method of improving the available data will help the driver improve quality of decisions — and this will improve safety.

But the driver cannot take in up-dated data at a rate faster and more distant than his senses can perceive. Better communications are required.

Radio is an obvious way to improve communication and the BBC are working on a plan that will provide motoring information at all times, rather than relying on disk jockeys who give it at present.

The proposal is that network groups of single frequency stations be created at 50 km separations working on an exclusive medium-wave frequency to ensure easiest reception.

Time-multiplexing the stations in a group will put sixteen of them on the air together at any one time, sending a thirty second message. This way a vehicle will receive data at eight minute intervals and the problems of interference will be largely avoided.

An override control will enable a central transmitter to speed up the interval time to cope with more urgent messages. These groups would be repeated with minimum distances of 200 km between identical transmitters to reduce mutual interference.

There is also talk of an international motoring service that would extend the concept beyond Britain into the all European community. As the reception is at a single frequency the receivers would be inexpensive.

The use to which the system can be put is widespread. A traveller in each group area can be informed of bottle-necks to avoid and of approach into fog or rain; police messages can be sent more readily and so forth.

The system provides communication in the macro road system but would

approach

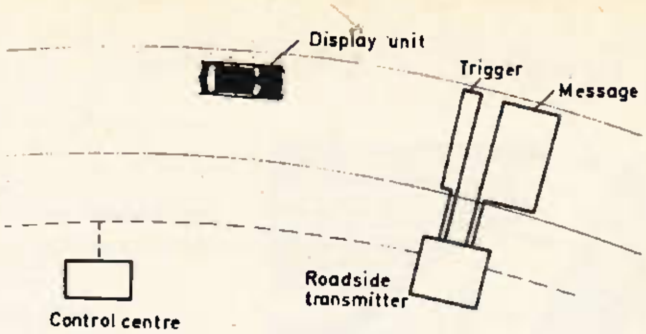


Fig. 3. Loops set into the road trigger the AWARE panel in the vehicle.

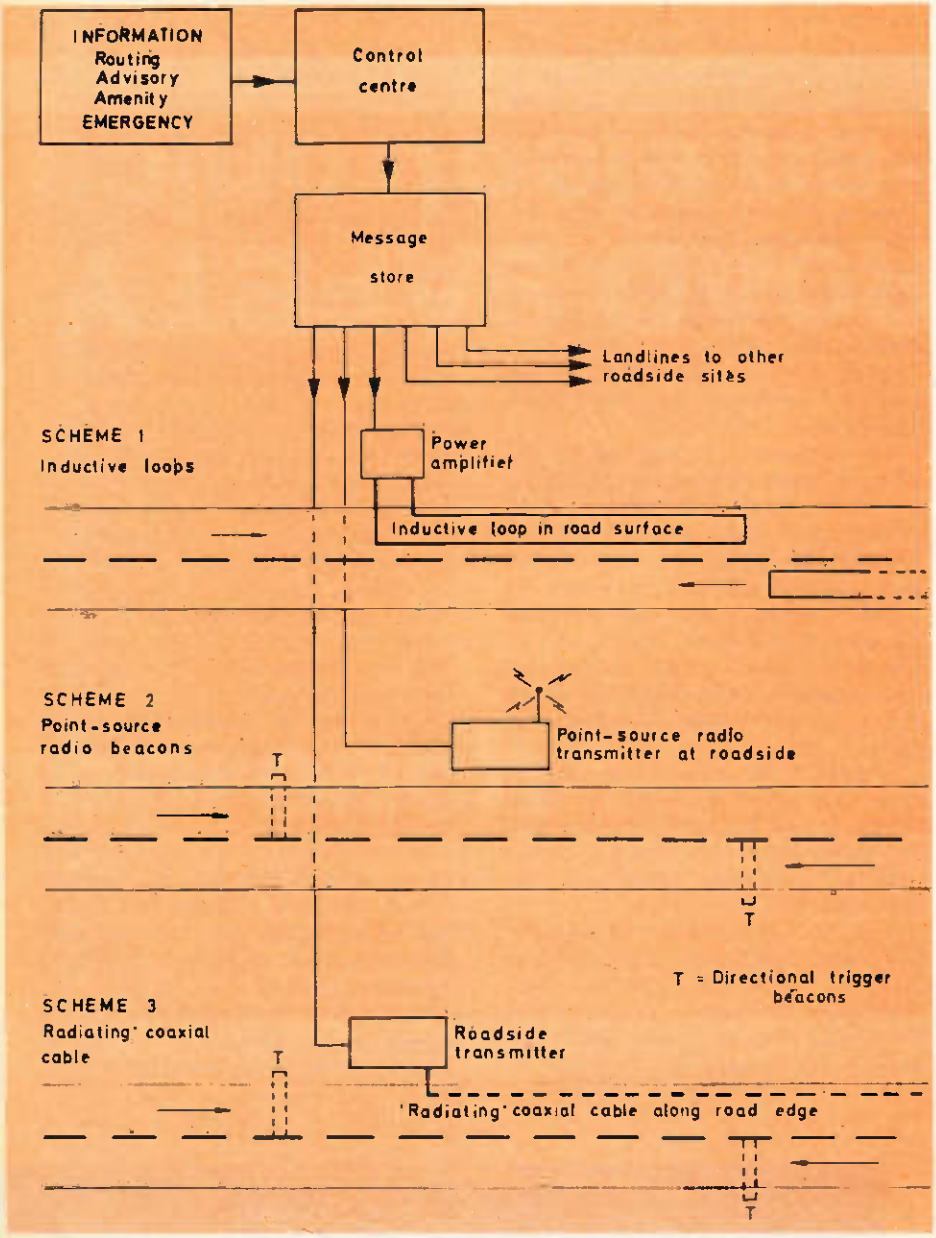


Fig. 4. Alternative schemes under study as means to provide driver communication.

be unable to provide for the very immediate needs of the driver. This would be catered for by other systems now in development. Firstly let us look at "AWARE".

ADVANCE WARNING EQUIPMENT

The design aim is to provide the driver with a number of valuable tit-bits of information as well as danger warnings. On the dash panel will be a display — shown in Fig. 2 — that normally appears opaque.

The rear mounted signs will illuminate selectively to compose a message. For example, to warn of a hazard or delay ahead it would show for about one minute.

"CONGESTION 1 MILE 20 MINS DELAY"

It can also be used to suggest alternative routing and the nature of the road hazard. (The displays exhibited have now passed through four different physical forms. The next stage is said to be rear projection to bring the message into a single line but obviously an LSI light emitting diode matrix will come with time to reduce the area needed and the cost of the display).

The next requirement is that the display be set up by some means that is external to the vehicle as it travels.

Inductive loop and ferrite-cored coil sensing is proposed in the manner shown in Fig. 3. Alongside the appropriately serviced road is a system to excite the message loop (after the unit in the car is triggered on).

At present, 108 bits of data can be sent. Fourty four control the message, thirty two carry the variables of the message and five are used for checking. A trigger loop is included to provide the necessary directional data ensuring that the driver gets data for what lies ahead, not behind.

This is an EEC development, and is intended for use on the European road network in general.

Allied to the same concept is RITA (road information transmitted aurally) which gives the driver similar information via the ear rather than the eye.

There are many reasons for pursuing this alternative and it is yet unclear which is the best as both have their respective pros and cons.

Language variation across Europe is an obvious problem for aural systems whereas visual distraction and changing illumination levels go against visual counterparts.

Three alternatives are under study for RITA — inductive loops, point-source radio beams and radiating coaxial cable. The alternatives are shown in Fig. 4.

It remains to be seen which system of communication will be adapted but certainly any is better than the present virtually non-existent services.

The potential of this work is great for it paves the way to automatic vehicle guidance and navigation.

LIGHTING

Lighting is one area where electronic methods are increasingly being considered.

Headlights need to be used as effectively as possible with as little glare to oncoming drivers as is

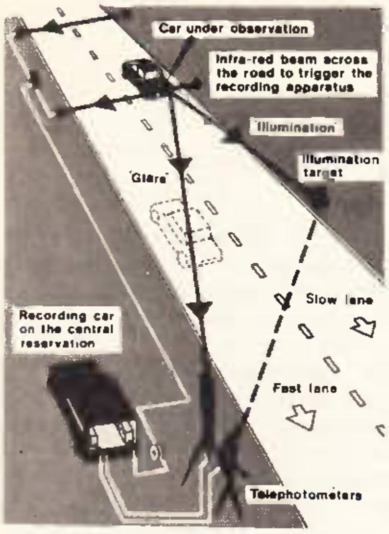


Fig.5. Telephotometers are used this way to monitor glare.

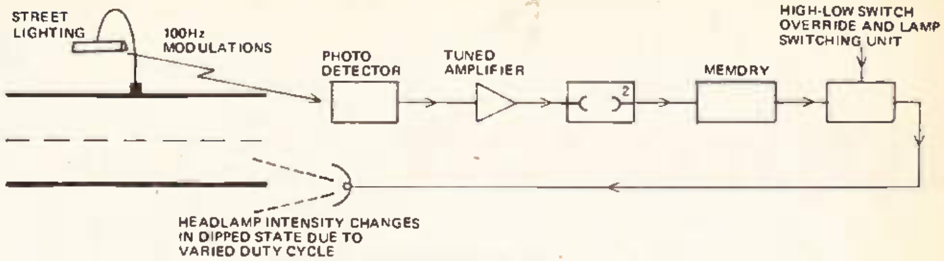


Fig.6. Schematic block diagram of TRRL automatic dimming system.

practicable. Designers need to ensure that the vehicle warning lights are efficient in all conditions that may exist. Also there are the probable improvements that can be made to street lighting.

Reducing headlight glare.

There exist a number of possible solutions: one design aim is to ensure that the headlights point correctly regardless of vehicle attitude.

Research has shown that modern vehicles tilt significantly with varying load application — 30% of private vehicles tilt from the design position by 0.5 degrees and 7 percent by up to 1.0 degrees.

These changes cause a normally well-adjusted beam to generate severe glare.

Several solutions have been tested by the TRRL and they each use some form of automatic arrangement that swivels the lamp in its bearings.

The Cibie method use hydraulic actuation, the Martin-Vaughan prototypes are entirely mechanical in principle. Road tests have shown that one feels somewhat divorced from the self-levelling lights at first, a sensation that eventually becomes acceptable.

Having provided means to keep the lights pointing correctly, it is then necessary to make actual measurements of beam distribution of the moving vehicle to decide how to reduce glare.

Figure 5 shows the TRRL set up used to monitor an on-coming car's headlights.

The recorders are triggered on by infra-red beams that are intercepted by the car. Two telephotometers (narrow viewing-angle light meters) set up (60m ahead) record the illumination level seen by the on-coming driver.

This equipment has been used to compare the British cum/American Standard with its Continental counterpart for each differs somewhat in respect to the beam distribution in space.

Research has shown that dipped lights are often annoying to other drivers in well lighted streets and that the driver cannot accurately decide whether to use them dipped or to use side lights only.

In Britain it is normal to use only side and tail lamps when driving through cities at night. This appallingly dangerous practice still continues despite many accidents directly attributable to it — one in particular, occurred about twenty years ago when a bus ran down and killed nearly 30 people.

A decade ago suggestions were made to use two-level dipped lights the effect being produced with a series resistor that dropped the lamp voltage to about 60 percent of maximum supply.

It was called the dim-dip system. The ability of drivers to use this system correctly was doubted so the TRRL designers pressed on to automate the idea.

The system specifications needed were that it be insensitive to other vehicle lights, have variable dim range (not just switched high-low), be slow to dim but fast to brighten and that no dimming should occur in daylight fog.

Basically the first TRRL system made use of the light level of the modulated content of street lights (at 100 Hz). A schematic of the system is shown in Fig. 6.

A detector is coupled to an ac amplifier which peaks selectively at 100 Hz. The output from this initial stage is proportional to light level of the 100 Hz signal.

In daylight the stage provides zero output as no 100 Hz signal is present. The ac output is then fed to a circuit that generates a square wave as long as the peak value exceeds a minimum reference value.

The variable mark-space ratio of the square wave conveys the required intensity level to a circuit that charges

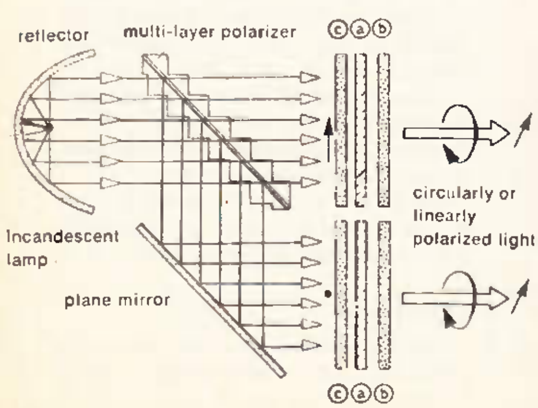


Fig.7. The Bosch polarized headlamp

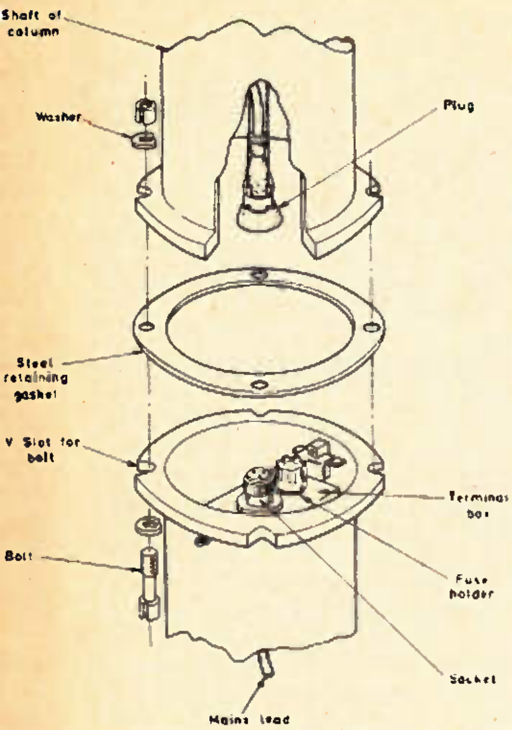


Fig.8. Breakaway column joint incorporating disconnecting plug.

a capacitor memory, providing the time constant needed, plus an output that is inversely proportional to street light level.

Headlight intensity is adjusted using this signal by on-off switching, with on periods varying from 120 to 1.2 ms, and a fixed 2 ms off period.

The switch is controlled by the voltage existing on the memory capacitor. Intensity range swing is about 75 per cent.

Another way to reduce glare is to vary the centre road-side cut-off angle of the undipped beam so that it does not shine with full amplitude into the on-coming driver's eyes.

As far back as 1969 Lucas designed a system called "Autosensa" that worked this way. As the same system was on display again without mention of improvements it appears that the idea is yet to be perfected.

It uses a projection lamp rather than the normal car bulb, with a controllable projection aperture that can be vignetted with a servo-driven slide to cut off one side of the beam.

A photo-cell senses the location of the oncoming car by the car's beam strength and causes the shutter to move across accordingly.

By far the most actively promoted scheme to reduce glare is the use of polarized lights and special polarized viewers fitted in front of the driver.

It is a relatively simple matter to polarize white light from lamps by using special optical elements. Treated this way the light can only pass a similar viewing window when the direction of polarization is the same as that of the window material.

Rotation of the polarization of the oncoming beams to be at a different angle to the viewer will give a very marked reduction in intensity. No electronics are needed and (in principle) it works.

A demonstration system was on display and one could easily look into a 100 W halogen lamp and see past it.

Unfortunately, it is not quite so easy to implement in everyday practice. Problems to be overcome include getting everyone to co-operate with the fitting of polarizers to both lights and windscreens, finding a way of maintaining correct polarization even though the vehicle is still tilted; producing polarized viewers that do not attenuate ordinary light substantially more than for polarized light and able to withstand heat generated in headlamps. Finally producing cheap polarizing elements.

A Bosch proposal is shown in Fig. 7 together with a picture of an installation in a recent model car.

The subject has been in vogue since the late 40's and could continue for some time before we see it in widespread use.

Rear lights are also receiving attention. In the ESV shown by Nissan, the tail lamps have changeable brightness to suit day or night conditions.

On the 'heavier' side are the now standard high-intensity rear warning fog lamps fitted to the Crane-Fruehauf 'doubles' haulage units.

It has long since been recognised that lighting columns should break away under impact thus reducing vehicle damage substantially.

To further reduce the hazard, and to reduce re-erection cost of the columns, TRRL have designed a special breakaway joint which also disconnects the electricity (see Fig.8) on impact.

INSTRUMENTATION

There was a period in automobile design when the instrument panel was reduced to a bare minimum.

That time seems to be passing as more alarms and indicators are introduced to keep the driver informed.

Several vehicle accessory manufacturers were displaying lamp failure indicators. Smiths method, for which a schematic circuit is given in Fig. 9, uses two reed-relay switches to monitor the two rear stop lamps. If either fails to operate, a transistor driver is operated by one of the relays, lighting a warning lamp.

Side and rear lamp indicators use a series connected bimetal switch contact that closes if no through

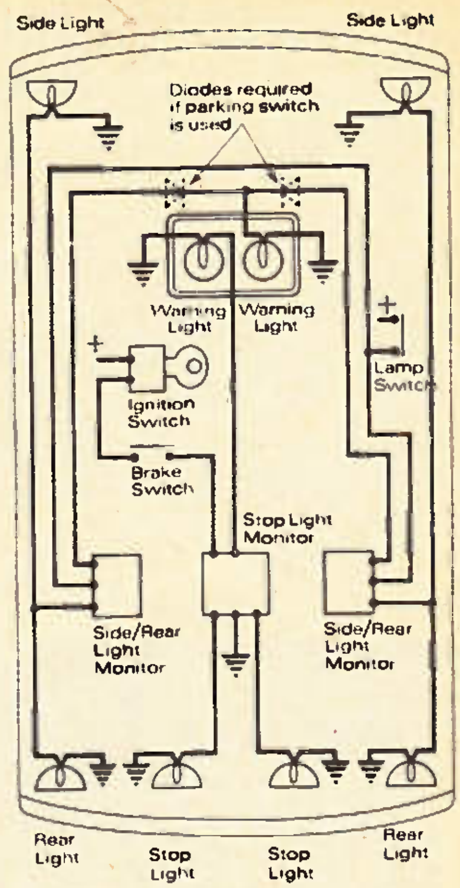


Fig.9. Lamp failure indicators are now available from original equipment suppliers.

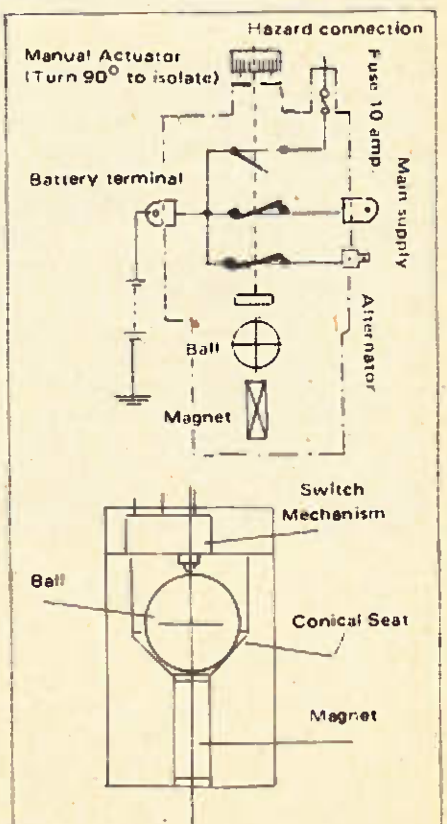


Fig.10. Schematic arrangement of inertia switch.

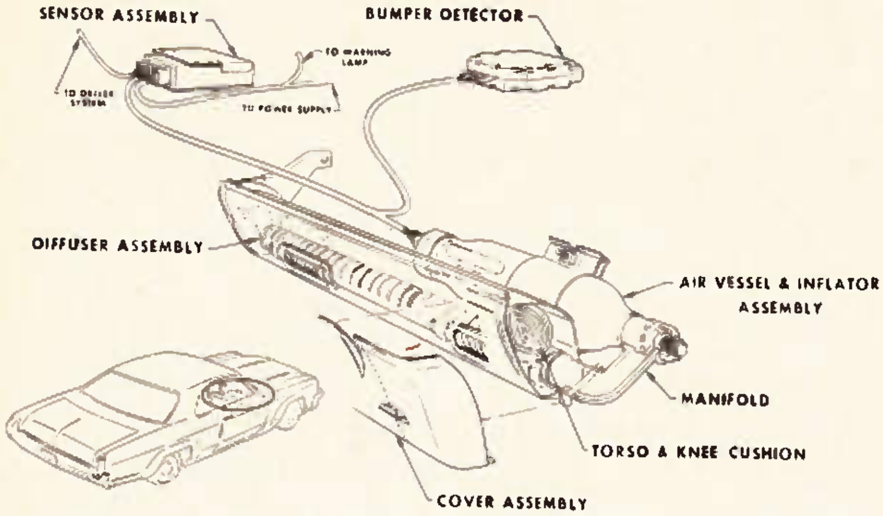


Fig.11. Accelerometers mounted in the bumper and on the fire wall are used to trigger the developmental air bag of GM.

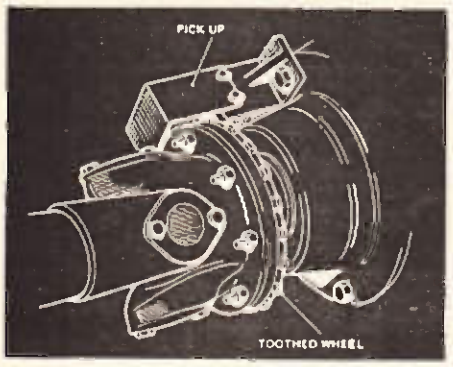
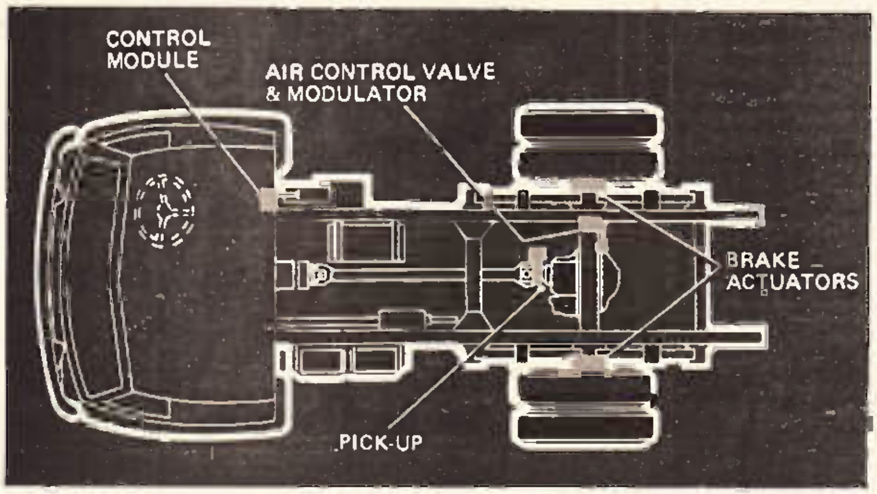


Fig.12. Position and appearance of velocity sensor used in Lockheed anti-lock braking system.



current exists to heat and bend the bimetal.

Tyre pressure sensors are also incorporated in some of the ESV units. Checks that doors are locked and even a built-in device indicating excessive breath alcohol content (Honda) were also outlined along with indication of vital component failure.

Another unit, available for original equipment only at this stage, is the Smiths dual level sensor for indicating low coolant and brake fluid levels.

The sensors make use of the change in electrical conductivity between probes mounted high in the fluid chamber. The two sensors use one integrated circuit mounted on a printed circuit board.

Several manufacturers have included audible as well as visual alarms, into their instrumentation array.

The Crane-Fruehauf double outfit (engine unit with its semi-trailer and a second coupled trailer) goes as far as incorporating closed-circuit television to aid the operator in backing.

The camera is contained in a safety enclosure under the rear of the tray.

Also on show were several forms of headup display of vital panel meter readings. These use a simple projector to place an image of the dial on the windscreen, the speedometer for instance is in the direct view of the driver as he looks ahead.

Digital and analogue forms are being tried out in tests in which the West Yorkshire Metropolitan Police are co-operating.

COLLISION AND ANTI-COLLISION MEASURES

When collision occurs, some mechanisms need to be terminated, others initiated.

Various safety standards now call for devices that cut the petrol supply and the ignition via the battery circuit, thereby reducing fire risk.

Switches that open or close have been devised to act when the acceleration (or deceleration) exceeds certain values, typically in excess of 5g.

Inertia seat belts also require acceleration sensing — in the range exceeding 0.4g; electrical sensing has been proposed for this as an alternative to mechanical methods.

A whole range of sensors covers electric supply isolation, fuel pump cut-off, fuel line cut-off, passive restraint crash sensors; severe braking indication to operate high intensity rear warning lights and inertia switches to operate seat belt locks.

The method used by Inertia Switches is simple, as Fig. 10 shows. Magnetic pull on a steel ball provides the retardation force to hold the ball until the g forces exceed the limit, releasing the ball and toggling the contacts.

The ball seats in a cone holder, thus providing a directional force characteristic that can be tailored to suit side accelerations as well as those produced dead ahead.

A typical 48 km/h impact produces deceleration of over 20 g with the vehicle coming to rest in only one tenth of a second!

The Honda and Nissan ESV's include accelerometer sensing to disconnect the fuel and electrical systems.

The General Motors development air-bag restraint system uses two accelerometers; one is placed in the bumper bar and operates the safety device at around 25 km/h impacts; a back-up unit is placed in the fire wall (see Fig.11) acting at 35 km/h impact in case the bumpers override.

It was also clear that more advanced sensors are in the research stages. Nissan described a radar sensor that was now operational (in prototype form). No doubt theirs is but one of a number being developed.

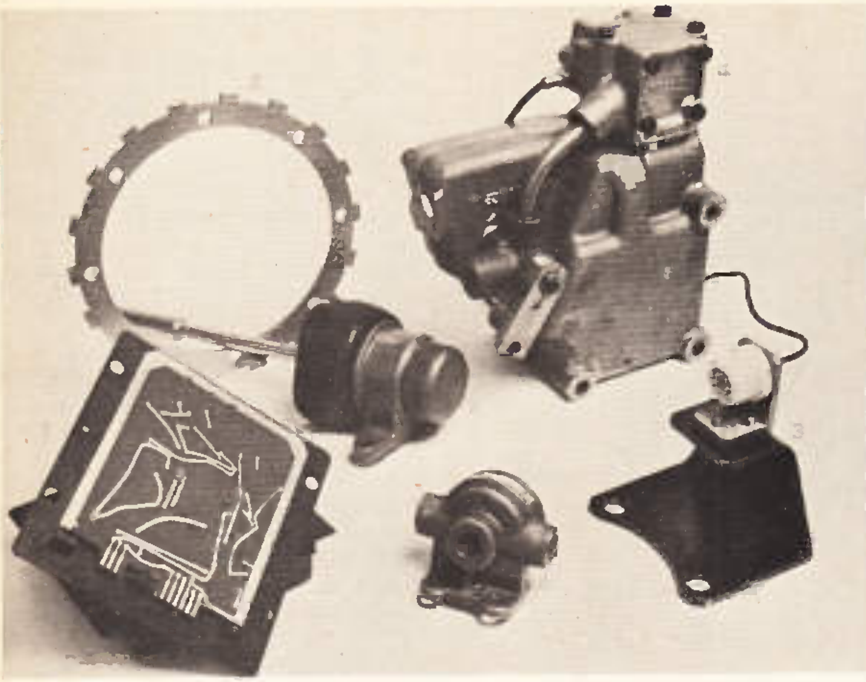


Fig.13. Actual components of anti-lock/system. The toothed wheel produces pulses in the pick-up coil shown on the lower right. After signal processing with the circuit (lower left) the brakes are applied and released as needed.

Fig.14. Engineers set up a pedestrian dummy at the Rolls Royce test centre.

The Harrison-Fraba general-purpose infra-red sensing system makes use of a modulated IR beam to flood the path ahead. Any obstacle in the path sends a return signal to the photo detector which operates an alarm.

