BRITAIN'S DYNAMIC MONTHLY

JANUARY 1973 20p

electronics TODAY INTERNATIONAL

ALL ABOUT FIBRE-OPTICS

SPECIAL FERRANTI RADIO PROJECT

electronics TODAY INTERNATIONAL

JANUARY 1973 Vol 2 No 1

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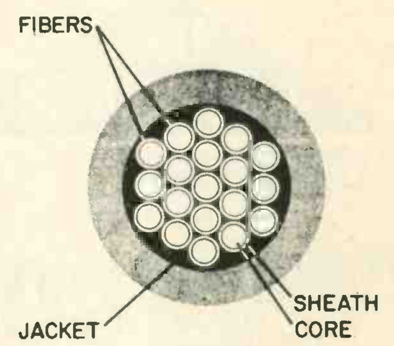
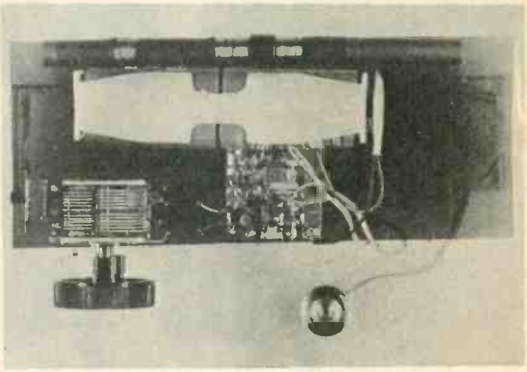
news & information

COVER: Fibre optics in the home. These space age fibre-optic table lamps are available in a variety of forms.

mini – features



"CROFON" LIGHT GUIDE



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Shaun Kannan
Editor, British Edition

the electronic mad-hatter machine

IN the April edition of ETI we reported on the biological feedback experiments conducted at Harvard Medical School. By watching an oscilloscope display of one's own brain waves, and by thinking about it, it is possible to achieve control over a surprising number of unconscious bodily functions. For example it is possible to will down one's blood pressure or body temperature, to increase learning rate or improve memory.

Now Aleph One Limited of the UK has released a range of instruments for professional and Do-It-Yourself feedbackers. Using these instruments it is claimed one can reduce headaches or produce relaxation at the end of a hectic day.

It is also claimed that the units can be used to reduce drug abuse. Dr Robert Wallace of Harvard Medical School found that the people who indulge in 'alpha' meditation were more likely than others to have once been on drugs, and that turning on with biological feedback actually replaced real drugs. So it seems we now have a new tool to fight drug addiction. Or do we?

It is to be hoped the tool itself does not become an addiction with people switching-on to electronic-phantasy land.

Don't go through the looking glass Alice, there's an electronic way to take that trip.

ETI

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news digest

COLOUR TV ON DISK

A Philips development team has succeeded in creating a new system by which colour programs lasting thirty to forty-five minutes can be recorded on a disk resembling a gramophone record of normal LP size.

For the play-back of these video long-playing records, a player has been developed that is equipped with an optical pick-up system and can be connected directly to a TV set.

The system combines pulse code recording techniques with 1500 rpm turntable speeds to obtain the signal output density needed for video and audio playback. This is identical with the approach taken by Telefunken on the Teldec system it plans to market late next year. (This system was described in detail in Electronics Today – April 1971).

However, Philips substitutes an optical pickup for the contact pickup chosen by Telefunken, reportedly providing sufficient groove density to get up to 45 minutes of continuous playback per side. Each side holds 60,000 frames.

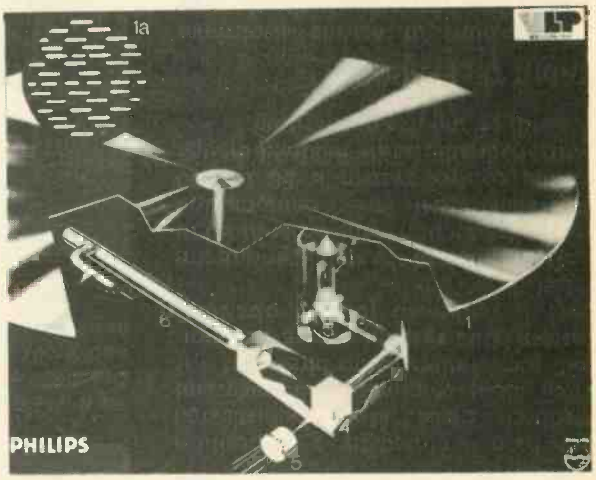
The small helium-neon laser, which Philips says is inexpensive and can be mass-produced by a new specially developed production method, feeds through an automatic-focusing lens and the beam is reflected up by indentations on the metallized vinyl record to a photo diode, amplified and processed, and fed directly to the input of any TV set.

Philips uses a track monitoring system in the pickup head, and feedback is used for continual compensation to keep the groove in line.

As the system operates without contact between pickup and record, usage life should be extended.

The system is extremely flexible in use (providing, for instance, stills, slow-motion, or even reverse-motion pictures from the recorded scenes).

This opens up new possibilities in the diffusion of information in picture and sound.



Schematic representation of the new Philips VLP system.
1. Video long-playing record. Detail (1a) shows the pattern of pits. (pits appear white).
2. Spring-suspended lens with automatic focusing of the light beam.
3. Hinged mirror for following the track.
4. Beam-splitting prism.
5. Photodiode (detector).
6. Light source.

NUCLEAR COMMUNICATION

A revolutionary communications technique using *neither electromagnetic radiation nor electric current* has been developed at the US Argonne National Laboratory by physicist Richard C. Arnold.

The totally new method uses *ultra-lightweight* nuclear particles called muons. These particles have so little mass that they are able to penetrate dense shielding.

Using Argonne's high energy synchrotron, Arnold has successfully transmitted and received coded messages over distances exceeding 150 yards – through two feet of dense concrete, a caravan full of computers and a metal building.

The consequences of the Philips video long-playing system for such widely varying purposes as education, information retrieval and, of course, entertainment, will undoubtedly be far-reaching.

The unit is not yet available commercially.

Although proven technically feasible, it is not yet known whether or not the technique is practicable commercially. If it proves so to be it will find applications in inner city communications.

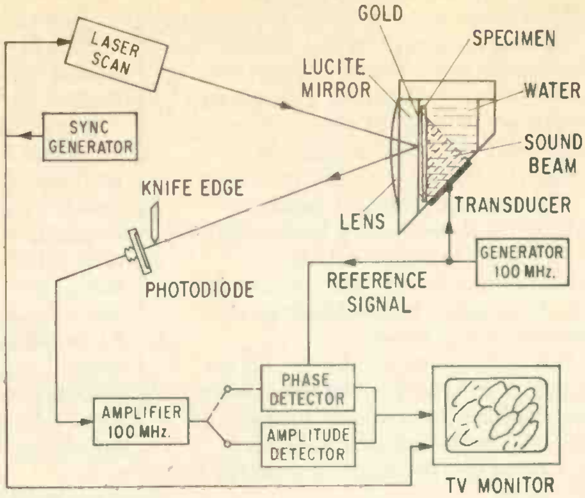
AVIS RENT-A-CAR TO GO ELECTRIC?

Latest news in the quest for a practical electrically powered vehicle is that the US Atomic Energy Commission is researching a new type of battery.

Still very much in the experimental stage, these batteries use sodium or sulphur salts and are stated to be very much cheaper and lighter than their lead-acid equivalents. Some authorities are quoting prices as low as 25 cents/kW/h compared with the typical 48 $8/kW/h for lead acid batteries.

Car rental companies are now looking very seriously indeed at electric vehicles for city hiring. Avis Rent-A-Car for one are known to be very interested in the electric vehicles being produced by Anderson Power Products in Bedford, Mass.

news digest



ACOUSTIC MICROSCOPE

Acoustics and holographics have been combined in a microscope developed by USA's Zenith Radio Corporation.

The specimen to be observed is immersed in water and ultrasonic energy – at 100MHz – is passed through it.

The ultrasonic energy – now carrying spatial information derived from the specimen – is superimposed on a plastic mirror thus causing a minute ripple pattern to appear on the mirror surface.

A laser beam scans this surface. Ripples cause the laser beam to be deflected and this deflection is picked up, converted into an acoustic hologram, and displayed on a TV monitor.

At present, resolution of the acoustic microscope is one-thousandth of an inch. However by increasing the ultrasonic energy frequency from the present 100MHz to 5000MHz it is hoped that the resolution of this new instrument will approach that of conventional optical devices.

Advantage of the new technique is that as sound is a mechanical wave motion whilst light is an electromagnetic wave motion, an acoustic instrument can magnify details that are not apparent when seen through an optical microscope. This is of special importance in biological studies.

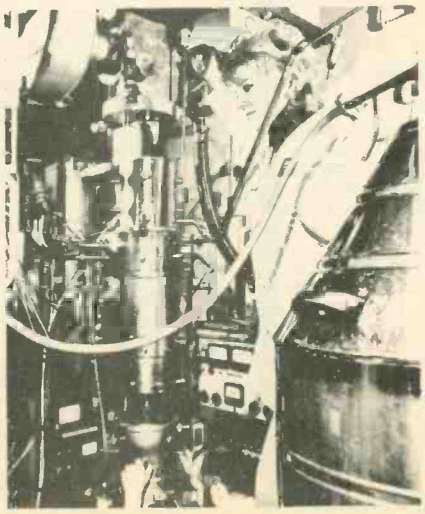
CRYOGENIC ELECTRON MICROCSOPE

In Munich, Siemens research workers are developing a new type of electron microscope which they hope will eventually be able to produce images of atoms. The technique involves ultra-low temperatures near absolute zero.

A fundamental limit affecting all microscopes is their resolving power. The best electron microscopes now resolve about three ten-millionths of a millimetre.

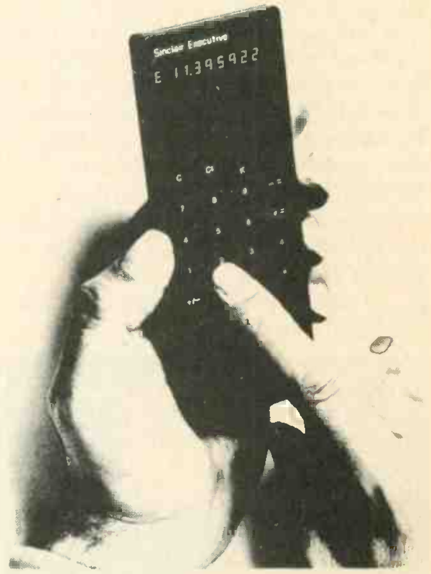
To improve resolution further, the electron beam which creates the image would have to pass through a stronger magnetic field. In the conventional design "magnetic lenses" consist of an iron-cored coil whose strength cannot be increased beyond the point where the iron is magnetically saturated.

Instead of the iron core, Siemens employ an iron-free system making use of superconductivity, i.e. the phenomenon which allows an electric current to flow without resistance at temperatures near absolute zero (-273^{o} Celsius). This method has produced a magnetic field strength twice as high as the previous possible limit. A further advantage is light weight. A conventional iron system in a high-energy electron microscope with a "beam voltage" over a million volts weighs two tons, while the superconductive design including the low-temperature cooling equipment would only weigh 45lbs or less than one hundredth of the weight.



Although considerable problems have yet to be overcome, particularly regarding superconductive material, results obtained so far indicate that the experimental microscope is based on a sound principle and promises one day to lead to the aspired goal.

WORLD'S SMALLEST ELECTRONIC CALCULATOR?



What is claimed to be the world's smallest electronic calculator, at just over ¼ inch (0,250mm) thick, has been introduced by a British electronics manufacturer Sinclair Radionics Ltd, London Road, St. Ives, Huntingdonshire, England. Called the Sinclair 'Executive' it measures 2 inches (50,8mm) wide by 5½ inches (139,7mm, long and is claimed performs all the functions of large desk machines. The total weight, including batteries, is 2½ ounces (71g approx.)

The illuminated display has a capacity of 8 digits and the machine will add, subtract, divide and multiply virtually instantaneously. Other features include automatic squaring, reciprocals, fixed or floating decimal point operation, and a memory for locking-in instructions to repeatedly multiply or divide by a pre-determined factor (this greatly speeds a series of calculations with the same factor, eg. currency conversions or discount prices). Power for the calculator comes from three low-cost 'hearing aid' batteries measuring about ¾ inch (19mm).

news digest

PYE TMC UPDATES THE TELEPHONE

Pye TMC Ltd announces a major new development. It is applicable to any ordinary dial telephone and simplifies the making of calls, particularly numbers that are used frequently. In the form of an add-on unit it brings three important improvements to the ordinary telephone.

1. It replaces rotary dialling by press button signalling, thereby simplifying operation and improving the chances of getting the right number.
2. It has a memory. If, before making a call to a frequently used number appropriate buttons are pressed, the unit will remember the number it has signalled and repeat it automatically when required for future calls. The number will be repeated if only two buttons are pressed, so obviating the need to dial a string of digits each time, as would be the case with an ordinary telephone. Ten such numbers can be remembered and it is easy to change them.
3. The third important feature is the 'try again' facility. It always remembers the last number manually keyed, even after the handset has been replaced for an indefinite period. Thus, if a number is engaged when first called it can be tried again, any number of times, by operating one button instead of going through the whole performance of dialling. This number remains available for press-button operation until it is replaced by manually keying a further number.

The new equipment is based on MOS/LSI techniques, a field in which Pye TMC Ltd is particularly experienced, having been first in the world to apply this technology to telephone equipment.

It is designed as an add-on unit for use with an ordinary dial telephones and replaces the 'dialling' function on the telephone instrument without impairing this should it be required at any time.

Operating from telephone line power, the unit, when approved by the PTT authorities concerned, can be fitted to any standard telephone line anywhere in the world by what is virtually a simple two-wire connection. It will operate with most PABX, PAX, or main exchange equipment.

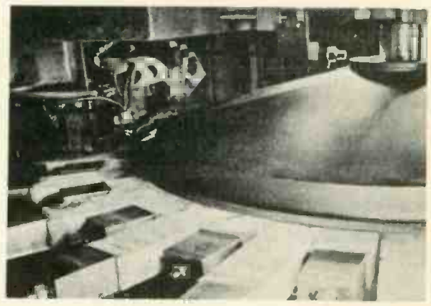
ADVANCED HIGH-SPEED TRANSPORT SYSTEM

At Siemens the experience gained in other fields of electrical technology is being applied in the development of a high-duty railway on the basis of the electrodynamic suspension system using superconductive magnets.

The fundamental principles of three magnetic suspension and guiding systems were compared:

The permanent-magnet suspension system uses permanent magnets in the vehicle and on the track. It is scarcely suitable for high-speed transport, since it is highly unstable, has no adequate damping characteristics and is very costly both in weight and volume.

The electromagnetic suspension system operates with electromagnets on the vehicle located below a ferromagnetic reaction rail on the track. The magnetic forces produced attempt to reduce the distance between magnet and reaction rail by attraction. The power input necessary to produce the magnetic cushion can be kept small only if the air gaps in the magnetic circuit are very small. At high speeds this introduces a risk which can only be minimized by the use of complex control equipment. The absolute reliability of this control equipment is the criterion for the application of this system at the high speeds involved.



At Siemens, the decision was in favour of the electro-dynamic suspension system which does not require such control equipment for suspension. Superconducting magnet coils are used in the vehicle and continuous conductor rails on the track. The motion of the vehicle generates currents in the conductor rails which lead to strong repulsive and self-stabilizing magnetic forces between the vehicle and the track. The high magnetic fields of superconductive magnets permit operation with a large air gap. Since the magnetic fields of superconducting magnet coils do not collapse suddenly, even in the case of disturbances, due to the stored magnetic energy and the physically inherent high time constant, the electrodynamic suspension system possesses outstanding emergency running properties. The suspension and guiding devices are also independant from stationary supply equipment while the vehicle is in motion.

On a test rig in the Siemens Research Centre the guide rail is initially being simulated by a rotating aluminium disc. Measurements are made of the lifting forces perpendicular to this disc, as well as their damping characteristics and the eddy current braking effects. The research workers state that it will not be long before they are in a position to present not only the experimental, but also the exact three-dimensional theoretical solution for the dimensioning of superconductive suspension and guide systems. The railway will be driven by linear motors, of which both the synchronous and the induction types are being investigated.

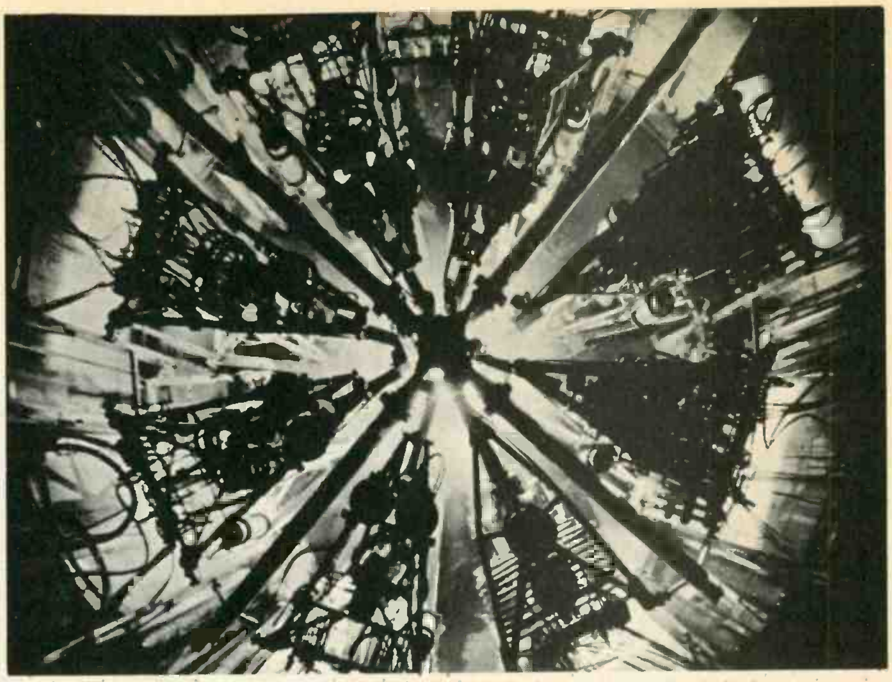
The work will soon lead to trial operation on a test track in the grounds of the Siemens Research Centre, a circular track of 280m diameter being scheduled. This track is to be used for long-duration tests at 200 km/h of the system and all its components, such as the linear motors and current collection gear.

This research project, for which AEG-Telefunken, BBC and Siemens have formed a joint research and development group will take about 3 years. The total costs are expected to be about 14 million DM. The aim of the work is to develop the electrodynamic suspension and all the components of this novel transportation system to such a state that it can be used on the high-speed trials facility planned by the Federal German Government in the Donauried area. This will be the basis for a long-distance transportation system that is faster, less harmful to the environment and more reliable.

COMPUTER KEEPS TRACK OF CHINON'S NUCLEAR FUEL

Stock management of the 120,000 natural uranium cartridges that form the basic fuel for the three nuclear reactors at the French electricity authority's Chinon power plant is now entrusted to a £40,000 Honeywell 58 computer.

Some 25,000 cartridges are received at Chinon or sent out in batches during a year. Each has a life of between three to five years and must be permanently identified and carefully controlled



throughout the various processing chains.

The cartridges arrive at Chinon in containers, each accompanied by a punched card giving identification number, type of fuel, origin, container number and other similar information. This information is recorded by the Model 58 computer which controls all movement of individual or batched cartridges from that point on. The computer initiates a check upon arrival, gives stocking instructions and prints other documentation to control the preparation of cartridges for loading into the reactors, the replacement of cartridges in the reactors, the storage of used cartridges in the cooling installation and the shipment to re-processing plants.

At each stage in the process, a card is marked by the specialist in charge of the operation indicating the transaction that occurred. This is returned to the computer and read by an OCR device, recording the transaction in the computer memory.

The history of each cartridge or reactor channel is held on disk files and is, therefore, immediately accessible to the Chinon specialists. And operational statistics are produced for local management and for the French electricity authority's central offices in Paris.

The Model 58 computer has 5K bytes of main memory, two disk units with a combined storage of 4.6 million bytes, card reader, card punch, line printer and the optical mark reading device.

The Chinon nuclear power station was the first CO_2-cooled, graphite-moderated natural uranium reactor in France, the centre of uranium ore production in Europe with a yearly output of 1,700 tons. It is one of eight (soon to be increased to ten) natural uranium plants now operating within the EEC. In 1971 Western Europe, including the UK with its eleven natural uranium power stations, produced 251 million megawatts of nuclear electricity, compared with the United States' 92 million and the rest of the world's 69 million.

FOR TWO PINS....

This circuit board, the basic building block of a Honeywell computer, holds 3,400 inch-high pins to anchor a maze of wiring. But product consultant Lois Goerner doesn't have to count them - a Honeywell-developed machine inserts the pins automatically and accurately.

CANOES BEAT BLUE NILE RAPIDS

Incongruous though it may seem at first, radio manpacks supplied by Racal-Mobilcal Limited formed part of the standard equipment carried in canoes in which a four-man team successfully completed the first

news digest

navigation of the upper waters of the Blue Nile. The 250 mile journey from Lake Tana to Shafartak Bridge in Ethiopia had never been done before and earlier attempts by military expeditions using rubber rafts had both failed with loss of life.

Steve Nash, a line inspector with Racal-Mobilcal and himself a canoeist of international repute, was in charge of communications. Using two Minical manpacks in the canoes and with a Syncal manpack as a base station in the expedition's support Land Rover, excellent communications were maintained throughout the trip. This first-class demonstration of the performance of these production equipments was achieved not withstanding the fact that, on occasions, the team had to operate out of gorges almost one mile deep, to the base camp some 200 miles distant.

One of the most amusing anecdotes to emerge from the expedition concerns the team's safe arrival at Shafartak Bridge where they were met by a news agency correspondent. When told that they had used Minical (an extremely compact HF packset) to keep in touch with their support vehicle, he expressed such disbelief, that Steve Nash arranged a demonstration for him in which contact was established with the Land Rover then some 200 miles distant and beyond the 16000 ft Globe Mountains. The communication was so clear that it was obvious to the team that he still wasn't convinced and when they left him, Steve said he was hunting through bushes upstream sure that the team had hidden a confederate with a walkie-talkie just out of sight.

FOUR COMPUTERS ON ONE DISC DISC STORE

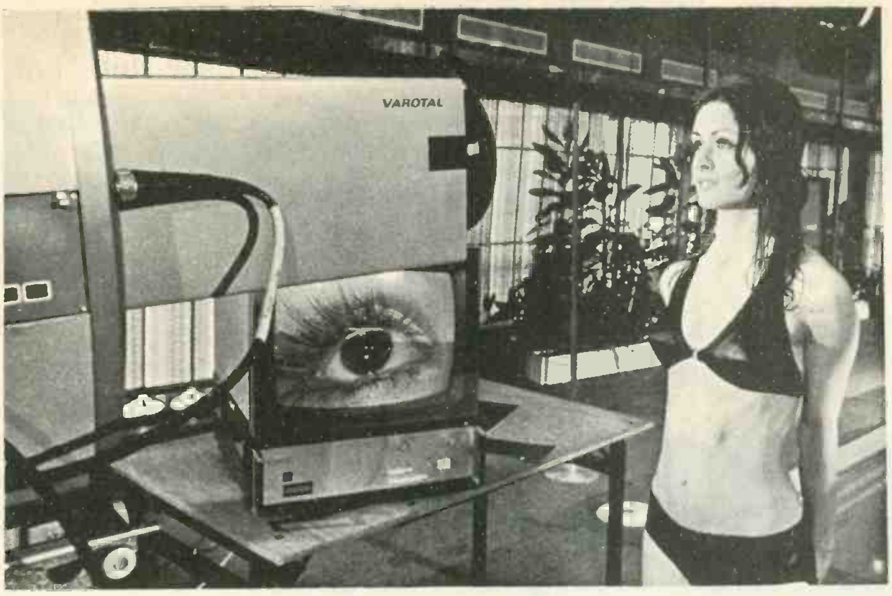
Experimenting with a new concept, which will enable them to operate four different computers from one disc store, the Computer Centre at Essex University have purchased a Series 100 disc memory from Process Peripherals Limited of Thatcham, Berkshire.

The disc, comprising 64 separate tracks of 80,000 bits of information per track will enable four mini computers at the university to have their existing core storage capacity extended by up to 1.3 million bits each.

The computers, an Interdata 70, Nova 1200, PDP 8 and Honeywell 316, will be separately connected to four head stations on the disc. Operation of each computer is entirely independent of the other three to such an extent that all of them can work on completely different technical earth systems. The computers are able to access the disc at any time, calling up information at the same time as similar transfers are being carried out by the others. The system, therefore, operates just as if all four computers each had their own discrete disc store but at a very much lower cost.

An additional advantage of some significance to the fast-expanding computer department at Essex University is that the Series 100 is completely ruggedised and therefore immune to any shocks or jolts which it may suffer when being moved from one place to another. It is also unaffected by dirt or dust which normally presents such a hazard to rotating memories.

NEW ZOOM LENS



Orders worth £¼ million have been received by Rank Precision Industries for this new Varotal colour TV lens, including £180,000 from USA and Europe. The BBC have just ordered three at a cost of £15,000. It enables a single camera to vary the picture on the screen from a panoramic view of a swimming pool to a magnified close-up of an eye. The eye on this monitor screen belongs to model Sandra Brown of Leicester.

The lens also damps down 'flare' - the sudden flashes of light that spoil colour television pictures without warning. They are caused by light bouncing into a lens from bright objects and are particularly bad when water is being televised. For this reason the glass in the lens has been given a special treatment developed after several years of research.

The versatility of the lens, which can achieve very wide or very narrow angled shots even in small studios, will enable producers to bring a new range of dramatic effects to the screen, particularly in sports like boxing, wrestling and swimming.

It is built on an entirely new principle, using a three moving member system instead of the two used in all current zoom lenses. Zoom ratio is 10:1. The lens has a minimum object distance of 45cm (18ins) and a horizontal angular field of view up to 56 degrees. A new kind of range extender gives an angular field of view ranging from 28 degrees to three degrees - instantly and without shifting the focal plane or centre of gravity. There is no change in magnification when the lens is focussed at the widest angle in extreme depth of field conditions.

There is a choice of five different control systems, designed to a modular concept. Three are servoed, one manual and one combines both servo and manual.

HUD ADVANCE

A new extension in the capability of head-up display was recently shown as a working exhibit by Marconi-Elliott Avionics, by which a pilot can see the outside world through the windscreen while flying in pitch darkness. He can find and identify targets like bridges, ships and even road vehicles at a range of several miles in darkness as he can in daylight. This done by displaying the TV-like picture from a night-viewing device in the head-up display together with the usual guidance symbols.

Head-up display allows the pilot to see his instrument and aiming information apparently superimposed upon the view of the ouside world through the windscreen (a see-through instrument system) so that he gains maximum benefit from the simultaneous and coordinated view of instruments and outside world. The Marconi-Elliott digital head-up display is already standard equipment in certain US Navy and Air Force aircraft and conversion to 24 hour capability requires only the addition of an electronic scan converter unit. This combines the TV master scan of the picture from the night sensor with the stroke-written symbols generated by the head-up display computer. **(153)**

ELECTRONICS FOR SMALL BOATS

New techniques and miniaturization have brought sophisticated electronic systems within reach of the small-boat owner

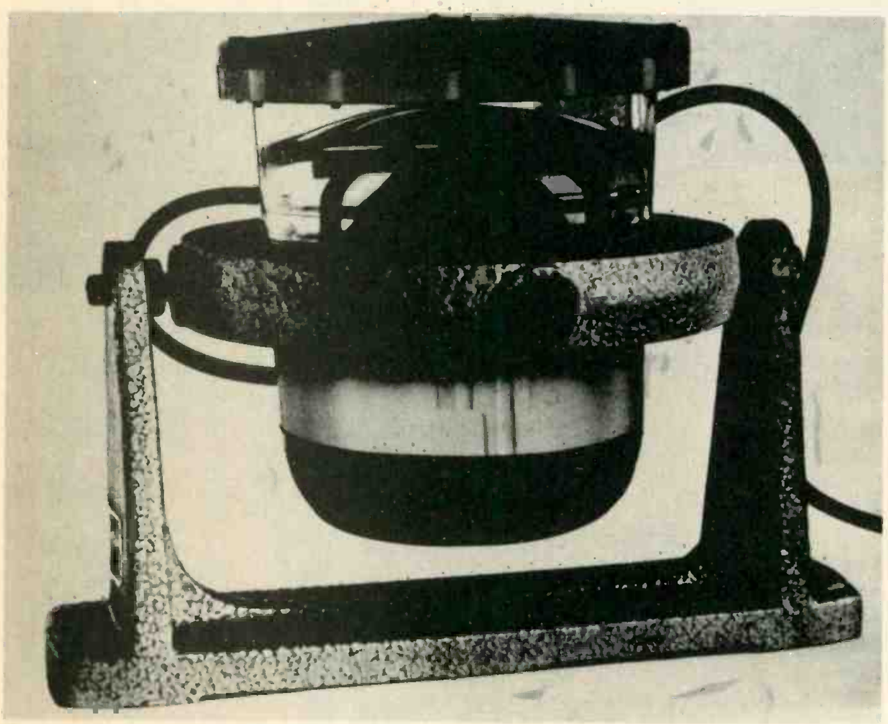


Fig 1a A master compass for use with auto pilot and repeater compass systems.

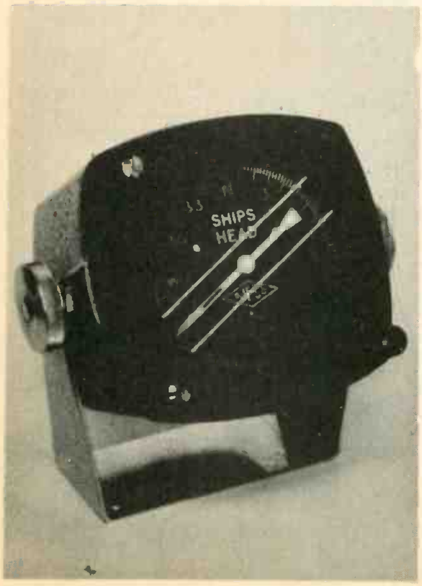


Fig 1b Repeater compass in free standing housing by Neco Pty Ltd

NAVIGATION is one of the oldest sciences and the classical aids for this activity have developed little over several hundred years — until recently that is. The navigational tools have been, and are still, the compass, log, sounding equipment and sextant with chronometer. However verification of position by sextant relies on good weather to a great extent. This means that with traditional methods the information is not available when most needed, that is, in bad weather.

Over the last two decades or so electronic aids for ships have undergone considerable development and in the last couple of years we have seen the introduction of simple low cost devices for small boats. This new generation of navigational aids considerably reduces the reliance on good weather conditions for accuracy as well as reducing the amount of specialized training required.

These new aids are supplementary to the old and by no means replace them completely. They offer simple methods of obtaining positional information with speed, and accuracy.

The compass as used in small craft is almost invariably of the magnetic type with sometimes the addition of repeaters, a typical master compass from Neco Marine is illustrated in Fig 1a and a repeater compass from the same company in Fig 1b. As we are concerned here mainly with electronics we will not discuss compasses further but will pass on to consider log systems.

THE LOG

The log, an instrument for measuring distance run and/or water speed, may be one of several basic types. These are the rotary head with towed or fixed probe, the pitot-tube probe, the magnetic-head probe and more recently the doppler head. Impellerless electronic systems (eg doppler) are still not sufficiently accurate as the measurement depends greatly on the condition of the water in which the system has to function.

An example of an impeller type system from Brookes and Gatehouse Ltd is shown in Fig 2. In this system a tiny magnet in the impeller induces small pulses of current in a coil which are then counted digitally to achieve scaling, and the output of this scaling counter is then fed to an electromechanical counter as a log of nautical miles. A frequency-to-analog converter then produces a voltage to provide a meter indication of knots. An optional amplifier and meter provide a five-times magnification of the speed allowing accurate tuning or trimming of a yacht in light weather.

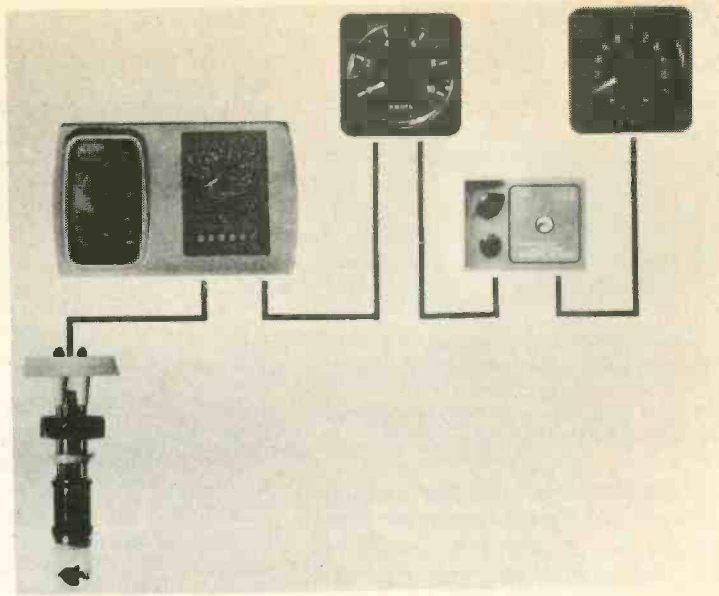


Fig 2 The Brooke and Gatehouse Ltd log and speedometer. The system includes a X5 speed amplifier for greater resolution

THE DIRECTION FINDER

The direction finder is a simple and reliable instrument for obtaining the bearings to known radio sources or beacons. Two such bearings will fix the position of the craft with reasonable accuracy. There are two basic systems used, firstly the ferrite rod antenna which may be either hand held in simpler units or a manually operated fixed installation, and secondly, the automatic system which employs two loop antennae at right angles from which the bearing is determined electronically. Facilities for the reception of radio and time transmissions may also be incorporated. In more elaborate systems a compass-like readout of beacon bearing may be supplied and this then forms what is known as a radio compass.

An example of a simple DF system from Brookes and Gatehouse is shown in Fig 3.

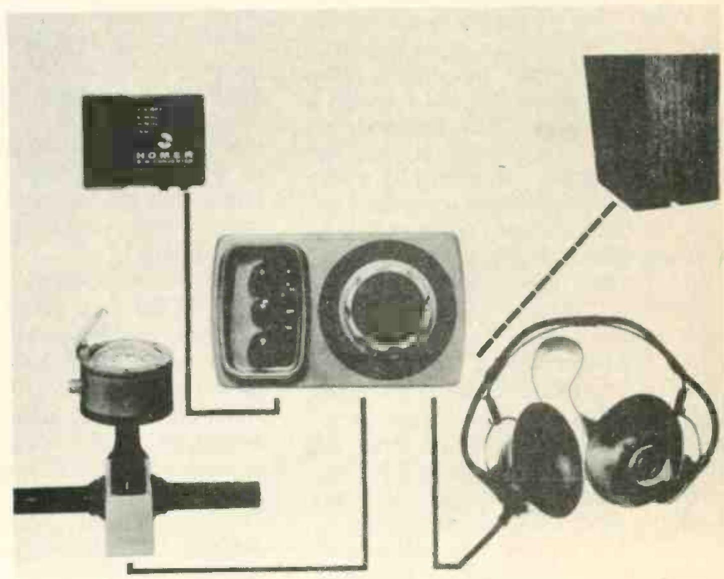


Fig 3 The 'Homer' direction finder equipment from Brookes and Gatehouse Ltd

THE ECHO SOUNDER

Apart from knowing where you are and in which direction you are heading, it is also nice to know that there is sufficient water under the keel, and for this purpose there are many relatively cheap depth sounders available.

For small boat use a simple meter indication of depth is mostly all that is required such as is provided by the Marine Electronics Ltd instrument shown in Fig 4. This provides a depth reading to 100 feet with 3% accuracy and costs as little as £27.50. Alternatively, fishing vessels may require a chart recording of depth such as is given by the Ferrograph G500 (Fig 5). In either case this type of instrument is a worthwhile investment. The method used in echo sounding is the same regardless of make. A piezo-electric transducer is used to transmit a short pulse of ultrasonic energy which is reflected back from the seabed. The transmission time, to seabed and back, being directly proportional to depth.

THE AUTO PILOT

An automatic pilot is no longer a gimmick. Indeed in bad weather on an extended voyage it may be said to be essential. Steering a small boat in fine weather is a pleasant task, but in bad weather, wind and high seas make this an extremely tiring task and it requires the utmost concentration to maintain course. A typical auto pilot for sailing yachts as manufactured by Sharp and Company Ltd in Kent, England is the 'Mate' system shown in Figs 6a, 6b and 6c.

A complete auto-pilot consists of a SENSOR, CONTROL UNIT, AMPLIFIER, POWER DRIVE AND FEEDBACK UNIT. In the case of an auto pilot for sail, the sensor is usually a wind-vane, Fig 6a. The desired wind direction is set on the wind vane unit which then provides error voltages to the control unit, Fig 6c, if the yacht veers from the desired headings. Alternatively, it may be a magnetic-compass unit which provides the error voltage (as shown in Fig 6c). The control signal is amplified before being fed to a power drive which adjusts the steering until the correct heading is obtained.

SAILING PERFORMANCE COMPUTER

An interesting new system is the sailing performance computer of which the HORATIO manufactured by Brookes

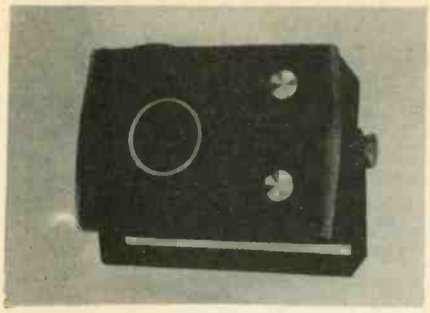


Fig 4 This simple and low cost echo sounder is manufactured by Marine Electronics

and Gatehouse is a typical example. Horatio is the newest instrument in the B & G range of electronic navigational aids for sailing and was the first Velocity Made Good (Vmg) computer to be placed on the market. Its purpose is to enable a yacht to be sailed to windward to best advantage and thus to reach the windward mark in the least possible time. In more scientific terms, it can be said to indicate when the Vmg to windward has reached a maximum value for the existing strength of the wind. It has the additional facility of providing a very sensitive indication that optimum sail trim has been achieved when the yacht is sailing with the wind free.

The system takes signals from an underwater impeller unit, an anemometer and a wind vane transmitter. These are processed in a small analog computer to solve a fairly complex equation which yields the value of Vmg/Vt as a dc signal to drive the performance meter. In addition it processes the anemometer and wind-vane signals to drive the three wind dials.

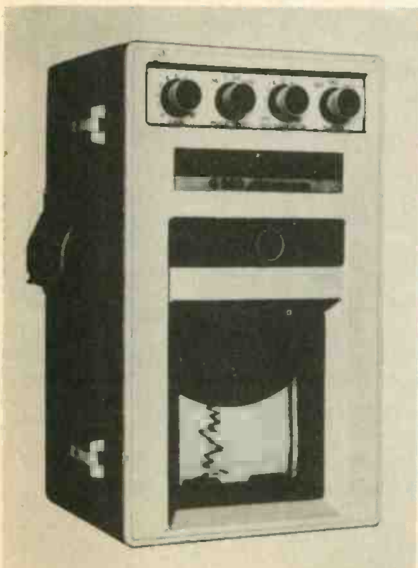


Fig 5 The addition of a chart recorder to an echo sounder is an essential for fishing vessels

RADAR

Radar has two main applications, the avoidance of collisions and the fixing of position. Up until fairly recently radar has been an instrument only for large ships being too bulky and costly for small boats. Decca Marine, however, brought radar to small boats with the introduction of their Super 101 model. Now Decca have released the 'Decca 050', a completely new mini-radar aimed at the world's pleasure craft and work boats under 40 feet. It will be unveiled at the London boat show on January 5th and make it's debut at the New York boat show a fortnight later.

Though smaller than anything made before and very simple to operate, the Decca 050 has the same design philosophy as the large 'Super 101'. No design engineering corners have been cut in favour of price, which in the UK will be £695 for the basic unit.

The system is in two basic units, the first, a slotted waveguide scanner, transceiver and power supply is housed in a waterproof, glass-fibre radome which incredibly weighs only 57 lb and may therefore be readily mounted on the mast of a small craft. The second of the two units is a neat display connected to the aerial unit by a single plug in cable. The display unit is so portable that it may easily be carried ashore if necessary.

The seven controls provide ranges from 25 yards to 12 nautical miles. A bearing cursor is provided plus, amongst other functions, a fully variable anti-sea-clutter facility.

The unit is fully solid state, with the exception of the magnetron and the cathode ray tube, and the total power consumption is a very low 75 watts. The new system now makes radar available to the small boat at reasonable cost.

STABILIZERS

Stabilization is another technique, traditionally used only on large ships, which has in recent years been applied to small boats. Vosper have been fitting stabilizers to yachts since the mid-fifties (at a price). It was only with the introduction of their 'Maxi-Fin' equipment in 1969 that stabilization could be fitted to yachts down to 35 ft. Their new 'Mini-Fin' may be applied to medium sized yachts and stabilizer sets now start from about £1500 making it a practical proposition for luxury cruisers.

Stabilizer Control

Stabilizing fins project from the hull on shafts, and when rotated a small amount, create positive and negative lift on opposite sides of the hull. They are driven hydraulically, each fin being actuated by one ram for each direction of movement. The hydraulic pumps, one for each side, can be driven by the vessel's main engine(s) or by separate electric motors.

Fig 6a

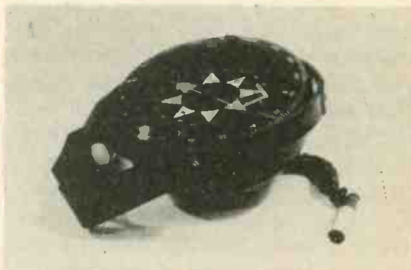


Fig 6b

Fig 6 The Sharp and Company autopilot for sail. (a) The wind vane unit (b) This magnetic compass provides a course error voltage (c) The control unit, the motor drive varies according to the boat and is not shown

Control is by means of a simple servo loop. Rate of roll is sensed by a small gyro which provides the basic control signal for the hydraulic solenoid valves.

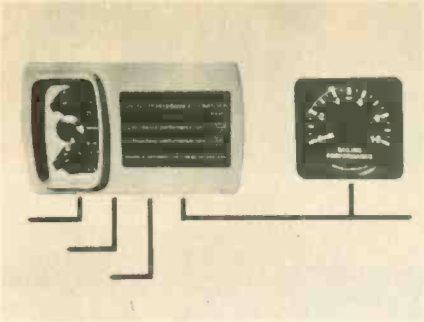


Fig 7 The sailing performance computer by Brookes and Gatehouse makes every skipper Olympic class

Fig 8 The 57lb fibre glass radome of the Decca 050 marine radar is completely waterproof and does not interfere with sail handling

Fig 11 A typical SSB transmitter and receiver from S P Radio Pty Ltd

The loop is closed by a fin-position feedback signal. More sophisticated servo loops employing roll angle and roll acceleration terms are used for custom-built systems where performance is optimised for any particular vessel.

Effectiveness of the stabilizer is dramatic, roll reduction in the order of 80 to 90% being usual. Power consumption of the control system is 50 to 100 watts, hydraulic power required though depends on the size of fin fitted.

RADIO TELEPHONE

No account of marine electronics would be complete without some mention of radio telephone facilities. Figure 11 shows a typical system from SP Radio known as 'SAILOR'. The top unit in the photograph is a 31 channel SSB or DSB transmitter and the bottom unit is a SSB receiver. The units are fully transistorized and are well sealed and protected for a marine environment.

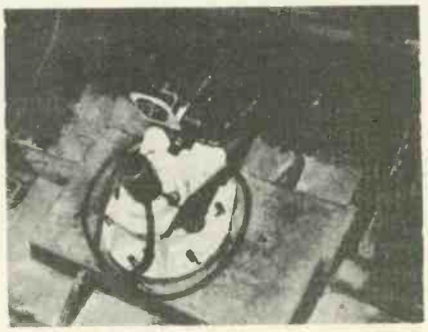


Fig 10 The fin-drive unit as fitted to a fibre-glass hull takes up very little precious space

THE FUTURE

Perhaps with the development of doppler systems which provide motion data with respect to the bottom, we will see computer systems that show true position on a chart in real time.

Inertial navigation systems, although at the present time way too expensive, will no doubt become feasible for small boats in the future. So the day when it will be possible to dial in a set of coordinates and sit back and let the computer do it, are fast approaching.

Somehow, though, when this does happen it may not be too popular as such systems will remove all the fun of messing about in boats. ●

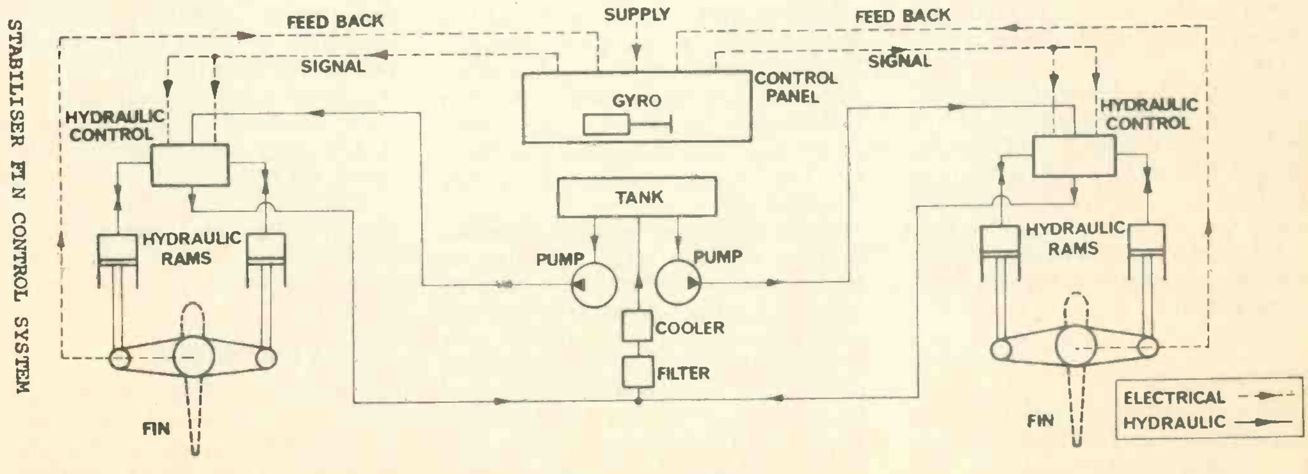
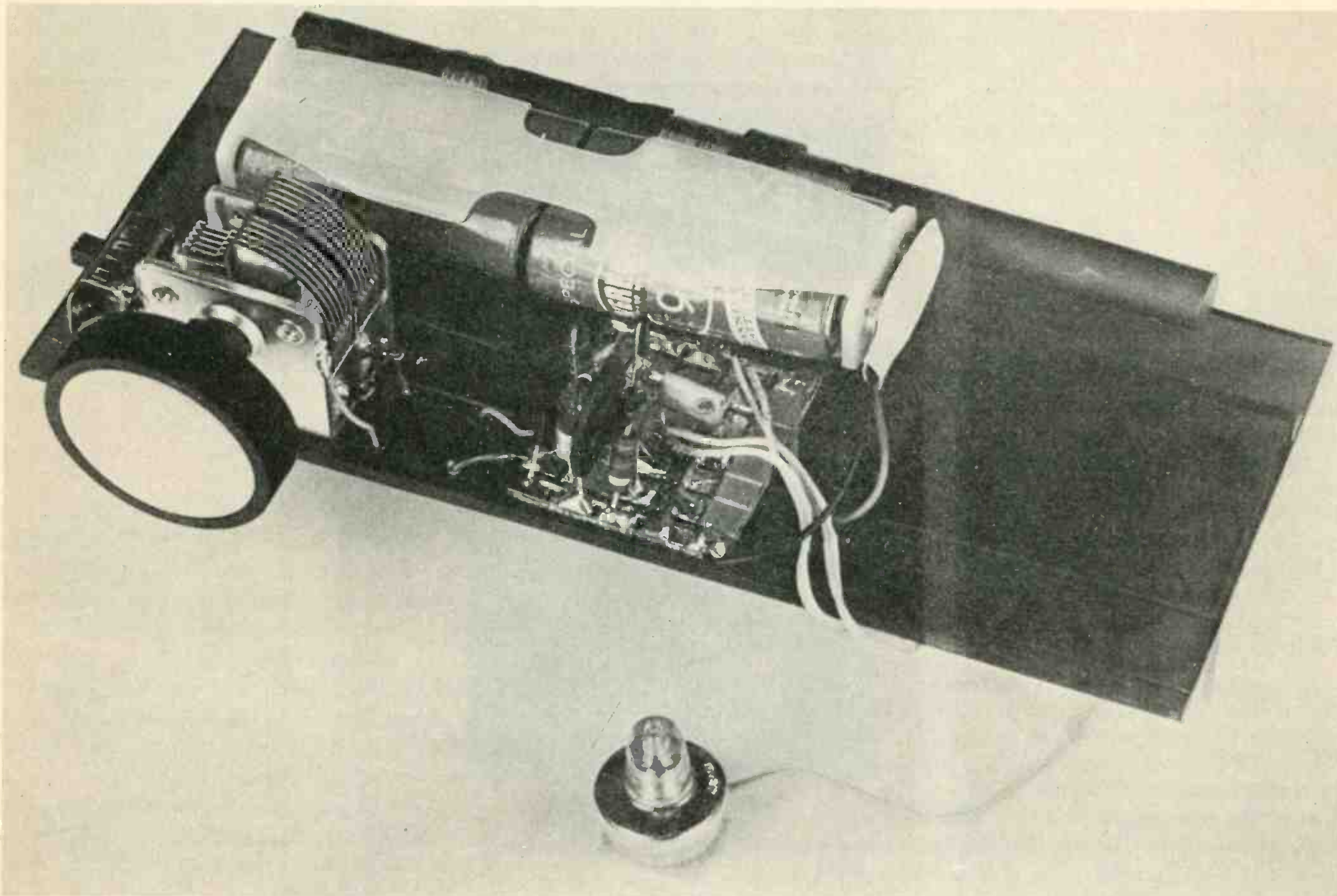


Fig 9 Block diagram of the Vosper Thornycroft stabilizer fin control unit

ONE CHIP



THIS little radio set is an ideal project for the beginner. It draws very little current from the battery, (2 ma) and one set of batteries will drive the radio for months, virtually the normal battery self life.

