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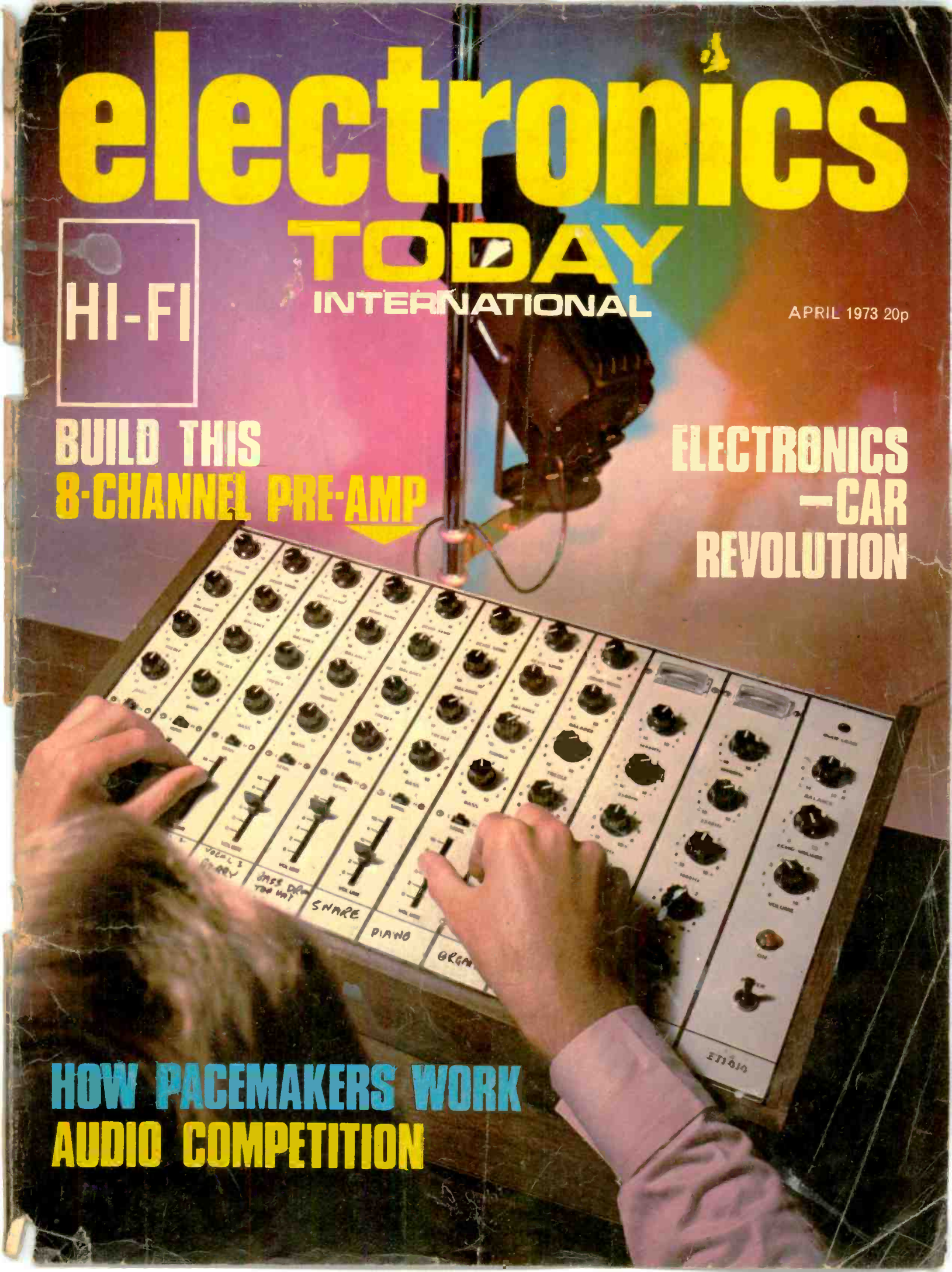

HOW PACEMAKERS WORK

AUDIO COMPETITION

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APRIL 1973 Vol 2 No. 4

main features

product tests

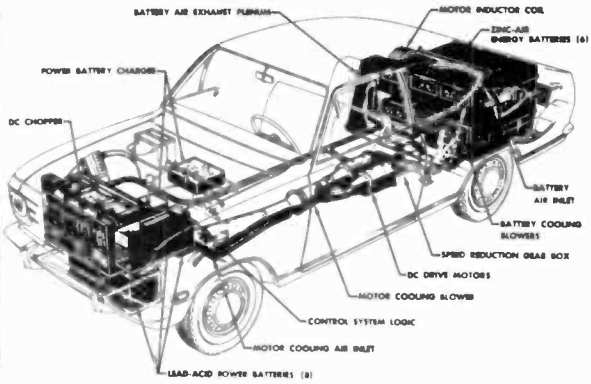
projects

reviews

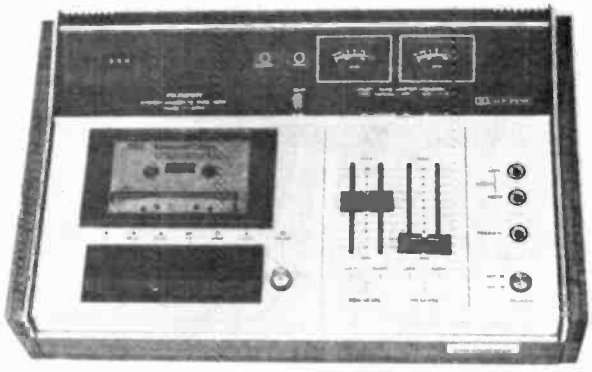
news & information

COVER: This versatile multi-input mixer/preamplifier has all facilities required for professional public address system use. Full constructional details start on page 66.

mini-features



page 24



page 52

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Space flight, computers, advanced instrumentation systems, pocket calculators and the ubiquitous transistor radio are all taken for granted by engineers and scientists as well as by the man in the street. Yet it is only 25 years since Doctors Shockley, Brattain and Bardeen, (at that time with Bell Labs), made the momentous discovery which produced all these and many other technological marvels.

The discovery of the transistor, rivalled only perhaps by nuclear fission in its impact on mankind, earned for its co-inventors the Nobel Prize for physics in 1956. At first the transistor received little acclaim, but never in the history of mankind has one discovery led to such far-reaching technological developments.

The mammoth companies of Texas, Motorola and Fairchild owe their entire market empires to products based on the first crude device fashioned by Shockley and his co-workers.

In the future it is to be hoped that solic-state electronics will be applied to the betterment of the world's environment, rather than to instruments of war, and thus help create a utopian future for our descendants.

Electronics Today International joins with the entire electronics industry in paying homage to Shockley, Brattain and Bardeen in 1973, the 25th anniversary year of their discovery. ●

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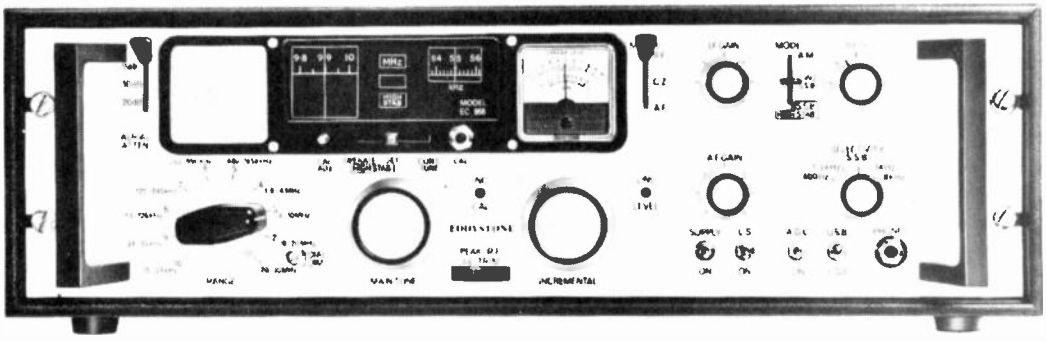

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EMI-SCANNER WINS AWARD

The computerised X-ray technique for diagnosing brain disease, reported in our June 1972 issue, has won for Mr Godfrey Hounsfield and EMI Ltd the MacRobert Award consisting of £25000 and a Gold Medal. The Award is given each year for an outstanding and innovative contribution in engineering, physical technologies or application of physical sciences which enhances UK prestige and prosperity.

The citation for the Council of Engineering Institutions' Award echos our summation of the new technique, viz, that 'no comparable discovery has been made in this field since Röntgen discovered X-rays in 1895' and pays special tribute to Mr Hounsfield as the 'guiding expert' for what was, in effect, a 'one-man invention'.

Since the EMI-Scanner was introduced last year, orders have now totalled £600,000 with two-thirds of this from USA. The technique has so far been applied only to cranial examination but the principle of the invention has wider potential, not only in medical diagnosis but also perhaps in the examination of inanimate objects.

COMBUSTION PRESSURE MONITORING

ASEA has developed a system for the continuous measurement of the pressure in the cylinders of marine diesel engines. This system has been given the name CYLDET (CYLinder pressure monitoring and condition DETection). Up to now the engine-room watchkeepers have had to make routine checks at certain intervals. Days or even weeks may elapse between such measurements, and this may have serious consequences from the safety viewpoint.

To realise such a system, it was first necessary to develop a pressure transducer which can be connected up continuously to the combustion chamber in the cylinder of a diesel engine without the need for any forced cooling. The sensor adopted is a PRESSDUCTOR magneto-elastic force transducer – an ASEA invention dating back to the 1950's and widely used today for roll-force measurement in rolling mills, crane scales in steelworks etc.

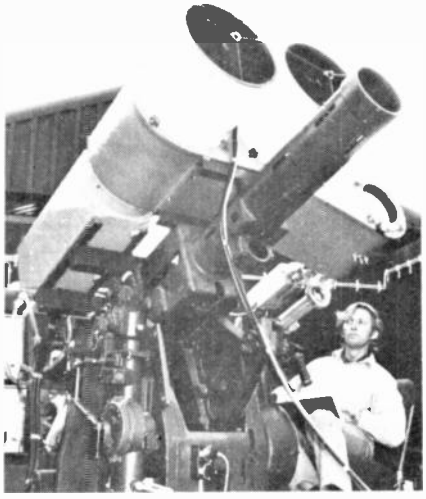
In the CYLDET system the transducer is connected to a normal indicator cock. A diaphragm converts the pressure of the combustion gasses to a force which is transferred to the PRESSDUCTOR sensor via a heat-insulating piston and shield which limits the temperature on the sensor, even though the diaphragm temperature may rise to 350°C.

Either the peak pressure of an arbitrarily selected cylinder or the mean peak pressure of all cylinders, may be displayed on the indicator module which incorporates a pointer instrument. The system gives an alarm as soon as the peak pressure of any cylinder deviates significantly from the calculated mean value of all cylinders.

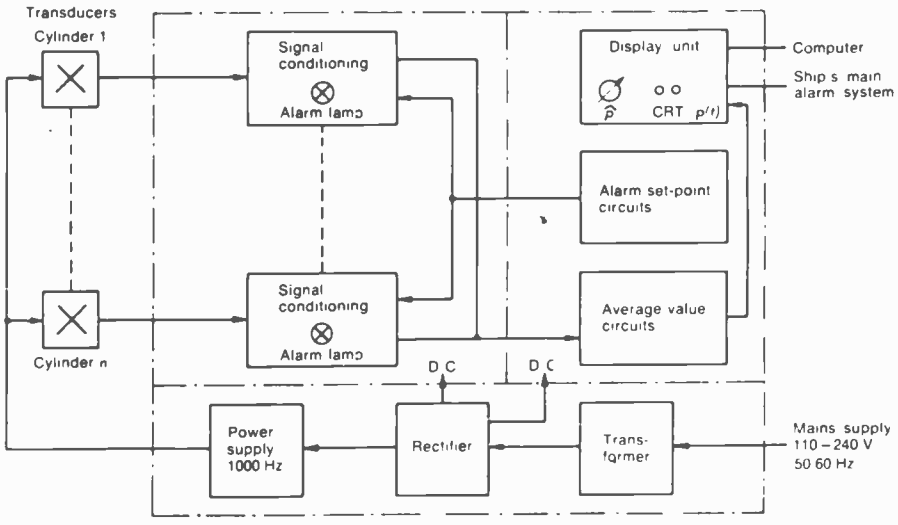
LASER GEODESICS

The artificial satellites which orbit the Earth out in space are being used more and more for 'down-to-earth' purposes. The Institute of Applied Geodesy (IFAG) recently started operating a satellite observation post in Bavaria, West Germany, to precisely measure the trajectory of survey satellites to within a centimeter with the aid of a large laser telemeter, in connection with an international research program.

The principal equipment in the Bavarian observation post is a Siemens giant pulse laser with a peak intensity of more than 100 MW available during the 20-50 ns pulses. The laser beam is



reflected back to the ground station by a corner reflector mounted on the satellite. The distance between the ground station and the satellite at the



news digest

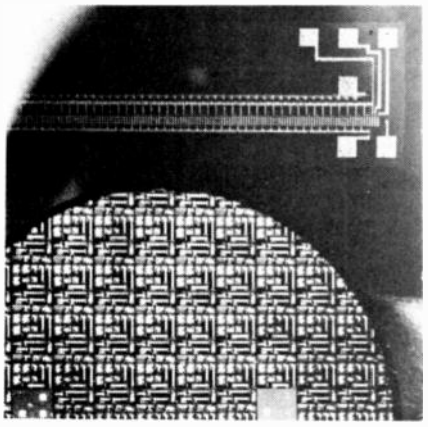
instant of measurement can be determined with the aid of a universal time clock from the time taken by a laser pulse to reach the satellite and return. However, to obtain a precise definition of the satellite's position in space, it is also necessary to photograph it so as to record its position in relation to the constellations, taking sidereal time into account. The exact position of the satellite at the instant of measurement can only be ascertained from the combined information obtained from the return time of the pulse, sidereal time and universal time.

It is hoped that in the course of time the wealth of data obtained will help answer questions about the Earth's gravitational field, since any deviations in the satellite's prescibed flight path are caused by changes in the Earth's field of gravitation. Besides this, scientists think that they will be able to find out more about the phenomena known as continental drift (the disruption and drifting apart of the land masses) and polar migration. Besides the IFAG system, there are observation posts in France, Australia and the United States making up the international chain of research stations. **(301)**

CHARGE-COUPLED DEVICES

MOS shift registers are readily assembled from charge-coupled devices (see Sept 1972 and Feb 1973 issues). Linear LSI-ICs composed of such registers are of interest for large memories. A problem is posed however by the possible falsification of stored information as a result of the transfer losses occurring between one device and the next. A novel implantation technique developed by Siemens makes it possible to reduce the disturbing influence of the potential thresholds encountered in the gaps between MOS devices to such an extent that the charges can be transferred from one device to the next almost completely without loss.

The charges representing the information are transferred by means of electric boundary fields between the electrodes of the MOS devices. The transfer efficiency depends on the potential thresholds in the gaps between the electrodes: part of the charge to be transferred in unable to pass a potential threshold in the gap. Siemens have introduced an implantation step in which boron ions are implanted in the gaps between the devices, thereby reducing the potential thresholds to a level favourable for charge transfer. Potential thresholds could hitherto only be reduced by way of the electric stray fields of the devices, which necessitated very narrow gap widths (less than 3μm). The new implantation technique

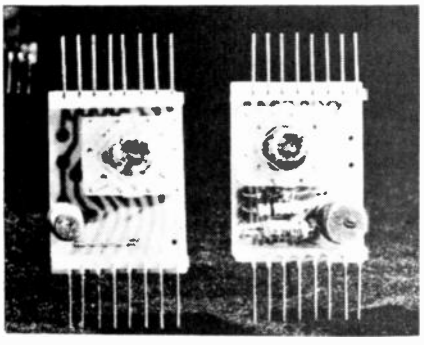


reduces the disturbing potential thresholds by building up a counter-potential.

This technique is particularly advantageous to fabrication because it allows a larger gap to be used between the metal electrodes without endangering charge transport. Since gaps of 7μm are allowed, quantity production is possible. Experiments conducted with charge-coupled devices with 150 electrodes showed that even with relatively large gap widths the transfer losses remain below 0.2%. Before the introduction of ion implantation the losses for a gap width of 7μm were almost 100%. **(302)**

TELEPHONE COMPONENTS

High-standard telephony today relies on components and function elements whose design and properties render them equally suitable for use in completely different fields. Read-only memories, MT components, keylock connectors and automatic cutouts are some examples of such components.



M T Component

The plug-in ROM (Read Only Memory) developed by Siemens for electronic control of large telephone exchanges can be adapted to other applications such as programmed measuring instruments, NC machine tools, small-size and process-control computers. Each semipermanent magnetic storage element consists of two U-shaped cores, one of which carries the secondary winding. The second core can be removed to allow re-laying of word wires for program changes. The original capacity of 512 words of 24 bits each can easily be changed to 1024 words of 12 bits each.

The MT (magnetic-core transistor) component developed detection of switching criteria in dc signalling systems, has a magnetic core with a rectangular hysteresis loop to detect signals which are amplified by the transistor. The core and transistor circuits are operated at the same potential and the defined Yes/No statements can be evaluated electronically or via relay circuits. **(303)**

Read Only Memory

BUTTON PHONES

A major breakthrough for the use of push-button telephone instruments in public networks has occurred in the Netherlands where the Telecommunications Administration has placed orders for more than 50,000 telephones of this type with Ericsson Telefoonmaatschappij.

Previously, push-button telephones have been used in the Netherlands in connection with private automatic telephone exchanges only and, in Europe generally, only in limited numbers in the public network. The orders now placed by the Dutch Administration therefore represent a

new and important development. They cover instruments with multi frequency code-signalling (MFC).

The designers of this Ericsson company, in co-operation with LM Ericsson Telephone Company of Sweden, were successful in replacing the usual dial of the Dutch standard telephone instrument T65 by a push-button unit. For subscribers, push-button telephones mean speedier and more simple dialling and open up possibilities for future uses of telephones for additional services and as data terminals. (304)

AIRPORT SECURITY

Computerised detectors capable of making a head-to-toe, three dimensional search of passengers for concealed weapons have been installed at eight major airports throughout the United States.

The new device is designed to ignore harmless metal objects like buckles, keys and cigarette lighters but signal an alarm when a passenger is concealing a weapon. Key to the new weapon detector is an electromagnetic field which works at two frequencies and in three dimensions. The field is generated inside a portal through which passengers pass on the way to their departure gate.

Conventional magnetometers are passive devices which sense disturbances in the earth's magnetic field caused by metal objects, but are not selective enough to discriminate between objects commonly carried on the person and a weapon. False alarms mean inconvenience, longer waits for passengers and increased screening costs for airlines.

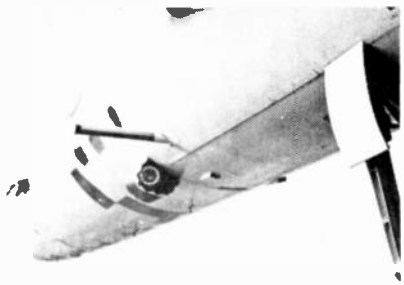
The Westinghouse unit is an active device which sets up its own magnetic field and will distinguish between metal objects and weapons such as pistols. It operates by generating two electromagnetic fields at different frequencies, one high and one low, in three planes within the passageway. No matter how or where the weapon is carried, it is certain to be detected. The console of the detector has data processing circuitry which analyses disturbances in the fields with a high degree of accuracy. This gives the selectivity which cuts down false alarms. (305)

CCTV

Airborne in temperatures down to −30°C, a closed-circuit television camera mounted on the outside of Concorde 002 is serving as a flying 'eye' for BAC engineers during the current flight-test programme. Giving a rearward view under the port wing, the camera feeds pictures of the complete aerofoil, including the engine intakes, to video recording equipment in the aircraft.

The THV-1160 camera from Bell & Howell is an all-weather type with a built-in heating system to combat the extreme cold of high altitudes. Low temperature operation is fundamental to the present tests which are concerned with the formation and dispersal of ice. The camera has been adapted to operate under external sync control and its housing pressurised. It is otherwise the normal 1160 camera, with automatic gain control, peak white limiting and servo iris.

A second closed-circuit camera, a THV-1100, installed inside Concorde 002, supplies a digiclock input for superimposition on the video recordings. The signal is routed, through a Viscount keying system, to the video tape equipment, IVC type 821. Another 821 is on the ground for replaying the recordings. The IVC 821 was chosen for use in Concorde



mainly because it is a full-bandwidth VTR with read-after-write facility for the video track, a feature particularly important on such projects as the Concorde flight tests, where it is vital that no information should go unrecorded. (306)

BUBBLES GALORE

A significant breakthrough in magnetic bubble technology has been reported by IBM Research Division.

Magnetic bubbles (see Feb 1973 issue) are microscopic islands which can be made to follow circuit paths and incicate, by their presence or absence at a particular location, the '1' and '0' of computer terminology. Till now, such bubbles have been reported to exist in crystalline materials only. The breakthrough is that amorphous materials have also been found to be suitable for bubble applications – and thereby considerably increase the versatility of bubble techniques for storing and processing computer data.

Whereas the preparation of crystalline films requires upto seven steps to get a single crystal film on a single crystal substrate, the amorphous bubble films are said to be easier and cheaper to fabricate by means of a simple sputtering process to deposit the film on the substrate; the substrate can be either a crystalline material such as silicon or an amorphous one such as glass.

The IBM team is reported to have fabricated an experimental shift register operating with 2 micron diameter bubbles. Smaller bubbles have also been observed in the new films, pointing to the feasibility of storing more than 10^{12} bits of data per square inch. (307)

FLEXTIME

The Federation of Personnel Services which represents about 1000 private employment agencies has said that office workers in London – and there are nearly a million – should be allowed to choose their own working hours.

Well, haven't they been doing it already? In London and elsewhere? ●

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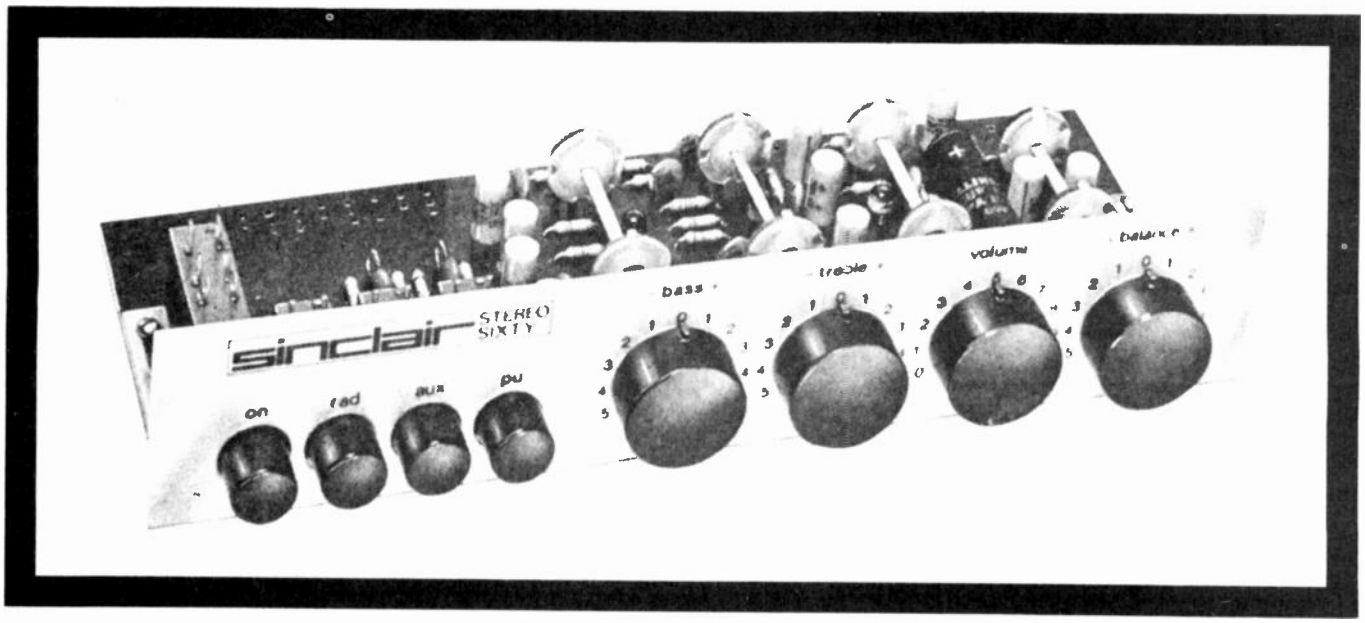


Measuring noise in amplifiers

Totally accurate descriptions of amplifier noise must relate both operating frequency and source resistance. This article, by the technical staff of Princeton Applied Research, explains the technique.

A VARIETY of techniques have been used to measure and specify the noise characteristics of amplifiers. One of the best-known and certainly the simplest technique is to short the amplifier input to ground and measure the rms voltage appearing at the output over a specified bandwidth. This value is then divided by the gain of the amplifier and the resultant figure is specified as 'noise referred to the input'.

This method is probably satisfactory where a comparison of a number of amplifiers is to be made and the proposed operational bandwidth of the amplifiers is known.

If an accurate description of amplifier noise is to be determined, it is necessary to realize that amplifier noise is a function of both operating frequency and source resistance. The 'noise referred to the input' technique disregards the fact that source resistance exists in every application. This source resistance may vary from several tenths of an ohm, for devices such as thermocouples, to many megohms for photomultiplier tubes or vibrating capacitors.

In order to specify completely the noise performance characteristics of any amplifier, the designer must measure the noise at a number of different frequencies and source resistances. To accomplish this type of measurement the following test circuit can be used.

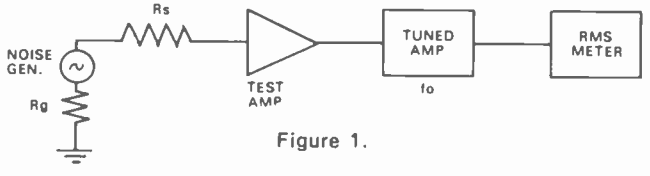


Figure 1.

A calibrated white noise generator (equal power per unit bandwidth) is set for zero output and the source resistance (R_S) is inserted into the circuit. The tuned amplifier is adjusted to the desired centre frequency. Under these conditions the reading on the rms meter is read and recorded. The noise generator output is then increased from zero until the rms meter reads 1.4 times its former value. At this point the calibrated front panel meter of the noise generator reads the total noise due to the amplifier plus the source resistance in volt-$Hz^{-\frac{1}{2}}$.

By varying the source resistance while maintaining the centre frequency constant the total noise as a function of source resistance can be determined. By varying the centre frequency while maintaining the source resistance constant, total noise as a function of frequency can be determined.

Once the entire frequency range and source resistance range of the amplifier have been measured, the data must

Measuring noise in amplifiers

be reduced for presentation in a relatively straightforward way. One method is to calculate the noise figure for each frequency and source resistance combination for which data has been recorded.

The noise figure relates the amount of noise being added by the amplifier to the amount of Johnson noise inherent in the source resistor. Johnson noise is an rms voltage generated in a resistor due to random electron motion present at any temperature above absolute zero. It can be calculated from the following equation:

$$E_n = \sqrt{4KTR_SB_N} \qquad (1)$$

where:

- E_n = rms noise voltage within a bandwidth of measurement.
- K = Boltzmann's constant = 1.38×10^{23} joules/Kelvin.
- T = Absolute temperature in Kelvins.
- R_S = Resistive component in the impedance across which the voltage is measured.
- B_N = Bandwidth across which the noise voltage is measured.

$$\frac{E_N}{\sqrt{Hz}} = 1.28 \times 10^{-10} \sqrt{R_S}$$

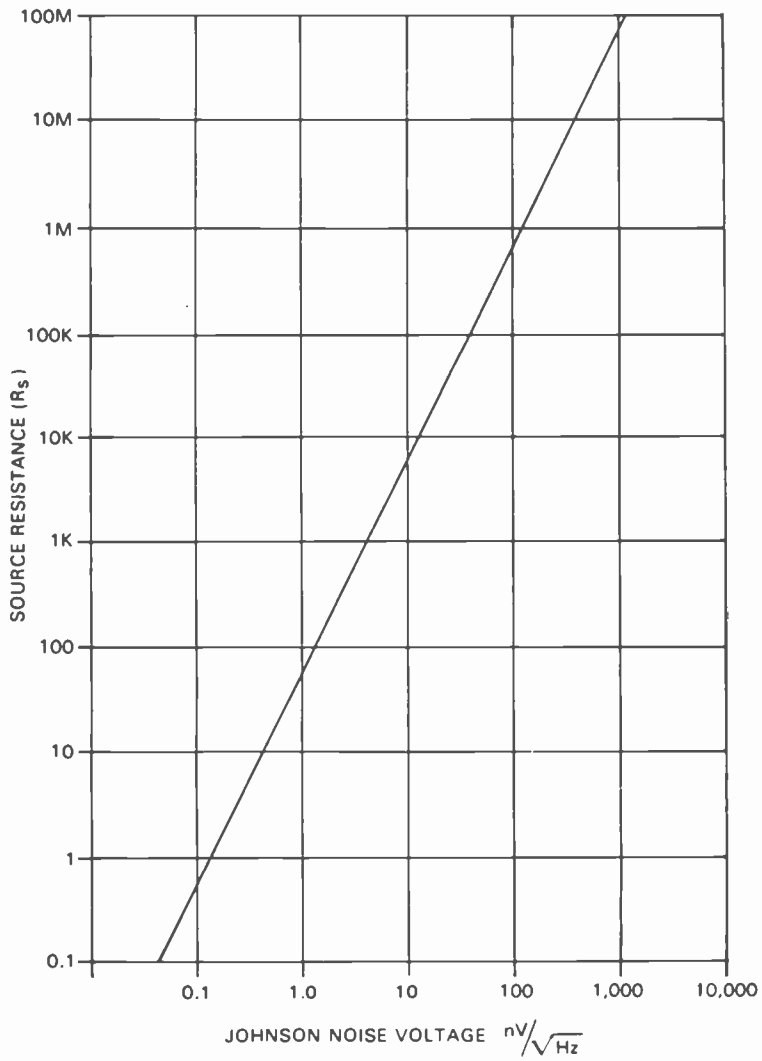


Figure 2.

For any given source resistance operating at room temperature the Johnson noise per root-hertz is:

$$\frac{E_n}{f^{1/2}} = 1.28 \times 10^{-10} R_S^{1/2} \qquad (2)$$

This equation is plotted in Figure 2 for source resistances over the range of 0.1 ohm to 100 megohms.

Since the theoretical noise of the source resistance is now known and the total of this noise plus the amplifier noise has been measured, the noise figure can be calculated from the following equation:

$$NF = 20 \log 10 \frac{\text{Johnson noise + Amplifier noise (measured)}}{\text{Johnson noise (calculated from Equation 1)}} \qquad (3)$$

The three variables of frequency, source resistance and noise figure can best be shown by plotting the contours of constant noise figure on full logarithmic frequency vs. source resistance scales. A typical set of noise figure contours for a low noise preamplifier is shown in Figure 3. As can be seen, this noise figure specification completely describes the noise performance of the amplifier for every source resistance and frequency combination over which it was designed to operate.

Noise figure contours are extremely useful because of the variety of information which they can provide. Noise figure contours can be used as follows:

1. SELECTION OF THE PROPER PREAMP – When the source resistance and operating frequency are fixed by experimental limitations, the contours of several preamplifiers can be compared to determine the proper instrument for minimum noise. For example, an experiment may be set up in which a modulation frequency of 104 Hz is fixed because a mechanical light chopper is used. A particular infrared semiconductor detector is also being used which fixes the source resistance at 80 kilohms. Since neither of these parameters can be varied, an experimenter could review the noise figure contours of all available preamplifiers to find the one which would provide the lowest noise figure and hence the lowest noise performance.

2. DETERMINING OPTIMUM FREQUENCY AND SOURCE RESISTANCE – If a particular preamplifier is already available, the experimenter may be able to design his experiment so that the source resistance and frequency appear at the lowest noise figure point on the contour. Assume, for example, that the PAR Model 113 Preamplifier was available and the experimenter had relatively wide latitude on frequency and source resistance. From the Model 113 noise figure contour shown in Figure 3 it is evident that, with an operating frequency of 100 Hz and a source resistance of 5 megohms, a noise figure of less than 0.05 dB would be realized. The experimenter would then try to arrange his equipment to provide this combination of source resistance and frequency and thereby obtain the lowest noise possible.

3. APPROXIMATING MINIMUM DETECTABLE SIGNAL – An amplifier cannot usefully amplify signals which are below its own internal noise level. Since noise figure contours provide complete information on internal amplifier noise, they can readily be used to determine the minimum signal one can expect to detect when using a particular amplifier. As mentioned earlier, the noise figure relates total amplifier noise plus Johnson noise to

Johnson noise alone. The Johnson noise from a given source resistance can be obtained from Figure 2. The amplifier noise plus Johnson noise can be calculated by solving Equation 3 for this value as follows:

Johnson noise + Amplifier noise =

$$\text{Johnson noise} \times 10^{\frac{NF}{20}} \qquad (4)$$

Noise Figure (dB)	$10^{\frac{NF}{20}}$
0.05	1.006
0.10	1.012
0.20	1.023
0.50	1.059
1.0	1.122
3.	1.414
6.	1.995
10.	3.162
15.	5.632
20.	10.0
30.	31.62

If it were necessary to calculate the minimum detectable signal of the Model 113 Preamplifier at 1 kHz and 10 kilohms source resistance, the following procedure would be used:

1. From Figure 2, the Johnson noise for the 10 kilohms source resistance is approximately 12 nV-Hz$^{-½}$.
2. From the noise figure contour (Figure 3), the noise figure for this source resistance and frequency is 1.0 dB.
3. From Table 1, for a noise figure of 2 dB, $10^{\frac{NF}{20}}$ is 1.222.
4. From Equation 4, the Johnson noise plus amplifier noise is

$$12\ \text{nV-Hz}^{-½} \times 10^{\frac{NF}{20}} = 12\ \text{nV-Hz}^{-½} \times 1.122 = 13.5\ \text{nV-Hz}^{-½}$$

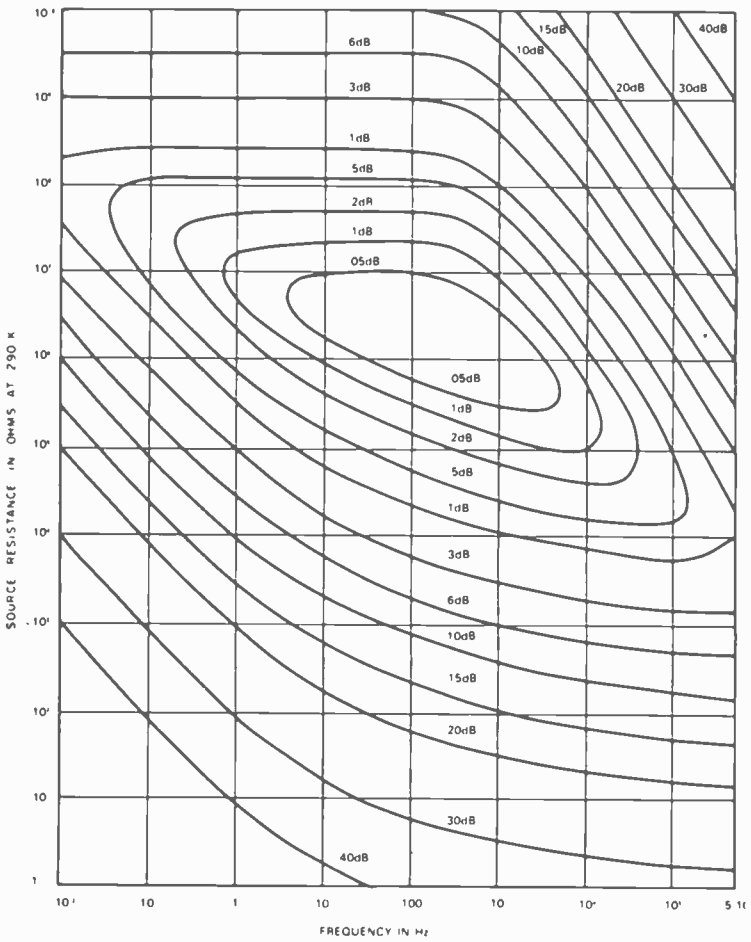
This is the level of signal at which the signal-to-noise ratio will be unity. If the signal bandwidth were 1 Hz, then the actual noise would be 13.5 nV rms.

4. DETERMINING EQUIVALENT INPUT NOISE RESISTANCE (Re) – This specification is used to define amplifier noise in terms of a resistor whose Johnson noise is equal to the amplifier noise at a given frequency. For example, if one wanted to find the 'equivalent input noise resistance' for a Model 113 Preamplifier at a frequency of 1 kHz, he would follow the 1 kHz ordinate to the lower 3 dB noise figure contour. The source resistance on the abscissa (5 kilohms) would be the 'equivalent input noise resistance'.

To summarize, noise figure contours offer an extremely useful tool in evaluating the noise performance of amplifiers for use in low-level signal processing. In addition to describing completely the noise performance of an amplifier over its entire operating range, they provide the researcher with the information necessary to determine the ultimate performance of his system.

For those who wish to obtain further insight into the measurement and specification of noise, we recommend the following references:

1. IRE Standards on Methods of Measuring Noise in Linear Two Ports – H. A. Haus, et al – Proceedings of the IRE, January 1959.
2. Representation of Noise in Linear Two Ports – H. A. Haus, et al – Proceedings of the IRE, January 1959.



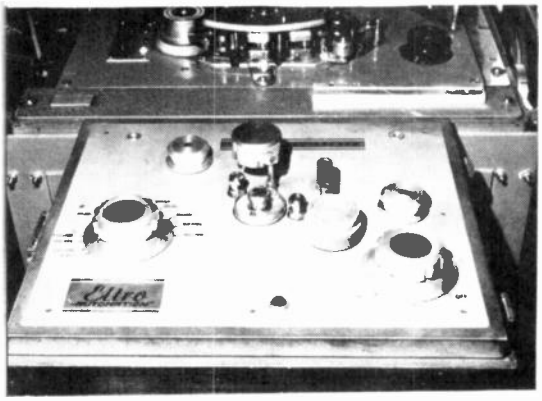
Typical Noise Figure Contours

Figure 3.

Voltage-controlled Signal/Noise Generator Model 132 from Fluke International – an adequate source for signal/noise measurements

VOCOM-an entirely new concept in communications

A Pandora's box of electronics, this unit can theoretically produce all possible sounds – Terence Mendoza reports



ELTRO 'Tempophon' – Magnetic tape time/frequency compression system.

For effective use to be possible, an essential property of any communications system is an output that is consistent with that system's input. The basic information must not be confused or distorted by the system. And while not essential, a very desirable asset is a quality of output signal comparable with the input signal.

The telephone, probably the most basic of electronic communication systems, is an analog device – the amplitude and frequency of impulses acting upon the receiving earpiece bear a direct relationship to the air-pressure variations impinging upon the associated microphone diaphragm. It is self-evident that the telephone has certain technical shortcomings, only two of which need concern us here – a low signal-to-noise ratio, the "poor line" we occasionally find ourselves battling against and which impairs the intelligibility of transmitted information, and a second and more basic drawback which is that of inefficiency – only a very small quantity of information can be handled on one telephone line.

When a large volume of information has to be transmitted "long-hand", satellite links and undersea cables incur large expense. Naturally, under these circumstances, the greater the density of the transmitted data, the more economical will be the system in use.

For many years communications' engineers have researched possible methods of squeezing more information into less time.

This research has followed four paths – Time/Frequency Compression, Assignment Speech Interpolation, Coarse Amplitude Quantization and Voice Analog Vocoders.

TIME FREQUENCY COMPRESSION

Time/frequency compression can be accomplished with magnetic tape devices incorporating rotating heads; intermittent sampling of the signal is carried out and the sampled periods "joined up". The periods when "stretched" in this way, give a proportionally reduced frequency bandwidth and consequently a narrower channel requirement. The system, with its finely balanced mechanics, is bulky and so far experiments have indicated that a marked limitation exists; intelligibility is seriously imaired before a reasonable bandwidth saving can be achieved.

Recently the scope of integrated circuit technology has enabled the production of a solid-state device which, when used in conjunction with a tape replay mechanism, allows variable-speed constant-pitch reproduction. This analog device, marketed by an American firm Cambridge Research and Development, will allow blind users of "talking book" services to adjust the replay speed to suit their capacity for information intake – devoid of annoying "chipmunk" effects.

ASSIGNMENT SPEECH INTERPOLATION

The method termed assignment speech interpolation can increase data handling efficiency by up to 300%. This system is used in conjunction with some sort of multi-channel installation; its principle relies on the expedient of filling natural pauses in one person's speech with syllables from the conversation of another's.

COARSE AMPLITUDE QUANTIZATION

In coarse amplitude quantization, the speech waveform is converted to a clipped square wave and although the result is rasping in quality, it still manages to retain good intelligibility. The system is cheap and not as yet fully exploited, despite the potential of bandwidth economy in excess of 200%.

VOICE ANALOG VOCODERS

An interesting, mainly experimental group is that of the Voice Analog Vocoders. These devices analyse speech into its constituent frequency bands and relate these patterns to the physiological position of the speaker's vocal cords, lips and tongue. During coding, unnecessary information is discarded, and the condensed information fed to a store/receiving terminal. The speech is reproduced using imitative circuits analogous to the physiology that produced the speech originally.

At present much work is in progress in this field which shows promise of providing up to .1000% bandwidth savings. However it *is* an analog system and requires a large volume of circuitry and, of necessity, an analog-to-digital converter in association with a digital computer.

VOCOM

Now, in England, a unique new system has been developed which, in the very near future, could possibly obsolete all the varied techniques just described.

International Voice Movement is the company that has researched and will be marketing the system, which

surprisingly has been developed as a fortunate spin-off by the designers (who up to now have been more familiarly associated with the manufacture of sophisticated electronic musical equipment).

Vocom, short for "voice communication through compression and computation", instead of trying to reproduce a speaker, concentrates on recreating and reproducing sounds.

Speech is fed into the system which then analyses and simplifies it to produce a code corresponding to the frequency patterns or "domains"

Average speech will result in a (simplified) digital coding of around 200 bits/second; telephone lines are capable of carrying data containing up to 60,000 bits/second. Therefore Vocom has a potential to transfer data at 300 times the original speed.

The data is "reconstituted" at the receiving terminal in such a refined manner that not only are the words intelligible but the original speaking voice is recognisable!

To bring this achievement into perspective it should be noted that Vocom is capable of condensing a 30 minute speech to a mere six *seconds!*

HOW DOES VOCOM WORK?

The heart of the system is a bank of sixty-four special devices, each of which can function either as a filter or an oscillator. The devices are switched to the former mode to receive the input signal – this part of the system has been likened to the basilar membrane of the inner ear; each fibre responds maximally to one particular frequency with a sensitivity that gradually falls off to zero at pitches above and below the resonant point. Our brains recognise characteristic sounds and musical pitches by the relative amplitudes of signals from these fibres.

(In fact it is not the *amplitude* that is the variable parameter but the frequency of trigger pulses elicited from each activated fibre – the more violently a fibre is vibrated the greater the frequency of trigger pulses sent to the brain which *interprets* this as different amplitudes of the particular frequency corresponding to the stimulated fibre).

The narrow frequency band that each filter is most responsive to, is also that frequency at which the same device will oscillate when this mode of operation is selected (during "replay").

To understand the system consider one continuous unchanging sound fed to the input. The sound (unless white noise) will have a limited bandwidth, hence some filters will not respond at all, and the rest in varying degrees according to how the energy of the signal is distributed throughout the frequency spectrum. Every filter is simultaneously and regularly sampled at a very high speed. The amplitude of output of a filter at a particular instant of sampling could be any one of an infinite number of values. The designers have (empirically) proved that a 256-level differential between zero signal and maximum signal provides adequate amplitude resolution. An associated computer can, in this way, using 8-bit words, store records of the output amplitude of every filter at each specific sampling interval.

To reproduce the stored information in audio form, the filters are switched to the oscillating mode and the amplitude of each of the 64 outputs controlled by the relevant 8-bit word. It is evident that any sound, however complex, can be analysed and stored.

The fidelity of the "re-synthesised" sound depends on the sampling clock speed – the smaller and more frequently the samples are taken, the greater will be the fidelity of the resultant sound. An analog exists in photography – the finer a film-grain, the higher is the potential definition in a photograph.

