electronics TODAY INTERNATIONAL

MARCH 1973 Vol 2 No 3

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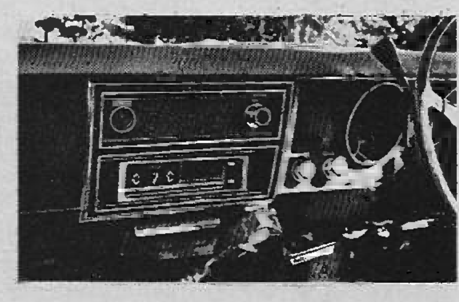
COVER: Ceramic work of art, entitled 'Donor', by Sylvia Halpern – reproduced by kind permission of Fairchild.



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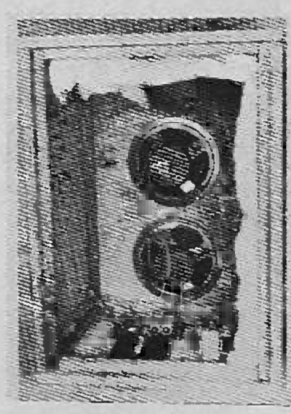

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Owing to lack of space, Recordings reviews, Tech Tips and Solve A Problem could not be published this month.

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filling the gap

Electronics is no longer a somewhat esoteric technology that hardly touches the everyday life of the proverbial man-in-the-street. Gone forever are the days when it was, almost exclusively, about active devices such as thermionic valves in which the flow of electrons was controlled by electrical signals to perform relatively simple functions such as rectification and amplification.

A more accurate definition, which also describes the role of electronics in the '70s, is 'Engineering of Information' in all its diverse aspects — generation, transmission, storage, recovery and processing of data in some form or other. This is why electronic engineers are today equally at home in most other forms of specialised engineering or other activities, and why most such activities can — and do — benefit from the use and application of electronics.

Keeping oneself informed about this gigantic role thrust upon electronics is not easy. At one extreme there are specialist journals serving one (at most, a few) of its many facets — such as circuit design, components, instrumentation, production etc. At the other extreme are the hobby periodicals which, at their best, can do no more than touch briefly upon the most readily appreciated usages of electronics. Between the two, the average reader has the Hobson's choice of knowing more and more about less and less (till he knows too much about too little), or less and less about more and more (till he knows too little about anything).

As our readers have already appreciated, ELECTRONICS TODAY INTERNATIONAL fills precisely this gap between the two extremes. Our policy — now justified by its truly international success in three countries (Great Britain, France and Australia) — is two-fold:

1) to serve a wide range of readers from every profession, vocation and hobby — and at all levels from the novice to the professional, from the schoolboy to the elder citizen, from the apprentice to the engineer; and

2) to keep them informed of the way in which electronics has permeated their everyday life, professions or vocations, does so at present, and will continue to do so in the exciting future that lies ahead.

news digest

GPO NEWS

● DECISION TIME

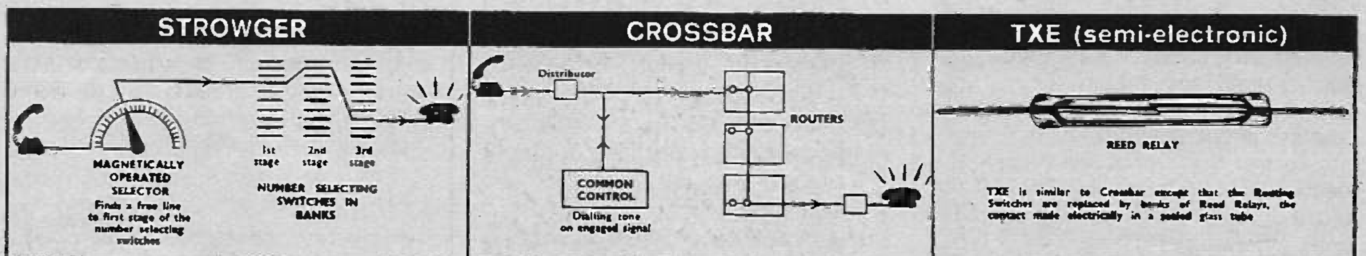
By the time this issue is printed, Sir John Eden, Minister of Post and Telecommunication, may well have given his seal of approval for the Post Office's plan to invest £4000 million over the next five years, about a third of which will be spent on telephone exchanges. There is currently much controversy — and some bitterness among leading PO equipment suppliers — about the type of exchange equipment and the sort of technology that the PO envisages for the future. This magazine does not intend to enter this controversy but some background information may not be amiss.

widely established in Europe and USA. It is interesting to note here that the few Crossbar exchanges in UK are largely the result of a desperate step-back by the PO in the early '60s after the fatal electronic convulsions at Highgate Wood Exchange put an end to its high hopes for (and 10-plus years work on) an electronically controlled exchange, and that the potential high-speed of Crossbar is not fully utilised when working with the slow-speed British dialling system.

It is said that the PO has decided to plumb for the TXE4 exchange (the first one is not due to go into service till 1975) which uses reed switches and so demands less

development engineers and those involved in developing new and ingenious electronic devices. One would have thought there was not much difference between the two technologies but the research personnel obviously do not share this view and have kept themselves apart.

Among problems requiring Dr White's solutions will be how to combine the new video imaging techniques (example, see February '73 issue) with the advances in microminiature technology to fit tomorrow's needs for video-telephones and facsimile systems — and, naturally, the ever-elusive all-electronic computer-controlled 'System X' exchange, of course.



More than 90% of UK's 6000-odd exchanges still use the traditional Strowger system and/or the uni-selector variations of it. It is robust and reliable and is based on a sequential selection principle using electromagnetic techniques; the connections between caller and receiver are made via a series of stages and the equipment in a moderate-sized exchange consists of thousands of electrical contacts requiring regular adjustment and maintenance. It is also slow and expensive in the long run.

The Crossbar system although technically not much of a leap forward from the Strowger, operates virtually in a matrix fashion, the input line being connected to the equivalent of a vertical matrix and the output line being selected on the horizontal matrix. It still uses electromagnetically actuated contacts but it is simpler, has a greater call-handling potential and has the advantage that additional lines can be added without disrupting the existing installation. Crossbar is

space and little maintenance. It has limited export prospects for the PO suppliers and, because it is still electromagnetic, is severely derided as 'old hat' by some opponents who would rather see the PO plan for the future with a truly electronic exchange. However the PO is apparently not yet fully recovered from the burns received at Highgate Wood, and the expensively acquired caution of USA's Bell Telephone after some still sticky problems with its launch into computerised exchanges has not helped.

● ONE-MAN DIVISION

In its research laboratories, the PO has created a new division for its sole occupant Dr Gerard White. Apparently this was the only way Dr White could be tempted back from Bell Laboratories. His responsibility is understood to be to bridge the gulf (apparently a gulf does exist!) between the telecommunication system

'QUICK CASH' — A WORLD FIRST

Lloyds Bank customers are being provided with a unique new 'quick cash' service — a computerised cash dispenser, the first of its kind in Britain and the first to be linked direct to a computerised branch banking network anywhere in the world. The Lloyds Cashpoint dispenser, unlike other existing machines, can issue variable amounts of cash and will be available to all customers provided they have enough funds.

As it is linked direct to the bank's centralised computer system (see feature on page 14), it will automatically update each transaction in a real-time data processing operation with a time scale of under 40 seconds for a single valid transaction.

Lloyds began working on the Cashpoint concept three years ago and was unhappy with the first generation of cash dispensers. Ideally, Lloyds were looking for a real-time computer operation which could be linked to its centralised branch accounting system through its network of on-line branch terminals which today is the largest in the country. Following discussions with system manufacturers and studies of various systems, Lloyds finally decided to develop its specification in conjunction with IBM(UK) who have since been responsible for the development of the Cashpoint hardware and software while Lloyds have developed the technique for integrating the system into its computer operations. **(226)**

RESEARCH FOR PROFIT

While everyone is aware of Harwell's nuclear research activities, not everyone may be aware of the fact that it has, since the mid-1960s, been engaged in an active policy of selling its non-nuclear research activities to industry, including some of the biggest spenders in Britain. This contract research business is already expected to earn about £4 million for Harwell in '72-'73 and a large proportion of the research effort sold goes to quite diverse industries such as motoring, food processing, sea transport, instrumentation etc. In proving that Harwell could earn a substantial part of its keep in the open market, in the non-nuclear field, it has had some spectacular customers such as BLMC in its £300 000 worth of research and development of a rotating heat exchanger of a new ceramic, silicon nitride, for gas turbines in heavy-duty trucks.

In the last few years, Harwell has evolved a three-way research service approach. The first makes use of its special research facilities, such as selling neutrons by making its reactors available to outside scientists for research purposes. The second is specific contract research for a single customer, such as developing a new microwave spectrometer analyser for Cambridge Instruments or writing computer programs to optimise bulk carrier scheduling, investigate new business possibilities and forecast trading results for the Seabridge Shipping company. The third is participating in the financial risk of exploiting products, techniques or processes, such as investing £150 000 with two commercial firms in the application of vibro-compaction, a method of making refractory bricks for lining steel furnaces such that uniform properties can be obtained in a large variety of shapes and sizes.

CAR SAFETY

Simpler than anything so far devised and proved to have been more effective in field trials than more complex systems in preventing 'drunken' drivers from even starting to drive cars is an experimental system from General Motors engineering staff in USA. The idea seems to have been derived from aircrew testing methods and the equipment is said to use existing fitments on the car to carry out the 'test' which consists of controlling the movement of the car's own steering wheel on an instrument panel satisfactorily so that the necessary interlocks can be completed and the driver is permitted to insert the ignition key and start the car.

The only 'catch' in the system, insofar as the British car-user is concerned, seems to be that the law in UK, as it stands, renders the driver guilty if he has more than a specified amount of alcohol in his body, irrespective of whether he can concentrate sufficiently to pass this test (and presumably be deemed safe to drive the car) with that much alcohol in his bloodstream.

LNG STUDIES

Consumption of fossil fuels, of which petroleum products are derivatives, at the present rate may well deplete the earth's natural resources and create a serious energy crisis by the mid '80s. In some energy conservation circles, scientists are convinced that the logical and practical answer is to exploit and develop an extra-abundant energy source such as hydrogen which can be generated by processing the equally abundant sea-water and which, on combustion, returns water to the environment. They foresee huge generating stations on the seas, supplying the gas through pipelines and tankers; hydrogen can also be transported in the liquefied state by cooling it to −423°F when it also needs only one-eight-hundredth of the gaseous-state transport capacity.

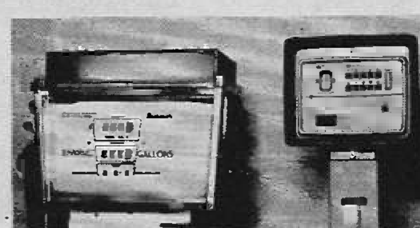
Now, with its experience in the Apollo space programme to help it, Beech Aircraft Corporation (Witchita, Kansas, USA) plan to invest considerable funds in a development programme to demonstrate the feasibility of liquefied natural gas (LNG) as a fuel for automobile, truck and bus vehicles. Prototype container systems and installations on test vehicles for environmental testing by Govt agencies and fleet operators is the first stage of the programme. Knowledge and experience gained in working with LNG is expected to give the company an immense advantage when hydrogen or any other natural gas becomes the established and available fuel. Tests have shown that exhaust emissions from hydrogen fuel have been cleaner than present-day city air and it will not be long before environmental standards will require the use of such fuels. **(227)**

'MONEY CARD' FUEL PUMPS

An entirely new electronic payment system called 'Money Card' offered by Automated Fuel Dispensing Ltd (Harpenden, Herts) promises to solve most of the problems at present associated with motor fuel self-service units.

The Money Card itself is of laminated plastic, the same size and shape as a bank card, encoded electronically with permanent information identifying the retailer or credit organization and an account number which identifies the customer. It also carries variable information (such as an expiry date and the current purchasing power of the card) carried by a high-coercivity magnetic stripe embedded in the card and unaffected by stray fields or attempts at distortion or erasure. This information is completely confidential and cannot be read from the card by any other commercially available device.

Cards are for issue to customers on a deposit basis, whereby the initial purchasing power is electronically 'written' on the card and sold for cash. Alternatively they can function as credit cards, with the control limit 'written in'.



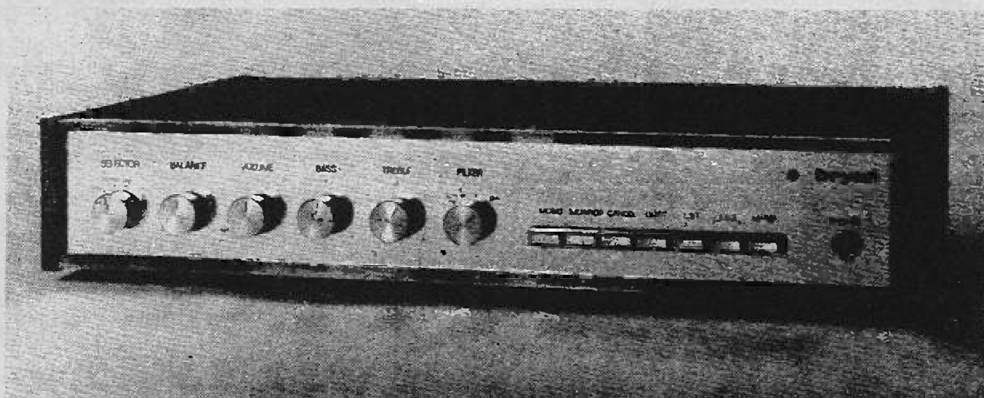
To obtain fuel, the customer inserts his card into the slot of the Money Card Terminal associated with the pump. The permanent and variable information on the card is then read and passed to a small computer in the terminal which checks card validity, issuing organization, date-expiry, recorded purchasing power and the account number. Invalid cards are automatically rejected; valid and accepted cards initiate an illuminated legend to instruct the customer to prove ownership of the card by inserting his personal security code number using a ten digit keyboard on the Terminal panel. Insertion of the correct code unlocks the system and the user is instructed to SERVE FUEL.

The fuel pump is linked electrically to the computer in the terminal which deducts the cost of the drawn fuel

If you're a real Hi-Fi enthusiast, please read on . . .

bryan amplifiers — we're only a small company, and when we wish to produce something really special, it involves most of our resources. So when our design team spend over 12 months planning what they regard as the most superb range of amplifiers ever — we take them very seriously.

We call it 'The Leader' range, because it is very advanced and very beautiful. All the technical specification is in our brochure but to whet your appetites; it has a power output of over 35 watts RMS into 8 ohms per channel, a signal to noise ratio of 70 dB, a wide input capacity and harmonic distortion of 0.05%. It also has full short circuit protection on the output.



Those of you who want something special in audio equipment should take a close look at our LE 720 amplifier. From the front panel to the back panel the standard of design and construction is easily appreciated by anyone who knows good engineering when they see it. Have a look inside it. That is how top quality electronic equipment should be made.

We know, we are Electronic Engineers, that's why we call it 'The Leader', its a long way out in front.

The price is not cheap, but then the better things in life never are.

The LE 720 Amplifier is available from selected Hi-Fi Dealers, at about £96.00.

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(270)

news digest

from the recorded purchasing power of the Card. On completion of the refuelling, the magnetically stored purchasing-power data on the Money Card is automatically updated to equal the final balance; and a receipt is issued by a printer in the Terminal showing the initial balance on the card, the value of fuel drawn, and the final balance of the transaction.

Automated Fuel Dispensing Limited, 151 Lower Luton Road, Harpenden, Herts. **(228)**

COMPUTER LAYS CABLE

The British Post Office is to use an ultra-high accuracy, computer-based navigation system to help lay the latest Transatlantic telephone cable, CANTAT 2, between the UK and Canada. The Marconi Hydroplot system will be used to navigate the cable-laying vessel accurately along the shortest route between the two shore terminals — necessary because, were the cable to be laid more than 0.15 nautical miles off-course, another 6½ nautical mile section of cable and repeater would have to be inserted, at a cost greater than that of the Hydroplot system.

Initially, the system will be fitted to the cable-laying vessel, CS Mercury, on charter from Cable & Wireless Ltd, where it will navigate the ship, and also record with complete precision the position of the repeaters which are located in the cable at six-mile intervals to save protracted and expensive retrieval operations when necessary.

The navigation and position fixing is calculated in the computer from the simultaneous inputs of four different navigation systems — Decca, Omega, Loran and the Transit satellite navigation system. Depending on the relative accuracy of these, it is possible for a navigator to establish the position of a repeater within the length of his own ship.

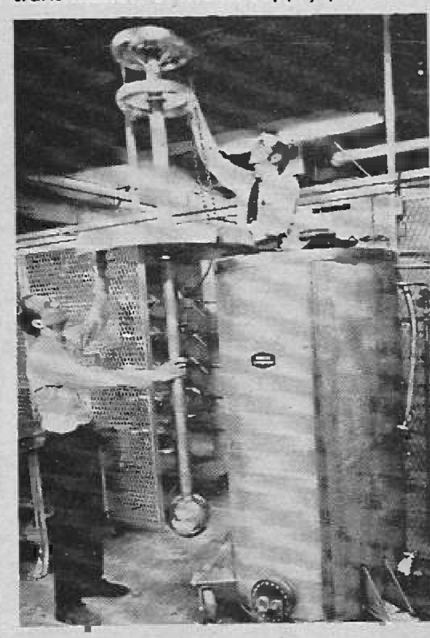
WATER PURIFIER

Introducing silver ions into a water supply pipe to purify drinking water and kill bacteria is the principle of a purifier manufactured by C & N Electrical Industries (Gosport, Hants). The unit operates on mains or battery power and is compact enough to permit inserting in the water supply pipe. The silver ions introduced in the water stream accumulate in the storage tank and, after a short 'bacteria kill' time, the water, free of all known bacteria, can be drawn off for use. Designed to cater for a maximum flow-rate of nearly 300 litres a minute, the equipment seems to be ideal for boats, cars and caravans as well as for use in regions where the water supply is suspect. **(229)**

CRYOGENICS

● Details have just been released of the Cryotech '73, the second international exhibition of low temperature technology, to be held at Brighton in November '73. The event, which includes attendant conferences sponsored by the British Cryogenics Council, the Gas Liquefaction Commission of the International Institute of Refrigeration, is expected to cover many aspects of the technology including transport and storage, refrigeration at below 150°K, superconductivity and cryo-surgery.

● One of the many applications of superconductivity at cryogenic temperatures is more efficient cable transmission of mains supply power.



The illustration shows a liquid helium dewar being used to study the breakdown properties of solid dielectrics at —450°F at Union Carbide's Tarrytown, NY, high-voltage testing laboratories, over a range of voltages and corresponding gap spacings which have apparently never been studied before. **(243)**

UCL ARRAYS

The main difficulty in designing a special-function semiconductor integrated circuit or equipments using them for complex electronic functions is that, unless the market justifies manufacture of the chips in large quantities, the exercise can prove very costly. Various techniques have been tried from time to time by semiconductor manufacturers to reduce the developmental and manufacturing costs of large scale integration (LSI) arrays, such as using a matrix of identical cells (or circuit 'blocks') and achieving functional variability by modifying the interconnection of these standard elements, or using a laser to deposit the conductor patterns etc. In spite of refinements of design and production techniques, there has always remained the bothersome question of 'yield' — many slices being rejected for faulty cells, connections etc.

A new development, recently announced by Ferranti, is known as the uncommitted logic array (UCL) using the CDI technology described on page 10 of the December 1972 issue. The process uses four masks of a permanent fixed design, and a fifth variable-design mask for the aluminium interconnections. This, according to Ferranti, should open up usage of LSI to a wider range of smaller users who could not otherwise consider using multi-function LSIs. First samples can be had in as little as two months and development costs kept as low as £1250.

The circuit available now has enough elements for a total of 200 gates or a mixture of gates, flip-flops etc; a single package could replace 50 quadrupie 2-input logic elements. The individual elements could also be interconnected to perform linear functions such as amplification, in addition to or distinct from digital functions. To avail themselves of the inherent versatility of the system, Ferranti also offer a choice of plastic or ceramic packages and terminations up to 40-pin dual-in-line.

SKYLAB TV

Apollo-17 will be the last chance to see images of astronauts bounding through the eerie light and sharp shadows of the moon or sitting out long journeys inside the tight confines of a moonship.

Next Spring, a tiny Westinghouse TV camera will beam back to earth the interior view of an orbiting space station with 40 times more livable space than the Apollo command module. The initial three-man-tour on duty inside the 13,000-cubic-foot interior of Skylab is scheduled for a 28-day stay. Two later tours will each last up to 56 days.

The first astronauts on duty aboard Skylab will perform 55 experiments. Some will be complex investigations in solar physics. Still others could provide interesting TV watching: a spider attempting to spin a web in the weightlessness of space, or a test to determine whether dissimilar metals can be welded together in space using an electron beam welder.

On the 26th day an astronaut will climb outside the 118-foot-long cluster of orbital workshop, docking adapter and command service module to retrieve film from a camera. Skylab's compact colour TV camera will televise the proceedings from its perch on the end of a 18-foot-long boom protruding from the side of the space station.