The radio, as shown in the photograph, was constructed using a piece of 1/8 inch plastic as a breadboard. If required it may be mounted on a plastic case to suit individual taste. Operation on medium and longwave is provided and, in a later issue, we will be describing a simple audio amplifier to provide loudspeaker output.

CONSTRUCTION

The Ferranti ZN414 integrated circuit has a very high gain (70dB) and high input impedance (1·5 megohm). For this reason it is strongly recommended that a fibre-glass printed circuit board be used. The use of veroboard or similar materials will increase the possibility of inferior performance.

Although it may be thought that the ZN414 would be an ideal means of producing a miniature radio, this is not recommended. The radio is capable of providing good quality audio and it would be a pity to waste this capability merely to obtain 'gimmick' value. Miniture radios must necessarily sacrifice performance for size. In fact the output of this radio fed to a hi-fi amplifier, will provide surprisingly high quality reproduction.

An air spaced tuning gang is recommended and the aerial coil may be readily wound by hand on a piece of 3/8 by 6 inch ferrite rod. The coil should be wound in accordance with Fig 5, 250 turns of 40 swg enamelled copper wire multilayered, for L1, and 85 turns of 32 swg for L2. A shorter ferrite rod, not less than 3 inches, may be used, if required, although performance will not be as good. If a smaller rod is used, the number of turns on each coil will have to be increased. Winding is not critical and it is quite easy to wind on more turns and then take them off again until the stations fall in the correct position of the tuning gang. If it is desired to place Radio 2 (1500 metres LW) directly above, either Radio 1 or, Radio 4 when switching bands, this may be achieved quite simply by adjusting the number of turns on the long wave coil L1.

The positions of the aerial coil and tuning gang with respect to the PC board are not critical, however, leads to the tuning gang should be kept separate and not twisted. The wave change switch should be located as close as possible to the tuning gang (see photo).

THE OUTPUT STAGE

Although the ZN414 is capable of driving a high impedance earphone direct, greater output and improved stability can be gained by using a transistor amplifier stage. An amplifier also enables a cheaper and more readily obtainable earpiece to be used. In fact the cost of adding one resistor and one transistor is more than compensated

RADIO

This simple MW/LW radio is an ideal project for beginners

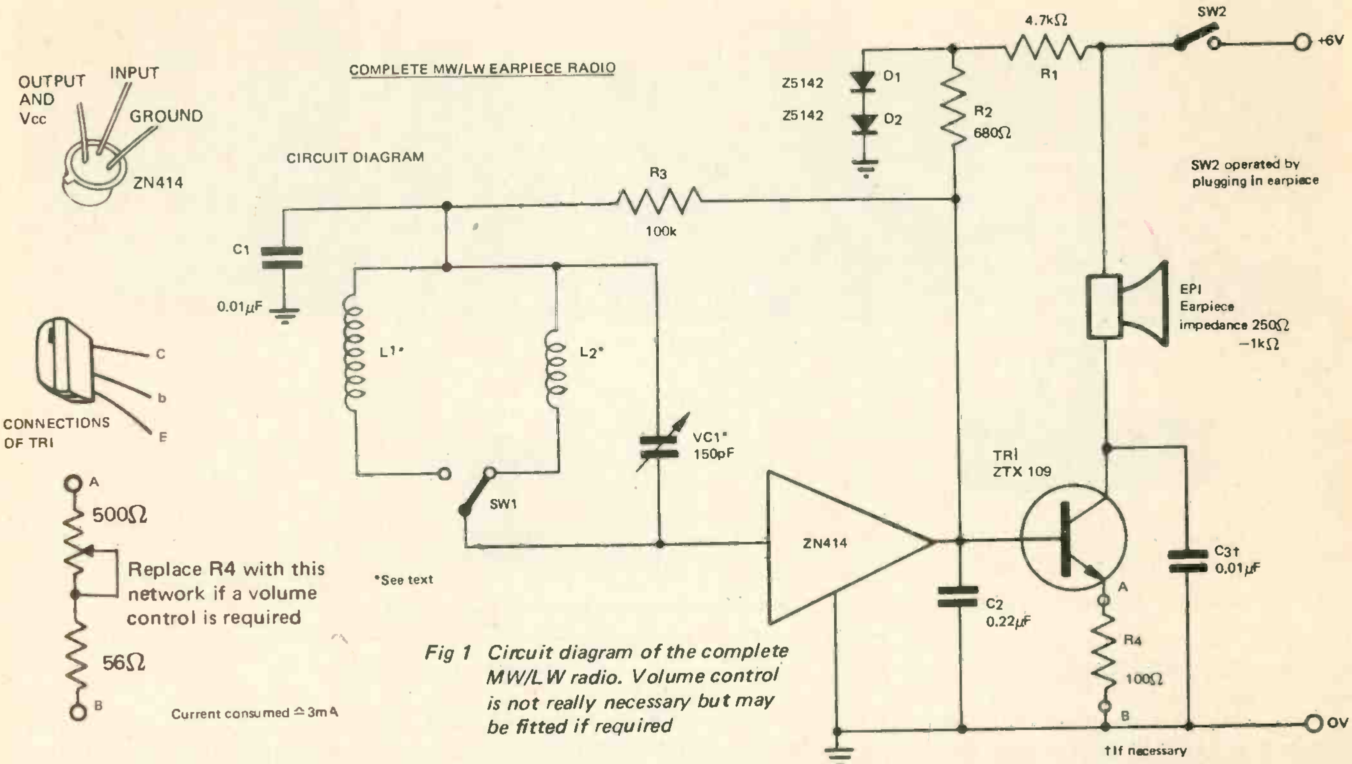


Fig 1 Circuit diagram of the complete MW/LW radio. Volume control is not really necessary but may be fitted if required

PARTS LIST

R1 — resistor 4·7k ¼ watt 10%

R2 — resistor 680Ω ¼ watt 10%

R3 — resistor 100kΩ ¼ watt 10%

R4 — resistor 100Ω ¼ watt 10%

C1 — capacitor 0·01μfd 30V ceramic

C2 — capacitor 0·22μfd 30V

C3 — capacitor 0·01μfd 30V (see text)

TR1 — transistor Ferranti ZTX109

IC1 — integrated circuit Ferranti ZN414

D1, D2 diode ZS142 Ferranti

VC1 tuning capacitor, air spaced 150pf

L1, L2 aerial tuning coils wound on ferrite aerial rod 3/8" x 6" lond (see Fig 2)

EP1 — high impedance earpiece, 250Ω — 1kΩ Henry's Radio type MR60

Earpiece socket with switch, battery cradle, four size AA penlight cells, fibre-glass Pc board

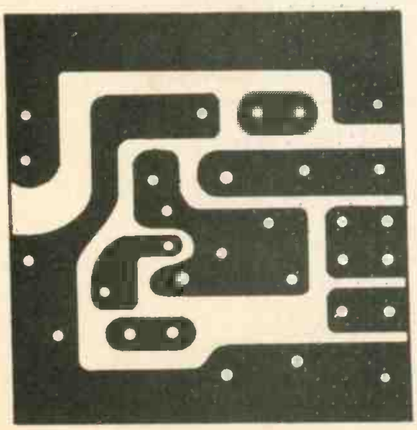


Fig 2 PC Board layout shown twice actual size

NB 'A' must be connected to 'earthing' (Chassis) side of VCI
'B' must be connected to fixed part of VCI

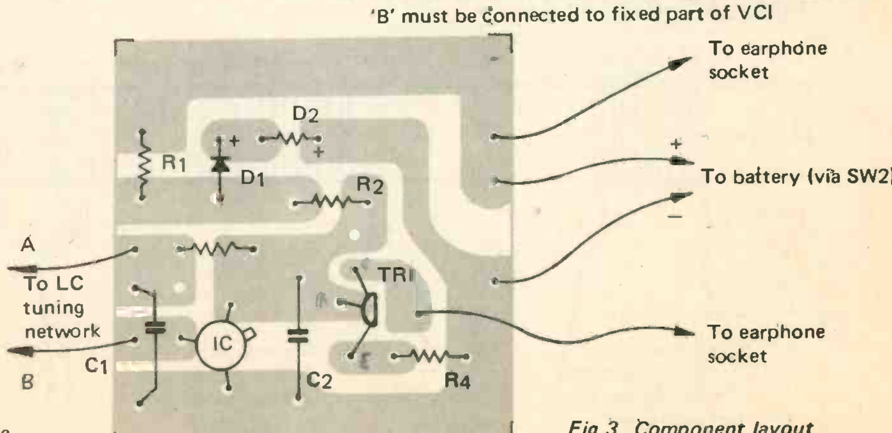


Fig 3 Component layout

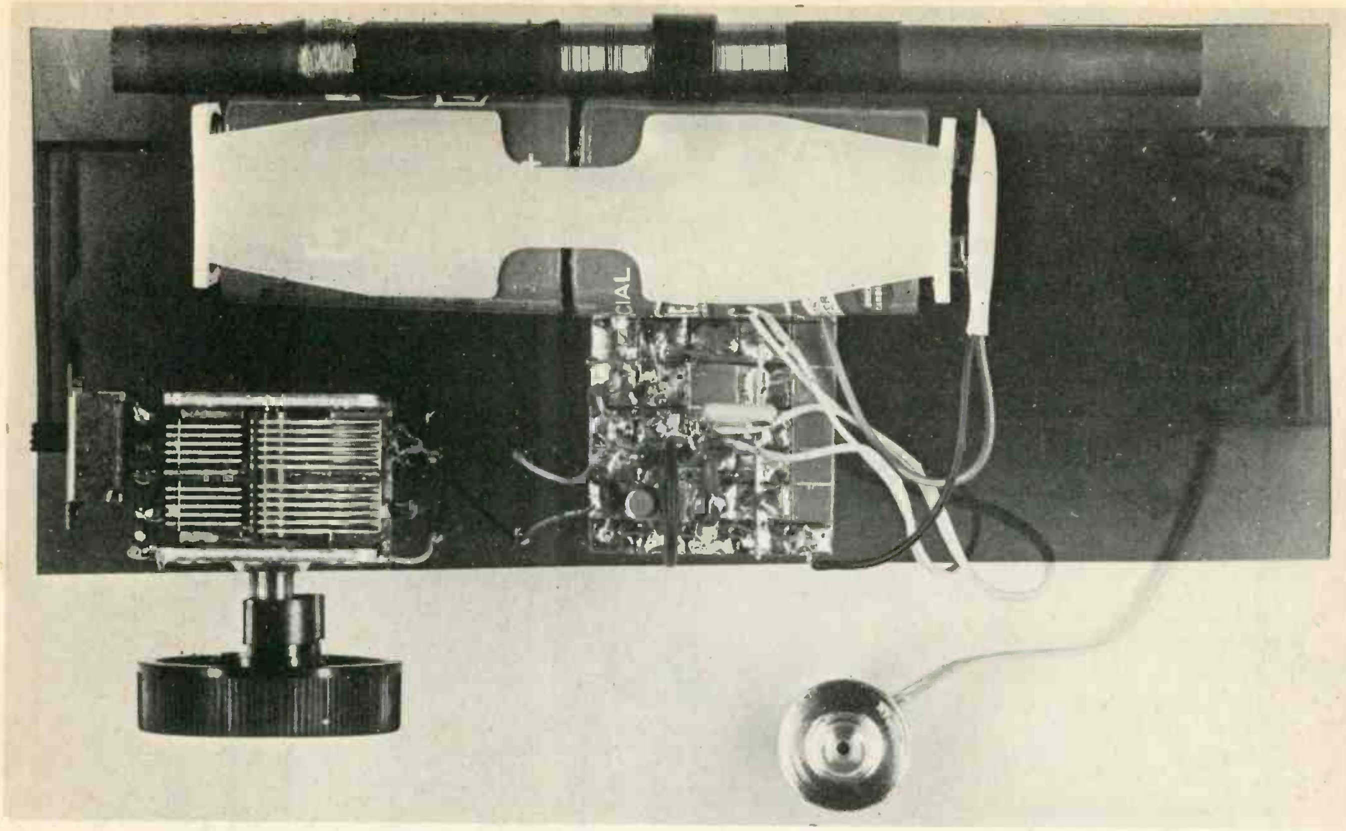


Fig 4 Layout of our prototype receiver. Note position of wave change switch to left of tuning gang

for by the saving on the earpiece. The type specified, MR60, should be available for about 25 pence.

If desired, two earpieces may be fitted. It is much better to listen over extended periods to music with both ears rather than only one. If two earpieces are used in parallel, make sure that they are phased correctly otherwise an unpleasant effect will be noticed. If this effect is noticed, merely reversing the leads of one earphone will put matters right.

Kits of parts including a PC board are available from A Marshall and Son (see inside front cover for address) it is anticipated that the complete kit excluding the ZN414 IC will cost about two pounds. Due to the expected high demand there may be some delay in the supply of these kits.

Last month we made a special offer on the Ferranti IC, unfortunately these have all gone. Coupons were dated as received and the first 1000 opened will receive their IC's. The unlucky ones will have their money returned. Those who missed out may obtain IC's from Henry's Radio Ltd, 303 Edgeware Rd, London W2 or Bywood Electronics Ltd, 181 Ebberns Road, Hemel Hempstead, Herts at a cost of £1.25 each. ●

HOW IT WORKS

The integrated circuit, Ferranti ZN414, is a 10 transistor TRF circuit with built in AGC and detector, which provides an audio output from a modulated RF input. The input signal is tuned in the long wave band by tuning capacitor VC1 and L1, and on the medium wave band by VC1 and L2. The appropriate band is selected by SW1.

The AGC operation is determined by R2 and C2, diodes D1 and D2 provide a stabilized 1·2 volts supply to the AGC network. Transistor TR1 provides a gain of between two and a half and ten, depending on earpiece impedance (ratio of earpiece impedance to resistance of R4). The Ferranti diodes and transistor specified must be used otherwise performance may suffer due to differing Vbe for other devices. Capacitor C3 may need fitting if any instability in the output amplifier occurs.

COIL WINDING DETAILS

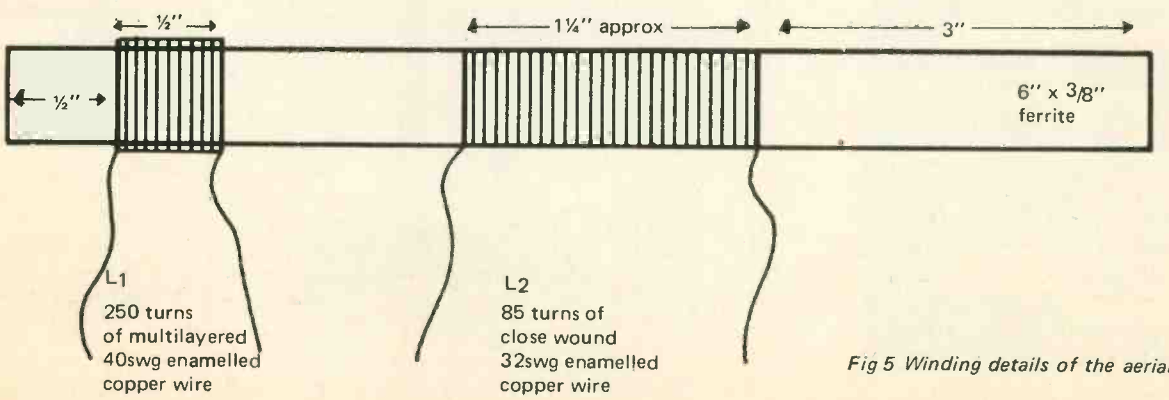
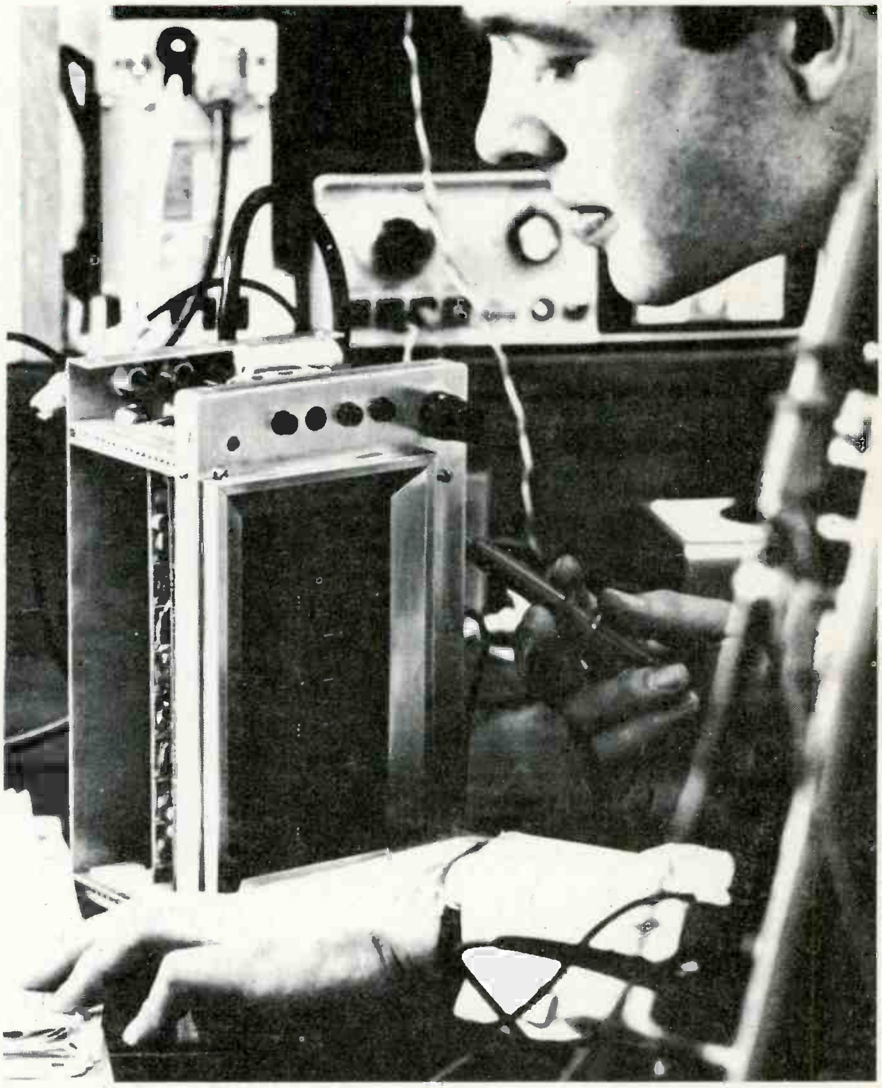


Fig 5 Winding details of the aerial coil

(The article Solid-State 'CRT' is continued from page 19 to 78)

SOLID-STATE 'CRT'

New display uses matrix of light emitting diodes.



This new display is based on the use of a matrix of light-emitting diodes and it approaches the very thin, 'picture-on-the-wall', type of display which has always been regarded as the ideal form of display presentation.
The prototype system is a small radar display used in the control tower to provide air traffic controllers with a radar picture of either the approach or the take-off path, as an aid to safe and rapid clearances.
The prototype unit is seen in operation in the laboratory, displaying three simulated aircraft tracks on an approach path.

A completely new form of solid state radar display, which eliminates the conventional cathode ray tube, has been announced recently by Marconi Radar Systems Limited, in England.

This new display is based on the use of a matrix of light-emitting diodes and it approaches the very thin, 'picture-on-the-wall', type of display which has always been regarded as the ideal form of display presentation. The display itself is less than one inch thick, and, with its associated system, is easily capable of being let into an operator's desk.

The prototype system takes the form of a Distance-From-Threshold Indicator, (DFTI) – a small radar display used in the control tower to provide air traffic controllers with a radar picture of either the approach or the take-off path, as an aid to safe and rapid clearances.

The use of light-emitting diodes (LED's) provides a bright display which can be seen without difficulty in the high ambient light levels of an airfield control tower. Display brightness can be as high as 1000 foot-Lamberts.

The complete display is only a fraction of the size of the equivalent cathode ray tube equipment, and it required less than a twentieth of the power supply. This cuts down the heat dissipation of the complete system, and thus reduces the demand on air conditioning and cooling equipment.

Marconi engineers predict that the reliability of this new type of display will be many times higher than that of conventional displays. The LED device is inherently very rugged and reliable, and even if one should fail, only a minute portion of the complete display would be lost, and it could be quickly and easily replaced. Under normal operation, an aircraft track would have at least two diodes lit at any one time to give a directional 'tail' as it moves across the screen.

HOW IT WORKS

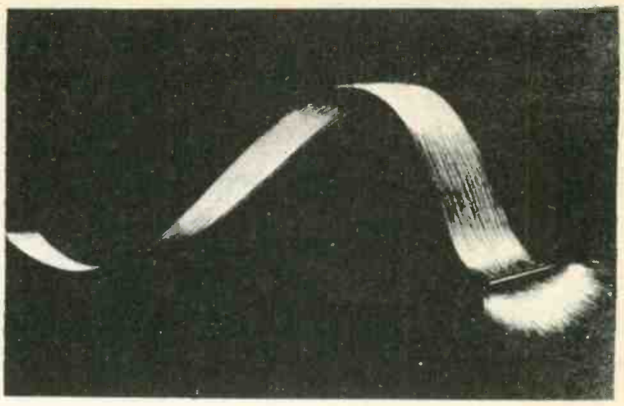
The new display uses a matrix of gallium arsenide phosphide diodes, mounted in groups and wired directly on a double sided printed circuit board. The diodes are wired in 'rows' and 'columns' such that any one diode can be energised by supplying a voltage across one row and one column. The spacing of the diodes can be sufficiently close to provide ¼ mile resolution of a radar picture.

Apart from a five volt 15 watt power supply, the only inputs required for this display are the radar turning information and the raw radar signals, after they have been passed through a moving target indication system.

The turning information is converted to a digital form, providing 'x' and 'y' co-ordinates of the radar range and

FIBRE OPTICS-

TODAY!



Yesterday a laboratory curiosity; today a developing scientific field, fibre optics is finding uses in the home, automobile, industry and science. Here is how it works; how it is used.

As early as 1870, the British physicist John Tyndall demonstrated that light could be made to follow a curved path. He directed a light into a tank of water, from which a stream flowed through a hole punched in the side of the tank.

The stream of water contained part of the light from the tank, and tended to illuminate the spot upon which it fell. However, not until 1950, did an intense investigation into optically-coated fibres begin, with simultaneous efforts starting in the Netherlands, England and the U.S.

As the 1960's unfolded, fibre optics came of age, and both the news media and sales representatives were touting this new technology as a solution to many problems. In the U.S., giant electronics and optical companies leaped into the production of light pipes for every application imaginable and as requests for prototypes were received by these corporations, their research and development also expanded. However, every product must eventually pay its own way, and many of these corporations soon tired of simply drawing fibres and building prototypes. The finished assembled fibre optic product rarely materialized.

In the 1970's, this situation resulted in two types of fibre optic

But in the beginning of 1970 this situation changed and today fibre-optic components are finding increasing commercial application throughout science and industry.

HOW FIBRE OPTICS WORK

Light transmission through a fibre-optic guide is basically a wave phenomenon, in which the fibres serve as wave guides for electromagnetic radiation at visible frequencies. Wave-guide phenomena must be understood and used when fibre optics which have a diameter comparable to the wavelength of light are used, transmitting energy in complex patterns. But for the components discussed here, energy transmission theory can be approximated by conventional geometric optics, in which "rays" of light are traced through the system and used to explain the system's operation.

The entire theory of fibre optics hinges on the principle of total internal reflection, a refraction effect, as the light rays travel along a fibre. Refraction occurs whenever light passes from one material to another. It occurs because light travels at different speeds in different materials. In Fig. 1, a light ray travelling in a material that has an index of refraction "n_1" and an angle of incidence ϕ_1 is bent as it crosses the interface into a second material whose index of refraction is "n_2" by an angle ϕ_2 according to the following relation, Snells Law:

$$n_1 \sin \phi_1 = n_2 \sin \phi_2$$

Angle "ϕ" is always measured with respect to a perpendicular to the interface of the two materials, and the direction of the light ray may be reversed without changing the path of the light ray. For this equation to be precise, the light should be monochromatic.

This refraction effect accounts for "apparent" distances when looking at an underwater object. When looking straight down, refraction causes a body of water to appear shallower than it actually is.

A light ray travelling from a material having a high refractive index n_1 (an optically dense material) to a material having a low refractive index, n_2 (an optically rare material), crosses the interface and penetrates material 2 only if angle of incidence ϕ_1 is less than critical angle ϕ_c as in Fig. 1-b. At incident angles greater than the critical angle, the light can not cross the interface, and instead is totally

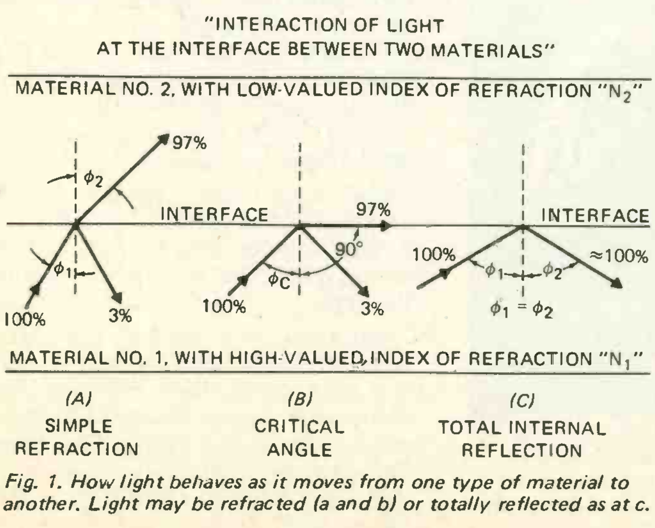


Fig. 1. How light behaves as it moves from one type of material to another. Light may be refracted (a and b) or totally reflected as at c.

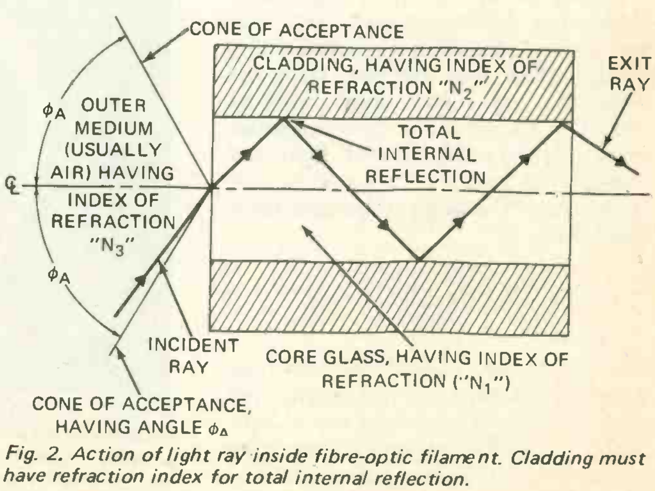


Fig. 2. Action of light ray inside fibre-optic filament. Cladding must have refraction index for total internal reflection.

FIBRE OPTICS-TODAY!

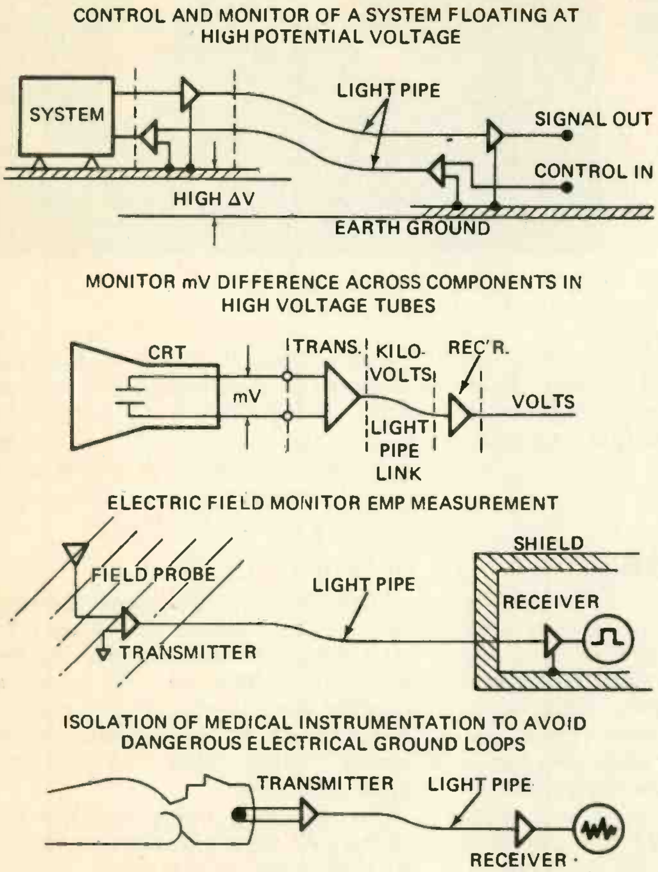


Fig. 3. Fibre-optic system provides isolation between receiver and transmitter.

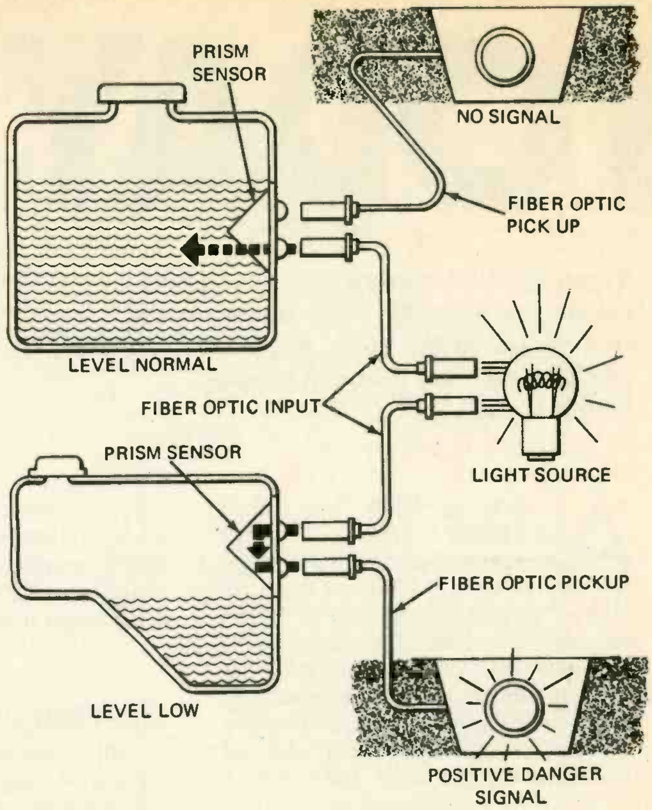


Fig. 4. Fibre-optics monitors two liquid levels. Single lamp excites the optics and provides alarm signal when needed.

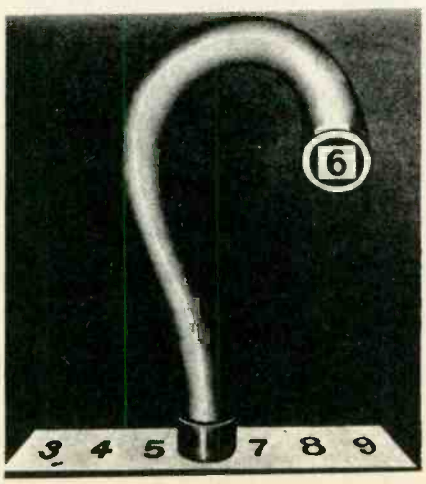
reflected back into medium 1 as in Fig. 1-c. This critical angle is determined from Snells Law to be:

$$\sin \phi_c = n_1/n_2$$

The principle of total internal reflection is found in many optical instruments where glass prisms rather than silvered surfaces are used to reflect light, since even the best silvered surface absorbs a fraction of the incident light. To apply this principle to a fibre-optic light-guide filament, a cylindrical core glass with an index of refraction n_1 is clad with a second glass that has an index of refraction n_2. For total internal reflection to occur, n_1 must be greater than n_2 and the incident light ray must fall within the angle of acceptance. This angle of acceptance is given by:

$$\sin \phi_1 = \frac{\sqrt{n_1^2 - n_2^2}}{n_3}$$

Sin ϕ_a is also called the Numerical Aperture (NA), and represents the maximum angle at which a ray of light which is incident on the transmitting core glass can be trapped within the fibre. Beyond this maximum angle, rays are either reflected off the core face, or escape the core/cladding interface. The higher the numerical aperture becomes, the greater the angle of acceptance and the greater the light gathering power exhibited by the fibre. These relations are summarized in Fig. 2. In photographic terminology, the f/number = 1/2 (NA), where a low f/number indicates a large light gathering ability by the lens. Since n = 1 for air, the NA can never exceed 1, and the f/number can never be less than 0.5.



Flexible plastic fibre optics transmits images in full colour. Light loss is 20% per foot plus 10% at each end.

Light loss during transmission through a typical fibre depends on several factors. The length of the fibre attenuates the light ray in relations to the absorption coefficient of the core glass, which is dependent on the colour of the surface light. Over the wavelength range of 4.5×10^{-5} to 10.0×10^{-5} cm, average absorption loss is 7% per foot of length. Special core glasses can be obtained, however, to transmit ultraviolet.

The ends of a fibre optic bundle also have losses. The areas between fibres do not transmit light, and light energy incident on the clad glass portion of each filament is poorly transmitted. These losses are referred to as packing-fraction losses. They occur for a 30% loss of the incident energy falling within the acceptance angle of the device.

End losses also include those that occur at the air/fibre interface on each end of a device. Each reflection loss accounts for about 4% of the incident energy. For a one-foot bundle, these losses can be multiplied to yield about 50% transmission efficiency. For longer lengths, this figure should be multiplied by 93% per foot (7% absorption loss per foot).

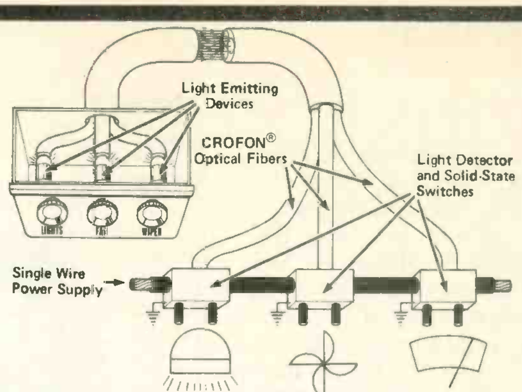
Although a single unclad rod, such as Lucite, can be used to transmit light, transmission efficiency is quite poor. The key to an efficient light transmitting rod is in the smoothness and purity of the reflecting surface. With an unclad glass or plastic fibre, the smooth outer surface along the length of the fibre can easily be scratched or contaminated with dirt and fingerprints. In addition, when single glass fibres are bunched together in a matrix, light can jump from fibre to fibre (cross-talk), degrading the transmission characteristics of the array.

Cladding provides several advantages. The critical angle remains constant along the length of the fibre, and the critical interface (between core glass and clad glass) is protected, and stays as smooth as when manufactured. Further, cladding provides a way to separate the individual fibres to prevent light leaks. In some optical arrays, a layer of opaque material is applied as a second cladding, resulting in light absorption outside the acceptance angle.

Fibre-optic devices come in a multitude of sizes and forms, but most are based on the single clad-glass fibre or filament.

The simplest way to draw a single clad-fibre that has discrete index of refraction between core and cladding is the rod-in-tube method, in which a rod of glass (the intended core) is inserted inside a glass tube (the intended cladding) and then fed into a furnace which heats the glass to a temperature just below melting. Then the heated end is drawn out into a fibre that has, on a smaller scale, the same relative core-to-cladding refractive index ratio as the original rod-in-tube.

The conventional single-fibre optic filament can be made in any size from



The concept of using fibre optic materials to carry electro-optical signals from switches to electrical application areas in the automobile is illustrated in this drawing. While the head-light, fan and windshield wiper are used as examples, such a bundle of fibres can activate every electrical function in the car from tiny light-emitting diodes located at the control points.
By varying the wave length of the signal, one cable of optical fibres can control every operation in the motor-car, either consecutively or simultaneously.
Courtesy Dupont Corporation.

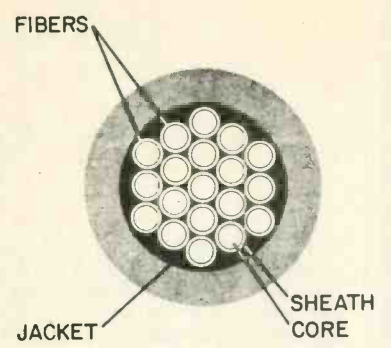
This is neither a scene from "2001" nor a satellite's view of the eye of a hurricane. It's a glimpse down a rifle barrel illuminated at the chamber end by a Corning Flexiflash fibre optic unit. The unit is proving useful for gun enthusiasts in examining rifling, the chamber, the wear in the barrel's throat — all areas that can effect a weapon's accuracy.

FIBRE OPTICS-TODAY!

20 microns up to ¼-inch in diameter (and occasionally larger and smaller). The larger size is frequently called a rod. These filaments are made of either glass or plastic. Glass has the advantages of being sturdier, resisting high temperatures without damage, resisting most chemical environments, and is generally more efficient than plastic. Plastic fibre-optic filaments, however, are generally less expensive than glass, and can frequently be used without end polishing if they are cut cleanly.

Single fibres by themselves are not very useful, except to demonstrate how fibre-optic bundles are made.

But an equipment designer should not waste his time fabricating fibre-optic bundles and arrays since this approach presents more problems than it solves. Excellent design kits of production fibre-optic devices are available from several sources. These kits make it possible to build a prototype instrument without worrying about a sloppy fibre-optic component.



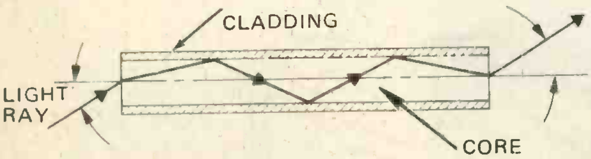
"CROFON" LIGHT GUIDE

An interesting offshoot from the basic fibre fabrication technique is the SELFOC fibre, recently introduced by Nippon Electric. It is a lenslike glass fibre-optic light guide in which there is no separation of core and clad glass. Instead, the refractive index of the fibre changes continually in a radial direction from a maximum value at the centre to a minimum value around the circumference. As there are no internal reflections, the fibre itself acts as a lens, and the tranmission efficiency appears to be greater than with a conventional fibre-optic

BASIC DATA ON FIBRE OPTICS

The principle by which Fibre-Optic work is called total internal reflection

Total internal reflections will exist at any smooth interface between two transparent materials having different refractive indexes, such as between glass and air. Contamination such as one fibre touching another, or dirt deposits on the interface, interferes with total internal reflection by absorbing or scattering a fraction of the light. This problem has been solved by in the case of fibre optics by applying a transparent "cladding" of low reflective index over the higher refractive index of the fibre. This permits highly efficient light transmission through the fibre core.

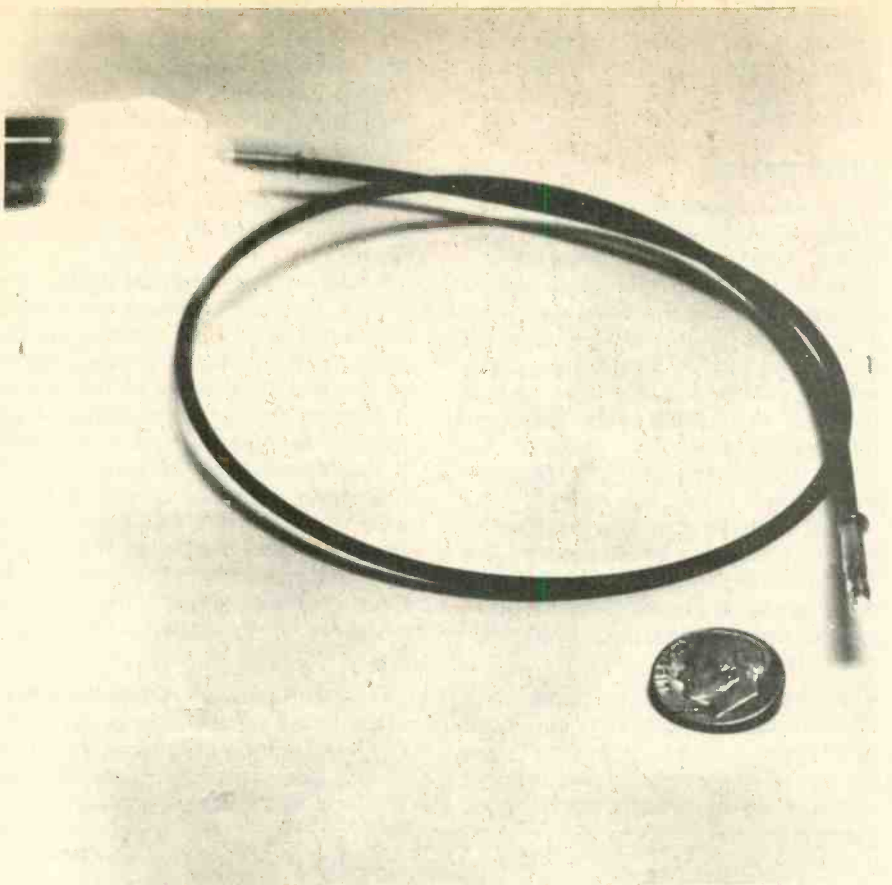


The amount of light transmitted depends upon (a) the intensity of the light source, (b) the loss characteristics of the cladding and core structures, (c) the length of fibre and the number of fibres per bundle.

PERFORMANCE CHARACTERISTICS

The general performance characteristics of commercially available fibre optic materials is listed below. The information is more representative than conclusive because of the wide difference in specimens and techniques in construction.

OPTICAL CHARACTERISTICS	
Acceptance angle	70 degrees F
End losses	10% average (depends on end finish)
Line losses	10% per foot exponential
Transmission range	0.4 to 0.9 microns
Bend radius	20 times fibre diameter
PHYSICAL CHARACTERISTICS	
Bend radius	Smaller fibres can be lightly knotted without breaking
Density	1.04 grams per cubic cm.
ENVIRONMENTAL CHARACTERISTICS	
Temperature (Maximum continuous exposure	180 degrees F
Minimum temperature	Operates at cryogenic levels. Remains flexible to approximately 50^{o}C.
Heat distortion temperature	100 degrees C at 264 psi.
Moisture absorption	None
Chemical resistance	Unaffected by alkalies, non-oxidizing acids, salt water, photographic solutions, etc. Damaged by acetone and other strong solvents.
Aging	Three years history of dark storage reflects negligible transmission variations.



filament. In addition, a SELFOC filament produces no phase differences during transmission. The phase of the exit signal is the same as the entering signal.

Perhaps the most interesting use of a single fibre is in the fibre-optic laser developed by American Optical for photocoagulation of the retina-choroid portion of the eye to treat detached retinas. A small cabinet contains the flashlamp and the portion of the laser-fibre that is excited. Output energy travels along the single large, 300-micron diameter, clad laser fibre to a handheld probe, that is directed toward the desired spot by a surgeon. This application allows the precise positioning of intense energy with minimal danger to patient or the physician.

MAKING FILAMENTS INTO BUNDLES

When a number of fibre-optic filaments are grouped together into a bundle, a fibre-optic light guide results. It is a bundle of single fibre-optic filaments, that are either epoxied or fused together at the ends and left free to flex in between. Since no effort is made to align the fibres at the ends of the bundle, the light transmitted through the bundle is scrambled or noncoherent, and the main application of these bundles is simple light transmission.

A noncoherent bundle is perhaps the most useful fibre-optic component available. This device comes in many sizes and shapes, although all have potted, ground and polished ends, and the ends are usually held in metal ferrules.

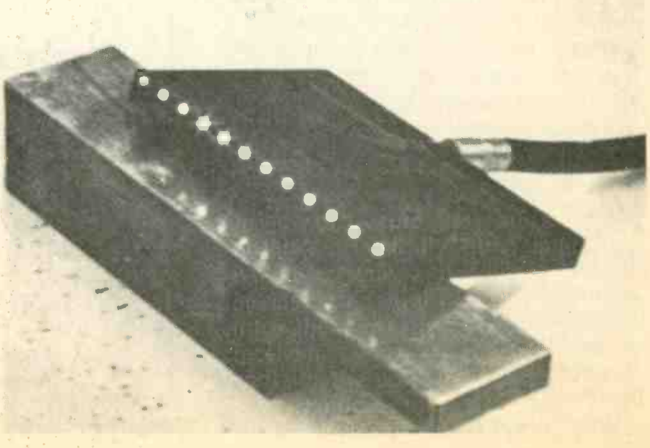
The combination of the fibre bundle provides a source of cool, intense light for readouts, displays, photography, or medical uses – any situation that calls for intense, heat-free light.

The simplicity of a bundle of fibres which serve no purpose other than transmitting light is deceiving. Since light is energy, a fibre-optic bundle can be used to transmit raw energy to a load. One device could be a solid state laser system designed for failproof firing of explosives at a remote distance. Typically, the laser head would contain a neodymium pulsed laser set to deliver one joule of energy into the fibre-optic bundle. At the receiving end, a power cartridge contains the propellant and an optical glass window that admits the laser light to the propellant. Such a device can be used to fire explosive bolts in rockets to separate stages, and since the firing mechanism has only a glass fibre input, it cannot be accidentally set off by static electricity or electromagnetic interference.

Another novel use of a fibre bundle is transmission of data. The isolation signal amplifier shown in Fig. 3 provides both a means of isolation and a means of data transmission. Each system consists of a transmitter, receiver, and connecting fibre-optic cable. Using a battery power source in the transmitter, the system can operate with immunity in areas of high ground-plane and common-mode voltages. The system is used to isolate medical instrumentation, safety measure high voltages, and isolated measurement of rf fields.

Although fibre-optic bundles can be used simply to supply light in an inaccessible area, a much wider application is in photoelectric sensing circuits. Although a light and photocell could be used without a fibre-optic guide, for simple object detection, the light and photocell would be subjected to any mechanical stress that affected the measuring site such as vibrations on a conveyor system. With a fibre-optic guide, both the light and the photocell can be located at a remote point, increasing their reliability and serviceability.

In punched-card readers, a photocell-lamp combination has been superior to the earlier method of brushes and contacts. However, the lamps have a short lifetime because of the vibration set up by the card-handling equipment. By using a



Single light source is a feature of this punched-card reader. Light shines on far end of 12-branch fibre-optics light guide.

FIBRE OPTICS-TODAY!

single incandescent light source, and a 12-branch fibre-optic light guide, reliability is increased while the total number of lamps required is decreased.

A more interesting use for lamp-photocell combinations in a reflection sensing to sense a mark on a card. In use, a two branch (bifurcated) bundle is used, with light travelling from the control unit to the tip of the bundle along one branch, or set of fibres. This light illuminates the area of interest, while light reflected from this same area is picked up by the other light guide in the same bundle, and carried back to a photocell in the control unit. These units are widely accepted in industry for such things as mark sensing, colour matching, colour change determination and edge sensing. With proper selection of light source and light guide, a unit like this can detect a spot as small as 0.002", 50 or more feet from the sensing site. This type of sensing can be applied easily to an optical tachometer. IBM has also considered applying reflection sensing to temperature monitoring so a central control panel would monitor the temperature of remote devices that have been painted with a temperature indicating paint. When a given temperature reaches the alarm point, the paint changes colour say from white to black. The level of reflected light that is carried back along the fibre bundle to the indicator lens changes accordingly.

AUTOMOTIVE APPLICATIONS

It has recently been proposed that car instrument panels be illuminated from a single bulb. This light would be focused on to a many-branched fibre-optic bundle, with each branch being routed inside the wiring harnesses to a different point on the panel.

In the USA, this year's Chevrolets have an optional level-indicator system that can be installed on the windshield washer tank. The system consists of a sending unit, a light conducting fibre-optic bundle, and a lens assembly for the instrument panel. Similar in design, but suited for washer tanks or any application where you want to sense a liquid level is a liquid-level monitor evaluation package.

COHERENT FIBRE-OPTIC BUNDLES

Manufacturing a bundle of fibres whose beginnings and ends are aligned in the same orientation produces a coherent bundle that can be used to convey an image, instead of simply transmitting light. This type of bundle is collectively called a flexible fibrescope, and enables the observation of inaccessible places such as the inside of the human stomach or the inside of a jet turbine.

SHEET OPTICS

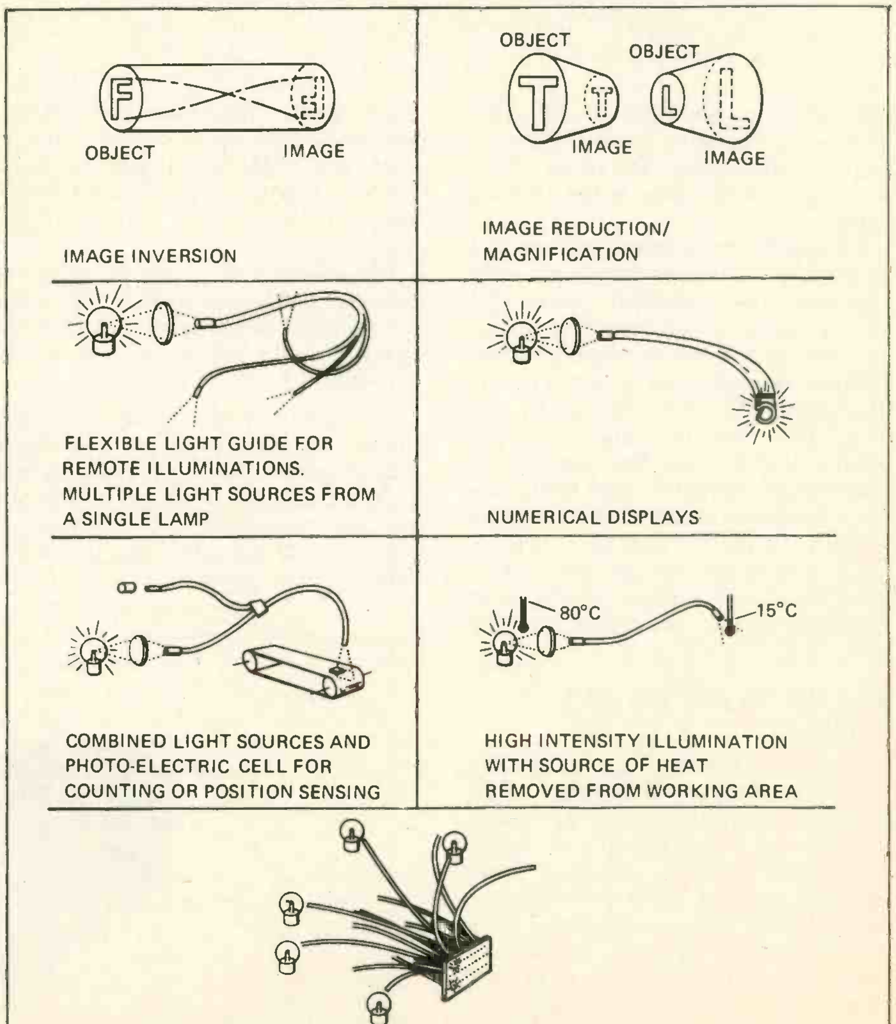
Individual fibre-optic filaments can also be arranged side by side in a sheet. If the sheet of fibres is arranged in a circular shape at one end, and a different shape at the other end (such as a straight line), the light accepted by the end formed into a straight line will be delivered at the other end in the form of a lighted circle. This is the line-to-circle-converter, and it has many applications in facsimile transmission.