It can be adjusted to provide surveillance over a range set from 2-30m. A similar system can detect fog and monitor traffic flow.

VEHICLE CONTROL

It is some years now since anti-lock braking was launched as the answer to braking on slippery surfaces, but displaying a prototype is one thing, producing units is another.

Lockheed gave impressive demonstrations of their system as applied to semi-trailers. Although the system uses mainly hydraulic and pneumatic control its basis is an electrical sensor that measures the velocity of the propeller shaft.

Figure 12 shows the location of the pick-up sensor and the sensor itself. The principle of operation is that velocity change of the propeller shaft is processed to indicate the degree of deceleration.

If it exceeds the value known to be close to wheel lock (1.5 g), the brakes are released and reapplied when speed is regained.

The result, on wet roads, is pulsed brake operation with greatly reduced braking distances.

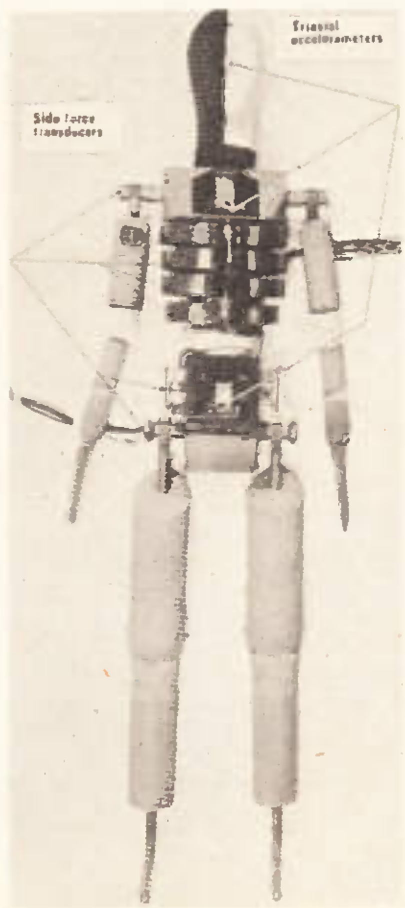


Fig.15. In his "birthday" suit an anthropometric dummy might look like this.

ROAD SAFETY

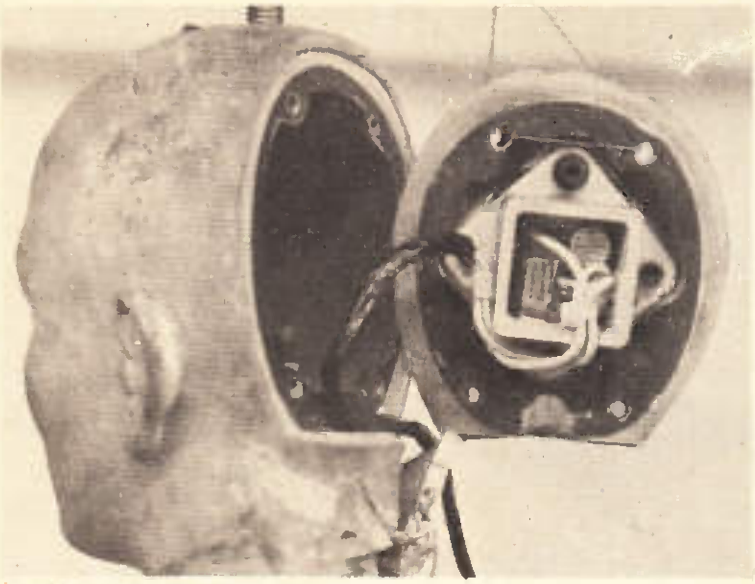


Fig.16. The main sensor unit used in dummies is the three-axis accelerometer.

On perfect road surface conditions braking is slightly inferior to ordinary (non-controlled) methods. Figure 13 shows the extra components that are added to provide anti-lock braking for the rear wheels of a semi-trailer prime mover.

A demonstration clearly showed that trucks without anti-lock are extreme hazards on wet surfaces and lack all control once skids start. With this device the unit could brake and steer around sharp bends under normal control.

Semi-trailers can now have a 'swing' sensor fitted to indicate when the rear has reached the *jack-knife* limit.

It will not be long, with so many warning devices to monitor, before the transport driver needs to be as highly trained as an air pilot.

RESEARCH

Considerable effort still goes into the use of actual crash testing using anthropometric dummies simulating occupants and now, with increasing interest, pedestrians.

The manufacture and sale of dummies is a commercial enterprise with a growing turnover. Designs are becoming very sophisticated. Triaxial accelerometers measure g forces. Side force transducers measure side impact loads at the main upper skeletal joints and bones. Compressional load cells determine the loads in the thigh bone.

Figure 14 shows a male dummy used in research at Rolls Royce Motors' pedestrian-to-car collision rig at Crewe in Cheshire.

The test trolley in the rear gains energy, falling down the ramp, rolling on to collide with the propped up dummy.

With clothes removed a well instrumented dummy appears as in Fig.15; this 'man' is used primarily for side-impact tests in cars.

Close-up, the triaxial accelerometer unit would look like the Endevico unit shown in Fig. 16. Dummies can be most complex with as many as 50 odd signal channels being needed.

Nevertheless, no manufacturer suggests that the anthropometric dummy is still any more than a crude experimental tool.

Another interesting phase of research is that of vehicle automation. Several exhibits, again mainly from TRRL sources, displayed how automation might come to road vehicles.

Estimates suggest it is worth £50 per vehicle and £2,500 per kilometre of lane and that mass production costs would be less than these figures.

Given automated control, the gains expected would be less accidents, more accurate steering allowing more lanes in a road, safer headway as reaction time is reduced thus enabling vehicles to travel closer together, stress-free travelling for occupants and a cheaper mode of transport.

One pamplet suggested it could be in full scale use by 2000 AD.

Control systems envisaged are fairly obvious in principle; control of lateral steering and vehicle spacing. This creates the need for steer, braking and speed servomechanisms.

Numerous devices are envisaged as alternatives for each, but basically the block diagram of eg. steering appears as in Fig.17. Sensors A, B decide the lateral clearances giving an error signal that actuates the power-steering mechanism. (The steering wheel, you will be pleased to know, will remain for override purposes).

The throttle controls of the TRRL design use electro-vacuum sensors in which the error signal acutates an electric-magnetic pull-motor that in turn controls a vacuum assisted control of the throttle butterfly.

If you see a radar set pointing at you on the highway it may not be a cause for alarm for they are now being used as much to investigate driver behaviour as to control speed.

One unit, lawful in the States but not in all countries, takes a photo as you approach, recording speed and time at the same time. These units can operate in fog as well as in the dark. As they use infra-red photography the driver is totally unaware of their existence.

Another means of observing drivers is to follow the unsuspecting with a television camera. A video tape unit mounted out of sight records the scene. The aim of these research workers is not to catch a driver out or invade his privacy but to establish how drivers react in real situations.

It is clear that electronics plays a major role in road safety. The motor vehicle is rapidly becoming a piece of elaborate equipment that needs sophisticated servicing and care. The days of do-it-yourself repairs will soon be over. ●

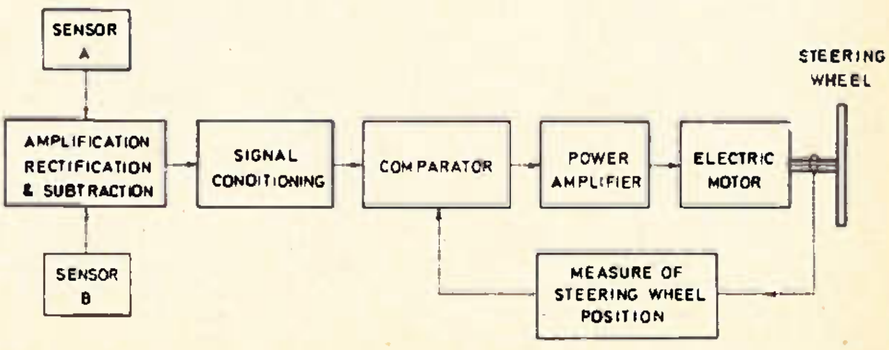


Fig.17. Block diagrams of lateral control system of probable automatically controlled car.

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USING THE LM380

Two projects using the LM380/SL60745 audio I.C. which is available as one of this month's ETI offers.

TIME WAS when the main considerations in any circuit design were to assemble the electronic components in the right order. IC's have changed all that: now we have a vast variety of 'standard' circuits already encapsulated. Even now most linear IC's require a number of external components, to set the gain, decouple, provide bias currents etc. The LM380, which has been around for some time is an IC which requires virtually no external components. For most purposes it can be regarded as having four connections, +, −, in and out. Although encapsulated in a 14-pin package, there are only six different connections (see Fig. 1). The connections in addition to the four already mentioned are a second input pin giving a choice of inverting or non-inverting input relative to the output and an optional hum-decoupling pin.

The LM380 is available from a number of suppliers and also as this month's ETI reader offer: two for £1.00. Our devices are made by National Semiconductor but carry a different coding as they have a slightly higher voltage rating than the regular LM380 (the coding is SL60745).

The supply voltage for the LM380

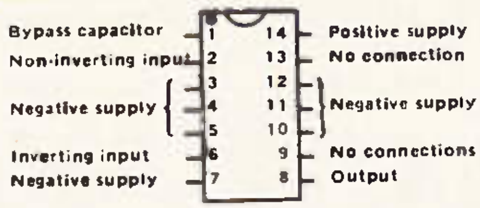


Fig. 1. Connections to the LM380.

can lie between 9V and 22V. However the low limit is a bit misleading as one assumes that a common 9V battery will do. Certainly it will, but distortion will appear under 8V giving you little use from a 9V battery. For full output about 200mV at the input is necessary, though this varies with the supply voltage.

The maximum output at 22V is about 4W. No heatsink is necessary, nor is a tab provided for this.

Two circuits are described in some detail but of course the LM 380 has almost unlimited uses.

INTERCOM

Intercom circuits have appeared in all the constructional magazines at one time or another but most of them that we have seen are thoroughly impractical.

Our circuit has a number of useful points. 1. Only two wires connect the Master Unit to the Slave. 2. Either station can signal the other with a tone burst to draw attention. 3. Batteries are only needed at the Master Unit. 4. The quiescent current on standby is insignificant.

The circuit is shown in Fig. 2 but has the disadvantage that it appears considerably more complex than in fact is it due to the wiring of SW1. Operation is fairly unusual and is explained in the separate box.

The Master Unit contains all the main components including the battery and amplifier. The Slave unit comprises a small loudspeaker, electrolytic capacitor and switch and these can be housed in a much smaller case.

Relatively few components are used and although we have used a PCB and show the pattern (Fig. 3), some readers may feel that a small

PARTS LIST

C1 Capacitor 100μF 25V electrolytic
C2 " 3000pF polystyrene, ceramic, etc.
C3 " 100μF 25V electrolytic
C4 " 100μF " "
IC1 LM380/SL60745 Audio I.C.
T1 Transformer Transistor output transformer (Approx. 10 or 20:1 ratio).
LS1 Speaker 8Ω small type
LS2 Speaker 8Ω small type
SW1 Rotary Switch 4-pole, 3-way.
SW2,3 Switch Push-to-make.
P.C. Board or Drilled S.R.B.P.
Plastic Boxes, one large one small.
Twin wire to connect units
2xPP3 or equivalent 9V batteries.
Battery terminals.

COMPONENT COMMENTS

The LM380 is this month's ETI offer but is available from many of the semiconductor mail-order companies once the offer closes. Transformers suitable for T1 are widely available. perhaps the best known is the Eagle LT700 but other types are listed in catalogues.

The electrolytic capacitors should have a minimum working voltage of 25V but this can be higher. The unit will work using even 10μF components for C1 and C4 but output will be marginally down. Values higher than 100μF will improve output but only marginally and the cost will be higher.

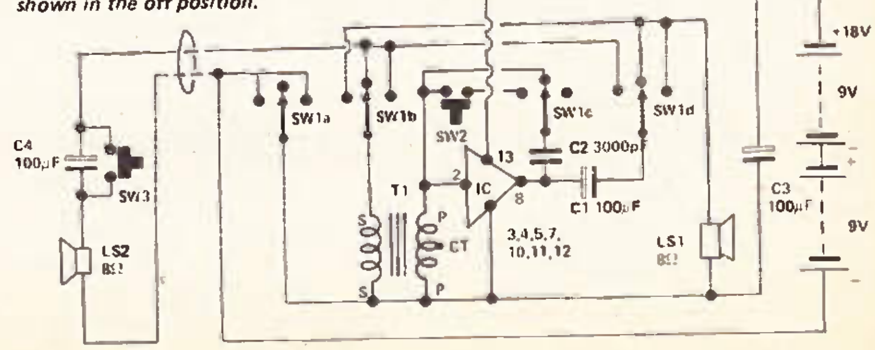
C2 can be any form of capacitor and the value can be between 2000pF and 0.01μF; in the main text we suggest that this may advantageously be experimented with.

Suitable cases are the M2 and M3 from Doram but others will do quite as well.

The speakers listed are 8Ω types but we tried the circuit using the high impedance speakers (35Ω—80Ω) and operation was perfectly satisfactory.

We have in the past used very small push button switches made in Japan: we cannot recommend these as even when soldering quickly to the terminals, the plastic body melts.

Fig. 2. Complete circuit of the intercom. All sections of SW1 are ganged and are shown in the off position.



piece of drilled s.r.b.p. board is all that is necessary.

T1, the LM380 and three capacitors are mounted on the board which should be near the main switch SW1. The PCB or component board should be mounted at right angles to the front panel of the case. The construction, component layout and switch wiring are shown in Fig. 4. The two PP3 type batteries should be clamped firmly in the body of the case.

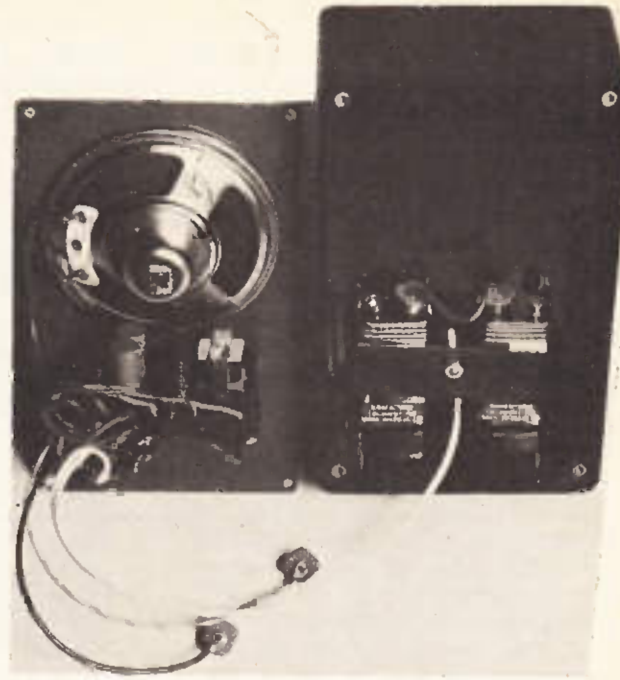
The Slave unit is much simpler and a component layout can be seen clearly in the photograph.

Some readers may query using two small batteries for an IC which can draw up to 200mA at the supply voltage of 18V used here. This is quite satisfactory for an intercom circuit. Firstly current is only drawn when the unit is actually being used. Secondly the input will not normally be high enough to give full output. When the IC is used to signal one of the units the current drain is very high but this will normally be only for a second or two at the most. Even if the unit is left switched on, unless there is a lot of noise near the input, current drain is a modest 15mA or so.

OPERATION

MASTER TO CALL SLAVE. Switch SW1 to Talk and press SIGNAL button,SW2. If there is doubt about anybody being there, switch SW1 to LISTEN for acknowledgement, otherwise talk.

> **HOW IT WORKS**
>
> The loudspeakers at the Master and Slave double as microphones but as a microphone are unsuitable for connecting to the input to the LM380 and therefore a transformer is used to step up impedance and signal level, this is T1.
>
> SW1 is the main controlling switch and it can be seen in the off position shown in the circuit that the battery does not connect to the main circuit. Other parts of the switch place C2 between the input and the output of the I.C. making it oscillate; LS1 is connected to the output and the slave loudspeaker LS2 connected to the input via C4.
>
> When the slave presses SW3, battery negative is applied to the main circuit negative line via LS2 and one winding of T1. The circuit oscillates and a tone comes up on LS1.
>
> On receiving the signal the master unit switches to listen, disconnecting C2 and picking up the battery negative.
>
> For the Master to call the Slave, SW1 is switched to Talk and SW2, a push-to-make switch, can be pressed, the tone will then be connected to LS2.
>
> SW1b and SW1d switch the speakers as required.



Inside views: Above is the slave, on the right is the master. Note the mounting of the components board and the method of holding the two batteries.

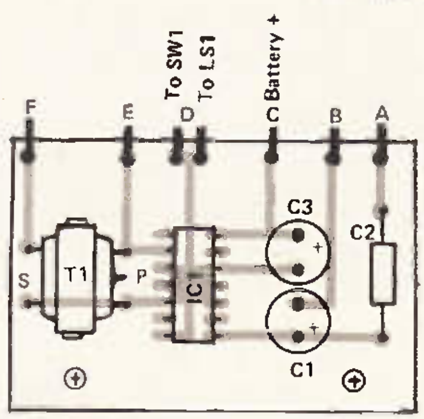


Fig. 4a. The components layout on the p.c.b. The letters A–F refer to the switch connections.

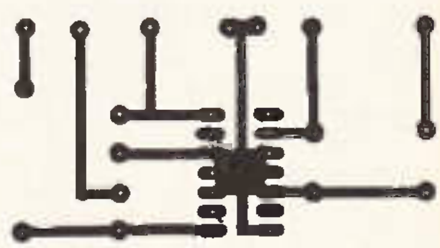


Fig. 3. The p.c.b. pattern shown full size.

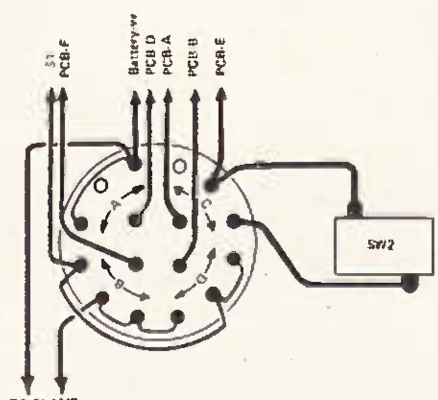


Fig. 4b. The wiring of the switches in the master unit.

SLAVE TO CALL MASTER. Press SIGNAL button SW3, wait a couple of seconds and talk.

MASTER ACTION ON RECEIVING TONE. Switch to TALK if acknowledgement is the normal practice or LISTEN if not.

The need for acknowledgement will depend on individual circumstances.

GENERAL NOTES

All components should be widely available: alternatives and suppliers are mentioned in the special box.

Fixing speakers to flat surfaces is often a problem. We used an ordinary impact adhesive — this is quite adequate.

Continued overleaf.

Note that T1 is used in reverse: the windings normally regarded as the primary (and marked as such on the circuit) become the secondary. Most transformers of this type have a centre tap on the primary – this should be ignored.

The signal tone may be considerably different from one station to the other: this will be due to the use of C1 and C4 in series when Master calls Slave, the effect of the wire etc. C2 is not a critical value and may be experimented with to obtain a satisfactory tone in both units.

The only current drain on standby should be the leakage of C4: it is worthwhile checking to ensure that C4 is a healthy component by measuring current drain: it should certainly be no higher than 20μA. If it is, change C4.

BABY ALARM

The circuit and switching allow the unit to operate as a baby alarm, but two modifications are suggested for this. Firstly a baby alarm will have to be on for several hours at a stretch and battery operation is therefore uneconomical. A mains power supply should therefore be substituted (a suitable one is used with our record player).

Secondly, whilst a volume control is unnecessary with an intercom, this does not apply with a baby alarm. Therefore a simple volume control can be fitted. This should be a 1MΩ log pot wired with one end connected to input pin 2, the slider and other end wired to pin 6. This should be fitted with a d.p. switch which can be connected to the power supply mains.

RECORD–PLAYER AMPLIFIER

Having an output of about 3W, the LM380 makes for an excellent record player amplifier for use with ceramic or crystal pickups. The quality will be nothing to write home about but compares favourably with commercial amplifiers at the low end of the price scale.

To match the high impedance of the pickup, a high value volume control is needed – 500kΩ is shown in the circuit. The tone control is a simple passive top cut but this gives adequate control for the type of amplifier we have in mind. The circuit is shown in Fig. 5.

The power supply is perfectly conventional; a 15V transformer feeding into a bridge rectifier. The low value of the smoothing capacitor C4 is not an oversight. If a low value capacitor (10μF) is connected between pin 1 on the I.C. and the negative line, there is excellent hum rejection permitting the use of a low value for C4 (and a resulting cost saving).

A higher value capacitor is used for C3 than in the intercom to improve the low frequency response.

PARTS LIST

RV1	Potentiometer	500kΩ log. pot with double pole mains switch.
RV2	"	10kΩ linear pot.
C1	Capacitor	0.05μF ceramic, polyester etc.
C2	"	10μF, 25V electrolytic
C3	"	500μF, 25V "
C4	"	500μF, 25V "
IC1	LM380/SL60745 integrated circuit.	
D1-D4	Diode	1N4001 (50V, 1A) silicon rectifier.
T1	Transformer	240V/15V at 500mA.
Drilled s.r.b.p. board.		
Small metal chassis as illustrated.		

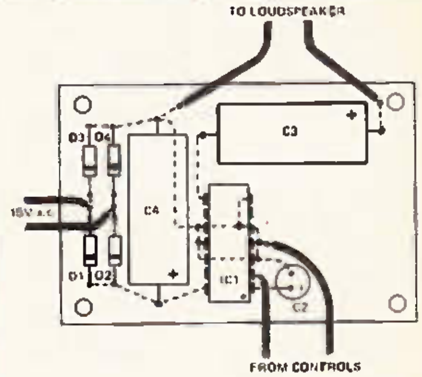


Fig. 6. Top view of the components layout. Underneath connections are shown dotted.

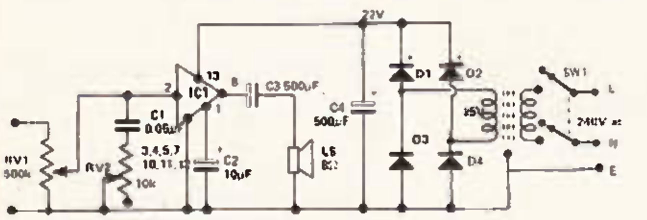
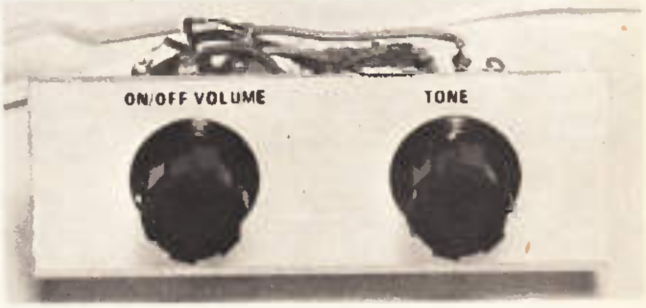


Fig. 5. (above). Circuit of the record-player amplifier.



COMPONENTS COMMENTS

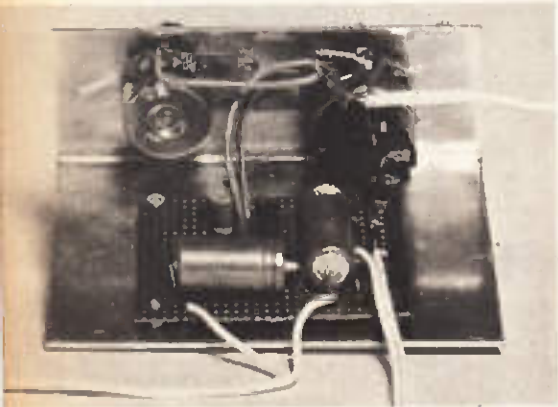
RV1 can lie anywhere in the range 250kΩ to 2MΩ with no effect on performance. RV2 should by the value shown to give proper control over the tone but a 25kΩ could be used. C1 can be any type of capacitor and should lie in range 0.03-0.1μF: different values will effect the tone.

All electrolytics can have working voltages higher than the 25V shown.

A bridge rectifier capable of handling at least 0.5A can be used in place of D1-D4 but these are much dearer than using the four individual diodes.

The transformer can have a secondary in the range 12-15V. If lower than 12V the output will be reduced; if higher than 15V the voltage rating of the components will be exceeded after the a.c. is rectified. Current rating should be at least 200mA but the 500mA value specified is more common and will give sufficient reserve power. Most of the mail order catalogues list transformers of this type.

For safety reasons a double-pole mains switch should be used and the negative line of the circuit connected to the record player deck and earth.



Rear view of the amplifier. For clarity the on/off switch wires are not shown. C1 is mounted on the tags of RV1 and RV2.

CONSTRUCTION

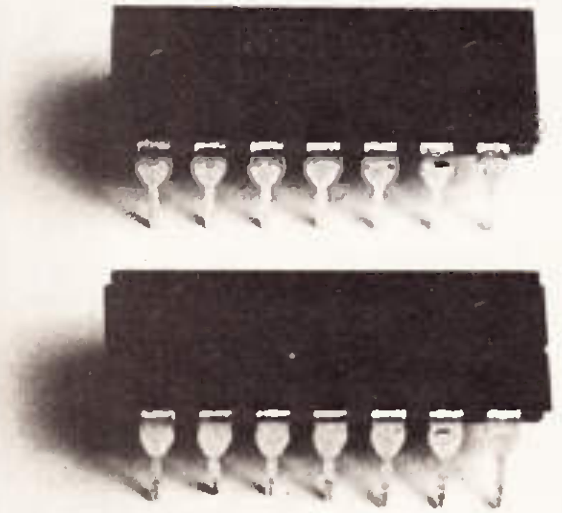
There are so few components that a P.C. board is hardly necessary – we built our unit on drilled s.r.b.p. board (the layout is shown in Fig. 6). The component board can be mounted on a simple chassis as shown with the front bent up to hold the two controls as seen in the photograph. However layout is not critical and readers may well wish to build the unit into the record players plinth.

It is worthwhile using a reasonable sized speaker; these are more efficient and give better quality than small ones.

It is important that screened wire is used for the connection between the pickup and RV1. ●

this month's eti offers:

TWO LM380
3W audio ICs



£1.00

With SAE and Coupon

This price includes VAT but each coupon must be accompanied by a self addressed strong envelope with the correct postage in UK stamps.

LIMITED TO THE FIRST 2000 COUPONS BUT ORDERS WILL NOT BE DEALT WITH UNTIL NOVEMBER 20TH TO GIVE OUR READERS IN THE PROVINCES A CHANCE.

NO SPECIFICATION SHEETS SO KEEP THIS ISSUE.

THIS OFFER IS STRICTLY LIMITED TO TWO ICS PER COUPON

TO: ETI IC OFFER
ETI MAGAZINE
36 Ebury Street,
London SW1W 0LW

Please find my cheque/P.O. for £100 (payable to ETI) plus a stamped self-addressed envelope for the return of the ICs or my money should the offer be over-subscribed.

Name . . . .

Address . . . .

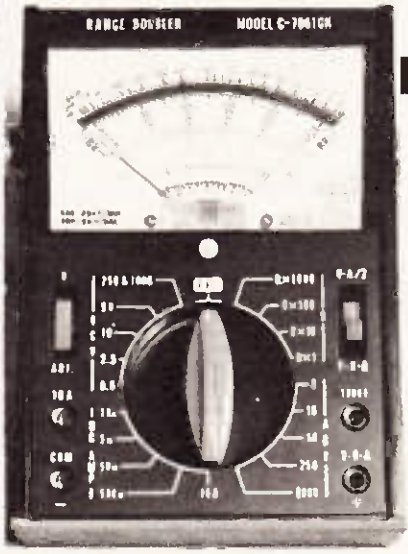
. . . .

. . . .

This offer open 20 Nov. 1974 and closes 31 Dec. 1974.