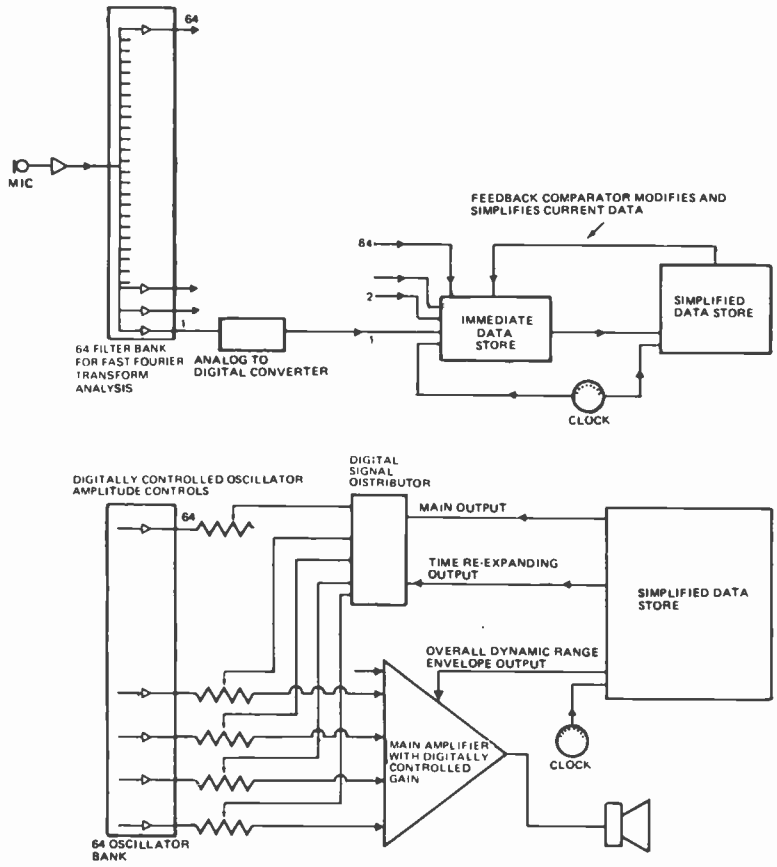
In the analysing stage of Vocom the bit rate can sometimes run as high as 1,000,000 bits/second. This figure includes many repetitive items of data. For instance, if a vowel is spoken, the sound may remain of virtually constant amplitude over a 70 ms period. To reduce the bit rate, Vocom, during its high speed sampling carries out instantaneous comparisons between the code being (at that moment) fed to the computer memory and the codes being stored from the sampling periods immediately past.

Thus the vowel in our example may activate three particular filters at the same individual levels over the 70 ms period. Vocom will recognise this fact and instead of storing a series of, say, ten commands (meaning samples would have occurred every 7 ms) to set the levels at x, y and z amplitudes, it will store only one command to set the levels at x, y and z and a further instruction to the three oscillators to "remain at x, y, z amplitude for the ten sample periods."

Extensive use has been made of large scale integration technology to give Vocom this "commonsense".

As well as the eight bits that control amplitude, eight more bits are incorporated to define the rate of frequency or amplitude change and a further six bits control three output amplifiers, to supervise the overall dynamic level, forming the "vocal envelope".

More bit-saving is possible with Vocom's prepared phoeneme generators; certain consonants, once identified, lead the computer to label



Simplified block diagram of VOCOM. TOP: Encoding; BOTTOM: Decoding.

VOCOM-an entirely new concept in communications

them with special digital codes. When, during the "re-synthesis" phase, the same digital command appears, the relevant phoeneme generator will be activated.

The 64 filter/oscillators need not necessarily remain spaced over the complete audio spectrum – by allowing the devices to be concentrated over a smaller area when required, any degree of fidelity is possible. The closer the filters are together the more accurate is the re-synthesis over the frequency bandwidth covered.

So far we have discussed the intake of speech and simplification of data. Once the data is in the computer there are innumerable handling possibilities. Mention has already been made of the 1 to 300 possible compression ratio.

Where secrecy is paramount though telephone lines convenient (military applications?), automatic vocal coding and decoding can be effected. Furthermore programming can regularly and automatically change the code number dialled to make the Vocom link and continuously alter the coding/decoding "cipher".

The computer can store whole vocabularies to act as a telephone answering service with a message capable of being easily updated. The user will be able to modify the information from any telephone and in its "message-taking" capacity *any* length of message can be handled.

The service will not only be useful to large businesses but to any member of the public with a telephone. The only hardware necessary is the Vocom terminal, a small box about the size of a small cassette recorder that is stood beside the telephone. The subscriber just dials numbers on his terminal and the reply comes back as ordinary speech through the telephone earpiece or a small ancillary loudspeaker. The terminal should cost no more than about twenty five dollars although the designers visualise it being rented as part of a Vocom service. A directory would be given detailing codes to link the subscriber into the various services; this would obviously not cover the special confidential codes like the "cypher-system" described above.

Vocom, being computer-linked, can carry out rapid calculations with the bonus of being able to voice the result.

Used as an inventory control system, receiving input data keyed from the stockroom, it can calculate how much stock remains and maintain accurate Vocom listings. A salesman on the road at any time can 'phone in to be 'told" the latest stock situation. The speech that he hears will have come from Vocom's vocabulary bank after computerized assessment – no human will have actually spoken the formation of words that advises the salesman. If security isn't a major consideration it is quite feasible for the salesman to use an ordinary telephone number to link him to Vocom.

The stock market reports, rail and air travel announcements and advance bookings all afford opportunities for Vocom to decrease workload and increase efficiency.

In research it permits fine analysis of sound of incredible potential resolution. Vocom in sound synthesis is literally a Pandora's box – without limit. Theoretically capable of producing any and every sound and even of understanding vocal patterns.

One point worth pondering over – a computer with the capacity to hold an intelligent conversation need no longer be a figment of some science-fiction writer's imagination! ●

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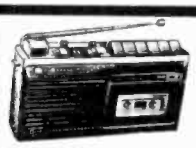

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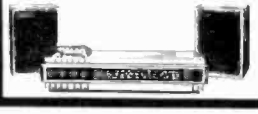

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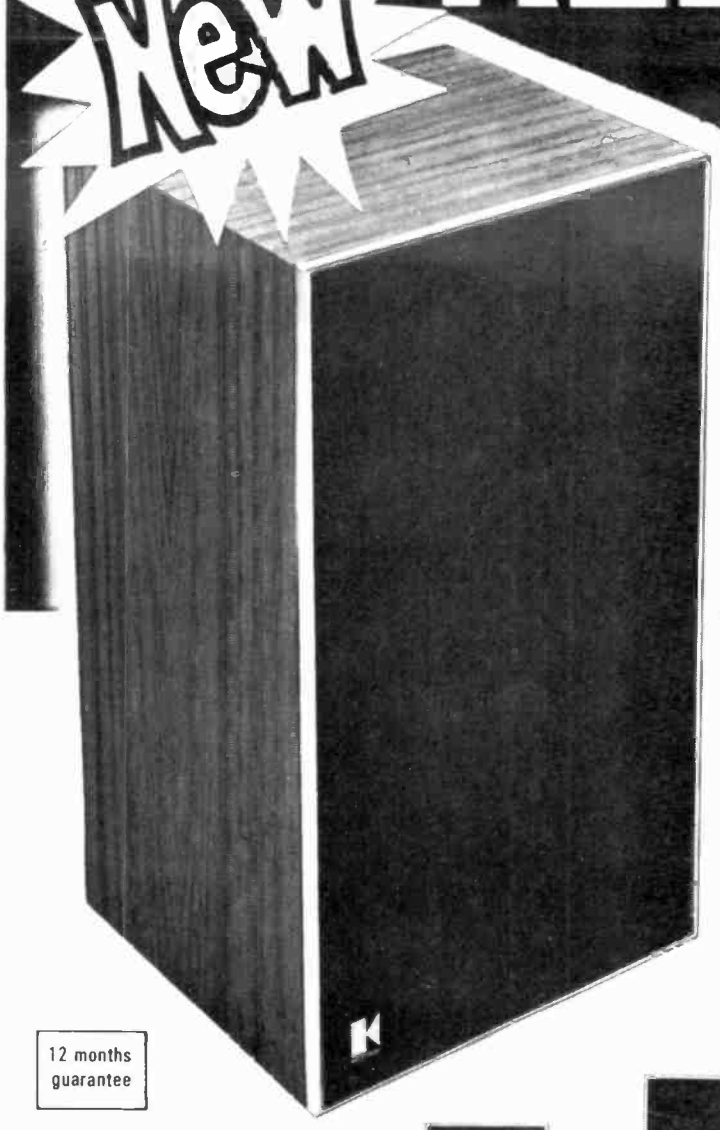

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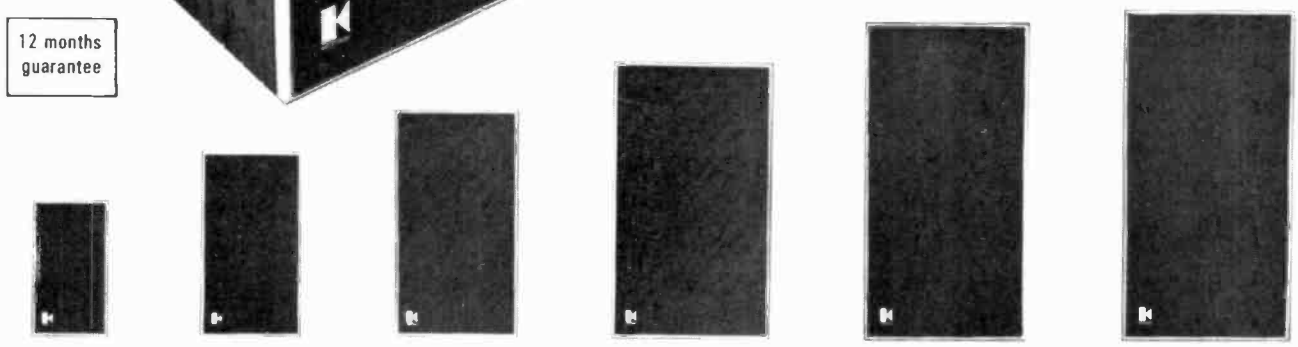

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SONEX '73 — A PREVIEW

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This early preview of some of the hi-fi equipments to be shown at the exhibition must necessarily be incomplete as manufacturers tend to withhold releasing 'new' information till nearer the opening date. We have, however, listed the main exhibitors at the end of this feature.

Armstrong 626 FM/AM Tuner-Amplifier

Sonex '73 has been chosen by **ARMSTRONG** to launch their new Series 600 range of amplifiers, tuners and receivers. Their designers believe that the new models — the results of five years development — represent a breakthrough in performance, facilities and styling at most competitive prices. The 631 Stereo Amplifier, for example, priced at £75. 90 (assuming 10% VAT) is rated to deliver 40W continuous sine-wave power per channel with both channels driven, with low distortion, and has electronic gate switching, two pairs of individually selected speaker outlets, comprehensive low-pass filtering with slope control, adjustable phono sensitivity and variable tape output.

Stereo tuners 623 (AM/FM) and 624 (FM only) incorporate bandpass filtering, dual gate FETs, varicap tuning, ceramic IF filters, ICs and a phase-lock-loop stereo decoder. In addition to manual tuning, upto six stations can be preset. All this plus centre-zero and dual range field-strength tuning, AFC and a mute control, at £79. 20 for the 623, and £59. 40 for the 624. The 623 also features continuous tuning through the LW and MW bands without any switching.

Complete tuner-amplifiers, Model 625 (FM) and 626 (AM/FM), have the performances, controls and facilities of the tuners and the amplifier; RRPs are £110 and £132 respectively.

COSMOCORD's exhibits include a range of Martin speakers (made by the Eastman Sound Manufacturing Co Inc, New Jersey) — from the Micro-Max Model 110, a two-way system selling at £32.71 exclusive of tax, right up to a Sound Tower with eight units and quoting a response from below 28 Hz to above 20 kHz, priced at £189.24 plus tax, and measuring 52in (H) x 16¼in (W) x 7¾in (D).

The new Acos Lustre tone-arm (from Japan) is said to be an elegant transcription model using magnetic repulsion technique for bias correction, and with easy 'one touch' height and overhang adjustment. Stylus pressure is directly read, with 0.5g calibrations matched simultaneously with the bias comparator for accurate tracking. Cosmocord also will market three magnetic cartridges, Acos M6, M6E and M6EX — a notable departure for this company.

ACOUSTIC RESEARCH are to demonstrate three product developments which will be available through their dealers from April: the AR-4xa hi-fi speaker system with new tweeter and cross-over network said to offer better hf response and sound dispersion, and to accept upto 100W on normal speech and music, and selling for £32 inclusive of VAT; the AR-5, fitted with 25cm woofer and hemispherical midrange and tweeter units of the same design as used in the AR-3a, and priced at £80, and — said to be a real hi-fi bargain — the AR turntable with a specially equalised Shure M91-ED cartridge, precision tone-arm, base and dust-cover, at £52 with VAT.

AR-5 Loudspeaker

FISHER RADIO — an outgrowth of Avery Fisher's hi-fi and radio hobby — claim in their advertisements 'We invented high fidelity!'. Though very successful in USA, they are yet to make significant headway in UK and the current onslaught of Fisher Radio

WHEN AND WHERE

VENUE: Excelsior Hotel in the London Airport complex. Exhibition entrance separate from the main hotel entrance. Sound sessions on the ground-floor using part of the ballroom.

OPEN TO PUBLIC: March 30 to April 1;
11 am to 9 pm on first two days,
11 am to 6 pm on the last day.

ADMISSION: No charge but admission by tickets only, available from retail shops and consumer hi-fi Press announcements.

(Europe) is via a new distributor and with seven high-grade speaker systems in the XP series, two tape decks and five receivers – all to be shown at Sonex '73. A 'Fidelity Standard' test LP is already being sold through ICP Ltd (Hainault House, Hainault St, SE9) for £1.00 which has been matrix-encoded for the CBS-SQ system.

HARMAN KARDON products to be demonstrated include the latest HK 1000 Stereo Cassette Tape Deck with Dolby processor and a performance reputed to be comparable with top-class reel-to-reel machines (RRP: £185); four multi-channel tuner amplifiers from the '50+' model at £175 to

Philips N6720 DNL Unit

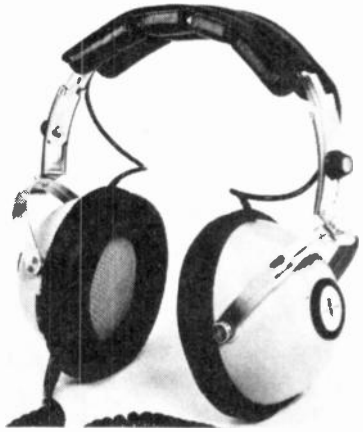
the '150+' unit at £375; and the Citation models 14 and 15.

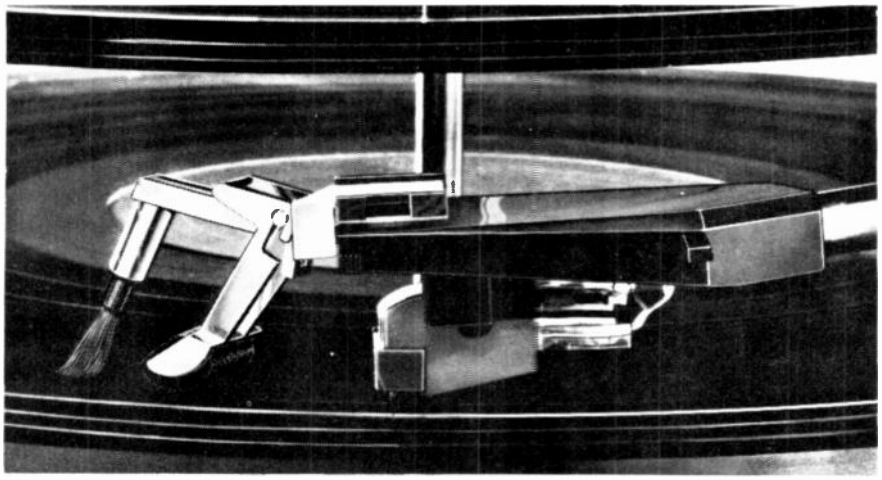
Visitors' interest at such exhibitions will not be confined to straight audio equipment such as amplifiers, speakers, tuners etc. To cater to associated interests, there will be stands exhibiting instrumentation, ancillary devices and equipments, components etc.

SUGDEN, for example, will demonstrate their Audio Instrumentation range including a Distortion Measuring Unit (RRP £30) and their 453 Oscillator at £40.

TAPE RECORDER SPARES, well-known for their Audio Packs of interconnecting plugs, sockets and cables,

Philips N6302 headphones have a control for altering the stereo effect





BIB Changer Groov-Kleen

will display a new series of Sound Selector Units which, in various combinations, permit the connection of pairs of headsets and speakers to one or more outlets of an amplifier.

MEMOREX, known for their tape in open reel and cassette forms, have introduced a range of Audio Training Cassette kits, consisting of a library box, program index, labels and 100 cassettes in C30 to C120 sizes, primarily intended for schools and industrial training

Armstrong 624 FM Tuner

BIB SALES will display nine new accessories for the hi-fi enthusiast, the latest being the Changer Groov-Kleen (Ref: RRP), said to be easily fitted to record changers which have flat cartridge-top housings. Model 60 is their newest Groov-Kleen with chrome finish and can be fitted to practically any turntable deck.

With stereo transmissions being extended by the BBC in the months to come, the receiving aerial assumes increasing importance for mush-free signals, in view of the multiplex systems used for stereo transmissions and consequent drop in S/N ratios. Multi-path problems also affect stereo quality and require special attention to be paid to the aerial arrays. Visitors will find it worth their time to visit the stands of **J-BEAM AERIALS** and **ANTI-FERENCE LTD** to see their range of specialised FM aerials for mono and stereo reception over the European FM band.

WHOM TO SEE

Acoustic Research (AR)
Acoustical Mfg (QUAD)
Acoustico Enterprises
AMS Trading (AMSTRAD)
Antiference
Armstrong Audio
BASF-UK
BIB
B & W Electronics
Candor Electronics
Cosmocord
Denham & Morley
Farnell-Tandberg
Fisher Radio
Gale Electronics & Design
Hayden Labs
IMF Electronics
Interconti Electronics
Jordon-Watts
KEF Electronics
Klinger Controls
Lecson Audio
Lowther Mfg
Lustraphone
Memorex
Metrosound
Keith Monks
Mordaunt-Short
J Parkar (ONKYO)
Philips
Precision Tapes
Pyser-Britex
Richard Allan
Rogers Developments
Rola Celestion
SABA Television
Sinclair
Sonab
Spendor Audio
A R Sugden (CONNOISSEUR)
J E Sugden
Vernitron (SANSUI)
C E Watts

Wharfedale Hi Fi Isodynamic Headphones.

(Isodynamic, *adj*. Of or pertaining to equal (magnetic) force).

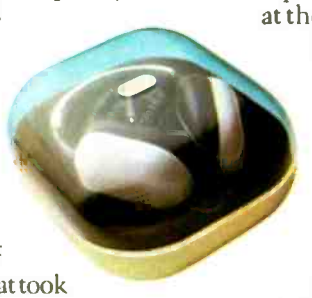
Mission Accomplished: electrostatic quality for less than half the price.

That was our mission.

The same superb quality of performance as electrostatic headphones. But for less than half the price.

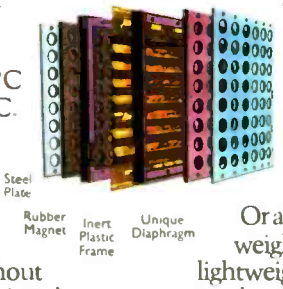
And by going to the moon we've accomplished it.

Because one of the things that took man to the moon was a unique polyimide film. And we've turned it into a unique diaphragm. Giving you pure stereo sound at the revolutionary price of £19.95.* Plus. Lightweight comfort. And good looks. Complete with this elegant foam-lined container with transparent lid. It'd look good beside your deck. And let you store the phones neatly and dust free



Unique Diaphragm

In the NASA space capsules polyimide film has to withstand great temperature fluctuations. As low as –269°C or high as 400°C. And it also has to withstand tremendous vibrations. So it has to be flexible. But without destroying the printed circuitry. Which is bonded into the polyimide film.



Rubber Magnets

Another Wharfedale Hi-Fi exclusive. Which give you an equal magnetic force from lightweight magnets. And so avoid the heavy iron magnets used in more conventional headphones.

Weightless Capsule

Or almost. For the whole lot weighs a mere 13ozs of sheer lightweight strength. So you can wear the phones for as long as you like. And if you'd like the full inside story then fill in the coupon.

*Manufacturer's recommended retail price at time of printing.

UK and Foreign Patents exist. Further Patents applied for.
UK Registered Design No. 956537. Other Design Registrations Pending.
Made in England.

HET/4

Send me details of Isodynamic Headphones and your nearest recommended dealer.

NAME

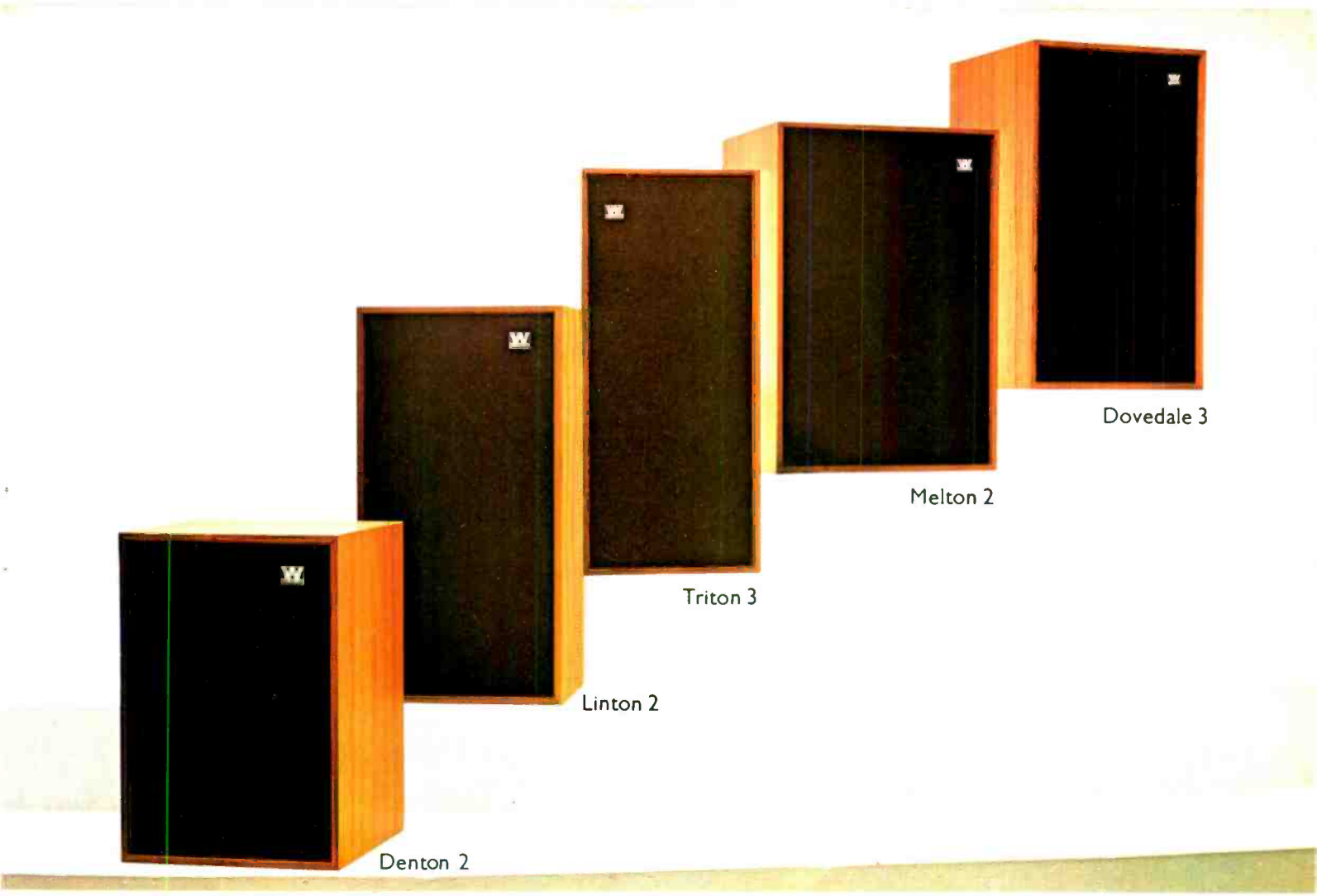
ADDRESS

(BLOCK CAPITALS PLEASE)

Wharfedale Hi Fi
Idle, Bradford, Yorkshire.
A division of the Rank Organisation

Wharfedale Hi Fi. Pure and simple.

Wharfedale Hi Fi, Idle, Bradford, Yorkshire



Wharfedale Hi Fi start with the best low priced speaker.
and get better and better and better and better.

And to start with the Denton 2. Simply the best low priced pure hi fi speaker money can buy.

Wharfedale Hi Fi will stake their worldwide reputation on it.

And we know what we're doing. Simply because we've specialised in the pure hi fi business and nothing else for over thirty-five years. (We're quite happy to leave washing machines, alarm clocks and television sets to other manufacturers.)

But there's more to our speakers than just superb engineering.

For instance our specially designed craftsman made cabinets in finest matched teak or walnut veneers. And acoustically transparent grille cloths in either black or brown.

So the outside looks as good as the inside sounds.

And the **Dentons** work out at £42.00* a pair.

Of course if you want to spend a little more then naturally you get more and more and more and more for your money.

For £52.00* you can buy a pair of Britain's best selling pure hi fi speakers. The **Linton** 2 bookshelf speakers.

Or the **Triton 3**. A big 3-way speaker system that'll still fit on your bookshelf for only £65.00* a pair.

Then there are **Melton 2** floor standing speakers with outstanding bass performance which work out at £35.00* each.

And for the connoisseur. The all powerful **Dovedale 3**. £47.50* each

Whichever you choose. A Wharfedale Hi Fi Speaker is simple to install. Simple to operate. And gives you pure hi fi sound.

Because whichever you choose they all have the same advantages. Like our exclusive connector for quick and easy wiring to your system.

Whichever hi fi system you choose.

Of course it wouldn't surprise us if you chose the complete Wharfedale Hi Fi Linton System. With its Linton 2 Speakers, Linton Amplifier and Linton Turntable. What'll surprise you is the price. Well under £160.00

Or you can mix and match to your heart's content.

Take the Linton Amplifier and Turntable. But instead of Linton 2 Speakers you may prefer a pair of our Dovedales. Or Meltons. Or Tritons. Or Dentons.

The choice is yours.

And if you'd like to know any more about any of our speakers or the Linton System itself then simply fill in the coupon.

*Manufacturer's recommended retail price at the time of printing

Wharfedale Hi Fi. Pure and simple.

Send me details of speakers and Linton System and your nearest recommended dealer

SET/4

(BLOCK CAPITALS PLEASE)

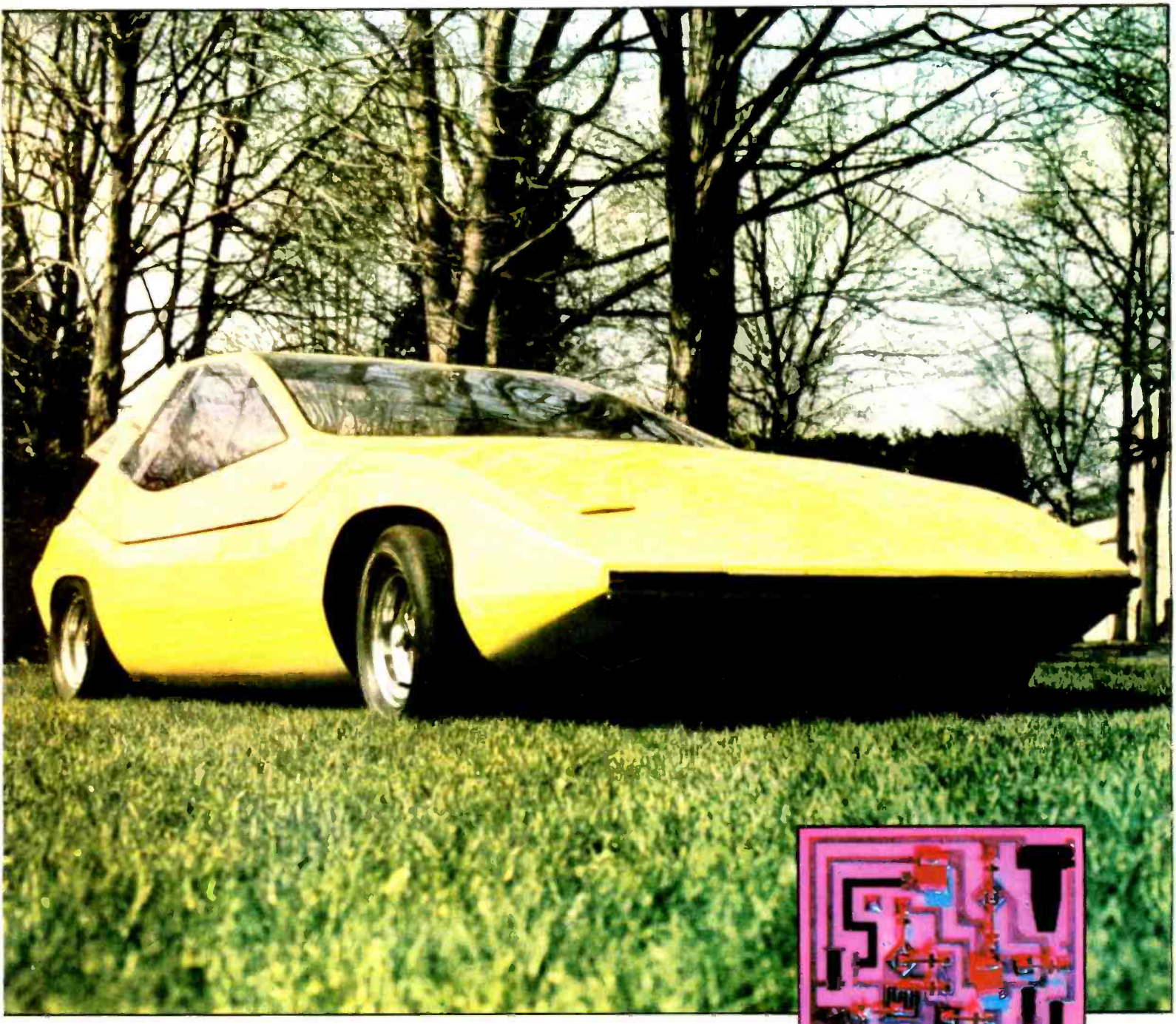
NAME

ADDRESS

Wharfedale Hi Fi
Idle, Bradford, Yorkshire.
A division of the Rank Organisation.

Wharfedale Hi Fi, Idle, Bradford, Yorkshire

CARS— FUTURE SHOCK?



Vehicle of the future? Sundancer I has been built by US ESB Corporation to research desirable vehicle characteristics for electric propulsion (Inset is solid-state voltage regulator from Britain's Joseph Lucas organisation).

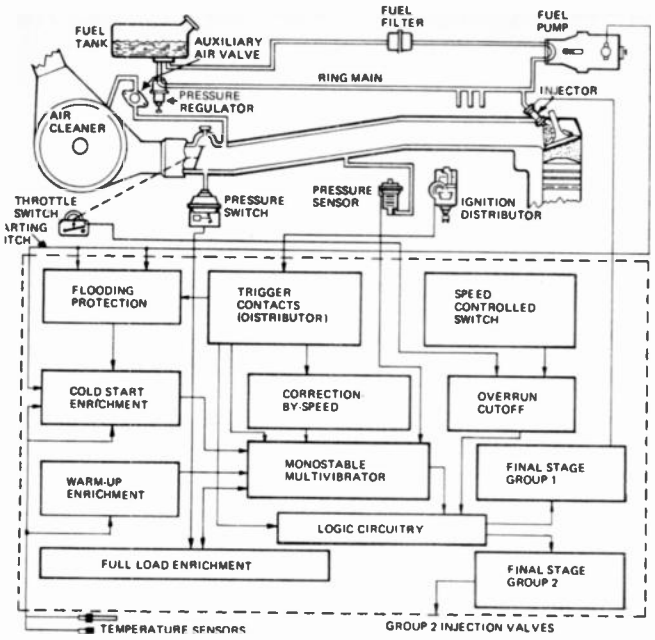


Fig. 1 Schematic drawing of fuel injector system.

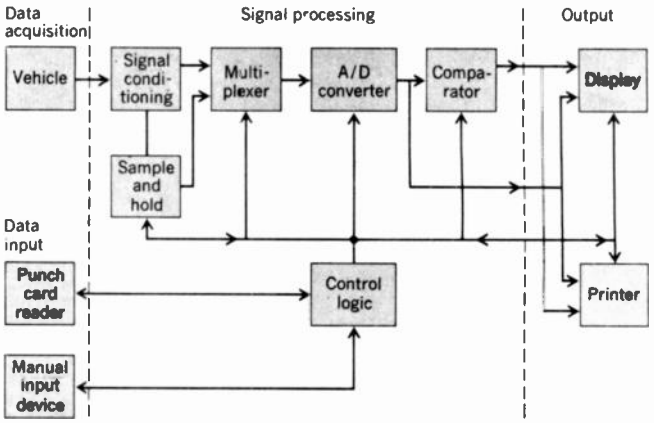


Fig. 2 Block schematic of VW's computer diagnostic system. In use, the vehicle is connected to the computer via 28-way cable.

Electronics may revolutionize the car as we know it today — ex GM research engineer and now Editorial Director of Electronics Today International — Collyn Rivers reports.

Since Shockley's invention of the junction transistor back in 1949, electronics engineers have confidently forecast the solid-state take-over of Detroit.

The latest estimate by Lester Hogan (President of Fairchild Camera and Instrument Corporation) is of a $5 000 000 000 market for vehicle electronics by 1980 in the USA alone.

This seems optimistic in the extreme, for assuming that the US car manufacturing market will level off to the generally predicted 10 million per year, Hogan's forecast implies that the cost of the electronics per car will be $500 at *manufacturing level alone*, hence the value of electronic assemblies in the finished vehicle would be at least $1500, nearly half the price of the car.

Nevertheless electronics is being used more and more by the motor industry — in many cases because electronics is the only practical solution to the anti-pollution and safety problems that the government has insisted the carmarkers resolve.

Dr. Villa, head of FIAT'S electronics division takes a more cautious view. In a paper delivered to the I.E.E.E. last year he forecast that (assuming the retention of petrol driven vehicles), electronics would account for some 10% of the cost of a car by 1980 and 12% by 1985.

He felt that the areas of expansion would include solid state transducers and actuators, and the development of digital devices using MOS technology in MSI and LSI custom made chips to aid in system integration.

Needless to say electronics are being used more and more in today's vehicles — and will continue to be so as solid-state devices are developed that can stand up to the surprisingly harsh environment in which they must operate.

Few electronic engineers realize just how harsh this environment can be. Underbonnet temperatures for example can vary from −45°C to +120°C — humidity from zero to 100% — in fact devices must continue to work even if covered in oil or water.

Apart from the wide range of ambient temperature, the nominal 12 Vdc supply is very far from being that. Transients approaching 400 volts are quite common; just disconnecting the battery may produce a negative spike from the alternator of at least 70 volts. Many garages will 'boost start' a cold vehicle using a 24 volt battery, so here again steady voltages of at least 28V may be experienced.

As if this were not enough, vibration and shock loadings can be unexpectedly high. Even a simple action such as slamming a car door can transmit acceleration levels of well over a hundred G to the dashboard.

Small wonder then that so many ill conceived CDI ignition systems ceased to operate after a short time!

Fortunately the recently developed complementary MOS (CMOS) can tolerate harsher working conditions than previous integrated circuitry and has the additional advantage that it can more readily be interfaced with 12 volt operated devices.

CURRENT DEVELOPMENTS

At present, research and development is concentrated on several areas. The first is to see what existing mechanical or electro-mechanical assemblies can usefully be replaced by solid-state equivalents. And by 'usefully' what the motor industry means is more cheaply, for the existing systems have been proved more or less adequate for many years. Incremental cost is very much the name of the game.

In this category are electronic ignition and fuel injection systems, solid-state voltage regulators, air conditioner controls, warning systems, instrumentation etc.

ELECTRONIC IGNITION

Although one would never believe this from the advertisements, the conventional (Kettering) ignition system provides adequate performance for the average (non-racing) car. And providing the system is maintained in good order, little (if any) increase in performance will be attained by fitting an electronic system.

But the key word is 'maintained', and in practice very few cars have ignition systems in good working order. The big advantage of the electronic systems is that once installed, the ignition system will from then on require very little routine maintenance.

Whilst the more ambitious electronic systems seek to replace most components of the existing ignition system, (as in CDI systems), many companies are content to devise ways of eliminating the contact breaker points alone.

Chrysler (USA) has now switched

CARS– FUTURE SHOCK?

totally to a semi-electronic ignition system for their full range of petrol driven vehicles. The company have devised an outwardly normal-looking distributor, but one in which the contact breaker points have been replaced by a rotating magnet and a reluctance transducer – basically a coil of wire in which a pulse is induced by the rotating magnet.

The magnetically generated voltage pulse is amplified by a power transistor which switches the primary circuit of the ignition coil.

A similar system has been available from General Motors for some years – but only as an optional extra.

Critics of the system say that it does not put out uniform pulses over the full range of engine speeds, and that as the output from the reluctance transducer is related to velocity, engine starting is very difficult at low cranking speeds. In practice however, the system seems to work very well.

Mallory use a breakerless system in which the contact breaker points are replaced by a small globe and photocell. A shutter wheel rotating between the two, exposes the photocell to the light from the lamp at the precise points where ignition pulses are equired.

Also available – but not so far as original equipment – is the capacitor discharge ignition system (generally abbreviated to 'CDI'). All CDI systems work in a basically similar way. In effect they use a dc-to-dc converter to raise the level of the 12 Vdc supply to approximately 400V. The output of the converter then charges a (typically) 1.5 uF capacitor which is discharged through a switching element – such as an SCR – into the primary winding of a specially wound ignition coil.

A recently developed CDI unit – the Delta Mk Ten 'B' controls the spark duration as well as intensity – an effect that the maker claims reduces exhaust pollution.

Although electronic ignition systems got off to a shaky start – due primarily to the electronics industry's failure to allow for the harsh working environment – it seems practically inevitable that the electronic ignition system will shortly replace the electromechanical system – if only because the reduced need for maintenance lessens the probability of pollution from badly tuned engines.

ELECTRONIC FUEL INJECTION

As with electronic ignition systems, electronic fuel injection plays a valuable role in reducing pollution In the latter case it does it directly: accurately metering the air-fuel requirements of the engine.

A number of electronic fuel injection systems are already used as standard equipment. A typical unit is shown in Fig. 1. This unit, developed jointly by Bosch and VW contains some 250 components including 30 transistors and nearly 40 diodes.

Fuel is pumped from the tank into a ring main for distribution to all injection valves. A pressure regulator maintains a constant 28 psi in the ring main.

Electromagnetic injector valves in the inlet manifold are opened and held open by a pulse from the control unit. The pulse width, is governed primarily by engine speed and load conditions, it varies from two to 10 milliseconds.

The ignition distributor has the usual breaker points etc, but in addition two non-adjustable trigger contacts 180° apart are located in the lower part of the distributor housing.

Signals from these contacts are used in the electronic control unit to trigger a speed controlled switch, flooding-protection circuitry and a monostable vibrator circuit.

Load information is provided by a pressure sensor in the intake manifold. Information is also obtained from sensors monitoring cold-start conditions, warm-up, enrichment, etc.

In Britain, Joseph Lucas have developed a fuel injection system based on an MOS digital memory. In this system the main parameters monitored are throttle angle and engine speed and digital signals derived from these and other parameters determine engine fuel requirements.

The digital memory used in the Lucas system has a storage capacity of 256 x 7 bits words – i.e. 1792 bits altogether.

When tested on a Triumph sedan, the emission measurements were just short of that required to meet the USA's fairly stringent 1975 Federal and Callfornian legislation requirements.

As with electronic ignition systems it seems reasonably certain that electronic fuel injection will take over from conventional carburetors. In fact in a report to the Environmental Protection Agency, the USA's National Academy of Sciences said that in their opinion, electronic fuel injection would enable the automobile industry to meet current anti-pollution legislation – in particular the difficult-to-meet section that requires the vehicle engines to maintain emission levels below the legal limits for at least 50 000 miles without adjustment.

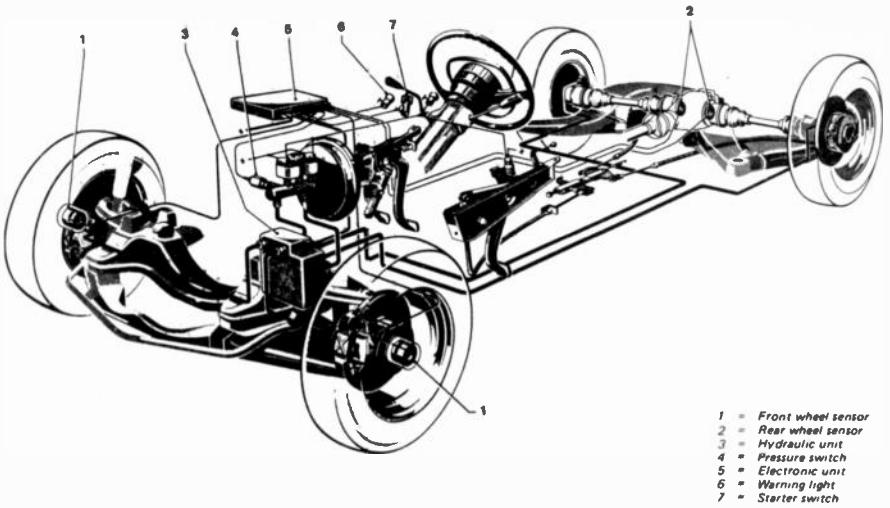


Fig. 3 Mercedes anti-lock braking system. Digital transducers (1,2) send signal proportional to wheel velocity to central control unit. If signal indicates wheel deceleration is above 1.3G, electro-magnetic valve reduces pressure in hydraulic brake line to wheel/s concerned.

ELECTRONIC SERVICE CENTRES

A second area in which the automobile and electronic industries have formed an alliance is in developing computerized testing facilities.

This is an area that scares both industries half out of their collective minds, for the automobile people are only too well aware of just how bad servicing can be – and will even admit this privately. The electronics people quake at the thought of the average semi-skilled garage mechanic attempting to sort out the entrails of a fuel injection computer.

Here, Volkswagen appear to have beaten their competitors with a computerized self-analysis system.

Designed (in conjunction with VW) by Siemens in Germany the diagnostic unit checks out over 60 separate items in less than thirty minutes.

The diagnostic unit is plugged into the vehicle via a multi-way connector (built into all VWs from 1972 onwards). A program card, applicable

to each model and year, is inserted into the diagnostic unit's program card reader. Then, using a hand-held input unit, a technician follows a predetermined test sequence. Most tests are made automatically, but occasional tests must be made manually (tyre pressures for example). At the end of the sequence the complete test results are printed out on a diagnosis form.

Figure 2 shows a block schematic drawing of the diagnostic unit. As may be seen, the unit is basically a data logging system in which input data are translated into a form compatible with the system. The data is then digitized and compared in sequence with the manufacturer's specifications. If any measured parameter is found to be outside the correct limits a note to this effect is printed out on the results card.

Some of the tests performed include:–

a) Cylinder compression – (this is checked by monitoring the voltage drop across the battery earthing strap whilst the starter is turning over the engine (the ignition system is meanwhile temporarily disabled). The ac component of the drop is related to engine compression and it is this component that is monitored.

b) Ignition timing – a metal projection on the engine flywheel indicates top dead centre position. This projection is sensed by a reluctance transducer, and related against a signal derived from the spark plug firing times, provides data enabling the diagnostic computer to evaluate the timing.

Battery condition – checked via an inbuilt battery probe (for electrolyte level). An inbuilt load resistor enables checks to be made of on-load performance.

Other automobile companies are also working on similar lines to VW. General Motors for example have developed a series of diagnostic vehicles. One such, known as Delta I illustrates how a vehicle can be plugged into a simple data terminal which then uses telephone line connections to a central computer. A second GM vehicle, Delta II, has an inbuilt computer which advises the driver of the status of all critical components and systems.

Other diagnostic units are being developed for use on manufacturing production lines – hopefully to ensure that vehicles have been properly screwed together before sales.

The major difficulty facing the proponents of automated diagnosis is that major car manufacturers are adamantly opposed to standardized plug-in test gear. Their argument is that electronic systems of various cars are not compatible anyway – and apart from that, one manufacturer's service staff would not be able to work on vehicles from another – and vice versa.

No doubt the prospect of being able to ensure that only XY agents service XY cars has not been overlooked.

However in the USA at least, the car manufacturers may soon find themselves with little choice for a Bill, passed both by the Senate and the House last year, may soon require all vehicles to be subjected to diagnostic testing before sale, and after accidents.