Sheet material can also be used to project and detect a light curtain. This type of arrangement is frequently used on large punch presses to insure that a part has been ejected, prior to the start of a new punch cycle.

Another important area of fibre-optics applications is mosaic fabrication. Here, many glass fibre-optic filaments are fused together into a plate or mosaic, having many parallel light channels. This is a difficult process, and some companies first surround each filament with an opaque coating (called extramural absorption) to deter crosstalk between adjacent filaments in the finished mosaic. They are used as image magnifiers, inverters, intensifiers, and a faceplates in special-purpose cathode ray tubes.

A long-standing problem is obtaining a hard copy of an image on a CRO. Conventional CRO's simply do not deliver a sharp enough image, because of the scattering effect of the light as it passes from the phosphor layer through the glass faceplate. However, if the faceplate is a fibre-optic mosaic that has a phosphor coating over the internal ends of the fibres, then as the phosphor layer is scanned and excited by an electron beam, the emitted light travels only along the parallel filaments in its path to the outside world.

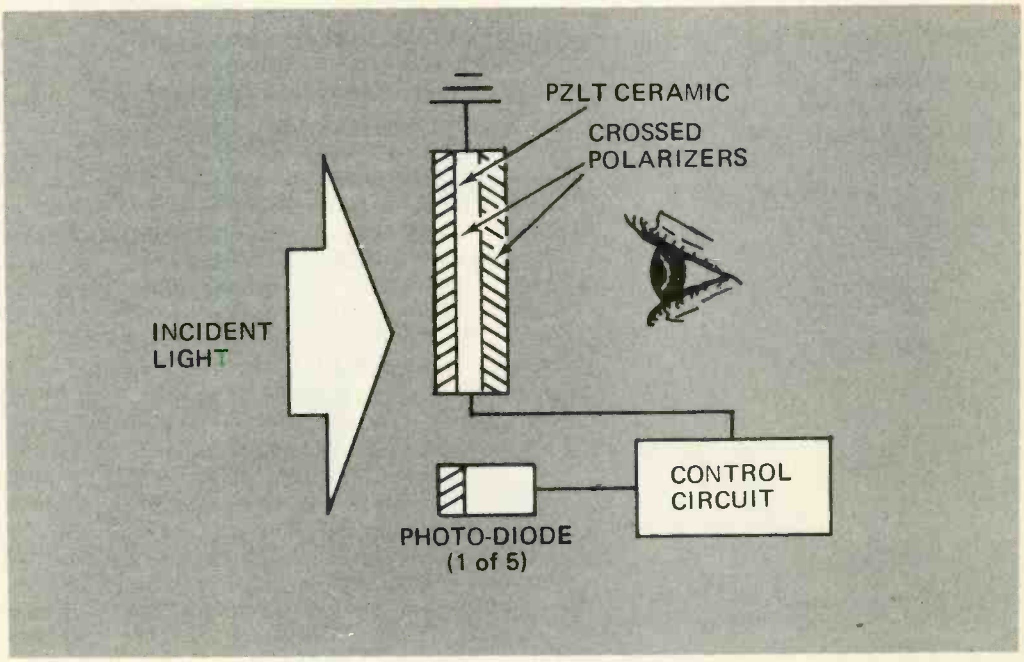
This configuration produces a very sharp image on the outside face of a CRO and can be used to contact print a dry photosensitive paper directly, resulting in a crisp hard copy picture●



FIBRE OPTIC APPLICATIONS are more numerous than we realise. Several different categories are illustrated here.

Flash-blindness protection

Electro-optic variable density goggles offer protection even from nuclear flashes!



A NEW design for instantaneously-actuated variable density goggle lenses has been devised by researches at Sandia Laboratories in Albuquerque, New Mexico. The lenses in effect furnish the wearer with an "electronic blink" which cuts off the peak brilliance of light flashes. The system can be switched from transparent to near opaque (0.01% transmission) within 50 microseconds (millionths of a second), and returns automatically to the transparent state when light levels drop to a non-hazardous value.

Primary applications for the goggle include flashblindness protection from nuclear flashes as well as from damaging light levels in industrial jobs such as arc welding and metal working. The same general device also may be used to protect sensitive light detectors (such as image intensifiers and vidicon tubes), as an electronic shutter in photographic applications, as an optical switch or light gate, and as a variable density transmission window providing a gray scale over four orders of magnitude. A fast-reacting window has been developed using this latter property, to provide a constant level of light transmission when coupled with a photodiode detector behind the lens. The device may also be operated at higher voltage levels as a colour filter.

The system, which incorporates an all-solid-state electro-optic PLZT ceramic element sandwiched between crossed polarizers, possesses several desirable features. The self-contained power supply — consisting of a 5.4 volt battery, dc-dc converter and electronics — displaces only 12 cubic inches and weighs 10 ounces but has not been fully miniaturized. The battery will power the goggles for about 200 hours. While the converter yields 950 volts potential, maintaining the goggles' "ON" state requires only a few pico-amperes of current.

The newly-developed filter can be stored indefinitely, and is resistant to fatigue. Units developed at Sandia have been triggered several thousand times without measurable degradation.

Light transmission through the goggles in their "ON" state is about 21%. The goggles are more transparent than conventional sunglasses (U.S. Air Force regulation sunglasses transmit 15%), and are essentially colorless. When desired, transmission may be set to any level between 21% and the "opaque" value of 0.003% by means of a simple rheostat control.

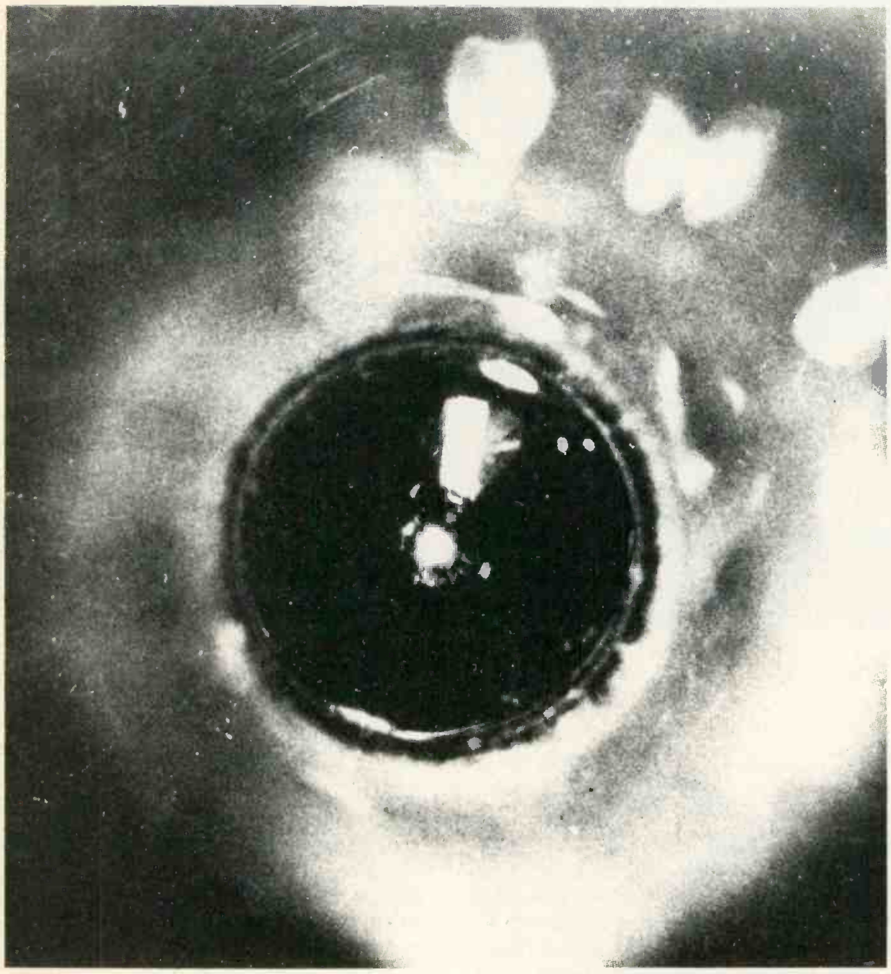
The prototype goggles contain two lenses measuring 1½ inches in diameter. Similar filters having areas of 100 square inches or more, could be controlled by the same shirt-pocket-size power pack.

The lenses are a sandwich consisting of a polarizer, an electroded PLZT (lanthanum-modified lead zirconate-lead titanate) ceramic, and a second polarizer (analyzer) crossed (oriented at 90°) with respect to the first. The PLZT surface is overlaid with an interdigital electrode array in which the electrodes (either sputtered copper or vacuum deposited chromium-gold) are 2 mils wide and separated by 40-mil gaps.

(Continued page 78)

OPTICAL COMMUNICATIONS

150 million 6MHz TV channels can be accommodated on one single communications channel.



Using hollow glass waveguides – tiny tubes with inner diameters about one half the thickness of a pencil lead – a Bell Telephone Laboratories (BTL) scientist has succeeded in miniaturizing gas lasers. Spaced at intervals along a light path, miniature gas lasers could amplify light signals to compensate for transmission losses.
In most gas lasers, including the new waveguide lasers, coherent light is generated by means of an electrical discharge similar to that which causes a neon sign to glow. For many gas lasers the gain (the increase in intensity that the light experiences in passing through the gas) increases as the diameter of the discharge tube is decreased.
But, a smaller inner diameter is only part of the key to obtaining the required gain for gas laser action in very short lengths of tubing. In conventional gas laser designs, for example, tubes with small inner diameters would block the passage of some of the laser light and more than off-set the benefit of higher gain.
To overcome this problem, waveguide gas laser tubes are fabricated with inner walls that are very straight and highly polished. By focusing light into this special tube in such a way that in passing down the tube it expereinces multiple reflections at the walls, a beam can be efficiently transmitted with low losses. Light is actually "guided" down the axis of the tube where it can be amplified by a gas discharge.
In this way, much higher amplification can be obtained for a given length of tube than in conventional lasers.

'EXPLOSION' analogies seem to be in vogue – even Paul Erlich called his book about population increase 'The Population Bomb' – and now we are constantly bombarded (there's another one! – Ed.) with warnings about everything from power useage to pollution.

Another of these so-called 'explosions' concerns the generation of information, and closely allied with this is the problem of the ever-increasing need for communications both within and between countries and continents.

By way of illustration, the number of new books published in the USA has risen from 7000 per year in 1945 to over 40,000 in 1972. The number of overseas telephone calls is 20 times greater now than 15 years ago and is still increasing at a dramatic rate. Other media such as telex traffic, satellite television coverage, facsimile and high speed data links all add to the staggering increase in demand for extra channels and increased bandwidths.

On international communications services these needs are being met by two current technologies. Firstly there are communications satellites of ever increasing complexity – the latest Intelsat satellite for example, has a capacity of 5000 voice channels or 12 television channels. – Secondly, new submarine cables are being developed to carry ever-increasing amounts of traffic. Cables scheduled for installation in the late 1970's will provide 10,000 voice channels or more.

Transcontinental traffic is largely carried by microwave links supplemented by co-axial cable systems. Obviously the largest amount of information possible should be carried on any one channel. This requirement naturally imposes wide frequency bandwidth requirements, and as a corollary, very high carrier frequencies. A typical microwave link, for example, would operate at 12 GHz and have a bandwidth of 12MHz. Adjacent channels share the same antenna path but have slightly different carrier frequencies.

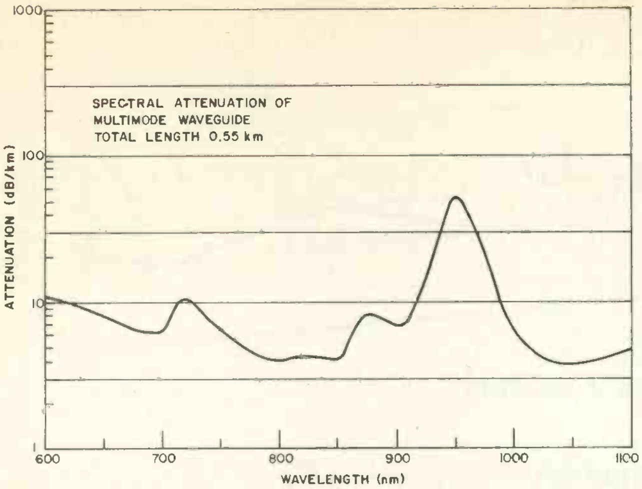


Fig. 1. This graph illustrates the spectral attenuation of a Corning multi-mode waveguide at various frequencies.

INFORMATION CAPACITY OF COMMUNICATION MEDIA

MODE	CHANNEL BANDWIDTH	CAPACITY BITS PER SEC
Telephone	3 kHz	6×10^4
AM Radio	10 kHz	8×10^4
FM Radio	200 kHz	2.5×10^5
Records or Tape	15 kHz	2.5×10^5
Television	6 MHz	9×10^7
Microwave Link (1200 Phone Channels)	20 MHz	7.2×10^7
Coax Cable (10,800 Phone Channels)	57 MHz	6.5×10^8
Millimetric Wave-guide 250,000 Phone Channels	70 GHz	15×10^9
Laser Optical	10 THz	10^{11}

But in the future, instead of tens of thousands of voice channels per link, we need to develop a technology providing *tens of millions* of voice channels per link, and this implies bandwidths of the order of 1GHz. How will this be possible?

OPTICAL COMMUNICATION SYSTEMS

One answer lies in the new laser technology and in the even newer fibre-optic technology. These two techniques when used together provide a communication medium with staggering information transmission capabilities.

Conventional lasers operate in the region between 0.3 micron and 5.3 micron — that is 60 Terahertz +. In this bandwidth, 200×10^9 voice channels could be accommodated, or, 150 million, 6MHz wide, TV channels. On a single laser beam, millions of voice channels, or thousands of TV channels could be accommodated.

Practical optical communication systems should commence service within the next decade and by that time most of the technology should be readily available.

Light sources in the form of lasers and light emitting diodes are available now — as are suitable detectors such as PIN diodes. One area however that is still receiving intensive research effort is the conducting medium. Obviously, line of sight transmission will not be possible under all conditions, and some means of piping the light around corners must be developed. This is where fibre-optics will find its most extensive application.

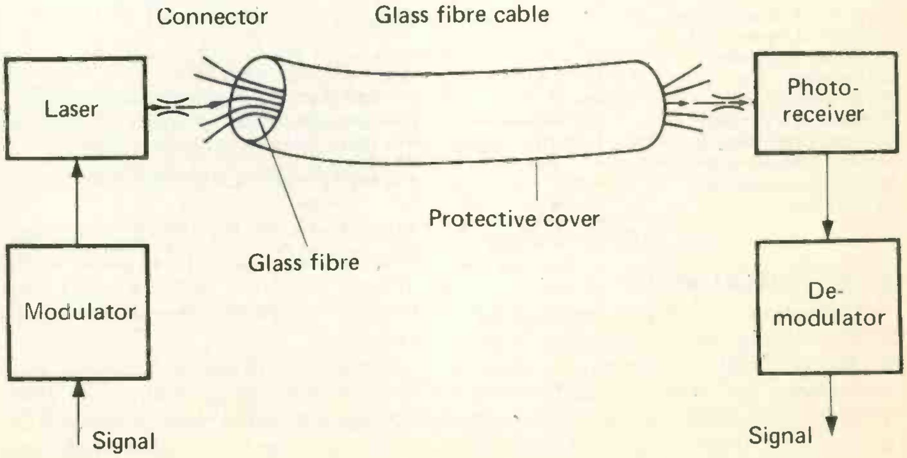
FIBRE-OPTIC SYSTEMS

Transmission of information via fibre-optic systems was only practicable over very short distances until recently. The main problem was attenuation of the light (i.e. signal) level due to losses within the fibre itself; in fact losses in the best available fibre have been 20dB/kilometre or more. (At 20dB per kilometre only 1% of the input light emerges at the end of a fibre one kilometre long.)

But even with a loss of 20dB per kilometre the technique is practical, for current engineering methods using light sources and detectors allows a 30 to 50dB loss to be tolerated. This means that fibre-optic transmission is now possible over distances greater than one kilometre which is essential in any practical system. (A repeater station every kilometre or so is normal in coaxial cable systems). Furthermore, glass fibres are mechanically flexible, simple and trouble-free in contrast to more complicated alternative optical transmission techniques.

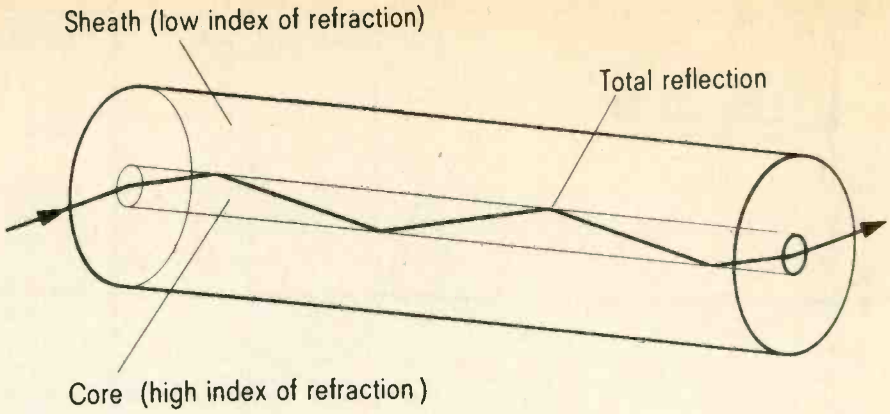
In the USA, Corning researchers have recently reduced attenuation losses in glass fibre-optic waveguides to only four dB per kilometre at 850 and 1060 nanometers — (which are convenient wavelengths for laser light sources). Losses between 600 and 900 nm are all 12 dB/km or less. (See Fig. 1.) Corning first attained an attenuation loss of 20 dB/km in 1970, and scientists said then this development greatly enhanced the prospect of high information-capacity optical communication systems. The more recent four dB/km performance arose from composition research, and improved multimode fibre-preparation techniques. Corning's goal is now said to be fibre with losses of only two dB/km.

Multimode low-loss waveguides are fabricated by drawing down a rod of core glass sealed to a tube of the cladding glass. This is impractical for single-mode waveguides, because the core must be very small. However a new technique, of drawing down a tube with a film of the core glass



Optical communication transmission via glass fibres

OPTICAL COMMUNICATIONS



Light ray conduction in a glass fibre.

inside, has been developed to circumvent this difficulty.

The bandpass of single-mode optical waveguides is limited by guide dispersion and dispersion of the glass materials. Calculations show it to be over 10^{10} bits per second per kilometre of length.

Multimode waveguides are difficult to evaluate accurately but the approximate bandpass can be shown to be approximately 10^8 bits sec^{-1} km^{-1}

As stated before, the most important parameter of a fibre waveguide is its attenuation. Losses are due to both scattering and absorption. Scattering arises from imperfections, core diameter variations, and intrinsic refractive index fluctuations within the material. Absorption arises from intrinsic material properties, impurities, and unwanted oxidation states of the glass components. Water, present as OH^-, is an especially important impurity as its presence increases absorption. Most of these quantities can be evaluated explicitly and correlated with observed attenuation and most of these factors may be minimized by using a high silica content glass system. These glasses have low dispersion and hence higher bandpass as well as low intrinsic scattering. A representative attenuation curve for titania-silica waveguide (Fig. 1.) illustrates the low loss that can be achieved. The contributions to the loss can be further understood through measurement of the loss mechanisms outlined above. For example, a single mode guide showed the following contributions:

	633 nm	800 nm
Bulk material scattering (measured separately)	5	2
Residual measured scattering	2	2
Water absorption (estimated from tails of ultra violet peaks)	0	5
Residual measurement absorption (impurity or intrinsic)	9	11
Total	16 dB/km	20 dB/km

BASIC OPTICAL LINKS

Attenuation of typical waveguides show a strong water absorption peak at about 9500Å with minor water absorptions at about 7200Å and 8700Å Therefore, there are good transmission regions around 8000Å and 10,000Å At the latter wavelength, losses below 10 dB/km are possible. For single mode waveguides either GaA1As or Nd:YAG lasers would provide satisfactory sources. For multimode guides a solid state incoherent source emitting near 8000Å (like GaA1As) is preferred because of its simplicity. Since low loss waveguides have low numerical aperture (see previous article), it is important to reduce the angular spread of the source power. Thus, the important quantity for the source is its radiance (W/srm^2) since this determines how well the emitted light can be collimated and coupled into the waveguide.

Coupling into the detector is only a minor problem, and hence noise generation is the main consideration. Furthermore the lack of detector sensitivity at 1.06 micron mitigates against sources at this wavelength.

OPTICAL FIBRE PARAMETERS

Glass fibres, as used for optical communications, may be likened to optical waveguides and indeed are so-called. The propagation characteristics of such optical waveguides are defined by a parameter V.

where $V = 8.9\sqrt{\dfrac{Rc\,.\,\bar{n}\,.\,\Delta n}{\lambda}}$

and Rc = radius of core.
λ = wavelength of conducted radiation
$\bar{n}$ = average refractive index of the glass
Δ = difference in refractive index between core and cladding.

Optical waveguides where V is less than 2.4 are classified as single-mode. These require laser sources for efficient coupling and have the highest bandpass.

Waveguides where V is greater than 2.4 are classified as multimode. These operate with solid state diodes (LEDs) which produce non-coherent light, and because of their relative simplicity have many present applications. This is in contrast to the single-mode laser systems which are still very much in the development stage.

CALCULATING SYSTEM LOSSES

The minimum discernable signal (MDS) is taken as the point where the Signal to Noise Ratio (SNR) equals 1. This may be computed from:—

$MDS = B^{1/2}\,[(NEP)^2 + B(TEP)^2]^{1/2}$
where B = Bandwidth
NEP = Noise Equivalent Power
TEP = Thermal Equivalent Power

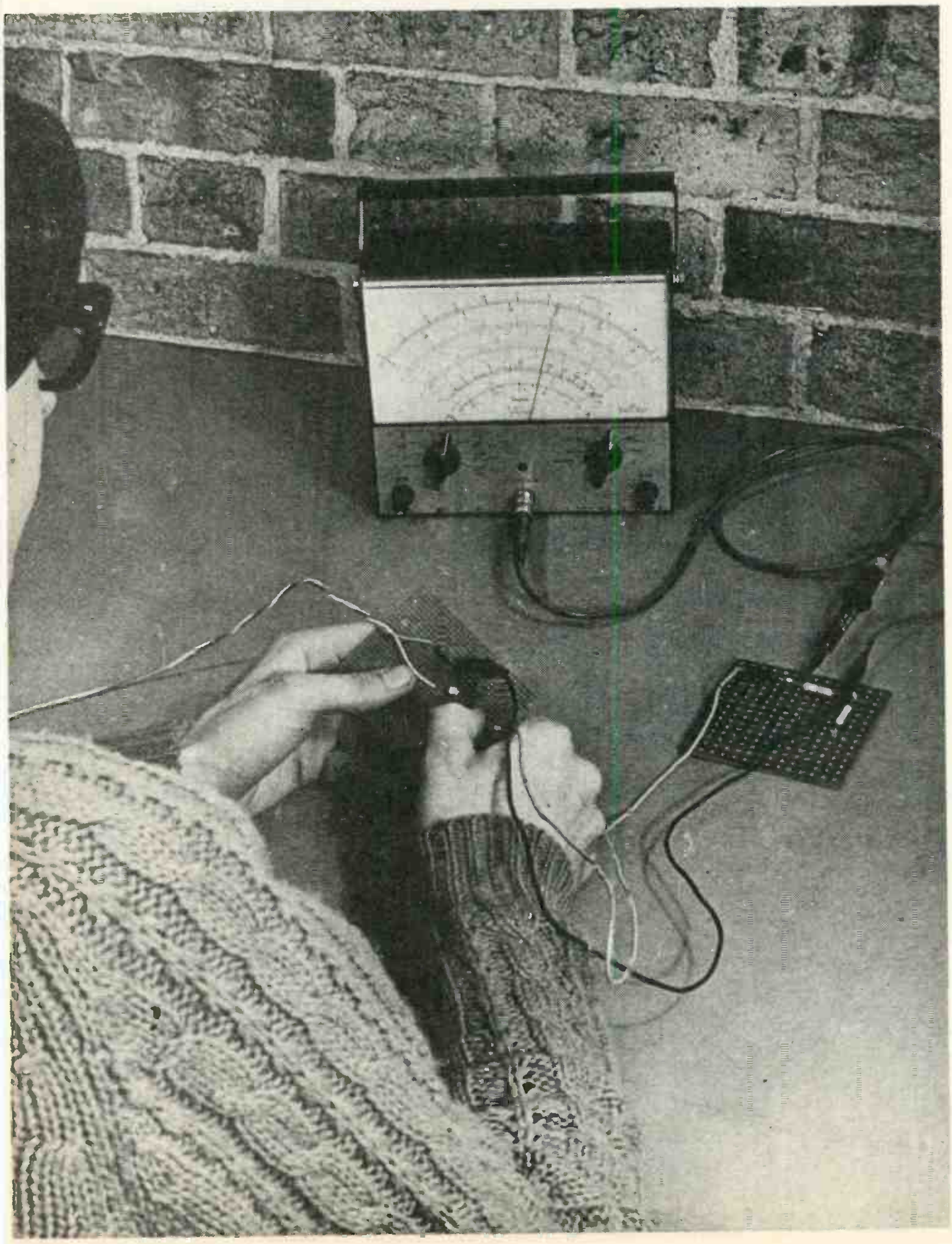
Now from published data, a typical PIN photodiode has an NEP of 10^{-7} watts at 100 MHz and an avalanche photodiode an NEP of 10^{-9} watts (100 times better). Therefore if a SNR of 20dB is required with a source power of 10 mW, a PIN diode allows a transmission loss of 30dB and an avalanche photodiode 50dB. Any other desired system performance can be calculated in a similar way. These principles are applicable to present source-transmission line — detector systems and illustrate design parameters for such basic optical links.

FURTHER NEEDED WORK

Individual fibres can be coated and used as a single transmission line, but at the moment, bundles of many fibres functioning in parallel appear more practical for incoherent sources. They offer a large cross section for source coupling efficiency, while retaining flexibility. Additionally they offer redundancy to offset fibre breakage. The redundancy question can be handled in terms of a single parameter for any length bundle when the breakage is random. The experiments in bundle construction and incorporation of bundles into cable have just begun. The future will require development of suitable cables and associated hardware, such as couplers, before totally qualified system components become available. ●

THE SOPHISTICATED VOM

External components extend applications for volt-ohmeters



Many engineers think of the VOM as being capable only of simple measurements of voltage, resistance and current. Furthermore, accurate and flexible operation has been considered the exclusive province of the "full size" instruments, with the pocket-size units relegated to the role of elementary servicing aid.

With the simple addition of a few readily available components to the circuit external to the VOM, the instrument is able to measure such values as current and voltage differential, capacitance, and micro-volt attenuation, to mention a few which will be discussed here. Though specialized instruments may be used to make such measurements, one may not be at hand when needed, or else the rarity of such measurements may make it economically impractical to buy one. The VOM may conveniently fill the breach.

SEGMENTAL VOLTMETER

Suppose we wish to detect or measure very small voltage variations in a dc signal. For example, consider 50 mV differences in a 14-volt signal. This is difficult to achieve using the VOM "straight." That is, the 50-volt range would have to be used to cover 14 volts, and 50 mV is not very readable on this range.

To read the 50 mV, it is necessary that the VOM function as a segmental voltmeter, with most of its lower range suppressed. To accomplish this, a bucking reference voltage is inserted in the circuit as in Fig. 1. If the reference were 12 volts, the meter would have to read only the 2-volt difference on its 2.5-volt range. On this lower range, the 50-mV variations could be clearly observed, a feat not possible on the 50-volt range.

If the reference voltage is precisely known, this segmental technique increases the accuracy of the total voltage reading. If not precisely known, the technique still facilitates the detection and more accurate determination of the voltage variation or difference.

It is always desirable when applying a bucking voltage to use a level that is close to the measured value, yet lower than the latter's smallest value. (It is possible to use a reference voltage higher than the measured value, but this requires subtraction of the difference reading.) For instance, suppose the reference in Fig. 1. were 13.5 volts, the 0.5 volt difference could then be read on the 1-volt range, a range which permits even closer determination of the 50 mV variations than the 2.5-volt range.

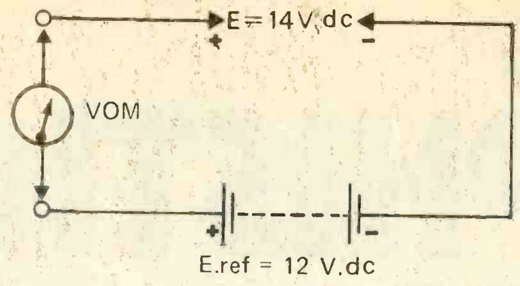


Fig. 1. VOM used as segmental voltmeter. Bucking reference voltage permits accurate reading of small signal variations.

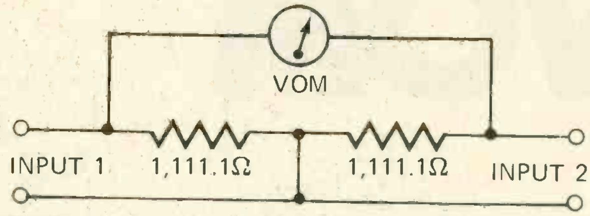


Fig. 2. Differential current reading between two inputs is made possible by using two resistors of proper value.

DIFFERENTIAL CURRENT-VOLTAGE METER

A VOM will function as a current or voltage sensitive differential meter to measure the difference between two individual signals. The preceding is an example of a differential voltage measurement using a fixed value on one side so that an absolute measurement results.

Where simple differential between voltages is desired, the connections of Fig. 3. would be used, except that the second unknown voltage would replace the battery.

For current differential measurements, two resistors are required. The resistor value is dependent on the maximum current differential to be measured. The value may be determined by using the formula:

$$R = \frac{R_m \; I_m}{I - 2 \times I_m}$$

where R is the resistor value, R_m is the resistance of the VOM on the range being used, I_m is the current sensitivity of the VOM on the range being used, and I is the desired full scale current sensitivity.

Assuming the use of a 20,000 ohm/volt meter the 1.0-volt range and the need for 1.0 mA sensitivity, we would have:

R_m = 20,000 ohms
I_m = 0.00005 (20,000 ohms/volt)
I = 0.001

$$R = \frac{20{,}000 \times 0.00005}{0.001 - 0.0001}$$

= 1,111.1 ohms

Fig. 2 shows the circuit which would be used. Of course, the VOM can serve simply as a null balance in such a circuit. Furthermore, it may also be used with ac inputs instead of the dc shown if external rectifiers are used.

WIDE RANGE AMMETER

There are conditions wherein a widely varying current can not be measured properly on a single range. A low scale will not cover the high end of the excursion, and a high scale will not permit accurate reading of the low end. The solution is to make the scale nonlinear by shunting the VOM with a silicon diode as in Fig. 3a. The resulting readings will be as illustrated in Fig. 3b, with the low end remaining essentially unchanged by the diode, but the high end reading currents more than 20 times greater than before.

Until the diode starts to conduct, the shunt is effectively open, and the deflection is linear as without the diode. When the input voltage increases to the point that the diode conducts, more current is shunted past the meter. Where 50μA caused full scale deflection without the diode, a current of 1100 μA might be needed with the diode. Exact scale distribution is dependent upon the values R_m, R_1 and R_2.

Since the diode is a nonlinear resistance, using this approach in voltage measurements should be restricted to voltages of at least 20 volts full scale or substantial scale errors may result.

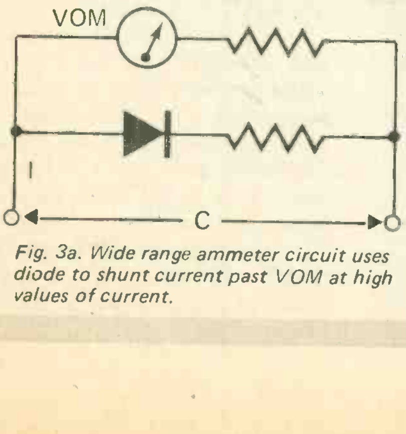


Fig. 3a. Wide range ammeter circuit uses diode to shunt current past VOM at high values of current.

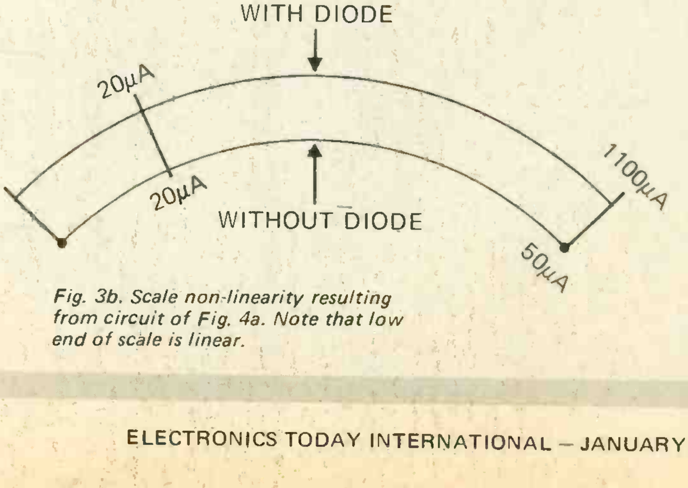


Fig. 3b. Scale non-linearity resulting from circuit of Fig. 4a. Note that low end of scale is linear.

THE SOPHISTICATED VOM

CAPACITANCE METER

The VOM does a creditable job of measuring capacitance. The simplest method compares the unknown capaciter with a known one, as in Fig. 4. The capacitances of C_1 and C_2 are inversely proportional to the a-c voltage across each:

$$\frac{C_1}{C_2} = \frac{E_2}{E_1}$$

Since the VOM impedance may be low as compared with the impedance of low capacitance units, the loading error should be minimized by using capacitors of approximately equal value. Another way to minimize error is to use a higher ac source frequency to decrease the capacitive reactance. If the known capacitor is accurate within 1%, the unknown capacitor can be determined within 5% by this method. (Caution: Do not attempt to make capacitance measurements on electrolytics by this method. Capacitance values will be in error and the capacitors may be damaged.)

The VOM can also make capacitor measurements without a known capacitor if the accessory circuit of Fig. 5 is used. The resistor values depend upon the VOM sensitivity. For 5000 ohms/volt ac, the resistors should be:

R_1 .... 12,500 ohms
R_2 .... 2,370 ohms
R_3 .... 232 ohms

By switching one of these resistors into the circuit, less current passes through the meter, thereby making the instrument less sensitive for higher capacitances. The resistor values are selected to facilitate conversion of the VOM voltage readings on the 10 volts ac scale to microfarads as shown in Table 1. When an unknown capacitor is inserted in the circuit, the switch is in Position 3. If the capacitance is less than 0.1μF, the voltage reading will be below 1 volt, so we switch instead to Position 2. A reading of say, 2.5V would indicate approximately 0.025 μF.

MICROVOLT ATTENUATION METER

By making up a simple precision voltage divider network, any unknown ac or dc input voltage may be calibrated for millivolt or microvolt output. See Fig. 6. This can be a handy circuit for checking choppers, audio amplifiers, etc.

Let's use 1 megohm for R_1 and 1 ohm for R_2, both 1% resistors. If 2.5 volts — as read on the VOM — are tapped off the input, the output would be 2.5 μV.

There are hundreds of other specialized uses for the VOM — testing the ignitor in an ignitron, measuring amplifier phase shift, tracing receiver r-f signals, and so on. All that may be needed are a few external components, at times a bit of inventiveness, and a willingness to recognize the VOM as a truly versatile instrument capable of handling a number of the measurements frequently made by expensive specialized equipment. And those specialized instruments may either not be available or may not be conveniently portable. ●

TABLE 1 — CAPACITOR TEST

Unknown Capacitor μF	Approximate Pos. 1 Reading A-C Volts
.001	0.6
.002	1.1
.003	1.5
.004	1.9
.005	2.5
.006	3.0
.007	3.6
.008	4.0
.009	4.4
.010	4.8
	Pos. 2
.01	1
.02	2
.03	3
.04	4
.05	5
.06	6
.07	7
.08	8
.09	9
.1	10
	Pos. 3
.1	1
.2	2
.3	3
.4	4
.5	5
.6	6
.7	7
.8	8
.9	9
1.0	10

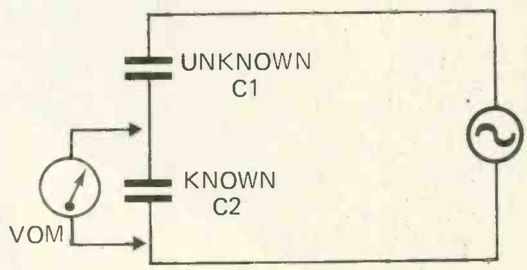


Fig. 4. As a capacitance meter, the VOM measures voltage across known and unknown capacitors.

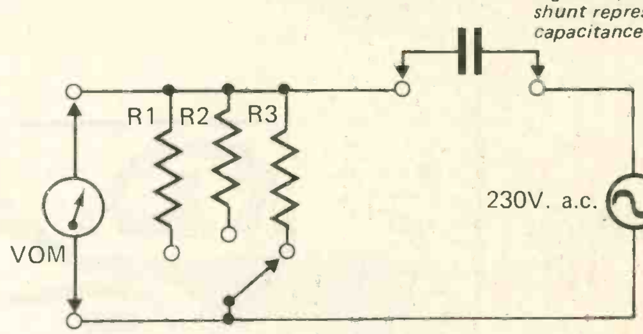


Fig. 5. Voltage reading for a particular shunt represents capacitance.

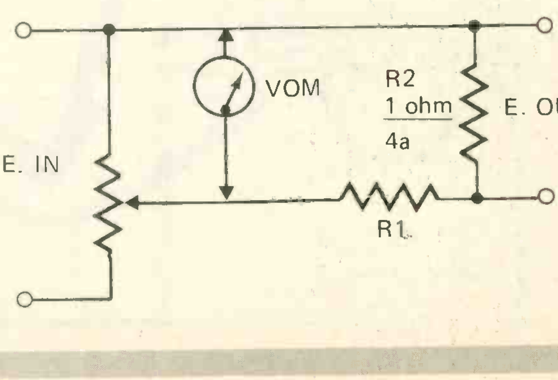
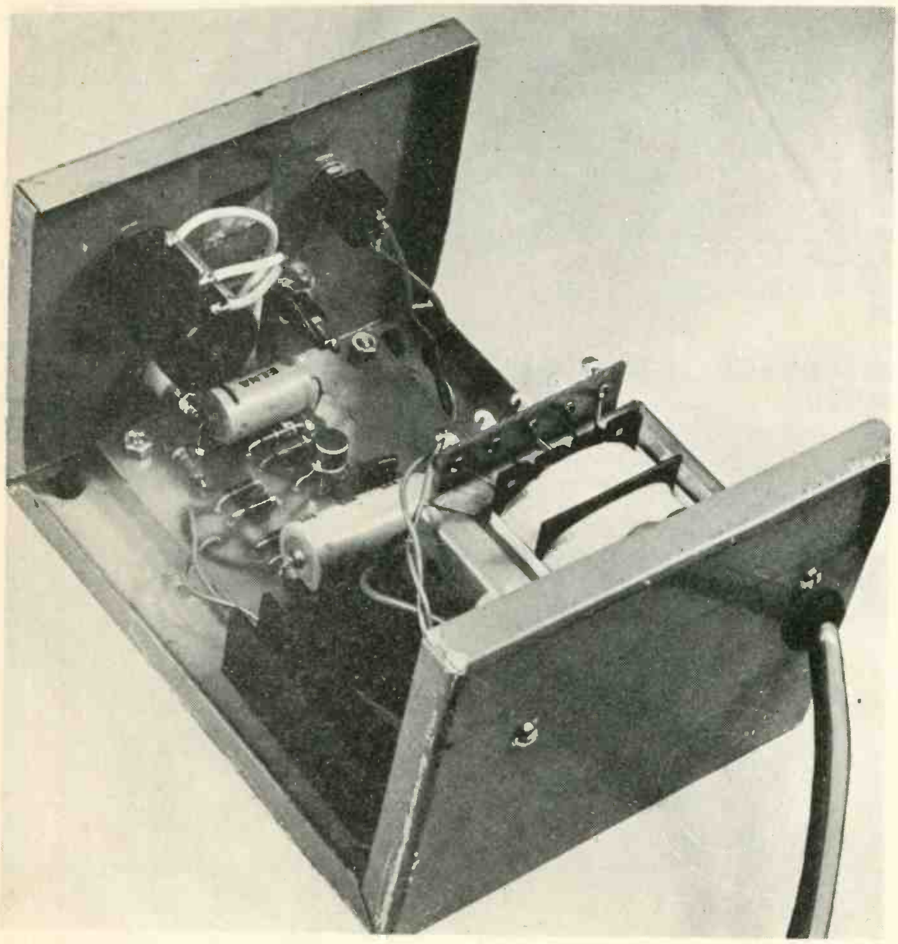


Fig. 6. Microvolt attenuation meter circuit employs voltage divider.

IC POWER



IN our April 1972 issue we published constructional details of a dual power supply unit for the experimenter. Since then we have received a surprisingly large number of requests for a simple unit to power RTL and TTL logic circuitry.

Here then are details of a simple yet versatile power supply capable of delivering 1 amp up to 10 volts and ½ amp up to 15 volts.

The unit may readily be adapted to operate over other voltage and current ranges.

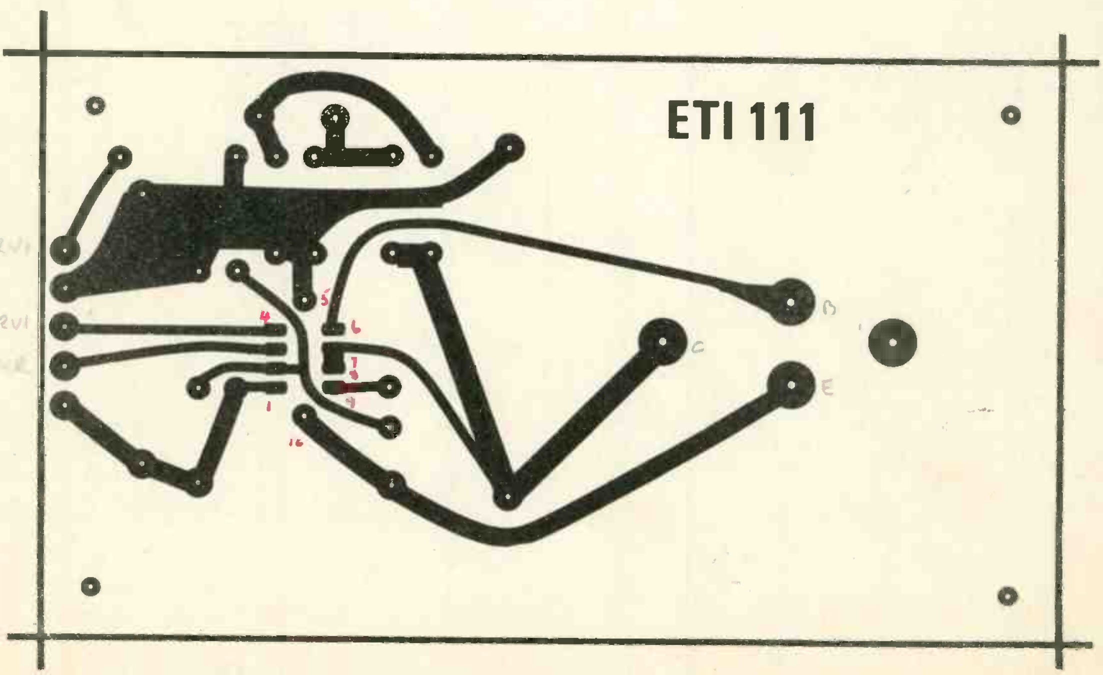
If required, refinements such as output voltage and current metering, variable current limiting etc. may be added to the basic circuit.

VOLTAGE REGULATOR IC

The control circuit of this supply is formed by the integrated circuit precision voltage regulator — shown as IC1 in Fig. 1. This IC is now produced by a number of companies including SGS, Fairchild and Motorola (respective type numbers are included in the parts list for this project).

The integrated circuit is a monolithic voltage regulator constructed on a single silicon chip using the planar expitaxial process. The device consists of a temperature compensated

ETI
PROJECT 111



Foil pattern for logic power supply (actual size).

SUPPLY

Simple, adjustable power source has innumerable applications.

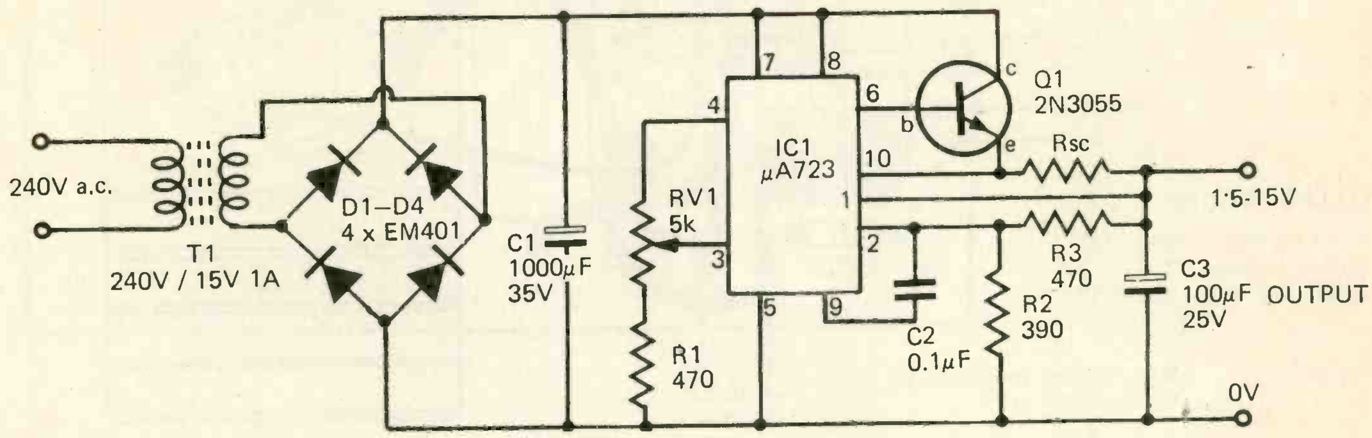


Fig. 1. Circuit diagram of regulated supply.

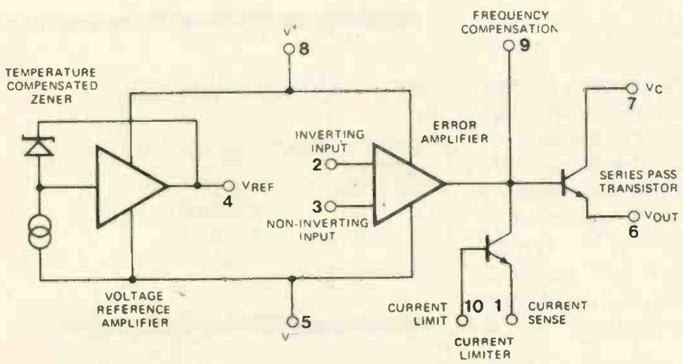
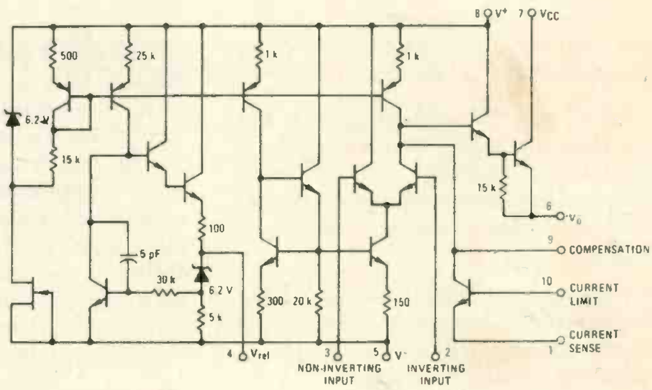


Fig. 2. Simplified schematic of uA723.



Circuit schematic of IC uA723.

reference amplifier, error amplifier, power series-pass transistor and current limiting circuit. Additional external npn and pnp pass elements may be used when output currents exceeding 150mA (from the IC) are required. Provision is made for adjustable current limiting and remote shut-down. In addition to this the IC features low standby current drain, low temperature drift and high ripple rejection.

CONSTRUCTION

Our prototype unit was built on an epoxy glass board, however the constructional method is not critical and the unit may alternatively be built on matrix board, tag strips etc.

The power transistor is mounted on a 2" strip of extruded heatsink which in turn is located on the printed circuit board by the same screws that locate the transistor. One of these screws is

HOW IT WORKS

Figure 2 shows a simplified equivalent circuit of IC1. The voltage reference amplifier produces (typically) 7.15V at pin 4, this voltage has a maximum temperature coefficient of 0.015%/°C.

The V_{ref} voltage is taken to potentiometer RV1 which enables it to be varied between 0.7V and 7.15V. The error amplifier (within the IC) drives a power transistor (also within the chip), and this in turn drives the external series pass transistor Q1.