Cut

50,000 & 25,000 OHMS PER VOLT
MULTITESTER



BIG SIZE
6.5" x4.75" x 2.5"
EXCLUDING HANDLE

Uses a 15μA meter. Accuracy is ±4% or better on all ranges except 1.5V (±5%)

12 DC VOLTAGE RANGES

0.5	2.5	10	50	250	1000V . . . at 25,000Ω/V
0.25	1.25	5	25	125	500V . . . at 50,000Ω/V

10 AC VOLTAGE RANGES

3	10	50	250	1000V . . . at 5,000Ω/V
1.5	5	25	125	500V . . . at 10,000Ω/V

10 DC CURRENT RANGES

0.5	5	50	500mA	10A
0.25	2.5	25	250mA	5A

4 RESISTANCE RANGES

16k	160k	1.6M	16M	full scale
100Ω	1k	10k	100k	mid scale

£10.25

(Inc. VAT and P & P) With SAE and Coupon.

This is a high specification instrument which is comparable to models normally sold for over £18, and features built-in diode protection, big mirrored scale, 10 decibel ranges, a handle which can support the meter at a convenient viewing angle, dampened needle when switched off, etc. A range doubler switch operates on voltage and current ranges to double the sensitivity.

A self-addressed stamped envelope must be included for return of money if the offer is over subscribed.

LIMITED TO THE FIRST 750 COUPONS BUT ORDERS WILL NOT BE DEALT WITH UNTIL NOVEMBER 20TH TO GIVE ALL READERS A CHANCE

THIS OFFER IS STRICTLY LIMITED TO ONE METER PER COUPON

TO: RICHARDS ELECTRICS,
16 Friar Street,
Worcester WR1 2LZ.

Please find my cheque/P.O. for £10.25 (Payable to Richards Electrics) plus a stamped self-addressed envelope for a multitester (model C-7081GN).

Name . . . .

Address . . . .

. . . .

. . . .

Allow 21 days for delivery.
This offer opens 20 Nov. 1974 and closes 31 Dec. 1974.

Cut

What to look for in January's eti

TWO GREAT ETI READER OFFERS

1\.
FIFTEEN BC108 TRANSISTORS

Brand new BC108's made by ITT and carrying the 'C' suffix (highest gain grouping). Price includes VAT and postage.

£1.00

2\.
36 ELECTROLYTIC CAPACITORS

Not mixed, but specified new components covering 10μF-1000μF, 10V/25V. Details of types next month. Price is inclusive of VAT and postage.

£2.50

ETI SPECIAL SURVEY: CONSTRUCTIONAL KITS

We have been scouring the country to collect details of kits available for the amateur constructor. Specifications are of course given but we will be giving a lot more details.

MATRIX TV

Considerable progress has been made recently towards solid-state picture transmission, doing away with c.r.t. etc. Details in next month's issue.

GRAPHIC ROOM EQUALISER

A project which gives gain of plus or minus 13dB at nine frequencies which enables you to tailor the output curve.

RUMBLE FILTER

Inexpensive project gives very sharp cuts below 36Hz and gets rid of low frequency noise.

TECH—TIPS

Earlier this year we increased our Tech—Tips section. Popular demand has meant we will be increasing this even further from next month.

electronics today INTERNATIONAL

JANUARY 1975 ISSUE ON SALE DECEMBER 13TH

25p

AT YOUR NEWSAGENTS

The features mentioned here are, at the time of this issue going to press, in an advanced state of preparation. However, circumstances, including highly topical developments may affect the final contents.

INPUT GATE

LETTERS FROM OUR READERS

COMPONENTS FOR OVERSEAS

Over the last few years, I have tried to help friends of mine from abroad to get components advertised in your magazine for their projects, especially those components not available in their own countries.

I have worked out a way to help acting as a buying and distributing centre. It is a non-profit making venture and if your readers would like to get in touch with me by sending a prepaid envelope (i.e. International Postal Coupons, etc.). I shall be glad to send them details of how to order what they need.

I hope this letter will solve some of the problems of your overseas readers, as I was one of them not so long ago.

— S. Tan,
15, Winterstoke Road, London SE6

UPSIDE-DOWN CALCULATOR PROBLEMS

We've already received a couple of letters with upside-down calculator problems. We're printing these below. We'll not be judging the competition until next month (see Electronics Tomorrow November issue).

NAUGHTY LESLIE

Leslie and Mary drove at an average speed of 50km per hour for exactly 1.0748 hours in a southerly direction starting from near Welwyn Garden City and finishing in Highgate Woods, London. Find the total distance they covered in millimetres, and what Mary said when Leslie wanted to go further.

— J. Keheally, Weymouth, Dorset.

NOT OUR HELEN

ETI's secretary went out last night with six friends. Between them they drank 54.007415 litres of beer. If they all drank the same amount how much did she drink in c.c.'s and why didn't she turn up for work this morning?

Add 37344.655 to the answer you'll get our reaction.

P.S. Add another 12656 and you'll find out what you breathe with when there's that much drink about!

— D. G. Evans, Southampton.

CALCULATORS IN SOUTH AFRICA

I wish, on behalf of a number of colleagues and myself, to thank you for your August edition of ETI which featured the Directory of Calculators. We're high school teachers, and were beginning to find that the amount of "figure work" involved in education, put us in line for personal calculators. As many of the calculators featured are locally available, the Directory was of immense value in helping us decide what we needed for our particular requirements.

We appreciate the amount of work which must have gone into its compilation, but feel that one of the most important columns was omitted - approximate battery life in hours. It would also have been of value to have included a column stating whether zero suppression was featured or not - a fact directly related to the cost of operating these calculators.

The South African market has become flooded "overnight" with calculators - mostly from America and Japan. Prices seem to be very reasonable compared to those in your Directory. We have a local discount store selling a reasonable small model with 6 digit display, fixed decimal (2) and the usual four functions (+—÷x) for about £6.50 - very popular with the pupils! The Sinclair range cost no more here than in the U.K. and our Bowmar prices are better than yours. You had the price for the Canon Palmtronic LE83 as £32.45. It markets here (not discount!) for R35.50 (about £14.00). I have included the above information purely for interest.

In conclusion may I say how much I personally appreciate your publication — I've only missed the one copy since it became available out here. The one disappointment is that we cannot benefit by your special offers.

— A. D. Johnstone,
Transvaal, South Africa.

ANY MORE OFFERS?

I would like to congratulate you on the Sinclair Scientific kit offer. As soon as I received the magazine I placed my order for the calculator and received the kit in well under 3 weeks. After only two hours of assembly my calculator gave the answers in the operating instructions, down to the last digit! I have only one question to ask: How come you don't do these special offers more often? There are plenty of firms who's products are worth buying. Why not have special offers for oscilloscopes, digital voltmeters, digital frequency meters, digital watches, etc. I am sure the manufacturers would not be disappointed by the advertising your magazine can provide for their product. As a regular reader of your magazine from the No. 1 issue I make sure that I get every issue of ETI.

How about an electronic digital watch kit in your next issue? I am sure it can be done like the Sinclair offer.

Well done Mr Editor.

— G. Szabo, London NW6.

LETTERS SENT IN WITH CALCULATOR OFFER COUPONS — DROOLS

Your offer on the 'Scientific' is quite phenomenal — quite the best you've done yet!

I must also say that every issue I get makes me positively drool as I first skim through it and see just how much exciting reading awaits me.

Without doubt, your mag' is unique and beats all others into a cocked hat — keep it up.

— C.B. Capital Radio.

TIP

You will notice that the mentioned price of the special offer is £14.95 and that the enclosed postal orders amount to £15 leaving a surplus of 5p.

Well! I considered that the offer was such good value for money that I would dedicate a fabulous, never to be repeated, tip of 5p to be shared equally amongst all the staff of ETI.

No thanks are necessary.

— R.W.M., Skipton, N. Yorks.

Any gratuities are accepted with Thanks! — Ed.

eti product test

HEATHKIT M1-1031 DEPTH SOUNDER

THIS IS ONE of three depth sounders available in kit form from the Heathkit range of marine electronic equipment. The M1-1031 is a dual range instrument supplied complete with transducer and has an audible alarm for alerting the helmsman of entry into shallow water or of underwater obstacles. This alarm can be preset for any given depth from 5 feet. The two depth ranges cover 0 to 60 feet and 0 to 240 feet and the unit operates from a 12V supply. The other two depth sounders marketed by Heath are the M1-1030/1, a single range, 0 to 250 feet, instrument but without the alarm (retailing at £39.95) and the M1-101/1 which has a digital read-out, shallow water alarm light and depth ranges of 2.5 to 19 feet and 20 to 199 feet (retailing at £77.80). The M1-1031/1, the subject of this review, retails at £46.45.

DESCRIPTION

The display unit is shown in Fig. 1 and is housed in a waterproof plastic case which also contains the sounder electronics. The display is mounted on a gimbal and can be adjusted to a convenient viewing angle. Depth indication is by means of a rapidly flashing neon which is clearly visible even in direct sunlight. Only two connections are made to the display, the 12V d.c. supply cable and the transducer co-axial cable, both via plug and socket entry which allows the display itself to be quickly removed and stowed away when not in use.

Two types of barium titanate transducer are available: a through-hull type and a transom mounting type. The price of the kit is the same whichever transducer is required. The through-hull type can be mounted on the bottom, i.e. with the securing fitting through the hull itself, or can be mounted inside in a small water container to impart the supersonic pulses from the transducer through the body of the hull, providing it is made of wood or fibreglass. Full instructions and diagrams for transducer mounting are given in the handbook.

PRINCIPLE OF OPERATION

First a master pulse is generated by a small magnet attached to a rotating disc driven by a d.c. motor. As the magnet rotates it passes over a pole-piece mounted within a coil, generating a voltage pulse across that coil. The pulse is then shaped and adjusted for the required duration: 0.8mS for the 60ft range and 1.5mS for the 240ft range. Then it drives the supersonic pulse generator (the transmitter) and the output is connected direct to the transducer. The master pulse is simultaneously used to strike the rotating neon indicator which flashes at zero feet as in Fig. 2. When an echo is returned from the sea bed, via the transducer, it goes to a 200kHz receiver, where it is amplified and rectified into a d.c. pulse which is used to strike the neon again but some time later. This is the time taken for the echo to return so it can be used to indicate depth, as shown in Fig. 2, by matching the position of the second flash to the nearest reading on the calibrated scale. The neon spins at 2400rpm for the 60ft range and 600 rpm for the 240ft range. The pulse repetition rate is 40 and 10 times per second for 60 and 240ft respectively.

The shallow water alarm operates from a gate circuit which passes only

SPECIFICATIONS

Range:	0 to 60 feet on hard bottom. 0 to 240 feet on hard bottom.
Accuracy:	±2% with motor speed of 2400rpm in the 0-60 foot range and with motor speed of 600 in the 0-240 foot range.
Sounding:	Rate: 40 times per second on the 0-60 foot range. 10 times per second on the 0-240 foot range. Frequency: 200kHz ±5%. Amplitude at the transducer: 150V peak-to-peak minimum. Pulse width: 0.8 milliseconds on the 0-60 foot range. 1.4 milliseconds on the 0-240 foot range.
Noise Rejection:	Fixed at approximately 500 mircoseconds integration time.
Receiver Sensitivity:	75μV nominal at 200kHz.
Depth Indication:	Neon lamp flashes at zero and again at the indicated depth from the object.
Alarm:	5-59 feet on the 0-60 foot range. 5-239 feet on the 0-240 foot range.
Controls:	Sensitivity, with on-off switch. Alarm, with a pull-to-read alarm depth and off position. Range, with two indicating ranges (0-60 feet and 0-240 feet).
Transducer:	Barium titante ceramic element encased in a watertight housing.
Tranducer Cable Length:	25 feet with transom-mount type transducer. 15 feet with through-hull type transducer.
Power Requirements:	13.8 VDC nominal (11-15 VDC) at 225mA when using the 0-60 foot range, or 125mA when using the 240 foot range, with only one return flash.
Dimensions (less Gimbal Mounting Bracket):	5-¾" wide x 6-½" high x 7-¼" deep.
Net Weight:	2-¾lbs.

SUMMARY: This is a complete system which gives a visual depth reading (on one of two ranges) and has an audible alarm to warn the helmsman of shallow water. The Heathkit M1-1031 does both these jobs well, and the finished equipment would soon become almost indispensible to a boat owner.

There is nothing special needed for construction and setting up except for patience. Building-up should not be rushed and the unit should not be relied upon until the builder is completely satisfied that it is calibrated exactly and functioning perfectly.

Fig. 1. The finished display unit.

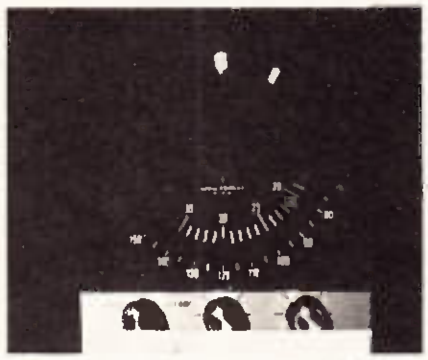


Fig. 2. Top central flash at zero feet and echo flash at 6 feet (to the right).

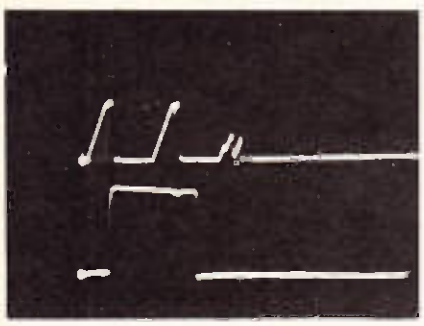


Fig. 3. Upper trace: transmitted pulse at zero feet and echo at 6 feet. Lower trace: the gate pulse takes in this echo which sounds the shallow water alarm.

Fig. 4. Strobe effect obtained when setting the disc motor speed.

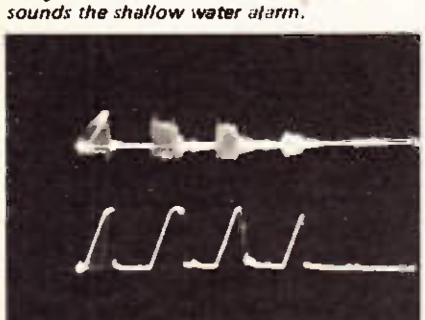


Fig. 5. Upper trace: transmitted pulse (extreme left) and three echos, one from 6 feet followed by two repeats. Lower trace: same signals after rectification.

echo signals from a given depth (see oscillogram, Fig. 3). The depth can be pre-set with a panel control and the gated echo triggers off a multi-vibrator to give an af signal which is amplified and taken to a small loudspeaker at the rear of the display.

CONSTRUCTION AND PERFORMANCE

As with all Heathkit projects one should find no difficulty providing the highly detailed and well illustrated instruction book is followed precisely and great care is taken with the soldering. Assembly is virtually on a single circuit board which supports the drive motor and the rotating disc (which carries the neon indicator) as well as the small components and transistors. Remember, however, that mistakes can be made and one may even find that a component is missing or faulty, but this is very rare and can happen with any kit project. Heath are not infallible but they do provide a good service. If your project fails to work they will get it going for you.

The total building time of this project, without hurrying, was about 8 hours and it takes another hour to check out and set the motor speed. Final tuning for maximum sensitivity can be done without instruments, but has to be done with the transducer mounted on the boat and with a reasonable depth of water (10 feet or more). The motor speed can be adjusted for both ranges with the pre-set controls and a 50Hz supply. Instructions for doing this are given and it is quite simple using the neon indicator as a strobe for showing true speed, as in Fig. 4.

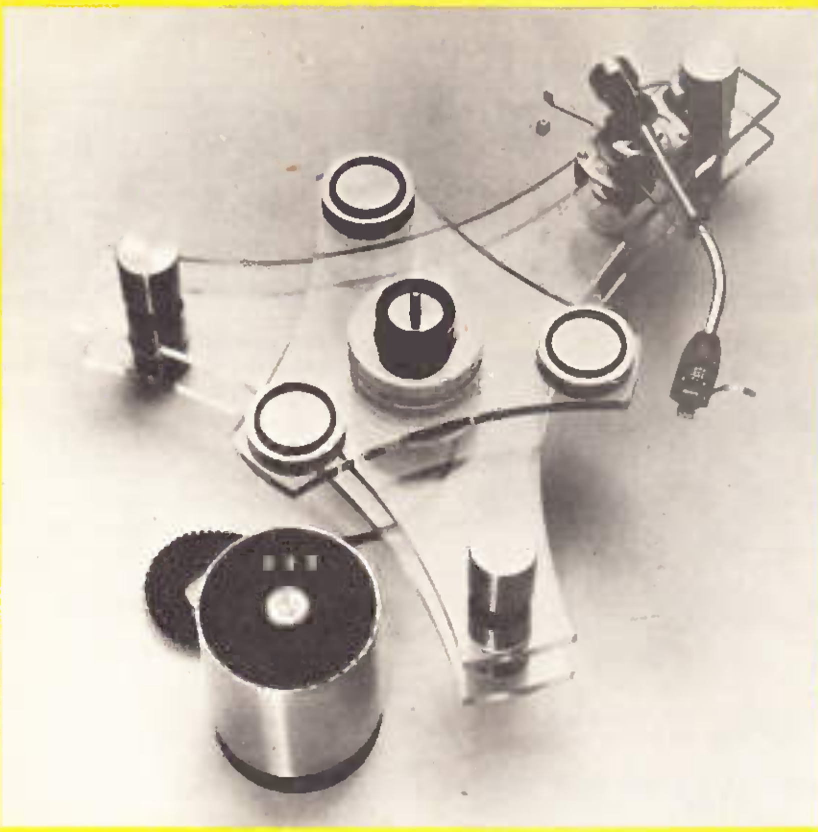
Performance tests were carried out with the depth sounder installed in a 21ft cruiser fitted with twin outboard engines. The upper trace of the oscillogram (Fig. 5) shows the signal prior to the detector stage with the transmitted pulse (left) and three echos obtained in a 6 foot deep tank. The lower trace shows the rectified pulses which trigger the neon. Initial instrument tests showed the sounder to be accurate to within less than 1 foot on the 60ft range and to within less than two feet on the 240ft range. The shallow water alarm comes into operation at about 2 feet more than the setting to allow a small safety margin.

The waveforms obtainable at various points are shown in the circuit diagram in the instruction book. The measured transmitter pulse output was a little over 120V (pk to pk) for a 12V supply, which agrees with the specification (150V with a supply of 13.8V). The pulse widths, repetition rates and the supersonic operating frequency (200kHz) were as specified.

Tests carried out on the water proved operation to be satisfactory. The shallow water alarm was reliable and quite audible above the noise of two outboards at full power! However, a word of warning. Ignition interference from engines not fitted with suppressors could be troublesome despite the fact that the depth sounder receiver has a built-in noise suppression circuit. Ignition pulses produce random flashes around the dial and these can intermittently (or even continuously) trigger off the alarm circuit. Sensitivity was very good even over areas with a deep mud bottom which is about the worst condition for reliable depth sounding.

Although this is an excellent and worthwhile project, inaccurate operation could run you aground or into dangerous rocks. Initial trials should be carried out in known safe water. A small but well illustrated booklet on the operation of the unit and interpretation of readings is also included with the kit. ●

Collyn Rivers looks at hi-fi developments this year and tells us what to watch out for in 1975.



Apart from its startling appearance, the GALE GT2101 turntable incorporates many technical innovations which have more in common with inertial guidance systems than high fidelity record players. The turntable is continuously adjustable in speed from 10.0 rpm to 99.0 rpm and incorporates a 5.0MHz crystal-controlled reference oscillator to provide the time base, ensuring speed control independent of the mains frequency (stability is better than 0.001%).

The speed indicated by LED displays. The three-phase, brushless DC servo motor turntable drive system is unique in its incorporation of an optical shaft encoder to both measure the turntable speed and provide the error and control signals necessary for the servo system. This results in a short-term speed stability claimed to be better than any other turntable currently on the world market. The manufacturers also claim a rumble figure which is lower than anything that was previously possible.

hifi today

Nineteen-seventy-four was the year of the cassette player.

This year, for the first time ever, we were able to say that we have a cassette machine that can compete on open terms with open-reel machines and the gramophone record format.

The machine, the Nakamichi 1000, costs the earth! But so do the open-reel machines that it trounces.

On a more down to earth level, machines such as the TEAC A-450, the Harman Kardon HK 1000 and the Pioneer CT 5151 to name just three of several, have performance so close to better quality gramophone records as to be virtually indistinguishable.

Until very recently it seemed improbable that the cassette players and cassettes would make really deep inroads into the gramophone record market — let alone ever replace it. Now we are not so sure.

Cassette tapes have improved enormously; when used with a suitable recorder, virtually all premium tapes can now handle the complete audio spectrum. Many have a response extending beyond it.

The widespread adoption of the Dolby Noise Reduction system has ensured that tape hiss can be reduced to a level where it is about the same as from an average to good quality gramophone record.

Pre-recorded cassettes are also improving in quality. Most are still churned out on cheap low performance tape, but several recording companies, in particular DGM, are now producing pre-recorded cassettes on good quality material using Dolby processing.

There is still a marketing battle between proponents of ferric oxide tapes and chromium dioxide tapes.

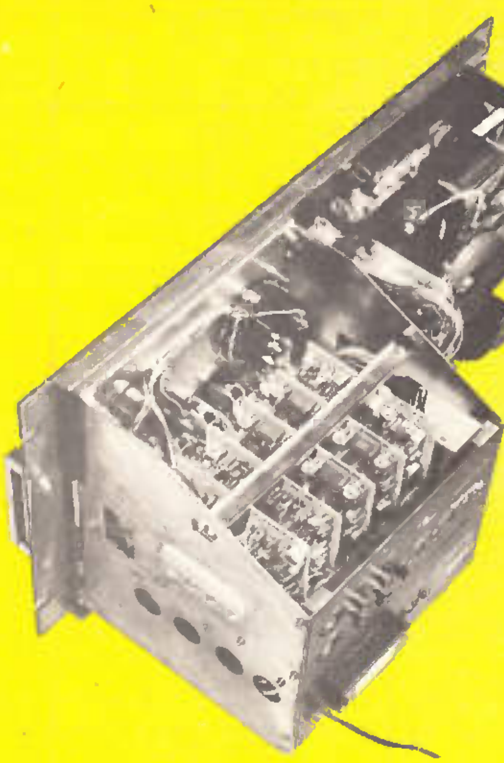
The use of these two types of compounds would not matter particularly were it not that cassette recorders must have control circuitry to optimize the bias and equalization characteristics for type of tape.

But the tape industry is about to release a new generation of high-energy tape formulations that combine the two hitherto competing materials.

Pioneered initially by Sony, the ferri-chrome combinations optimize performance by taking advantage of ferric oxide's particular advantages for 'lows' — and of chromium oxide's advantages for the 'highs'.

The 3M company, who until very recently were strong advocates of ferric-based tapes, have now signed an agreement with DuPont to manufacture a ferri-chrome tape cassette (which 3M launched at the US Consumer Electronics Show.

Japan's Fuji Film Company — in cooperation with the Japanese National Broadcasting Co — has developed a single layer ferri-chrome tape which it will offer to other manufacturers. Maxell are also developing a ferri-chrome tape.



Inside the Nakamichi 1000 cassette recorder.

Other tape manufacturers including BASF, TDK, Ampex and Capitol are known to be preparing to release new products shortly.

Although it is far from certain that all tape manufacturers will settle for the new combined formulation, there are indications that chromium dioxide may be on its way out.

In a recent press statement, George Johnson, President of Audio Magnetics, said "the recent development in the field of ferri-chrome is a return to the ferrite fold on the part of certain manufacturers who have realized that chromium technology has reached a plateau."

Despite their involvement in the chrome field, Ampex agree with Audio Magnetics, saying, "Chrome is not where the high-end customer is going to be - not where he is now for that matter".

A contrary view is expressed by BASF. A company spokesman (in America) said that in BASF's opinion, chromium dioxide is the ultimate in recording — it is the high end of the market. Significantly though, BASF is currently putting a lot of effort into promoting its new SK low noise, high output ferrite cassettes and recently released a new high energy ferrite tape.

We also have details of a revolutionary new cassette system from BASF. Designated 'Unisette', the new cassette is totally different from the standard Philips' designed unit. It uses ¼" tape of recording studio quality and has been designed for use at 1.7/8"/sec, 3.3/4"/sec, or 7.1/2"/sec.

BASF are saying very little about the new cassette — except that it will negotiate licencing arrangements in a similar fashion to those laid down by Philips.

However 'informed sources' tell us that the cassette is quite large (about the size of a paperback book), has no moving parts — in the sense that it relies upon the hardware for all transports, and can compete in every way with open-reel tapes of any quality. In Europe, the tape industry's association quote pre-recorded tape sales at 9.8 million cassettes (and 5.7 million cartridges) worth approximately £25 million. The total of 17.5 million units is nearly twice the previous year's.

There is a strong swing away from the cartridge format and it is our opinion that cartridges will eventually be used only for automobile systems. Even there, cassette players are making big inroads into the market.

A possible rival to the cassette machine is a new system called Mavica which has just been released by the Sony Corporation.

Intended at present for video replay, the system is based on a flat chromium oxide card 160mm by 220mm. This provides 10 minutes playback in colour, plus stereo sound.

The blank cards cost only a few pence each (in volume) and recording is virtually a mass-duplicating process similar in many ways to printing — except that the programme material is transferred thermally.

It is not yet clear whether Sony intend to market an audio-only version of the Mavica system. From initial reports it seems ideally suited for hi-fi sound reproduction — especially as the method of replicating recordings is so cheap and simple.

RECORD QUALITY

This year seems to be the year when record quality hit an all-time low.

One pressing I heard recently could only have been made by a Serbian fishmongers' co-op during a low point in a five year plan.

Or by a manufacturer so cynical about quality control that the mind boggles. (Two further pressings of the same recording were just as bad).

Criticizing record quality, brings squeals of rage and anguish from record manufacturers.

Several told us that their quality was better than ever. Others said that they had received no customer complaints.

Manufacturers are rather more realistic, accepting that present-day quality *is* bad.

One major British record manufacturer has admitted this publicity — stating ominously that quality could even become worse.

The cause of the decreasing quality seems to be the world shortage of vinyl. This has resulted in record manufacturers relaxing their quality control in order to obtain more saleable records per batch of raw material.

A further cause is that several manufacturers are now recycling their rejects. At first this seems commendable. It becomes less so when one realizes that they recycle the whole record. Paper labels, glue and all! Great for the signal/noise ratio!

The infuriating thing is that there does not seem to be any positive correlation between quality and price. As one of our readers pointed out last month, one often finds that the $1.99 specials are far superior to the full price efforts.

One company (Phase Linear) has a partial solution to the poor signal/noise ratio problem.

Phase Linear have developed an absolutely fascinating pre-amplifier with an auto-correlator built in. This device has sophisticated circuitry that can tell the difference between noise (which is of a basically random nature) and programme material (which has a recognisable pattern — or harmonic structure).