An astronaut acting as TV cameraman inside the Skylab will pan, tilt, adjust the focus and iris using a set of remote controls to direct a remote lens assembly on the camera. A TV monitor with a screen the size of a credit card will show him the pictures being transmitted back to earth. **(244)**

MINICOMPUTER PROSPECTS

'The minicomputer market as we know it today will be dead inside five years' according to Neil Blake, a senior planning consultant with Honeywell Information Systems.

Predicting 'bloody battles' ahead and a 'strong polarisation of the market place very soon' as a result of changing technology and tumbling costs, Blake says the minicomputer would stop trying to be a universal answer to a lot of different user needs, would abandon this 'middle course' and develop instead down two distinct variants: first, the 'packaged' machine, oriented towards particular problems and equipped to solve them without much effort on the part of the user; and second, a 'chips with everything' approach by semiconductor manufacturers offering simple and inexpensive minicomputers to the original equipment manufacture (OEM) market.

The first development, already evident in the industry, would arise because, although the costs of minicomputer hardware is decreasing, manpower costs continue to rise so that overall user costs in implementing projects are not necessarily falling.

The second development, following from the advent of large scale integration (LSI) in semiconductor technology, would be a market move by semiconductor manufacturers seeking a new outlet for their devices. The simple and inexpensive OEM minicomputer was likely to become a focus for the semiconductor manufacturers' attention according to Blake.

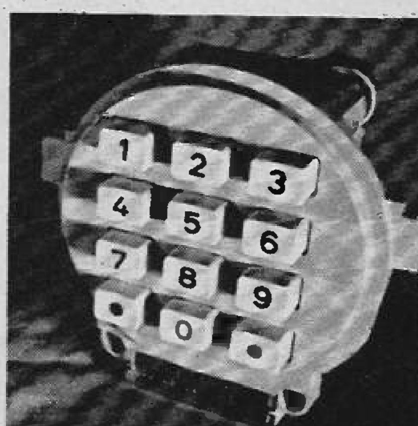
Prices for the two minicomputer variants would in future also tend to diverge. 'The OEM products will maintain their downward trend towards the £100-a-chip goal over a long period, while prices for the packaged minicomputer products will tend to stabilise by comparison, reflecting the need to recover increasing software development and continuing support costs'. **(245)**

PUSHBUTTON KEYBOARD

A 12-button keyboard with mechanical coding — originally developed for the modern telephone — is also a multi-purpose means of generating simple signals which can be used, for example, to control a machine, work an automatic vendor, or operate an illuminated digit display. The two customary methods of transmitting pushbutton signals in telephony — dc diode code signalling and multifrequency code signalling (MFC) —were demonstrated by Siemens recently.

For representing the digits as a code, the time-proven principle used in telegraphy presented itself as a possibility for both methods: By depression of a key, code bars arranged in parallel are shifted in relation to each other, causing actuation of the contacts. In this way, the number of contacts can be reduced to a minimum.

In the case of dc diode code signalling,



'n-out-of-four' coded instructions are converted into a polarity code by means of the two lines and the positive and negative potential, and at the receiving end they are decoded again by a code receiver.

In the MFC method, a specific combination of two voice frequencies —within the speech band (300 to 3400 Hz) — is transmitted for each digit direct from the keyboard via eight (VF) voice-frequency oscillators. The '2 x 1-out-of-4 code' for VF pushbutton calling — already standardized in telephony — provides two groups of four frequencies each. To generate a signal, one frequency from each group is used (lower group: 697, 770, 852 and 941 Hz; upper group: 1209, 1336, 1477 and 1633 Hz), so that altogether 16 different signals are possible. **(246)**

NEW ALUMINIUM PROCESS

Aluminium Company of America has disclosed it has applied for patents on the Alcoa smelting process, a new electrolytic method of producing primary aluminium and expected to reduce by as much as 30 percent the electricity required by the most efficient units of the Hall process presently used worldwide.

The new process uses a system said to be free of undesirable emissions, to afford a better working environment. Requiring less energy, the process is also more tolerant of power interruptions than the Hall process, and can accept power reductions during daily periods of peak demand by the public. Its total operating costs are also expected to be lower. It also will permit plants to be located on smaller sites, with greater location flexibility.

As in the Hall process, the new method employs alumina, the oxide of aluminium, which currently is refined from bauxite ore; alumina obtained from ores other than bauxite will be equally suitable for the new process. In the Alcoa smelting process, alumina is combined with chlorine in a reactor unit which chemically converts the oxide to aluminium chloride. The chloride is electrolytically processed in a completely enclosed cell which spearates the compound into molten aluminium and chlorine. The chlorine is continuously recycled back to the reactor in a closed loop.

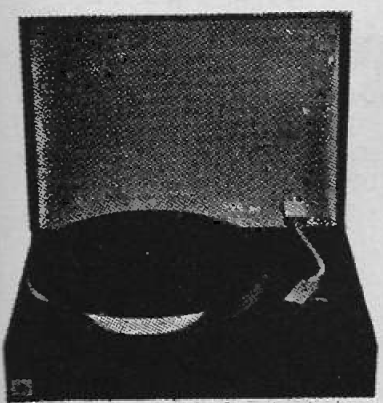
In the traditional Hall electrolytic process, alumina is dissolved in molten cryolite, a fluoride chemical which has become increasingly scarce and costly. Alcoa's new process not only disposes of the need for cryolite, but also the expense involved in containing the fluoride emissions. **(247)**

EEC FOOTNOTE

Now that we are in the EEC, do we order coal and coke *á la carte* or *cul-de-sac?* ●

The AR turntable: "One of the occasional welcome reminders of what high fidelity is all about."

Modern Hi-Fi and Stereo Guide

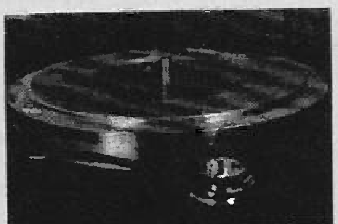


Since its introduction, the AR turntable has had a profound effect upon both design and performance standards of home record playing equipment. Yet it remains unique in the degree to which it combines broadcast quality performance with completeness and convenience, simplicity of operation, and low cost.

Standards of Performance

The AR turntable meets all NAB specifications for broadcast studio turntables on wow, flutter, rumble, and speed accuracy. Its miniature synchronous motor and belt drive make the AR turntable inaudible during operation.

Larry Zide stated in *The American Record Guide*, "There is no audible rumble. None. I found myself hearing the rumble built onto the record by the cutter before I heard sound from the AR!" As to speed accuracy, *High Fidelity* magazine found "the lowest speed error ... encountered in [fixed speed] turntables ...", and Julian Hirsch reported in *Stereo Review*: "The wow and flutter were the lowest I have ever measured in a turntable."



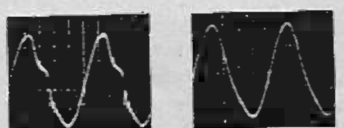
Belt-drive system of the AR turntable.

Integrated tone arm

The AR turntable comes complete with a tone arm of exceptionally low mass and friction. In Mr. Zide's words: "This arm extracts full value from [modern cartridges], imparting a minimum of itself – just what an arm, after all, is supposed to do!"

The AR guarantee and AR value

"The three-year guarantee ... attests to the basic reliability of this turntable, whose performance is unsurpassed," said Julian Hirsch. And Percy Wilson writing in *The Gramophone* stated, "I have, in fact, only one criticism of the AR turntable and arm; it is greatly underpriced."



Left: Cartridge output using too little stylus force.
Right: Cartridge output on same test with correct stylus force. A listing of stylus force requirements for current cartridges, based on our own tests, is supplied with each AR turntable.

A three-point suspension system renders the AR turntable insensitive to even moderately heavy hammer-blows. "Magic? No, just sensible design", said Hi Fi News.

The suggested retail price of the AR turntable is £ 41.90, including arm, plinth, and dust cover. AR products are available only from selected hi fi dealers. Write to the address below for more details.

Acoustic Research International
High Street
Houghton Regis, Beds.
Phone:
Dunstable (0582) 603151

AR — You can see the difference

(271)

PHONE

Electronic pranksters turn telephone systems

Some twenty years ago the USA's largest telephone company made a decision to convert its entire nation-wide switching system to a technique using 12 electronically generated combinations of six master tones.

And in so doing they made a decision that has left many of their major telephone networks as vulnerable as a MOSFET in a Van de Graff generator factory, for in order to save equipment costs, they decided to carry these (toll traffic signalling) tones within the voice transmission band.

Because of this it became possible for anyone with the required technical knowledge to construct a tone generator which could be used to initiate and switch telephone calls, through national and international circuits, from any one of countless millions of private and public telephones.

But knowing how the system works is not in itself sufficient – it is also necessary to know the frequencies of the control tones used.

Ironically enough this information was made publically available by A.T. & T. – the telephone company that initiated the system in a technical article published in the Bell System Technical Journal. Included in the article was the complete list of all frequencies used to control the company's entire trunk network.

Publication of the article was a catastrophic error. Within days, technically minded young Americans had built devices to generate the required audio switching tones – and were hard at work finding out how to use them.

The magnitude of the error was quickly realized by Bell and every possible copy of the paper was withdrawn – but not before many photostat copies had been made.

Some time later the (US) semi-underground magazine 'Ramparts' published full details of the techniques used. This publication was found to be in violation of the California Penal Code and was seized – but again not before a large number of copies found their way into the hands of interested recipients.

So far the only country seriously affected is the USA. For whilst calls can be made by phone phreaks to practically anywhere in the world (they can even set up complex loops in which calls are directed right around the world – terminating at an adjacent phone!) it is only possible to initiate these calls within an in-band signalling telephone system. The USA is the only country using this technique to any major extent.

Nevertheless other countries propose to convert to the system, and full details of such proposed in-band systems continue to be published.

Britain for example, is actively planning to convert to the in-band system within the next five years. There the British government attempts to use its powers, inherent in their Official Secrets Act, to prevent publication of information of value to phone phreaks – yet the signalling frequencies to be used in the proposed system have been made publicly available in the (British) Post Office Engineering Journal since 1969.

Another source of information was an article by two senior Post Office engineers published in The Institute of Post Office Electrical Engineers quarterly. The article entitled 'Signalling System AC No 9' provided ample data for phone phreaks to work on.

It is practically impossible to restrict this type of information for it is essential for technical information of this nature to be available to many thousands of telephone engineers. It is just not possible for systems as large and complex as international telephone networks to be designed, installed and operated without a large number of engineers having access to 'sensitive' information. Hence the existence of standard reference works, such as Atkinson's 'Telephony', which contain full details of practically every piece of telephone gear used today; apart from this, details of all international and many national communications channels is contained in International Telegraphs and Telephones' White Book'.

EXPANSION OF SWITCHING NETWORK

At present only a small percentage of the US telephone network uses electronic switching. The great majority of exchanges still use direct-control and/or electro-mechanical switching. But it is planned to extend the electronic switching network to cover the whole system by the year 2000.

We have found it virtually impossible to establish just what techniques are being used to detect phone phreaks. Certainly though, the FBI are taking the problem very seriously – prosecuting under a Federal felony statute (Title 18 of the United States Code, paragraph 1343 entitled 'Fraud by Wire, Radio, or Television'). Penalties include fines of up to $1000 and/or imprisonment for 'not more than five years'.

The only really practical long term solution to the problem is the removal of the signalling tones from within the voice frequency band – but this is a long and extraordinarily costly operation.

Above all, the situation has again emphasized what a growing number of engineers and hopefully – accountants – are beginning to accept. And that is that the social implications of their actions must be given as much consideration as engineering techniques – or cost/benefit factors.

An ex-phone phreak was recently in our offices and gave the following interview to one of our staff.

ETI: You've asked us not to use your name – so we will call you 'Mike' during this interview. Mike, just what is phone phreaking?

MIKE: *Well it started in the 'States a few years back. Phone phreaks use a specially designed box to give them access to the trunk telephone network. Once they've switched themselves in they can use the entire system without paying.*

ETI: What do you mean by 'the entire system'?

MIKE: *Just what I said. For example in the space of one hour I've rung the talking clock in London, I've listened to the Sydney Stock Exchange report, I've spoken to a switchboard operator in Moscow and listened to a pre-recorded music programme from Munich.*

ETI: Did you do all this from your home phone?

MIKE: *Hell no! – that would have been too easily traced. We used pay phones – but it didn't cost us a cent.*

ETI: That box you spoke about must be a complex device.

MIKE: *Not at all. The phone companies call them 'blue boxes'... they're just a simple tone generator controlled by push buttons. They are quite small – about the size of a pocket calculator. I designed mine around a few IC's I bought from the local electronics parts supplier.*

ETI: Where did you get the circuit from?

MIKE: *That's the easy bit. It's just a sine-wave oscillator – it generates*

PHREAKING

into electronic playgrounds.

discrete frequencies individually selected by push-buttons. The hard bit's finding out what frequencies to use.

ETI: We can understand that! But can you tell us how you found out?

MIKE: *Sure. Actually the whole thing's a bit of an embarrassment to the phone companies. It was a bit incredible. What happened was that the whole concept of the multi-frequency switching system was published in the Bell System Telephone Journal a few years back. It told everything. How it worked and even the frequencies used.*

It must have been the world's biggest printing mistake! The top brass realised what they had done almost immediately . . . but it was just too late. Photostats were already in circulation . . . It was just what the kids needed — and within a few days the initial boxes were in use.

Actually the American magazine 'Ramparts' also ran the article but the authorities stepped in pretty smartly and the issue was withdrawn. (Actually the issue concerned was openly available in Australia — Ed.)

ETI: We've heard that it is possible to get into the network without actually using one of these boxes.

MIKE: *That's right. It can be done without any equipment at all — there's a couple of stories I can tell you about this if you've got time.*

The first concerns a blind kid called Joe Engressa. The story goes that Joe was born with perfect pitch. He could actually whistle the tones better than the phone company's gear could generate them. He used to whistle long distance connections for fellow students at the University of South Florida!

Then there was this breakfast cereal called Captain Crunch . . . A few years back they had this big sales thing going and offered a toy whistle in each packet as a treat for the kids. Somehow a phone phreak discovered the whistle would produce a perfect 2600Hz tone — one of the basic tones used in the multi-frequency system. The fellow who found this out — he is always called Captain Crunch nowadays — was transferred to England with his Air Force unit, and he used to receive scores of calls from his friends Stateside and 'mute' them — make them free of charge — by blowing his Captain Crunch whistle at his end.

ETI: So a few phone phreaks don't use any equipment to speak of — but most use blue boxes like yours?

MIKE: *That would be right.*

ETI: When you spoke of Joe Engressa and Captain Crunch you spoke almost as if they were some sort of folk heroes.

MIKE: *Sorry I got a bit carried away.*

ETI: We get the impression that blue boxers are organized into some sort of a club. Is this right?

MIKE: *Yes, in a way. But you must remember that phone phreaking is highly illegal . . . if the FBI catch you, you can go away for five years.*

ETI: Is that why you stopped doing it?

MIKE: *Well I don't want to get all moralistic about it. But you see the whole thing started off with a group of technically minded kids doing it for kicks. Sure it was illegal but we only did it at night and the loss in revenue to the phone companies was negligible.*

But it's not like this anymore. The commercial boys have got into the act. I've heard of large gambling syndicates tying up coast-to-coast trunks almost for days on end. It's gone a long way past a hobby.

ETI: What about Europe — or England?

MIKE: *There're a few there . . . nothing like the number there are in the States though. The British Post Office system is more 'sluggish' than ours (USA's — Ed.), it's not quite so easy. But I've heard that they are upgrading their system and they may soon have to face the problem themselves.*

ETI: What about Australia?

MIKE: *Well Australia is a favourite call for blue boxers ringing from the States . . . No, I don't know of any blue boxers originating calls from here.*

ETI: How widespread is the phone phreaking today?

MIKE: *Well like I said, it's gone way beyond the kids. Bell Telephone says that its losses are around $150,000 a year — but I think they've put it as low as this so as not to encourage people to have a go themselves. Some authorities put it as high as $150 million! I suppose a lot depends upon how you calculate the losses.*

ETI: What are the US phone companies doing to combat phone phreaking?

MIKE: *There is not a great deal they can do. The system is so automated you see. One way they spot phone phreaks is by using sophisticated computer programs to analyse call distribution patterns. This highlights abnormal activity.*

In England — and I imagine here in Australia also — the Post Office use STD call meters. These were originally designed for companies to monitor STD calls, they recode the extension making the call, number called and length of call. They enable any 'illegal' calls to be tracked down to the extension used.

I don't know if it works the same way here but in England the Post Office can hang one of these STD meters on to a line without infringing their wire tapping laws.

ETI: Thanks for the story Mike . . . it's been fascinating talking with you. Just one thing finally — do you have any comments for readers who want to have a go?

MIKE: *Yes — don't. I'm not taking any moral stand on this mind you . . . but as I said earlier it's gone way beyond a game for the kids — there are a lot of 'heavies' mixed up in it now. I don't know if you read this in the (US) IEEE paper recently but they reported that individuals said to have built fraud devices for organized crime syndicates have either disappeared or died violently. (I.E.E.E. Spectrum, August 1972 — Ed.). That's an extreme situation of course . . . but there's no doubt that telephone security engineers will find ways of trapping phone phreaks. It just isn't worth the risk.* ●

COMPUTERS IN BANKING

Millions of cheques to be sorted each day — over 20 million accounts to be maintained. That is the situation in British Banks today. To cope, the major banks now use mammoth data-processing centres that soon will be direct on-line to all branches throughout the British Isles. To find out how their plans have advanced, Electronics Today International arranged special interviews with staff of two of the Big Four, National-Westminster and Lloyds Bank. In this report, Dr. Sydenham describes the vast undertakings being implemented to provide more efficient service.

Fig. 1

"I want to take £3 out of my current account and put 45p into my deposit account. No, 25p into my current account and 22p into my savings account. Or maybe I should put the whole lot into the savings account and transfer £12 from my deposit account into my current account, because I've got these bills to pay and . . ."

THE foundations of banking can be traced way back to times when people needed to barter product for product but found the method inappropriate when the goods were impracticable to transport.

Trading goods direct gave way to the use of money systems in which an intrinsically valuable commodity was used to represent the value of the goods. Gold, silver, shells, even stones with holes have been used.

In Babylonian times, temple treasuries safeguarded money on behalf of its owners. In Roman times silver dealers carried out international money trading. Gold always has been sufficiently scarce to remain valuable, and in the Middle Ages goldsmiths acted as bankers, issuing paper receipts for entries of gold paid to them. It was logical that trading just in the receipts followed, for this avoided the need to transfer gold. It was confidence in the knowledge that there was wealth to back the receipts which enabled banking to grow.

These goldsmiths receipts were, in fact, an early form of banknote and these people gradually became bankers. Goldsmiths from Lombardy in Italy, where this development originated, settled in London, and today Lombard Street is still the centre of banking. Other forms of viable transfers were created along with bankers receipts and today the majority of monies transfer via the cheque.

In Roman times, comparatively few of the then small population of Britain would have needed to bother about trading at a sophisticated level. By contrast, today in the British Isles there are an estimated 21 million active accounts operating. National-Westminster (one of the larger of the Big Four in British

Banking — the others are Barclays, Lloyds and Midland) have, for instance, seven million operating accounts. Entries into Lloyds five million odd accounts run into 400 million a year. Yet everyone expects absolute accuracy (Fig. 1) in the account keeping down to the smallest legal currency unit and with immediate recall.

A cheque received by a creditor is paid into his or her bank for crediting against the appropriate account and then for debiting against the person using it. Two banks are, therefore, involved with each cheque issued. With so many active accounts, it is easy to see that an enormous number of cheques are in transaction each day. The task of clearing the cheques and adjusting the accounts both ways is performed by certain clearing banks which are set up with special facilities for this type of work. Lloyds handle one million cheques a day, National-Westminster 1.25 million. At times four million are cleared.

Conventional banking consists of passing cheques from one bank branch to the other for debit purposes. This is very inefficient from the labour point of view due to the large number of cheques concerned and the high growth rate (6% per annum) of accounts. However as much of this work is of clearly defined routine nature, it is suited to automatic data processing methods using digital computers.

In the mid 1960's, the major British banks started organization programmes designed eventually to provide central data-processing systems connected on-line (that is able to be connected immediately when desired) to all branches of the bank. British banking was able to make efficient use of the technique for banks have branches which are comparatively close to each other and in which large volume business is experienced.

Although banking is regarded as a conservative enterprise, the change to computer operation was adopted without serious opposition, for the task of performing routine monetary operations was taxing human resources and capability for few employees find that aspect of banking rewarding. The Big Four have each installed sophisticated and powerful data processing centres.

Fig. 3 Information is transmitted between branch offices and the London or Birmingham Computer Centres. This schematic map shows how branch terminals and centres are linked by telephone line.

The aim of these huge investment programmes (about $150 million has been involved so far) is ultimately to provide direct, remote access to records from any branch of a bank no matter where it is located. These plans are nearing fulfilment now. For example, of National-Westminster's 3000 plus branches, 1100 are now on-line and the remainder should be connected by 1974. But bank business involves more than cheque clearing and sorting, and other services including registration of companies, trusteeship and investment portfolios have been computerized. To provide these functions has required the creation, and continuing expansion, of some of the largest data-processing centres in the world.