The output of Q1 is divided by R2 and R3 (÷2.2) and this voltage provides the feedback signal for the error amplifier. Hence the output voltage will be approximately 2.2 times the voltage on RV1.

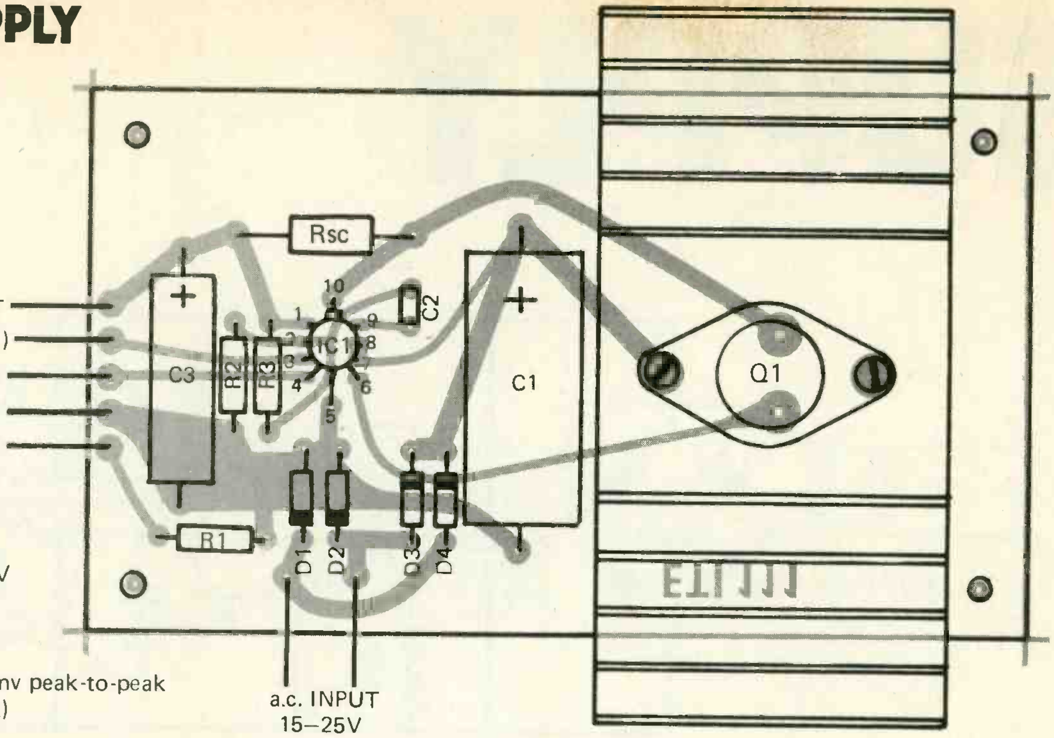
Current limiting is determined by the voltage drop across RSC. If this exceeds 0.6V, the current limit transistor within the IC becomes forward biased and bypasses any further increase in drive current from the output stage.

The max. output voltage and current of this unit is a function of the transformer, filter capacitor, and the heatsinking of Q1. The prototype unit used a 15V centre tapped 1A transformer (AR 2155) and this provided 1A up to 10V and ½A at 15V. The drop in output current is due to rectified dc voltage decreasing on load. If a higher voltage transformer is used – or one with a higher current rating, thus providing better regulation – then higher output currents may be expected.

The maximum output voltage may be altered by changing the ratio of R2 and R3. Note that the maximum no-load voltage across C1 should not exceed 35V.

IC POWER SUPPLY

Fig. 3. Layout of components on circuit board.



SPECIFICATIONS

Input Voltage	220-240V
Output Voltage	1.5V – 15V
Output current	1A at 10V ½A at 15V
Ripple	Approx. 5mv peak-to-peak (at 10V-1A)
Regulation	0-100mA = 4mV (10 Volt) 0-1.0A = 20mV (10 Volt)

also used for the electrical connection for the collector of the transistor.

The IC may be soldered directly into the circuit – ensure that the device is correctly orientated – and avoid excess heat. Recommended maximum lead temperature during soldering is 300°C.

A load sensing resistor (RSC) is used to provide overload protection. In our prototype we used a short length of resistance wire cut to length to limit the current to the desired value. An interesting alternative is to substitute a 20 ohms 5 Watt wire-wound potentiometer for RSC. This enables the current limiting facility to be steplessly varied. With this feature the user can start experimenting with a very low current limit and then increase the current when the circuit is operating correctly.

The basic circuit described in this article can be modified to provide other ranges of voltage and current. The main design limitations are that the voltage across the IC must not exceed 40V and that the output current from the IC must not exceed 150mA, or 800mW of power.

Transistor Q1 (2N 3055) is capable of dissipating up to 115 watts but if power levels of this magnitude are envisaged then a second transistor should be added, in a Darlington pair configuration, to transistor Q1. This will reduce the loading on IC1. A larger heat sink will also be required.

INCREASED RIPPLE REJECTION

The integrated circuit chosen for this project has a typical ripple rejection of 74 dB. This is more than adequate for most applications. However by additional filtering at the non-inverting input (pin 3), the ripple can be even further reduced. A typical performance, using a 4.7μF capacitor across the non-inverting input and V_{ref} is approximately 86 dB. ●

RSC – TYPICAL VALUES

Value of RSC	Current Limiting
10 ohms	65mA
1 ohm	650mA
0.5 ohms	1.4A
0.2 ohms	3.2A

PARTS LIST ETI 111

R1	resistor 470 ohm ½W 5%
R2	resistor 390 ohm ½W 5%
R3	resistor 470 ohm ½W 5%
RSC	see text
RV1	potentiometer 5k linear
D1-D4	diodes EM401, 1N4005 or similar
Q1	transistor 2N3055
IC1	integrated circuit uA723 (or SGS L123, or MC1723CG) (metal can types)
C1	capacitor 1000 uF 35V electrolytic
C2	capacitor 0.1 uF 100V
C3	capacitor 100 uF 25V electrolytic
T1	transformer 240V primary 15-20V sec @ 1A

PC board ETI 111
on-off switch, terminals, knob, 3 core flex and plug, metal box approximately 4½ x 3½ x 6 etc.

LIFE ON MARS?

Top Soviet scientists G. Petrov and V. Moroz describe Russia's latest space probes.

SCIENTIFIC equipment on board a space vehicle has to meet rigorous requirements as to its volume and weight. Hence in making the choice in the composition of scientific equipment on the USSR man-made satellites to be put in orbit around Mars it was necessary to keep in mind the basic target of the project, which was "Is there Life on Mars?"

The history of the exploration of Mars started with the "discovery" of canals. These were later found to be an optical illusion. More recently it seemed organic molecules had been discovered in the dark regions of the planet, but this too proved to be erroneous.

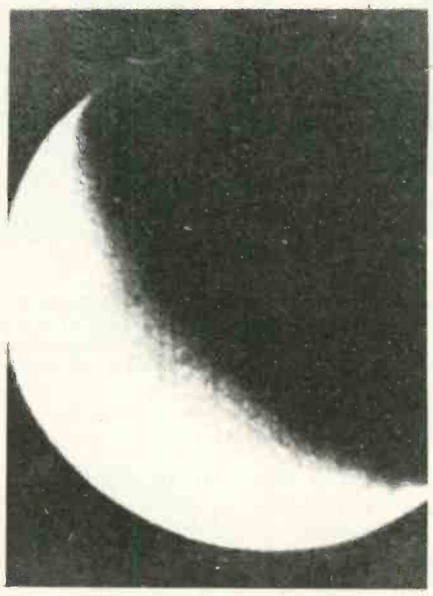
But no matter how many times we are disillusioned, one thing is quite certain – if life *does* exist on any of the solar system's planets, (apart from Earth) it is most likely to be on Mars.

We know the Martian climate is severe, but this does not mean that life does not exist there. It is a fact that the adaptability limits of living organisms are very wide – particularly in their simplest forms.

The general trend in the exploration of Mars is to make preparations for sending automatic biological laboratories equipped with instrumentation capable of identifying complex organic compounds and micro-organisms. Before such laboratories can be sent however, it is necessary to explore the planet thoroughly. To study it "far and wide" and to look at its surface for some 'oases' – areas more suitable for life than others. But how can they be found?

The biosphere, must in all probability, be concentrated in such 'oases' if it exists at all under the severe Martian conditions. These areas are expected to possess greater warmth, to be situated on the lowland and to have a relatively high humidity.

The temperature of the planet's surface can be measured at a distance by means of its infrared radiation. We can even estimate the ground temperature at some depth below the surface from the ground radio emission. The surface relief can be studied, with the aid of photographs, although they do not allow easy determination of the elevation difference between remotely situated large areas, despite the fact that this is of primary interest.



Photograph of the planet Mars transmitted from the Soviet automatic station "Mars-3". Taken by a camera with a focal length of 52 mm at a distance of about 50,000 km. The photograph, obtained by the spectrozonal method through a blue light filter, clearly shows the limb and terminator of the planet.

The simplest method of solving this problem from a man-made satellite would involve a systematic determination of the thickness of the Martian atmosphere over different regions from the intensity of the absorption bands of carbon dioxide which essentially makes up the planet's atmosphere. Lastly, an appraisal of the atmospheric humidity can be obtained by measuring the steam content in the atmosphere.

ASTROPHYSICAL EXPERIMENTS

The problem of life on Mars, is, in fact, a crucial one. But, as can be seen, tackling the problem involves a great many other issues, the study of physical conditions on the planet generally. Ultimately, the list of astrophysical experiments selected for *Mars-2* and *Mars-3* was as follows:

- measuring the surface temperature by means of its infrared radiation:
- studying the relief from the optical thickness of the atmosphere in the carbon dioxide absorption band;
- studying the photometric properties of the surface and the atmosphere;
- measuring steam content in the atmosphere;
- measuring the temperature (and, simultaneously, the dielectric constant) of the ground from the planet's radio emission;
- studying the ultraviolet radiation of the atmosphere in the resonance peaks of hydrogen, oxygen and argon.

Each experiment was to be performed by specially manufactured instruments meeting the rigorous space requirements – ability to function in superhigh vacuum, vibro-resistance, low weight, and minimal power consumption. The instruments for the first three experiments listed above have been combined in a common housing and have the appearance of a single unit – the photoradiometric complex.

The infrared radiometer consists of two miniature telescopes, one of which is directed at the planet and the other into outer space. The entire radiometer is small enough to be held in the hand and weighs slightly more than 1 kg. It can easily measure radiation from an object at a temperature of $-100^{o}C$.

Martian temperatures can be very low. In the first measurements made from Mars-3 the temperature along the route passing through the equator was at the time not above $-15^{o}C$. At a distance of 1500 km the temperature is averaged over an area of 30 km diameter. In observations from the earth it is rarely possible to measure infrared radiation even from areas twenty times as large. Moreover, by means of measurements made from man-made satellites of Mars it is possible to obtain the temperature of the planet's nocturnal side, which is beyond reach of observations conducted from the earth.

Another infrared instrument – a photometer for relief exploration – operates on short waves (about 2 μm in length) where the planet's radiation is exclusively reflected sunlight. This solar radiation, reflected from the surface, passes twice through the atmosphere, downward and upward,

PRACTICAL GUIDE TO TEMPERATURE CONTROL

PART III

In this article Collyn Rivers explains how to obtain really precise temperature control.

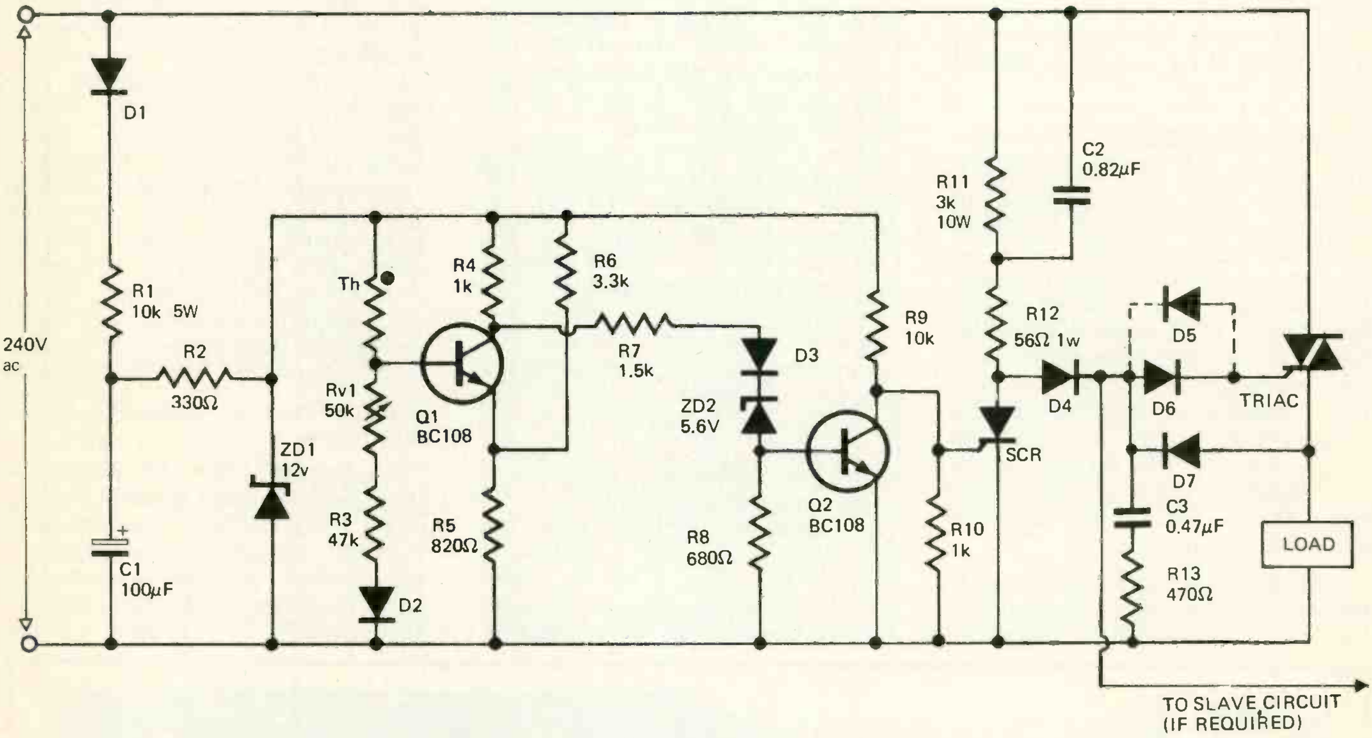


Fig. 1. Triac should be selected to suit the load, thermistor resistance should be approximately 100k at sensing temperature.

THE temperature control circuits described in parts one and two of this series are capable of maintaining temperatures to within ½% to 1% of the 'set' temperature.

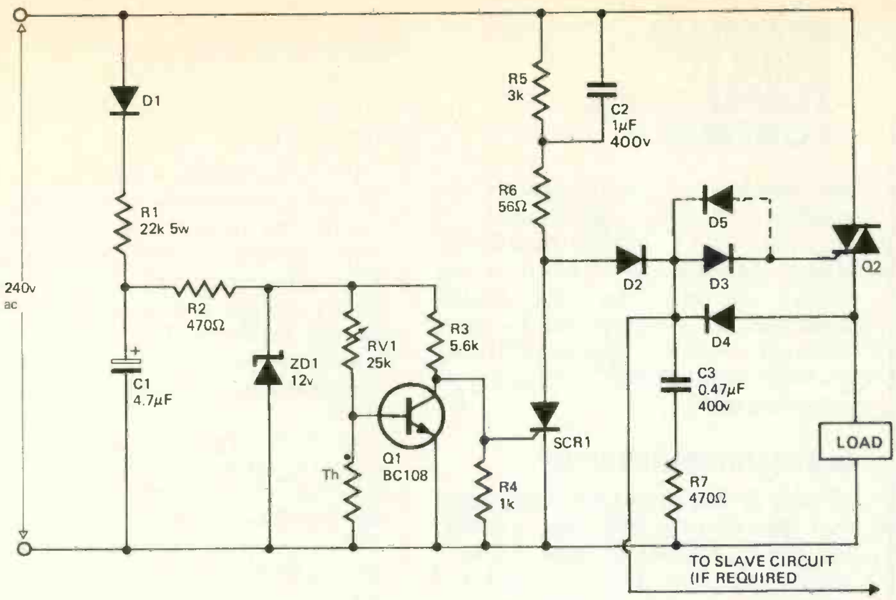
A temperature differential of this magnitude is adequate for the vast majority of engineering and laboratory applications. Nevertheless there are some applications where a temperature differential of 0.1% or better is required. Here then are two circuits capable of maintaining temperatures within this level of accuracy — we have also included a simplified version of one of these circuits which can maintain temperatures within 0.15%.

All three circuits utilize the 'zero-voltage switching' technique in which the output Triac is switched on for entire cycles and off for entire cycles, control being achieved by varying the ratio of 'on' cycles to 'off' cycles.

The circuits shown in this article are all capable of 'slave-driving' a number of additional Triacs each supplying a separate heating element. Thus heating loads varying from a few watts to many thousands of watts may be controlled by selecting Triacs of the required ratings in suitable combinations. It must however be borne in mind that massive heating control systems are generally more economic to build using inverse-parallel SCR's.

Figure 1 shows a control circuit capable of maintaining a differential better than 0.1°C at temperatures between 10°C and 150°C.

In this circuit D1,R1,R2, and Zener



diode ZD1 provide a regulated dc power supply for the sensing circuit consisting of the thermistor (Th), R3, D2 and 'temperature set' potentiometer RV1. Power is also supplied by this circuit to transistorQ1 and Q2.

A change in the resistance of the thermistor causes a change in the base current of Q1. This change is dc amplified and is then used to turn the SCR on or off. The SCR, in turn, synchronously clamps and unclamps the mains-derived trigger voltage to the Triac.

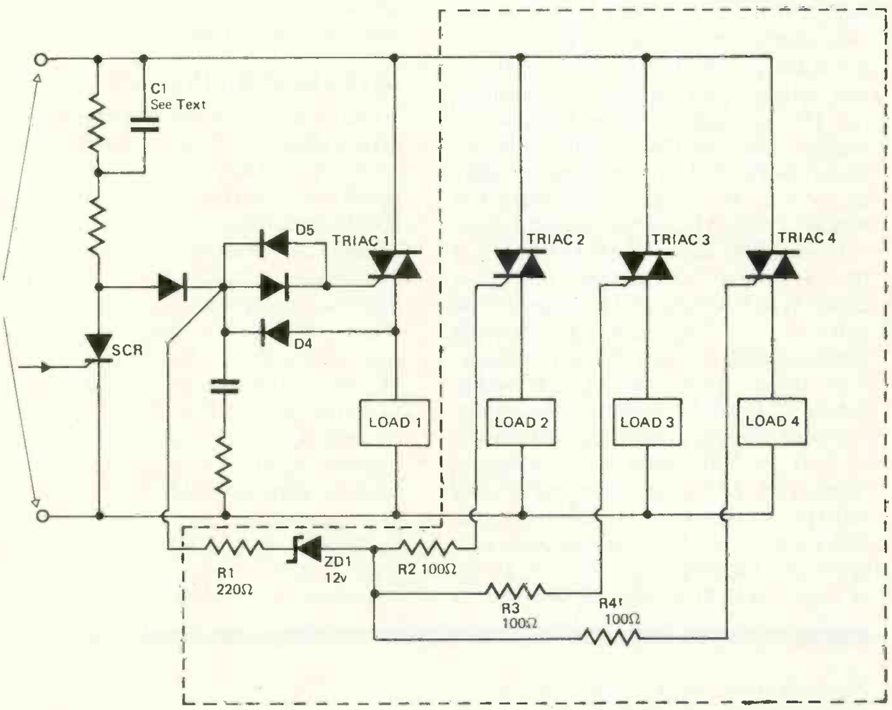
The triggering action is slightly more complex than at first it may appear. Assuming that the SCR is in the 'off' state, the Triac is triggered via R11, C2, R12, D4 and D6 during the initial period of the positive going sine-wave of the 240 volt line. As soon as line voltage appears across the load, capacitor C3 charges positively (relative to the low side). At the start of the negative-going part of the mains waveform, C3 (which still carries a positive charge), discharges via D6 thus triggering the Triac for the negative going half-cycle.

Diode D5 – shown dotted in Fig.1 – is used only when the circuit is used to slave-drive other Triacs. If only one Triac is used then D5 may be omitted.

Again, when only one Triac is used in this circuit, it may be necessary to increase the value of capacitor C2 in order to reduce the conductive RFI caused by a small notch formed at the beginning of the positive going waveform.

Figure 2 shows a simplified version of the above circuit. In this version, temperature may be controlled within 0.2°C between 10°C and 150°C.

Circuit operation is very similar to that of Fig.1, with the exception that only one transistor is used. The differential of this circuit is largely a function of the gain of the transistor (Q1). the higher the gain, the smaller



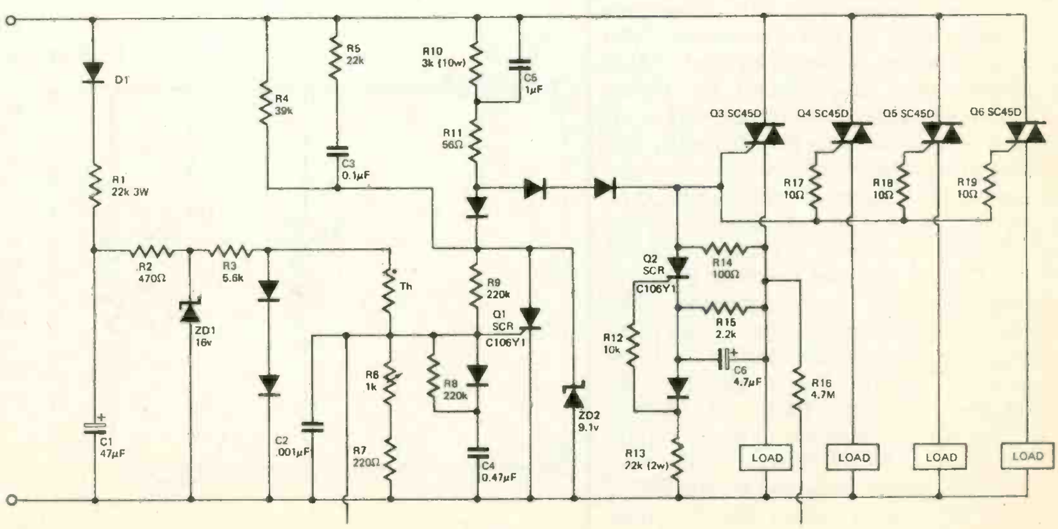
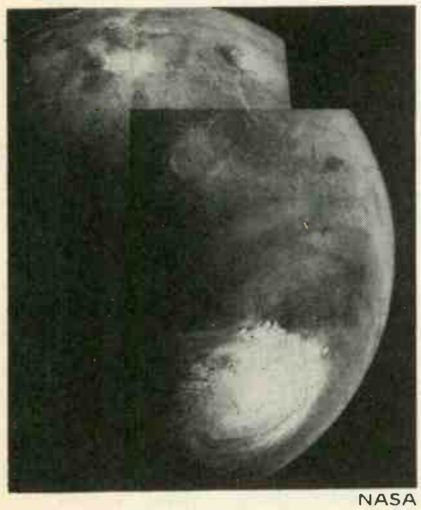


Fig. 2. (top) This circuit is a simplified version of that shown in Fig. 1. Thermistor resistance should be approximately 2k at sensing temperature.

Fig. 3. (centre) Slave circuit may be driven from either of the circuits shown as Fig. 1. and Fig. 2. Note – additional components are shown inside dotted lines.

Fig. 4. (right) This circuit may be used for either on/off or proportional operation.

MARS-FIRST PICTURES



NASA

THE northern hemisphere of Mars – from the polar cap to a few degrees south of the equator – is seen in this mosaic of three photos taken by the National Aeronautics and Space Administration's Mariner 9 spacecraft on August 7, 1972. The north polar ice cap is shrinking during the late Martian spring and the area shows complex sedimentary systems. Fractured terrains partially flooded by volcanic extrusions are visible in the center of the disk. In the bottom photo are the huge Martian volcanoes and the west end of the great equatorial canyon (lower right). The volcanic mountain Nix Olympica (lower left) is 500 kilometres (310 miles) across at the base and stands higher than any feature on Earth. When Mariner 9 went into Mars orbit last November, only Nix Olympics and the three aligned volcanoes to the right protruded above a plant-wide dust storm. When the dust settled, clouds of water or dry ice crystals continued to obscure the area north of the 50th parallel until recent months. The northern hemisphere now appears free of atmospheric obscuration. The three photos, among 7,273 obtained by Mariner 9, were taken 84 seconds apart from an average range of 13,700 kilometres (8500 miles). They have been computer-enhanced by the USA's Jet Propulsion Laboratory's image processing team. ●

PRACTICAL GUIDE TO TEMPERATURE CONTROL

the temperature differential If the smallest possible differential is required, than a BC108B or BC108C should be used for Q1. (It is not always realized that the BC108 transistor is manufactured in three different types – labelled BC108A, BC108B and BC108C in order of ascending gain).

SLAVE-DRIVE CIRCUITRY

Figure 3 shows the slave-drive circuit that may be used with Figs. 1 and 2. For clarity, the output stage of Figs. 1 and 2 has been shown – and the additional circuitry required for slave driving is that shown within the dotted lines.

In operation, as soon as Triac 1 conducts on the positive half-cycle of line voltage, gate currents are provided for the additional Triacs via parallel diodes D4 and D5, resistor R4 and Zener diode ZD1. The purpose of ZD1 is to act as a buffer between the master Triac (1) and the slaved Triacs.

Resistor R4 must be selected to suit the individual application. Its value depends on the size and number of the extra heating loads and the operating temperatures of the Triac junctions. For three slaved Triacs the value shown (220 ohms) will be about right, however this may need to be increased to 470 or 560 ohms if the loads or number of Triacs are increased. If this resistor is increased in value beyond 600 ohms or so, RFI may be become a problem. Capacitor C1 (shown as C2 in Figs 1 and 2) should be selected to provide optimum temperature differential combined with low RFI.

ON-OFF OR PROPORTIONAL OPERATION

The circuit shown in Fig. 4 is unusual in that it may readily be changed from 'on-off' to proportional operation – both modes nevertheless utilizing zero-voltage switching.

It is slightly less accurate than the circuits shown in Figs. 1 and 2 but nevertheless can maintain temperatures to within better than 0.4%.

As shown, the circuit operates in the proportional mode, 'on-off' operation is effected by deleting components R8, R9, C4 and D4.

The total heating load controllable by this circuit – using the components specified – is 9.6 kW. Naturally if smaller loads are used, then any or all of the slaved Triac stages (Q4, Q5 and Q6) may be omitted.

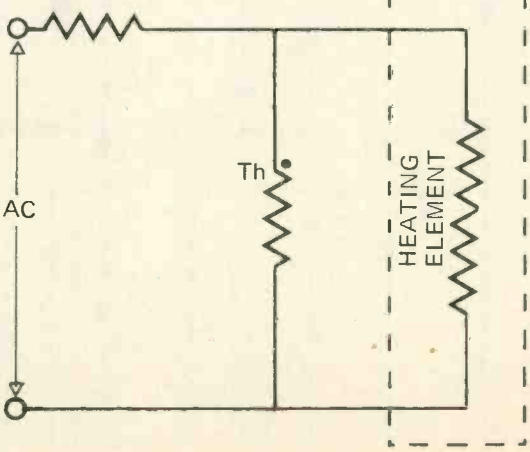
INTEGRATED CIRCUITS

The circuits described in this month's article have slightly complex control circuitry. They are capable of excellent performance and use components that are readily available.

Recently however, zero voltage switching integrated circuits have become commercially available and these in effect may be used to replace practically the entire control circuitry of the circuits shown in Figs 1 and 2. Circuits using this type of IC will be described in the next part of this continuing series – it is suggested that readers who are considering building high precision zero voltage switched controllers should wait until they have read this next article before commencing construction. ●

Fig. 5. Constant temperature control of small enclosure is achieved using this circuit.

Fig. 5



Several readers have asked us for a really simple circuit for maintaining a constant temperature inside a small enclosure.

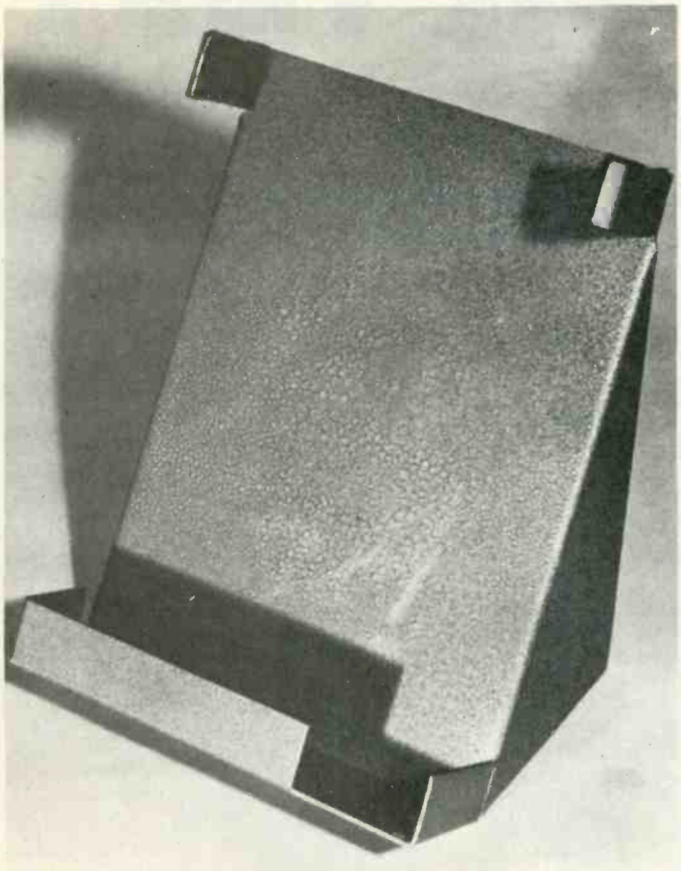
The very simple circuit shown in Fig.5 is often used. Temperature differential is about 3°C.

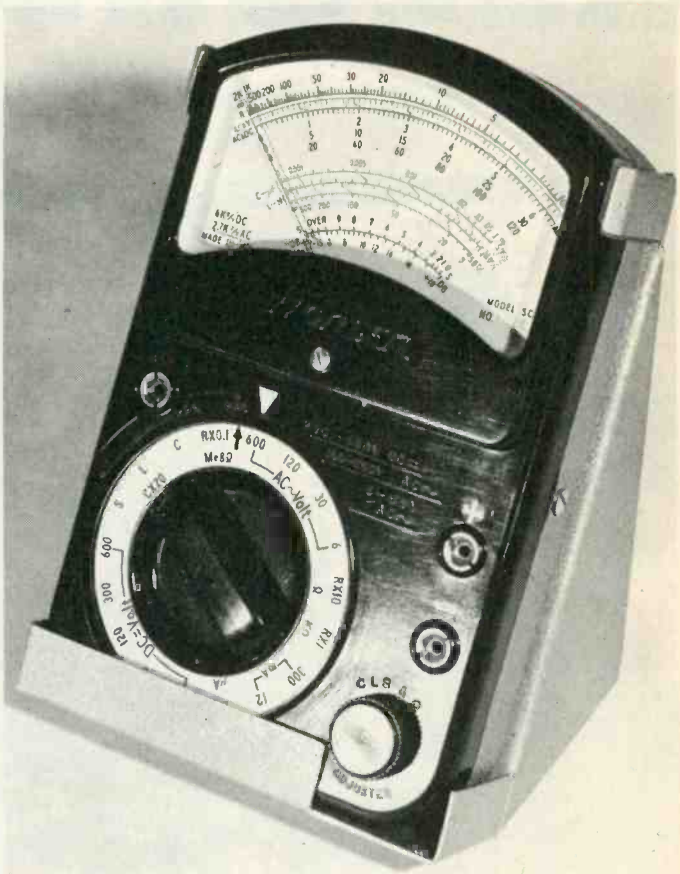
In this circuit the thermistor is mounted outside the container but is connected in parallel with the heater. As ambient temperature rises, current through the thermistor will increase, hence decreasing current flow through the heating element.

The thermistor chosen must of course be large enough to dissipate the external current without excess heating.

METER MOUNT

Simple yet effective, this meter stand takes only an hour or so to make.



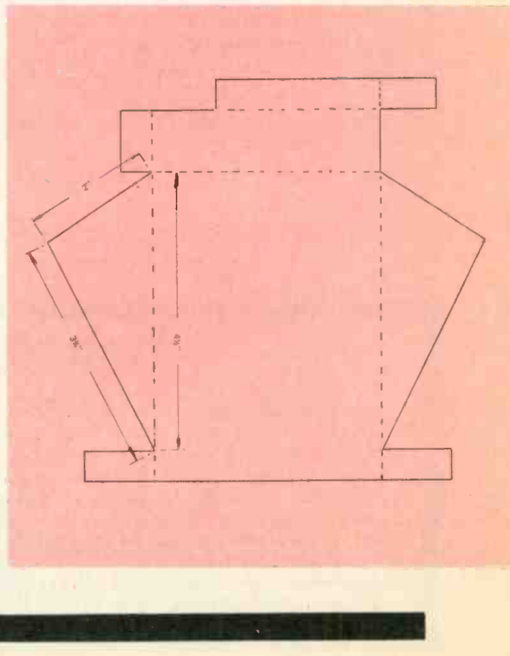


ETI PROJECT 209

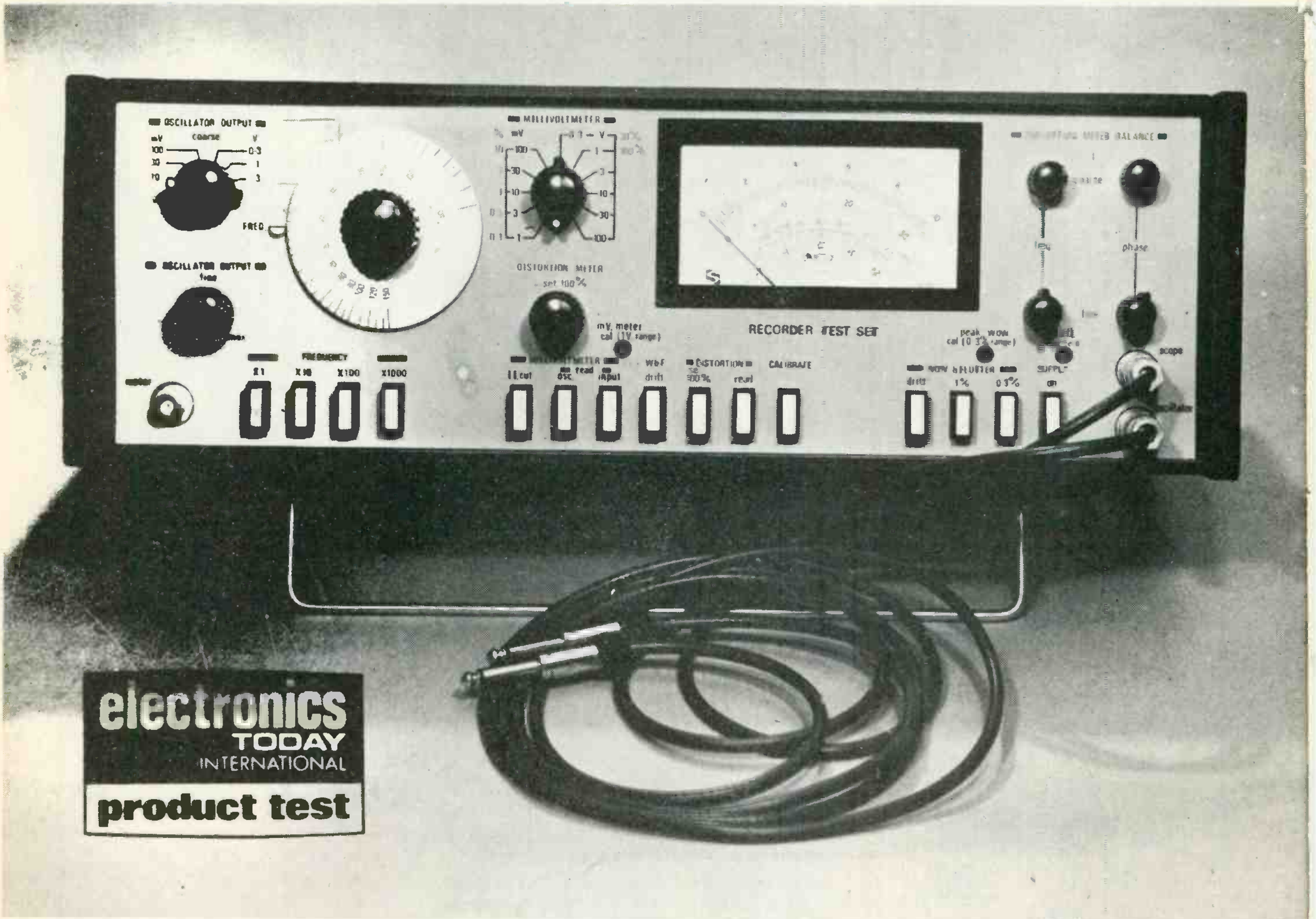
Here's a half-evening project well worth the trouble. This mount for a multimeter costs almost nothing and yet makes your meter more easily read whether you're sitting or standing. It gets rid of reflections from overhead lights, reduces bench space required and, to some extent, protects a meter from the occasional dropped tool, which glances off rather than penetrates.

The original was made for a meter measuring 3½" x 5½" from one piece of aluminium 7" x 6", cut to the shape shown in the drawing. No rivetting is required and all folds can easily be made in a vice. Full dimensions have not been shown as they have to be made suitable for individual meters. However, dimensions of the triangular sides are shown as a guide, as they determine the slope of the mount. These proportions should be retained for meters of all sizes.

The folds are along the dotted lines, and the direction of fold is clear from the finished mount. Provision for the ohms zero adjusting knob is made by leaving a cutout at the appropriate corner. The mount may be painted and lined with felt where thought necessary, to preclude scratching the meter. This is one of those 'why-didn't-I-think-of-it-before' gadgets. When you have it, you'll wonder how you did without it. Make one!



FERROGRAPH RECORDER TEST S

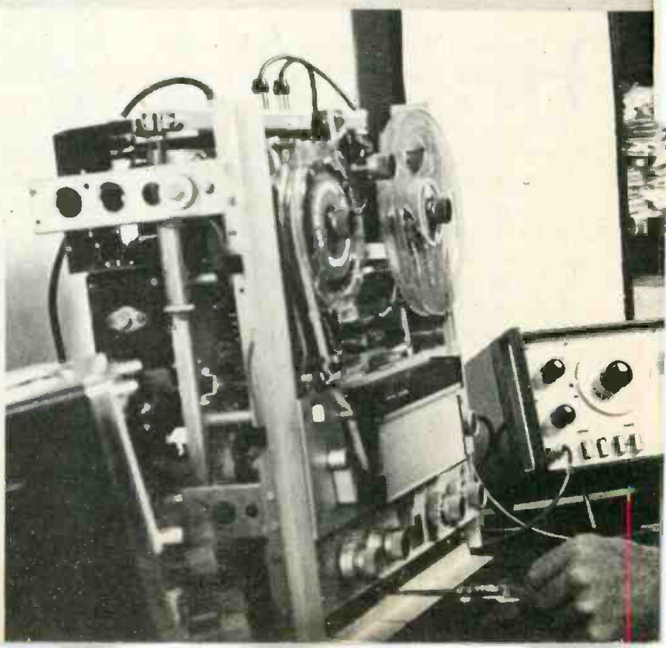


STOP PRESS

Ferrograph have just announced production of a Mk II version of the unit described in this review.

Improvements include a more stable regulated power supply, simplified distortion meter controls (balancing the distortion bridge is a slow tedious affair on the Mk. I unit), addition of a wow and flutter range of 0.1% fsd, and a millivolt meter calibrated in dBm as well as volts.

Temperature stability of the oscillator is claimed to be improved by a factor of four, and independence of mains voltage fluctuations by a factor of 10.



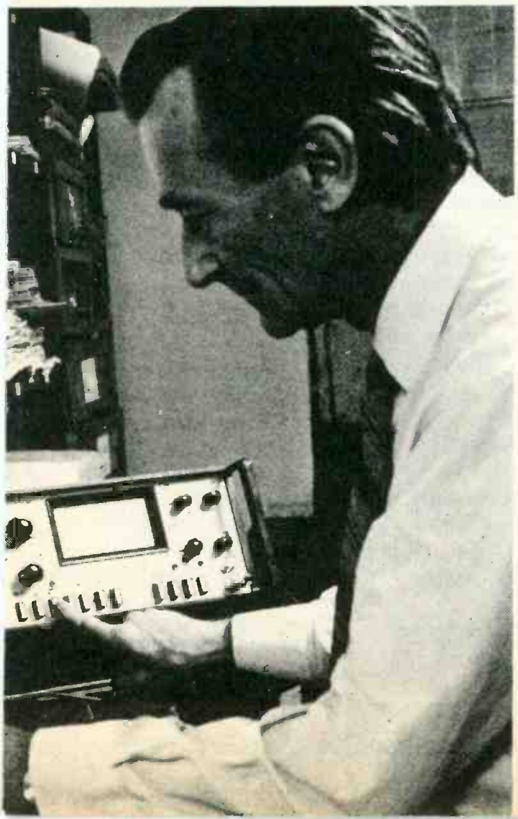
Multi-function test set is specifically intended for tape recorder maintenance and repair

ET

THE Ferrograph Recorder Test Set incorporates all the necessary sources and measuring facilities to measure the main performance parameters of tape recorders and amplifiers. It is designed to cater for the needs of repair technicians specialising in tape recorders, amplifiers and similar audio equipment. The following parameters may be measured with the test set:—

a) Frequency Response
b) Distortion
c) Signal to noise ratio
d) Wow and flutter (Peak weighted to DIN 45507)
e) (Frequency) Drift
f) Gain
g) Sensitivity

The external appearance is very business-like with its standard rack-mounting enclosure finished in dark grey paint and the front panel finished in light grey paint. All controls are arranged in an orderly array, the only exception being the meter input and the oscillator output sockets which are located at opposite ends of the panel away from their respective controls.



MEASURED PERFORMANCE OF FERROGRAPH RECORDER TEST SET MODEL RTS–1 SERIAL NO 150

Oscillator Output at 150Hz

Range	Measured Output	Meter Reading
10mV	9.8mV	9.4mV
30mV	30.5mV	29.4mV
100mV	97mV	93mV
0.3V	.305V	.295V
1V	.96V	.93V
3V	2.8V	2.97V

Range	Frequency	Measured Output	Meter Reading
3V	15,000Hz	2.85V	2.98V
	150,000Hz	2.75V	2.84V
1V	15,000Hz	2.85	2.96V
	150,000Hz	2.78V	2.84V
0.3V	15,000Hz	.305V	.295V
	150,000Hz	.31V	.296V

Input Attenuator

Range	Error
10V	0
3V	Reference
1V	0
0.3V	0
100mV	−0.2mV
30mV	−0.2mV
10mV	0
3mV	0
1mV	0

Meter Scale Accuracy

dB scale — ± .5%
voltage and distortion scales — ± 1%
drift scale — ± 0.2%
wow and flutter scales — ± 0.5%

Oscillator Scale Accuracy

Scale Setting	Range	Measured Frequency Hz
15	X1	16
150	X1	153
15	X10	150
150	X10	1508
15	X100	1503
150	X1000	14940
15	X1000	15400
150	X1000	145900
15	X10	151
20	X10	202
25	X10	251
30	X10	302
40	X10	402
50	X10	500
60	X10	598
70	X10	703
80	X10	803
90	X10	906
100	X10	1009
120	X10	1205
150	X10	1506

Wow and Flutter

Test frequency 3.143 kHz
Short term accuracy 5 parts in 10^5
(1 hour period)

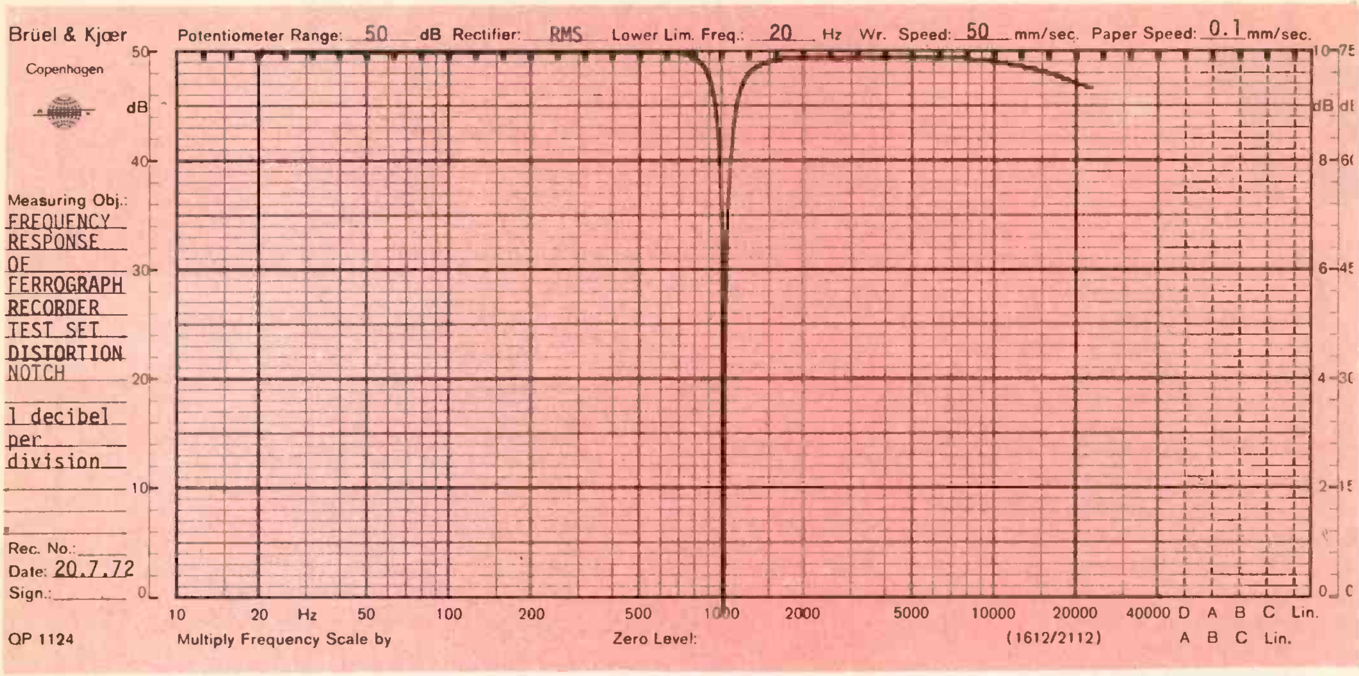
Distortion Meter Range	Source Distortion	Meter Reading
30%	30%	34%
10%	10%	9.6%
3%	3%	2.9%
1%	1%	.94%
.3%	.3%	.29%
.1%	.1%	.1%

Effective Range of Coarse Frequency Potentiometer 530Hz to 1700Hz
Effective Range of Fine Frequency Potentiometer 5Hz at 1kHz

Dimensions
44/mm wide x 143mm high x 254mm deep including handles.

Weight
5.9 kg

FERROGRAPH RECORDER TEST SET



Seven pushbuttons provide the following facilities:—

a) low frequency cut with 3dB point at 400Hz

b) oscillator read

c) input read

d) wow and flutter and drift mode

e) 100% distortion set

f) distortion read

g) calibrate for peak wow and flutter, drift and voltmeter.

The righthand end of the front panel contains the distortion meter balance controls and the wow and flutter range buttons. The balance controls consist of two coarse controls and two fine controls — for frequency and phase respectively. Below these are four pushbuttons and two B.N.C. output sockets. The four push buttons are for

i) drift read

ii) wow and flutter read, 1% full scale

iii) wow and flutter read, 0.3% full scale

iv) mains ON switch.

The two B.N.C. sockets are for 'scope output and oscillator output. The signal at the scope output is obtained just prior to the meter rectifier so that the signal may be further analysed by external equipment.

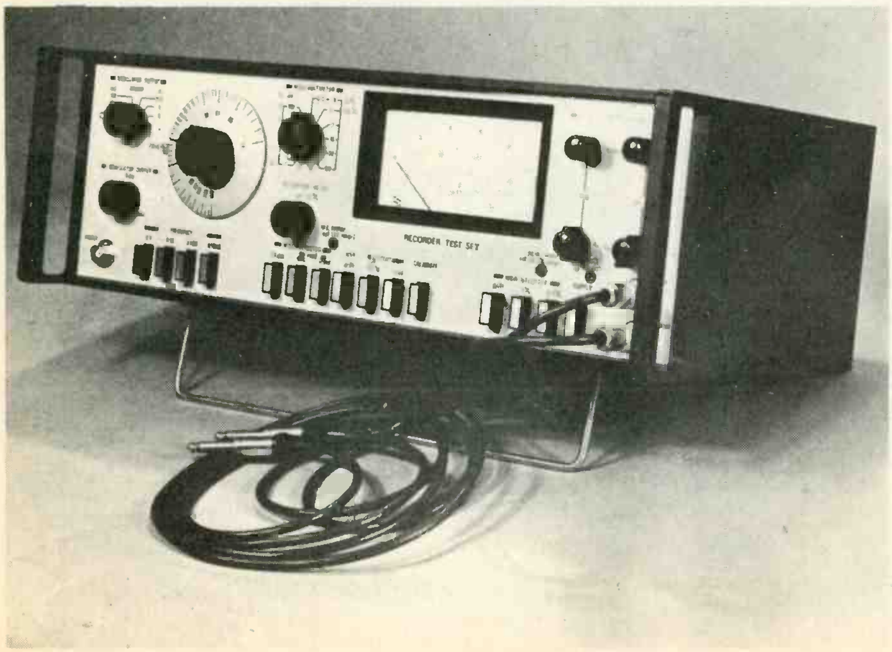
The left-hand end of the front panel contains all the oscillator controls. These consist of a frequency calibrated dial (calibrated from 15 to 150), four frequency range select pushbuttons for X1, X10, X100 and X1000 and two level controls; one with five 10dB steps from 10mV to 3V and the other a continuously variable fine control providing 15dB adjustment. The next set of controls located between the meter and the dial determine the meter mode. These consist of:—

a) a meter range switch

b) a distortion meter control knob

c) a set of seven push buttons for mode selection.