Henry's

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SN7400N	0.22	SN7492N	0.70
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SN7402N	0.22	SN7494N	0.80
SN7403N	0.22	SN7495N	0.80
SN7404N	0.26	SN7496N	0.96
SN7405N	0.22	SN7497N	3.87
SN7406N	0.42	SN74100N	1.89
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SN7423N	0.37	SN74132N	0.72
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SN7428N	0.40	SN74151N	1.00
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SN7433N	0.37	SN74155N	1.00
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SN7442N	0.79	SN74162N	1.38
SN7443N	1.27	SN74163N	1.38
SN7444N	1.27	SN74164N	1.76
SN7446N	1.00	SN74165N	1.76
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SN7448N	1.27	SN74170N	2.52
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SN7484N	1.00	SN74195N	1.10
SN7485N	1.63	SN74196N	1.20
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SN7489N	3.87	SN74198N	2.77
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Triacs	£ p
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SC35A	0.85
SC35B	0.91
SC35D	0.99
SC35E	1.30
6 Amp	
SC40A	0.88
SC40B	0.97
SC40D	1.20
SC40E	1.50
10 Amp	
SC45A	1.09
SC45B	1.12
SC45D	1.50
SC45E	1.88
15 Amp	
SC50A	1.46
SC50B	1.57
SC50D	1.80
SC50E	2.00
Also	
40430	0.85
40669	0.90
40486	0.85

SILICON CONTROLLED RECTIFIERS

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	£ p
T05 1 Amp	
CRS1/05AF	0.42
CRS1/10AF	0.48
CRS1/20AF	0.52
CRS1/40AF	0.60
CRS1/60AF	0.78
T048 3 Amp	
CRS3/025AF	0.36
CRS3/10AF	0.48
CRS3/20AF	0.64
CRS3/40AF	0.68
CRS3/60AF	0.80
T048 7 Amp	
CRS7/400	0.84
CRS7/600	1.14
T048 16 Amp	
CRS16/100	0.78
CRS16/200	0.85
CRS16/400	0.96

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B025/025	0.14	B4/20	0.54
B025/05	0.16	B4/40	0.60
1 Amp		B4/60	0.70
B1/05	0.20	B4/80	0.90
B1/10	0.21	**6 Amp**	
B1/20	0.24	B6/05	0.50
B1/60	0.25	B6/10	0.58
B1/100	0.30	B6/20	0.68
2 Amp		B6/40	0.75
B2/05	0.30	B6/60	0.87
B2/10	0.35	**1 Amp Tubular**	
B2/20	0.40	W005	0.27
B2/40	0.44	W01	0.29
B2/60	0.48	W02	0.30
B2/100	0.55	W06	0.33
4 Amp			
B4/05	0.45		

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AAZ13	0.12	BLY36	6.00	TIP42A	0.90
AC107	0.51	BSX20	0.13	TIS43	0.28
AC128	0.18	BU105	2.20	V405A	0.22
AC187	0.21	BY100	0.27	ZTX108	0.08
ACY17	0.40	BY127	0.12	ZTX300	0.13
ACY39	0.78	BYZ13	0.42	ZTX302	0.18
AD149	0.50	C106D	0.54	ZTX500	0.13
AD161	0.44	GET111	0.72	2N697	0.16
AD162	0.44	GET115	0.90	2N706	0.12
AF117	0.24	GET880	0.60	2N930	0.18
AF118	0.57	LM309K	2.00	2N987	0.42
AF139	0.41	MAT121	0.28	2N1132	0.24
AF186	0.45	MJE340	0.47	2N1304	0.28
AF239	0.44	MJE520	0.83	2N1613	0.21
ASY27	0.33	MJE3055	0.77	2N1671	1.20
BA115	0.10	MJF2955	1.27	2N2147	0.78
BAX13	0.06	MPF105	0.36	2N2160	0.78
BC107	0.14	NKT404	0.66	2N2926	0.12
BC108	0.13	OA5	0.72	2N3053	0.18
BC109	0.14	OA81	0.18	2N3054	0.48
BC109C	0.18	OA200	0.08	2N3055	0.48
BC113	0.15	OA202	0.06	2N3440	0.58
BC147	0.10	OC28	0.66	2N3442	1.39
BC148	0.08	OC35	0.55	2N3525	0.81
BC149	0.10	OC36	0.60	2N3614	0.68
BC169C	0.18	OC44	0.20	2N3702	0.11
BC182	0.12	OC45	0.20	2N3714	1.41
BCY32	0.85	OC71	0.18	2N3771	1.77
BCT39	1.50	OC72	0.28	2N3773	2.40
BCY55	2.64	OC77	0.54	2N3790	2.10
BCY70	0.18	OC81	0.29	2N3819	0.38
BCY71	0.22	OC83	0.27	2N3886	0.72
BCY72	0.12	OC140	1.14	2N3903	0.18
BD124	0.65	OC170	0.30	2N4002	0.14
BD131	0.42	OC200	0.54	2N4126	0.15
BF115	0.20	OC202	0.90	2N4871	0.34
BF180	0.36	OCP71	1.20	2N5457	0.30
BF194	0.10	ORP12	0.50	2S303	0.60
BFX13	0.26	ORP60	0.66	40550	0.64
BFX34	0.70	P346A	0.18	40361	0.48
BFX68	0.24	TIL209	0.20	40362	0.40
BFY50	0.21	TIP29A	0.48	40408	0.50
BFY51	0.20	TIP30A	0.57	40486	0.85
BFY64	0.36	TIP31A	0.61	40636	1.00
BFY90	0.81	TIP41A	0.74	40430	0.85

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CA3019	Diode array	£1.12
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CA3022	Low power video amp	£1.93
CA3028A	Diff cas wide band	£1.03
CA3036	Dual Darlington pair	£1.08
CA3046	Transistor array	£1.03
CA3048	4 X low noise pre-amps	£2.76
CA3075	FM IF limiter and detector	£1.75
CA3081	Hi-Amp 7 seg com emit driver	£1.80
CA3089E	Complete FM IF system	£2.94
CA3090Q	PLL stereo decoder	£6.40
Signetics		
NE555	Timer	£0.88
NE560B	Phase lock loop (PLL)	£5.00
NE561B	PLL analogue multiplier	£5.00
NE562B	PLL open loop for dividers	£5.00
NE567B	PLL tone detector	£3.50
Motorola		
MC1303L	2 X low noise pre-amp	£1.42
MC1304P	Stereo MPX decoder	£1.79
MC1310P	PLL (coil-less) MPX decoder	£2.91
MC1458CPI	Twin op-amp	£0.77
MC1710CG	Level detecting op-amp	£0.50
MFC4000P	250mW amp	£0.46
MFC4010P	Wide band pre-amp	£0.55
MFC6040P	AF attenuator	£1.00
Others		
TBA800	5W power amp	£1.50
SN76003N	5W power amp (finned) (2 for £2.85)	£1.60
SN72741P	8 pin d.i.l. op-amp	£0.50
SN72748P	8 pin d.i.l. Hi-Z op-amp	£0.61
702C	(TO5) op-amp	£0.75
709C	(TO5 or d.i.l.) op-amp	£0.39
723C	(TO99 or d.i.l.) reg	£0.90
726C	(TO99 or d.i.l.) reg	£0.46
741C	(TO5, 8 or 14 pin d.i.l.) gen pur op-amp	£0.50
747C	(TO5 or d.i.l.) gen pur dual op-amp	£1.00
748C	Hi-Z op-amp	£0.61
LM309K	5V 1.6A reg	£2.00
TAA960	3 st filter (ultrasonic transd)	£1.78

CASH AND CARRY PRICES for callers or by post

GB Post/Packing 15p per item

Ref No.		Price
1.	D1203 telephone amplifier—SUCTION	£4.95
2.	D1201 telephone amplifier CRADLE	£7.50
3.	T1206 2 station intercom	£4.95
4.	T1306 3 station intercom	£9.95
5.	T1406 4 station intercom	£12.50
6.	TA/A 2 station telephones intercom	£13.50
7.	W1,2 2 station wireless intercom	£18.20
8.	DP303 door phone intercom	£7.00
9.	PK3 ETCH your own printed circuits	£2.25
10.	EA41 reverberation amplifier	£11.75
11.	US50 ultrasonic switch	£12.75
12.	XP4002 photoelectric alarm system	£13.50
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16.	4 amp 6–12 volt battery charger	£4.85
17.	FF21 car radio/tape quad adaptor	£4.88
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19.	Electric disappearing car aerial	£7.80
20.	ET (F1009) Morse code key/buzzer	£1.70
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22.	LM300 50K disco mic	£12.95
23.	OF50B 50K communications mic	£5.75
24.	Car lighter plug 12w voltage adaptors 300mA (state 6/7½/9 volt)	£1.95 each
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26.	Gravenro 931A photo electric unit (with data)	£3.50
27.	3 cw. 3 X 500 watt sound to light	£21.50
28.	3 cw. 3 X 1000 watt sound to light+override	£41.25
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31.	MX100 deluxe 4 channel mixer	£6.78
32.	H67(G1320) stereo headphone amplifier	£10.50
33.	MP12 6-CH. slider control mixer	£27.95
34.	RE208 stereo phone adaptor	£2.25
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37.	CIS250 stereo phones	£8.50
38.	G1301 and G1305 stereo phone controls	£2.95
39.	Car stereo speakers in pods Special offer Pr.	£2.95
40.	Crystal lapel microphone	£0.60
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43.	Bib record care kit (ref. No. 43)	£2.20
44.	Bib cassette recorder care kit (ref. No. 26A)	£1.98
45.	Bib cassettee tape splicing kit (ref. No. 24)	£1.84
46.	BASF reel-reel hobby box	£2.40
47.	2000 ohm headphones	£1.50
48.	4000 ohm headphones	£1.55
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53A	Sinclair Cambridge Memory	£23.95
54.	BC808 pocket calculator	£21.95
55.	BC817 memory pocket calculator	£28.95
56.	BCM 85 and memory calculator	£33.25
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58.	Antex soldering iron kit (SK1)	£3.30
59.	Bib record care kit (ref. No. 59)	£1.17
60.	5pc chassis punch kits	£5.50
61.	Longs desoldering tool	£5.50
62.	1 amp in line mains suppressors	£2.50
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64.	Weller 8200D-PK expert gun kit	£8.20
65.	'S' dec breadboard	£1.98
66.	'2' dec	£4.29
67.	'4' dec	£7.50
68.	'T' dec	£3.65
69.	Instant head soldering gun	£2.30
70.	40 watt soldering iron	£1.90

ELECTRONIC COMPONENTS

(Post/Packing 15p per 1–6 items GB unless stated)

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Miniature 10.7MHz filters 40p pair

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CA3089 10.7MHz IC £2.94

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Sinclair 6 watt IC
IC12 with data and PC board £2.10

Radio IC chip
ZN414 Radio IC with circuit £1.20

Stereo Cassette Tape Heads
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ZF112A £5.00

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HR1 6" twin spring £6.85 pp 25p

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15m dia. mares tails £10.50 each

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Matched pair for 465 kHz IF £2.00 pair
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605	Power supply for 115	5.31	80	Scope Calibrator	2.08
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615	Power supply for 2 X 120	6.64	525	120–160MHz VHF timer	11.31
230	AM/FM aerial amplifier	3.29	715	Photo cell switch	8.07
240	Auto packing light	6.90	795	Electronic continuity tester	4.97
275	Mic. preamplifier	8.98	860	Photo timer	15.51
525C	120–160MHz VHF tuner	11.31	235	Acoustic Alarm for driver	8.61
570S	LF generator 10Hz–1mHz	21.46	465	Quartz XTAL checker	9.90
575S	Sq. wave generator 20Hz–20kHz	19.77	220	Signal Injector	2.65
			390	VOX	£13.62
590	SWR meter	9.47	432	Testakit	21.83
630	STAB Power supply 6–12v 0.25–0.1A	9.24	670	Buffer Battery Charger	7.59
			850	Electronic Keyer	16.37
690	OC motor speed Gov.	3.31			

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Amplifiers (All single channel unless stated)

4 300	9 volt	300 MW	o/p 3–8 ohm, 1–10mVi/p	Special offer	£1.75
2004	9 volt	250 MW	o/p 3–8 ohm, 10–10mVi/p	Special offer	£2.70
104	9 volt	1 watt	o/p 8–10 ohm, 10mVi/p		£3.10
304	9 volt	3 watt	o/p 1–8 ohm, 10mVi/p		£3.95
555	12 volt	3 watt	o/p 8–16 ohm, 150mVi/p		£4.10
555ST	12 volt	1½ × 1½ watt	o/p 8 ohm, 150mVi/p	Stereo module	£5.95
E1208	12 volt	5 watt	o/p 4–16 ohm, 25–60mVi/p		£5.10
608	24 volt	10 watt	o/p 4–8 ohm, 30–50mVi/p		£4.95
410	28 volt	10 watt	o/p 8 ohm, 160mVi/p		£4.95
620	45 volt	30 watt	o/p 1–8 ohm, 150mVi/p		£9.95
240	30/35 volt	15 watt	o/p 1–8 ohm, 100mVi/p		£5.45
260	45/50 volt	25 watt	o/p 1–8 ohm, 100–250mVi/p		£6.95
SA681	7 24 volt	8 + 8 watt	o/p 8 ohm, 100mVi/p	Stereo module	£10.20

Amplifiers with controls

E1210	12 volt 2½ + 2½ watts 8 ohms	Stereo	£8.25
R500	Mains 5 watts 4–16 ohms	Mono	£8.30
SAC14	Mains 7 + 7 watts 8 ohms	Stereo	£11.75
SAC30	Mains 15 + 15 watts 8 ohms	Stereo	£14.95
CA038	9 volt 1½ + 1½ watts 8 ohms	Stereo	£8.85
CA068	12 volt 3 + 3 watts 8 ohms	Stereo	£10.50

FM Modules

Mullard LP 1186 FM tuner (front end) with data 10.7MHz o/p	£4.85
Mullard LP 1185 10.7MHz IF unit	£4.50
Gorler Permability FM tuner (front end) 10.7MHz o/p	£4.20

FM and AM tuners and decoders

FM 5231 (tu 2) 6 volt FM tuner	All models fitted dials supplied with instructions	£7.95
TU3 12 volt version (FM use with decoder)		£7.95
SD4912 Stereo Decoder for Tu 3.12 volt		£7.95
SP52H 6 volt stereo FM tuner		£14.95
A1007 9 volt MW AM tuner		£4.80
Sinclair 12/45 volt FM tuner stereo recorder for above		£7.45
A1018 9 volt FM tuner in cabinet		£13.95
A1085M (S) 9–12 volt stereo decoder FM for above		£7.50
1062 12 volt stereo decoder. General purpose		£8.50

Preamplifiers

Sinclair	Stereo 60 Preamplifier. With Controls. Special Offer.		£6.75
E1300	CART/TAPE/MIC INPUTS 9 volt	Modules	£2.85
E1310	Stereo 3–30mV mal cart 9 volt	"	£4.75
FF3	Stereo 3mV tape head 9 volt	"	£4.95
3042	Stereo 5–20mV Mag. cart. mains	"	£6.95
EQ25	Mono 3–250mV Tape/cart/flat. 9 volt	"	£1.95

Power Supplies—Mains input (*chassis-rest cased)

470C 6/7½/9V 300mA with adaptors	£2.25
P500 9 volt 500mA	£3.20
HC244R 3/6/7½/9 volt 400mA stabilised	£5.50
*P1124 volt ½ amp £3.30, *P15 28 volt ½ amp	£3.30
*P1080 12 volt 1A £4.70, *P1081 45 volt 0.9A	£7.80
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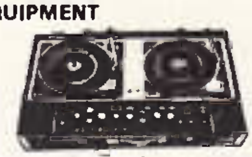

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* [illegible]	£19.50
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hifi today

Having determined which bits of the total signal are programme and which are noise, the auto-correlator automatically filters out the noise.

We have heard the device in operation. With most programme material it is extra-ordinarily effective. Even a dreadfully noisy record was 'magically' quietened.

There are some probably insoluble problems with this technique — it cannot for instance cope with synthesized white noise — which is random by definition. Nor can it cope very successfully with hand clapping — although that might be a blessing in disguise!

Auto-correlation is not a new technique. It has in fact been used for years — especially in space communications where it successfully extracts minute signals which are often below the level of noise.

Although not new it is still an expensive technique and it is unlikely that it will be widely adopted unless one of our enterprising IC manufacturers produces a chip with the auto-correlator function included.

FOUR-CHANNEL FOUL-UP

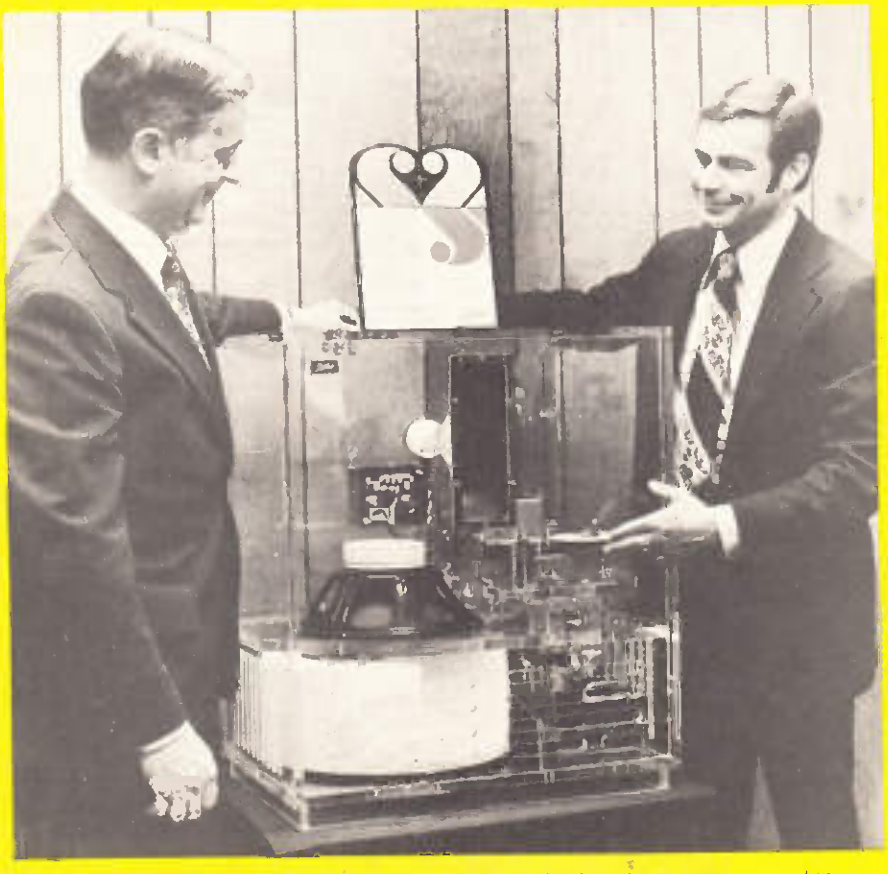
The four-channel scene remains much as it was this time last year. We seem no closer to one agreed system, and even the matrix protagonists have yet to agree on one universal matrix format.

It's bad news, and the public have every reason to treat the sorry scene with caution.

One possible solution is a new format developed jointly by Nippon Columbia and Dr. Duane Coopa of the University of Illinois.

Nippon Columbia's President, Takami Shobochi, told us that the system is completely universal — not only can it handle both discrete and matrix recordings without the need for switching — but it is completely compatible in both stereo and mono modes as well.

Currently, UD-4 is just an engineering concept. Prototype units are currently being demonstrated to interested manufacturers but no commercial units are yet on sale. Nevertheless, according to Nippon Columbia's Record Division at least, there is a strong possibility that the system will be on sale soon.



The rotating baffle under the bass driver in Leslie's Plus 2 enclosure causes sound to 'sweep' the room, thus eliminating standing waves.

In our last issue the review of the Sennheiser Dummy Head recording system described how a two-channel recording played back through perfectly ordinary two-channel headphones can provide almost total spatial location.

The effect is quite uncanny — if it could ever be adapted so that speakers could be used instead of headphones one could probably forget the whole existing four-channel scene.

In Britain, two academics and a leading loudspeaker manufacturer are developing their new concept of surround sound — which they have called Ambisonics. The technique has been described extensively in recent issues of ETI.

So far practical demonstrations have been disappointing, mainly, it is claimed, because the venues chosen have been unsuitable for the new system.

As patent applications are still pending, not a great deal of technical information has been released, but it is significant that several major US and Japanese companies are now said to be investigating the whole ambisonic technique.

On the four-channel broadcasting scene, it now seems virtually certain that the US Federal Communications Commission will sooner or later lay down a standard for *discrete* four-channel FM broadcasting.

Certainly, GE, Zenith, RCA, Nippon Columbia, and Lou Dorrin all have discrete systems under evaluation by the (US) National Quadrasonic Evaluation Committee.

Matrixed four-channel recordings are broadcast by a number of stations around the USA, but station managements are naturally reluctant to spend a great deal of money on equipment that will soon be technically obsolete.

There are now strong indications that the previous objection to broadcasting discrete four-channel, i.e. that of the great bandwidth required — has been overcome. It is probable that the US will end up using one of the five currently competing discrete systems, and techniques will be devised for processing matrix material so that it can be transmitted via the discrete broadcasting link.

A matrix-type link can only handle discrete material by reducing that material's channel separation to matrix proportions.

WATTS RMS NOW OFFICIAL

Like the contenders in the GREAT AMERICAN HORSEPOWER RACE, US and Japanese amplifier manufacturers have now largely ceased their practice of seemingly multiplying their product's power output by the last two digits of their telephone number.

Soon, in the USA at least, manufacturers will have no choice anyway because the US Federal Trade Commission has now set strict new rules for audio power claims.

Legislation, from November 4 this year, specified that amplifier power output *must* be quoted as *continuous* power capability – to be expressed in that technically dubious but colloquially accepted unit, the 'watt rms'.

Other specifications, such as peak power or music power may still be used, but must be based on recognised industry standards – and must be subservient to the main power output disclosure.

There is of course a strong argument for disclosing both figures – for in assessing amplifier performance it is necessary to know the amplifier's ability to handle peak transients as well as continuous high levels.

BIG MUTHERS

The trend to ever more powerful amplifiers continues, and now there are at least ten domestic models available with outputs of 200 watts and more. There is even one monster that puts out 2 kW!

Whilst power such as this is not needed for driving low-priced speakers – in fact such speakers could not withstand the electrical onslaught for more than a second or two – there is a growing trend toward large speakers of very low efficiency.

Transmission-line enclosures are a typical example. Speakers such as these really *do* need a lot of power if they are to operate satisfactorily.

It is also our opinion, having listened to a very large number of amplifier/speaker combinations, that virtually *all* speakers sound cleaner and firmer when driven by amplifiers of thirty five or fifty watts rating than by the more generally used twenty five watt units.

We stress that there is not a great deal of difference in maximum sound output. In fact as the ear has a vaguely logarithmic response to sound pressure levels it would be necessary to go from

Two hundred and fifty watts continuous power per channel! Big amplifiers like this Marantz model 250 really are needed to drive many of today's power-hungry loudspeaker systems.

twenty five to two hundred and fifty watts even to double the subjective sound levels. The difference is rather one of quality – and it is a *big* difference.

WHAT OF THE FUTURE?

Apart from the recent development of truly hi-fi quality cassette recorders, and a few loudspeakers, hi-fi development still consists largely of refining and polishing what went before.

With rare exceptions, speaker drive units are still made very much as they were forty years ago. Cone materials and magnets have been improved and performance is substantially better than was obtainable from the early units – but improvements in loudspeaker performance owe more to developments in enclosure design than drive unit design.

Small modern loudspeakers are dramatically better than they were fifteen years ago, but size apart, Paul Klipsch's horn-loaded speakers, designed in the late nineteen-forties, (and largely unchanged ever since) have still to be seriously out-performed.

Much the same is true of electrostatic speakers. It is now nearly twenty years since P.J. Walker's dramatic demonstration of the full-range Quad ESL.

Yet here again few other speakers can equal the Quad's performance even today. Let alone surpass it.

In fact many authorities believe that the Quad electrostatic speaker is still *the* top unit – at all but high sound levels, which are not any electrostatic's best point.

Amplifier design has improved to the point where a good example closely approaches the ideal of a piece of straight wire having adjustable gain.

In some areas, particularly that of distortion, several amplifiers have been 'over-developed' – to the point where buyers are paying for 'improvements' that could only be detected by physical measurements.

Not all the improvements have filtered through to the cheaper low-powered models – but even there, amplifiers are probably the strongest link in the hi-fi chain.

Turntables and cartridges too have improved and performance of the top models has now reached the stage where their limitation is the quality of the programme material.

We expect to see progressive refinements of programme material and of loudspeakers for some years to come. Eventually though we believe that there will be a complete change in the technology employed.

The change, we believe, will be to a totally digital technology.

Such a technology would have been unthinkable even three years ago – because of the enormous complexity and sheer quantity of operating elements. Literally thousands of transistors would be required.

But solid-state technology has now advanced to the point where thousands of transistors and associated components can be formed on a single chip – making feasible many applications that were hithertoo totally impossible.

The adoption of digital technology would virtually eliminate any problems of noise – either from programme material or generated within the reproducing equipment.

It would open the way to a totally new concept in loudspeaker design. These would become a bank of innumerable tiny transducers – driven in various ways and combinations – but capable of reproducing original sounds in a way that can never be even approached by present-day speaker systems.

Sounds way out?

Maybe it is, but in the past few weeks we have discussed this possible trend with four of the world's leading audio equipment engineers – all were *actively* investigating similar approaches.

SPRING REVERBERATION UNIT

Built-in mixing facilities and stereo operation are provided in this versatile unit.

THE SOUND of many musical instruments may be "enhanced" by the addition of reverberation. Particular examples of instruments, to which reverberation is commonly applied, are the electronic organ and the guitar.

Reverberation is defined as the persistance of sound within an enclosure after the original sound has ceased. It may also be defined as a series of multiple echoes, decreasing in intensity, so closely spaced in time as to merge into a single continuous sound eventually dying away to nothing.

Reverberation, added with discretion, gives life and brilliance to the music from individual instruments which otherwise appear dull and flat. It is less commonly known that, when reproducing recorded material, the addition of reverberation can considerably enhance the liveliness of the material and its apparent spatial depth.

Artificial reverberation can be achieved in several ways. One system employs echo chambers to achieve the delay. A second system employs magnetic tape-loop techniques, whilst a third, the one used in this project, uses an amplifier that drives springs to provide the delay. It is also possible to achieve delay by fully electronic means but, for normal instrumental or home use, the circuitry is prohibitively complex and expensive.

The unit described is based on a sensitive reverberation spring assembly and is suitable for incorporation into existing amplifier instrumental setups, or for adding reverberation to the reproduction from stereo Hi-Fi systems.

This unit has the required mixing facilities built-in, the proportion of echo to original signal being adjustable by a control called DEPTH. In addition, we decided to make the unit capable of adding reverberation to stereo systems. This involves very few extra components since both channels are mixed into the reverb spring and the combined echo then separately mixed with the original left and right channels. This extra expense is only that of an extra transistor stage and is well justified, even if the unit is mainly intended for monophonic work.

As the unit is completely functional within itself, and fitted into a strong but attractive metal cabinet it will be equally suitable for use by professionals or high-fidelity audio enthusiasts.

SPECIFICATION

INPUT VOLTAGE	
Maximum	1 volt
Range	100 mV – 1 volt
FREQUENCY RESPONSE	
Direct	–3 dB at 20 Hz, 50 kHz
Delayed	50 Hz – 4 kHz
IMPEDANCE	
Input	approx. 47 k
Output	< 5 k
CROSS TALK	
With 10 k source impedance	– 40 dB
GAIN	
Maximum	unity
SIGNAL TO NOISE RATIO	
Direct	> –60 dB ref IV
Reverberation	> –50 dB ref IV

CONSTRUCTION

We housed our unit in a simple pan-shaped chassis with metal cover.