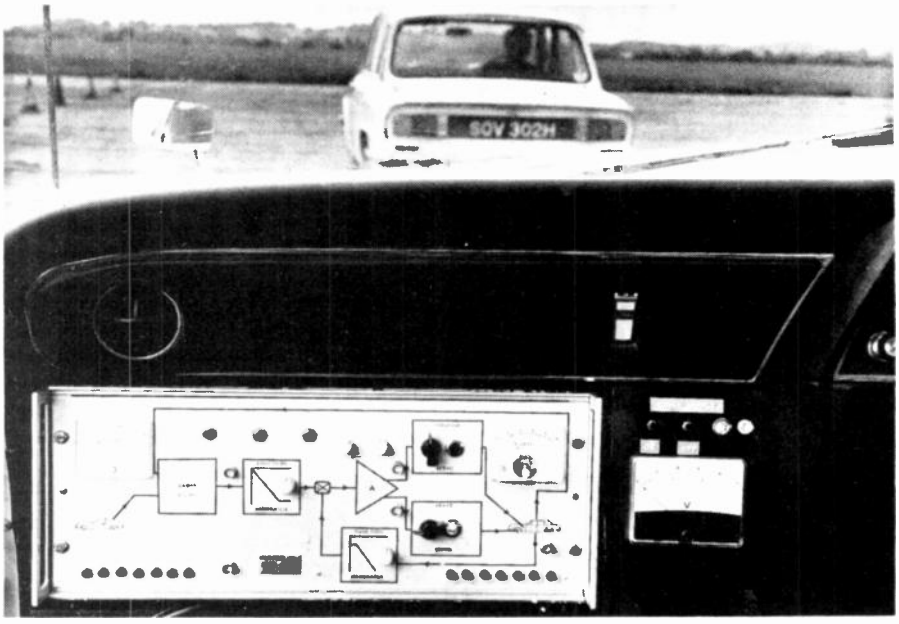


Fig. 4 Lucas system uses micro-wave radar to measure relative speed and spacing of vehicles and then adjusts these values by automatic operation of throttle and brakes.

SAFETY PACKAGES

Having spent several decades insisting that the public would not buy cars in which safety was accented, the automobile industry has done a complete volte-face and some of the less reactionary organisations have admitted that Ralph Nader may even have been right. (The remainder still concentrate on picking out inconsistencies in some of his evidence in the extraordinary belief that this negates the whole of it).

ANTI-SKID SYSTEMS

Such systems have been in common use on aircraft for years, and one or two specialised cars have recently been fitted with adaptations of aircraft systems.

So far these devices work by sensing wheel deceleration – using magnetic sensors. If the deceleration exceeds a predetermined level, an electronic control unit actuates control valves that release brake hydraulic line pressure. A drawing of a typical system is shown in Fig. 3

Once again this in an area in which Government legislation may force vehicle builders to fit anti-skid units. In the USA a Federal motor vehicle safety standard – to become effective in 1974 – is so stringent that braking requirements (for trucks fitted with air-brakes) can probably only be met by installing anti-lock systems. Without doubt these requirements will be extended to cover other classes of vehicle in the near future.

In Germany, Mercedes' plan to install the Teldex anti-locking unit appears to have been delayed by unexpected production difficulties – the price also is reported to be much higher than was originally hoped.

In England, Michael Bertioli, Manager of Lucas' Electrical Circuitry Department recently described an automatic headway system that his department has developed.

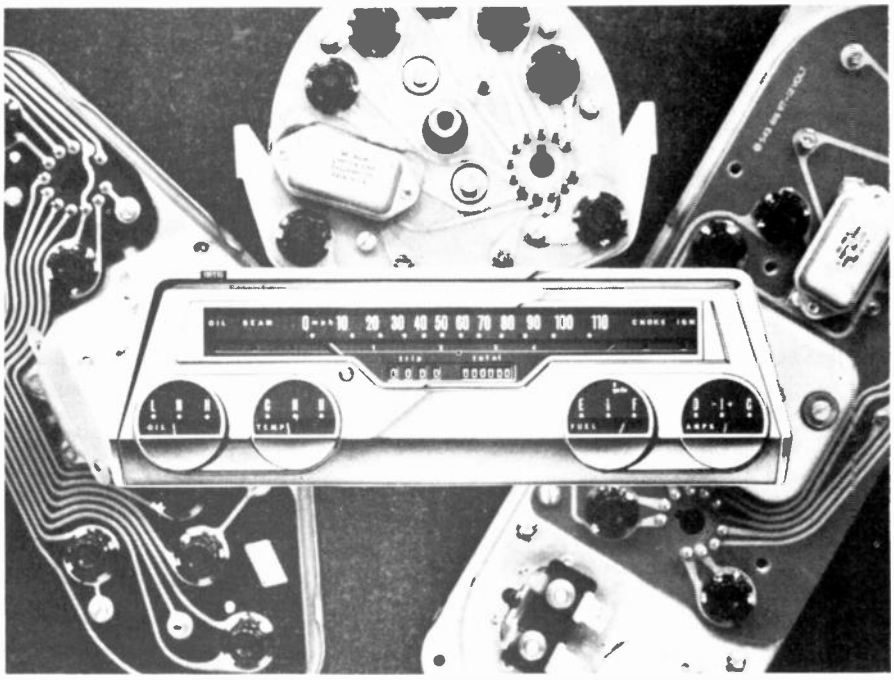
The Lucas system (Fig. 4) uses micro-wave radar to measure the relative speed and spacing of the vehicles and then adjusts these values by automatic operation of the brake and throttle.

Mr Bertioli said that the system would be no larger than a rectangular headlamp and would cost no more than a car radio. However he added that the system would only be completely effective if universally enforced by legislation.

The British Government's Dept. of Environment has awarded some $60,000 for future development of the Lucas scheme.

Although automatic braking systems seem fraught with potential difficulties, industry spokesmen are optimistic. William Miron, President of Bendix Automotive Group said

CARS– FUTURE SHOCK?



All-in-one instrument panel from Smiths uses printed circuit construction and is connected to vehicle's wiring harness via multi-way plug.

recently that the Bendix system could be fitted as an option as early as 1974 – price probably less than $200.

General Motors' view is that radar is still the most promising technique. According to a spokesman from their research laboratories at Warren, Michigan, they have investigated other techniques including lasers and ultrasonics but have rejected them as being insufficiently robust.

Their experiments so far prove that an automatic braking system can be faster, more accurate, and hence safer than a human driver operated system, primarily because the reaction time between recognizing a system as potentially dangerous and taking avoding action is reduced to practically zero.

ANTI-COLLISION

Right from the early days of motoring, as the accident rate continued to climb, 'authorities' explained that accidents were due almost entirely to lack of driver skill."There was no real need to produce intrinsically safe vehicles or even safer roads – all that was required was a higher degree of driving skill."

Fortunately this simplistic view is no longer widely held and it is accepted that the multiple decisions often required in quick succession to avoid collisions may be beyond the ability of the average driver to make.

Hence the move towards automatic control of some vehicle functions. (This area is covered in greater detail later in this article).

The first of such automatic control systems to be given serious consideration is intended to maintain a safe distance between vehicles.

A number of companies are working on these systems including Bendix, Ford, RCA and Sylvania.

Typical of such systems is the ASC (Adaptive Speed Control) from Bendix. This uses a 16 GHz radar beam to detect vehicles at distances up to 100 metres. It relates this data to the speed of both vehicles and to the relative distance between them and automatically brakes or accelerates to maintain a safe following distance.

A basically similar unit from Ford uses an optical beam to provide the distance sensing signal. This (infrared) beam is reflected back to the sensing vehicle by reflectors built into the tailights of the vehicle ahead.

Common to the radar operated systems are problems of jamming and false indication. RCA propose to overcome this by mounting a reflector on the rear of all vehicles, which reflects the received signal at *twice the original* frequency (Fig. 5). However how this system could detect say, a fallen tree blocking the highway, is not known.

ELECTRIC PROPULSION

Even were there no pollution problems, the mere fact that the world has a limited supply of petroleum is a compelling reason to look for sources of motive power other than this type of fuel. In his Message on Energy Resources (June 1971), USA President Nixon clearly warned "we can no longer take our energy resources for granted".

Of the currently known alternative

This prototype vehicle built by Britain's Electricity Council's Research Centre is powered by sodium sulphur battery. The battery is one fifth weight of conventional lead acid batteries and gives vehicle a range of 100 miles at 40 mph.

fuel sources suitable for transportation requirements, the most appealing is electricity.

Electricity, whether derived from storage batteries, fuel cells or from a central power station, is far less polluting *at the point of use* than petroleum derived energy. It makes more efficient use of our most readily available energy sources. It is silent, and because of the efficiency of electric machines, it gives off less heat during vehicle operation.

But until recently there has been a widespread feeling that no worthwhile progress could be made in the development of electrically powered vehicles until batteries with much greater storage capability per unit weight became available.

This view is no longer so widely held and a surprisingly large number of companies all over the world are actively developing or producing specialised vehicles.

A great deal of effort is going toward battery development, and it is now generally agreed that a battery with an energy density approaching 100 watt-hours a pound, a power density of 50 watts per pound, and made of cheap materials can be developed. Such a battery could power a 2 500 pound four-seat car and provide it with a top speed of 80 mph – cruising speed of 50 mph and a range of 150-200 miles.

At a meeting of the International Union of Producers and Distributors of Electric Energy held in Brussels in March 1972, the Union's Executive Secretary, Jack Young said 'There are a number of electrochemical solutions to the problems implied by these requirements (i.e. production of a battery with specifications outlined above). While all technological forecasting must be on shaky ground, it is our impression that two or three years – and a lot of work – should produce a commercially feasible battery of the characteristics I have been discussing'.

If this sounds optimistic consider these facts –

1. The USA's Federal Power Commission's National Power Survey recently forecast 38 million on-the-road electric vehicles by 1990.
2. The USA's Environmental Protection Agency forecasts 40 million vehicles by the same year.
3. Even the Shell Oil Company is forecasting five million electric vehicles by 1985.
4. In Germany, Volkswagen AG and RWE AG (the largest electric company in Germany) are jointly developing an electrically powered version of the Kombi. If successful the combine plan to have 200 experimental vehicles running by 1974.

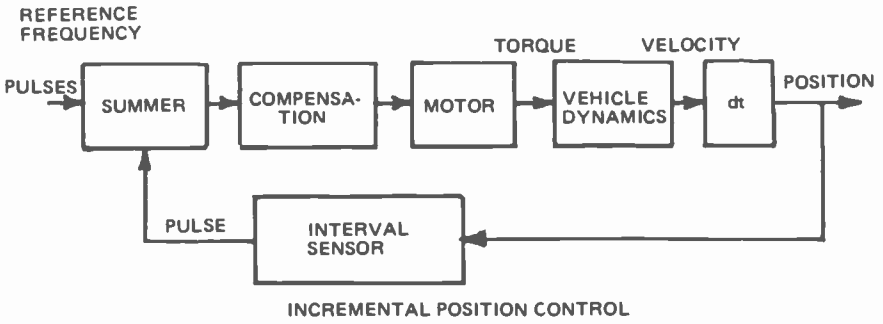


Fig. 6 Incremental position control

5. Japan's Ministry of Trade and Industry has commissioned a $14 million program to develop a better type of lead-acid battery and five types of electric cars and vans. Thirteen companies including, battery manufacturers, car manufacturers and electrical supply authorities are working together to have the vehicles on the market by 1975.
6. In France, the government-owned electricity supply authority 'Electricite de France' is currently building 60 experimental electric cars based on the Renault 4L. This year the company will build a further 100 vehicles to test the possibility of launching into full scale production.
7. In Zermatt in Switzerland, a town of 2 800 inhabitants with up to 13 000 visitors, all transport is by electric vehicles. No other form of motive power is allowed.
8. And in Britain even bigger strides are taking place to get the electric car on the road. The efforts of the Electricity Council, initiated in 1966 to find an economic and practical city electric car, seem to have produced results.

This year the Isle of Wight company, Enfield Automotive, plan to produce 500 examples of their Enfield 8000 battery-powered city car which will be delivered to interested customers for evaluation.

The first 61 go to the Council for distribution to its regional boards with a further 20 on option. The remainder go to other interested parties both in Britain and in overseas countries. Australia has ordered 50 and these will be evaluated by State Electricity Councils and by Australian lead producers. Enfield Automotive expect to be producing around 3000 Enfield 8000's a year from 1974 and from early next year, after production of the initial 500, the company hopes to offer cars for sale to the public at £1000 including VAT.

From an electronic engineering point of view a change to electric propulsion removes many of the difficulties which

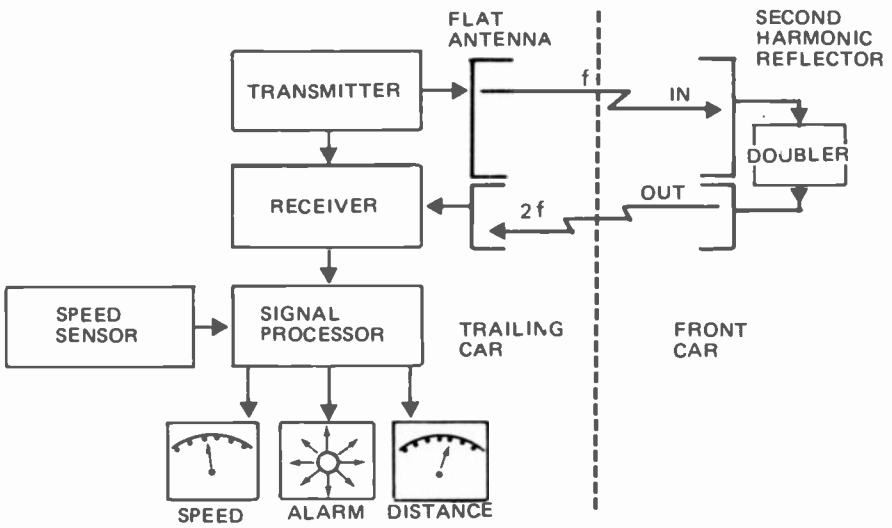


Fig. 5. RCA anti-collision system. Transmitter radiates 9 GHz vertically polarized beam. Signal is picked up and 'Passive' antenna on target car uses diode micro-strip filters to re-radiate signal back to following car at twice the frequency (18 GHz). Polarization is also changed to horizontal. Technique is claimed to eliminate background noise. The system provides audible and visual warning if vehicles are too close for safety.

CARS–FUTURE SHOCK?

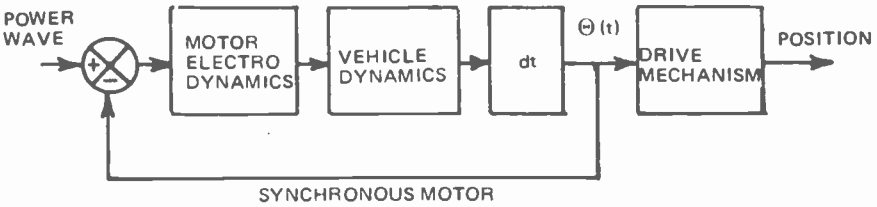


Fig. 7 Synchronous motor control

Central light source is divided by 27-way distributor and fibre-optic light guides to provide individual instrument illumination.

currently arise because of the need to interface between two quite different technologies.

It also simplifies any future move toward automated guideway transportation systems – which many authorities feel may eventually be used for transportation both between and within cities.

AUTOMATED GUIDEWAY TRANSPORTATION

Ironically, the motor vehicle – originally conceived as a means of providing individual mobility, has (because of its practically universal acceptance) become a threat to that very same concept.

We cannot *ban* the automobile, rather we must devise ways in which the automobile can better be adapted so that it becomes more harmonious with our primarily urban style of life.

Present indications are that our future transportation will consist of independently powered vehicles which can be individually (manually) controlled as at present, but capable also of travelling more or less synchronously on automated guideways.

Three basic control systems are currently being investigated by the US Dept. of Transportation.

Central control – in which each vehicle's position and velocity is determined by a central computer which receives data from the vehicle itself – or from wayside sensors. Velocity commands are then sent at regular intervals to each vehicle. However because of the large number of vehicles involved this does not appear to be a feasible approach.

Incremental local control – A sensor on the vehicle counts distance increments over time and compares the result against a prescribed position/time profile to generate an error signal. A periodic absolute-position signal is used to update the data and thus prevent the accumulation of position errors. (Fig. 6).

Typical of proposed systems of this type is to match the frequency of passing magnetic or electrical discontinuities with a reference clock signal. In effect the vehicle is 'phase-locked' into the guideway.

Local moving wave – This technique involves reading absolute position from a reference wave. A synchronous motor for example would be a direct mechanical implementation of this concept. However to qualify as an absolute position controller, the transformation from rotational to linear motion must be exact – as through a rack and pinion drive. (Fig. 7)

An alternative method involves a moving information wave which gives the vehicle a direct indication of its relative position error at all times. This is equivalent to reading the position from a fixed wayside marker. By presenting the information as a wave, a time and position reference is provided. The vehicle then follows the null point of one of the wave cycles as it moves down the track at prescribed speed. (Fig. 8).

Extraordinary precautions are being considered to reduce accident rates to a very low figure. The current target is that personal injuries should not exceed 1.86 per million vehicle/miles – and fatalities should not exceed 0.2 per million vehicle/miles.

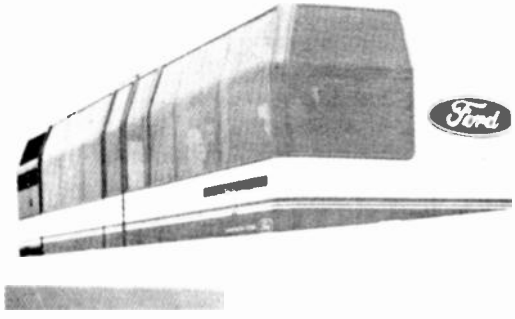
Automated guideways systems may also be co-ordinated with, or backed up by, Personal Rapid Transport (PRT) systems.

Common to most PRT systems is the concept of small independently powered vehicles travelling along controlled guideways. In use a passenger enters an individual module, programs his destination and is then taken directly to that destination. Speed and switching are controlled by computer, which also controls distances between vehicles. The result is personal transportation from origin to destination but which at peak travelling times may be shared with other people going to the same destination.

It is significant that one of the many major organisations actively developing PRT systems is the Ford motor company.

Concepts such as these may seem unreal in light of the relatively minor role that electronics plays in present day automobiles.

But in automobile engineering – as in so many other fields – we are faced with problems of ever-increasing magnitude that can only satisfactorily be solved by the use of electronic and related technologies. It seems probable that they will be. ●



In USA, Ford have developed this electrically propelled, computer controlled transport system.

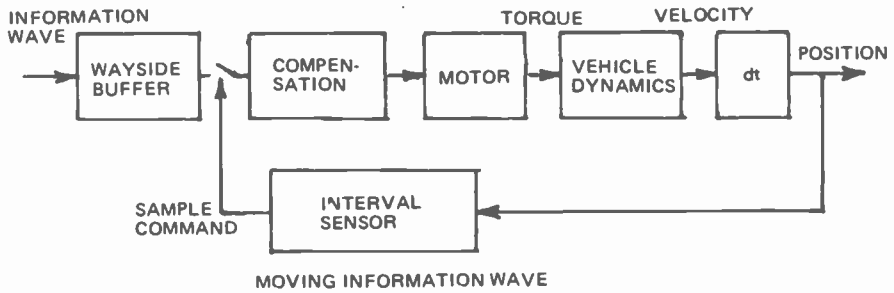


Fig. 8 Moving information wave.

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PART 9

TRANSDUCERS IN MEASUREMENT AND CONTROL

Dr Sydenham describes the various methods used for measuring moisture.

KNOWING the water content of a substance is often of vital importance. In paper and board making, the moisture content of the pulp must be controlled; storage of valuable art objects and books demands humidity control of the environment; in the manufacture of synthetic textiles the air must be moist to prevent static electricity building up; personal comfort depends much upon the moisture present in the air.

In some areas of research it is necessary to monitor humidity in order that instruments are operated safely, for few are designed to work in saturated air. The laser interferometer method described in a previous article requires correction for the humidity of the radiation path if accurate length measurements are to be obtained. In wheat milling, moisture content is important for it largely controls the amount of insufficiently ground grain that must be sold as reject material. The growth of plants depends upon the moisture content of the soil, plant and atmosphere.

In the study of radio propagation, it is necessary to determine rainfall and its droplet size distribution, for rain alters transmission significantly. Drops of rain impacting on a surface can cause erosion by impact and cavitation effects. In instances such as soil or structure erosion, the amount and size distribution of the drops is important. This article deals with the techniques used to transduce water content data such as these into more convenient signals which are usually but not exclusively of electric form.

DEFINITIONS OF WATER CONTENT

Many definitions of water content exist, and it is necessary to have a basic understanding of these in order to comprehend the techniques employed to monitor it.

Moisture can occur mixed with other carrier gases, as found in the atmosphere, or it may be of interest when combined with solids to form a substance such as paper pulp.

In 1801, John Dalton, a British chemist, formulated Daltons law which states that the total pressure of a mixture of gases (or vapours) is equal to the sum of the pressures of each constituent gas if it occupied the same volume by itself. These individual pressure values are called the partial pressures. He also speculated that all gases would liquify if the temperature were sufficiently low. Consequently from this, we can see that if a gas containing water vapour is cooled, there comes a point where water commences to liquify or condense out. This temperature is the DEW POINT: it occurs where the vapour is 100% saturated with water. The greater the water content, the sooner the water condenses as the temperature is lowered. Unless the temperature is raised, the gas will take in no more water in vapour form. The same concept can also be compared with the state change to ice (the solid phase of water) instead of liquid: this is known as the FROST POINT. These two points each define the partial pressure of the water vapour but not in a single manner. Various institutions such as the Smithsonian Institution in the United States (see reading list) publish tables enabling the water vapour content to be assessed if the dew or frost points are known.

If the partial pressure is known, then the numerical value of any other definition of humidity can be obtained.

Other definitions commonly encountered are –

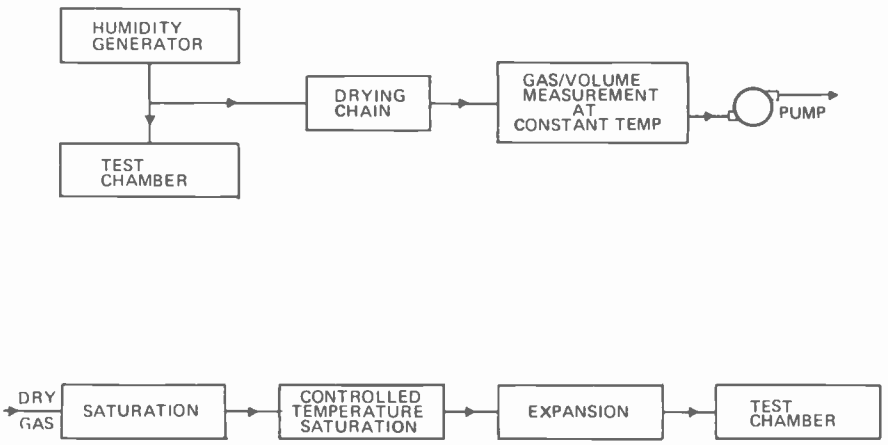
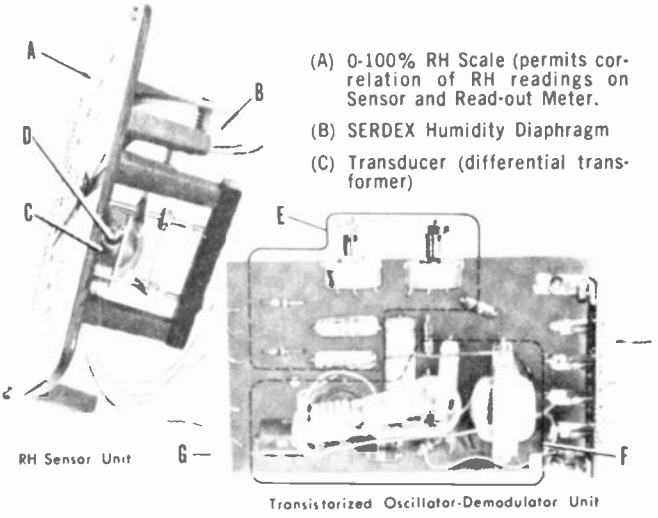


Fig. 1. Layout of the calibration standards for humidity.
a) gravimetric determination of moisture content (the absolute standard).
b) two pressure humidity generator (the transfer standard).



(A) 0-100% RH Scale (permits correlation of RH readings on Sensor and Read-out Meter.
(B) SERDEX Humidity Diaphragm
(C) Transducer (differential transformer)
(D) Transformer Core
(E) Differential Demodulator
(F) Temperature Stabilized Oscillator (approx. 4 kc.)
(G) Printed Circuit Board

Fig. 2. Operation of this SERDEX humidity sensor is based upon a hygroscopic animal membrane forming a diaphragm.

RELATIVE HUMIDITY, RH for short – this expresses the amount of water vapour present, compared with the maximum that could be at the temperature of interest. (The quantity of water vapour present would only apply for a stated temperature). RH is expressed as a percentage. For example, a dry day in the summer could be as low as 20% whereas when it is actually raining, it rises to 100%. The need for this relative unit occurs because many processes do not depend upon the absolute water content, but on the amount that could be absorbed or liberated from the air. RH is probably the most commonly used unit outside of process control areas.

PARTS PER MILLION, PPM – this expresses the water content by virtue of the weight of water, PPM_W or its volume, PPM_V, so it is either the ratio of the partial pressure of the water vapour to the total pressure, or else the PPM_V value multiplied by the ratio of the molecular weights of water to the other gas to yield the first value. Care is needed to define which is intended, for both units are dimensionless, and appear the same unless qualified with a (by weight) or (by volume) statement.

WET BULB TEMPERATURE (no accepted abbreviation exists) – if a thermometer has its sensing area wetted with water (usually with a saturated wick) and air is passed rapidly over it, the thermometer reads a value less than that of an identical dry thermometer by an amount depending upon the relative humidity. If the air is 100% saturated, no more moisture can be taken up so the bulb is not cooled at all. (The same reason is why evaporative air coolers do not give as much cooling in humid weather). This concept is used in the wet-and-dry bulb hygrometer.

MIXING RATIO – the ratio of weight of water vapour to dry carrier gas.

POUNDS/KILOGRAMS PER HOUR – this expresses the absolute amount of water vapour supplied per hour. For example, heat treatment of metals requires knowledge of the water content in the furnace as this controls the carburizing process reaction rate.

RELATIVE EQUILIBRIUM MOISTURE (rem or em) – in the paper industry, it is the ability of the fibres to lose or absorb water (the sorption process) that decides the shrinkage, tearability, etc. Equilibrium will eventually occur between the air humidity and the paper content. To make it clear that it is the paper moisture content that is stated, em is quoted. Hence a lower em than RH means the paper takes in moisture.

LIMITATIONS OF DEW POINT MEASUREMENT

Not all moisture measurements make direct use of the dew point phenomena but it is instructive to consider the limitations of the process for the effects are present in most procedures.

THE KELVIN EFFECT – In 1870, Lord Kelvin arrived at the conclusion that the vapour pressure over a concave liquid surface is less than that over a plane surface of the same material. Water condensing on a surface forms droplets which produce a curved interface surface with the surrounding vapour. It has not been an easy matter to prove Kelvin's theory, for the effect is small, but convincing electron microscope studies of evaporating lead, carried out at Imperial College in London, have shown it to be true for lead and gold. The Cambridge Systems Company of Massachusetts have estimated the depression in dew point temperature due to 30 μm dropsize condensation as 0.005K. Few people would find the Kelvin effect error a problem.

THE RAOULT EFFECT – In 1887 Raoult produced a law governing the

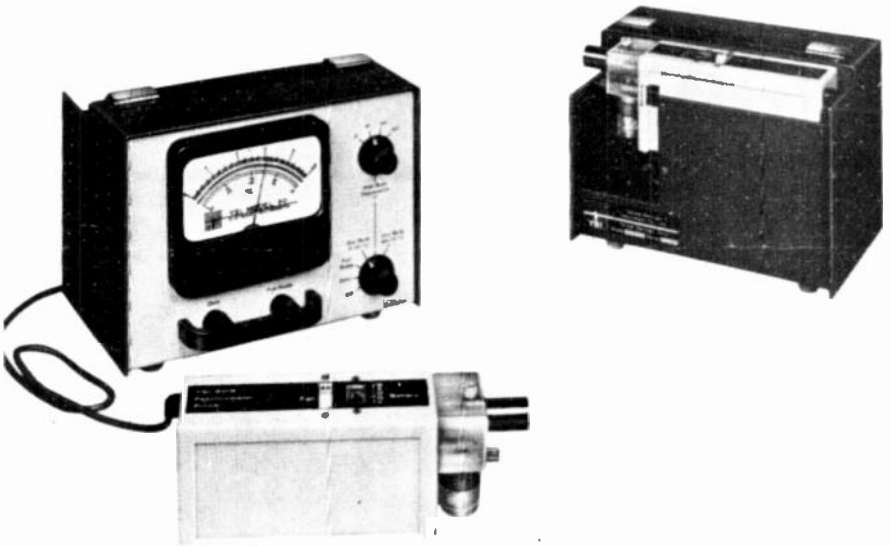


Fig. 3. The Yellow Springs Instrument Co. aspirated psychrometer. The righthand view shows the unit packed for transportation. Thermistors are used as temperature sensors.

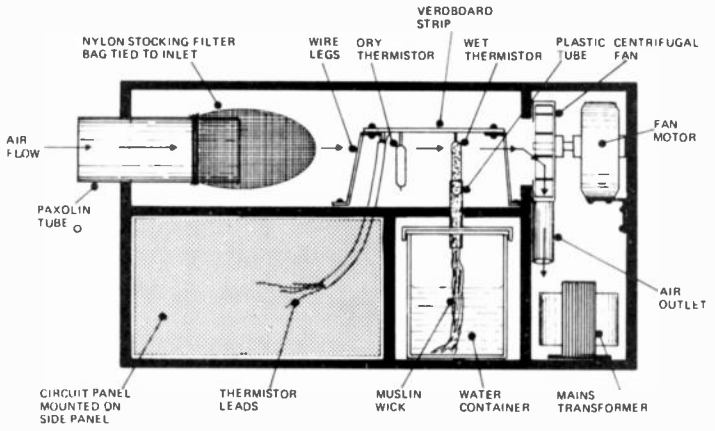


Fig. 4. Inside layout of an aspirated wet-and-dry bulb hygrometer which uses computing circuitry to produce a RH output.

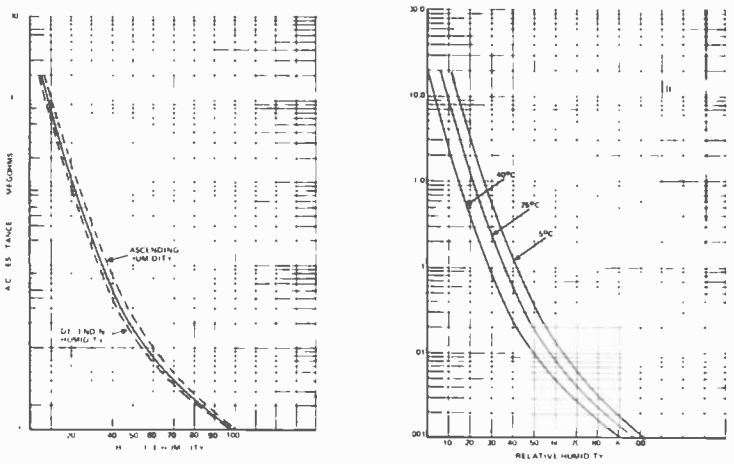


Fig. 5. Performance curves for the Warren Components Corporation humidity sensing element.
a) these curves show the lag error depending on the direction of approach to a value.
b) here are shown curves of resistance variation with humidity. Note the shift due to temperature and the slope away from a truly logarithmic response at high RH.

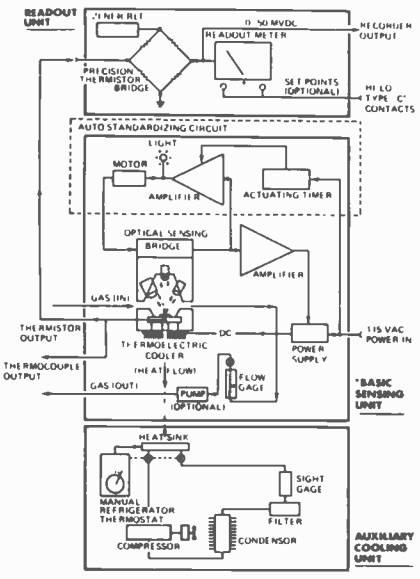
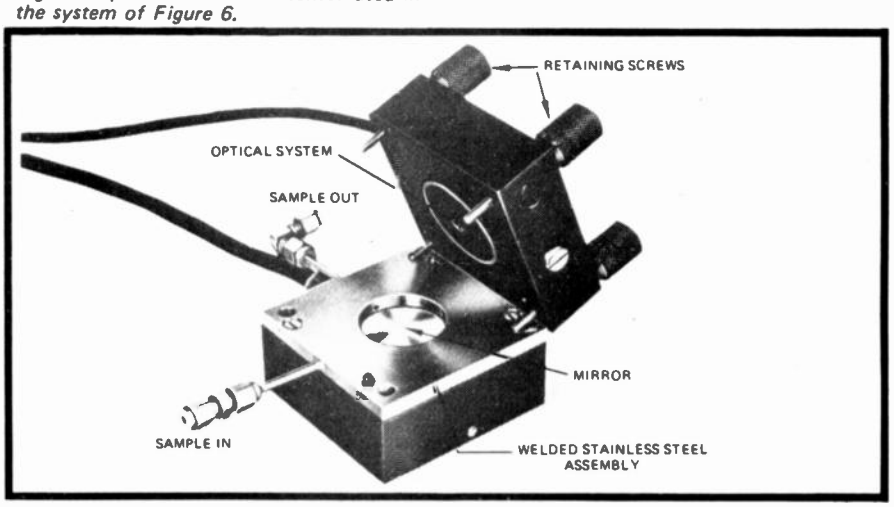


Fig. 6. System configuration of the Cambridge Systems dew point gas analyser. (The detector is in the centre of the system).

Fig. 7. Exposed view of the sensor used in the system of Figure 6.



effects of impurities on vapour pressures. If contaminants exist upon the dew forming surface, the vapour pressure is decreased. It has been estimated that this produces an error equal but opposite in sign to the Kelvin effect error if the same surface with its 30μm drops is contaminated with a 10 molecule thick salt layer. These errors are random so they will not necessarily cancel. The Raoult error is reduced if there is more water on the surface diluting the impurity. As we shall see later, this heavy dew operation can be achieved by simple adjustment in dewpoint measuring methods so is preferred in exacting applications.

THERMAL MEASUREMENT ERRORS – the determination of dew point involves temperature measurement so this also needs to be of adequate accuracy. The two previous parts of this series dealt with temperature measurement so it is only necessary to reiterate that errors due to sensor calibration, heat loss and gain due to mounting thermal conductivities need consideration if accurate results are to be obtained. Generally, thermal measurements limit the precision of dew point devices.

STANDARDS AND CALIBRATION

The standard used to calibrate moisture determing instruments is called a gravimetric hygrometer. This uses a procedure, shown in Fig. 1a, whereby the water vapour is absorbed in chemicals, leaving only the carrier gas – which is weighed with great precision. The process has greater accuracy than other methods (as it should have, being the standard) but is bulky and time consuming requiring many hours to make a determination.

A second, less accurate device, known as a two pressure humidity generator, (see Fig. 1b), is used as a transfer standard (its value is set in relation to the standard hygrometric method and can be used to test many instruments

before needing recalibration). In this method a dry gas is saturated and then passed into a superior controlled system where the saturation is ensured by using temperature control of the vapour. It is then passed into an expanding chamber where the device to be tested is housed. The degree of expansion decides the vapour pressure of the water. In field or factory use, neither of these is satisfactory due to size, cost and time factors. Instead a substandard, preferably a dew point device, is used which, (if warranted) is calibrated by a standards laboratory. The wet-dry bulb method is sub-standard (in order of standards hierarchy) to the dew point methods, the tables used with it having been derived from dew point data.

A simple method to produce a test environment is to inject a known amount of water into a known volume evacuated chamber. Dry inert gas is then introduced to provide the pressure needed. This idea has been used at the von Karman Gas Dynamics Facility in the United States to provide a calibration accurate to a dew point error of ± 0.8K. This is not as accurate as the ultimate standard methods but does suffice to check and intercompare most daily-used techniques.

Gravimetric equipment is capable of dew point determinations to about 0.01K, the two pressure generator to 0.06K and the dew point method to 0.25K. Other methods are generally inferior, but each must be considered, for the specific application may render accurate methods inaccurate due to peculiar factors.

MEASUREMENT OF HUMIDITY

With this background, it is now possible to discuss actual techniques.

HYGROSCOPIC MEMBRANES AND HAIRS

The least scientific but easiest principle to employ makes use of the fact that some organic materials alter dimension with changing moisture content. Human hair, for instance, is used in laboratory clockwork driven humidity recorders. It extends some 3% for the change from zero to maximum water content. Several commercial instruments use the movement produced to drive a microdisplacement transducer thereby providing an electrical signal – one unit, shown in Fig. 2, uses an inductive solenoidal transducer; another, a strain gauge placed on a driven mechanical member of the linkage operating the indicator pointer. Such devices could be expected to work to a few percent RH accuracy only and it is recommended that they be used only in the range 15–90% RH and in the temperature range 1–40°C. Their operation is prone to stiction effects and somewhat erratic response is experienced. They also need cross calibration to a more fundamental method.

WET-AND-DRY BULB PROCEDURES

The simplest wet-and-dry bulb hygrometer consists of two mercury thermometers in a frame, with the bulb of one covered by a wet muslin sleeve. The evaporative effect is at the mercy of draughts so this static procedure is not very accurate. Dew point temperatures are not achieved on the wet bulb. Rough estimates can be made of the dew point using Glaishers factor (which varies with the temperature) but for best work standard tables and charts are used.

A better arrangement is to cause the atmosphere to pass over the wick at high speed. As the surface velocity is increased, the cooling effect falls off as the air velocity is increased, and at around 30m/min there is little to be gained by it going faster. The obvious development step, therefore, was to whirl the two thermometers. Devices made this way are called whirling or sling psychrometers. (The grand name is applied without real distinction to the term hygrometer). One maker supplies a unit with a built-in slide rule scale that gives RH directly from the wet and dry readings taken after three minutes of rotation. In general, it is necessary to use the charts. Where electrical signals are needed or where the delicate glass thermometers need to be omitted, other methods are used.

As it is the relative wind speed that matters, it is easier in wet-and-dry instruments to aspirate the two thermometers by driving the air over them using a fan. The Assman psychrometer uses a clockwork or electrically driven fan to do this. This form of instrument is amenable to automation by replacing the mercury thermometers with proportional readout electrical sensors. Commercial units are available that aspirate thermistor sensors, (see Fig. 3), reading wet bulb depression directly.

It is still necessary, however, to resort to tables to obtain values of RH and other units with these. In 1969, 'Wireless World' reported a design that went one stage further. An inside view of the device is given in Fig. 4. The thermistor resistance variations were firstly linearized and then combined in an operational amplifier arrangement to yield a direct linear scale of RH to ± 5% accuracy. It has several short-comings, namely not being useful near freezing point temperatures (as is the case with all wick-type devices) and at low RH values. It does, however, show that a direct reading aspirated wet-and-dry bulb method can yield RH values without the need to use tables making it useful in automatic control or recording applications.

RESISTIVITY AND CAPACITIVE METHODS

The resistance between electrodes connected to a moist substance such as paper or soil is a measure of the moisture content. On paper making machines, wiping fingers have been used; in soil, electrodes embedded in a plaster block have been suggested. The variation of resistance with moisture content is roughly logarithmic but the actual value depends much upon contaminants and salts in solution that produce electrolyte. The use of ac measuring techniques is superior as this eliminates the electrolytic effect.

Evaporated grid sensors (gold fingers interleaved over an inert substrate) are made in which resistivity varies. Akin to this is the Warren sensor which consists of a special plastic backing having a humidity sensitive conducting plastic grid on the surface. Again the response is logarithmic and a small temperature coefficient and hysteresis effect exists – as Fig. 5 shows. The

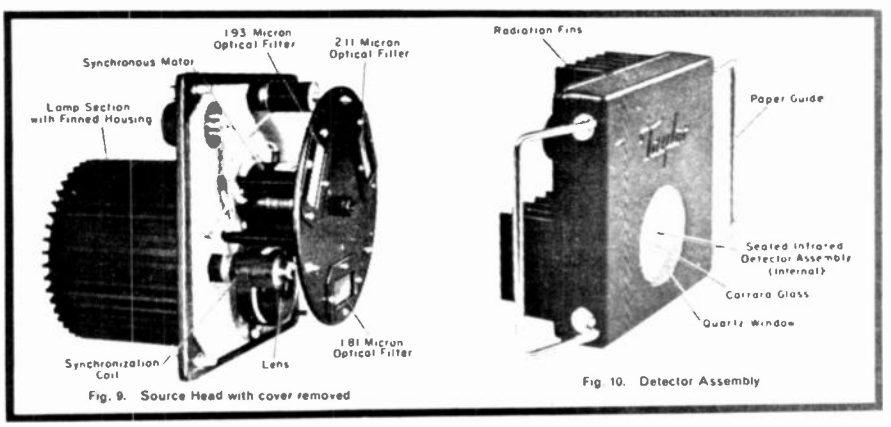


Fig. 8. Source head and detector assembly of the Taylor infra-red moisture gauge.

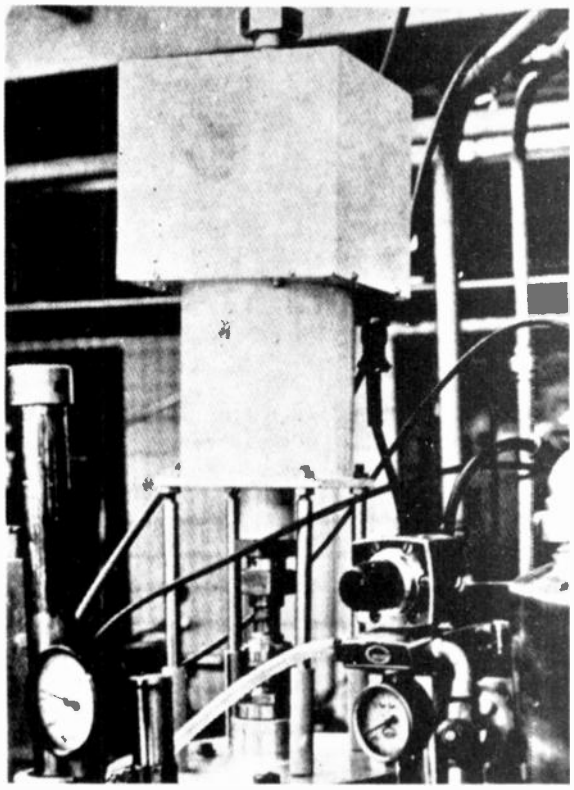


Fig. 9. Microwave moisture meter (Skandinaviska Processinstrument AB, Sweden) mounted in line for monitoring of moisture of materials flowing in tubes.

Dunmore sensor (originated in the 1930's) is made as two wire spirals forming electrodes on a former which is coated with lithium chloride.

Changes in capacitance also can be utilised. Simple sensors use plates separated by the medium of interest to form a capacitor. Differential arrangements assist in reducing errors. For air humidity sensing, a sensor has been made from porous anodized aluminium strip, coated each side with gold layer electrodes. This acts as an aluminium oxide capacitor in which moisture diffuses into the pores.

Although a simple matter to measure the resistance changes and display them on a calibrated non-linear scale meter, it does not yield dew point nor give a linear scale. The overall accuracy of an instrument using these detectors can be improved if the humidity sensor is used only as an error detector of dew point.

DEW POINT DETECTORS

The most obvious way to detect the appearance (or disappearance) of moisture is to optically monitor the reflectance of a mirror surface. Several devices do just this. Simple instruments are manually observed. A mercury thermometer is placed in a heat conducting block having a mirror surface. Cooling is applied uniformly with ice or ether to the block as the air is aspirated across the mirror. The temperature, when mist occurs, is the dew point. (In practice, a rough run is made first, with a second slower rate taken as the system heats up to loose the condensate.) Improved designs are still being reported in the scientific literature. They are inexpensive and accurate to 1K.

Automation has been achieved by viewing the reflected light with a photo resistor. One system using this is shown in Figs. 6 and 7. A stainless steel mirror is cooled by a thermoelectric Peltier cell until reflectance drops as the condensate forms. It is then temperature servoed to track a constant reflectance situation. The block temperature is held at the dew point of the gas passing over it. Temperature is transduced by thermistor or thermocouple in the unit shown. By altering the level of the reflectance signal, it is possible to operate with a heavy dew reducing the Roault errors. A precision instrument is actually more sophisticated in its peripherals, as can be seen in Fig. 6.

Resistance and capacitance sensors can also detect the presence or not of moisture, and many dew point meters use them instead of the optical method, for there is a sharp transition when the condensate is boiled off as the element is heated.

Where size is vital, the Spanner method (after D.C. Spanner in 1951) can be used. This uses two thermocouple junctions, one dry, the other in the active environment. The generated voltage is read for the dry unit. It is then used as a Peltier junction, cooling it for a timed interval. Water condenses upon it. The circuit is then switched back to measuring: the voltage measured is related to dew point. The principle has been used by many people since 1951. The procedure has been largely automated. The low cost of the sensors makes the method very applicable in field studies of soil-plant-water relationships where many tens of measurements are needed. A single cyclic switching and interogating unit is used to operate the sensors in turn.

HYDROLYSIS

A thin film of phosphorous pentoxide, held between noble metal electrodes, absorbs the moisture of the sampled gas as it flows through. A dc voltage across the electrodes breaks the water down into hydrogen and oxygen. The electrolysis current flowing is a measure of moisture content and will cover ranges from 0–100 to 0–10,000 parts per million with about 5% accuracy of the full scale setting chosen.