The meter range switch has ten 10dB steps from 1mV to 100V. The steps from 1mV to 1V are also used for distortion ranges from 0.1% to 100% — these are also in 10dB steps. The distortion meter control knob is used for adjusting the meter on the 100% range for different sensitivity source signal. The meter has four scales, one from 0. to 10, one from 0 to 30, one in dBm from —12 to +2 and the last one for percentage drift from —2% to +2%.



FERROGRAPH RECORDER TEST SET

With the exception of the distortion bridge the instrument is very easy to calibrate and operate. Separate adjustments are provided for calibration of the millivoltmeter, 100% distortion set, calibration of the peak wow and flutter, and zero drift set. Balancing the distortion bridge is slow and tedious, requiring very close tuning by the single turn coarse control potentiometers before the fine control potentiometers become effective.

For wow and flutter and drift measurement a nominal 3.15 kHz LC oscillator is switched to the oscillator socket when the meter mode switch for wow and flutter or drift is selected. This oscillator was found to have a short term accuracy of 5 parts in 10^5 which is more than adequate for measurements down to 0.01%.

The only items located on the back panel are an English type three pin mains socket, a mains fuse holder, and a voltage selector plug. As well as four rubber feet on the base of the unit there is a hinge down wire bracket which raises the front for easier reading when used on a bench. One feature missing is a light to indicate that the mains power is on, however, we understand that more recent units have this feature. The "Operating Instructions" supplied with the unit are spiral bound and consist of 12 pages of operating and maintenance instructions and 2½ pages of technical specifications (but no circuit diagram).

The internal layout of the test set is very well arranged with most of the wiring between the six printed circuit boards eliminated by the use of three 'mother boards'. These 'mother boards' contain sockets to accept the printed circuit boards and all of the push button switches. All rotary switches and potentiometers are also mounted on the printed circuit boards and are fitted with removable extension shafts to simplify removal for maintenance (if required).

The Ferrograph Recorder Test set is ideal for aligning tape recorders before and after repair or maintenance, but due to the narrow frequency range of the distortion bridge, has limited application for testing amplifiers. The measured performance of the unit was equal to or exceeded the manufacturer's specification in all respects.

The Ferrograph Recorder test set represents an excellent compromise for the technician who cannot afford to buy expensive individual instruments to measure the various parameters of a tape recorder's performance. ●

HOMES FOR OHMS

A SIMPLE WORKSHOP PROJECT by A.J. LOWE

CAN you find a 680k resistor in 10 seconds or less? Can you lay your hands on a dozen 1k resistors in the same time? Can you check, within a minute, whether you have a 47 ohms, a 3.3k, an 820k, and a 1.8M needed for a project?

If your answer is 'Yes' to all these questions, then this project is not for you. But, if the storage and finding of resistors is time consuming, annoying and gives you a pain in the head – read on. Your problem's solved. Here's a resistor store which can hold up to 1275 ¼ watt resistors, and enable you to answer 'Yes' to all those questions, and a lot more like them.

The store comprises a rack of two plates of 18 gauge aluminium, separated by sides 2¼" deep. (Fig. 1). The rack carries 75 plastic 'pill tubes' about 3½" long x 5/8" diameter. Each tube is for one value of resistor, so that the rack can hold all values from 5.6 ohms up to 8.2 megohms. Each tube will hold about 17 ¼ watt resistors (Fig. 2).

The rack is supported, at a convenient angle for bench use, by two pivoted legs which fold away when the rack is to be put on a shelf or in a drawer.

The first thing to buy is a set of pill tubes. That is their correct name in the pharmacy trade. Some persistence may be needed with your pharmacist; another source of supply is the scientific supply companies. The original rack used '4 gram long' pill tubes. They cost just over £1 per hundred.

Having bought the tubes, work out the size of aluminium needed to accommodate the tubes with the staggered layout shown in the photograph. If you get tubes exactly as specified above then copy the layout shown in Fig. 3. You'll need two plates each 10" x 8".

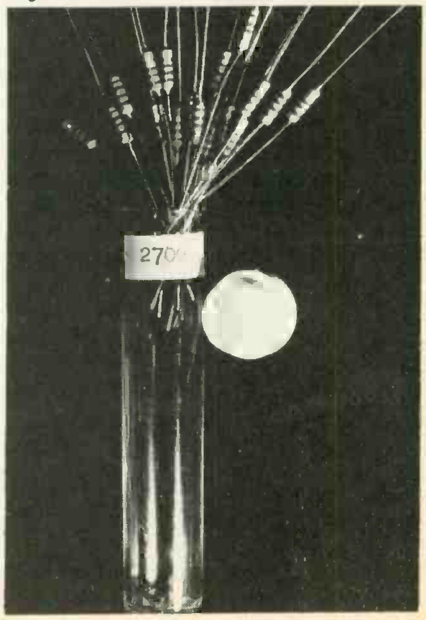
Mark out one plate very carefully, and then clamp it to the second plate, edge to edge. Drill two or three small holes, on hole centres, through both plates and then bolt them tightly together. Next drill through both plates all the pilot holes needed for a chassis punch. Separate the plates and make the final holes with an 11/16" chassis punch.

Now, assemble the top plate to the side pieces – 2¼" x ½" pine, using wood screws. Make two narrow spacers to give clearance for the baseboard. They should be ¼" thick and the same width – ½" as the side pieces. Cut a base-board from ply or Masonite and attach it with

(Turn to page 77)

Fig. 1.

Fig. 2.



COLOUR TV GOES DIGITAL

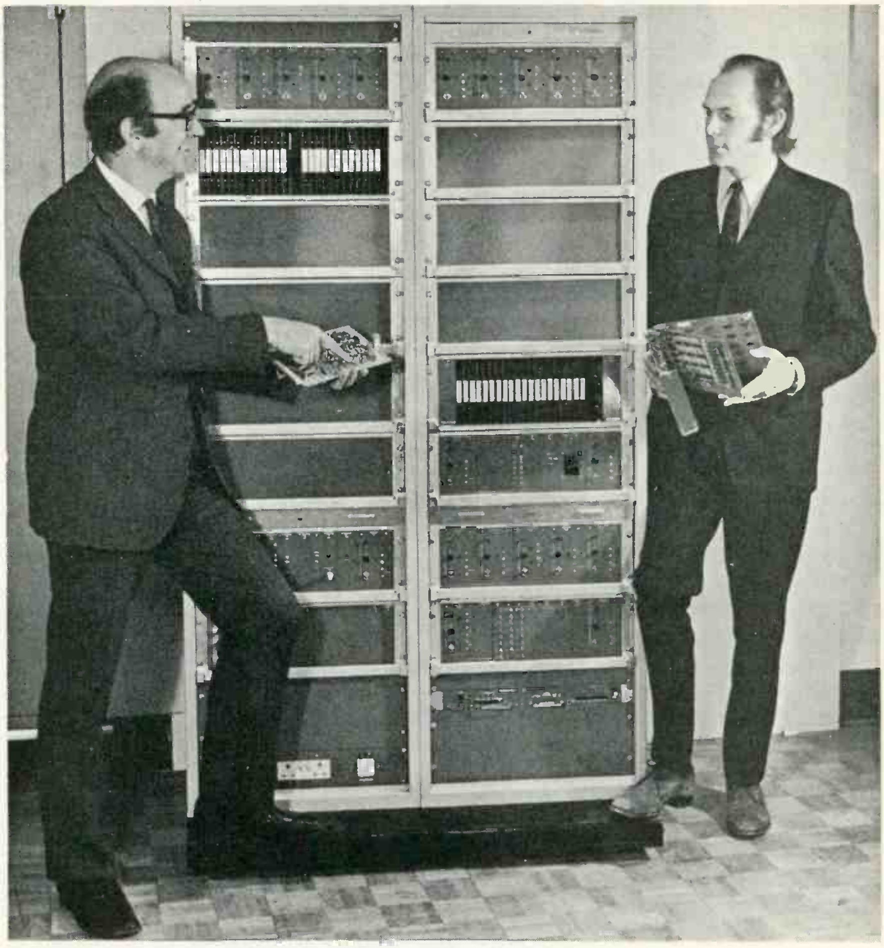
A new picture converter for transatlantic colour television uses computer technology

Engineers of the Independent Broadcasting Authority in the United Kingdom have demonstrated the world's first television picture converter to use digital — or computer-type — techniques for changing American or Japanese television signals (NTSC) into European television signals (PAL or SECAM). The new equipment shows marked improvements in the quality of the output colour pictures, is smaller than existing equipments, has no line-up adjustments and is confidently expected to prove itself completely stable in operation.

Last year the IBA completed its first digital standards converter which changes 625-line colour television signals into 405-line black-and-white signals, and this line-frequency converter was used operationally for a trial period at the main IBA London VHF transmitter. The latest extension of this work solves the much more complex problem of changing from one colour television system using 30 pictures a second - as in America - to another using only 25 pictures a second - as in Europe. With its negligible picture distortion in the conversion process, the new equipment will satisfy a global demand for better quality in the satellite exchange of programmes between countries. It will also enable programme contractors who are making television recordings for sale in both America and the United Kingdom to offer a much higher technical picture quality to the home market.

The new equipment measures only some 1ft 6in by 3ft 6in by 6ft and although costing no more than the cheapest of the existing analog converters, uses some 8000 integrated circuits, while the main storage devices alone represent more than 15 million transistors.

The new converter uses digital television techniques and the standards conversion process is to all intents and purposes free of distortion. It uses a number of novel techniques for decoding the NTSC signal and for interpolating between fields and lines. The converter will eventually be bi-directional (ie 625/50 to 525/60) but this facility has not yet been added.



The new IBA Digital Field-rate Television Standards Converter

EARLY SYSTEMS

The earliest type of field converter to be used for changing 60-field signals into 50-field signals was an optical type which used a camera, operating on one scanning standard (eg PAL), to look at a cathode-ray-tube picture display operating on the other scanning standard (eg NTSC). A later development for colour television has been to use two such arrangements, with one camera-to-display unit converting the *luminance* (brightness) picture and a second camera-to-display unit converting the coded *chrominance* (colour) signal. In general, optical standards converters have problems with halation, spot-size, lag, phosphor grain pattern blemishes, the compromise between phosphor decay-time and movement judder, chrominance resolution and registration between luminance and chrominance. All the above factors tend to produce a converted picture considerably degraded from the original.

All-electronic analog converters avoid some of the problems of optical converters but have been, to date, much more expensive, and much larger.

In the conversion from 525/60 to 625/50, extra fill lines must be generated. As there is no original information available to produce these lines, a new line must be produced by averaging two adjacent lines. To compare two lines in a sequential scanning system one line must be stored and for this purpose quartz-delay lines have been used in analog systems.

The use of these delay-lines introduces many problems. As delay time varies with temperature, close temperature control is required and equipment start up from cold is not practicable.

The write-in and read-out rates have to be the same, and organisational problems arise in continually switching between numerous lines of different delay times. Spurious signals in the delay lines cause picture defects, especially on high-purity colours, and attenuation in the lines, coupled with the need for amplitude and group-delay equalization, make the devices electrically noisyand tedious to line-up.

Since the subcarrier which emerges from the delay-line is used to judge the time delay, the noise on the subcarrier signal limits the timing accuracy of the output. The analog separation of chrominance and luminance is imperfect and gives rise to further picture defects.

ADVANTAGES OF DIGITAL TECHNOLOGY

By converting the analog video signal into a digital form, considerable improvements can be made in the conversion process. In place of the quartz-delay lines we may now employ digital storage elements which in the new converter are computer shift registers using MOS FET technology. Such storage of digital data in shift registers is impeccable and there is no degradation of the signal in the store. At the same time, the write-in and read-out rates can be different, and the delay between writing and reading is flexible and precise.

The machine has an instantaneous warm-up and there are no preset controls in the digital-conversion circuits. A unique feature of the design is the type of spatial filter which is used, among other operations, to produce the luminance, and the I and Q chrominance signals from the incoming composite data stream. Inherently, the spatial filters have perfect tracking and there are no adjustable controls.

Because digital techniques are used, it is not possible for the performance to drift away from its design tolerance, and the converter will, for example, give a k-rating factor of better than 1%, providing of course there are no component failures.

Although the converter uses nearly 8000 integrated circuits and the shift registers represent some 15 million transistors, an important element of the design is the repetition of circuits, ic's and boards, which has reduced costs and simplifies repair work. Most of the circuit boards can be tested on plug-in go/no-go test sets which not only show if a fault is present but also indicate its location. The cost of integrated circuits is falling steadily and the machine should become even cheaper.

PRINCIPLES OF THE FIELD-RATE CONVERTER

There are three main functions which such a converter has to carry out. It must change the field rate from 60Hz to 50Hz (and lengthen the duration of the field period), it must change from a 525-line scanning rate to a 625-line scanning rate, and it must change both the colour subcarrier frequency and the modulation of the subcarrier.

The operation of the digital field-rate converter will be described with reference to the block schematic of Figure 1. After synchronising signals have been fed to the timing control circuits, the first operation of the converter is to change the incoming coded analog video signal into a digital signal in an analog-to-digital converter. The sampling rate chosen is three times the subcarrier frequency (10.7MHz). Each picture element so sampled is then analysed into one of 256 equally-spaced amplitude levels to produce an eight-bit binary-coded output pulse-train, or word. To reduce the maximum operating-speed requirement of the solid-state devices in the following circuits, eight-wire parallel circuit feeds are used from this point onwards – and further down the chain this is increased to 24 parallel feeds, and later to 32.

MOVEMENT INTERPOLATION

Now consider two cameras panning, together, round a scene at an angular rate of 6° of arc per second of time. Suppose that one camera is operating on the American 525-line system, whilst the second camera is on the PAL 625-line standards. Presume that suitable optical arrangements ensure that both cameras see the same view. Then the American camera with a 60Hz field frequency will be panning at the rate of 0.1° per television field, while the PAL camera with the lower field frequency of 50Hz will be panning at the rate of 0.12° per television field. That is to say, the amount of horizontal movement per television field is different in the two television systems and it is this difference which the movement interpolator must create. It does this by combining, in appropriate proportions (which differ from one field to the next), the signals from two sequential fields of the incoming signal. It is thus necessary to provide storage facilities in shift registers for two complete fields, as mentioned earlier.

When the fields on both input and output systems coincide, then picture information from field one of the incoming signal may be used directly to produce the first field of the outgoing signal. However, the second field of the outgoing signal must show a greater change of position of moving objects than the second field of the incoming signal. To achieve this, the outgoing signal is made up of a (large) proportion of picture information from the second incoming field and a (small) proportion of picture information from the third incoming field. Similarly, the third outgoing field consists of a combination of information from the third and fourth incoming fields, and so on. The whole process repeats 10 times a second, which is the approximate common repetition frequency of the two standards involved.

Of course, in order for such a combination of signals to be satisfactory, the signal from two sequential incoming fields must at any moment relate to identical picture points. This is not the case when the signal is generated because of the interleaved relationship between succeeding picture fields.

Information is read out of the two field stores simultaneously, at a rate depending on the required outgoing line frequency. Each field store is made up of 48 modules arranged in groups

(Continued on page 84)

DIGITAL STANDARDS CONVERTER 525/60 – 625/50

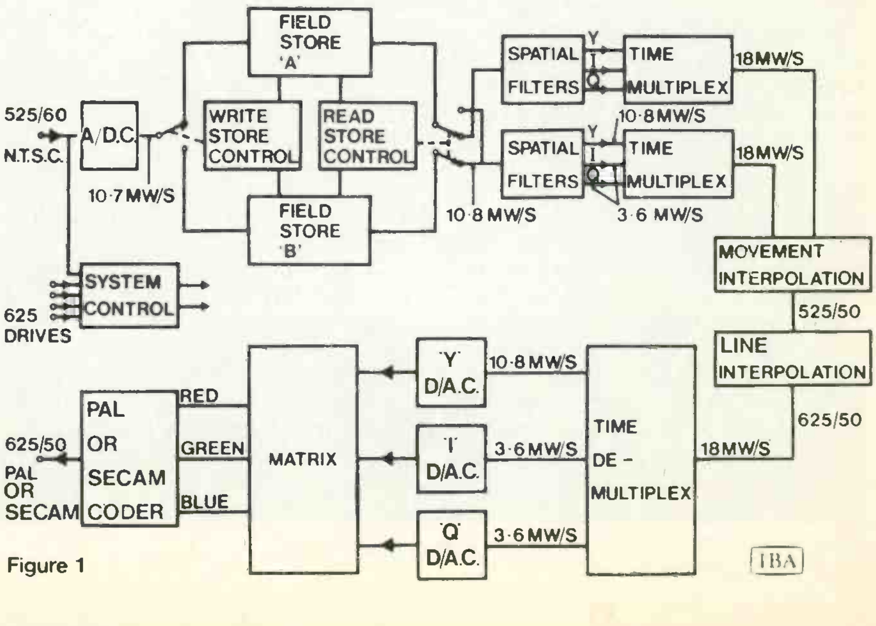


Figure 1

FIBRE OPTI

Some 1973 European cars will be fitted with fibre-optic instrument-illumination systems developed by Lucas

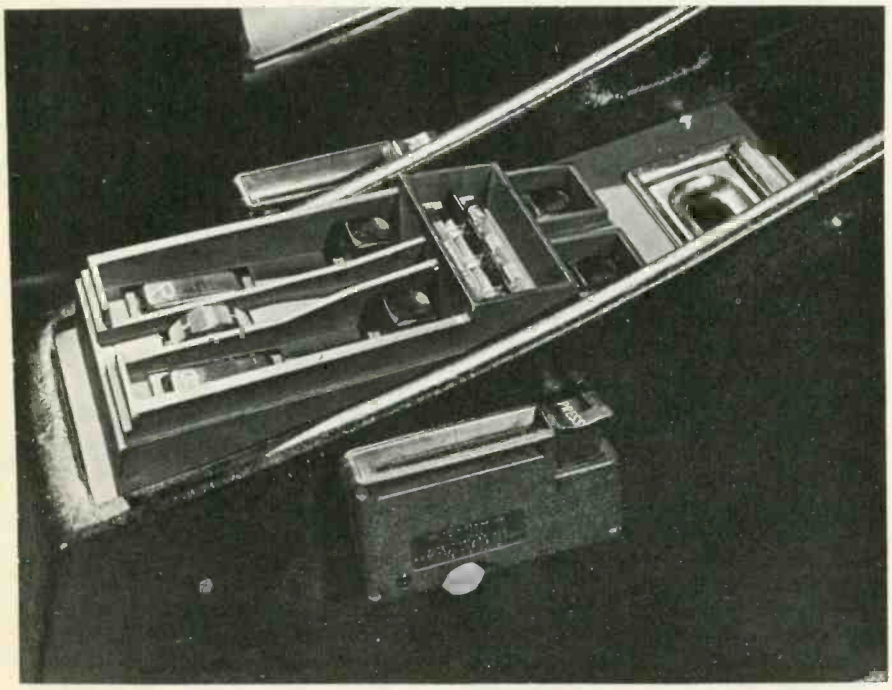


Fig 1 The centre console of the Lucas simulated vehicle which incorporates fibre-optic illuminated controls

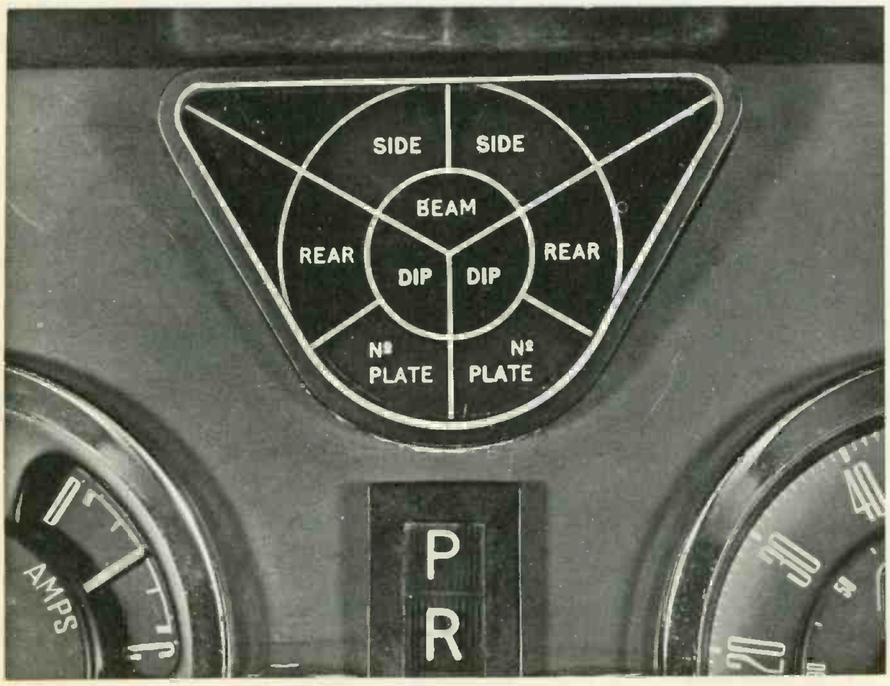


Fig 2 Fibre optic system for monitoring bulb failure by logic group principle (see text)

IN the laboratories of Joseph Lucas Limited in Birmingham a full mock-up of a vehicle driving compartment has been constructed and has been in use for many months. The purpose of this mock-up is to study the application of fibre optics in vehicle-instrument systems and to develop the necessary basic hardware.

This programme is now all but complete. Lucas have fully developed fibre-optic systems which will be fitted to some cars in 1973. Just which cars will be so fitted is still a closely guarded secret, but we are convinced that purchasers of these cars, whatever make they may be, will be delighted with the extended facilities offered in their instrument panels. The immediate advantage of using fibre-optic systems are: the reduction of wiring harness complexity, a reduction of the number of individual panel lamps behind the dash, increased reliability and an easing of the service problem.

Have you ever had a faulty lamp in the speedo unit? Usually you find it hard to get at, and have to undo the panel supporting the instruments to gain access because it is usually physically impossible to get your hand round the back of the speedometer. Then in the effort to get the lamp out of the middle of a maze of wiring other wires are pulled off and it is difficult sometimes to discover where they came from. All this need no longer occur because, by using fibre optics, a single lamp may service a number of instruments (see the 27 way distributor of fig 1) and the lamp housing may then be located in an easily accessible position.

The 27 way central light source reduces the number of conductors required in the wiring harness and, as special fittings are not required at the end of the fibre-optic bundles, instrument design is also simplified. Further, as light may be easily piped to wherever it is required, illumination of essential knobs and switches, and the monitoring of essential functions, may readily be incorporated at little extra cost. Examples of such extensions of the instrument art are shown in figs 1 and 2.

Fig 1 shows the centre console of the Lucas simulated vehicle compart-

CS IN CARS

ment in which the switches are progressive in operation and are illuminated for ease of location. When the switch is operated the illumination changes colour to indicate the 'on' condition. As an alternative to push buttons, rocker-lever switches were also fitted and in addition a thumb-wheel rheostat for panel-lamp dimming has been incorporated.

Fig 2 shows one example of a monitoring system. The bulb-failure monitoring readout uses the logic grouping principle to monitor failure of all the exterior driving lights. A pattern of regular shape has one division illuminated for each lamp, so that failure of one or more lamps will break the pattern and attract immediate attention. In an alternative system, a fibre gathers light from the headlight bulb and conducts it to a small bezel mounted above the appropriate lamp on the mudguard so that it is visible to the driver. Considerable thought needs to be put into the fitting of these repeaters, however, so that the aesthetics of the car body are not disturbed.

Work is also in progress on the monitoring of liquid levels (petrol, water, oil and even hydraulic fluid), tyre pressures etc, and on the integration of all these parameters and others such as fuel combustion and ignition control systems into a total integrated vehicle system, perhaps based on a small computer, to ensure optimum performance of the car under all conditions.

Exactly where solid state electronics (eg MSI, logic) takes over from fibre optics is still controversial. For example, liquid level monitoring in theory is very simple with fibre optics (see page 23) but foreign matter in the liquid can soon coat the surface of prism and render the system entirely ineffective. So unless a solution can be found to this problem, it may be better to use other traditional sensors.

Nevertheless it seems certain that fibre optics is here to stay as a means of instrument illumination and will have some part to play in the total vehicle monitor systems which are still under development. ●

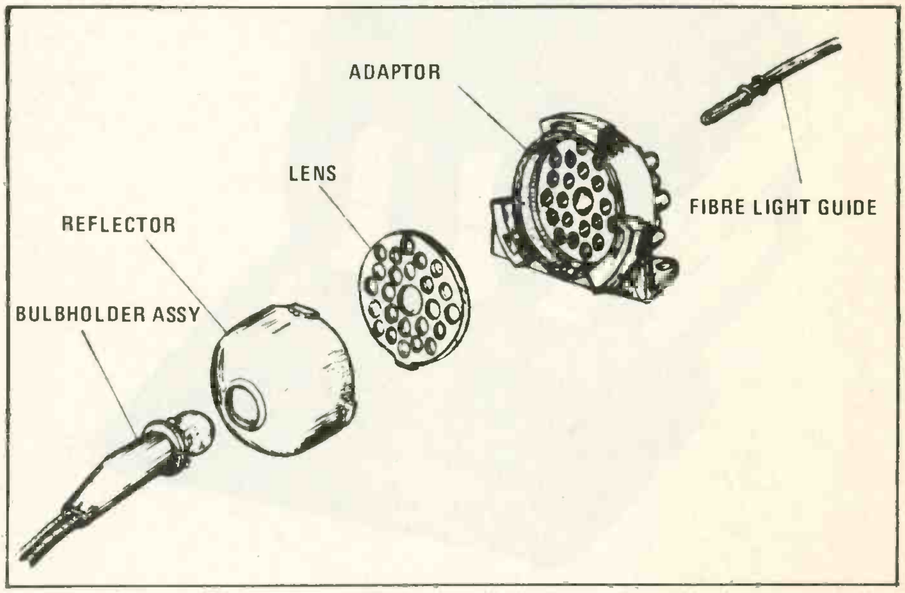


Fig 3 A 27 way central light source divides the illumination from one lamp into 27 fibre light guides which simply plug in to the rear of the adaptor

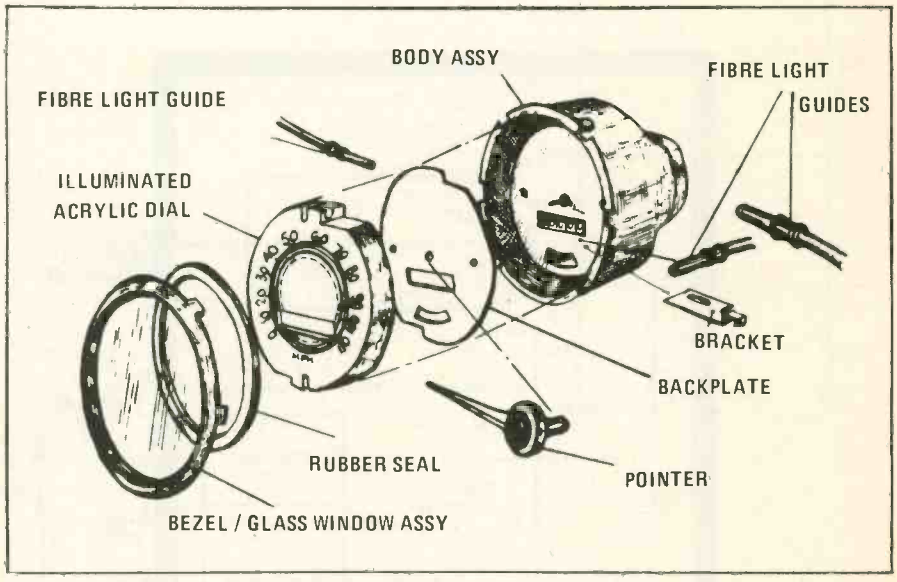
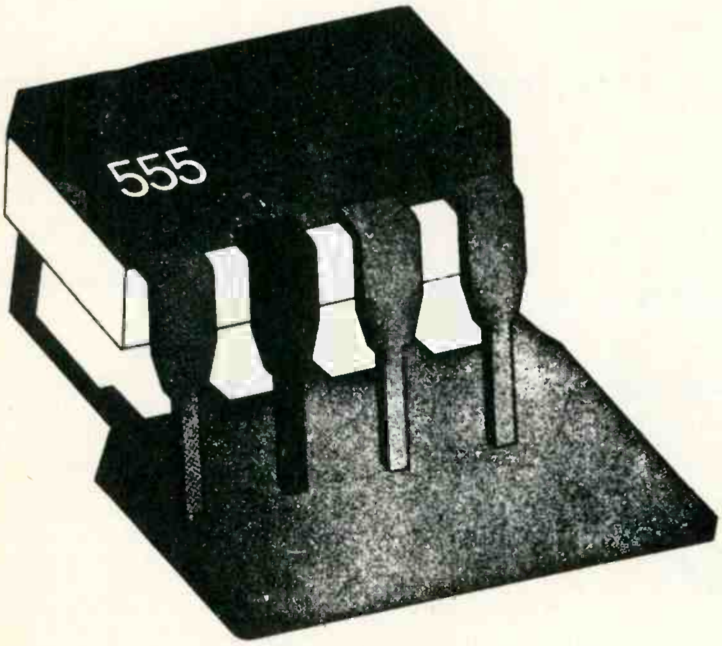


Fig 4 The method of inserting fibre light-guides into a speedometer is typical of all instruments. One guide illuminates the acrylic dial and others are used for the mileage counter etc

LINEAR IC



Under £1 IC provides resettable time delays from microseconds to one hour.

ELECTRONIC timers have innumerable applications, and, providing the time period over which measurement of control is required does not exceed a minute or two, such timers are simple enough to design and manufacture.

But there are many applications where timing devices must operate over periods of an hour or more and whilst such timers *can* be produced they are complex, and it is often cheaper and simpler to use a mechanical equivalent.

Generally, electronic timers use some type of voltage dependant switching device that continuously samples the changing voltage across a simple RC network: at the beginning of a timing cycle the capacitor (C) commences to charge via the resistor (R) and, as the voltage across the capacitor slowly increases, a voltage level is reached at which the switching device is activated.

It is difficult to obtain long-duration timing circuits in this manner because the relatively low input impedance of most switching devices (such as transistors, unijunctions, etc.) in effect acts as a second resistor in parallel with the timing capacitor — preventing the capacitor charging beyond a certain level.

Another disadvantage of many voltage dependent switching devices (such as UJT's) is that their manufacturing tolerances are quite wide and as a result their spread of characteristics results in large differences in performance when used in timing circuits.

A new linear integrated circuit, designed by Interdesign Inc. and manufactured by the Signetics Corporation largely overcomes this problem. Specifically intended for use as a general purpose timing element, the Signetic 555 uses an inbuilt comparator to sense the RC voltage. This comparator has an extremely high

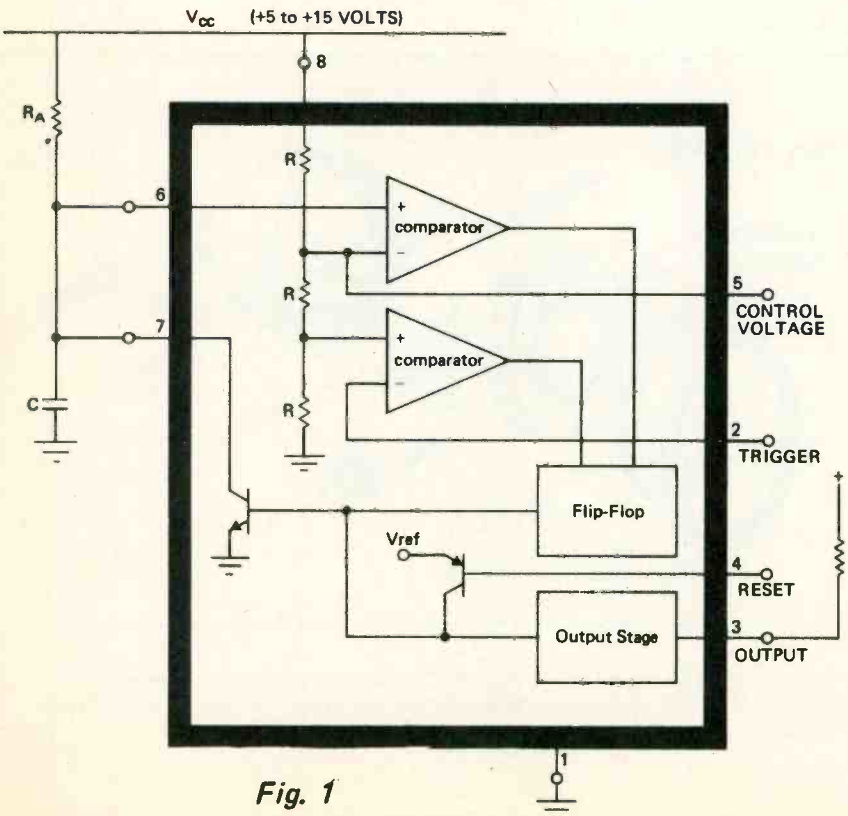


Fig. 1

TIMER

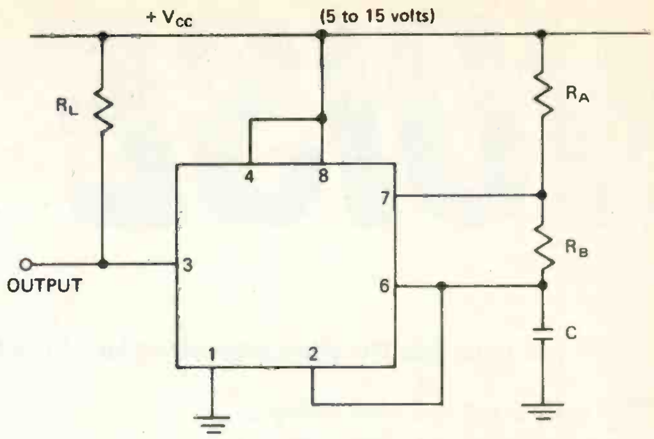


Fig 2. Astable Operation
In this mode of operation the IC will free-run as a multivibrator. The external capacitor charges through R_A and R_B but discharges through R_B alone. Thus the duty cycle is set precisely by the ratio of these two resistors.
Frequency of oscillation is: $f = \frac{1}{T}\frac{1.44}{(R_A + 2R_B)C}$

Duty cycle is $D = \frac{R_B}{R_B + 2R_B}$

input impedance and consequently has negligible shunting effect across the timing capacitor. Typical component values for a one hour timer are a 10 megohm resistor and a 330uF capacitor.

The IC is internally compensated for component tolerances and temperature drifts. It requires only one external resistor and one external capacitor to enable it to be used for time delays ranging from fractions of milliseconds up to one hour with an accuracy and repeatibility of better than 99%. (The spread of characteristics is much closer than with UJTs).

Two inbuilt high-current transistors connected in an inverting output stage enable the IC to supply about 200 mA to a load — which may be connected either to V_{cc} or ground. Loads may be connected for either 'normally on' or 'normally off' operation.

TYPICAL APPLICATIONS

Figure 1 shows how the IC may be used as a 'one-shot' timer (all components inside heavy black lines are of course within the IC).

In its quiescent state, capacitor C is shorted out by the internal npn transistor. The timing cycle is initiated by reducing the voltage on IC pin 2 to less than 1/3rd V_{CC}. This may be achieved by a slow reduction in voltage level, by a negative going pulse, or simply by shorting pin 2 to ground.

The triggering signal applied to pin 2 toggles a flip-flop which removes the short from the timing capacitor C and simultaneously energizes the load. The voltage across C now increases exponentially at a rate determined by the values of R and C. When the voltage across C reaches 2/3 V_{cc}, the internal voltage comparator resets the flip-flop which in turn rapidly discharges the capacitor and at the same time de-energizes the load.

The time that energy is supplied to the load is $1{\cdot}1R_AC$ and this time interval is independent of the supply voltage.

A characteristic of this timer is that once triggered, the circuit remains in this state until the set time ($1{\cdot}1R_AC$) has elapsed — even if further triggering pulses are received during the set period. This renders the circuit immune to false triggering due to contact bounce etc. In fact in this form the circuit makes an excellent pulse stretcher.

If it is required to reset the timer *before* the set time has elapsed, this may be done by applying a negative pulse to the reset terminal (pin 4). This discharges the timing capacitor and causes the cycle to start all over again.

Apart from its obvious value as a simple 'one-shot' timing device the IC may be used for many other purposes. These include free-running pulse generation (from 0.00001Hz to 500kHz) missing pulse detection, frequency division, pulse-width and pulse-position modulation, and test sequencing.

Timing may be adjusted over an extremely wide range by varying R_A and C. An additional timing variation of approximately three to one may also be obtained by applying an external control voltage to IC pin 5. ●

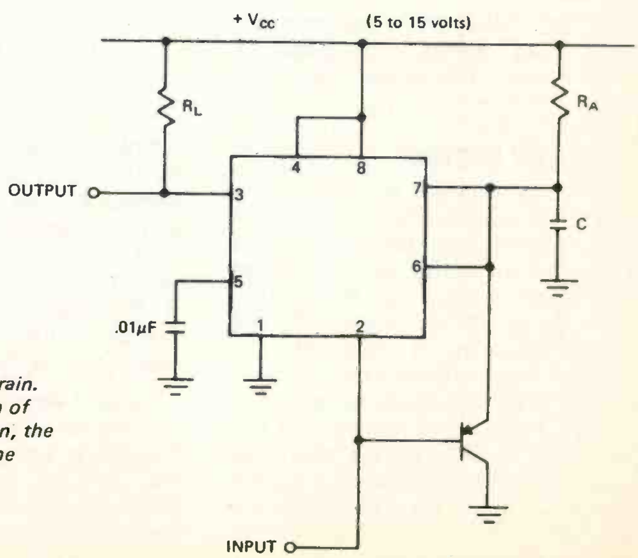


Fig 3. Missing Pulse Detector
Here the timing cycle is continuously reset by the input pulse train. A reduction in frequency, or a missing pulse, allows completion of the timing cycle and hence an output signal. For this application, the time delay must be set to be slightly longer than the normal time between pulses.

NOISE REDUCT

This article describes the operating principles of the Dolby and Philips noise reduction systems.

PERHAPS the two most dramatic developments in high fidelity sound reproduction during the past few years have been firstly, the development of magnetic recording tapes with a wide dynamic range, and secondly, the noise reduction systems introduced by Dolby, Philips et al.

These two developments have been exploited by manufacturers of cassette tape recorders, several of whom have recently introduced advanced machines, that perform practically as well as top quality record systems.

Product reviews of these latest tapes and tape recorders have been published in recent issues of Electronics Today — but until now, little has been published about the actual circuit operation of noise reduction systems.

These noise reduction systems are an inherent part of the new generation of recorders — in fact without them it is unlikely that such recorders could have *been* developed, for their slow tape speed and narrow track made it practically impossible to achieve wide range recordings without accompanying background hiss.

There have been many attempts in the past to reduce this noise electronically, but few of these systems were satisfactory, and practically all added a noise of their own — best described as a 'pumping' sound.

Then in 1966 a young physicist named Ray Dolby introduced a revolutionary tape-noise reduction system.

THE DOLBY SYSTEM

Ray Dolby's system is unique for a number of reasons: it is used both during recording and playback, it does not process the entire frequency range as a whole, it does not process the louder parts of the signal, and its action is so fast that it is inaudible.

The original Dolby system was developed for professional users. It processes the signal being recorded and reprocesses it on playback over four frequency bands. This achieves noise reduction over the entire audio spectrum.

A less complex system (known as Dolby B) was subsequently developed by Dr. Dolby and this operates on the middle to high frequency part of the audio spectrum, thus removing the tape hiss inherent in the recording process. This system reduces noise by 3 dB at 600 Hz, by 6 dB at 1200 Hz and by 10 dB at 4000 Hz and above — where the ear is most sensitive to hiss.

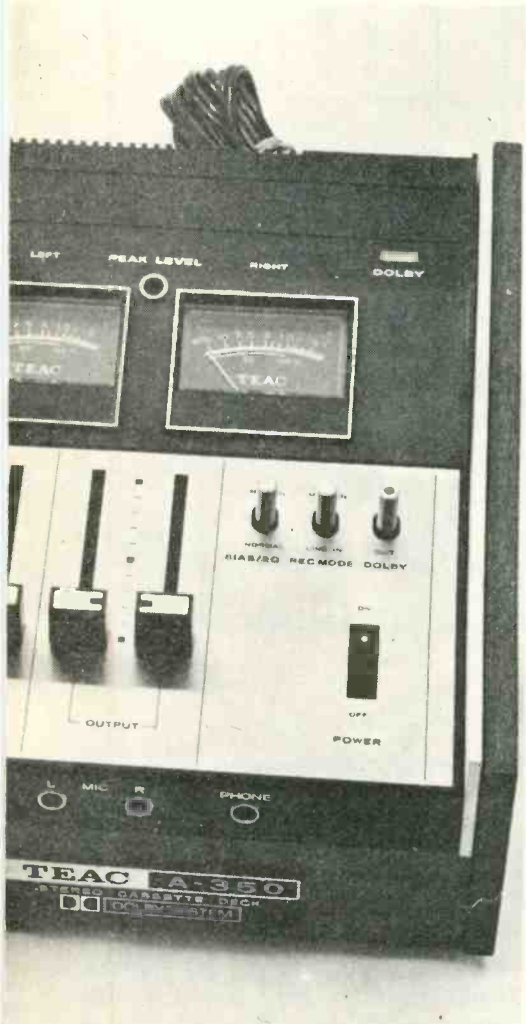
Figure 1 shows the basic principle. In the recording mode, high level parts of the music being recorded are passed through the record Dolby circuits unchanged. By means of a level-sensitive 'threshold' circuit, low-level high-frequency signals are boosted in level, to a degree dependent upon how low in level they are. The quietest high frequency signals are boosted the most, by as much as 10 dB. As the level of the high frequencies approaches OVU (that is — loud), the degree of boost becomes less and less. At OVU, there is no boost at all.

The resultant recording is now processed — or as it's often called 'Dolbyized'.

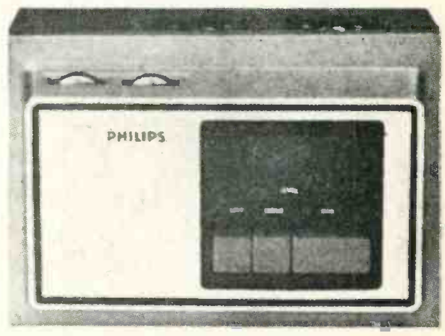
A similar principle is used for playback — but in the reverse direction. Now, the high level signals pass through the playback Dolby

TION SYSTEMS

-HOW THEY WORK



This 'new generation' TEAC cassette recorder has the Dolby system built-in (TEAC A-350)



This is one version of the Philips dynamic noise limiting system – but most of these systems will be built-in. Philips are granting free licences to companies intending to use the system.

HOW THE DOLBY SYSTEM WORKS

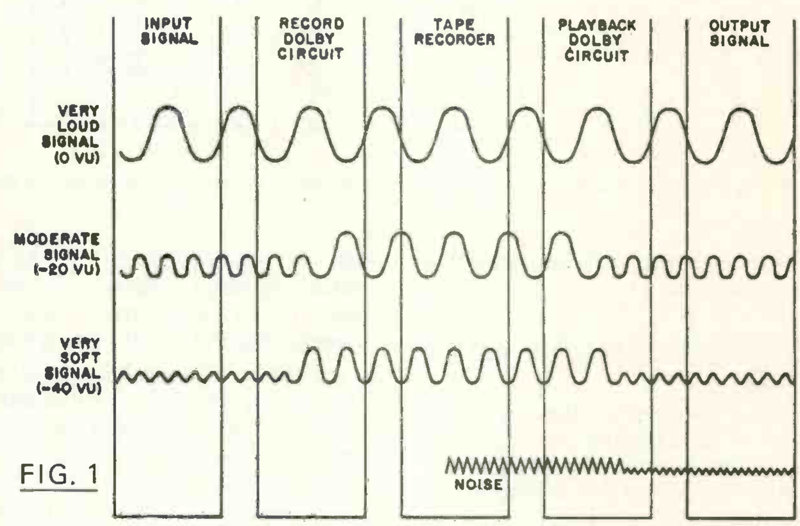


FIG. 1

1. The signal being recorded passes through the record Dolby circuit *first.* The Dolby circuit operates on the higher ("hiss") frequencies in a predetermined manner, depending on their loudness level. The loudest signals (0vu) pass unaffected through the circuit. Signals of moderate intensity (–20vu) are boosted moderately, while the very soft signals (–40vu) receive maximum boost.

2. After being thus "Dolbyized," the signal is recorded onto the tape. It is at this point that tape hiss makes its appearance. You can see on the diagram how the record Dolby circuit's action has made the low-level signal louder than usual, relative to the tape hiss.

3. On playback, the signal from the tape is passed through the playback Dolby circuit, which is an exact "mirror-image" of the record Dolby circuit. The playback Dolby *lowers* the previously boosted parts of the signal, by precisely the same amount they had been boosted. The tape hiss – which made its appearance between the record and playback halves of the Dolby System – is automatically lowered at the same time by a very substantial amount, effectively 10 db or 90%. At the same time, because of the precise "mirror-image" playback action, the Dolby System causes no other change in the signal relative to the original source that was recorded.

circuit unchanged. The previously boosted low-level high-frequency signals are now lowered by precisely the same amount by which they had been boosted.

The tape hiss – which made its appearance between the record and playback halves of the Dolby system – is automatically lowered by a very substantial amount, effectively 10 dB (approx 90%). At the same time, because of the precise 'mirror image' playback action, the Dolby system causes no other change in the signal level relative to the original source that was recorded. It does not, as many

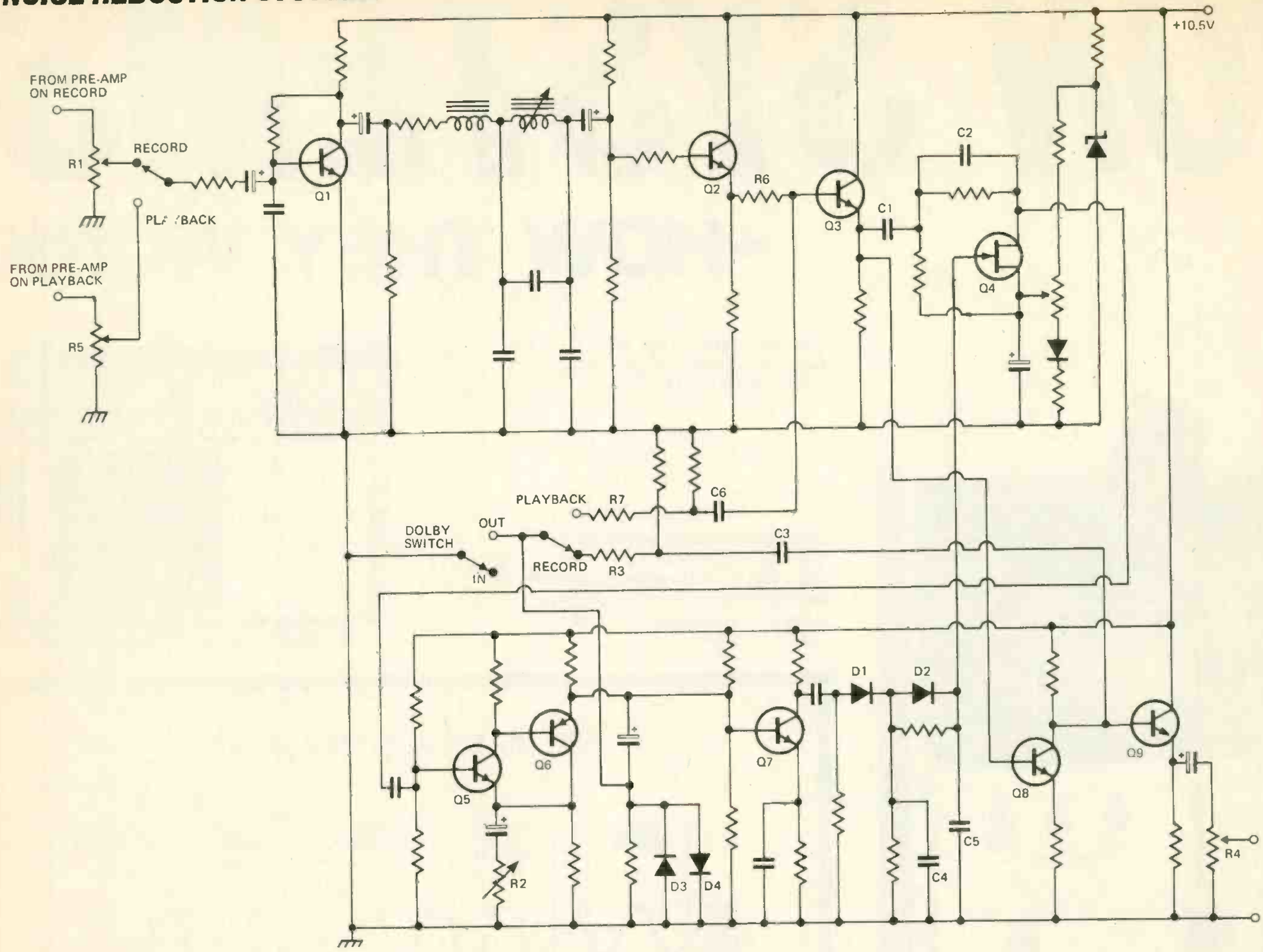


Fig. 2. This is the full circuit drawing of the Dolby system — shown in block schematic form in Fig. 3.

people think, reduce noise by cutting high frequencies.

THE CIRCUIT DETAILS – DOLBY SYSTEM

A circuit diagram of the Dolby 'B' system — as installed in a current model cassette recorder — is shown in Fig. 2. A simplified block diagram of the system is shown in Fig. 3.

In the recording mode the incoming audio signal passes through the input attenuator R1 to the base of emitter-follower Q2 via a filter which removes any supersonic signals. This is necessary in countries that use FM stereo broadcasting as a very high frequency pilot tone is transmitted along with the audio signals. (Pilot tones or other supersonic signals or noise affect the Dolby noise reduction circuits).