Fig. 2 — Cheque clearing in the City Computer Centre

CLEARING AND SORTING CHEQUES

The reconciliation of cheques involves intercommunication between the two banks involved and hence there are practically innumerable cross-combinations between the many banks in existence. To handle these cross-combinations an institution, recently renamed B.A.C.S. (Banking Automated Clearing System), has been set up in which some of the larger banks provide clearing facilities on behalf of them all.

Cheques arrive at the clearing banks in random order and require sorting.

This process is largely automated using, in the main, IBM 1419 cheque reader/sorter machines (as shown in Fig. 2.) In these a pile of cheques is placed in the input chutes. They slide off one by one from the bottom of the pile at 1600 per minute and are transported horizontally for reading

(Turn to page 17)

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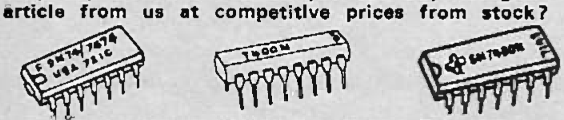

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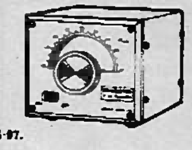

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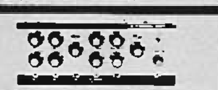

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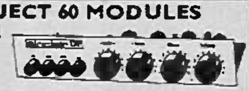

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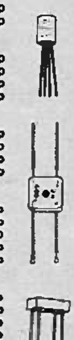

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CRS 3/60	600	55p
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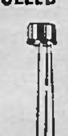
CRS 5/400	400	80p
SEVEN AMP (TO48)		
CRS 7/100	100	60p
CRS 7/200	200	65p
CRS 7/400	400	70p
CRS 7/600	600	85p
SIXTEEN AMP		
SCR 16/100	100	65p
SCR 16/200	200	75p
SCR 16/400	400	85p
SCR 16/600	600	£1·00



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COMPUTERS IN BANKING

(Continued from page 15)

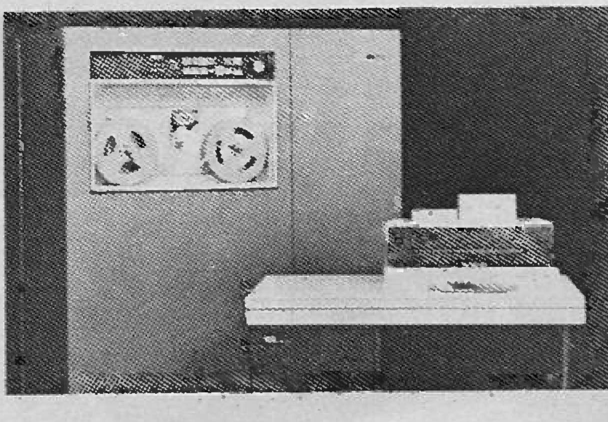

Fig. 4 – The 3981 computing concentrator cabinet and 3982 keyboard terminal at a typical on-line branch.

and sorting. Before processing, each bank encodes the amount of the cheque in a manner similar to the account number so that the magnetic sensors can read the number and cheque value. As the cheque moves across, the ink is magnetized, then the value and account number are read and stored for account adjustment. Finally, the cheque is fed into the appropriate out bin.

Many machines like this are needed to handle the vast quantities of cheques. National Westminster use a row of 17 of which 13 are coupled on-line to the computing power of the centre. Visual display units (V.D.U's) are placed at strategic locations to assist the machine operators. A small army of personnel cope with the machine-unacceptable cheques in a manual reconciliation area.

ON-LINE NETWORKS

It was one thing to decide that all branches should be put on-line and another to do it, for it was not entirely a bank decision. Communication by radio or telephone between centres and other geographical locations is, by law, General Post Office controlled (G.P.O.).

Various methods were investigated. Lloyds, the first to have all of their accounts centrally processed, used a mixture of on-line terminals and special messenger-transported paper tape communications. It took them four years to achieve this and it was completed in October, 1970. It is, however, not entirely on-line but by 1974 they hope to be without any tape links.

The organisation of the networks are basically similar for each of the banks involved. Figure 3 shows a schematic map of the double shell-burst configuration. Two main centres (two have been chosen as optimum) house the data processing equipment and the many computers involved. From the centres run lines, rented from the G.P.O., over which data can be sent and received in a compatible form from outlying concentrator branches. These, as the title implies, pack up the data into high time-density form from the surrounding branches.

At a typical on-line branch will be found an IBM 3980 bank teleprocessing system. This system, seen in Figure 4, was developed by IBM specifically to cope with future demand in banks. It consists of two units, a 3981 computing concentrator and a 3982 keyboard terminal. Each concentrator unit can accept up to ten keyboard terminal links and contains computing circuitry and storage facilities for data used to control the terminals and the flow of data between them. Each has magnetic-core memory capable of storing 8196, 16 bit words (a bit is the smallest piece of computer logic and can be in only one of two states: a word is a set of bits, usually sixteen in length but some times longer). The memory facility enables the concentrator to have its own permanent programme built in, and this can be altered to suit the changing needs at a particular location. More recent concentrators can accept up to 16 terminals.

Telephone lines are used to connect the keyboards to the concentrators and concentrators to the central processing unit (C.P.U.). This way smaller branches operate into larger ones using low speed lines. For example, each keyboard terminal needs 147 baud lines (the baud is a unit of transmission speed and is near enough the number of bits of binary data received in a second). A concentrator to C.P.U. (Central Processor Unit) line is graded at 1200 baud.

Not all banks use IBM equipment. National-Westminster have Burroughs terminals connected into IBM concentrators. Their network has at present 180 concentrators needing 90 main line G.P.O. links.

COMPUTING AND DATA PROCESSING CENTRES

London is a natural choice for the first centre, the other somewhere central: Birmingham for Lloyds and soon Kegworth for National-Westminster. At present National-Westminster uses four centres in London

(Turn to page 60)

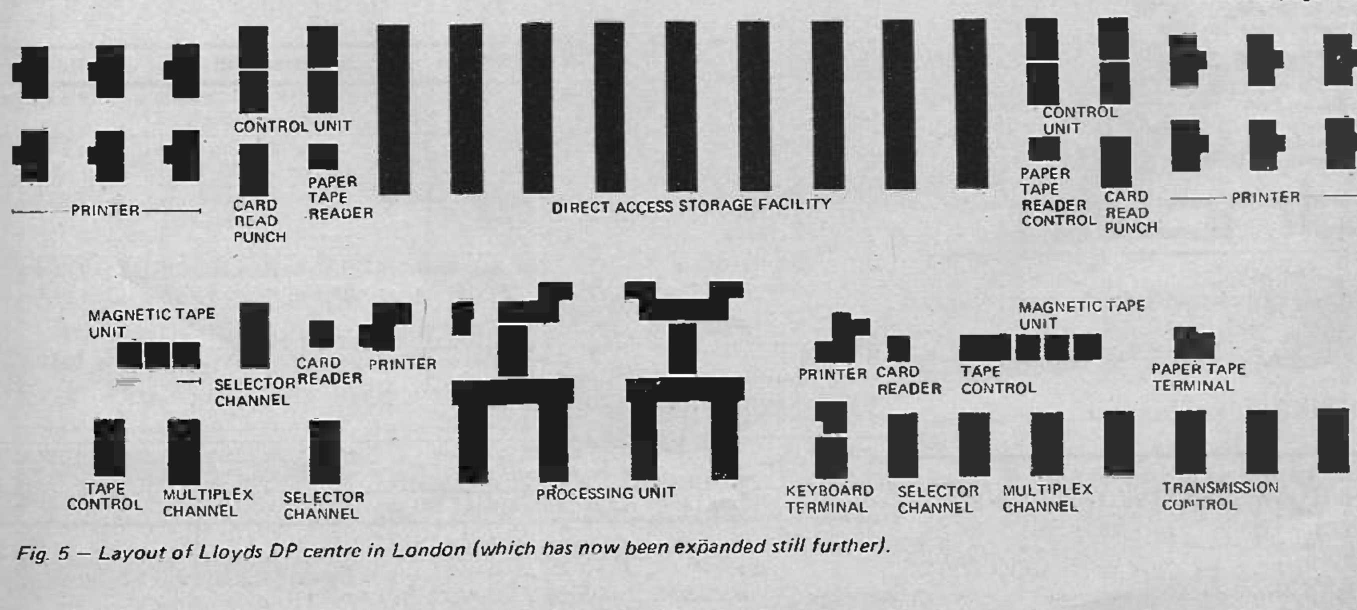

Fig. 5 – Layout of Lloyds DP centre in London (which has now been expanded still further).

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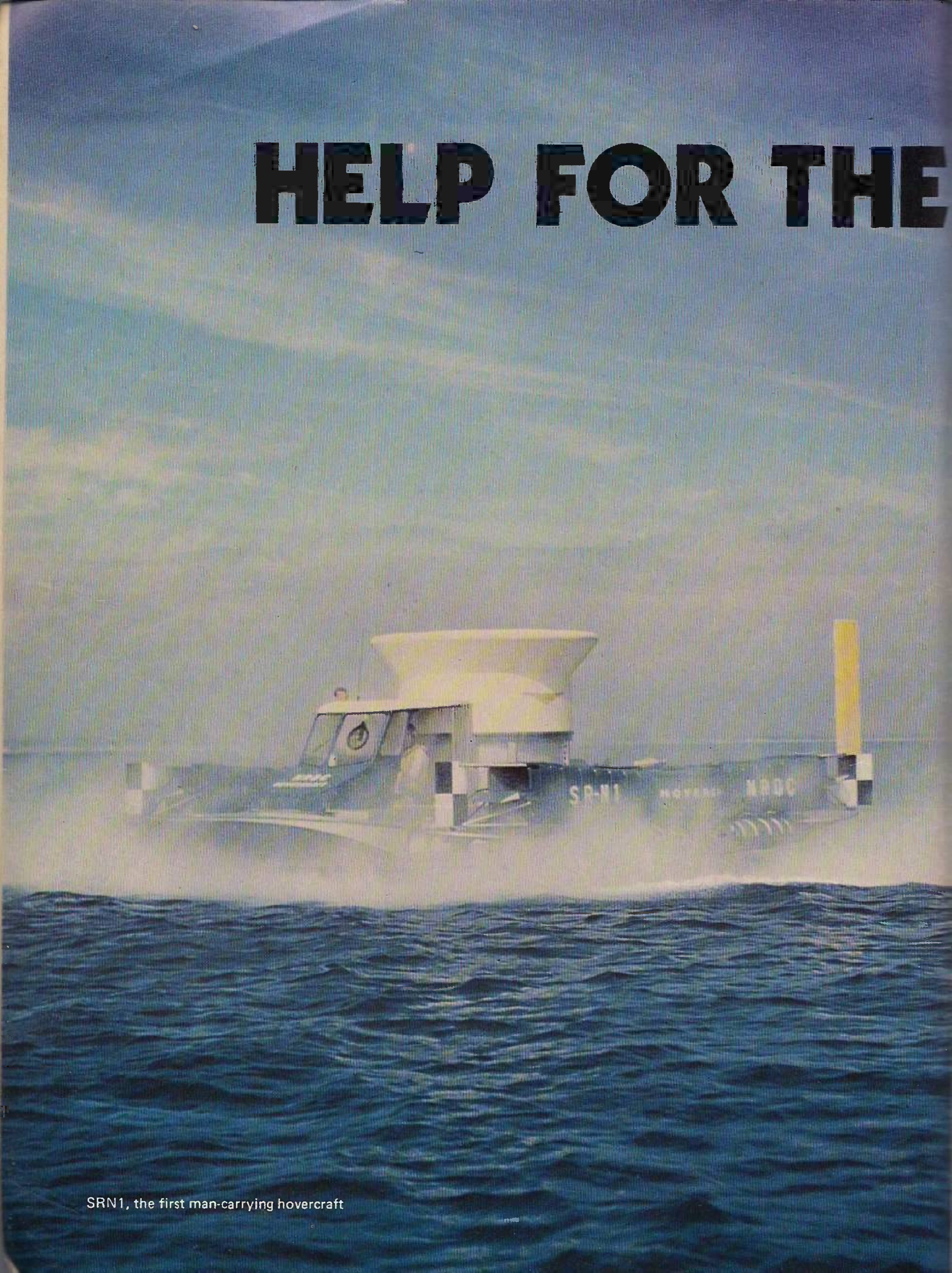


SRN1, the first man-carrying hovercraft

INVENTOR

Should an inventor with a worthwile idea see it go to waste for lack of support in this country or sell it overseas for their exploitation?

In his presidential address to the Institution of Electronic and Radio Engineers in Dec 1971, Mr A A Dyson commented on the exploitation of ideas and said: 'Britain originally had the benefit of Clerk Maxwell's work. A little later Marconi settled here and continued with all his major development work. We, as a nation, were too slow in developing these ideas throughout the whole of the public and private sector, both here and abroad, and even at this time were rapidly overtaken by other countries'.

In this feature, Mr P G Tanner (Manager, Electrical Engineering and Electronics Group, NRDC) shows that NRDC goes some way towards assisting the inventor to bring his ideas to fruition. ETI acknowledges the kind permissions given by Mr Tanner and the IERE to publish this extract from a recent paper in the Institution Journal.

IN his Hunter Memorial Lecture in 1970, Prof G H Rawcliffe suggested that, if the National Research Development Corporation (NRDC) did not exist, we would have had to invent it.

Back in 1948, when NRDC did not in fact exist, it was felt necessary to invent it; there was then a suspicion that Britain was wasting its natural inventiveness and could turn this to much better effect. As a country we were then still suffering financially, having lost the initiative on penicillin, for example, which we had pioneered ourselves but which had subsequently been capitalised on by USA with its established manufacturing techniques.

As a result, the NRDC was set up as a Public Corporation to see that, in future, we were not slow to develop ideas originating in this country. In the last 25 years, the British economy has benefited substantially as a result of NRDC's activities in this direction.

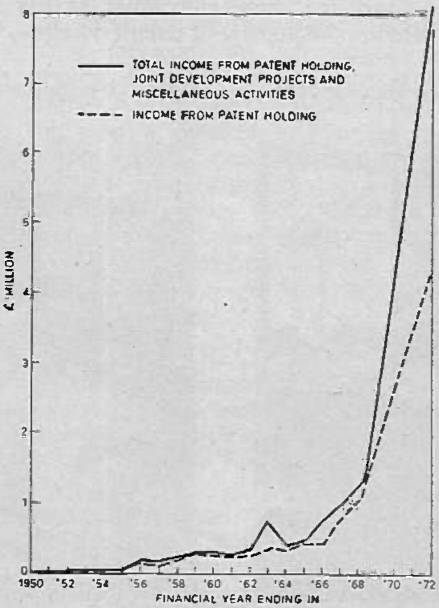
So far, NRDC has borrowed £25M from the Government to invest in exploitation and development of inventions, which has resulted in stimulation of new manufacture in UK to the extent of £90M per annum, and £60M per annum overseas, all this producing £3M a year for the British Exchequer. The extent of this recovery is shown in the graph for NRDC's growth.

While NRDC's function is to secure the development and exploitation of inventions across the whole spectrum of scientific and engineering activity, this article will deal primarily with its electronics and electrical engineering aspects.

EARLY BACKING

The Hovercraft, with which NRDC's activities are traditionally linked in people's minds, is only one of its achievements. Closer to home, on the electronics front, NRDC has pioneered to establish printed circuits in this field by advancing development and working capital to Technograph Printed Circuits Limited which was formed to exploit the inventions of Dr Paul Eisler. This assistance enabled the Company to develop the techniques to a production stage and establish itself at the forefront of the technology and, in addition, to maintain a very effective portfolio relating to these inventions with the prospect of very substantial royalties.

Growth of NRDC's income



Similarly, Dr Francis Bacon's fuel cell patents were jointly taken up by Energy Conversions Limited and NRDC (the former set up in conjunction with British Petroleum, GKN and British Ropes). Through cross-licensing with an American company, the substantial development work done on these patents led to the fuel cells used in the *Apollo* spacecraft. However, in common with other prospects held out for direct energy conversion in the 1950s, none of which has yet materialised, further results in this field have proved disappointing.

The above cases of early backing by the Corporation show how, from the beginning, its objective has been to try and capitalise on sound technical ideas originating in this country. In this activity, it organises the development of inventions from Government laboratories, University Departments and private individuals into industrially viable propositions by means of suitable licensing arrangements — and provides financial support for development projects with industry itself.

PAST INVOLVEMENT

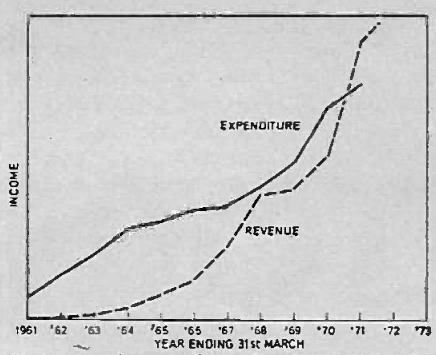
NRDC's Electrical Engineering and Electronics Group holds about 200 patents in the UK, with many of these also granted overseas. The aim is to get all these ideas accepted by the industry; in fact, about a third of these patents have been licensed. In addition, the Computers and Automation Group is handling around 100 patents as well as the copyright in a considerable amount of computer software.

A group of inventions in the electrical field, which has proved profitable, concerns Pole Amplitude Modulated motors developed at Bristol University. These inventions, by Prof Rawcliffe, enable the speed of an induction motor to be varied by grouping the coils such that a simple switching arrangement is sufficient. The first British licenses were granted in 1963 and the considerably increased licenses in the last few years now include many of the major manufacturers in the West. However, it took 14 years, from the first invention in 1957, for NRDC to break even on this exercise. This is by no means unusual. Industry can be very slow in accepting new ideas from the outside, even when these have been developed to an advanced stage. The income/expenditure graph for p-a-m project shows how long the break-even period can be, even in a successful enterprise.

It is precisely in such circumstances that NRDC stimulates innovation and involvement in the innovation by industry. In the p-a-m case, it gave financial support to the exploitation by paying for a share of the development expenditure as well as covering the cost of all the patents involved. Such costs can be considerable and call for constant reappraisal. Without the involvement of NRDC, such ideas might never have been taken up by industry in any substantial way, and the economy would suffer as a result.

Naturally, not all the NRDC's investments in University projects have been as successful. For example, the support given in the past to the developments of the flat cathode-ray-tube, the thermionic generator, television bandwidth compression and image intensifiers did not, or have not yet, proved successful. But the involvement of NRDC did enable the thorough exploration of the prospects for the ideas, supplying the industry with all the information needed to assess their potentials in detail. Although NRDC goes a long way in furthering inventive ideas, whether these ideas get into production will ultimately rest with industry; what is achieved, however, is that the ideas do not remain submerged through lack of adequate and proper support.

A case where University involvement led to substantial industrial support is in computers. Some of the first patents assigned to NRDC were from Manchester University, resulting from wartime work on the storage of radar



Income and expenditure for the p-a-m project

signals. With other patents from Ministry Departments and the National Physical Laboratories, a substantial portfolio was built up and licensing arrangements concluded, with IBM among others. Between 1951 and 1957, NRDC extended this support by funding developments of a number of machines for the UK computer industry to a total value approaching £2M; these included the Ferranti Mark I, the Elliott *Pegasus* and the Emidec 2400 and contribution to the Ferranti *Atlas*. In 1965, £5M was made available to ICT as a contribution to the development of the 1900 computer series. In recent years, considerable support has also been given to the development of mini-computers, including the *Micro 16* and the *Arcturus 18C*.

NEW TECHNOLOGIES

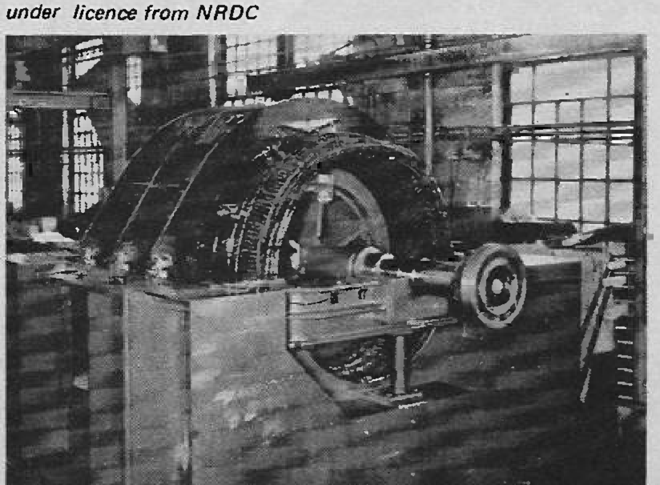
For a healthy electronics industry in general, and a successful computer industry in particular, a strong and dynamic components sector is a necessary basis. NRDC's involvement for many years in this field led it, in 1957, to consider ways to assist, in particular, the development of integrated circuits which were then clearly becoming the basic 'bricks' of future electronics technology. A proposal from Ferranti was expanded, at the request of the then Ministry of Technology, into support for three companies in the field in a programme of circuit developments closely related to computers, telecommunications, instrumentation etc. Despite the adverse trading conditions prevailing in the microelectronics industry, both here and in the USA, in recent years, it remains as true today as it was in 1967 that, without a strong micro-electronic technology, the traditionally leading position of UK in the electronics field will be seriously jeopardised.