ENERGY ABSORPTION METHODS

Gas molecules absorb electromagnetic radiation in a selective manner. Water vapour attenuates energy in the region of 3–6 μm wavelength (infra red). Microwave frequencies in the region of 100 to 4000 MHz are also strongly attenuated by moisture vapour.

In both cases, the same idea is applied. A source of the radiation (a tungsten lamp for IR work or solid-state low-power microwave sources) is viewed by a sensor through the gas. Measuring the difference between the ideal signal and the absorption signal enables the loss to be determined, and hence the moisture content. In the IR instrument, the difference may be obtained by rotating a filter wheel so that the detector sees the source through the sampling cell – first with a bandpass optical filter and then with a selective absorption band filter. Another method, shown in Figure 8, sequentially applies three (two have been used also) IR sources (the same tungsten-halogen broadband lamp but with different narrow band-pass filters to select wavelengths needed) to radiate through the gas stream onto a lead sulphide detector. This provides three levels of signal which can be combined and processed to give the moisture content in the required units.

Most microwave devices operate by monitoring the amplitude loss as it is easier to measure attenuation, and experience in such measurements is commonplace. The use of phase shift effects instead is relatively new, but at

the Royal Institute of Technology in Stockholm whose unit is shown in Fig. 9, a number of these (which measure dielectric effects) have been built proving their feasibility.

INSTALLATION OF MOISTURE MEASURING DEVICES

Many instruments are operated to continuously provide moisture measurement. Where the through volume is large a sampling line is bled off to feed the detector. This line may introduce errors by contaminating the input gas with leaks or chemical reaction or more likely by condensing moisture out of the gas. The line temperature must never drop below the dew point so heated lines may be needed. Fig. 10 is a schematic layout of a sampling system recommended by Cambridge Systems. Filters may be needed to remove solid contaminants but usually dew point meters include these. Flow meters are vital in order to know the amount of gas sampled. Teflon or stainless steel tubing are used for they are non-hygroscopic.

If the hygrometer is multiplexed between a number of lines, problems can occur due to the time taken for the materials of the lines to lose the absorbed moisture. The lower the dew point value, the longer it takes to purge the lines so switching between widely differing samples will have a restricted response. For example, a poor line (nylon for instance) takes several hours to re-establish equilibrium. Lines are usually purged clean with dry air or nitrogen before use. Freon 114 is an excellent solvent gas to use.

RAINFALL

It has become necessary to use higher frequencies (10–30GHz) in communication links to gain more bandwidth. Unfortunately, at these wavelengths, rain can seriously attenuate signals, so the major laboratories (Bell Telephone and the British Post Office, for example) have research programmes going to investigate this. One of their first problems was to produce continuously recording rain gauges, for the manually-read weather station rain gauge only gives values integrated over long time intervals.

The Bell system makes use of the fact that rainwater has a high dielectric constant. A collecting area gathers rain, funneling it into a narrow run-off channel. Inserted in the channel are

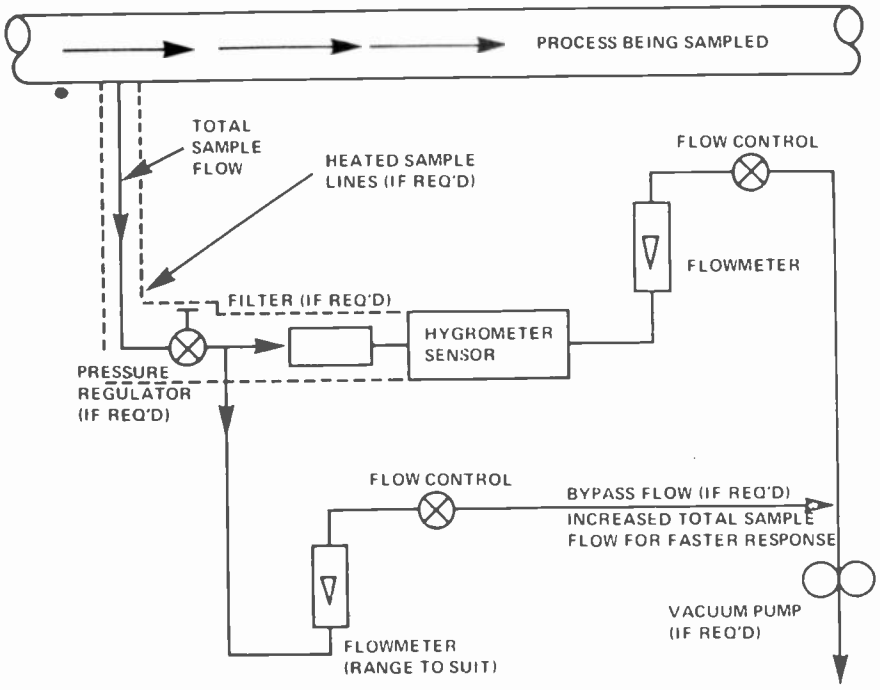


Fig. 10. Components and layout of a moisture sampling system.

electrodes which are 'normally separated by air. When rain spills down the chute, the dielectric constant between the plates change (in proportion to the amount flowing) and this is used to alter the capacitance of an R-C oscillator. The output appears as a frequency deviating signal. The Bell company placed 96 of these units over a 50 square mile area and telemetered the data back to a central recording unit. The data was processed to produce isometric plots of the rainfall, as shown in Fig. 11. It was then correlated with the signal loss of microwave tranmissions.

The British groups (Post Office Research Department and the Radio and Space Research Station) recently reported another technique. The collected rain-water is fed, (see Fig. 12), to a 3 mm internal-diameter tube where it drips through as constant size (but varying rate) drops. The falling drops are detected with a simple photo transistor light interruption sensor. A digital unit telemetry link is used to send an 8 bit binary code of the drop rate to the processing centre.

RAIN DROP SIZE DISTRIBUTION

In many instances where rain fall is measured, it is necessary to know more than just the amount of water precipitated. For a number of reasons – (erosion being the most general need, for the droplets can damage a surface – soil for instance is eroded by impact and washing,) the research worker needs to obtain data on the nature of rainfall. Drop sizing and distribution (rain spectra) is a recurring measurement problem. As early as 1904 a simple method of flour balling was used (flour encases the drop as it falls into it). High speed photographic methods have been reported regularly. The advent of electronics enabled drops to be monitored faster and more accurately. The list of methods is extensive.

A recently reported development by staff of the I.I.T. Research Institute in Chicago, uses a television scanning arrangement to count and size the droplets as they pass a viewing area. The drops are virtually frozen by using a rapid flash of a xenon lamp to illuminate them in front of a vidicon tube. During this period, the scene is scanned and line data stored. The video signal is then processed to decide the quantity of drops and their size distribution and these data are printed out using a number of channels. To routinely test the instrument, slides which have drop cross-sections on them, can be inserted in the optical space.

For best performance assessment, water sprays and falling glass beads were used whose distribution had been proven by independant methods. In one method a belt of sensitized paper was moved past a test slit. Drop imprints on the paper through the slit were made permanent by exposure to ammonia fumes. The method is similar to many sizing systems now in use (blood cell and leaf area came to

(continued on page 75)

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AC117K	0·20		0·85	BC151	0·20	BD140	0·60	BF196	0·14	OC23	0·42	2G374	0·17	2N2222	0·20	2N3391A	0·16	2N4062	0·12
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AC125	0·17	AF114	0·24	BC153	0·28	BD175	0·60	BF200	0·45	OC25	0·38	2G378	0·16	2N2369	0·14	2N3393	0·14	2N4285	0·17
AC126	0·17	AF115	0·24	BC154	0·30	BD176	0·80	BF222	0·95	OC26	0·25	2G381	0·16	2N2369A	0·14	2N3394	0·14	2N4286	0·17
AC127	0·17	AF116	0·24	BC157	0·18	BD177	0·65	BF257	0·45	OC28	0·50	2G382	0·16	2N2411	0·24	2N3395	0·17	2N4287	0·17
AC128	0·17	AF117	0·24	BC158	0·12	BD178	0·65	BF258	0·60	OC29	0·50	2G401	0·30	2N2412	0·24	2N3402	0·21	2N4288	0·17
AC132	0·14	AF118	0·35	BC159	0·12	BD179	0·70	BF259	0·55	OC35	0·42	2G414	0·30	2N2646	0·47	2N3403	0·21	2N4289	0·17
AC134	0·14	AF124	0·30	BC160	0·45	BD180	0·70	BF262	0·55	OC36	0·50	2G417	0·25	2N2711	0·21	2N3404	0·28	2N4290	0·17
AC137	0·14	AF125	0·25	BC161	0·50	BD185	0·65	BF263	0·55	OC41	0·20	2N388	0·35	2N2712	0·21	2N3405	0·42	2N4291	0·17
AC141	0·14	AF126	0·28	BC167	0·12	BD186	0·65	BF270	0·35	OC42	0·24	2N388A	0·55	2N2714	0·21	2N3414	0·15	2N4292	0·17
AC141K	0·17	AF127	0·28	BC168	0·12	BD187	0·70	BF271	0·30	OC44	0·15	2N404	0·20	2N2904	0·17	2N3415	0·15	2N4293	0·17
AC142	0·14	AF139	0·30	BC169	0·12	BD188	0·70	BF272	0·80	OC45	0·12	2N404A	0·28	2N2904A	0·21	2N3416	0·28	2N5172	0·12
AC142K	0·17	AF178	0·50	BC170	0·12	BD189	0·75	BF273	0·35	OC70	0·10	2N524	0·42	2N2905	0·21	2N3417	0·28	2N5457	0·32
AC151	0·15	AF179	0·50	BC171	0·14	BD190	0·75	BF274	0·35	OC71	0·10	2N527	0·49	2N2905A	0·21	2N3525	0·75	2N5458	0·32
AC153	0·20	AF180	0·50	BC172	0·14	BD195	0·85	BFW10	0·60	OC72	0·14	2N598	0·42	2N2906	0·15	2N3646	0·09	2N5459	0·40
AC153K	0·20	AF181	0·45	BC173	0·14	BD196	0·85	BFX29	0·27	OC74	0·14	2N599	0·45	2N2906A	0·18	2N3702	0·10	28301	0·50
AC156	0·20	AF186	0·45	BC174	0·14	BD197	0·90	BFX84	0·22	OC75	0·15	2N696	0·12	2N2907	0·20	2N3703	0·10	28302A	0·42
AC157	0·24	AF239	0·37	BC175	0·22	BD198	0·90	BFX85	0·30	OC76	0·15	2N697	0·13	2N2907A	0·22	2N3704	0·11	28303	0·42
AC165	0·20	AL102	0·55	BC177	0·19	BD199	0·95	BFX86	0·22	OC77	0·25	2N698	0·24	2N2923	0·14	2N3705	0·10	28303	0·55
AC166	0·20	AL103	0·55	BC178	0·19	BD200	0·95	BFX87	0·24	OC81	0·15	2N699	0·35	2N2924	0·14	2N3706	0·09	28304	0·70
AC167	0·20	A8Y26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N706	0·08	2N2925	0·14	2N3707	0·11	28305	0·84
AC168	0·24	A8Y27	0·30	BC180	0·24	BD206	0·80	BFY50	0·20	OC82	0·15	2N706A	0·09	2N2926 (G)		2N3708	0·07	28306	0·84
AC169	0·14	A8Y28	0·25	BC181	0·24	BD207	0·95	BFY51	0·20	OC82D	0·15	2N708	0·12	0·12		2N3709	0·09	28307	0·84
AC176	0·20	A8Y29	0·25	BC182	0·10	BD208	0·95	BFY52	0·20	OC83	0·20	2N711	0·30	2N2926 (Y)		2N3710	0·09	28321	0·56
AC177	0·24	A8Y50	0·25	BC182L	0·10	BDY20	1·00	BFY53	0·17	OC84	0·20	2N717	0·35	0·11		2N3711	0·09	28322	0·42
AC178	0·23	A8Y51	0·25	BC183	0·10	BF115	0·24	BFX25	0·85	OC139	0·20	2N718	0·24	2N2926 (O)		2N3819	0·28	28322A	0·42
AC179	0·28	A8Y52	0·25	BC183L	0·10	BF117	0·45	B8X19	0·15	OC140	0·20	2N718A	0·50	0·10		2N3820	0·50	28323	0·56
AC180	0·17	A8Y54	0·25	BC184	0·12	BF118	0·70	B8X20	0·15	OC169	0·25	2N726	0·28	2N2926 (R)		2N3821	0·35	28324	0·70
AC180K	0·20	A8Y55	0·25	BC184L	0·12	BF119	0·70	B8Y25	0·15	OC170	0·25	2N727	0·28	0·10		2N3823	0·28	28325	0·70
AC181	0·17	A8Y56	0·25	BC186	0·28	BF121	0·45	B8Y26	0·15	OC171	0·25	2N743	0·20	2N2926 (B)		2N3903	0·28	28326	0·70
AC181K	0·20	A8Y57	0·25	BC187	0·28	BF123	0·50	B8Y27	0·15	OC200	0·25	2N744	0·20	0·10		2N3904	0·30	28327	0·70
AC187	0·28	A8Y58	0·25	BC207	0·11	BF125	0·45	B8Y28	0·15	OC201	0·28	2N914	0·14	2N3010	0·70	2N3905	0·28	28701	0·42
AC187K	0·20	A8Z21	0·40	BC208	0·11	BF127	0·50	B8Y29	0·15	OC202	0·28	2N918	0·30	2N3011	0·14	2N3906	0·27	40361	0·40
AC188	0·22	BC107	0·09	BC209	0·12	BF152	0·55	B8Y38	0·18	OC203	0·25	2N929	0·21	2N3053	0·17	2N4058	0·12	40362	0·45
AC188K	0·20	BC108	0·09	BC212L	0·11	BF153	0·45	B8Y39	0·18	OC204	0·25	2N930	0·21						
ACY17	0·25	BC109	0·10	BC213L	0·11	BF154	0·45	B8Y40	0·28	OC205	0·35	2N1131	0·20						
ACY18	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	B8Y41	0·28	OC209	0·40	2N1132	0·22						
ACY19	0·20	BC114	0·15	BC225	0·25	BF156	0·48	B8Y95	0·12	P346A	0·20	2N1302	0·14						
ACY20	0·20	BC115	0·15	BC226	0·35	BF157	0·55	B8Y95A	0·12	P397	0·42	2N1303	0·14						
ACY21	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	OCP71	0·43	2N1304	0·17						
ACY22	0·16	BC117	0·15	BCY31	0·26	BF159	0·60	C111E	0·50	ORP12	0·43	2N1305	0·17						
ACY27	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	C400	0·30	ORP60	0·40	2N1306	0·21						
ACY28	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	C407	0·25	ORP61	0·40	2N1307	0·21						
ACY29	0·35	BC120	0·80	BCY34	0·25	BF163	0·40	C424	0·20	ST140	0·12	2N1308	0·23						
ACY30	0·28	BC125	0·12	BCY70	0·14	BF164	0·40	C425	0·50	ST141	0·17	2N1309	0·23						
ACY31	0·28	BC126	0·18	BCY71	0·18	BF165	0·40	C426	0·35	T1843	0·30	2N1613	0·20						
ACY34	0·21	BC132	0·12	BCY72	0·14	BF167	0·22	C428	0·20	UT46	0·27	2N1711	0·20						
ACY35	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	C441	0·30	2G301	0·09	2N1889	0·32						
ACY36	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	C442	0·30	2G302	0·19	2N1890	0·45						
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	C444	0·35	2G303	0·19	2N1893	0·37						
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·30	C450	0·22	2G304	0·24	2N2147	0·72						
ACY44	0·35	BC139	0·40	BD123	0·65	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57						
AD130	0·38	BC140	0·30	BD124	0·60	BF180	0·30	MAT101	0·20	2G308	0·35	2N2160	0·60						
AD140	0·48	BC141	0·30	BD131	0·50	BF181	0·30	MAT120	0·19	2G309	0·35	2N2192	0·35						
AD142	0·43	BC142	0·30	BD132	0·60	BF182	0·40	MAT121	0·20	2G339	0·20	2N2193	0·35						
AD143	0·38	BC143	0·30	BD133	0·65	BF183	0·40	MPF102	0·42	2G339A	0·16	2N2194	0·35						
AD149	0·50	BC145	0·45	BD135	0·40	BF184	0·25	MPF104	0·37	2G344	0·18	2N2217	0·22						
AD161	0·33	BC147	0·10	BD136	0·40	BF185	0·30	MPF105	0·37	2G345	0·16	2N2218	0·20						

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BA126	0·22	BYZ13	0·28	OA91	0·06
BA148	0·14	BYZ16	0·40	OA95	0·07
BA154	0·12	BYZ17	0·35	OA200	0·06
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BY105	0·17		0·5	IN34A	0·07
BY114	0·12	CG631		IN914	0·06
BY126	0·14	(Eq) OA70·		IN916	0·06
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U 4	40	Germanium Transistors like OC81, AC128	0·50
U 5	60	200mA Sub-Min. Silicon Diodes	0·50
U 6	30	Sil. Planar Trans. NPN like BSY95A, 2N706	0·50
U 7	16	Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0·50
U 8	50	Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·50
U 9	20	Mixed Voltages, 1 Watt Zener Diodes	0·50
U10	20	BAY50 charge storage Diodes DO-7 Glass	0·50
U11	25	PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·50
U12	12	Silicon Rectifiers Epoxy 500mA up to 800 PIV.	0·50
U13	30	PNP-NPN Sil. Transistors OC200 & 2S 104	0·50
U14	150	Mixed Silicon and Germanium Diodes	0·50
U15	25	NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0·50
U16	10	3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0·50
U17	30	Germanium PNP AF Transistors TO-5 like ACY 17-22	0·50
U18	8	6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0·50
U19	25	Silicon NPN Transistors like BC108	0·50
U20	12	1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·50
U21	30	AF. Germanium Alloy Transistors 2G300 Series & OC71.	0·50
U23	30	MADT's like MHz Series PNP Transistors	0·50
U24	20	Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·50
U25	25	300 MHz NPN Silicon Transistors 2N708, BSY27	0·50
U26	30	Fast Switching Silicon Diodes like 1N914 Micro-Min.	0·50
U27	12	NPN Germanium AF Transistors TO-1 like AC127	0·50
U29	10	1 Amp SCR's TO-5 can, up to 600 PIV CR81/25-600	1·00
U30	15	Plastic Silicon Planar Trans. NPN 2N2926	0·50
U31	20	Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·50
U32	25	Zener Diodes 400mW DO-7 case 3-18 volts mixed	0·50
U33	15	Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0·50
U34	30	Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	0·50
U35	25	Silicon Planar Transistors PNP TO-18 2N2906	0·50
U36	25	Silicon Planar NPN Transistors TO-5 BFY50,51,52	0·50
U37	30	Silicon Alloy Transistors SO-2 PNP OC200, 2S322	0·50
U38	20	Fast Switching Silicon Trans. NPN MHz 2N3011	0·50
U39	30	RF. Germ. PNP Transistors 2N1303/5 TO-5	0·50
U40	10	Dual Transistors 6 lead TO-5 2N2060	0·50
U41	25	RF Germanium Transistors TO-5, OC45, NKT72	0·50
U42	10	VHF Germanium PNP Transistor TO-1 NKT667, AF117	0·50
U43	25	Sil. Trans. Plastic TO-18 A.F. BC113/114	0·50
U44	20	Sil. Trans. Plastic TO-5 BC115/NPN	0·50
U45	7	3A SCR. TO66 up to 600PIV	1·00

Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

QUALITY TESTED SEMICONDUCTORS

Pak No.			Price 8p
Q1	20	Red spot transistors PNP	0·50
Q2	16	White spot R.F. transistors PNP	0·50
Q3	4	OC 77 type transistors	0·50
Q4	6	Matched transistors OC44/45/81/81D	0·50
Q5	4	OC 75 transistors	0·50
Q6	5	OC 72 transistors	0·50
Q7	4	AC 128 transistors PNP high gain	0·50
Q8	4	AC 126 transistors PNP	0·50
Q9	7	OC 81 type transistors	0·50
Q10	7	OC 71 type transistors	0·50
Q11	2	AC 127/128 Complementary pairs PNP/NPN	0·50
Q12	3	AF 116 type transistors	0·50
Q13	3	AF 117 type transistors	0·50
Q14	3	OC 171 H.F. type transistors	0·50
Q15	7	2N2926 Sil. Epoxy transistors mixed colours	0·50
Q16	2	GET880 low noise Germanium transistors	0·50
Q17	5	NPN 2 × ST.141 & 3 × ST.140	0·50
Q18	4	MADT'S 2 × MAT 100 & 2 × MAT 120	0·50
Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0·50
Q20	4	OC 44 Germanium transistors A.F.	0·50
Q21	4	AC 127 NPN Germanium transistors	0·50
Q22	20	NKT transistors A.F. R.F. coded	0·50
Q23	10	OA 202 Silicon diodes sub-min.	0·50
Q24	8	OA 81 diodes	0·50
Q25	15	1N914 Silicon diodes 75 PIV 75mA	0·50
Q26	8	OA95 Germanium diodes sub-min. IN69	0·50
Q27	2	10A PIV Silicon rectifiers I8425R	0·50
Q28	2	Silicon power rectifiers BYZ 13	0·50
Q29	4	Silicon transistors 2 × 2N698, 1 × 2N697, 1 × 2N698	0·50
Q30	7	Silicon switch transistors 2N706 NPN	0·50
Q31	6	Silicon switch transistors 2N708 NPN	0·50
Q32	3	PNP Silicon transistors 2 × 2N1131, 1 × 2N 1132	0·50
Q33	3	Silicon NPN transistors 2N1711	0·50
Q34	7	Silicon NPN transistors 2N2369, 300MHz (code P397)	0·50
Q35	3	Silicon PNP TO-5, 2 × 2N2904 & 1 × 2N2905	0·50
Q36	7	2N3646 TO-18 plastic 300 MHz NPN	0·50
Q37	3	2N3053 NPN Silicon transistors	0·50
Q38	7	NPN transistors 4 × 2N3703, 3 × 2N3702	0·50

ELECTRONIC SLIDE-RULE
The MK Slide Rule, designed to simplify Electronic calculations features the following scales:— Conversion of Frequency and Wavelength. Calculation of L, C and fo of Tuned Circuits. Reactance and Self-Inductance. Area of Circles. Volume of Cylinders. Resistance of Conductors. Weight of Conductors. Decibel Calculations. Angle Functions. Natural Logs and 'e' Functions. Multiplication and Division. Squaring, Cubing and Square Roots. Conversion of kW and Hp. A must for every electronic engineer and enthusiast. Size: 2 cm. × 4 cm. Complete with case and instructions. Price each: £3·35

NEW LOW PRICE TESTED S.C.R.'s

PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0·23	0·25	0·35	0·35	0·47	0·50	0·83	1·15
100	0·28	0·33	0·47	0·47	0·50	0·58	0·83	1·40
200	0·35	0·37	0·49	0·49	0·57	0·61	0·75	1·80
400	0·43	0·47	0·58	0·58	0·67	0·75	0·93	1·75
600	0·53	0·57	0·68	0·68	0·77	0·97	1·25	—
800	0·63	0·70	0·80	0·80	0·90	1·20	1·50	4·00

SIL. SECTS. TESTED

PIV	300mA	750mA	1A	1·5A	3A	10A	30A
50	0·04	0·05	0·05	0·05	0·07	0·14	0·21	0·60
100	0·04	0·06	0·06	0·06	0·13	0·16	0·23	0·75
200	0·05	0·09	0·08	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·86
800	0·10	0·17	0·11	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·14	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·38	0·57	0·75	—

POWER TRANS BONANZA!

GENERAL PURPOSE GERM. PNP
Coded GP100. BRAND NEW TO-3 CASE. PO88IBLE REPLACE:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. TI3027-3028, 2N250A 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS life 30-170.

PRICE	1-24	25-99	100 up
	43p each	40p each	38p each

SILICON High Voltage 250V NPN
TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.
OUR PRICE EACH:

1-24	25-99	100 up
50p	45p	40p

2N3055
115 WATT SIL POWER NPN 50p EACH.

SILICON 50 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic. BIP 20 PNP. Brand new. VCBO 100/VCEO 50/IC 10A. HFE type 100/fT 3mHZ. OUR PRICE PER PAIR:

1-24 prs. 60p	25-99 prs. 55p	100 prs. 50p

AD161/162 *PNP*
M/P COMP GERM TRANS. OUR LOWEST PRICE OF 55p *PER PAIR*

SILICON PHOTO TRANSISTOR
TO-18 Lens end NPN Sim. to BP × 25 and P21. BRAND NEW. Full data available. Fully guaranteed.

Qty.	1-24	25-99	100 up
Price each	45p	40p	35p

F.E.T.'S

2N3819	35p	2N5458	50p
2N3820	50p	2N5459	40p
2N3821	35p	BFW10	40p
2N3823	30p	MPF105	40p

JUMBO COMPONENT PAKS
MIXED ELECTRONIC COMPONENTS
Exceptionally good value
Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1·50 only.

A LARGE RANGE OF TECHNICAL AND DATA BOOKS ARE NOW AVAILABLE EX. STOCK. SEND FOR FREE LIST.

BI-PAKS NEW COMPONENT SHOP NOW OPEN WITH A WIDE RANGE OF ELECTRONIC COMPONENTS AND ACCESSORIES AT COMPETITIVE PRICES—

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-the lowest prices!

74 Series T.T.L. I.C'S

BI-PAK STILL LOWEST IN PRICE FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

	1	25	100+		1	25	100+		1	25	100+
SN7400	0·15	0·14	0·12	SN7450	0·15	0·14	0·12	SN74123	£2·80	£2·70	£2·60
SN7401	0·15	0·14	0·12	SN7451	0·15	0·14	0·12	SN74141	0·67	0·64	0·58
SN7402	0·15	0·14	0·12	SN7453	0·15	0·14	0·12	SN74145	£1·50	£1·40	£1·30
SN7403	0·15	0·14	0·12	SN7454	0·15	0·14	0·12	SN74150	£3·00	£2·70	£2·50
SN7404	0·15	0·14	0·12	SN7460	0·15	0·14	0·12	SN74151	£1·00	0·95	0·90
SN7405	0·15	0·14	0·12	SN7470	0·29	0·26	0·24	SN74153	£1·20	£1·10	0·95
SN7406	0·35	0·31	0·28	SN7472	0·29	0·26	0·24	SN74154	£1·80	£1·70	£1·60
SN7407	0·35	0·31	0·28	SN7473	0·37	0·35	0·32	SN74155	£1·40	£1·30	£1·20
SN7408	0·18	0·17	0·16	SN7474	0·37	0·35	0·32	SN74156	£1·40	£1·30	£1·20
SN7409	0·18	0·17	0·16	SN7475	0·45	0·43	0·42	SN74157	£1·90	£1·80	£1·70
SN7410	0·15	0·14	0·12	SN7476	0·40	0·39	0·38	SN74160	£1·80	£1·70	£1·40
SN7411	0·25	0·24	0·23	SN7480	0·67	0·64	0·58	SN74161	£1·80	£1·70	£1·60
SN7412	0·35	0·31	0·28	SN7481	£1·20	£1·15	£1·10	SN74162	£4·00	£3·75	£3·50
SN7413	0·29	0·28	0·24	SN7482	0·87	0·86	0·85	SN74163	£4·00	£3·75	£3·50
SN7416	0·43	0·40	0·38	SN7483	£1·10	£1·05	0·95	SN74164	£2·20	£2·15	£2·10
SN7417	0·43	0·40	0·38	SN7484	£1·00	0·95	0·90	SN74165	£2·25	£2·20	£2·15
SN7420	0·15	0·14	0·12	SN7485	£3·60	£3·50	£3·40	SN74166	£3·50	£3·25	£3·00
SN7422	0·50	0·48	0·45	SN7486	0·32	0·31	0·30	SN74174	£2·30	£2·20	£2·10
SN7423	0·50	0·48	0·45	SN7489	£5·50	£5·25	£5·00	SN74175	£1·60	£1·50	£1·40
SN7425	0·50	0·48	0·45	SN7490	0·67	0·64	0·58	SN74176	£2·50	£2·40	£2·30
SN7427	0·45	0·42	0·40	SN7491	£1·00	0·96	0·90	SN74177	£2·50	£2·45	£2·30
SN7428	0·70	0·65	0·60	SN7492	0·67	0·64	0·58	SN74180	£2·00	£1·80	£1·40
SN7430	0·15	0·14	0·12	SN7493	0·67	0·64	0·58	SN74181	£5·50	£5·00	£4·75
SN7432	0·45	0·42	0·40	SN7494	0·77	0·74	0·68	SN74192	£2·00	£1·80	£1·60
SN7433	0·80	0·75	0·70	SN7495	0·77	0·74	0·68	SN74184	£3·50	£3·25	£3·00
SN7437	0·64	0·62	0·60	SN7496	0·87	0·84	0·78	SN74190	£1·95	£1·90	£1·85
SN7438	0·64	0·62	0·60	SN74100	£1·65	£1·60	£1·55	SN74191	£1·90	£1·85	£1·80
SN7440	0·15	0·14	0·12	SN74104	0·97	0·94	0·88	SN74192	£1·95	£1·90	£1·85
SN7441	0·67	0·64	0·58	SN74105	0·97	0·94	0·88	SN74193	£2·00	£1·80	£1·75
SN7442	0·67	0·64	0·58	SN74107	0·40	0·38	0·36	SN74194	£2·70	£2·60	£2·50
SN7443	£1·30	£1·25	£1·20	SN74110	0·55	0·53	0·50	SN74195	£2·00	£1·90	£1·80
SN7444	£1·30	£1·25	£1·20	SN74111	£1·25	£1·15	£1·10	SN74196	£1·80	£1·75	£1·60
SN7445	£1·80	£1·77	£1·75	SN74118	£1·00	0·95	0·90	SN74197	£1·80	£1·75	£1·60
SN7446	0·97	0·94	0·88	SN74119	£1·35	£1·25	£1·10	SN74198	£5·50	£5·00	£4·50
SN7447	£1·00	0·97	0·95	SN74121	0·40	0·37	0·34	SN74199	£5·50	£5·00	£4·50
SN7448	£1·00	0·97	0·95	SN74122	£1·40	£1·30	£1·10				

The AL50 HI-FI AUDIO AMPL

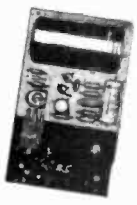
50W pk 25w (RMS)

0·1% DISTORTION! HI-FI AUDIO AMPLIFIER

- Frequency Response 15Hz to 100,000—1dB.
- Load—3, 4, 8 or 16 ohms. • Supply voltage 10-35 Volts.
- Distortion—better than 0·1% at 1kHz.
- Signal to noise ratio 80dB.
- Overall size 63 mm x 105 mm x 13 mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT—TESTED—GUARANTEED.

BRITISH MADE. only £3·25 each



STABILISED POWER

MODULE SPM80 £2·95

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm x 105 mm x 20 mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:— Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p.

TRANSFORMER BMT80 £1·95 p. & p. 25p

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41/14 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

All indicators 0-9 + Decimal point. All side viewing. Full data for all types available on request.

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA1000 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50KΩ	Filters: Rumble (high pass)	100 Hz
2. Radio, Tuner	35mV into 50KΩ	Scratch (low pass)	8kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
All input voltages are for an output of 250mV.		Input overload	+26dB
Tape and P.U. inputs equalised to RIAA curve		Supply	+35 volts at 20mA
within ±1dB from 20Hz to 20kHz.		Dimensions	292 x 82 x 32 mm

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £23.00 FREE p.&p

only £11·95

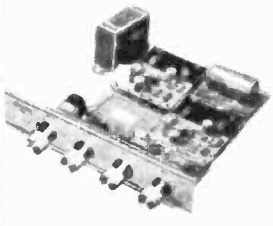
INTEGRATED CIRCUIT PAKS

Manufacturers "Fall Outs" which inclue 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	0·50	UIC46	= 5 x 7446	0·50	UIC86	= 5 x 7486	0·50
UIC01	= 12 x 7401	0·50	UIC47	= 5 x 7447	0·50	UIC90	= 5 x 7490	0·50
UIC02	= 12 x 7402	0·50	UIC48	= 5 x 7448	0·50	UIC91	= 5 x 7491	0·50
UIC03	= 12 x 7403	0·50	UIC50	= 12 x 7450	0·50	UIC92	= 5 x 7492	0·50
UIC04	= 12 x 7404	0·50	UIC51	= 12 x 7451	0·50	UIC93	= 5 x 7493	0·50
UIC05	= 12 x 7405	0·50	UIC53	= 12 x 7453	0·50	UIC94	= 5 x 7494	0·50
UIC06	= 8 x 7406	0·50	UIC54	= 12 x 7454	0·50	UIC95	= 5 x 7495	0·50
UIC07	= 8 x 7407	0·50	UIC60	= 12 x 7460	0·50	UIC96	= 5 x 7496	0·50
UIC10	= 12 x 7410	0·50	UIC70	= 8 x 7470	0·50	UIC100	= 5 x 74100	0·50
UIC13	= 8 x 7413	0·50	UIC72	= 8 x 7472	0·50	UIC121	= 5 x 74121	0·50
UIC20	= 12 x 7420	0·50	UIC73	= 8 x 7473	0·50	UIC141	= 5 x 74141	0·50
UIC30	= 12 x 7430	0·50	UIC74	= 8 x 7474	0·50	UIC151	= 5 x 74151	0·50
UIC40	= 12 x 7440	0·50	UIC75	= 8 x 7475	0·50	UIC154	= 5 x 74154	0·50
UIC41	= 5 x 7441	0·50	UIC76	= 8 x 7476	0·50	UIC193	= 5 x 74193	0·50
UIC42	= 5 x 7442	0·50	UIC80	= 5 x 7480	0·50	UIC199	= 5 x 74199	0·50
UIC43	= 5 x 7443	0·50	UIC81	= 5 x 7481	0·50			
UIC44	= 5 x 7444	0·50	UIC82	= 5 x 7482	0·50	UICX1	·25 Assorted 74's	1·50
UIC45	= 5 x 7445	0·50	UIC83	= 5 x 7483	0·50			

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

The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5·5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak
Freq. res. 25Hz-25kHz
Harmonic distortion typically 0·25% at 1 watt
Input 1 (Cer.) 300mV into 1M
Input 2 (Aux.) 4mV into 30K
Bass control ±12dB at 60Hz
Treble con. ±14dB at 14kHz

£12·25 free p. & p.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0·50
C 2	200	Capacitors mixed values approx. count by weight	0·50
C 3	50	Precision Resistors 1%, mixed values	0·50
C 4	75	¼th W Resistors mixed preferred values	0·50
C 5	5	Pieces assorted Ferrite Rods	0·50
C 6	2	Tuning Gangs, MW/LW/VHF	0·50
C 7	1	Pack Wire 50 metres assorted colours	0·50
C 8	10	Reed Switches	0·50
C 9	3	Micro Switches	0·50
C10	15	Assorted Pots & Pre-Sets	0·50
C11	5	Jack Sockets 3 x 3·5mm 2 x Standard Switch Types	0·50
C12	40	Paper Condensers preferred types mixed values	0·50
C13	20	Electrolytics Trans. types	0·50
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·50
C15	4	Mains Toggle Switches, 2 Amp D/P	0·50
C16	20	Assorted Tag Strips & Panels	0·50
C17	10	Assorted Control Knobs	0·50
C18	4	Rotary Wave Change Switches	0·50
C19	3	Relays 6—24V Operating	0·50
C20	4	Sheets Copper Laminate approx. 10" x 7"	0·50

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20.

RTL MICROLOGIC CIRCUITS

	Price each 1-24	25-99	100 up
Epoxy TO-5 case uL900 Buffer	35p	33p	27p
uL914 Dual 2i/p gate	35p	33p	27p
uL923 J-K flip-flop	50p	47p	45p

Data and Circuits Booklet for IC's Price 7p.

DUAL-IN-LINE IC's. TWO PROFESSIONAL & NEW LOW COST. PROF. TYPE No. Ranges

	1-24	25-99	100 up.
T80 14 pin type	30p	27p	25p
T80 16 " "	35p	32p	30p
LOW COST No.			
BP8 14	15p	13p	11p
BP8 16	16p	14p	12p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application (DTL 930 Series only).

LINEAR I.C.'s—FULL SPEC.

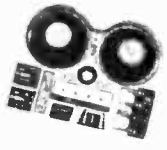
Type No.	Price 1-24	25-99	100 up
BP 201C—8L201C	63p	53p	45p
BP 701C—8L701C	63p	50p	45p
BP 702C—8L702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	36p	34p	30p
BP 709P—μA709C	36p	34p	30p
BP 710—72710	44p	42p	40p
BP 711—μA711	45p	43p	40p
BP 741—72741	75p	60p	50p
μA703C—μA703C	28p	26p	24p
TAA 263—	70p	60p	55p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p

S.G.S. EA1000 £2·63

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	Price 1-24	25-99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9083	40p	38p	35p
BP9084	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

SYSTEM 12 STEREO



Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms, the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner. Further details available on request.

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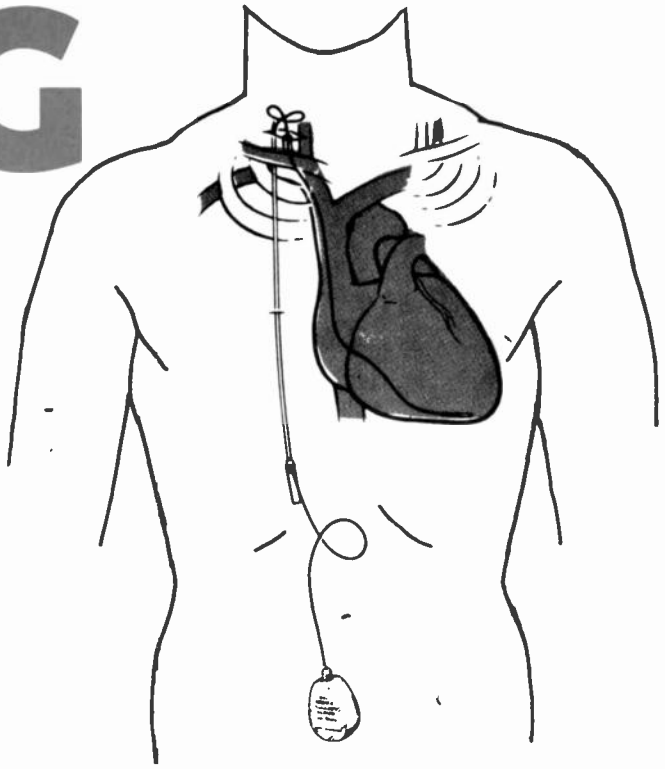
SETTING THE PACE



Latest heart pacemaker can be checked in-situ with simple equipment — Brian Chapman reports.

Typical cardiac pacemaker implantation. Note that the trigger electrode is inserted into the heart via the jugular vein.

Heart disease is one of the most common causes of death and is the subject of considerable world-wide research. Part of this research is devoted to evolving long-lasting and ever more reliable implantable pacemakers. These devices and their associated electrodes are surgically implanted to assist, or completely replace, the naturally generated electrical signal which controls the heart's pumping action.

Many new types of pacemaker are on the market and before describing some of these we will briefly describe the cardiac (heart) system so that pacemaker terminology may be better understood.

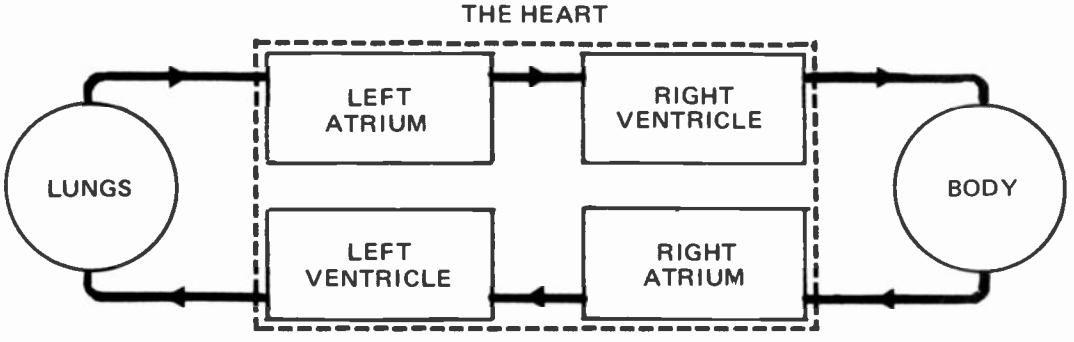
THE BIOLOGICAL PUMP

The heart is an electrically triggered pumping mechanism for forcing blood through the circulatory system. Its action may be understood by reference to Fig. 1, where it can be seen to consist of four chambers. Two of the chambers, known as *auricles* or *atria* receive the incoming blood and the other two chambers known as *ventricles* expel the blood from the heart. Each atrium is connected via a one-way valve to its associated ventricle. The right ventricle pumps blood to the lungs where it picks up a fresh supply of oxygen and this oxygenated blood then goes to the left atrium. After passing through the valve to the left ventricle, the oxygenated blood is pumped into the circulatory system where it distributes oxygen to the tissues of the body. The de-oxygenated blood then returns to the right atrium, passes to the right ventricle and is pumped back to the lungs for replenishment.

The pumping action of the heart is triggered by electrical signals, generated within the heart itself, causing the muscles of the heart rhythmically to contract and then relax. During relaxation the chambers fill with blood and then, when the muscles contract, the blood is forced out into the circulatory system.

The electrical activity of the heart is

Fig. 1 The circulatory system of heart, lungs and body.



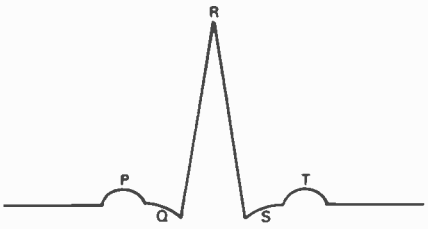


Fig. 2 Typical electrocardiogram waveshape showing letter designations used for various sections of the wave.

thus the primary pumping motivation. This activity may be detected by electrodes placed on the surface of the body. The signals thus picked up are amplified and then used to produce a recording known as an electrocardiogram. Figure 2 shows a typical heart waveform as seen on an electrocardiogram. The various components of this wave are firstly the P-wave which occurs during the muscular contraction of the atria, then the QRS pulse which corresponds to ventricle contraction, and lastly, the T-wave which occurs when the ventricle muscles relax.

TYPES OF PACEMAKER

Pacemaker research is continuing on three specific requirements.

(a) more reliable components and circuits
(b) longer life, built-in power sources
(c) improved clinical performance and testing facilities.

In general, the components used have now been developed to a level where their life exceeds that of the power supply and additionally, work is in progress on nuclear power sources aimed at providing an implantable life in excess of 10 years. See Nuclear Heart Pacemaker ELECTRONICS TODAY INTERNATIONAL, August 1972.

Improved performance has been achieved by developing pacemaker types specifically for certain classes of heart malfunction and by building in test facilities. There are four basic types of pacemaker which can be combined with various electrode systems to suit each respective patient. These are:—

1) FIXED RATE — this pacemaker is suited for patients requiring a slow, continuous, basic rhythm and where there is no tendency to interference from impulses generated by the patient's own heart.
2) VENTRICLE TRIGGERED (RS synchronous or QRS inhibited) — this pacemaker covers the largest area of application and can be advantageously used for patients who display normal heart activity. In the QRS synchronous type, the pacemaker generates impulses which synchronize with the patient's R-wave (and hence do not affect normal action) as long as the heart beat rate exceeds 60 imp/min. When the beat rate falls below 60 imp/min, the pacemaker generates impulses at a fixed rate of 60 imp/min. The basic rate of the pacemaker is adjustable to suit individual requirements.
3) QRS INHIBITED — same as that above except that is inactive until the beat rate falls below the present level, it then generates fixed rate impulses until the natural basic rate is restored.
4) ATRIUM TRIGGERED — this type of pacemaker is synchronized by the P-wave and after a short delay, generates an impulse which triggers the ventricle by means of an electrode implanted within it.

THE VARIOPACEMAKER

A company very active in research and development of pacemakers is Medical Applications Pty. Ltd., a joint venture of Philip Industries Holdings Limited of Australia and Siemens A.G. of West Germany. They manufacture units covering the full range of applications as detailed above and in addition, have

(Turn to page 46)

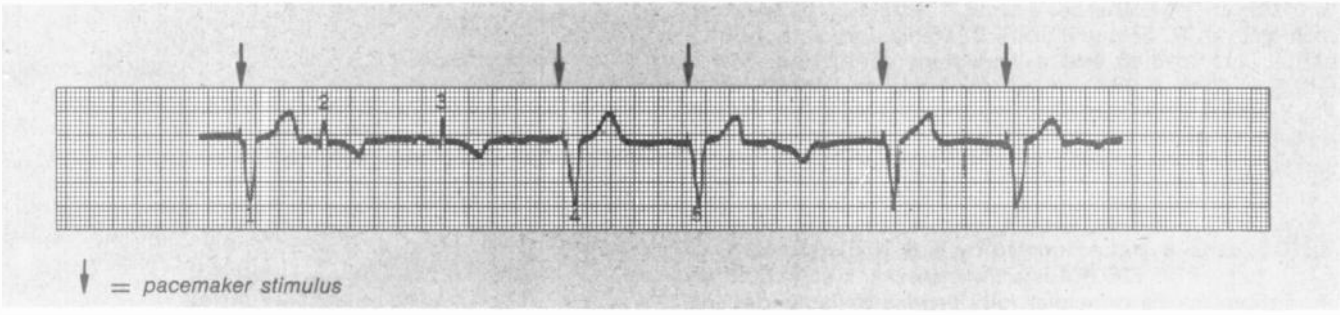


Fig. 3 Actual Electrocardiogram of patient fitted with QRS inhibited pacemaker. Patient's own heart pulses can be seen at (2) and (3) which each suppress pacemaker's output for 1000 milliseconds. After further 1000 milliseconds patients' own pulse is missing so pacemaker induces pulse (4). This operation is also called 'Demand' mode.