Emitter-follower Q3 provides low impedance drive to the filter from which the noise reduced signal is derived. The filter consists of two high pass sections, the first consisting of C1 and a fixed resistor and the other being C2 and the field effect transistor Q4. As the resistance of the field effect transistor depends on the dc level at its gate, the output will likewise depend on this voltage which is derived as follows: The output from the filter is amplified by Q5 and Q6 the gain of which is adjusted by R2 to limit the maximum amount of noise reduction signal available.

This signal is further amplified by Q7, whose collector is shunted by an RC network — this network provides approximately 30 dB of droop to prevent tape overload.

The signal from Q7 is integrated by D1 and C4, and then, on slowly varying signal levels, by a resistor and C5. On transients, the voltage across the resistor forward-biases D2 and this conducts, reducing C5's charging time constant. (The fast transient attack time is masked by the transient itself and is not noticed by the ear). The integrated signal is then used to control the effective impedance of Q4.

A second, unprocessed part of the input signal is taken from emitter-follower Q3 to the base of unity gain amplifier Z8. The output of Q8 and the noise reduced signal from Q6 are in phase and these two signals are now summed by Q9, an emitter follower feeding the head drive amplifier via the record calibration preset.

The maximum level of the noise reduced signal component is limited on transients by diodes D3 and D4. This effect is again masked by the transient itself and is unnoticeable.

In the playback mode, exactly the same circuitry is utilized, but with some rearrangement of signal paths.

The signal from the playback pre-amplifier is filtered as for the record mode, and again appears at the emitter of Q2. Here it is summed with the signal component from the active filter via amplifier Q5 and Q6, resistor R7 and capacitor C6. This component is in antiphase to the input signal and hence reduces its amplitude. As the same filter and amplifier are used for record and playback, the result is an output signal identical in dynamic range to the original, but with reduced noise. The action of the filter and integrator stages is exactly the same in both modes.

To summarise, the difference between the two modes is that the two signals are summed (in phase) at the base of Q9 in record mode, and out of phase at the base of Q3, in the playback mode.

THE PHILIPS SYSTEM

The Philips noise reduction system is somewhat less ambitious than the Dolby principle, and Philips openly admit that theirs will not enable true high fidelity sound to be obtained from cassette recorders.

It operates as a dynamic treble cut filter operating solely on playback. Unlike the Dolby system, no prior processing of the recording signal takes place and so the Philips unit can be used with most existing equipment simply by connecting it between the playback unit and the amplifier.

Whilst at first this progressive attenuation of all low level high-frequency material seems to be musically disastrous, Philips say that musical instruments played softly have a low harmonic content — most fundamentals being below the 4.5 kHz frequency at which the attenuation commences.

The circuit of the Philips system is shown in Fig. 4.

In this circuit transistor Q1 is a phase splitter which receives the replay signal. The phase-inverted signal from the collector of Q1 is passed, via a preset potentiometer, directly to the output of the unit. The in-phase signal from the emitter of Q1 is passed through a two-stage high-pass filter to the base of Q2 where the high frequencies *only* are amplified. Further amplification is provided by Q3 and Q4.

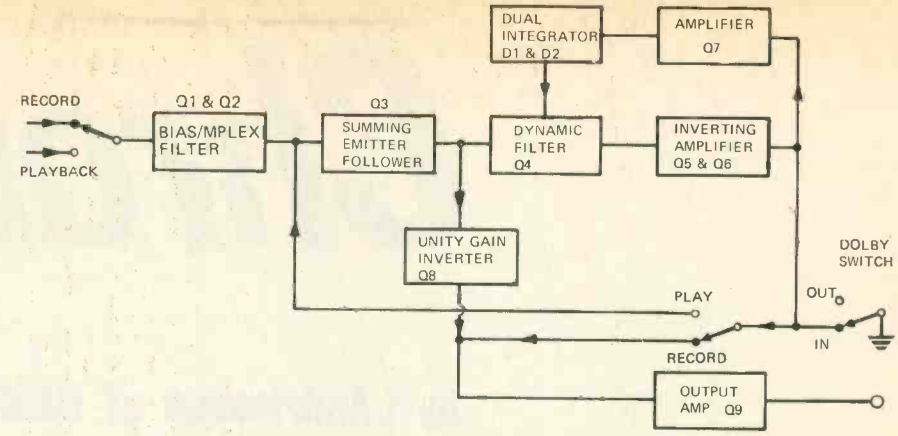


Fig. 3. Block schematic shows the operating principle of the Dolby (B) system.

Back-to-back diodes are connected, via a capacitor, between the base of Q3 and the emitter of Q4 to provide signal limiting, and to ensure fast decay of the compression performed by D3 and D4.

Transistor Q4 is also a phase splitter, and the signal from its collector feeds diodes D1 and D2 which respectively charge C4 (positively), and C5 (negatively). A potential therefore exists across diodes D4 and D3 that will cause them to conduct when the signal level reaches a specific value. When this happens, the junction of D3 and D4 will be effectively grounded by C4 and C5 in parallel. This prevents the high frequency component from the emitter of Q4 passing, via the 22k and 120k resistors, to the output. As this component is in antiphase with the output signal its presence would reduce the level of the high frequency signal component and hence noise.

The circuit does not operate on high level signals, which are passed through with a substantially flat frequency response, but only on those high frequency signals below a certain threshold level.

Essentially, the circuit provides heavy attenuation of signal and noise for frequencies above 4.5 kHz that also fall below the threshold level. Philips claim that an effective signal-to-noise ratio improvement of 10 dB at 6 kHz and 20 dB at 10 kHz is obtained.

Overall gain of the circuit is unity, and this allows the unit to be inserted between playback devices (such as tape decks, record players etc.) and amplifiers of existing equipment with a minimum of change.

We have assembled this circuit in our laboratory and, subjectively at least, a substantial reduction of tape hiss could be immediately noticed. The input level to the Philips circuit must be at least 300 mV for satisfactory results. (The transistors specified in the circuit are not readily obtainable in UK — however the following substitutes will almost certainly be satisfactory — Q1, BC 108B; Q2, BC 108B; Q3, BC 108C; Q4, BC 108B. ●

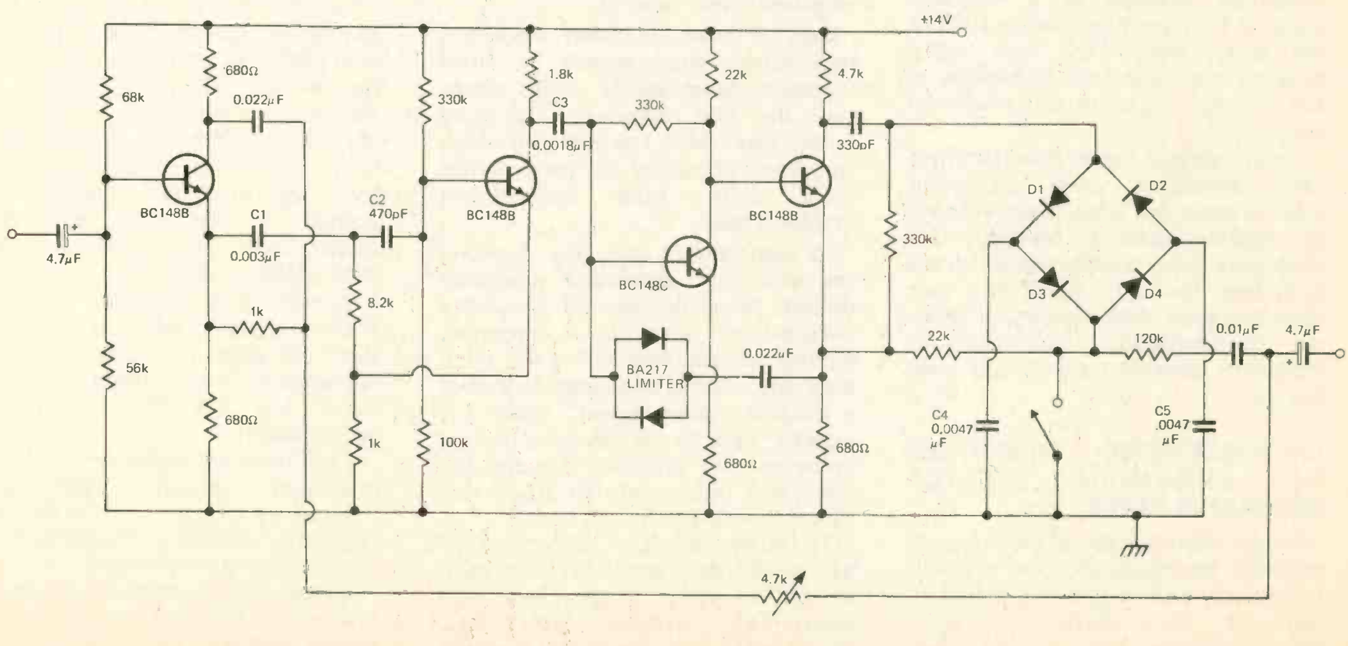
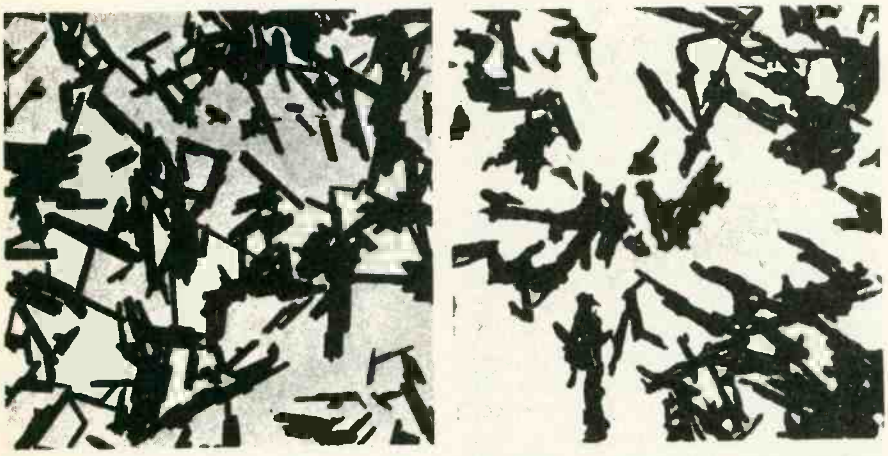


Fig. 4. This is the circuit diagram of the Philips dynamic noise limiting system.

Chromium

by I. Andriesson of BASF AG, West Germany



Figs. 1 and 2. Photo-micrographs of chromium dioxide (left) and conventional tape (x20,000)

OVER the last two years, an increasing interest has been shown among professional tape recording engineers, as well as serious high fidelity enthusiasts, in what can be done with the new chromium dioxide magnetic tapes.

Although the first trials to use chromium dioxide as a magnetic material for recording tapes go back to the early sixties, the first tapes, showing the important advantages of this material, appeared not earlier than about 1966.

Today various tape manufacturers have developed good chromium dioxide tapes and a few manufacturers of quality cassette recorders are marketing cassette recorders which are optimised for the use of this new recording tape. Also discussions about the standardisation implications of chromium dioxide have already been started.

CHARACTERISTIC PROPERTIES OF CHROMIUM DIOXIDE RECORDING TAPES

A main characteristic of the magnetic material, chromium dioxide, is that it is relatively easy to vary the coercivity (this is the ability to resist demagnetisation) over a wide range, which means that is is possible to choose the appropriate optimal coercivity for a certain application. Also it is not difficult to maintain this chosen coercivity in production.

Another advantage is that the form of the single particles approaches more or less an ideal needle shape so that extremely good homogenity can be obtained (Figs. 1 and 2).

Both of these properties result in a remarkable improvement in high frequency recordability, which means that the high frequency maximum output level (MOL) as well as the high frequency sensitivity are much better than those from conventional magnetic tapes.

To demonstrate this, Fig. 3 shows the maximum obtainable saturation output as a function of frequency (without HF bias), of a chromium dioxide cassette tape with a 4 μ thick magnetic coating, compared to that of a modern "conventional" BASF LH cassette tape, having the same coating thickness. For simplicity reasons, the saturation output of the BASF LH tape is assumed to be flat (zero).

Of course, this kind of comparison has to be interpreted with some care, as the saturation output levels are determined without HF bias. Nevertheless, this presentation shows clearly the differences and advantages of chromium dioxide tapes, compared with conventional tapes.

COMPACT CASSETTES

The very high maximum output at high frequencies is of decisive importance for quality recording at very low tape speeds, such as the compact cassette tape speed of 1·7/8 ips.

As anyone, who has tried to make a good recording on cassettes knows, the major limitations of the compact cassette system are: poor background noise and critical high frequency recording (lack of brilliance), especially with music with much top (high frequencies). Cassettes mostly sound rather dull.

To understand this, it is necessary to look at the curves given in Figs. 4, 5 and 6 and to study their interdependance.

Figure 4 shows the maximum output level (MOL) as a function of frequency that is necessary to obtain high fidelity on a recording medium. This curve is the result of various analyses of the spectral amplitude distribution in different kinds of music, one of the primary criteria for high fidelity.

For correct understanding, it is emphasised that this maximum output level (MOL) as a function of frequency has nothing at all to do with the frequency response curve, which normally is given at low recording levels (far below maximum output level) and which is a measure of the transducing linearity of the recording system only. The maximum output level (MOL) curve as a function of frequency gives the tape output at either constant distortion, constant intermodulation distortion or constant compression from linearity of the signal (e.g. 5% THD or 1.5 dB compression).

If the recorded signal passes over this maximum output level limit, unacceptable distortion, intermodulation distortion or compression is unavoidable.

Independent of this MOL curve, the frequency response curve of the system (recorder plus tape) measured at a level far below MOL might be flat,

Dioxide Tape

...Cassette recorders on the way to true high fidelity

because it is established by the recorder adjustment only, if a reference medium is used like the unrecorded portion of the DIN test tape. For reasons of simplification, it is usual in audio tape measuring technique to choose only two frequencies, one in the low part of the sound frequency spectrum, the second in the high part. At 1-7/8 ips tape speed measurements, it is convenient to use 333 Hz and 8000 Hz.

This simplification makes it possible to say that *for true high fidelity* it is a basic requirement that the MOL at 8000 Hz shall not be more than 10 to 12 dB down compared with the MOL at 333 Hz. This is already a compromise since, for professional studio recording techniques, the difference between high frequency and low frequency MOL is normally not more than about 2 dB.

Now we look at Figs. 5 and 6 where the measured MOL curves at 333 Hz and 8000 Hz as a function of HF bias are given for the two tapes previously mentioned. It is immediately clear that if the 10dB hi-fi criterium as mentioned before is applied, the HF bias adjustment for the "conventional" tape would be so low

1. What are the characteristic properties of chromium dioxide recording tapes?
2. What are the advantages of chromium dioxide tapes, if used in compact cassettes?
3. In what respect are cassette recorders optimised for chromium dioxide tapes, different from conventional cassette recorders?
4. Are chromium dioxide cassettes usable on normal cassette recorders, that is to say on recorders which are not optimised for chromium dioxide tape?
5. Is it possible to meet the DIN hifi requirements if chromium dioxide cassettes are used for chromium dioxide optimised cassette recorders?
6. Are there additional advantages if chromium dioxide cassettes are used on recorders using an electronic noise surpressing system like the "DOLBY B" system?
7. Is it worthwhile to modify reel to reel domestic recorders for chromium dioxide magnetic tape?
8. Is chromium dioxide tape important for musicassettes?

This article provides the answers . . .

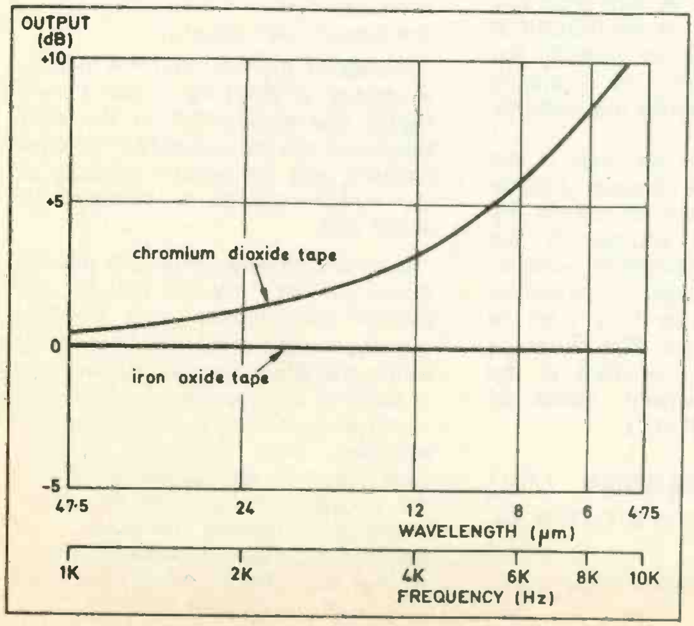


Fig. 3. Comparison of maximum high frequency saturation output of chromium dioxide and iron oxide tape (assumed to be 'flat')

that the low frequency MOL would be very poor, resulting in a poor signal-to-noise ratio. According to DIN requirements, the S/N has been defined as the ratio between MOL at 333 Hz and the noise in dB measured according to DIN 45405 (weighted, quasi-peak).

Also the drop out sensitivity increases at low HF bias. This implies that, although from a theoretical point of view the hi-fi MOL difference between 8000 Hz and 333 Hz can be reached with conventional tapes, the HF bias adjustment would mean a critical utilisation of the tape from a practical and engineering point of view.

In practice most cassette recorder manufacturers utilise nearly all available low frequency MOL of the tape, which requires a relatively high HF bias setting, in order to obtain a

Chromium Dioxide Tape

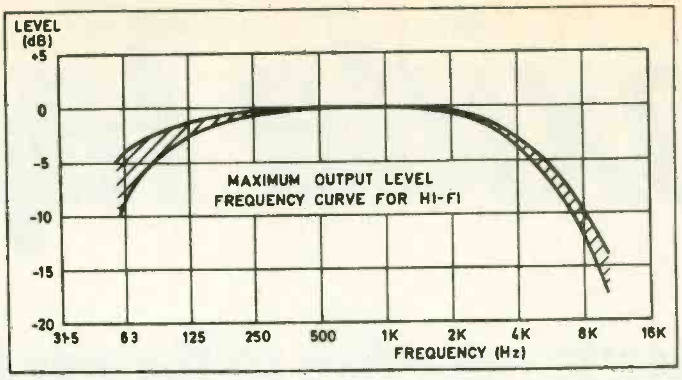


Fig. 4. Maximum output level (MOL) for high fidelity reproduction of music.

good signal-to-noise ratio. However, in such cases the loss in high frequency sensitivity is compensated by using a very strong preemphasis in the recording amplifier (often more than 14 dB at 10,000 Hz) to give a flat frequency response at very low recording levels. However, the loss in high frequency maximum output level (MOL) cannot be compensated and the increased danger of high frequency intermodulation distortion or compression is avoided by connecting the VU meter (output meter) following the preemphasis in the recording amplifier circuit. This safeguards the user against high frequency distortion, etc., because if the music contains much top this top establishes the VU meter indication (rather than the bass) so that the user will tend to record at a lower level.

On paper this looks healthy enough, but, extremely strong preemphasis (over 14 dB at 10,000 Hz) means that the actual recording level will be mainly determined by the top part of the music, resulting in a rather significant discrepancy between the signal-to-noise ratio at measurements relative to MOL at 333 Hz and that obtainable in practice with music. Also, one should recognise that too high a preemphasis does not help hi-fi very much because the required LC active filters cause serious oscillations, resulting in square wave form distortion. This is clearly shown if one observes the overall 1000 Hz square wave performance of such a recorder.

Figure 6 shows the same MOL curves as a function of HF bias for chromium dioxide tape. It is obvious that the situation is much better here; because the chromium dioxide tape allows a good balance between high and low frequency MOL, namely 10 to 12 dB difference at a HF bias setting which guarantees a good utilisation of the tape properties from an engineering point of view.

It should also be said that chromium dioxide is a low noise oxide, which implies that, at the same background noise level as obtained from modern "conventional" tapes, a remarkable improvement in high frequency output (MOL) is available, whereas the signal-to-noise ratio improves because the MOL at 333 Hz can be better utilised. This gives the chromium dioxide cassettes their superior dynamic range and their exceptional brilliance and transparency.

(We have found that chromium dioxide tapes produce at 1-7/8 ips tape speed, the same sound recording quality as conventional tapes at 3¾ ips – Ed).

All considerations made so far have been based on the assumption that the replay part of the cassette recorder will not be changed. But in practice it is expected that cassette recorder manufacturers will use at least a part of the high frequency MOL advantages of the chromium dioxide tapes to improve the signal-to-noise ratio of their recorders.

The key to this is the replay equalisation time constant. If this constant (which has been standardised internationally at 120μs) could be reduced to a lower value, the background noise would be reduced more or less in proportion. However, this can only be done at the cost of the beautiful MOL frequency curves because at least a part of the high frequency output is lost.

It is still an unanswered question, where the economical optimum lies, for, it is clear that an improvement of the signal-to-noise ratio of cassette recorders is very desirable.

An additional complication is the fact that many cassette recorder manufacturers have solved the noise problem by means of electronic noise surpression systems. A very good and well known example is the DOLBY B system, by means of which the signal-to-noise ratio of cassette recording systems can be improved by approximately 9 dB.

It would probably be ideal if the noise problem with compact cassette hi-fi recorders could be solved by means of one or another of the electronic noise suppression systems, so that the advantages of chromium dioxide tapes can be fully used to improve the brilliance. (See review of Advent and TEAC recorders in the November and current issues of ELECTRONICS TODAY).

DIFFERENCES BETWEEN CRO_2 AND CONVENTIONAL RECORDERS

As chromium dioxide tape has a significantly higher coercivity than conventional cassette tape, it is necessary for correct utilisation of this tape, to increase the HF bias current. This is shown by Figs. 5 and 6.

For the same reason, an increase of the erasure capacity is required. Also, less preemphasis should be applied, however, should the replay time constants be changed, it might be possible that the recording preemphasis need not be altered.

How great these modifications will be, depends strongly on the actual recorder circuitry, and this varies considerably from one manufacturer's product to another.

In order to be able to give at least some data, the measuring results, obtained at the DIN HF bias adjustment, are considered. (DIN HF bias equals 2.5 dB sensitivity fall off, over maximum sensitivity at 6300 Hz.)

With the chromium dioxide tapes, this bias setting method results in a 2 to 2.5 dB HF bias current increase relative to the bias of the conventional tape. The LF sensitivity at 333 Hz of the new tape is about 2 dB lower, which means that the recorders have to compensate this to make sure that the recording level meter reading corresponds with the available MOL of the tape at this frequency.

Thanks to the fact that the relative sensitivity at 8000 Hz is about 6 dB higher, the preemphasis at the same frequency can be reduced by the same amount, and the erasure capacity of the recorder has to be increased by about 40%.

So it is clear that chromium dioxide tapes are not *fully* compatible with modern conventional tapes, and that cassette recorders will only *completely* utilise the advantages of the new tape if some of the recorder functions are modified accordingly. In practice it is expected that chromium dioxide cassettes will automatically operate the necessary switches of the special chromium dioxide recorders, for instance, by means of a similar device to that now used to prevent undesired erasure of prerecorded cassettes.

CHROMIUM DIOXIDE CASSETTES ON NORMAL CASSETTE RECORDERS

Here the situation is a little more complicated and we must distinguish between Replay, Recording and Erasure.

REPLAY

The reproduction of pre-recorded cassettes with chromium dioxide tape is simple because it is easy to take care of the different properties during the duplicating process. Should cassette recorders or reproducers change to a new replay time constant, and pre-recorded cassette manufacturers follow this change, the reproduction of such cassettes on conventional cassette recorders will give an increase, and possibly even an over-emphasis of high frequencies. However, on recorders with tone controls this can easily be compensated. In addition there will be a noise improvement.

RECORDING

From a theoretical point of view, the different recording properties of new chromium dioxide cassettes could be expected to cause problems during recording.

However, as already pointed out, many recorders have such a high HF bias adjustment that they are practically right for chromium dioxide tape. A bias setting which gives maximum output at low frequencies on conventional tapes is more or less optimum for chromium dioxide tape. (See the MOL curves as a function of bias, Figs. 5 and 6).

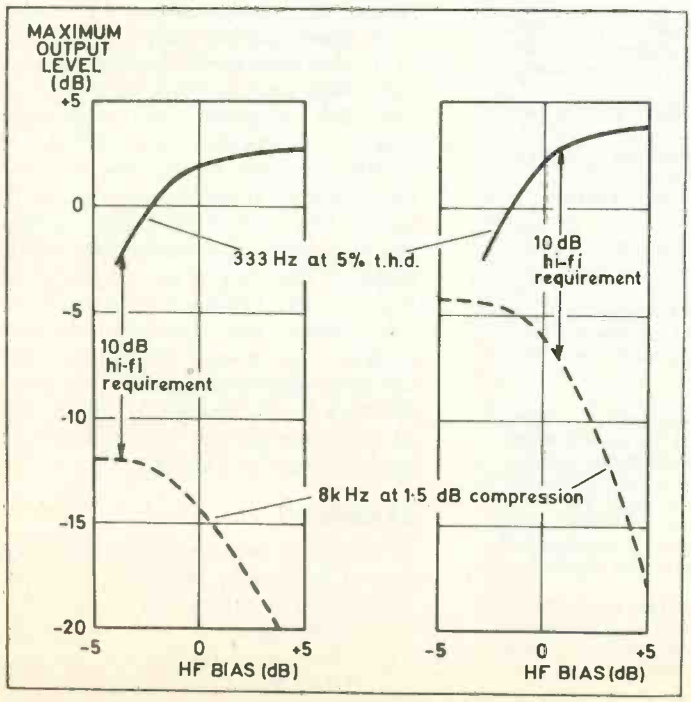
For that reason in most cases, it will not be the bias setting which causes incorrect recording, but the relatively strong pre-emphasis in the recording amplifier, resulting in an over-emphasis of high frequencies. However, during reproduction on good equipment this can be compensated just as simply as in the case of cassettes, prepared for modified replay characteristics, by using the tone controls.

ERASURE

The erasure of chromium dioxide tapes on conventional cassette recorders remains the only real problem.

Erasability is directly proportional to the coercivity of the tape (about 40% lighter on chromium dioxide tape).

The erasure capacity of different cassette recorders varies very strongly. We found extreme cases where the erasure capacity was scarcely enough for conventional tapes (less than 50dB!) Even within one make there are big differences. Many tests in our laboratories have proved that most of the recorders tested, have enough erasure capacity to erase the chromium dioxide tapes at standard working voltage, (e.g., with fresh batteries). This is logical because battery cassette recorders in particular need a certain over-capacity in erasure capacity in order to compensate the decrease in voltage over the life of the batteries. Nevertheless it remains a fact, that on quite a number of the recorders tested, the erasure of chromium dioxide tapes was insufficient, varying from 48 dB down to 20 dB!



Figs 5 and 6. Comparison of MOL curves at 333 Hz and 8,000 Hz as a function of bias for conventional tape (left) and chromium dioxide (right).

CHROMIUM DIOXIDE CASSETTES AND DIN HI-FI REQUIREMENTS

The existing DIN hi-fi requirements for tape recorders (DIN 45500) are again under discussion. It is expected that the new standard will require a signal-to-noise ratio of 47 dB at 3% THD from a 333 Hz signal. Further requirements like wow and flutter, tolerance of tape speed, tolerances for replay and overall frequency response, are of no significance here.

The requirements of 47 dB at 3% THD is about the equivalent of 50 dB at 5% THD, which has been the tape measurement criterium up till now.

On compact cassette equipment, the mono tracks have a width of 1.5 mm, whereas on stereo equipment this 1.5 mm is divided in 2 x 0.6 mm and a separation track of 0.3 mm. So the DIN requirement has to be met by means of the 2 x 0.6 mm tracks, totalling 1.2 mm. At the testing track width of 1.5 mm, the chromium dioxide tape produces at least 53 dB S/N at 5% THD which means approximately 52 dB at 1.2 mm trackwidth.

So, in principle, it should be possible to realise DIN standards although there is very little room for recorder electronic tolerances. Therefore it is understandable that, if no electronic noise suppression is used, a part of the excellent high frequency properties of the chromium dioxide tape will be used to improve the noise. In this connection a replay characteristic modification from 120 μs to 70 μs is under discussion and this will bring a noise improvement of about 3 dB. In a way the DIN hi-fi requirements are a little irrelevent for tape recording because they do not consider any requirement for maximum output level at high frequencies, which is of basic importance for high fidelity; as we have already shown.

CHROMIUM DIOXIDE TAPE WITH ELECTRONIC NOISE SUPRESSION

On recorders with effective electronic noise suppression (mostly the more expensive recorders) the noise problem has already been solved. For example, recorders having the DOLBY B noise suppression system easily reach about 57 dB S/N (which is much better than the DIN requirements). On such recorders the chromium dioxide cassettes are an ideal medium because there is no need at all to give some of the high frequency advantages away in order to improve signal-to-noise. And so the tape will show its full brightness and brilliance even in loud passages with much treble. It is even expected that such recorders may surpass the quality of good LP records because the tape

(Continued on page 81)

How often would you have liked to add extension speakers and not been quite sure what to do? This article tells you how.

extension

Some amplifiers have provision for connecting and switching extension speakers in and out of circuit. Many do not.

Yet this facility is most useful — for music is often required in more than one room, but without the expense of duplicating equipment, or lugging bulky speakers about the house.

At first sight, wiring extension speakers is a simple enough task — but there is more to it than at first appears. Here then — in answer to requests from many readers — is how to do it.

Modern transistor amplifiers operate best with load impedances between four and eight ohms, and as with these amplifiers the power developed in the load is proportional to load impedance, one cannot necessarily just wire extra speakers in parallel with the existing ones without possibly overloading the amplifier.

Generally, load impedances of less than four ohms may damage the amplifier, whilst impedances greater than 16 ohms will prevent the amplifier developing full power — it is for this reason that 16 ohm speakers are rarely made nowadays — and will not be discussed in this article.

The circuits shown here assume that the amplifier has an output impedance of between four and eight ohms. Most amplifiers have nowadays — if in doubt, the output impedance is almost invariably quoted in the manufacturer's handbook. Amplifiers with switched (or tap selected) output impedances — such as transformer coupled units — should be set to four ohms when these extension speaker circuits are used.

BASIC CONNECTIONS

The basic rule for connecting extension speakers is that — providing the amplifier is not overloaded — any combination of speakers of similar or different impedances may be connected in parallel, but speakers connected in series must have similar impedances. If speakers of differing impedances are connected in series, each will affect the distribution of power/frequency connected to he remainder, for example one speaker may end up with predominantly high frequency response and another may have little high frequency response.

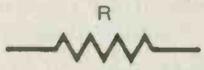


Fig. A. Symbol for a resistor.

Fig. B. Two resistors in series.

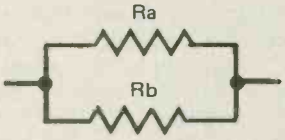


Fig. C. Two resistors in parallel.

RULES OF COMBINATION

Some readers who wish to add extension speakers may not be familiar with electronics. For their benefit here are the rules for calculating the combined impedance of series and parallel speaker combinations.

For this purpose, each speaker may be considered as a resistance, the symbol for which is shown in Fig. A. Series connected resistors are shown in Fig. B and parallel connected resistors in Fig. C.

The combined value of two resistors connected in series is given by simply adding the individual resistance values. Thus:

The combined resistance $R_s = R_a + R_b$.

Parallel combinations present slightly more difficulty.

For the same two resistors in parallel:

The combined resistance

$$R_p = \frac{R_a \times R_b}{R_a + R_b}$$

Hence if we parallel an 8 ohm resistor with a 15 ohm resistor

$$R_p = \frac{8 \times 15}{8 + 15} = \frac{120}{23} = 5.2 \text{ ohms}$$

approx.

The term resistance, strictly speaking, may only be applied when speaking in terms of direct current (dc), whereas speakers are driven by alternating currents (ac). The term impedance is used to denote the effective resistance of a speaker (or any other device) to alternating current.

When putting speakers in parallel or series the same rules as above apply but we talk in terms of impedances rather than resistances.

EXAMPLE 1

Four ohm main speakers — one pair of four ohm extension speakers.

Switching arrangements:

(1) Main speakers only
(2) Auxiliary speakers only
(3) Main and auxiliary speakers

The extension speakers cannot be simply paralleled across the main speakers because four ohms paralleled with four ohms is two ohms — and a load such as this will probably damage an amplifier.

Here the only way to connect the extra speakers is by wiring them in such a way that, when switched into circuit, they are in series with the main speakers.

As their combined impedance is now eight ohms the subsequent mismatch will cause some loss of power to each speaker. Fortunately the response of the human ear is logarithmic and so the subjective drop in sound level is somewhat less than one might at first expect.

Figure 1 shows how the speakers should be connected.

EXAMPLE 2

Eight ohm main speakers and one pair of eight ohm extension speakers.

Switching arrangements:

(1) Main speakers only
(2) Auxiliary speakers only
(3) Main and auxiliary speakers

In this example the main and extension speakers are wired in parallel. If they were wired in series the resultant impedance would be 16 ohms and hence amplifier power would be reduced considerably. If the speakers are paralleled (as shown in Fig. 2), the resultant impedance of four ohms will provide adequate output. The overall sound level will not alter appreciably when the extra speakers are switched into circuit, and so this arrangement is preferable to that described in Example 1.

EXAMPLE 3

Four ohm main speakers and one pair of eight ohm extension speakers.

Switching arrangements:

(1) Main speakers
(2) Auxiliary speakers

In this example the only practicable

speakers

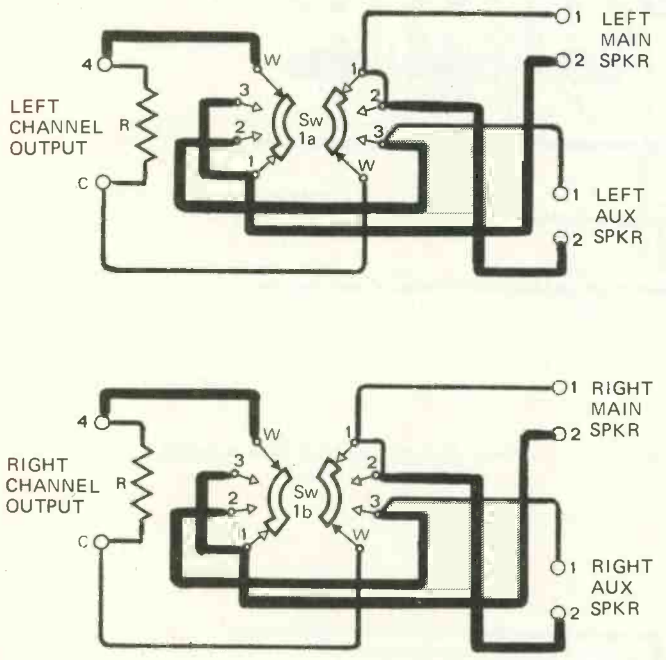


Fig. 1. Four ohm main speakers with one pair of four ohm extension speakers.

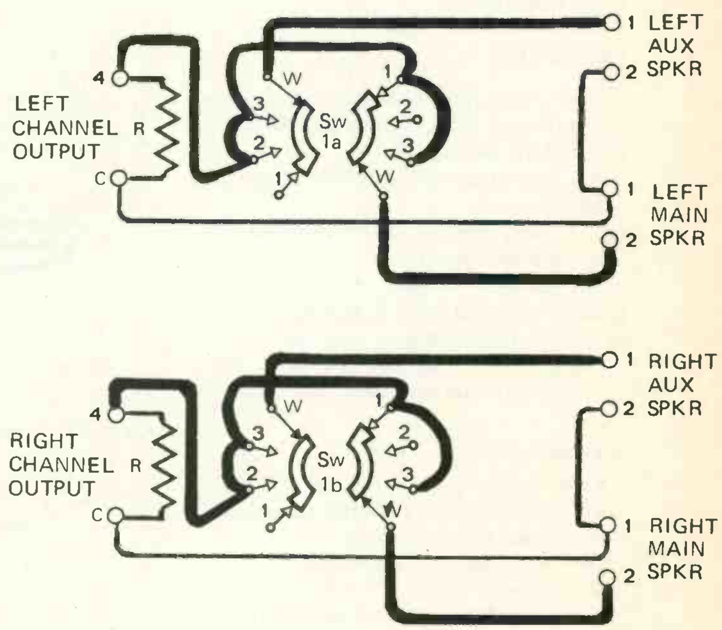


Fig. 2. Eight ohm main speakers and one pair of eight ohm extension speakers.

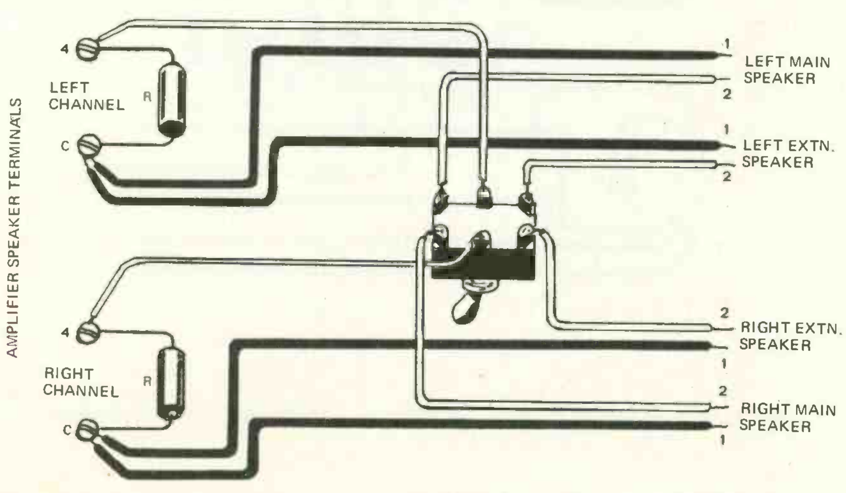


Fig. 3. Four ohm main speakers and one pair of eight ohm extension speakers.

way of interconnecting main and auxiliary speakers is by wiring them in series, as a parallel connection will reduce the combined impedance to a possibly unsafe level. In the arrangement shown in Fig. 3 we can use the main speakers alone, and the auxiliary speakers alone — but not both sets simultaneously — remember that any attempt to series connect speakers of different impedances will cause distortion.

EXAMPLE 4

Four ohm main speakers and two sets of eight ohm extension speakers.

Switching arrangements:

(1) Any pair of speakers may be used alone

(2) Both pairs of extension speakers may be used together

(3) Neither pairs of extension speakers can be used at the same time as the main speakers

Figure 4 shows how the interconnections are made.

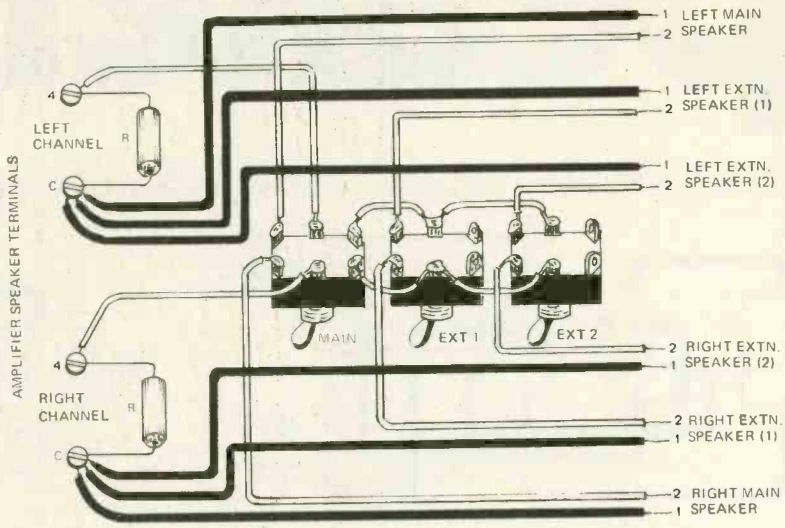


Fig. 4. Four ohm main speakers and two sets of eight ohm extension speakers.

EXAMPLE 5

Eight ohm main speakers and two pairs of eight ohm extension speakers.

Switching arrangements:

(1) Any pair of speakers may be used alone

(2) Any two pairs of speakers may be used together

(3) All speakers must not be used simultaneously

Wiring arrangements are shown in Fig. 5.

INSTALLATION

In all cases 50 ohm 5 watt resistors are wired across the speakers outputs. These reduce the annoying click that is otherwise experienced when switching from one speaker combination to another. Apart from this function, many amplifiers will oscillate at very high frequency (in the Megahertz range) if the output is open-circuited. The resistors will prevent this occurring whilst switching.

Speaker wiring should be run in twin-core flex (23/0076 is ideal). If possible try to obtain flex that has each conductor colour coded — or identified in some way — as it is most important to maintain the connection sequence shown in the diagrams. Crossed-over wiring will result in incorrect speaker phasing and consequent cancellation of some frequencies.

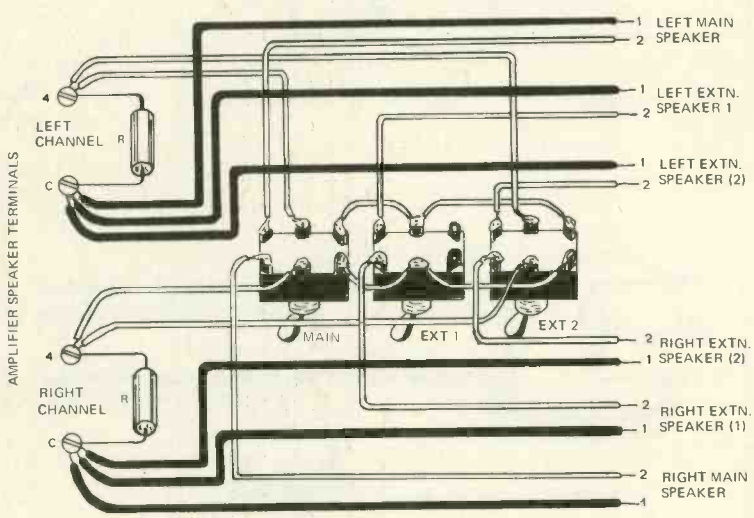


Fig. 5. Eight ohm main speakers and two pairs of eight ohm extension speakers.

A lighter gauge wire (14/0076) may be used for runs of less than 50 feet. However this lighter wire is not as readily obtainable as the 23/0076.

Ordinary hook-up wire may be used to interconnect the switch units — but again be quite sure to connect all leads exactly as shown.

MODERN FOOD PRESERVATION
–the use of x-ray radiation

New technique could revolutionize the food preservation industry.

IN 1895 Wilhelm Roentgen discovered the existence of electromagnetic radiation at wavelengths of 10^{-10} to 10^{-12}m. They became known as X-rays. The penetrating power of X-rays has enabled the interiors of visibly opaque objects to be seen, and much of our knowledge of the atomic structure can be credited to the use of the X-ray diffraction technique.

Slower to be released was the potential of X-rays for preserving food, and their use in other biological applications such as insect disinfestation in grain, flour, tobacco, raw wool and leather and also for the deliberate causation of mutations in plant breeding. X-rays can also be used to inhibit the sprouting of vegetables such as potatoes, onions and carrots. Cold sterilization of medical products is also feasible using X-ray irradiation.

The powerful ionising effect of X-rays enables food stuffs to be preserved by eliminating the pathogenic and spoilage bacteria. Irradiation methods, including gamma ray isotope radiation which is also useful for preservation, are of particular interest in the preservation of food, especially in instances where the usual preservative methods are not viable. Heating, for example, may damage the product, and the addition of preservatives may not be desired. With radiation methods there is no chemical residue, the aroma is unchanged and pasteurization penetrates throughout the food.

The effect produced depends much upon the dose given as can been seen from the various groups shown in Figure 1.

In a number of countries the use of irradiation has already progressed from the laboratory to pilot plant stages as possible commercial processes. It is quite likely that food preservation could become the major use for radiation sources in the near future.

In the sea-food industry, radiation pasteurising is an economically valid proposition. Fishing trips for fresh fish (not deep frozen) and, in particular, crustaceans such as shrimps, have one basic problem.

The trawler can only stay out for as long as the first-caught fish will stay fresh enough for subsequent sale or processing. In salt-water fishing the ports are very distant from the fishing grounds and it is common for a trawler to return only half full. In deep-sea trawlings, a trip is not really economic unless it is at least two-thirds full upon return. Storage on ice is not always feasible so irradiation with a low dosage on the trawler itself is an attractive proposition for maintaining the keeping qualities of the food without causing damage or changing the natural aroma.

Shrimping has other problems as well. The hard shell must be removed for the majority of marketing and this is usually done on land using labour at home. The quantity caught depends much upon the tides at the fishing grounds which vary from day to day. These variations coupled with the real possibility of late arrival at port means there is often no labour available for immediate processing. A method to prolong the freshness by two to three times is attractive from many points of view.

In the German Federal Republic (West Germany), the Federal Fishery Research Institute located in Hamburg, has been conducting research into methods and practice of preserving the quality of fish and other sea creatures on behalf of the Fishing Industry. For the past five years it has been operating a high powered X-ray ionisation plant (200 kV at 32mA) for research into food preservation. More recently they have installed a higher powered unit (200 kV at 150 mA) on the fish research vessel "Walther Herwig" in order that fish can be irradiated immediately after they are caught.

(Continued overleaf)

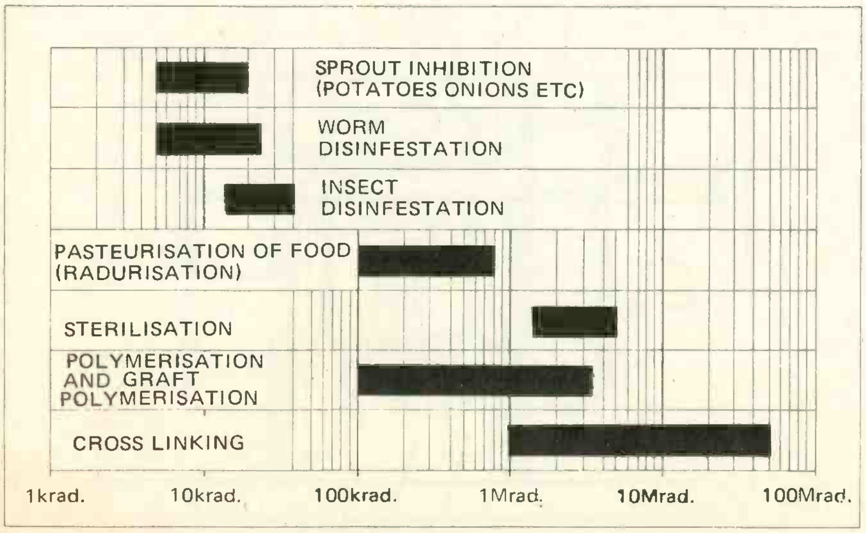


Fig. 1. Dose ranges for the main use of ionising radiation – the phenomena produced depends largely upon the dose.

MODERN FOOD PRESERVATION

The fresh fish is packed into cylindrical containers which automatically pass through a zone of radiation in a continuous manner. A container is seen being removed from the experimental ship-board unit in (Fig. 2).

Some 50-70kg of fish can be pasteurized per hour with a mean dose of 100 k rad. in this pilot plant. AEG-TELEFUNKEN, who designed the equipment, have already planned tandem units which will be able to process at the rate of 1-3 tons per hour.

Although the plant is heavy and large compared with the small containers it processes, it is, in fact, smaller and lighter than the equivalent isotope radiation plant. It can also be switched off when not needed and maintenance is simplified as there is no health hazard when the power is disconnected.

HIGH POWER X-RAY TUBE

The heart of the unit is a high-powered X-ray tube of unusual design. It consists of a cylindrical, water-cooled anode of about 150 mm in diameter around which is the cathode as seen in (Fig. 3) When used in a vertical orientation it forms what is terms a pot anode. The same basic

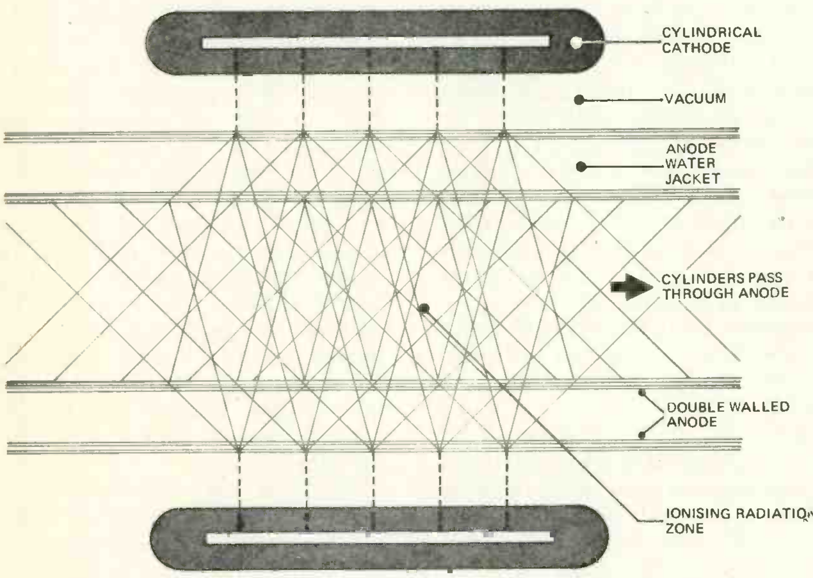


Fig. 3. Diagrammatic layout of the cylindrical X-ray tube.

Fig. 2. Removing the fish cylinder from the X-ray treatment plant on-board the ship "Walther Herwig".