We in UK have always had a first-class competence in solid-state technology in our Govt establishments, Universities and industrial laboratories. Where we have failed is in managing the outcome of this capability toward competitive manufacture and worldwide sale. At the start of its microelectronics exercise, NRDC recognised that this success would only be achieved by marshalling the UK resources into a concerted effort. To this end, a collaborative agreement has been set up between the companies to allow exchange of know-how and minimise duplication. Although the limited objectives of this exercise have been fully realised, it is only a shadow of what could be achieved by a full-fledged and truly integrated activity in this field.

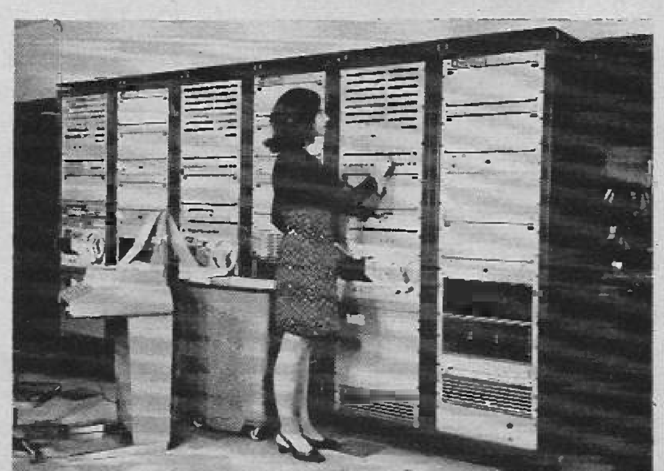
In the field of Telecommunications, NRDC has also tried to ensure that new ideas are given full scope. British export in this sector, at one time 50% of manufacture, has painfully dwindled over the years to a miniscule share by comparison; powerful in Strowger,* we were virtually knocked out in crossbar.* The next round is Stored Program Control (SPC) — a method of using computer techniques to the operation of automatic telephone exchanges. With a particular export prospect in mind, Plessey approached NRDC in 1969 for extensive support in the development of such a system and an arrangement was subsequently set up. The immediate export possibility did not materialise but the work is pro-

**See page 6 — Ed*

A 7,000 hp PAM induction motor manufactured by Westinghouse under licence from NRDC



Plessey's 2-processor System 250 prototype SPC under test

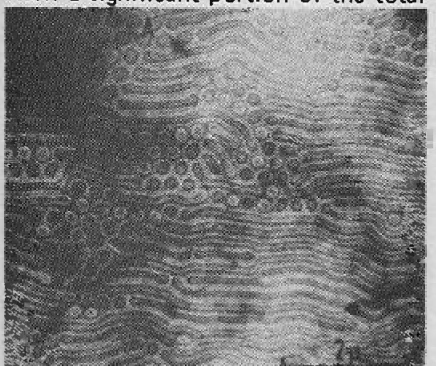


gressing very satisfactorily and a strong competitive position can be established in this area.

SMALL PROJECTS

The above examples demonstrate investments, by NRDC, of considerable sums in attempts to advance new technology. However, NRDC's activities are by no means limited to major commitments but also extend to investments of a few hundreds of pounds. With a small project, the cost of setting it up may be disproportionately large relative to the investment involved, and its innovation aspects are particularly important for the enterprise to be worthwhile.

An idea investigated recently, for example, was a highly novel method of interconnecting microcircuits. Most of the cost of packaging the circuit — itself a significant portion of the total



A film of magnetic bubble which could function as a computer memory

cost of integrated circuits — is in bonding the package leads to the silicon chip. This aspect of the process is still labour-intensive, an operator manually repositioning the package each time a connection is to be made; and flip-chip bonding, spider bonding etc are all processes intended to overcome this costly and tedious manipulation. A selective etching process devised by one inventor could be considerably significant to the industry, and NRDC set up a small project with the company formed by the inventor and spent £500 on evaluating the technical features of the assembly. With this support, the inventor has produced initial samples and established contact with a major microcircuit manufacturer. Although a positive result is still to come, the point is that the idea of an individual has not been allowed to lie fallow and, with NRDC's support, although very modest in this case, the idea was thoroughly investigated.

In selecting proposals for support — and clearly some selection is necessary — only supernatural vision could ensure that selection is 100% right every time. In dealing with innovative projects, selection on a commercial basis may tempt one to reject everything. This is neither the policy of NRDC's operation nor the basis on which it has achieved its present success. Of equal importance is the fact that projects need careful scrutiny, not only in the assessment stage but also throughout its subsequent stages when effective monitoring and revaluation ensure that quick decisions can be made to discontinue projects which look like failing or take steps to change policies which are proving ineffective.

RISK FINANCE

A few words now about the way in which NRDC invests true risk finance in industry to promote innovative projects. In a typical situation, after assessment in the usual way of a company's proposal (by technological, commercial and patent evaluations), NRDC agrees to provide some of the finance required. Since it concerns itself with viable projects principally, NRDC need provide no more than half the investment for a project so as to give sufficient incentive for the project to go ahead. This not only reduces the company's repayment to NRDC but also ensures a positive interest and a direct commitment by the company to the project. If the technical risk (as regards its commercial viability) in a project is low, the company would be required to contribute a greater portion of the cost. (In extremely low-risk cases, the involvement by NRDC is inappropriate and the company would more sensibly seek conventional sources of financial assistance). In all such cases of shared project financing with NRDC, the Corporation does not take active role in the management of the project. However, for a very high-risk project, funding by NRDC can be higher than 50% and the Corporation may wish to protect its investment by acquisition of property rights and may also want to play a more positive role in managing the development programme.

Obviously no one wants to undertake projects which fail but this is an inevitable risk when engaging in speculative developments. The accuracy of original assessments largely dictates the degree of success in this type of financing, and a detailed analysis at the outset is always necessary, taking into account not only the build-up of costs in the development itself but also the total cash flow necessary to launch the project and satisfy the market. A lot depends on the market forecasts made at the time.

INVESTMENT RECOVERY

Once the development has finished and sales have commenced, NRDC begins to recover its investment. Ideally, with an equal investment by two parties at equal risk, they ought to share equally in the outcome. However, where a project is one of several with which the company is concerned, it is not easy to identify the true profit margins relating to one project. A better approach is to set a levy on sales, this levy being determined at the outset to give a satisfactory return based on the estimated market forecast. Risk analysis is a subject in itself and it is sufficient to say that NRDC's return on investment is expected to include costs of capital, interest, administration and a risk premium — and the levy on sales is calculated on this basis.

The rate at which recovery of investment is achieved will depend very much on how accurate the sales forecast proved to be, in the light of later realisation. In order to lessen this dependence, a two-part levy is also useful. During the first part, the plan is to recover the capital invested, together with interest and administrative costs — this corresponds to the break-even point. During the second phase, the risk premium is covered at a much lower levy. Such an arrangement is normally of advantage to both parties since, if sales escalate, the 'pay back' is that much quicker.

Some conflict can sometimes occur in mutually agreeing the recovery terms acceptable to both the company and NRDC, particularly if the extent of the risk is viewed differently. However, these differences are usually settled by negotiation.

It has been claimed that the Corporation's money 'costs too much'. This is often due to a misunderstanding of the true nature of NRDC's support which is pure risk capital. If the project is highly successful, the return to NRDC can be high but both parties share in the success achieved. Where a project fails, there is no liability to make any repayment and, where sales are far below expectation (not uncommon in the high-risk area in which NRDC operates), NRDC's money is, in fact, the cheapest possible.

CONCLUSION

Despite the Corporation's excellent record in its attempts to reduce the loss of British inventions to overseas exploitation, there is much more that could be done. More aggressive management policies, particularly reflecting on the export field, are likely to have more impact on a project than the money involved. In this country, there is neither a shortage of good ideas nor perhaps a shortage of money for their development. But there is a real shortage of management capability to take them to a profitable conclusion. NRDC at least can ensure that such ideas do not fail to see the light of day.

In a country churchyard in 1750, Thomas Gray wondered whether any mute inglorious Milton rested there. If in 1973 there is still amongst us an as-yet-mute inglorious Marconi, he should hurry up and get in touch with the Corporation! ●

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

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SN7400	0·15	0·14	0·12	SN7450	0·15	0·14	0·12	SN74123	£2·80	£2·70	£2·60
SN7401	0·15	0·14	0·12	SN7451	0·15	0·14	0·12	SN74141	0·67	0·64	0·58
SN7402	0·15	0·14	0·12	SN7453	0·15	0·14	0·12	SN74145	£1·50	£1·40	£1·30
SN7403	0·15	0·14	0·12	SN7454	0·15	0·14	0·12	SN74150	£3·00	£2·70	£2·50
SN7404	0·15	0·14	0·12	SN7460	0·15	0·14	0·12	SN74151	£1·00	0·95	0·90
SN7405	0·15	0·14	0·12	SN7470	0·29	0·28	0·24	SN74153	£1·20	£1·10	0·95
SN7406	0·35	0·31	0·28	SN7472	0·29	0·28	0·24	SN74154	£1·90	£1·70	£1·60
SN7407	0·35	0·31	0·28	SN7473	0·37	0·35	0·32	SN74155	£1·40	£1·30	£1·20
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SN7410	0·15	0·14	0·12	SN7476	0·40	0·39	0·38	SN74160	£1·90	£1·70	£1·40
SN7411	0·25	0·24	0·22	SN7480	0·67	0·64	0·58	SN74161	£1·80	£1·70	£1·60
SN7412	0·35	0·31	0·28	SN7481	£1·20	£1·15	£1·10	SN74162	£4·00	£3·75	£3·50
SN7413	0·29	0·28	0·24	SN7482	0·87	0·86	0·85	SN74163	£4·00	£3·75	£3·50
SN7416	0·43	0·40	0·38	SN7483	£1·10	£1·05	0·96	SN74164	£2·20	£2·15	£2·10
SN7417	0·43	0·40	0·38	SN7484	£1·00	0·95	0·90	SN74165	£2·25	£2·20	£2·15
SN7420	0·15	0·14	0·12	SN7485	£3·60	£3·50	£3·40	SN74166	£3·50	£3·25	£3·00
SN7422	0·50	0·48	0·45	SN7486	0·32	0·31	0·30	SN74174	£2·30	£2·20	£2·10
SN7423	0·50	0·48	0·45	SN7489	£5·50	£5·25	£5·00	SN74175	£1·60	£1·50	£1·40
SN7425	0·50	0·48	0·45	SN7490	0·67	0·64	0·58	SN74176	£2·50	£2·48	£2·30
SN7427	0·45	0·42	0·40	SN7491	£1·00	0·95	0·90	SN74177	£2·50	£2·40	£2·30
SN7428	0·70	0·65	0·60	SN7492	0·67	0·64	0·58	SN74180	£1·20	£1·00	£1·40
SN7430	0·15	0·14	0·12	SN7493	0·67	0·64	0·58	SN74181	£5·50	£5·00	£4·75
SN7432	0·45	0·42	0·40	SN7494	0·77	0·74	0·68	SN74182	£2·00	£1·90	£1·60
SN7433	0·80	0·75	0·70	SN7495	0·77	0·74	0·68	SN74184	£3·50	£3·25	£3·00
SN7437	0·64	0·62	0·60	SN7496	0·87	0·84	0·78	SN74190	£1·95	£1·90	£1·85
SN7438	0·64	0·62	0·60	SN74100	£1·65	£1·60	£1·55	SN74191	£1·90	£1·85	£1·80
SN7440	0·15	0·14	0·12	SN74104	0·97	0·94	0·88	SN74192	£1·95	£1·90	£1·85
SN7441	0·67	0·64	0·58	SN74105	0·97	0·94	0·88	SN74193	£2·00	£1·80	£1·75
SN7442	0·67	0·64	0·58	SN74107	0·40	0·39	0·36	SN74194	£2·70	£2·60	£2·50
SN7443	£1·30	£1·25	£1·20	SN74110	0·55	0·53	0·50	SN74195	£2·00	£1·90	£1·80
SN7444	£1·30	£1·25	£1·20	SN74111	£1·25	£1·15	£1·10	SN74196	£1·90	£1·70	£1·60
SN7445	£1·80	£1·77	£1·75	SN74118	£1·00	0·95	0·90	SN74197	£1·80	£1·70	£1·60
SN7446	0·97	0·94	0·88	SN74119	£1·35	£1·25	£1·10	SN74198	£5·50	£5·00	£4·50
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SN7448	£1·00	0·97	0·96	SN74122	£1·40	£1·30	£1·10				

The AL50 HI-FI AUDIO AMPL 50W pk 25w (RMS)

0·1% DISTORTION! HI-FI AUDIO AMPLIFIER

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

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

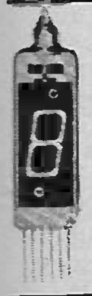
BRITISH MADE. only £3·25 each

STABILISED POWER MODULE SPM80 £2·95

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

TRANSFORMER BMT80 £1·95 p. & p. 25p

NUMERICAL INDICATOR TUBES



MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41/14 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·56	£1·90

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

STEREO PRE-AMPLIFIER TYPE PA100

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

SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50KΩ	Filters: Rumble (high pass)	100 Hz
2. Radio, Tuner	35mV into 50KΩ	Scratch (low pass)	8kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
		Input overload	+26dB
		Supply	+35 volts at 20mA
		Dimensions	292 x 82 x 35 mm

All input voltages are for an output of 250mV.
Tape and P.U. inputs equalised to RIAA curve within ±1dB from 20Hz to 20kHz.

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

only £11·95

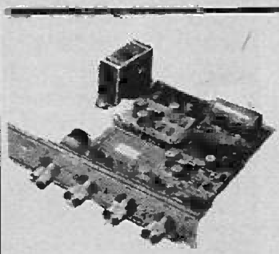
INTEGRATED CIRCUIT PAKS

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

Pak No. Contents	Price	Pak No. Contents	Price	Pak No. Contents	Price
UIC00=12±7400	0·50	UIC46=5×7446	0·50	UIC86–5×7486	0·50
UIC01=12×7401	0·50	UIC47–5×7447	0·50	UIC90–5×7490	0·50
UIC02–12×7402	0·50	UIC48–5×7448	0·50	UIC91=5×7491	0·50
UIC03=12×7403	0·50	UIC50=12×7450	0·50	UIC92=5×7492	0·50
UIC04=12×7404	0·50	UI351=12×7451	0·50	UIC93–5×7493	0·50
UIC05=12×7405	0·50	UIC53=12×7453	0·50	UIC94=5×7494	0·50
UIC06–8×7406	0·50	UIC54=12×7454	0·50	UIC95=5×7495	0·50
UIC07=8×7407	0·50	UIC60=12×7460	0·50	UIC96–5×7496	0·50
UIC10=12×7410	0·50	UIC70=8×7470	0·50	UIC100–5×74100	0·50
UIC13=8×7413	0·50	UIC72=8×7472	0·50	UIC121=5×74121	0·50
UIC20–12×7420	0·50	UIC73=8×7473	0·50	UIC141=5×74141	0·50
UIC30=12×7430	0·50	UIC74=8×7474	0·50	UIC151=5×74151	0·50
UIC40–12×7440	0·50	UIC75=8×7475	0·50	UIC154=5×74154	0·50
UIC41–5×7441	0·50	UIC76=8×7476	0·50	UIC193=5×74193	0·50
UIC42=5×7442	0·50	UIC80–5×7480	0·50	UIC199=3×74199	0·60
UIC43–5×7443	0·50	UIC81=5×7481	0·50		
UIC44–5×7444	0·50	UIC82=5×7482	0·50	UICXI–25 Assorted 74's	1·50
UIC45=5×7445	0·50	UIC83=5×7483	0·50		

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

The STEREO 20



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

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

£12·25 free p. & p.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0·50
C 2	200	Capacitors mixed values approx. count by weight	0·50
C 3	50	Precision Resistors 1%, mixed values	0·50
C 4	75	⅛th W Resistors mixed preferred values	0·50
C 5	5	Pieces assorted Ferrite Rods	0·50
C 6	2	Tuning Gangs, MW/LW/VHF	0·50
C 7	1	Pack Wire 50 metres assorted colours	0·50
C 8	10	Reed Switches	0·50
C 9	3	Micro Switches	0·50
C10	15	Assorted Pots & Pre-Sets	0·50
C11	5	Jack Sockets 3 x 3·5mm 2 x Standard Switch Types	0·50
C12	40	Paper Condensers preferred types mixed values	0·50
C13	20	Electrolytics Trans. types	0·50
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·50
C15	4	Mains Toggle Switches, 2 Amp D/P	0·50
C16	20	Assorted Tag Strips & Panels	0·50
C17	10	Assorted Control Knobs	0·50
C18	4	Rotary Wave Change Switches	0·50
C19	3	Relays 6—24V Operating	0·50
C20	4	Sheets Copper Laminate approx. 10" x 7"	0·50

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

RTL MICROLOGIC CIRCUITS

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

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

DUAL-IN-LINE IC's. TWO Ranges PROFESSIONAL & NEW LOW COST.

PROF. TYPE No.	1–24	25–99	100 up.
TSO 14 pin type	30p	27p	25p
TSO 16 „ „	35p	32p	30p
LOW COST No.			
BPS 14	15p	13p	11p
BPS 16	16p	14p	12p

LINEAR I.C.'s—FULL SPEC.

Type No.	Price 1–24	25–99	100 up
BP 201C—SL201C	63p	55p	45p
BP 701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	36p	34p	30p
BP 709P—μA709C	36p	34p	30p
BP 710—72710	44p	42p	40p
BP 711—μA711	45p	43p	40p
BP 741—72741	76p	60p	50p
μA703C—μA703C	28p	26p	24p
TAA 263—	70p	60p	56p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p
S.G.S. EA1000 £2·62			

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

Type No.	Price 1–24	25–99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

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

SYSTEM 12 STEREO

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

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BEATING THE LASER BUG

The laser bug is no myth – it exists right now. Here's how it works – and how to beat it.

LASER eavesdropping equipments, it is alleged, are being used by Security and Intelligence organisations in quite a few countries, to monitor conversations in rooms up to two miles away.

There is much controversy and some secrecy about this but there is no question that such devices do exist.

In fact, Mr Laisk, a physicist in the Macquarie University (NSW, Australia) and his third-year students have built a laser snooping device and monitored conversations in a room 30 yards away – far short of two miles but it does show the feasibility of such devices.

WHY ARE THEY USED?

The laser bug has many advantages over more traditional techniques.

Possibly the greatest advantage is that no equipment whatever needs to be installed in the premises to be bugged – nor, in fact, does access have to be gained to the premises at any time.

A second advantage – and, to many people, one that is more important than the first – is that the device to some extent obviates the need for telephone tapping.

HOW LASER BUGS WORK

The basic principle is very simple. Any sound generated within a room will cause the windows – and, to a lesser extent, the walls – to vibrate very slightly in sympathy with the generated sound. This effect can readily be demonstrated by applying one's ear to the end of a stick, the other end of which is pressing against the glass. Any sounds within the room will be heard quite clearly.

An even more dramatic demonstration is to turn up the volume of a record player in a small room – when the window glass can often be seen and felt to be moving.

The laser bug exploits this effect. Sound within the room being monitored causes minute vibrations in the window glass (and in the walls). The laser beam is directed against this window. It is therefore now impinging on a surface that is moving at a velocity which is changing in sympathy with the sound inside the room. The changing velocity of the glass surface causes a doppler shift in the laser beam frequency. The reflected beam is therefore frequency modulated by the speech within the room.

The buggers (for want of a more couth phrase) receive the reflected – and now frequency modulated – beam, and mix this beam, together with a sample of the transmitted (and hence unmodulated) laser beam, in a PIN photodiode. The output of the diode is therefore the varying difference frequency between the outgoing and incoming signals.

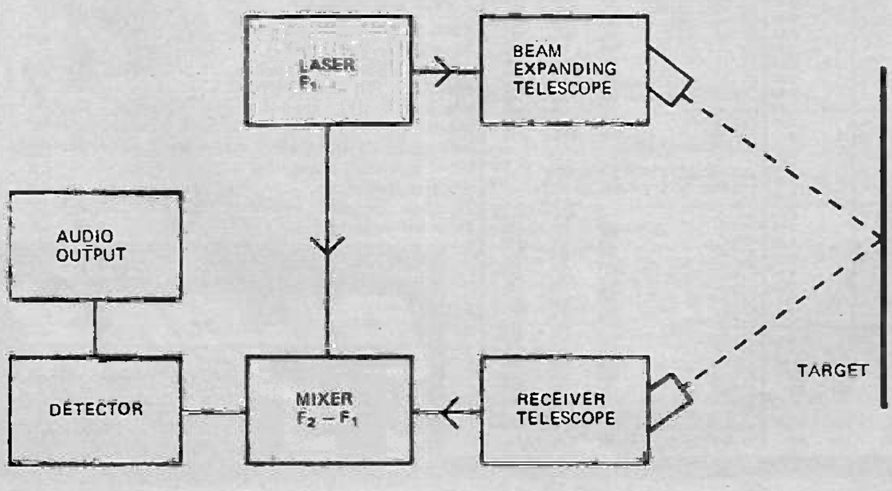
This signal is then further amplified and then detected. In Mr Laisk's equipment the final detector is a special high speed diode from Monsanto. In more elaborate systems, a double heterodyne principle may be used to provide extra gain before detection.

