

BRITAIN'S DYNAMIC NEW MONTHLY

AUGUST 1972 20p

electronics TODAY

INTERNATIONAL

**Solid-state
watches**



**Electronics
in the
Olympic Games**

electronics TODAY

INTERNATIONAL

AUGUST

Vol. 1 No 5

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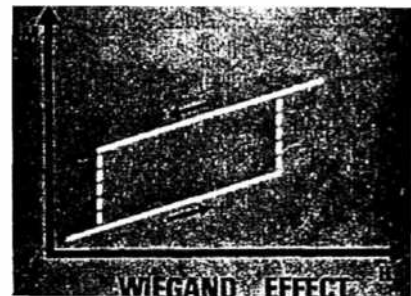
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COVER: Avia solid-state watch with digital readout is superimposed on a Intel 3013 chip

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Keep the wheels turning

Economies such as ours function properly only while some people keep making things and others keep buying them.

The result is an effect known to economists as the "multiplier" - and, in theory at least, we all end up better off than we would be if we each did our own thing.

Unfortunately, the success of the system does not depend upon the intrinsic value of the manufactured products. It really makes no difference whether factories churn out typewriters or plastic wall ducks, just so long as they churn them out and enough people keep buying them.

But in many prosperous countries, such as UK or the USA, most people already have all the typewriters and plastic ducks they want, and it has become necessary to create "needs" which did not previously exist, or of which people weren't previously aware, in order to keep the wheels of industry turning.

A classic example of this is the automobile industry, which spends enormous sums of money every year on restyling its products, and by so doing creates a totally artificial consumer "need".

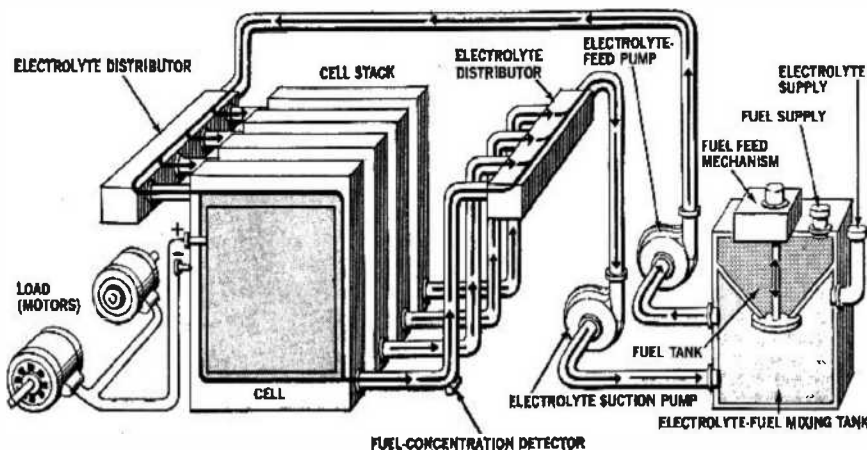
Wasteful? - Certainly. But there's no denying that it's good for the economy. Some of the latest hi-fi gimmickry is an extension of this principle. A loudspeaker with a multiplicity of drive units may actually be inferior to another which has only two or three, and an amplifier with thirty-eight control knobs on the front panel does not necessarily out date one that has only seven.

Bear this in mind when shopping around for new equipment - and if you need advice on making a choice, be sure you get it from a specialist dealer.



news digest

ELECTRIC CAR - LATEST



In Japan, the Sony Corporation recently demonstrated a prototype electric car claimed to be capable of speeds up to 56 mph.

The power source is a 'refuelable' zinc-air 6 kW battery consisting of 256 individual cells each measuring 6" by 8".

Each cell has two positive porous-carbon electrodes with a negative electrode sandwiched between them. Separators prevent the electrodes touching.

An external tank contains the fuel which consists of powdered zinc suspended in an electrolyte. This fuel is pumped into the spaces between the positive and negative electrodes for an eight second period every 52 seconds.

The powdered zinc suspended in the electrolyte becomes trapped on the negative electrodes. Air entering the cells (which are vented to atmosphere) permeates through the porous-carbon positive electrodes thus oxidising the zinc and liberating electrons. The expended zinc particles are then flushed from the cells at the end of the 52 second period.

As some zinc is dissolved in the electrolyte during the 52 second power cycle its concentration is measured during the flushing cycle. A concentration detector linked to the fuel supply system then maintains the zinc at the correct level.

The finally-used-up zinc is recycled by an external electrolytic process, power for which is taken from the 240V mains. The recycling process is reasonably efficient and Sony claim that just under 4 kWh are required to process the quantity of zinc required to produce one kWh of energy in the battery.

The prototype vehicle also carries a 10 kW nickel-cadmium booster which is switched into circuit for starting, accelerating and hill climbing. This battery also provides power during the eight second cell re-fueling period. It is charged from the main zinc-air battery when the car is running at steady speeds.

According to Sony, the cost of the battery will be approximately \$600.

CAR DISTANCE WARNING

In the USA, the Radio Corporation of America have demonstrated a radar system that tells a driver if he is too close to the car ahead.

Unlike most previous designs of this sort the RCA device uses a passive reflector on the rear of the preceding vehicle. The reflector contains two arrays each of 128 dipoles. The car behind transmits a vertically polarized 9GHz signal and this is received by the

array and - after passing through a passive non-linear device - is frequency doubled and retransmitted back to the car behind (this time horizontally polarized).

A small computer in the transmitter/receiver then measures the distance to the car ahead, relates this to vehicle speed, and if the distance is too close for safety at that speed, sounds a warning. (presumably the system is disabled when overtaking).

Selling cost is said to be about \$10 for the reflectors and \$80 to \$100 for the transmitter/receiver.

The manufacturers do of course appreciate that as reflectors would have to be fitted to all vehicles the system is not really viable unless it is made obligatory by legal sanction.

FUZZ FINDER

The Nuremberg Police Force (Germany) has been testing a system developed by Siemens for locating patrol cars by computer. From radio signals transmitted at regular intervals by the vehicles they can be monitored on a TV screen by the dispatcher.

Although computer-controlled location is not new in principle, until recently it was thought to be impracticable for urban areas because buildings impede the straight line propagation of radio waves.

Siemens has now demonstrated that urban application is feasible. The computer was programmed to evaluate the signals resulting from radio waves rebounding from buildings. As this is carried out in fractions of a second, the position of each car at any given moment is established by the "differences in propagation time" of the individual signals and the results are flashed on to a data display unit.

This new system eliminates delays inherent in radio communication where headquarters contact cars individually one after the other and the dispatcher gradually charts a unified view of their positions, resulting in loss of valuable time before they are directed to the scene of action. It has similar application for fire departments, emergency repair and maintenance services and ambulances.



FIREMAN'S PERSONAL RADIO



A new fireman's personal radio system developed by Multitone in close co-operation with the Home Office and the Suffolk and Ipswich Fire Service, covers 36 fire stations over an operational area of nearly 2000 square miles.

The system, regarded as a technical breakthrough in fire-fighting communication, was designed to enable fire brigades to alert firemen to report to unattended fire stations when an alarm is raised. It replaces the traditional sirens and house bells (noise-nuisances in their own right and yet unsatisfactory when competing with local environmental noise), and eliminates costly DX landlines between brigade HQ and the unattended stations to activate their 'alert' signals.

The system comprises: a control encoder at brigade HQ, with call facilities for up to 40 stations;

a radio bearer link, using the standard brigade radio system already in use for HQ contact with radio vehicles, to convey the Multitone signals to receiving aerials at unattended stations;

the decoder and re-transmission units at all regional stations which respond, only when individually addressed, by decoding the signals for function, returning audio and visual verification signals to HQ and retransmitting appropriate instructions over its local coverage area;

and pocket receivers carried by all

retained firemen, which 'bleep' when they are in the respective areas.

The Multitone signals are function-coded for:

Fire-call: emergency attendance at an 'incident'.

Fire-test: to check operation of entire system.

Radio link test: to test bearer link only, without activating re-transmission at the stations.

Senior Officer call: for the HQ to locate, and instruct by voice message, senior officers within the regional areas but out of contact with their vehicle radios. This last feature meets an increasing requirement now that senior officers are involved in fire prevention duties at premises in their areas.

In successful field trials, culminating in an order for £104,000 by the Home Office, a much larger percentage of firemen responded to call-outs by this system which also virtually eliminates the high installation and maintenance costs of the old system.

In phase 2 of their current program, Multitone are developing a fire-ground system for voice communication between firemen at the scene of the fire.

AERADIO CONTRACT

A contract worth £4 million has been obtained by International Aeradio from

the Ministry of Defence & Aviation of Saudi Arabia for the provision of aviation technical services in the kingdom.

The contract covers management, supervision, operation and maintenance of a major proportion of the country's extensive aviation communications network used operationally by the Directorate of Civil Aviation and Saudi, the Saudi Arabian Airline, these services to be provided continuously on a 24 hours per day basis and to include the radio teletypewriter aeronautical fixed telecommunications network, the radio navigation aids, and the nationwide air-to-ground single-sideband radio telephone service.

The contract also covers operation and maintenance of the diesel electric generating plant at 20 locations, including the supply of fuel, lubricants and spare parts, and airfield lighting system and associated equipment maintenance at the airports of Jeddah, Riyadh, Taif and Medina.

IN-LINE GAUGING

Electronic gauging units manufactured by Thomas Mercer Limited have been the basis of a new in-line gauging system designed by the Skefco Ball Bearing Co Ltd for new production lines for the manufacture of bearing rings and races.

The system, used for measurement of various characteristics during the grinding of bearing rings and races, operates on a 100% basis. Should a faulty component be detected, the equipment sends a signal back to either stop or adjust the grinding machinery.

Typical characteristics measured include race and bore tolerances of the order of 0.01mm.

The system prevents a build up of faulty components at the end of the production line and keeps machine down-time to an absolute minimum.

Alternative methods of inspection, based on manual inspection on a statistical sample basis, did not provide the degree of quality control required by the company. The new system is said to be capable of inspecting one component every four seconds.

Currently, seven types of system have been developed to inspect the many different sizes and types of bearing designed and manufactured by Skefco. In some cases inspection is by means of

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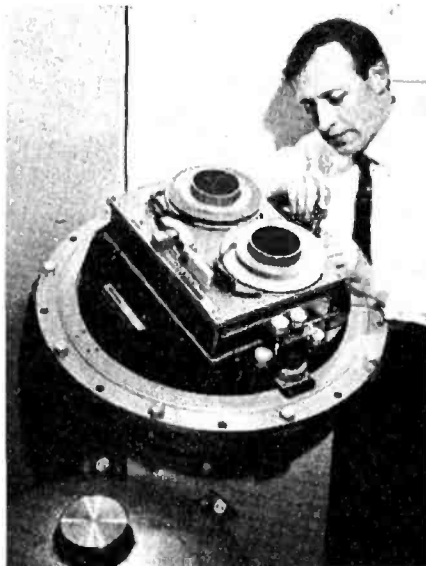
direct electronic measurement, while other readings are made by means of air jets, the resulting air pressure signals being converted into electronic signals by pneumatic/electronic transducers.

The Mercer 155 unit on which all the systems are based allows choice of four metric and four inch-reading scales for direct signal or differential measurement by electronic probes. On the finest reading scale, each graduation is equivalent to 0.00001 in. giving a magnification of approximately 4,200: 1. Two other models are available giving longer and shorter measurement ranges for the gauging of coarser or finer tolerances than is possible with the basic unit.

Further information from Thomas Mercer Limited, Eywood Road, St. Albans, Herts.

UNDERWATER DATA

This underwater data centre produced by GEC-Marconi - accepts inputs from almost an oceanographic instruments and records



time-correlated data in computer retrieval form on magnetic tape.

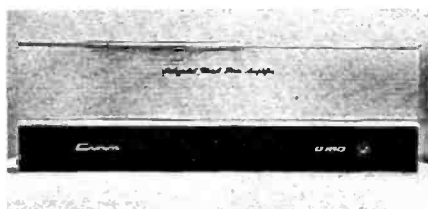
The unit can for example take readings from up to ten current sensor units and will operate for over 1,000 hours from its self-contained batteries.

Six hundred feet of seven track tape may be loaded into the unit, and sampling and integration periods are available from fractions of seconds to over two hours. Usually located on the sea bed to avoid surface weather conditions, the unit with its associated electronics and battery power source can be readily housed in a standard oceanographic sphere, 24 inches in diameter.

PYE LINKPLAN

Coincident with the recent announcement that the first batch of local commercial radio stations are scheduled to be on the air in UK by the end of 1973 and, in all, 26 towns and cities are now scheduled to receive local commercial radio, Pye Group have issued the first comprehensive brochure introducing the 'Pye Linkplan' designed as a unique service to applicants for local commercial radio licenses, consultants and program contractors. Pye offers to provide a comprehensive service with advice on every facet of

CROWN INTERNATIONAL



D150 Power Amplifier

Power: up to 150 watts RMS from each channel.

Power Bandwidth: ± 1 dB 5 Hz to 20,000 Hz.

THD: About 0.0005%

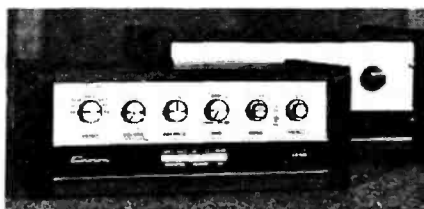
IM Distortion: Below 0.05%.

Hum and Noise: 110 dB below 75 watts.

Size: 17" x 5 1/2" x 9".

Weight: 22 lbs.

PRICE: £199



IC150 Pre-Amplifier

Designed to team with the fabulous DC300 Power Amplifier

Frequency Response: Hi-Level: ± 0.6 dB 3 Hz-100 kHz with high impedance load. ± 0.1 dB 10 Hz-20 kHz with IHFlload; Phono: ± 0.5 dB of RIAA, calibrated.

Phase Response: High-level: typically $+1^\circ$ to -12° 20 Hz-20 kHz with IHF load; Phono: typically $+5^\circ$ 20 Hz-20 kHz additional phase shift.

Hum and Noise: 20 Hz-20 kHz inputs shorted; High-level: 90 dB below rated output (typically 100 dB with IHF "A" weighted measurement; Phono: 80 dB below 10V input) typically 0.5 μ V input noise.

Distortion THD: Essentially unmeasurable; IM: less than 0.01% at rated output with IHF measurement (typically under 0.002%).

Inputs: Five high-level inputs (1 tuner, 2 auxiliary, 2 tape), two equalised phonos.

Input Gain and Impedance: High-level 20.8 dB ± 0.2 dB, 100 Kohms; Phono: 50-70 dB (adjustable), 47 Kohms.

Phono Input Capability: 33-330 mV at 1 kHz, depending on gain (100 mV when set to 60 dB total preamp gain).

Output: 10V maximum before overload, 2.5 rated, 600 ohms output impedance. **Phono Output and Impedance:** (At tape out.) 600 ohms with typical maximum output of 9 V RMS at 1 kHz into high-impedance load.

Filters: Rumble -3 dB at 50 Hz with 6 dB per octave cut-off; Scratch: -3 dB at 5 kHz with 12 dB per octave cut-off.

AC Outlets: Four switched with 25A switch, one unswitched.

Power requirements: About 2 watts at 120 V or 240 V 50-400 Hz AC.

PRICE: £128



D-60 Power Amplifier

Power: up to 60 watts RMS from each channel.

Power Bandwidth: ± 1 dB 5 Hz to 20,000 Hz.

THD: Below 0.05% through band.

IM Distortion: Below 0.05%.

Hum and Noise: 106 dB below 30 watts level.

Size: 17" x 8 1/2" x 1 1/2".

Weight: 10 lbs.

PRICE: £97

Sole Importers:

MACINNES LABORATORIES LTD.,
STONHAM, STOWMARKET, IP14 5LB.
Tel. Stonham 486.

Appointed Dealers:

Audio T, 119 Oxford Street, London W.1.
Southern Organs Ltd., Honeywood House,
Horsham, Sussex.

Excel Services, 49 Bradford Road, Shipley, Yorks.
K. J. Enterprises, 10 St. Albans Road, Watford, Herts.

news digest

station planning, financing, design, engineering, equipment, installation, commissioning, operation and maintenance. The brochure provides a guide as to how a commercial radio station can be built from its simplest form up to the type of configuration likely to be needed in the major British cities.

Further information from Pye of Cambridge Ltd., St. Andrew's Road, Cambridge.

ANCHORS AWAY!

A new Honeywell positioning and control system for deep-water oil exploration which positions vessels without anchors has passed initial sea tests. Known as the Automatic Station keeping (ASK) system, the new technique employs special computer controlled propellers to keep a ship automatically centered over an oil well hole. It was developed by Honeywell's Marine Systems Centre at Seattle. The ASK System will now be put to work in the East Indies, where the SEDCO Internationale's drill ship 'SEDCO 445' will attempt test drilling later this year off Borneo in up to 2,000 feet of water without use of conventional anchoring.

The ASK system is expected to be the first of its kind used for oil exploration in the ocean. Similar systems have been used only for core sampling, usually in less than 700 feet of water. While

positioning of vessels in deep water (more than 1,500 feet) without anchors for short periods has been achieved before, the Honeywell system is designed to enable continuous positioning under a variety of winds and sea conditions for the months that are required claimed to be able to operate in water depths of nearly four miles.

COM SYSTEMS

Pertee have announced news of seven more COM installations. Among the users are a British banking clearing house, data processing service bureaus, and organisations in the savings and loan service and the motor industry.

The Pertee 3700 COM system prints data on microfilm up to 20 times faster than the fastest impact printer, accepting data at 60,000 characters per second and printing up to 26,000 lines per minute. Through put can be from 150 to 500 pages per minute depending obviously on the page size and blocking, with 230 pages per minute as the typical roll film rate. Microfilm stored data uses only 2% of the space required by computer generated paper printouts.

The system accepts IBM 360/370 print tapes including 1600 cpi density. Further information from: Pertee, 21 London Street, Reading, Berks.

ERRATA

We apologize to our readers for substituting, at the last minute, the "4-channel Sound -A simpler way" project in the July issue in place of the "4-channel Sound In Your Car" Product Test which will now be featured in a future issue.

And, in the parts list on page 67 (July), capacitor C5 value should obviously be 220pF.

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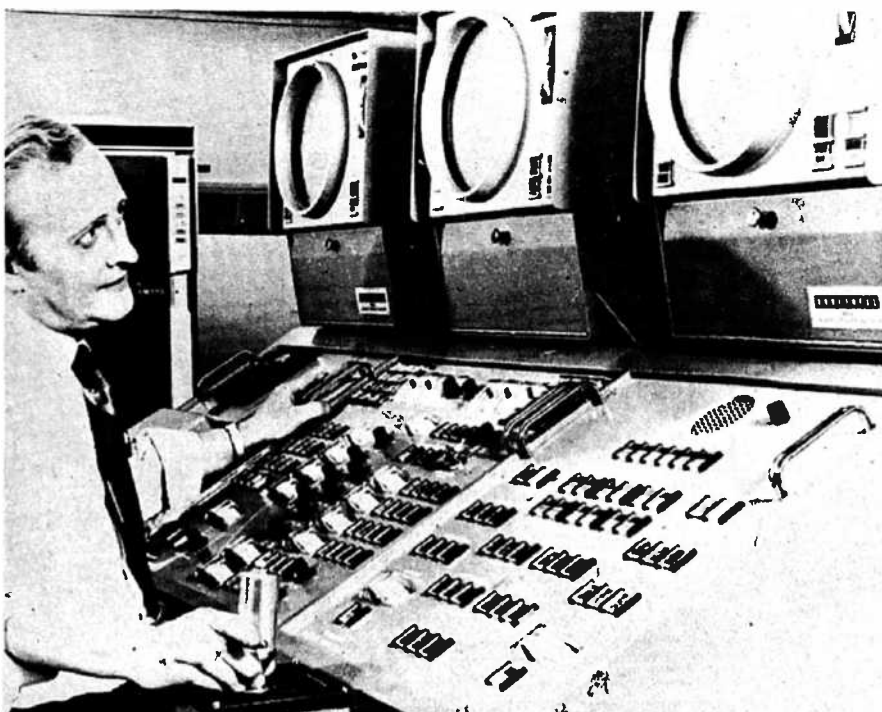
KITS OF PARTS

SCS COMPONENTS will be pleased to forward you a priced list of parts required for any constructional project featured in this magazine on receipt of a SAE.

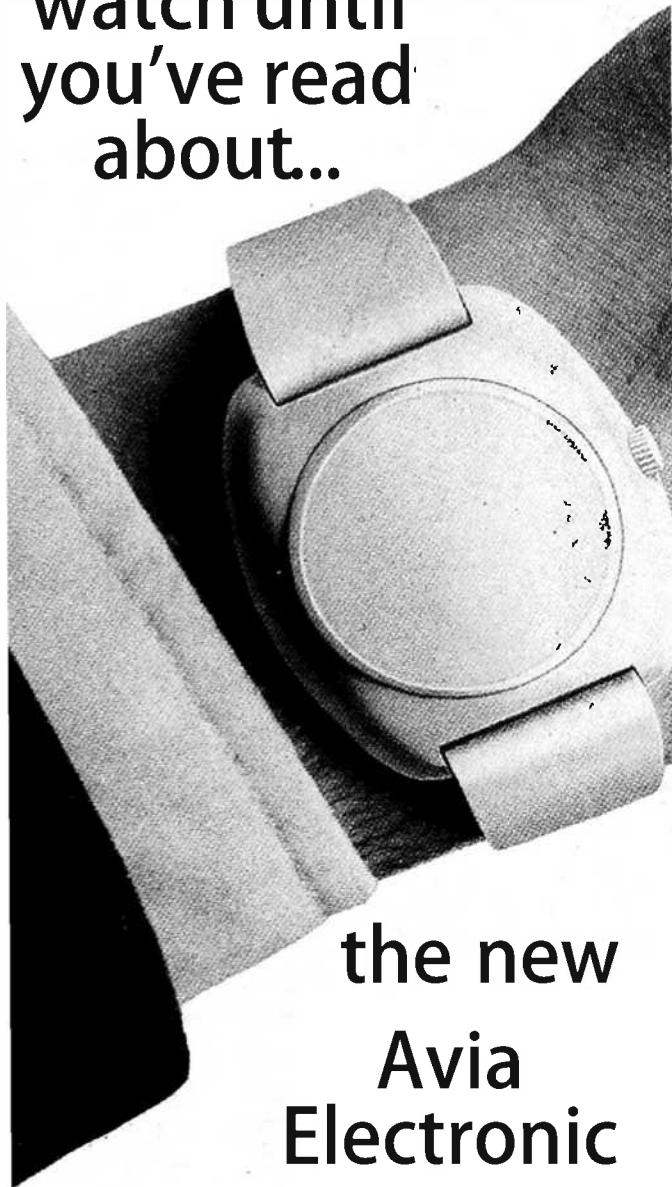
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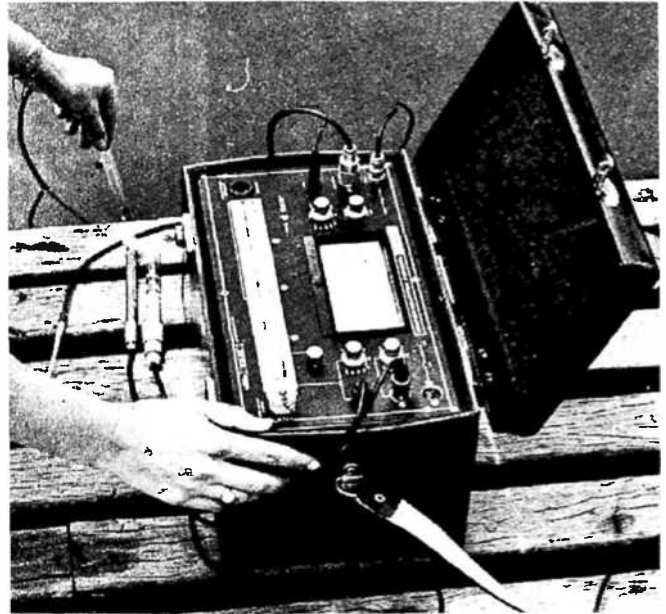


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POLLUTION DETECTOR



An Australian-made instrument is attracting world-wide attention.

Within weeks of announcing its portable pollution tracking equipment, Townson and Mercer Pty. Ltd., of NSW, Australia, had received more than 500 enquiries from potential buyers overseas.

Sales have been made in Malaysia, the Philippines, New Zealand and Japan.

The detector is used specifically for tracking pollution in lakes, rivers, dams and other waterways. It can be slung over the shoulder in a leather carrying case and is virtually a complete water testing "laboratory".

Working from an internal, rechargeable Ni/Cd battery it can be taken anywhere to provide readings on water temperature, suspended solids, dissolved oxygen, conductivity; pH, flow, depth, or a number of other factors. Basically it consists of a series of ion selective probes placed in the water being tested. Measurement is provided quite simply by pushing a button and noting the readings shown on a clearly graduated meter.

The detector provides a simple answer to the complex problem of transporting and operating a number of laboratory-type instruments in the field. It also eliminates the need to take large samples continuously to laboratories for analysis.

By continuously sampling, while moving up a river flow, it is possible to track down how and where pollution is reaching the waterway. Instant meter readings provided by the probe on the concentration of the pollutant enable tracking by a simple "hot or cold" technique.

Company officials say that, once government authorities world-wide set limits on pollution levels, even greater use can be made of this equipment to maintain a constant check that levels do not infringe government regulations or impair the environment.

To date, overseas organisations that have bought units include a privately-owned manufacturing company in the Philippines which would monitor its own effluent, a meat processing plant in New Zealand, and a university in Malaysia.

INFRA-RED AERIAL SURVEY

ELECTRONICS TODAY INTERNATIONAL wish to acknowledge the co-operation extended by EMI Electronics Ltd and the kind permission granted by IERE to reproduce parts of a paper by Mr. E. S. Kingston of EMI Systems & Weapons Division.

In an airborne linescan system, the optics associated with the infra-red scanner are designed to provide a very narrow beam. This small instantaneous angle of view is made to traverse the ground below the aircraft at right angles to its track. By suitably processing the sensor signals, a continuous recording (called a thermogram) of the terrain below the aircraft is built up in the form of a strip. In a simple system the aircraft must fly substantially straight and level since changes in pitch, yaw and roll will modify the results; however, if electrical analogue signals of such changes are available, distortion can be eliminated.

Until recently, infra-red linescan has been used mainly for military surveillance. Line scan for commercial purposes has a different set of requirements, some of which are more stringent.

The resolution and temperature sensitivity of the sensor depend on the type of survey but an instantaneous resolution of 2 milliradians and a temperature sensitivity of 0.2C is the most stringent situation. Finer optical resolution is desirable in certain circumstances but the temperature sensitivity then need be only 0.5C. Coverage of the ground should preferably be 100% in the along track direction but this is essential only in some circumstances. In the across track direction the sensor should be capable of accommodating as wide an angle as possible.

A variety of means of observing the output from the sensor is required in order to cater for differing commercial uses, e.g.

rapid-retrieval strip map form for qualitative assessment of information at the survey site

slow-time production of high-quality strip-maps for quantitative assessment of information

rapid-retrieval thermal profile information along the aircraft track

real-time display of strip-map

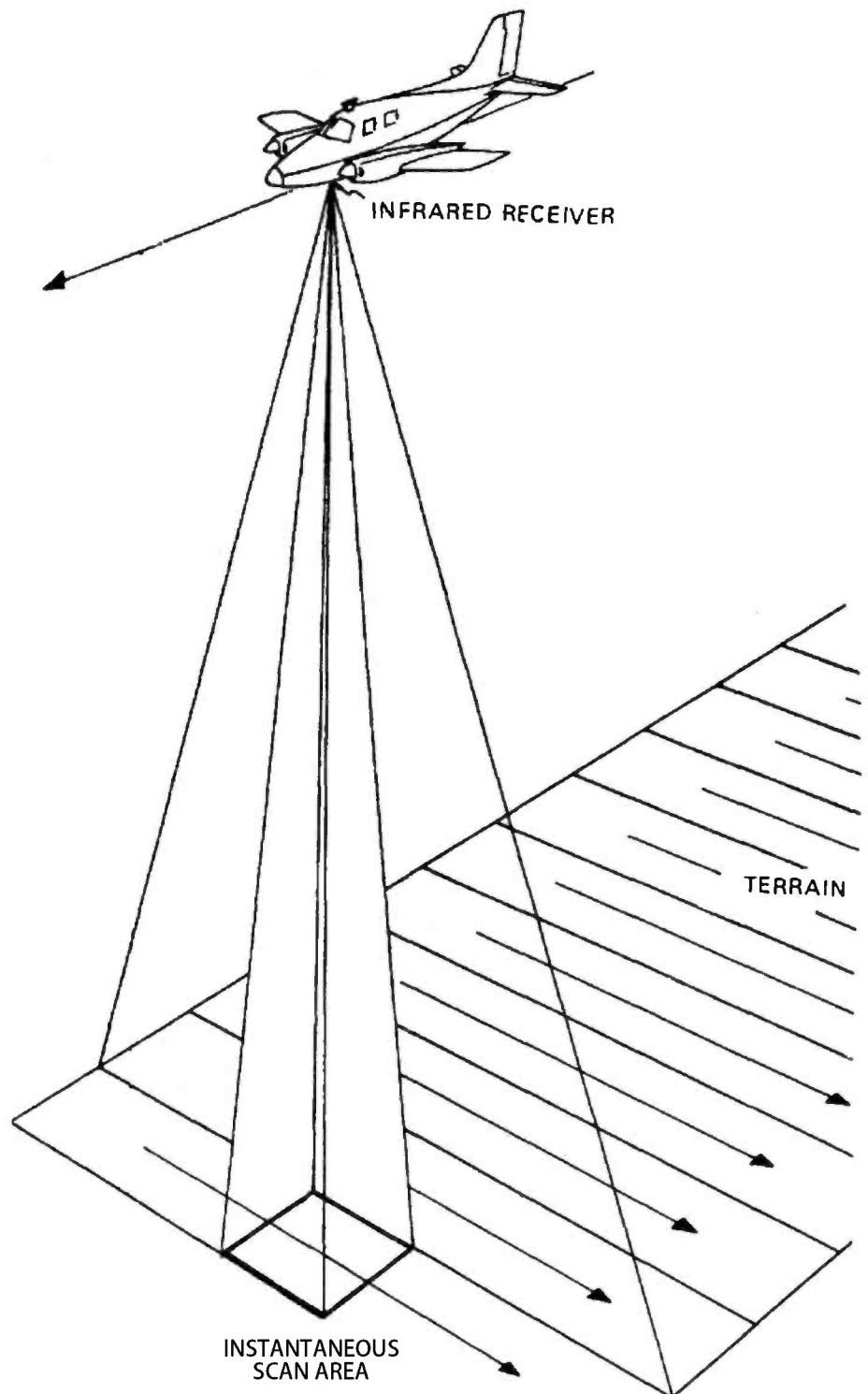


Fig. 1. Scan diagram.

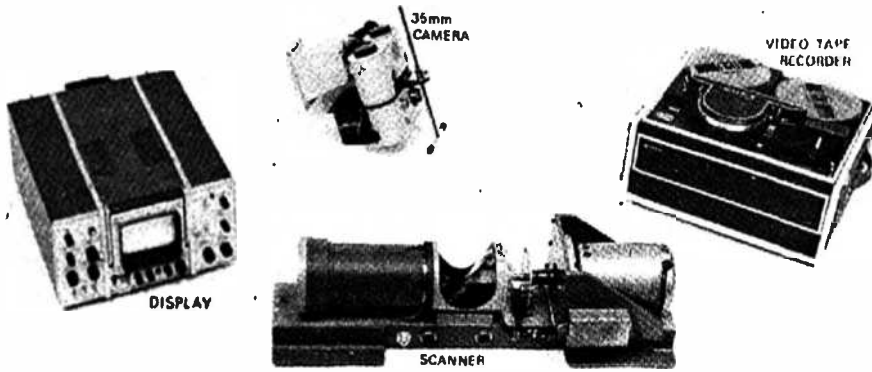


Fig. 2. Airborne equipment.

to assess rapidly changing thermal situations.

EQUIPMENT

The airborne equipment consists of a scanner, a video tape recorder, a liquid nitrogen cooling system, a cathode-ray display unit and a DC/AC inverter. The display monitor is useful for critical adjustment of the received signals and, if desired, for in-flight recording directly on film. A high-quality cathode-ray tube replay system is used on the ground for production of strip-maps from the tape recorded information. Since a greater dynamic range can be stored on tape than can be displayed on a cathode-ray tube or reproduced on film, many different film records can be produced from the results of one flight so as to accentuate different features of the scene.

Across track scanning is done by a rotating single-sided plane mirror

set at 45 degrees to its axis of rotation. Reflected radiation is focused by a parabolic mirror on to a single element indium-antimonide detector cooled to liquid nitrogen temperature (77 degrees K). The rotating mirror is driven by a synchronous motor.

One synchronizing pulse per revolution is generated by a photocell pick-off coupled to the motor shaft. Also mounted on the scanner are the circuits associated with the synchronizing pulse generator and a pre-amplifier for the video signals generated by a detector. Focusing is by thumb-screw adjustment of the mirror-to-detector distance.

The tape recorder, a modified version of an instrument originally designed for the recording of television signals, uses a rotating head system and 1/2 inch (13 mm) wide tape. Video amplification and bandwidth can be adjusted to give optimum performance with a given resolution. A synchronizing pulse is mixed with the video information before recording. Both the mean

video level (mean temperature) and the video gain (temperature sensitivity) are adjustable so that, for any scene, the maximum excursion of the tape characteristic can be used. A manual gain control is provided for use in quantitative surveying where calibration is required. A variable threshold limiter facilitates recording of small temperature differences in a cool part of the scene when the remainder of the scene is at a much higher temperature. In situations where it is sufficient to observe the mean amplitude of signal being recorded, a monitoring meter is used. However, if critical setting of the signal amplitude in a part of the scan is required, the cathode-ray tube monitor must be used. An audio channel is available for recording significant events during a survey.

The received signals can be displayed either as vertical deflections (A scan) or as variations of intensity (Z modulation) on the 10 cm wide screen of the video monitor. The scan angle displayed can be varied according to the requirements of the survey. Both the mean temperature and the temperature sensitivity can be adjusted to display any required feature in the scene to best advantage. The A scan display can be used as a critical monitoring system while making a tape recording. Alternatively, at any selected scan angle, a small interval of the total scan can be displayed and the thermal profile along track can be recorded on 35 mm film using a motor-driven camera with film transport in the same direction as the trace on the monitor. The Z

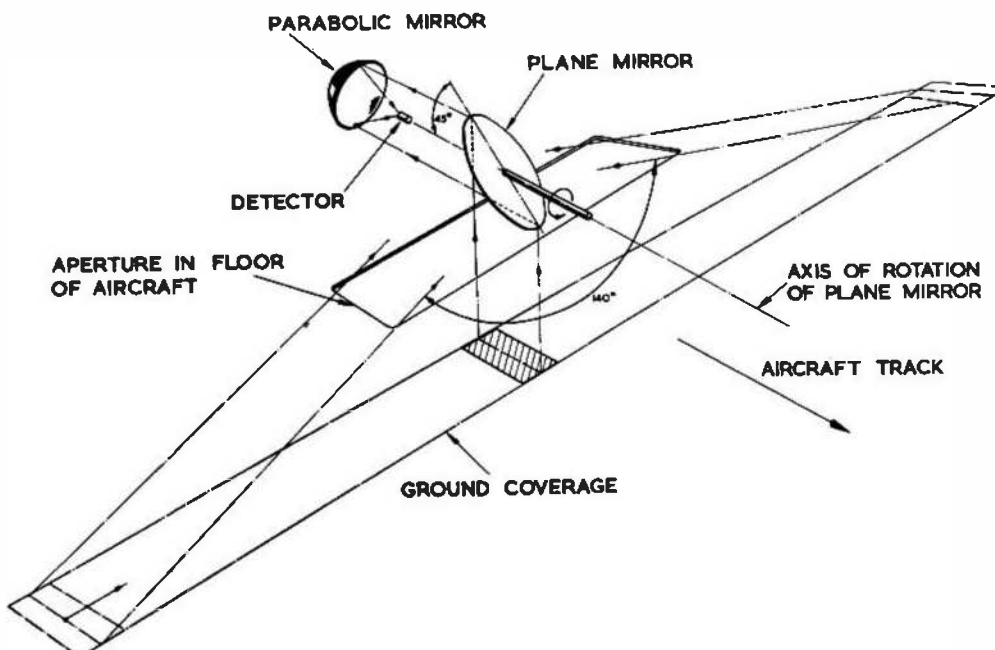


Fig. 3. Scanning geometry.

modulation display can be selected to show hot objects brighter or darker than cold objects. A strip map can be produced on 35 mm film using the motor-driven camera with the film transported at right angles to the trace. The speed of film transport is continuously adjustable and this type of film record can be produced either directly from the scanner during flight or from the tape recorder after the survey is complete.

A similar monitor, fitted with a long persistence tube and having a vertical time base can be used for real time viewing of the information from the scanner.



Fig. 4. Volcanic action in the Acolian Islands, Sicily.

The ground replay equipment consists of a tape recorder similar to the air-borne one, a high quality cathode-ray tube display and a variable-speed 35 mm camera. Temperature variations in the scene are displayed as variations of intensity with hot objects brighter than cold objects. Both the mean temperature (black level) and the temperature sensitivity (contrast) can be adjusted to display any required feature of the scene to best advantage. The scan angle displayed is also adjustable. The 35 mm camera is used to produce strip map records in the same manner as for the video monitor.

SURVEY RESULTS

Over coastal waters and rivers the temperature variations in the water are likely to be small and hence the temperature sensitivity must be set high. However, any land in the field of view will be at a much higher general temperature than the water

and, in order to reduce the dynamic range and eliminate reflected solar energy, it is desirable to do the surveys at night. However, it is possible to use the peak amplitude limiting and the mean temperature control to view the variations in the cold part of the scene with maximum temperature sensitivity. Under these conditions all detail in the land area except for the outline of the coast will disappear.

On geological surveys, since the differences in emitted energy due to changes in sub-surface rock may be very small and may be masked by reflected solar energy, it is essential to carry out such surveys

at night. If, however, changes in drainage are being surveyed, some solar energy is essential. If isolated sources of heat on the surface are to be made less significant, either the peak amplitude limiter must be employed or a coarse instantaneous resolution should be selected; the latter action is the most desirable since the temperature sensitivity for large area subjects is increased while the collected energy from subjects subtending an angle smaller than the instantaneous resolution is unchanged.

If it is required to observe the temperature of small objects, e.g., power lines and insulators, the width of strip scanned on the ground must be no greater than say 6 ins. At the minimum resolution of 1.5 milliradians this spot size on the ground is achieved at an altitude of 333 ft and 100% cover on the ground is achieved at a velocity of 25 ft per second or about 16 knots. Such surveys would be carried out most conveniently using a helicopter.



Fig. 5. Colliery slag heaps showing areas of spontaneous internal combustion.

Sub-surface water will be detected only if there are differences in temperature at the surface, generally caused by differential evaporation and some external radiation. Surveys should therefore be carried out at different times of day to ensure that the conditions for maximum thermal contrast have been experienced. The same comments apply to archaeological surveys where the objects below the surface show because of differences in drainage.



Fig. 6. Dispersal pattern of power station effluent into the sea.

ELECTRONIC WATCHES

Fully solid state watches without any moving parts are now a reality. Brian Chapman traces recent developments.

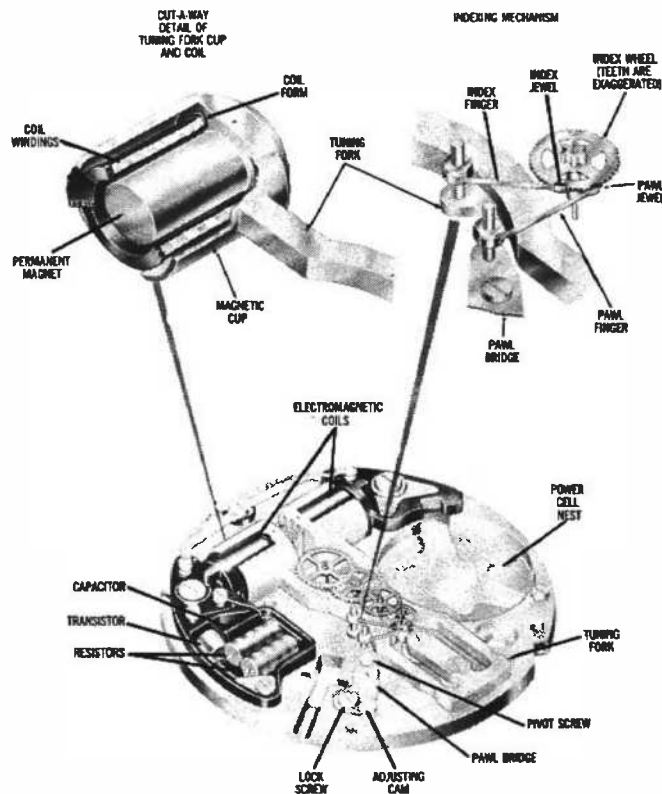
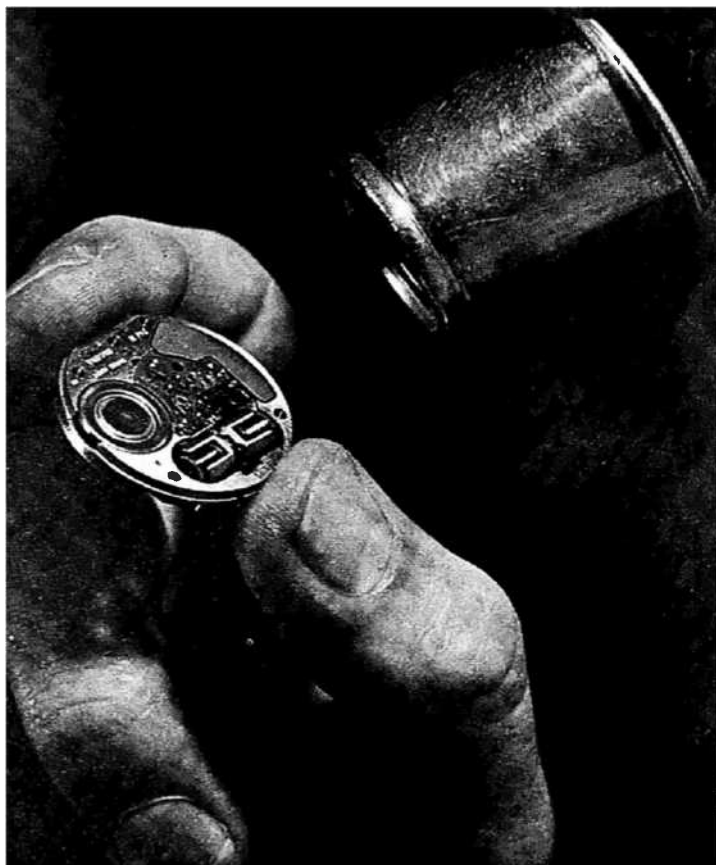


Fig. 1. The Accutron - major elements.

By 1980 the world watch industry will almost certainly be producing 300 million watches a year. This output can only be achieved by placing heavy reliance on automation, and simplification of watches' existing mechanical construction. Only an increase in productivity per capita will allow this output to be achieved whilst still maintaining competitive prices. The horological industry has been well aware of these problems for many years and large sums have been invested in researching new methods and techniques. It is now generally agreed that the current trend towards electronic watches provides not only an answer to the productivity problems, but at the same time offers accuracy never before realised (or possible), in any wristwatch previously made.

TUNING FORK WATCHES

The first generally successful electronic watch, the Bulova Accutron, made its appearance in 1960. It was the first watch not to use a balance wheel and hairspring. Instead, the Accutron uses a tuning fork as the time keeping reference. The operation may be seen by reference to Figs. 1 and 2. The tuning fork forms the feedback path of a transistorized oscillator operating at a frequency of 360Hz and the vibratory motion of the fork is converted into rotary motion by a ratchet wheel and pawl indexing mechanism. This construction reduces the number of moving parts from 23 to 12 - with consequent reliability increase. Overall accuracy (of the Accutron) is greater than that for conventional movements - to such an extent that the

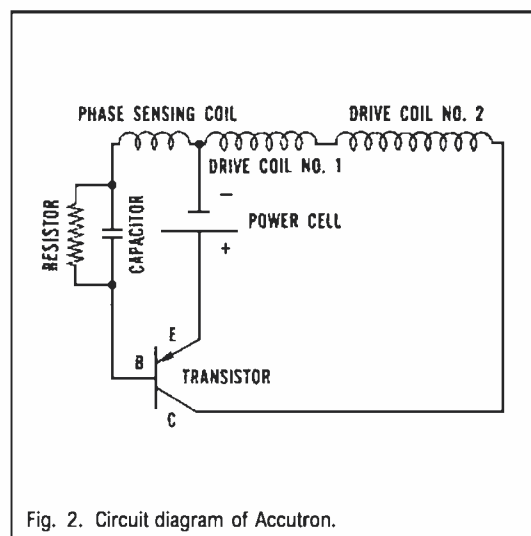


Fig. 2. Circuit diagram of Accutron.

construction reduces the number of moving parts from 23 to 12 - with consequent reliability increase.

Overall accuracy (of the Accutron) is greater than that for conventional movements, - to such an extent that the standard Accutron unit exceeds the Horological Guild's standards for "Wrist Chronometers" by a considerable margin - see Table 1. This unprecedented accuracy for standard production models has allowed Bulova to offer a written guarantee of accuracy to within a minute a month.

ELECTRONIC WATCHES

Whilst tuning fork watches went a long way towards alleviating the productivity problem, they still contained a relatively large number of moving parts and were fairly expensive. Obviously the ideal solution is an all electronic, fully solid-state watch, but until quite recently the technology to do this within the space available, and at a reasonable cost, had not been evolved.

But within the last few months two techniques have been developed which make the fully solid-state watch a reality and many manufacturers already have such units on the market. Typical among these are those of Roamer Seiko, Swiss CEH and Longines. Figs. 3 to 6 give the block

Characteristic	Tolerance for Chronometer	Tolerance for Chronometer with mention (all rates seconds per day)	inherent performance characteristics of ACCUTRON
1. Regulation - Mean rate in 5 positions at room temperature.	-3 to +12	-1 to +10	-2 to +2
2. Mean variation in rate for above test.	3.2 max.	2.2 max.	less than 1
3. Rate difference between 6 up and dial up.	9	6	less than 1
4. Mean variation in rate for above test.	12 max.	8 max.	5
5. Largest difference in rate for any of the 5 positions tested and mean daily rate.	18	12	4
6. Rate - Temperature Coefficient in sec/day/degrees C from 4 C to 36 C.	1 max.	.6 max.	.3 max.
7. Recovery (change in rate as result of exposure to temperature test).	9 max.	5 max.	less than 1

Table 1. Comparison of Accutron-with "Wrist Chronometer" standards.

diagrams and layout of these watches. The first technique to find application was that of CMOS (Complementary Metal Oxide Semiconductor) integrated circuitry. The CMOS family of integrated circuits are characterized by extremely high packing density and very low

power dissipation - the lowest of any logic form. In addition high volume production ensures low unit cost.

AU these features are exactly those required for the electronic watch industry market and Motorola have been quick to see the application and to capitalize on it.

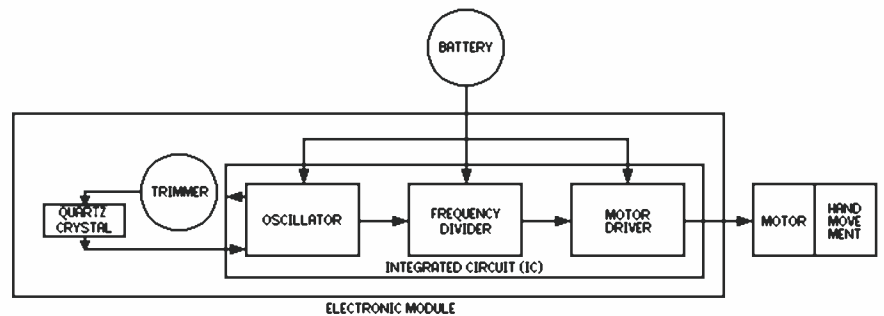
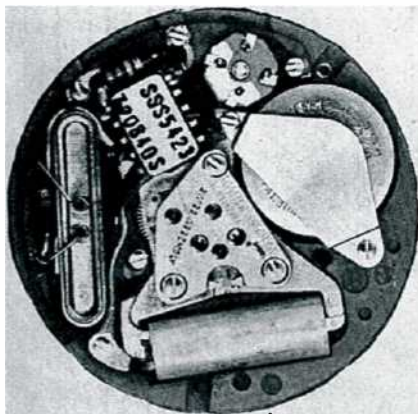


Fig. 3. ROAMER - The Roamer Micro Quartz uses an IC to divide down a 32,768kHz crystal to 0.5Hz. The square wave output drives a stepper motor and then the date/time gearing. The watch uses electronics supplied by General Time Corporation of the USA. Liquid crystal display model should be available at the end of the year.

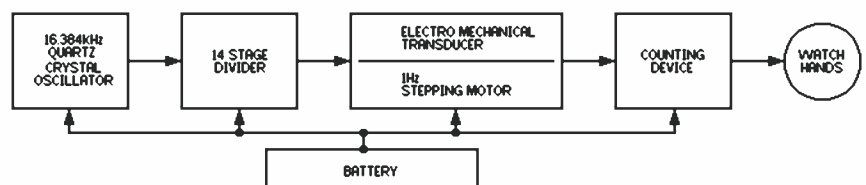
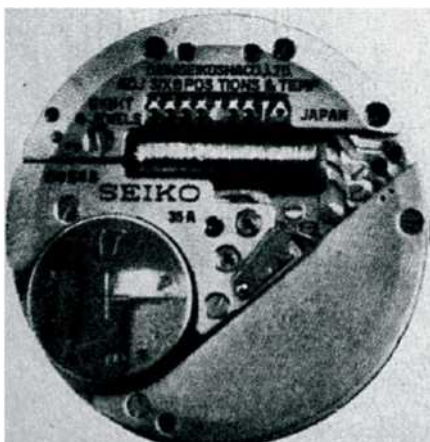


Fig. 4. SEIKO - The Seiko watch utilizes a 16,384kHz crystal oscillator divided down by an IC to 1Hz. The 1Hz pulse drives a six pole stepping motor in 60 degree increments and thence the second hand in one second increments.