1. Radiation lock
2. Anode cooling water
3. Double-walled flow-through anode
4. Cathode
5. Vacuum
6. Radiation lock
7. Air outlet
8. Depot
9. Outfeed magazine with transport units
10. Lead shielding
11. Oil-filled cathode insulator
12. Transformer for cathode heating with high high voltage cable and plug
13. Ion getter pump
14. Infeed magazine with transport units

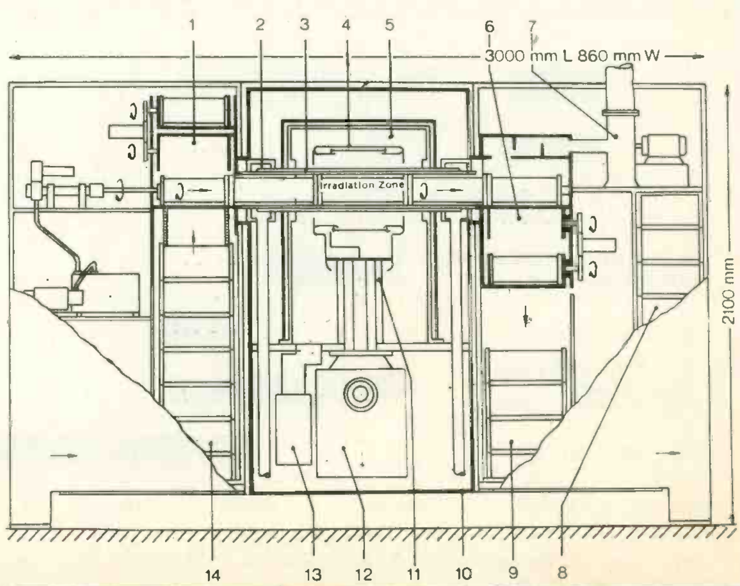


Fig. 4. Cross sectional view of the shipboard installation using the flow-through anode configuration.

MODERN FOOD PRESERVATION

form of X-ray tube enables cylinders to be passed horizontally through the internal radiation zone as seen in the simplified diagram showing the interior of the AEG ship plant (Fig. 4).

Distribution intensity of the ionising radiation in the irradiation zone is reasonably homogenous inside the cylinder and the type of fluid in the zone makes little difference to the distribution. Plots of iso-dose lines in the cavity are given in Fig. 5 — the desirable intensity is given as 100% in the tube centre. To ensure maximum uniformity of irradiation for the contents, the cylinders are rotated as they travel through the radiation.

The dose rate can be adjusted by two simple methods. Firstly the tube current can be controlled to give the desired radiation rate as seen in the graph of Fig. 6. Secondly, the speed of travel of the cylinder can be varied.

The entire equipment is, naturally, fully shielded to protect the operators from both the high voltages and from stray radiation. The cylinders which move up the infeed magazine transport, are sent horizontally through the irradiated zone and are then let down the outfeed conveyor. The in and out-feed arrangements are provided as safety radiation locks.

The provision of 200 kV at up to 500 mA requires a large transformer and cooling of the anode by circulating water is essential. The entire X-ray system is surrounded by a lead shield.

Irradiation is not yet fully commercial, for many factors still need to be established and clarified. In the German Federal Republic, for instance, the "Food Irradiation Promotion Group" of Bremen formally applied in December 1971 for permission to treat fresh salt-water fish by this method.

The Food and Agriculture Organization of the United Nations (FAO) and the International Atomic Energy Agency (IAEA) are holding an international symposium in Bombay, India, later this year, on the subject of radiation preservation of food. This assembly will bring the world's experts together and will consolidate the experiences of many people possibly leading to wholesale use of this new method of preserving foodstuffs. ●

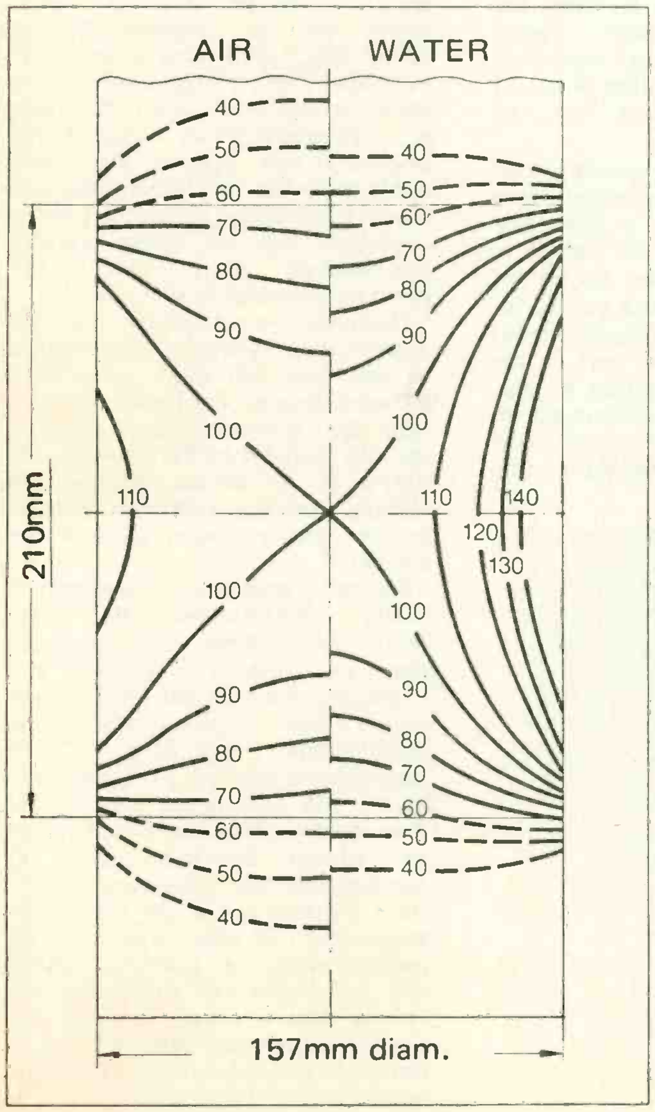


Fig. 5. Intensity distribution inside the irradiation zone of the X-ray tube.

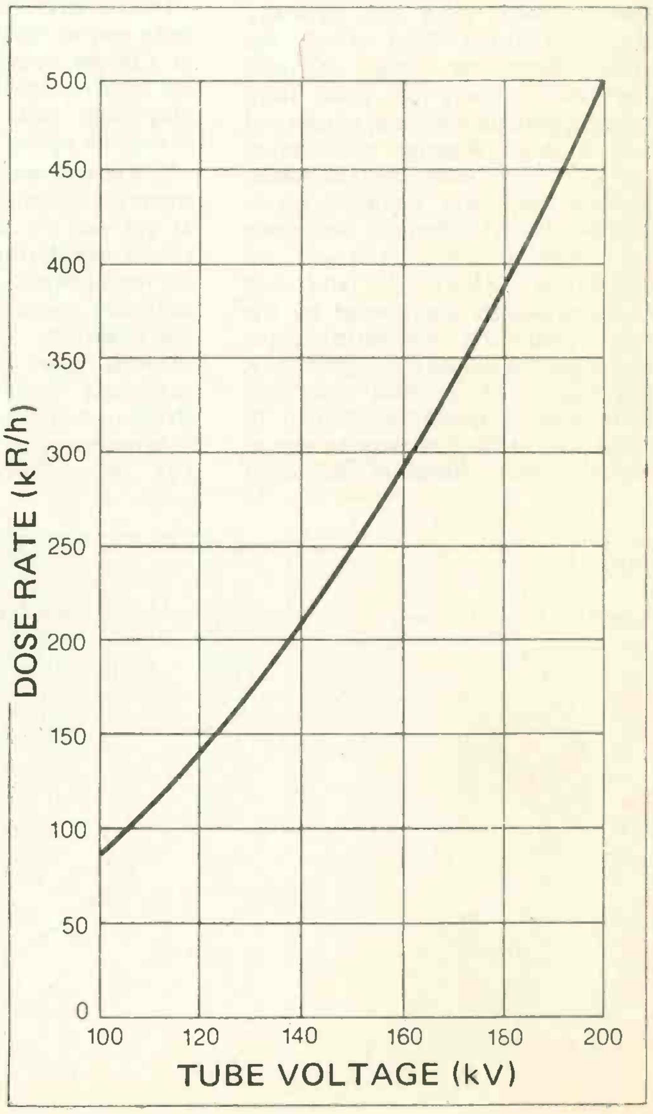


Fig. 6. Dose rate in the centre of the irradiation chamber (with a tube current of 32 mA).

PART 7

TRANSDUCERS IN MEASUREMENT AND CONTROL

Dr. Sydenham explains the history and technique of thermistors and semiconductor temperature sensors.

It was not until the mid 1940's that suitable temperature sensitive bulk resistance materials could be made with stable characteristics. In 1946 staff of Bell Telephone Laboratories reported their work on thermally sensitive resistors from which the name thermistor has derived. Thermistors usually are made from solid semiconducting metal oxides and have a large negative temperature coefficient of electrical resistance. (Positive coefficient thermistors also exist but are less common). Resistance is exponentially related to temperature, Figure 1, and two constants, which are quoted by the maker, enable the characteristic curve to be drawn to within a few percent. A wide range of nominal resistance values (usually quoted at 20 and 25 deg.C) are available – ohms to tens of kilohms. The temperature coefficient is greater than for conductor resistance sensors. For example, one commercial resistor that is 10 kohm at 0 deg.C is 153ohms at 100 deg.C but, of course, the relationship is highly non-linear.

Thermistors are used in much the same way as resistor sensors – that is, in a bridge network. Lead resistances are usually uncritical being orders of magnitude less in value than the thermistor value.

It is rare to see design procedures for thermistor thermometers in text books as yet but the process is reasonably simple (see the reading list). Factors to be considered are the choice of optimum bridge resistance values, for the sensitivity (in mV/deg.C usually) depends upon these as well as the thermistor type and applied voltage. Bridge currents heat the thermistor so it is necessary to design for a tolerable rise in offset temperature (the encapsulation insulates the sensor from the environment enough to produce a temperature drop across it); this fixes the maximum bridge excitation voltage. Finally, the sensitivity can be calculated. typical values will lie between 1 and 100mV/deg.C depending on the offset allowable. There is seldom real need to design for high sensitivity in the bridge as integrated-circuit operational amplifiers can provide adequately stable gain. For best results (but not always needed) the bridge can have ac excitation and use phase sensitive rectification to enhance the signal-to-noise ratio at the output.

Thermistors are available that can operate from cyrogenic temperatures to well over 300 deg.C using three different groups. Encapsulations vary from dot size beads to flat disks. They are also available ready mounted, see Figure 2, in devices ranging from 500μm diameter hypodermic needles to the robust sensors used in car engines.

Portable electronic thermometers using thermistors are now commonplace. When first introduced they were said to be unstable and unreliable with time but this is not so now. Well aged units (the manufacturer does this) can hold temperatures stable to 1 millideg.C per month and even better over shorter time periods. Their non-linearity can be reduced by using them in combination with series and parallel fixed resistors but at the expense of sensitivity. For wide range, accurate measurements, the resistance sensor still is superior but thermistors are finding more and more use each day Electric motors use them (as well as resistance sensors) to sense the hottest temperature of the winding. This is obviously superior to bimetal devices that only monitor the average carcase temperature.

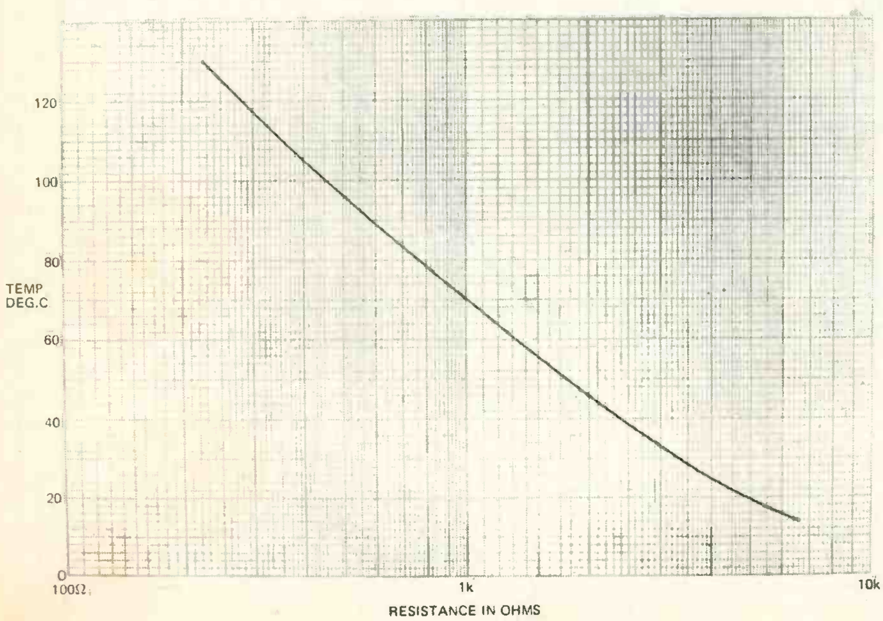
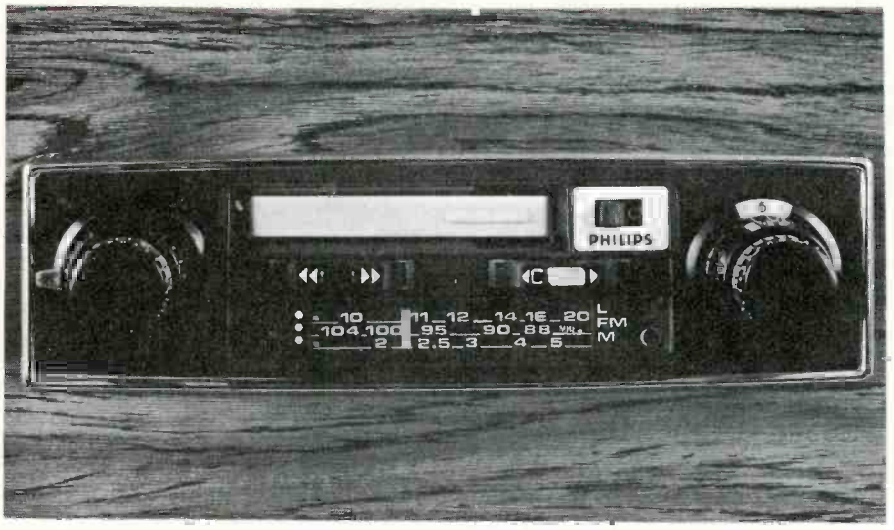


Fig. 1. Resistance variation with temperature of a typical thermistor.

(Continued on page 74)

AUDIO NEWS



PHILIPS AM/FM STEREO CASSETTE CAR RADIO

The latest Philips AM/FM Stereo Cassette Car Radio, RN 712 will, when fitted, make any car the most sophisticated in terms of sound quality, listening choice and freedom from accessory clutter.

Philips RN 712 is a stereo cassette car radio receiving three wavebands – the long wave, the medium wave, and FM Stereo. The latter is now coming into its own as Radios 2 and 4 join Radio 3 with almost full-time stereo transmissions. The 712 also integrates a cassette recorder with full stereo playback facilities in the one unit. Accessories supplied include a separate coiled-flex microphone with a remote control stop/start switch. The mike has been specially designed to cut out unwanted wind noise, and its holder can be mounted in any convenient position.

The RN 712 combination is a small unit by comparison with many other pieces of in-car entertainment. It is the size (180 x 51.6 x 162mm) of a pushbutton AM car radio and will therefore fit most standard dashboard apertures. The radio which includes an improved six station 'Turnlock' system automatically changes the waveband for the pre-selected station. The components used in the unit include one integrated circuit, 49 transistors and 34 diodes – three times the components used in the average black and white television set. The set also includes Philips unique FM interference absorption circuit which ensures quality FM stereo reception even in fringe areas with virtually no interference from passing cars.

The cassette car radio has an output power of 2 x 5 watts, a continuously variable treble and bass tone control and a stereo balance control. The tape unit has an electronic tape speed control for constant speed. Particular pieces on the tape can be found very quickly by either the fast wind or the rewind switch which locks down if required. The recorder has an automatic recording level control for the best and safest recording results. The radio's volume control is completely independent during recording. There is also an automatic end of tape stop which switches the unit back to radio output when one side of the cassette is fully wound.

The radio is suitable for 12 volt negative earth and has connections for a car aerial, including an electric one, microphone and loudspeakers.

DIGITAL RECORDING

Japan's Nippon Columbia company have developed a digital recording technique. The new equipment, said to cost over £125,000 uses pulse code modulation.

Advantage of this technique is its virtual imperviousness to noise and distortion. Further details will be published as they come to hand.

HIGH QUALITY PRE-RECORDED CASSETTES

In the USA, the Advent Corporation are shortly to market a range of pre-recorded extra-high quality chromium dioxide cassettes.

Programmable material is to be obtained from the Nonesuch Record organisation and will be recorded directly from that company's Dolby A master tapes.

These master tapes are of superb quality and many have been recorded by Marc Aubort who was previously vice-president of Dolby Laboratories in the USA.

Unlike the majority of pre-recorded cassettes – which are recorded at a speed 32 times faster than their normal playback speed – Advent will be recording their new range at a speed ratio of only four to one.

Sound is reliably reported to be quite superb, with little tape hiss and no drop-outs or modulation noise.

REEL-TO-REEL TOO

Tape recording enthusiasts using the reel-to-reel format will be interested to hear that American Ampex Stereo Tapes are shortly to introduce pre-recorded Dolby B reel-to-reel tapes.

Our information is that they should be on the market by the end of this year.

The recently announced Vanguard quadraphonic reel-to-reel tapes are also now recorded using the Dolby B system.

VIDEO CASSETTE STANDARDS

Philips will make its video cassette recording system freely available to other manufacturers in order to promote worldwide standardisation of VCR. The company some years ago offered its audio Compact Cassette system in the same way.

In Europe, 10 companies manufacturing PAL colour TV equipment have already agreed to adopt the VCR system.

Three more companies are expected soon to sign VCR standardisation agreements with Philips.

Now Philips and Shiba Electric Company of Tokyo have agreed that Shiba will submit an official standardisation proposal to the Electronic Industries Association of Japan's standardisation committee. This proposal relates to the NTSC system, the colour television system used in Japan and the United States.

In the USA, North American Philips Corporation has made a similar proposal to the Society of Motion Picture and Television Engineers.

Philips and the Minnesota Mining and Manufacturing Company (3M), St. Paul, USA also have signed a standardisation contract relating to the Video Cassette Recording system (VCR) developed by Philips. Under the contract, 3M company will sell VCR apparatus in Europe and in other countries where either the PAL or the SECAMcolour TV system prevails. The 3M company will market the high energy video tape developed by them in VCR cassettes. Philips plan to use this tape in addition to the chromium-dioxide tape, which is used in the VCR cassettes already for sale.

INPUT GATE

LETTERS FROM OUR READERS

CASSETTE RECORDERS

A couple of hi-fi dealers have told me that good cassette systems now have a performance equal to top quality record systems. Do you agree with this?

—F S Bathurst, N S W

Almost. Certainly the latest cassette recorders incorporating the Dolby noise reduction system and using top quality tape have an excellent performance. In fact they are at least as good as the vast majority of record systems. Nevertheless they do not quite equal the really top quality record systems — such as say a Thorens deck and Shure or Stanton cartridge.

However the manufacturers of cassette decks improve their performance almost daily and these comments may be out of date before they are even printed! Frankly if the cassette format appeals to you we suggest you go ahead and buy one.

TIT FOR TAT

I have just received the November issue of Electronics Today International and would like to thank you for giving details of the British Amateur Electronics Club in your letter column.

Even though I am not particularly interested in audio I found that the article 'Designing a 700 Watt Amplifier' by Mr R Carver was extremely interesting and would like to congratulate you and Mr Carver for taking the trouble to explain in a very interesting way exactly what the advantage is in having a very high power amplifier. I immediately passed on my copy to one of our local members who is particularly interested in Hi-Fi and I know that he will also be very interested in this article.

Once more, many thanks for your interest in the British Amateur Electronics Club and congratulations again on your magazine.

—C B, Penarth, Glam

Thanks! and you're welcome.

CHEAT, CHEAT!

In your Pièce de resistance Problem an argument exists that if the use of a digital computer is admissable to solve the problem an analogue computer must be equally admissable. Therefore I solved the problem by constructing such an instrument. A network of resistors was set up in a similar manner to fig 3 in your Oct edition, each resistor sealed by a factor K. A Voltage of V, volts was applied to the network and the resulting current i measured. This data was fed into a handy IBM 370-195 and the result of 121·43179Ω obtained. Would this have qualified for a prize if it had been amongst the lucky 10? *—P M, Maidstone, Kent*

A mathematical, not practical, solution was required. If you had set up the equations and then used your analog computer (slide rule) ok.

TAKE YOUR PICK

I read, with great interest, the article in November ETI explaining why a 700 watt amplifier is a necessity for true, undistorted music reproduction, by Robert Carver, President and Director of Advanced Projects, Phase Linear Corporation.

His experiences with amplifiers of similar rms power rating but smoothed and unsmoothed power supplies causing differences in clipping levels with transients are very enlightening, but is it not incorrect to compare two amplifiers of similar rms power rating? I have built a high quality 35 watt (rms) per channel amplifier, and have employed a regulated power supply of 55V, but the rms continuous power would have been greatly reduced due to this voltage falling under loaded conditions, though the voltage at clipping under transient conditions would be the same. Is it not better to have the higher rms power? If an amplifier can operate from 90V why not hold the supply at 90V so that the dynamic range of the music is not compressed under high power-demanding sections of music due to the supply voltage falling? Surely a load section of music is softened due to this!

I feel the use of a regulated supply is more than justified (added advantage of slow switch-on, low ripple, mains transients removed current limiting available). Mr Carver's article appears to condemn the use of them.

I would be very pleased to have a reply.

—G D, Hexham, Northumberland

The 'Phase Linear' article was written specifically by the manufacturer as an answer to the points made in our September review of the amplifier. We still do not believe that 700 watts are really necessary, even with Bose speakers. The reason for preferring 'unregulated' to 'regulated' power supplies is that an unregulated supply allows a much higher transient power response for a given rms rated amplifier, provided that the powers transistors have adequate voltage rating.

If an amplifier with a regulated power supply is driven to its rated rms output, the transients will be clipped resulting in objectionable distortion. This does not apply to the same degree with unregulated supplies.

Thus, as you say, an amplifier with a regulated supply must be operated at a power level much less than the rated rms to achieve acceptable transient response.

COVER LOVER

My introduction to your excellent journal was on Victoria Station during a rummage through Smiths bookstall for something to read on my train journey to Scotland. It was the outstanding cover that caught my eye. Rather unusual, I must agree, but it certainly did draw a lot of attention from many people around me. Thank you for that cover as I am now a registered reader with my newsagent as from December Issue.

In passing, the contents are the best I have read in my twentyfour years in the electronic industry.

—C W, Dartford Kent

PROJECT IDEAS

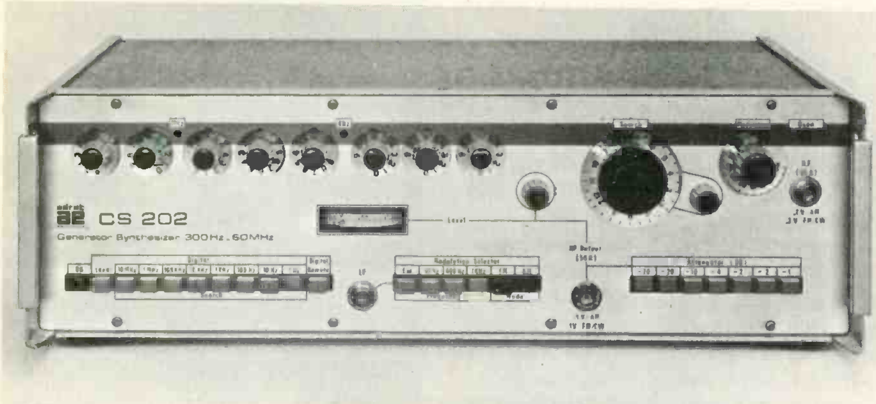
Here are two projects, no doubt most of your readers would like to see in Electronics Today, namely: 1—A complete diagram for a light actuated car ignition system; 2—A diagram of a light operated tacho, preferably using an incandescent bulb instead of LED.

Both projects should be simple yet reasonably reliable and I feel sure, these would satisfy a very large number of your readers.

If however your programme is full for the near future, perhaps you would be good enough and let me know where I can obtain the necessary details of above. I have constructed a couple of tachos, but they were not particularly dependable. They were however my own design. *—B B, Scunthorpe, Lincs*

We have some plans in this direction for the future, but in the meantime, Lucas have an excellent optoelectronic ignition-conversion unit which is very simply installed. We recommend you contact them. ●

EQUIPMENT NEWS



SIGNAL GENERATOR SYNTHESIZER

A remotely programmable Signal Generator -Synthesizer covering the 300 Hz to 70 MHz frequency range is being marketed by Racal Instruments Limited as one of their specialized international products. Manufactured by Adret Electronique, the Codasyn 202 provides signal generator versatility with synthesizer accuracy over a wide temperature range. The frequency is set by front panel controls with resolution of 1 Hz. A calibrated search or interpolation oscillator is included which is said to permit meaningful settings to 0.001 Hz. FM and AM modulation is built in, with three internal modulation frequencies, while an external mode allows modulation from dc to 10 kHz. Adjustment of output level is by a built-in 0-59 dB attenuator and a ± 1 dB vernier.

The synthesizer accuracy and stability is claimed to be within 2 parts in 10^9 per day and the digital dividers ensure a spectrally pure output. The Codasyn 202 is ideal for communications, carrier systems and telemetry applications as well as filter, network and other measurements requiring an accurate, and/or programmable, signal generator.

A full range of accesories is available for systems use, including remote displays, programmable attenuators, frequency programmers and comb generators.

Further details from: Racal Instruments Limited, Duke Street, Windsor, Berkshire SL4 1SB.

(195)

PORTABLE DATA CAPTURE DEVICE

DATALINK, which is of totally British design, development and manufacture, provides a convenient and easily portable means for data capture at source, and records data in a form suitable for subsequent direct analysis by computer. Visual validation of data keyed into the device is facilitated by means of simultaneous print-out through a specially designed printer incorporated in DATALINK unit.

The unit is completely portable - weighing only eight pounds - and contains controls, cassette tape, keyboard, printer and control electronics. Portability is further enhanced by the fact that it has a seven-hour working life on battery operation. Battery power is monitored and the unit provides a visual warning of low power by means of a flashing light. When this warning occurs, the keyboard is automatically disabled to ensure that no more work is carried out on the unit until its batteries have been re-charged, or it is plugged into the mains. Battery re-charge requires a period of five hours.

DATALINK has been designed for anyone to use, and requires minimal operator training. This has been achieved by means of in-built logic and electronic controls. For example, the risk of recording undetected

errors has been made extremely remote through self-intelligent electronic circuits which check commands from the internal store, on a write-read principle on tape, before the command to print is given.

Should an operator attempt to enter more than ten characters in a block, then a visible and audible overload warning is generated. On-off control is again controlled internally in the DATALINK unit. When any key is operated, the unit automatically switches on, and a built-in time delay ensures switching off five minutes after the last entry or command has been made.

The portability, adaptability and low cost of the unit opens up vast new fields of application. DACE Limited envisage its use in: retail stores for stock checking; freight control; store records; ministry inspection records; process control; on-line production tests; quality assurance engineering; goods inwards control; production engineering; service engineers' records; shop floor inspection; field surveys; medical records; aircraft inspection records and aircraft maintenance, victualling and ground movement control.

Technical features of DATALINK include: 48-character alphanumeric touch keyboard with 0 to 9, A to Z, x 100, x 1000, command and symbol keys; twin track, standard tape cassette with over one million bit/character capacity; 10-bit, in-line, simultaneous print-out on pressure sensitive paper; solid-state load indicators, mounted in a line of ten and initiated as each character is operated; and an 'operator only' key to personalise each unit.

Further details from: Dace Ltd, Ferndown Industrial Estate, Stapehill, Wimborne Road West, Wimborne, Dorset.

(196)

AUTOMATIC DIRECTION FINDER

A solid-state 3 band portable automatic direction finder - the Autofix 100 - is now available from EMI Marine, Sevenoaks, Kent. This unique equipment incorporates an 8 inch bearing pointer. This large 360° pointer automatically and continuously homes on to the selected radio beacon or transmitting station. The azimuth ring may be rotated to indicate relative true or magnetic bearing, without calculation. The built-in sensing circuitry and telescopic antenna eliminate the risk of 180° bearing error.

The Autofix 100 is especially designed for use on yachts, power boats, fishing vessels and other small commercial or leisure craft. It costs £235, complete with earphones, earth lead and carrying case.

EQUIPMENT NEWS

It incorporates a 3 band tuning scale the Beacon Band (175 - 420 kHz), the Broadcast Band (535 - 1280 kHz) and the Marine Band (1250 - 3000 kHz).

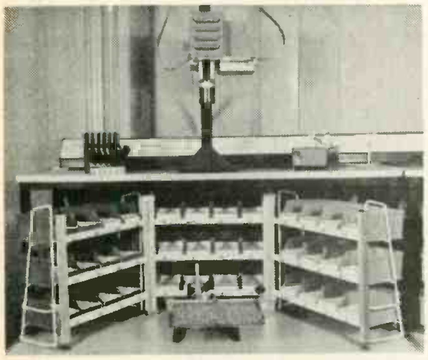
The compact Autofix 100 weighs approximately 10lb and measures 11in x 11in x $3\frac{3}{8}$in. It is fitted with a carrying handle and may be operated from 8 high power 1.5 V dry cell batteries which are housed within the unit. An adaptor is available for fitting within the case, to allow operation from 12 V or 24 V dc ship's supply.

(193)

SAVE TIME ON PC BOARD PRODUCTION

Kitmaster Sales Limited have introduced the KITMASTER, a fully programmed assembly system to simplify the production of printed circuit boards.

By means of an overhead projector, advanced by a foot pedal linked to a bin indicating panel, a continuous 35mm loop film is focussed onto the whole board area to simultaneously illuminate the position of all similar values accurately. Light bars or symbols actually link the holes into which the components are to be fitted, and the bins containing the required parts. The binning system is specifically designed for kit marshalling, to ensure the correct sequencing of components. Polarity indications can also be projected at the same time.



The system, developed over a number of years, is capable of indicating 100 component locations and can use three different display systems. The small and local beam of projected light for each compartment is comparitively bright, so that the operator can work in low ambient lighting. This reduces fatigue and so leads to greater efficiency. Complete boards can be economically manufactured in one operation, eliminating the costs associated with breaking down the assembly into simple stages.

Further details from: Kitmaster Sales Ltd Redfields Estate, Church Crookham, Aldershot, Hampshire, England.

(194)

AUTO ZERO SUPPRESSION UNIT

An effective increase of 9 times the chart width is possible when using the Watanabe Model BA115 automatic zero suppression unit. With a positive increasing signal a scale length of 50 inches can be obtained with a 10 inch chart width recorder.

The unit zero-suppresses and brings back the output signal within the measuring range when an input signal exceeds a pre-set limit. With the Model BA115 small signal variations on a large variable signal can be successfully recorded with the original sensitivity and accuracy it is claimed.

Adjustment is normally made such that when full scale deflection is reached a dc Bias is automatically switched in to bring the pen back to the zero position on the recorder. Plus 4 and minus 4 comparator levels can be utilised and indication of zero suppression is given by 8 luminous-diode lamps (± 4 steps).

The unit has a frequency response of dc-1 10kHz and can be used with potentiometric, galvanometer and moving coil recorders.

In the manual mode fixed dc suppression voltages up to ± 4 volts are obtainable.

The instrument can also be used as a highly sensitive and stable dc Amplifier with a maximum gain of 1000 and 11 switched input ranges of 1mV to 50V.

It is envisaged that the automatic zero suppression unit will find applications where it is desired to record small signal variations on a large standing signal and where large signal variations are expected. Practical applications are gas chromatography, mass spectrometer and optical density recording; measurements of small dynamic strain measurements on large dc strain variations; small temperature variations at high temperatures; small pressure variations at high pressures etc.

The Model BA115 is available in single channel, 3 channel and 6 channel configurations.

Further details from: environmental Equipments Limited, Denton Road, Wokingham, Berks.

(197)

NEW VERSION OF INFRA-RED FIRE DETECTOR

A new version of its well-proven infra-red detector, the AFA Infrascan, has been introduced by AFA-Minerva (EMI) Ltd, Twickenham, Middlesex, an EMI company, for operation on 24V battery power supplies. Previously only available as a 240V ac model the latest version of this scanning detector ensures continuous fire surveillance of automatically switching to battery supply in emergency situations.

Infrascan provides early warning of a fire by automatically detecting infra-red radiation and identifying the radiation output from flames as distinct from other sources. Mounted normally above the area of fire

risk, the detector employs a revolving scanning reflector to monitor through 360°, its line-of-sight extending 10° above the horizon of the equipment.

Further details from: EMI Electronics and Industrial Operations, Hayes, Middlesex.

(186)

VENTURE MULTIMETER CHALLENGE FROM SMITHS INDUSTRIES

With the new Venture Multimeter 3, Smiths Industries Limited, Industrial Instrument Division, is assailing a market that has been for decades dominated by one or two makers. SI believes that the long list of features designed into the new Multimeter, together with its compactness, lightness and price, will sweep it into market leadership in 1973.

First impressions of the Multimeter 3 are of a compact, easily carried, 52-range instrument cleanly designed around a single 24-position rotary switch. Sensitivity of the taut-ligament

EQUIPMENT NEWS

movement is 31.6 kohms/V for dc and 5 kohms/V for ac, with accuracies of ± 1% and ± 1.5% respectively.

A single standard 1.5 V leak-resistant NATO-approved cell energises the movement on all five resistance ranges covering 0.2 ohms to 50 Mohm.

The designers have striven for simple and unambiguous operations in order to minimise the chances of misoperation or misreading. AC and dc 10 root 10-ranged scales are identical, and are selected by push-button, as is the ohms range. With ohms selected there is only one 'ohms adjust' control for all ranges; this both simplifies and speeds resistance measurement at a single stroke. There is a welcome simplification provided on the resistance ranges for testing unidirectional components such as capacitors and diodes without the need to reverse leads or terminals: press-buttons select the polarity of test voltage, and simultaneously reverse the meter movement.

The Multimeter 3 has been designed to comply with the latest IEC recommendations. The anti-parallax clear view 110mm scale is unlikely to be obscured by leads because the input terminals are above it. The case of the instrument is of two-tone grey impact-resistant abs plastic, with a slide-away carrying handle.

The patented safety cut-out is of a type newly introduced to non-electronic multimeters with this Venture instrument. Its high-speed action (5 to 10 ms from overload to interruption) is achieved by an electrical circuit which reacts to the *rise time* of the applied signal; it does not rely on the movement of the pointer, but actually breaks the circuit before the pointer reaches full scale. It is equally sensitive in the forward or reverse direction, and the circuit cannot be reconnected while the overload condition persists.

Multimeters 1 and 4 complete the new range of Venture multimeters. Physically of the same size, weight and appearance as the Multimeter 3, the Models 1 and 4 vary only in movement sensitivity and measuring ranges.

Multimeter 1 is designed especially for electricians and power engineers. It has current ranges up to 30 A and voltage ranges selected so that common national grid supplies will give high scale readings, for maximum accuracy.

Multimeter 4 is the choice for the purely electronics engineer, with unusually high sensitivities of 100 kohm/V dc and 20 kohm/V ac.

Shunts, multipliers, current transformers and leather carrying cases are available as optional extras for all three multimeters in the new range.

Further details from: Smiths Industries Limited, Industrial Instrument Division, Waterloo Road, Cricklewood, London NW2 7UR. **(198)**

LOGIC PROBE

Logic probe type LP.500/1, now in service with the Royal Navy under NATO number 6626-99-119-2584, has been specified as standard test equipment for use with data processing equipment fitted in RN ships. Designed for testing DTL and TTL circuitry, the probe can detect seven different types of logic signal which are identified by the lighting sequence of the probe's opal lamp. The 18cm long device enables rapid functional tests to be carried out without the need for expensive test equipment such as oscilloscopes.

The probe distinguishes between logic 1, logic 0, open circuit, +ve going pulses, -ve pulses, square waves below 1MHz approx and pulse trains (including square waves) with a pulse recurrence frequency above 1MHz. It can be powered by the equipment under test, from a 4.5V battery or from a standard bench power supply. The device is provided with self-check and is protected against overload from input voltages up to ±100V and supply polarity reversal. **(100)**

FAST RESPONSE RECORDER

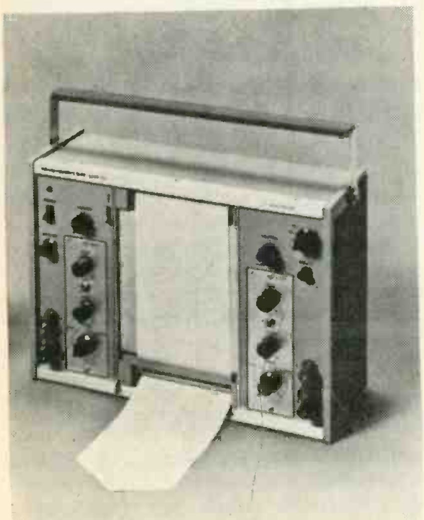
The new Watanabe Mini-writer WTR751 is a 2-channel Recorder plus Event Channel with electrically heated pen stylii giving a rectilinear trace. The frequency response is from dc to 100Hz.

Each channel has a recording width of 4cm and with the latest type of heat sensitive chart paper produces an extremely clear blue trace on a white background. Independent zero, gain, pen heat, calibration and

EQUIPMENT NEWS

range controls are available on each channel. The 15 switched input ranges give sensitivities from 2.5mV/cm to 50V/cm. The input is fully floating and has a minimum input impedance of 100kΩ. Five different gearboxes, each with 4 switched chart speeds are available, giving a total speed range from 3mm/min to 100mm/sec.

The recorder is portable, weighing only 11Kg (24lb), has a low power consumption of approximately 40 watts and can operate in the ambient temperature range –5°C to +45°C.



The Mini-writer is suitable for horizontal or vertical use and can be rack mounted.

It is envisaged that this recorder will find many applications where it is desired to record two independent variables that have fast transient responses.

Typical applications are dynamic measurements of strain, temperature, vibration and in medical research.

Single channel versions are also available with built-in rechargeable battery.

Further details from: Environmental Equipments Limited, Denton Road, Wokingham, Berks. **(203)**

PRECISION LABORATORY POWER SUPPLY

APT Electronics Ltd have just announced the production of a laboratory standard bench power supply combining the advantages of both switching ('transformerless') and linear regulation circuitry. The power supply, has been designated type SSU 10-50 and will provide a variable voltage output from 0 to 50 volts at 10 amps.

Basically the power supply uses an inverter operating at 20kHz to eliminate the heavy 50Hz mains transformer and to provide an isolated dc output for a conventional series

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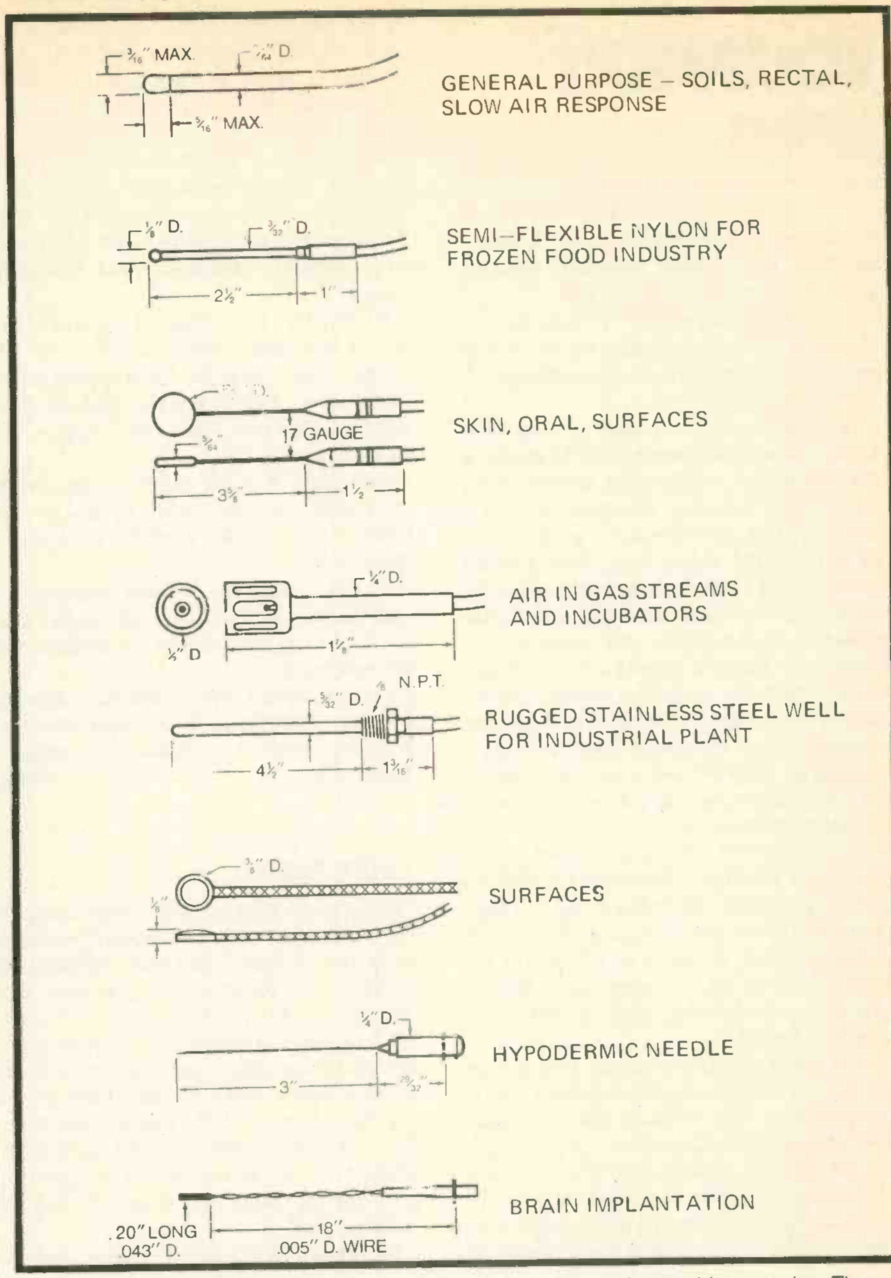
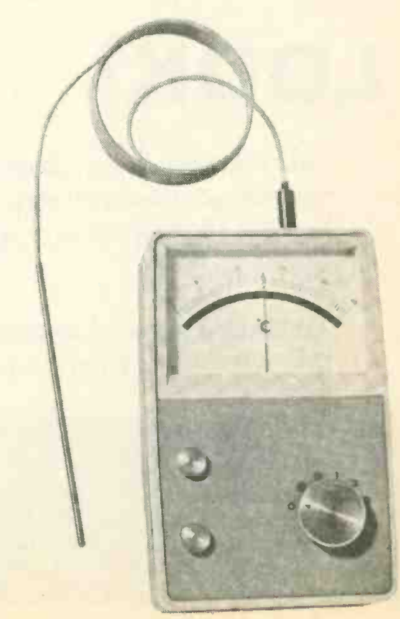


Fig. 2. Portable thermistor thermometers are now commonplace and inexpensive. The probes are available to cover most contingencies.

SEMICONDUCTOR THERMOMETERS

One of the basic shortcomings of early semiconductor devices, especially the germanium types, was their temperature dependency. The relationships between collector current, base-emitter voltage and temperature were known but it was not until 1958 that technical papers began to appear showing how to employ this defect for temperature sensing. Since then a few people have improved the technique to a point where a silicon transistor can be used to make an ultra-linear calculable thermometer for the range –50 deg.C to 100 deg.C in which the output signal is decided only by the temperature and knowledge of two basic physical constants. This method is not described in books on



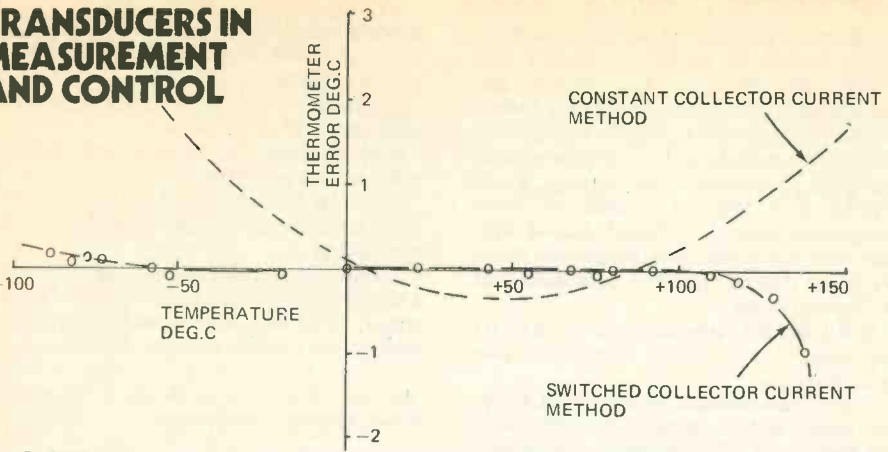


Fig. 3. Calibration curves for the transistor temperature sensor produced at the South African National Research Institute for Mathematical Sciences.

thermometry and therefore suggested reading is given at the end of this article.

If a silicon transistor is supplied with a constant collector current it can be shown theoretically that the base-emitter voltage V_{be} is proportional to the absolute temperature and is reasonably linear as shown by the curve of Figure 3. In this simple case V_{be} is not entirely independant of the transistor materials or geometry. However, if the collector current is cyclically switched between two current levels it can further be shown that the output is now extremely linear (see Figure 3 again) and independant of all parameters of the device except for the ratio of Boltzman's constant to electron-charge (two precisely known fundamental numbers in physics). Sensitivity is reduced by the switching to 0.6 mV/deg.C compared with the approximately 2.0 mV/deg.C for the basic circuit having constant collector current. Linearity falls off above 150 deg.C and below −50 deg.C due to secondary effects becoming significant. Although complete circuit designs were published in 1962 and patents taken on features of the switched current method in 1968, there has been little interest in what appears to be a most useful thermometer principle. Several integrated-circuit manufacturers incorporate transistor junctions for controlling the chip temperature or shutting down the circuit in case of overheating but they do not use the V_{be} method. Like all methods it has a disadvantage. As V_{be} is proportional to absolute temperature the device output increases with temperature; at room temperature it delivers around 600 mV. If measurement is needed to high precision, say milli-deg.C, the expensive requirement of a precision digital voltmeter resolving to five or six decades is needed unless stable means of generating an offset voltage can be provided instead. Thermocouples are similar to this — they generate the offset voltage with the reference couple that must be temperature controlled. By contrast, thermistor and resistor sensors, being passive devices, need only stable calibrated resistors (voltage supply variations are a secondary effect on precision) to make accurate measurements. So no matter which electrical method is employed, measurement precision is ultimately limited by the stability of a secondary physical component.

In the next part of this series, temperature transducers using radiation and acoustic principles will be discussed along with less common methods. ●

FURTHER READING

There are many books on thermometry; here is a selection. Few discuss thermistor or transistor methods at any depth so technical papers are also listed.

"Fundamentals of Temperature, Pressure and Flow Measurements". R.P. Benedict, Wiley, 1969.

"The Measurement of Temperature". J.A. Hall, Chapman & Hall, 1966.

"Methods of Measuring Temperature" E. Griffiths, Griffin, 1947. (This gives more detail of the older methods than modern texts).

"Measuring Temperature" L.C. Lynnworth and J.J. Benes, Machine Design. Nov. 13, 1969. 190-204. (An interesting summary of new techniques).

"Measurement Systems: Application and Design". E.O. Doeblin, McGraw-Hill, 1966.

"Precision Temperature Controlled Bath". E.C. Bell and L.N. Hulley. Proc. I.E.E., 1966, 133, 1667-77.

"p-n Junction (Transistor) as an Ultralinear Calculable Thermometer" T.C. Verster, Electronics Letters, 1968, 4, 9, 175-176.

(Continued from page 74)

linear regulator. The voltage across the series control element is measured and a feedback system incorporating a pulse width modulator varies the output of the switching regulator to limit the dissipation across the series transistor to 30W.

The technique has resulted in a 500W power supply of laboratory standard only weighing 7.5kg (16.5lb).

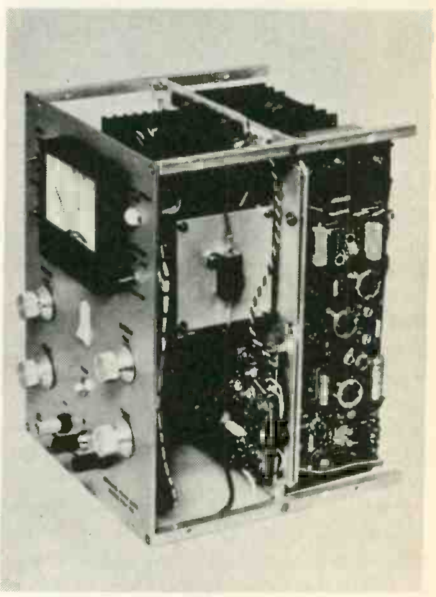
Constant voltage or constant currents within the range of the unit can be obtained, it is claimed, with setting accuracies of ±10 mV or ±5mA. In the constant voltage mode line regulation is said to be 0.001% + 1mV for a 10% load variation. Ripple and noise on the output does not exceed 5mV peak and the output spike attributable to the inverter is typically 20mV.

In the constant current mode line regulation is 0.01% + 2mA for a 10% mains variation and 0.1% + 10mA for a 10 to 100% load variation.

When used in the temperature range 0 to 40°C a temperature coefficient of 0.02%/°C is claimed. The SSU 10-50 measures 203 x 216 x 260mm (8 x 8.5 x 10.25in).

Also available is the SSU 5-50 which is similar to the 10-50 in all but output current capability. The 5-50 has a maximum output of 5 amps.

Further details from: APT Electronics Ltd, Fernbank Road, Ascot, Berks. **(185)**



NEW TAPE SPOOLER

The Systems Division of IDM Electronics has introduced a new tape spooler for use with the AR range of readers.

Available in two versions offering reading speeds of up to 30 inches per second, the AS spoolers are said to offer a complete tape handling facility for the AR readers.

The AS10 (15 inches per second reading rate) for use with the AR21.

Mr C Hutton-Penman, Sales Manager of the Division said: 'Both units continue the basic Adtrol philosophy of minimising mechanical parts to ensure the maximum reliability.

Further details from: IDM Electronics Ltd, Systems Division, Arkwright Road, Reading RG2 0LH, Berks. **(208)**

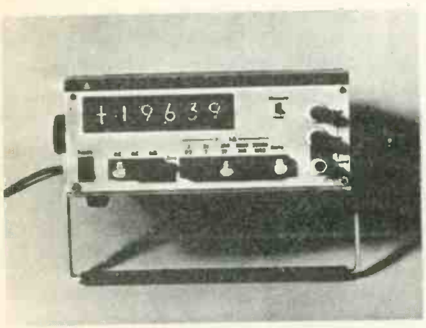
EQUIPMENT NEWS

DIGITAL VOLTMETER

Having a claimed dc voltage accuracy of 0.01% of reading ± 0.1% of full scale, the Advance DVM5 will autorange over five dc, five ac voltage ranges and five resistance ranges. Manual ranging is also provided.