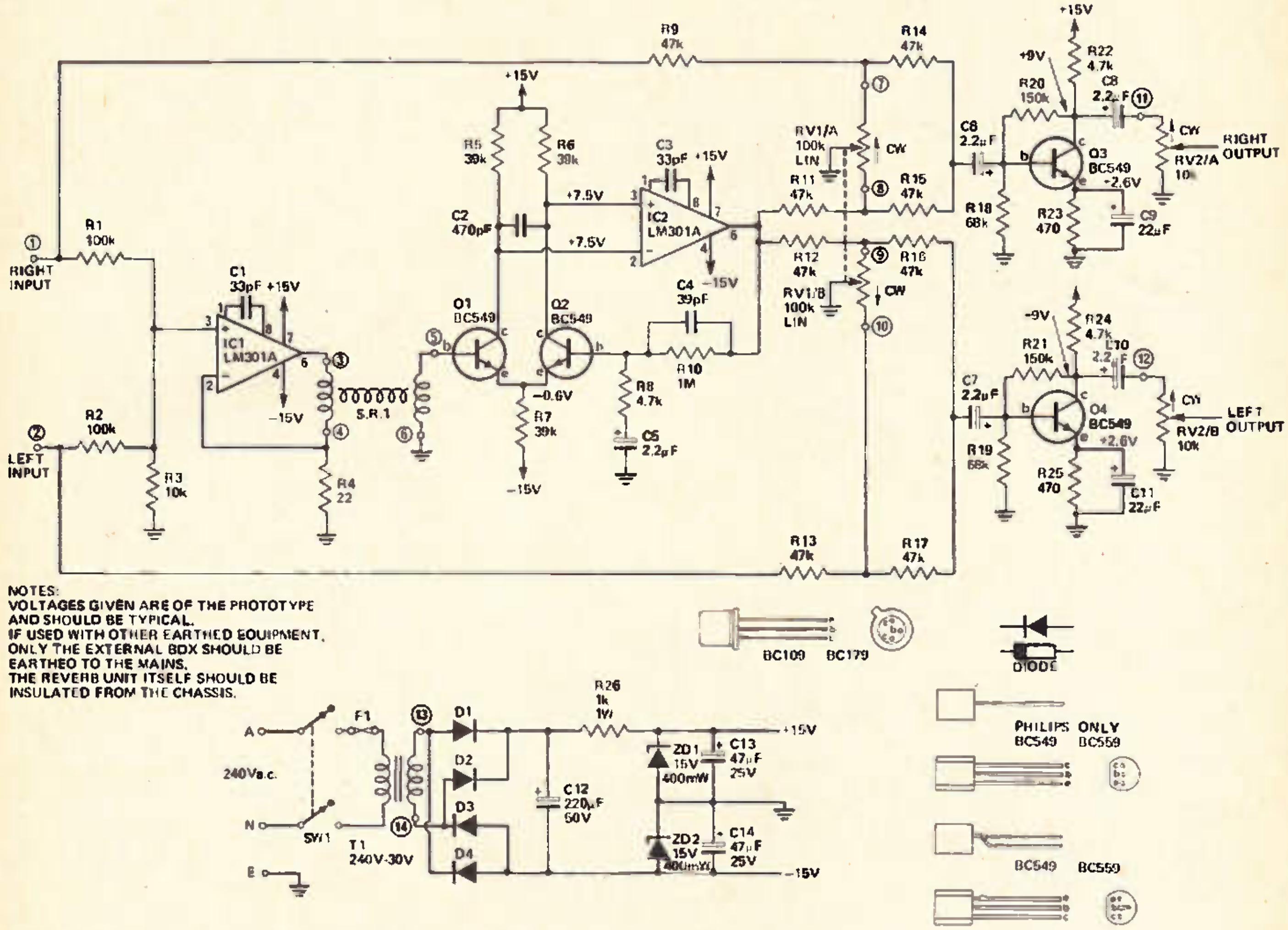


Fig. 1. Circuit diagram of the spring reverberation unit.

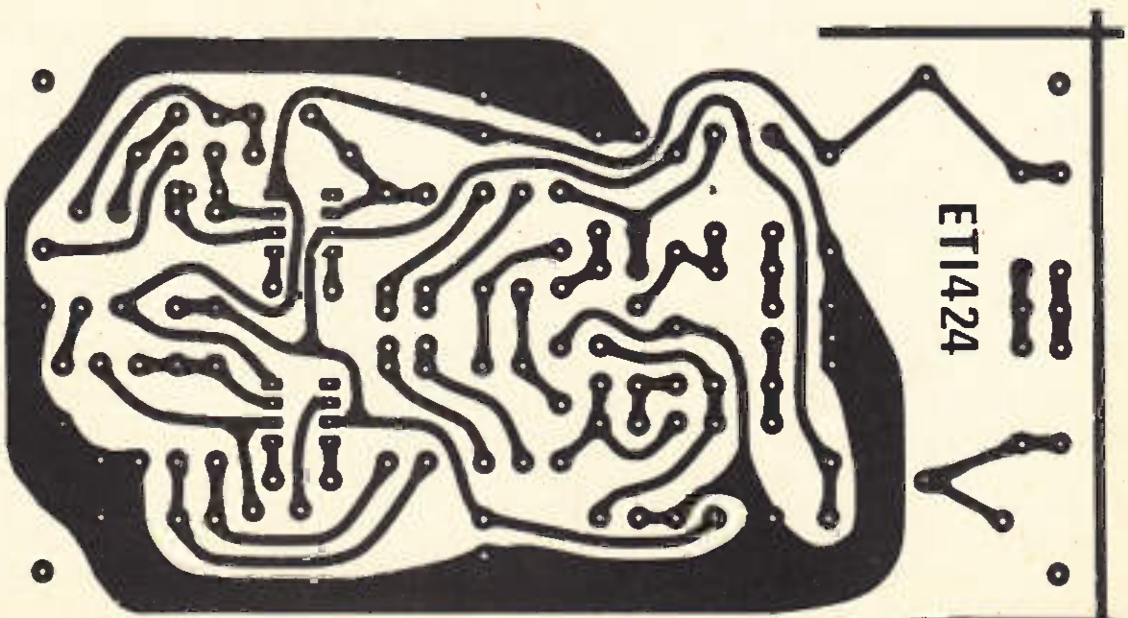


Fig. 2. Full size printed circuit board layout.

SPRING REVERBERATION UNIT

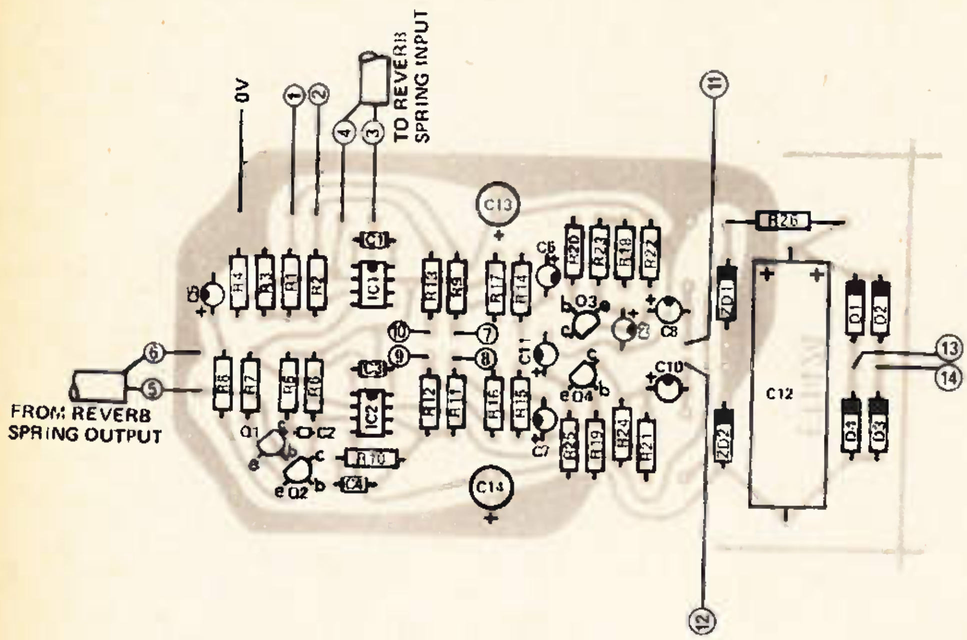


Fig. 3. Component overlay.

This enables the unit to be used as a flexible system component, but, if desired, the electronics may easily be incorporated within an existing system-box if room permits.

The majority of the components are mounted upon one single printed-circuit board, although matrix or veroboard can quite easily be used if preferred.

Whichever constructional method is used, it is essential to check polarized components, for correct orientation, before soldering. Note especially that

ETI 424 PARTS LIST

R4	Resistor	22	½W	5%
R23,25	"	470	"	"
R26	"	1 k	1W	"
R8,22,24	"	4.7 k	½W	"
R3,	"	10 k	"	"
R5,6,7	"	39 k	"	"
R9,11,12,13	"	47 k	"	"
R14,15,16,17	"	47 k	"	"
R18,19	"	68 k	"	"
R1,2,	"	100 k	"	"
R20,21	"	150 k	"	"
R10	"	1 M	"	"

RV1	Potentiometer	100k dual lin rotary
RV2	"	10 k dual log rotary

C1,3	capacitor	33pF ceramic
C4	"	39pF ceramic
C2	"	470pF ceramic
C5,6,7,8,10	"	2.2µF 10V electrolytic
C9,11	"	22µF 10V electrolytic
C12	"	220µF 50V electrolytic
C13,14	"	47µF 25V electrolytic

Note: all electolytics except C12 are pc mounting.

D1-D4 diodes 1N4001 or equivalent
ZD1-ZD202 Zener diodes BZX 79 C15 or any 15V 400mW type

Q1-Q4 transistor BC549, BC109 or equivalent
IC1,2 operational amplifier LM301A
PC board ETI 424
SW1 switch 2 pole on-off 240V rated
F1 fuse and fuse holder 500 ma chassis mounting
Spring reverb unit

T1 transformer 250V/30V 500mA

3 core flex and plug
2-way phono sockets — 2 off
12mm long spacers 4 off
chassis to Fig. 7
metal cover to Fig. 8
front panel to Fig. 6
rubber grommet for power cord and insulating reverb unit.
Insulated RCA socket for reverb.

SPRING LINE: a sensitive spring line unit is needed — the LM301A cannot drive the common 16Ω type. An input impedance of 150Ω or more is required. Elvins Electronic Musical Instruments of 40 Dalston Lane, Hackney, London E8, have an 150Ω unit, the E150, selling at £7.56 (inc. VAT), P & P 35p.

HOW IT WORKS

The reverberation spring is an electro-mechanical device for delaying and producing echo on audio signals – it operates in the following manner. A relay-like transducer vibrates one end of a spring in response to an input audio signal. The spring continues to vibrate after the excitation has been removed and thereby produces a decaying 'echo' as well as delaying the propagation of the signal to the transducer at the other end.

The mechanical system naturally has many resonances and the frequency response therefore cannot be flat over a small frequency range, but is substantially flat over the broad frequency range of 50 Hz to 4 kHz.

Integrated circuit IC1 is connected so as to provide current drive to the input transducer of the spring. The transducer is inductive and hence, the voltage across it will increase with frequency. However, since the current remains constant, the power in the transducer also remains constant. The stereo input is summed into R3 by resistors R1 and R2 (with a loss of 20 dB) to provide a composite signal at pin 3 of IC1. As the amplifier always tries to keep pin 2 at the same potential as pin 3, the voltage across R4, and the current through it, is therefore proportional to the input voltage. As very little current flows into pin 2 of the IC, all this current flows through the transducer.

The output signal from the transducer at the other end of the spring is very small (about −50dB referred to the input and is therefore amplified back to a reasonable level by Q1, Q2 and IC2. Transistors Q1 and Q2 are low noise types and are arranged as a differential pair to add gain before the inherently noisy IC. The gain is set by (R10+R8)/R8 to about 46 dB. The low frequency cutoff is set by C5 and R8, and the high frequency cutoff by R10 and C4. Note that these last figures refer only to the receiving transducer amplifier and not to the whole system.

The direct inputs, left and right, are now both mixed with the common reverberation signal in mixers Q3 (right) and Q4 (left). The proportion of direct and reverberation signals is adjustable by means of depth control RV1. The gain of the output stage is set by R20, R21 and the bias by R18, 19, the overall gain of the complete system being approximately unity.

If single channel operation only is required, simply delete the second mixer transistor and its associated components. If reverberation only, without the mixing facility, is required the output may be taken direct from pin 6 of IC2.

In the event that a volume control is not required resistors may be fitted to the board (holes provided on board) to set the volume to any desired level. These resistors may have any value between 10 k and 1M.

two different pin configurations for the BC549 are available and that it is the Philips type which is shown on the overlay.

The unit should be wired, as shown in Fig. 1, taking care to keep all 240 volt ac wiring well clear of the electronics and especially clear of the receive end of the reverberation spring. The metal case itself should be earthed even though the electronics itself is not earthed.

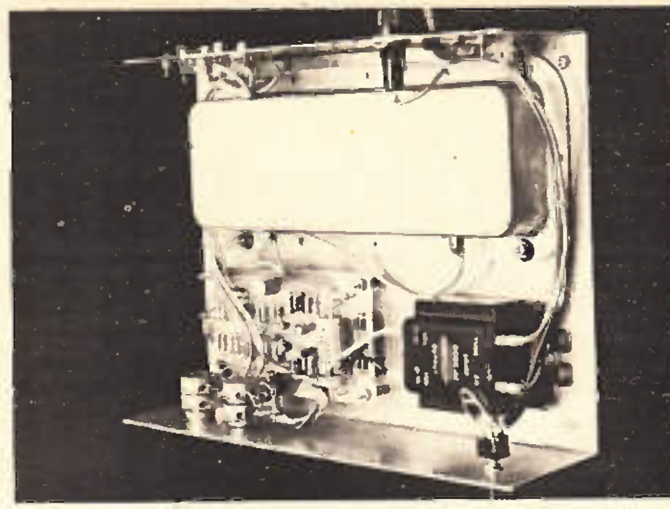


Fig. 4. Method of mounting the hardware and printed circuit board into the chassis is illustrated in this internal view.

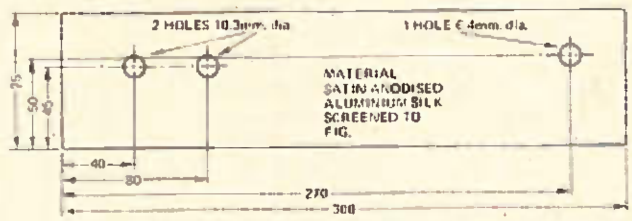


Fig.5 Front panel drilling details.

Fig. 6. Front panel artwork for the spring reverberation unit (half size)

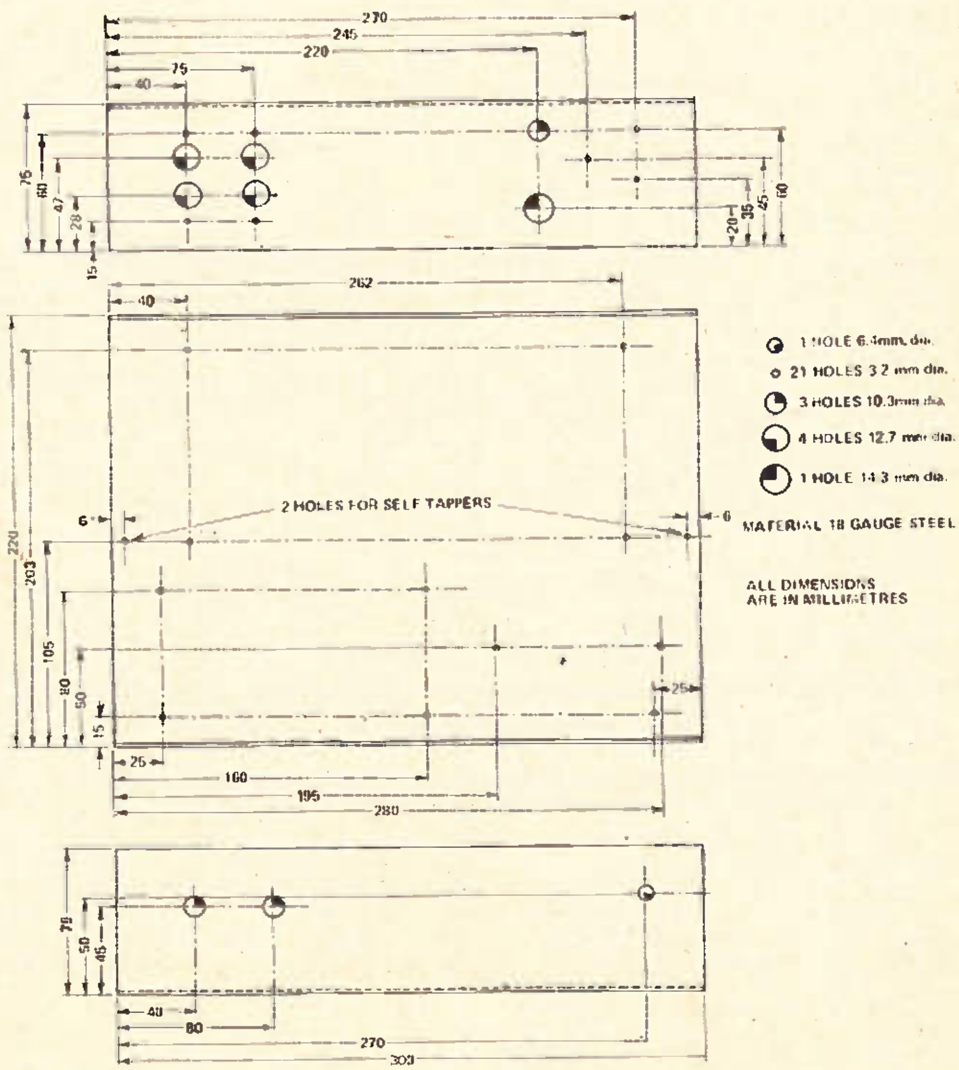


Fig. 7. Dimensions and drilling details of the chassis.

SPRING REVERBERATION UNIT

SETTING UP

As the reverberation spring is a mechanical device, vibration will produce unwanted outputs. Hence it is an inherently noisy device and should be used at a point in the system where the signal level is high.

Two typical points at which the unit may be inserted in the system are:–

1. Between the preamplifier and the main amplifier.
2. After the disc preamplifier, or high level input and the preamplifier.

If inserted between pre and main-amplifiers, i.e. after the volume control, turn the reverb volume control to maximum and adjust the preamplifier volume control such that the main amplifier is just below clipping level. The reverb volume control can then be used to set the level required.

If the reverberation unit is inserted before the system volume control, the volume control on the reverberation unit should be set to maximum (or deleted altogether if desired) and the preamplifier volume control used to set the required level. ●

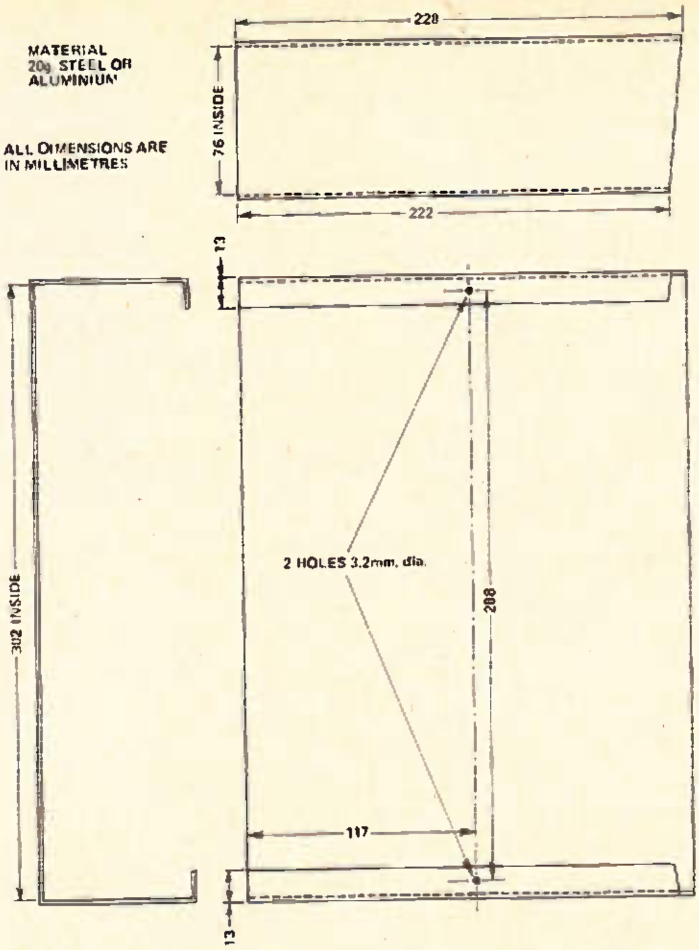


Fig. 8. Detail of the cover.

PART 3 ELECTRONICS IN CRIME

In the battle against crime — *both* sides are using increasingly sophisticated techniques, Electronics Today reports.

MOST people have an 'it couldn't happen to me' attitude toward crime. This results in what the police call 'patchwork' security — the householder waits until a crime has been committed before installing an alarm system — which is then more than not only partially effective.

Nevertheless there are many domestic alarm systems, commercially available, that can provide very effective anti-intrusion security — especially if tailored to suit individual applications.

PERSONNEL SECURITY SYSTEMS

On a larger scale the security of widely dispersed installations presents a more complex problem.

Airports, factories, warehouses and other public buildings must be protected not only against the clandestine intruder, but, also against the activities of extremists carrying firearms or explosives as well.

Arson is particularly difficult to prevent. If the potential arsonist can penetrate an intrusion security screen, then there is very little that can be done to prevent him planting devices and successfully starting a fire. Such devices are quite ingenious and can be made to look like everyday objects.

One example is a device used by saboteurs during the Second World War. It looked just like a pencil — hence its name 'fire-pencil'. Inside were two compartments, separated by a thin wall of copper. One compartment contained picric acid (a highly sensitive explosive compound). The other contained a concentrated mineral acid inside a membrane.

When the membrane was perforated the acid would come in contact with the copper dividing wall and after a desired time, (determined by the thickness of copper), would eat through the wall and attack the picric acid.

The result was a violent reaction producing a sheet of flame of high temperature that ignited any surrounding flammable material. The time delay gave the saboteur ample time to leave the scene.

More effective intrusion security and patrolling of areas seems to be the only effective measure against the potential arsonist.

Where an "insurance" job takes place, about all that can be done is to determine the cause of a fire and investigate suspected persons.

It is estimated that about a third of reported fires are deliberately lighted.

AREA SECURITY

Alarm systems play a key role in the reduction of burglary, robbery and other crimes. The mere presence of an audible alarm system may act as a deterrent. Its primary mission is to

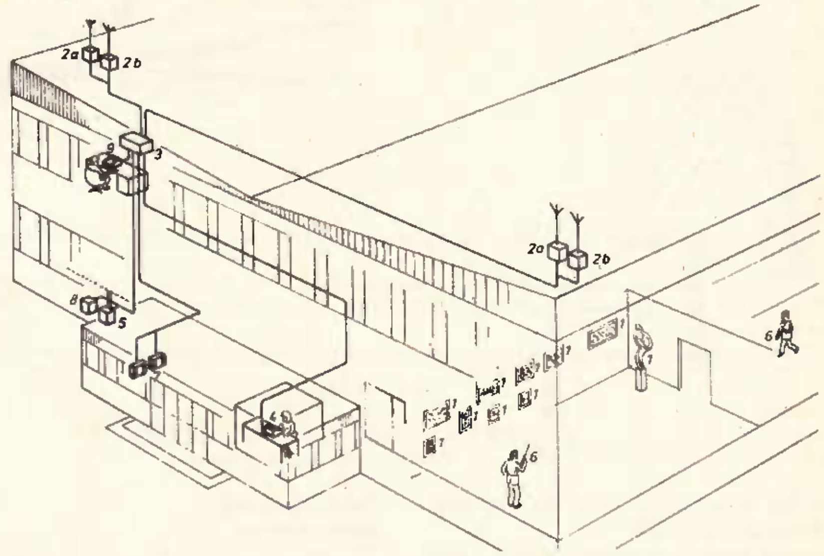


Fig.1a. Perimeter Security Area and guard communications.

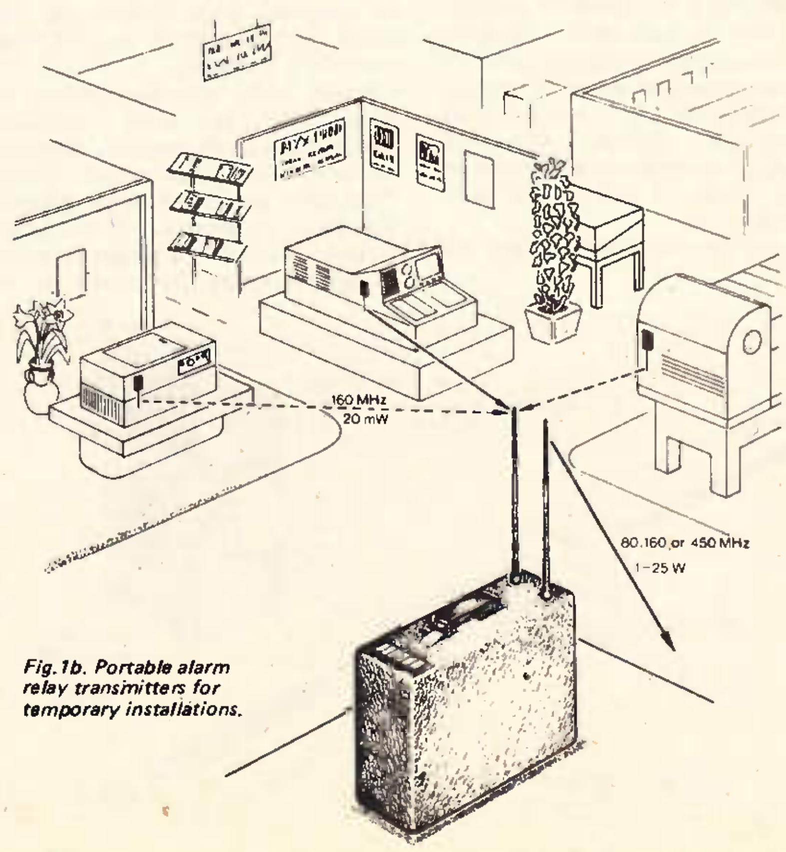


Fig.1b. Portable alarm relay transmitters for temporary installations.

ELECTRONICS IN CRIME

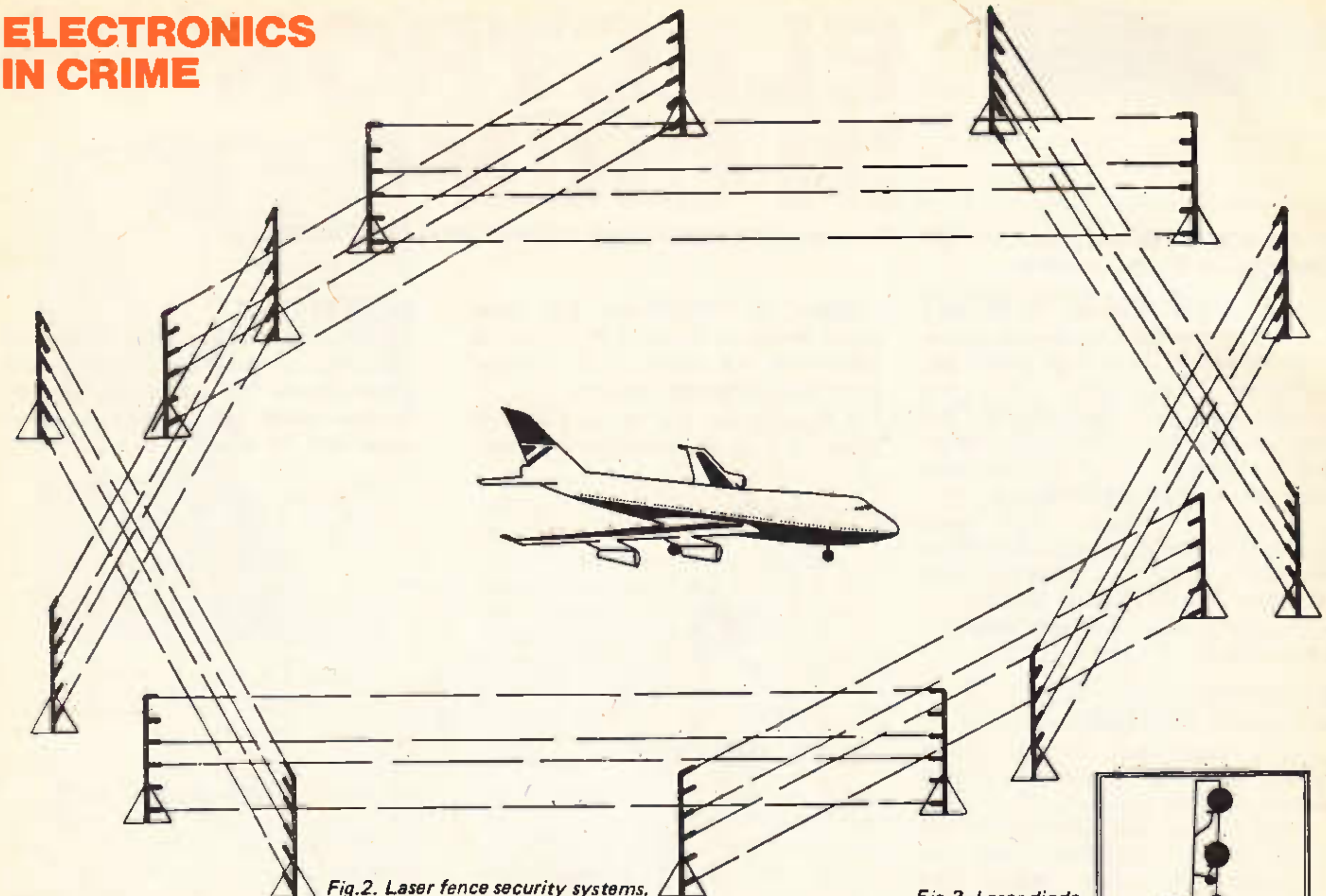


Fig.2. Laser fence security systems. Airliner is not drawn to scale.