ELECTRONIC WATCHES

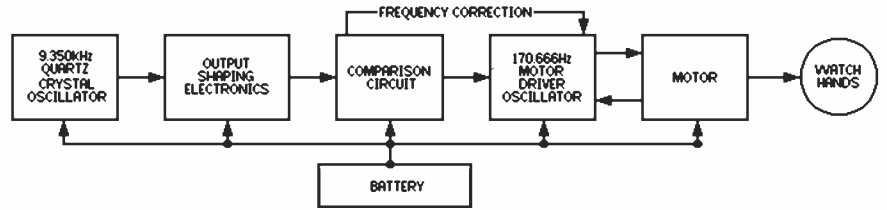
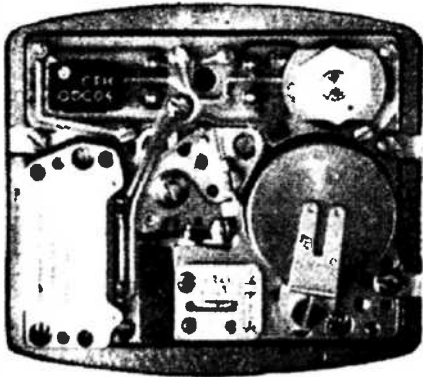


Fig. 5. SWISS-CEH - The Swiss Centre of Electronic Horology developed this movement for a number of member companies including Bulova and Omega. It uses an 9.350kHz oscillator and five stage IC divider to produce 256Hz which is fed direct to a motor. Gearing provides the remaining step down.

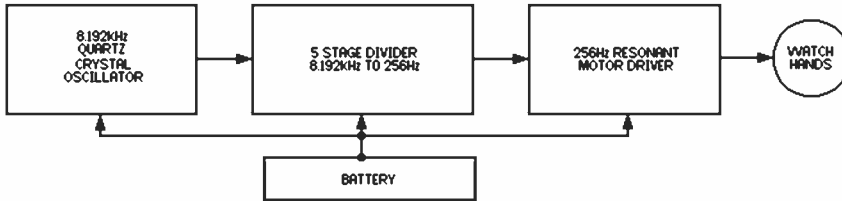
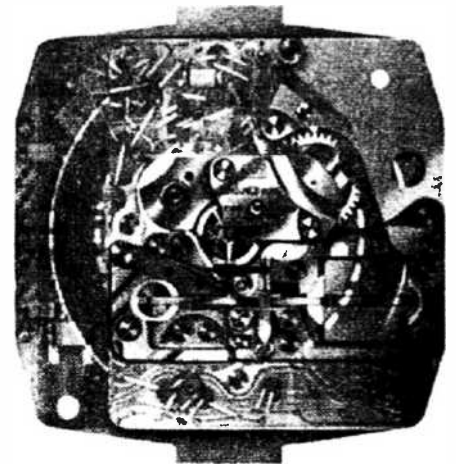


Fig. 6. LONGINES - The Longines watch uses a feedback system which compares the output of a 170Hz motor driver oscillator with the output of a 8.192kHz quartz oscillator. The error signal thus developed is used to correct the motor driver oscillator frequency. A discrete component circuit utilizes 14 transistors.



Motorola have marketed a complete watch kit consisting of three matched components. These are:

- 1) A silicon gate CMOS MSI (Medium Scale Integration) oscillator, divider and buffer circuit.
- 2) A miniature, precision quartz crystal, cut for 32.768kHz.
- 3) A micro-miniature stepper motor.

The kit is initially selling for approximately US \$15 but Motorola confidently expect that this will

reduce to about \$3 US when volume of sales increase. Thus watches retailing for about \$17 US or more will almost certainly be built in this fashion.

Apart from the components listed above, all that is additionally required to construct a watch are a trimmer capacitor, a micro-miniature battery, watch case, gearing, dial and hands. The quartz crystal operation provides an accuracy at least four times better

than that attainable with tuning forks and will be within 15 seconds per month. Figure 7 shows the three components of the Motorola system in relation to a conventional watch case. Within a few days of the announcement by Motorola Semiconductors that they had produced the necessary components for electronic watches, the ITT Components Group of Europe announced that they also had time

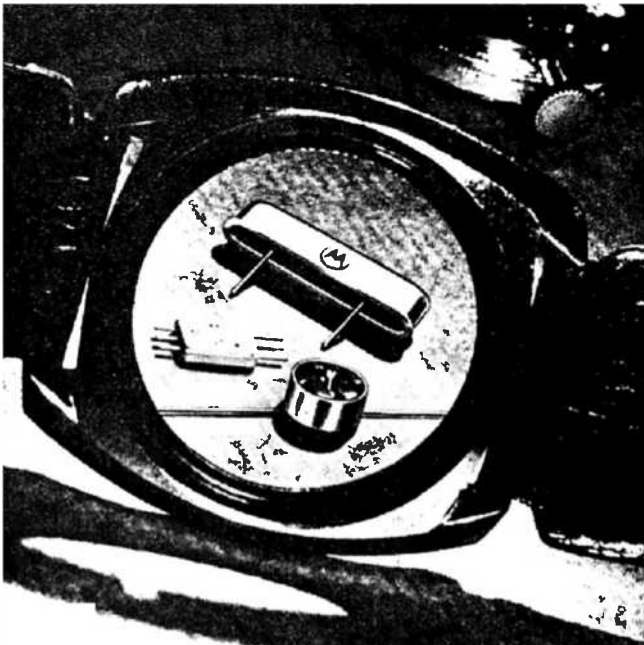


Fig. 7. Components of Motorola system in relation to conventional watch case.

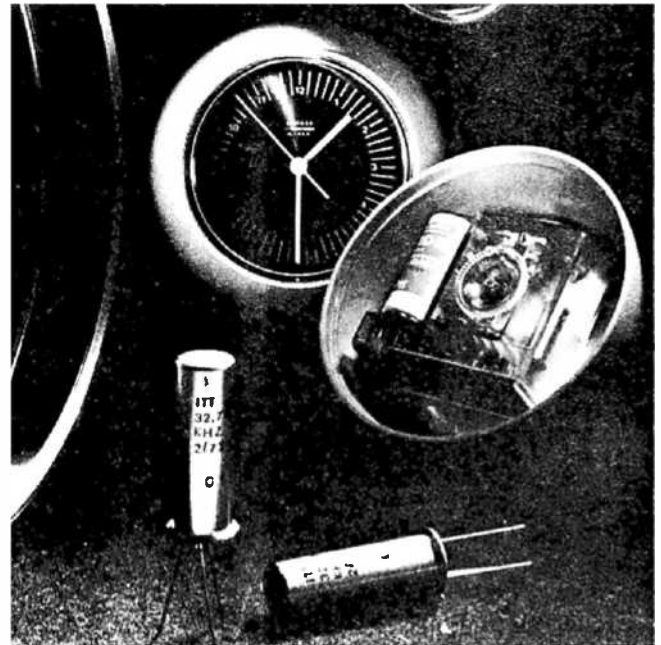


Fig. 8. The Staiger Chrometron which incorporates electronics by ITT.

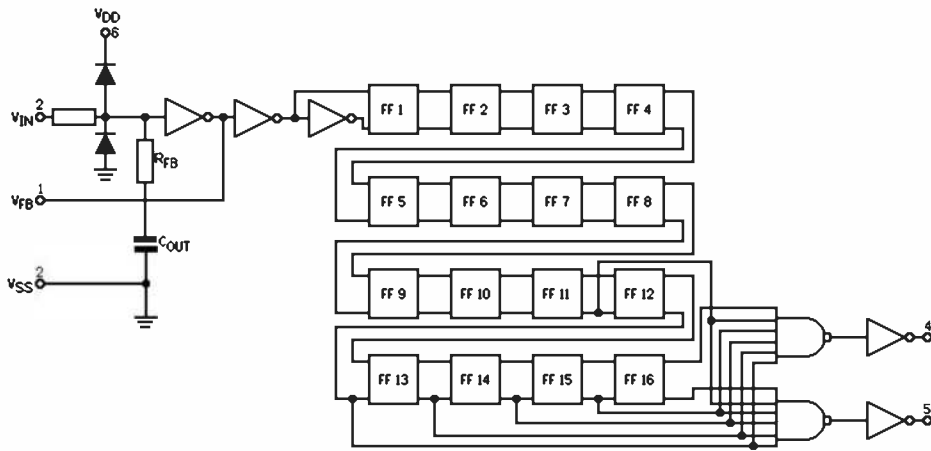


Fig. 9. Block diagram of the CMOS watch integrated circuit developed by Motorola.

monolithic MS1 chip fabricated by means of the silicon-gate CMOS process. The monolithic die measures 82 x 94 mils and contains 312 active devices. As explained previously, except for the external trimming capacitor, the oscillator passive components are also integrated.

POWER REQUIREMENTS

For a system current drain of 15µA at 1.5V, and a battery life of 12 months (8,760 hours), a 131 mA-hr battery is required. For the same life from a 1.3V battery and 13µA drain, a 114 mA-hr battery is required. Typical power consumptions are shown in Table 2.

THE QUARTZ CRYSTAL OSCILLATOR

The NT-cut, quartz crystal is a length-width flexure type crystal used in its fundamental mode of oscillation. An NT-cut crystal, while yielding performance levels equivalent to other low frequency crystal types, is unique in that it requires only 1/4 as much quartz.

Another important advantage of the NT-cut lies in its ability to withstand shock. Because the NT blank is very thin, four-point support can be provided while maintaining a very slender package configuration. This accounts for the superior shock resistance quality: less than two parts per million frequency shift after repeated shocks of 1,000 G and 0.4 ms duration. The Motorola NT will survive shock levels as high as 3,000 G which is equivalent to an approximate one metre drop to a hardwood floor.

The MT021 crystal was especially

keeping electronics available which had been used in the first electronic clock to be mass produced - the German made Staiger Chrometron, Fig. 8.

Both Motorola and ITT use crystals with frequencies of 32.768kHz whereas the newly released Timex watch has a 49.192kHz crystal. Unfortunately details of the Timex watch are not available and the principle of operation is somewhat of a mystery, particularly as the frequency used in the Timex Watch is not a power of two.

THE MOTOROLA SYSTEM

The heart of the Motorola system is the CMOS integrated circuit, the block diagram of which is shown in Fig. 9. The operation of the system may be seen from Fig. 10. The basic time reference is a quartz crystal controlled oscillator consisting of a basic CMOS inverter circuit with a crystal and feedback resistor connected in parallel between the inverter output and input. Both input and output have capacitors to earth. As the feedback resistance can range from 10 ohms to several hundred megohms without appreciable effect on operating frequency or current drain, this component is also integrated into the monolithic chip structure.

Either of the two capacitors could be used to adjust the frequency, but because the power dissipation of a CMOS inverter is a function of output capacitance, the capacitor is fixed at about 22pF and is also integrated onto the chip. An external trimmer capacitor is then used across the inverter input to provide frequency adjustment. This is necessary in order to compensate for long term frequency drift of the crystal. The drift due to ageing of the crystal is typically two parts per million per year, that is, 30 seconds per year.

The oscillator output frequency is divided down to 0.5Hz by a chain of

16 CMOS flip-flops. A pair of NAND gates accepts the outputs from the last six flip-flops and produces two parallel trains of 31.25 millisecond pulses each at a frequency of 0.5Hz and separated in phase by 180°

Further inverters provide buffering and wave-shaping before the pulses are fed out and combined to provide the motor with one drive pulse per second. For maximum power transfer these drivers are high current-capacity MOSFETs.

Because of stray capacitance, power dissipation of the complete chip is proportional to frequency and the first 10 flip-flops consume 99.99 per cent of the power. Therefore, the counter performance, and power drain, is virtually independent of the number of flip-flops used.

Thus oscillator binary divider, wave-shaping and buffering circuitry are all contained on a single

	1.5 V Silver Oxide	1.3 V Mercuric Oxide
IC	5.0 uA	4.5 uA max
Motor	10.0 uA	8.5 uA max
System Total	15.0 uA	13.0 uA max
Battery capacity required for 12 months (8760 hours) operation	131 mA-hrs	114 mA-hrs

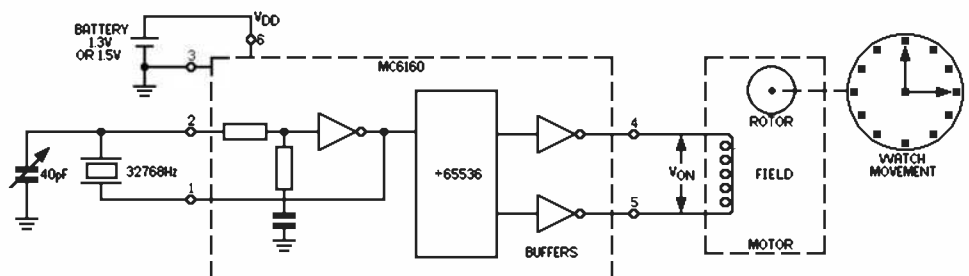


Fig. 10. Typical electronic watch system using Motorola components.

ELECTRONIC WATCHES

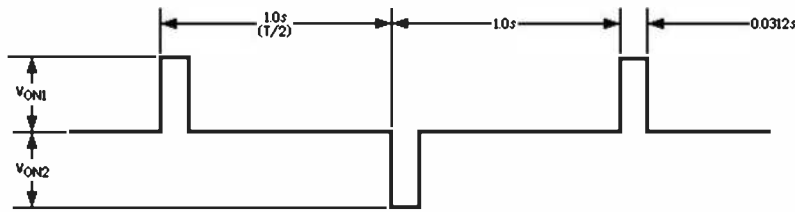


Fig. 11. Output waveform across Motorola watch motor.

designed for wristwatches. The small size, low power requirement and CMOS oscillator compatibility are especially attractive in this application. Why 32.768kHz? For minimum crystal size, the frequency should be chosen as high as possible. However, for minimum power dissipation in the integrated circuit, and extended battery life, it is desirable that the frequency be kept as low as possible. 32.768kHz represents a compromise frequency which yields a crystal size usable for a man's watch and a power requirement and size easily satisfied by presently available batteries. As circuit and battery improvements are made, it is expected that the frequency can be increased, to obtain smaller crystal sizes. These improvements would then permit the manufacture of even smaller watches.

THE MINIATURE MOTOR

The Motorola MTM series motor is a miniature motor of the rotary stepping type. These motors are unidirectional

and rotate 180° each second, coming to rest after each rotation. The motors have sufficient torque, if proper reduction is provided, to drive a typical watch movement and day/date display. Average current consumption is only 8.5μA at 1.3V and 10uA at 1.5V. The typical signal driving the motor in the system described here is shown in Fig. 11.

The Motorola components are being incorporated in a large number of watches which are either on the market now, or are shortly to be released and it would seem that the heavy investment in this technology will pay off.

Electronic watches previously bore price tags of from us \$595 to us \$2200, putting them well out of the working man's reach. However Timex have recently announced that their quartz watch will sell for \$125 in the USA, a price which represents the first, real market breakthrough.

Although Timex were first on the scene with lower prices, several companies are in hot pursuit - Seiko of Japan, Roamer and Avia to mention just a few - have all introduced quartz models at competitive prices.

The stepping motor, gearing and hands are the last remaining moving parts and these also have succumbed to the electronic onslaught. The technology which is being used to replace these components is that of liquid crystal displays.

LIQUID CRYSTAL DISPLAYS

Liquid crystals, as the name implies, are materials, which although in liquid form, have a crystalline structure.

There are many thousands of liquid crystal materials which may be considered to fall into three distinct groups, having different but interesting properties. The group that is of interest for electronic watch displays is known as "nematic crystals" and is more suitable for this purpose than any other known technique.

Nematic crystals are normally aligned with each other and appear clear. Whenever an electric field is applied the crystal alignment is destroyed and the material scatters the incident light and hence appears milky or cloudy.

Liquid crystals consume no power at all when clear and are only very poor conductors drawing very little current in the milky state. Additionally liquid crystal displays do not generate light, they only reflect or transmit it. Thus the higher the ambient light level the brighter the display. Finally liquid crystals interface readily with CMOS I. C's. All these factors make them ideal for watch displays and several companies are marketing "all electronic" watches. Societe des Garde - Terrips SA, the producer of Avia watches plans to sell more than 20,000 of its new all electronic watches before the end of the year in the USA and in Europe. It is expected that the watch will retail for about \$200 US. This new time piece has been developed by SGT in collaboration



Fig. 12. The Avis electronic watch with liquid crystal display.

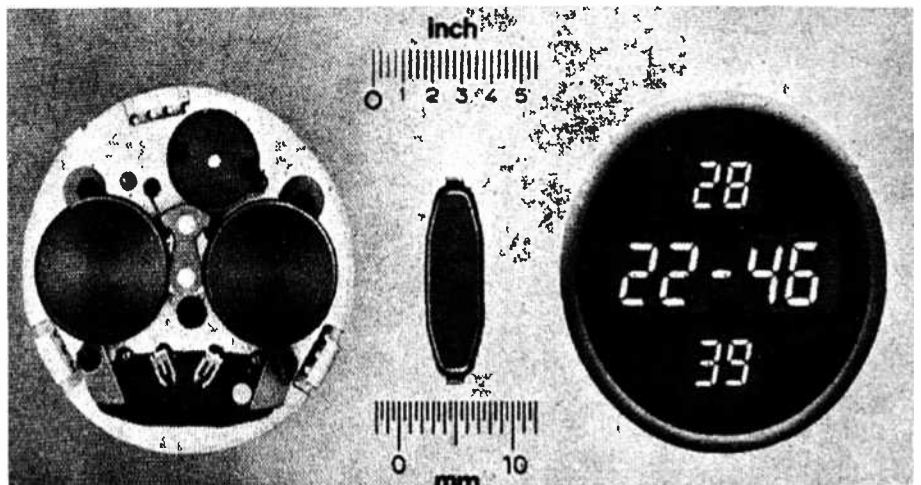


Fig. 13. The Ebauches SA electronic watch operates at 32kHz and has a liquid crystal display by Texas Instruments. The display gives day of month, hour, minute and seconds.

with Optel Corporation, Princeton, New Jersey, U.S.A. who are manufacturers of a wide range of liquid crystal displays. The hours and minutes are displayed by means of seven segment digits as shown in Fig. 12, and the seconds are indicated by the flashing of two decimal points between the hours and the minutes digits.

A second all electronic watch has been developed by Ebauches SA utilizing a crystal display from Texas Instruments. This will be marketed later this year by Longines' at US prices from \$30 to \$300. (Fig.13).

The Optel display is scheduled to be used by six other Swiss watch manufacturers including Omega and Ditrone SA - a union of five smaller watch companies.

Although liquid crystal displays are definitely here to stay, it is by no means certain that those at present being fitted to electronic watches are free of problems. Warnings can be found from many sources that liquid crystals have life problems.

Mr. Edward Kornstein, vice-president of Optel Incorporated was quoted as saying that he believed that electronic watches would be the first mass market for LCD, but admitted that there were yield and manufacturing problems as well as lack of life test data, but by next year, this would all be solved.

Mr. Chuck Johnson, Motorola's marketing manager for quartz time piece components, does not believe that LCDs will replace the mechanical motor driven watch display until the reliability, life and price problems are solved. (Motorola incidentally is also developing liquid crystal displays).

"In order for the watch makers to go LCD in a big way, life of displays will have to be longer than a year to 18 months," he said.

At present most manufacturers of LCD are only forecasting a life of 2000 to 10,000 hours, that is, 2 1/2 months to a year. Replacement at such intervals as this could certainly deter would be buyers. But it would appear that within the next two years the all electronic watch will capture at least a third of the total watch market. If prices of all electronic watches drop to the extent forecast, they may well in time, completely replace the traditional mechanical and hybrid types.

The only people likely to be unhappy at this prospect are Swiss watchmakers, who will now be faced with the fact that US dominance in the field of electronics will relegate these watchmakers to the role of assemblers of US movements into Swiss cases.

Ion Implantation

New semiconductor fabrication process improves electronic watch ICs.



Ion Implanter at Motorola's Semiconductor Products Division. Ion accelerator, shown, can implant up to 26 wafers automatically with precise control of both penetration depth and distribution of dopant atoms. Target wafers are contained in the vacuum sealed carousel, foreground.

A new semiconductor fabrication process known as ion implantation is now being successfully used in the manufacture of CMOS (complementary metal oxide semiconductor) integrated circuits by Motorola's Semiconductor Products Division.

First applications of this new fabrication technique have been directed toward the silicon-gate CMOS circuits that Motorola supplies for electronic wristwatch systems. These watches employ a quartz-crystal oscillator to generate an ultra-stable reference signal, which subsequently, is electronically divided down to a single pulse per second by means of the CMOS circuitry. The pulsed output drives a tiny rotary motor to turn the hands on the watch face. Heart of the quartz-watch system, the CMOS IC contains oscillator, binary divider, wave-shaping and buffering circuits on a single 82 x 94-mil chip that operates from 1.5 V levels at only micro-watts of power dissipation.

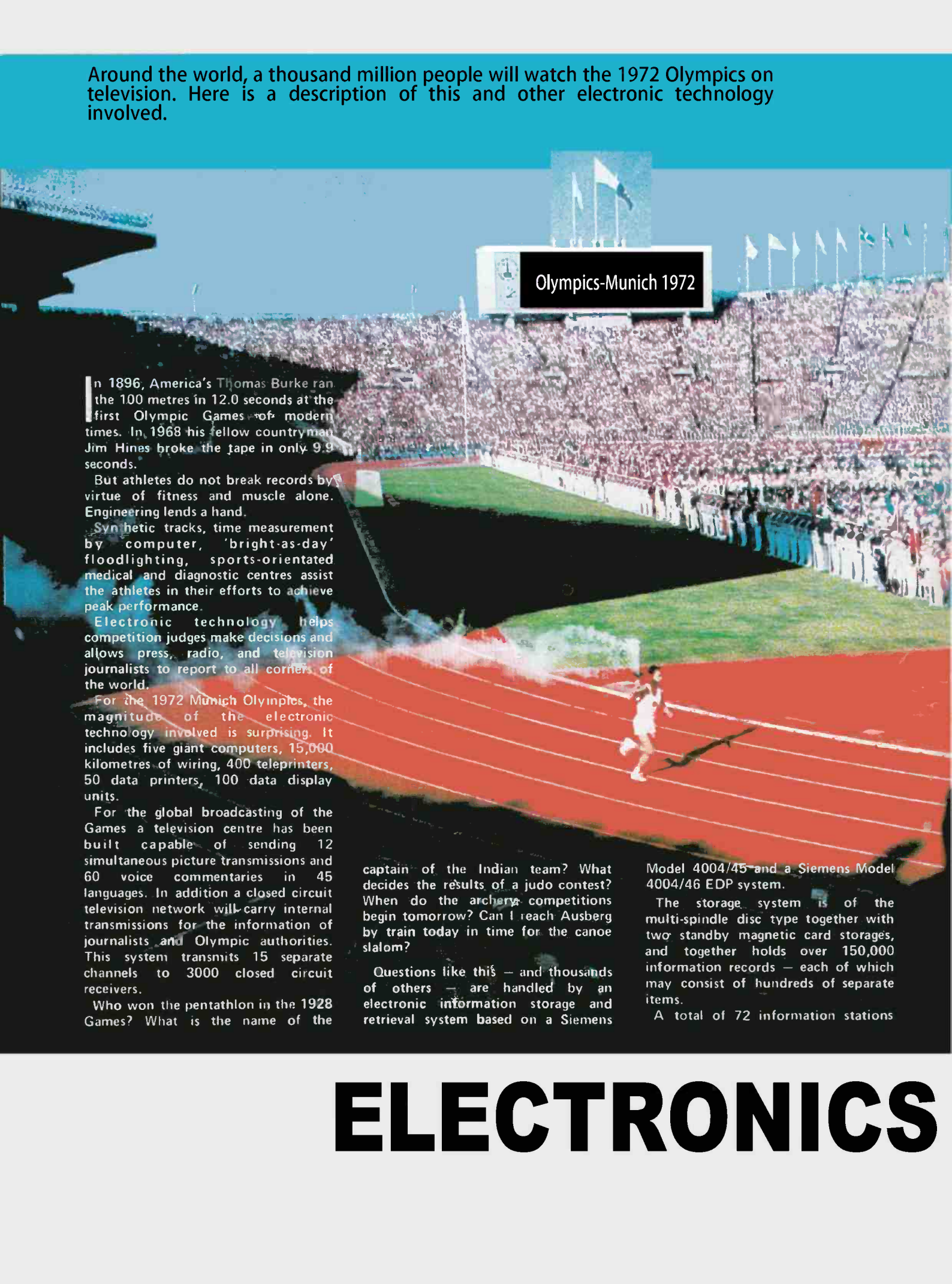
Combined with conventional semiconductor technology ion implantation techniques will enable improvements in the performance characteristics of existing CMOS devices, improvements that could not be made easily without the implantation process. For example, the characteristically low threshold

voltages that represent the major advantage of CMOS devices for wristwatch systems (enable year-long operation from a small, single cell battery) can be controlled with extreme precision with the implantation technique.

In contrast to the epitaxial refill technique, the method used today to fabricate the complementary-type material, ion implantation introduces the dopant atoms into the semiconductor crystals by accelerating them to high velocities and directing them against the crystal surface. The ions penetrate the target material and remain embedded in it. In this latter process, the depth of penetration and the distribution of impurity atoms is an exact function of energy and dose, both of which can be precisely controlled electronically. The final depth is achieved by a thermal redistribution process.

The extreme accuracy and control offered by the ion implantation process translates into high production yields and, consequently, into substantially lowered manufacturing costs. For that reason, the successful transition of ion implantation from research status to a powerful, new production tool is considered to be a milestone in the brief history of electronic watch components.

Around the world, a thousand million people will watch the 1972 Olympics on television. Here is a description of this and other electronic technology involved.



Olympics-Munich 1972

In 1896, America's Thomas Burke ran the 100 metres in 12.0 seconds at the first Olympic Games of modern times. In 1968 his fellow countryman Jim Hines broke the tape in only 9.9 seconds.

But athletes do not break records by virtue of fitness and muscle alone. Engineering lends a hand.

Synthetic tracks, time measurement by computer, 'bright-as-day' floodlighting, sports-orientated medical and diagnostic centres assist the athletes in their efforts to achieve peak performance.

Electronic technology helps competition judges make decisions and allows press, radio, and television journalists to report to all corners of the world.

For the 1972 Munich Olympics, the magnitude of the electronic technology involved is surprising. It includes five giant computers, 15,000 kilometres of wiring, 400 teleprinters, 50 data printers, 100 data display units.

For the global broadcasting of the Games a television centre has been built capable of sending 12 simultaneous picture transmissions and 60 voice commentaries in 45 languages. In addition a closed circuit television network will carry internal transmissions for the information of journalists and Olympic authorities. This system transmits 15 separate channels to 3000 closed circuit receivers.

Who won the pentathlon in the 1928 Games? What is the name of the

captain of the Indian team? What decides the results of a judo contest? When do the archery competitions begin tomorrow? Can I reach Ausberg by train today in time for the canoe slalom?

Questions like this — and thousands of others — are handled by an electronic information storage and retrieval system based on a Siemens

Model 4004/45 and a Siemens Model 4004/46 EDP system.

The storage system is of the multi-spindle disc type together with two standby magnetic card storages, and together holds over 150,000 information records — each of which may consist of hundreds of separate items.

A total of 72 information stations

ELECTRONICS

are set up in the press centres at the various competition sites, and also at focal points of visitor traffic. Each station consists of a data display terminal on which the answers from the computer appear, and a keyboard operated by a trained hostess. The 72 information centres are linked with the main computers via serial modems which permit a data transmission rate of 1200 bits/second.

Fifty of the data display terminals are connected with printers so that information displayed on the screen may be printed out.

The largest section of the Olympic data bank, which has been compiling for two years, contains the personal data on the 10,000 athletes and 5,000 officials. The information system will be able to provide, for example, full name, date of birth, nationality, height, weight, marital status, number and sex of children, hobbies, club memberships, best events and previous successes and victories. The complete rules of all 196 events of the 21 Olympic sports and significant sporting terms in German, English and French are also stored. A daily summary of the Munich competition results will be fed into the information system during the night by means of a special up-dating service.

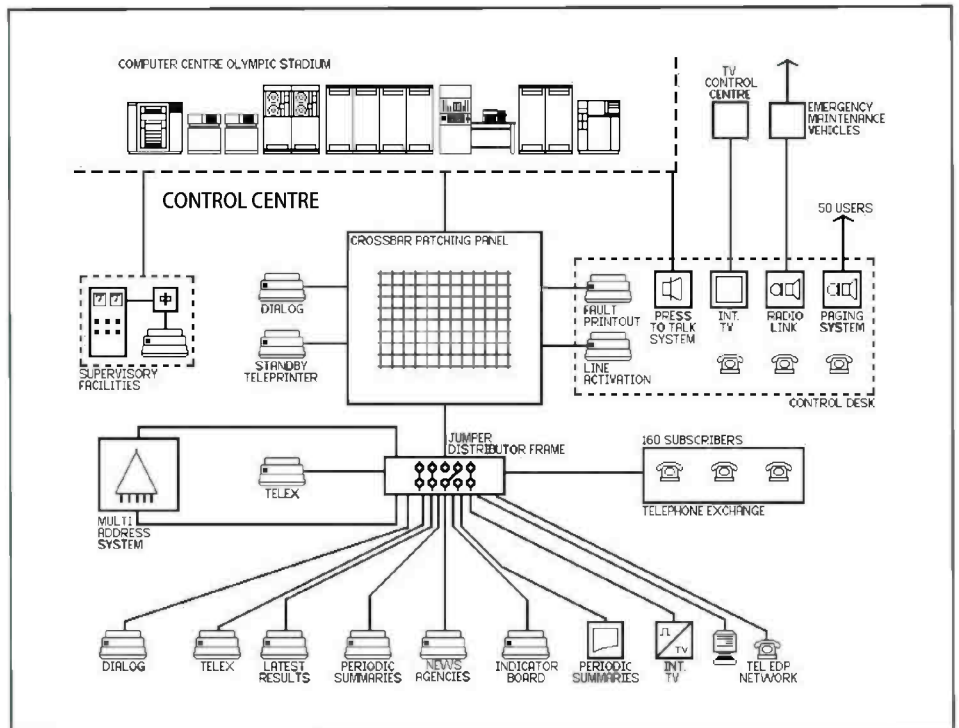
A particular advantage of this electronic information system is that the desired answer can be obtained very quickly from the vast source of information using simple search questions without spending time referring to keyword catalogues.

COMPUTER CONTROLLED SCOREBOARDS

Spectators, at the most important sites will be informed of the progress and outcome of events primarily by means of large lamp-array scoreboards. The majority of the scoreboards receive their information from the main competition results system. The actual code conversion of information for the multi-bulb panels or lamp array of a particular scoreboard is generally formed by an associated "scoreboard control computer". A satellite computer, assists the main competition results system. It has the task of informing the spectators of every individual result, directing the athletics results either to the scoreboard for the track events, or the scoreboard for the field events.



Main computer centre has been specifically installed for the 1972 Olympics.



Control centre for the competition results system.

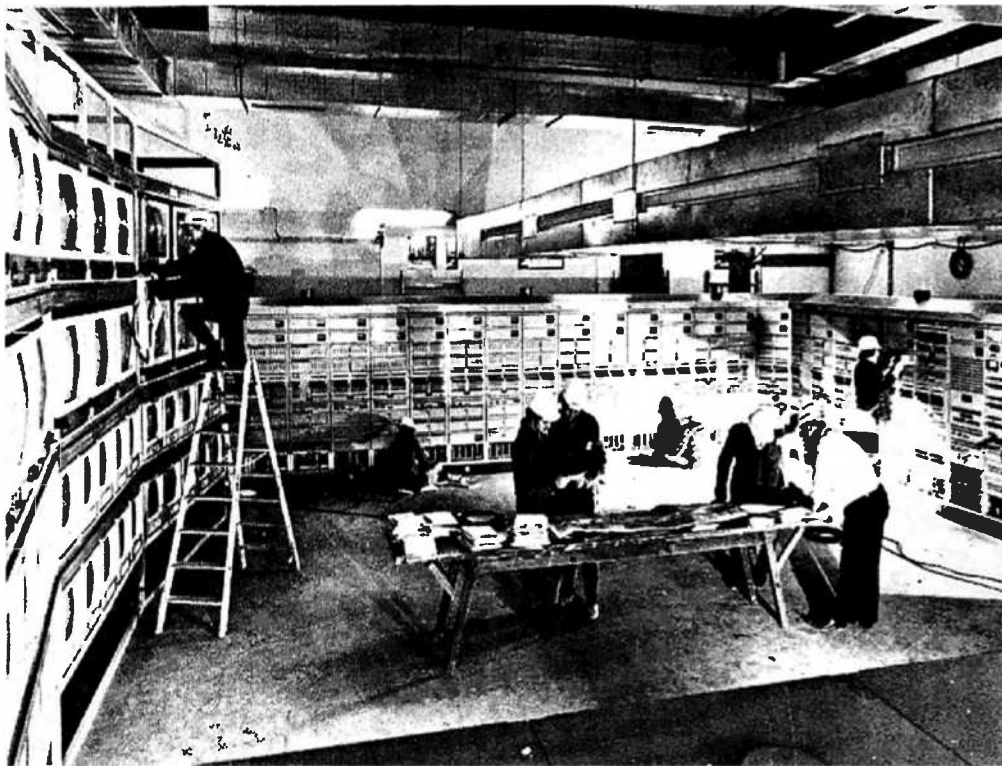
IN THE OLYMPICS

Experience has shown that on-line control of large scoreboards at sports meetings is very difficult owing to the continually changing situation. A human "controlling link" is therefore generally required between the computer and the indicator. Each scoreboard is accordingly associated with a separate control room, which accommodates both an output teleprinter with tape punch connected to the computer centre and the controls for the scoreboard. With just a few exceptions, the computer centre of the competition results system thus supplies the control rooms exclusively with tapes containing information in the format required by the scoreboard (up to ten 34-character lines) and with the associated logs.

After each new item of information has been checked by the control room personnel, it is immediately fed via a tape reader to the scoreboard control computer and thus to the scoreboard. Each scoreboard is associated with a data display terminal, by means of which the data to be entered may be checked, and where necessary supplemented.

OLYMPIC STADIUM

Since the competitions in the two main sectors of athletics (track and field events) take a completely different form, two 20 x 10m lamp-array scoreboards have been provided in the Olympic Stadium. A total of six input keyboards can be connected to the satellite computer installed in the scoreboard control room. One such keyboard is installed in the time-keeping box and one in the distance-recording box. A total of 13 connecting points are available in the arena for the other input keyboards. Competition start numbers and results



About a thousand million people all over the world will be able to watch the 1972 Olympics on TV. Shown here is the TV Control Centre. The master monitor wall (seen on the left) has a matrix of 48 monitor screens back, and right, are part of the total of 61 audio equipment racks.

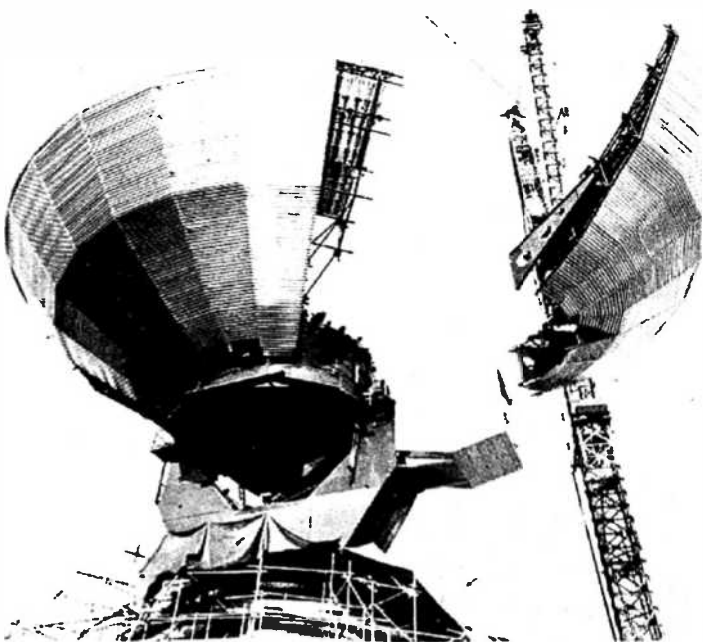
are transmitted to the computer via the appropriate keyboards. The computer adds data such as name and nationality (which had previously been stored under the start numbers), calculates where applicable the momentary placing, determines if the result is a world or Olympic record and then passes on the information in the correct format to the scoreboard. The display appearing on the scoreboard a few seconds after a track event has ended is at the same time the final result.

SPORTS HALL

The gymnastics competitions being held in the Sports Hall place high demands on the scoreboards. While standard small scoreboards are provided for displaying the individual performances or each apparatus, a large lamp-array scoreboard is used to follow the overall progress of the event. In this case too, the computer centre of the competition results system supplies the necessary information. In the event of short scoreboard texts, the computer ensures correct output format by completing the remaining empty lines with dots. The text in each tape is preceded by a code, which the scoreboard control computer identifies as the start-of-message code. The end of the text is indicated by an end-of-message code.

SWIMMING STADIUM

Because the swimming events are numerous and often follow each other



Third antenna currently being fitted to the Raisting Satellite Earth Station will send colour TV pictures around the world.

very closely, extremely high demands are also placed on the multi-bulb panel scoreboard in the Swimming Stadium. The list of competitors for an event appears on this scoreboard before the start of the race. The scoreboard panels displaying the times are, as an exception, connected on-line with the automatic timing system (touch pads in the swimming pool). The times thus appear on the scoreboard simultaneously with the finish of the race. With the aid of the internal scoreboard control computer it is also possible to display the placings. Independently of the direct display, the computer centre supplies final results lists upon completion of the competition, which can also be used for the scoreboard display, should it be required.

Further computer systems are used to provide data for the 4,000 journalists covering the events.

A total of 48 teleprinters, connected to the computer centre in the Munich Olympic Stadium, will be installed at the 31 locations of the Olympic contests. The computer centre consists of three computers together with magnetic tape devices, disc and drum storages and the various other equipment required for remote data processing. The moment the result of the contests are announced by the judges, this data is passed via teleprinter and telegraph line to the computer centre. In some cases 'the electronic timing device can be connected direct to the computer. "Validity checks" ensure that the computer promptly protests if it is presented with incorrect data by mistake. For instance, a computer "knows" that the times clocked by Olympic runners in the 100 metres must be somewhere around the ten-second mark. If it were told that a sprinter had covered the distance in 6.3 seconds, it would not mark up a new record but would detect the error and call attention to it.

PLACINGS AND QUALIFICATIONS DETERMINED AUTOMATICALLY

At the press centres and other locations, results lists will be printed out by 196 output tele-typewriters and high-speed printers. There will also be TV converters which reconstitute the data so that it appears in the form of written characters on the television screen.

The computer determines the placings of contestants, notes which athletes have qualified for the next round, represents graphically the pairings for boxing, judo, wrestling and fencing, and indicates any new Olympic or world record which may have been set.

This data processing and transmission

system will have its finest hour when the final report on the Games is issued. At Tokyo it was two years after the end of the contests before the final summary of all results was on hand. In Munich the press will be handed the full final report on the last day of the Games!

TV COVERAGE

About a thousand million people around the world will watch the 1972 Olympic Games on TV. About 1200 radio reporters and 1500 technicians will collaborate in the sports broadcasts. There will be over 100 electronic cameras to cover the sports events and up to 450 sports reporters to give running commentaries. Approximately 85 video tape recorders, 12 slow-motion machines and 14 film scanners will sort out the mass of pictures and sound material for 13 video and 60 audio channels. Due account will also be taken of the requirements of more than 40 German and foreign broadcasting organizations whose needs may vary greatly within a very short period depending on when and what they want to transmit and on other unforeseen events. No TV broadcasting of such complexity has even been tackled anywhere before - not even when the Americans landed on the moon.

The first and second German TV programs have joined forces in the "DOZ" (Deutsches Olympiazentrum Radio Television German Radio and Television Olympics Centre) in order to co-ordinate technical and organization facilities. The heart of the DOZ facilities is the TV control room. It consists basically of 61 audio and 14 A total of 550 video equipment

racks with a total width of 41m. There is a master control monitor wall made up of 48 monitor screens in front of which the controls for the largely pre-programmed switching sequences are located. The audio racks incorporate 800 buffer and distribution amplifiers, approx. 105 automatic identification keys, 1000 modulation controllers, 4000 crossbar element 105 monitoring units, 5000 cradle relays, together with 40km of a.f. cables and 20km of control cables. The amplifiers, modulation controllers and monitoring units were specially designed for the 1972 Olympics.

Besides the TV centre described above, there is also a studio in which the world programs will be produced. Like the TV centre, this studio has a master monitor wall with 25 black-and-white and 10 colour screens. The technical facilities at the disposal of producers include two video tape machines with four-track audio recorders, a slow-motion machine, a film scanner, a projector slide scanner and a special TV colour camera for interposing texts, diagrams and still pictures. In addition to the generalized world program, many broadcasting organizations will be transmitting so-called "unilateral" programs which will be trimmed to the particular national audience in question.

The 'off-tube' complex permits reporters to comment on sports events at various locations without moving from the spot. They watch the events on a monitor and add a commentary for the particular broadcasting station. The 'off-tube' complex comprises 60 cabins with room for two



A total of 550 floodlight projectors are used in the main Olympic Stadium. This illustration shows one of the two main towers each with 144 projector units. The total installation draws over 2,000,000 Watts.



Seen here is one of the 550 metal halide vapor lamps used in the main stadium. Each lamp draws 28 kW.

commentators each, plus a common production studio. For on-the-spot commentaries from the sports facilities there are a total of 450 reporters positions. Sixty five of these are in the stadium opposite the finishing line.

For the first time ever at the Olympic Games, all the events will be recorded on tape in a video centre containing 18 AVR1 Ampex video recorders. The taped scenes can be played back on a slow-motion machine. There are also two scanners for converting filmed material into equivalent video signals.

MOBILE RADIO REPLAY SYSTEM

Live television coverage of events at sites which cannot be directly connected to the TV transmission network will necessitate the use of tributary radio links established at short notice and on a purely temporary basis.

The region of the radio-frequency (RF) band around 7GHz hitherto utilized for the outside broadcast television service is increasingly required for long-distance telecommunications. The mobile radio relay equipment for the outside

broadcast television service therefore utilizes the hitherto unexploited region of the RF band around 13GHz. Another advantage of using this region of the RF band is that a large antenna gain can be achieved with relatively small antennae. The baseband of the radio relay equipment comprises a television program channel for black-and-white or colour transmission and one or two sound program channels. In the region between 12.611 and 12.989 GHz any one of 28 RF channels - the separation of their centre frequencies is 14MHz - can be selected. One of these channels is therefore permanently assigned to each 13GHz radio link.

The transmitting station of the mobile radio relay equipment consists of a modulator for converting the video and sound signals from the baseband position to a frequency modulated intermediate-frequency (IF) signal with a standardized mid-band frequency of 70MHz, a transmitter with flange-mounted antenna reflector for transposing the IF signal to the RF region around 13GHz, and also a control device; this contains the common power supply for the modulator and the transmitter and equipment for monitoring the system characteristics.

The coaxial cable which carries the video signal to the modulator can be up to 130m long. The attenuation/frequency response of the cable can be compensated for in stages by an adjustable equalizer. The sound signal modulates the frequency of a 7.5MHz sub-carrier. After the video and sound signals have been combined via a network, the signal band is passed through a pre-emphasis circuit. A high-linearity balanced modulator with a steep characteristic - the oscillator frequencies lie in the region of 800MHz - converts the signal to the frequency-modulated IF signal. A parametric power modulator in the transmitter now translates the signal to the RF region. The modulation frequency (between 116 and 120MHz, depending on the transmission channel) is derived from a crystal controlled oscillator. An oscillator power of more than 0.8 Watt 13GHz is achieved by means of frequency multiplication (factor 108) and power amplification at 720MHz (20W).

In the receiving station the receiver, which - like the transmitter - is directly connected to the antenna reflector, translates the frequency-modulated 13GHz signal (input power approx. 10-8W) to the IF region. The demodulator reproduces the original baseband from the IF signal. Video and sound signals, for further processing in the studio for

relaying to the omnidirectional transmitters, thus appear at the demodulator output. In the receiving station, too, there is a control device which contains the common power supply for demodulator and receiver and also equipment for monitoring the system characteristics.

When they are to be used, the senders and receivers (housed in stable weather-proof cases), are set up together with their antenna reflectors on a tripod in the neighborhood of the vehicle or are mounted on the vehicle on an extensible mast. The modulation and control devices, supervision devices (such as monitors and TV monitoring receivers) and measuring instruments for lining up the radio link are contained in the operations room of the vehicle. A service link inset enables speech circuits to be set up between the vehicle and the outside broadcast TV van, the studio and the public telephone network.

EXCLUSIVE NETWORK FOR TV REPORTERS

Television is going to be one of the most important sources of information for the broadcasting journalists.

A total of 400 outlets in the various studios and in the 60 commentators cabins of the 'off-tube complex' will be supplied with 16 programs; nine of these channels being located in the UHF range, six in the VHF range.



A single loudspeaker combination - weighing over half a ton - is the primary source of sound in the main Olympic Stadium. Our picture shows a model of this array, which will hang above the main stand and which will consist of 26 pneumatic and 54 cone speakers. These will be supplemented by smaller, vertical speaker arrays around the track.

Twenty nine amplifiers in various parts of the DOZ Centre, balance out the frequency response of the cable circuits and ensure an adequate level at the outlets, which receive their HF energy over stub lines.

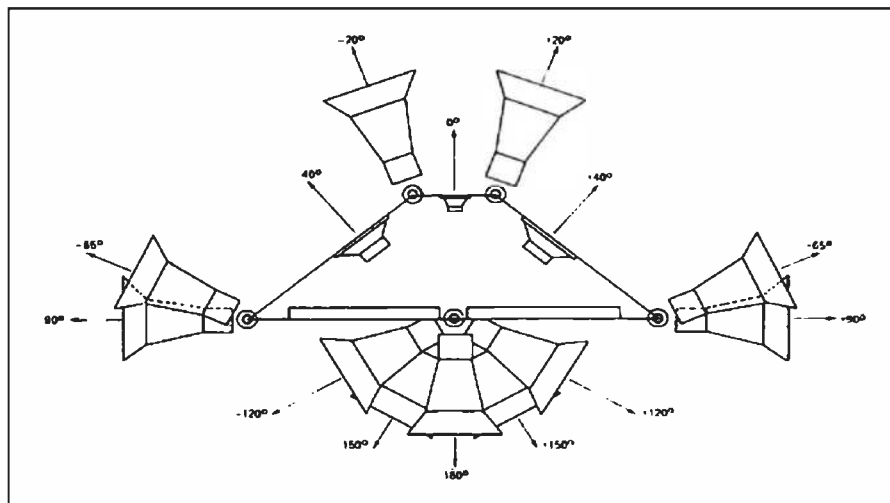
A remaining 2600 receivers of the television cable network can only be connected by VHF links - due to the relatively long transmission distances. These receivers are mostly located in the Olympic Stadium and in the Press Centre. Information stations for the general public, to be set up on the Olympic site and in its vicinity, will each be equipped with 12 television receivers. In order to provide at least 12 programs at all these outstations despite the restriction to the VHF range, six special channels lying above and below (three in each case) the standard VHF range are used in addition to the six VHF channels available in the standard frequency range. The signals transmitted over the six standard channels are initially converted to the special channel frequencies by means of frequency converters in the central closed-circuit transmission system. Reconversion to the UHF standard channel frequencies is effected at transfer points at the individual competition sites and in the information stations. By way of distribution networks one such transfer is able to serve several hundred receivers.

A total of 10km of coaxial cable pass the signals to the various transfer points, the unavoidable line losses being balanced out by 14 broadband amplifiers, which amplify the frequencies from 40 to 272MHz.

SATELLITE LINKS

The Olympic Games will present long-range communications with a challenge of massive proportions: In meeting it, the Deutsche Bundespost has commissioned new communications links for the transmission of television and sound program broadcasts, telephone calls, telex messages and data. Within the Federal Republic of Germany, new routes are accordingly being established and the capacity of already existing facilities enormously expanded. In order to enhance worldwide communications potential, the satellite earth station at Raisting is currently being equipped with a third antenna system.

The almost 300-metre high television tower at the Oberwiesefeld serves not only as a symbol of the Olympic grounds, but of modern radio relay engineering as well. Radio links connect the tower to Stuttgart, Frankfurt, Nuremberg, Salzburg and over the Zugspitze to Italy. Most of the 4GHz radio relay equipment for



This plan view shows the sound distribution of the multi-speaker array (bottom right - page 20).

these links has already been transferred from the Blütenburgstrasse telecommunications tower to its Olympic counterpart. Supplementing present facilities will be the new "Olympic Route", planned to connect Munich tower directly, via six relay stations, to the central switching terminal in Frankfurt, where Olympic television transmissions are fed into the networks of the Federal Republic of Germany and Eurovision.

Each of eight possible RF channel pairs can be employed optionally, either to carry one television program and up to four sound programs, or up to 1800 voice channels. The frequency band encompasses the RF range between 5925 and 6425MHz. The TV channels are adapted for the PAL, NTSC and SECAM systems. As with all other routes emanating from the Munich tower, the Olympic Route is secured by automatic standby circuits against link interruption or deterioration of transmission quality. Changeover to a standby route is accomplished at the 70MHz IF level. An IF switching distributor accommodated in the tower's switching terminal enables quick, uninterrupted and faultless management of the complex switching tasks.

The Olympic Route will be connected to the Raisting satellite earth terminal via a tributary link, for which a wideband radio relay system operating in the 7.5GHz range is being provided.