The display employs five neon numerical indicators with decimal point. Polarity and over range are automatically displayed.

Ranges on ac and dc volts are 200mV, 2V, 20V and 200V and 1kV. Resistance ranges are 2kohm, 20kohm, 200kohm, 2Mohm and 20Mohm. On the voltage rnages, maximum resolution is 10μV.



The input arrangement is two terminal floating with guard terminal. Input impedance on the 200mV and 2V dc ranges is said to be greater than 1000Mohm and 10Mohm on the other ranges. A 2Mohm/50pF impedance is offered on the 100mV and 2V ac ranges and 1Mohm/25pF on the higher ranges.

Resistance measuring current is 1mA on the 2kohm range, 10μA 20kohm range, 10μA 200kohm, 1μA 1Mohm and 100nA on the 20Mohm range.

The common mode rejection of 50Hz with 1kohm unbalance is said to be greater than 130dB on the dc ranges and in excess of 110dB on the ac ranges. Series mode rejection of 50Hz on dc ranges is greater than 60dB. The unit offers fully isolated BCD options at TTL levels.

Dimensions of the DVM5 are 20.5 x 9 x 30cm. Power requirements are 100 – 125V, 45 – 65Hz, 25VA or 200 – 250V, 45 – 65Hz.

Further details from: Advance Electronics Ltd, Instrument Division, Raynham Road, Bishops Stortford, Herts. **(184)**

SUMLOCK COMPUCORP CALCULATORS

The Sumlock Compucorp 400 Series comprises a choice of desk-top programmable printing calculators of greatly enhanced power and flexibility. A choice is available from models of increasing capacity and power, in terms of data storage and programme steps. The model 425 for general scientific, engineering and surveying users progress from Model 425-11 with data stores and 512 programme steps, through Model 425-22 with 138 data stores and 1024 programme steps, and Model 425-44 with 266 data stores and 2048 programme steps, to Model 425-88 with 522 data stores and 4096 programme steps.

Model 445 for statistical application offers the same choice of data storage and programme steps.

Other characteristics include: Full 4 rule arithmetic, and a^x operates into and out of all data stores. The machines can be programmed from the keyboard, and full programme printout capability simplifies editing. Under programme control, memory and programme storage can be intermixed to obtain an ultimate of more than 1,000 data storage registers or 8,000 programme steps.

425 Models offer input/output in degree-minutes-seconds, full 4-quadrant co-ordinate conversion, radian to degree conversion statistical summation (n, x, x^2), standard deviation and mean, factorial, sum-square backout for correction of summations, degree/grad operation, and trigonometric functions.

Model 445 statistical machines contain labelled keys for single and grouped summations, standard deviation and mean, paired-data summations, linear regression and independent and dependent tests.

The user can accumulate three sets of summations at once and the machine will automatically calculate linear regression for up to 3 variables. A key permits removal of unwanted data from summations.

There are keyboard functions for chi-square statistic (observed and expected frequencies) Z-statistics, permutations and combinations, normal probability, factorial, standard deviation using the n formula, and predicted values.

Keyboard arithmetic is fully algebraic, with nesting of parentheses.

Most equations can be entered in natural order as they are written.

Keys are buffered so that the user can continue entering data while the machine is calculating.

The 400 Series machines will interface with a variety of peripherals – input/output typewriter, XY plotter, mark-sense/punched card reader, tape cassette recorder, Teletype.

Further details from: Sumlock Comptometer Limited, Anita House, Rockingham Road, Uxbridge, Middlesex. **(200)**

TUNING FORK UNIT

Adretta Ltd has now added the P.1040 Tuning Fork Unit to its existing range.

The P.1040 is a development within a similar outline of the well established P.1012 unit. The design provides a low cost stable frequency source or tuning element covering the range 200Hz to 4000Hz on fundamentals, but differs from P.1012 in utilizing improved circuits and mechanical arrangements, permitting 5V operation with lower consumption, and yielding a considerably improved temperature coefficient.

Insensitivity to supply voltage permits the use of a simple shunt regulator and ballast where higher voltage or unstabilized supplies are necessary. The special alloy steel fork is retained, together with the tough resin protected transducers and silicon semiconductor circuits.

Further details from: Adretta Limited, Station Approach, Fleet, Hants. **(183)**

Continued from page 47

TECH–TIPS

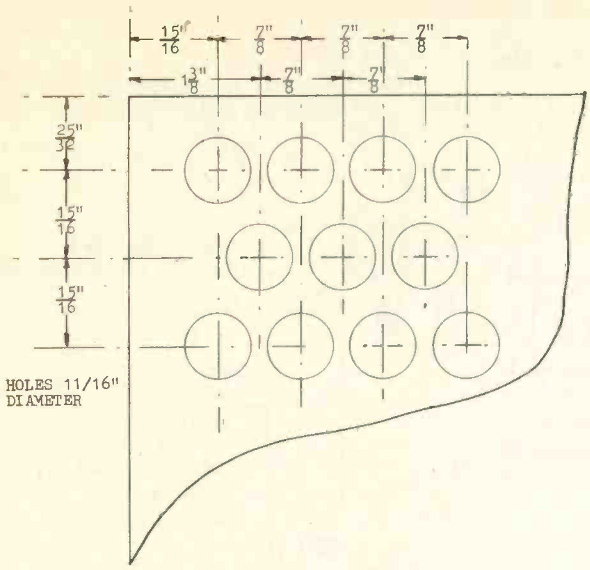


Fig. 3.

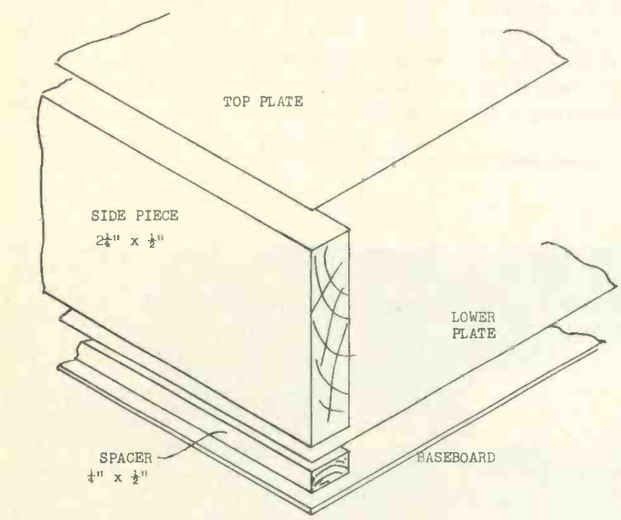


Fig. 4.

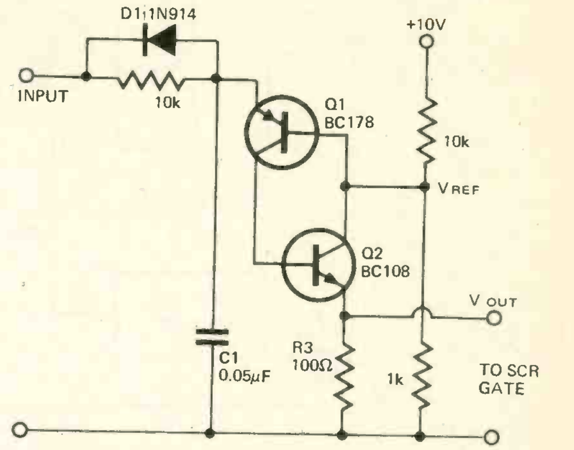
countersunk wood screws running right through the base, the spacer, and the lower plate into the side pieces. The legs may be attached and pivoted as shown.

Labelling is done by typing resistance values on a number of ¼" strips of adhesive-backed press-on paper — (Fasson or similar), and sticking them directly to the aluminium plate. Each store tube — not the lid, is labelled with the same material.

If you have real difficulty in getting pill tubes, then glass test tubes with stoppers would make a substitute — although these are rather more fragile. If you need to store larger quantities of resistors, enquire about larger pill tubes, and work it out from there.

There's a fair amount of work in punching all those holes, but the time used is saved many times over in the ready availability of resistors of all the values you'll need. ●

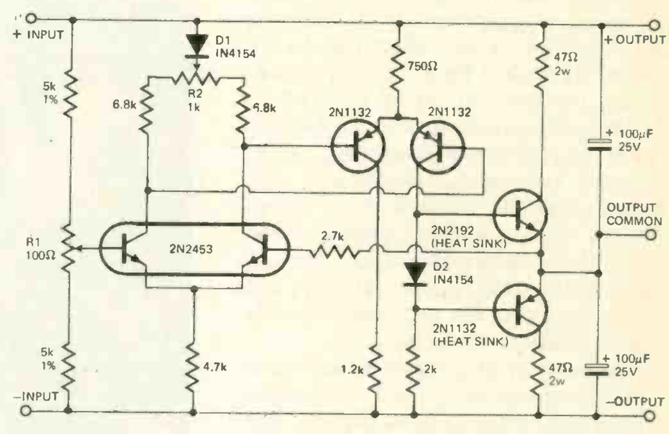
NOISE REJECTING SCR TRIGGER



When switching inductive loads, unreliable triggering is sometimes encountered due to feedback of switching transients.

The circuit shown overcomes this problem by using an integrator together with a voltage comparator to eliminate transients. Data pulses should be of 8 volt amplitude and 0.5 millisecond duration. Discrimination against noise pulses will depend on their energy content. For example a 70 volt 10 microsecond wide pulse will not cause triggering, but a 100 microsecond pulse must not exceed 20 volts amplitude.

CONVERTING SINGLE-ENDED POWER SUPPLIES TO DOUBLE ENDED



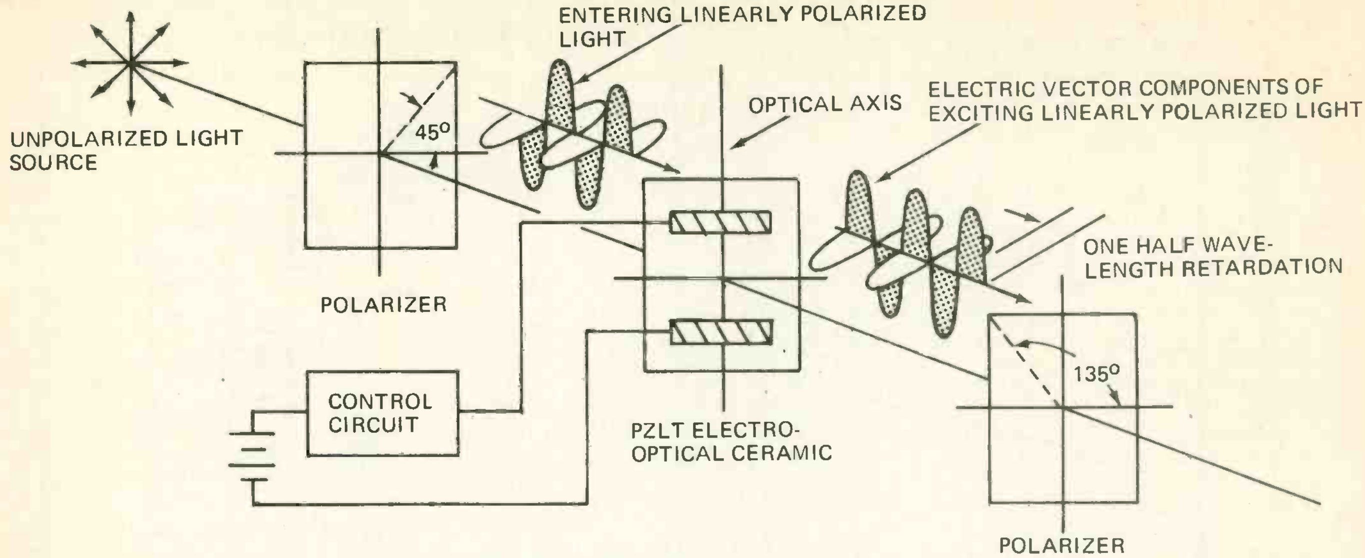
Operational amplifier circuitry requires double-ended power supplies. This simple circuit converts a conventional single ended supply to a double ended operation. Once adjusted, the positive and negative rails will track within a few millivolts without further adjustment.

The circuit will provide output voltages within the range five to 25 volts at output currents up to 100mn. The corresponding supply voltage range is 10 to 50 volts.

Potentiometer R1 is used to balance the output voltage (test by precision divider network) and potentiometer R2 is adjusted to provide best tracking.

Flash-blindness protection

Continued from page 27



Flash hazard is detected by an array of five photodiodes located between the goggle lenses. The diodes – each of which has a different angle of "visibility" – are integral parts of a discriminator circuit which senses the light-intensity threshold and switches the goggles to their opaque state. Threshold may be adjusted by changing the values of resistors in the circuit.

The electro-optic variable density optical filter upon which the goggles are based is the subject of a patent application filed by the U.S. Atomic Energy Commission in the names of C.B. McCampbell, G.H. Haertling, J.T. Cutchen and J.O. Harris. All are members of Sandia Laboratories' electro-mechanical and control component development organization. Haertling is the inventor of the basic PLZT ceramic material. (Full story on PLZT will be published in Electronics Today International in a forthcoming issue). ●

SOLID-STATE 'CRT'

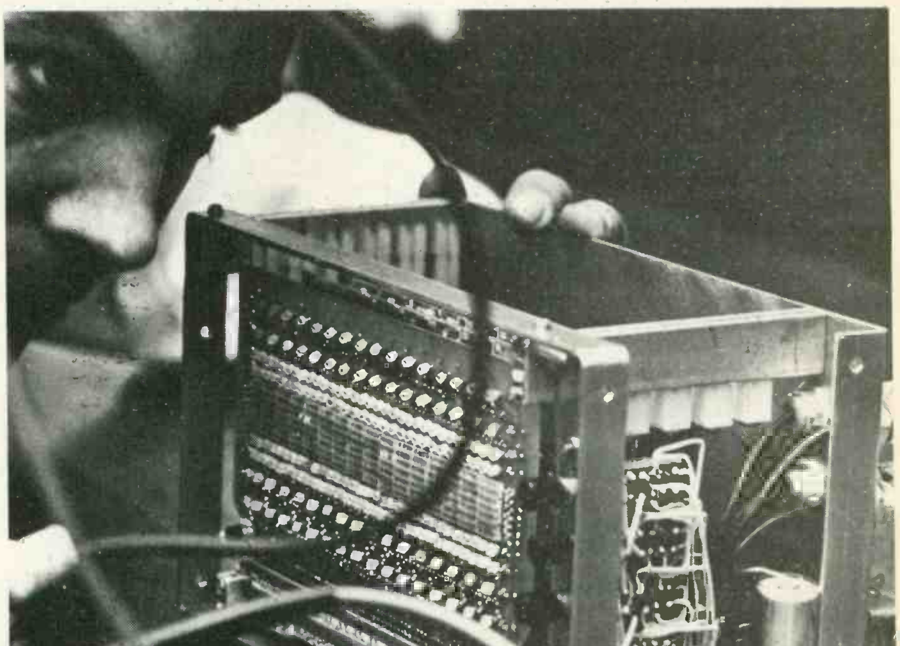
Continued from page 43

azimuth throughout the scanning pattern. The radar video signals are passed through a target extractor unit, which provides an input to a small, 512-bit central memory unit. As each radar signal enters the memory, the 'x' and 'y' position co-ordinates are stored, together with a time signal, derived from a central timing clock. This time information is used to control the effect of 'persistence', and the point at which each new signal is erased from the memory.

The memory is scanned sequentially and the stored data used to energise appropriate diodes on the display. The switching current is reduced for each successive occasion on which a particular stored position is scanned, to give the effect of a gradual decay in brightness, similar to the afterglow of a cathode ray tube.

The memory is completely scanned 400 times per second, at which rate there is no observable flicker on the display panel.

The total prototype system, including the plot extractor unit, can be accommodated in a unit measuring 10in by 5½ins, and 5ins deep. ●



The prototype unit is seen here with the front panel removed to show the light-emitting diodes.

COMPONENT NEWS

MULTIPLE HEAD LIFE

Performance data on Potter Data Products' new 'Hard Coat' digital magnetic recording heads suggests they will have a life of over ten times that of standard heads. The new dual-gap magnetic heads, which have a patented hard-wearing ceramic coating, are now fitted as standard to all tape drives supplied by Potter to customers in the UK.

Further details from: Potter Data Products Ltd, Station House, Harrow Road, Wembley. (222)

WARNING BY CYBERTONE

An electronic multi-signal acoustic warning device has been developed by A P Besson Ltd – member of the Crystalate Group.

The device – named 'Cybertone' – is intended to satisfy requirements where a range of audible warnings of different and easily distinguishable types are required.

The Cybertone is based on Besson's earlier 'Bleeptone' signaller, but allows a choice of nine completely different signals from the same unit. The sounds are all highly penetrating audio signals, each one differing in either frequency or modulation. The standard signals will penetrate even very high ambient noise conditions, although quieter versions can be specified, if required.

The unit is small (40mm x 46mm) and weighs less than 2oz, making it particularly suitable for fixed or portable applications. A P Besson state that the Cybertone is highly reliable by virtue of the fact that it has no make/break contacts. Operating voltage is 12V dc and consumption about 20mA. Temperature range is -20°C to +55°C.

Further details from: A P Besson Limited, St Joseph's Close, Hove, Sussex BN3 7EX. (224)

NEW FET OPERATIONAL AMPLIFIER

A general-purpose FET operational amplifier which features fully protected inputs and outputs and a ± 10V common mode voltage capacity - at a unit price of only £4.95, has been introduced by Ancom Limited, the analogue module specialists of Cheltenham, Glos.

The company believes that their new 15A-37 amplifier is the first to break the £5 cost barrier with a combination of performance characteristics often not available in much more expensive units.

Made conventionally from fully encapsulated discrete components, it is intended to compete favourably, against integrated circuit FET amplifiers, for those applications where physical and electrical robustness are required - notably in the educational field, but also in many industrial/medical spheres.

Particular features are the fully protected inputs, which are designed to withstand ± 18V compared to the customary ± 4 to 5V, and the ± 10V common mode which gives greater flexibility in many situations where ± 15V supply rails and ± 10V signal levels apply. In fact, the 15A-37 has a supply range from ± 9 to ± 18V, which also allows for battery operation.

Principal characteristics are said to be: bias current 50 pA; open-loop gain: 100,000; input impedance: 50,000 megohms and an offset voltage versus temperature of 50 μV per °C. Its high input impedance makes it particularly suitable as a unity gain buffer, especially in circuits where a common mode limitation might otherwise restrict use of the full output of the amplifier. Other typical suitable circuits are: sample and hold, integrators, differentiators and photo-cell pre amplifiers.

In addition to educational uses, where the protection factor against misuse is clearly an advantage, there are also many situations in physical, medical and industrial instrumentation where there is a risk of FET damage through malfunctioning of interlocking units. Ancom offer their usual applications assistance in the best use of these modules to solve customer problems.

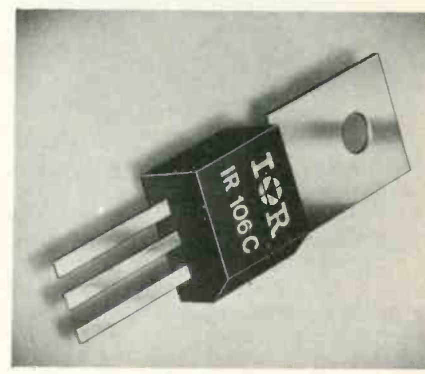
The Ancom 15A - 37 measures 1 x 1 x 0.5 ins. (25.4 x 25.4 x 12.7 mm) and being, manufactured and designed in the UK, is available on short delivery. There is a discount structure which brings the unit price down to about £4.00 for large quantities. (225)

LOW-COST LOW-POWER THYRISTOR

International Rectifier, who already offer to industry a range of Silicon Controlled Rectifiers from 1 - 550 Amperes, have announced an addition to their range of low-cost economy packaged low-power Thyristors.

Rated at 4 Amperes RMS this new plastic encapsulated Silicon Controlled Rectifier series, designated IR106, covers a V_{RRM}/V_{DRM} range of 15–400 Volts.

The device is housed in the industry standard TO-202AA package which allows for printed circuit mounting, or when high ratings are required, for the anode tab to be connected to a heat exchanger.



This new miniature low-power Thyristor manufactured using planar techniques, is intended for use in industrial and domestic applications covering heating and lighting controls, automotive appliances, power supplies, meter controls and similar applications.

Further details from: International Rectifier, Hurst Green, Oxted, Surrey. (217)

HIGH NOISE IMMUNITY INSTRUMENTATION AMPLIFIER

Ohmic's latest instrumentation amplifiers (Models HBC20, HBC20X) are designed to provide precision amplification of signals in the presence of high common mode noise.

The excellent performance specifications claimed by the manufacturer include high CMRR (100dB minimum); input impedance (300MΩ); input voltage offset drift (0.25 μV°C max for the Model X); current drift (less than 1nA/°C); linearity (±0.01%); output (10mA at ±10V, small signal frequency response of 30kHz min).

The HBC 20 and HBC 20X are gain programmable over the range of 10 to 2000 using a single resistor.

These small, rugged and fully encapsulated modules can be readily located near the signal source.

The amplifiers are said to be ideal for most

COMPONENT NEWS

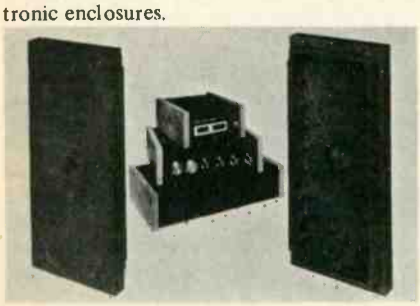
critical low level signal applications (eg bio-medical probes, strain gauges, thermocouples, pressure transducers).

Ohmic is an affiliate of Bourns and represented in the UK by Bourns (Trimpot) Limited.

Further details from: Bourns (Trimpot) Limited, Hodford House, 17/27 High Street, Hounslow, Middlesex. (219)

SIDE PANELS FOR INSTRUMENT CASES

Paramount Plastics are introducing a system of standard side panels which can be used to aid rapid and economic manufacture and assembly of instrument cases and electronic enclosures.



The side panels are designed to allow cases of any width to be built up by adding top and bottom panels and back and front plates of any design and material. Slots are incorporated on the inside of the side panels, to facilitate internal subdivision of the case in either the vertical or horizontal plane – or to allow positive location of printed circuit boards and sub frames.

Made from a special grade of Polystyrene, the side panels are produced by using a novel injection moulding technique employing a nitrogen foaming agent – resulting in a structural foam with an unusually effective wood-grain appearance. The material can be drilled, tapped and machined, and has excellent mechanical and electrical properties.

Paramount are already in full production on the first of a series of standard sizes (257 x 112mm) and are also able to economically produce special sizes and designs at their Anerley works.

Further details from: Paramount Plastic Products Limited, 5-9 Anerley Station Road, London SE20 8 NT. (218)

IRON CONSTANTAN THERMOCOUPLE CONNECTOR

Sealectro Limited announce the availability of connectors from the Fischer range, suitable for use in iron-constantan thermocouple circuits.

Utilising either ptfe for temperatures up to +210°C or ceramic insulation for temperatures up to +400°C, the new circular connectors are manufactured in two versions; one for capillary connection and one for compensating cable connection, The configurations are free plug, free socket and chassis socket.

With an overall body diameter of only 11mm the connectors also feature the exclusive Fischer latch-lock engagement said to prevent accidental separation of the connector halves when the cable is pulled. Mis-mating with consequent damage to pins and insulator is said to be eliminated by a foolproof orientation system.

Both the male pins and female sockets in the connectors are manufactured from iron and constantan to ensure error free continuity of signal.

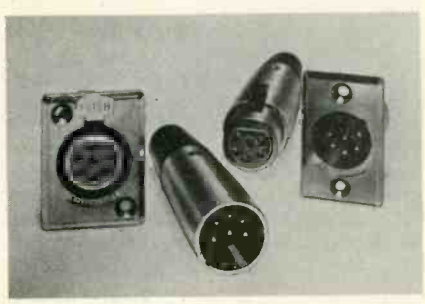
Other connectors in the Fischer range are available for chromel – alumel and copper – constantan thermocouples.

Further details from: Sealectro Limited, Walton Road, Farlington, Portsmouth, Hants. (215)

NEW AUDIO CONNECTOR

A new 6-pin addition to the Switchcraft Q – G range of audio connectors has been announced by F W O Bauch Limited of Boreham Wood.

This complements the existing 3, 4, or 5 contact range and incorporates all the now established features of the Switchcraft connector series – streamlined design, high dielectric strength, rugged construction and simple snap-in positive connection.



Fully compatible with other leading makes, the Switchcraft audio connector series is said to be particularly suited to critical applications such as microphones, amplifiers, mixers and public address equipment.

Further details from: F W O Bauch Limited, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ. (216)

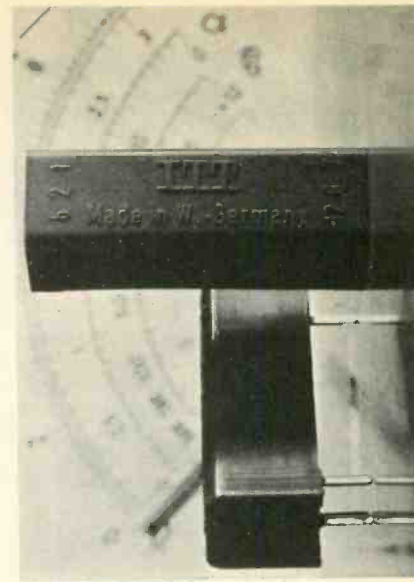
NEW ITT DRY REED RELAY

ITT Components' newly-introduced HRE 1398 dry reed relay is available in both open and potted versions with a choice of five different pin configurations suitable for a wide range of applications.

These relays have a single reed with make contact. Maximum switched power is 12VA and the relays are said to be rated at 0,5A, 220V ac/dc, the initial contact resistance being less than 150milliohm. Coils are available with nominal operating voltages of 3, 4, 5, 6, 12, 24V.

With heights of only 9,6mm (open) and 10,5mm (potted) the HRE 1398 is said to be especially suitable for direct mounting on printed-circuit boards. Also the screen design permits use on plated-through-hole pc boards.

Further details from: ITT Components Group Europe, Electromechanical Product Division, West Road, Harlow, Essex. (214)



SEVEN-SEGMENT-LATCH DECODER-DRIVER

Motorola Semiconductors have introduced a seven-segment decoder with storage capacity that will drive light emitting diodes, incandescent displays or gas discharge (Nixie) tube directly.

Normally with CMOS integrated circuits it is necessary to use additional discrete or integrated circuit transistors to perform the display driving function. The MC14511 overcomes this problem by incorporating bipolar drive transistors on the same chip as the msi CMOS Logic. The current sinking capacity of 20mA at 5V is more than adequate for a large number of displays that are currently available.

An interesting feature of the device is that the display blanking input can be used to vary the brightness of the display.

When the 'latch enable' input is 'low' a BCD input is decoded and fed to the output for display in decimal form. As the 'latch enable' goes from 'low' to 'high' the BCD input is stored in the latches and remains on the display. Under these conditions the BCD input can be changed without altering the display until the 'latch enable' input is again taken 'low'. These characteristics mean that flicker free displays can be obtained in counter/timers and in similar applications. When the MC14511 is used in multiplexed displays the 'blanking input' is used to turn the display off during digit selection.

Ripple blanking inputs and outputs are available on the chip and can be provided as an optional extra for leading zero suppression etc.

As with other Motorola CMOS devices supply voltage can be from 3 to 15V, noise immunity is said to be at least 30% of supply voltage and the operating temperature range is -55 to +125°C (AL series) or -40 to +85°C (CL series).

The MC14511 represents an important step in CMOS technology and, it is claimed, will be a key device until reliable liquid crystal displays (which will interface directly with CMOS) become available.

Further details from: Motorola Semiconductors Limited, York House, Empire Way, Wembley, Middlesex. (213)

6.3 TO 100V DC ELECTROLYTIC CAPACITORS

Jermyn Distribution have now extended their comprehensive selection of electrolytic capacitors held in stock with the introduction of Siemens' B 41070 series. The new range comprises 28 different types, operating at seven rated voltages between 6.3 and 100V dc.

Their performance characteristics are said to be unusually good for electrolytic capacitors in that they perform in accordance with both DIN 40040 climatic category GPF (-40 to +85°C, humidity category F) and DIN 41332 (type 11A).

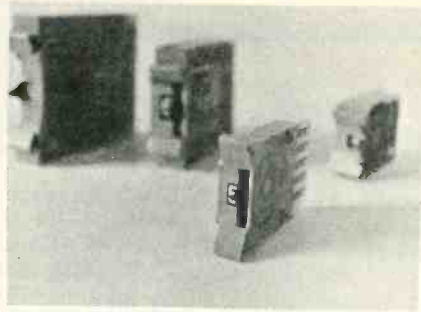
All units in the range are housed in cylindrical aluminium cans with both poles being brought out to solder tags and the negative pole common to the can. Physically they are smaller than one might expect – for example, the largest capacitor in the series (a 47mF device with a 10V working voltage) measure only 40mm in diameter by 100mm long.

Further details from: Jermyn Distribution, Vestry Estate, Sevenoaks, Kent. **(210)**

NEW THUMBWHEEL SWITCHES

Two new additions to their range of SM sub-miniature thumbwheel switches have been announced by Birch-Stolec Limited, Hastings. The first being a two pole ten position changeover type with decimal read out and the second a '1248 Complements' switch.

Both new types have the same overall dimension and mecanical mounting detail as earlier SM switches, overall height and

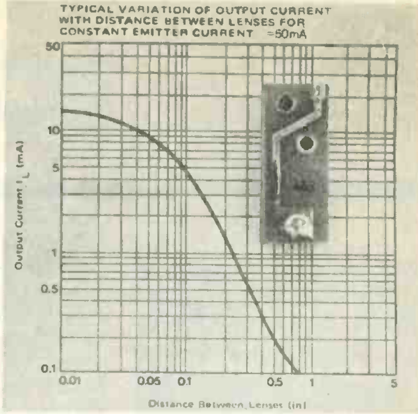


width being 33.02mm and 7.92mm respectively, with a figure height of 47.57mm. A wide range of special features are available, including extended printed circuit boards to allow additional circuit components to be added, if required. Life expectancy is given as 1,000,000 operations and prices range from £o.65 each for 100+ quantities of the Single pole decimal read out type.

Further details from: Birch-Stolic Limited, Ponswood Industrial Estate, Hastings, Sussex. **(212)**

OPTIC MODULES

Type SDA20/2 optically coupled modules are readily-mounted cards containing a silicon light sensor and a spectrally matched gallium-arsenide light source, suitable for a wide range of engineering applicaitons such as position indication, pulse transmission and replacing mechanical switches. Main features are high speed, direct TTL standard and TTL low power compatibility, high reliability and



a narrow coupling beam. Electrical characteristics (at 25°C) include a maximum leakage current of 100nA, a maximum static forward voltage of 1.5V, a maximum collector/emitter saturation voltage of 0.75V and a minimum ouput current of 2.0mA. **(78)**

WIDEBAND DETECTOR

A wideband detector, 100MHz, was developed by the Spinner Company of Munich, West Germany specially for test purposes.

It is said to combine a nearly linear characteristic of output voltage with high sensitivity and thus represents an indispensable auxiliary test apparatus, specially for wobble operation. Selected pairs can also be supplied.

Claimed frequency response of the output voltage:

100MHz – 10.5GHz ± 0.25dB overall
10.5GHz ± 15GHz + 0.25dB
15GHz – 18GHz + 0.6dB

Further details from: Hayden Laboratories Ltd, Hayden House, 17 Chesham Road Amersham, Bucks.

Chromium Dioxide Tape

(Continued from page 61)

will not show the usual end groove distortion, record clicks and other surface noises.

CHROMIUM DIOXIDE AND REEL-TO-REEL RECORDERS

Figure 3 has shown clearly that the main advantage of chromium dioxide tape is produced at high and very high frequencies. That is why it is so effective at low cassette tape speeds.

Most reel-to-reel recorders are designed in such a way that they produce good sound quality at high tape speeds, e.g., 7½ and 3¾ ips. At such speeds the difference between chromium dioxide tape and conventional tape, is negligible. Even at 3¾ ips the advantage is still relatively small, especially taking to account the recorder circuitry switching necessary to utilise this advantage; and the higher costs of chromium dioxide tapes.

Only in professional audio applications will it be worth using chromium dioxide tapes at 3¾ ips because there it is still possible to choose optimum working conditions.

CHROMIUM DIOXIDE TAPE IN MUSICASSETTES

There are no technical objections at all against the use of chromium dioxide tape for musicassettes. All differences in recording properties can be easily taken care of during the duplicating process. It is also easy for musicassette manufacturers to follow any future change in replay characteristic of the cassette recorders and reproducers.

As it is, musicassettes with chromium dioxide tape will give an immediate quality improvement, at least in brilliance and thanks to the higher recording level which can be utilised, also in dyanamic range. On "Dolbyised" musicassettes (as produced for instance by Decca), chromium dioxide will be an excellent combination.

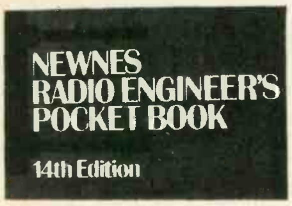
Chromium dioxide magnetic tape is of great importance if we are to obtain good sound quality within the compact cassette system.

On recorders with optimised adjustments hi-fi quality can be obtained. On most conventional cassette recorders a significant increase and improvement in high frequency reproduction will be apparent, though there might be erasure problems. Musicassettes will show an immediate improvement in brilliance and dynamic range.

Chromium dioxide tape is especially effective on recorders having electronic noise suppression, because LP record quality and brilliance can be obtained in loud music having a strong high frequency content. ●

BOOK REVIEWS

REVIEWER Brian Chapman



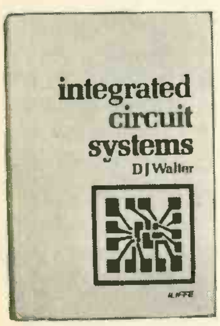
NEWNES RADIO ENGINEERS POCKET BOOK. Revised by H.W. Moorshead. Published 1972 by Butterworth and Co. Hard covers, 188 pages 4¾" x 3". Review copy supplied by Butterworths. Price £1.20

This little pocket-book is a valuable compendium of radio facts, figures and formulae, which are indispensible to the designer, student or electronic hobbyist.

The new edition has been completely revised, a lot of obsolete information deleted, and much new material added.

Everything necessary is included, from wire tables to mathematical tables, television radio and time standards, network theorems etc. etc.

If you are forever trying to find the right tapping drill, what gauge wire to use, or, what was that transformation theorem? – this little book is for you. – B.C.



INTEGRATED CIRCUIT SYSTEMS by D.J. Walter. Published by Iliffe Books London 1971. Hard covers, 228 pages 8½" x 5½". Review copy supplied by Butterworths Pty. Ltd. Price £3.50

No one in electronics can now be unaware of the impact of integrated circuitry on modern technology. Indeed, IC useage in professional equipment is probably rivalling, on a component count basis, that of discrete transistors.

This book is aimed at the practising engineer and students in the last years of degree or diploma courses. It is assumed that the reader has a knowledge of transistor circuitry, Boolean algebra and binary counting. The level of the book is adequate to achieve understanding of simple digital systems such as desk calculators and digital voltmeters.

The first chapter deals with basic forms of integrated circuits and then deals with factors affecting reliability, and the calculation of system reliability. This chapter gives a clear and concise treatment of a subject which is too often neglected in most textbooks.

Manufacturing processes are then discussed, epitaxial and thin and thick film included. The discussion includes brief details and formulae for component design within the various methods and I found it very interesting reading. This contrasts with the more pretentious texts which invariably make this subject very dull.

Chapter 3 describes the various basic logic gates and uses these as a basis for expounding the manipulative rules of Boolean algebra. This is followed by a chapter on flip-flops, counters and registers, and then another on arithmetic, error-correction and codes.

The last three chapters deal with MOS logic systems, IC operational amplifiers and D to A, A to D converters in that order. In all, the book is clearly written and conveys the information in a manner which makes for interesting reading. I would like to see an expanded version of this text covering much greater territory, as it is, it needs supplementing with other texts to provide a well rounded education in integrated circuit technology. But it is thoroughly recommended. – B.C.

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 6½ x 9½, soft covers. Review copy supplied by the League.

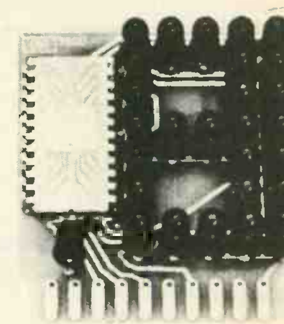
The following comment by the American Radio Relay League, Inc came with the review copy and we can only agree with the statements therein.

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 all-time 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 '72 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. – B.C.

LARGE-SCALE LED DISPLAY



Using discrete solid-state light emitting diodes, this new display from Hewlett Packard is readable up to 60ft away.

The diodes are arranged in a 5 x 7 matrix – character height is 1½".

Because the discrete diodes are mounted in a single plane, the display can be viewed far off axis. Average brightness per digit is typically 1.25 millicandelas. Brightness can be varied.

Decoder/driver circuitry, on board with the display, allows direct addressing using standard BCD code (8421 positive logic input). The displays require only a 5 volt supply, thus are DTL-TTL compatible.

They are suited to any application where the displays must be read at a distance. These include process and supervisory control panels, medical equipment, and data displays. Type number of the displays is HP Model 5082-7500.

RECORDINGS... CLASSICAL

REVIEWERS: Tanya Buchdahl
John Araneta, C.M. Wagstaff.

MOZART: Missa Brevis in C, K.257 ('Credo'); Mass in C, K.317 ('Coronation'). Helen Donath, Gillian Knight, Ryland Davies, Clifford Grant, Stafford Dean; John Alldis Choir, L.S.O./Colin Davis. Philips SAL 6500-234 ($6.20).

Another to join the recent crop of quality choral performances – this one exudes enthusiasm from beginning to end, something which is absolutely necessary for Mozart's masses. The joyousness in them was counter to the customary idea of solemnity and proper reverence in liturgical music, to the point of profanity, but the simple faith in God shines through without question.

The 'Credo' Mass (so called because of the peculiar four-note cry "Credo!") is very early, but from the very first "eleison" is unquestionably Mozartean. Unlike much of his later choral work it is almost anti-coloratura, but it has a definite unity in themes which are short, blunt, but punch home the point. The 'Coronation' is a considerable development on this stage. To begin with, there is less awkwardness in fitting the words to the music, more thematic variety, more drama. An interesting comparison, particularly on this last point, is afforded by a Turn-about recording by the Vienna Pro Musica and Oratoria Choir conducted by Jascha Horenstein. In short, the Horenstein pays less attention to detail than the Davis (now that we are in a period of musical purism) but is perhaps a little tighter; conversely, the Davis has the great advantage of making the words distinct. It also managed the crossovers between the Osanna and Benedictus which can be outright clumsy. The soloists in the Davis are a little far from the microphones to have a chance, probably the only recording deficiency on the record, but the echo (presumably recorded in a church) at the end of each movement is magnificent – the Horenstein has unfortunately had all the sections spliced to such an extent that it sounds as if it had been recorded in a shoebox.

Helen Donath suffers by comparison with the wonderful Wilma Lipp. I am thinking in particular of the thunderous climax to the entry "Et in spiritum sanctum Dominum" which just doesn't come off (partly due also to distance from the microphone. But she sings the pseudo-aria 'Agnus Dei' with such loving care that I suspect she is more at home with Lieder than oratorio.

The nicest thing about this recording is its consideration for Mozartean colouring and balance which is often carried to excess in pussyfooting delicacy, though all but abandoned in his (non-operatic) choral works. It may have something to do with the large number of Late Romantic editions in use; but it is good to see the Mozartean essence here. Thoroughly recommended. T.B.

1. MOZART: Symphonies Nos. 34 (Haffner) and 40; March K.408/2.
2. HAYDN: Symphonies Nos. 52 and 53 (L'Imperiale).
3. BEETHOVEN: Symphonies Nos. 1 and 2.
4. J.C. BACH: Six Symphonies Op.3. Academy of St. Martin-in-the-Fields/Neville Marriner. Philips Stereo, 1; 6500-162. 2; 6500-114. 3; 6500-113. 4; 6500-15.

In the set form in which these four records were originally issued as "The Rise of the Symphony", there was the disadvantage of possibly obtaining multiple copies of one or more of the works (not to mention the slightly odd choice of title for such a limited number of selections). Though still available in the set, it is a stroke of good common-sense to issue them separately.

The Academy's crisp and exact sound is ideal for all four composers who span the Classical period. It is heartening to see a recording of the insufficiently recorded works of 'the English Bach', and a little curious to hear the more common first two Beethoven symphonies played as they should be; that is, with a chamber rather than a full-size orchestra which also bears in mind that these works are not at the beginning of the Romantic style but still very much in the Classical tradition of Haydn and Mozart (the Academy uses First-or Urtext editions).

The sprightly happiness which makes the two middle-Haydn works such a success does not, unfortunately, work as well in the Mozart No.40, which stands in relation to No. 41 as Beethoven's 4th Piano Concerto stands in relation to the 5th, or as 4th Century Greek sculpture stands to Hellenism. Whereas the latter in each pair has qualities of the superartist, shown for instance in high drama and which earns it descriptions like 'Olympian' (note the nicknames "Jupiter" and "Emperor" for No.40 and the 5th, respectively), the former in each pair reaches the supreme balance of reason in its particular art form or style. There is a certain tendency to comfortableness, bordering sometimes on complacency, in this performance (but not in the "Haffner", which is quite exquisite and some of the best Mozart playing available) which cannot in any circumstances supplant the gentleness of reasoned experience.

Dwelling on the deficiencies of this one side should not however detract from the rest; the cover notes are better than most, the production is excellent, and the records are to be thoroughly recommended. – T.B.

HANDEL – Oboe Concerti; Concerto grosso, Op.3/3; Sonata a 5 in B-flat. Heinz Holliger (oboe), Kenneth Sillito (violin) English Chamber Orchestra, Raymond Leppard (cond.) PHILIPS SAL 6500 240.

With at least three other fine recordings of the oboe concerti already available and more important Handel otherwise unavailable, I must consider this disc a rather useless bit of duplication. Holliger, not surprisingly, elicits very lovely sounds from his instrument. Unfortunately, the tempos and phrasing are strangely languorous, very slow, and definitely non-baroque. Grave is surely not just an adagio, yet Leppard's distinction between movements can hardly be called marked. Where are the accents, the dotted rhythms so characteristic of Handel's music? All in all, I do not find much consideration for proper performance practices here. Presumably, Leppard plays continuo but his harpsichord is rather faint sounding and in any case the playing lacks interesting invention and does not help to accentuate rhythms at all.

There are certainly other recordings of this music preferable to this one: the Goossens-Menuhin performance on HMV ASD-500, the ARCHIVE recording (SAPM 2533 079) using original instruments, and my own particular favorite, the Lord-Marriner performance on ARGO ZRG-5442. Compare the present recording with Marriner's if only to confirm how important dotted rhythms are for this music. The Concerto grosso here is also rhythmically slack and embellishments sound as if they were tacked onto the music for their own sake. Once again how much more preferable it is to hear Marriner's reading on ARGO ZRG-5400 with its sense of stylish elegance and strong grace.

The inclusion of the Sonata a 5 is interesting since it contains material from the second oboe concerto. Sillito's violin playing is very fine but his style and the general atmosphere of the playing is certainly more suited to Bruch than Handel, and that elaboration of the solo in the adagio is simply overblown and tasteless. Definitely alla Giazotto.

Recording is good with the exception of that faint sounding harpsichord but a more judicious spacing would have given us the G minor concerto complete on one side. J.A.A.

COLOUR TV GOES DIGITAL

(Continued from page 49)

of four, and each group of modules stores 21 lines of picture information, using a total of 96 shift registers each of 1024 bit capacity. The out-going line-time is very nearly the same as the incoming line-time, and the rate is now 10.8 megawords a second. However, because of the difference in field rate required, there are at this stage some line gaps so that 21 lines occupy the time required for 25.

THE SPATIAL FILTERS

The signal from each field store then goes to a spatial filter, which has three functions. Firstly, it modifies the output signal in such a way as to cancel out the effects of interlace between sequential incoming fields. Secondly, it separates the luminance and the chrominance components of the signal without any loss of either vertical or horizontal resolution – at any rate for still pictures. Thirdly, it produces from the chrominance signal obtained, I and Q components. The output signal from the spatial filters consists then of three separate parts; a train of luminance signal values 'Y'; a train of chrominance signal components 'I'; and a train of chrominance signal components 'Q'. These three trains of pulses are interleaved in the time multiplexer. Because the I and the Q signals are of narrower bandwidth than the luminance signal, a slower sampling rate is sufficient and the time multiplexer produces a sequence of output signal pulses in the form of Y, I, Y, Q, Y; Y, I, Y, Q, Y,...... The data rate at this point is approximately 10 megawords per second.

As shown in the block diagram, the spatial filters, which are arranged as complementary pairs, are fed in turn from the field stores A and B. In the spatial filters, separate matrices are used to generate the luminance and the chrominance signal. The matrices examine at one time a series of 15 sampling points arranged as five points in three sequential lines. Appropriate proportions of the signals at each of these 15 points are taken to produce either a luminance signal without a chrominance component or a chrominance signal without a luminance component. The chrominance signal is separately demodulated to produce the I and Q components.

The movement interpolator takes proportions of each of the multiplexed signals and for every six incoming fields produces the appropriate five outgoing fields. The ratio of the two standards is not precisely 5/6 and the actual operation is somewhat more complex. At the output of this movement interpolator the signal consists of 525 lines of picture, but running at the 50 field rate.

THE LINE INTERPOLATOR

The function of the line interpolator is to generate from these 525 lines, a sequence of 625 lines each with the information appropriate to its position in the picture. This, of course, fills in the line gaps mentioned above.

An interpolation process is again used. The picture points in each out-going line being produced by selecting appropriate proportions of the corresponding signal points from three incoming lines.

The time demultiplexer separates the luminance pulses from the I and the Q information and each is separately converted back from the digital to the analog form. The three signals obtained are then matrixed to produce standard R, G, B, signals and the composite colour signal is finally obtained using a standard colour coder, either a PAL coder or a SECAM coder.

SYNCHRONISATION

As was mentioned above, the reading rate for the field stores depend directly on the outgoing line frequently required. The converter is designed to be locked by station synchronising signals in the same way as a camera or any other picture source.

Having described how the machine works you may well ask – is it worth all the trouble? The answer is definitely yes. At a demonstration in the IBA studios, two colour receivers were operated side by side. One receiver was operating on 525/60 and the other on the reconstituted 625/50 from the standards converter.

One member of the audience asked how it was that the reconstituted signal appeared *better* than the original. The answer of course is that the digital technique is so flawless, that the improvement due to PAL encoding vice NTSC was plainly visible.

The test material was a film sequence independently produced by a firm who knows all the failings of standards converters, and who had been charged to make the film as difficult as possible. Fast pans, black/white edges etc were extensively used and the only failing visible was on sharp, bright, almost horizontal moving edges, where some break up was noticed. This was very minor however and the new converter must considerably advance the standard of international television.●

Owing to lack of space we have held over 'Solve a Problem' until the next issue

NEW LITERATURE

● 'Your connectors are only a phone call away' is the title of a new 8 page concertina folder issued by Intel Connectors Limited, one of the leading connector distributors.

Intel Connectors Limited, Henlow Trading Estate, Henlow, Bedfordshire.

● A comprehensive 1,538 page Semiconductor Data Handbook published by General Electric is available from Jermyn Distribution. The handbook is a mine of useful information containing data sheets, circuits, application tips and hints, equivalent and device selector guides and indexes to application notes and technical publications. The handbook covers the full range of semiconductor devices manufactured by the General Electric Company. The semiconductor Data Handbook can be obtained from Jermyn Distribution, Vestry Estate, Sevenoaks, Kent, price £2.30 including postage and packing.

● A new series of Data Sheets, Nos. 150, 151 and 152 has been published by Alkaline Batteries Limited to provide essential information about the physical and performance characteristics of the extended range of ALCAD nickel cadmium batteries introduced earlier this year.

Alkaline Batteries Limited, Power Sources Division, PO Box 4, Union Street, Redditch, Worcestershire.

● The continuing demand for the Mullard book, 'Transistor Audio and Radio Circuits' has made a second edition necessary. This edition incorporates many new circuits that take advantage of developments which have occurred since the first edition was published in 1969. The book, which comprises ten chapters and nearly 300 pages, is in A5 size, clothbound, and available (price £1.80) from booksellers and certain radio and television dealers.

● The British Standards Institution has published three new standards in the Data Processing field. They are BS4822 – Key board arrangements for data processing, £1.25 and BS4810 – Magnetic ink character recognition. Part one £1.25, and Part two £1.90. BSI Sales Branch, 101 Pentonville Road, London, N1 9ND.

● A new applications handbook for users of the H100 series of high level logic devices is available from SGS/ATES. The handbook provides about fifty applications in digital, computing, waveform shaping, pulse and interface circuitry. SGS (United Kingdom) Ltd, Planar House, Walton Street, Aylesbury Bucks.

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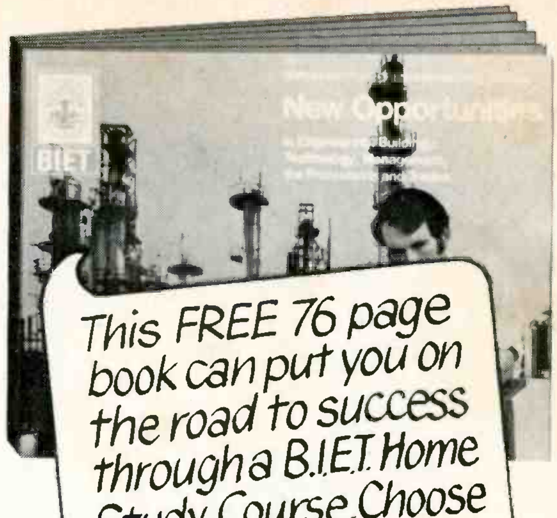

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