At first sight it would seem essential – in order to receive the reflected beam – to have the receiving and transmitting devices set up so that the beam is normal (at right angles in two planes) to the window glass.

In practice, when the incident ray strikes the glass, diffuse reflection takes place (as well as normal reflection) – i.e., some of the energy is reflected in all directions. Therefore the laser may strike the window from practically any angle, and sufficient energy will be diffusely reflected to provide a usable signal.

And this technique is feasible with relatively unsophisticated detectors such as PIN diodes at distances of 50 metres or more. Where greater range is involved, more sensitive detectors are required – probably operating at very low temperatures in order to provide an increased signal/noise ratio. As reported by Dr Sydenham in his transducer series, one commercially available IR detector system is capable of sensing the detail of a TV tower through 70km of thick fog.

Instruments are available commercially which with slight modifications can be used for snooping. These are known as Laser Velocimeters and are being bought in large numbers for use in industrial control applications. There is no doubt that modified versions of such instruments are being used for surveillance purposes.

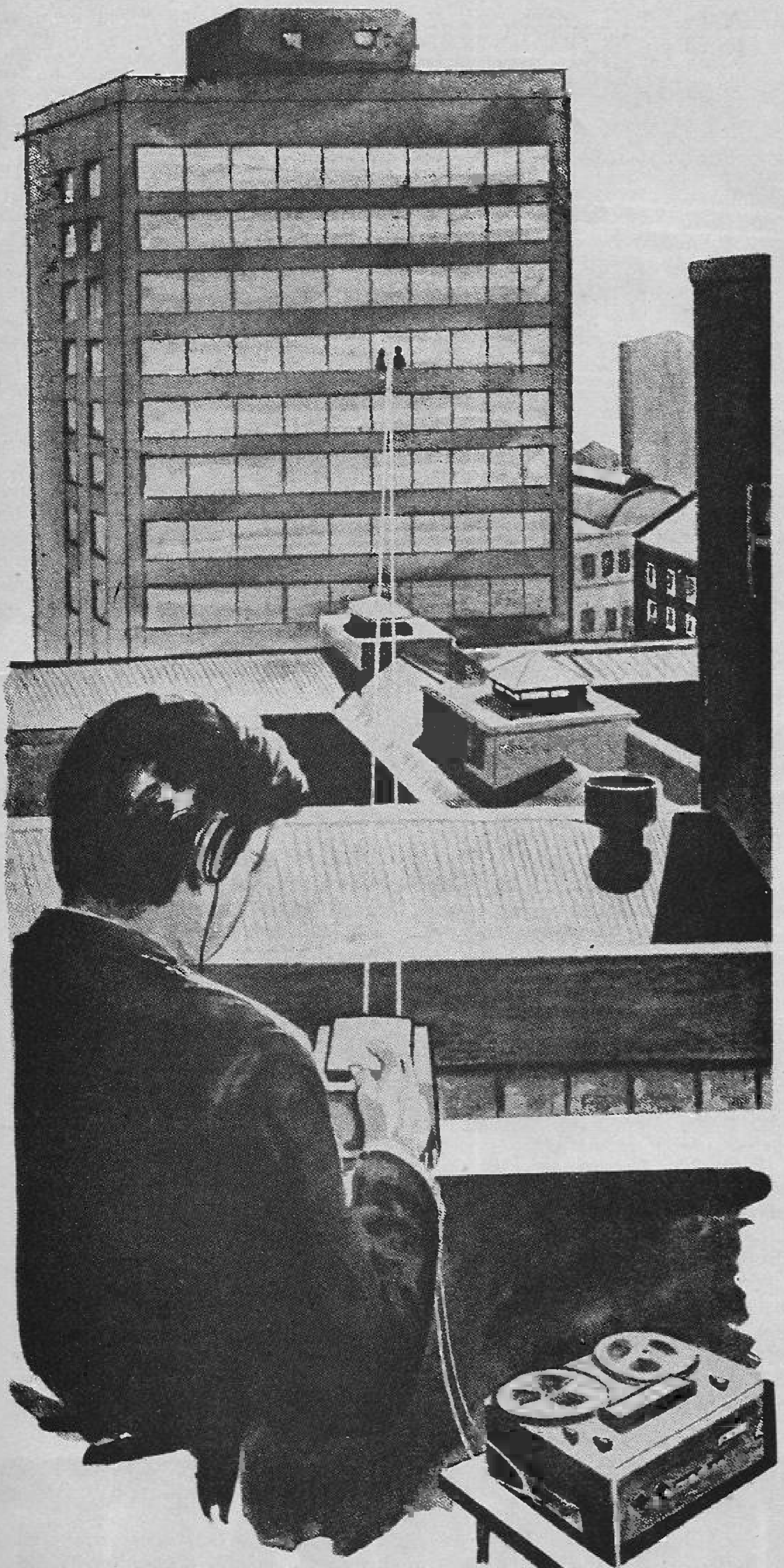


Basic laser bug principle.

WIDE BANDWIDTH

Bandwidth of the modulated signal is very wide. For a laser operating at say 1000mm (i.e. 300 Terahertz), a glass movement of only a few microns at a few kilohertz will necessitate a bandwidth in the receiver of nearly 1GHz! Again, this is readily achievable with modern technology.

The sensitivity of these instruments is extraordinarily high.



Conventional laser interferometers can now detect movements of one angstrom (10^{-10} metres) and it is reported that detection of 1/100th angstrom movements has been achieved.

Thus there is no doubt at all that laser snooping is technically feasible and that equipment is commercially available with the required capability.

BEATING THE LASER BUG

As we have shown, the laser bug is a relatively simple device. It is practically certain to be used by many organisations — especially by those engaged in 'aggressive market research' — or industrial spying as it should really be called.

The easiest way to defeat it is merely to ensure that no confidential discussions ever take place in a room with an outside wall, but such is the sensitivity of the device that even then the conversations should be conducted at a very quiet level.

A more sophisticated approach is to install heavy double glazed windows — with the air space open to atmosphere, the outer pane should then be mechanically excited by a white noise generator (it would also be desirable to install a 'one way' mirror material on the outer pane to prevent optical coupling across the cavity). White noise should also be introduced into the air space of cavity walls.

In a less serious vein — a very effective approach would be to paint the entire outside of the premises matt black. This would totally absorb the energy of the laser beam thus preventing reflection!

Quite simple equipment can be used to detect the beam — but bear in mind that whilst most commercial interferometers use visible light, the laser snooping devices operate in the infra red part of the spectrum and hence cannot be seen. Nevertheless the heat energy can be detected quite readily.

So if you feel yourself getting hot under the collar, who knows? Maybe ASIO, SMERSH, or some other interested parties are after you.

Electronics Today International would like to thank the many academics, scientists and industrial organizations who supplied us with background material for this article.

They are not named — at their unanimous request! ●

Electronic taximeter is located in car radio aperture.

Odd things, taximeters — more moving parts than a steam organ. All except one, that is — an all-electronic unit developed by an Australian firm. Collyn Rivers and Brian Chapman tell how it works.

WOULD YOU believe that taxi drivers almost invariably charge less than their legal entitlement — sometimes by as much as 10%?

Believe it or not, they do. But not from choice — it's just the way their meters work.

The total fare is based on two rates — one relating to time, the other to distance. The taximeter monitors both time and distance and automatically totals that rate which will produce the higher revenue at any given moment. In UK, the taximeter must change from distance to time when speed falls below about 4 mph (the optimum change-over speed is determined by dividing the time rate by the distance rate and expressing the result in miles per hour). Above 4 mph the meter must register 'distance'.

A conventional taximeter monitors distance by counting the number of revolutions of a gearbox-driven cable and time is measured by a mechanically or electrically driven clock. A compensating drive connects the fare-totalling mechanism to the clock mechanism at speeds below 4 mph and to the distance mechanism when this speed is exceeded.

Every time this happens the taxi-driver tends to lose money, because the meter's change-over from time to distance (and vice-versa) is not instantaneous.

There is a lag — and during this time which may vary from one to ten seconds (typically four seconds), the totalling section is not driven and the meter accumulates nothing at all.

DOLLAR-A-SHIFT LOSS

Four seconds' lost revenue may not seem very much, but the average city-based cab accelerates and decelerates through the change-over point of 4 mph over 400 times during each shift. Four seconds multiplied by 400 is the equivalent of one £ or so in lost income, every few hours.

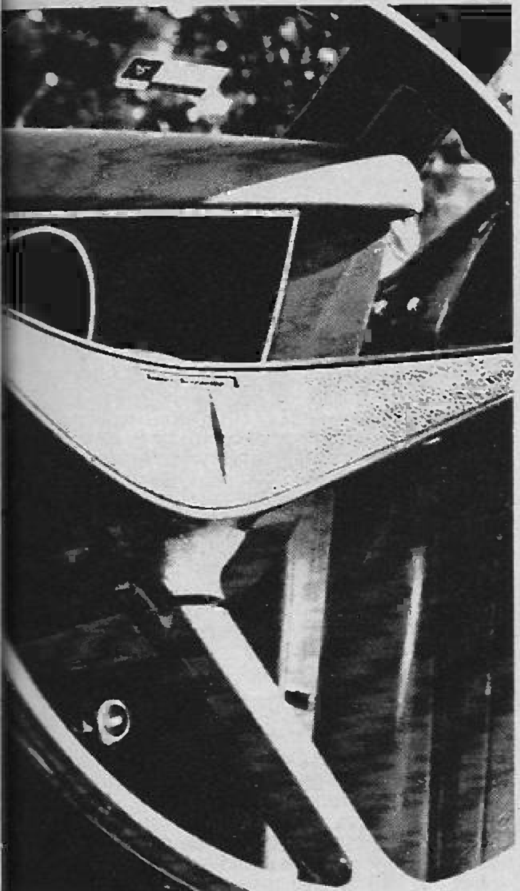
At the industry's average of 13 shifts a week, the lost income mounts up.

And that, say Natronics Pty. Limited, who manufacture and hold world patents on electronic taximeters, is just one of the mechanical meter's disadvantages.

Another is the difficulty of calibration and rate changing. Either, they claim, involves loss of revenue whilst the cab is off the road for half a day, and with many types of meters it is only

SOLID-STATE

TAXIMETER



possible to change rates over a small range.

Whilst a conventional taximeter is a very fine piece of precision machinery, here, felt Natronics, was a classical example of a problem waiting for a more appropriate technology to evolve.

In this case the technology was digital electronics — a technique in which Natronics have considerable expertise.

The application of solid-state digital electronics has resulted in a meter in which most of the older instrument's failings have been overcome in one go.

TAXIMETER USES ICs

Ease of maintenance is one of them. As can be seen from Figs.1 and 2, the taximeter is made up of a number of plug-in circuit cards, each readily exchangable by semi-skilled labour.

The circuitry is illustrated and described in Fig.3. It utilises a number of integrated circuits, most of which are used in divider stages. Readout is by numerical neon tubes.

Calibration and fare-setting is achieved simply by plugging links into appropriate sockets. The operation is completed in a few seconds. Even a change-over from miles to kilometres involves less than five minutes' work.

The big selling feature of the new meter is that the change-over period between 'time' and 'distance' is virtually instantaneous — and, as a consequence, cabs fitted with electronic meters earn at least a dollar a shift more than cabs fitted with nearly all other types of meters.

There is no doubt about this. In an extended test, a director of Red de Luxe Cabs equipped a taxi with both mechanical and electronic meters, driven from the same gearbox take-off and operated simultaneously.

In the suburbs both meters totalled practically identical amounts, but in the city the electronic meter slowly crept ahead and, as expected, totalled a dollar a shift more.

This is the experience of the increasingly large number of drivers whose cabs have gone electronic. On average they earn over a

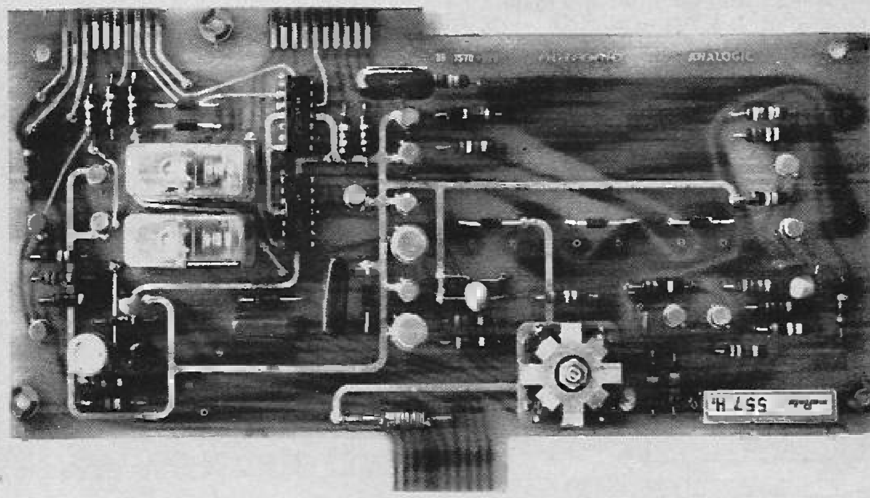
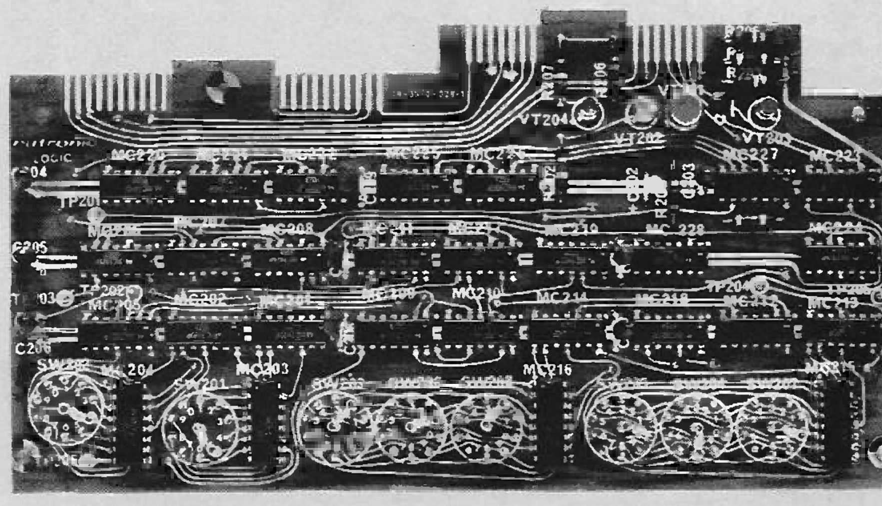


FIG. 1 ABOVE: Analogic board holds Murata piezo-electric tuning fork, relays (left), switch illuminated roof signs. FIG. 2 BELOW: Decade switches on logic board facilitates changing time, distance and flag fall rates.



SOLID-STATE TAXIMETER

dollar a shift more. To which they are legally entitled.

We have one reservation.

If the electronic taximeter really does clock up a dollar more, then someone must be left with a dollar less.

Guess who?

TECHNICAL DETAILS

The electronic taximeter consists of the following sections:

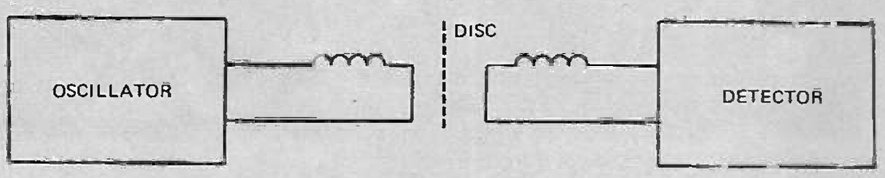
1. Distance transducer and divider stage.
2. Master oscillator and divider stages.
3. Multiple pulse generator and control gating.
4. Decade counter and display stage.
5. Control counter and gates.

Distance transducer and calibration divider

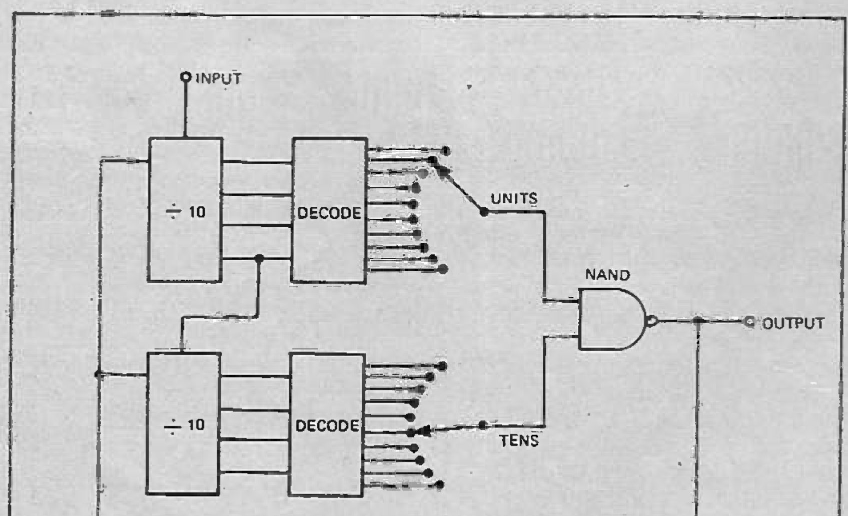
The distance transducer is fitted to the vehicle gearbox between the speedo cable and its housing. An oscillator in the transducer generates an electromagnetic field at a frequency of 7.5MHz in a ferrite-cored coil. This field is sampled by a similar ferrite-cored coil and detector stage. A slotted brass disc rotates between the two coils, chopping the field of the oscillator coil and thus causing the detector output to be modulated. The output of the detector is therefore an analogue representation of the shaft angle multiplied by the number of slots, which for British distance measurement is fourteen.

As the disc rotates it produces a 1.5 volt peak to peak sine wave, the frequency of which is fourteen times the shaft revolution per second. In a normal vehicle, with standard transmission ratios and correctly inflated tyres, 15,600 pulses will be produced by the distance transducer in one mile of travel. As the basic distance reference required is one pulse per one-hundredth of a mile, transducer output must be divided by 156 to produce the required result. This division ratio is purely nominal as tyre wear and inflation will affect the accuracy of the result.

This variable calibration requirement is provided by a 'variable ratio divider', which can be preset to any division ratio between 100 and 199.



Block schematic of distance transducer.



Distance calibration is provided by variable ratio divider which can be preset to any division ratio between 100 and 199.

(Continued on page 32)

Master oscillator and divider stages

The basic time reference is provided by a 'Murata', 557Hz piezo-electric tuning fork. The primary oscillator frequency is divided by two to 278 Hz, then further divided by TTL integrated circuits to provide three main clock frequencies. These are:

1. 27.8 Hz — that is, 100,000 pulses per hour. Used as clock frequency in the time mode.
2. 13.9 Hz — that is, 50,000 pulses per hour, each pulse having a duration of 1/100,000 hour. Used as clock frequency in time and flag modes in time/distance comparator.
3. 0.139 Hz — that is, 500 pulses per hour, each pulse having a duration of 1/1000 hour. This output resets the multiple pulse generator decades when in the time mode.

The two rates, time and distance, are compared in a variable ratio divider stage called the time/distance comparator. Inputs to the unit are the 1/100 mile pulses from the divide by 156 stage and the 13.9Hz. timing pulses. The 1/100 mile pulse resets the divider counters which then commence counting the 13.9Hz. If the count (as preset on a pair of link selectable decade-decoded outputs) is not reached before the next 1/100 mile pulse, the meter will remain in the TIME mode. As the vehicle speeds up, a speed will be reached where the count is completed and the next 1/100 mile pulse will change the meter to the DISTANCE mode.

Multiple pulse generator

Five variable ratio dividers are used. The functions controlled by these dividers are:—

1. Distance calibration.
2. Time/distance change-over.
3. Flag fall rate determination.
4. Time rate determination.
5. Distance rate determination.

These dividers perform a considerable part of the logic requirements of the meter and, in basic form, consist of two TTL MSI decade counters in series, each decoded to decimal by a further IC. The outputs of the decoders are then selected by two switches and fed to an 'AND' gate such that, when the count as set on the switches is reached, the 'AND' gate provides an output.

The flag-fall determination, time-rate determination and distance-rate determination function simultaneously and therefore share common decade counters and decoders. Exclusively 'OR' gates are used to provide the necessary function change for the decades. The combined unit, consisting of three sets of switches, common decade counter/decoders and gating is called the 'multiple pulse generator'.