A third, supplementary antenna system in Raisting, scheduled for completion in the Summer of 1972, will make possible the simultaneous transmission of several live, colour broadcasts to America, Asia, and - most recently - Africa. Raisting 111 will be similar in construction to Raisting 11, with a

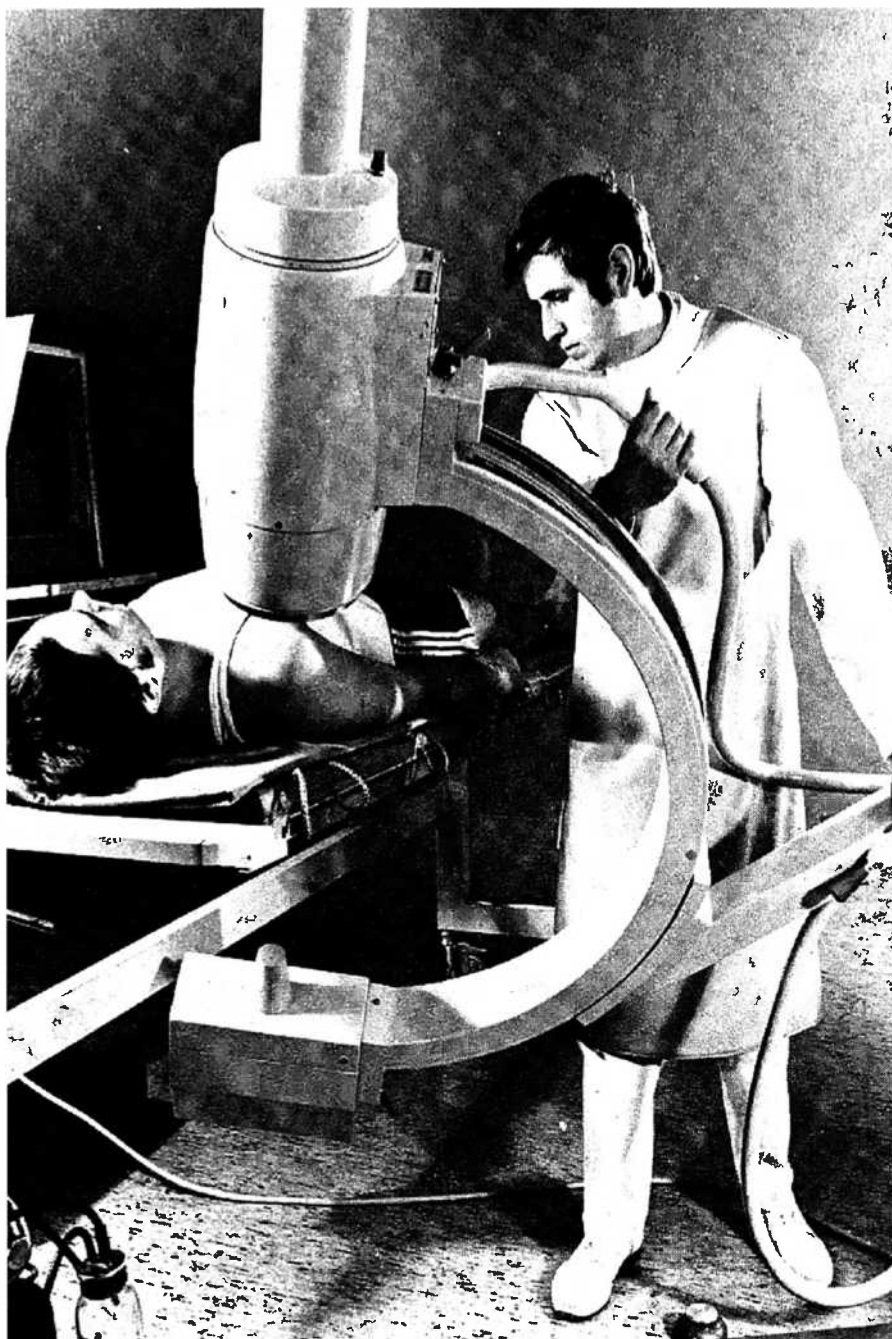
28.5 metre parabolic reflector and no protective radome. As with Raisting II, snow and ice are prevented from forming on the main reflector by several thousand infrared radiators. Raisting III's receive amplifier is directly coupled to, and rotates with, the antenna, thus reducing the connecting cable length and somewhat improving conditions for reception.

LIGHTING

Until a few years ago, the light conditions in a large stadium would have been completely inadequate for evening TV transmissions in colour. Meanwhile, the pre-requisites for such transmissions have been created by recent lighting engineering developments and progress. The metal-halide lamp specially developed for floodlighting the Olympic Stadium and other sports arenas in Munich has excellent colour rendering properties, an optimum colour temperature and a first-class luminous efficacy.

A mean vertical luminance of 1875 lux in all four main directions is specified for the stadium floodlighting. This requirement has been met by a high capacity projector with a symmetrical highly polished and anodized specular reflector with a diameter of 80cm. The maximum luminous intensity is 3,500,000 cd at a lamp flux of about 300,000 lm. The lamp has a colour temperature of 6,000K and a colour rendering index of over 80 and is therefore ideal for colour TV transmissions.

A computer was used in the designing of the floodlight installation. On the basis of these exhaustive calculations, a total of 550 of the above-mentioned floodlights forming a total connected load of about 2000 kW were installed. The floodlights are mounted on two 65m high towers over the playing field, two groups on the



This X-ray intensifier unit is used in the medical centre.

roof and a number of supports under the stadium roof. The aiming angle of each individual projector is fixed to provide completely uniform illumination on the playing field.

AUDIO SYSTEM

The so-called "railway station effect", i.e. multiple echo due to differing sound station propagation times, generally presents great difficulties when installing public address systems in sports stadiums. This problem has been overcome in the main Olympic stadium, which holds 80,000 spectators. The sound comes out of a single loudspeaker combination installed under the transparent stadium canopy. The 80 loudspeakers of this combination are

aligned so that all areas of the grandstand are uniformly irradiated with sound.

To prevent the spectators right under the combination from hearing the sound coming from it, this area -the so-called proximity zone is served by two small loudspeaker battens at the edge of the sports field. The sound propagation time between between the battens and the spectators is shorter than that between the loudspeaker combination and the grandstand, so that the spectators have the impression (due to a law of acoustics) that the sound is coming only from the battens, i.e. from the front. Sixteen low-mounted loudspeaker battens are installed around the track for the sports field. They ensure that the

music has the same beat for gymnastic shows and also when the national teams march into the stadium.

The loudspeaker combination which weighs 500kg has 26 pressure-chambers and 54 cone loudspeakers, some of which were specially designed for use in the Olympic stadium. They are connected together in groups which can be controlled individually. The object here, however, was to reduce the irradiation to the secondary sport's facilities outside the main stadium and also to the adjacent residential area.

The loudspeaker system is controlled by a mixing desk located in a special sound control room which is equipped with 15 fully transistorized amplifiers with an output of 100 W each, plus two tape machines and two record players each. The 20 microphones connected to the system are located in the announcer's cabin, the organizing committee room, the box for distinguished guests, the sound control room and the sports directors room. There are another ten microphone connections available in the reporters' pits between the track and the grandstand which permit announcements to be made direct from the sports field.

MEDICAL CENTRE

Modern, top-performance athletic activity demands an effort on the part of the participants which extends to the physiological limits of human performance and sometimes beyond. Therefore, about 300 doctors and some 1,400 nurses (both male and female), radiographers and laboratory technicians, ambulance men and masseurs will be responsible for the rapid and thorough medical care of the 10,000 or so competitors expected. For this purpose, an extensive medical centre is being set up on four floors of a building in the Olympic Village in Munich. The equipment is predominantly of a diagnostic nature and has been so conceived that it can be retained after the games to form a considerable part of the technical requirement of the private medical centre which is to remain.

The heart of the Olympic Medical Centre will be the floor for X-ray diagnosis. The second floor of the building is being provided with three X-ray facilities and all the associated requirements ranging from changing cubicles to high-voltage generators. The X-ray facilities all contain the sort of equipment that is used in modern hospitals, both by internists for comprehensive examinations of body functions, and by surgeons and orthopaedic surgeons for the establishment of exact diagnosis in injuries to the bones. The internal medical X-ray installation in the

Medical Centre comprises, in the main, a universal tilting unit on whose television monitor, details can be recognized even in brightly-lit rooms and which, if required, permits photographic documentation of the findings. With the aid of a spot film device, the image can be constantly observed until the radiographic exposure is effected.

The high energy required to drive the X-ray installation is provided by a 12-pulse diagnostic X-ray generator operated by three-phase current, which also includes all the necessary control elements. For surgical/orthopaedic radiography, the Medical Centre is equipped with a Bucky table (Multix) and a mobile floor-to-ceiling support. The unit is provided with a floating table top, electromagnetic brakes and a built-in Catapult Bucky cabinet.

A special unit for the radiological determination of the heart volume and of the cardiac output makes it possible for a team of sports doctors to gain information as to the stress to which athletic activity subjects the human organism. The X-ray installation intended for these scientific examinations enables a true-to-scale representation of the heart to be obtained by effecting radio graphs in two mutually perpendicular planes. In the X-ray department there is also a urological examination room and a number of equipment for use in the fields of surgery, anesthesiology, orthopaedics and shock treatment.

The department of physiotherapy on

the ground floor is provided with a total of ten pieces of equipment. Thus, for example, there is a "Neuroton 626", an exponentially progressive current unit for the complete diagnosis and treatment of paralytic conditions that can be caused by accidents. The pulse program of this unit, together with the automatic pushbuttons and the pulse tabulator, guarantee operating simplicity. There are three each of the "Neodynator 625" (a unit for the treatment of pain after sports injuries) and the "Sonodynator 634".

In the case of the latter unit, the combination of stimulation current and ultrasound gives rise to a potentiating of the analgesic effect. Three short-wave therapy units are available, two "Ultratherm 608 Superautomatik" and one "Siretherm 609", an ultra-high-frequency therapy unit for the direct heating of internal organs with a physiological temperature gradient.

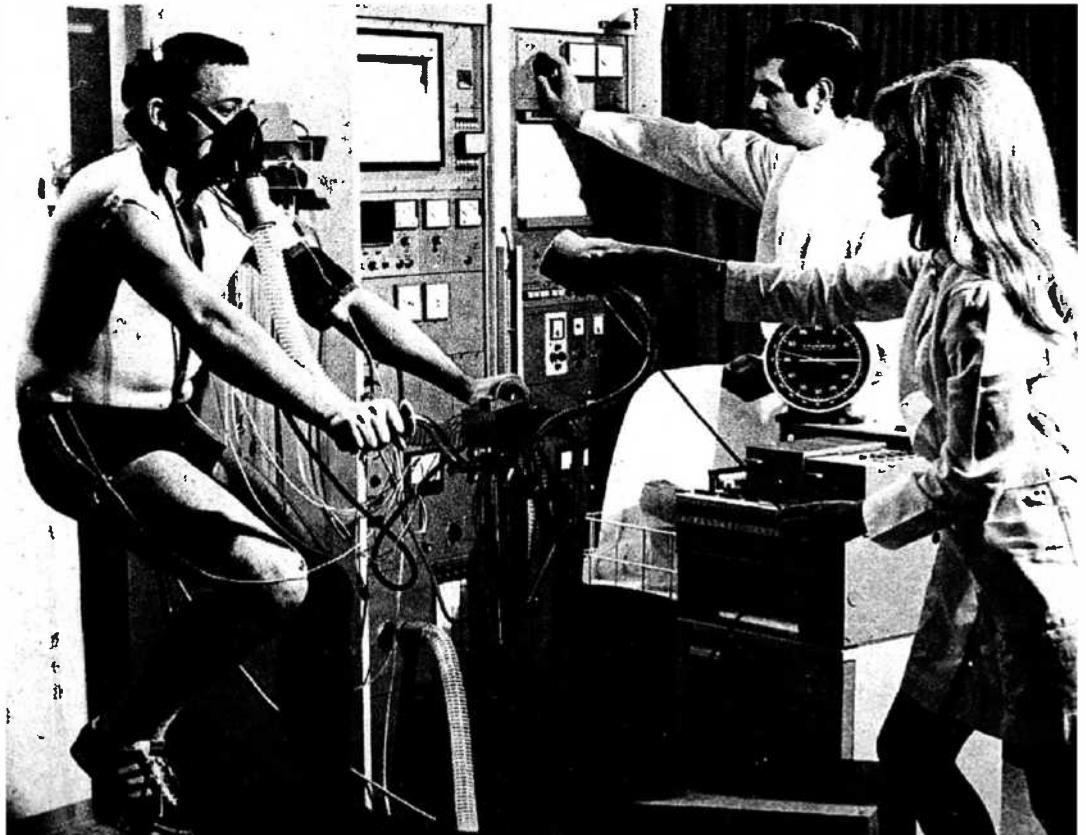
The first floor is equipped to carry out different kinds of performance tests. Accordingly, the equipment comprises, in the main, three ergo-spirometric set-ups and two electrocardiographs. The ergo-spirometric set-ups make it possible to draw conclusions as to the physical efficiency of a test subject by measuring the respiratory volume, respiratory rate, oxygen consumption, carbon dioxide output and other data of the respired air analyzed by the unit. The two electrocardiographs are the model "Cardirex 6T" a mobile, fully-transistorized direct-writing jet

recorder for electrocardiography and phonocardiography.

In the in-patient wards on the third floor of the Olympic Medical Centre, there is a compact crash cart available for acute cardiac cases. The Clinocar contains equipment for cardiac diagnosis, artificial respiration and resuscitation, and an electrical cardiac pacemaker. In addition, there are a number of telemetric systems, a cardiac massage and ventilation unit and a three-channel electrocardiograph for rapid ECG recording. Several physiotherapy units, such as a short-wave unit, a Neodynator and a Sonodynator, complete the equipment of the wards.

In order to provide immediate aid for injured athletes, the Olympic Stadium has also been provided with a treatment room. Here, a mobile X-ray image-intensifier unit (Siremobil 2) in conjunction with a special casualty transport trolley makes possible a particularly rapid and versatile X-ray examination. On this equipment, surgeons or orthopaedic surgeons can keep the operating field constantly under observation during operations or complicated examination procedures. In the Siremobil 2 the X-ray tube is located in one end of a C-arm having a diameter of just one metre. On the other end then is an image-intensifier tube and a television camera which transmits the fluoroscopic image to a TV monitor. In addition, for emergency cases, there is a cardiac massage and ventilation unit.

This 'spirometric' device is installed in the Olympic medical centre. The athlete undergoing examination pedals the bicycle-like trainer until he is out of breath; he then breathes through a mouthpiece attached to the equipment. From this instrument's analysis of the volume of intake, inspiration, expiration frequency, oxygen requirements, carbon dioxide production and other respiratory data, conclusions may be drawn as to the physical condition of the subject.



SONY PS5520

This new Sony turntable is good value for money - Louis Challis reports...

electronics TODAY INTERNATIONAL product test

The model 5520 is the latest in Sony's range of turntables. It was supplied for testing with the Sony VM-22GA induced-magnet cartridge. The unit is belt-driven with selective automatic or manual tone arm control.

The external appearance is similar to many other turntables currently available. The bottom edge of the polished timber plinth is recessed and painted black. This reduces its apparent height.

The smoked perspex dust cover is fitted with "clip on" type hinges. These hinges are fitted with nylon bushes and spring assemblies, which effectively control the closing of the lid, thereby eliminating possible jarring of the turntable.

The turntable base is finished in matt black and has two chrome plated switches at the left hand end for 45 rpm or 33 1/3 rpm speed selection.

The manual/automatic control lever and record diameter select lever are positioned around a circular raised section at the right-hand front corner of the turntable base. The manual/automatic control lever has five positions. These are a central position to the lever returns at the end of each record, and two further positions on each side of this central position.

The two positions on the left are marked 'manual' and 'repeat' and are for manual operation only. In the manual position the arm is placed manually on the record and automatically returns to the arm rest at the end of the record, before turning off the power. In the repeat,... position the arm automatically returns to the beginning of the record and keeps replaying the record until the manual position is selected.

The two positions on the right hand

side are marked 'reject' and 'start'. The 'start' position must be selected to initiate operation of the turntable, and once selected, the arm is automatically lifted and placed on the record. Once the start sequence has finished, the reject position may be selected and the arm will return to the rest and stop the turntable.

The record diameter select level has three positions for 17cm, 25cm and 30cm diameter records. The cueing lever is adequately damped in the lowering mode and 1,1damped in the lifting mode. The tone arm is constructed from chrome plated tubing and is fitted with a plug in a head shell designed to accept cartridges with 1/2 inch mounting centres. Balancing is obtained by rotating a cylindrical counterweight on the end of the arm and then setting the tracking force by moving the balance weight a calibrated distance.

Anti-skating is provided by a small

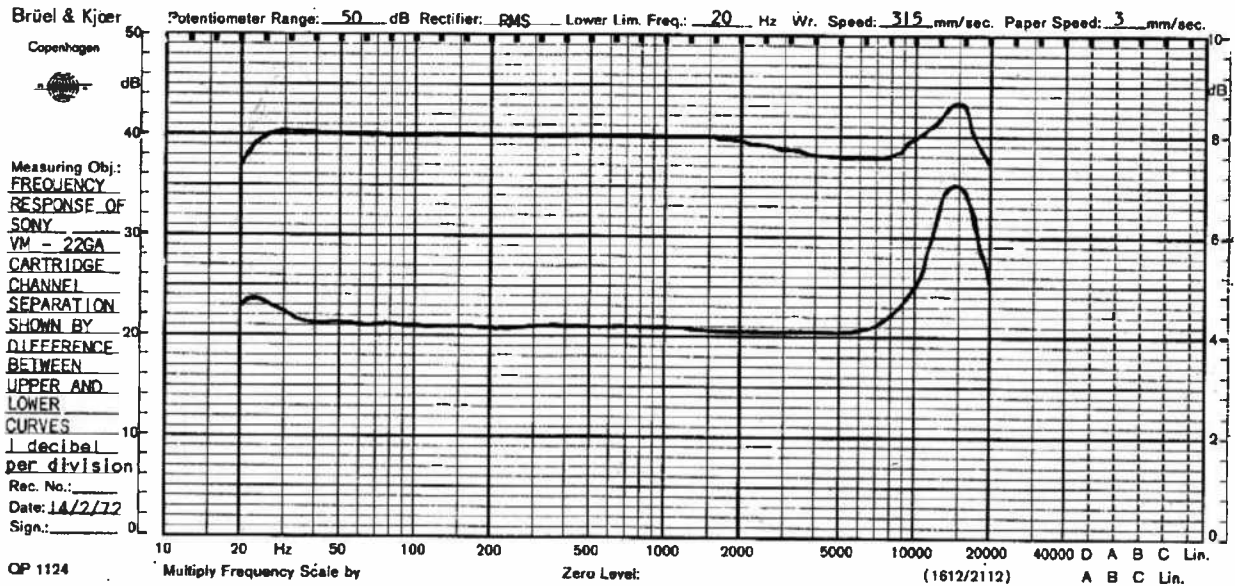
weight on a line. This is connected onto one of three positions on a small arm projecting out at right-angles to the main arm. The inner position is for tracking weights behind 'h gram and 1.5 grams, the middle position for 1.5 to 2.5 grams and the outer position for 2.5 to 3.0 grams. The arm rest is fitted with a stop on the right hand side so that it is impossible for the arm to overshoot the rest when returning. Similarly an automatically controlled stop prevents the tone arm from falling off the cueing arm as it approaches the centre of the turntable.

One feature which we feel is essential but has not been included on this turntable, is the ability to clamp the tone arm to the rest. The lack of this feature can be a nuisance, particularly when changing cartridges, apart from the increased probability of knocking the arm off the rest and damaging the stylus.

The cast aluminium alloy turntable is



TURNTABLE



MEASURED PERFORMANCE OF SONY AUTOMATIC TURNTABLE MODEL PS 5520 SERIAL NO. 10084.

TURNTABLE	45 rpm	33-1/3 rpm
Wow and Flutter	0.1%	0.1%
Hum & Rumble 1kHz at 5cm/sec (unweighted)	- 44dB	- 44dB
Speed Error	- 0.3%	- 0.3%

TURNTABLE WEIGHT= 21bs 3ozs

PICK UP ARM

Transverse friction	70 mg
Vertical friction	50 mg
Arm resonance	7 Hz

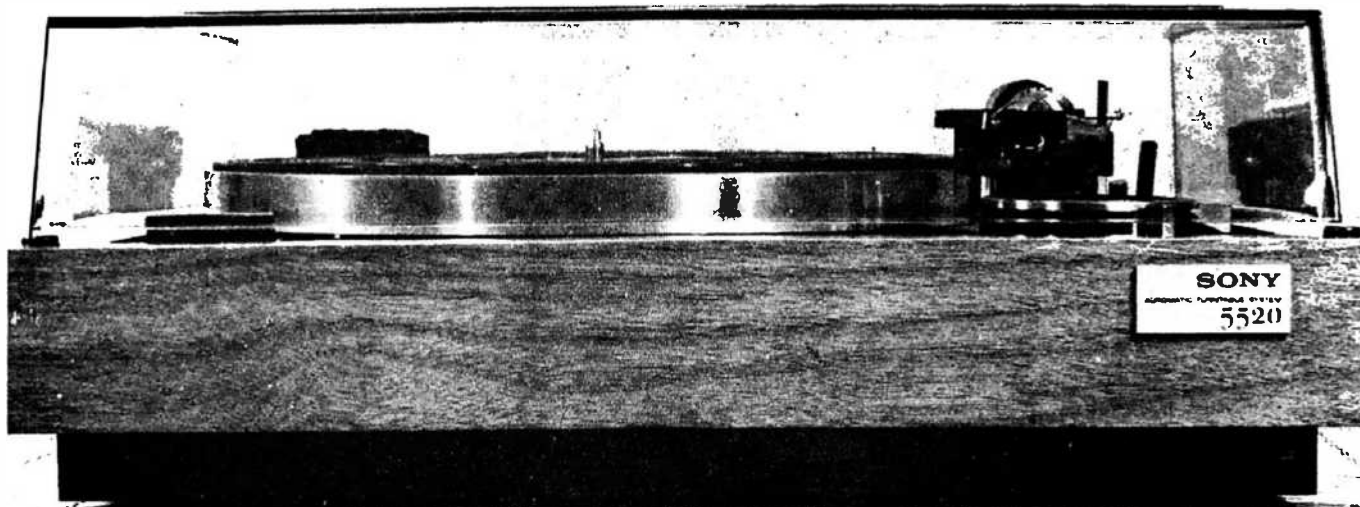
TRACKING FORCE CALIBRATION

Setting	Measured Tracking Force
1.0 grams	1.0 grams
2.0 grams	2.0 grams

CARTRIDGE TYPE VM-22GA

Frequency Response	20 to 20 kHz	3dB
Cartridge weight	= 6.9 grams	
Channel separation at 1kHz	= 19 dB	
Channel difference at 1kHz	= 1/2 dB	
Output at 1kHz 5cm/sec	= 5.5 mV	
Cartridge impedance	= 47K	

Price - recommended retail price £67.80



finished with a brushed rim and fitted with a ribbed rubber mat. The turntable is driven by a four pole condenser-hysteresis motor, via a synthetic rubber belt, to an inner rim on the turntable.

SUBJECTIVE EVALUATION

Subjective evaluation of the cartridge and turntable was performed with the Nana Mouskouri record "Over and Over" and the J.B.L. demonstration record PRO 496. Some sibilance was noticeable on the Nana Mouskouri record but no mistracking was audible on the J.B.L. demonstration record.

In fact the clarity of reproduction from this cartridge was much better than we expected and was a delight to listen to.

(It should be noted that most cartridges; with the exception of one or two that we have heard, mistrack slightly at the higher frequencies resulting in sibilance).

MEASURED PERFORMANCE

The measured performance of the turntable and cartridge was equal to, or better than the manufacturer's specifications in all respects excepting channel separation which was typically 19 dB. Some mistracking occurred at the higher frequencies with moderate to high velocities (about 8 cm/sec at 10 kHz). This did not result in audible distortion even on our very demanding test records. The cartridge output is also higher than most induced magnet type cartridges.

With the low transverse and vertical frictions measured on the tone arm this unit would be suitable for cartridge capable of tracking as low as 1/2 gram.

The turntable was supplied with a multi-language instruction manual printed on 27 pages of high gloss paper. The instruction manual was arranged in a logical sequence with each section graphically depicting the various operations. The table of contents detailed below clearly shows the extent of the information given in the manual.

Preparing for Use

- Unpacking
- Assembly
- Adaption to local power line
- Tone arm adjustments
- System connections

Operating instructions

- Preparation
- Automatic operation
- Manual operation

Care of your PS 5520

- Cleaning and removing the dust cover
- Stylus replacement
- Using another cartridge
- Repacking for shipment

For a recommended selling price of £67.80 complete with cartridge the Sony PS 5520 turntable represents good value for money. For the audiophile who wants more exacting reproduction this turntable will compliment a more expensive cartridge with higher performance.

END THE SEARCH FOR THOSE "HARD TO FIND" COMPONENTS

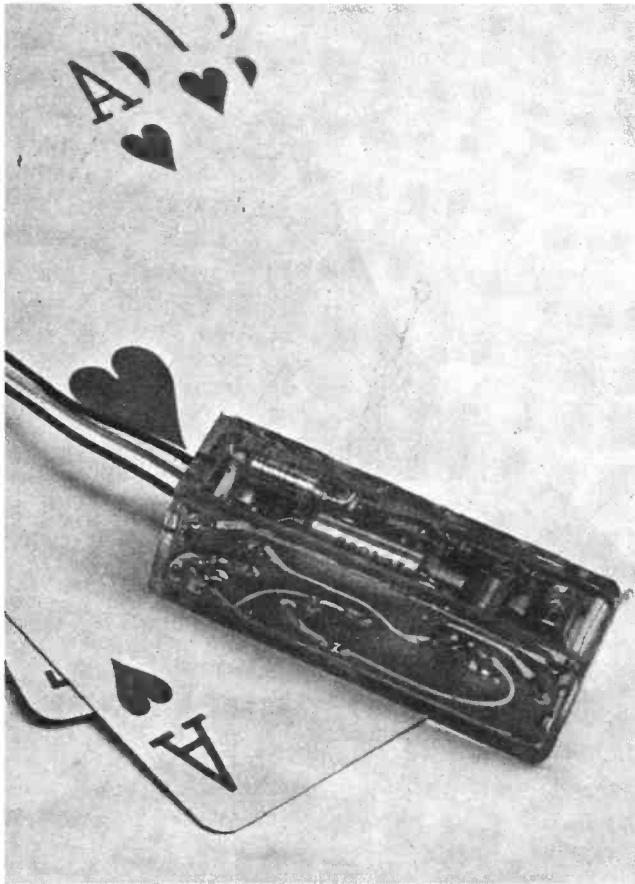
ELECTRO SPARES are now supplying ALL the components for the con-structional articles in this magazine.

Just forward a foolscap-sized S.A.E., and state which project in "Electronics Today International" you intend to build, and we will forward to you a complete price list of all the specified components, P.C. boards, etc.

No further searching for those difficult and specialised "bits and pieces", no further purchasing of those expensive catalogues in the hope they may contain what you want!

Please Note : All our components are brand new, first quality and to specification.

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NUCLEAR HEART PACEMAKER

Latest heart pacemaker may have a life span exceeding ten years.

NEW type of heart pacemaker is currently under development in USA. Employing electronic modules built to aerospace reliability standards, the devices will be powered by nuclear energy to give them a life of 10 years instead of two, as presently experienced with mercury batteries.

Raytheon is building the units for ARCO Nuclear of Apollo, Pennsylvania, a wholly owned subsidiary of Atlantic Richfield. The experimental program is being conducted by the Atomic Energy Commission to study the reliability of the new devices and determine whether or not they can be produced as reliably as, and at an expense comparable to contemporary pacemakers.

The program was instituted by the AEC after studies indicated that as many as half of all contemporary pacemakers fail in less than two years and none has ever completed four years of operation. In addition to promoting peace of mind for the patient whose well being depends upon an artificial heart timer, the extended-life devices now in pilot production could dramatically reduce expense and inconvenience to the patient who must now submit to chest surgery at frequent intervals within the reliability life span of present pacemakers.

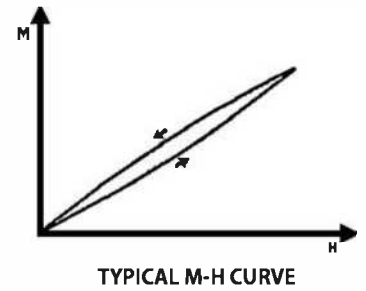
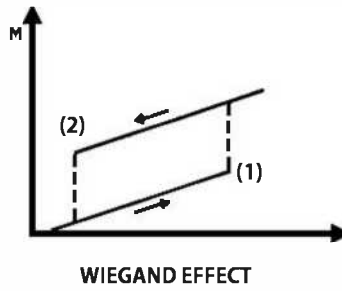
The new devices weigh about half as much as present models.

They have been extensively tested in laboratories with animals. Clinical testing in humans will begin once the AEC is thoroughly convinced that the unit is 100 per cent safe and reliable for human beings.

About 50,000 persons now depend upon pacemakers. It is estimated that an additional 5,000 to 10,000 will join their ranks annually as the reliability and longevity of the devices is increased.

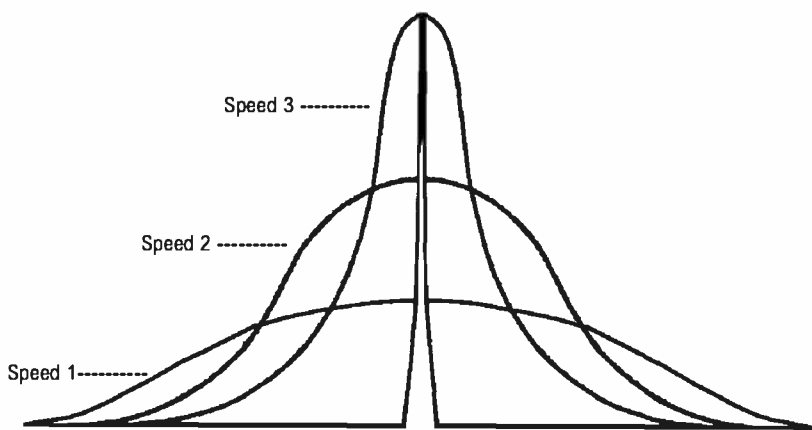
Electronic circuitry of contemporary pacemakers outlasts the present mercury power sources but with the shift to nuclear energy and its 10-year life, the circuitry had to be upgraded.

The Weigand effect is explained by these graphs showing the relationship between the magnetization of the material (M), and the applied magnetic field (H).
 LEFT: SNMW wire.
 RIGHT: Ordinary ferro-magnetic material.



THE WIEGAND EFFECT

Identical output pulses independent of relative mechanical velocity produced using new ferromagnetic material.



SNMW v/s MAGNETIC ROTORS

Comparison of the rare characteristics of the SNMW system and conventional magnetic rotors. The SNMW system is not affected by rate and thus generates a distinct pulse at low, medium or high rotor speeds.

A totally new method of magnetically generating electrical pulses has been developed by John Wiegand of the Comgeneral Corporation, an independent research and development company of Dayton, Ohio in the USA.

Unlike all existing techniques, the new method produces a clear distinct pulse regardless of rotor speed. It senses at very low speeds and produces exactly the same waveform at all speeds. It is the only known magnetic system that is not rate-sensitive.

The so-called Wiegand effect depends upon the unique ability of a ferromagnetic wire to suddenly change from one level of magnetization to a much higher level when subjected to a magnetic field.

In one application, a wire made of the special ferromagnetic material is initially magnetized to a predetermined level. The wire is brought close to an external magnetic field, and then at a certain critical field strength, a threshold switching action takes place, and the wire's magnetization suddenly increases to a new and much higher level.

A pick-up coil senses this sudden change in magnetic field and generates a pulse proportional to the rate of the change in field strength, but not in any way affected by the speed at which the wire approaches the magnetic field. Hence the characteristics of the generated pulse are independent of relative velocity. In this form the wire

and head have been registered as the SNMW system.

The significance of the Wiegand effect is most clearly explained by the following graphs showing the relationship between the magnetization of the material (M) and an applied magnetic field (H).

As the applied magnetic field is increased, at a determinable value the magnetization in the SNMW wire switches to a higher magnetization level virtually instantaneously (1). As the applied magnetic field is reduced, the magnetization curve retains its slope until point (2) when it switches back to a lower magnetic level. The change in magnetization is sensed by the read head which produces an output pulse with the following characteristics:

Pulse width of approximately 10 seconds.
Signal to noise ratio of approximately 40 dB.

Minimum output voltage 50-250 millivolts.
Pulse polarity is inherently a function of direction.

Output not affected by temperatures over a range -950F to +3000F.

APPLICATIONS

One obvious application for the Wiegand effect is electronic ignition systems for automobiles. As the pulse waveform is unaffected by uniform pulses will be generated regardless of engine speed, also pulses can be generated over a wide range of ambient temperatures.

The Wiegand effect does not rely upon mechanical contact for its operation, hence the system has virtually unlimited life in any equipment in which it is used. The system will operate in critical environments including aqueous, gaseous, organic solvents and in a vacuum.

The device is uniquely bi-directional and bi-polar. A different pulse may be generated whenever the wire passes the sensing head either in forward or reverse this is a significant advantage for the industrial process and control industry.

DATA STORAGE

The Comgeneral Corporation believes that the SNMW system offers a solution to the permanent data storage card problem. A card is formed using discrete wires and laminated plastic. The wires are coded with the necessary data in standard or unique codes. This card is then inserted into a reading device whenever the information is needed. The reading device senses the magnetic pulses generated by the passage of the wire which can then be transferred to a view screen or printer.

In addition to the rotary configuration for applications as ignition systems and the flat plane for card readers, the wire can be used as a disc, vane, or in bundles.

In a bundle each wire generates its

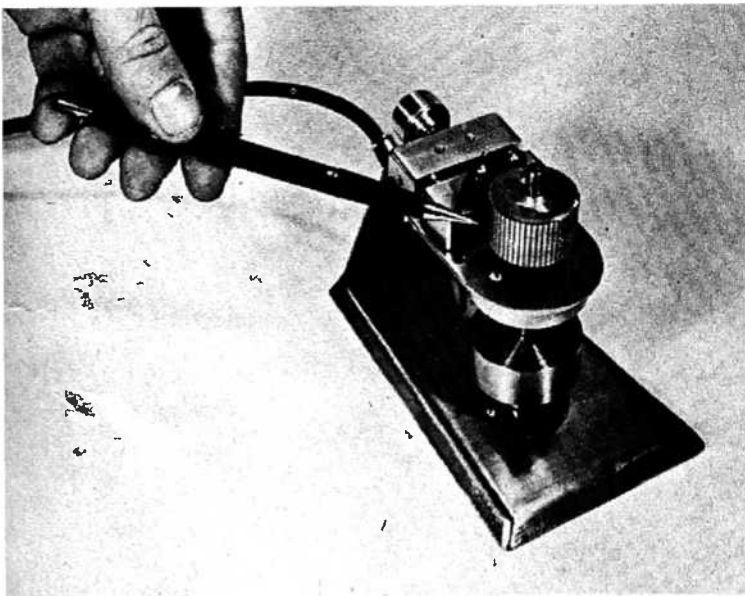
own distinct-pulse. Therefore, these wire bundles could be used in a coded key for a high security lock. The key would be placed in a lock and only the right combination of wires generating the right number of pulses would open it. In hotels, for example, each room lock would be coded to accept only a certain key and when a person checked out, the code could be changed instantaneously at no cost to the hotel.

In addition to a rotary pulser, a card reader, coded key, simple switch and ignition system, Comgeneral has laboratory models currently under test that include shih registers, compass devices, magnetic field sensors, thermostat controls, and other magnetically operated devices.

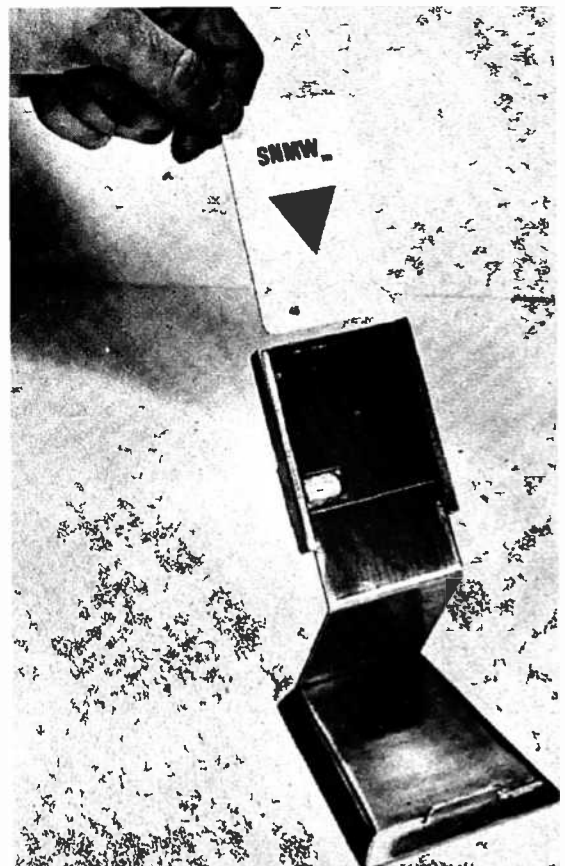
Because of the wide range of potential applications, the manufacturers are planning to negotiate with companies wishing to develop specific product lines in their fields of interest.

As the system is not as yet fully protected by patents, complete technical details cannot be released, however independent proof that the technique is viable has been provided by Professor Philip Wigen of Ohio University's Dept. of Physics.

Professor Wigen states "I have completed my study of the patent applications and the basic technology. I found all of the properties of the wire to be consistent with the basic theories of magnetism.



In this application a pulse is generated as each SNMW wire passes the read head.



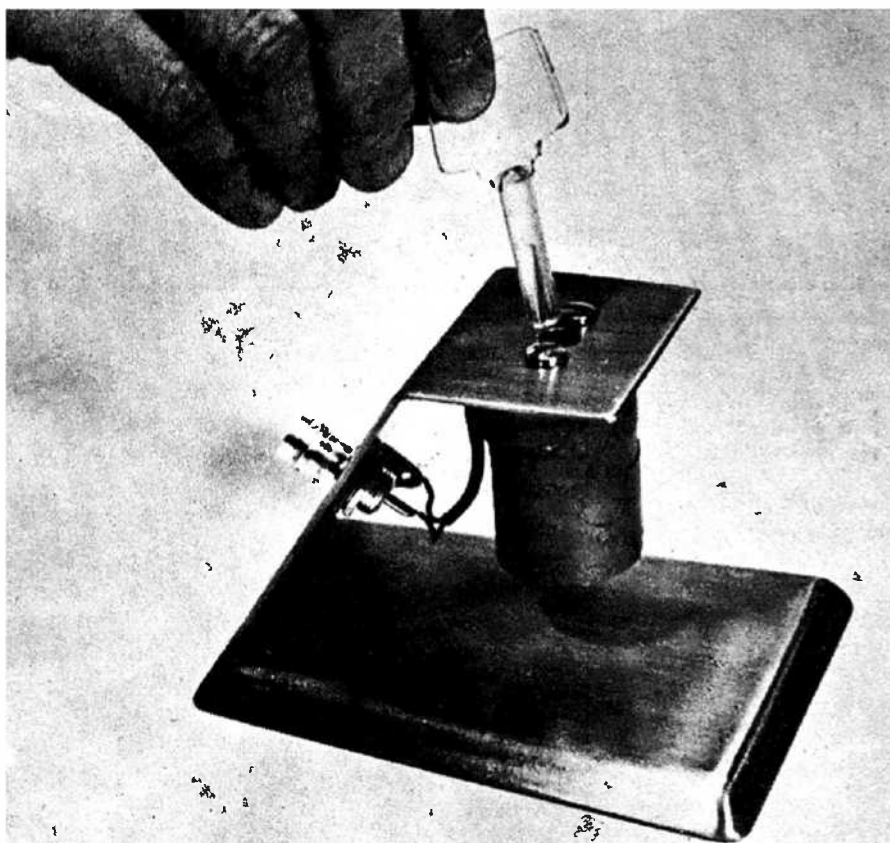
Since each wire generates a distinct pulse, the SNMW system may be used for data storage and retrieval. A card is formed using discrete wires coded with the necessary data. Whenever information is needed, the card is inserted into the reading device which senses the individually coded pulses generated by the passage of the wires. There are no moving parts and response is virtually instantaneously available.

I have carried out some calculations that indicate the wire should produce a signal having a pulse width of the order of 10⁻⁴ seconds. The practical temperature range of operation should be from at least 70C to 150C or well within the operating range of most sensing devices.

The materials in the wire are readily available and the wire can be processed in an inexpensive manner. Once processed, the wire will be magnetically stable and the signal is very reproducible.

Other physical properties of interest include the unlimited lifetime of the device, its solid state nature, and its velocity independent signal output. The signal will be observed, in a variety of environmental conditions; gaseous, aqueous, organic solvents or vacuum. In corrosive media the device can be embedded in a noncorrosive material without effecting the operation of the wire.

The wire has unique properties and should have a large number of applications in a wide variety of devices."



This prototype high security lock utilizes the ability of the SNMW system to generate distinct pulses even when several wires are grouped together in a bundle. A lock would be coded to accept only the right combination of pulses to open a door. The individual key code can be changed whenever and as often as it is necessary at essentially no cost. And, tampering with the key or lock will destroy the code.



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A PRACTICAL GUIDE TO ZENER DIODES

PART II

The zener diode is generally associated with DC applications, such as the control and regulation of DC power supplies. Most Zeners are in fact used for this purpose but nevertheless they have many uses in ac, audio, RF, and AC control systems.

When supplied with alternating current and connected as a shunt regulator (Fig. 13), the Zener diode will limit both the positive and negative halves of the ac cycle. The diode conducts almost immediately after the signal passes through zero and into the negative segment. On the positive half cycle, the diode does not conduct until the applied voltage reaches the Zener voltage (Fig. 14). The result is a non-symmetrical square wave. Asymmetry can be improved by using high input voltages, but can never be completely eliminated unless two shunt connected diodes are employed in a back-to-back configuration. (Fig. 15).

The Zener diode configuration shown in Fig. 15 is often used to provide stabilized filament supply voltages especially to oscillator

circuits and DC amplifiers. When using Zeners in this application bear in mind the ratio of average to peak Zener current. A figure of 0.6 is satisfactory.

Zener diodes may also be placed in the primary side of a step-down (or step-up transformer). When connected in this manner the diodes will regulate all associated secondary windings. The arrangement does require high voltage rated Zeners and is sometimes rather costly - however it is often used when high voltage secondary supplies need rudimentary stabilization.

Where power consumption is a prime consideration on AC power circuits, the Zener load resistor (R_S) can be replaced by an inductance or capacitance. The device selected should have a reactance approximately the same as the calculated value for R_S at the supply frequency.

OSCILLOSCOPE CALIBRATOR

A single Zener diode may be used as an inbuilt oscilloscope voltage calibrator that is independent of line voltage variations. Figure 16 shows how simply this facility may be incorporated in practically any

oscilloscope. A selected 10 volt Zener may be used to provide a calibration voltage of one volt per division.

ZENER NOISE VOLTAGES

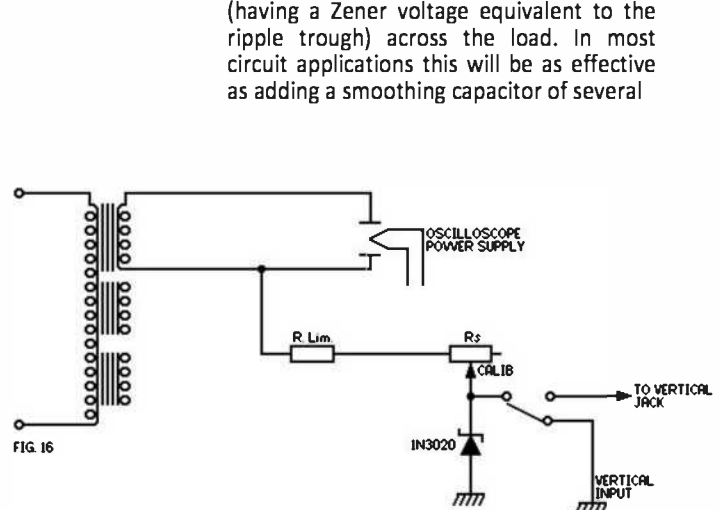
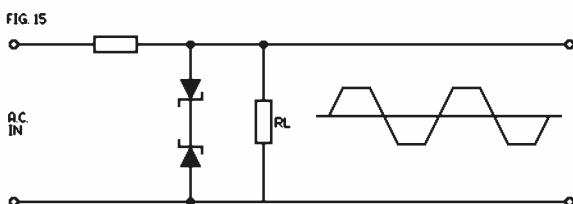
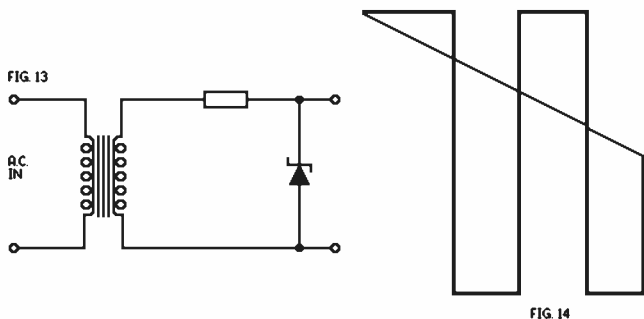
As with neon regulator tubes, Zener diodes generate noise voltages. With Zener diodes, these voltages are associated with junction avalanche effects, and may vary between 10uV and 1mV depending upon the Zener type and voltage rating.

But unlike neon regulator tubes - where the incorporation of parallel filter capacitors is an excellent (if unintentional) way of making a relaxation oscillator - a Zener diode may be suppressed by adding parallel capacitance of 0.01 to 0.1uF. This will reduce the noise voltage by a factor of at least 10 and yet maintain completely stable operation. (Figs. 17 and 18).

THE ZENER DIODE AS A FILTER

The Zener diode will respond to ripple voltages in much the same manner as it does with slow voltage variations. It has a very low dynamic impedance and thus reacts in much the same way as a filter capacitor.

Excellent power supply filtering can be obtained by connecting a Zener diode (having a Zener voltage equivalent to the ripple trough) across the load. In most circuit applications this will be as effective as adding a smoothing capacitor of several



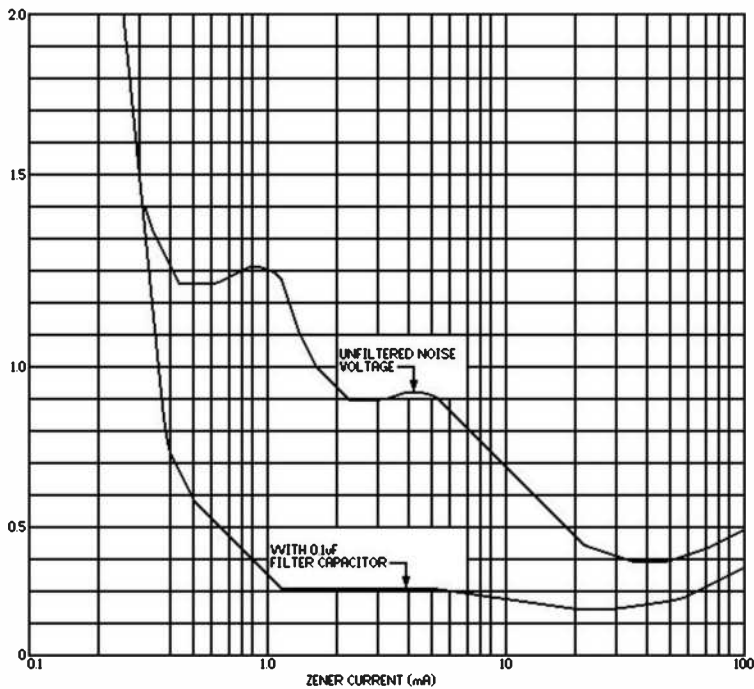


Fig. 18. This graph shows the reduction in noise obtainable by paralleling a capacitor across a Zener diode (as shown in Fig. 17).

thousand microfarads capacity, and will provide a considerable reduction in the level of ripple superimposed on the DC output.

INCREASING POWER HANDLING

Parallel connection is one way of increasing the power capabilities of Zener diodes. But a simple parallel connection (Fig. 19) is not practicable, for the Zeners will rarely be sufficiently well matched to conduct at exactly the same voltage. But by including very low resistance trimming resistors, the current levels can be matched so that both Zeners carry substantially equal amounts of the total current. (Fig. 20).

Although, as shown above, Zener diodes can be paralleled in order to increase their load carrying capacity it is usually more practicable to use a series or shunt transistor circuit with a Zener diode providing a voltage reference. This configuration will not only improve the power handling capability by a factor of ten or so, it will also improve the regulation of the circuit by an amount equal to the current gain of the transistor. A simple Zener controlled shunt regulator is shown in Fig. 21.

The shunt regulator is very suitable for experimental and instructional use as it is totally short circuit proof. But, since maximum transistor current flows at zero load (and vice versa), it is also very inefficient, and for applications where power availability is limited the series transistor configuration is preferable. A series regulator is shown in Fig. 22.

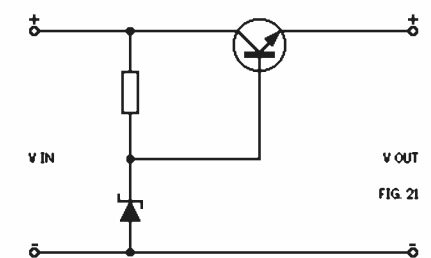
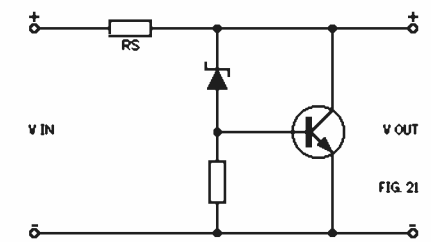
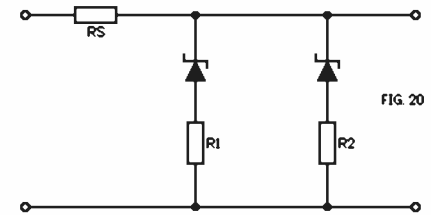
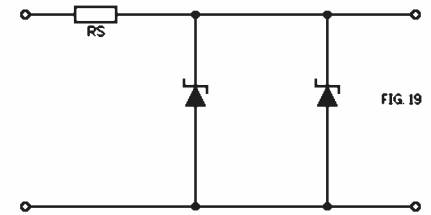
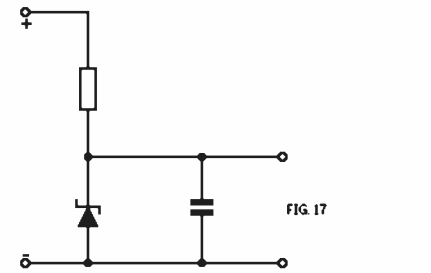
In this circuit the Zener diode establishes a reference voltage for the series transistor, which, in effect, operates as an emitter follower. Thus the emitter voltage is held within a few tenths of a volt of the base potential (which is determined by the Zener diode).