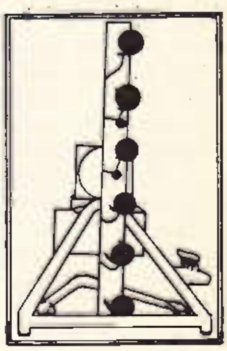


Fig.3. Laser diode array for security fence.

prevent a crime from occurring and thereby prevent loss.

In contrast a "silent" alarm with remote "alert" facility has no deterrent value, but provides a better opportunity to capture the intruder.

The widespread introduction of electronic alarm systems is forcing many criminals to rethink their methods of working. Successful disabling of alarm systems demands an increased level of skill — and more specialised tools.

Various types of alarm systems are used:

The hard-wired alarm system

In this a series of switches and trips are wired into strategic locations such as windows, door catches etc. The alarm is triggered if any of these switches is activated.

Whilst fairly effective against the casual thief, the more determined intruder can overcome such alarms by studying the system and placing "jumpers" across switch terminals or trip wires. Furthermore if the system is mains powered the simple expedient of disconnecting the power at the main will immobilise the system unless automatic changeover to standby batteries is included.

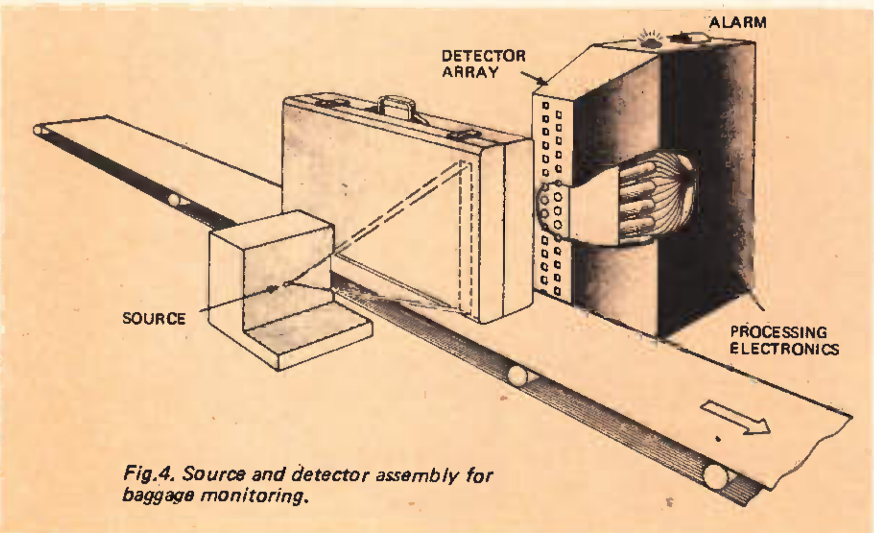


Fig.4. Source and detector assembly for baggage monitoring.

"Volumetric sensor" alarm systems

Volumetric sensors provide a three-dimensional detection zone. A variety of these devices are available; ultrasonic, passive acoustic, microwave, radar, optical and passive infra-red are the most widely used.

They offer a formidable obstacle to the intruder, but are prone to a high percentage of false alarms.

They operate by detecting noise or heat produced by the intruder, or by detecting movement in the protected area (by reflected energy or by Doppler effects introduced into a sonic or RF field saturating the area).

"Perimeter security" systems

In larger industrial applications where security is required beyond the buildings themselves, more elaborate methods are necessary. Here, alarm systems may be used in conjunction with guards patrolling the area.

Where variable factors come into play as at exhibitions, museums, trade fairs etc. a flexible system has been developed that can be quickly set up and linked to a central control unit, as well as providing communications with guards. (see Fig. 1a and 1b)

This system consists of miniature alarm transmitters that are portable and can be quickly placed at strategic locations. Portable alarm relay stations link one or more of these transmitters with a central processing unit, (which is part of the fixed equipment) together with diversity receivers and control units.

The alarms are sensitive to acceleration, temperature and position and when triggered send a signal identifying that transmitter. The alarm signal is picked up by a receiver and transmitted to a central processing unit.

Immediately a signal is received, the guard nearest the alarm point is alerted by UHF radio or an inductive loop. If the guard fails to acknowledge the call a nearby group of guards is alerted. At pre-set time intervals other actions may be initiated, eg. automatic closure of doors, telephone alarms to the police etc.

All alerts are registered on a printer which registers date, time and location as well as the name of the guard.

This integrated system has been developed by Sweden's Sonab AB and is representative of a modern highly effective security system.

The laser "fence"

Because installations such as airports and military bases are vulnerable to intrusion, the US Air Force has developed a laser system for perimeter security.

Solid-state injection lasers (giving off radiation in the near infra-red) generate narrow beams of energy which are monitored by remote receivers.

Any intruder crossing the optical path will trigger an alarm. Fig. 2 shows how an overlapping array of laser fences can provide total security around a given area. The units shown in Fig. 3 are portable and can withstand the high winds experienced around airfields.

They are operable even when visibility is poor. The low power laser sources are safe to personnel.

Weapon detection

With the current wave of terrorist attacks and hijackings the need for security at airports, post offices, and other public places has resulted in a large range of devices coming into use.

Baggage, for instance, is checked prior to loading into a plane's cargo-hold. Security guards usually search each piece by hand but this is both time consuming and costly.

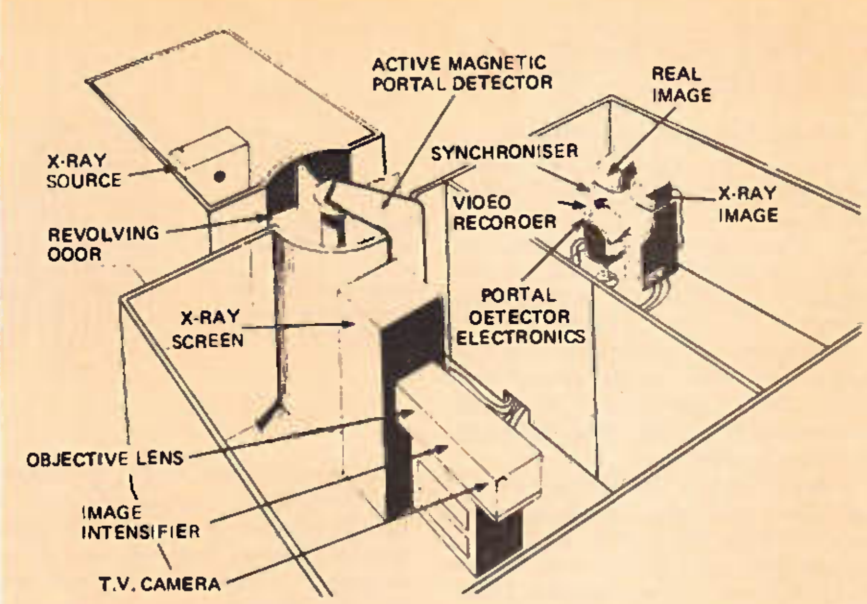


Fig.5. Personnel X-Ray screening portal and alarm system.

Devices are now available for automatically checking luggage for weapons and other hidden items.

Westinghouse, have developed a gamma-ray detection system for continous luggage monitoring.

The luggage is scanned as it is carried along a horizontal conveyor, between the gamma source and the detector array. (see Fig.4).

A fan beam of gamma rays passes through the luggage and is monitored by an array of scintillation detectors. By adjusting the detection level appropriately the system detects the presence of a weapon by looking for radiation falling below a preset threshold level.

The high degree of absorbtion by weapons, especially lead bullets, makes them stand out compared to most metal objects carried by travellers. The incidence of false alarms is sufficiently low to make this an effective and fast security monitor.

Since the radiation source consists of a radioisotope inside a shielded container, the unit is compact and easily transportable.

Another type of system that can be used on conveyor belts is the magnetic metal detector similar to that used to detect tramp metal in quarries and mines.

Goods moving along the conveyor pass through a detector loop which is adjusted to detect metal objects above a certain size. When a metal object enters the activated loop, it distorts the magnetic field and triggers the alarm. Units such as this have been tested in postal sorting offices with good results.

Detecting explosive and non-metallic objects

Firearms are relatively easy to detect, their concentrated mass of metal can be spotted by conventional metal detectors.

But explosives and non-metallic objects pose a more difficult problem

Fig.6. X-Ray of dummy carrying concealed weapons.

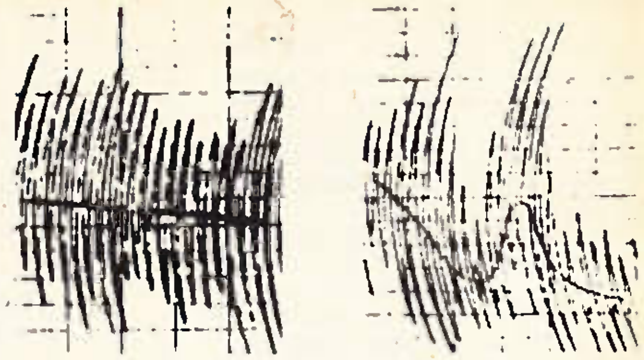


Fig. 7. Voiceprints of stressed and unstressed subjects. Modulation of the unstressed (right) voice almost disappears "under stress" (left).

— in fact many of the recent 'letter bombs' were impossible to detect without the use of very sophisticated equipment.

At present the only effective way to detect explosives and non-metallic objects is to sense their characteristic odours.

Explosives are naturally unstable compounds. They emit vapours that can be detected by gas chromatographs, and other forms of chemical analysers.

These 'electronic sniffers' sample the air (often routinely), in places where explosives are likely to be concealed: luggage lockers at airports and railway stations are common examples. These units can also detect fire-arms by sensing the vapours of the oil with which they are usually lubricated.

Specially-trained dogs are also used to detect the odour of explosives, firearms and other contraband material. At present, trained dogs are the most sensitive of our sensors, in fact their sensitivity to very small concentrations of vapour far exceeds that of even the most sensitive gas chromatograph. (Both dogs and chromatographs are much more sensitive than an unaided human.)

Protecting key public figures

Assassination and terrorism is a growing menace.

A great deal of research into personal protection has been carried out by the US Army's Mobility Equipment Research and Development Centre (MERDC).

MERDC's recent efforts have been concentrated on three main research projects. These are, controlled access to crisis areas, crowd surveillance, and sniper fire detection.

Controlled access checkpoints have existed since hostile actions started between groups of human beings. Until recently these consisted of visual and physical checks, and evaluation of behaviour patterns. But now, these checks are aided by various electronic devices.

The principle hazard is concealed weapons. These are usually detectable by channelling people through a limited number of entrances housing various types of magnetic and X-ray equipment coupled to alarm systems. (Fig.5). Figure 6 shows an X-ray of a simulated 80 kg human. The dummy is a walking arsenal. Observable on the X-ray are several otherwise-concealed weapons distributed about the body. This X-ray photo was taken using an image intensifier. TV screen displays are also used. These are less clear but improved systems are being developed.

Fig.8. Thermal image of concealed weapon.

Whilst this technique provides a quick generalised 'scan' of the population, more sophisticated methods are used to investigate individual suspects.

One device that shows great promise is the psychological stress analyser. This device analyses changes in involuntarily modulated components of the human voice (Fig. 7). In use, the suspect is asked a series of questions and his answers recorded. The subsequent tape is run through the analyser which produces a chart which must then be interpreted by a trained operator.

MERDC's goal is to produce a unit which can analyse suspects' speech directly, indicating the presence and degree of stress without operator interpretation.

Basic voice analysis units are currently being used by several police forces and army units worldwide. Regrettably, these devices are also being used by employers to vet their prospective employees — with or without their permission. However legislation may well soon be passed in the USA to outlaw their use — except, presumably, by security organisations.

Another device used for crowd surveillance is the infra-red imager. Figure 8 shows how a weapon will reveal its presence thermally at a distance of about four metres. This technique works well but has not yet been evaluated practically.

Another device developed by MERDC detects and locates the source of sniper fire. Naturally this is only effective *after* the act, but some measure of protection is provided if the origin of a shot is known.

The device uses multiple radiometers in a 360 degree array to detect and locate the infra-red component of a gun-flash. Maximum range is about 300 metres. The unit covers twelve 30 degree segments in azimuth and four 20 degree layers in elevation. Thus there are 48 fields of view (Fig. 9). The unit incorporates an acoustic alarm actuated when ancillary sensors detect gunshots close by.

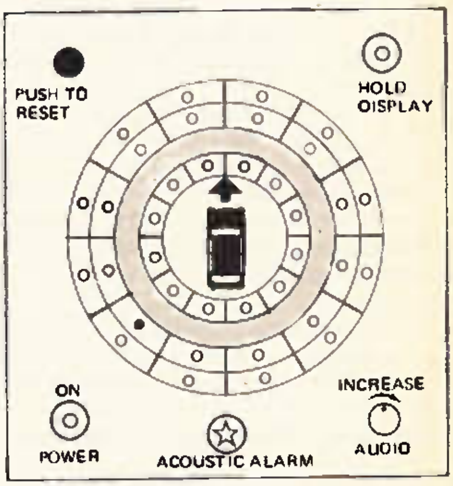


Fig.9. IR gunflash detector display console.

The various technologies being researched by MERDC have many civilian applications and their efforts have been closely coordinated with the US Dept. of Transportation, Federal Aviation Agency, Customs, Secret Service etc.

At the beginning of this century there were only three crimes a year per thousand people. By 1971, this figure had increased to three per one hundred people — ten times as many. (Source — Prof. Sir Leon Radzinowicz, Wolfson Professor of Criminology, University of Cambridge).

American gangster Al Capone once said 'There is in this country a gangrene . . . it is called the almighty buck. As long as people are prepared to do anything to get it, I can control them'. ●

ETI TOP PROJECTS

CONTENTS

We show the actual contents section here — there's really something for everybody! All articles appear as they did originally but have been updated for new components etc. where necessary.

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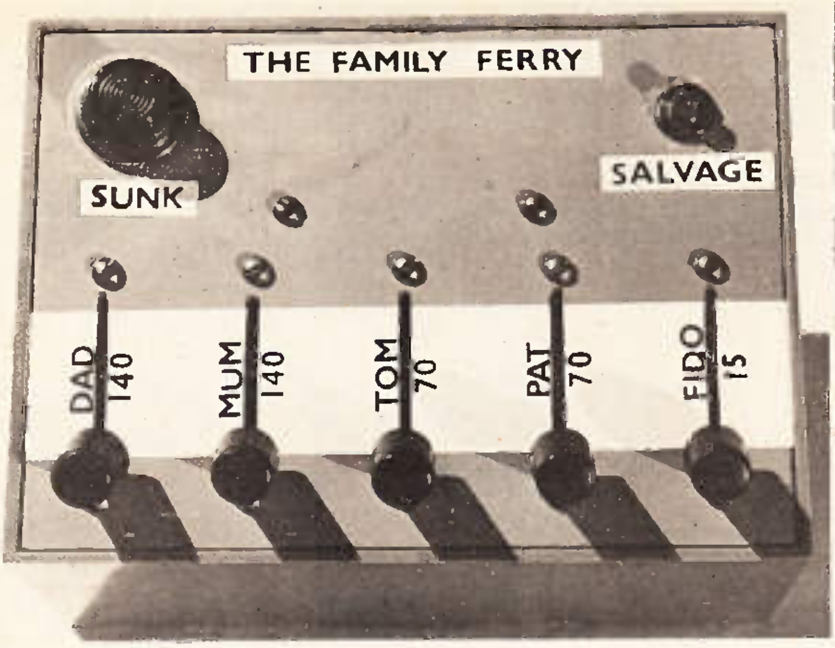

Fig. 1.

THE FAMILY FERRY

An old problem updated – electronically

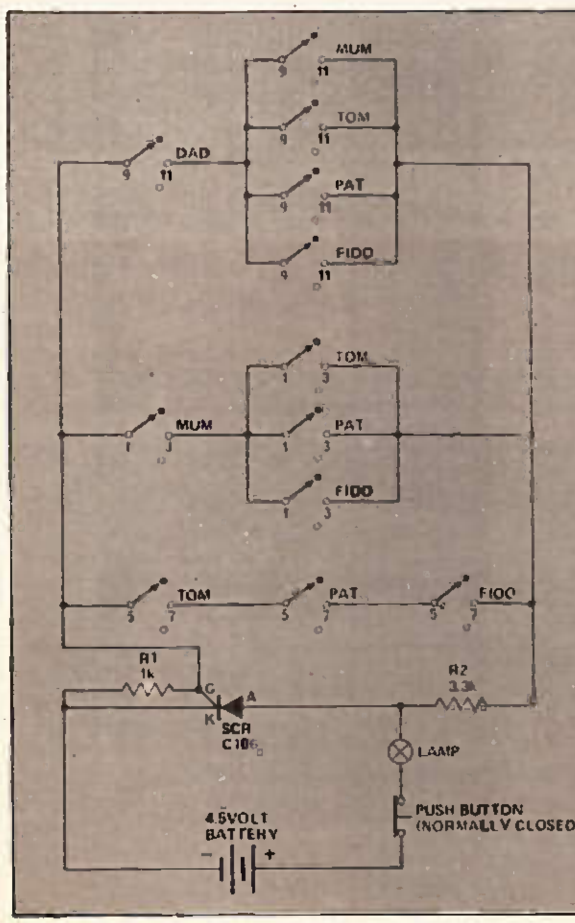

Fig. 2. The five slide switches are labelled 'DAD', 'MUM', 'TOM', 'PAT', and 'FIDO' respectively – as shown in photograph above. Numbers on switches correspond to pin numbers shown in Figs. 6 & 7.

eti PROJECT 230

THE ORIGIN of this problem is not known. The writer heard it a while back, and thought it would be fun in electronic form. So here's the story:

> A family comprised Dad, who weighed in at 140 lbs, Mum, who also tipped the scales at 140 lbs; son Tom – 70 lbs, and daughter a nimble 70 lbs, plus Fido a well fed dog of 15 lbs. They all came to a river which they wanted to cross. In the boat which was tied up there, was a notice which read 'CAUTION! MAXIMUM LOAD 150 lb.' Now this river was infested with crocodiles, so no one was keen on swimming. Problem: how did all the family get across the river?

The circuit is arranged so that the alarm operates while switches are being moved from side to side – if the total load they represent exceeds 150 lbs.

Each member, including the dog, is represented by a three-position lever switch.

Only the contacts in the middle position are used, as they are closed while the levers are passing through the 'dangerous' position, i.e., while people are in the boat. Fig. 1 illustrates the arrangement. The alarm is a red pilot lamp marked SUNK.

The circuit is shown in Fig. 2. The lever switches used are 3-pole three position, although the links between poles are not shown in the circuit. All the levers are shown in one side position, and they close circuits only momentarily as they pass through their centre positions. This brief contact applies a voltage to the gate of the silicon controlled rectifier SCR, which turns it on and leaves it on, thus leaving the SUNK light turned on. The moving contacts on the switches are so wide that if the switches are moved reasonably together there is no chance of failing to make a circuit when one should be made.

To reset the game after the boat has been sunk, a SALVAGE push button is provided. This is a normally closed push button, which, on being pushed, simply opens the circuit momentarily

PARTS LIST – ETI 230

R1	Resistor	1k	½W	5%
R2	"	3.3k	"	"

Switches 5 by 3 pole 3 position rotary
1 by normally closed push button.

SCR1 Silicon controlled rectifier C106 or similar

4.5 volt battery, 4.5 volt pilot lamp.

and so turns off the SCR – unless the switches have been left in a 'sunk' arrangement.

A study of the circuit will show that the lamp is turned on if any circuit is made between the right and left hand side lines. The switches between these lines are such that, in all dangerous situations, a circuit IS made. No main switch is provided as the leakage through the SCR is negligible.

CONSTRUCTION

This project was assembled on an aluminium panel in a plastic box. The underside view of the panel is shown in Fig. 3. The SCR and two resistors involved are mounted on a tag strip, as shown in Fig. 4 and the wiring diagram.

Switches should be assembled first, and wired one by one as they are mounted – there is too little space to get at all the terminals once they are all mounted.

The switch wiring is shown in Fig. 4, where each dot represents one of the 12 terminals on each switch. The terminals on the switches are not actually numbered, but the numbers given to them in the right hand column of Fig. 6 relate to the positions indicated by numbers in the switch diagram in Fig. 5.

After mounting and wiring the switches the tag strip should be wired and mounted. An aluminium clip was made to hold the flat 4.5 volt battery, and this was anchored by the tag strip mounting screws. The pilot lamp and push button should be mounted and wired last.

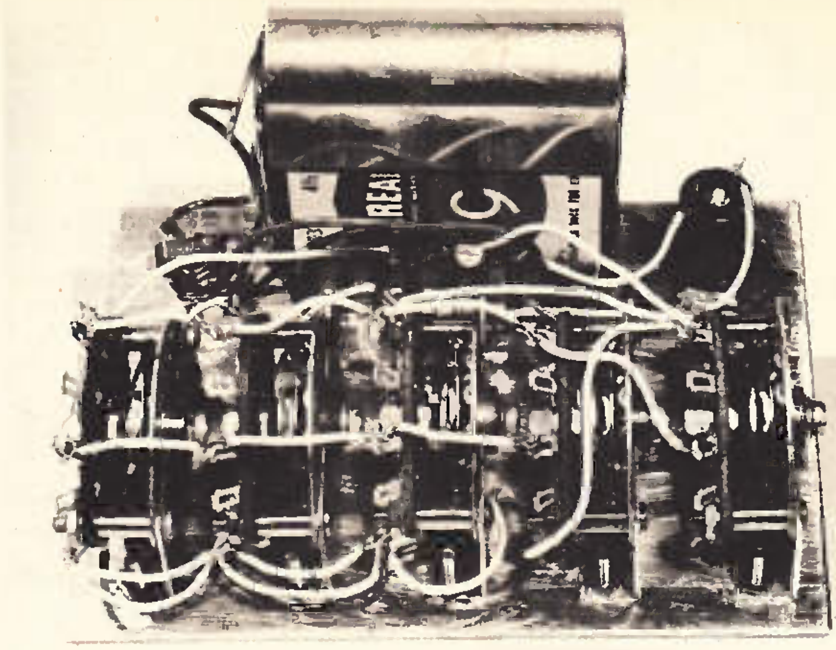

Fig. 3. Underside view of the front panel showing how switches are mounted.

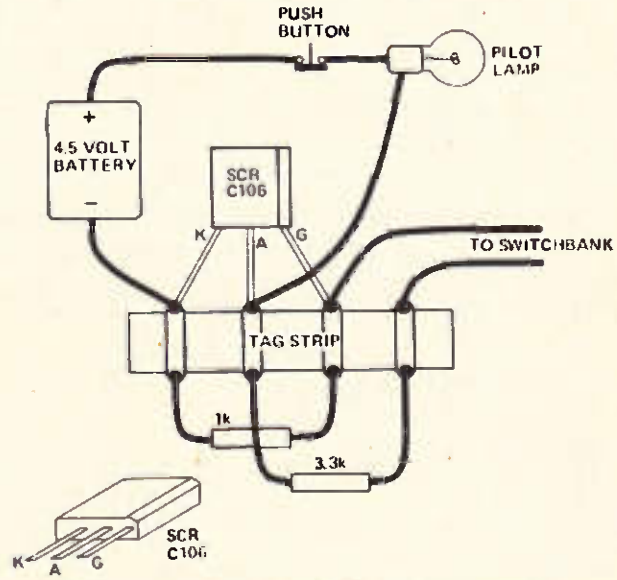

Fig. 4. Schematic of the connections to the tag strip.

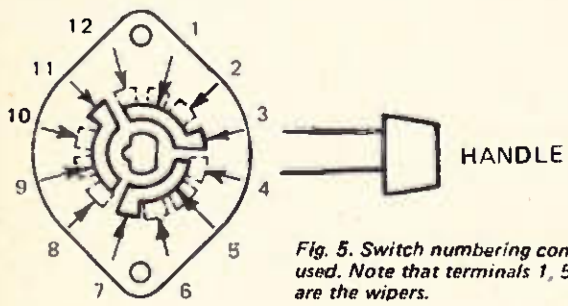

Fig. 5. Switch numbering convention used. Note that terminals 1, 5 and 9 are the wipers.

CHECKING

Each of the 'dangerous' conditions should be set up to see that the SUNK lamp comes on as it should. If there is any difficulty with the SCR turning on, the value of R2 may be reduced. The value shown suits the SCR specified, but other SCRs with less sensitive gates may need more current to trigger them, and so the resistor may be reduced to suit.

Incidentally, if you can get this family across the river safely in less than eleven crossings, let's know how you do it! ●

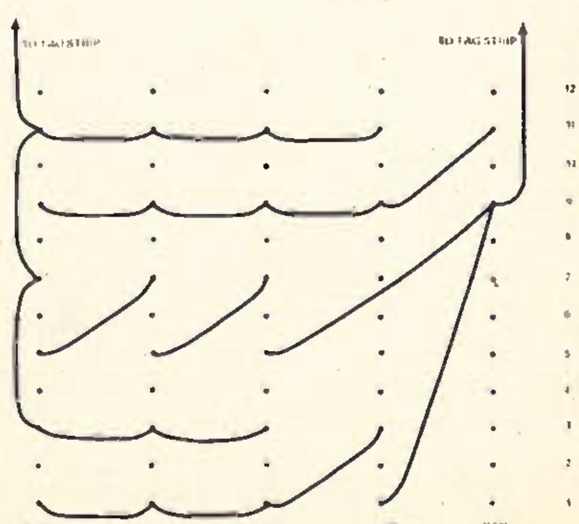

Fig. 6. Method of wiring the switches. Pin numbers at side are the same as those shown in Fig. 5.

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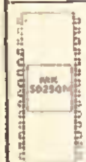

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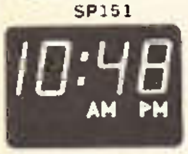

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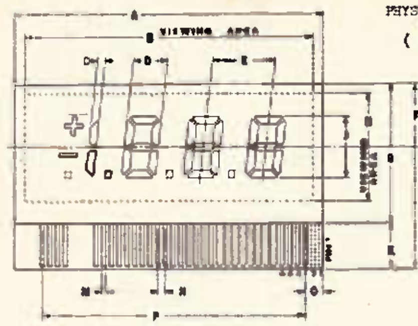

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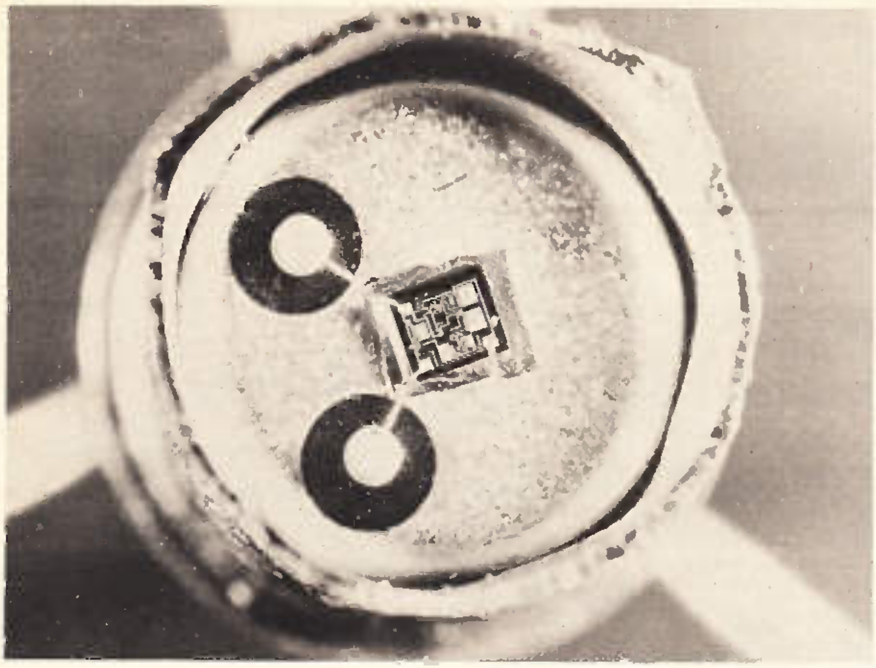

PART 11

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ELECTRONICS -it's easy!