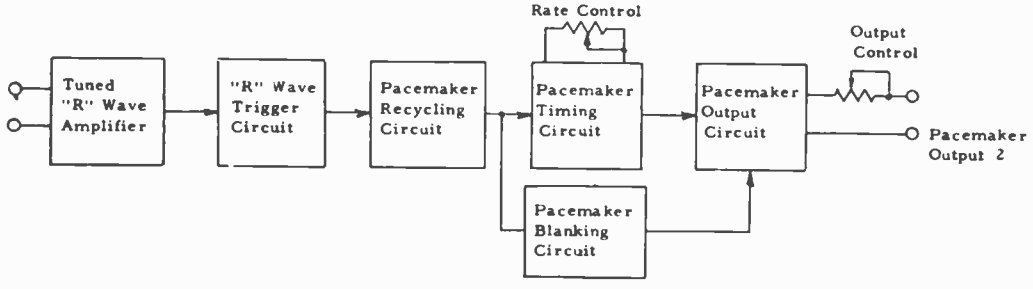


Fig. 4 Block diagram of a QRS inhibited pacemaker, (external) shows the method of suppressing pacemaker output whilst patient's own pulses are present.

AUDIO COMPETITION

No reader can afford to miss this competition. We not only offer a first prize of a Linton system but also have three runner-up prizes: a pair of speakers, an audio amplifier and CrO_2 cassette tapes.

All you have to do is to place, in a descending order of preference, the characteristics of a hi-fi speaker, tell us in a few words why you placed them in your chosen order — and fill in the entry coupon. There are no entry fees. More information about your entry form is given below.

THE PRIZES

The main prize winner will receive a Linton audio system, donated by Rank Radio International and worth around £150. It consists of a Linton turntable, a Linton amplifier and a pair of 'Linton 2' loudspeakers. The plint-mounted turntable is fitted with a Shure M44-7 cartridge. The amplifier is equipped with switchable radio input facilities and two unswitched power outlets, one for energising the turntable and the other for a tuner if required. The speakers each have an 8" bass unit and a 2" treble unit, with infinite baffle bass loading and a maximum continuous power rating of 25W (20W nominal according to DIN 45-500). The four items are not only pleasing looking and excellent performers in their own right but, as a total system, they are beautifully matched in appearance as well as performance.

The first runner-up wins a pair of the new Keletron KS20 speaker systems donated by K & K Electronics Ltd. Each item (RRP £35.80) is a three-speaker system built on the infinite baffle principle, fully padded to damp out any panel resonance and housed in handsome slim-line cabinets, ideal for shelf or wall mounting; power handling rating is 20W rms.

The second runner-up wins a Teleton GA202 amplifier (RRP: £50) featuring push-button and slider controls and rated to deliver 2 x 16W rms. The stereo amplifier, finished in a smart wood cabinet, has four inputs (magnetic and crystal pickups, tape and an auxiliary input), high-cut, loudness and mono controls, tape output, and phone sockets.

The third and last runner-up wins £15 worth (retail value) of CrO_2 tape cassettes donated by BASF (UK) Ltd. The cassettes, known for their increased dynamic range, lower background noise, reduced head wear and longer tape life, come in three sizes, C60, C90 and C120 — all fitted with BASF's 'Special Mechanics' (SM) for anti-tangle and slip-free operation. The winner can mix his cassettes from the range or take all cassettes of the same type.

YOUR ENTRY

Choosing a loudspeaker is never an easy task as so many considerations have to be taken into account. It is to some extent a matter of individual taste as to what is required from a loudspeaker and what is believed to be the salient points of any one speaker system.

There are certain characteristics which every speaker system must possess. But the decision as to whether the point of prime mportance is the appearance, the size or the frequency response is often a matter of the individual buyer's personal requirements.

The purpose of this competition is to find a sequence of priorities to act as a guide when buying a speaker system. We would like you to mark down the features we have listed in order of preference and then to write in thirty words or less why you have placed them in that order.

Wharfedale Linton system

Contest Conditions

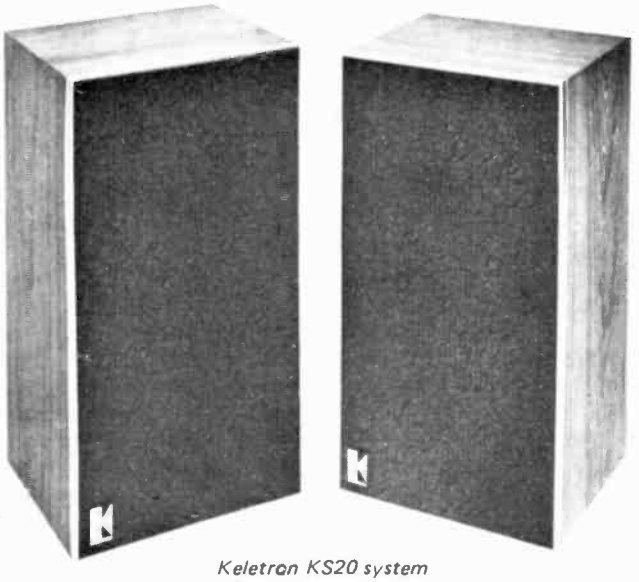
All entries must be accompanied by the coupon from Electronics Today International. There is no entrance fee, but any entry not accompanied by a coupon will be deemed invalid by the judges.

The winners will be decided by a panel of judges appointed by the Editor of Electronics Today International. The judges' decision will be final and no correspondence will be entered into concerning the outcome of the contest.

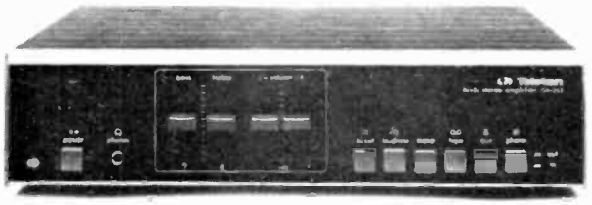
All entries should be addressed to: Audio Competition, Electronics Today International, Whitehall Press Ltd., Wrotham Place, Wrotham, Sevenoaks, Kent.

Ensure that your name and address is printed clearly on your entry coupon.

Closing date for the competition is May 31st, 1973.



Keletron KS20 system



Teleton GA202 Amplifier

BASF Cassettes

Mark your order of preference in the boxes, i.e. 1 for first choice, 2 for second choice, etc.

- [ ] 11 High efficiency 0.001%
- [ ] 8 Low distortion 95%
- [ ] 3 Wide frequency response 20 → 13000 ±2
- [ ] Smooth frequency response
- [ ] 9 Wide polar response
- [ ] 2 Attractive appearance
- [ ] 6 Reasonable size
- [ ] 4 High power handling capacity 2w
- [ ] 10 Parts and labour warranty
- [ ] 5 Moderate price £p
- [ ] 7 Superior transient response (IF ITS PLUGGED IN)

Explain in thirty words or less the reasons for your order of preference.

We made this decision because we like it the same as you the quality is very good when you go by these things,

ENTRY COUPON.

ELECTRONICS TODAY INTERNATIONAL AUDIO COMPETITION

Herewith, please find my entry for your **Audio** Competition. I have read the rules of the contest and agree to abide by the judges' decision.

SIGNED Nicholas Cochrane DATE 1/4/73

NAME (block letters) Neil Johnson

ADDRESS 27 25 Lovelace Drive

A separate coupon must accompany each entry.
Closing date for the Audio Competition is May 31st, 1973.

SETTING THE PACE

(Continued from page 43)

recently added the *Variopacemaker* to their range.

As the success of electrical pacing of the heart greatly depends on the stimulation threshold of the electrode by which the impulses are transmitted to the heart, it is important that this parameter can be readily measured and if need be, corrected before any changes in threshold cause medical difficulties. This is now possible with the Vario pacemaker.

The unit is basically a QRS inhibited pacemaker and normally operates in the manner previously described. The main difference is that a vario function has been added. The vario function is activated by a small bar-magnet which is placed on the skin above the implanted pacemaker. The magnet activates a reed switch and the pacemaker automatically switches to a control frequency of 100 impulses per minute and lowers the impulse amplitude in sixteen equal steps until the sixteenth pulse reaches zero. The unit then returns to full amplitude and commences another step-down series. This process is repeated until the magnet is removed (See Fig. 5).

This means that the whole pacemaker/electrode system can be checked without the use of complex electronic test methods and equipment. Any changes in threshold due to electrode integrity are thus detected well before any medical symptoms arise. It would seem that this new technique offers another worthwhile step towards pacemakers having lifetimes exceeding that of the patient. ●

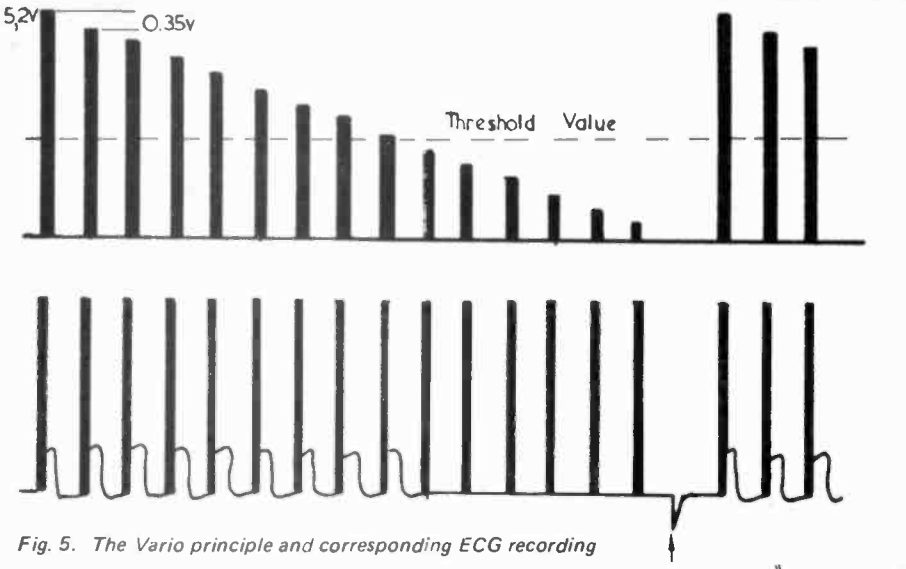


Fig. 5. The Vario principle and corresponding ECG recording

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2G303	0·25	2N3855	0·16	BC113	0·18	BFY52	0·16	NKT677F	0·22
2G306	0·30	2N3855A	0·16	BC115	0·15	BFY53	0·15	NKT713	0·30
2G309	0·30	2N3856	0·16	BC116	0·15	BFY56	0·34	NKT717	0·44
2G371	0·15	2N3856A	0·16	BC116A	0·18	BFY75	0·40	NKT781	0·20
2G374	0·15	2N3858	0·16	BC118	0·11	BFY76	0·28	NKT10419	0·20
2G381	0·25	2N3858A	0·16	BC121	0·20	BFY77	0·24		
2N404	0·23	2N3859	0·16	BC125	0·15	BFY90	0·55	NKT10439	0·27
2N696	0·15	2N3859A	0·16	BC126	0·20	BFY39	0·38		
2N697	0·15	2N3860	0·16	BC140	0·30	B8X19	0·13	NKT10519	0·23
2N698	0·25	2N3866	0·70	BC147	0·10	B8X20	0·14		
2N706	0·10	2N3877	0·25	BC148	0·09	B8X21	0·20	NKT20329	0·32
2N708	0·13	2N3877A	0·26	BC149	0·11	B8X26	0·34		
2N709	0·38	2N3900	0·20	BC157	0·09	B8X27	0·34	NKT20339	0·36
2N718	0·21	2N3900A	0·21	BC158	0·10	B8X28	0·25		
2N914	0·15	2N3901	0·32	BC159	0·10	B8X60	0·54	NKT80111	0·67
2N916	0·17	2N3903	0·22	BC160	0·11	B8X61	0·42		
2N918	0·30	2N3904	0·22	BC167B	0·11	B8X76	0·15	NKT80112	0·84
2N929	0·14	2N3905	0·21	BC168B	0·10	B8X77	0·20		
2N930	0·14	2N3906	0·22	BC168C	0·10	B8X78	0·25	NKT80113	1·00
2N1090	0·30	2N4058	0·12	BC169B	0·11	B8W70	0·28		
2N1091	0·32	2N4059	0·90	BC169C	0·11	B8Y24	0·20	NKT80211	0·75
2N1131	0·20	2N4060	0·11	BC170	0·11	B8Y25	0·20		
2N1132	0·20	2N4061	0·11	BC171	0·13	B8Y26	0·20	NKT80212	0·75
2N1184	1·27	2N4062	0·11	BC172	0·11	B8Y27	0·15		
2N1302	0·16	2N4303	0·32	BC182	0·10	B8Y28	0·15	NKT80213	0·75
2N1303	0·16	2N5172	0·09	BC183	0·09	B8Y38	0·15		
2N1304	0·20	2N5174	0·22	BC184	0·11	B8Y39	0·15	NKT80214	0·75
2N1305	0·20	2N5175	0·26	BC212L	0·12	B8V51	0·25		
2N1306	0·22	2N5176	0·32	BCY30	0·35	B8Y52	0·25	NKT80215	0·75
2N1307	0·22	2N5245	0·43	BCY31	0·40	B8Y53	0·25		
2N1308	0·25	2N5459	0·33	BCY32	0·60	B8Y54	0·30	NKT80216	0·75
2N1309	0·25	3N128	0·63	BCY33	0·30	B8Y56	0·79		
2N1507	0·30	3N140	0·76	BCY34	0·35	B8Y78	0·40	OC20	0·85
2N1613	0·20	3N141	0·69	BCY38	0·40	B8Y79	0·40	OC22	0·50
2N1651	0·38	3N142	0·54	BCY39	0·80	B8Y790	0·45	OC23	0·50
2N1637	0·36	3N143	0·64	BCY40	0·50	B8Y95A	0·09	OC24	0·80
2N1638	0·32	3N152	0·79	BCY42	0·15	C111	0·53	OC25	0·50
2N1711	0·17			BCY43	0·15	C424	0·15	OC26	0·25
2N1893	0·34			BCY58	0·18	C425	0·36	OC28	0·65
2N2147	0·70			BCY59	0·19	C426	0·25	OC29	0·60
2N2148	0·60			BCY70	0·17	C428	0·25	OC35	0·50
2N2193	0·58			BCY71	0·22	GET113	0·25	OC36	0·65
2N2193A	0·61			BCY72	0·13	GET114	0·20	OC41	0·30
2N2194A	0·30	40050	0·50	BCZ10	0·35	GET119	0·35	OC42	0·35
2N2219	0·20	40251	0·53	BCZ11	0·50	GET120	0·40	OC44	0·15
2N2220	0·20	40309	0·26	BD116	0·75	GET873	0·15	OC45	0·12
2N2221	0·20	40310	0·37	BD121	0·75	GET880	0·35	OC46	0·27
2N2222	0·20	40360	0·35	BD123	0·82	GET887	0·20	OC70	0·12
2N2222A	0·32	40361	0·37	BD124	0·60	GET890	0·35	OC71	0·12
2N2368	0·11	40362	0·40	BD131	0·75	MJ400	0·78	OC72	0·12
2N2369	0·12	40406	0·40	BD132	0·75	MJ420	0·86	OC74	0·25
2N2369A	0·17	40407	0·31	BDY10	1·25	MJ421	0·88	OC75	0·22
2N2046	0·45	40408	0·41	BDY11	1·50	MJ430	0·75	OC76	0·22
2N2711	0·12	40410	0·53	BDY17	1·50	MJ440	0·71	OC77	0·40
2N2712	0·12	40467A	0·57	BDY18	1·75	MJ480	0·75	OC81	0·20
2N2713	0·17	40468A	0·35	BDY19	1·97	MJ481	0·85	OC81D	0·20
2N2714	0·17	AC107	0·35	BDY20	1·00	MJ490	0·94	OC82D	0·25
2N2904	0·18	AC126	0·20	BDY38	0·65	MJ491	1·10	OC83	0·20
2N2904A	0·29	AC127	0·20	BDY60	0·90	MJE340	0·47	OC84	0·20
2N2905	0·26	AC128	0·20	BDY61	0·85	MJE520	0·59	OC139	0·25
2N2905A	0·28	AC154	0·20	BDY62	0·75	MPF102	0·25	OC140	0·30
2N2906	0·18	AC176	0·16	BF115	0·25	MPF103	0·33	OC170	0·25
2N2906A	0·23	ACY17	0·25	BF117	0·43	MPF104	0·33	OC171	0·30
2N2907	0·18	ACY18	0·15	BF163	0·20	MPF105	0·33	OC200	0·40
2N2923	0·12	ACY19	0·20	BF166	0·35	NKT124	0·42	OC201	0·65
2N2924	0·12	ACY20	0·20	BF167	0·18	NKT125	0·40	OC202	0·65
2N2925	0·12	ACY21	0·18	BF173	0·19	NKT126	0·38	OC203	0·42
2N2926		ACY22	0·13	BF177	0·25	NKT128	0·48	OC204	0·42
Green	0·10	ACY28	0·18	BF178	0·31	NKT135	0·26	OC205	0·85
Yellow	0·10	ACY40	0·17	BF179	0·38	NKT137	0·32	P346A	0·18
Orange	0·10	ACY41	0·17	BF180	0·35	NKT210	0·25	TIP29A	0·49
2N3053	0·15	AD140	0·55	BF181	0·34	NKT211	0·25	TIP30A	0·58
2N3054	0·47	AD149V	1·23	BF184	0·17	NKT212	0·25	TIP31A	0·62
2N3055	0·60	AD150	0·55	BF185	0·17	NKT213	0·25	TIP32A	0·74
2N3390	0·20	AD161	0·33	BF194	0·14	NKT214	0·15	TIP33A	1·01
2N3391	0·20	AD162	0·36	BF195	0·15	NKT215	0·21	TIP34A	1·51
2N3391A	0·22	AD161) PR		BF196	0·15	NKT216	0·46	TIP35A	2·90
2N3392	0·13	AD162)	0·60	BF197	0·15	NKT217	0·50	TIP36A	3·70
2N3393	0·12	AF106	0·24	BF198	0·18	NKT219	0·25	TI834	0·50
2N3394	0·12	AF114	0·25	BF200	0·40	NKT223	0·17	TI843	0·21
2N3402	0·17	AF115	0·25	BF224J	0·14	NKT224	0·25	TI844	0·07
2N3403	0·19	AF116	0·25	BF255J	0·19	NKT225	0·21	TI845	0·10
2N3404	0·24	AF117	0·20	BF237	0·22	NKT229	0·29	TI846	0·11
2N3405	0·27	AF118	0·50	BF238	0·22	NKT237	0·31	TI847	0·11
2N3414	0·10	AF124	0·24	BF244	0·16	NKT238	0·18	TI848	0·11
2N3415	0·10	AF125	0·20	BFX13	0·23	NKT240	0·19	TI849	0·11
2N3416	0·15	AF126	0·20	BFX29	0·25	NKT241	0·20	TI850	0·17
2N3417	0·21	AF127	0·20	BFX30	0·25	NKT242	0·15	TI851	0·11
2N3570	1·25	AF139	0·33	BFX44	0·33	NKT243	0·63	TI852	0·13
2N3572	0·97	AF178	0·55	BFX68	0·30	NKT244	0·17	TI853	0·23
2N3702	0·11	AF179	0·65	BFX84	0·24	NKT245	0·18		
2N3703	0·10	AF180	0·50	BFX85	0·29	NKT261	0·21		
2N3704	0·11	AF211	0·55	BFX86	0·24	NKT262	0·19		
2N3705	0·10	AF239	0·36	BFX87	0·27	NKT264	0·21		
2N3706	0·90	AF279	0·47	BFX88	0·25	NKT271	0·18		
2N3707	0·11	AF280	0·47	BFX89	0·45	NKT272	0·18		
2N3708	0·70	A8Y26	0·25	BFY10	0·35	NKT274	0·18		
2N3709	0·90	A8Y27	0·30	BFY11	0·45	NKT275	0·23		
2N3710	0·90	A8Y28	0·25	BFY17	0·90	NKT401	0·70		
2N3711	0·90	A8Y29	0·30	BFY18	0·35	NKT402	0·76		
2N3715	1·23	A8Y50	0·20	BFY19	0·35	NKT403	0·65		
2N3716	1·30	A8Y55	0·35	BFY20	0·50	NKT404	0·61		
2N3791	2·06	A8Z21	0·55	BFY29	0·40	NKT405	0·80		
2N3819	0·26	AU103	1·25	BFY41	0·43	NKT406	0·63		
2N3823	0·62	BC107	0·12	BFY43	0·65	NKT603F	0·30		

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Matching charge (audio transistors only) 15p extra per pair.
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SN7401	0·20	0·18	SN7437	0·64	0·06	SN7473	0·43	0·41
SN7402	0·20	0·18	SN7438	0·64	0·60	SN7474	0·43	0·41
SN7403	0·20	0·18	SN7440	0·23	0·21	SN7475	0·45	0·44
SN7405	0·20	0·18	SN7441AN	0·87	0·83	SN7476	0·45	0·44
SN7406	0·80	0·75	SN7442	0·85	0·81	SN7480	0·70	0·65
SN7407	0·80	0·75	SN7443	2·86	2·70	SN7481	1·40	1·38
SN7408	0·20	0·18	SN7444	2·86	2·70	SN7482	0·87	0·82
SN7409	0·20	0·18	SN7445	2·50	2·40	SN7483	0·87	0·82
SN7410	0·20	0·18	SN7446	1·00	0·95	SN7484	2·00	1·85
SN7411	0·23	0·21	SN7447	1·00	0·95	SN7485	3·62	3·40
SN7412	0·48	0·46	SN7448	1·00	0·95	SN7486	0·33	0·30
SN7413	0·40	0·38	SN7449	1·00	0·95	SN7490	0·87	0·84
SN7420	0·20	0·18	SN7450	0·20	0·18	SN7491AN	1·21	1·10
SN7423	0·51	0·47	SN7451	0·20	0·18	SN7492	0·87	0·84
SN7427	0·48	0·45	SN7453	0·20	0·18	SN7493	0·87	0·84
SN7428	0·80	0·75	SN7454	0·20	0·18	SN7494	0·87	0·84
SN7430	0·23	0·18	SN7460	0·20	0·18	SN7495	0·87	0·84
SN7432	0·48	0·42	SN7470	0·40	0·38	SN7496	0·87	0·84

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1A	8p	8p	10p	11p	12p	15p	20p	—
3A	15p	17p	20p	22p	25p	27p	30p	35p
6A	—	—	25p	30p	32½p	35p	—	—
10A	30p	35p	40p	47p	58p	68p	75p	—
15A	36p	45p	48p	55p	65p	75p	87p	—
35A	70p	80p	90p	£1·00	£1·40	£1·70	£2·75	—

1 amp and 3 amp are plastic encapsulation.

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IN916	7p	AAZ13	12p	BAY31	7p	OA10	20p
IN4007	20p	AAZ15	12p	BAY38	25p	OA9	10p
I344	7p	AAZ17	10p	BY100	15p	OA47	8p
I8113	15p	BA100	15p	BY103	22p	OA70	7p
I8120	12p	BA102	25p	BY122	47½p	OA73	10p
I8121	14p	BA110	25p	BY124	15p	OA79	7p
I8130	8p	BA114	15p	BY126	15p	OA81	8p
I8131	10p	BA115	7p	BY127	17p	OA85	10p
I8132	12p	BA141	17p	BY164	57p	OA90	7p
I8920	7p	BA142	17p	BYX10	22p	OA91	7p
I8922	8p	BA144	12p	BYZ10	35p	OA95	7p
I8923	12p	BA145	17p	BYZ11	32p	OA200	7p
I8940	5p	BA154	12p	BYZ12	30p	OA202	10p
		BAX13	5p	BYZ13	25p	TIV307	50p

"SCORPIO" CAP DISCHARGE IGNITION SYSTEM
(As printed in P.E. Nov. '71). Complete kit £10·00 P. & P. 50p.

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A.	PIV		A.	PIV	
1	100	37p	4	50	60p
1.4	140	57p	4	100	70p
2	50	32p	4	400	80p
2	200	41p	6	50	62p
2	400	46p	6	200	80p
			6	400	£1·10

THYRISTORS (SCR)

PIV	50	100	200	300	400
1A	25p	27½p	37½p	40p	47½p
4A	40p	45p	55p	—	60p
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¼ watt 5%, 1½p.	
¼ w 2% M/O 4p.	
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MULLARD C280 M/FOIL CAPACITORS

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0·47 .. .. .. 9p
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1μF 14p
1·5μF 21p
2·2μF 25p

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2·5 watt 5% (up to 270 ohms only). 7p
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10 watt 5% (up to 25kΩ only), 10p

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Carbon:
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0·2 Watt	6p	OR
0·3 Watt	7½p	HORIZONTAL

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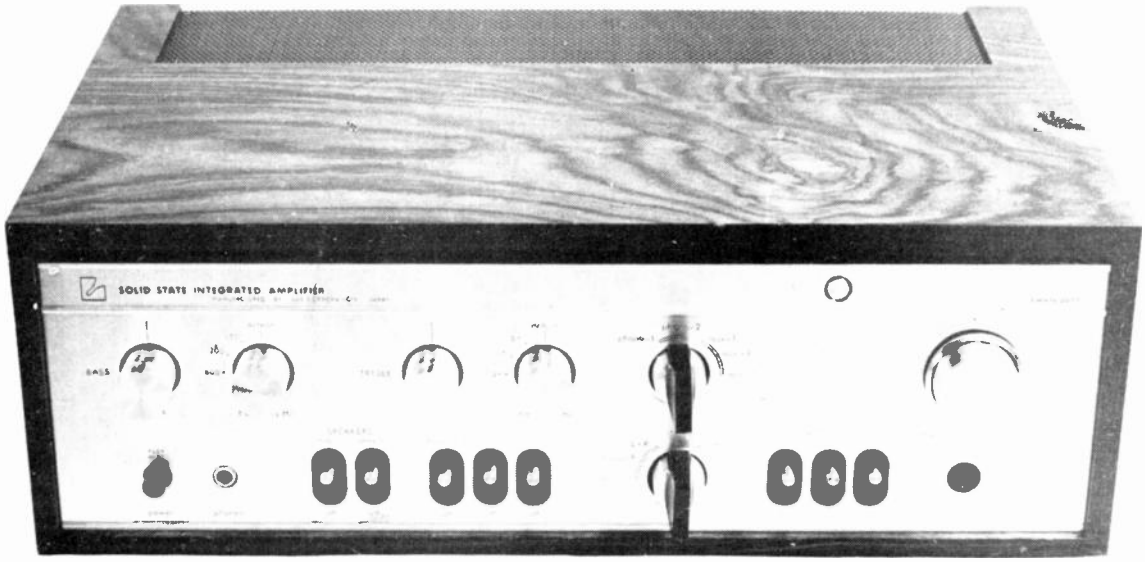


LUXMAN SQ507X AMPLIFIER

Latest version of Lux SQ507 amplifier has some excellent additional features.

Some years ago we tested the Lux SQ507 amplifier and were impressed by its performance. We were therefore most interested to see what changes had been made in the latest version of this unit, the Luxman SQ507X.

The new model is in fact very similar to the earlier SQ507, both in appearance and general performance. Most of the features that made the SQ507 so good are retained, although the electronic protection circuit has been removed. A number of additional features have however been included.

FACILITIES PROVIDED

The front panel of the SQ507X is a brushed aluminium extrusion with two rows of controls. It is framed by an oiled rosewood veneer timber enclosure into which the complete amplifier chassis is housed.

The top row of controls, from left to right, have the following functions:—

a) Dual concentric indexed bass boost and cut potentiometers, with five boost and five cut positions.
b) A bass turnover frequency select switch with four positions for 600Hz, 300Hz, 150Hz and "defeat", the latter designating "not operational."
c) Dual concentric indexed treble boost and cut potentiometer with five boost and five cut positions.'
d) A treble turnover frequency select switch with four positions for 1.5 kHz, 3kHz, and a "defeat" position.
e) A rotary source select switch with five positions for phone 1, phone 2, auxiliary 1, auxiliary 2 and auxiliary 3.
f) A large volume control knob with concentric ring for balance adjustment

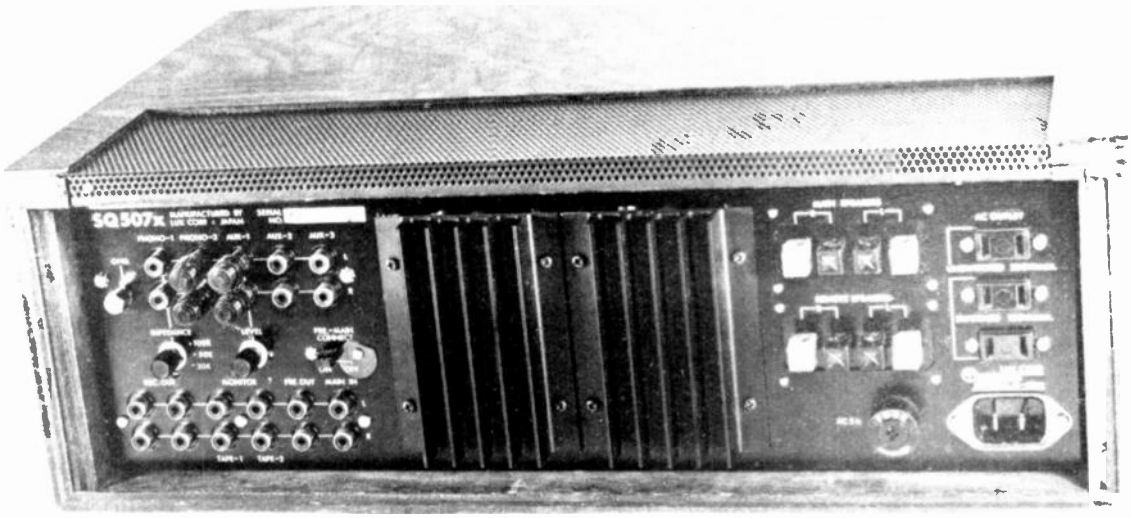
The lower row of controls — from left to right are:—

a) Push on, push off mains switch.
b) Ring tip and sleeve socket for headphones.
c) Toggle switch for main speakers selection.
d) Toggle switch for remote speakers selection.
e) Toggle switch for low frequency boost (6dB at 100Hz).
f) A large volume control knob with concentric ring for balance adjustment.

The lower row of controls — from left to right are:—

a) Push on, push off mains switch.
b) Ring tip and sleeve socket for headphones.
c) Toggle switch for main speakers selection.
d) Toggle switch for remote speakers selection.
e) Toggle switch for low frequency boost (6dB at 100Hz).
f) Toggle switch for low frequency cut (6dB at 70Hz).
g) Toggle switch for high frequency cut (6dB at 6kHz).
h) Rotary mode select knob with five

MEA
SERI
Frequ
Powe
(both
Chan
Hum
(Unw
Powe
Input
Total
At Ra
Tone
Bass
Trebl
Filter
Low
Low
High
Atter
Dimer
Weigh
Recor



SURED PERFORMANCE OF LUXMAN SQ 507X AMPLIFIER
AL NO. 018250P

electronics TODAY INTERNATIONAL
product test

iency Response at Rated Output	20Hz to 20 kHz ± ½dB			
r Output at Rated Input Channels Driven)	54 watts			
nel Separation at Rated Output	Auxiliary Input	100Hz 1kHz	54dB 43dB	
and Noise eighted with Respect to Rated r)	Auxiliary Input Phono Input		68dB 52dB	
Sensitivity for Rated Output	Input		mV	Impedance
	Phono 1 & 2		1.8mV	Phono 1 (variable) Phono 2 (47kΩ)
	Auxiliary 1		85mV variable	50kΩ
	Auxiliary 2 & 3		85mV	200kΩ
Harmonic Distortion ited Output	100Hz 0.3%		1kHz 0.3%	6.3 kHz 0.5%
Controls Boost and Cut at 50Hz	Frequency Setting		Boost	Cut
	150Hz		9dB	9dB
	300Hz		12dB	12dB
	600Hz		13dB	13dB
Boost and Cut at 10kHz	Frequency Setting		Boost	Cut
	1.5kHz		11dB	11dB
	3kHz		8dB	9dB
	6kHz		4dB	4dB
Controls				
Boost	6dB at 50Hz			
Cut	6dB at 50Hz			
Cut	6dB at 10kHz			
uate Switch:	19dB cut at 1kHz			
nsions	450 mm wide x 160 mm high x 268 mm deep			
t	11 kg			
nmended Selling Price	£167·00			

positions; mono, left channel, left plus right channel, normal stereo, and reverse stereo.

j) Toggle switch for tape 1 and tape 2 monitor.

k) On-off toggle switch for tape monitor.

l) Muting toggle switch providing approximately 20dB.

m) Combination record – playback DIN socket for tape recorder No. 2.

All input and output sockets, with the exception of a DIN socket on the front panel for tape recorder patching, are located on the rear panel. These consist of pairs of RCA sockets for phone 1, phono 2, auxiliary 1, auxiliary 2, auxiliary 3, tape 1 monitor, tape 2 monitor and main amplifier inputs. Pairs of RCA sockets are also used for tape recorder outputs and preamplifier outputs.

The preamplifier output and main amplifier input sockets are internally bridged by a slide switch located on the back panel.

(Continued overleaf)

LUXMAN SQ507X AMPLIFIER

(Continued from page 49)

Impedance matching selection for the phono 1 input is achieved by a small rotary switch which on the unit tested, did not align with the corresponding markings on the panel.

Speaker terminals for connecting both the main and remote speakers are of the spring loaded type and very practical. They are colour coded to facilitate phasing.

Three 2– pin American-type mains sockets are also provided on the back panel for powering other equipment. Two of these sockets are switched through the mains switch on the front panel whilst the other is unswitched.

The handbook supplied was written in Japanese with a few odd figures and words in English interspersed throughout the publication. Surprisingly, the wiring diagram, details, component lists and ratings were all in English.

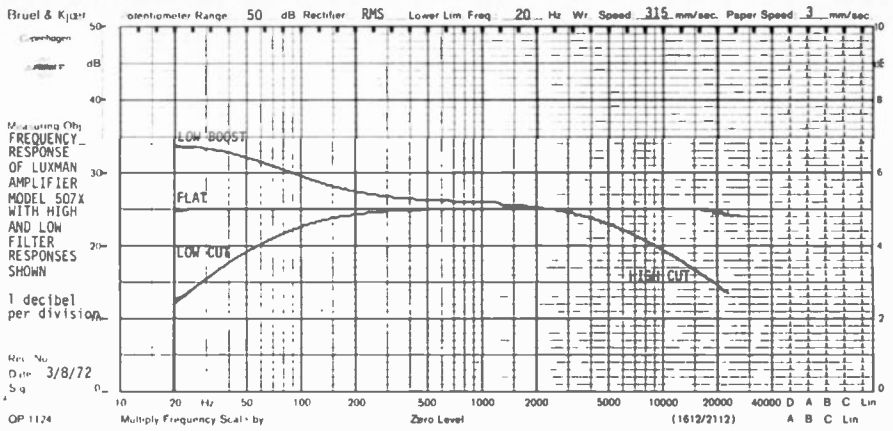
The internal layout of the new unit has been entirely revised and generally improved.

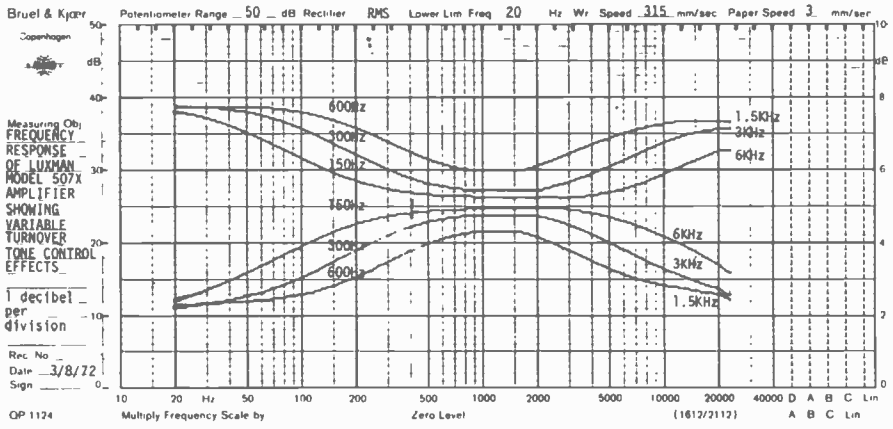
Firstly, each heat sink is a large multi-finned aluminium section projecting through the rear panel of the unit.

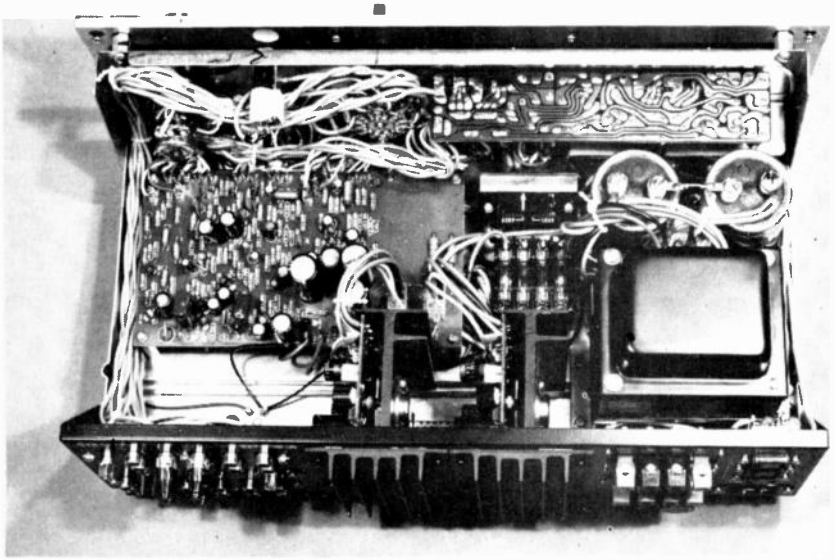
Secondly, the power transistors and the power amplifier boards are all mounted on internal sections of the heat sinks which are located over a small ventilation panel set in the base plate of the chassis. The rest of the circuitry is located on two large printed circuit boards mounted on the base of the chassis.

Fuses in each of the speaker outputs provide primary protection. These fuses are located in the middle of the amplifier and require the removal of the chassis from the enclosure to provide access.

One feature which differs from the general layout used by most Japanese manufacturers is the location of the voltage selector plug inside the unit, instead of on the back panel. This necessitates complete removal of the chassis from the cabinet to check that the voltage is correctly set, but thereafter ensures that the plug will not be accidently altered with subsequent expensive results.



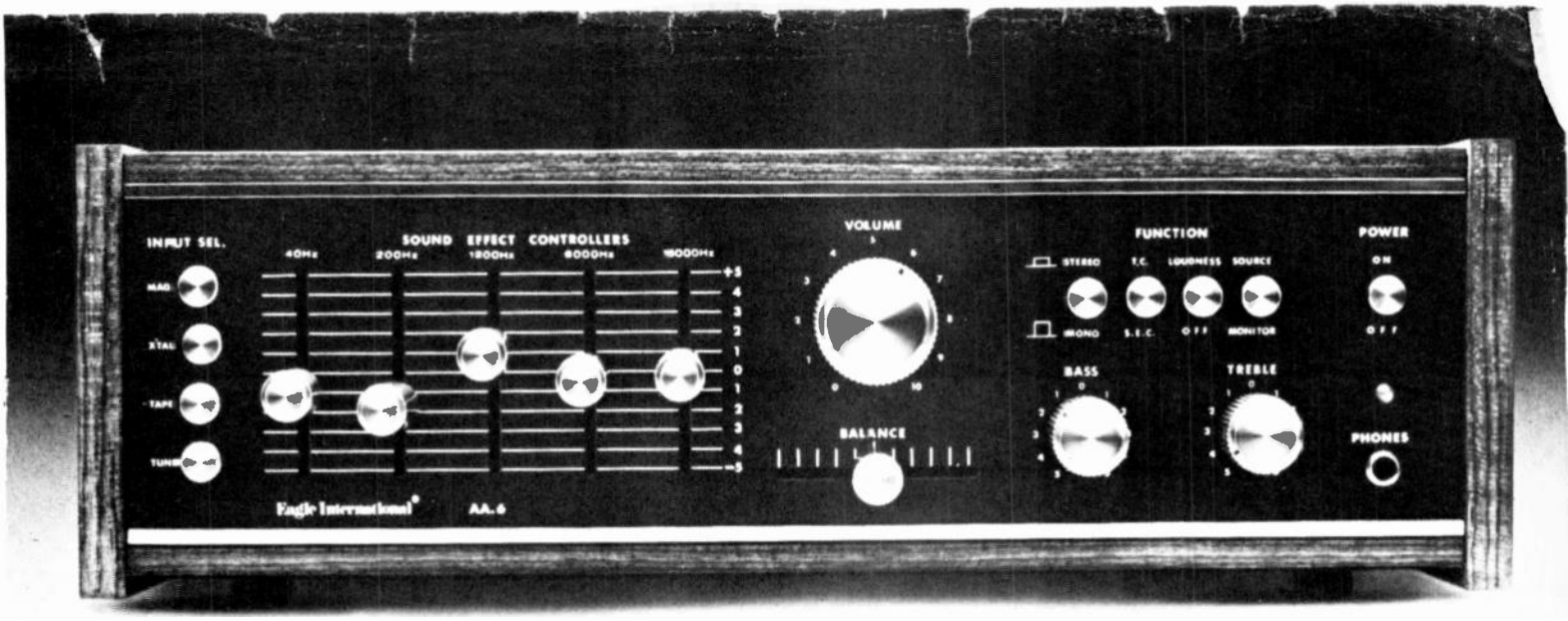




Measured performance of the amplifier was very good, with most parameters being equal to the manufacturer's stated figures as far as we could ascertain from the handbook. However the distortion at maximum output power was 0.3% which was higher than the 0.1% stated in the handbook.

At a recommended selling price of £167, the Luxman SQ507X is clearly not for those who choose equipment on price alone. But it is to the ever increasing number of people who look at engineering features rather than just price tickets, that this amplifier should appeal.

It combines very good performance with a neat and well balanced external appearance. The inclusion of variable turnover tone controls has advantages for correcting roll-off of different speakers and room characteristics at both high and low frequencies. Also the addition of a second set of record and playback tape recorder sockets is in keeping with the latest trends. ●



To boost the violins, slide the fourth knob from the left upwards.

To boost the bass trombones, slide the first knob upwards.

To get Gigli or Sinatra to sing out, slide the third knob upwards. It gives the human voice more 'presence'.

We could go on, but by now you'll take the point.

With the new Eagle AA6 amplifier, you have complete control over the sound you hear.

Much more than you ever had with normal Bass and Treble controls.

Why?

Because the five slide controllers allow you to boost or cut five separate sectors across the whole frequency range, around 40, 200, 1,200, 6,000 and 15,000 Hz.

As opposed to ordinary Bass and Treble controls which simply give you 'blanket' cut or boost, generally around 100 and 10,000 Hz.

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With the AA6, you can literally pick and choose what you hear.

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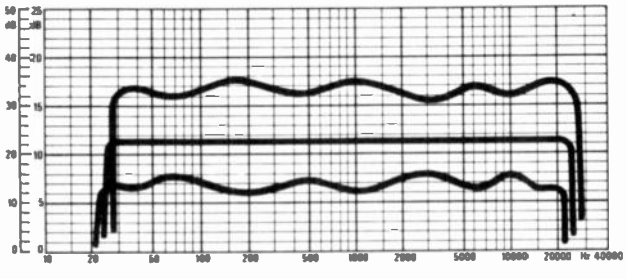
Or poor recordings.

Or quirks in your other hi-fi components.

And when you're not listening so critically, you can revert to simple Bass and Treble controls merely by pushing a button.



Graph shows degree of control throughout frequency range with Sound Effect Controllers in maximum and minimum positions.

Now there's something you must do. Visit your Eagle dealer and ask for a demonstration.

More than any other amplifier, you need to have the Eagle AA6 demonstrated.

To hear it. And to experiment with the controllers.

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ET1

PIONEER CT 4141 CASSETTE DECK

Frequency response of new Pioneer cassette deck rivals reel-to-reel machines

electronics TODAY INTERNATIONAL
product test

With the introduction of the Dolby Noise Reduction System and chromium dioxide recording tape, the majority of cassette recorder manufacturers quickly developed units incorporating Dolby circuitry, together with the (practically essential) facilities for changing the bias level when using chromium dioxide tape.

But Pioneer was an exception to this trend for the company has only recently released a Dolby cassette recorder. Those who have waited for this unit to appear will not be disappointed.