Thus the transistor acts as a series element to absorb voltage variations. All load current flows through this series transistor. The power handling ability of this type of supply is determined entirely by the number and type of transistors used (and the ability of the heat sink to remove heat). Figure 23 shows the regulation obtained from the simple circuit of Fig. 22 which uses a 4.7V 1/4W Zener and a 1k series resistor. The regulation may be improved by a factor of 10 by substituting a low dynamic resistance 4.7V 3.5W Zener (we used an 1R1N1589) for the 1/4W device.

This circuit (Fig. 22) can provide a variable voltage regulated output by connecting a 1K potentiometer across the Zener diode. The variable reference voltage is then applied to the base of the series transistor. However, this modification reduces the degree of regulation due to the shunting effect of the potentiometer. A better system is to switch different Zener diodes into the circuit for different voltage outputs.

CONSTANT CURRENT REGULATION

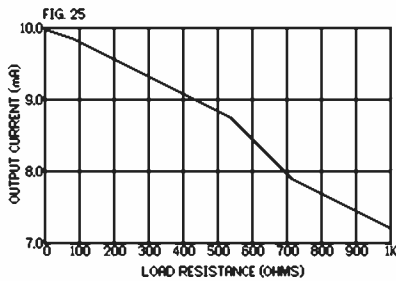
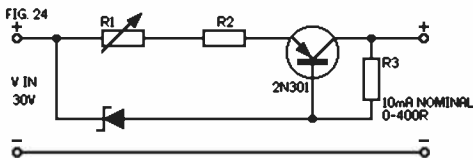
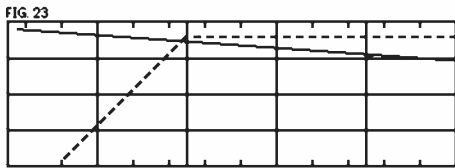
A simple Zener-regulated constant current supply can be built using a single transistor as a variable series



resistor. Figure 24 shows how it is done. Two circuit paths exist; one through the Zener diode which is in series with the bias resistor, and the other through R1, R2 and the 2N301 series transistor. Any change in the current through R3 causes a change in bias, the series transistor thus changes resistance to correct the current flow. In operation the current will remain substantially constant (within about 10%) from a short circuit to a 400 ohm output load. A graph of the output characteristics is shown in Fig. 25.

LOGIC CIRCUITS

In many ways a Zener diode



resembles a switch; and is therefore often used in computer and instrumentation logic circuitry. The advantage of Zener diodes for this purpose is their extremely rapid operation when switching around their avalanche point. Whereas germanium or silicon diodes are limited to data rates of less than 2.5MHz (due to storage of minority carriers) Zener diodes switching about their avalanche point have switching times practically equal to their relaxation time. For silicon this is 10.9 seconds.

A typical AND gate, using two 6.8V Zener diodes is shown in Fig. 26. The positive 12 Volt bias is applied to both cathodes through the common load resistor, maintaining the diodes in avalanche condition. If a positive pulse is now applied to input A, the associated Zener will be gated out of the avalanche region. But due to the low impedance of the parallel connected Zener (associated with input B), the output (point A.B) remains clamped at 6.8Volts. The same circuit conditions apply if a pulse is applied solely to input B. However if a pulse arrives simultaneously at points A and B both Zeners will be gated out of the avalanche region and the output voltage will rise from 6.8 Volts to the 12 Volt supply potential during the time that the pulse is coincident at the two inputs. Thus a positive pulse is produced coincident with the input pulse. Negative input pulses will not affect the circuit.

Figure 27 shows how a similar technique may be used to provide an OR function. In this configuration a pulse applied to either input will produce a pulse at the output.

SORTING

In the circuit shown in Fig. 28 the relays will be progressively energized as the input voltage increases. This circuit is often used for voltage controlled sorting. The relay contacts may be arranged to open chutes and illuminate indicator lamps for rapid sorting.

OVERVOLTAGE PROTECTION

The voltage sensitive characteristic of Zener diodes can be combined with the current sensitive characteristic of fuses to protect circuit components from over-voltage surges whilst at the same time eliminating the 'nuisance' fusing that occurs when a fuse too close to the operating current is used.

By connecting a Zener diode of the correct voltage rating across the load, a fuse adequate to carry the normal load operating current for long periods may be used. But if the input voltage increases - and so exceeding the Zener breakdown voltage - the Zener diode will conduct. The sudden increase in current will blow the fuse practically instantaneously. (Fig. 29). A similar circuit may be used in conjunction with a circuit breaker rather than a fuse.

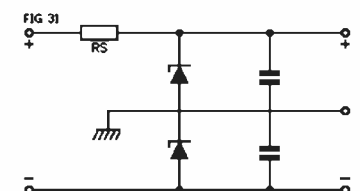
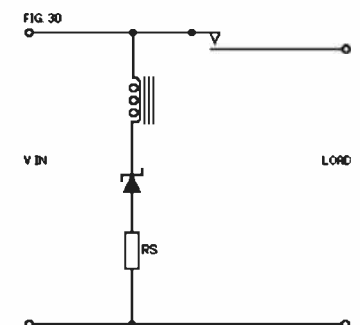
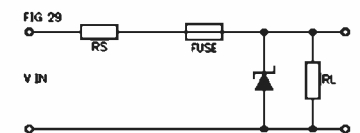
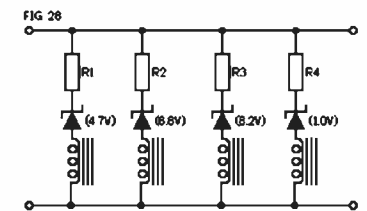
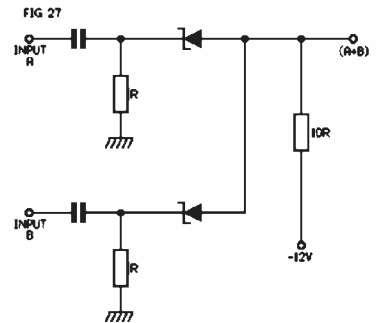
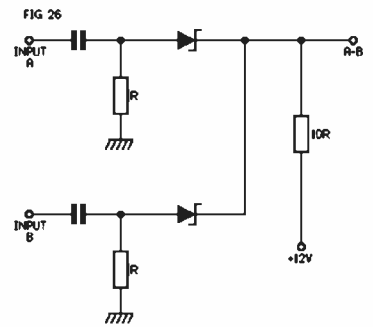
UNDERVOLTAGE PROTECTION

In some applications it may be necessary to disconnect a load from the mains supply if the supply voltage falls below critical level. A simple circuit that will provide this function is shown in Fig. 30. The series resistance R1 is chosen so that at normal operating voltages the Zener diode is broken down and sufficient current flows to hold the relay closed. When the supply voltage falls below the desired level, the Zener ceases to conduct and the relay drops out. The addition of the Zener diode to this circuit provides an accurate reference point, increasing reliability and eliminating the need for specially selected relays for different voltages.

DUAL VOLTAGE SUPPLY

Most logic circuitry needs a dual power supply - (one positive and one negative with respect to zero). The useful, but little known circuit shown in Fig. 31 can supply a dual output of balanced or unbalanced voltage from a single ended power supply. Zener diodes should be chosen to suit the voltages required.

Full details of operating characteristics of Zener diodes can be obtained from most semiconductor manufacturers.



PHOTOGRAPHIC TIMER

PROJECT 512

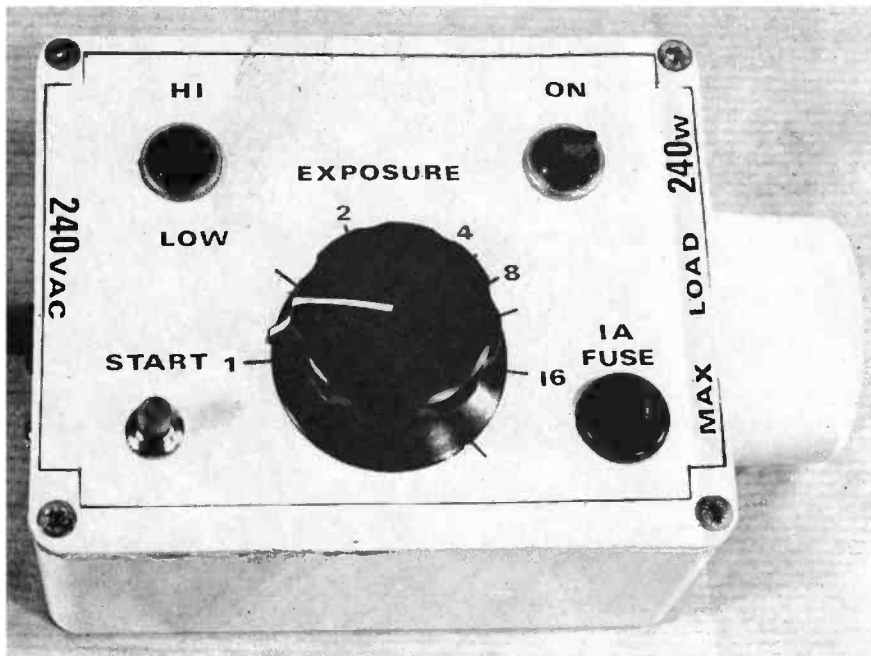


Fig. 1. The completed photographic timer.

This unit provides reliable and accurate timing of photographic processes

ACCURATE, dependable timing of photographic printing processes is essential to avoid costly wastage of paper. ELECTRONICS TODAY INTERNATIONAL'S process timer provides just this. This unit ensures precise and repeatable timing from less than one second to over 300 seconds. The wide timing range of the instrument allows it to be used as an enlargement exposure or development timer. This dual application makes the unit superior to all but the most expensive commercial timers that are usually only suitable for one or the other of the above tasks.

CONSTRUCTION

By far the easiest method of construction is by the use of a printed circuit board, and this is the method we used in our prototype. However, layout is not critical and any other construction methods, such as Veroboard, may be used if desired. It must be firmly kept in mind that the unit is connected directly to the mains power and the circuitry is "above earth". Therefore, good workmanship is essential with particular attention being given to such points as clearances and insulation. Our unit was constructed in a diecast aluminium box which although a little expensive, is convenient and results in a very professional appearance. Full drilling details for this box are given in Fig. 4. If a different box is used it may be necessary to vary the layout somewhat. Assemble the components to the board in accordance with the component overlay Fig. 5. Make sure that all components are mounted the right way round as shown in the overlay. Leads should now be soldered to the

HOW IT WORKS

The 240V ac mains is rectified by DI-D4. Resistor R1 drops this voltage down to about 20V and capacitor C1 provides smoothing.

The main control device SCR 1 (C106D1) and the load connected in series with its anode are connected across the rectified mains. The SCR being a two state device is either non-conducting, or conducting: If the SCR is turned on by a pulse or a DC potential on its gate it will remain on as long as there is a DC potential at the gate or current is flowing in the anode circuit.

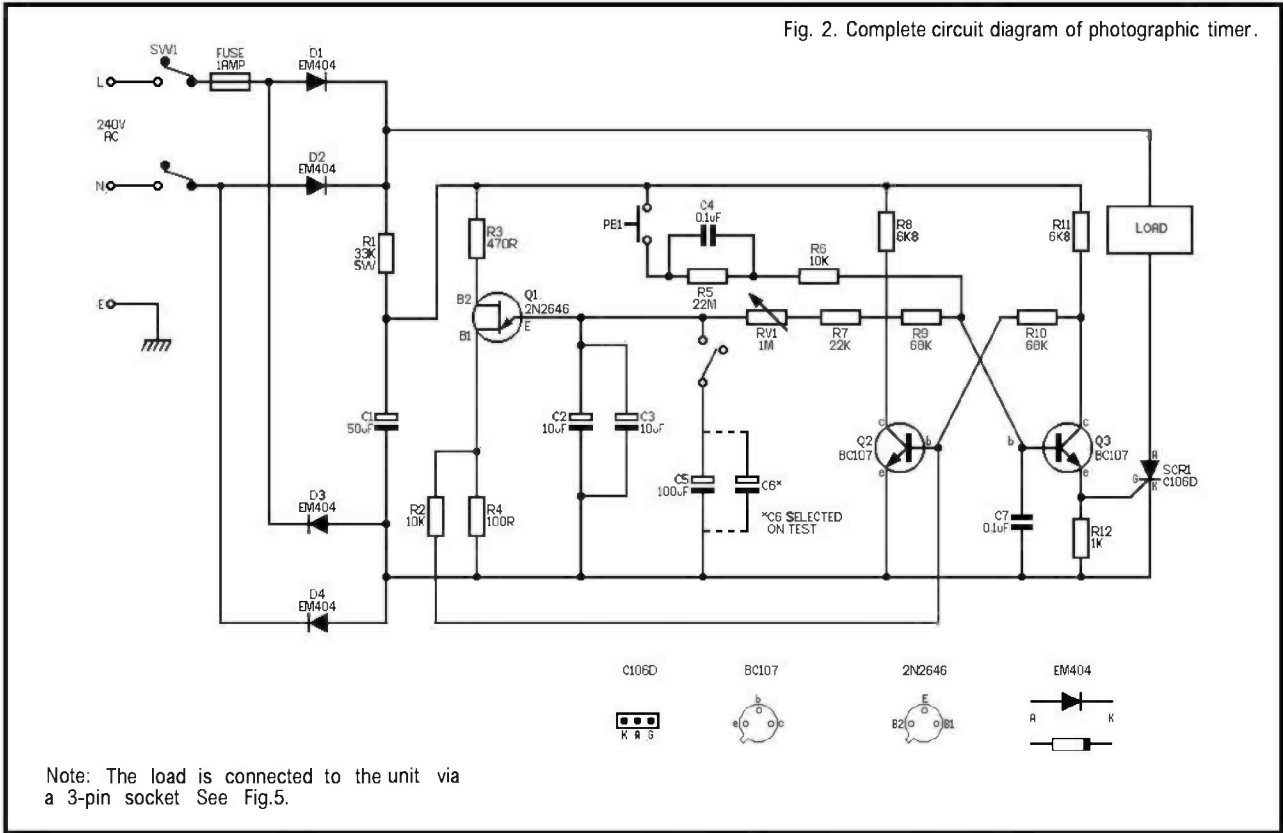
The anode current will drop to zero every half cycle as the mains voltage passes through zero (resistive load). With this circuit a DC potential is applied to the gate for a preset time interval. The SCR will be on for this time plus the time remaining in the half cycle during which the control signal is removed.

Transistors Q2 and Q3 form a flip flop having two stable states. These are Q2 on and Q3 off, or Q2 off and Q3 on. If Q3 is on, the voltage at its emitter will be high and the SCR will also be on. Pressing PB1 applies a "turn on" pulse to the base of Q3. The consequent drop at Q3 collector is passed to the base of Q2 turning Q2 off.

When Q2 turns off, capacitors C2 - C6 begin to charge via RV1 and R7. These capacitors are across the emitter of the unijunction transistor Q1. The emitter appears as an open circuit until the capacitors reach about 60% of the supply voltage. When this point is reached the emitter B1 junction of the unijunction becomes a very low resistance and the capacitors are discharged through R4. The resulting pulse across R4 is coupled to the base of Q2 by R2 turning Q2 on and Q3 off thus ending the timing cycle.

PHOTOGRAPHIC TIMER

Fig. 2. Complete circuit diagram of photographic timer.



board for later connection to the switches and other components mounted directly on the box. Assemble the completed board into the bottom of the box using half inch spacers, making absolutely certain that all wiring and components are clear of the case.

Mount all external components on the box and wire them in accordance with Fig. 5. Note that where wires pass through the metal case a rubber grommet must be used. Install the mains cable and secure it with a proper clamp. The practice of tying a knot in the cable is highly dangerous, illegal, and should not be used. The earth lead of the cable should be firmly bolted to the case. Check the unit thoroughly to ensure that all wiring has been properly performed before switching on.

TEST AND CALIBRATION

Remember that this unit operates at mains potential. Before attempting to make any internal changes or adjustments, switch off and remove the power plug from the mains outlet. Connect a lamp load not exceeding 240 watts. Plug the unit into the mains outlet and switch on. A short flash from the lamp may occur at initial power switch-on and is quite normal.

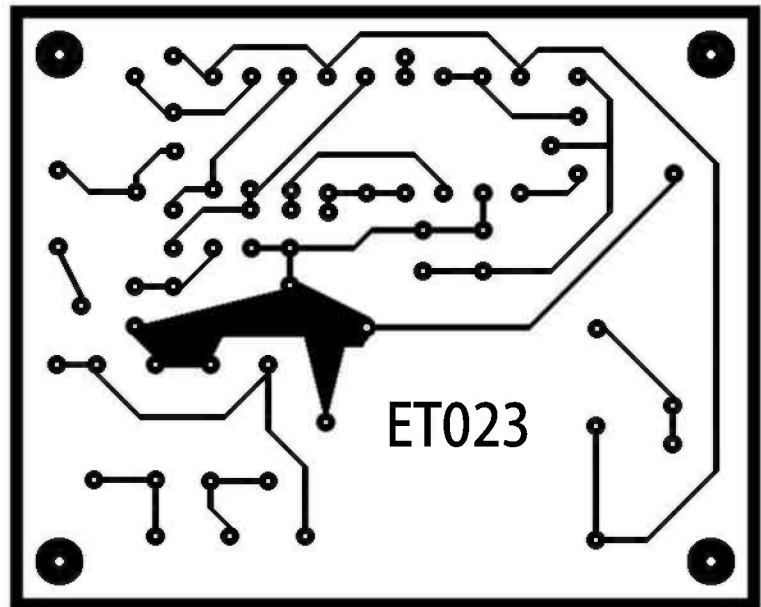


Fig. 3. Foil pattern for the printed circuit board.

PHOTOGRAPHIC TIMER

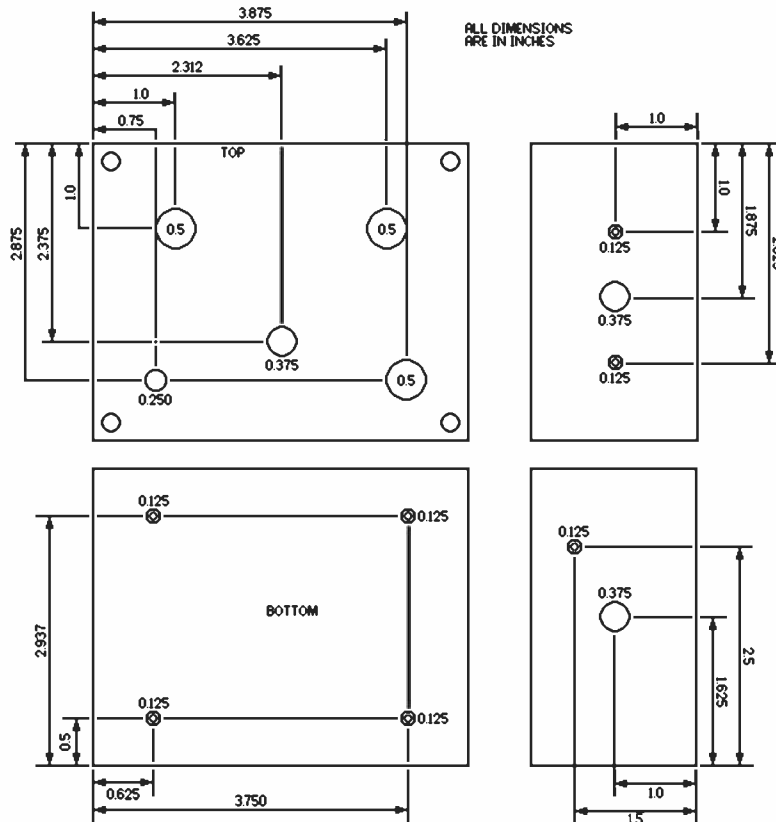


Fig. 4. Drilling details for cast aluminium box.

PARTS LIST ET 512
All resistors 1/2 watt 10% unless specified otherwise.

RESISTORS

R1	33K 5W 10%
R2	10K
R3	470R
R4	100R
R5	22M
R6	10K
R7	22K
R8,R11	6K8
R9,R10	68K
R12	1K

CAPACITORS

C1	50uF 50V electrolytic
C2,C3,C4,C5	see text
C6,C7	0.1uF 100V

SEMICONDUCTORS

Q1	2N2646
Q2	BC107
Q3	BC107
SCR1	C106D/2N24444
D1-D4	EM404/1N4004

MISCELLANEOUS

SW1	2-pole 240V 1A on-off
SW2	1-pole on-off
PB1	push-to-make push button
Metal box Eddystone type 6908P or similar;	
3-core cable; Mains plug three pin 5A; 3-pin mains socket	

Select the low range, minimum time and press the start button. The light should come on for less than one second. Now turn to maximum time and press the start button again. The timer should now stay on for about 30 seconds. Perform the same procedure again on the high range, the time range should now be about ten times that obtained on the low range.

The calibration of the timer may vary widely from unit to unit due to component tolerances and timing capacitor leakage. Tantalum capacitors have been recommended for this unit because of their relatively low leakage. These capacitors are expensive and may be replaced by ordinary electrolytics with some deterioration in performance. Different scales would then be required for each of the two ranges due to the higher leakage of these capacitors. Calibration is performed by selecting the value ohC2 or C3 to obtain the desired time range on "low" and C5 or C6 for the desired time range on "high".

On the scale as shown in Fig. 7, the calibration is from one to sixteen, the graduations being at half stop intervals. Capacitor values should be trimmed to make the time range

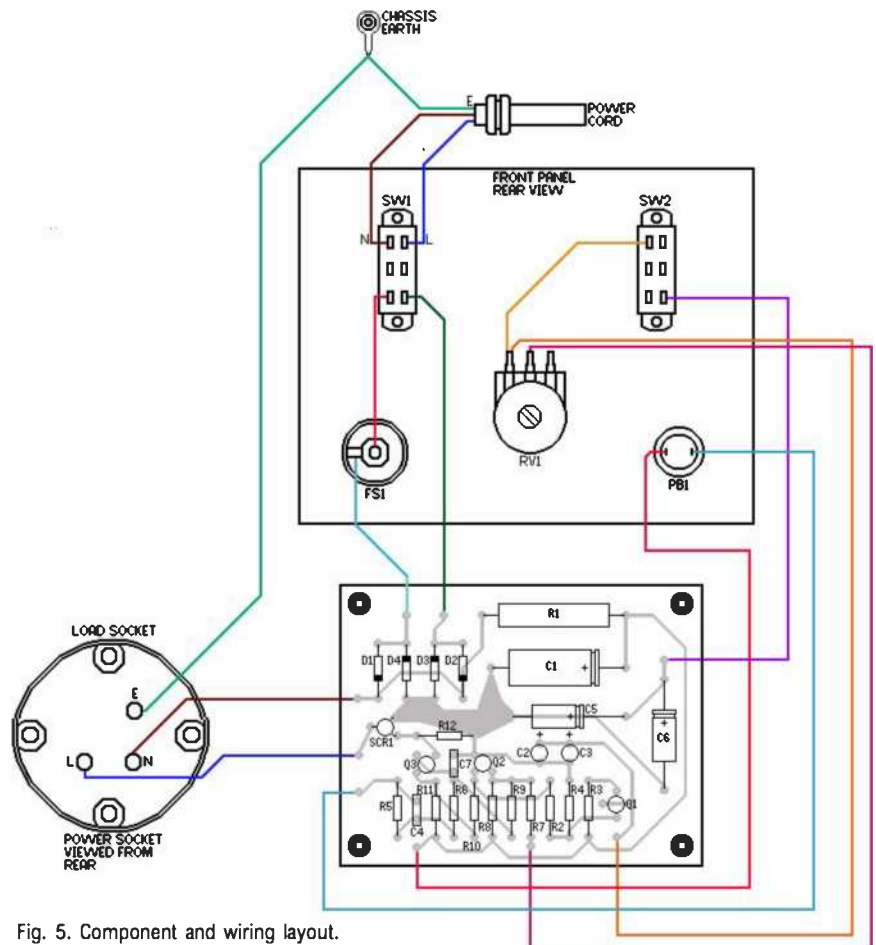


Fig. 5. Component and wiring layout.

PHOTOGRAPHIC TIMER

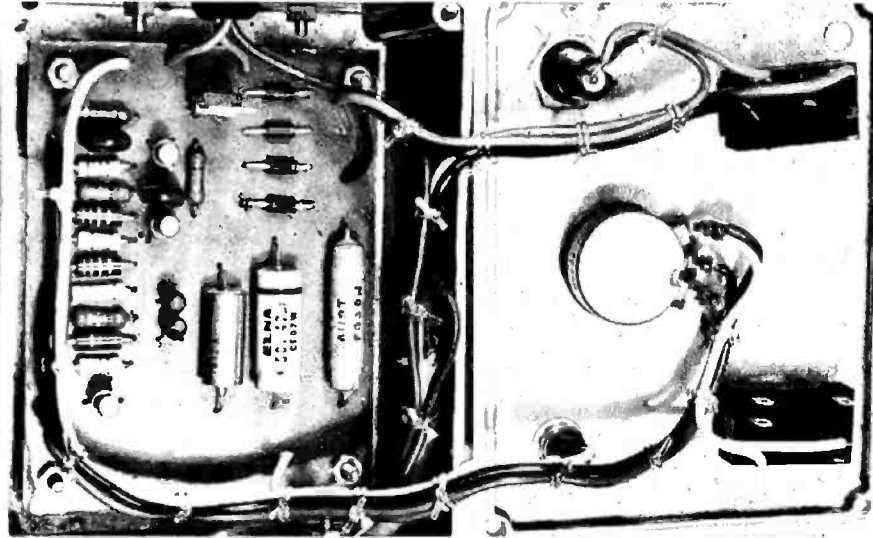


Fig. 6. Internal layout of the timer.

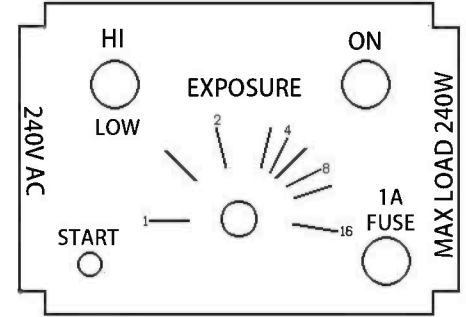


Fig. 7. Front panel marking reproduced half size.

correspond to the scale markings. This is done by increasing capacitance to extend the time interval, or reducing capacitance to shorten the time interval.

The same procedure should be used if different time scales are required, the same scale graduations but different time figures are used. However it should be borne in mind that capacitor leakage may well prevent the practical realization of time intervals much longer than 300 seconds.

SPECIFICATION

Power	maximum load	1 amp (240W).
Time	(low range)	1 sec - 30 sec.
	(high range)	10 sec - 300 sec.
Time ranges simply selectable by change of capacitance values.		

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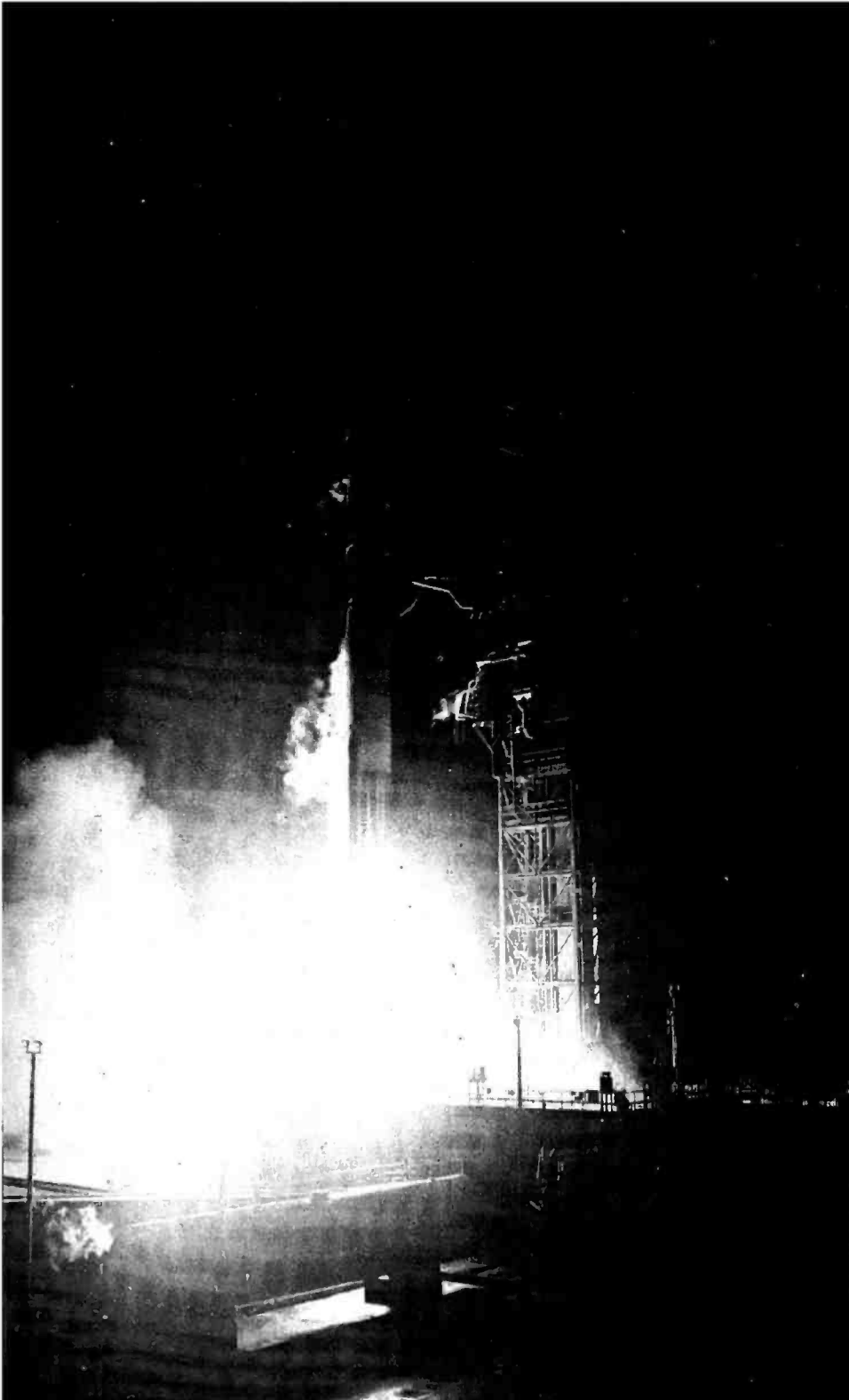
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SPACE SPECTACULAR



The US National Aeronautics and Space Administration are seriously investigating the possibility of landing men on Mars - in 1985. This report - based on a NASA Technical Paper - outlines the proposed mission.

In all likelihood the next body in our solar system to be visited by man will be the planet Mars, for possibly the most intriguing question faced by man today is the prospect of life on other planets, and although recent data from Mariners VI and VII discourage such prospects on Mars, they do not rule them out. Therefore, the search for life has been given the highest priority, followed by the desire to learn more about the origin, and evolution of the solar system.

PROPOSED MISSION

Two planetary space vehicles, of essentially the same design, will depart Earth in the Spring of 1985 on a heliocentric transfer to Mars. Each space vehicle will have two principal components: a planetary mission module (PMM) and a Mars excursion module (MEM). After a Venus swingby the space vehicles will arrive at Mars where, after a brief orbital period, one MEM from each space vehicle will descend to the surface. The planetary mission module will remain in orbit. After a 40 to 60-day surface stay-time, the ascent stage of the MEM will rendezvous with the planetary mission module for a direct heliocentric transfer to earth. The approximate dates for the proposed 1986 mission are as follows:

Launch from Earth.....	March 26, 1985
Arrive Venus.....	Sept. 12, 1985
	170 days
Arrive Mars.....	March 11, 1986
	350 days
(About 60 days at Mars, 40 days on surface)	
Leave Mars.....	May 10, 1986
	410 days

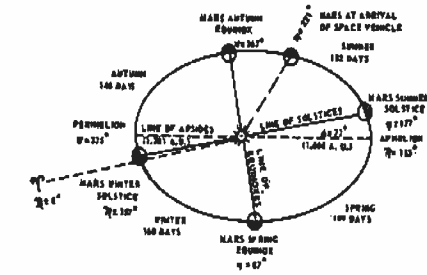
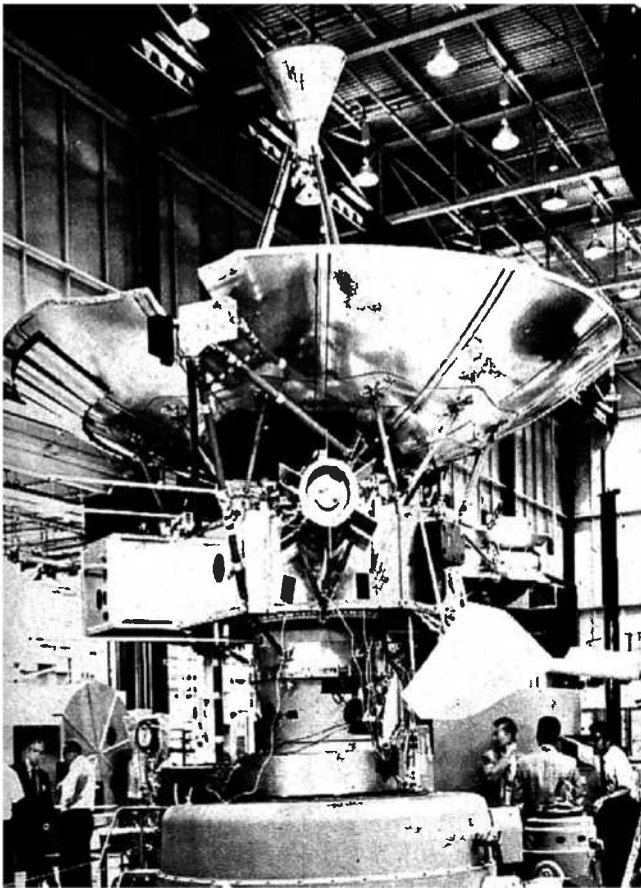


Figure 1. Position of Mars in orbit on arrival.

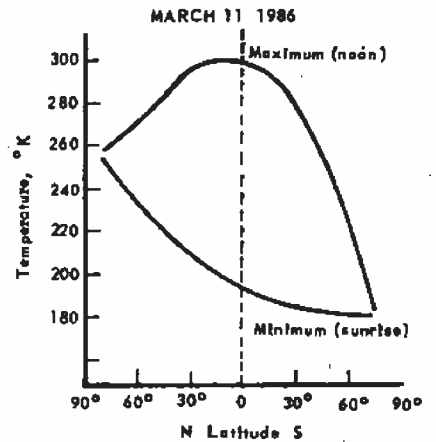
Preceding the proposed manned Mars space flight are a number of unmanned journeys to the outer solar system.

Here a test model of a Pioneer spacecraft is seen mounted on a shaker table to check its ability to withstand in-flight vibration.

Pioneer F is the first spacecraft designed to travel into the outer solar system and operate effectively there, possibly for as long as seven years. It will travel a distance of one and a half thousand million miles from the Sun, and explore a curving strip of space 620 million miles long extending from the Earth's orbit to Jupiter.

The spacecraft's primary objective will be to take the first close-up look at Jupiter. It will return data on about 20 aspects of the planet, its moons and environment.

Figure 2. Martian temperature variations with latitude at the time of landing.



Arrive Earth Oct.7, 1986,
560 days

Some of the important physical features existing at Mars on arrival are illustrated in Figures 1, 2, and 3. Figure 1 presents the locations of Mars in its orbit, Figure 2, the temperature as a function of latitude, and Figure 3, the extent of the polar caps and wave of darkening.

In accomplishing the experimental objectives, the inherent and unique abilities of man will bring a dimension to scientific investigations heretofore absent in the study of any planet other than Earth. Man is the only reliable instrument available that can rapidly adjust observations over the many orders of magnitude resolution needed for some scientific investigations. His judgment is unsurpassed in selecting locations for instruments and for gathering samples and examining complex situations. His ability to interpret experimental results and, if necessary, redirect the investigations will be very valuable. He can manipulate and repair the instruments. His faculty for appraising and correlating interdependent measurements (some occurring simultaneously of many physical properties and for improvising when unexpected situations occur cannot be overemphasized.

Estimates of the instrumentation state-of-the-art in the early 1980's can be made by extrapolating the advances that have occurred during the last 10 to 15 years.

Using these estimates as a guide it is envisioned measurement results will be transmit in real-time to earth.

Earlier pace missions will test for the presence of life, and if these tests are positive, scientists will attempt to measure and characterize this life. If any indications of life are found, the question of compatibility or possible pathogenesis and back contamination must be resolved.

Therefore, an additional precursory experiment that may be beneficial, and even necessary, to the manned mission is a lander system which contains numerous earth-type life samples, even possibly including human tissue cultures, that could be exposed to the Martian bio-environment and the results monitored. Because of the highly specific nature of pathogens, a positive result may be a necessary but not sufficient guarantee that man (or any earth organisms) will be safe, but at least such an experiment would be a partial answer.

Some biologists believe that it is necessary to firmly establish before a manned mission whether life exists on Mars and if so, whether it is pathogenic to Earth life. If this is to be done, the number and type of unmanned probes needed, e.g., Viking, and Soft Landers with remote-controlled roving vehicles and with soil samples return capability, may be greater than is currently planned.

THE ORBITAL MISSION

Soon after arrival at Mars a landing module (MEM) will separate from the space vehicle and descend to the surface, leaving in orbit the part designated as the planetary mission module. The orbital part of the mission will consist of experiments done on the planetary mission module and experiments done on an unmanned spacecraft. The unmanned spacecraft mode is needed because of the orbital characteristics required for in-situ atmospheric measurements in the transition zone. This zone, located at about 80 to 120 km in the Earth's atmosphere and probably below 100 km in the Martian atmosphere, divides the uniformly chemically mixed region and the diffusely separated region. A 100-km altitude would be unacceptable for periphraisis of the planetary mission module because of orbital lifetime, aerodynamic heating, and other engineering considerations.

One unmanned spacecraft will be launched from each space vehicle (before MEM descent) and placed into

SPACE SPECTACULAR

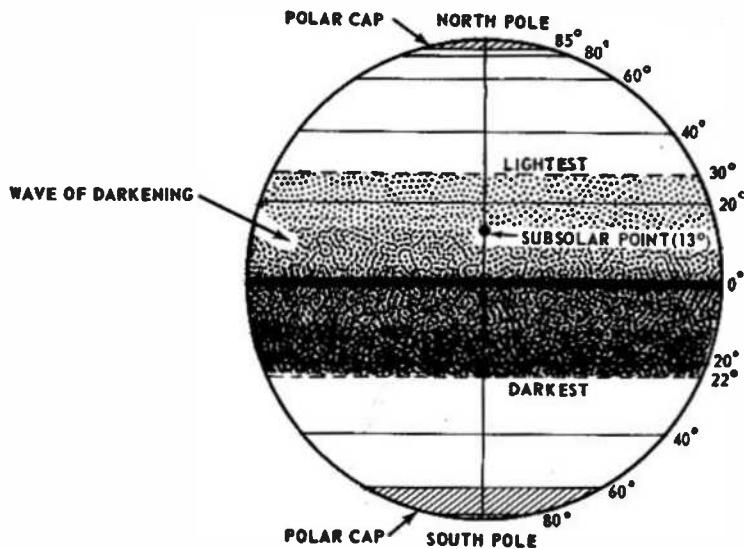


Figure 3. Physical conditions on Mars at time of landing.

an elliptical orbit around Mars with a periapsis and apoapsis of approximately 100 km and 1000 km, respectively. The first orbiter will be deployed soon after the space vehicle orbit is determined. After observation of orbital parameters, the scientist will select and optimize the orbital parameters for the second orbiter.

Although the principal activities on the planetary mission module during the initial orbital phase will be related to preparations for the manned descent, several experiments, in addition to those on the unmanned orbiter, will be accomplished to support the final site selection. Among these will be the topographic and thermal mapping experiments. The scientists will study the most interesting areas determined from precursor data, compare and evaluate the most recent information (in particular noting significant changes from the precursor data), and choose the site with the greatest potential for manned exploration and scientific return.

A very significant experiment to be done from Mars orbit will be the observation of the two Martian moons (Phobos and Deimos). These moons will appear to observers on Mars as smaller objects in the sky than the Earth's moon appears to observers on Earth. Only if the spacecraft approaches within about 1800 km of Phobos (or about 900 km of Deimos) will they appear as large as the earth's moon.

However, high-resolution observations can be made with the reflecting telescope if the proper orbit can be achieved. In any case, the observation of the Martian moons by scientists in the planetary mission module will be a major activity.

THE SPACE VEHICLES.

The convoy mode (spaceships separated) is recommended over the single mode (spaceships coupled) during the voyage to and from Mars. The convoy mode will enable cooperative experiments between the two spaceships, such as investigation of low-frequency RF transmission through the solar plasma. Also, it may be possible to compute the solar wind velocity by recording the time needed for particles to travel the distance separating the spaceships. Tracking of orbiters about Venus can be done from two points rather than one if the two spaceships are separated. In Martian orbit the separated spaceships can reduce the problem of continuous communication by serving as relay links.

At the Venusian encounter each spaceship will launch an orbiter which will provide information about density, temperature, composition, magnetic fields, charged particles, and electron density. The orbiters will be placed into elliptical orbits with a periapsis of approximately 150 km and an apoapsis of approximately 5000 km. The orbiters will have inclinations differing by about 90 degrees. From each orbiter an entry probe will be launched. Each entry probe will divide into two probes an atmospheric drifter and a soft-lander. These will make vertical soundings to measure the atmospheric temperature, pressure, and composition; additionally, the soft-lander will carry a TV camera. The drifter may search for biological activity at an altitude of approximately 25 km.

Each space vehicle will have accommodations for an astronomical

observatory, which will house a 25 to 40 cm size telescope. During the transit part of the mission, opportunities for viewing celestial bodies, including the earth, will exist. In transit and while at Mars opportunities, unavailable from Earth, may occur for the observation of stellar occultations by the outer planets.

On arrival at Mars each space vehicle will launch one unmanned orbiter and several relay satellites. The orbiters will pass through the upper Martian atmosphere and make measurements of the physical properties. This is not possible from the planetary mission module because of its orbit. The orbiters will be placed in equatorial and polar orbits and will have a periapsis and apoapsis of about 100 km and 1000 km respectively.

The relay satellites will provide real-time communication-links between the MEM, mission module, remote stations, and other components. A module using a laser system to obtain high data-rate transmission will be separated from each mission module (just before return to Earth) and will serve as a continuous communication link between Mars and Earth. This orbiter will continue to relay data from automated, surface measurements to earth after completion of the mission.

The landings should be made at different sites, permitting the investigation of different locations. For this mission two sites have been selected. One is located at about 50 degrees south latitude so as to be on the edge of the polar cap, permitting investigations of this interesting feature. The other site should be at or near the equator, perhaps in the Tithonius Lasus area which is located at 5 degrees south latitude. This area becomes darker earlier than other areas in the region. The equatorial region probably has a greater chance of harboring life because of the higher temperatures, 2980K maximum at the equator).

A manned Martian rover similar in design to the lunar rover will be necessary to fully explore the immediate surface area. It should be able to carry two scientists over a traverse distance of approximately 30 km. The vehicle should also be designed to carry heavy equipment to the remote stations and possibly to pull an automated drill to the drilling sites.

The MEM should be designed to provide adequate transportation to the Martian surface for the scientific instruments and associated laboratory equipment, the drill, and the rover. The five scientists will use the MEM for transportation to the surface, as crew quarters, and as a base of operation.



CROWN IC150 PREAMPLIFIER

Unlike a number of present day audio equipment manufacturers, Crown put performance before price. They appear to build to a specification rather than a marketing formula.

The Crown Preamplifier, type IC-150 is built as a self-contained unit and may be used in conjunction with any suitable power amplifier, although it is of course primarily intended for use

with the Crown DC150 or DC300. It contains all tone controls and selection facilities normally to be found on most combined amplifiers.

The front panel is constructed with a polished aluminium section consisting of three horizontal raised ribs; one at the top, one approximately two thirds down and one at the bottom. The top section contains all the control knobs

We test the Crown IC-150 preamplifier and the DC300 main amplifier.

IMPERIAL

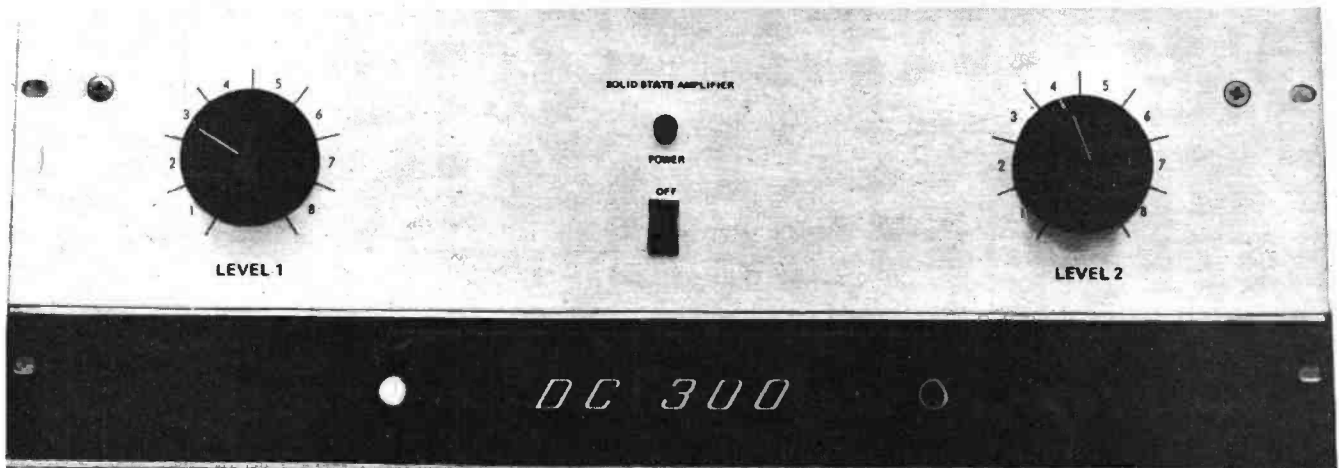
CROWN DC300 MAIN AMPLIFIER

The Crown DC 300 is a true laboratory power amplifier. Even its external appearance, with two large volume control knobs and rack mounting facilities, has a truly professional appearance.

In some respects the Crown DC 300 matches the IC-150 preamplifier, the front panel having a black trim across the bottom part of the panel and a brushed

aluminium top section.

The level control knobs are located at either end of the brushed aluminium section with a power switch located in the centre of the panel and a small neon indicator above the switch. The lower black section contains a removable centre panel retained by two chromed



which are backed by a brushed aluminium escutcheon plate. The bottom section contains five push buttons and is finished with an imitation black leather facing. The fluted black plastic control knobs are fitted with brushed aluminium caps and, from left to right, provide the following facilities:-

- a) input selector with positions for phono 1, phono 2, tuner, auxiliary 1, auxiliary 2, tape 1 and tape 2.
- b) volume control
- c) balance control
- d) panorama control with three positions; namely, normal stereo, mono, reverse stereo.
- e) dual concentric bass controls with boost, cut and flat positions.
- f) dual concentric treble controls with boost, cut and flat positions.

A small "push on" "push off" button located between the selector switch and volume control, switches the loudness circuit in and out. A similar push button located between the bass and treble control switches the bass and treble controls out of



circuit to give a flat frequency response.

Five rectangular push buttons centrally located in the bottom part of the front panel provide, monitoring of tape 1 or tape 2, selection of high or low filters, and mains on.

All input and output sockets are

located at the rear, on a recessed horizontal panel, (as opposed to the more common location on the vertical back panel). The left hand end of this panel contains five 2-pin power outlets, four switched and one unswitched.

Adjacent to these sockets on the

POWER

electronics
TODAY
INTERNATIONAL
product test

knurled-head screws. Removing this panel exposes five fuses and four DC balance adjusting potentiometers. This panel also has four replacement fuses clipped to the back of it.

All input and output terminals are located on the rear panel between the power transformer, which is located in the centre of the panel, and the respective channel heat sinks, located one at each end of the rear panel. The inputs are standard 1/4 inch tip and sleeve sockets. The outputs connections for each channel are located behind removable metal boxes and consists of a 1/4 inch tip and sleeve socket and two banana plug sockets; one coloured red and the other black. Presumably the covers are fitted to minimize accidental removal of the output leads.

Behind each end panel a slide switch is located for selection of the desired VA overload characteristics. This switch has two positions marked Hysteresis and Normal.

The Hysteresis position will tolerate much greater reactive VA phase relationships at a given power output and is therefore recommended for

inductive loads such as loudspeakers. The Normal position, with its closer tolerances, is mainly for laboratory applications and, in most instances, will limit the power output so that the fuses will not blow, even when the output terminals are shorted. The amplifier circuit consists of a transistor preamplifier stage driving a single ended push-pull stage with four

Westinghouse 2N3773 transistors as the final power stage. The overload circuit consists of two transistors in a feedback loop which varies the base bias of the first transistors in the main amplifier.

MEASURED PERFORMANCE

The measured performance was very good and in most respects was equal to



MEASURED PERFORMANCE OF CROWN PREAMPLIFIER, MODEL IC-150 SERIAL NO. 1471

Frequency response	20 to 20kHz 1/2 dB	
Channel Separation	100Hz	44dB
	1kHz	44dB
Signal to noise ratio		
Phono Input	52dB	
Auxiliary Input	- Stereo Mode	88dB
	- Mono Mode	78dB
Inter-modulation Distortion	960Hz and 1kHz	0.01%
Input Sensitivity for Rated Output of 2.5V		
Input	mV	Input Impedance
Tuner	225	100K
Auxiliary 1 & 2	225	100K
Tape 1 & 2	225	100K
Phono	0.75	47K
Harmonic Distortion	Less than 0.001%	
Tone Controls		
	14dB Boost at 50Hz	
	15dB Cut at 50Hz	
Treble	14dB Boost at 10kHz	
	15dB Cut at 10kHz	
Loudness Control		
	17dB Boost at 50Hz	
	3dB Boost at 10kHz	
Low Filter		
	4dB Cut at 50Hz	
High Filter	11dB Cut at 10kHz	

PRICE - £128.00

IC-150

right hand side are two screw terminals. These have a jumper wire installed at the factory. Open-circuiting these terminals de-energises a muting relay which shorts the preamplifier outputs to earth. A remote switch may be connected between these terminals to provide remote silencing of the output as required. The left hand end of the panel contains eleven pairs of R.C.A. sockets - four pairs for outputs and seven pairs for inputs. Two pairs of output sockets are for tape 1 and tape 2 recorder inputs, the other two pairs are for connecting to power amplifier inputs. One somewhat surprising omission was a headphone socket for monitoring with the speakers isolated.