Introducing the elements of amplification.

AN AMPLIFIER, whether electronic, mechanical, acoustic or optical, is a system building block. It allows the amplitude of an input signal to control a secondary source of power such that the amplifier output is of larger power (or voltage or current etc.) than the input signal. This concept is shown as a block diagram in Fig.1. In its simplest form, an electronic amplifier has one input, one output and source of power. The common line is usually not shown in block diagrams, being there by inference. Actual circuits always require a common line which is variously referred to as earth, ground or negative rail.

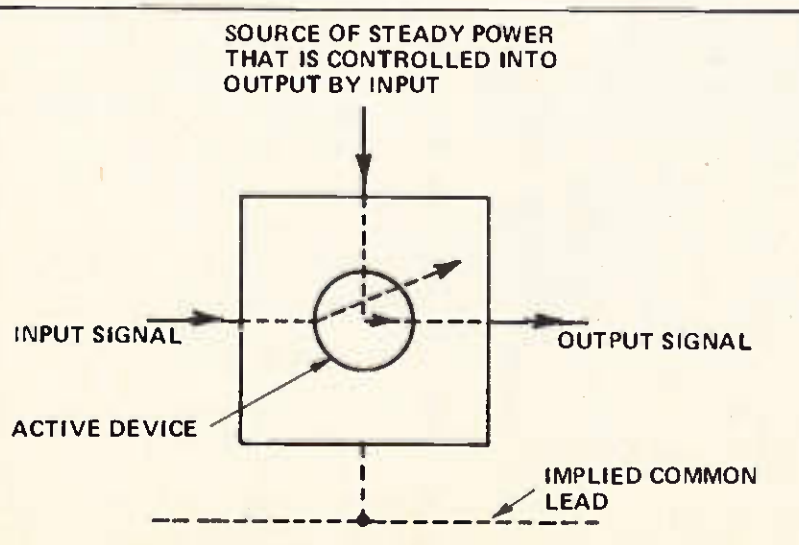


Fig. 1. Schematic diagram illustrating the Amplifier function.

ALL SHAPES, SIZES AND PURPOSES

Although the basic electronic building blocks now available are extremely versatile, there is still no single magic box that can perform all amplifier tasks at the best price *and* performance. Consequently, we make do with many different forms of amplifier to suit an even greater number of applications.

Most amplifiers increase signal voltage amplitude; others, more unexpectedly may reduce it. In both cases we say the amplifier has a gain eg. a gain of 10 – or a gain of 0.1.

The most common need to amplify the *voltage* at the input, but often we may need to increase the current or power level. Yet another need might be to accept a current input and provide a voltage output. The purpose of the amplifier must be clearly understood, for the design and trouble-shooting procedures will differ for each case.

Newcomers to electronics may think that an amplifier must alter the signal/amplitude-level linearly without affecting its time or frequency characteristics, that is, it should amplify with fidelity. This is certainly so with hi-fi audio-frequency amplifiers and with very sensitive transducer amplifiers, but again some amplifiers are designed to distort the signal in some ways to suit a particular purpose. More about these later.

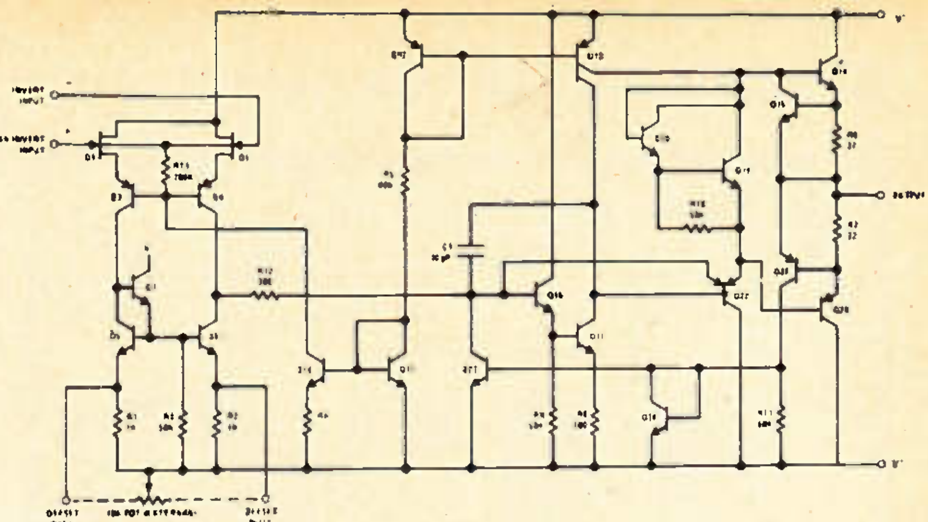
AMPLIFIER JARGON

The role of an amplifier is denoted, to some extent, by a prefix. For example a *pre-amplifier* may precede a main amplifier. It amplifies low-level signals (micro amperes, microvolts and microwatts). Figure 2 shows a string of amplifiers in a typical system.

A *power amplifier* increases the power level of signals in order to drive the output device of the electronic system e.g. the loudspeaker in a hi-fi system; the display tube in an electronic counter. What constitutes a power amplifier and what constitutes a small-signal amplifier is quite arbitrary in absolute terms -- the power stage of a digital pocket calculator needs to drive devices rated in milliwatts, but a rolling-mill control may need tens-of-kilowatts capability.

Amplifiers have other applications apart from providing gain. You will

An exampled of a hybrid FET-input, operational amplifier IC. The small chip contains two FET transistors, the large chip the remaining bipolar transistors. The circuit contained in these two tiny chips is shown on the right. Each division of the scale on the left is ½ mm.



remember in an earlier section, we discussed how connecting a low impedance meter to a high impedance circuit could affect, or even damage, the circuit. This effect, the loading of one stage by another, may be overcome by using an amplifier as a "buffer" between the stages.

Buffer-amplifiers usually have a voltage gain of less than one. However, they do have a power gain and their usefulness is mainly in that their input resistance is considerably greater than their output resistance. Thus the output of a buffer stage can be loaded heavily with little effect on the input. They are, in effect, impedance converters.

Another amplifier characteristic of interest is whether it can handle direct-coupled signals or not. If the signal is coupled to the input via a capacitor, dc signals cannot pass, and such an amplifier is known as an *ac amplifier*. This is not necessarily a disadvantage for, in many systems, only ac signals are of interest.

Another type of amplifier that will often be encountered is the so-called *operational amplifier*. In the early days of electronics, dc amplifiers were difficult and expensive to build because any drift of component values or gain resulted in an unwanted output change. Thus special design procedures had to be used for dc amplifiers, making them very expensive. Nevertheless, they were used extensively in early analogue-computer systems to perform basic arithmetical operations — adding, subtracting, sign inversion and integration — hence their name. (This will be expanded later in the series). Today the operational amplifier can be manufactured inexpensively in integrated circuit form.

In fact, the tables are now turned; the modern operational amplifier is even challenging the single transistor in price, and has tremendous advantages in stability and flexibility, over discrete transistor stages. Indeed these new basic building blocks come close to providing an all-purpose basic amplifier unit.

FREQUENCY RESPONSE

A very small change in the dc level at the input of a dc amplifier will produce a corresponding dc output-level change. The ratio of output to input-level change is called *dc gain*. In an ac amplifier this change is virtually zero because dc signals are not recognised. This does not, however, mean that there is zero dc level at the output, merely that it is unchanged by very-low frequency signals.

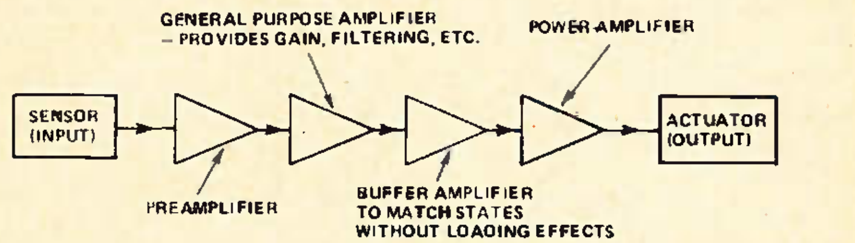


Fig.2. Amplifiers having different functions are often combined in a series chain to achieve an overall purpose.

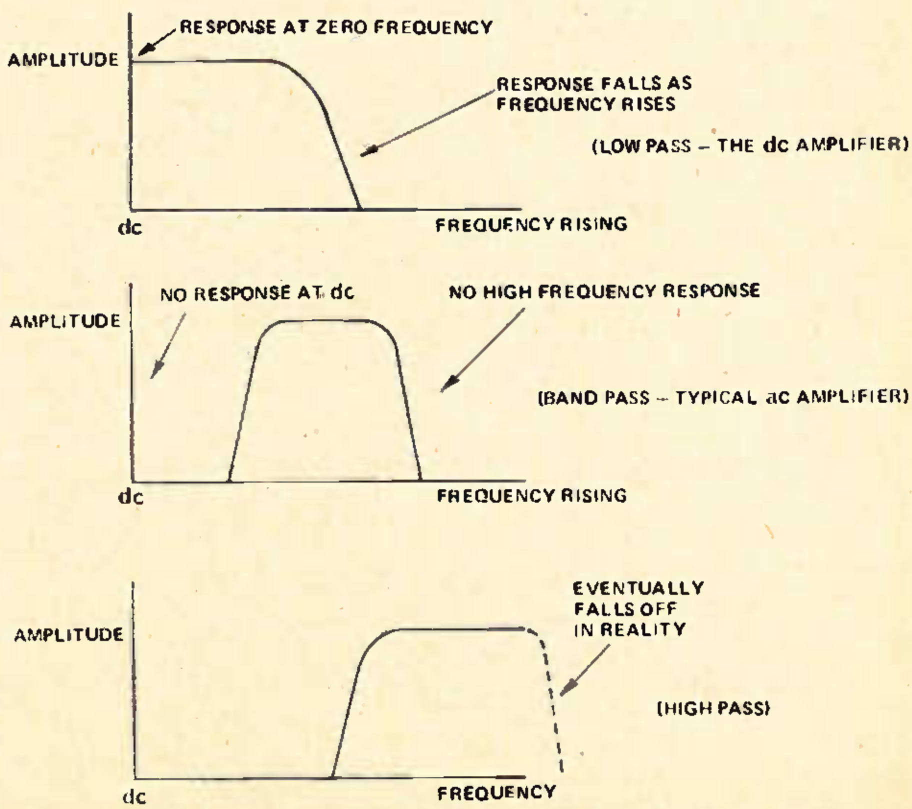


Fig.3. Response curves of amplifiers having three different amplitude/frequency characteristics.

ELECTRONICS –it's easy!

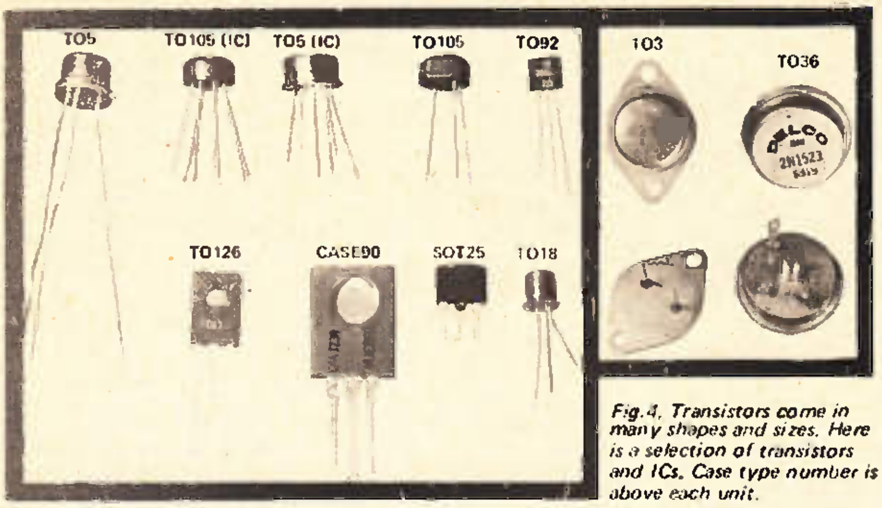


Fig.4. Transistors come in many shapes and sizes. Here is a selection of transistors and ICs. Case type number is above each unit.

The frequency performance of all amplifiers can be shown by two graphs – amplitude versus frequency and phase versus frequency. The first is more commonly encountered. There are other things a designer needs to know, such as time-response to a step-change input, but for the moment we will restrict ourselves to the amplitude versus frequency characteristics.

Physical factors make amplification very difficult at high frequencies. Thus all amplifiers cease to be effective at some upper frequency, but in practice, it is the attainable relative-frequency limit that matters. For example, if the signal to be amplified has no content beyond 20 kHz – as in hi-fi sound systems – there is little point in using a unit with 200 MHz capabilities. This would be more expensive to build and, therefore, a waste of effort.

We use several descriptive terms that denote an amplifier's type of frequency response. Figure 3 shows three main classes – Low Pass (passes only frequencies below a selected cutoff point) Band Pass (passes only frequencies between upper and lower cutoff points), and High Pass (passes only frequencies higher than a selected cutoff point).

Note that the high-pass amplifier still has some upper frequency limit beyond which its response will drop off. The same terms apply to filter circuits – indeed amplifiers can be regarded as filters capable of providing gain.

The frequency response of an amplifier is primarily limited by the active device itself (transistors etc) and secondly by the passive components around the active device which modify its performance. Some amplifying elements will work at megahertz frequencies, some only at kilohertz frequencies. Each have their uses.

PRACTICAL LIMITATIONS

The first active electronic-amplifier element was the triode thermionic valve (briefly described in the last section). This has now been replaced in most applications by the transistor. The transistor does the same job but with less power loss, smaller space requirements and much reduced cost. Several packaged forms of transistor are shown in Fig.4.

The system designer would ideally like amplifiers that accept any polarity of input signal (be it negative or positive with respect to the common lines) and amplifiy it without changing the polarity, or distorting the wave shape in time or amplitude.

Unfortunately neither the thermionic valve, nor the transistor, can provide these facilities unless they are used in special ways along with passive elements. Both devices individually will only operate with one polarity of input signal – see Fig.5. If the signal swings to the other polarity, the output disappears: they become rectifiers. Transistors may be constructed to operate with either polarity dc signal, but not both polarities with the same device. That is, they may be constructed as *complementary* units, valves cannot.

Another practical limitation is that these basic devices can only tolerate certain maximum-magnitude signals; as the input signal is increased, a point is reached at which the output signal ceases to increase in amplitude (it gets clipped). If exceeded still further the device may fail altogether. These two effects are the main shortcomings of both valve and transistor, and are illustrated diagramatically in Fig.6.

Eventually an active element may be discovered that does not suffer from these shortcomings; until then we must modify the characteristics of existing active elements in order to obtain the characteristics we need.

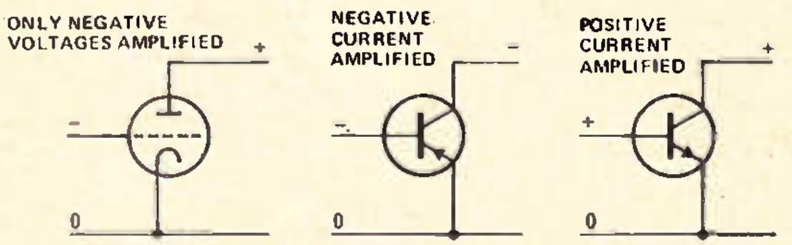


Fig.5. Valves and transistors, when used above, can only handle one polarity of signal. Any other polarity signal is clipped as in a rectifier.

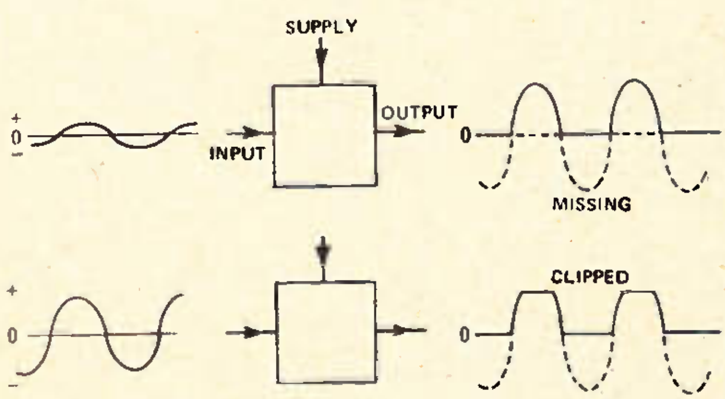
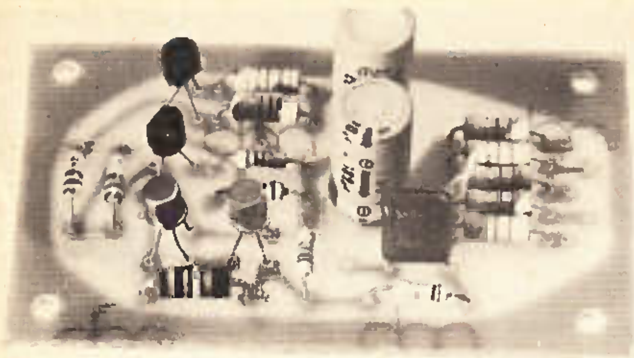
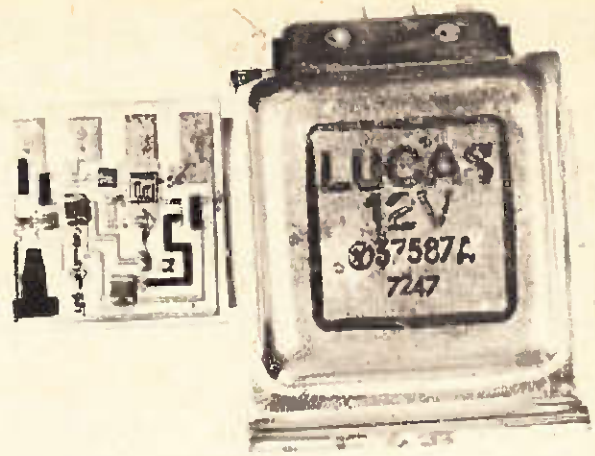


Fig.6a. Effect of feeding a smaller bipolar signal into a transistor. One polarity of half cycle is clipped. (6b). If the input signal is increased sufficiently the tops of the waveform will also be clipped.

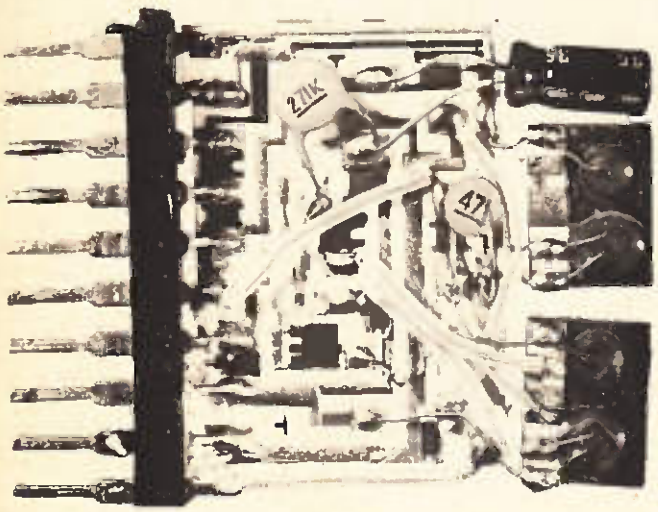


7(a)



7(c)

Fig. 7. Typical amplifiers using devices having differing levels of integration. (a) Typical discreet transistor stage. (b) Internal view of Sanken 10 watt power amplifier of hybrid design. Note power transistors at top of module. (c) Voltage regulator for cars (from Lucas). It contains the thick hybrid IC on left which has three transistors, two diodes, two capacitors and five resistors assembled onto a 25mm square ceramic substrate. See if you can pick the individual components.



7(b)

This is done by using the device in combination with other active and passive elements to form complete circuit combinations that become our required basic amplifier blocks. Such circuits are either built from individual components – the discrete circuit; or alternatively they are purchased ready designed and manufactured as hybrids – a discrete circuit packaged into one unit. A third alternative is the integrated circuit (the IC) in which all active and passive elements are fabricated on a common substrate. Figure 7 shows several modern amplifiers based on the transistor amplifying element.

AMPLIFIER CHARACTERISTIC CURVES

The various types of individual amplifier elements behave differently, have different signal-level handling ability and have different input-to-output signal ratios (gain). Furthermore, the gain may depend upon the amplitude of the input signal and on what is connected to the output.

The information, needed by a designer on device characteristics is commonly provided by graphs known as characteristic curves. We met the simplest form of curve when we discussed the light-dependent resistor in Part 2 of this course. In that case there was only one relationship – that of resistance versus light level.

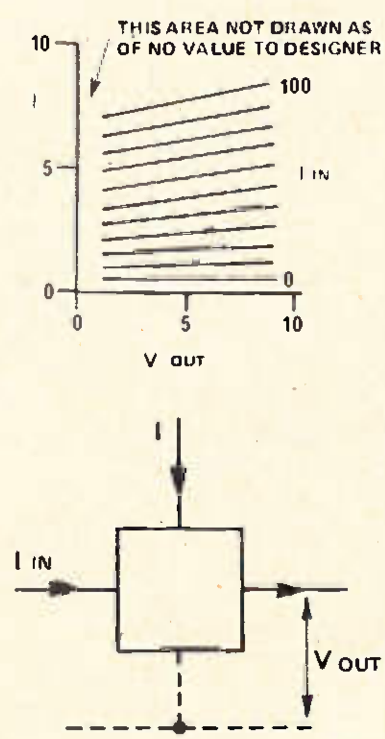


Fig.8. How characteristic curves are used to describe the performance of an active device.

The problem of presenting characteristic curves for amplifiers is more complex than for that light-dependent resistor, for there are an infinite number of describing curves. To understand this, consider the relationship between the supply current (I) flowing into an active element (Fig.6) and the voltage developed at the output (Vout). It is not possible to draw a unique single graph, as the relationship depends upon the signal current into the input terminals – call it I_{in}. For each value if I_{in} there will be a specific graph of I versus V (out).

A convenient way of representing what happens is for us to draw individual curves at evenly-spaced, realistic values of I_{in}. The result is a family of curves as depicted in Fig.8.

A little thought shows that other families can be constructed also output-voltage versus input-voltage for various values of input current is one. Furthermore the fixed parameter – could be input voltage instead of current – as is the case for valves.

The characteristics of both valve and transistor devices can be visualised this way (as indeed can any type of three terminal amplifier) and these curves are of great value to designers.

Most people engaged in electronics do not need to measure the characteristic curves for themselves; they are provided in manufacturers' data sheets. It is important for us to understand these curves, for they help explain how the non-ideal characteristics of active elements (discussed above) are overcome in practical circuits. Before discussing how this is done we need to know more about the transistor itself. ●

Electronics Tomorrow by John Miller-Kirkpatrick

I BELIEVE that I have mentioned before that there are radio stations in the USA and in Switzerland that transmit accurate information on VHF. This data ranges from pulses at specific time intervals right through to full BCD coded time of day. So far nothing anything like this is available in this country but - when CEEFAX/ORACLE starts up full time transmissions - the date, day of the week and time of day is to be transmitted on each page header. The page header contains data to identify it to your receiving equipment with the intention that the equipment will ignore all pages except the one that you have chosen to view on your selector. The rate at which new pages are transmitted is of course a lot faster than one per second but as one page may contain a full screen of data and another page only a few lines, the time between pages is not constant.

The new Advance programmable calculator showing the plastic strip programming device, together with the punch for writing programs.

TELLING THE TIME WITH CEEFAX

A TV tuner with basic decoder circuitry for page headers added would give a source of some very valuable data. At present the data is transmitted in ISO-7 (or ASCII) coded format to enable all 64 character codes to be transmitted along with some instructions and a parity checking bit, this in total makes up into 8 bit words where the low order bits for the numbers 0-9 are in standard BCD format. After the sync and control data for each page header (which could possibly be ignored in most applications) comes data in the format 'CEEFAX P309 Thu 19 Feb 14.05/34'. This data starts in word number 14, ie after 13 words of eight bits, and is 32 words long. To extract the time data you would need to check the clock run in (the first two words of the control data), then ignore the next 34 words (34 x 8 bits). This would put you at the first bit of the tens of hours digit, as we do not need the first four bits of any ISO-7 word for numeric purposes we can now ignore 4, read 4, ignore 4, read 4, ignore 12 (includes separator), read 4, etc until we have read the six lots of 4 bit BCD data into a storage register. We can now parallel read from this register into a set of latches to give us latched BCD time information with an accuracy of about +/— 10mS from an accurate nationwide source.

Thus we have a system whereby we can have any number of clocks all of which will always read the same correct time, a digital TIM. The only two problems at present are the cost of such a unit, which would not deter those who need this sort of accuracy, and the fact that the source is only available during normal TV transmission times. If you think that this facility, or even the whole of the CEEFAX/ORACLE system should be available 24 hours a day then write to BBC or IBA and put forward some good reasons for a 24 hour service.

PROGRAMMABLE CALCULATOR WITH PLASTIC TAPE INPUT

Once upon a time I was quite involved with a range of calculators from Advance Electronics, they are the people that produced an 'Executive' at the same time as Sinclair. I still have an Advance model 8B which I think is one of the best ergonomically designed machines on the market even if it is too expensive for its functions. The same company has also had a programmable machine on the market for about 18 months and recently has offered this as a kit (see last month's ETI), the machine has two memories, square root, percent, and 16 digit readout (8+8). The programmability is restricted to a total of 40 steps over two programs one up to ten steps and one to 30 steps, these are enough for most engineering and scientific calculations. There were in my opinion only two faults with this machine, the first was the fact that there was no 'compare' available and thus whenever a comparison was required the machine stopped for a manual comparison and then a continue or switch to program 2 instruction was given - manually. The second fault was that the memory was mains dependant and so the machine had to be reprogrammed after being disconnected from the mains. This fault has now been overcome with a new adaptation to the basic 162P calculator which consists of a plastic strip with instruction steps punched into it on a simple mechanical punch similar to an ordinary portable paper-tape punch.

In operation, the new programming device bypasses the calculator keyboard; the program is punched as a series of indentations on a sprocketed plastic strip which is fed over a sensing device by a miniature drive motor. A novel principle is used in the patented sensing device; the indentations in the plastic strip are detected by a row of miniature ball bearings which then depress a strip of electrically conductive rubber onto a row of contacts. The 162P calculator fitted with the new programming mechanism and complete with the punch costs £249. In addition Advance Electronics is making available a series of commonly used programs and providing an advisory service to users who wish to write their own routines.

BUTTONS ARE OUT!

Television sets were one of the first, and light switches not far behind - what? The no buttons revolution, touch-tuning TVs, proximity sensing lift 'buttons', touch-sensitive light switches are all part of the new revolution away from pushes and clicks. The latest application of this approach is a little more sensible than most, with the advent of the electronic alarm clock with the 'snooze' feature the idea is to not really wake you fully but to warn you that the time to emerge from your cocoon is approaching. To activate the ten minute or so alarm delay that the 'snooze' gives you, you have to close a circuit somehow. The first answer is to put a button on the back of the clock which will kill the alarm when pushed, the problem here is that there are probably at least five or six buttons on the back of the clock and by the time you have found the right one you are fully awake anyway and might as well get up. So far there have been two approaches to this problem, the first uses a mercury switch or swinging magnet and relay to give a 'snooze' closure when the clock is tilted; this needs to be thought of at case design stage so that the case can be tilted and return to rest safely. The second approach is to use a large touch switch area on the clock case where you just have to touch it in the right area to activate the 'snooze'.