The Pioneer CT 4141 includes a number of very practical features – that we have not seen on any other cassette recorder. In particular, there is a "skip" button and a 'memory' button, which we will describe in more detail later in this article.

At first sight, the unit seems to be a copy of the latest trend in cassette recorder shapes. But whilst this is partly true, additional novel and practical features give the Pioneer unit a character of its own.

The top panel is divided into two main parts, the front section, which is approximately 6" wide, is a brushed aluminium panel and contains the following facilities:–

The left hand side has a row of six piano-key type switches across the front. These are for record, rewind, play, fast forward, stop, and cassette eject. To the right of the eject key is a 'push on' 'push off' pause key. Behind

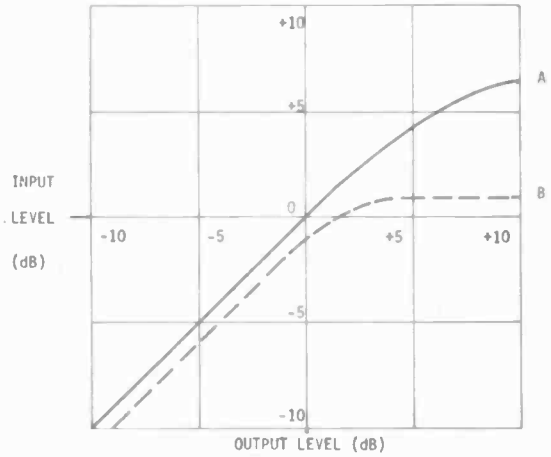


Fig. 1. Transfer characteristics of recorder showing the effect of compression circuit. 'A', is a curve obtained using no compression 'B', is a curve using compression.

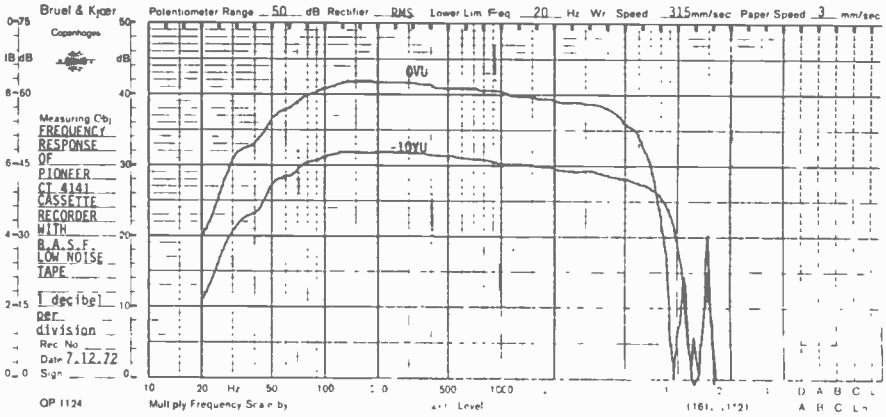
the six key switches, which are black and have a narrow block surround around them, is the cassette-well with a smoked perspex cover, chamfered on all edges.

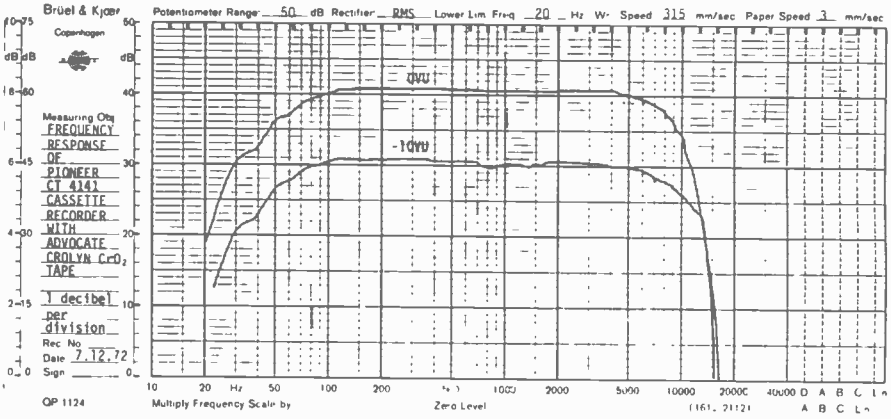
The righthand side of the brushed aluminium panel has four slide potentiometers mounted side by side and located adjacent to the cassette-well. The first two potentiometers are for record level, left and right channel respectively. The second two are for playback level controls. These controls are linearly graduated from 0 to 10.

The left and right channel microphone inputs, the headphone output socket, and the power push button, are arranged in line down the righthand side of the panel. Tip and sleeve sockets are used for the microphone inputs, and a ring tip and sleeve socket for the headphones output. The power switch is a push-on push-off button.

The back section of the panel is all black and consists of a flat section with a number of pushbuttons, and a sloping section with the VU meters and indicators. The push buttons on the flat section are, from left to right:—

a) A hold down skip button (or cue button). This is only operative in the play mode and feeds the tape through at twice the normal speed of 1-7/8" per second (i.e., at 3¾" per second) with the playback head engaged. This





Frequency response of machine as received. ABOVE: Using BASF low noise tape. BELOW: Using Advocate Crolyn tape.

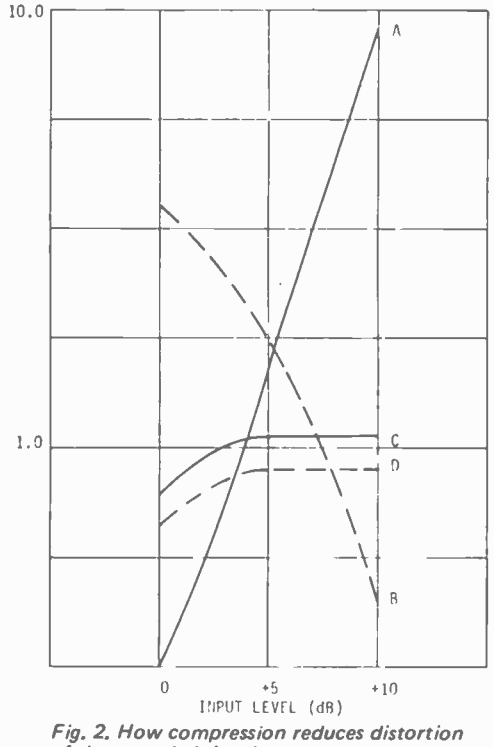


Fig. 2. How compression reduces distortion of the recorded signal.
A) 3rd. harmonic — without compression
B) 2nd. harmonic — without compression
C) 3rd. harmonic — with compression
D) 2nd. harmonic with compression.

is an excellent feature and one that we have not seen on any other cassette recorder. It makes it possible to find a passage in the middle of a tape without having to hop from fast forward to stop, to play, to stop, to rewind etc, as is the case on all other machines we have seen unless one hand manipulates the play button.

b) A set of four rectangular "push on" "push off" buttons which provide the following:

i) 'Dolby noise reduction' switching.
ii) 'Tape equalization level 'normal' or 'chromium' '
iii) 'Limiter' switch which when selected, switches in a compressor circuit to reduce any excessive transients. (The response of this compression circuit is shown in Fig. 1).

The use of this compression circuit resulted in a significant reduction in distortion (as seen in Fig. 2).

An interesting feature is that when the compression circuit is in use, the VU meter and the peak indicator light still operate on the input level *before* compression.

iv) A memory switch which works in conjunction with the counter. When this switch is selected and the rewind key pressed, the tape will automatically rewind to zero and stop. This means that if you wish to start a recording in the middle of a tape you can press the memory button, set the counter to zero and then, if you make a mistake during recording or you want to go back and hear what you have recorded, it is only necessary to press the rewind button and the tape will automatically stop when it gets to zero, eliminating any tedious cueing.

The sloping section of the panel, which is fluted, has a resettable tape counter at the left hand end. This counter has yellow numerals on a black background. This is more easily read than the usual white numerals on a black background. To the right of the counter is a novel tape-run indicator. it consists of light rotating behind a segmented bezel. The light rotates at the same speed as the tape, being synchronized with the take-up spincle, and therefore immediately indicates if the tape has jammed or stopped. When recording, the yellow

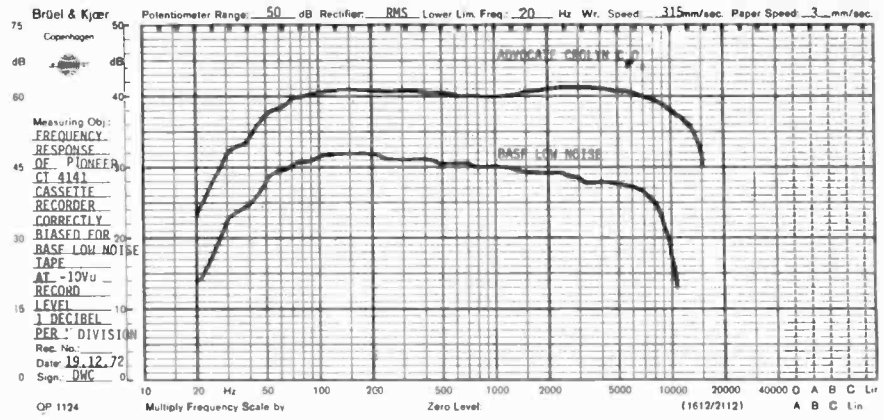
PIONEER CT 4141 CASSETTE DECK

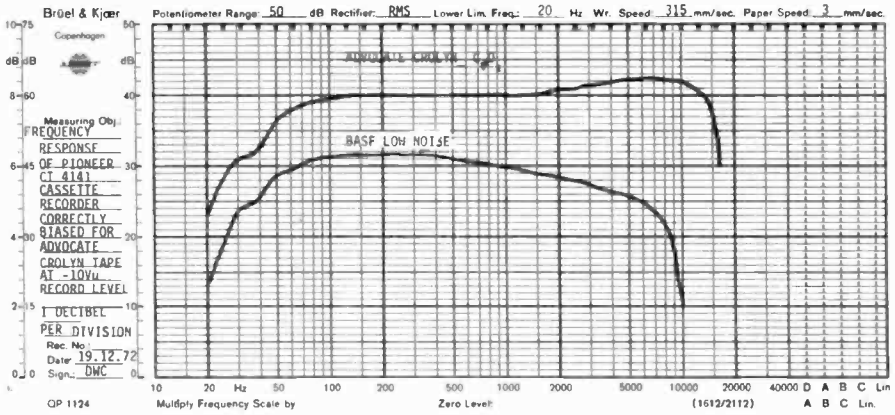
lamp is extinguished and a red lamp now indicates that the record mode has been selected.

To the right of the tape run indicator are two small indicator lights. The first one is blue and indicates that Dolby noise reduction has been selected. The second one is a red light for indicating peaks and this indicates that distortion causing peaks are occurring in the music. The light supplements the inbuilt-VU meters which because of their response time and circuit characteristics, do not always respond to sharp transients (which may cause distortions).

The two VU meters are located directly above the slide potentiometer on the sloping section. The meters are illuminated when the power is on and are accurately graduated +3, +2, +1, 0 −1, −3, −5, −7, −10, and −20dB. All input and output sockets are located on a recessed panel in the back of the recorder. They consist of two pairs of R.C.A. socket for line input and line output respectively, and one DIN combination record playback socket. Each end of the recorder has a veneered timber edging.

All the potentiometers on the main board are clearly marked to facilitate adjustments. These include the bias level adjustment potentiometers, equalization adjustment potentiometers and playback adjustment potentiometer – to name a few of the eighteen adjustment points that we could see.





The Dolby Noise Reduction circuit is located on a separate board mounted on edge at one end of the chassis. The fuse in the unit reviewed was soldered in place internally but we understand that later production models have an externally accessible fuse. The record-playback head uses a ferrite magnetic material to minimise the wear which may occur with some

MEASURED PERFORMANCE OF PIONEER CT 4141 CASSETTE RECORDER SERIAL NO. SF 13011

Frequency Response (Factory set bias) — Advocate Crolyn C_rO_2
0VU 50Hz to 8.5 kHz $\pm \frac{1}{3}$ dB
(optimized bias)
−10VU 50Hz to 9 kHz $\pm \frac{1}{3}$ dB
−10VU 50Hz to 16 kHz $\pm \frac{2}{3}$ dB

Frequency Response (Factory set bias) — BASF Low Noise
0VU 50Hz to 4 kHz $\pm \frac{1}{3}$ dB
−10VU 50Hz to 7 kHz $\pm \frac{2}{3}$ dB

Total Harmonic Distortion (at 1 kHz)
0VU = 0.8%
−10VU = 0.1%

Intermodulation Distortion
1 kHz & 960Hz
0VU = 0.1%
−10VU = 0.06%

Signal to Noise Ratio

(with respect to 1kHz at 0VU)	With Dolby	Without Dolby
Unweighted	49dB	49dB
'A' Weighted	58dB	53dB

Erase Ratio For 1kHz at 0VU
−67dB (BASF Low Noise)
−72dB Advocate C_rO_2

Cross Talk at 0VU

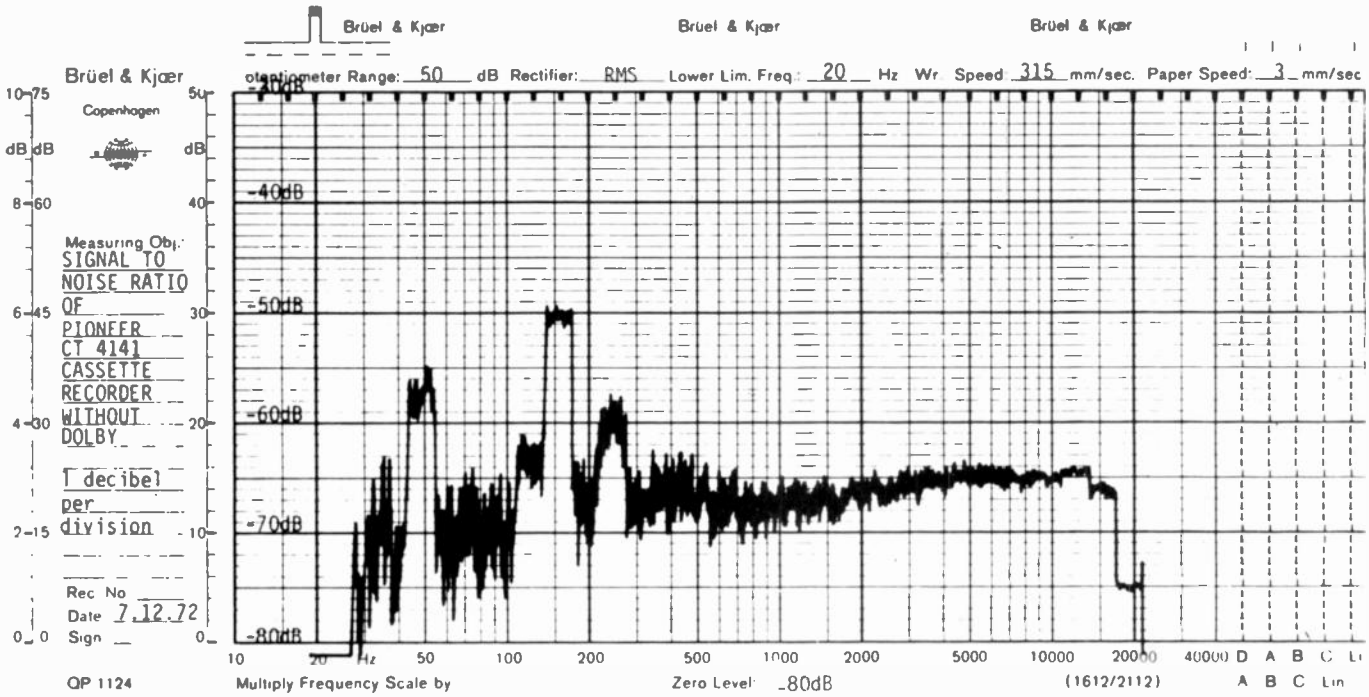
100Hz	40dB
1kHz	40dB

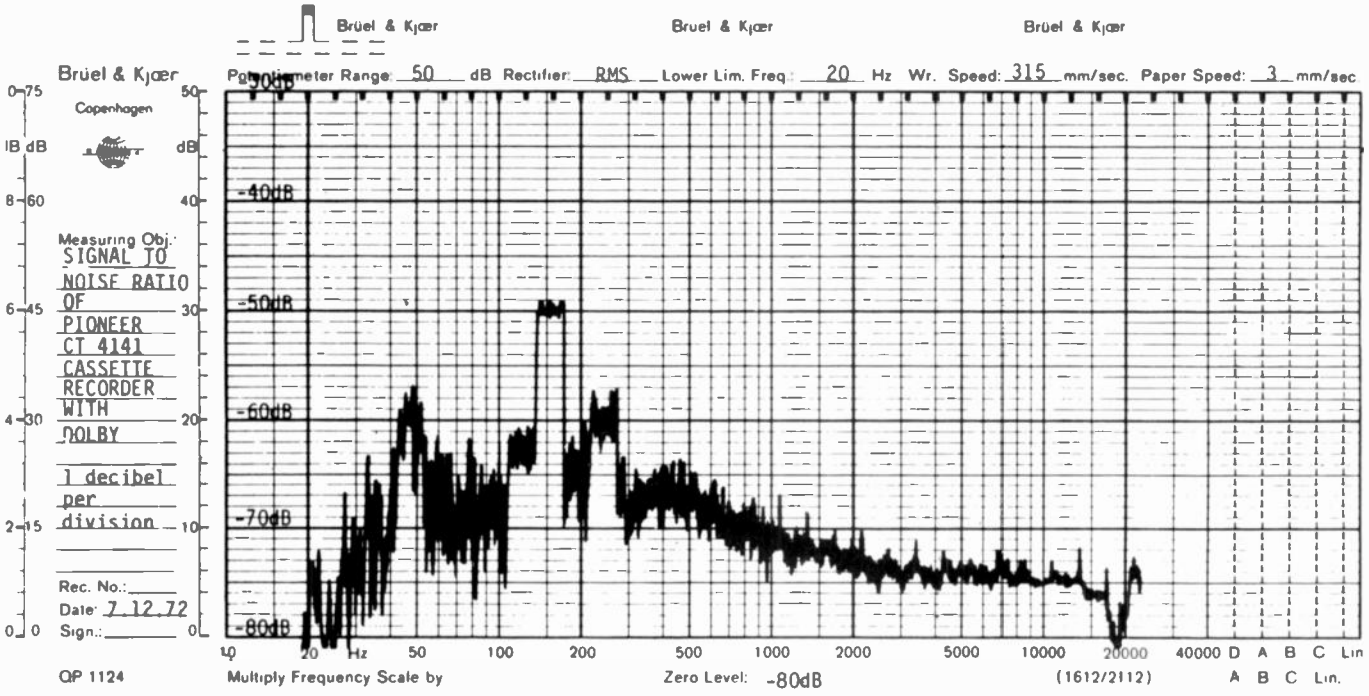
Wow and Flutter
0.03% rms

Speed Error
+ 0.05%

Line Input Sensitivity For 0VU
250mV

Maximum Line Output
(0VU input – BASF low noise tape)
900mV





chromium dioxide tapes on normal iron heads.

We were surprised to find that the iron oxide/chromium dioxide tape switch changed only the record *equalization* and not the record *bias*. This results in a less effective system, and one that can be correctly biased for only one type of tape.

To check this out we firstly adjusted the bias with the switch on the chromium dioxide position and obtained a frequency response to 16 kHz using Advocate Crolyn tape. Using the same setting but this time with BASF tape and with the switch set to the iron oxide position, the results were very poor with a frequency response to 4 kHz only.

We then tried to adjust the bias with the switch in the iron oxide tape position and using BASF tape. This resulted in a marginal improvement.

The equalisation circuit – with the bias switch in the iron oxide position – appeared to limit the performance of the machine when using conventional iron-oxide tapes. With the switch in the chromium dioxide tape position it is possible to obtain a further improvement in frequency response of *iron oxide* tapes – but this seems to negate the purpose of having the switch in the first place.

This machine appears to have been made primarily for use with chromium dioxide tapes and if these are used the frequency response rivals that of full reel to reel machines.

Wow and flutter signal to noise ratio, and distortion, were the lowest we have measured on any Dolbyized cassette recorder to date.

With the exception of frequency response, which with a change of bias level was improved to 16 kHz, the Pioneer CT 4141 is one of the best Dolbyized cassette recorders we have seen to date. At a recommended selling price of £150. 02 it is competitively priced and offers a number of worthwhile features not currently seen on other cassette recorders in the same price range. ●

Recommended retail price – £150.02

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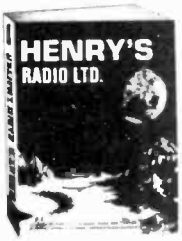

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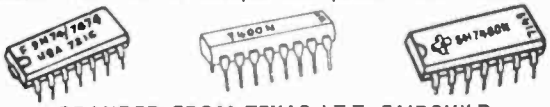

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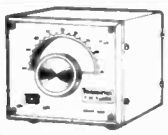

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CRS 7/200	200	65p	
CRS 7/400	400	70p	
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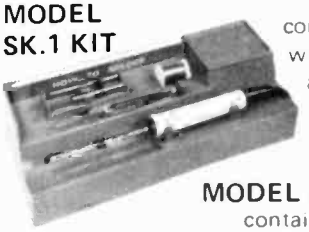

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POWER SUPPLIES

This series of articles by B. Doherty outlines the operation, performance, limitations and design aspects of the modern dc power supply.

PART 2

THE first part of this series published last month described the way in which ac power can be transformed to a higher or lower voltage, and, by various forms of rectification, converted into dc.

But, as was shown, the output voltage from an unregulated supply may vary considerably with changes in input voltage, load current and ambient temperature.

This can be overcome by comparing the output voltage against a 'reference voltage' (that will remain constant despite external variations) and correcting accordingly.

The zener diode may be used as voltage reference source for just this purpose. It is simply a diode manufactured in such a way that it has the unique ability of maintaining a very high reverse resistance, until, at a certain critical voltage, the dynamic resistance falls to a very small value. In this region an essentially constant voltage will be maintained over a wide range of currents. This is shown graphically in Fig. 28.

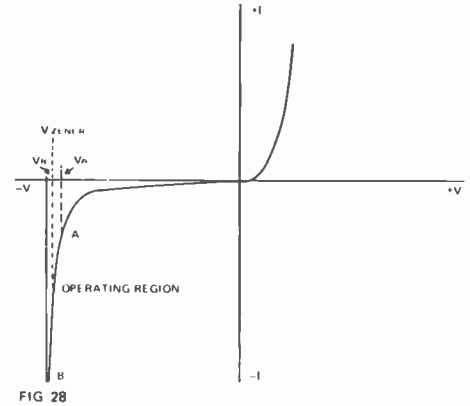


FIG 28

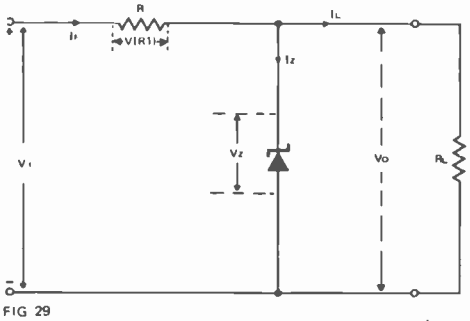
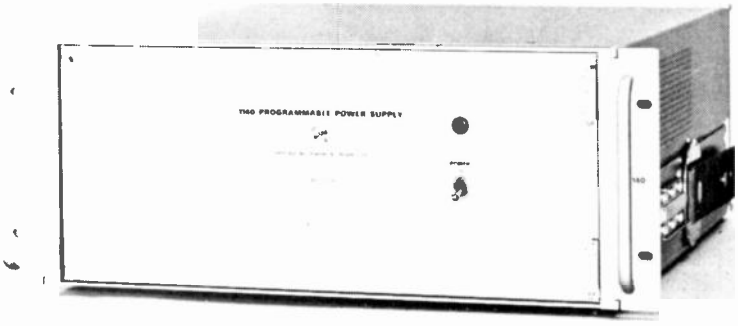


FIG 29



This unit from Tektronix contains three 40 volt supplies, one 100 volt supply, and one current supply. The power unit can be externally programmed.

Fig. 29 shows a zener diode used to produce a constant voltage despite varying load current and supply voltage. As these vary, the zener shunt element draws more or less current. The nett result is a substantially constant output voltage across R_L.

The series resistor R is selected so that the minimum current passing through the zener, lies beyond the knee of the curve shown in Fig. 28, but at the same time ensuring that the zener diode does not exceed its maximum specified power rating (which is at a maximum at zero load).

The design proceedure for the simple shunt regulator shown in Fig. 29 is:—

1. Specify maximum and minimum load current (I_L), say 10 mA and 0mA.
2. Specify the maximum supply voltage V_i that is likely to occur (say, 12 volts) but ensure that the minimum supply voltage will always be approximately 1.5 volts higher than the breakdown voltage of the zener to be used.
3. Thus at any time $V_i = V_z + V_{(R1)}$, where V_z is the breakdown voltage of the zener, $V_{(R1)}$ is the voltage across R_1. And $I_Z = I_Z\,(min) + I_L$, where I_L is the maximum load current required.

Assume that the required output voltage, and hence the zener voltage is 6.5 volts, and the specified minimum zener current is (I_z min) is 100 micro-amps.

Then the maximum I_z is 100 micro-amps + 10 mA which is 10.1 mA.

Thus the series resistor R1 must conduct 10.1 mA at the lowest input supply voltage: and so allowing 1.5 volts minimum drop across R1 (in other words $V_i - V_z$) then

$$R1 = \frac{1.5}{10.1 \times 10^{-3}}$$

$$= 148.5 \text{ ohms}$$

The value of R1 is thus 148.5 ohms, and the nearest preferred value to this is 150 ohms.

At the maximum supply voltage (12 volts) the voltage drop across R1 is I_zR1.

$$I_Z = \frac{(12 - 6.5)}{150} \text{ mA.}$$

$$= 36.7 \text{ mA.}$$

And this is the maximum current that will flow through the zener at any time, i.e., maximum input voltage and

zero external load.

The power dissipated by the zener under these conditions is

$$Pd = I_Z V_Z$$
$$= 6.5 \times 36mA$$
$$= 234 \text{ mW}.$$

This power dissipation is within the capabilities of most small zener diodes – which are rated at 400 mW min.

It should be noted that whilst the zener voltage should be equal to the desired dc output voltage, there is always a small tolerance on the nominal value of the voltage (typically ± 5%), and selection may be necessary in critical applications.

SHUNT REGULATORS

The regulation and power handling capability of a zener diode may be increased by using it as a voltage reference element in an amplifier circuit.

The simplest of these, the shunt regulator, is shown in Fig. 30.

Fig. 30 illustrates the way in which

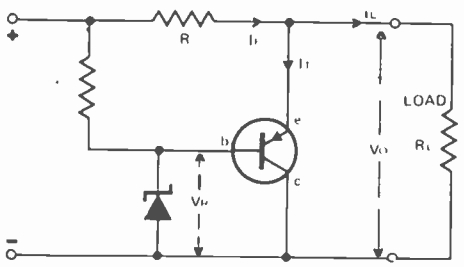


FIG 30

an amplifier is combined with a zener diode.

In this circuit arrangement the zener voltage is made nearly equal to the desired output voltage, and holds the base of the transistor fixed at voltage V_R. If V_o decreases, the voltage between the emitter and base of the transistor will decrease by the same amount, so reducing the emitter current I_T, and with it I_f ($I_f = I_T + I_L$), so tending to restore V_o by decreasing the voltage drop across R. All other variations are similarly accommodated.

The two main advantages of this type of circuit are that the power rating of a transistor is usually greater than that of a zener diode, and this allows a lower value of R to be used, thus improving the regulation of the circuit and secondly, the amplification introduced by the transistor increases the sensitivity of the circuit to much smaller changes in output voltage.

The shunt regulator is inherently short circuit proof, and because of this it is often used for simple power supplies intended for schools, and experimental use. The circuit is however, basically inefficient, and because of this, the series type of regulator is more commonly used.

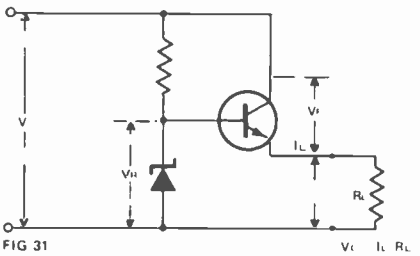


FIG 31

SERIES REGULATORS

The basic series regulator circuit is shown in Fig. 31.

The voltage at the base of the transistor is held at a constant voltage, V_R, by the Zener diode. If the output voltage rises, a greater current may pass through the transistor (since $V_o = I_L R_L$). But this increase in V_o decreases the voltage between emitter and base of the transistor, so reducing the current which the transistor may pass. And since $V_f = V_i - I_L R_L$, increasing the collector to emitter voltage (V_f) reduces V_o back towards its previous value.

The main disadvantage of this circuit is that the regulating transistor is in series with the output, and because of this it must be capable of carrying the full load current; if a short circuit load is applied, the full dc voltage appears across the transistor.

REGULATORS – a more general view

Both the series and shunt transistor regulators described above measure the difference between a fixed reference voltage and the output voltage, and use this voltage difference to control the regulator. In other words the regulator compares output voltage to reference voltage and makes an adjustment in accordance with this difference.

All regulators use a comparator circuit, and this introduces the problem of providing a fixed reference suitable for both a non-variable voltage source and a variable voltage source, (which must of course have an adjustable reference).

A fixed standard voltage can be provided by using either a standard cell as a well defined known voltage; or a zener diode which, with proper circuitry, gives a fixed (but not necessarily accurately known) voltage.

The standard cell voltage reference will only remain accurate if negligible current, or at least a constant current is drawn from it, so that the internal voltage drop is constant. The main drawback of the standard cell is that it "goes flat", but if treated with due respect, it offers a very accurate reference, and in critical applications this disadvantage may be tolerable.

Loading on the cell can be prevented by using a buffer amplifier. The type of amplifier used will take the difference between two inputs and give an output proportional to this difference.

A simple buffer amplifier is shown in Fig. 32.

Terminal 1 is at zero potential and terminal 2 is at a potential $V_r - E_r$. The load current is supplied by the amplifier, not by the standard cell, which now serves only to maintain a fixed voltage difference across the amplifier. If the input resistance of the amplifier is high, the current drawn through the cell will be small. Ideally, the input resistance of the amplifier will be infinite, so that no current is drawn from the standard cell. This circuit allows a substantial current flow at the reference terminals without loading the standard cell.

The inconvenience of periodic cell replacement may be avoided by using a zener diode, although this results in a small sacrifice in accuracy.

A zener diode circuit can however be made extremely stable by maintaining a constant current in the zener (there being only one voltage on the characteristic curve corresponding to any one particular current). In order to maintain a constant current, the zener diode is connected across the terminals of a constant current generator as shown in Fig. 33.

In this circuit, (Fig. 33), terminal 1 is at zero potential and terminal 2 is at a potential Vr – Ez. The load current is supplied by the amplifier, not by the zener diode which now serves only to maintain a fixed voltage difference across the amplifier. If the input

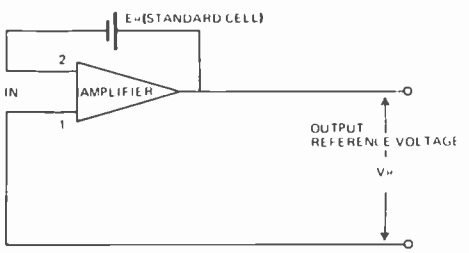


FIG 32

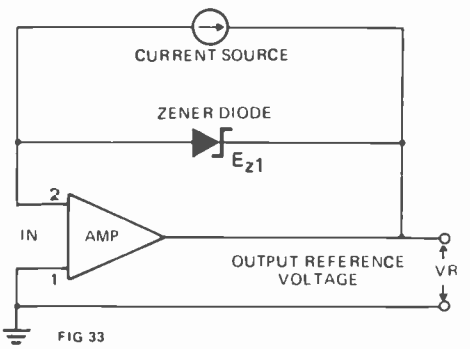


FIG 33

resistance of the amplifier is high, or at least constant, the current through the zener diode will be a constant value at all output load conditions.

An adjustable reference is provided by circuits of the basic type shown in Fig. 34.

Either a potentiometer or a stepped switch may be used to vary the potential input to the amplifier, and hence its output. There are many refinements to this circuit which can be readily seen in specific regulator circuits.

Since the regulator tends to counter any fluctuation in output voltage it will tend to reduce the effect of the ac component of the dc, thus assisting the filter circuit.

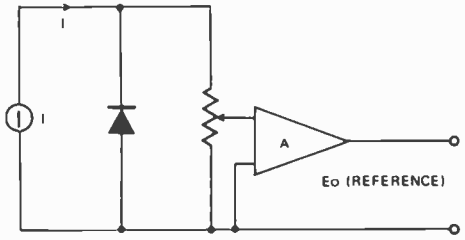


FIG 34

CONTROL OF POWER DISSIPATION AND VOLTAGE RANGING.

The regulator circuit must be capable of dissipating a good deal of power. For a shunt regulator with no load the full voltage is across the regulator, and for a fully loaded series regulator, the full current must flow through the series transistor. The power dissipated by the regulator is the product of voltage across it and current through it.

The series type regulator is generally preferred for high power application because the power dissipated is less than for the shunt type, and it is more suitable for use with pre-regulator circuits.

The pre-regulator circuit adjusts the output voltage of the transformer to a few volts above the desired dc output voltage, so that there need only be a low voltage across the series transistor, hence reducing its power dissipation.

There are two basic approaches to this. The first is to provide a variable transformer output voltage by having taps at various voltages on the secondary with a rotary switch to select the desired tap (a refinement of this being the continuously variable variac type transformer). The second is to use Silicon Controlled Rectifiers (SCRs) in the type of bridge rectifier circuit shown in Fig. 35, the output of

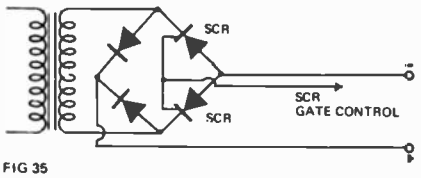


FIG 35

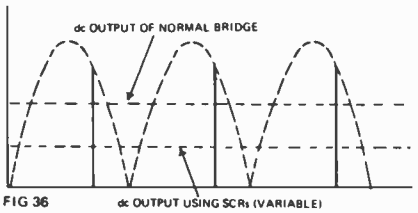


FIG 36

which is shown graphically in Fig. 36.

PROTECTION

The protection of a power supply involves protection of each of the main elements, (the transformer, the rectifier, and the regulator) from overpower, overcurrent, and overvoltage in both steady and transient form.

The simplest form of protection is the fuse, or in its more elaborate variant, the circuit breaker. The fuse uses the heat produced by the overload current to melt a fine piece of wire, which, on melting, produces a gap in the wire over which an arc will be struck until further melting increases the gap beyond the length that the arc can sustain. The break in the circuit is then complete.

The circuit breaker uses the overcurrent to operate an electromagnet which separates contacts to break the circuit. There is an arc drawn at the initial opening of the contacts, but this breaks before the opening is complete.

Both fuse and circuit breaker are quite adequate for protection of the transformer, but unless they are of special construction, have severe limitations if used for semi-conductor protection.

The transformer heats quite slowly because of the large masses of material used in its construction. The semi-conductor material however is only a fine chip, which will heat very quickly to its maximum allowable temperature (which is quite low).

A conventional fuse will not break the flow of current immediately. It must first be heated to its melting point. Typically, this will take about one second at twice normal current, 100 milliseconds at four times normal current and 10 milliseconds at 10 times normal current. A silicon diode will be destroyed, typically, after half a second at twice normal current, after 30 milliseconds at four times normal current, and after five milliseconds at 10 times normal current. Thus if the diode and fuse are rated for the same current the diode will protect the fuse.

A similar problem arises with a circuit breaker, which, because of its inductance, delays the current build up and requires a finite operating time for contact movement.

The conventional protective devices are, therefore, limited in their application, unless they are rated well below the diode current maximum. This, in fact, is the usual solution applied to "built-in" power supplies which have only to carry the load they are intended for.

A safe formula that will ensure that the diode is adequately protected by the fuse is

Diode max. current = 0.8 X short circuit current.

With present-day diodes this substantial over-rating can be achieved quite easily in most cases, and at moderate cost.

Another method is to use special types of fuse and circuit breaker that act much more rapidly than the conventional type, and are therefore, suitable for protection of semi-conductors. But care should be taken when considering the use of fast-action fuses, because of the possibility of someone inadvertently replacing them with conventional fuses.

In most cases using over-rated semi-conductors is better.

Clearly it will be desirable to limit the short circuit current to as low a value as possible. With a normal transformer the internal resistance of the transformer and diodes is the only limit on the short circuit current. But as we have already seen the higher the internal resistance the more difficult the problem of regulation, so there is an obvious need to compromise and it is usually towards a lower resistance to improve regulation and reduce transformer heating in regular service.

It is here that the self-regulating (saturating core) transformer possesses a marked advantage.

The currents in primary and secondary of the transformer are related so that if the secondary current increases, so does the primary current required to maintain the secondary current, and as the current increases so does the flux, which is the only link between primary and secondary. In a

conventional transformer this is so up to the full short circuit current, so the primary continues to supply the flux to support a high secondary current. But the self-regulating transformer saturates, i.e., the flux does not increase after a certain level, so there is no increased flux to support an increase in secondary current, thus the maximum current which can be supplied by the secondary is limited by the saturation of the transformer core.

The circuit is, therefore, self-limiting and theoretically has no need of any other protection provided that the rectifier and regulator can carry the maximum current which the secondary will deliver.

The simpler type protection described above is not always adequate and there are a range of electronic protective circuits which give better protection.

OVERCURRENT CONTROL

The basic method of current control is to insert a low value resistor in series with the output current and then utilize the voltage drop across this resistor in the same way that is done with a voltage control circuit. Thus a

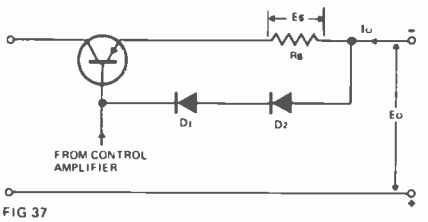


FIG 37

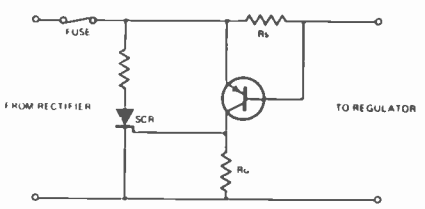
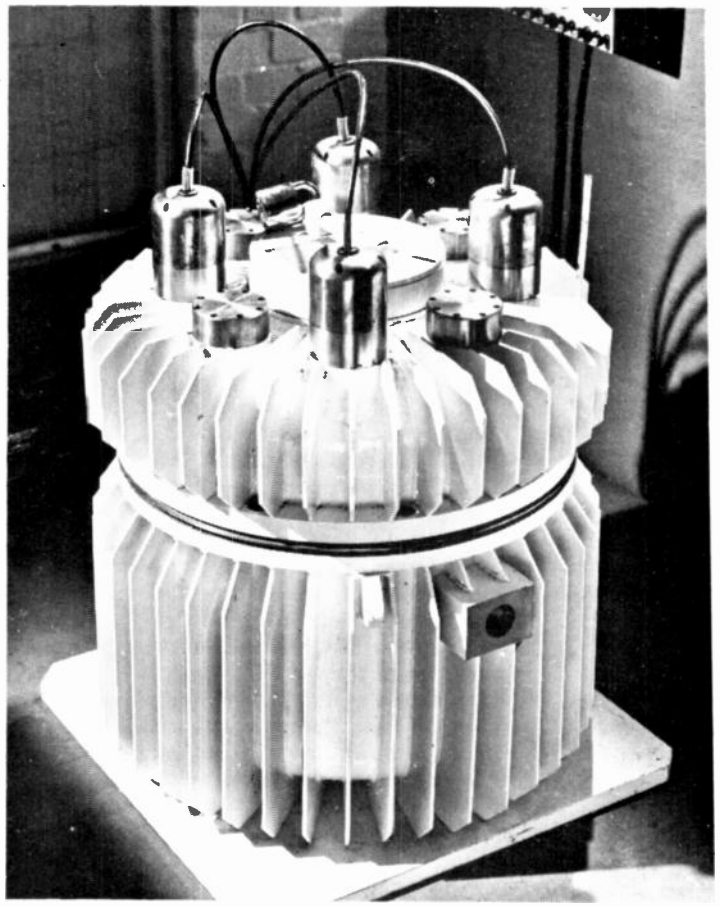


FIG 38

basic current limiting circuit is as shown in Fig. 37. Diodes D1 and D2 are non-conducting when the forward voltage drop across them is less than 0.25V for germanium diodes and 0.7V for silicon diodes. But if the volt drop across R_s exceeds this level, the diodes will conduct and provide negative feedback which reduces current through the transistor. If R_s is made variable, the short circuit current may be altered as desired.

Another type of overcurrent protection that is quite commonly used is "crowbar" protection. (Fig. 38) In broad principle this consists of switching a short circuit across the output of supply and before the input of the circuit to be protected and then relying on the supply protection to operate. This is useful because the short circuit can be switched in very quickly, thus protecting following semi-conductors, and the fuses can then operate with their usual time lag without any danger to the remainder of the circuit.

The value of Rs is chosen so that normally the transistor is cut off and so, therefore, is the SCR, but if the current rises to an unsafe value the voltage across Rs will increase and turn the transistor on, producing a voltage across R_G and so triggering the SCR which will conduct heavily within about 20 microseconds, well before the one millisecond or so danger time for semi-conductors. The fuse will then blow after say 10 milliseconds. The main limitation of this type of circuit is that there may be some sharp transient effects produced by the rapid switching of the SCR. These may be sufficiently large to endanger the circuit which it is intended to protect.



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OVERVOLTAGE PROTECTION

Wherever semi-conductors are used it is essential to safeguard against overvoltages which may breakdown the semi-conductor structure and allow excessive currents to flow.

There are various causes of overvoltages. The main ones are as follows:

(i) Hole-storage effect. When a semi-conductor is switched on (or off) there is a time lag before the minority carriers move into (or from) the base region. This tends to act as a capacitor, giving a voltage spike on switch on (or off) This is normally reduced by connecting small capacitors across the line.

(ii) When a short circuit is interrupted by a fuse an overvoltage is developed the magnitude of which depends on the arc voltage and the circuit of the power supply.

(iii) Transient voltages are similarly produced when a circuit breaker opens.

(iv) If an unloaded rectifier is disconnected on the ac side, some of the magnetic energy stored in the core is converted to electrostatic energy in the winding and lead capacitance.

(v) Ac supply transients will be

Miles Hivolt's TH25/25 can be switched on/off locally or remotely, and the voltage controlled manually or, by a low-voltage input, remotely. DVM readout of voltage and current provides remote monitoring.

transmitted across the transformer. The usual protection for all these overvoltages is to use diodes with a voltage rating of at least one and a half times the peak inverse voltage.

All transient voltages may be reduced by connecting capacitors into the circuit which absorb the energy of the transient pulse (by charging up to the pulse voltage).

In many cases a more sophisticated form of overvoltage protection is desired, and this may be obtained either with a simple zener diode as shown in Fig. 39, or a crowbar circuit as shown in Fig. 40.

In Fig. 39, if the output voltage rises above the zener voltage the zener will conduct heavily, so shunting the output.

In Fig. 40, if the output voltage rises the zener diode will conduct and pass a current to the gate of the SCR thus triggering it. This places a short circuit across the supply and blows the fuse.

The circuit of Fig. 39 is self-restoring, while that of Fig. 40 is not. That is to say once the overvoltage has ceased to exist the circuit of Fig. 39 returns to normal operation, whereas the fuse must be replaced in the circuit of Fig. 40.

These circuits are usually only required for special applications, and for in-built supplies for various equipment it is usually sufficient to use conservatively rated diodes, and a capacitor or two.

OVERPOWER PROTECTION

Overpower protection is not used widely since it will usually be accompanied by overcurrent or overvoltage.

However, in some applications there may be a particularly expensive device, or some critical apparatus which must be protected from excessive power dissipation (with its consequent excessive heat build up).

One of the simpler techniques is to fix a thermistor to the heatsink of the component to be protected as shown in Fig. 41.

The potentiometer is adjusted so that at normal operating power the SCR is non-conducting, but if the power rises so does the temperature, thus lowering the thermistor resistance and increasing the SCR gate voltage. This type of circuit is not very accurate (±10°C approx.) but may be refined if need be, to give better sensitivity.

The methods of protection described above are by no means the only ones available, but are certainly the most widely used.

USE OF INTEGRATED CIRCUITS IN POWER SUPPLIES

Bridge rectifiers in integrated circuit form have been available for several years now. They consist of the four diodes of the bridge rectifier combined inside a single package with two ac terminals and a + and a– terminal.