ELECTRONIC CIRCUITRY

The circuitry is very simple and is all contained on two printed circuit boards, with the exception of the power transformer, the wafer type selector switch and the five push buttons. The smaller of the two boards measuring 2 inches by 3-1/2 inches contains the two phono input preamplifier's and is mounted internally on the back panel in close proximity to the phono input

DC300

the manufacturer's specifications. Very low hum and noise figures and a typical noise spectrum are detailed in the instruction manual and we checked these by examining a detailed 3.16Hz bandwidth spectrum analysis of the noise. It is interesting to see the extent of the harmonic content due to the mains frequency - in particular the third and fifth harmonics.

The inter-modulation distortion and harmonic distortion at the rated output was much lower than we have measured on any previous power

amplifier, being less than 0.1% at the rated output of 150 watts (both channels driven to full power.) However, for any audio application, harmonic or inter-modulation distortion below 0.1% in an amplifier is of no real advantage because of three significant factors:-

- a) source distortion
- b) speaker distortion
- c) the masking characteristics of the human ear.

Source distortion, be it from a record or a tape lies typically between 1% and 10% and can be as high as 20% on peaks or transients. (These figures, of course,

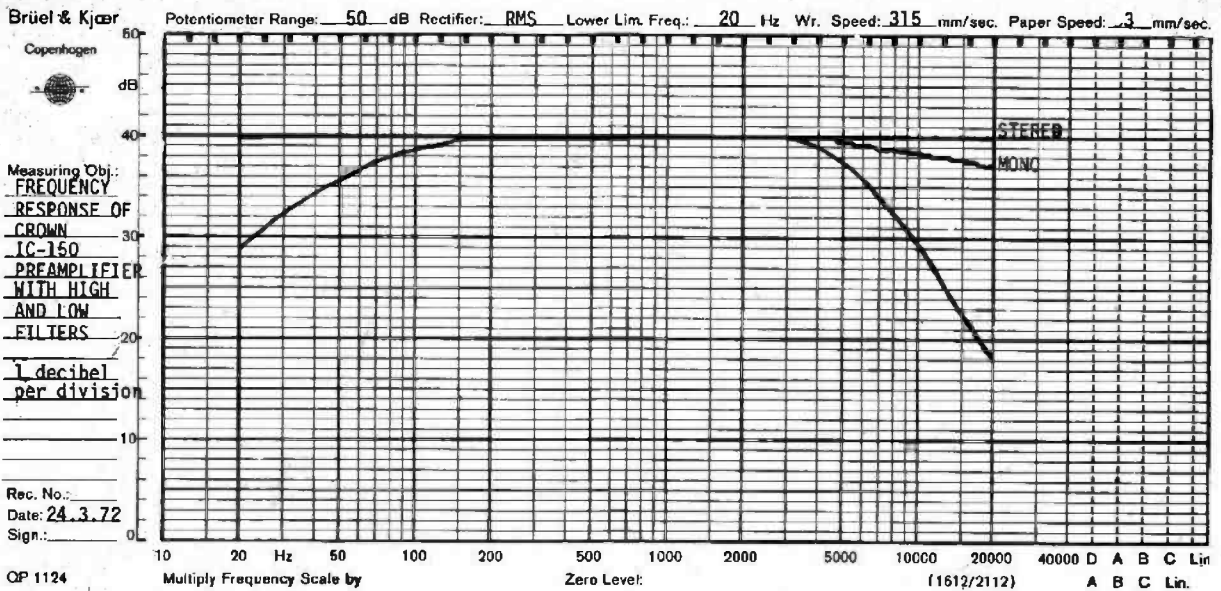
are the sum of the distortion on the record or tape and the distortion generated in the pick-up or tape deck.) Speaker distortion is dependent mainly on the power input, and for normal listening levels lies typically between 0.5% and 10%.

One of the curious effects of the human ear which makes correlation of instrument analysis to subjective assessment very difficult and complex, is the phenomena known as masking. Considerable research has been conducted by numerous organizations into this effect and has resulted in the publication of the International Organization for Standardization. Recommendation No R532 "Procedure for Calculating Loudness Level." If a fundamental exists together with its second and higher order harmonics then it is possible for the harmonics to on be audibly masked by the fundamental. Assuming the fundamental is 500Hz at a sound pressure level of 90 dB then, if the second harmonic is below 65 dB, it will be inaudible. Similarly, if the third harmonic is below 30 decibels it will also be inaudible. These levels correspond to distortion levels of 5.5% and 0.1% respectively for the second and third harmonics. However, not only would a level of 30dB be lost in

MEASURED PERFORMANCE OF CROWN DC300 POWER AMPLIFIER, SERIAL NO. A-1859

Frequency response	20 to 20kHz 1/2 dB	
Power Output (8 ohms load-rated input 1.75V)	145 watts both channels driven 155 watts one channel driven	
Channel Separation (at rated output)	100Hz - 84dB 1kHz - 84dB	
Signal to Noise Ratio (at rated output)	110dB	
Total Harmonic Distortion	Less than 0.02% 20Hz - 20kHz	
Inter-Modulation Distortion (1kHz and 960Hz)	0.02%	
Dimensions (rack mounting)	19" wide x 7" high x 9-3/4" deep	
Weight	40lbs	

PRICE - £360.00



sockets. Each channel has gain adjusting potentiometers with adjusting screws protruding through the rear panel. The second printed circuit board, measuring 13" x 3", contains all the control potentiometers, the muting relay, and the two integrated circuits preamplifier output stages. The I.C.'s

are fitted into solder-less receptacles to facilitate easy replacement and to eliminate possible thermal damage during the soldering process. The power transformer is fully encapsulated and located in the far right hand corner when viewed from the front. The most interesting feature of

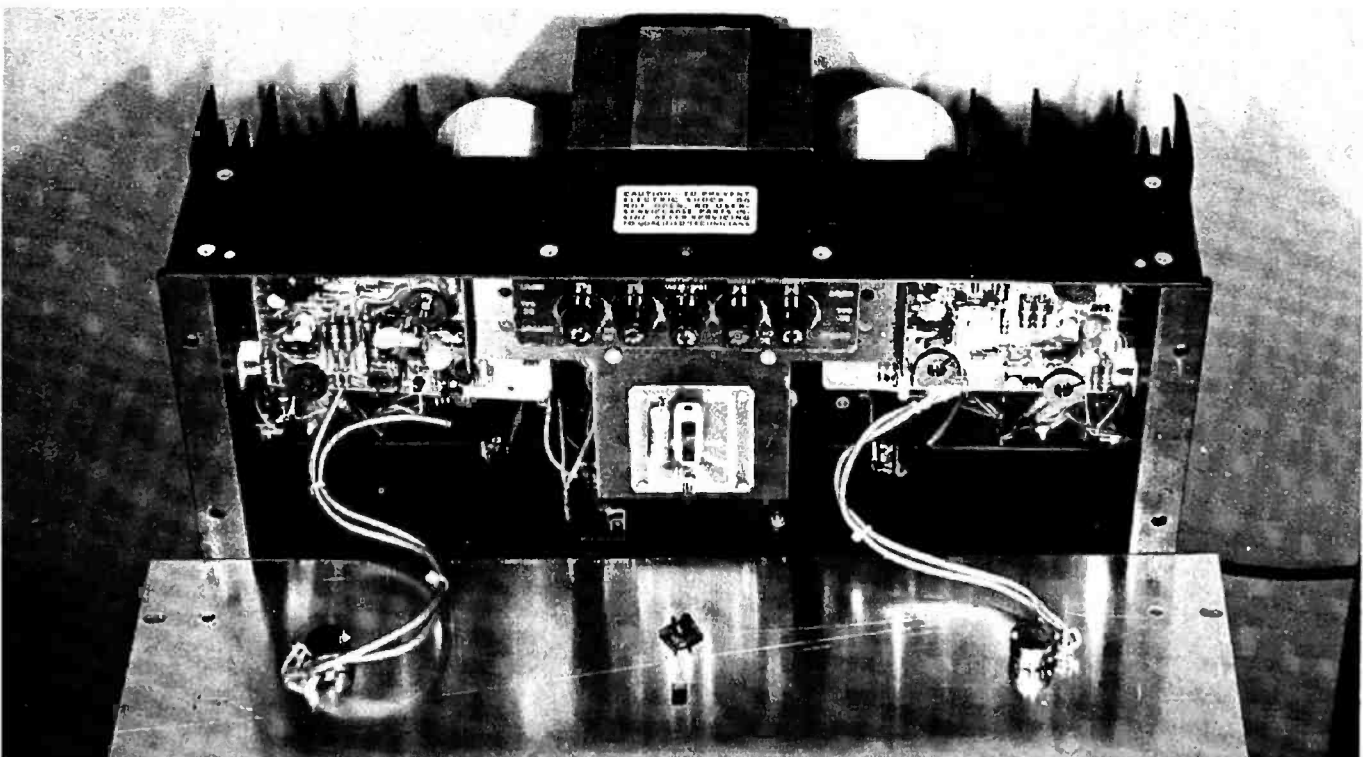
the circuit is the "Panorama" control which consists of two potentiometers and one three position rotary switch ganged together and wired to provide variable stereo spread from full normal stereo through mono to reverse stereo. The IC's used are Motorola, type 3490 operational amplifiers with the

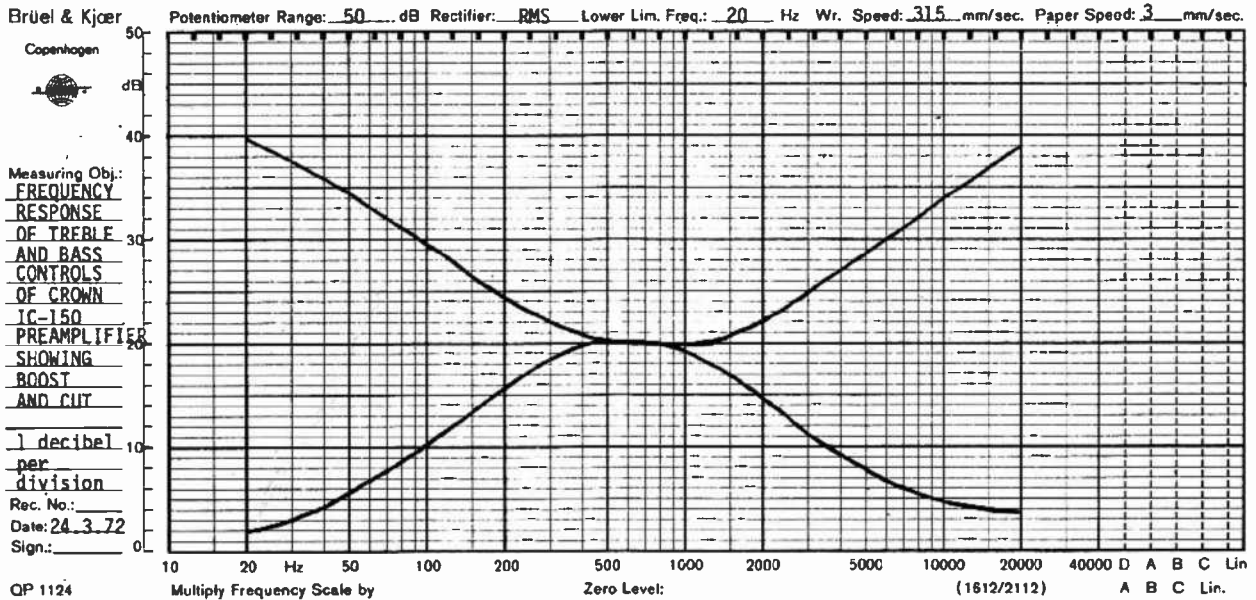
the background noise under most listening conditions but a level of 90 dB is approximately 20. to 30dB higher than normal listening levels.

Because of all these factors it is impossible under most listening conditions to detect distortion less than 1% (40dB below the level of the fundamental). On a theoretical

basis the sum of the individual distortion components is additive on an RMS basis. Therefore if we assume a speaker distortion of 0.5%, an amplifier distortion of 0.1% and a source distortion of 1% the resultant distortion is only .1122%. Even if we ignore the amplifier distortion the resultant level is still 1.118%, a

difference of 0.004% which cannot be detected by most instruments or the human ear. Going a step further, most sources, be they tape recorders, record players, or even a live performance, rarely have a signal to noise ratio exceeding 50dB, which is equal to a distortion level of 0.3%. Even if the signal to noise ratio was 60dB, which





IC150

bass and treble controls in the feedback circuitry.

The measured performance was very good with most parameters being equal to or better than the manufacturer's specification.

Harmonic distortion was exceptionally low - it was literally unmeasurable being below our source harmonic distortion of 0.012%!

INSTRUCTION MANUAL

The 27 page instruction manual is a loose leaf volume with a plastic multi-ring spline. It is divided into two

sections: No 1, General Operation, and No. 2, Technical Description. The page labeled "From Box-to-Bach in 7 minutes 30 seconds" adequately describes the connections necessary for immediate operation but shows the cable between the preamplifier and amplifier incorrectly connected to the "tape one" record output which in

DC300

most professional equipment does not exceed, the equivalent distortion level is still only 0.1%.

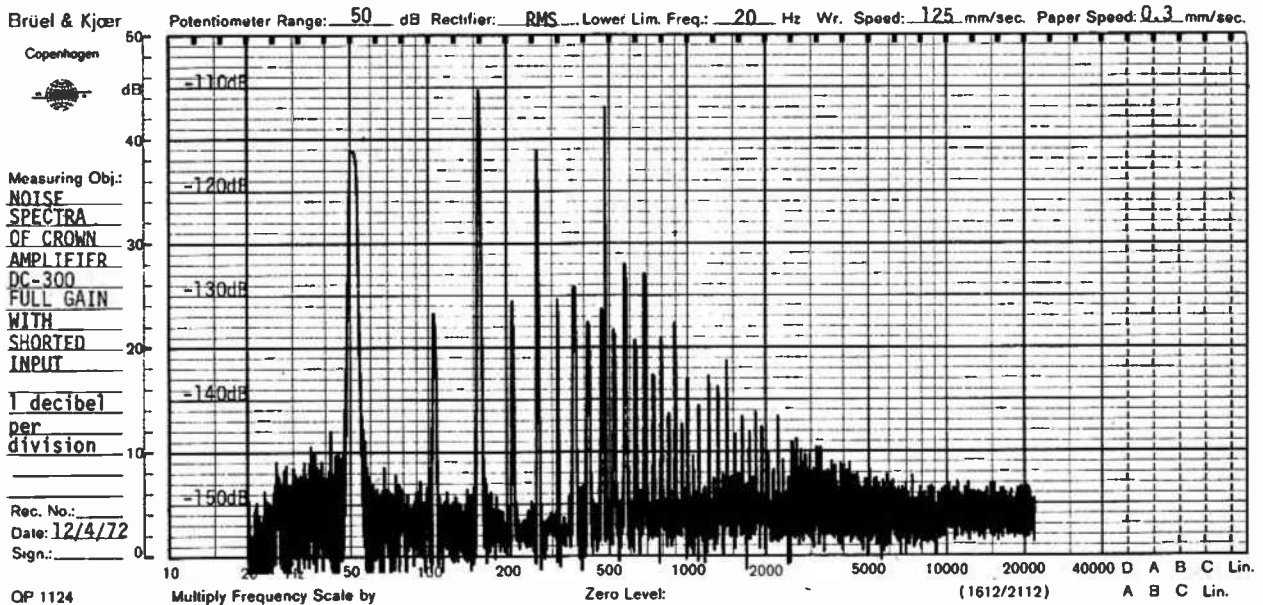
The inter-modulation characteristics of the Crown DC 300 were measured at 0.2% at rated power and this is

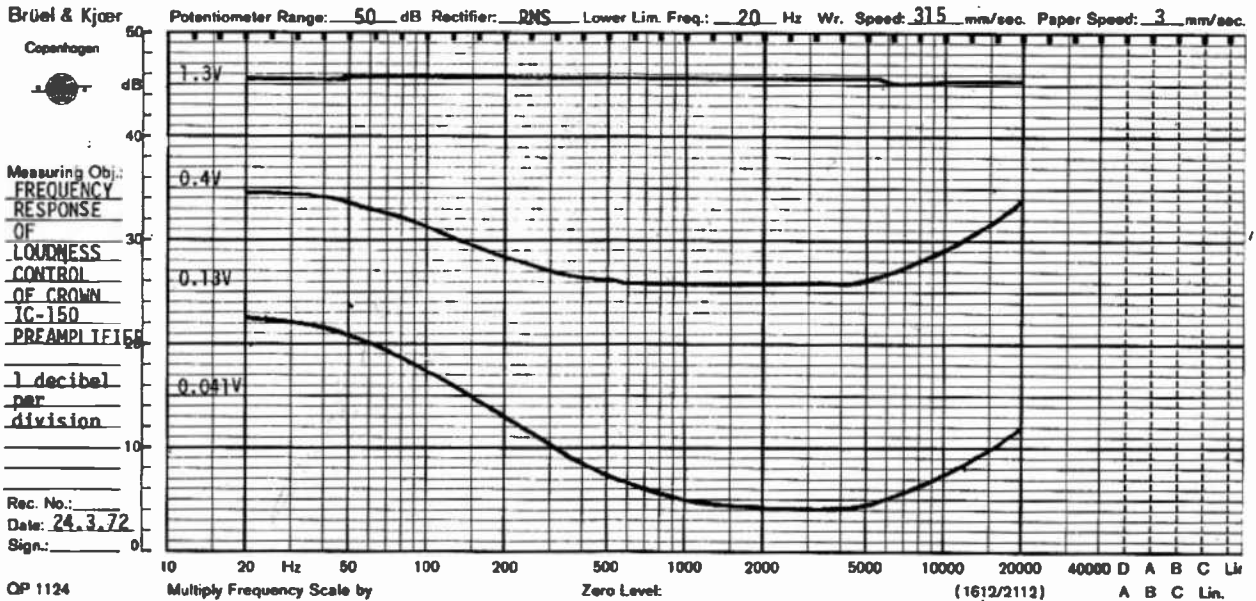
particularly good by any standard. Such a performance is exemplary, it is in fact better than one would normally require for even the most exacting application.

SUBJECTIVE TESTING

Subjective tests were performed with good quality speakers and different

high quality audio amplifiers to assess whether any audible difference could be detected between the Crown DC 300 amplifier with its known exceptionally low distortion characteristic and other amplifiers with distortion characteristics varying between 0.05% and 0.01%. However in every case it was impossible to detect





IC150

fact comes out before the tone and volume controls of the preamplifier approximately 20dB below the normal output level. The technical section discusses all performance parameters in considerable detail together with graphic illustrations. It includes the

characteristics of the tone controls, loudness control, high and low filters, inter-modulation distortion, etc. The manual also includes a reply paid application card for a three year warranty title, but does not describe what is covered. Presumably this three year warranty title extends the normal 90 days cover

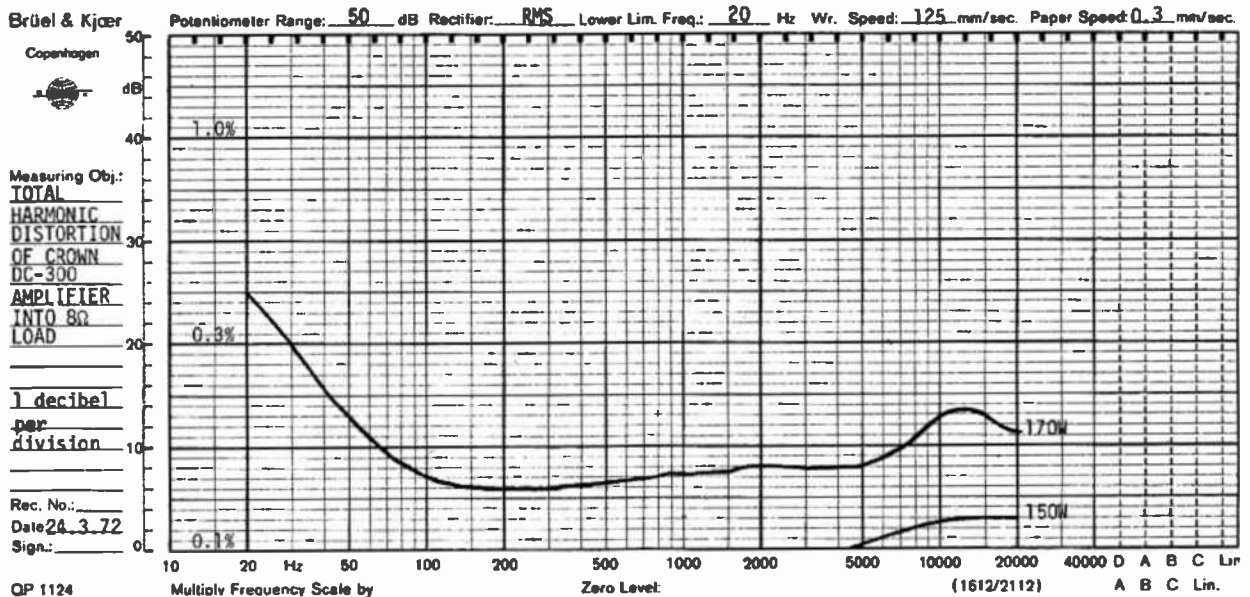
to three years with certain conditions. At a recommended selling price of £128.00 the Crown preamplifier is certainly not the cheapest on the market, but it is the only preamplifier that we have seen whose harmonic distortion and inter-modulation distortion was equal or better than our measuring systems.

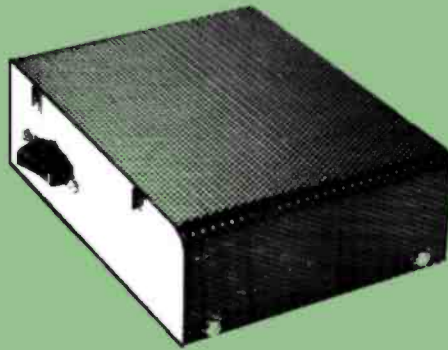
DC300

any difference between the Crown amplifier and the other good quality amplifiers. The tests were conducted with the same program source and

the same speakers so that the only change in the system chain was the amplifier. With a power frequency response from DC to 35kHz, this amplifier is basically designed for laboratory and control system operation and, in fact, does not include

speaker selection facilities. More exacting requirements are necessary in certain industrial applications and, in this respect, the Crown amplifier is most certainly the best we have seen.





A major failing of most car burglar alarm systems is that the driver must take action to set them. Many drivers forget. Here is one that is virtually automatic, and is simple to install as well.

AUTOMATIC CAR - THEFT ALARM

also protects trucks,
boats & caravans

Some months ago an organization that we know received a car burglar alarm for evaluation. One day someone forgot to switch it on, and the car was stolen complete with the alarm.

Question. -Was this a good alarm system? In our opinion emphatically NO - for just as some people steal cars - others forget to switch on alarm systems.

And so the ETI car-theft alarm system is automatically set. This is achieved by incorporating a circuit that 'arms' the alarm system some 30 seconds

after the ignition is switched off.

The alarm is triggered by any drop in the battery supply voltage caused by an increase in loading on the vehicle's electrical system. Thus if a door is opened, this will activate the interior light, and the increase in electrical load will trigger the alarm.

This operating principle simplifies installation, for practically all vehicles have courtesy lights with actuating

switches installed in at least two doors - and it is fairly easy to install further switches in the rear door pillars if required. Both the boot and under bonnet areas may be protected in a similar manner -indeed many vehicles have lights already fitted in these areas, if not, it is a simple matter to incorporate them into the circuit.

Remember that these lights must be switchable at all times - not just when the ignition is on.

The alarm will also be actuated by anyone pressing the brake pedal -or if a light is fitted -by opening the lid of the glove box.

DELAY CIRCUIT

The delay circuit built into the unit enables the driver to leave the vehicle without triggering the alarm.

As the alarm is triggered by an *increase* in electrical load, any doors or other protected areas may be closed at any time before \)r after the end of the time delay period, providing the doors are initially *opened* before the preset time. The subsequent *decrease* in load as the lights are extinguished will not trigger the alarm.

In the initial design stage we considered incorporating a second time delay to obviate the need for any external re-entry switches.

But as this would allow a thief quickly to break into a parked car and steal goods from the interior before the alarm was energized, we decided to U6e an instantaneous alarm and an external re-entry switch.

AUTOMATIC CAR - THEFT ALARM

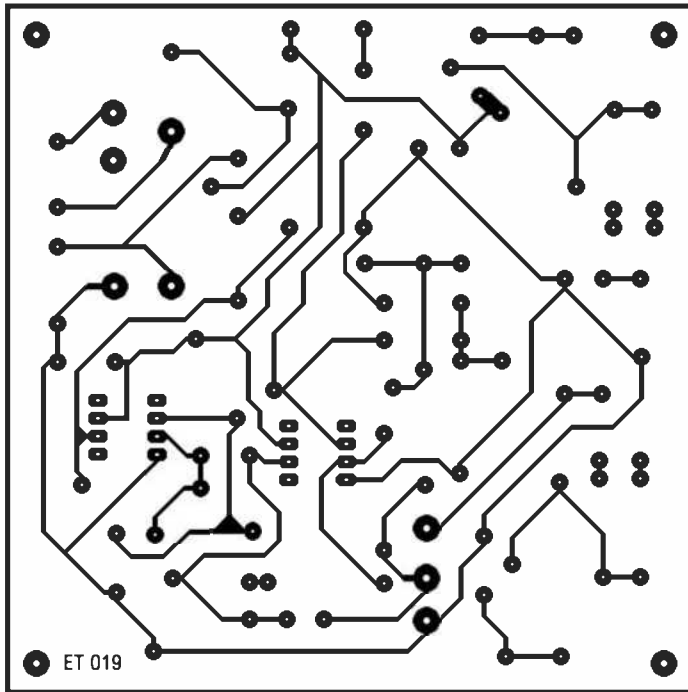


Fig. 1. Foil pattern of the printed circuit board, reproduced full size.

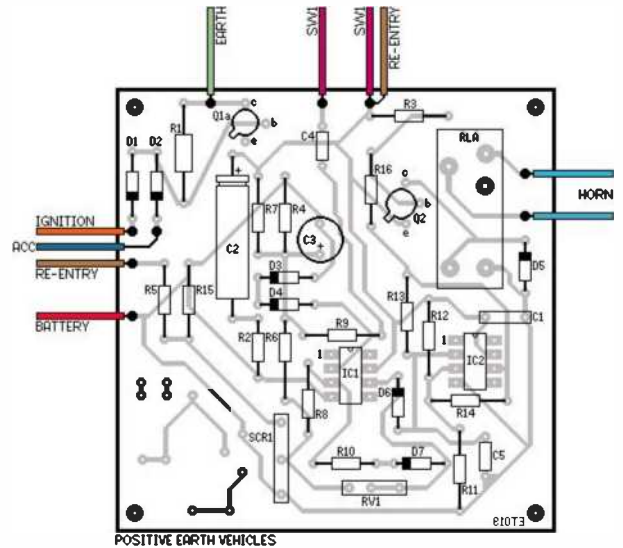


Fig. 2. Component layout (positive earth vehicles).

Electronics Today International understands that patent applications have been made for devices incorporating some of the features outlined in this project. Whilst there is nothing legally preventing people from constructing this unit for their own use, companies intending to manufacture the unit commercially are advised to consult a patent attorney.

In the Metropolitan (London City) area alone, nearly 10,000 cars a year are reported as stolen and not recovered, and 30,000 cars 'taken unauthorized' (Scotland Yard's term for cars stolen but recovered within a month). Theft of motor vehicles and or their contents is one of today's most prevalent crimes:

What can one do to protect one's own vehicle and its contents? The Police advise the following precautions:

Close all windows, lock all the doors and take your key with you when you leave the car,

Never leave valuables such as clothes, cameras, or radios on seats or anywhere visible within the vehicle.

Avoid loading valuables into your car in public, for a thief may be watching.

Do not leave any papers of identification, such as Driver's License, Registration papers or private correspondence within the car. At least don't keep them in the glove box.

Avoid parking in isolated places. If you have no garage, try to park under a street lamp, or in a lighted area.

Record the serial numbers of your engine, car body and car radio somewhere other than in your car. This data will considerably assist the Police in identifying your vehicle. If you leave it in the car, you are providing the thief with the support of the claim that the car is his.

Promptly report anyone loitering near or trying the door handles of parked cars.

Leave only the ignition key with the attendant when leaving car in a garage where the car is parked for you.

Install a steering lock and or alarm system. (Legal regulations in UK have required compulsory fitting of steering locks in cars, manufactured since April 1971).

In the alarm system shown here, once the alarm has been de-activated by the external key, it remains de-activated until, the ignition key is switched on. It is then automatically canceled.

Bear in mind that the re-entry switch merely inhibits the alarm circuit. The unit is actually switched off as the ignition is switched on.

It is quite feasible to interconnect the re-entry key with the main door locking mechanism. Police statistics show that it is very rare indeed for a car to be illegally entered by using a door key. We have equipped one of our staff cars in this fashion and the system has proved both reliable and practically impossible to misuse - for the alarm is 'armed' by switching off the ignition, and reset by using the door key to enter the car in the normal way.

Alternatively a re-entry switch, may be located on a body panel, or other convenient place.

A separate switch is built into the alarm unit to de-activate the system whilst the vehicle is being serviced.

The circuit is arranged so that once the alarm has been triggered it cannot be de-energized by either the re-entry or de-activating switches. It can only

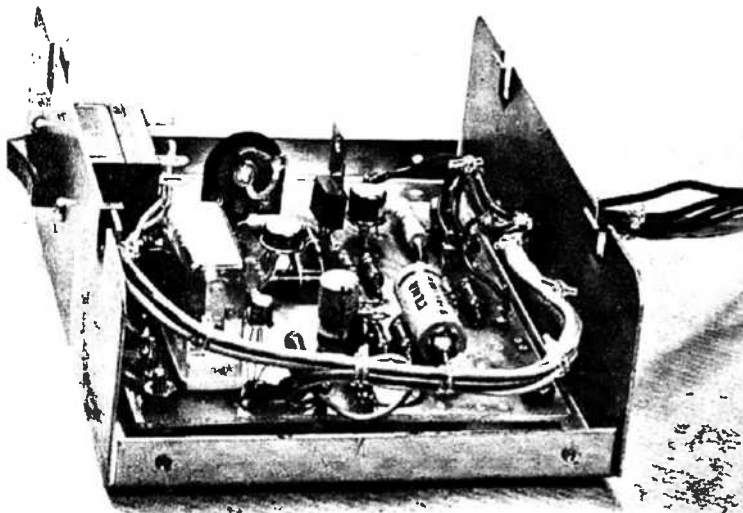
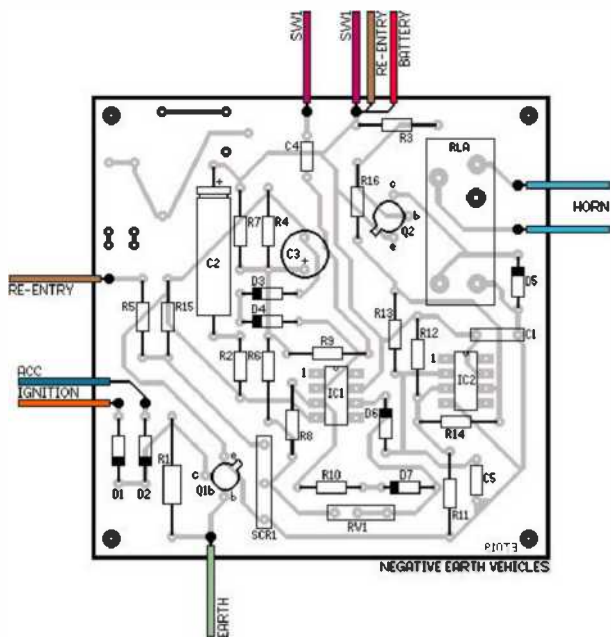


Fig. 3. Component layout (negative earth vehicles).

be reset by switching on the ignition. The unit has been designed for vehicles with 12V electrical systems and by including or excluding a number of components (marked clearly on the circuit diagram), it can be used with either positive or negative earth electrical systems. It is not possible to use this alarm circuit with six volt electrical systems.

CONSTRUCTION

By far the simplest way to assemble this

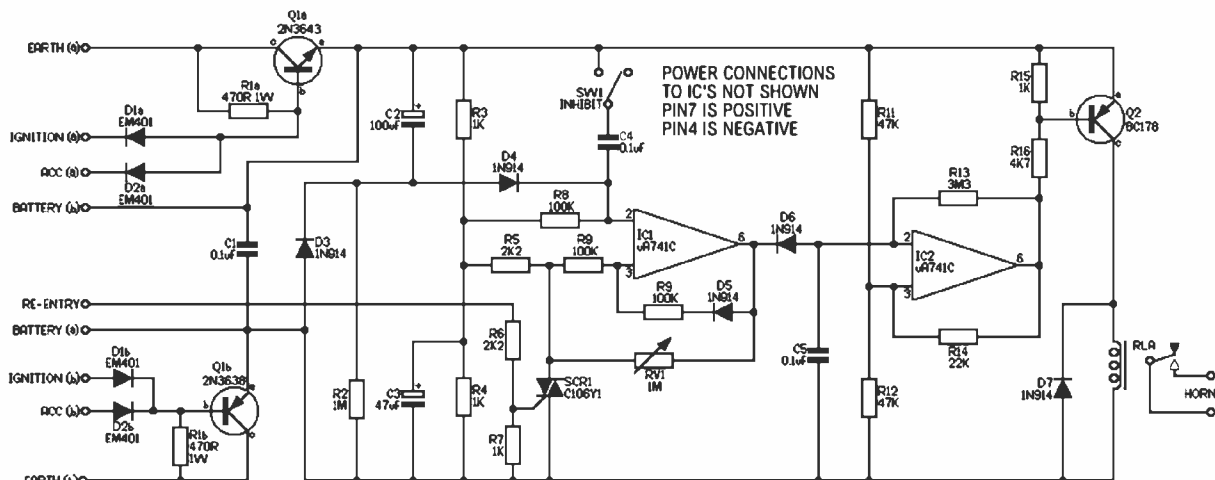
unit is to mount all the components on the printed circuit board (the foil pattern of which is reproduced full-size in Fig. 1). The same board is used for both positive and negative earth systems.

Figures 2 and 3 show how the components are located on the board. Note that Fig. 2 shows the component layout for positive earth vehicles, and Fig. 3 is for negative earth vehicles.

The circuit diagram of the complete unit, shown in Fig. 4, illustrates the

difference between the positive and negative earth systems.

When assembling the board observe carefully the polarity of the electrolytic capacitors and the pin connections of the operational amplifiers and transistors. Check all soldering for dry joints, or for drops of solder that may be shorting across any tracks. Also check that all components are rigidly mounted and that no leads are touching. Re-check all connections to the operational amplifiers. Set



COMPONENTS AND CONNECTIONS MARKED (a) ARE FOR POSITIVE EARTH VEHICLES ONLY. COMPONENTS AND CONNECTIONS MARKED (b) ARE FOR NEGATIVE EARTH VEHICLES ONLY.



Fig. 4. Circuit diagram of the complete alarm unit.

AUTOMATIC CAR - THEFT ALARM

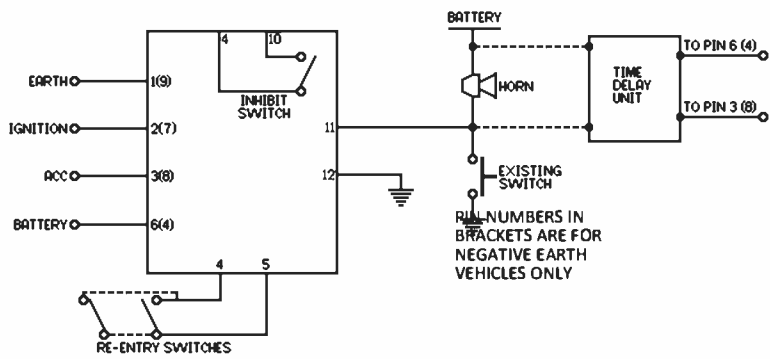


Fig. 5. This drawing shows how the alarm unit is connected into the vehicle's electrical system.

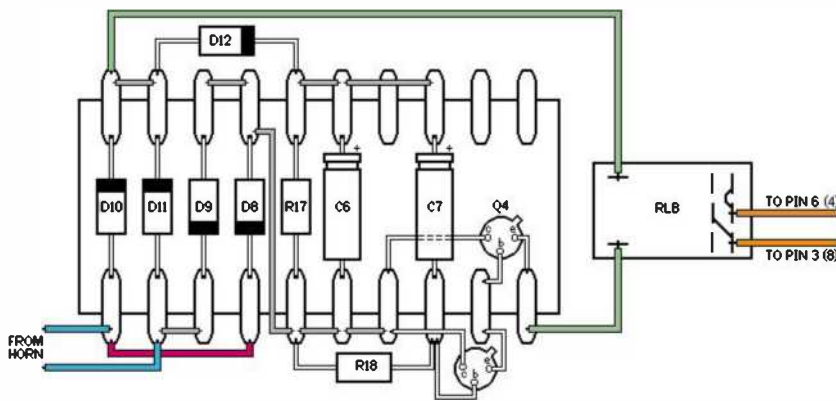


Fig. 7. Constructional details of circuit shown in Fig. 6.

potentiometer RV1 to maximum resistance.

INSTALLATION

The completed unit should be installed out of sight, but in a fairly accessible place to enable the unit to be disabled when the vehicle is in for servicing.

Ensure that the alarm unit has been built to the correct polarity for the vehicle and that the electrical system is 12 Volt.

Solder leads onto the pins provided on the alarm unit and long enough to reach the points indicated on the installation drawing (Fig. 5).

Mount the alarm unit in the chosen location and run the wiring to the positions indicated on Fig. 5.

As explained earlier, the external re-entry switch, can with a little ingenuity, be built into the existing door locking mechanism. But make sure that the switch is operated only by the key and not when the door is opened from the inside.

If an external key switch is used it should either have a momentary contact mechanism (or if a normal type of switch is used it may be

momentarily turned on, then off again).

(If the vehicle has any fiberglass or alloy panels a reed switch may be used for the external reset function. Just mount the reed behind a convenient panel and actuate it externally by a small bar magnet).

As the unit is operated by a momentary drop in battery voltage, caused by lamps being energized, it is essential that all globes be maintained in working order. One advantage of this system is that any fault in the triggering mechanism is immediately obvious.

The function of the potentiometer RV1 is to provide a sensitivity control. During the early development of this unit we were plagued by false alarms at intervals of a few hours. This was finally traced to the electric clock

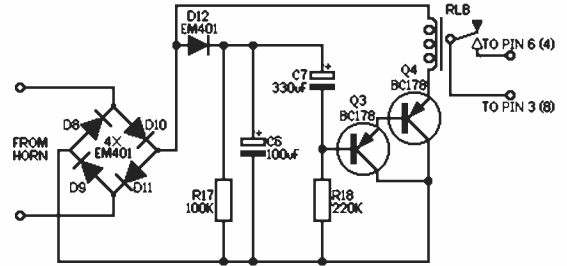


Fig. 6. This (optional) unit switches off and resets the alarm system after a preset time.

PARTS LIST ET305

RESISTORS

R1	470R 1W 5%
R2	1M
R3,R4,R7,R15	1K
R5,R6	2K2
R8,R9	100K
R10	33K
R11,R12	47K
R13	3M3
R14	22K
R16	4K7
RV1	1M preset potentiometer

CAPACITORS

C1,C4,C5	0.1uF 100V
C2	100uF 16V electrolytic
C3	47uF 16V electrolytic

SEMICONDUCTORS

IC1,IC2	uA741C 8-pin
SCR1	C106Y1 or similar
Q1a	2N3643 transistor (positive earth)
Q1b	2N3638 transistor (negative earth)
Q2	BC178 transistor
D1,D2	EM401 or 1N4001 diode
D3,D4,D5,D6,D7,D8	1N914 diode
RLA	12V coil 1 c/o 6A relay

MISCELLANEOUS

SW1	s.p.s.t. toggle or slide switch
	Metal Case

which had a mechanism that was electrically rewound at regular intervals! If this occurs then just back off RV1 meanwhile ensuring that the unit functions correctly when triggered in the normal way.

The vehicle's existing horn may also be used as the alarm horn - however it is well worth while installing a separate horn specifically for the alarm function. If this is done it should be mounted in an inaccessible position and the associated wiring carefully concealed.

Whilst not included in the basic alarm unit we have also shown a circuit (Fig. 6.) that will switch off the horn alarm at the end of a 90 second period. The unit then resets automatically and will be re-activated if any further attempt is made to re-enter the vehicle.

HOW IT WORKS

The alarm circuit is best considered as a number of separate interconnected units. These are:-

1. Power supply.
2. Detector.
3. Initial time delay.
4. Inhibiting network.
5. One cycle oscillator.
6. Output stage.
7. Maximum alarm-time unit (optional).

POWER SUPPLY

For vehicles with positive earth systems, the power supply is formed by Q1a, D1a, D2a, R1a and C1. (Components with suffix 'b' are used in the negative earth version.)

With the ignition key in the ACC., on, or start positions, power is supplied to resistor R1a via D1a or, D2a. If power is supplied to this resistor, Q1a is turned off and no power is supplied to the alarm circuit. When the ignition key is turned to the off position no power is supplied to R1a and so R1a turns on Q1a and power is applied to the alarm circuit.

The reason for taking power signals from both the ignition coil and ACC. positions is that in many vehicles all secondary electrical loads are disconnected in the start position. This would otherwise cause the alarm to operate whilst starting the car.

DETECTOR CIRCUIT

This is primarily an operational amplifier (IC1) with differential inputs. The inverting input (-ve) is Pin 2, and the non-inverting input (+ve) is Pin 3. If the input to Pin 2 is more than four millivolts higher than Pin 3, the output (Pin 6), will be within two volts of the negative supply rail. If Pin 2 is four millivolts, or more, lower than Pin 3, the output at Pin 6 will be within two volts of the positive supply rail.

A common centre tap, derived from R3 and R4, is used for both inputs. The voltage at the non-inverting input (Pin 3) is modified by feedback from the output, (Pin 6).

When the alarm is in the non-triggered state the output of IC1 is in the low state and the voltage at Pin 3 is between 5mV and 1V lower than the voltage at Pin 2 depending on the setting of RV1.

If a negative pulse occurs on the supply rail, this pulse is coupled into Pin 2 by C4. Providing this pulse is greater than the bias on Pin 3, the output of IC1 will go high and will be held in this state by the action of the feedback loop.

If the de-activating switch SW1 is in the off position, the negative pulse on the supply rail cannot be coupled into Pin 2. This will prevent the alarm from being triggered, but will

not stop the alarm once it is triggered.

INITIAL TIME DELAY

When power is initially applied to the circuit, C2 charges via O4, RS and R2. The charging current through RS causes Pin 2 of IC1 to go higher than normal for the first 30 seconds, and during this time a negative pulse on the supply rail will not trigger the alarm. After 30 seconds or so, C4 is completely charged by R2 and has no further effect on the circuit.

INHIBITING NETWORK

To enter the car without triggering the alarm it is necessary to make a momentary contact between the two 're-entry' terminals. When this contact is made, SCR1 latches on and pulls the voltage on Pin 3 of IC1 out of the range of the triggering pulse. This circuit is inoperative if the alarm has already been triggered.

ONE CYCLE OSCILLATOR

This circuit causes the horn to pulse at one second intervals.

It is based on a second operational amplifier of a similar type to that used in the detecting circuit.

Increasing the value of R13 will decrease the pulsing frequency - and vice versa. If the output of IC1 is in the low state, the oscillator is inhibited and the output of IC2 is held high.

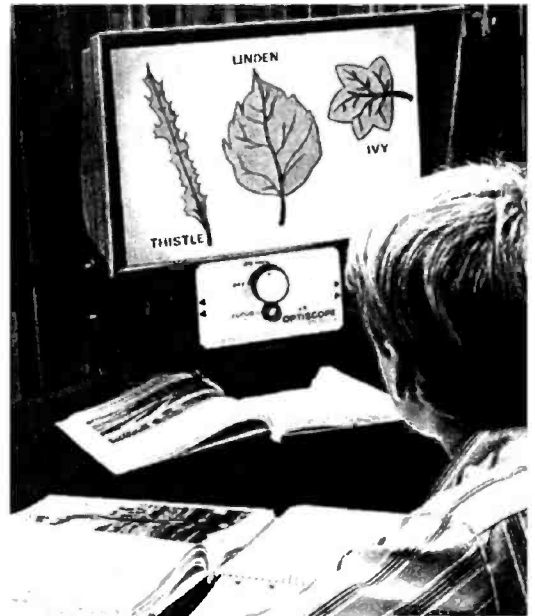
OUTPUT STAGE

The output stage is simply a relay driven by transistor Q2 which in turn is driven by IC2. Diode D7 prevents reverse spikes from the relay damaging the transistor.

MAXIMUM ALARM TIME UNIT

This is an optional unit and has not been included on the main printed circuit board. Details are shown in Fig. 6. The unit resets the alarm circuit after a preset time.

The unit is connected across the alarm horn which is energized when voltage is applied to the circuit. Capacitor C7 is charged via R18. Transistors Q3 and Q4 are emitter followers and carry the relay current. When voltage is high enough the relay closes and momentarily applies power to the accessories. This resets the alarm. The alarm will be re-triggered if the vehicle's electrical system is again disturbed. The circuit values shown will provide a time period of approx 1.5 minutes, but this may vary with different relay coil resistances and capacitor tolerance. Increasing R18 or C7 will increase the time period and vice versa.



AID FOR BLIND

A company in Long Island New Jersey has developed a new medical instrument which will enable millions of legally blind persons to read.

The instrument known as the Optiscope Enlarger, allows many persons with low-vision capability who may be considered blind by legal standards, to read ordinary books, magazines, newspapers, letters and other printed or graphic material. The instrument is said to have advantages over high-magnification eyeglasses and telescopic and microscopic lenses by permitting the patient to see a larger field and to have the reading material at a comfortable and natural distance.

The Optiscope Enlarger operates by projecting a greatly enlarged, illuminated image of the graphic material onto a built-in 9 x 14 inch screen which is made of a polarized material to reduce harmful glare. The instrument relies on a patented light source to intensify the amount of light reaching the retina thereby increasing the ability to see images clearly. It also displays clearly illuminated, magnified images in full colour or black and white.

The manufacturers are Opaque Systems, Ltd., Hempstead, Long Island, N.Y. U.S.A.

non-contact velocity measurement

Sophisticated laser techniques used to solve difficult measurement problems.

Despite dramatic advances in measurement techniques in the past decade, it is only quite recently that a method has been devised for non-contact velocity measurement of gas flow, and other 'non-cooperative materials. This problem has been overcome by a sophisticated laser Doppler technique developed in the UK by Dr Bohdan Watrasiewicz and Dr Michael Rudd.

Dr Watrasiewicz graduated in physics, obtained his M.Sc. on semiconductor technology and his Ph.D. at the Applied Optics Section of Imperial College. During his subsequent time at the British Aircraft Corporation, in Bristol, he became involved in optical and acoustic holography, laser interferometry, infrared, albedo and solar sensors, and imaging in partially coherent illumination.

In 1967 Dr Michael Rudd, then a Ph.D. research student from the Cavendish Laboratories at Cambridge, joined the team headed by Bohdan to develop a non-contacting measurement technique for studying flow velocities in fluid dynamics research. Within 18 months a laboratory prototype had been developed and Michael Rudd returned to Cambridge to continue his main research interest.

The potential of the method was realized at the time for many other uses could be made of the same basic instrument. However, BAC could not see a way to finance the market development and Dr Watrasiewicz joined Cambridge Consultants Ltd. (a year ago) to nurse the prototype through its development stage.

The move was a logical one for Cambridge Consultants have been developing skills and experience in sophisticated electronic techniques for several years.

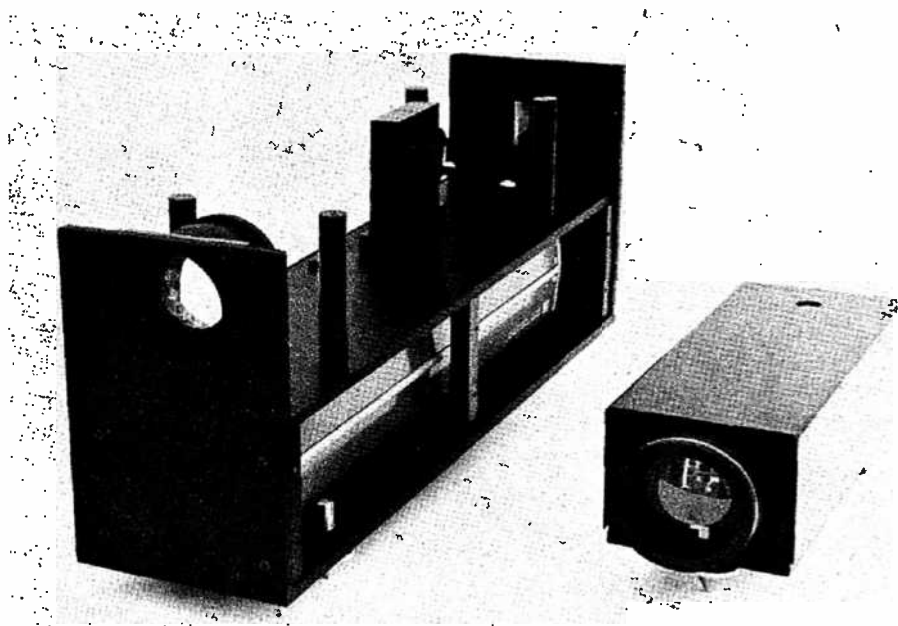


FIG. 1

BLACK BOXES

To the user, the Laser Doppler velocimeter consists of two black boxes (in both senses of the word) each having a lens as the only external feature. Coupled to both is an electronic unit displaying velocity in a digital readout form.