Decade counter and display stage

The output from the multiple pulse generator and its associated gates is passed to the fare-counting decade counter and indicators. There are three TTL/MSI decade counters in series, each with its TTS/MSI BCD to decimal

(Continued from page 30)

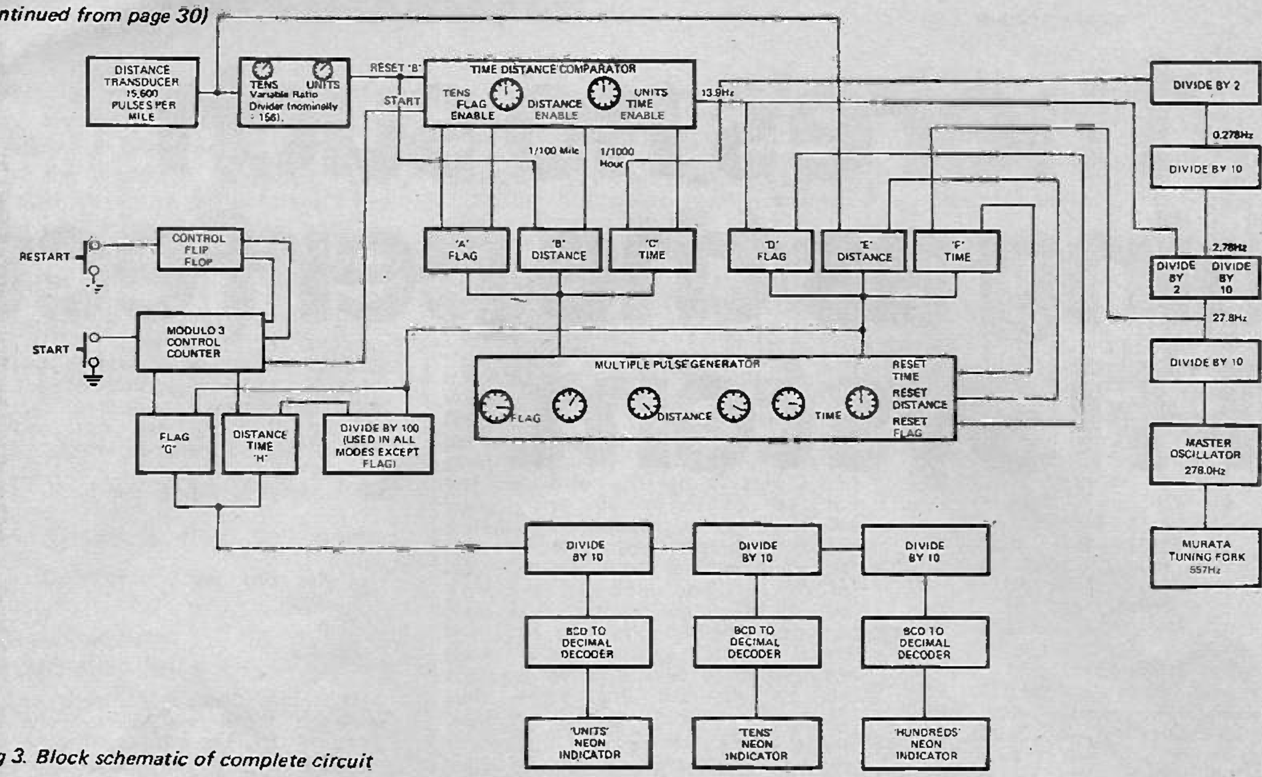


Fig 3. Block schematic of complete circuit

decoder/driver and numerical indicator tube. The decades are thus capable of displaying a total fare of $9.99 and are reset by returning the meter to the VACANT mode.

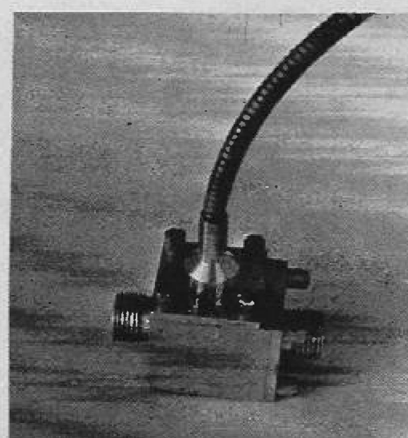
In addition to the indicator tube display there are three mechanical counters, displaying respectively 'total miles', 'engaged miles' and total cents'. These counters are non-resettable and provide a built-in tamper-proof method of counting.

An illuminated roof sign displaying ENGAGED, VACANT and NOT FOR HIRE is actuated automatically by the meter when in the appropriate mode. The front of the electronic meter is without projections; correctly mounted in the vehicle radio aperture, the meter is not a hazard in the event of accident.

Control counters

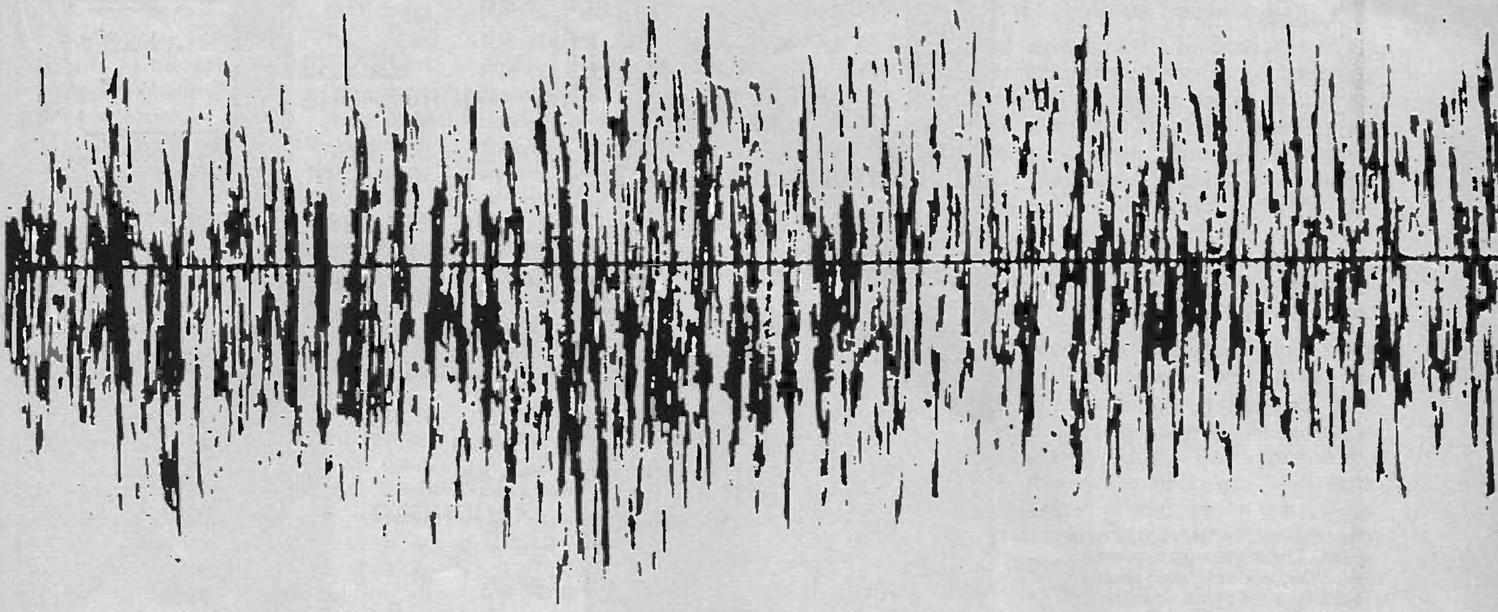
A momentary-action push-button steps a modulo three counter which programmes the meter for its three possible modes. First push of the button causes the meter to register the flag-fall charge and switch to the distance-time mode. The second push puts the meter into a distance-only mode, and third push returns the meter back to VACANT.

A second push-button is provided so that the meter may be returned from the distance-only mode to the distance-time mode, whilst a third switches on the NOT FOR HIRE sign. ●



The distance transducer is a vane-chopped rf oscillator operating at 7.5MHz.

Electronic taximeter displays total fare on numerical indicator tubes.



TESTING SPEAKERS WITH RANDOM NOISE

By EDGAR VILLCHUR

THE supposed inability of objective testing to reveal the quality of a loudspeaker has become a first principle among the "hi-fi" writers and dealers who advise the public on the esoteric mysteries of sound reproduction. Explanations usually have to do with hearing differences in different individuals, differences in tastes, and differences in room environment. All of these explanations make good sense once we accept the hypothesis that a loudspeaker is a new musical instrument, a creator rather than a reproducer of sound.

On the other hand, if the function of loudspeakers is merely to recreate with maximum accuracy sounds that have already had an objective existence, the explanations of why loudspeakers cannot be tested appear quite thin.

Differences in individual hearing have no more to do with comparing a facsimile to its original than differences in vision affect the objective accuracy of a matching sample of colour. The same hearing aberrations are brought into play with both the live and reproduced sound, and do not affect the process of matching.

Taste may determine whether a listener prefers one or another symphony orchestra, or a small string group to a large brass band, but it cannot influence objective determination of the simple accuracy of reproduction.

Room environment profoundly affects the final acoustic output of any sound-reproducing system, but this effect might just as well be used to establish the fact that amplifiers, pickups, needles, or turntables are not subject to objective evaluation. If there is to be compensation for room environment, it should not be sought in loudspeakers.

Taste can be a valid element in establishing preferences of one reproducing component over another in two instances:

1. Where the reproduced sound is accepted as an entity in itself, with little relation to the world of live concert music.

2. Where a choice must be made between different kinds of inaccuracy — for example, intermodulation distortion vs transient ringing.

In the late 1930's the Museum of Modern Art in New York had a special exhibition in which American paintings were exhibited next to colour reproductions of the same paintings in the same size. In many cases it was impossible to tell the difference, or the differences were very small. An observer could judge the accuracy of reproduction

Simple method of speaker testing uses a reference sound to ensure reliability.

TESTING SPEAKERS WITH RANDOM NOISE

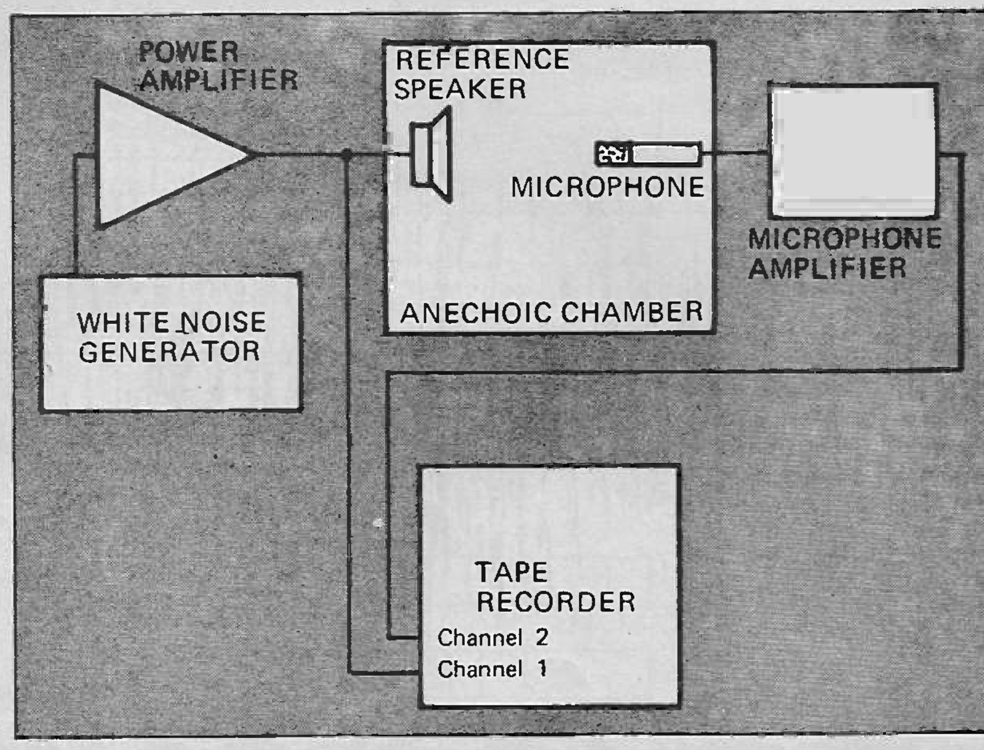


Fig. 1. How the test recording is made. The white noise generator, amplifier, and reference speaker make up a reference acoustical generator, whose sound is recorded in an anechoice chamber.

independently of his artistic taste, the kind of lighting employed. or whether he had astigmatic vision. The kind of evaluation that was called upon was entirely different from that involved in choosing between one painting and another, or between a Stradivari and a Guarneri violin.

The testing method to be described here bears a similarity to the Museum of Modern Art's exhibition efforts. In testing reproducing accuracy, this testing method makes direct reference to the original sound. Its genesis is in two types of experience — the staging of "live vs recorded" public concerts, and the use of white noise input for subjective loudspeaker testing.

In a series of live vs recorded concerts with which the author was associated, a string ensemble would record sections of a movement in a non-reverberant environment. Then, at the concert, live playing would be alternated with electronic reproduction at the same level. This was a direct A-B test between the live music and the reproduced music, with no time lag. Even the musical beat was not interrupted. Small differences in timbre, in transient attack and decay, or in other elements were painfully evident when something was wrong in the record-reproduce chain.

WHITE NOISE INPUT

The use of white noise input, the second type of experience referred to, had been made standard procedure at the author's company (and undoubtedly others) as part of the testing programme for speaker development. Some of the development personnel had worked up to the point where they thought they were experienced enough in listening to white noise to differentiate between "good" white noise and "bad" white noise. Nevertheless, during each test there was doubt and new soul searching in trying to decide which kind of noise best predicted reproducing accuracy. The test signal was, after all, produced by an electrical generator. It started out as a purely electrical signal without independent existence as sound, and there was no sure way of knowing which sound was right.

Each of these test techniques makes up part of a very powerful investigative tool. The white noise technique is able to reveal even subtle distortions in the texture of reproduced sound related to ringing, uneven presentation of acoustical energy in different parts of the frequency spectrum, dispersion, etc. The live vs recorded technique establishes a reference standard, providing validation of the test technique. The two together make up what has proven to be a very sensitive and reliable test for speaker evaluation.

The basic technique is to establish an acoustical reference sound (using a particular white noise generator and a particular speaker), and then to stage a live vs recorded display as was done with the string quartet.

A white noise generator and amplifier provide an input signal which is fed simultaneously to the "reference" speaker (placed in an anechoic chamber) and to one channel of a stereo tape recorder. The acoustical output of the reference speaker is picked up by the microphone and recorded on the second channel of the tape, as shown in Fig. 1. We then have a two-track tape in which one channel represents the electrical input signal that was fed to the speaker, and the other track represents a recording of the sound produced by that speaker.

HOW THE SYSTEM WORKS

In the live vs recorded display the same reference speaker must be employed as standard, mounted on the same baffle. When the recording of the purely electrical input (Channel 1) is fed to the reference speaker, the sound produced is the same sound that had objective existence in the anechoic chamber, before it was picked up by the microphone. It is as though the live quartet performed again, during the live vs recorded display, the music that it had played when the original recording was being made. The system producing the random noise may be thought of as a reference acoustical generator.

The second channel represents a recording of the random noise that existed in the chamber. When the second channel is fed to a speaker under test, at the same volume level as is used for the reference sound, we have a true live vs recorded comparison: The speaker under test is expected to imitate the reference noise, working from a very accurate recording. If the speaker is perfect the sound will be the same as that from the reference speaker. The other elements in the system, assuming well matched channels in the tape record-reproduce system, will have little effect in creating differences in sound. A diagram of the test display arrangement is shown in Fig. 2.

If, on the other hand, the speaker under test has a particular type of coloration, this will be clearly evident. In the live vs recorded displays with a string quartet it was usually impossible to detect the switch-over from live to recorded sound. The verisimilitude of reproduced random noise, however, was never so close that the difference could not be detected. With the best speakers tested the differences were not too great; with lower quality speakers the differences were so gross that it seemed as though the speaker under test were being fed by a completely different type of noise, sometimes with a concentration of energy at some part of the frequency spectrum that was almost identifiable as a tone.

Once we had familiarized ourselves with the technique we then tried the same procedure with musical programme material for the original electrical input. The results were similar although not quite as sensitive, and the kind of colouration predicted by the random noise comparisons was clearly present.

The above is the bare outline of the test technique, and a few comments on some of the details are in order. For one thing, the entire test relies on the ability to make a recording in a highly anechoic environment. If any reverberation is present in the recording made from the microphone, this will be introduced as a false note in the comparison display, an element not present on the channel that was recorded directly from the electrical generator. The reverberation imposed on the sound during the display must be the same for both the live and the recorded noise. As a matter of fact, the staging of this display in a normally reverberant environment is a distinct advantage in that integration of the sound radiated by the speaker at different angles from the axis is automatically taken into account.

SPEAKER MAY BE OF ANY TYPE

Both tape channels were recorded at the same recording level, and extreme care was taken to keep the playback levels of the reference speaker and of the speaker under test the same. This is not as easy as it sounds, because differences in colouration and frequency emphasis affect the listener's impression of loudness. Actually the level of the speaker under test was adjusted until the sound was most similar to the reference sound.

The two tape recorder channels were matched so that the total record-reproduce differences was no more than ½ dB at any frequency. The matching of these channels is, of course, more important than the range of response, although it is desirable to have the complete frequency range.

The creation by a loudspeaker of an exact facsimile of sound on the spot, as it were, is not an exact test of its total function in home reproducing systems. A home loudspeaker system must recreate, within the home acoustical environment, both the original raw sound and the particular "mantle of reverberation" surrounding that sound in the recording hall, an element involving both time and space.

The listener sitting in his living room will then hear something similar to what he would hear if he were at a concert. Success in anechoic facsimile reproduction does not necessarily solve the entire problem. Our tests indicate that it does, at the least, solve most of the problem, and that success or lack of success in facsimile reproduction, especially of random noise, is an excellent index of loudspeaker quality.

The test described is especially useful in comparing two or more speakers — to assign relative evaluations to each, or to test a particular design variation. The reliability of the test reading is very high in spite of its subjective nature because of the existence of the reference sound, and because of the absence of a time lag between comparisons. The very subjectivity serves to isolate those factors significant to aural perception. ●

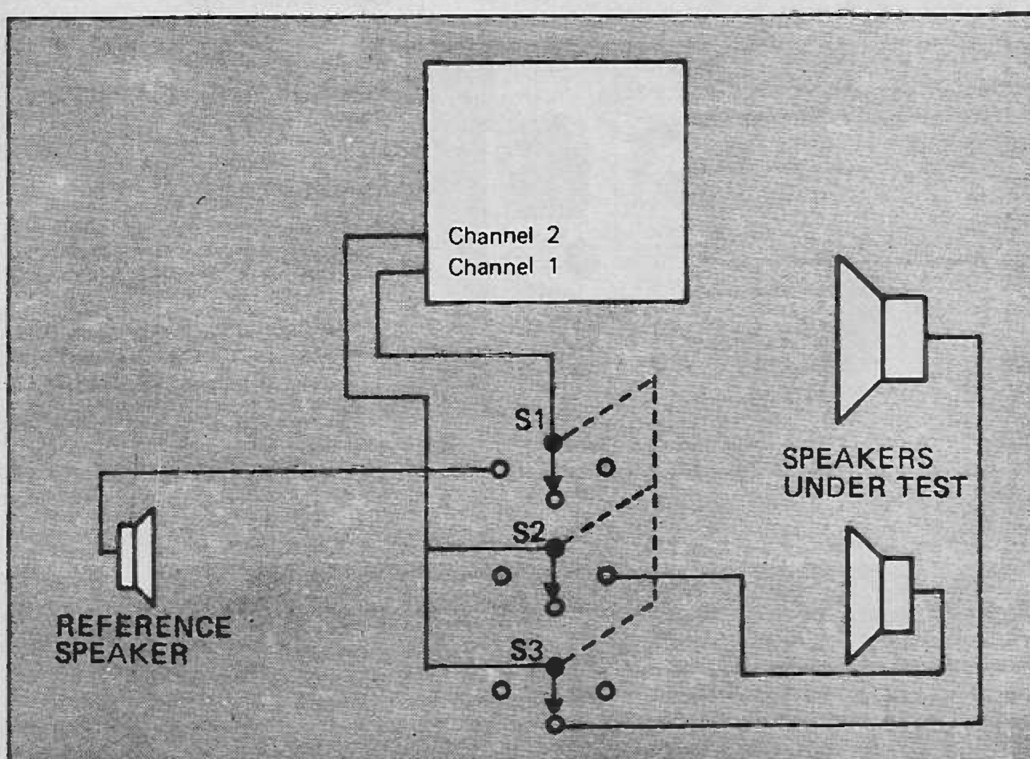


Fig. 2. The live vs recorded test display. The reference sound is recreated by playing channel 1 of the tape through the reference speaker. This is the 'live' display. The speaker under test is then asked to imitate the reference 'live' sound from tape channel 2.

BRUEL AND KJAER TYPE 7001 FM TAPE RECORDER

electronics TODAY INTERNATIONAL **product test**

MAGNETIC tape recording has proved to be of immense value in modern life. From the early beginning in 1898, when the Danish scientist and inventor Valdemar Poulsen demonstrated his first "telegraphone", and up to modern instrumentation tape devices, a tremendous amount of scientific effort and ingenuity has been laid down in modifying and improving the magnetic recording and reproducing technique.