More recently integrated circuit regulators have become available (see

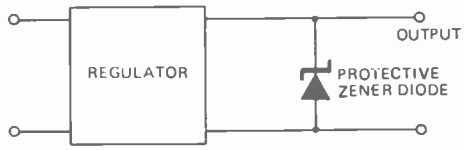

FIG 39

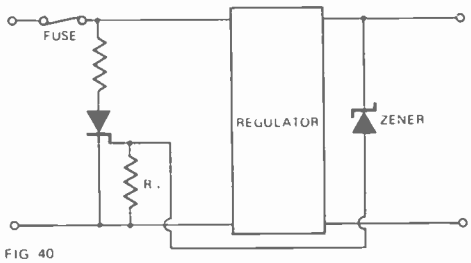

FIG 40

the January 1973 issue of ETI for an example), and there are also integrated crowbar circuits on the market. The main limitation of integrated circuits for power supply applications is their power ratings. Existing ICs cannot cope with the power which discrete devices can handle, at least at their present stage of development. Otherwise, integrated circuits give the same advantage in power supplies as in any other circuit.

The theoretical circuits considered so far require some additional components before they become useful practical circuits.

A PRACTICAL CIRCUIT EXPLAINED

The series regulated supply shown in Fig. 42 combines controlled voltage and current limiting and uses zener diode ZD1 as a reference source.

Reference diode ZD1, which is supplied by resistors R1 and R2, clamps the base of transistor Q4 at a fixed potentional. Capacitor C1 smooths out any 100 Hz ripple from the input.

The output voltage of the power unit is sampled by R6, RV1 and R7 and this is compared against the zener reference voltage by transistors Q4 and Q5. The voltage at the base of Q5 is the zener voltage minus the two base-emitter voltages, i.e. $V_z - 1.2V$. The output voltage is then this voltage multiplied by the ratio of the resistors in the divider chain.

The output of the comparator is taken via R5 to the output stage consisting of transistors Q2 and Q3.

The action of this part of the circuit is as follows, if the output voltage drops (because the load has increased) then the difference between the zener reference voltage and the divided output voltage will increase. And since this voltage appears across the base-emitters of Q4 and Q5, these

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H7	40	Wirewound Resistors. Mixed types and values	50p
H40	20	BFY50/2. 2N696. 2N1613 NPN Silicon uncoded TO-5	50p
H8	2	OCP71 Light Sensitive Photo Transistor	50p
H39	10	Integrated circuits. 6 Gates BMC 982. 4 Flip Flops BMC 945	50p
H30	20	1 Watt Zener Diodes. Mixed Voltages 6.8–43V.	50p
H35	100	Mixed Diodes. Germ. Gold bonded etc. Marked and Unmarked.	50p
H28	20	OC200/1/2/3 PNP Silicon uncoded TO 5 can	50p
H38	30	Short lead Transistors. NPN Silicon Planar types.	50p
H41	2	Complimentary Power Transistors. BD131/BD132	50p

UNMARKED UNTESTED PAKS

B86	150	Germanium Diodes Min. glass type	50p
B83	200	Trans. manufacturers' rejects all types NPN, PNP, Sil. and Ge-m.	50p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B85	100	Sil. Diodes sub. min. IN914 and IN916 types	50p
B88	50	Sil. Trans. NPN, PNP equiv. to OC200/1 2N706A, BSY95A, etc.	50p
B1	50	Germanium Transistors PNP, AF, and RF.	50p
H6	40	250mW Zener Diodes DO-7 Min. Glass Type	50p
H34	15	Power Transistors. PNP. Germ. NPN Silicon TO–3 Can. P & P 8p extra	50p
H17	20	3 Amp. Silicon Stud Rectifiers. Mixed volts	50p
H18	30	Top Hat Silicon Rectifiers. 750mA Mixed volts	50p
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90 Watt	24p	22p	20p

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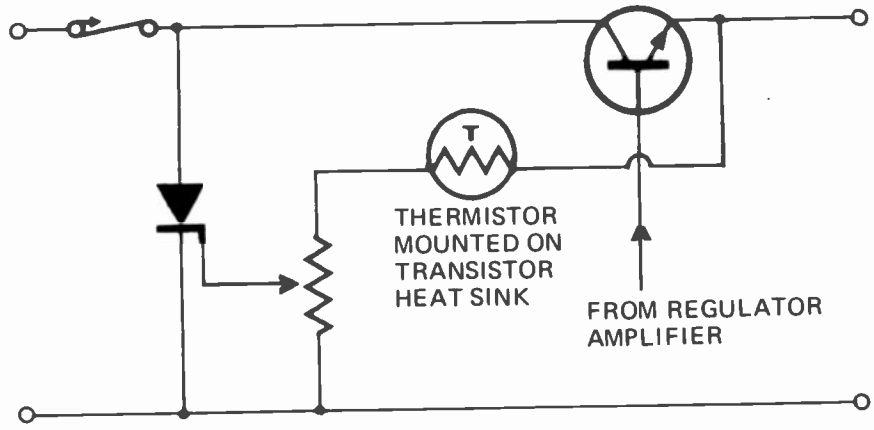

FIG 41

transistors will pass more current. This causes Q3 and Q2 to conduct more heavily, thus reducing the voltage drop across them and so allowing the output voltage to rise and compensate for the increased load; for every load there will be a stable output voltage the regulation of which is dependant on the gain of the comparator amplifier.

The second mode of operation is current limiting, and this is used to protect both the power unit and the load in the event of a short circuit or load that exceeds a predetermined level.

When the current increases beyond a predetermined level, the voltage drop across R3 is sufficient to bias transistor Q1 into conduction. When this occurs the output from the voltage comparator Q4, Q5 is progressively removed from the output transistors Q3 and Q2; these in turn reduce the excess current flowing into the load and an almost constant current is now supplied to the load regardless of any further load increase.

POWER SUPPLY PERFORMANCE CRITERIA

(i) **LOAD REGULATION**
Load regulation is a measure of the ability of a power supply to maintain a constant voltage at its terminals regardless of load variation. The regulation is normally specified as a percentage of the nominal output voltage for a fixed voltage supply or of the maximum voltage of a variable voltage supply. So if regulation of a 50V supply is given as say 0.01%, the terminal voltage will not fall below (50 -0.005)V or rise above (50 + 0.005)V.

(ii) **LINE REGULATION**
Line regulation is a measure of the ability of the power supply to absorb changes in the ac mains voltage while holding the output voltage steady. The ratio of the change in output voltage for a change in mains voltage multiplied by 100 gives the line regulation percentage.

(iii) **RIPPLE**
This may be measured with either a true rms reading meter or with a cathode ray oscilloscope. Then ripple is

$$r\% = \frac{\text{rms of ac component}}{\text{dc component}} \times 100$$

(iv) **TEMPERATURE STABILITY**
The output of a power supply should be constant, regardless of ambient or operating temperature. A performance figure is sometimes quoted in mV/°C.

(v) **CURRENT STABILITY**
The above four quantities may be evaluated for current stability by inserting a series resistor in the circuit so that the voltage produced across it is proportional to the current.

(vi) **TRANSIENT RECOVERY TIME**
In some applications it may be important that should the loading be sufficient to force the output outside the tolerance band set by the regulator, the supply will re-adjust itself swiftly. The transient recovery time gives a measure of the speed of re-adjustment.

(vii) **LONG TERM STABILITY**
There is some drift in the performance of a power supply if it is used continuously for say 8 hours. The % change in output voltage may be quoted per 8 hours, 12 hours, 24 hours or whatever the maker specifies.

In assessing the performance of a power supply note should also be taken of its overload protection facilities, and of any transients observable on switch on/off, or with operation of the protective circuits.

A further article, to be published shortly, will deal with a relatively new development, viz, power supplies without mains transformers. ●

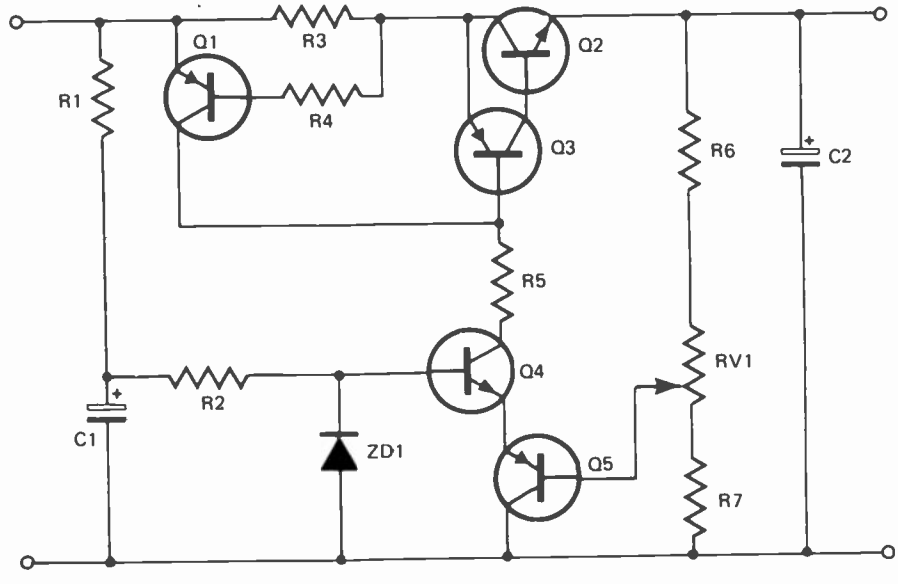

FIG 42

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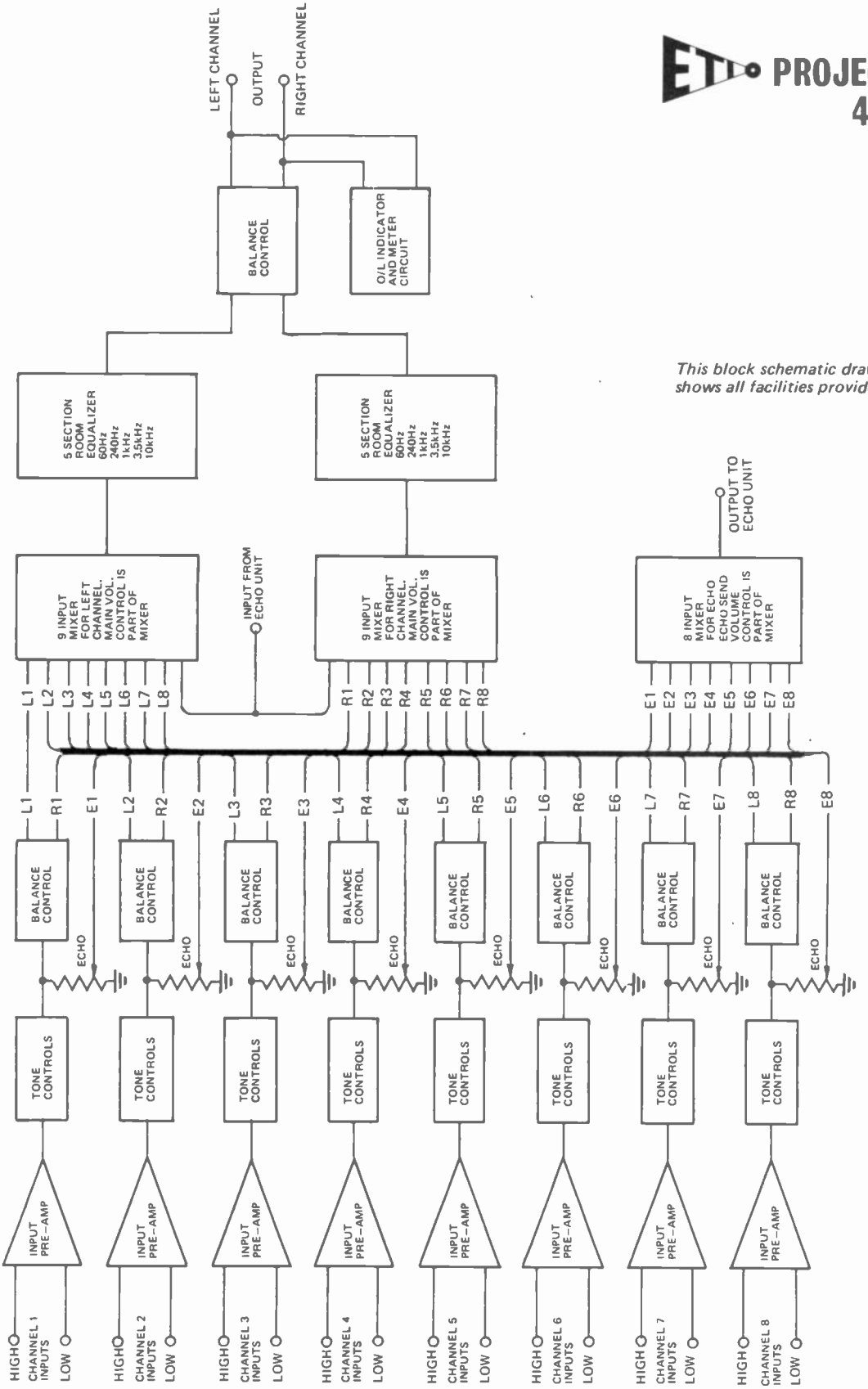
ETI MASTER-

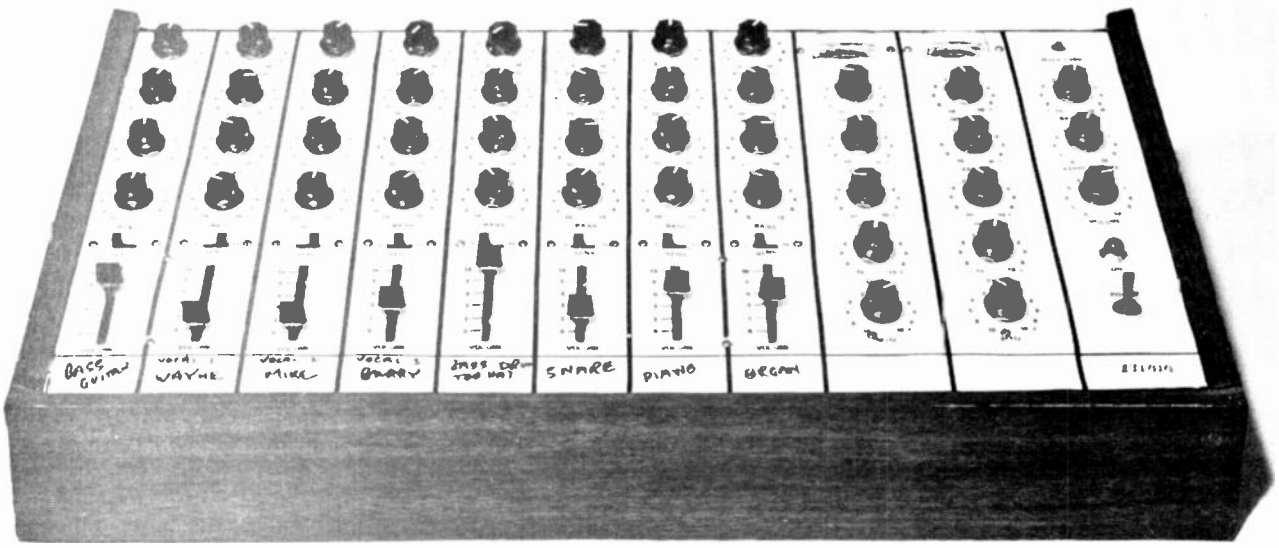
ETI PROJECT 414



This block schematic drawing shows all facilities provided.

MIXER

Versatile multi-input mixer/preamplifier has all the facilities required for professional PA use.



- **Multiple inputs**
- **Low noise**
- **Stereo outputs**
- **Inbuilt equalizers**
- **Echo facilities**
- **Professional design**
- **Overload immunity**
- **Stage monitor facility**

Anyone who is associated with a pop group or band, will be familiar with the steps one must take to ensure optimum sound in varied localities and halls.

Outdoors, each amplifier and/or public address system must be adjusted separately to ensure sufficient sound and optimum overall mix.

Indoors, one must also cope with the acoustics of the particular building.

Many of the smaller groups merely adjust their sound on stage with one member at the back of the hall giving a subjective indication of the sound he is hearing. Larger groups often employ a person whose main function is to ensure that the final sound is exactly as it should be (as regards volume, mix, quality, etc).

The 8-channel mixer described in this article will allow the total sound to be adjusted at the one point – perhaps the rear of the hall, while at the same time, eliminating several expensive amplifiers, and still ensuring an optimum overall sound. (This is only part of the story as the reader will realize from the full description of the unit).

INPUTS

As the name of the unit indicates, there are eight separate input channels. Each of these input channels has two input sockets, one of 47k impedance, and the other adjustable by changing one resistor, (maximum 4.7κ). In our case we have a 200 ohm resistor in circuit so we shall refer to the 200 ohm input from here on.

Each input channel has a slide control potentiometer for volume. This potentiometer is in series with a sensitivity network that is adjusted by a three position slide switch.

The remaining input channel controls are rotary potentiometers facilitating balance, bass, treble and echo-send volume. We shall discuss these controls in detail later in this article.

Each input, after passing through the preamplifier and tone control stages, is divided to provide identical signals. The relative level of these signals can be varied by the input channel balance control. The outputs from the balance controls drive the output mixers. This creates a stereo effect, allowing the performers to be audibly "positioned" on stage.

OUTPUTS

The unit has two output channels. The unit can of course be modified simply to provide one main output and an onstage monitor output. These receive signals from the input channel balance controls and external echo unit, or similar, if one is employed. Rotating any of the input channel balance or echo-send controls will affect the output for that particular input only.

There are also controls provided for overall volume, balance and echo volume. Finally five more rotary controls per output channel have been provided for frequency equalisation. These allow compensation for hall acoustics etc. These controls operate at 60Hz, 240Hz, 1000Hz, 3500Hz and and 10kHz and provide approximately 10dB boost or cut.

Two VU meters also feature on the front panel, together with an overload indicator light which becomes

TURN INDICATOR CANCELLER

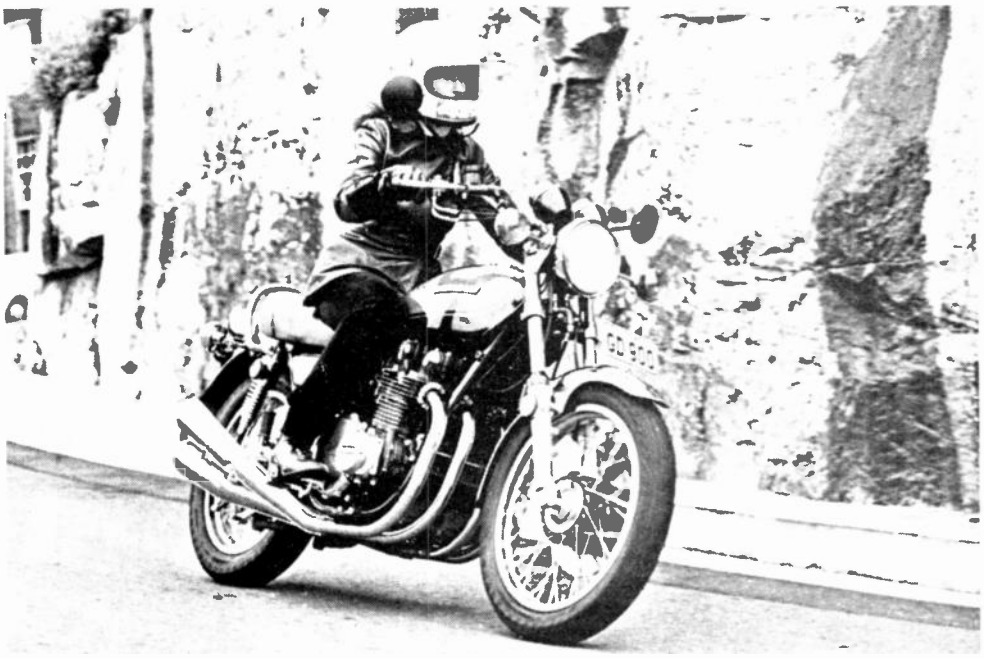
Simple electronic unit cancels turn indicators after 30 seconds.

ETI PROJECT 308

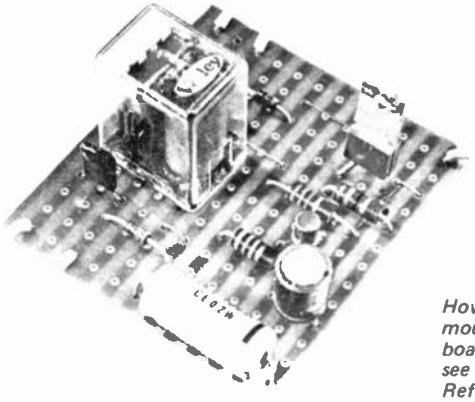
For some time now, in some countries, it has been compulsory for drivers of vehicles fitted with turn indicators to signal right or left turns, to cancel the turn indicator after a turn has been executed.

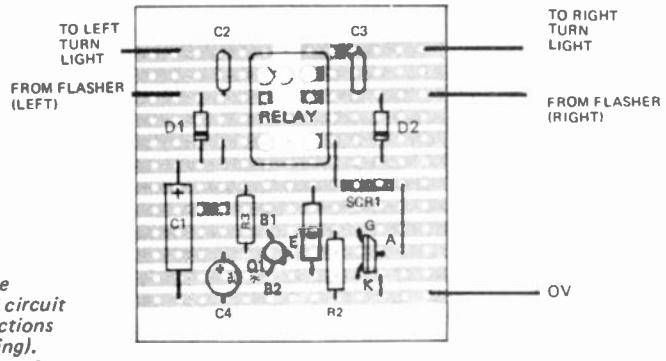
In the UK, the regulations do not (as yet) require legally obligatory cancellation of turn indications. All modern cars are fitted with automatically cancelling indicators. However, there are still, on our roads, many older vehicles which require manual operation to signal a turn as well as to cancel the indication. Besides, motor cycles, scooters and some mopeds fitted with turn indicators, also do not have automatic cancelling facility.

Driving or riding such vehicles, fail-

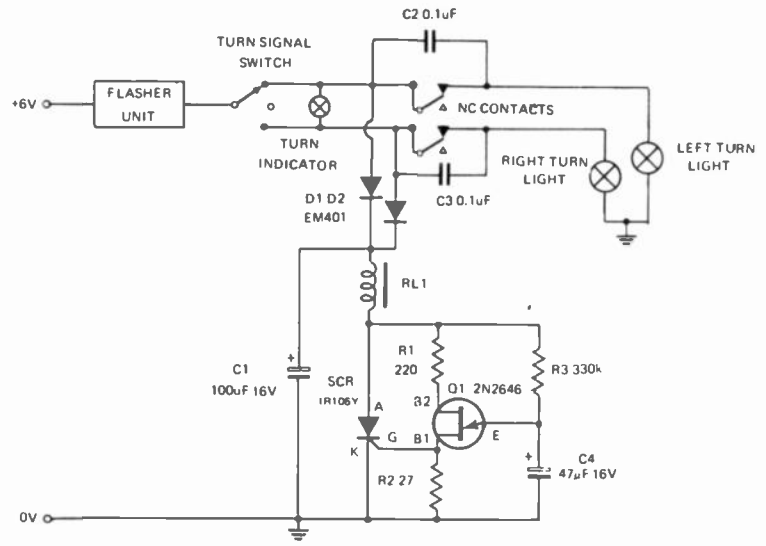


For the motor cycle enthusiasts amongst our readers, the machine in our lead picture is the latest 4-cyl 900cc. Kawasaki. Lucky lady handling it so expertly is our associated magazine Revs Motorcycle News' editorial assistant Christine Froebel





How the components are mounted on the printed circuit board. (For relay connections see accompanying drawing). Refer also to photograph left.



Circuit diagram of complete unit.

ure to remember to cancel the indicator causes traffic nuisance and hold-ups and, in extreme cases, may even render you legally culpable (in the eyes of some magistrates) for any ensuing accident.

ELECTRONICS TODAY INTERNATIONAL presents this project specifically for users of such vehicles. The unit described is an economical means of ensuring that turn indicators are switched off automatically 30 seconds after a turn signal has been initiated. However, being essentially a 'delay-off' circuit operating on 6 or 12 volt pulses, it may also find other uses such as immobilisation of electrical circuits after an alarm has been initiated etc.

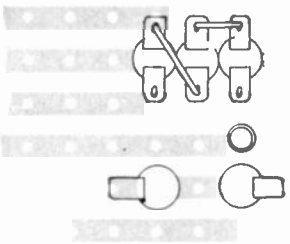
CONSTRUCTION

There are only 12 components all told, therefore there should be no problems with construction providing the wiring diagram and overlay are studied carefully.

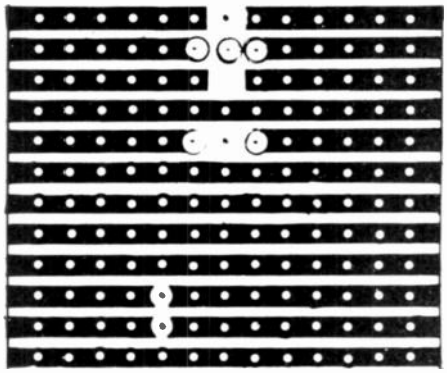
Most motor cycles have six volt power, either from a battery, or mag-dynamo and in this case a relay with 52 ohm coil should be used. Where a 12 volt system is used, the relay should have a 185 ohm coil.

Locating the unit will be a matter of choice, and will depend on the particular machine – for this reason we have not provided case details. The unit should be mounted as close to the turn signal switch as possible so that long leads are not necessary.

To wire the unit into the turn indicator circuit, locate the two wires coming from the flasher, cut both and connect them as shown on our overlay diagram. There is no need to identify left and right, so long as each wire is cut and then terminated with both sections on one side of the matrix board as shown. ●



Relay connections. Holes should be drilled through the veroboard large enough to accomodate the twin tags. The tags are then bent over and soldered as shown.



Use a sharp drill to break the tracks on the veroboard as shown. Several holes must be enlarged to enable the relay tags to pass through.

PARTS LIST ETI 308

SCR	—	silicon controlled rectifier IR106Y
Q1	—	unijunction transistor 2N2646
D1, D2	—	silicon diode EM401, BY126/100 etc
R1	—	resistor 220 ohm, ½ watt, 10%
R2	—	resistor, 27 ohm, ½ watt, 10%
R3	—	resistor, 330k, ½ watt, 10%
C1	—	electrolytic capacitor, 100uF, 16V, pigtail
C2, C3	—	polyester capacitor, 0.1uF, 100V
C4	—	electrolytic capacitor, 47uF, 16V, upright
Relay	—	miniature relay type VP2, 5A. For 6V vehicles (52 ohm coil), 12V vehicles 185 ohm coil — see text
Veroboard	—	2¾ inches wide, 3 inches long, 0.2 inch spacing
Sundries	—	hookup wire, solder etc.

HOW IT WORKS

When either blinker is switched on, pulses from the flasher unit charge C1 and C4 via either D1 or D2, and in the case of C4, also via the relay winding and R3. When the charge on C4 is sufficient to trigger UJT Q1, a pulse occurs across R2. This in turn gates the SCR on allowing C1 to discharge via the relay and the SCR. The C1 discharge current through the relay winding actuates the relay and the normally closed contacts are opened, breaking the current path to the light concerned.

This removes the major load on the flasher unit, which then stays on. Providing the indicator switch is left on, the SCR will continue conducting via the relay winding, thus the contacts remain open. Since the timing circuit is directly across the SCR, it is reset immediately the SCR turns on which ensures that the next timing period will be the same as the first. Switching the indicator switch to the off position, removes power from the relay and it then drops out.

The blinker on-time is determined by the C4/R3 time constant – in this case about 30 seconds. Increasing the value of either component lengthens the 'on' time, and vice versa. The capacitors across the relay contacts are included to protect the contacts from arcing.

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Completed by a decor-styled cabinet. Size approx. 43 x 7½ x 19cms. Speakers are the famous Wharfedale Dexton 2. Size approx. depth 8¾in. x width 9¾in. x height 14in. Turntable is the renowned Garrard SP 25 Mk III with the well known Goldring G800 magnetic cartridge plus deluxe plinth and cover. Size approx. depth 38½ x width 38 x height 19 cms. We at Audio Supplies have put a lot of research into this system and believe it is going to be the most popular system of the seventies.

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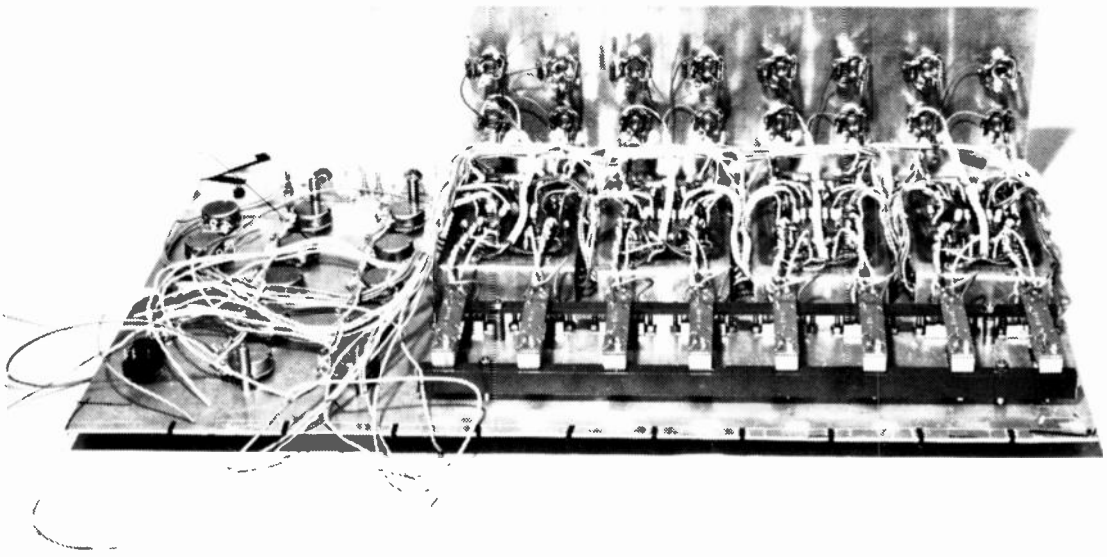
ETI MASTER-MIXER

(Continued from page 68)



This photograph was taken during construction of our prototype unit. The four input pre-amps may be seen on the right. Directly in front of the pre-amps are the slide potentiometers used for individual volume controls.

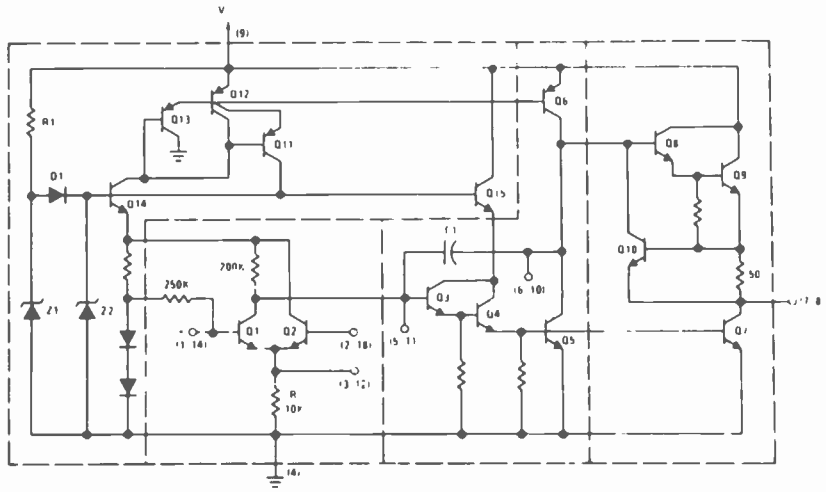
A nine-input mixer I.C. is employed at the input of each output channel. One of the nine inputs is in both cases used for echo input, while the others take the outputs from the eight input channels. The negative feedback of these op-amps is varied for overall volume control.

The outputs from the main mixers pass through the graphic equalisers and then to an overall balance control. The two VU meters and the overload indicator are connected at the output of the unit.

The metal panel of our unit is folded from one piece of 18 gauge steel. Eleven aluminium escutchions are used, although of only three different types. These should be available from kit suppliers, however should the reader wish to make his own panels and cabinet, diagrams of both metalwork and woodwork will be published in a later issue of this magazine.

The main purpose of this introductory article has been to familiarise the reader with the project without becoming too involved with actual circuitry and construction.

Circuit of National type LM381 dual low-noise pre-amplifier IC used in the 8-channel mixer.



We conclude this month with a description of the I.C. we have employed in the preamplifier stages.

The device is a National type LM381 dual low noise preamplifier IC. We have used one IC per every two input channels — a total of four, if one requires all input channels.

The total equivalent input noise is specified as maximum 1μV rms with a 600 ohm source impedance, over a frequency range from 10Hz to 10kHz

The open loop gain of each amplifier is typically 112dB, the supply range 9 to 40 volts, and power supply rejection better than 120dB.

Supply current is typically 10mA over the voltage range quoted above. Channel separation measured at 1kHz is typically 60dB. Total harmonic distortion measured at 1kHz with the gain set at 75dB is typically 0.1%.

The maximum recommended input voltage is 300mV, and the typical available peak-to-peak output voltage swing is Vcc minus two volts. This I.C. is short circuit protected.

Circuit diagrams and descriptions and constructional details of this unit will commence in our next issue. ●

(continued from page 37)

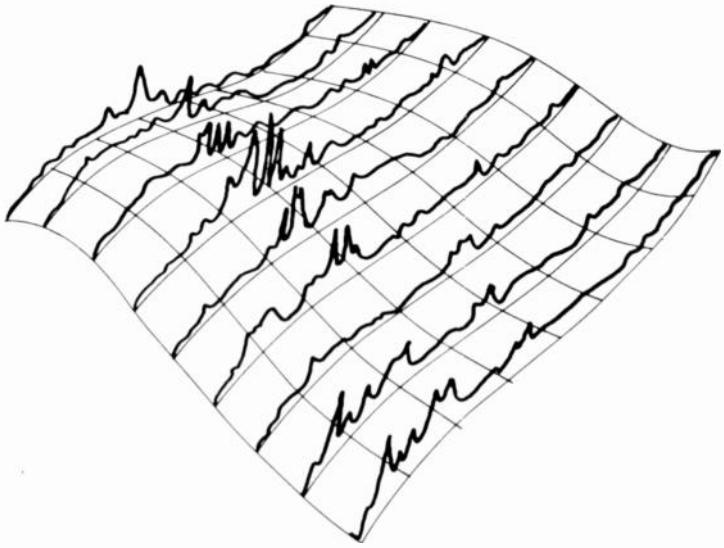


Fig. 11. Three dimension representation of rainfall distribution measured by Bell Telephone laboratories

mind) but here the image is dynamic and splashing drops on the terminal boxes of the equipment lead to errors.

Finally, a brief comment on ice measurement. On aircraft superstructure and North Sea trawlers, ice builds up impairing the performance, on the former it would lead to trouble so de-icing units, which heat or crack the ice away, are standard equipment. Generally, the pilot decides when to de-ice by subjective factors such as heaviness of control. Approval has recently been given to a small device that electrically indicates the amount of ice build-up. A probe about 25 mm across is fixed in the air-stream to simulate the worst point on the airframe. The probe is an oscillator in which its mechanical mass forms part of a tuned circuit. As ice builds up, the resonant frequency changes providing a continuously varying signal of build-up.

FURTHER READING

HYGROMETRIC AND PSYCHROMETRIC TABLES:
"Smithsonian Meteorological Tables, 6th ed., R.J. List, Publication 4014 Smithsonian Institute, Washington, D.C., 1963.
"Hygrometric Tables", H.M. Stationery Office, 1964.
"Psychrometric Tables (Marvin)" Published in U.S. available C.F. Cassella, Regent House, Fitzroy Square, London.

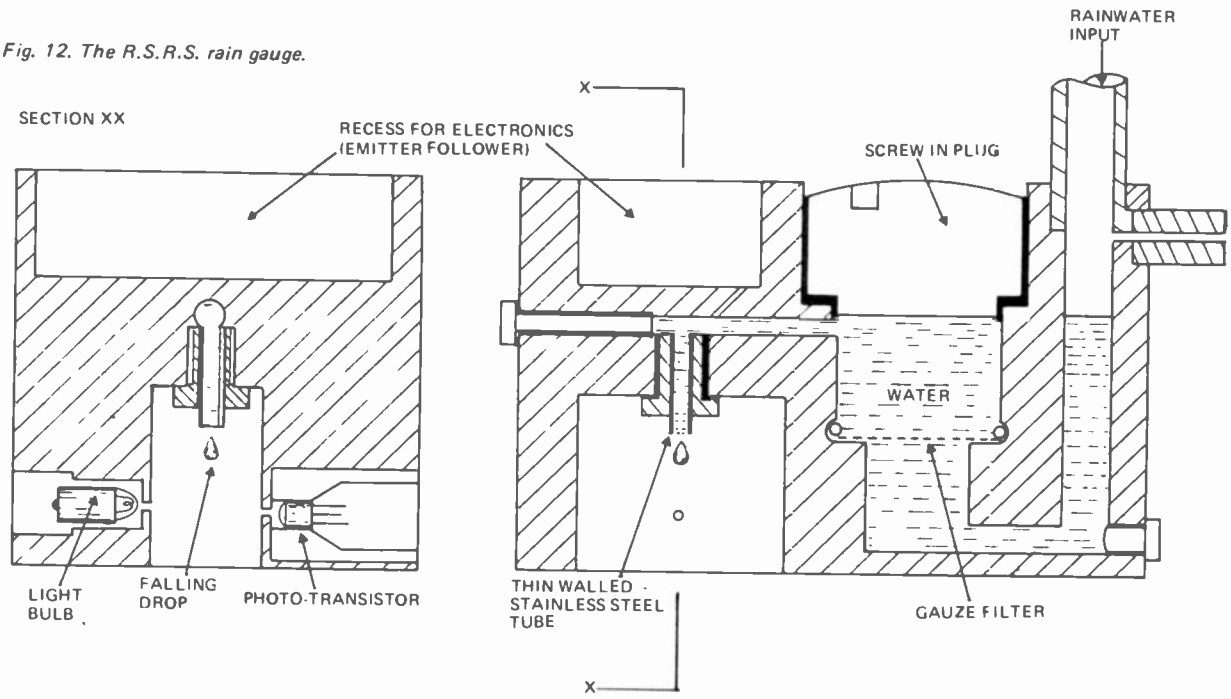
DEFINITIONS AND TERMINOLOGY:
Numerous working data pamphlets by Cambridge Systems Inc., Newton, Massachusetts 02158, U.S.A.
"Humidity and Moisture: Measurement and Control in Science & Industry" Reinhold Publishing Corp, N.Y., 1965, Four volumes.

CALIBRATION:
"Humidity Calibration Techniques", K.M. Cole and J.A. Reger, Instrum. & Control Systems, January, 1970, 77–82.

METHODS IN INDUSTRY:
Many papers appear in issues of "Measurement and Control" journal. ●

Editor's note: Part 10 in this series will deal with flow measurement.

Fig. 12. The R.S.R.S. rain gauge.



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Laser communication through the atmosphere

Laser beams may be used for intra-city communications.

ALTHOUGH communications engineers have already made it possible for several tens of thousands of telephone calls to be carried via coaxial cable, the search for new, even more efficient transmission media is continuing in view of the exponential growth of information flow.

The strong focusing properties, the high degree of security against interception and the wide available bandwidth of the laser beam render it potentially important for communication purposes. Scientists from Siemens Aktiengesellschaft Research Laboratories are investigating the possibilities of such a system over a 5.4km long path between the Munich districts of Giesing and Obersendling, in particular the effect of atmospheric conditions on laser-beam communications.

The CO_2 laser being used in the investigations emits infrared radiation at a wavelength of 10.6um at an output power of 5 W.

At the beginning of the experiments the use of a helium-neon laser was considered, but it has since been confirmed that the invisible infrared beam is considerably less susceptible to atmospheric influence than the visible helium-neon laser beam.

Nevertheless, even the CO_2 laser beam is subject to some perturbing effects: absorption by water vapour and carbon dioxide in the air, light scattering by minute particles of water and dust and atmospheric turbulence created by side winds and solar irradiation attenuate the laser beam, render it more diffuse, displace it and cause its intensity to fluctuate. Despite this, communication via a CO_2 laser beam is still possible in heavy mist and moderate rain, fog and snow.

The use of the laser in the communications field is thus full of promise since, in view of its very high frequency (28.3 THz for the CO_2 laser) it offers the possibility of large channel capacities for telephone calls and radio and television broadcasts. Laser transmission through the atmosphere has considerable potential use in earth-satellite links and short-range relay links between tall buildings in large towns and cities.

The optical transmission of information could also be of interest in connection with the introduction of videotelephony, which requires a bandwidth of 1 MHz and thus poses extremely complex transmission problems.

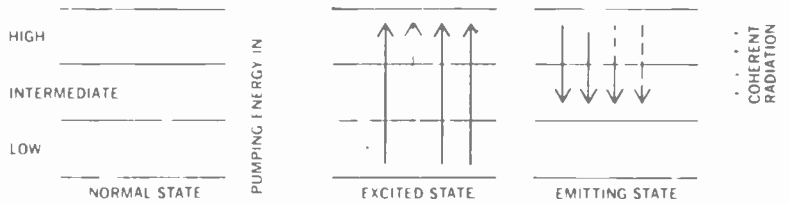
Finally, an application in the field of high-speed data transmission between computers and data centres is coming to the fore: the data could be sorted while the atmospheric channel is "closed" and retransmitted at high speed (data dumping) when the atmospheric channel is "open".

At the terminal stations of the 5.4km long trial path between the Siemens locations in Hofmannstrasse and St. Martinstrasse, the optical equipment consists of Cassegrainian telescopes, which have a concave primary mirror of 35 cm diameter and a convex secondary mirror of 3.2 cm diameter set 180 cm apart. After passing through a hole in the centre of the primary mirror, the modulated laser beam strikes the secondary mirror, which reflects it and causes it to diverge. The beam then travels to the primary mirror, at which it is again reflected before it emerges from the telescope. The incoming laser beam takes the reverse path through the telescope. The actual laser transmitter with the modulation equipment, or a detector for evaluating the incoming signal, depending on whether the equipment is designed to function as transmitter or receiver, is situated behind the primary mirror within the optical path.

The terminal stations consist of Cassegrainian telescopes having a concave primary mirror behind which there is a laser transmitter or a detector for evaluating the incoming laser light, and a convex secondary mirror (in the foreground). The picture shows the receiving equipment.

The information to be transmitted is impressed on the CO_2 laser beam by a gallium arsenide modulating crystal. It is transparent for laser beams and converts electrical signals into intensity-modulated laser signals. At the receiving end a lens focuses the laser beam emerging from the receiving telescope into the detector. The gold doped germanium detector, which is cooled in liquid nitrogen, converts the laser signals back into electrical signals again by means of a photo-conductive effect. ●

HOW LASERS WORK



A laser is a device for amplifying electromagnetic radiation waves. When energy in the form of light or radio waves, or even from a chemical reaction, is "pumped" into the material, atoms or molecules absorb energy and jump to a higher or excited state, then spontaneously decay to an intermediate level and give up energy in the process. The energy is emitted in the form of light. Laser light has the useful property of being coherent – all waves are in step. This happens because one bit or quantum of light given off by one atom stimulates another to give off its energy in step with the first and so on. (Laser stands for light amplification by stimulated emission of radiation).

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EQUIPMENT NEWS

Inside view of the Thought Tank with the dictating and transcribing units.

THOUGHT TANK

Described as 'Dictaphone's most important product in 25 years' and adding 'a new dimension to communication convenience', 'Thought Tank' system was introduced in USA a year ago and has now been launched in UK. The system consists of a 19" x 16" sealed 'tank' which houses a continuous loop of magnetic tape, capable of taking 60 minutes of dictation – equivalent to 4 hours conventional transcription – plus a telephone-like hand instrument on the executive's desk and a small transcribing unit on the secretary's desk. The tank itself can be put out of sight – under a desk, in a closet or wherever.

The user records by picking up the small telephone instrument. As soon as he starts to talk, an indicator lights on the secretarial unit. The secretary, equipped with a simple foot control and headset, can begin typing just 12 seconds after recording has begun and can transcribe simultaneously as he dictates. Because there is no need to operate an individual machine, the dictation process is simplified and the work is speeded by as much as 38%.

Unlike conventional dictating equipment, there is no loading or unloading of recording media like belts or discs, no index slips needed nor is any passing on involved of recordings to the secretary to transcribe. The Thought Tank is completely self-contained and ready for dictation at all times. The only visible elements are the compact telephone instrument and secretarial control unit.

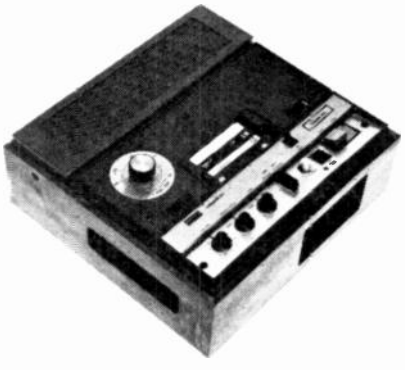
Additional telephone instruments and control units can be installed to expand the basic one-to-one system for use by up to 6 dictators thus providing further economies in 'word processing'.

Dictaphone Ltd, 12 Caxton Street, London, SW1.