From the larger optical unit, (Fig. 1) radiates two pencil-size laser beams that cross in front of the unit. In use the second, smaller unit is placed to see the intersection spot either as a reflection from a surface or as 'transmission' through a fluid or transparent solid.

Setting up time is therefore minimal and special skills are not required. Once installed the instrument will measure over

a dynamic velocity range from 10.0µm/sec to 100m/sec using several preselected settings. The near future aim is to be able to handle Mach 1 velocities (about 300m/sec). For the instrument to operate, the surface or fluid needs some scattering particles but not many. The natural flaws in ordinary glass, or the dust specks on a mirror create enough signal for the system to measure velocity. It is this aspect that requires a complex electronic system, for the signal to noise ratio is extremely low.

Another feature of the system is its pinpoint resolution. It measures the average velocity of only 10-3mm³ of volume. For this reason alone it is of great value in fluid velocity profile and turbulence measurements.

The apparent simplicity is just a feature of good ergonomic design, for the inside operation is, in fact, a battle to extract high quality data from a rarely existing and noisy signal.

HOW IT WORKS

To explain the operation let us first consider the optical principles involved. The optical layout is shown in Fig. 2; some sections have been exaggerated in size for the sake of clarity.

A medium price, unstabilized, laser acts as a high brightness source of light. (The technique will work in principle, with any intense light source). The output beam is folded to pass through the special dual-prism. This acts as a beam splitter providing two parallel, spatially coherent beams. These two beams are focused to cross at the point of interest. As the two optical path lengths are identical and the beams coherent, an interference pattern is 'produced in the spot - as a series of light-dark rings similar to those produced by a pinhole which is illuminated by light. As the circle of intersection is fractional millimeters in diameter, only a few fringes are produced.

The photo detector picks up the scattered and unscattered light from direct transmission or reflection. If the surface or fluid is moving the total light received by the detector, due to the Doppler effect, has a frequency component dependent upon a magnitude of the velocity. When measuring by reflection from an opaque surface the angle of incidence of the detector is unimportant. For transmission use the reading is in fact the sine of the velocity so correction is needed unless the detector views at close to 90 degrees.

THE ELECTRONIC CIRCUITRY

The signal from the photo-detector is now electronically processed to provide a measurement of velocity. The received signal consists of short

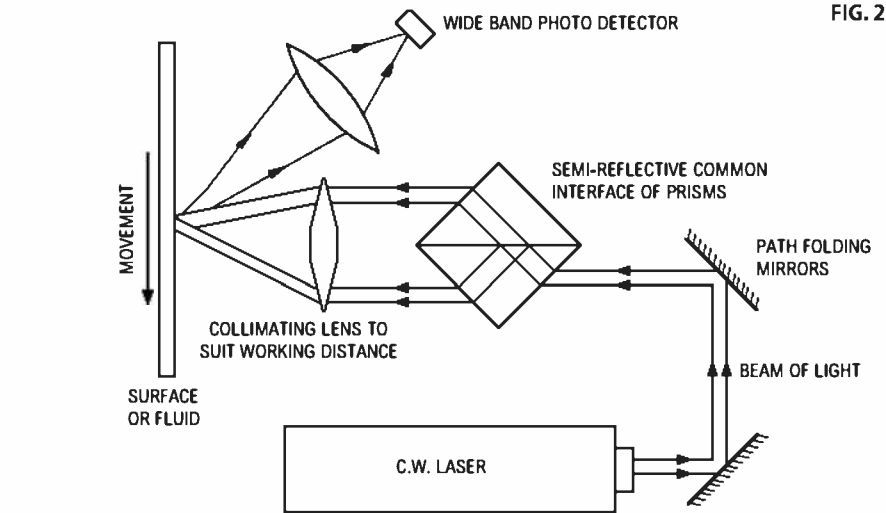


FIG. 2

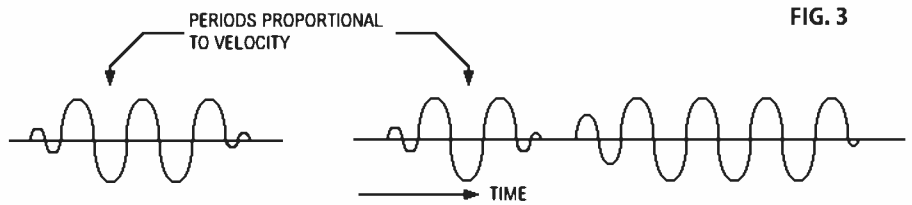


FIG. 3

bursts, or wave pockets (as shown in Fig. 3). Each burst contains the Doppler frequency of interest. They occur randomly with time and their length may vary from one to fifty cycles. These factors are determined by the scattering properties of the surface or fluid.

The task of the electronic unit is to measure the frequency of the cycles to a precision of better than 0.1%. To obtain such precision it is necessary to measure and average the period times for those cycles (many are not complete or sufficiently noise-free to be used) over a period of time.

A schematic diagram of the system electronics is shown in Fig. 4. The basic essentials are cross-hatched and will be described first. The first process - after initial preamplification at the photo-detector is an automatic gain control bandpass filter and amplifier. Their function is to reject the lower frequencies provided by the envelope of the bursts. Due to limitations elsewhere in the system this unit is mode-switchable to cover a series of 20:1 velocity ranges that cope with all speeds of interest.

The phase splitter provides a second

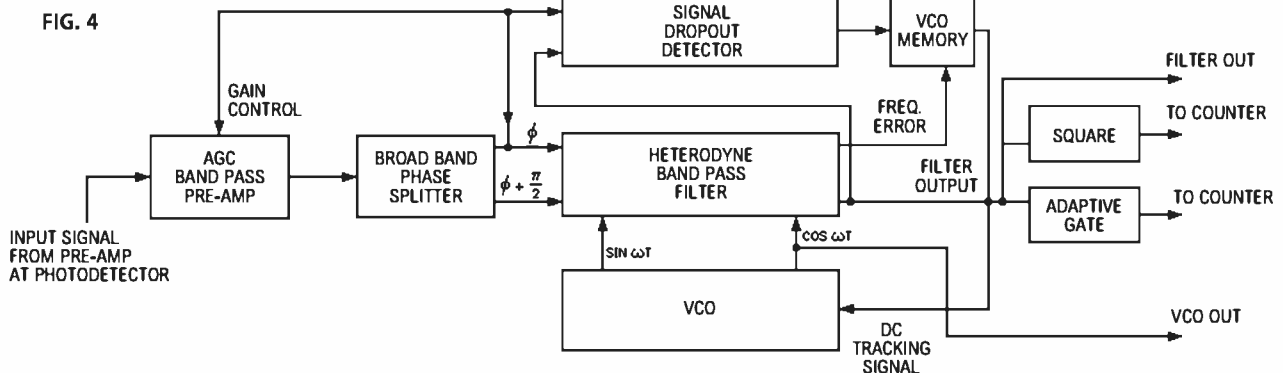


FIG. 4

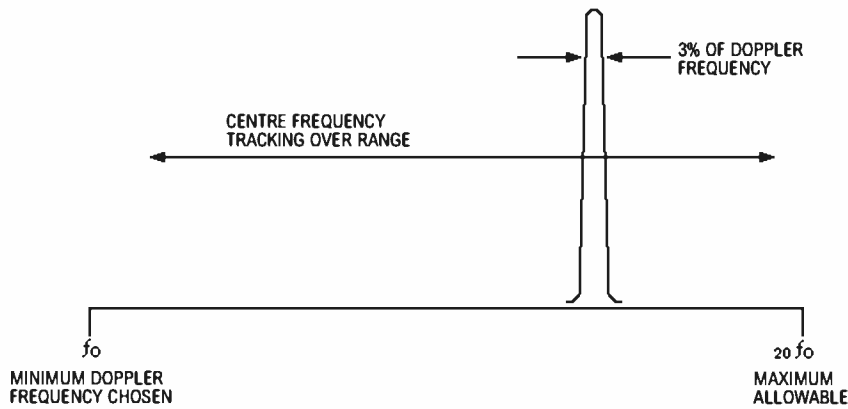


FIG. 5

non-contact velocity measurement

signal which is 90 degrees phase shifted from that of interest. This is a requirement of the heterodyne filter following.

In order to improve the signal noise ratio it is necessary to restrict the bandwidth of the signal used for counting. However the frequency can range widely due to variation in velocity. A band pass filter with a fixed center-frequency would thus have to be quite broad and therefore ineffective. For this reason the system has an automatic process that tracks a narrow bandwidth filter over the range selected. This concept is illustrated in Fig. 5.

The heterodyne box provides a detracting signal that controls the frequency output of the voltage controlled oscillator (VCO). It is unusual in that it provides only the wanted signal, there being no extraneous frequency sum-component that needs filtering, as is usual in most tracking filters. By this approach the quality of the Doppler frequency bursts are improved enormously.

The next stage is to square up the bursts and count the periods. However, as the bursts are short and may have incomplete start and finishes of cycles it is easy to see that a timer-counter will read falsely so the end effects are liable to provide errors of one part in 25. For this reason Cambridge Consultants have devised an adaptive gate unit which applies a test to see if a complete cycle has occurred. If it has the value is used. As some bursts may be only 3-4 cycles in

duration a criteria of calculation for greater than 2 is used.

Figure 6 shows a burst. At (a) the up-crossing of the trigger, the level is tested. If it occurs, the next zero crossing is recorded. The time is stored and if another half-cycle occurs at the end of the burst the two are utilised. This technique uses as much of the inherent signal information as is possible to enhance the precision period measurement of short bursts.

The counter also, is a little different from normal practice. If the gate of a frequency counter were actuated for a given interval in this system it would only indicate the total number of burst cycles in that line, not the period of the cycles. For this reason a pseudo-time scale is used in which the counter is controlled so as to be gated open for a given total period (operated by the squared cycles) rather than a continuously opened gate. Once the time period has expired the count is displayed giving the integrated period or average frequency which is a measure of velocity. Up to 90% of bursts may be rejected as unsatisfactory in which case the actual duration to make, say, a one second integration will be approximately 10 seconds.

The VCO output is made available. This is a reasonable, but not highly accurate, measure of average velocity for the oscillator tracks the Doppler

frequency. Also available in the commercial unit is an analogue velocity output for chart reading. The one common feature in all velocity measurement applications for the unit is the Doppler frequency. Different cases however, need velocity shown various units, so plug in boards are used to set up the output display as needed.

Although involved, the actual circuitry uses only a few printed-circuit boards and the entire electronics are housed in a standard 19 inch instrument case. Once designed and proven, the cost could reduce as common to many other areas of measurement, for example in Doppler sonar and structural resonance testing.

So far, orders include a unit for the British Iron and Steel Research Association (B ISRA) who assisted financially in the development of the electronics. They are to use the unit to measure the air-flow in the exhaust of a steel furnace in order to be able to compute the mass flow rate of waste products as a continuous process.

Another unit is to be used to measure the velocity of fine nylon fibre as it is drawn. This method lends itself because of the high accuracy and the small non-contacting probing volume.

The work will assist a better understanding of the drawing process.

Salford University have a unit for research into fluid dynamics of the air velocity around nozzles.

Other potential uses are to monitor water-flow over a range from a drop to thousands of gallons per minute, to measure velocity of "uncooperative" surfaces such as hot steel and plastics. It has also been suggested that this may be the answer to berthing supertankers and as a speedometer in high-speed marine work. At a cost of £4760 this is value for money if non-contact, high precision, pinpoint velocity measurements are needed.

TRANSDUCERS IN MEASUREMENT AND CONTROL

Part 5 of this continuing series will be published in our September issue.

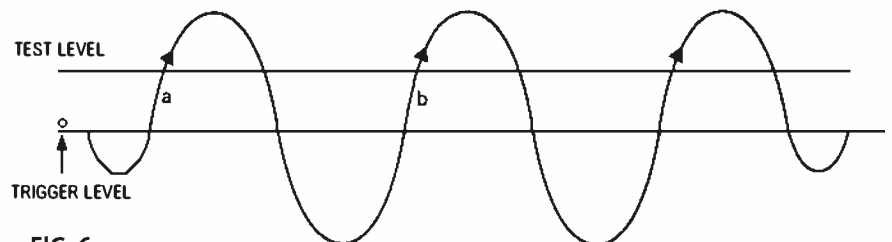


FIG. 6

BREAKERLESS AUTO IGNITION

Recent developments in solid state ignition.

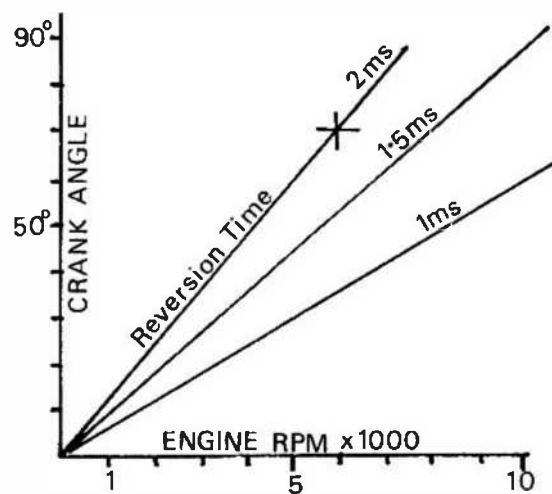
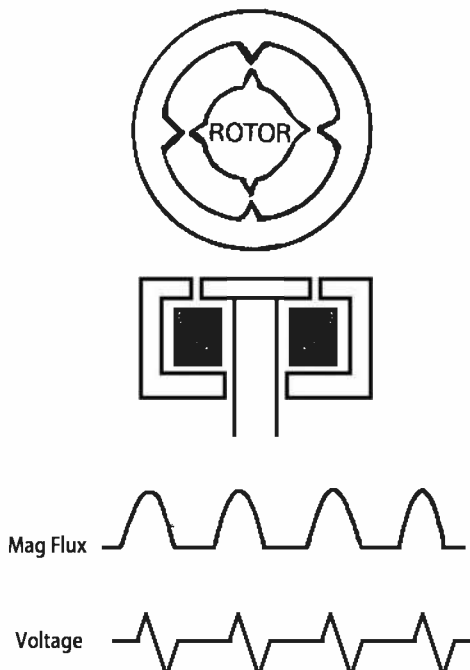
In a petrol engine, combustion process occurs in two distinct phases: the first being the delay period when a substantial nucleus of flame is built up with no perceptible rise in pressure, occupies a relatively constant time and calls for spark advance with increasing speed: the second one of rapid pressure rise, is of constant crank angle but not of constant time.

- Prof. R. Ricards, F.R.S.(1923)

Electronic ignition systems for internal-combustion engines have generally concentrated on substituting the ignition coil with electronic circuitry for generating the spark voltage. While this approach has its merits, it does seem to ignore the fact that the contact-breakers, still used to trigger the spark-generating

circuits on and off, require periodic maintenance, adjustment and replacement.

Truly maintenance-free breaker-less systems seem to be relatively less familiar. Two such systems are reported here - one of American origin and the other British. In both systems, the contact-breakers-which



normally trigger the ignition coil current are replaced with electronic or electromagnetic devices requiring little or no maintenance and giving certain other advantages as well, e.g.,

No need to optimise switching action for low or high speeds of engine revolution;

Duration of the "off" period of switching function not determined by the need for adequate contact separation and hence need not be so great;

No need to limit the maximum primary current in the ignition coil, and hence also the ignition system energy, since the current carrying capability of contacts no longer applies.

VARIABLE RELUCTANCE TRIGGER

The rotor, a magnetic head with four wedges projecting from its circumference, is the basis of such systems. As the four wedges come in line with, and move away from, the four wedges on the stator, the alternate rises and falls of pulse generate, in the trigger coil, voltage pulses of short duration.

The firing points should ideally be at the crossovers of the voltage waveform but, as it is difficult to

sense zero-voltage crossover, the trigger points are probably well down the negative going pulse.

These voltage pulses are used to turn off the ignition-coil primary current - and 'fire' the spark - by means of a monostable circuit which reverts, in a preset time, to the stable (on current) state. There is no precise control over the turning 'on' of coil-current again, ready for the next 'firing' point; the circuit, which is kicked off by a trigger like this, reverts to the stable 'on' state on its own and in constant time.

This reversion time is also the spark duration time and poses problems when it is fixed and not variable with engine speed. As shown in the graph, for a 2-millisecond 'burn' time, we would have a 70° 'burn' and a 20° crank dwell at 6000 rpm engine speed - but at a low rpm, say 50, the coil current would be turned 'on' again after 1.2° of crank rotation.

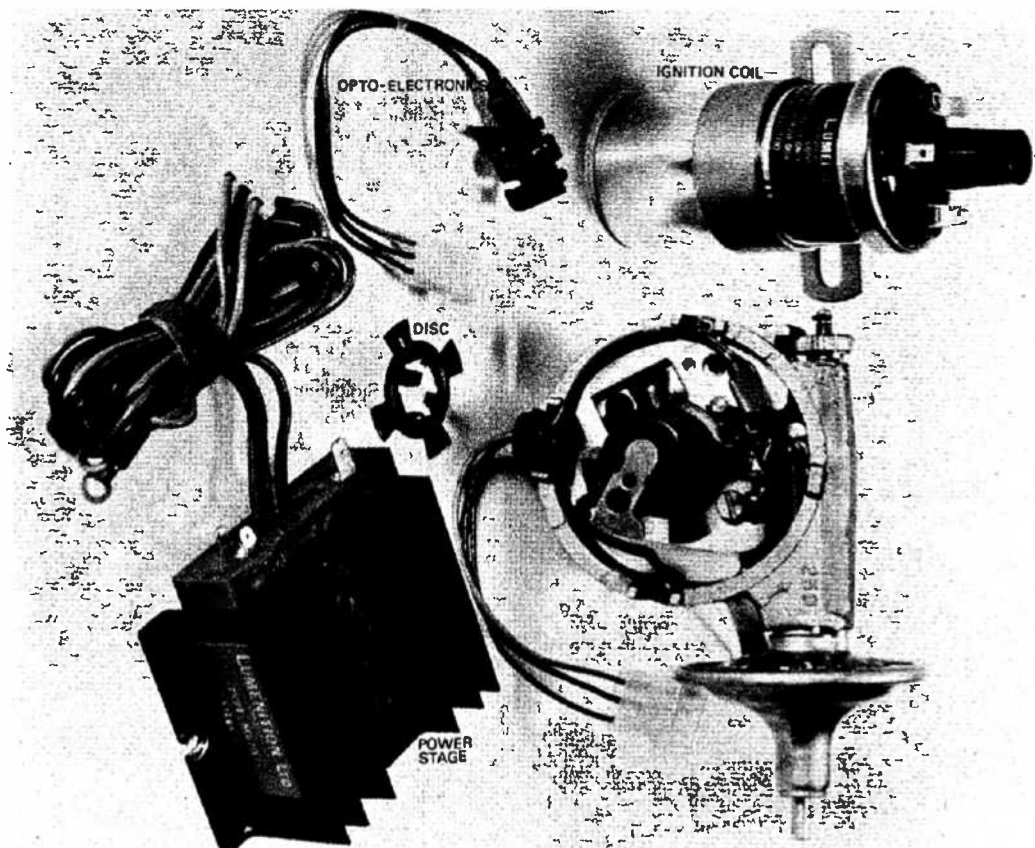
Clearly using a trigger of this type, the engine speed would have to be electrically monitored and the circuit revision time varied, say in steps by the insertion or removal of monostable timing capacitors at definite engine speeds - a very complex means of controlling the 'dwell' function.

Other demerits of such a system are: Weight of rotating members; permanent magnets tending to attract ferrous dust; relativity of flux in the system; low repetition rate; cannot be retro-fitted to existing vehicles; greater than desirable spark scatter; etc.

What is required, it seems, is a constant crank angle for spark duration, and to do this electronically.

'LUMENITION' SYSTEM

In 1969, a patented British system claimed to be the world's first breaker-less solid state opto-electronic system was developed and, in the next 18 months, was extensively researched and evaluated in the laboratories and on the road. The first conversion kits were marketed in April 1971 with claims which were fully justified in the experiences of several thousands of vehicle-owners as well as by independent trials conducted by the Royal Automobile Club of UK. The company, Lumenition Ltd. has recently marketed Mk 10 range of conversion units suitable for all cars fitted with Lucas 22D or 25D ignition distributors for 4 and 6 cylinder engines with negative grounded electrics. Lumenition's objectives for the system were: freedom from maintenance; dispensing with contact breakers and cams; inductive system permitting retention of the ignition coil in most cars and substitution of the coil in certain cars; 1 degree timing accuracy; minimum r-f interference



Lumenition system

Breaker-less Auto Ignition

simplicity of installation; low cost.

The inductive ignition principle was retained also because of its longer spark duration but design was concentrated in achieving the right amount of spark duration so that the spark is maintained continuously throughout the spark advance crank angle, i.e. 'burn' angle to equal spark-advance angle. To control 'burn' angle, both the firing point (switch off of coil current) and the spark-extinguishing point (switch on of coil current) should be controlled.

In the 'Lumenition' system, the

designed to prevent timing change due to line voltage variations or accumulation of dirt on the lenses. The final stage in the amplifier is a power transistor switching the primary current in the ignition coil.

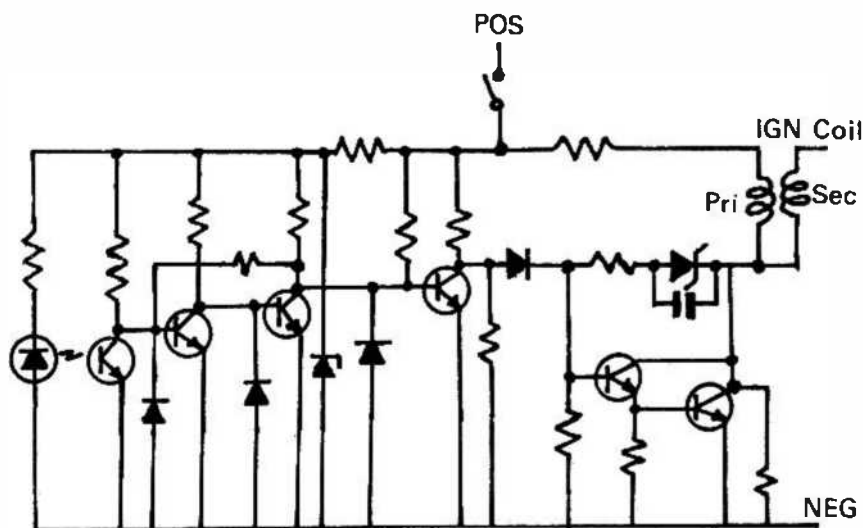
The ignition coil is a specially designed replacement item, dimensionally similar to the part it replaces, but with less primary and secondary turns; thus a higher primary current used and this, combined with the reduction in primary inductance, means that the coil operates to much higher engine rpm with very little fall off in secondary voltage

'Lumenition' system means to the average car owner in terms of maintenance and performance, as substantiated by extensive trials and user experience.

The distributor cap need never be lifted for contact adjustment or replacement. Timing is never out of phase for the lifetime of the engine, resulting in better sustained fuel economy and better acceleration at top speeds. There is virtually nothing to go wrong to upset the timing, no variation in timing overlap. The system, as supplied in kit form, is easy to fit.

FUTURE IMPLICATIONS

It should be obvious that the make and break opto-electronic item can be mounted anywhere in the engine where timing is obtained. This means, for example, that it could be



Lumenition circuit

triggering device is opto-electronic and consists of a Gallium-Arsenide semiconductor diode as the infra-red source and a silicon photo transistor as the detector. A segmented disc driven by the engine is interposed in the path of the infra-red beam; the segmentation is accurate to a 1/4 degree and controls both the firing accuracy and the 'dwell' angle thus an engine fitted with this system retains not only its original timing accuracy but also the timing of each cylinder relative to the others, for the lifetime of the engine.

The voltage applied to the Ga-As lamp is controlled by a zener diode, and its lens is designed to give no timing change in system operation even when 90% of radiation through it is obscured by dirt or oil.

The photo-detector forms the first stage of a bi-stable switching amplifier

and spark energy.

Spark duration is controlled to firing point accuracy of less than 1° crank, spark scatter is reduced to almost nil and dwell angle is precise and unaffected by variations in system voltage or ambient conditions.

The complete electronics is in the form of two thick-film integrated circuits, all of which could go into the distributor; alternatively, the power section may be mounted outside the distributor.

There are only four components to the system a simple steel chopper which clips over the cam, a thick-film hybrid IC which replaces the contact set, a power transistor heat-sink assembly and a special ignition coil similar dimensionally to the conventional coil.

USER EXPERIENCE

Let us look now at what the

immersed in oil in the overhead cam units or even in the sump taking the timing from the crankshaft. Tests with the opto-electronics immersed in oil have shown no deterioration of system accuracy.

Skew gears which normally drive the distributor shaft can be eliminated, and the segmented disc itself is light. This saves engine power by up to 15 BHP even on small engines - a boon to car manufacturers chasing HP to make up for losses in anti-pollution gadgetry. Considerable cost savings could accrue to manufacturers who decide to fit the system as standard equipment.

With very little extension of circuitry, the system can also be engineered to fit into computerised fault-finding and driver-warning systems which look like becoming standard features in cars.

DESOLDERING MADE SIMPLE

Removing miniature components from printed circuit boards can be difficult - if you don't know how. Here, A. J. Lowe shows a cheap and simple way to do it.

Desoldering tools tend to be messy, not easy to use, and expensive especially for the infrequent user. The technique described here is clean, simple, quick, and cheap, ideal for getting semiconductors off those disposal computer boards, or for repairing printed circuit boards.

You need to buy some 1/8 inch copper braid as shown in Fig. 1. It costs about ten pence a yard and can be obtained from electrical trade houses - preferably those who sell winding wire. Buy a few yards and cut it into lengths of about a foot.

Next, this braid must be fluxed, and the best way of doing this is with rosin. Put a few lumps of rosin (from a hardware store) in a jam jar and half fill the jar with methylated spirit. It takes time to dissolve, but, when it has dissolved you have a first rate flux lacquer for printed circuit boards, as well as a flux for this desoldering process.

Put your short strips of braid in the Jar and soak them in the rosin solution. Extract them, drain them into the jar and put them aside to dry.

Now, you have ideal solder absorbers. The copper braid will not tarnish as it is coated in rosin, and it will suck up solder as it is fluxed right through.

To desolder, first clean your soldering iron bit, so that there is no excess solder on it to be absorbed by the braid. Then hold the braid near the joint to be desoldered, and heat the braid near the end, with the iron. After a few seconds, press the braid on to the joint with the iron and, almost immediately, the solder is sucked into the braid. See Figure 2. This happens so quickly that there is little danger of overheating semiconductors. Device leads are left so free of solder that they can be raised with a knife and the

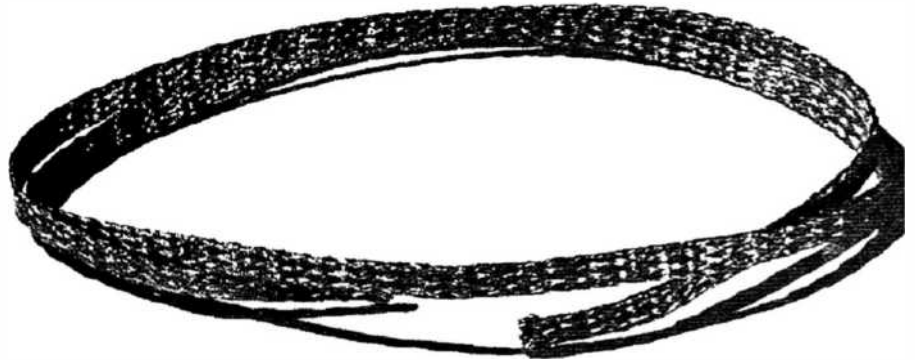


Fig. 1. The 1/8 inch copper braid.

device removed from the printed circuit board. When the end of the braid is full of solder just snip it off and discard it.

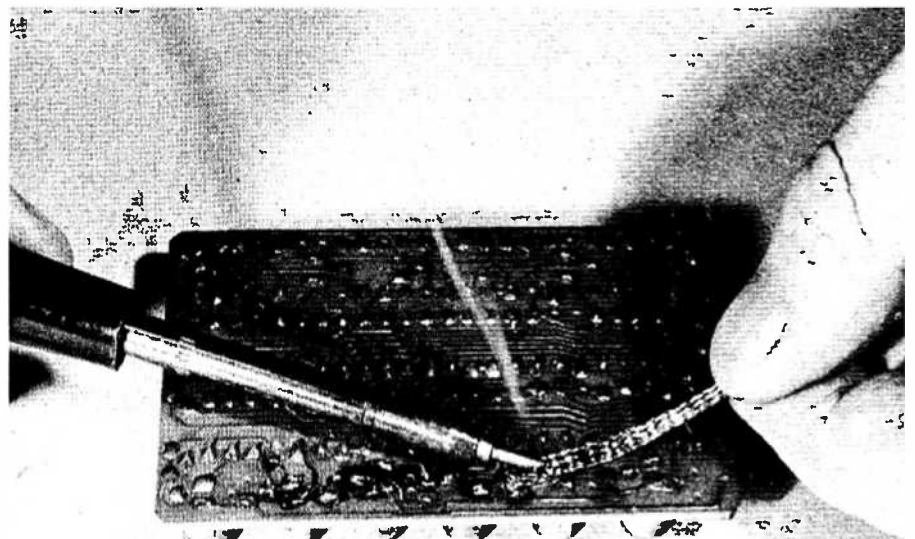
If you are desoldering devices whose leads have not been bent over at the back of a printed circuit board, but pass straight through, first pierce a hole in the braid with a scribe and then surround the device lead with the braid.

This method with braid works very

well on desoldering tag strips where several leads are almost knotted into the tag. It's possible to remove so much solder that the joint can be taken apart.

Before you start desoldering those bargain semiconductors from computer boards, have a practice run on the resistors you'll soon get the knack.

Fig. 2. Desoldering a computer board.



PART 4

TRANSDUCERS IN MEASUREMENT AND CONTROL

In this article Peter Sydenham M.E., Ph.D, M. Inst. M.C. discusses ways of measuring tilt and alignment.

The force of gravity causes liquids to settle with a horizontal surface and suspended objects to hang in a vertical direction. These two natural reference directions are used extensively in engineering construction, e.g., in the erection of buildings and bridges; in agriculture where drainage is vital; in road and railroad building to obtain smooth curves, and in the workshop when flatness or straightness is needed. The plumb line provides a perpendicular to the horizontal plane so each may be derived from the other.

The earth, being roughly spherical, has a curved level surface with the verticals being at different angles to each other at different locations. For most engineering structural requirements, however, it is adequate to regard the area of surface involved as flat. This curvature is roughly one part in 300,000 (0.1 mm in a 30 m distance)

and this is only relevant in the construction of the most precise engineering structures, such as large nuclear accelerators.

If these phenomena are studied more closely it will be found that the liquid surface does not smoothly vary around the Earth in a spherical shape but. takes up an undulating surface. This is the result of the varying gravitational forces brought about by the different distribution of mass in the Earth. The surface varies periodically in direction by a small amount, this being the result of the influence of the Sun and Moon which cause shape changes in the Earth. In geophysics these changes in the level surface or the vertical are monitored with great sensitivity in order to study the behavior and composition of our globe; There are, therefore, many disciplines needing

devices that can produce an electrical signal when deviations from the horizontal or vertical occur. In general, engineering inclinations need only be resolved to around an arc second at the best (but with a dynamic range of degrees). whereas in geophysical measurements the need is for the utmost in resolution with a range rarely exceeding arc seconds.

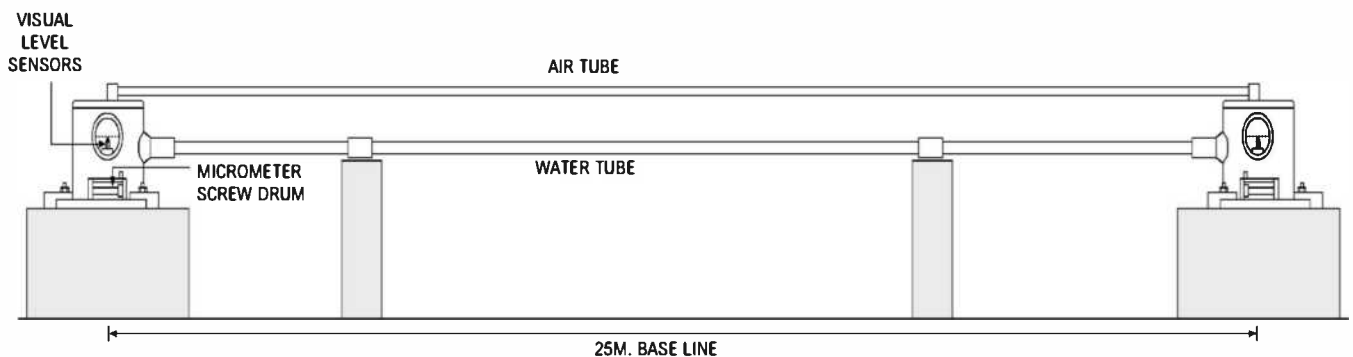
Another group of closely allied devices are those for measuring alignment. As many of these have leveling devices inbuilt, it is appropriate to discuss them together. An alignment device is capable of yielding measurement information about the degree of displacement of a point from a chosen line or plane surface, but usually there is no provision for deciding where that point is along the line.

TILT TRANSDUCERS

Liquid Level References

A large percentage of tilt transducers make use of water or mercury pools which are interconnected with a

Fig. 1. Side view of a water tube tilt meter.



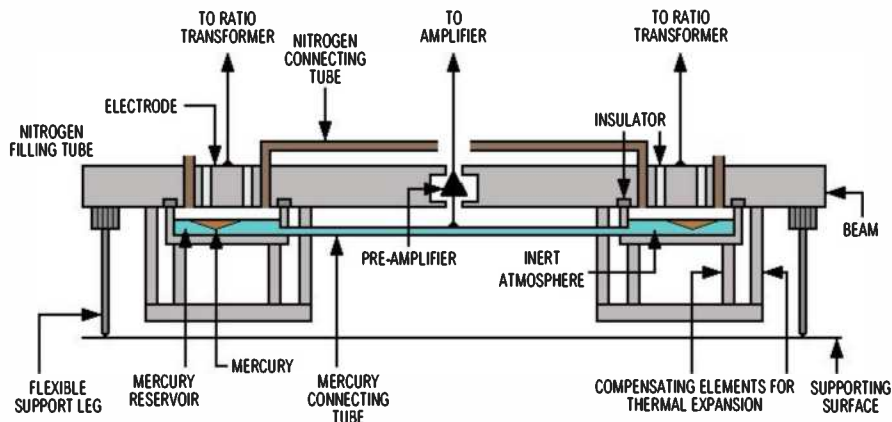


Fig. 2. Cross-section of a mercury cistern tilt meter.

communicating tube. As tilt occurs the pool heights at each end vary relative to their container. The changes in height are monitored with micro-displacement devices such as were described in Part 1. Tilt is basically an angular measurement, so it is apparent that the further the containers are apart, the greater the displacements resulting. A schematic view of one of a few water-tube tilt meters installed in New Guinea for crustal movement research is shown in Figure 1. This unit does not have automatic recording but relies upon visual observation of a needle that is manually driven upward with a calibrated micrometer-screw to a position where its point just breaks the surface. Using the microscope viewing units provided to see when the surface is broken, it is possible to resolve a $3\mu\text{m}$ difference in height in the 25 m base line used, giving it angular discrimination of 10^{-7} radians. Another application of the water-tube method is for monitoring the settlement of the structures of generating plants in power stations. It is not convenient to climb over the plant in order to read the individual levels.

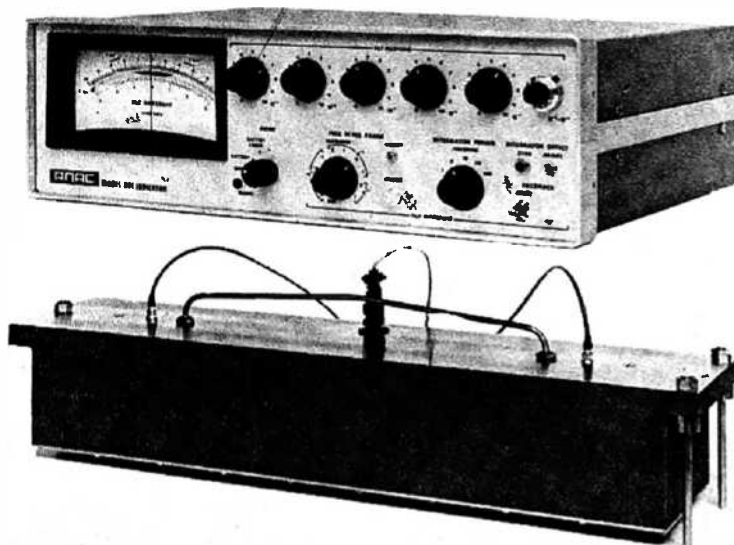
To avoid this a system is used that enables the operator at a central point to pump up the level at each remote container in turn, until an electrical circuit is made by the liquid touching an electrode. He then reads off the level at that point from his end. The leaning tower of Pisa is instrumented with a liquid circuit around its base. Transducers operated by floats give the tilt of the tower relative to the horizontal datum provided by the liquid. Diametrically opposite gauges provide differential signals that reduce errors due to level changes as the liquid heats and cools or evaporates. The largest type of liquid level measurement must be the sea-tide gauge. A common method uses a float driving a rotary transducer via a chain or wire. The units act with less than unity gain, for the amplitude of the movement is large. To obtain a well-conditioned response from the float, it has been found necessary to use a hydraulic filter consisting of a vertical tube containing the float with small entrance and exit holes that damp the rate at which the water can enter or leave the tube. This acts as a low pass filter removing the high frequency components.

The main difficulty with an extreme sensitivity water system is how to sense the surface position. If greater resolution were available in the surface detection, the base-line could be shortened reducing the size of the equipment. By using a conducting liquid the liquid itself can act as a common electrode in a differential capacitance sensing arrangement (see Part 1). For this reason several mercury-cistern tilt meters have been developed that have extreme sensitivity with only centimeter baselines. A cross-section of the A.N.A.C. instrument originally developed at the University of Queensland, is shown in Figure 2. Above each mercury pool surface is an insulated electrode, these and the mercury form part of a bridge-circuit which is completed by an electronic unit using ratio transformers. The unit, illustrated in Figure 3, can measure angular changes as small as 10^{-9} radians. This is two orders of magnitude better than the much longer water tube tilt meter described above.

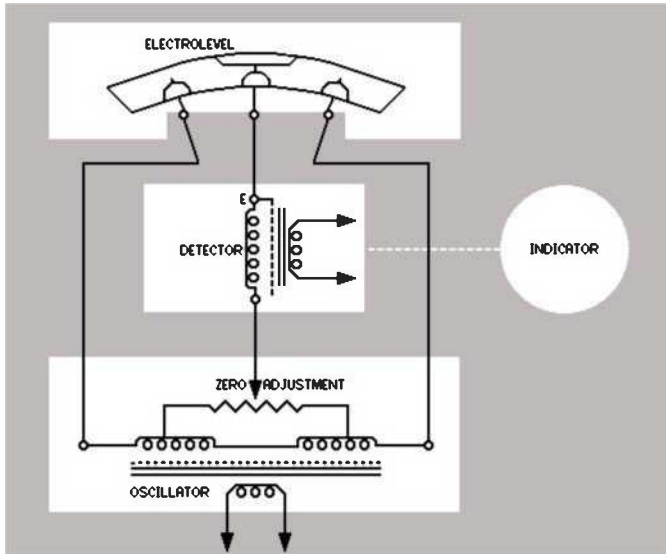
Not all tilt has to be measured with such exactitude. In building construction, for instance, the requirement is for only millimeter definition in metre distances. The familiar spirit level is the oldest form of liquid level in general use. In this a gently upturned curved vial contains a liquid in which a small air bubble is trapped; the bubble attempts to remain on the top of the curve. Sensitivity increases as the curvature flattens, and a good quality engineer's level can discriminate tilts from the horizontal of micrometers in a metre.

The bubble level has been automated by the British Aircraft Corporation. This unit has platinum electrodes set into the glass and the unit is filled with a conducting alcohol solution. As the bubble moves in the vial, the electrical resistance between the central and outer electrodes varies and the movement can be sensed using an AC bridge as shown

Fig. 3. Mercury-cistern tilt meter with electronic unit.



TRANSDUCERS IN MEASUREMENT AND CONTROL



bridge as shown in Figure 4. The most sensitive version can sense fractional seconds of arc with a settling time of less than a second.

Occasionally there is need for two-axis level readout and for this the bubble method has been employed by NASA personnel in a different form. A circular bubble, forms a lens that modifies the distribution of light passing through it. A reflecting mirror is placed above the bubble. Four photocells, used as position-sensitive detectors, monitor the reflected light distribution providing readout of angle in both directions (Fig. 5).

If the depth of the liquid is great, such as in the sea, changes in height can be monitored indirectly using the change of pressure head above a point deep down. In oceanographic research at the Horace Lamb Centre in Australia, the amplitudes of tides and swell are measured this way using a recoverable capsule which is placed on the ocean floor. In this a pressure gauge transducer, recorder and power supply

Fig.4. (above) Electro-level tilt transducer using a vial filled with a conducting fluid.

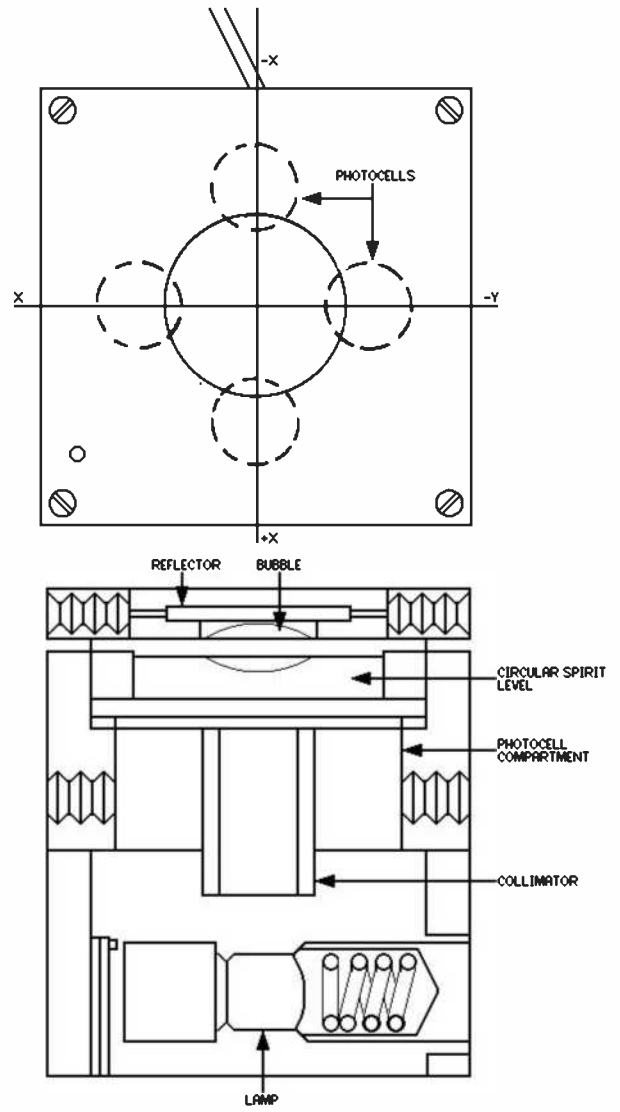


Fig. 5. (right) The N.A.S.A. biaxial tilt transducer. This is capable of 15 arc seconds resolution in each of the axis of tilt.

PENDULUM REFERENCES

As mentioned earlier, the vertical direction is directly related to the horizontal so pendulum devices can be used to measure tilt of the horizontal. Many tilt-meters make use of pendulums. The most straight forward type of pendulum is a mass hanging on a light suspension. Micro-displacement

transducers are used to determine the position of the pendulum relative to the mounting frame. If size is not important, the pendulum can be as much as a metre or more in length to increase the sensitivity. Several tilt meters are available commercially (at a price of many thousands of dollars) that can be lowered into a vertical bore-hole. In this application, liquid level devices would not be suitable due to the limited size of hole available. It is most important that the pivot point of the pendulum is precisely defined, for the angle of tilt is inferred from the displacement at the lower end together with length of the pendulum. The forces needed to deflect a pendulum are extremely small. For this reason feedback measurement is often used in which the pendulum position is restored by electromagnetic means in a force-balance technique. This helps to ensure that the measuring transducers are always in the same force-exerting position. Bore-hole tiltmeters often measure the tilt of two perpendicular directions.

If the micro displacement device is extremely precise, as is possible with well developed capacitance

Fig. 6. An inductively-sensed pendulum tilt-meter being used with an alignment telescope to provide a horizontal line of sight.

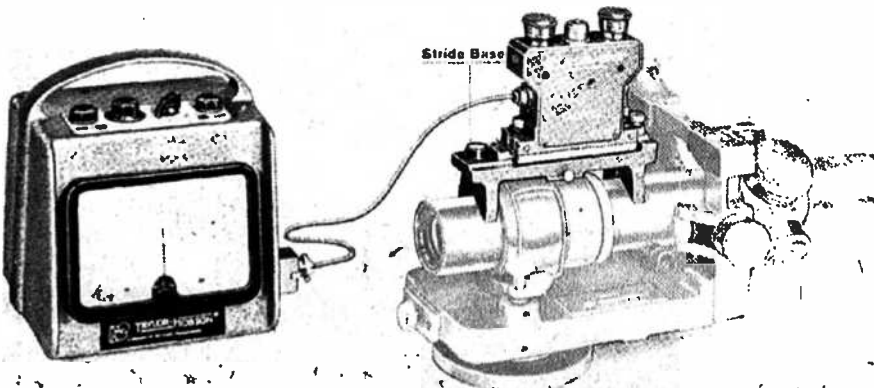
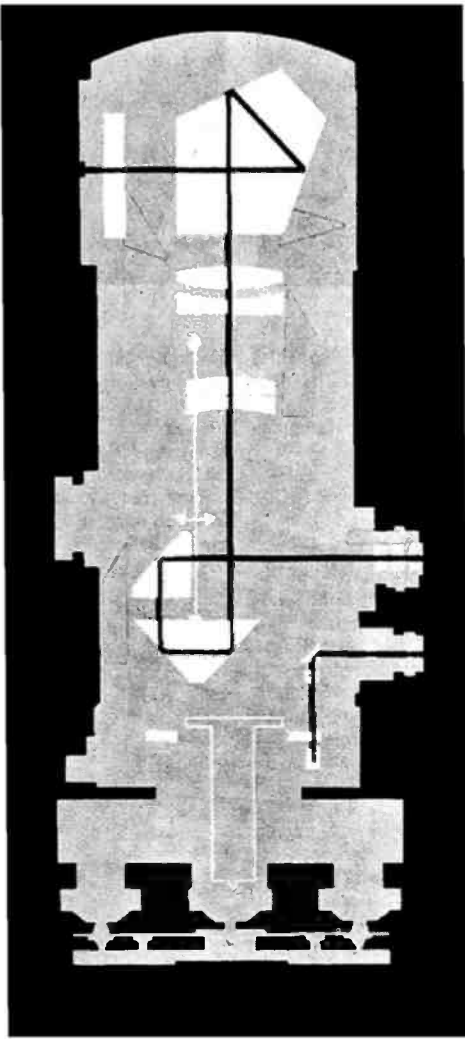


Fig. 7. Schematic of the Zeiss (Jena) automatic level. The prism always hangs vertically ensuring a level line of sight through the optical system. No electronics is used.



vogue as there were no other ways to obtain adequate amplification of the small movements. Nowadays, however, electronic displacement transducers can easily sense the fine displacements resulting.

greater length. Several instances of automated plumb bobs exist. The Russians have published details of a highly precise plumbing arrangement used during the erection of one of their large nuclear accelerators. It consisted of a steel wire plumb line having its bottom weight immersed in a damping fluid. A little above the bottom are two C cores arranged so that the wire forms the moving armature of a differential reluctance displacement transducer. They reported a centering accuracy of around $10\mu\text{m}$ which is the tolerance limit required in high precision engineering.

In surveying, the traditional bubble leveling instrument is being replaced by self-aligning or automatic levels. These use optical prisms which are suspended with fine wires so that the optical path always looks out in a level line to a precision of up to a few seconds of arc (in the precision models). There are a number of different methods used, Figure 7 shows just one. Surveying instruments are good examples of how other than electronic solutions to measuring problems may be the better to employ. In this instance the overall weight and, most important, the cost is less than the equivalent electronic method.

It is possible to build mechanical gain into a tilt-meter so that a larger movement occurs in the output member than in the member being driven by the tilt change. Before electronics, these methods were in

PLUMMETS

Before going onto alignment devices a brief description of the devices used

micrometer arrangements, the pendulum can be shortened. Professor Jones of the University of Aberdeen described small tilt-meters in Electronics Today, September 1971. Inductive sensing of the pendulum position has been used in the Talyvel engineering tilt-meter. In Figure 6, a pendulum is used astride an alignment telescope to define a level line of sight.

A plumb-line, as well as defining a line in the vertical direction, is a tilt-meter pendulum of relatively

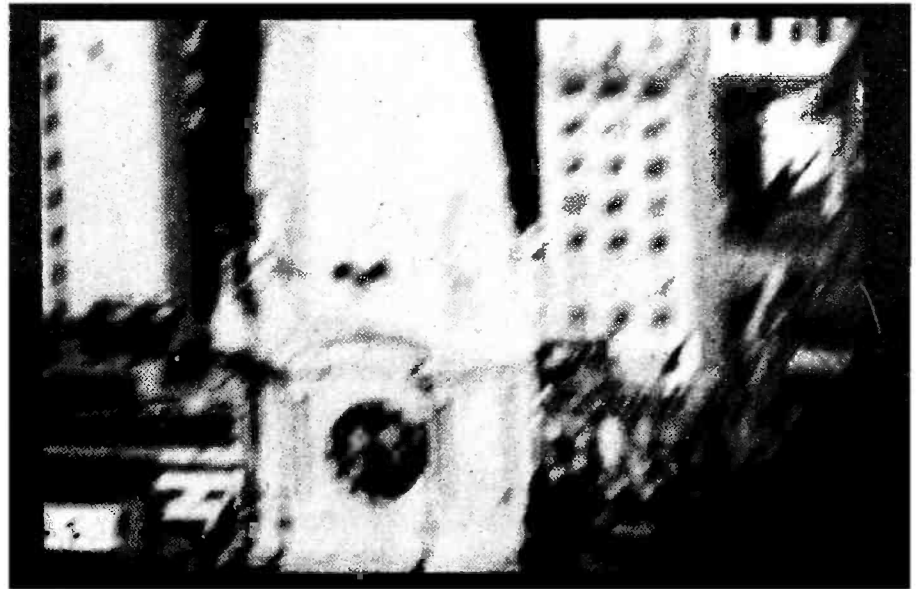


Fig. 9. The Dynalens image compensator removes vibration problems when using high powered telescopes.