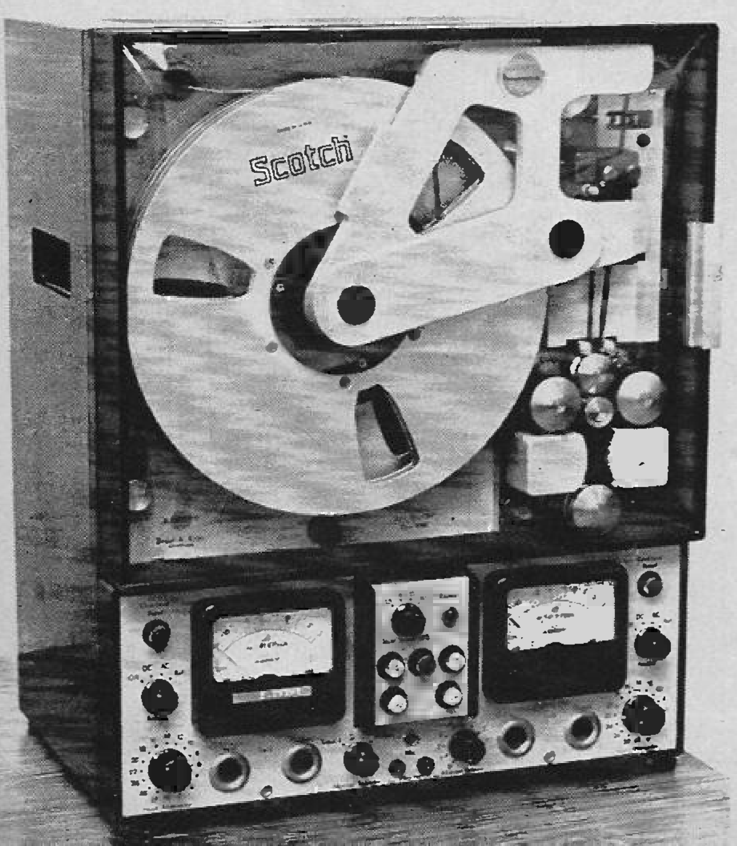
Even though there are many limiting factors in modern tape recording the ability of such systems to store information for later analysis, to expand and compress time scales, and by multichannel recording technique to preserve time coincidence between events, has made the magnetic tape recorder a key instrument in today's instrumentation systems.

The continuous improvement of magnetic recording technique over the last decade has resulted in the development of various recording principles, such as direct recording, frequency modulation, pulse coding, pulse width modulation, amplitude modulation, etc.

All of these types of recording techniques have their advantages and disadvantages, but the most widespread recording principles used for general purposes and analogue measurements today seem to be direct recording (with high frequency bias) and frequency modulation. If the recorded (analogue) data are to be stored for later spectrum analysis of single samples the direct recording technique is the simplest and most economical way of data preservation.

On the other hand, if very high amplitude stability is required, or if the stored data are very low frequency vibrations or contain necessary dc (static) information, the frequency modulation technique is far superior to direct recording.

Precision laboratory tape recorder from Denmark has frequency response from dc to 20kHz. A full report by Murray Wood, BE, BSc, ME. and Louis Challis BE.



The ability of FM recording to record highly stable analogue signals has resulted in several high quality FM recorders being released in recent years. These machines are finding their way into most fields of scientific research, particularly those where analogue processing of the signals is required at a later date. Typical applications for this type of recorder would be to record vibration measurements from bridges, aircraft, oil refinery stacks, etc.

The Bruel & Kjaer company — who manufacturer the Model 7001 recorder which is the subject of this review — produce more precision acoustical and audio frequency measurement equipment than nearly all the other manufacturers of similar equipment combined.

Their Model 7001 recorder is basically a two-channel FM four-speed machine which also has a third channel for speech and control purposes.

In view of the wide range of potential users and applications this test examines both the practical and theoretical aspects of the machine.

FM RECORDING — THE THEORY

Almost any practical ac signal can be interpreted as a sum of simple sinusoidal and cosinusoidal waves. For a basic understanding of, for instance, a modulation process, it is thus often sufficient to consider just one cosinusoidal signal.

$a = A_o \cos\phi$ (1)
where A_o is the maximum amplitude of the signal and ϕ is a continuously varying, generalized angle. For a constant frequency signal of frequency f ,ϕ can be written

$\phi = \int 2\pi f \, dt = 2\pi ft + \Phi = \omega t + \Phi$
where $\omega = 2\pi f$ angular frequency. If the signal frequency is not constant it is useful to define an instantaneous angular frequency

$$\frac{d\phi}{dt} = 2\pi f = \omega \quad (2)$$

In frequency modulated systems the amplitude factor A_o in equation (1) is kept constant while the instantaneous frequency is varied according to some function determined by the modulating signal. Using a simple cosine representation of the modulating signal the instantaneous frequency is given by

$$f = f_o + \Delta f \cos(\omega_1 t) \quad (3)$$

Here f_o is the carrier frequency around which the modulating signal varies with a frequency $f_1 = \frac{\omega_1}{2\pi}$ and a maximum frequency deviation of Δf.

Multiplying equation (3) by 2π and utilizing equation (2) the angle ϕ in equation (1) can be determined:

$$\phi = \int [2\pi f_o + 2\pi \Delta f \cos(\omega_1 t)] \, dt$$
$$= \omega o \, t + \frac{\Delta\omega}{\omega_1} \sin(\omega_1 t) + \Phi_o \quad (4)$$

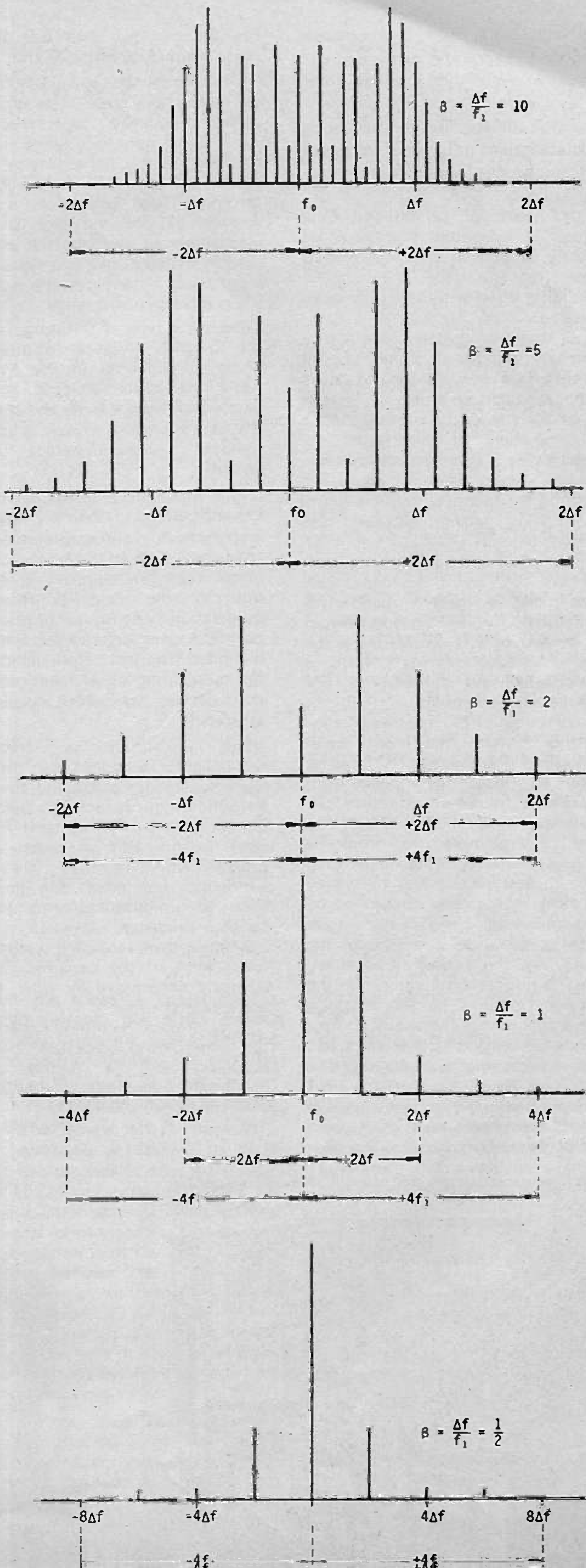
where ϕ_o is a constant, time independent angle (phase angle). An expression for the complete frequency modulated signal is thus:

$$a = A_o \times \cos(\omega_o t + \frac{\Delta f}{f_1} \sin(\omega_1 t) + \Phi_o) \quad (5)$$

It can be shown if ϕ_o is assumed to be 0 the expression given by equation (5) can be mathematically transformed into the following formula:

$$a = A_o [J_o(\beta) \cos(\omega_o t)$$
$$+ J_1(\beta) \cos(\omega_o + \omega_1)t - J_1(\beta) \cos(\omega_o - \omega_1)t$$
$$+ J_2(\beta) \cos(\omega_o + 2\omega_1)t + J_2(\beta) \cos(\omega_o - 2\omega_1)t$$
$$+ J_3(\beta) \cos(\omega_o + 3\omega_1)t - J_3(\beta) \cos(\omega_o - 3\omega_1)t$$
$$+ \text{----------------------}] \quad (6)$$

where $J_o(\beta)$ is the Bessel function of the first kind with argument β and order n, n being an integer. $\beta = \frac{\Delta f}{f_1}$ is a kind of modulation "index" and depends, as can be seen, not only upon the maximum frequency deviation frequency "swing", Δf, but also upon the frequency of the modulating signal itself, f_1. This is due to the dependency of the actual modulating phase angle upon the instantaneous frequency see equation (2).



The ratio $\Delta f/f_1$ max. is commonly called *deviation ratio* and in wide-band FM magnetic recording is in the order of 1:2 or greater.

Equation (6) describes the frequency modulated signal in terms of *sidebands* with frequencies $\omega_o \pm \omega_1$; $\omega_o \pm 2\omega_1$; $\omega_o \pm 3\omega_1$ etc.

It is necessary to establish the number of sidebands that must be correctly handled by the measurement system to reproduce the original modulating signal with negligibly small errors.

Fig. 1 shows modulation spectra of a frequency modulated signal of the kind discussed above for various values of the modulation index. It is seen that as long as $\Delta f/f_1$ is great then a great number of sidebands are necessary for a complete description. However, most of the important sidebands are found within the limits $\pm 2\Delta f$, the spacing between the sidebands being f_1.

On the other hand if $\Delta f/f_1$ is small only one (or two) sidebands are present and a general bandwidth requirement for FM-systems would thus be $4\Delta f$ or $8 f_1$ (whichever is the greater), a requirement which is practically always fulfilled in FM magnetic tape recording.

In practical FM magnetic tape recording systems the input signal frequency modulates a carrier frequency oscillator of frequency f_o to a maximum frequency deviation, Δf, (frequency "swing") of ±40% of the carrier. Furthermore, to obtain a reasonably large dynamic range, even at the highest modulating frequency fmax this is normally chosen to be approximately ¼ of the total frequency deviation (i.e. 20% of the carrier). All the sidebands necessary for a faithful reproduction of the input signal will then be recorded.

The actual carrier frequency chosen, depends basically upon the tape speed and the characteristics of the magnetic head. In the Tape Recorder Type 7001 the highest carrier frequency used is 108 kHz and consequently the highest input signal frequency component that can be recorded with full dynamic range is approximately 20 kHz.

A maximum tape speed of 60 inches per second is used. The choice of carrier frequency, tape speed and input signal frequency range might be regarded as the basic factors in the design of an FM magnetic tape recorder. These factors, and a careful development of the tape transport mechanism as well as the circuitry used in the recording and reproducing electronics, determines the optimum achieveable dynamic range.

The upper limit of this range is set by the so-called deviation ratio and the phase non-linearity in the circuitry, while the lower limit is normally determined by the wow and flutter of the tape transport, as well as spurious (random) noises inherent in the recorder.

The characteristics of the reproducing process cause the amplitude to vary considerably with frequency. This would be disastrous in direct recording/reproducing systems but in the case of frequency modulation systems, it is of practically no importance because the amplitude is limited (clipped) before detection of the modulating signal takes place and the recording tape can be magnetically saturated.

The amplitude vs. frequency non-linearity produced by the tape itself due to demagnetizing effects of neighbouring magnetic areas is unimportant in FM systems for the same reason. But as stated above, phase non-linearities are very important and great care must be taken to minimize and/or compensate for their existence.

In single track recording systems, the lower limit of the dynamic range is normally determined by wow, flutter and spurious noises.

In multi-track recording systems, on the other hand, crosstalk between channels, and a further effect commonly called skew or yaw also enters the picture.

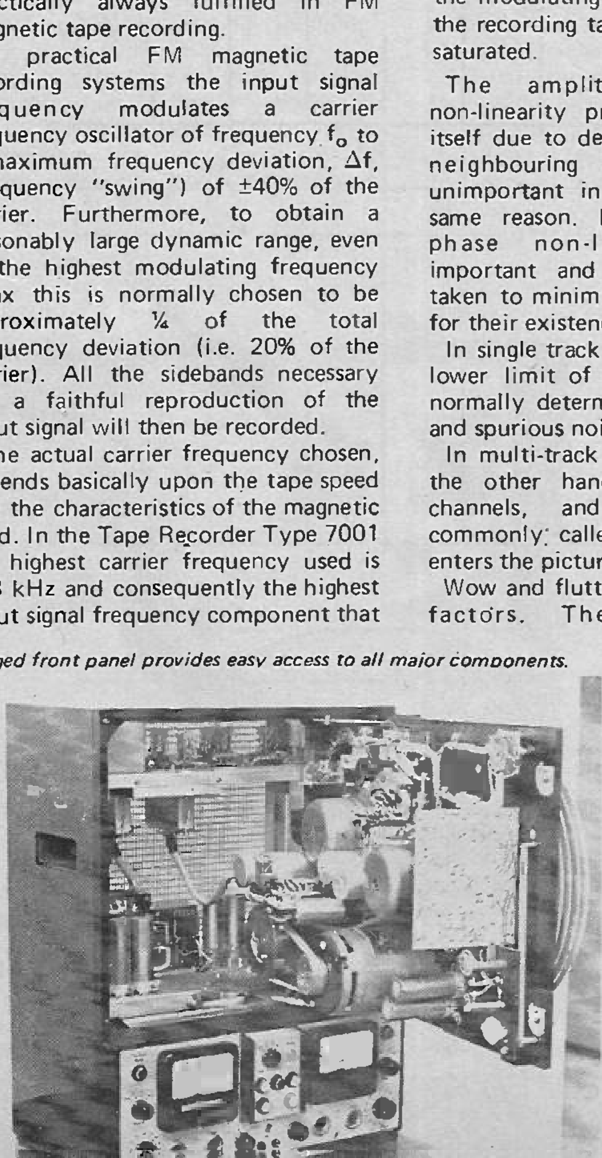
Wow and flutter are caused by many factors. These include small eccentricities in the capstan or pinch rollers, tension variations in the tape, variations in power supply frequency and phase, mechanical vibrations in the recorder, friction effects, and tape roughness.

Some of these factors cause periodic flutter components while other factors are of a more random nature. If the flutter is completely random and no resonance effects are present in the tape system, a more or less white, inherent noise would be expected. The output voltage caused by such a noise would increase with the square root of the measurement bandwidth.

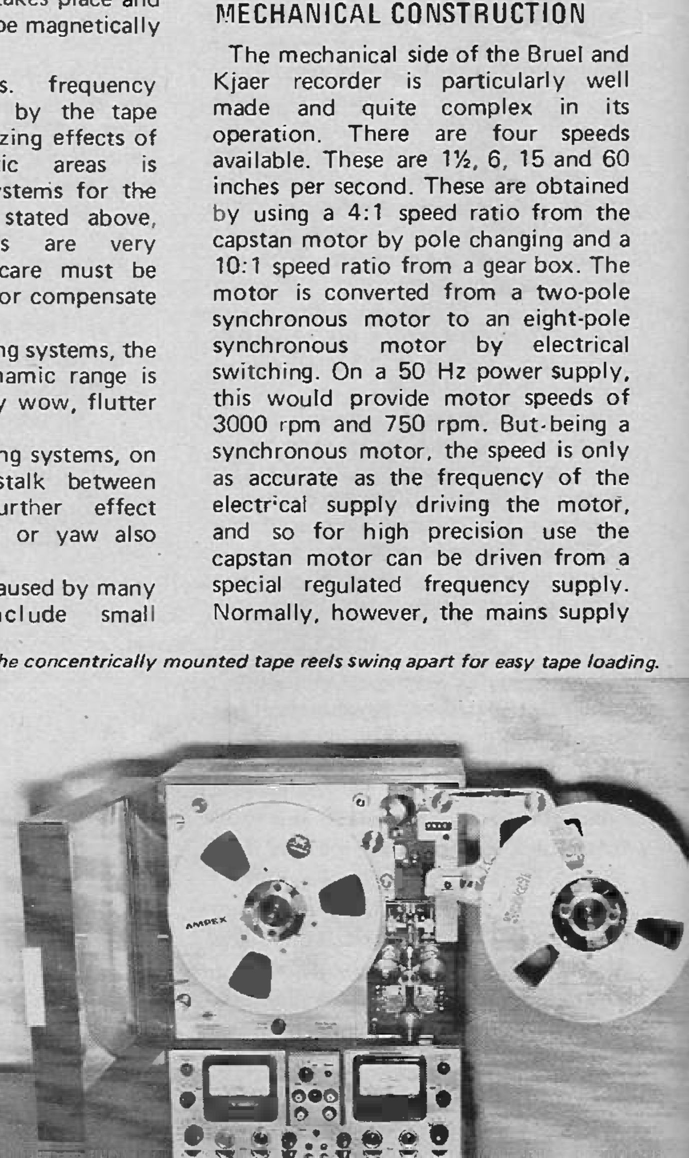
Crosstalk between channels is mainly determined by the shielding and separation distance between the sections of the magnetic heads belonging to different channels. As the crosstalk process is basically different for FM and direct recording systems, the two FM channels in the Tape Recorder Type 7001 have been separated on the tape by a direct recording track. The direct recording channel is, however, only meant as a voice channel for marking and identification of special parts of the tape when desired, and is not intended to be used for measurement purposes.