The new Heathkit digital clock kit, the CG-1092AE uses a strip of metal on the top of the case as a touch switch, if you have to have a lump of metal on your case you might as well make it useful in some other way so Heathkit have made it in the form of their logo - quite clever. For instance, when the electronic beep wakes you in the morning, there are no switches to fumble for. Instead, the slightest touch of the Heathkit logo on the top of the case turns off the alarm electronically. The snooze cycle, if activated the night before will give you another 7 minutes catnap (repeatable up to an hour). The clock has its own built-in battery supply that takes over in case of a power failure, keeping reasonably accurate time (without the lighted display) and still waking you in the morning at the correct time. When AC power is restored the correct time is once again displayed without needing to reset the clock by more than a few seconds.

The new Heathkit CG-1092AE digital alarm clock.

Other features are 12/24 hour format, 24 hour format, 24 hour alarm, automatic brightness control, and a battery switch so that the batteries do not discharge unintentionally. The kit is complete with plug-in ICs and case with optional stand and as with most Heathkit products no previous experience is necessary with their instructions. The price of the kit is rather high at £50.80 (incl. of P&P, VAT), and the completed ready-built clock at £72.40.

H.P.I.Cs.

What is the most expensive commercially available IC. We exclude customised ICs and very complex minicomputer ICs and only mean those that the average amateur or engineer might buy. The most expensive one I know of is £46.71 plus VAT and is only a digital stopwatch IC, the ICM7045 from Intersil via Celdis. The functions of this chip are basically a stopwatch with eight digits giving readings down to 1/100th of seconds from a 6.5536MHz crystal. Its functions include four run states —

1. Standard - After Reset, Start begins the timing, Stop halts the count and displays the total time. A second event can be timed from the previous time or from zero, ie Reset, Start, Stop, Reset, Start, Stop; or Reset, Start, Stop, Start, Stop.
2. Sequential - Here, after the initial Reset, the Start will time the first event. A second depression of Start will stop the first time, display and hold it whilst the clock has reset to zero and started timing the second event.
3. Split - Similar to Sequential except That the times are cumulative, ie the reset to zero at each 'Start' is not operative.
4. Rally - Basically similar to the Standard except that the times are cumulative and so the Reset function is disabled.

Very nice, well designed, ideal for most stopwatch timing applications. The only point is that the new Emihus chip with about £8 of low power TTL added will do the same jobs and more at a cost (including the TTL) of about one third of the Intersil chip. It's a lot extra to pay for the advantage of a one chip unit even if it is in low power CMOS. If there really is a big market for accurate stopwatches with all of these functions either Intersil should drop their price or Emihus should put an internal latch on their chip (that could then also be used as a frequency counter).

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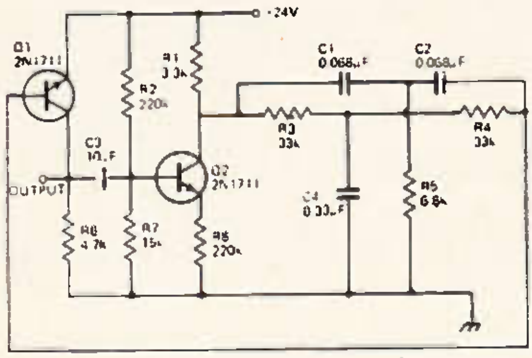
2. IBA, 70 Brompton Road, London SW7.
3. Advance Electronics Ltd, Raynham Road, Bishops Stortford, Herts.
4. Heathkit (Gloucester) Ltd, Gloucester, GL2 6EE.
5. Intersil Chips - Celdis Ltd, Loverrock Road, Reading.
6. Emihus Chips - Bywood Electronics 181 Ebberns Road, Hemel Hempstead, Herts.

Tech-Tips

STABLE RC OSCILLATOR



The frequency of oscillation of this circuit is determined by a twin T network and is stable to within 0.05% for ± 10% supply variation.

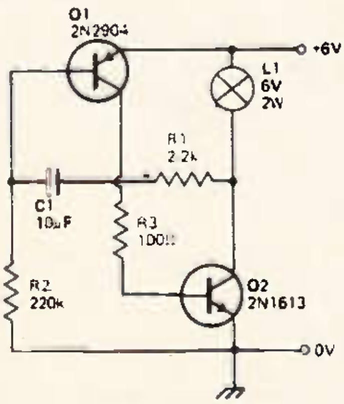
A temperature stability of 0.2% from −20°C to 80°C will be obtained if polycarbonate capacitors are used throughout.

With the values show the circuit oscillates at 60 Hz. It will operate at very low frequencies for which the values required are given by the formula:—

$$F = \frac{0.159}{R3C1}$$

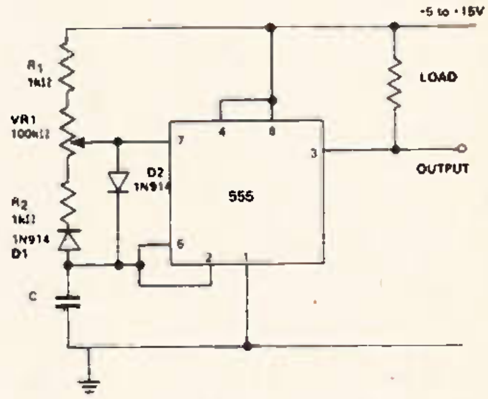
where F = frequency in hertz and R_3 is in ohms C1 in farads C1 = C2 = ½ C4 and R3 = R4 = 2R5.

TRANSISTORISED FLASHER



This simple circuit will flash a 6 volt lamp at a rate determined by the size of capacitor C1. It is most economical on power as it only draws current when the lamp is ON. When the lamp is OFF both transistors are biased OFF.

VARIABLE DUTY CYCLE OSCILLATOR



The circuit shown enables a rectangular wave output to be obtained with a duty cycle which can be varied over a wide range by the setting of the potentiometer VR1.

The well known 555 integrated circuit is used as a monostable device. The capacitor C charges from the positive line through R1, part of VR1 and D2. When the voltage across this capacitor rises to two-thirds of the power supply voltage, the state of the 555 is switched so that the capacitor C discharges through D1, R2 and the other parts of VR1 into pin 7 of the 555 device. The diodes therefore enable the charging and discharging paths to be separated; the effective value of the charging and discharging resistors can therefore be set independently of one another.

When the slider of VR1 is near to R2, the discharging time is very short and the output spends only a small fraction of its time in the low voltage state. In this case short negative pulses will be obtained at the output. Similarly, short positive pulses are obtained when the slider of VR1 is near to R1.

One great advantage of this type of circuit is that the frequency is almost independent of the setting of VR1 over most of its travel. If VR1 is in the centre of its track, the duty cycle will be approximately 1:1. The frequency is almost independent of the output current up to the recommended maximum of 200mA.

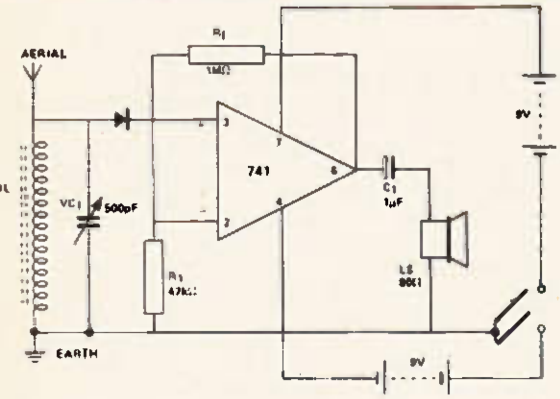
The value of C is chosen according to the frequency required. The latter can be as great as 100kHz or very low indeed - one cycle in a few minutes.

OP-AMP RADIO RECEIVER

The figure shows how to wire an op-amp so that it amplifies the voltage generated across a tuned circuit in order for the circuit to operate as a simple radio receiver. The '741' op-amp is suitable.

Note that the signal is applied to the non-inverting input of the op-amp so that good selectivity is provided due to the high input impedance of this connection which provides negilible loading of the tuned circuit.

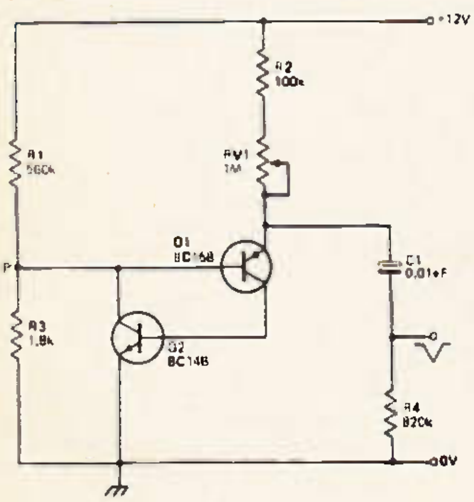
ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to the Editor, Electronics Today International 36 Ebury Street, London SW1W 0LW.



A 2000 ohm earpiece may be used directly at the output of the op-amp but, as shown, an 80 ohm speaker can be driven via a capacitor whose value should be selected for optimum results.

Should the signal suffer from distortion, this may be due to high frequency noise generated by the op-amp and can be cured by connecting a 470pF capacitor across the feed-resistor R_f. The values of the components are not critical.

PULSE GENERATOR

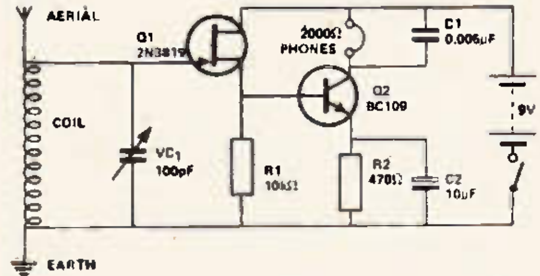


This simple pulse generator produces 100 nanosecond negative pulses of 8 volts amplitude.

At switch on, Q1 and Q2 are off, and C1 charges through R2, RV1 and R4. When the potential across C1 becomes 0.7 volts above point P, the transistors saturate, discharging C1 through R4. A negative pulse is thus generated across R4.

When the capacitor is fully discharged the transistors turn off and the cycle repeats. Pulse spacing may be adjusted between 1.5 and 15 milliseconds by RV1 and the pulse duration may be altered by using a different value for C1.

FIELD-EFFECT TRANSISTOR RADIO RECEIVER



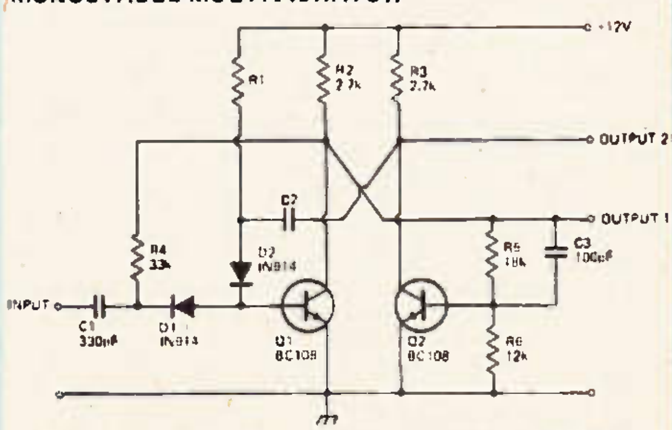
The circuit shown in the figure provides a simple radio receiver which is both sensitive and selective. A low-cost FET is used - the JUGFET 2N3819.

In order to ensure that the impedance of the parallel tuned circuit is high at resonance, the inductance of the coil should be high and the value of the tuning capacitor should be kept low.

The amplitude modulated carrier wave sets up a varying voltage across the tuned circuit which causes V_{GS} to vary and a changing drain current I_{DS} to flow. A varying voltage is developed across R1 which is amplified by the npn bipolar transistor Q2. Capacitor C2 decouples the emitter of the bipolar transistor to ground for AC signals and capacitor C1 decouples the radio frequency component of the signal from the phones.

Detection of the amplitude modulated carrier wave is achieved by operating Q2 close to the 'knee' of its transfer characteristic. If the receiver tends to be unstable, the tendency for it to break into oscillation can be reduced by coupling the aerial to the circuit by means of a 47pF capacitor.

MONOSTABLE MULTIVIBRATOR



The time constant T of this circuit is equal to $0.7\ R_1C_2$. Where T is in seconds, R_1 in ohms and C_2 in farads. For example when R_1 = 10 k and C_2 = 100 microfarads the time constant will be one second.

Capacitor C_2 may be selected over wide a range and R_1 may be a potentiometer 100 k maximum. Outputs 1 and 2 provide pulses of opposite polarity but the rise time of output 2 is long due to the charging current of C_2.

DX MONITOR

Compiled by Alan Thompson

This is the last ETI before Christmas so let me be amongst the earliest with wishes that you may have a Very Joyful Christmas and that 1975 may be a real great year for you, and yours, in every way possible! Merry Christmas everyone!

Before we start on the promised Asian Expedition there's some news from nearer home that - after a gap of some 40 years since the B.B.C. local stations at Swansea and Cardiff closed down - it is once again possible to get a QSL for a Welsh BC station. The Radio 4 Wales transmitter on 881kHz is located at Washford Cross on the English side of the Bristol Channel.

However on 30 September the Independent Local Radio Station for South West Wales began operations on 1169kHz and 95.1MHz VHF, under the slogan "Swansea Sound". The MW transmitter, located a mile or so to the north of Swansea, operates with a rated 500 watts, whilst the VHF transmitter is a 1kW job atop Kilvey Hill, overlooking the wide expanse of Swansea Bay, and transmitting much of its output in stereo, using circular polarisation. Early reports indicate that "Swansea Sound" is getting out really well and reception reports have come in from many areas of Britain and also from parts of Scandinavia. The station is on the air Monday-Saturday from 0600 to 2400 clock time, and from 0800-2000 on Sunday: normal scheduling has Welsh language programmes in the 1900-2030 spot each weekday evening with the rest of the schedule in English. A policy of checking each report against the station log means that a "Swansea Sound" QSL really will be worth having and the address to send your reports is: "Swansea Sound". Victoria Road, Gowerton, Swansea, West Glamorgan. I'll be doing a short spot especially for DX listeners - regularly on Thursday evenings around 2315 clock time.

And with that, let's up, up and away on our magic carpet to the mysteries of Asian DXing!

Reception is much more difficult than with the African stations previously discussed. One major factor is that the time differences between Asia and Europe are very substantial, ranging from 5 hours upwards (if we leave out the Middle and Near East areas) and this means that many Asian stations are only on the air for very brief periods during which reception is even *possible* in the U.K. Then we have the greatest difficulty of all and that is the languages of Asia are unfamiliar to the majority of Westerners and are completely different in structure to those of Europe, since tonal differences don't just signify varied emphases of a word or phrase (as in English): but often they give a particular syllable completely different meanings depending on how that syllable is uttered.

Yet another problem is the terrific variety of languages used: India alone recognises some 800 separate languages (not dialects but distinct languages!) and all these factors tend to make identification of Asian stations very much more difficult than is the case for African stations, assuming that you can hear them in the first place! So, let's do some picking and choosing in the hope that what follows will stir your interest in this fascinating area for DXing.

It doesn't seem illogical to start with **CHINA** since Radio Peking is one of the world's most powerful radio voices broadcasting in a vast array of tongues European, African and Asian. In the vast majority of the tongues used, the word "Peking" is not too difficult to recognise, but the two main Chinese Home Services, backed up by an array of regional services on many frequencies on the SW bands can be quite a puzzle as "Peking" is a noticeable absentee in the station identifications. The word to listen for is "Chungyang" followed by the phase "jen-min kwang-po tien-tai", meaning "Central . . . people's broadcasting station". In the case of the regional outlets "Chungyang" is replaced by the location of the station. One soon becomes adept at recognising the opening bars of a tune called "East is Red" which R Peking uses as an interval signal in most of its operations.

TAIWAN is the name by which "Free China" is now generally known, and the Broadcasting Corporation of China is the title of the organisation which transmits the External Service from Taipei. B.C.C. isn't all that hard to hear in the U.K. provided that one happens to chance on one of the frequencies currently in use but they change with bewildering irregularity(!): best bet is probably the 1900-2000 evening service in English for Africa and Europe normally broadcast on 6 or 7 channels in the 31, 25, 19 and 16 metre bands. Two favourite frequencies are 15125 and 17780kHz, so try your luck there!

JAPAN - if you are relatively new to DXing - can be a very hard country to hear but, having once made the break-through you will wonder why you have not heard it before! NHK, the Overseas Service of Radio Japan, has a service especially for Europe from 0630-0830 G.M.T. daily, with the English segment of the transmission running from 0800-0830 on 15430 and 17825kHz. The evening service, with English 1830-1900, is rather more difficult to hear owing to band congestion but the frequencies used are currently 9605 and 7195kHz. As an alternative, NHK has a General Overseas Service, throughout the 24 hours, in both English and Japanese: the spots are of 30 minutes with the first 15 minutes being in English and the second portion in Japanese: worth trying at this time of year are the transmission periods beginning at 0700, 0800 and 0900 when the frequencies are 15195, 9505 and 17855kHz.

Moving over to the Indian sub-continent, things start to get a lot more difficult. Problem No. 1 is the absence of detailed transmission schedules - very often they arrive after the stations have made further changes! - and Problem No. 2 is the extreme variability of some of the frequencies used. **INDIA**, however, has a marked liking for some out-of-band frequencies and 9912kHz is a frequency that All-India Radio seldom seems to leave for very long: others to try are 3905 and 15080 (but beware of R Teheran using 15084kHz for its Home Service!). **PAKISTAN**, too, shows a bewildering series of variations in both timing, languages and frequency usage. A good place to look, as this is being written, is 17690kHz between 0830 and about 1100, with programmes in Urdu and English: if this fails, try 11672 where R Pakistan is often to be found, or 6280kHz often used in the late afternoon period. **BANGLADESH'S** External Service is still in the formative stage with scheduling changes coming thick and fast: try 1200-1300 on about 15520kHz although the frequency varies by as much as 20kHz at times.

Many of the Asian countries carry their Home Services on the low-frequency SW bands and they are happy hunting grounds for the experienced Asian DXer in the winter period. The very absence of exact schedules is one of the spices flavouring this kind of DXing! As of mid-October giving some of the following a try should result in some good catches for the log – **SINGAPORE**: R Singapura is very good between 1500-1630 and 2230-2330 on two parallel channels, 5010 and 5052, in the 60 metre band. **NEPAL**: R Nepal is, at the moment, using the strange frequency of 3425kHz for its Home Service, in parallel with 7100kHz. Worth trying around 0020 when it signs-on for the morning, or again about 1500 in the afternoon. Much Indian film-music is included in the schedule. **TIMOR**: if you are very, very, lucky you may catch this one, in Portuguese on 3668kHz - another odd frequency - from about 1430 until 1500 on a day when conditions are really quiet! A really superb catch is this one! **MALAYSIA**: a variety of Home Services are broadcast by Radio Malaysia: two channels worth trying are 5005, which is Kuching in local languages from around 2230 to 2300 when it closes, and 4985kHz, about the same time, when it has a pleasant morning music programme with English news. **INDONESIA**: this is one country which I have deliberately left out of this "Expedition". The Indonesian broadcasting authorities are in the midst of a major reorganisation of their Home Services and it really is somewhat pointless listing stations which may well have ceased to operate. You could try 4805kHz about 1530 or 2230 when Jakarta - the new spelling for Djakarta - is often to be heard there. **AFGHANISTAN**: R Afghanistan has recently reduced its External Service and best bet is now 4775kHz throughout the afternoon in a variety of Middle East Languages.

Finally, a few words about DXing 60 metres. At this time of the year, it is the easiest thing in the world to come up with many mistaken identifications. There is a substantial Muslim influence throughout much of Asia and what sound like "Arab" stations may, in fact, turn out to be those of Indonesia or other parts of the Far East. Furthermore, a number of Russian local services are audible in the U.K. in late afternoon and some of those located to the north of the India-Pakistan area can cause real identification troubles: one to beware of, is Radio Tashkent on 4850kHz and another is Radio Baku on either 4785 and 4985kHz since the languages used are, to say the least, unfamiliar to many Westerners. It is a fascinating area for the keen DXer. ●

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Both models are supplied connected for automatic 50Hz sweeping. An external sweep voltage can be used instead. These units are encapsulated for additional reliability, with the exception of the controls (not cased, not calibrated).

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 Continued from page 8.

persons in trouble, and then despatch assistance. The six satellites could routinely be used for other important activities – since the search-and-rescue function would require only about a thousandth of any satellite's transmission power. The global satellite system could relay communications between ships, aircraft, and other vehicles and their home offices, while fixing the vehicles' positions with great accuracy. Then the search-and-rescue capability would be an added feature.

ILR FOR WALES AND YORKSHIRE

The first Local Radio service in Wales, Swansea Sound began on Monday, September 30, using the new radio transmitters of the Independent Broadcasting Authority. It will also be the first radio station providing listeners in Wales with stereo broadcasting. Details of Swansea Sound are given in DX Monitor by Alan Thompson.

Swansea is the seventh Independent Local Radio service to open and the first in Wales.

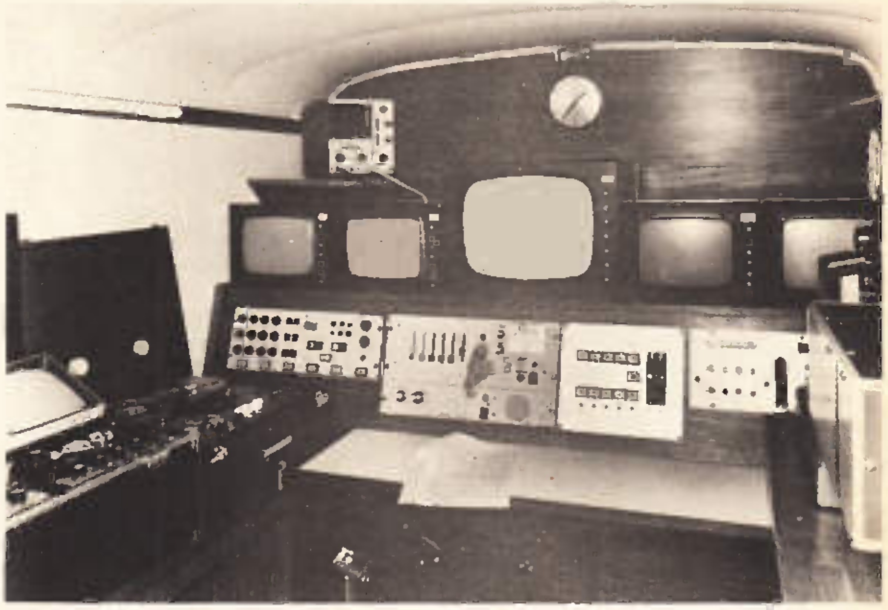
The first Independent Local Radio service in Yorkshire, Radio Hallam, began on Tuesday, October 1 using the new sound radio transmitters of the Independent Broadcasting Authority. It is in the Sheffield area providing listeners with stereo broadcasting.

The daily programmes will start just before 6 a.m. (7 a.m. on Sundays) and run through until midnight except on Saturdays when they will continue until 3 a.m. on the Sunday morning.

Initially the VHF transmissions will come from Tapton Hill on 95.2MHz and later they will be supplemented by a second VHF transmitter on 95.9MHz to improve reception in the east of the service area. The medium wave transmitter is at Skew Hill and is on 194 metres (1546kHz). The VHF coverage area, when supplemented by the Rotherham relay, will represent a population of about 660,000.

The present VHF transmissions on 95.2MHz come from an omni-directional aerial and are horizontally polarised. This means that aerial rods should be horizontal.

Each station is equipped with two transmitters, one of which acts as a standby and can be brought quickly into operation should this be necessary. Radio Hallam is the eighth Independent Local Radio service to open.



GASBOARD ELECTRONIC BLACKBOARD

The photo shows the control room of the mobile TV unit of West Midlands Gas. It is built into a Ford Transit Van and is part of a CCTV system that they use for training their staff. Up to six monitor screens are used to teach staff more quickly and effectively in the operation of their computer-based VDUs (visual display units).

Five years ago West Midlands Gas equippped its training department with the mobile TV unit, and it proved particularly valuable at its residential training centre in Stratford-upon-Avon. The CCTV equipment is new and has been installed at the same centre and to improve its versatility. The unit provides audio visual support to marketing and engineering training, supervisory development such as public speaking or speaking to a group, interview techniques, craft training, security guard training, telephone techniques, first-aid safety competitions, and for providing viewing facilities in an 'overflow' situation.

These training activities can be carried out at any West Midlands Gas premises.

The unit was manufactured and supplied by Reliance Systems Ltd. (A member of the GEC Group). It has also been used by the Wales, East Midlands, Eastern and Northern regions of the British Gas Corporation.

VIDEO SYNTHESIZERS NOW

An American company (Electronic Music Studios) is currently developing the video equivalent of the electronic music synthesizer.

The 'electronics pallette' enables the user to generate an almost infinite variety of moving or static coloured shapes or patterns. The system, called Sceptre, is digitally operated. It can generate images in a range of 64 fifferent colours and 16 levels of brightness.

CHEAP RAM

Walmore are offering Intel's new 2107A-8 4K RAM at £6.00 when ordered in quantities of 100 or more.

The 2107A-8 is a 4096-bit word, dynamic N-channel, MOS RAM with an access time of 420nS (max), designed for memory applications where low cost and large bit storage are important design objectives. Dynamic circuitry is used to reduce operation and standby power dissipation.

Information reading from the memory is non-destructive, and refreshing is accomplished by performing one read cycle on each of the 64 row addresses; each row address must be refreshed every two milliseconds. The memory is refreshed regardless of chip select being a logic one or logic zero.

SINCLAIR WIN MAJOR MARKETING AWARD

Sinclair Radionics, Europe's largest manufacturer of pocket calculators - has won the 1974 Institute of Marketing Award (Category 2, turnover £2–10m pa). According to the

The new specification, 20 channel, 4 group, 2 main output, broadcast console from Rupert Neve. The model 5301 is one of the most compact units in the world (1.2m long) offering such comprehensive facilities with no compromise having been made to performance standards.

IOM panel of judges, Sinclair was selected because they have "pioneered technological and promotional innovation in the calculator market".

Commenting on the award, Roger Helmer, Sinclair's marketing manager said "The award entry was based on our success in establishing Sinclair as the major European manufacturer of pocket electronic calculators over only a two year period. During that time, June 1972 to April 1974, turnover rose from £761,861 to £4,009,322 and exports from 35% to 56%. The rationale behind our marketing effort was to establish the pocket electronic calculator as a consumer electronic product. It had to become as much a personal possession as a transistor radio, a wristwatch or a briefcase".

During the last two years, calculator sales were responsible for 75% of the company's turnover.

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Good news for the cassette man who uses ferric oxide tape: now you will be able to get reproduction quality comparable to that of the guy who lashes out on chromium dioxide cassettes. And you'll still pay 30% less than he does.

Recent work with FeO tape has come up with an increase of 3-4dB, in the 8-15kHz range. This means brighter treble response. Overload characteristics have been improved to give lower distortion at high recording levels. Less tape hiss results from a widening of the dynamic range by increasing the magnetic remanence of the tape.

Overall characteristics are now extended to give good utility between 25Hz and 15kHz which ensures low intermodulation distortion.

EMI are calling their new tape 'X1000'. A new ferrite oxide microparticle is the basis of the new development which has taken two years to perfect. The VAT inclusive price for a C60 is recommended at £1.07.

ERRATA

Printimer November 1974 page 44.

The components list printed was that of our Australian edition. However the only difference is the Audible Alarm: the types mentioned are not available. Our parts list should have given Audible Warning Device (12V version) from Doram, P.O. Box TR8, Wellington Road Industrial Estate, Wellington Bridge, Leeds LS12 2UF.

Doram are producing a kit for this project including PC board, and case etc. for £7.99 which includes VAT and postage.

Knitting '74 Nov. 1974 page 21.

The computer system mentioned here uses multicolour VDUs developed from a system marketed by SERCK CONTROLS. We mis-spelt their name last month.

Kits for the Car Nov. 1974 page 43.

Since we printed this article we have been informed by Dabar Electronics that the Scorpio ignition system is suitable for all types of car ignition, including systems with a ballast resistor, and in this case modification is simple.

MINI-ADS

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If you have no trouble obtaining ETI from your newsagent, that's the obvious place to get it. However five out of the last six issues have been sell-outs and early analysis of the reader questionnaire has shown that one in three readers has trouble in buying ETI.

If you are one of those having trouble, why not take out a subscription? Normally you receive your copy a few days before our official publication. Note also that although the cover price of ETI is now 25p, we have not raised our subscription rates for the time being.

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