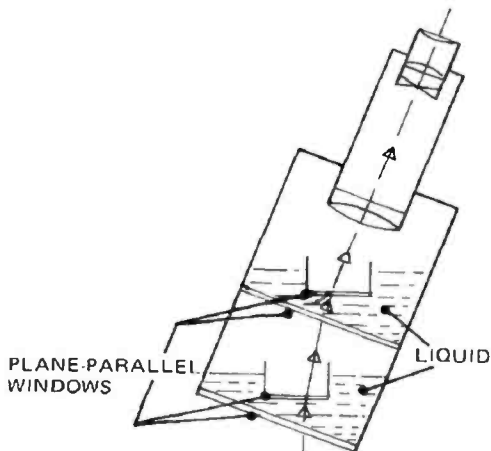
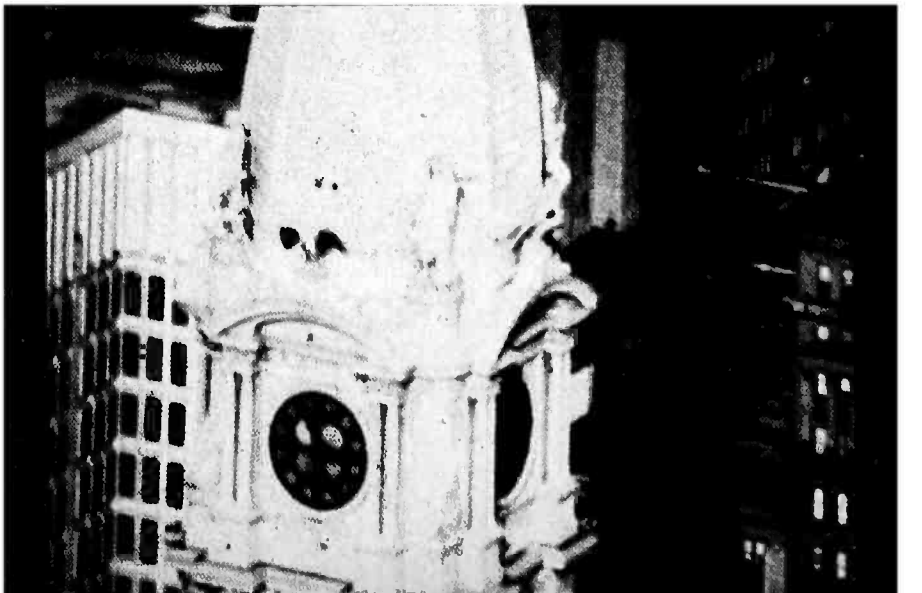


Fig. 8. The liquid prism optical plummet used for viewing vertically (even though the telescope axis is inclined).



TRANSDUCERS IN MEASUREMENT AND CONTROL

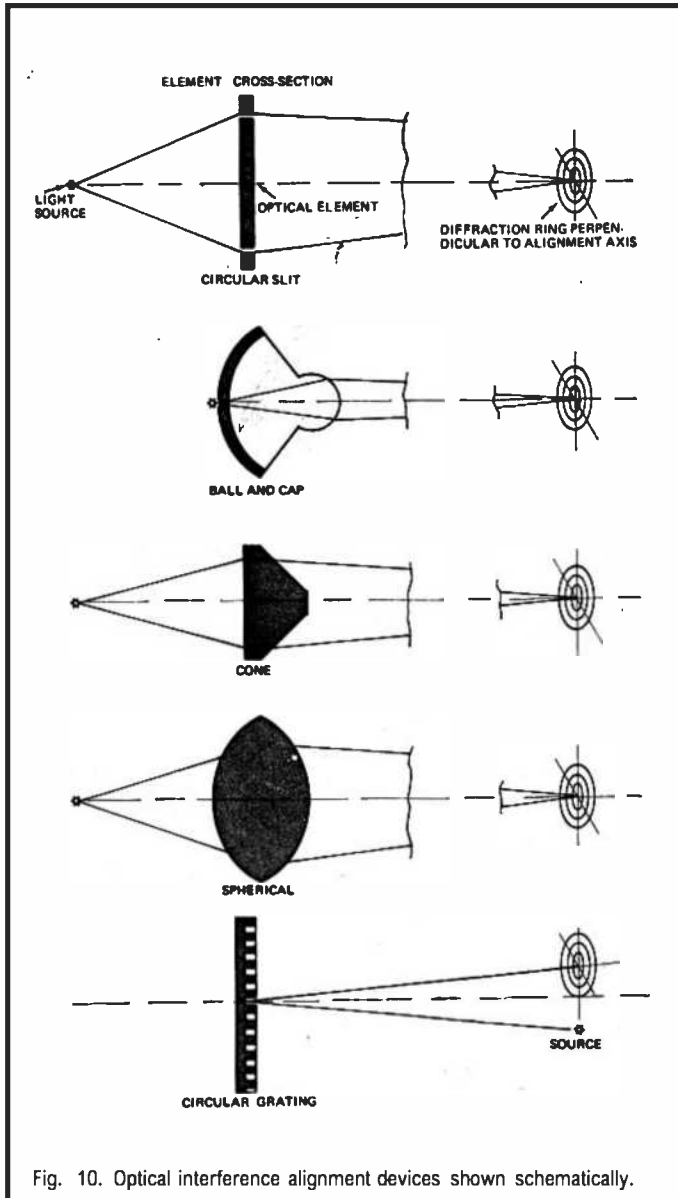


Fig. 10. Optical interference alignment devices shown schematically.

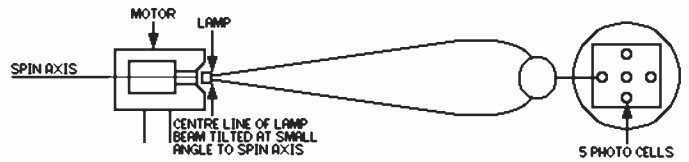


Fig. 11a. Sperry

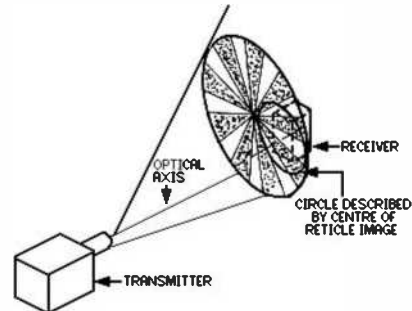


Fig. 11b. Yates-Hudswell.

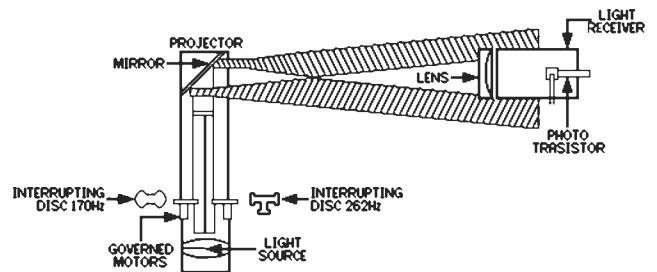


Fig. 11c. Agricultural Institute.

Fig. 11a,b,c. Spatially modulated optical alignment methods using conventional light sources.

IMAGE STABILISATION

An optical device which is useful when the observational platform is unstable is the liquid prism plummet. Figure 8 shows its principle. As the telescope tilts, the liquids flow to form changing dimension prisms which diffract the sight path in proportion to the tilt of the system. This helps to reduce the vertical sight path error caused by the tilt of the platform. Floating windows are used to overcome the vibrational effects on the surfaces of the liquid.

Gyros can be used to stabilize the position of a mirror, and in cases where the vibration is at a high frequency, a mirror spinning in the plane of its surface acts as a good reference. This method is used in bomb-sight equipments. It has also been used in high power binoculars to stabilize the sight paths. The gyroscope and the liquid lens have been combined in the Dynasciences. Corp., Dynalens image motion compensator. Inbuilt inertially-stabilized directional references are used to sense deviations from the steady state position. Error signals actuate liquid prisms, via

to define vertical sight lines is needed. We have already encountered the automated plumb line. Other methods use optical techniques to define a line perpendicular to the horizontal. In astronomy the vertical is defined by using the surface of a large mercury pool as the horizontal reference. Similar, but much smaller pools are made for use with telescopes in the engineering optical tooling setting-out procedure. At the top of the automatic level shown in Figure 7 is a penta-prism which provides a right angular optical path by careful manufacture of the angles between the surfaces. If the penta-prism is omitted, the visual path will be in the vertical direction. The same instrument is,

therefore, easily adapted as an automatic optical plummet. In mountain surveying operations it is often necessary to have a helicopter above a ground mark (with high precision) so that an electromagnetic distance measuring instrument can be used to read distances between ground stations. This is not easy, for the helicopter can wander in all six degrees of freedom. One solution is to use a ground-based television camera that is directed in the true vertical direction. A television monitor in the helicopter enables the pilot to see that the ground based camera views a reference mark on the underside of the helicopter. He hovers to keep the mark central in his screen.

TRANSDUCERS IN MEASUREMENT AND CONTROL

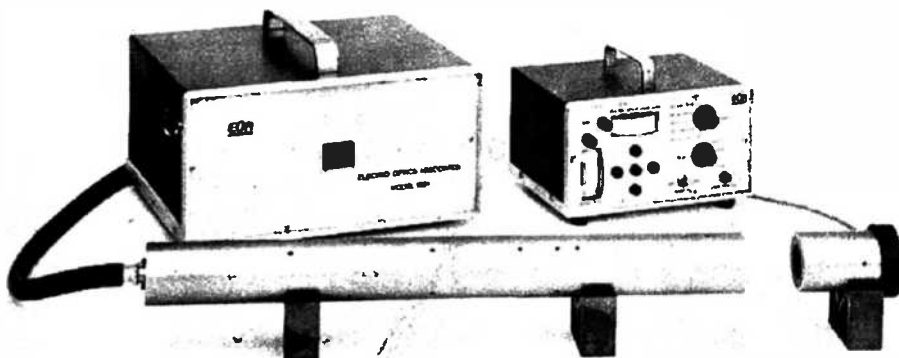


Fig. 12. Two axis, electrical readout, optical tooling laser.

electromechanical means, changing the optical axis to keep the sight path constant in space. This method has a much wider response bandwidth enabling it to cope in a broader range of circumstances. The dramatic difference between stabilized and unstabilized scenes, as viewed from a helicopter, is evident in Figure 9.

ALIGNMENT

A large number of situations require knowledge about straightness, flatness, parallelism, levelness, roll, pitch or yaw. At the high precision end of capability is the need to measure the flatness of machine tool beds, surface plates and optical components. Other applications such as agricultural drainage, pipe laying, pipe and pile borer guidance, road grading, concrete strip form paving and railway track tamping also share similar basic needs. Each require methods for measuring deviations from a given line or plane for measurement or automatic control purposes. Such techniques are called alignment methods and as always, no single method suits all cases, so various methods have been developed.

WIRE GUIDANCE

A tightly stretched wire provides an accurate line when viewed in the vertical plane. Special microscopes are available to measure deviations from the wire. These use a double image system that is correctly positioned when both are coincident. In the horizontal plane, allowance must be made for the catenary sag of the wire. The Sulzer factory in Switzerland issues a chart for the sag values. British and Russian reports claim alignment precisions of $20\mu\text{m}$ along distances of 50m by this simple method.

A number of concrete paving and kerbing machines use preset wires to define the road level. Micro-switches,

actuated by electromagnetic wire position sensors, control the raising and lowering of the paving slip edge. The precision is not high but the requirements for such cases need only centimeter control. As the speed of road and rail transport rises, closer control is needed. In the high speed experimental British Rail track, millimeter precision has been achieved using slip-form paver's.

OPTICAL TELESCOPES AND COLLIMATORS

A graticule placed in the viewing system of a reasonably powerful telescope provides the observer with a line of sight. Precision telescopes made for alignment (one is illustrated in Figure 6) have the optical axis precisely located with the axis of the body. Inbuilt graticule's and optical micrometers enable the observer to view targets placed along the line, for example, the bearing housings of a large engine.

An autocollimator is similar except that it has an inbuilt light source that radiates an image of a cross hair onto a mirror (placed at the point of interest)

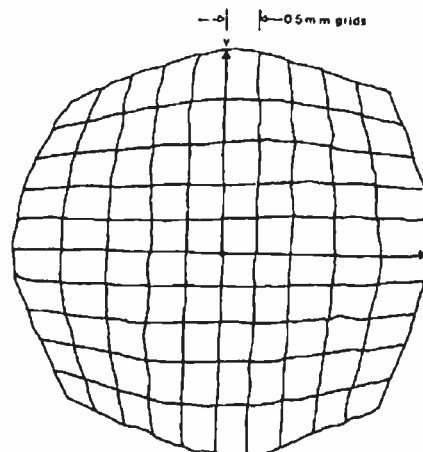


Fig. 13. A linearity plot of a two axis laser alignment readout system.

where it is reflected to appear in the viewing field alongside the original image. If the two images are coincident, the outward and return beams are in the same line of sight and the reflecting surface must be square to it. The autocollimator is, therefore, a sensitive angular measuring device. One of these devices is shown in Part 3 of this series -where it is used for setting the position of an angle encoder using a reflecting polygon. By using reflectors that remain at the same angle to their base, it is possible to measure flatness or straightness by calculation from the angular tilt of the surface (at chosen locations) and the position on the surface. Automatic readout autocollimator's are available that have built-in position-sensitive photocells to give an electrical signal corresponding to the angular deviations of the reflected beam. A specially built unit, operating on this principle, is used to align spacecraft to within an arc second over a range of several hundred metres.

OPTICAL INTERFERENCE METHODS

In 1950, it was suggested in Holland that a circular slit would produce a diffraction ring along the optical axis, and that could be used for alignment, (Figure 10). The method works reasonably well, enabling alignment to be checked by viewing the fringes with a specially marked piece of perspex. The major defect was that many rings are formed and so the light energy in the central, important one of interest, is not large. By using a number of slits made as close as possible to the shape of the diffraction rings produced when light shines through a pin hole, it is possible to concentrate much more energy into the central bright spot or ring. These plates are known as zone plates. The National Physical Laboratory in Britain use these to provide a reference base, several hundred metres long, upon which alignment devices may be tested. There are many other ways to produce such rings and a few are shown in Figure 10. Only the latter is marketed for industrial use. Current research aims at providing electrical readout from such rings by scanning across them in order to determine the best centre.

SPATIALLY MODULATED SYSTEMS

If a beam of conventional light is radiated, it diverges to such an extent that the centre is difficult to detect with precision. Furthermore, the amplitude will vary with time due to changing atmospheric conditions. For this reason, various methods have been evolved in which the beam is modulated in a spatial manner.

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A system developed by Sperry is shown in Figure 11. A motor rotates a slightly tilted optical system so that the optical axis nutates in space. A detector having five photocells is placed on the beam axis. If central on the detector, each of the four outer cells has an equal ac component and mark space ratio. In not aligned, error signals are produced. This method can resolve to 0.3mm in 30m distances and has been applied to an experimental road grader to hold the blade in a straight plane regardless of road surface. A pendulum sensor holds the blade's transverse angle in control.

The next method is adapted from a military tracking system. It is now used to control the plough in of agricultural pipes in Britain. A spinning disk produces a spatial chopped beam that also nutates. This is sensed to see if there is any out of balance ac signals in a somewhat similar manner to the one described above, the difference being that frequency modulation results (not amplitude). It is claimed that this has a better signal to noise ratio in practice, for optical transmission in the normal air environment is less noisy to frequency effects than to amplitude.

A third system, developed by the National Agricultural Research Institute is shown also in Figure 11. In this a light source provides two beams closely parallel to each other. One is chopped mechanically at 170Hz, the other at 262Hz. The detector sees a spatial overlap of each frequency. When central it gives even amplitude signals at the two frequencies. This was used in an automatic pipe laying tractor.

LASER ALIGNMENT

The automated techniques mentioned above were devised before the laser was developed (remember the laser is only an invention of the last decade) and the sophisticated methods were needed to overcome the lack of an intense narrow beam of light.

Continuous-wave lasers are now used extensively in alignment, for the beam can be collimated to keep the beam width down to millimeters over hundreds of metre distances. For crude alignment, the beam can be viewed by eye (but not directly for fear of eye damage). Electrical output is generally provided by a quadrant silicon photocell position detector. One set of equipment is illustrated in Figure 12. Alignment lasers are now especially designed to ensure that the beam leaves the precision ground

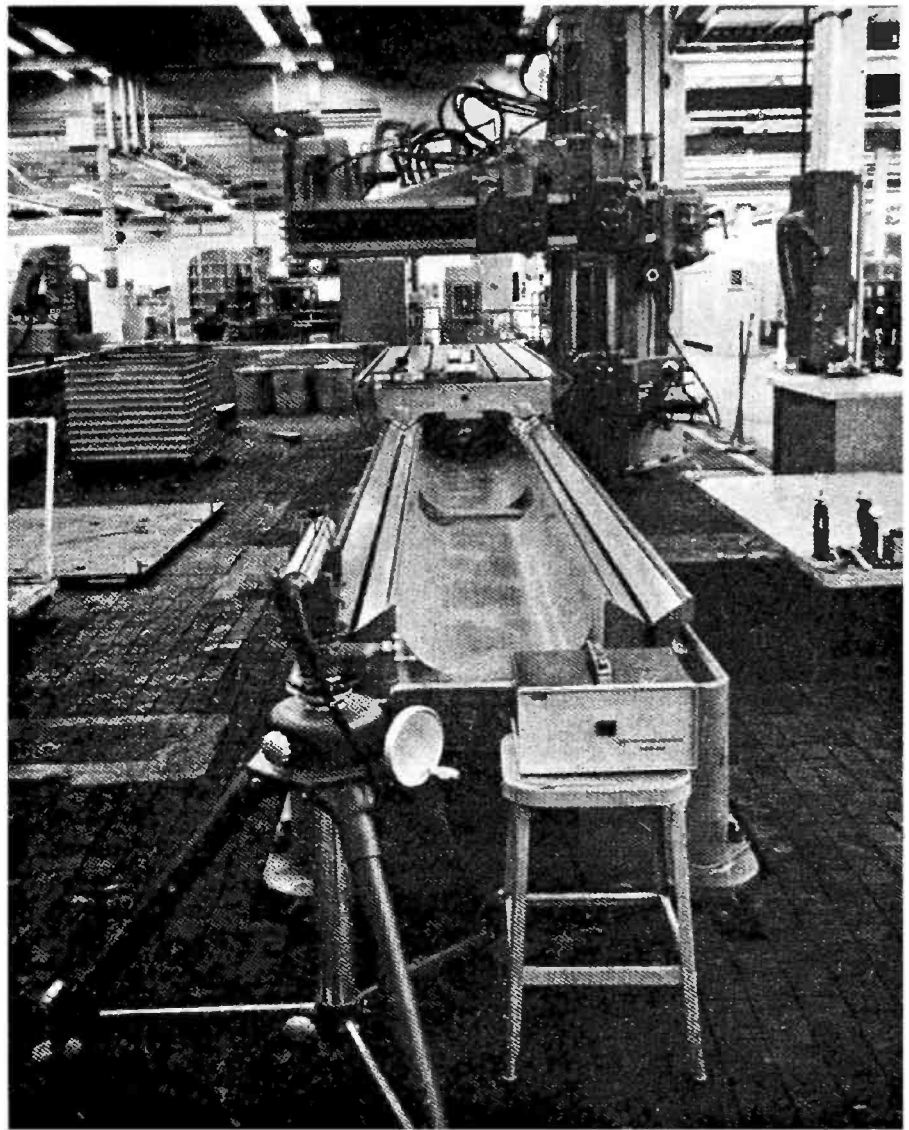


Fig. 14. Testing the straightness of travel of a planer.

barrel in the centre and does not have significant angular variations with time. When using a quadrant detector, the two output signals are interrelated to an increasing extent as the spot moves from the centre. Figure 13 shows a typical calibration plot of the linearity obtained from the x and y axis signals. In the centre the curves are the closest to a square, which is the ideal. A typical setup using laser alignment equipment is shown in Figure 14. If the time axis of a pen recorder is synchronized with the machine slide rate, the two axis alignment errors can be plotted automatically as the slide advances along the planer bed. Traditional manual methods could give similar accuracy but were tedious and extremely slow.

Alignment methods provide means to measure straightness. If constant grade is desired, for instance, then the alignment device is used in conjunction with a level defining method to set the line in the correct direction and plane.

Finally, on the subject of alignment measurement, mention should be made of the use of inertial guidance.

A gyroscope, once set going, produces torques if its non-spinning axes are rotated. By sensing the torques it is possible to hold a straight line in space without the need for a physical reference position. One interesting problem described in the Russian Literature was how to monitor the alignment and grade of pipes already buried. This was solved by making a small wheel-driven mole that drove itself through the pipe. It carried a gyro unit, recorder and distance meter. By synchronizing the recorder chart speed with the driving wheel and plotting the instantaneous grade at all times from the gyro, a plot of straightness was obtained.

Many applications of measurement and control require position to be transducer, not just length, angle, alignment or inclination. In the next part we shall consider how the various devices described in this and the previous parts are combined to yield two and three dimensional positional data.

TECHNOLOGY IN THE SEVENTIES

This feature, an exclusive to Electronics Today International, deals with the impact of the '60s technology on the '70s and takes a long view of the major technologies of the '70s which will influence the '80s. It was edited from a lecture given before the Washington Forum in New York City by Dr. Van W. Bearinger, Vice-President of Science and Engineering, Honeywell Inc., USA. ETI wish to acknowledge the co-operation extended by Honeywell Inc.



Dr. Van W. Bearinger.

I am sure this audience understands the general lag of six to 10 years between the development of technological capabilities and their exploitation in new products. I will first deal with technologies evolved in the '60s which will have major impact in the '70s. Later, I will also mention a few technologies that I believe will evolve in the '70s and have their major impact in the '80s. The technologies evolved in the '60s which I believe will have major impacts during the present decade include:

- A tremendous and greatly enhanced "computer power" base.
- Large-scale integration of micro-electronic circuits.
- A system technology;
- Coherent light (LASER) technology.

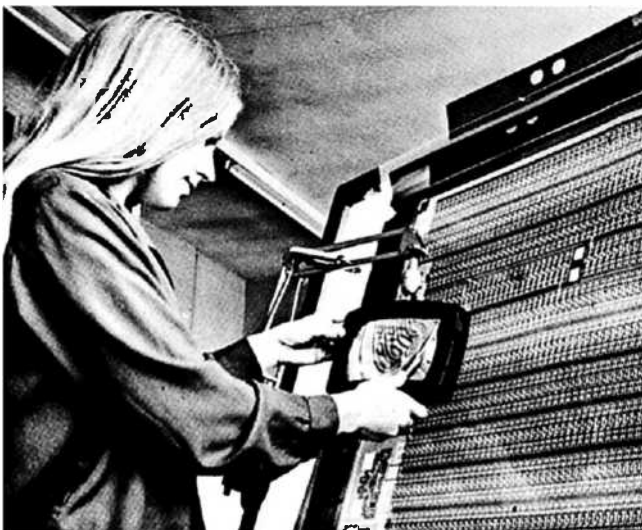
Computer power has grown in the past decade not only through thousand-fold advances in hardware speed and memory capacity,

but also through the evolution of "software" computer aids which have greatly increased the engineer's scope. It is possible today for a system designer at a remote com-puter terminal to call out programs from files in memory allowing him to design a system starting with requirements analyses, continuing through trade-off evaluations of systems concepts, through logic and circuit simulation, all the way to detailed instructions for manufacturing.

LARGE-SCALE INTEGRATION OF MICRO-ELECTRONIC CIRCUITS has almost unlimited potential in the next few decades and is significant because :

(a) we can achieve much lower costs in our complex electronics - a circuit designer has at his disposal two to four thousand active devices at the same size and cost as a single device in 1960 - and we can take advantage of this to achieve much higher reliability, maintainability and ease of servicing - if we wish; you have already seen the many small inexpensive hand calculators built around custom micro-circuits;

(b) its benefits and potential depend on the increased computer power just described. With new computer design aids, a designer today can implement his product with special custom microcircuits more economically than he could



Inspection of mask for 1024-bit LSI shift register.

have breadboarded the prototype yesterday, if the complexity is of the order of a few thousand components.

SYSTEMS TECHNOLOGY to me means the logical, systematic approach to solving problems, starting with requirements analysis and "scenario" development, then evolving concepts, doing computer trade-off analyses of various concepts and so forth. It includes the application of systems-management approaches using computerized tools such as PERT and configuration management. The systems engineer of the '70s will have technology tools which make him perhaps a hundred times more effective as a designer and implementer of complex equipment.

LASERS - sources of intense coherent light - were the most radical of the '60s technology breakthroughs. Large-scale use of lasers is still to come, but their potential is immense. Application of lasers in

are central to man's welfare, but economic, social and political barriers exist for which no equivalent set of potent tools has yet been derived.

Recently the President reassured the American public, in this State of the Union address, that he would mount an all-out attack on certain critical national problems: transportation, pollution, crime, health, education, and housing. These areas open up whole new vistas for the application of advanced technologies.

These national problems should be attacked in a systematic manner, and I maintain that the challenge of this decade lies in the harnessing of systems technology for solving these critical national needs.

Now I would like to give an example or two. First, consider our future's almost limitless needs for energy. All of our current approaches to solving our energy problems either spend irreplaceable resources at an alarming rate or produce

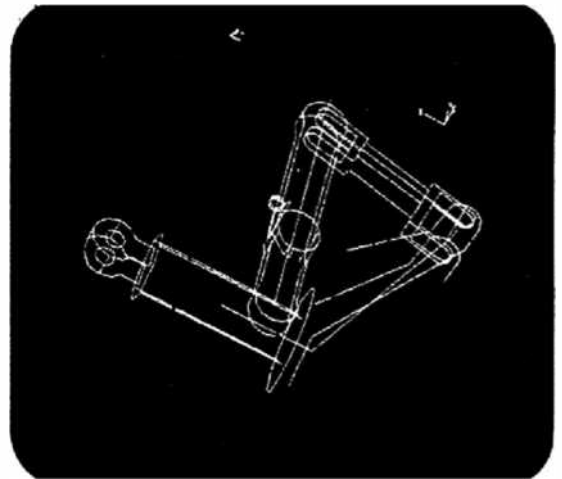
commitment of desert areas of the United States, but it will remain for social and political factors to determine the proper rate of implementation. How much and how soon will we be willing to pay the cost for the better health and the aesthetic values to be obtained from a cleaner atmosphere?

The point here is that technology alone will not overcome our basic problems of energy consumption or the problems of mass transportation, housing, pollution control, medical care, crime prevention and public health. We must concern ourselves not so much with technology as with problem solving.

As a second example, let us consider transportation where the rapid progress of advanced technology has given us new ways to configure systems so that they are more convenient to use, more economical to operate, and generally more responsive to the needs of the individual. During the '70s, the real challenge in transportation will be



Examples of computer-aided design in mechanical engineering (right) and MDS array mask design (left).



weapons systems, communication, and computers are evolving, but I believe their impact will become significant late in the '70s and possibly in the following decade.

CHALLENGE IN THE '70s

From my perspective in Honeywell the implications of these developments are profound. We somehow need to provide equivalent improvement in capacity to handle the social and political aspects of our national priority problems.

One of the most prodigious feats of systems technology in the '60s put a man on the moon through the Apollo program. Hundreds of companies, thousands of people working in concert toward a single objective - but the social and political aspects of this program were overshadowed by a strong commitment to a single goal made by the President of the United States.

Technology in the '70s could affect solutions to problems which

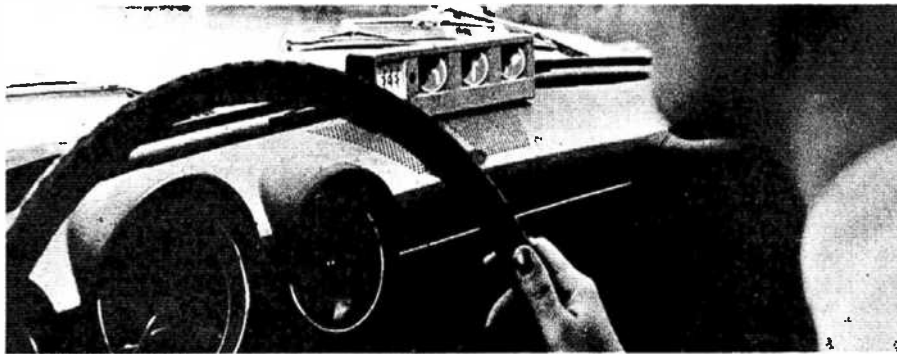
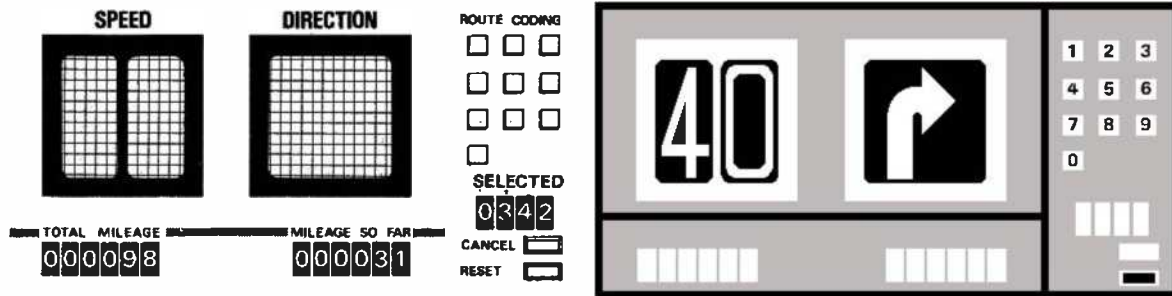
increasingly intolerable amounts of pollution. Yet there is a source of pollution-free power available today in solar energy. If one per cent of the solar energy falling on the Sahara desert were converted to electrical power it would supply the tremendous amount of energy we estimate the world will need in the year 2000; the solar energy falling on the state of New York is double the energy being obtained today from the world's present production of fossil fuel - that is, coal and oil.

Technical breakthroughs are not needed to solve this problem - the means to convert solar energy to electrical power is here today. The problem is an economic one. We must be willing to invest the capital required for energy coiversi9n equipment if we are to obtain . pollution-free power. Honeywell is among those currently working on the problem - providing the trade offs in terms of capital requirements, maintenance costs and required

to develop balanced manual and automated transportation systems, utilizing sophisticated computerised techniques. Decisions to be made involve both private and public sectors, social and political as well as technical.

We clearly need a system approach

* Based on our current prediction of solar power plant efficiency. we estimate an area roughly 8.4km by 8.4km is needed to generate 1,000 megawatts average electrical power over a year if stationed about 30° north latitude. This assumes only a very few days of overcast sky and that the 50% extra energy generated in the summer is used to supplement other power sources, for example, to supply the increased load caused by air conditioning. It is doubtful that solar energy will ever find extensive use in overcast and rainy climates. However, it is quite likely that home and business space heating and air conditioning with solar energy will become practical in the northern states of the United States.



AUTO NAVIGATION

Sophisticated console has push-button route selector, distance indicators and Nixie tube route and direction read-outs.

to urban transportation to make it relevant to land-use patterns of the present and desired land-use patterns of the future. Primary criteria for urban mass transit, for example, appear to be minimization of trip time, low operating cost and high reliability. Such goals will best be met with a high degree of automation for traffic and vehicle control, and this appears to be well within the scope of existing equipment and techniques.

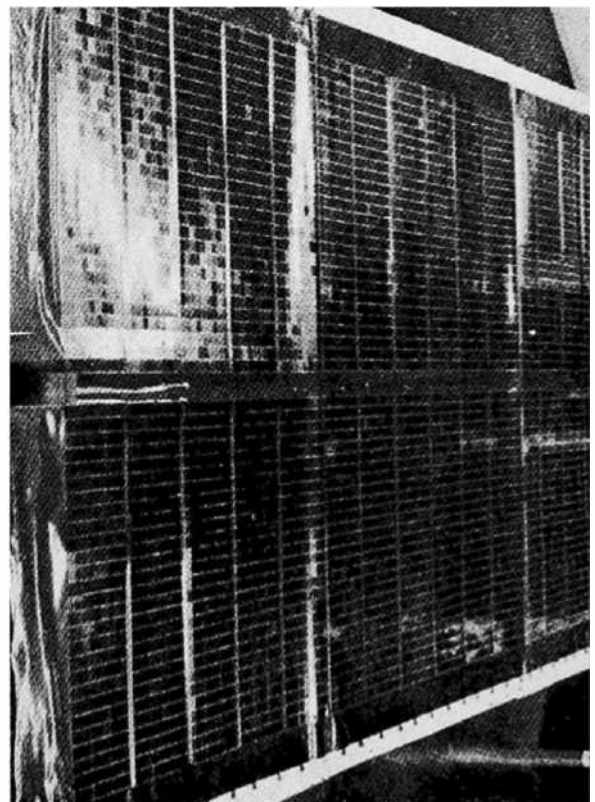
Vehicle size is another important system consideration. Small vehicles provide high flexibility but limit system capacity. Large vehicles have the opposite effect. Capabilities for automatically forming trains of small vehicles to meet peak demand may be desirable. Demand sensitive and off-line stations may also be provided. Safety, reliability, maintenance, and operating practices should be considered at every stage of system definition, specification, and design. Scheduling philosophies must also be determined. Scheduling strategies depend heavily on system geometry; and simulation model techniques, as a basis for system optimization, allow us to consider most of the technological and economic aspects of the mass transportation problem.

We are not as well equipped to handle the psychological and political aspects of the problem. However, the increase in computer power, and the application of techniques such as Jay Forrester's dynamic modeling of industrial urban and regional socio-economic systems may provide help in the late '70s in the form of objective concept evaluation of new approaches to social, political, and economic problems.

OUTLOOK FOR THE '80s

The technology developments of the '70s that will have their major significant impact in the '80s will also certainly include continuing developments in lasers and computers. Technology grows in response to need - when fertilized with money. Thus the President's new initiative to find cancer's cure should produce technology breakthroughs that lead to better understanding not only of this disease but of other areas of human health. Much aerospace technology is available to be applied to health problems, and of course the needs

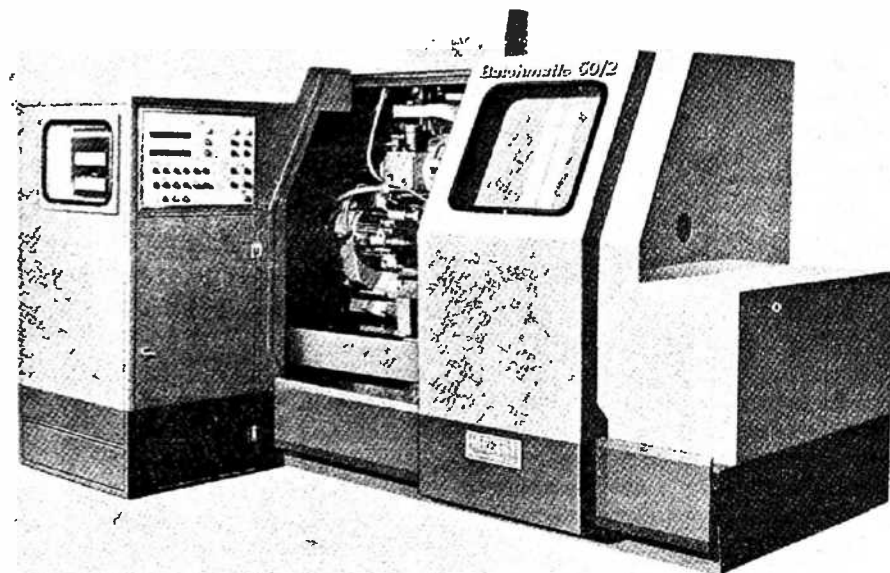
are great. The economics, though, have been generally unfavorable except in the application of computers to hospital data management. One of the areas of relatively profound technological need is the problem of computer software (programming). The generation of computer systems software is producing an increasingly large share of the cost of computer-based systems. It is a current bottleneck in our technology capability, and I believe there will be significant technology development during this decade that will improve our capability to generate good software.



Flexible solar cell array, 24 ft long and over 4 ft wide, with 15,500 Ferranti solar cells.

EQUIPMENT NEWS

TRANSDUCER FOR NC LATHES



Smiths Industries have developed a new Venture digital position transducer for the Herbert-BSA Ltd Batchmatic family of numerically controlled lathes. Venture transducers are used on three axes of each machine as the position elements in the new low-cost control system, at the heart of which is a mini computer.

The transducer is used with linear electro hydraulic rams to accurately sense the tool slide position and complete the loop of the servo system. The system is said to afford greater accuracy than a conventional type using ball lead screws, and to be fully digital, thus immune to the noise problems associated with analogue feedback systems.

Further information from Smiths Industries Ltd., Industrial Instrument Division, Waterloo Road, London NW2 7UR.

LF SIGNAL GENERATOR

Latest addition to the Advance range of "J" oscillators is the J3, offering facilities not generally available in transistorised



units. The frequency range of 10 Hz to 100 kHz is covered in four decade ranges. The 320° circular dial incorporates a 4:1 reduction drive.

Accuracy is within 2% + 1 Hz. Outputs available area: balanced floating (7.5-0-7.5V rms into 600 ohms, 15-0-15V rms emf), low impedance output (2.3V into 5 ohms), square wave (0 to + 5V with less than 1 μ s rise and fall time), low distortion output (2.5V rms from 5kl). The first output level is monitored by a meter calibrator in volts emf and dBm.

Output levels are flat to within ± 1 dB on the top three ranges and approximately 3 dB down at 10 Hz on the lowest range.

The unit measures 5.25" x 11.5" X 9" and weighs 14 lbs and is mains-operated.

Further information from Advance El Ironies Ltd, Instrument Division, Raynham Road, Bishops Stortford, Herts.

NURSE-CALL HAND SET

The design of Nelson Tansley's Nurse-Call Hand Unit type 14802 has been registered with Patent Office (Reg. No. 934123). The Unit is designed to be used with the company's Series 259 Nurse-call System to be installed at the new Freeman Road Hospital in Newcastle-upon-Tyne. The hand-sets, which plug into wall-mounted bed-head units, contain controls for up to six channels of sound and the illuminated push-button to call a nurse. The button, which is

duplicated on the bed-head unit, lights when pressed and remains lit until canceled by the nurse. Accidental disconnection of the hand-set plug causes the call signals to operate. A switch is provided on the hand-set for control of a bed-head reading lamp, and a nozzle accepts the connector of a disposable lightweight acoustic head-set.

The wall-mounted Series 259 units are contained in flush conduit boxes, which can be installed in a new hospital, complete with wiring, before plastering and decorating are carried out. A patented plug-and-socket method of interconnection then allows the wiring to be easily terminated on site, whereupon the bed-head units are quickly and simply secured in position with no danger of subsequent damage. For use in updating operations, surface-mounting conduit boxes can be used.

The control circuitry of the nurse-call functions is solid-state in concept, making for extreme reliability and a high degree of flexibility in specification.

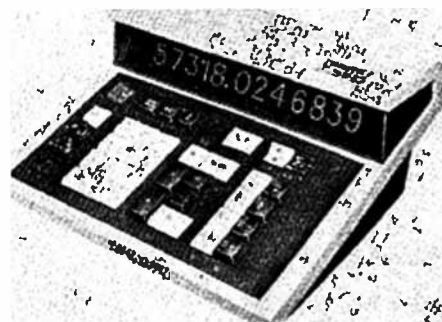
Further information from Nelson Tansley Limited, 10 Shepherds Bush Road, London W6.

TWIN-STORE CALCULATOR

Weighing only a little over 5 lbs (2.3 kg), the ANITA 1212D, measures (268 X 226 X 110 mm).

Wherever commercial applications pre-dominate, the ANITA 1212D is claimed to give the user maximum economy (and the opportunity for a dramatic reduction in office costs) combined with accuracy, speed, ease of operation and an exceptionally wide range of applications.

Latching keys provide sum of results and sum of first numbers; the free accumulating stores can also hold constants, and there is also a separate constant memory. Store contents can be freely manipulated and Stores I and II can be added to, or subtracted from, by direct entry or automatically on completion of calculations. A constant



EQUIPMENT NEWS

is held without affecting the normal full storage and calculating facilities.

In percentage calculations, the automatic decimal point facility combines maximum ease of operation with total accuracy.

Negative entry is facilitated by means of a "Change Sign" key and there is also an interchange key for adjusting factor order. A special "Inspection" key permits any result, no matter how small, to be recorded to 12 significant figures.

Equally important in day-to-day routine commerce is the total freedom of the rounding features. To aid total accuracy, rounding is eliminated throughout intermediate results, thus obviating the risk of cumulative errors creeping into lengthy calculations.

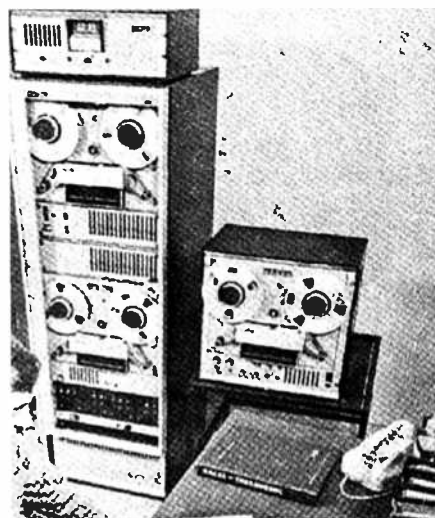
When rounding takes place at the Final Results stage, the user has a choice of rounding off (5/4), Rounding up or Truncated results, the last option giving a choice of rounding results to 0, 1, 2, 3, 4, or 6 decimal places.

The same machine, it is claimed, can be used with equal facility and the same degree of desired accuracy for such tasks as calculating bills of quantity and for executive discussions of estimated profit margins where totally different degrees of decimal accuracy are likely to be required.

Further information from Sumlock Comptometer Ltd., Anita House, Rockingham Road, Uxbridge, Middlesex.

BRITISH MULTI-CHANNEL RECORDER

Unveiled recently at the International Airport Construction and Equipment Exhibition in Geneva and claimed to be the most compact recording system in the world today, the International Communications Recorder has a continuous recording capability of 24 hours on a single 8 inch diameter reel of triple-play tape.



In addition, a large number of options are available such as dual electronics assemblies, pilot tone monitoring, voice-controlled operation, etc, so that any given installation can be custom designed to suit the particular needs of any user.

This latest recorder from Racal-Thermionic utilizes a building-block construction to provide installations up to 8, 16 or 32 channels for varied applications from that of a small jungle air-strip to the largest of air traffic control centres.

Illustration shows an ICR 32 recorder in use at communications centre in southern England. On top of the recorder is the "Talking Clock" which injects time signals, in any language, on to one channel. Along side the ICR 32 is the specially designed replay unit which may, of course, be used at a remote location to replay tapes.

Further information from Racal-Thermionic Ltd., Hythe, Southampton, SO4 6ZH.

3M DATA CARTRIDGE

High performance characteristics are claimed by 3M for its Scotch DC300A quarter-inch tape cartridge for data processing systems. 3M foresees many digital applications in the fields of mini computers, aircraft crash recorders, business data processing and data acquisition.

Inherently bi-directional, the cartridge is essentially its own transport, with precision tape handling built into it. The entire drive mechanism consists of a capstan, two tension rollers and a continuous drive band designed and developed by 3M, who claim that the tape cannot cinch, stretch or break under any condition. Tape handling is said to be so precise that each cartridge has a life expectancy in excess of 5,000 passes, and permits recording of up to four tracks at 1,600 bits per inch.

The cartridge, measuring 4" x 6" x 0.625" (10.16 cm x 15.24 cm x 1.6 cm), weighs only 9 oz (255 gm) and is loaded with 320 ft (97.5 m) of Scotch 777 computer tape. The band drive from the single motor transport eliminates the classical capstan common to most digital cassette systems, and the precise positioning of the tape within the cartridge is said to simplify tape/head alignment since no guiding is required external to the cartridge.

A generous head space allows the use of a variety of head and data configurations, from single track to multiple tracks, with consistently high data reliability. The uniform tension generated within the cartridge (a nominal 2 oz) eliminates the need for a pressure pad and reduces tape wear and resultant drop-outs, while the new drive technique dispenses with pinch rollers



and their associated mechanical problems.

To make system interface easier, the cartridge also includes an EOT/BOT sensing capability with "ready point" and "early warning" provisions, as well as an integral "file protect" capability.

Other features are: a clear top for easy viewing during operation; a completely enclosed package to protect the tape during handling and storage; and straight-in loading with automatic door opening to facilitate automatic changing.

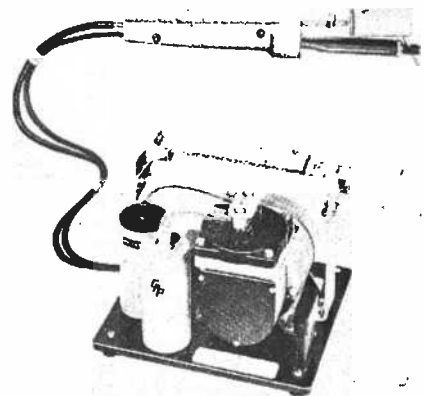
3M claims, for its data cartridge, a performance ratio three times as good as that for cassettes, and closely approaching that for half-inch tape drives, at a cost comparable to cassettes and only a quarter that of half-inch compatible tape decks.

Further information from 3M (UK) Ltd., Wigmore Street, London W1A JET.

DESOLDERING TOOL

Charles Austen Pumps Ltd have announced their Soldermaster Mk. V for removing multi-pin components from printed circuit boards.

A Weller 100 watt temperature-controlled iron has been adapted for use with the new unit which is fitted with a solder catch pot and an interchangeable hollow bit through which vacuum suction is applied. An Austen Capex Mk II diaphragm pump driven by a shaded pole motor provides the vacuum source. A polypropylene expansion chamber minimizes pump-noise and the pump is protected from resin fumes



EQUIPMENT NEWS

by a cleanable micro-filter.

Six bits are supplied with the standard unit, the bit holder being designed to facilitate quick interchange. The unit weighs 6 lbs and measures 7 inches x 6 inches x 6 inches high.

Further information from Charles Austen Pumps Ltd, 100 Royston Road, Byfleet, Surrey.

PORTABLE 8-CHANNEL RECORDER

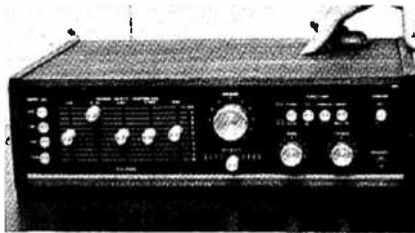
Pye TVT Ltd announces the availability in the UK of an 8-channel Philips communications recorder designated XMN-8. Designed for continuous use and fitted with a fail-safe fault detection and alarm indication system, the XMN-8 ensures a word-for-word record of all incoming and outgoing messages at communications centres such as air traffic control, police, ambulance and emergency services. Logging broadcast programs and commercials from commercial radio stations is another potential application which will enable the program companies to keep a record of promotions.

Using 8-inch reels with 1/4 inch triple-play tape, the XMN-8 provides a recording period of 12 hours. To ensure that continuous operation is not endangered by breakdown, elaborate safety provisions are incorporated. The XMN-8 is also fitted with an automatic switch-over device which enables a second recorder to be brought into action automatically when the 12 hours recording time of the first recorder is completed. Further information from Pye of Cambridge Ltd, St. Andrew's Road, Cambridge CB41DP.



STEREO AMPLIFIER

In addition to the normal bass and treble controls, the Eagle International AA6 stereo amplifier has five "slider" controls to boost or cut response in specific and independent sectors of the frequency range. The hi-fi enthusiast can thus mix the sound to suit his own taste, for example, bringing



up the violins or playing down the woodwind section. The five bands are around 40, 200, 1200, 6000 and 15000 Hz. An independent switch allows reverting to simple bass/ treble control when required.

With specified output of 12.5 watts RMS per channel and frequency range of 20 to 30000 Hz, the AA6 has the full complement of tape, tuner and pick-up inputs.

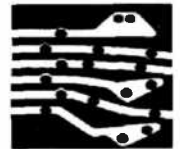
Further information from Eagle International, Heather Park Drive, Wembley, Middlesex HA0 1SV.

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COMPONENT NEWS

Thick film hybrid microcircuits are described in a six page two colour brochure by Coutant who are now offering custom design service. The brochure describes the manufacturing process and advantages of thick-film devices and gives guidelines for designing in thick-film. Typical specifications of facilities offered by Coutant are also given.

Further information from Coutant Electronics Ltd, Trafford Road, Reading RG1 8JR.

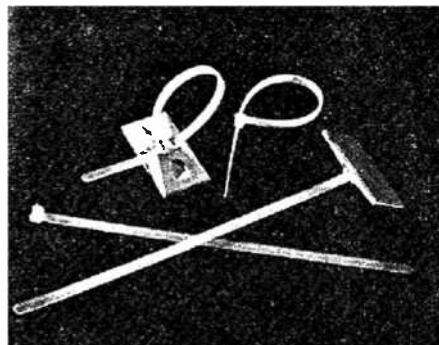
HANDCUFFS FOR CABLES

Scotchflex cable ties, designed for securing wire bundles up to 4.45 cm (1.75 inches) diameter, are available from 3M with or without self-adhesive base.

The nylon ties are serrated along their 18.2 cm length to self-lock in any position, release being effected by pulling a small tab with pliers.

Cable ties types 760 and 790 (the latter with 5 cm base with self-adhesive backing) are boxed in 100s and are suitable, say 3M, for use in a wide variety of applications calling for tidy wire assembly.

Further information from 3M (UK) Ltd., Wigmore Street, London W1A 1ET.