TIME COMPRESSION

Normal recording apparatus introduces frequency distortion if recording and playback speeds are altered, and tone and inflexion can be so altered that neither the speaker nor the message can be identified. VARISPEECH however offers time compression or expansion without distortion, and can therefore be used to synchronise a given script to any situation. The operating principle is to convert the voice signal, which is recorded in analog form on a normal cassette, to a digital equivalent. Then a special-purpose computer converts this digital signal to a second digital format with or without time compression/expansion. Re-conversion to analog form restores the original speech without loss of intelligibility or speaker identification.

Other applications are in telecommunication networks, where transmission time



tariffs provide high costs; for language and speech study; for updating applications in Law, Medicine, Engineering; for timing speeches, conference recording, dictation and transcription; professional applications such as broadcasting interviews and talks, commercial television, documentaries and films, where the requirement is to accommodate a given script to a given time.

F.W.O. Bauch Ltd, 49 Theobald St, Boreham Wood, Herts, WD6 4RZ.

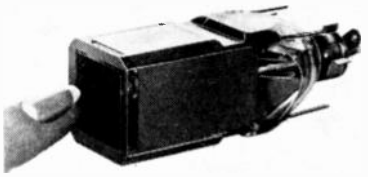
TOUCH SWITCH

A unique type of solid state switch, vandal-proof and able to work in any atmosphere – even in heavy snow, ice, rain smog or dirty oil – has been developed by GWE. Entirely solid state, the switch is activated by the presence – not necessarily the touch – of the operator's finger. There are no moving parts and its operational life

EQUIPMENT NEWS

should be almost unlimited. Vibration does not affect it and the switch operates on low voltage with no make-and-break contacts.

The switch has been designed for use in



industrial environments. Possibilities are limitless but examples are in self-service fuel dispensers and blenders, automatic car-parking controls and operator safety in automated production machinery. The sensitivity to approach (or touch) of a human finger is pre-set in the switch for the particular application. A halo of illumination, postage stamp size, shows that the switch is activated.

Although basically a proximity switch, the touch switch is unique in that if the surface of the switch becomes dirty or wet or otherwise contaminated, a special self-compensating circuit prevents spurious operation and at the same time leaves the switch with the same initial operational efficiency and sensitivity as in the 'clean' state.

The approach of the finger or other control object activates a capacitance-to-voltage converter and the resulting voltage change controls two open collector transistor outputs. The Touchswitch, which is not frequency-dependent, operates at a frequency in the region of 60kHz. Where more than one switch is mounted on the same panel it is necessary to synchronise their oscillators by a simple single pin-to-pin connection.

This feature of self-compensation not only balances surface effects such as snow and dirt but also compensates for any ageing of components, by matching-up or balancing through a differential amplifier and teaching the control electronics to ignore any slow-build up of capacitance while still retaining the same sensitivity to any intentional capacitive change.

Godwin Warren Engineering Ltd, Emery Road, Bristol BS4 5PW.

GENERATOR-SYNTHESIZER

Designed to meet the requirements of modern telecommunications techniques, the new Adret Model 6203 Generator-Synthesizer being marketed by Racal covers the 100 kHz to 32 MHz frequency range. Especially suited to transmitter and receiver drive applications or other areas where no modulation is required, the 6203 is offered at a most attractive price.

It is a digitally controlled, high level source generator, with output frequencies selected manually – 8 digit switches giving 1 Hz resolution throughout the range. Complete digital programming facilities enable the generator to be remote controlled and, when used with the model 212 programmer, it is said to provide rapid transmission frequency switching based on a pre-set programme. A revertive frequency check facility is also offered as an additional option, and the supplied integral crystal standard has an ageing rate of only 5 parts in 10^9/day.

Racal Instruments Ltd, Duke Street, Windsor, Berks, SL4 1SB.

MOTION ANALYSIS STROBOSCOPE

The Chadwick-Helmuth Model 109 is a complete, automatic, non-contacting motion analysis and speed measuring system. The Slip-Sync/Strobex uses the stroboscopic principle but can be triggered from a photo-cell, magnetic pick-up, oscillator or various transducers. It provides automatic slow-motion display of any repetitive event – rotating, vibrating, reciprocating, etc and stays 'locked on' regardless of changes in speed or rate.

The apparent motion can be stopped at any selected position in the cycle; plus and minus slew position push-buttons allow the image to be moved in forward and reverse directions. Non-contacting speed measurement (rotating machinery) can be carried out within the range 0 to 10,000 rpm, with an accuracy of 1%. Operation at line frequency provides a 'modelling light' feature and allows the checking of synchronous devices. The 'double image' facility enables displacement to be measured directly.

A few of the many investigation applications of the Slip-Sync/ Strobex giving slow motion images are: textile machines, engine valve trains, gear and belt drives, printing machinery, vibration tests, fans and air flow etc.

Environmental Equipments Ltd, Eastheath Avenue, Wokingham, Berkshire, RG11 2PP.

FLUXGATE MAGNETOMETER

A ring-core magnetometer for measuring small magnetic fields by utilising the non-linear magnetic characteristics of ferromagnetic core material in its sensing element, has been designed, manufactured and is now available from Thorn Automation, Rugeley, Staffs.

The magnetometer is expected to have wide application in magnetic airborne detection, search and surveillance operations, degaussing and minesweeping, exploration of magnetic fields in space, non-destructive testing of materials, vehicle detection for traffic control, anti-hijacking protection at airports, palaeomagnetism, and computer data store protection.

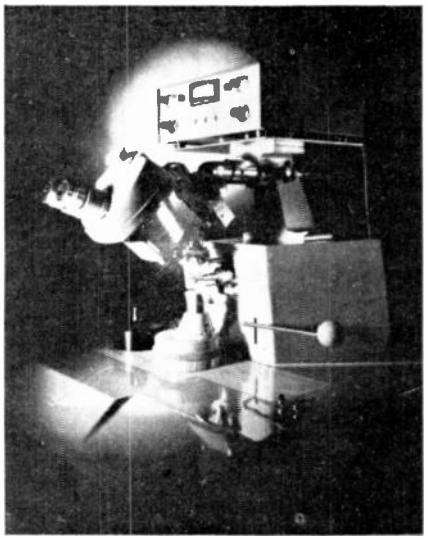
The equipment comprises a ring-core fluxgate probe, amplifier, drive unit, detector and output unit. The probe incorporates overall magnetic field feedback and can be used with other similar probes and amplifiers etc, either in an orthogonal three axis block assembly (as illustrated) or in any multiple single axis arrangement, enabling changes in the three vectors to be simultaneously monitored. The fluxgate makes use of a core of saturable magnetic material which is alternatively driven into magnetic saturation in opposite directions by an ac excitation field. Since the core is driven into saturation asymmetrically, the resulting second harmonic content of the signal is picked off by a sense winding wound on the probe and measured. The 10-0-10V output from the fluxgate probe contains a component at the second harmonic 20 KHz, the amplitude of which is proportional to the residual field strength at the probe.

The magnetometer is said to be capable of measuring very small fields, eg, changes of 0.5×10^{-9} Tesla (0.5 gamma).

Thorn Automation Ltd, Rugeley, Staffs.

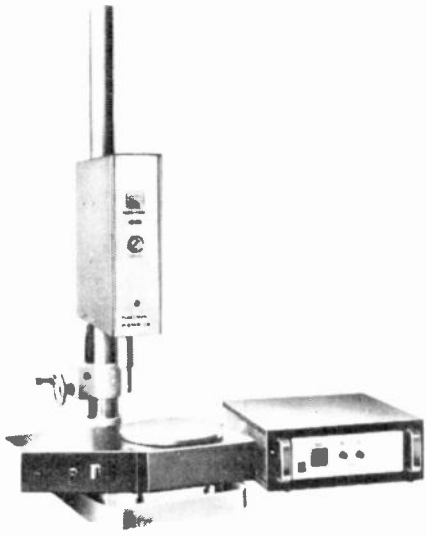
ULTRASONICS

Kerry Ultrasonics will be showing, at the International Electronic Components Exhibition (Paris 2 – 7 April), a wide range of ultrasonic systems to suit the needs of the electronics and precision manufacturing industries. The stand will also be featuring the advanced research and development activities of their associate company, Sonicstore



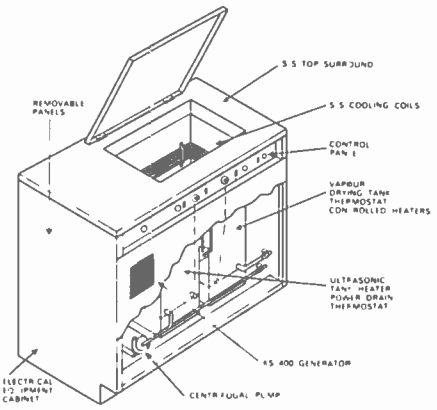
Sonobond micro-bonder

Ltd. Some of the equipments on show will be the 'Sonobond' Micro-Bonding Equipment, a fully transistorised ultrasonic generator feeding a standard Kerry Micro-Bonder transducer kit or positioner, and suitable for engineering into almost any micropositioner set-up; the 'Plastison' plastics assembly system which is designed to assemble plastic to plastic, plastic to metals, and plastic to other non-plastic materials using ultrasonic vibration to generate localised heat by causing one surface to vibrate against another; and the 'Compact' USC400 cleaning unit.



'Plastison' assembly unit

Solid ultrasonic delay lines manufactured from quartz, glass and ceramic materials will also be exhibited. Sonicstore are able to provide a design and manufacturing facility for delay lines engineered into computer, radar and instrument engineering. A working



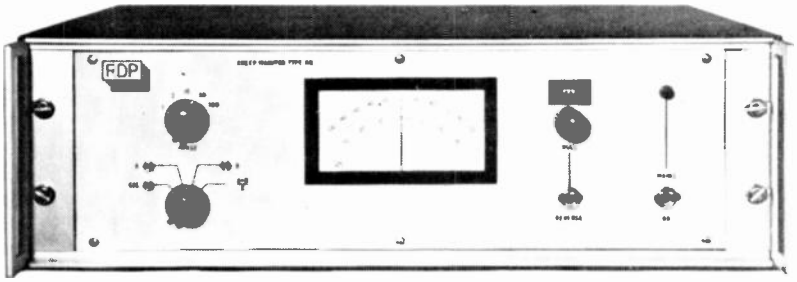
'Compact' USC400 Cleaning Unit

exhibit demonstrating the storage and delay characteristics of special purpose lines will be demonstrated.

Kerry Ultrasonics Ltd, Hunting Gate, Wilbury Way, Hitchin, Herts.

EXTENSOMETER

RDP's new low-cost extensometer and creep monitor will easily detect changes of 5 micro-inches in the length of metallurgical specimens. It is supplied complete with two precision gauging-head displacement transducers, individually calibrated with the instrument, for the remarkably low package-deal price of £240.



The 5" centre-zero, moving coil indicator gives direct-readings on five switched ranges or may be used as a null-indicator in conjunction with the calibrated nulling potentiometer which is fitted with a digital read-out dial. Provision is made for the examination of the strain on either transducer independently, or from the average of both so that the effects of bending of the specimen may be observed and compensated.

The instrument may be used for all normal extensometer and creep work but will readily adapt as a two-point comparator, thickness gauge etc, with a maximum range of ±0.1". There is an output for driving an external recorder.

RDP Electronics Ltd, Royal London Buildings, Princes Square, Wolverhampton.

SCOPE ADAPTOR

As an adaptor accessory to its lower priced oscilloscopes, S E Labs now market a dual trace unit to convert single beam instruments to dual channel operation. The self contained unit, HZ36, can be attached by simple cable connections to any S E or other single beam oscilloscope.

The instrument has a choice of three chopped modes (80Hz, 800Hz, and 80kHz) allowing a wide range of synchronised conditions. The two identical input amplifiers are ac coupled with a bandwidth of 2Hz – 30MHz (3dB). The attenuator is fully frequency compensated and has a maximum input sensitivity of 50mV/cm. Synchron-

isation may be achieved from either channel by use of a simple slider switch. An internal 9V PP9 battery provides all necessary power supplies.

S E Laboratories (Engineering) Limited, North Feltham Trading Estate Feltham, Middlesex.

DIY FIRE ALARM KIT

Under the Fire Regulations it is essential for all properties which provide overnight accomodation for more than six persons to be fitted with an acceptable fire alarm system. To meet this need Photain have produced a Fire Alarm Kit which can be installed by a handyman in a few hours and, whilst meeting all the basic needs, it can easily be extended for any larger size of installation.

It operates on a 'closed circuit' principle which ensures that the alarm bell sounds if a fault develops with the external wiring or if any sensor is removed from the system. The kit comprises a control unit Mk II, a heat detector, a preswitch and an alarm bell.

The control unit operates on mains 230/250V ac supply but a dry cell battery is incorporated in the unit together with an automatic change-over circuit so that in the event of a mains supply failure, the installation remains operative and changes back to ac supply when this is re-connected.

The heat detector is a fixed temperature normally closed, contact device, contacts being set to open at 135°F (57°C). The unit can be mounted in any position and provides coverage of approximately 400 square feet per detector. The Preswitch is a 'break glass to actuate' type of push button unit.

Photain Controls Limited, Randalls Road, Leatherhead, Surrey. ●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COMPONENT NEWS

OKI IN UK

Twentieth Century Electronics have announced thay they are now the UK agents for the OKI Corporation of Japan.

Twentieth Century produce a wide range of high quality opto-electronic products including photo-diodes, photo-multipliers and CRTs, marketed as the 'Centronic' range. The addition of OKI LEDs and photo-diodes makes Centronic one of the most comprehensive ranges of opto-electronic devices available in UK.

OKI LEDs are available in many shapes and sizes, from economically priced green and red panel indicators to high-power IR emitters. The LED numerical displays have character heights from 1mm to 6.8mm and are available in sticks of upto 12 digits. In addition to photo-diodes with good stability and hence ideal for photometry applications, the OKI range also includes photo-transistors and photo-couplers. According to Mr Richard Tomes, the Marketing Director, Centronic are also able to offer a custom-build service for special photo-diodes from state-of-the-art large-area low-noise devices to small-area high-speed (upto 1.5 GHz) photo-diodes.

Twentieth Century Electronics Ltd, King Henry's Drive, New Addington, Croydon.

REED CONTACT PROTECTION

Sealed contact reed relays, as a versatile means of interrupting current flow, are inherently reliable and can be actuated in a number of ways. However, being contact switches, their life can be substantially reduced unless the contacts are protected from excessive current or voltage surges.

Contact failure is often due to transient overloads and a good engineering practice is to use a series CR network across the contacts. Such a network (see Fig 1a) gives protection against damage when the current through resistive or inductive loads is interrupted. Figure 1b gives the values of C and R for various currents and loads.

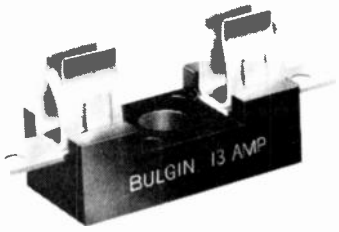
When used with certain loads, eg, incandescent lamps with low cold resistance or capacitive loads with low initial impedance, very high currents would flow when the contacts close and a limiter (thermistor or choke) should be connected in series with the load to protect the contacts.

Another way of protecting mains-switching contacts against transients, and preventing the transients reaching other equipment via the mains wiring, is to use a varistor. A varistor normally has a very high impedance. When the voltage across it reaches a certain critical value, it reverts to a low impedance condition, thereby effectively suppressing voltage transients. A suitable circuit is given in Figure 2.

Elliott Relays, 70 Dudden Hill Lane, London NW10.

FUSEHOLDERS

A range of five base mounting open fuseholders, accepting either 1in x ¼in or 1¼in x ¼in fuses, and consisting of a twin fuse model and two single-fuse models,



rated 13A at 250V, and two single-fuse models rated 5A at 250V have been announced by Bulgin.

A F Bulgin & Co Limited, Bye-pass Road, Barking, Essex.

STATIC CONVERTER

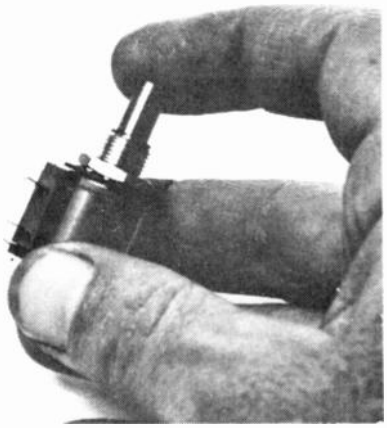
A new 3 watt static converter, giving ± 15 volts and up to ± 100mA output from 5 volt digital supply rails, has been developed by Ancom Limited, The 3W5-30 unit is designed for use in digital systems when it is required to power customary 15V analogue modules from a 5V logic rail, to provide power, for example, to drive three A-D converters and several operational amplifiers or comparators, just where it is needed in the circuit, without having to run additional power supplies throughout the system.

Performance characteristics include low ripple, input-output isolation of 200V standard (up to 2kV option) and fold-back short circuit protection. The unit cannot be harmed by reversed polarity at the input or by short term over-voltage as high as 60 per cent. Load regulation is ± 0.15% maximum change for a 100 per cent change in load. The unit measures 2.375in x 1.5in x 0.75in.

Ancom Limited, Denmark House, Devonshire Street, Cheltenham, Glos.

HELICAL POTS

The MMH series of 22mm diameter semi-precision helical potentiometers from May Precision feature glass-filled nylon assemblies in standard values of 50Ω to 100kΩ for 10-turn models, 50Ω to 50kΩ for 5-turn models



and 30Ω to 22kΩ for 3-turn models. Standard resistance tolerance of ± 5% and independent linearity tolerances of ±0.5% can be improved on request. This range is said to give minimum body lengths for maximum element length, thus offering precision tolerances in a miniaturised package. The 10-turn MMH-10, for example, has a body

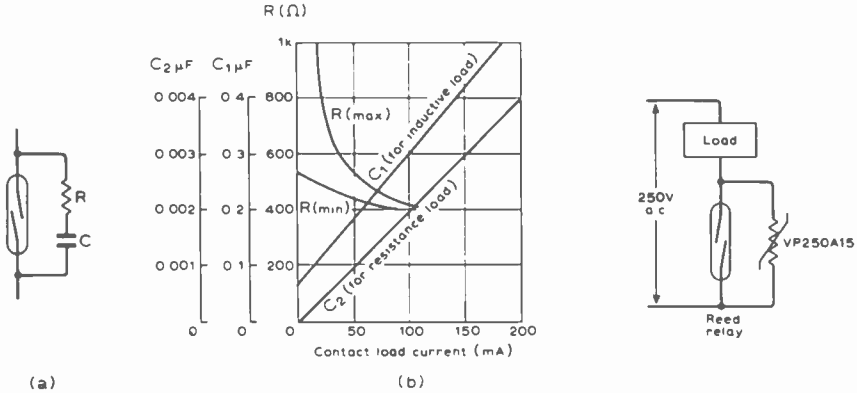


FIG 1

FIG 2

length of only 26mm and will handle 2W power. A precision wiper assembly tracks lightly but firmly to give low-noise operation, whilst proof voltage is better than 1000V dc. Insulation resistance is 500MΩ minimum.

Plain bush-mounting shaft or optional screw-driver slot or shafts for servo mounting can be supplied.

May Precision Components Limited, Bowlers Croft, Honywood Road, Basildon, Essex SS14 3EF.

SOLID STATE LAMPS

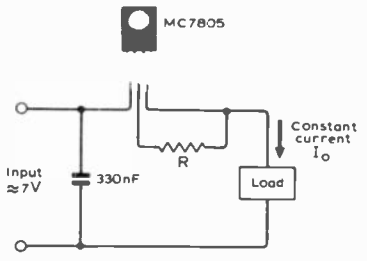
The Diodelite 521 series of gallium arsenide phosphide solid state lamps, marketed by SASCO, are available in red non-diffused and red diffused. Forward voltage at 20mA-I_f is typically 1.6V (2V max) and reverse current at −3V is 100nA typical with a capacitance at 0V of 90pF typical. Maximum ratings are: I_f = 40mA dc, reverse voltage 3V, power dissipation 80mW (derate 1.1mW/°C above 25°C). Luminance at 20mA is 750ft-lamberts while the current necessary to produce 50ft-lamberts is typically 2mA (10 mA max). Rise and fall times are 1nS typical. All Diodelites are said to be vibration and shock resistant. Overall dimensions are 0.12in x 0.1in x 0.1in.

SASCO Limited, PO Box 2000, Gatwick Road, Crawley, Sussex, RH10 2RU.

3-TERMINAL REGULATOR

Jermyn Distribution offer immediate delivery of the new MC7800 series of high-performance, monolithic voltage regulators produced by Motorola. Housed in a TO-199 style plastic package, MC7800 voltage regulators require no external components and can supply in excess of 1A at one of seven fixed output voltages between 5 and 24V.

Operating over the wide temperature range



Using an MC7805 series voltage regulator as a constant current source

of 0 to 125°C, the regulators offer a very good electrical performance. For instance, the 5V version has a typical load and line regulation of 50mV and ripple rejection at 20mA output is 70dB. MC7800 regulators can be used also as constant current regulators.

Jermyn Distribution, Vestry Estate, Sevenoaks, Kent.

Si AVALANCHE PHOTODIODE

A new solid-state avalanche photodiode, type S30550, has been announced by EMI, for use in communications systems, laser-based range finding equipment and vibration analysis.

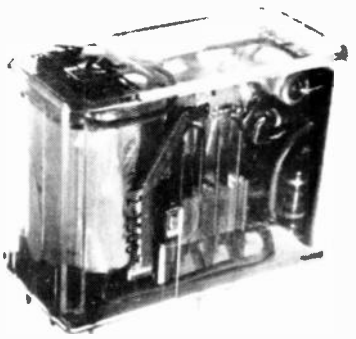
Offering a high degree of uniformity, the EMI silicon photodiode SPD1, with a fast rise time and an active area of 1cm^2, has been selected for use in a twin-beam spectrophotometer for measuring transmission loss in high quality optical glass used in making fibre waveguides for optical communications.

EMI Electronics, Blythe Road, Hayes, Middlesex.

DELAY-ON RELAY

The R12 series of compact time-delay relays, capable of switching currents up to 5 amps, with 2-pole change-over contacts, and variable delay ranges upto 120 seconds, are of the 'delay on operate' type, ie, the delay period commences when the coil energizing voltage is applied and the relay operates on the expiry of this period. When the coil voltage is interrupted the relay releases immediately.

A built-in solid-state electronic delay circuit is incorporated between the relay coil and the energizing input. The delay is effected by the use of an RC network and a solid-state trigger circuit to sense the voltage



across the capacitor. When this reaches a predetermined value, the trigger circuit operates a solid-state switch to connect the energizing input voltage across the relay coil. The timing control is a high-resolution 15-turn potentiometer allowing precise screwdriver-slot adjustment of the delay period.

Repetitive accuracy of time delay is said to be ± 2% for successive operations. Available timing ranges are 1 to 10, 1 to 60 or 1 to 120 seconds. Reset time for all ranges is 100 mS. Standard units are suitable for 24 volt dc coil supplies; units for operation from other voltages are available to special order. Supply polarity protection is incorporated so that no damage results from an accidental reversal.

AMF Potter & Brumfield, Binsey Lane, Oxford, OX2 0BR.

SLIDE SWITCHES

Two new multi-position Jeanrenaud slide switches, the CL6 and CL12, are now available from ITT Components Group Europe. The CL6 offers a maximum of 6 positions in the following combinations: 1-pole, 2 to 6 way; 2-pole, 2 or 3 way; or 3-pole, 2 way. Similarly the CL12 with a maximum of 12 positions offers all alternatives between 1-pole 12way and 6-pole 2 way.

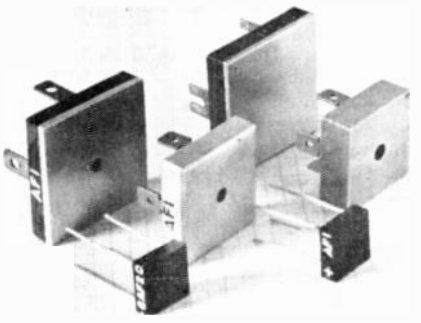
Both switches have maximum switching characteristics of 250V at 50MHz, 0.1A and 15W, although they can carry up to 5A. Rated insulation resistance is greater than 10^6 megohm and the dielectric strength between contacts greater than 1500V. The operating temperature range is from −10°C to +70°C. Either horizontal or vertical button positioning can be specified for the CL6 and CL12, together with a choice of wiring tags or pins for PCB mounting.

ITT Components Group Europe, Electromechanical Product Division, Edinburgh Way Harlow, Essex.

NEW BRIDGE RANGE

An entirely new range of full wave bridges available from PBRA consists of six basic types with average output currents of 1,2,6, 10, 15 and 25 Amps. Corresponding peak surge currents are 30, 50, 150, 200, 300 and 300 Amps. PIV is 50V to 1,000V for the 1, 2 and 6 Amp types, and 50V to 600V for 10, 15 and 25 Amp types. Junction operating and storage temperature range is −50 to +150C.

The range also includes a 40 Amp full-wave rectifier which can be used instead of two discrete 40A rectifiers. Peak one cycle (60 Hz) surge is 1000 Amps and temperature range −65 to + 175C.



PBRA Ltd, 33 Holmethorpe Avenue, Redhill, Surrey.

CHARACTER RECOGNITION

A new Mullard component has been designed for use in character and pattern recognition systems; it can also be used in page readers and in industrial equipment where the position and size of objects have to be indicated. The new component is an integrated circuit, development type 216 BPY, that contains an array of linear silicon photodiodes, scanning circuits, multiplex switches and a dynamic shift register. The photodiodes are scanned sequentially, and signals indicating their conditions are presented, also sequentially, by means of the multiplex switches and shift register.

The 216BPY devices are made with arrays of either 16 or 128 photodiodes, which measure 50 x 100μm and are located on

COMPONENT NEWS

centres 100μm apart; other versions that have multiples of 16 elements, however, can also be supplied. Scanning rates can be between 10kHz, and 5MHz, and a high sensitivity is said to be achieved by operating in the light integration (charge storage) mode.

Mullard Ltd, Mullard House, Torrington Place, London, WC1E 7HD.

DIGITAL CLOCK ON ONE CHIP

A complete digital clock on a single chip has been developed by National Semiconductor. Called the MM5314 series, the circuits contain all of the counting, decoding and multiplexing circuitry required for a 4 or 6 digit electronic clock.

The MM5314 series operates from a single 11V to 19V supply, from a half-wave rectified 50 or 60 Hz input. This input is then shaped and divided by either 50 or 60. Three other counter stages complete the division to 12 or 24 hours.

The built-in multiplexer samples the outputs from these counters and routes them to an on-chip ROM which is programmed to provide both BCD and 7-segment outputs. The display scanning rate is controlled by an external resistor and capacitor. The MM5314 is designed to work with inexpensive plastic transistors for digit and segment driving of standard LEDs or incandescent displays.

Fast slew, slow slew and a hold control are provided to set the clock. The fast slew advances the hours counter at a one hour per second rate; similarly, the slow slew control advances the minutes counter at a one minute per second rate. The hold control stops the counter chain and thus the seconds digits can be set.

Applications for the one-chip clock family include desk clocks, industrial timing devices, station-keeping timers, and time base for minicomputers.

National Semiconductors (UK) Ltd, The Precinct, Broxbourne, Herts.

TEMPERATURE INDICATING DEVICE

A new range of Thermindex temperature indicating devices offer a simple and accurate method of checking the temperature of almost any surface. The devices, designated Type 1, are supplied in match book form, each booklet containing 10 flexible and adhesive strips on which there are eight or nine numbered dots sensitive to a range of temperature.

A strip is fixed to the surface under examination and, as the temperature rises, a black dot appears against a number indicating the temperature in degrees Centigrade which has been reached or exceeded. The change is virtually instantaneous and the indication is said to be accurate to ±1% of the calibrated value.

The indicators are supplied in a series of five units covering five temperature ranges: 37.8°C to 65.6°C, 71°C to 110°C, 116°C to 154°C and 204°C to 260°C –each unit having either eight or nine graduations. The strips are waterproof and oil resistant and can be used for example to record if packages, components, bearings etc have been overheated at any time. There are also a considerable number of applications in the aircraft, automotive, electrical, electronic and food industries.

Synthetic & Industrial Finishes Ltd, Imperial Way, Watford WD2 4JN, Herts.

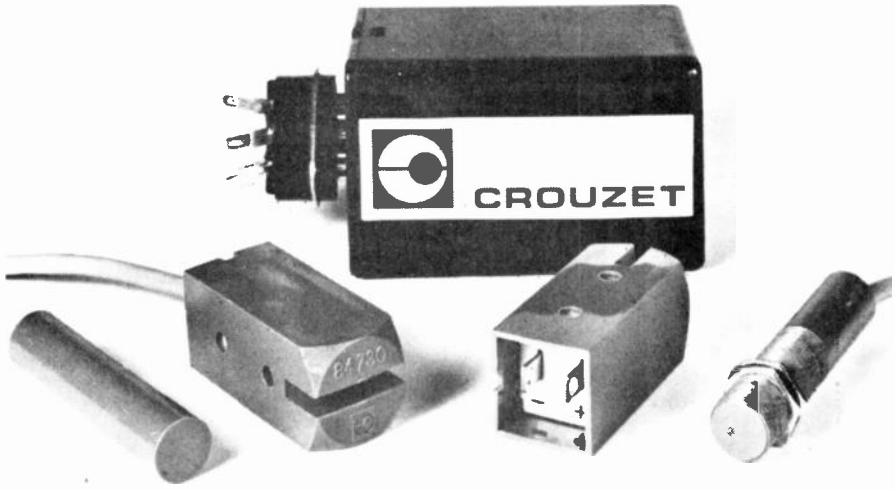
VANE PROXIMITY DETECTOR

Crouzet have introduced two new 24V dc Vane Detectors (Ref. 84.730.001 and 84.730.501). The units enclose an oscillator that generates an alternating magnetic field across the 3.7mm fork. Any metallic object passing through this field absorbs sufficient energy to stop the oscillations, causing an impedance change within the detector.

When used in conjunction with a series resistor, the cessation of oscillations effectively reduces the potential difference across the resistor; in the case of a series relay, the relay is de-energised.

The internal circuit is encapsulated and housed in a Rilsan case, whose dimensions are 20 x 20 x 48mm. Connections are by 5mm AMP tags or moulded screened cable. These units can be directly connected to the Crouzet range of Electronic Counters and Tachometers and have applications in coin sensing mechanism.

Crouzet, Thanet House, High St, Brentford Middx, TW8 8EL. ●



NEW LITERATURE

● A 16-page brochure describing the company's ranges of strain gauge load cells and pressure transducers, with full specifications for each range, illustrations and dimensioned line drawings. Also included is a useful glossary of standard transducer terminology.

Transducers (CEL) Ltd, Trafford Road, Reading RG1 8JH.

● A new publication, 'Electric Impulse Counters' describing resettable and non-resettable types of 'Venture' impulse counters with three to six figures and counting rates up to 3,000 per minute, giving working voltages, the various mounting arrangements and plug-in module options.

Smiths Industries Limited, Industrial Instrument Division, Waterloo Road, Cricklewood, London NW2 7UR.

● A four-page brochure describing typical applications of resistor networks consist of various thick film resistor configurations packaged in standard 14- and 16- pin DIP packaging.

Beckman Instruments Ltd, Glenrothes, Fife, Scotland.

● A new 18-minute colour film, entitled 'The Computer-Aided Design of Integrated Circuits' available on free loan or for purchase from Mullard Film Library, 269 Kingston Road Merton Park, London, SW19 3NR. The film describes in detail the use of the computer and its peripheral equipment in such functions as IC design and layout, mask-making and testing at every stage of production.

● A new booklet, 'Tygadure PTFE Equipment Wire and Cables' (No. TY33) giving details of the extensive range of PTFE equipment wires to meet both British Standard and American Military Specifications, together with information on PTFE Cables, PTFE electrical sleeving and PTFE glass tie cords and lacing tapes.

Tygadure Division of Fothergill & Harvey Ltd, Summit, Littleborough, Lancs.

● A new data sheet listing details of the extended relay range which now covers dual-in-line size, crystal-can sized and aircraft/industrial relays up to the 3-phase 90kVA Concorde contactor.

Plessey Switching Controls, Titchfield, Hampshire.

● A fully-illustrated brochure outlining its communications systems, guest room TV/radio services and a number of other hotel amenities such as fire alarms, pocket paging, and public address and sound reinforcement systems. Also another brochure, 'Rediffusion Services for education', dealing with a wide range of education aids and communication services for use in schools, colleges and universities.

Rediffusion Industrial Services Limited, Astronaut House, Hounslow Road, Feltham, Middlesex.

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BOOK REVIEWS

REVIEWERS: Brian Chapman
Shaun Kannan

SURVEY OF ELECTRONICS by Lee W. Churchman.
Published by Rinehart Press San Francisco 1971.
Hard covers, 500 pages, 9¼" x 6¼". Price: £6.80.

This book is definitely unique, its purpose being to provide a survey of the entire field of electronics. The material is presented in a manner suitable for students of other disciplines, or engineers, doctors etc. who require background knowledge in electronics.

To quote from the preface – "The justification for a survey course in electronics is easily stated. The student will live in a world in which the primary forces impelling social and cultural changes are largely the result of technological innovation. Electronics has become the nervous system of the body of technology. Knowledge of electronics has, therefore, now become an important part of the knowledge of the environment without which no education can be considered a general education".

When you think about it, the above statement is largely true, electronics has pervaded every aspect of technology and will do so even more in the future. Most engineers or technicians these days will find their equipment has some electronic sub assemblies or is interfaced with electronic equipment in some way. Take for example electronics in the modern car – alternators, IC regulators, radios, servo systems plus a whole host of future aids such as "miles per gallon" metering, braking computers etc. A mechanical engineer would be very unwise to treat electronic devices as black boxes – he may find himself redundant when the next generation of engineers comes along.

This illustrates the need for a book such as this, and greater general education in electronics in all technologies. Obviously a surgeon is the better for a rudimentary knowledge of the principles of the monitoring equipment (largely electronic) in the operating theatre.

Unfortunately the subject is so vast that interest is in danger if the student is pounded with too much unnecessary data, and hence, the course must be kept interesting and must only include the essentials.

The book under review has been written with these factors in mind. It commences by discussing the input and output formats of various pieces of electronic equipment with which the student is most likely familiar – such as cathode ray oscilloscopes, TV, computers and audio amplifiers etc. It then progresses to the study of functional units of the above systems, from which the student sees that many of these functional units are common to many systems. From here we go to the consideration of common components and then discuss future developments. Whilst the subject order may seem to be, and is, the reverse of that usual, it is obviously best in terms of the aim of the book – to maintain interest.

The book cannot be read like an encyclopedia as most of the latter material depends on having assimilated the earlier material. One must start from the beginning and read steadily on until the end. However, I feel that, judged on its avowed aim, the book is excellent, and is therefore recommended as a source of electronic knowledge for engineers of other disciplines. – B.C.

RELIABILITY ENGINEERING by D. J. Smith.
Published by Pitman, 1972.
Hard covers, 136 pages, 8½" x 6".
Price: £2.50.

This is one of the first monographs in the Electronic Engineering Series planned by Pitman Publishing. As stated in the Foreword by the Series Editor, Prof Gambling, the aim of the series is to provide a number of concise treatments, each covering a specific aspect of electronics. Particularly apt for the needs of today is Prof. Gambling's definition of electronics – as any function concerned with "transmission storage, control and processing of information in all its different aspects" – in preference to the now out-of-date concept of electron-activated device engineering.

Subjects for future monographs are intended to cover almost every aspect of information processing, be it electrical, acoustical, optical or other forms – and should prove very interesting and useful to electronic engineers who today feel "equally at home using photons, phonons, valence . . . electron spin and other quantum states, etc".

This particular monograph aims to provide an introduction to reliability engineering for students and newly qualified engineers entering industry. An unusual and interesting feature is the inclusion of some of the pitfalls in achieving and measuring reliability which an inexperienced engineer is so often prone to.

This book does not attempt to examine causes of failure in specific components or systems – this is outside the stated scope of the monograph. It does however, cover the theory and principles which form the basis for a study of system reliability. The reviewer found it particularly interesting that, going one step further than the IEC definition, reliability is defined by the author as the probability of satisfactory operation for a given period of time *without failure*.

Following a brief but very informative and readable introduction, the first chapter defines some fundamental terms associated with reliability activities and makes (what this reviewer regarded as) a passing reference to the need for effective organisation and management backing for the success of a reliability programme.

Chapter 2 defines reliability parameters using failure rates and makes the necessary (but oft ignored) distinction between MTBF and MTTF.

Chapters 3 to 7 discuss system reliability as a function of the reliabilities of its component items, the effects of operational and failure modes and stress aspects on system reliability, the suitability of Wiebull parameters for variable failure rate (wear-out) components, and reliability testing to acquire and demonstrate failure date.

Chapter 8 discusses the use of Baye's Probability Theorem and the general Binomial theorem in reliability assessment for active redundant systems, and compares standby redundancy with active redundancy.

Chapter 9 deals with the effects of preventive and corrective maintenance on reliability data and has a useful section on how repair times affect the reliability (in all cases) of a system.

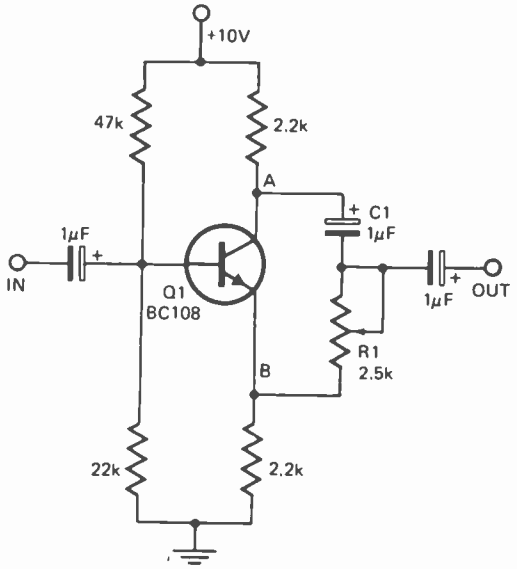
Chapter 10 is a brief exposition of the methods and organisation necessary to achieve reliability objectives – probably too brief considering that, for the price, this chapter could well have included specific case-history examples or a set of typical ground-rules for organising and operating a reliability program or for decision-making in trade-offs between cost and reliability.

There is a summary at the end of every chapter and certain chapters (dealing with theoretical and mathematical derivations) also conclude with problems for which fully and partially worked-out solutions are given at the end of the book. There is also a Glossary of terms and a set of Appendices on random failure rates of some electronic components, failure probability calculations for redundant systems, and tables and formulae. A bibliography and index complete the book; the former could probably have been more extensive and included some key papers as well.

Though a concise and logically developed book which provides a good introduction to engineers wishing to specialise in reliability engineering and "a complete coverage" for City & Guilds or National Certificate students in the subject, the book is perhaps a trifle over-priced for the amount or the extent of coverage of the subject. – S.K.

TECH-TIPS

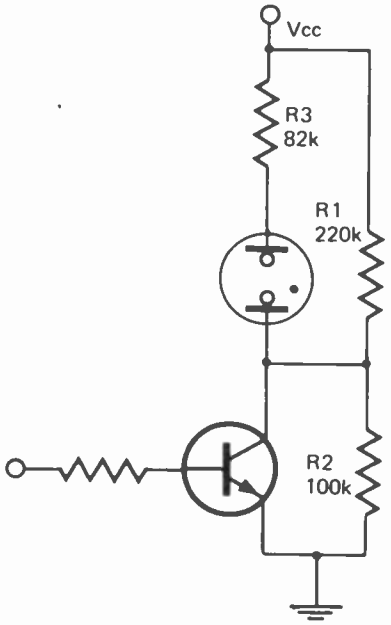
SINGLE TRANSISTOR PHASE SHIFTER



The circuit shown provides a simple means of obtaining phase shifts between zero and 170°. The transistor operates merely as a phase splitter, the output at point A being 180° out of phase with the input. Point B is in phase with the input phase. Adjusting R1 provides the sum of various proportions of these and hence a continuously variable phase shift is provided.

The circuit shown operates well in the range 600Hz to 4kHz.

LOW VOLTAGE TRANSISTORS DRIVE NEONS



A transistor having a Vcb rating of 35 volts may be used to switch neons or even Nixie tubes by using the circuit shown. Resistors R1 and R2 are selected so that the drop across R2 is less than the Vcb of the transistor and the drop across R1 is less than the striking voltage of the neon. With no voltage at the base of Q1 the neon is off (values shown are for an NE2) and with a positive voltage applied to the base the transistor and the neon are both turned on. When using an NE2, the supply could well be a full-wave rectified supply having a peak of 85 volts.

INPUT GATE

LETTERS FROM OUR READERS

100W GUITAR AMPLIFIER

A. M. Brooks of Sussex, G. Wheeler of Hants, W. Wallenborn of London, M. Dane of Middlesex are among the many readers who have queried certain details of design in the amplifier as published in our February 1973 issue and suggested improvements. May we thank all these readers and give the following cumulative reply ?

The 2N3055 and its equivalent MJ type transistors are rated for V_{ceo} of 60V. This is for the open-base condition. In this particular design application, they are slightly reverse biassed and, as such, are rated at over 70V, still well below breakdown voltage.

The transformer specified is conservatively rated. In this construction, it does get hot but is within the temperature specifications.

The 3A fuse has been found quite adequate for music applications but if the application has more speech the fuse can be 5A. *Editor*

BUGGING DEVICES

Your articles on 'listen-in' devices have been of great interest to us since we are a company specialising in telephone answering devices.

We have had clients requesting listen-in equipments to be installed in their own organisations to stop information leakage, and others asking for apparatus to sweep the telephone lines.

Your readers may be interested to know that legally we are permitted to install such devices on receipt of written confirmation explaining the full operation in detail as envisaged and desired by the client.

A. B. Macnaughton, MD, Phontronica Ltd, 21a South Richmond St, Dublin 2.

TAPES

Who makes the 180 minute cassettes mentioned on page 23 of the Feb 73 issue ?

—G. G. Meakin, Nottingham

BASF make a C180 version of their cassettes but they are at present manufactured, and available, only in Germany. *—Ed*

TEMPERATURE CONTROL

Disappointed to see that the February 73 issue did not contain anything about temperature control systems using ICs or building controllers, as you indicated on page 42 of the previous issue. —G. Somerset, Cheshire

The special IC on which an intended last part of the Guide to Temperature Control was based was withdrawn from production recently. Hence the gap in the series. We hope to publish a revised Part 4 shortly. *—Ed*

TOO MUCH AUDIO

Mr Wieczorel (Input Gate, Feb issue) should complain! As an electrical engineering student he should appreciate that car projects can usually be used for other applications with minor modifications.

Please remember the bookstalls of the world are groaning under the weight of multitudes of Hi-Fi magazines —but yours is the only IDEAS magazine!

— P. Swannell, Lode, Cambs.

The Feb issue was a special Hi-Fi issue. Nevertheless, our policy is to strike a balance between the various domestic, industrial and engineering applications of electronics. We don't think we have much to fear from specialist hi-fi or other engineering magazines, purely because of our own speciality which is a broad spectrum coverage. *—Ed*

BRAKE LIGHT WARNING

Can this project be used to detect the failure of side and rear lamps ?

—D. M. Smith, Cheshire.

Yes, it can, by substituting the sidelight switch for the footbrake switch. However, you may need two such circuits, one (say) for the front lights and one for the rear lights, since the loss of one lamp load out of four may not cause enough current change to switch Q1 on. *—Ed*

AUDIO SYSTEMS

Surprised that you have not, as yet, published any projects for tuners, hi-fi amplifiers and preamplifiers (apart from the Super-stereo project in the Sept 72 issue).

—L. E. Brown, Warwicks

Disappointed that you have not produced a project on audio recording amplifiers or for a hi-fi tape recorder.

—N. G. McHale, Queen's Univ of Belfast

We have considered construction projects on individual hi-fi equipment items. However, there is no guarantee that, when such individually constructed items are put together, the result will be an INTEGRATED audio system. Our projects dept. is working on such an integrated system and we hope to announce the details shortly.

—Ed.

OPEN HOUSE AT BERKSHIRE

The Berkshire Electronics Society, housed in the premises of the Presentation College (Bath Road, Reading), has recently obtained the use of a well-equipped workshop cum club room where members have the use of scopes, power supplies and other equipment for carrying out projects.

Anyone interested in any facet of electronics is invited to drop in any Wednesday after 7.30 pm.

Our members are currently working on a major project associated with tracking of weather satellites.

—R. Howden, Secretary, Boundary Hall, Tadley, Basingstoke.

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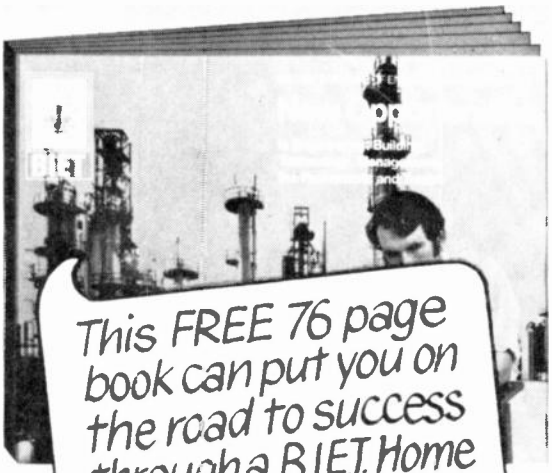

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