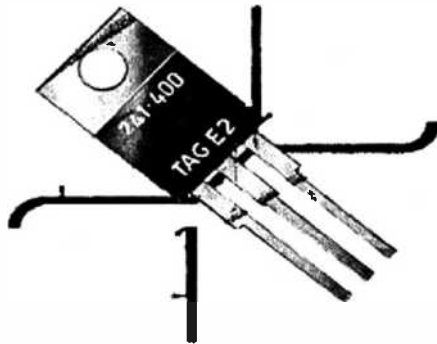


ISOLATED TAB TRIACS

Jermyn Distribution have announced the availability of a new range of isolated tab triacs from Raytheon-Tag. The insulated tabs enable these triacs to be fixed directly to any chassis or panel without the usual insulation or stand-off mounting arrangements.

This range is called TAG/240, 241, 245 and 246; the first two being the basic 5 amp types and the latter two the 6.5 amp devices. Every basic type in the range is available with voltage ratings from 100 to 800V (in 100V steps).

The surface of the active silicon is passivated to prevent the ingress of moisture

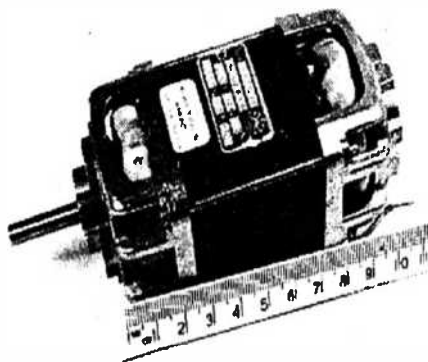


or ions of foreign matter by a technique called "glassivation" in which a glass disc with temperature coefficient of expansion matching that of the silicon is laid over and bonded to the silicon, resulting in a rugged device with good long-term stability and ability to withstand up to 2.5kV between the isolated tab and the active elements of the device.

Further information from Jermyn Distribution, Vestry Estate, Sevenoaks, Kent.

NEW ELECTRIC MOTOR

A single phase AC two-pole induction motor, known as Gefeg ES 5630-5650, suitable for applications such as calculating and duplicating machines, film projectors and precision drives for optics is now available from Magnetic Devices Ltd.



The flange mounted stator optimizes for the greatest possible performance with a die-cast squirrel cage rotor having maximum cooling air routes. Torque available is said to be 6 to 21 watts, within frame of 90 to 110 mm length by 56 mm, depending on features required.

Further details from Magnetic Devices Ltd, Exning Road, Newmarket, Suffolk.

RADIO MIKE BATTERY

Designed specially for radio microphone use, a new 14.74V mercury-zinc battery has been developed by Crompton Parkinson Ltd and introduced under the Vidor label. The battery, measuring 70 mm x 44.5 mm x 23 mm, consists of 11 KRK42 round cells connected in series and encapsulated in cold-set resin. It is said to withstand the considerable vibration and shock involved in such applications.

A radio microphone incorporating the new battery and designed to meet the requirements of TV outside broadcasts has recently completed trials by the BBC. With considerably greater power output than conventional radio microphones, it is intended for use in programs where long range is essential e.g. rock climbing. Because mercury-zinc is a high energy primary system, the new microphone and battery can be made small-enough not to hinder the wearer.

A level voltage characteristic on discharge, a feature of such batteries, enables the radio transmitter to deliver a constant power output without voltage stabilisation circuitry, thus minimizing the size and complexity of associated electronics.

Further information from Crompton Parkinson Ltd, 50/52 Marefair, Northampton NN1 1NY.

THE UNIVERSITY OF MANCHESTER

Department of Physics

EXPERIMENTAL OFFICERS

Applications are invited for two SRC funded posts to work with the High Energy Physics Group on experiments using the 5 GeV electron synchrotron at Daresbury Nuclear Physics Laboratory. The work involves the development and commissioning of scintillation counters, Cerenkov counters, spark chambers and multi-wire proportional chambers and their associated fast electronics. One post is available to September 30, 1973. Salary range p.a.: £1,320-£2,532 F.S.S.U. The other post is available to September 30, 1975. Initial salary in the region p.a. £1,320-£1,545 F.S.S.U.

Particulars and application forms (returnable by August 4) from The Registrar, The University, Manchester M13 9PL. Quote ref: 129/72/ET. Previous applicants need not submit fresh applications.

BOOK REVIEWS

REVIEWERS: Brian Chapman, Jan Vernon

**Radio
Television
and
Audio Test
Instruments**
2nd Edition
Gordon King
Newnes-Butterworth

RADIO, TELEVISION AND AUDIO TEST INSTRUMENTS, by Gordon J. King. Published by Newnes-Butterworths, London, 1972. 199 pages, 9 1/4" x 6", hard covers. £3.80.

Originally published in 1962 under the title "Radio and Television Test Instruments", this new edition complements without overlapping, the series of servicing handbooks by the same author. Although it is possible in the main to make do with a screwdriver and a simple multimeter, sooner or later the technician will be faced with a situation that demands the use of more advanced test equipment.

To use test equipment correctly, and to maximum advantage, requires a knowledge of the characteristics, operating principles and limitations of the instruments concerned. It is very easy indeed to come to a wrong conclusion by not understanding the measurement errors introduced by the instrument itself - for example, the error caused by loading a circuit with a low input impedance voltmeter. Hence it is vital that users of test equipment gain knowledge of the instruments they intend to use and perhaps more importantly - methods of measurement. This book provides an excellent introduction to test instruments in general and the way to use them. An introduction to instruments opens the book and is followed by sections on the application of DC and AC meters. The latter sections contain all the basics concerning various types, their use, shunts and multipliers and measurements of various physical parameters.

Following are sections on specific classes of instruments such as electronic meters, signal generators, oscilloscopes and then sections on instruments for valve and transistor testing, colour television and audio equipment.

The text is clearly and simply written and is well illustrated with circuit diagrams, pictures of instruments and waveform photographs, etc.

The book is very suitable for technicians and home experimenters wishing to advance themselves in 'the art of measurement in electronics'. - B.C.

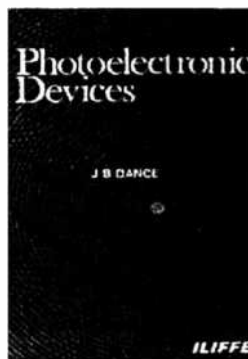
PHOTOELECTRONIC DEVICES. by J. B. Dance, M.Sc., B.Sc. Published 1969 by Iliffe Books. 172 pages 8 1/2 x 5 1/2, hard covers. Butterworths, £2.10

Photoelectronic Devices provides an outline of the operating principles of all the important types of devices which detect or produce radiation in the ultra-violet, visible or infra-red regions of the electro-magnetic spectrum, with the exception of television camera tubes.

Commencing with a section on semiconductor fundamentals, the book progresses through separate sections on Photoemissive materials, Photoemissive diodes, photomultiplier tubes, homogeneous semiconductor devices, junction photo-diodes, image intensifiers and converters, and then finally, electroluminescent devices.

Chapter layout consists of an introductory theory section followed by an application section containing illustrative circuit diagrams and drawings wherever necessary. At the end of each chapter an extensive list of references is given so that further material on any topic may be readily found.

The presentation of the book is simple and uncomplicated by a great deal of mathematics, although relevant formula are given wherever required. University and technical college students will find this book a valuable source of data on a subject which is growing importance at an astronomical rate. - B.C.



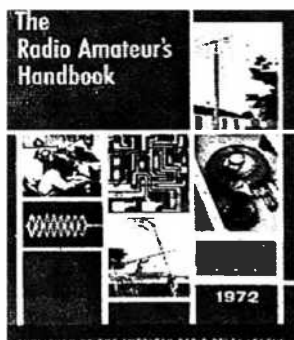
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THE RADIO AMATEUR'S HANDBOOK, 1972, by the Headquarters Staff of the American Radio Relay League. 49th edition, 1972, published by the League. Over 650 pages 6 1/2 x 9 1/2, Paperback: £2.70, Cloth: £4.00.

The following comment by the American Radio Relay League, Inc came with the review copy and we can only agree with the statements therein.

The 49th edition of The Radio Amateur's Handbook contains the most extensive revision and update ever attempted. Radio technology, especially in the areas of solid-state devices, has been changing at a rapid rate. Thus, in the 1972 edition 13 chapters have been rewritten to cover new devices and new techniques. The book has been completely reorganized to make individual material easier to find.

The changes incorporated in the 1972 edition will undoubtedly enhance the reputation of a book that has been published yearly since 1926, the only technical book on Time Magazine's list of alltime best sellers. The primary emphasis of the book is on practical approaches and practical details of the radio art. This no-nonsense format has made the Handbook popular in classrooms, research laboratories, libraries, and industrial organizations, as well as in the homes of radio enthusiasts.

Among the new sections contained in the 1972 Handbook, which has been expanded by 50 pages, are digital logic devices, linear ICs, hf and vhf antennas, broadband amplifiers, filter networks, converter designs, and ssb techniques. A new 28-page chapter on frequency modulation and repeaters has been included. Two hundred new drawings and charts have been used to present the current state of the art in all areas of amateur communications. - BC

RECORDINGS...

REVIEWERS: Tanya Buchdahl,
John Araneta

CLASSICAL

MOZART: Requiem K.626. Edith Mathis, soprano; Julia Hamari, alto; Wiestaw Ochman, tenor; Karl Ridderbusch, bass; Koniertvereinigung Wiener Staatsopernchor. Wiener Philharmoniker, conducted by Karl Balun. 2530 143. Text included, in Latin/ German/English/ French:

This is the last piece Mozart ever wrote and the piece around which there has been built a story concerning Mozart's death. Like the story of the freak thunderstorm at the hour of Beethoven's death - all true, but all highly romanticized. A certain Count was in the habit of commissioning composers to write a work which was then passed off as his own. The agent who was sent to Mozart appeared as "the mysterious stranger in grey" whom Mozart was convinced was a messenger from Death commissioning him to write his own requiem. In poverty and sickness he started what promised to be one of the greatest pieces of music in existence but he died before it was finished, leaving only the Introit/ Kyrie the first 8 bars of the Lacrimosa and a number of sketches. And so one of his students diligently set about piecing it together as best he could. His effort is commendable and surprisingly good, but as the work progresses it unquestionably sinks below the sublime inspiration of the first two movements. It demonstrates quite clearly the perfection of writing which is Mozart's, the unquestionable rightness of his music which nobody can reproduce. The requiem is Mozartean but not Mozart.

The Kyrie which of all the Kyrics (Christ movements I know, I find the most moving on this recording is taken very slowly which works very well particularly in the fugue "Christe Eleison" in which all the voices attack with convincing vigor. It's followed by the tempestuous Dies Irae and again the movement is taken slowly - too slowly I think as all the choruses except the first. Thematically and therefore musically, the Kyrie and Dies Irae are thesis and antithesis: the former is a gentle prayer for mercy and eternal rest, the latter a hell-fire warning of the impending Judgment day a Day of Wrath and Doom! So this particularly slow Kyrie would have been much better followed by a Dies Irae played presto spitting the syllables out like bullets.

The most strained chorus is the Agnus Dei which is taken so slowly as to seem an affectation on the conductor's part - the time spent in deep-breathing exercises before it is anybody's guess. I dislike listening to any piece in which I start wondering when the singers are going to run out of breath. It's the means intruding on the end (which is also one reason why Beethoven's vocally torturous choral music is not as great as his instrumental - very often you're waiting for some soloist or chorus line suddenly to collapse in ignominy). It's quite a pity in this case because the choir is obviously well trained and has a good feel for the music.

The solo movements fare much better: all four soloists sing well though the tenor is rather weak in places; Mathis sings magnificently in the recorder

and Ridderbusch excellently in the Tuba Mirum, the movement with the trombone solo (actually written by Mozart) which Einstein called a "painful fact" (even more painful for Australians because of an uncommon similarity with the theme music of "Blue Hills").

Technically the recording is excellent: it's a pity about the overdone slowness though it tends to make a funeral march of it. I mean, it is a funeral piece but it is a mass commending the dead person to God, so the idea textually ergo musically is not This Poor Bloke Down There In The Ground but on Sending This Man's Soul Up There: not putting down but reaching up. - T.B.



CARL ORFF - TRIONFO DI AFRODITE
Soloists, Czech Philharmonic Chorus, Prague Symphony Orchestra Vaclav Smetacek
Supraphon Suast 1120877.

It seems strange Trionfo di Afrodite has fared less well on records compared to either Carmina Burana or Catulli Carmina. This third installment to Orff's triptych on mundane joys is as clever, tuneful and direct as the two previous cantatas, and at least as risqué as Catulli, utilizing as it does some of the more lascivious texts of Catullus. Sappho and Euripides to depict Gracco-Roman marriage rituals. But then Orff is no longer as fashionable as he used to be in the early fifties when this music served as unpretentious relief to the mostly serial or scioso music being written even then. There is, naturally, a fine amount of truth in the statement, common enough nowadays, that once you've heard an Orff piece you've more or less heard them all. And certainly in Trionfo, some antecedents (Stravinsky's Les Noces especially comes to mind) rather unashamedly present themselves. But we do not have to enjoy masterpieces all the time and as entertainment I do enjoy Orff's triptych every now and then.

Vaclav Smetacek and his forces deliver a romp of a performance, most matters rather creditably done. His bride and bridegroom, however, merely negotiate their difficult music and with only an inkling for the ardente, sospirato, esultante. con calore. con

estrema intensita Orff had in mind.

For all the liveliness of this production, everyone seems rather inhibited, to put it rather lightly. It remains to be seen whether DGG's yet to be released Trionfo betters this presently only available recording. I myself dare not hope so since conductor Jochum's recent remakes of Carmina Burana and Catulli are decidedly less exciting than his now deleted mono only recordings. And Jochum's old Trionfo was certainly devilishly thrilling. It still seems too much for most recording companies to provide complete texts and translations of either Catulli or Trionfo and this Supraphon disc provides a mere synopsis of the proceedings, not even a complete Greek and Latin text to follow. We are still rather surprised, perhaps, at what our ancient forebears could write. Sound on this disc is good if not particularly overwhelming. J.A.A.

HANDEL: Dixit Dominus. Helen Donath, soprano; Aafje Heynis, alto. NCRV Vocaal Ensemble, Amsterdam Chamber Orchestra cond. Marinus Voorberg. Philips stereo SAL 6500 044.

A really magnificent record in all respects. This setting of Psalm 109 is very much in the Italian style and is such is very difficult in parts, but no one seems to have more than the slightest discomfort. The amazing thing is that the choir consists of only 17 singers, the quality and volume is that of twice the number. Moreover, there is virtually no individual variance in pitch which so often makes a small group sound third-rate: one voice at variance with twenty is drowned out but one against another three sticks out like a sore thumb.

Aafje Heynis sings with real feeling in the aria "Virgam virtutis tuac" (No 1) which is ideally suited to her smooth, lyric voice: and so does Helen Donath in the aria "Tecum principium" (No 3) which she sings with wonderfully sensual sweetness.

The orchestra is precise and watches all of the details without losing any of the lush richness and without making it pompous which is the Great Handelian Myth. The recording quality too is first rate as is usual on full-price Philips. Come to think of it, I don't recall ever having heard a less than first-rate technical performance on this label. The balance is superb, every voice and every line comes out dearly in its own right, and the sprightly cembalo playing by Leni van der Lee has just the right amount of attention: it's an instrument which is notoriously difficult to balance in recording.

If I had to choose the best movements I think it would be Nos. 4 and 7: No. 4 "Juravir Dominus" is a difficult chorus and No. 7 "De torrente" is a moving Pergolesi-like slow movement in which the three women soloists (Donath, Heynis and 2nd soprano Trudy Koeleman) wind their voices in and out, under and over one another in a manner which made my spine

TIN LIZZIE DAYS - Pearce-Pickering Ragtime Five Tin Lizzie Days: Rose In Her Window; Don't Monkey With It: Maison Bleu: Good Time Stomp; After I Say I'm Sorry; Felicity Rag. Cook Good Cabbage; Say It Simple: Bouncin' In Rhythm: Sweet Patootie Elite Syncopations: American Beauty Rose; Piping Hot. Swaggie SU93.

Tom Pickering is a big wig, in Tasmania's State Library - the State Librarian himself, or the assistant State Librarian. Maybe both.

He is also one of Australia's best jazz clarinetists and most interesting tenor saxophonists. And, judging by this record and its predecessor. Jazz mania, definitely our best jazz singer. By jazz singers, I mean those who are influenced in their singing directly or indirectly by Louis Armstrong, Jack Teagarden, Wingie Mannone, Jelly Roll Morton. People like Roger Bell, Will McIntyre. Dick Hughes, Ade Monsborough, George Tack. Frank Johnson and the late Warwick Dyer.

Pickering sings on five tracks of this worthy new record - Tin Lizzie Days., Don't Monkey With It, Good Time Stomp. Say It Simple. Sweet Patootie. He has just the right rasp to his voice so that it never sounds contrived. His diction is fine and his feeling for jazz unquestionable.

Roger Bell, in his sleeve notes, says Pickering's voice has "the rough grained, hoarse, good humor of a wet Airedale ... it is perfectly suited to this material and points up the purity of his clarinet nicely."

Pickering's clarinet tone is purer than it used to be. admittedly, but somehow (ye never thought of it as pure at all - until Roger Bell said so.

It's rather paradoxical - something like the tone of Bud Freeman's latter-day tenor saxophone. Some of Freeman's later playing has a tone as pure as Marcel Mule's, but somehow it comes out unmistakably as Bud Freeman's.

Anyway this is a damned fine record and the highest praise I can give it is that it comes up to the standard set by Jazzmania. No tired old warhorses here. There are two rags by Scott Joplin, which are played precisely but not pedantically, two rare Edmund Hall tunes (which may have first had an airing on that great clarinetist's Petite Fleur album), Maison Bleu (a Pearce original which would have delighted Sidney Bechel and Wally Fawkes.

Honi soil qui mal y pense, but those words to Dave Dallwitz's and Ade Monsborough's Don't Monkey With It do sound oh-so-rude and ever-so-shocking until Pearce plays his Take It From Here phrase to Tom's verbal clue identifying "it".

Monsborough also composed Piping Hot which, as a rag, scarcely suffers by comparison with Joplin's Elite Syncopations and Felicity Rag.

Good Time Stomp is a joint composition by Pickering and Pearce and a reminder that

Tom used to call his band of the late 40s and early 50s Tom Pickering's Good Time Music. Good Time music is a particularly apt description of the music on this record. It is not of the smile-darn-ya-smile look-how-unspeakably-jolly-we-are variety. Rather the rich laugh and the gentle smile.

Jan Pearce's piano playing here is as authoritative, swinging and pertinent as it was on Jazz mania.

The introduction he plays on After I Say I'm Sorry, incidentally, sounds peculiarly Australian, with doubtless quite unconscious echoes of Graeme Bell and Will McIntyre. Tom's tenor playing suggests Eddie Miller on this one.

Jan Pearce played trumpet in Tom Pickering's Barrelhouse Four in the early days of the Australian jazz revival with Rex Green on piano and Cedric Pearce on drums. He came to Melbourne in 1948 and played trombone with both Graeme Bell and Tony Newstead and later went to England where he played with Mick Mulligan. How he there got the nickname of Wylie is one of the funnier and more respectable episodes of George Melly's book, *Ownning Up*.

The rhythm works of Don Sheppard, bass, Michael Colrain, drums, and Oscar Smith, guitar, banjo, contributes enormously to the success of this record. Colrain's playing here is better than on Jazz mania, on which it very occasionally had a tendency to be ricky-ticky Smith's guitar solo work is very tasteful and his banjo is just right for the rags.

Pedants points: Maison Bleu should be Maison Bleue. What Can I Say Dear? is the title of the composition given here as After I Say I'm Sorry. - B. W.



LOUIS ARMSTRONG V.S.O.P. VOLUME 8. French CBS 62750. Lazy River, Georgia On My Mind, Chinatown, I Got Rhythm, Stardust, All Of Me, Between The Devil and The Deep Blue Sea, Keepin' Out Of Mischief Now, Lawd, You Made The Night Too Long etc. Last month we reviewed the second record of the

series, which included some of Armstrong's greatest early jazz performances. This, the last in the series (they are the two they sent us) has Armstrong fronting a band which can sound very like Guy Lombardi and coming on as the great showman. These tracks, which include at least four marvelous trumpet solos, some not so good ones by Armstrong's standards, and sixteen lightheaded vocals which show where Dean Martin got most of his slurred, behind the beat phrasing, were recorded between late 1931 and March 1932. Swaggie have a series which carries on from here, in similar vein through to the early forties.

It is an odd thing to consider that Armstrong's musical gifts were almost incidental to his massive and sustained popular career. Like Marlene Dietrich, Maurice Chevalier, Al Jolson, Elvis et al he was a popular image: the handkerchief, the perspiration, the teeth, the shaking belly laugh. While all great popular musical figures had something going for them musically, I would hesitate to ascribe musical genius to any of them except Louis. No, not even Hendrix, nor even Ray Charles would I unhesitatingly call genius in the light of all the great musical figures who have trod the earth. Louis, yes.

Thus, there is a dual interest in these rather strange old tracks. Much of it is firmly dated - as popular art which truly embodies its time must be dated and must in some degree hold a curious insight for us of a time past. The trumpet solos, mainly the ones on the second side, are timeless, tell us very little of any specific period - in fact they are futuristic, innovative, as was Beethoven's music. Louis had it "both ways. He must have been the happiest man in the world. - J.C.

STAN KENTON. Stan Kenton At Brigham Young University. Quadraphonic/Stereo. Compatible ST-1039 (CBS-Sony SQ matrix system)

We won't devote too much space to this double album because it is available only through Creative World, Box 35216, Los Angeles, California 90035. I am often sent Kenton albums, both old and new, so I thought I'd let the Kenton fans among you know what Stan's up to and how you can get his records.

Kenton opened my ears to a lot of sounds when I was a teenager, and I used, to take great delight in playing a Kenton record to my strictly rock and roll friends and seeing their astonishment as the cataclysmic dissonances thundered out. Now I would rather hear Little Richard, though it still gives me a charge to hear a Kent band blast off. I know that rock fans today would go out of their minds hearing them live, just for their great breadth of sound - something you just can't get with three guitars,

RECORDINGS...

REVEIWER: Michael Delaney

POP TRENDS



"MALO" - Malo. K46142 Pana - Just Say Goodbye - Cafe - Nena - Suavecito - Peace.

The drawback about Malo is that they're trying to ape the approach pioneered by Santana without that self-same fluency and detail afforded to the multiple rhythms. This ten-piece Latin group led by Jorge Santana tends to force itself upon each of the six cuts with a formal jazz design marked obvious by the unsophisticated brass/keyboards figures. They've tried to project, that random development with regard to melody, safeguards the spontaneous without actually becoming involved to the point where anything outside a quick guitar/percussion passage ever occurs to warrant their enthusiasm. There's a whole lot of beautiful feeling gone down into this album but it's all been misdirected due to their lack of knowledge. Malo doesn't really know how to use tone and texture. There's just not enough contrast between light and shade and differentiation between tempos. It always seems to fall a little below the mark no matter how hard they seem to try:

Malo is a good band simply because they sound like they're having fun with the music. They utilize their limited range with flair and imagination but it still makes them look like a second grade rip-off from Santana. "Just Say Goodbye" is the one track that features a tangent approach to the percussive rhythms. It's a haunting love song - low key atmospheric and close to the most worthwhile thing on the entire album. It makes you realize that Malo is going to be one helluva good rock/rhythm band once they get their own identity into focus. As things stand at the moment there's not much room for another Latin American big band due mainly to the monopoly imposed by Jorge's brother Carlos. The essential difference between the two outfits is nothing more than the youthful excitement of Malo compared to the ageless technique of Santana. Malo tries real hard to be subtle - but the mere fact that they've got to try, leaves them at an immediate

disadvantage. They're not a soft group and shouldn't delude themselves into thinking that they are because it'll soon sap all the guts out of their form. "Pana" and "Suavecito" stand as the other highlights.

Production is amazing once you consider that the album was recorded in L.A.'s old Pacific Studios - the stomping ground of West Coast musicians circa 1960. Malo is going to be a good band but I'll hold my breath till album No. 2 before I say anything more. M.D.

"DOMINO" - Van Morrison. Kinney. Stereo. WS. 2487. Domino - Crazy Love - Call Me Up In Dreamland - Cyprus Avenue - Come Running - Madame George - Blue Money - Brand New Day - Slim Slow Slider.

Van Morrison is quite fascinating. He just about defeats any attempt to either describe or illuminate his character in much the same way as Stephen Stills. His style does it level best to defy comparison due to the eclectic influences that predominate throughout. Each song sounds a bit familiar mainly because of the insistent jazz phrasings evident in his more pronounced balladic approach. "Domino" can't really be called a rock 'n' roll album as the energies involved relate to narrative blues.

Morrison is a tasteful performer. His music is at once deceptive and perplexing - not unlike Stills in a much less neurotic frame of mind. The central form adds continuity to his style by focusing on several simultaneous directions this permits him to act as both poet and interpreter without a loss in the dynamic interplay. He has a natural restraint that checks every move. Morrison is one of the few American based solo artists who hasn't developed a false refinement inhibiting subtlety and colour.

"Crazy Love" is perhaps the finest song for his emotive images. The arrangement is constantly underplayed so as to allow complete scope for each nuance to take form. "Madame George" - a cut from his first Kinney album "Astral Weeks" - is the one major highlight due to the nature of the concept. It's interesting to note that Morrison has never employed this particular mode outside that debut disc. More's the pity because, it proves time and again to be his most distinctive.

The general effect is mellow - less than energetic; sombre in tone. "Cyprus Avenue" ventures nearest in design to the "Astral Weeks" mode despite the labored atmosphere. "Come Running" is the obligatory raver along the lines established by the title track "Domino". Somehow this composite album comes together in a very appealing way - Morrison is an addictive songwriter. He has the ability to hold people spellbound. This guy sure has come on since the days as lead vocalist for Them. I bet you can still remember "Gloria" and "Baby Please Don't Go". - M.D.

AMERICA



"AMERICA" - America, K46093 2576. Riverside - Sandman - Three Roses - A Horse With No Name - Children - I Need You - Here - Rainy Day - Never Found The Time - Clarice - Donkey Jaw - Pigeon Song.

The thing that'll always sell America to any audience is the smile running through their songs. They might sound predictable if not imitative in approach but you're still going to find it hard not to react along with their facile beauty - innocent and free; almost bashful. This English trio late of New York has enjoyed a routine evolution with particular strength placed on the acoustic elements in so far as their Messiah seems to have been Crosby, Stills & Co circa "Suite: Judy Blue Eyes". In actual fact their whole style has been hatched by integrating the harmonic tenderness of the former with Bread's cocktail romanticism as per "Make It With You." From all of this they've devised a way to sing about love without ending up maudlin. America produce songs with a great deal of heart that seldom cross the demarcation line that separates the noteworthy from slop

The reason America can communicate so thoroughly has little to do with their musical standard as such, although it does count to a small degree. This band is a success because their essential character is both gentle and considerate - the gentlest I've heard since Seals & Crofts first discovered the mandolin. They respect music and worship its abilities to transform fact into fantasy - the most effective method to reach out and touch the dreams within us all.

There's nothing on their first album that you'd call brilliant, if you were out to criticize with values based on their original content, simply because "it's eclectic by nature and amorphous in function. America viewed from this angle would no doubt appear to be an ultimate rip off. But it's all to do with their loveliness - the counterpoint and multiple phrasing; swift harmonies and guitar combinations that glow and shimmer and glide. It's all to do

with the elusive imagery and the cascading warmth about each tune whether it be a ballad such as "I Need You" or an up tempo cut like "Riverside". America can remain lyrically sensitive whilst contributing more to the tonal balance of their style disassociated from the voice. They work around their range of textures limited as it may be and make them complement each other without undermining the initial mood. America purely refuse to introduce contrasting sounds thus maintaining complete simplicity and precision. So what if "A Horse With No Name" appears to be a pinch from Neil Young. It just doesn't figure like that these days because the song itself is beautiful and that can only be the final estimation regardless. Production is fine. "America" is a magnificent debut record from what promises to be an equally magnificent group. Get into it now and avoid the rush. M.D.



"FRAGILE" -Yes. Kinney. K50009

Roundabout -Cans & Brahms -We Have Heaven -South Side Of The Sky - Five Percent For Nothing -Long Distance Runaround -The Fish -Mood For A Day - Heart Of The Sunrise

Yes have developed into one of England's top bands simply because they've realized the need for a high degree of technical precision to support their complex style. It breaks down to a case of having sufficient skill and insight to utilize the available sound without misdirecting the major influences -most of which relate fully to a modern classical theme.

"Fragile" is their fourth album and finds the group concerned more with the expression of separate characters than that of the general approach as a unit. This is quite possibly the most significant thing about the record because they've been able to both compromise and counter balance the two aspects without either one suffering as a result. Yes have reached the point where they've been forced to introduce the personal ideas of each member as a move to prevent the composite range from stagnating. This enables them to maintain their overall identity whilst engaged more with individual pursuits -the best of which are channeled back through the band as new material. "We Have Heaven" -a multi vocal suite by singer/songwriter Jon Anderson and Rick Wakeman's "Cans & Brahms" stand out as the most successful of the five solo projects contained herein. The latter is an adaptation of an extract from Brahms' 4th Symphony In E Minor. It just goes to show how far a rock band can progress if they're prepared to play music and not spend every moment trying to get it on.

Yes occupy a unique position compared to

most other name outfits because their sum is equal to the whole. This band works with such a permissive flexibility in both method and design that it can juxtapose instrumental structures from motion to movement without conflicting with the score. "Heart Of The Sunrise" was built on a Stockhausen premise where each tempo/texture is forced through a number of simultaneous changes with the resultant rhythm handled in counterpoint. It's a matter of stretching and editing the melody to create an atmosphere unrestrained by a mere vocal passage. "South Side Of The Sky" was written along similar lines except for the pronounced lyric that takes its strength from the percussion and not the guitar/keyboard as one would expect with Yes a la "Roundabout".

I'd say that "Fragile" will end up as their definitive album because it seems to be a perfect climax to four years on the road. It's Yes at their peak and they're not going to get much better. Buy some. M.D.

"MARY CALLED JEANIE GREENE" -Jeanie Greene. Kinney. K42013

Yes I Do Understand -You Know Who You Are -Put Your Good On The Line - Thank God He Came -Like A Road Leading Home -Swaziland Remembered - Joa Bim -Mighty Time -Magdalene's Medley -Pr&Recognition -Only The Children Know -Peter Put Away Your Sword -Going Home.

As a singer/songwriter Jeanie Greene explores well-defined areas of White Gospel with a deceptive poignancy that prefers detail in arrangement to both depth of mood and contrast in performance. Her songs could have gone down as light hymnals had it not have been for the over-zealous production that seems to embellish everything except her own voice quite out of the context. There's just so much unnecessary background movement that her soul has been all but suffocated in the vast reservoir of pseudo-spiritual Memphis Muzak. Jeanie's message is based on the simplicity of her religious devotion not on the excellence of her Muscle Shoals producer Don Nix. I'm almost certain that she could have done herself greater justice without resorting to a sound cross between Isaac Hayes and The Staple Singers. This simply serves no purpose other than to provide an ego boost for the boys in the back room.

The most unfortunate thing about this album is that the songs just weren't meant to support the intricacies of an orchestral backing. There's too much of a strain placed on each tune and this just projects further the conflict between the artist and the poor coordination. Jeanie's songs are essentially introspective pieces that neither demand nor expect more than an ample acoustic base. "Joa Bim" and "Going Home" are the best examples of her work mainly due to the lack of instrumental motion. She just sings and sings. And that's why they're so good. "Peter Put Away Your Sword" stands alongside "Only The Children Know" as the two cuts that appear most suitable for the rather lush accompaniment. But even these tend not to sound authentic despite the obvious restraint self-imposed by director Jay Pruitt. "Mary Called Jeanie Greene" lacks feel and this is the most important aspect about Gospel. Half-measures that force compromise can only result in musical anemia. I would've thought that Don Nix could've done better particularly due to the fine work on his own solo album "Living By The Days". I've heard worse. M.D.

JAZZ

however loud. Perhaps it was the accessibility of the sounds like a catalogue of what you could do with instruments waiting for someone to take it all and give it a deeper meaning which made it pall. Gil Evans or Ellington, for instance, I still dig even more than Little Richard.

So much for my likes and dislikes. This is a recent Kenton band performing to a young enthusiastic audience in Mormon country and how like Mormon architecture Stan's music can be! It is much looser and possibly even louder than earlier bands and there is a heavy concentration on Latin rhythms, making it pretty accessible to a rock audience. They generate an undeniable excitement, which only starts to sound superficial after you have heard one side - to my ears anyway.

Stan opens the proceedings by promising his audience that they are going to take a bath in sound. The promise is definitely fulfilled. J.C.

MILES DAVIS -Miles Davis Live CBS - Double Album. Musicians include Miles Davis, trumpet and electric trumpet with waa-waa device, Keith Jarrett, piano; Jack de Johnette, drums; Joe Zawinu]. Chick Corea, Herbie Hancock, keyboards; John McLaughlin, guitar; Airto Moreira, percussion; Dave Holland, bass; Gary Bartz, Steve Grossman, alto and soprano saxes; William Cobham, drums.

It is hard to decide whether Miles has worked the only really successful jazz rock fusion, or whether he has just taken rock and turned it into another kind of jazz; given it the flexibility and adventurousness of jazz improvisation while retaining the simple and sustained cathartic quality of rock.

One could be excused for thinking: alright, electric rock has opened up some extraordinary tonal possibilities, but nobody seems to be particularly interested in exploiting them (what Pink Floyd usually does is to graft effects, often intriguing ones, onto fairly straight-forward rhythms and melodies; they rarely achieve a true integration of electronics and music in the way Hendrix's tonal distortions were part of the music, or Duke Ellington's growling and talking brass). It's as though Hendrix and The Who had done it all and everyone else was satisfied to stay within that spectrum.

Miles Davis listened to rock records almost exclusively for a few years before emerging with his electric sound. It's rumored that Oapton had been recommended "for the band, and that Miles listened to him in the studio, shook his head and left Obviously Miles was not going to bring out a band that would be, well, just another rock band. Miles did not emerge as part of the rock scene. He emerged about five years in front of it.

Around the time Miles was professing his dislike for the then avant-garde in jazz he was actually listening to Ornette Coleman's "new thing" every night in New York. Bill Motzing, late sound man with Blood Sweat

and Tears was there too. He told me that he waited two years before detecting any of Ornette's influence on Miles's playing. In terms of his reputation Miles was too cunning and in terms of his own artistic satisfaction too intelligent to just begin copying what either rock players or the new jazzmen were doing. He waited until he'd absorbed it and transformed it into something entirely his own. On this double album are several different bands. Each is a variation of Miles's concept, each could only have been led by one man.

What Miles and his men do with what is amazingly enough the same basic eight or four to the bar which sounds so antediluvian under Black Sabbath or Grand Funk, is practically beyond comparison. Their amazing time feel is hinted at on a record Howlin' Wolf made for Chess (I remember one track which starts off with two rhythms going simultaneously; a feeling like that of those foot-ways which move in segments in fun parlors; before dropping into the basic beat with an abruptness which throws your heart up into your mouth) but Miles goes way beyond that.

Sometimes they will impose a complex cycle over the basic beat. Then they will leave everything out except an accent in this cycle, an accent in the next. The effect is cryptic, almost unbearably tense. The accents start changing, swapping from one man to another. Ping when is it coming? ... Zap! You feel that you are being sniped at. Sometimes they will pull the rhythm pattern slightly out of phase - and they will continue to play like that, all conversing with each other, all developing individual ideas, all out of phase, without ever losing the basic pulse. As one man they will snap it back together. Tension and resolution. That's what music is largely about. Nobody makes music quite like these truly amazing musicians who must surely be able to read each other's minds.

Further, they've all developed a kind of shorthand: single inflected notes, tiny chromatic clusters clinging to the very cliff edge of a time change, sometimes popping and bubbling like rhythmically phrased serial music - in fact like the sudden shifts and darts of some cellular process. The earthy and the ethereal commingle, as in this changing life. Rhythm and melody are one. The music seems as full of amazing forms as a coral reef, but it is not cluttered, because there is no redundant note: everything is played in response to something else, except for Miles' statements which are like the voice of god. Where he uses the Waa Waa, though, Miles gets more involved in conversation with the others than he has done previously.

Parts of this double album are actually the closest Miles has come to straight hard rock. It is not so loose and adventurous, but damn near. Jarrett and de Johnette are superb and Miles' too brief open solos are some of the most intense he's ever recorded. Probably the best introduction to Miles of all his recordings. Sound is superb, though the trumpet could have been up a shade.

Unbelievable through headphones. J. C.

CLASSICAL

tangle. But that was a difficult choice and the whole product is a masterpiece of singing, conducting, playing, recording - tasteful cover - the lot. - T.B.

BEETHOVEN Symphony No. 6 "Pastorale" Overture "Prometheus" Colin Davis, London Sym. PHILIPS 6580 050.

Another reissue on PHILIPS UNIVERSO series. Attractive enough at the price (\$ 3.95) and with typical "music appreciation" notes on "the world around the music" - very useful for schools, I suppose. This performance is certainly a good one. It is straight forward and impeccably played. But what is lacking here is any feeling for what can make the Pastoral a magical experience. Colin Davis traverses Beethoven's countryside with an almost cold-blooded lack of regret. This is a reading, nothing more. Nothing excites Davis to seek for any subtleties, not even the storm. Its main attraction, then, is the price tag. Anyone really interested in this music must not hesitate to look elsewhere.

J. A. A.

LISZT - Piano Concertos I & 2. Byron Janis (piano) Moscow Philharmonic, Kiril Kondrashin (in No. 1) Moscow Radio Orch., Gennady Rozhdestvensky (in No. 2). PHILIPS 6582 003.

Janis obviously has a formidable technique for these tired concertos. Nevertheless there are moments particularly towards the end of both works when he seems to lose control and the momentum is somewhat lost. These instances are always minor enough, however, and never really detract from these otherwise technically fine performances.

Both Russian orchestras accompany with verve if not always with the greatest refinement. At the PHILIPS UNIVERSO price (\$3.95) these performances are certainly more than acceptable and the recording is always vibrant and clear. But for not much more, one really can acquire a performance that is not only tremendously exciting but also remarkable.

The Richter-Kondrashin recording (PHILIPS SAL 207) is furthermore wholly believable, which is what one likes to expect in this music. Richter does not sound tired of the music as I suspect Janis and his colleagues are, and I feel this is a quality one must avoid in this music. J. A. A.

BEETHOVEN: Piano Sonatas; no. 23 in F minor Op. 57 (Appassionata), no. 32 in C minor Op. 111. Alfred Brendel. Philips Stereo SAL 6500 138.

BEETHOVEN: Piano Sonatas; no. 29 in B Op. 106 (Hammerklavier), no. 24 in F sharp Op. 78. Alfred Brendel. Philips Stereo SAL 6500 139.

Alfred Brendel is one of the best pianists alive today, and if you don't believe me, listen to these records. It's very easy to turn Middle Beethoven into kitsch and Late

Beethoven into an empty mockery - there are plenty of pianists who avoid this but amazingly few who really understand what they are playing, for example the great Beethoven pianists Arrau, Kempff and Backhaus. Now we have two more great interpreters, Barenboim (the only pianist I

know who can express total calm) and Brendel, with his light, clear touch and the rare virtue of being able to stay off the pedals when so required.

He plays the Op. 78 as it was intended, a token of friendly affection for Therese von Brunswick, simple though written in the rather fumble key of F sharp major (six sharps). But the other three sonatas are much more interesting, because they are major essays of three different kinds.

The 'Appassionata' is the second sonata of the Middle and most popular period. It retains the early brilliant and witty originality (Beethoven after all was known in his day as a virtuoso pianist, not a composer) but hasn't gone into the late personal intensity and near incomprehensibility. But all the signs are there the hands playing octaves apart, the use of the trill as part of the melody rather than an ornament, and the rarefied subtle use of the diminished seventh. Brendel plays magnificently - he saves the first double-forte chord sequence from sounding like a lapse into bad taste, he projects the blunt stubbornness of the final movements presto ending, the unmistakable Beethoven perversity, just to mention a few delights.

The 'Hammerklavier' is the second sonata of the Late period and one of the most difficult pieces in all piano literature both technically and emotionally. It is only recently that pianists have dared to hazard it. Here is the fully-developed late style with all its trademarks, its intellectual and emotional gymnastics of near-maniac proportions, and in the last movement all combined in a mammoth fugue of harrowing profundity. Like the 'Grosse Fuge' string quartet Op. 133, one's first impression of it is disbelief, of wondering what stunt Beethoven was trying to pull. It's no stunt, just one of the greatest piano pieces ever written, and Brendel has come closer than anyone else I have heard to playing it properly. No faceless technical perfection, no muddy inaccurate emotionalism, but beautiful balance between the two.

The Op. 111 is a different proposition again. It's the very last sonata, and I happen to think it is one of the most sublimely beautiful and moving pieces of music in existence. It's universal - but intensely personal at the same time, which is the way it is with all great art. It has only two movements, allegro and aria with variations (another form which Beethoven developed just about to its limits), and as Brendel points out in his excellent cover notes it is theses and antitheses. The drama and passion of the first movement is countered by an aria of almost naive simplicity and incredible beauty - "simplicity as the product of complexity: distilled experience." Which is a pretty neat way of putting it. Again Brendel plays superbly, though purely as a matter of taste I prefer Barenboim's recording because he uses more weight and rubato in the first movement. But that's only taste, and there's no doubt that Brendel's performance is first rate, containing meticulous attention to detail, brilliant technique, and real personality which he projects through his very moving expression. And he keeps Beethoven's sense of humour too, which appears all the way through to his last work. You can't describe where to find it or what it is, it's just a feeling you get that Beethoven was laughing at something, probably himself. Which makes it a wider experience. - T.B.

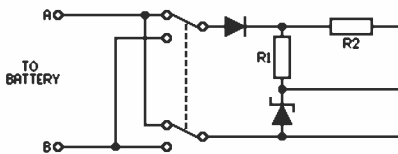
INPUT GATE

LETTERS FROM OUR READERS

MAY ISSUE PROJECTS

Regarding the Flash Unit Project in the May issue, it should be noted that the SCR is polarity conscious and the flash gun connections may need reversing to make the unit work.

For the Battery Saver Project in the same issue, may I suggest that automatic protection against reverse-polarity of battery connection can be achieved by modifying the circuit as shown.



The addition of a 2-pole 2-way switch gives on-off control as well; the switch, as shown, is set at 'on' for positive battery lead to A or alternatively at 'off' for negative battery lead to A. - P.F.H., Corby, Northants.

BASIS FOR STUDY

Please supply two copies of the April issue of your excellent magazine, which we missed when it was published. We are particularly interested in the series 'Practical Guide to Triacs' as this will form a basis at the study sessions of our Technical Society. Congratulations on your new monthly which fills the gaps left by others. - D.H., Worksop, Notts.

HOW WE TEST

I was very impressed with the content and style of your magazine. It is a pleasure to find a magazine with eye-appeal as well as articles of wide interest and high standard all the way through.

I am particularly interested in how you conduct frequency response tests on speaker systems and how the home experimenter could obtain some quantitative results. - P.S., Cambridge.

Speaker tests are carried out in an anechoic chamber, with extremely linear laboratory pressure microphones measuring the acoustical response. Manufacturers graphs generally tend to show a smoothed frequency response (by using a long averaging time). Our quantitative tests will show the true frequency response and are almost always supplemented by listening tests in typical home user environments. Means such as anechoic chambers, calibrated microphones and instruments are probably beyond the means of the average home experimenter, although one has heard of committed audiophiles who have clubbed together to construct and equip comparative test chambers. - Ed.

PIECE DE RESISTANCE

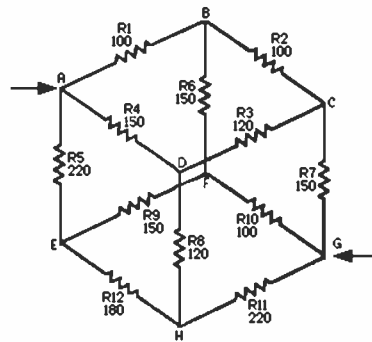
For several years I have been attempting to obtain an answer to a puzzle involving a rectangular square frame each rail of which consists of a ten ohm resistor.

The problem is to establish the total resistance, from one corner, to the corner diagonally opposite.

Every time I attempt this problem I come up with a different method and a different answer. It's driving me up the wall!

Many thanks for a wonderful magazine - I enjoy every issue.

K.H. Woy Woy, NSW



Believe It or not, there is quite a simple way of solving this one - apart from an AVO and a handful of 1% resistors! We are sure that many of our readers would like to have a go at it but we have made it just a bit harder by using a number of different resistor values so a year's free subscription to the first ten letters containing the correct (within one ohm) mathematically obtained answer to the question: What is the resistance from point A to point G on the drawing above? Also included in the answer must be a very brief description of the method used to get the answer.

To give our distant readers a fair go, we will not open any entrant's letter until September 1st.

Just draw a large ohm sign on the bottom left corner of the envelope when mailing it to our EC4 address. Remember that we need the answer and a brief description of how you obtained it. - Ed.

PROJECT COST

Congratulations! Your magazine covers a large and interesting area of electronics. May it long continue to do so.

Re your projects, which I find very practical and of an advanced nature; could you not give an approximate cost for each project? - R.W.B., Southport, Lanes.

We have had similar requests for approximate project cost to be indicated, but there are some difficulties. Several readers feel that this information would enable them to decide whether to start a project immediately or shelve it for later. How do other readers feel about it. - Ed.

QUAD-WRANGLE

As a result of an out-of-court settlement, RCA have changed their trade mark from Quad 8 to 08. Several other firms have also withdrawn names infringing our trade mark while others have devised various ways, e.g. QUAD-10, of trying to get round the problem.

QUAD is, and has been for two decades, the trade mark of the Acoustical Manufacturing Co. Ltd., registered in nearly all the leading countries of the world, and we would appreciate your cooperation by consistently using quadrasonic, quadrasonic, four channel or similar names in your editorials and articles on four channel reproduction. - J:H. Walker, Acoustical Manufacturing Co. Ltd., Huntingdon.

Noted - with thanks for the information. - Ed.

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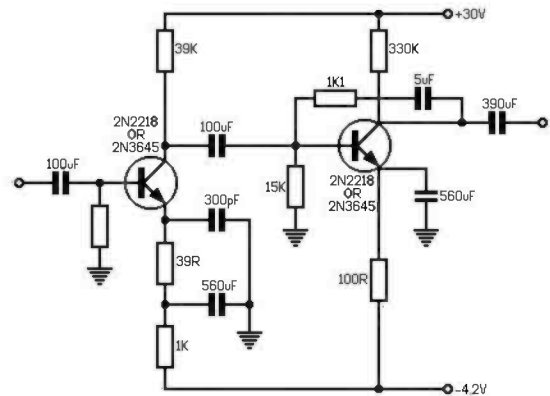
SIGNETICS NE555V Timer first time offered to constructors.

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TECH-TIPS

VIDEO POWER AMPLIFIER



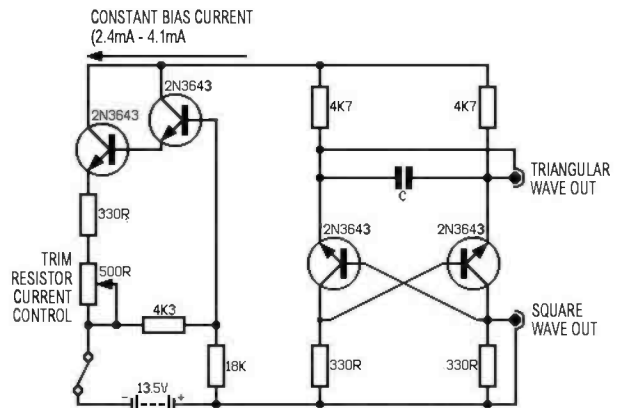
The amplifier shown has a frequency response of from 5Hz to 30MHz and is capable of giving a 10 volt output into a 100 ohm load. The circuit provides 26 dB gain and has excellent stability and linearity.

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BAW 63	36p	BCY 72	15p	ME 0412	15p	2N 708	12p
BAW 65	36p	BCY 89	97p	ME 0413	12p	2N 753	10p
BAW 67	35p	BD 115	75p	ME 0462	19p	2N 919	45p
BB 105	37p	BD 124	80p	ME 2002	8p	2N 920	42p
BBY 20	37p	8D 131	75p	ME 4003	12p	2N 1302	17p
BC 107	10p	8D 132	80p	ME 4102	10p	2N 1304	21p
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BC 116	20p	BF 125	25p	MEF 104	34p	2N 3055	55p
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WIDE RANGE MULTIVIBRATOR



In the circuit shown the multivibrator section is driven by a constant current generator. This causes the square wave across C to be flat and the triangular wave across resistor A to be linear. When the constant current is varied, the repetition rate of the multi is varied by 70% with the current control, and from 5Hz with C equal to 100 microfarad, to over 2.5MHz with C equal to 330pF.

Voltage to frequency conversion may be performed by injecting an analogue voltage into the base of the first current regulator transistor.

TECH TIPS

Circuits described and illustrated in this section are derived from manufacturers application notes, readers letters etc. They have not necessarily been tested by this magazine.

The section is intended primarily as a source of ideas for electronic engineers.

Because of the nature of the information we cannot enter into any correspondence concerning any of these circuits, nor can we provide any constructional details.

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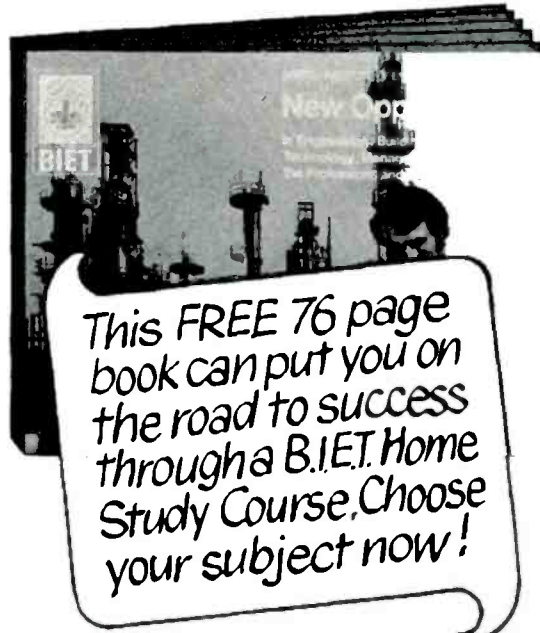
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