MECHANICAL CONSTRUCTION

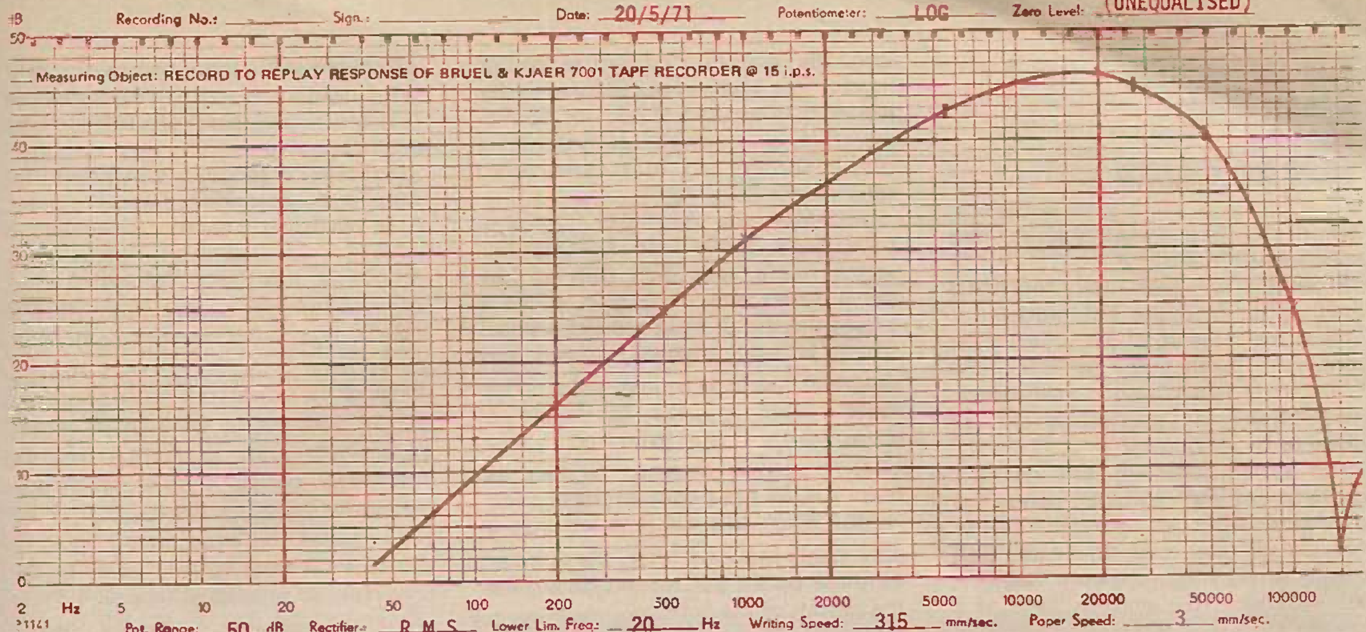
The mechanical side of the Bruel and Kjaer recorder is particularly well made and quite complex in its operation. There are four speeds available. These are 1½, 6, 15 and 60 inches per second. These are obtained by using a 4:1 speed ratio from the capstan motor by pole changing and a 10:1 speed ratio from a gear box. The motor is converted from a two-pole synchronous motor to an eight-pole synchronous motor by electrical switching. On a 50 Hz power supply, this would provide motor speeds of 3000 rpm and 750 rpm. But being a synchronous motor, the speed is only as accurate as the frequency of the electrical supply driving the motor, and so for high precision use the capstan motor can be driven from a special regulated frequency supply. Normally, however, the mains supply

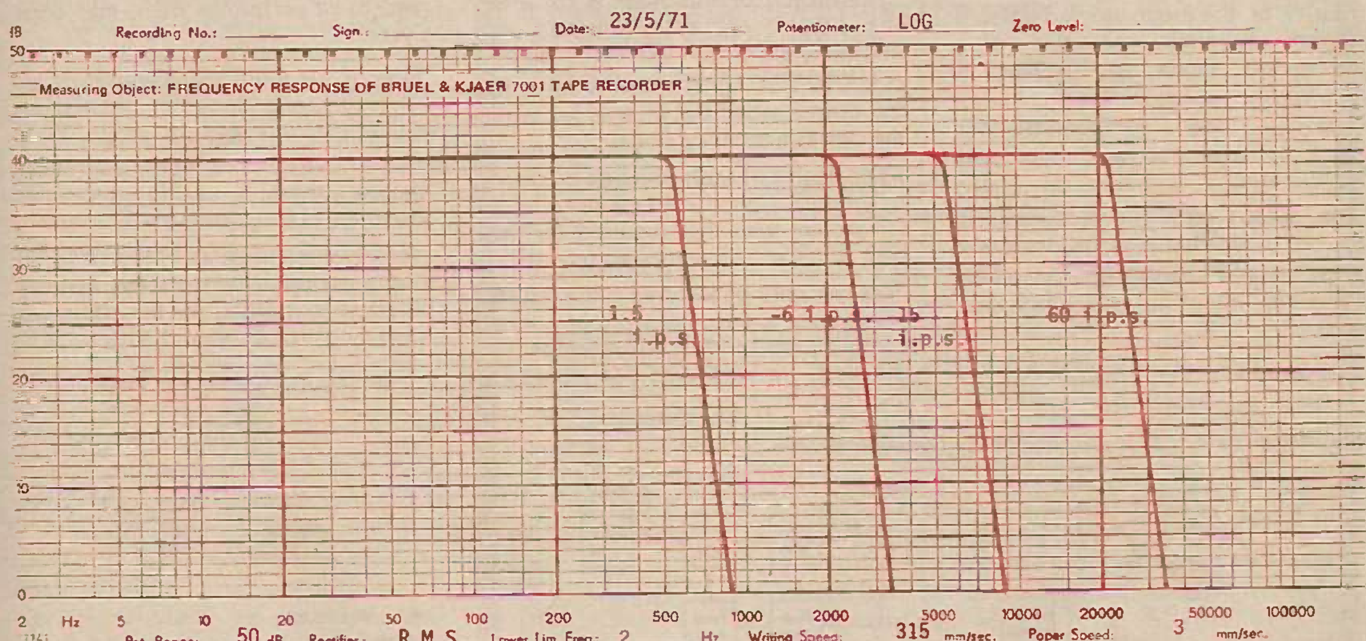


Hinged front panel provides easy access to all major components.



The concentrically mounted tape reels swing apart for easy tape loading.





would be adequate. The selection of the gear box reduction is performed by a solenoid operated clutch and the speed control is therefore entirely governed by electrical switching.

One of the problems associated with high speed tape transport systems is the physical difficulty of accelerating the reels and tape to the required speed. The method used by Bruel and Kjaer is very ingenious and while it would not be satisfactory for frequent stopping and starting, it is adequate for the type of usage envisaged by the designers of the machine.

The spool motors are controlled by servo amplifiers which derive a signal related to tape tension photo-electrically. When the play button is pushed, the tape is moved only by the spools until the speed (as measured by a photo cell on a serrated wheel) is close to the desired operating speed.

When the speed is approached, a solenoid releases the pinch wheels which then press the tape against the capstan both on the feed side and take up side of the heads. This ensures that tension is never high enough to stretch the tape.

At 60 inches per second it takes about two seconds to engage the tape, while at 1½" per second engagement is virtually instantaneous. There are two additional photo-sensors. One is used in conjunction with the controls when changing between fast forward or rewind, or play or record. It insures that the tape is stationary before changing function and thus further protects the tape from high stresses. The other stops the drive motors if the tape breaks at any time.

The actual deck arrangement is unusual in that the supply and take up spools are concentrically positioned so that whilst the recorder takes 10 inch diameter spools the deck is only 15" x 13".

ELECTRONIC CIRCUITRY

The record and playback circuitry of the 7001 Recorder is rather complicated. It consists of two frequency modulators, two frequency demodulators and conventional record amplifier, and a playback amplifier and erase circuit on the voice channel. A full block schematic diagram is shown in Figure 2.

OPERATION

The input signal is fed via an attenuator into a dc amplifier which provides an impedance conversion and a gain of approximately 10 dB. If the output voltage is greater than a preset level, it is clipped thus ensuring that the signal which eventually passes on to tape is within the prescribed limits.

The output from the amplifier is fed into a low pass filter which ensures that the frequency of the signal is

THE BRUEL AND KJAER TYPE 7001 FM TAPE RECORDER

within the frequency range for the selected tape speed.

From the low pass filter, the signal then passes into the FM modulator. This is the stage at which, unless great care is taken to perform the transformation to frequency modulation, the greatest errors are likely to be introduced.

The system used in this recorder consists of a voltage controlled oscillator. Although different carrier frequencies are used for each tape speed, to provide maximum stability, the oscillator frequency is kept at a constant 216kHz. To maintain linearity of the modulator a feedback network is used and this is a demodulator similar to that used in the replay mode. The complex feedback loop compensates for errors both in the modulator and demodulator.

The output from the modulator is fed into a flip-flop type divider chain which divides by 2, 8, 20 or 80 depending upon the choice of tape speed.

The output of the divider is then fed into the glass-bonded ferrite record heads. The level of signal used is far higher than would be used for normal recording since amplitude linearity is not important and it is desirable to saturate the tape.

On replay, the signal from the play back head passes into an amplifier which has a very high gain at low signal levels and unity gain above a preset threshold; this produces a signal which is very severely clipped and almost a perfect square wave. The square wave is used to trigger a monostable multivibrator. This multivibrator is designed so that its output pulse has a constant height and width. When this signal is fed into a very stable low-pass filter, the number of these pulses per second determine the output of the filter.

The output of this filter is fed into one input of a differential dc amplifier, the other input being fed by a constant dc signal which is equal to the output when the filter is fed with the carrier frequency alone.

The degree of sophistication required to produce a good FM tape recorder is far greater than that required for the best of the conventional recorders. This can only be justified if the results are equally spectacular without undue complication in using the machine. In the past, we have used FM recorders which although they gave particularly good results were extremely complex to handle, and hard to calibrate and understand.

However, ergonomic aspects of the Bruel and Kjaer 7001 Recorder seem to be particularly good.

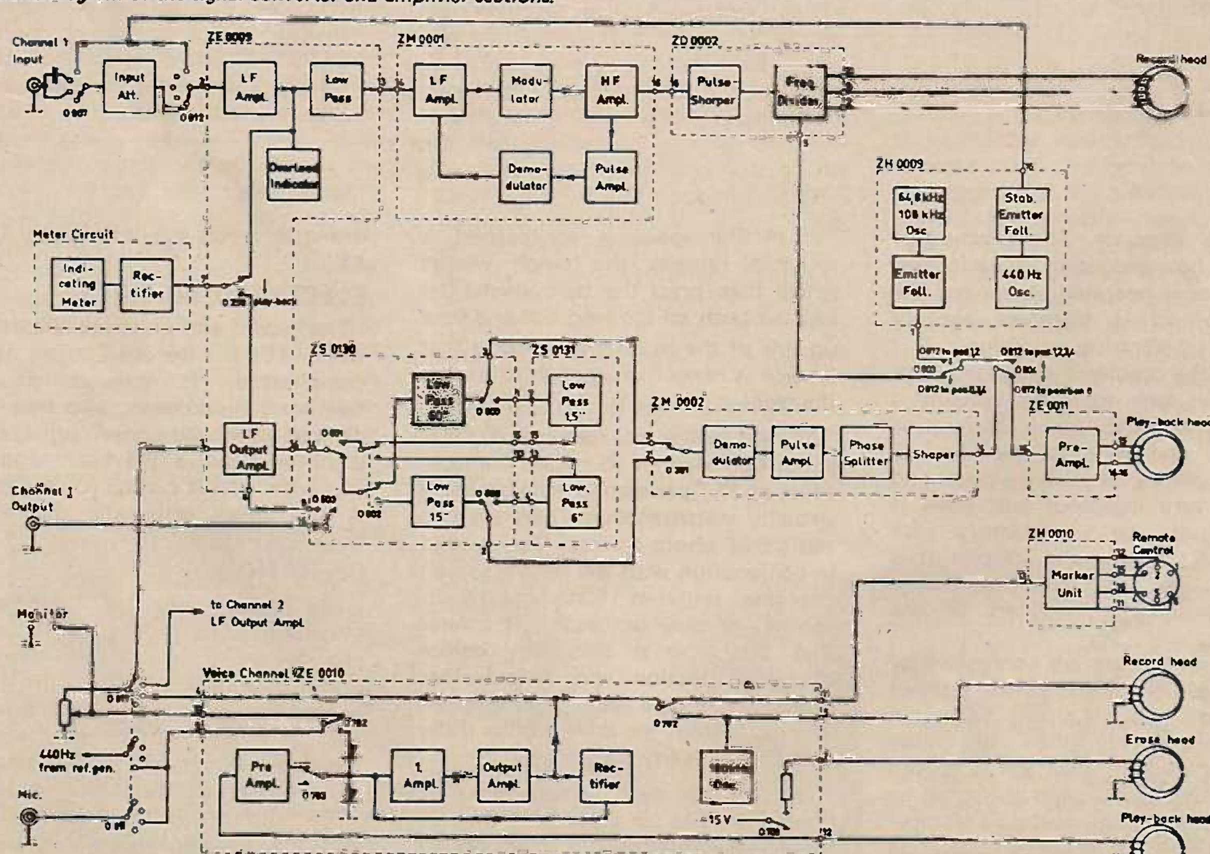
A fairly complex adjustment procedure has been reduced to an almost automatic procedure in which a switch is rotated through four test positions and corresponding screw-driver-adjusted potentiometers set to give meter readings of either zero deflection or 0dB. In the four-week period during which we tested the machine these adjustments only needed to be performed once. If the tape recorder is only going to be used for ac recording (above 4 Hz), these adjustments probably won't need to be performed more than once a year.

One of the more valuable uses of an FM recorder is frequency translation and whilst this can be done in a limited way using an AM tape recorder, there is usually not much advantage to be gained.

However, by using an FM recorder an exact frequency translation can be obtained from dc up to the maximum frequency on record or playback.

Thus by increasing the frequency it

Schematic diagram of the signal converter and amplifier sections.



is possible to look at low frequency phenomena with conventional equipment, while by decreasing the speed, rapidly changing signals can be followed by pen recorders rather than by using ultraviolet recorders or oscilloscopes.

Conventional audio frequency analysing equipment usually covers the frequency range from 20 Hz to 20 kHz. Using the Bruel and Kjaer FM tape recorder, it is possible to extend this range to 0.3 Hz to 20 kHz (or with the newer filters available, down to 0.03 Hz). This frequency range enables the examination of such phenomena as the movement of tall buildings under wind excitation and other effects in larger structures, with conventional analogue equipment. Without the use of such equipment, it is usually necessary to use digital techniques and computer analysis to obtain the same information.

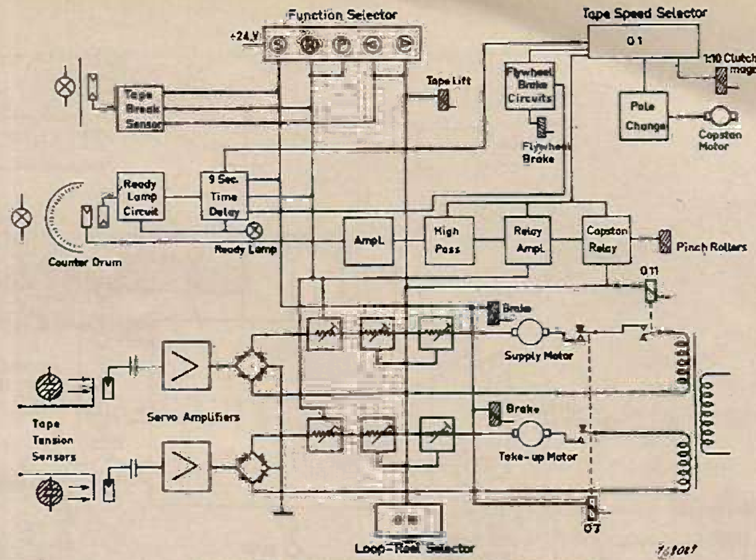
One useful feature is the provision for control and synchronising signals on the tape. These signals may be used with other Bruel and Kjaer analysis equipment to provide automatic starting and stopping of analysis and automatic switching of stepped filters.

This feature is particularly useful for the analysis of single events and does, in fact, enable many of the functions normally performed by real time analyers to be performed on conventional analysis equipment. Using this technique it is possible to examine the spectral content of the noise produced by an accelerating car, the response of a bridge or similar structure to a single impact, and other such phenomena.

For many years, we have used a precision, battery operated conventional tape recorder for storage of data in difficult locations. These locations may be hazardous because of the presence of explosive gases, confined spaces or the difficulty in moving heavy equipment into them. In all these spaces it is desirable to be able to have the minimum of equipment which is preferably battery operated and easy to carry. Unfortunately we feel that the 7001's weight of 85 lbs and its 240 volt 50 Hz power requirement preclude the unit from fulfilling this role.

The only real advantage of the Bruel and Kjaer tape recorder in field measurements is that it provides us with the ability to be able to collect data and subsequently decide which is the best way to process it. Because of its precision, the data is stored with sufficient accuracy for most purposes.

As far as we are concerned, the ideal tape recorder has yet to be developed but the Bruel and Kajer 7001 is a giant step towards it. ●



Schematic drawing of tape transport system.

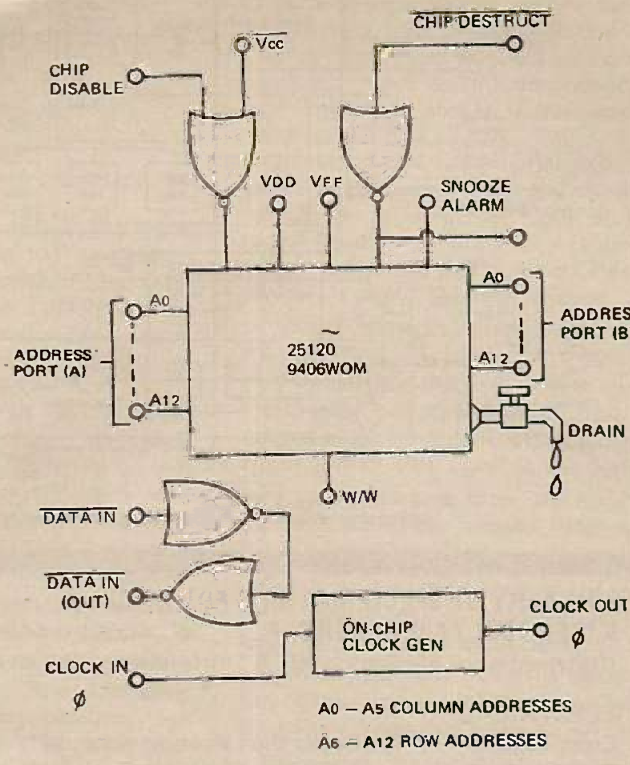
SUMMARY OF SPECIFICATIONS FOR BRUEL & KJAER 7001 TAPERECORDER

(Obtained using 3M Scotch 991 ¼" instrumentation tape)

ELECTRICAL

Cross Talk:	Better than signal to noise ratio
Distortion:	Less than 1.5% with 1 volt RMS output
Input Level	± 1.4 volts peak, with attenuator in most sensitive position.
Record Modes:	AC or dc (The lower limiting frequency of the ac input is 4Hz (-3dB)
Input Attenuator:	0-28dB in 2dB steps ± 0.2dB
Input Impedance	20k ohm in parallel with 100 pF.
Output Level:	1.4 volts peak with no load
Output Impedance	Less than 150 ohm
Heads:	Plug-in ferrite heads
Built-in-Reference Generator	1 volt ± 1%, 440Hz ± 1% sinewave
Voice Channel	For marking and identification of the tape. The frequency response is flat to within ± 3dB from 300 Hz to 3kHz and the channel is equipped with AVC.
Tape Speed Accuracy:	± 0.25% ± accuracy of power line frequency
Braking:	Dynamically during motion. Mechanically while stopping and when stopped.
Automatic Stop:	Actuated by photoelectric sensor which stops the tape transport at the end of the tape or in case of tape breakage.
Tape Tension:	100 ± 10 gramme force during record and playback. Automatically controlled from servo amplifiers.
Tape Counter:	4 digit reset counter counts length in feet. Accuracy better than 0.1% during record and playback.
Remote Control:	Control box removable. Extra lengths of cable can be inserted.
Capstan Motor:	Two speed synchronous hysteresis motor
Reel Motors:	AC torque motors
Power Supply:	100 – 115 – 127 – 150 – 220 or 240 volts ac 100-180W frequency 50 or 60 Hz. Built-in switch allows the capstan motor to be driven from an external precision generator.

Tape Speeds	1.5	6	15	60	ips.
Frequency Ranges ±0.5dB	0-0.5	0-2	0-5	0-20	kHz
S/N Ratio	>44	>48	>48	>48	dB
Carrier Frequency	2.7	10.8	27	108	kHz



WRITE-ONLY MEMORY

WOM special from Signetics incorporates First-in/Never-out (FINO) asynchronous buffers.

A new WOM from Signetics is described in a recent data sheet for the 25120, a fully encoded 9046 X N, random-access, write-only memory. Signetics points out that this is a final specification — and adds the footnote, "until we get a look at some actual parts".

The product is sufficiently unusual to merit substantial abstracting from the data sheet with only slight modification. It follows:

DESCRIPTION

The Signetics 25000 Series 9046 X N Random-Access Write-Only Memory employs both enhancement and depletion mode, p-channel, n-channel and neu[1] channel MOS devices. Although a static device a single TTL-level clock phase is required to drive the onboard multiport clock generator. Data refresh is accomplished during the CB[2] and LH[2] periods. Quadristate outputs (when applicable) allow expansion in many directions, depending on organization.

The static memory cells are operated dynamically to yield extremely low power dissipation. All inputs and outputs are directly TTL compatible when proper interfacing circuitry is employed. Device construction is more or less SOS[3].

FEATURES

- Fully encoded multiport addressing.
- Write cycle time 80 ns (max. typ.)
- Write access time[4].
- Cell refresh time 2 ms (min. typ.)
- TTL/DTL compatible inputs[5]
- Available outputs, n
- Clock capacitance 2 pF max.[6]
- V_{CC} = + 10V
- V_{DD} = 0 V ±2%
- V_{FF} = 6.3 V ac

APPLICATIONS

Don't care buffer stores
Least-significant control memories.
Post-mortem memories (Weapons systems).
Artificial-memory systems.
Non-intelligent micro controllers.
First-In Never-Out (FINO) asynchronous buffers.
Overflow register (bit bucket).

PROCESS TECHNOLOGY

The use of the unique SEX[7] process yields Vth (var.) and allows the design and production[8] of higher performance than can be obtained with competitors' techniques.

BIPOLAR COMPATIBILITY

All data and clock inputs plus applicable outputs will interface directly or nearly directly with bipolar circuits of suitable characteristics. In any event, use 1-amp fuses in all power-supply and data lines.

INPUT PROTECTION

All terminals are provided with slip-on latex protectors for the prevention of Voltage Destruction. (Pill packaged devices do not require protection.)

SILICONE PACKAGING

Low-cost silicone DIP packaging assures reliability by the use of non-hermetic sealing which prevents entrapment of harmful ions while allowing the free exchange of friendly ions.

SPECIAL FEATURE

Because of the employment of the Signetics proprietary Sanderson-Rabbet Channel, the 25120 will provide 50% higher speed than you will obtain.

COOLING

The 25120 is easily cooled by employment of a six-foot fan, 1/2 inch from the package. If the device fails, you have exceeded the ratings. In such cases, more air is recommended.

1. New channel devices enhance or deplete regardless of gate polarity.
2. Coffee Breaks and Lunch Hours.
3. Copywright U.S. Army Commisary, 1940.
4. Not applicable.
5. These inputs can somehow be driven from TTL. The method is obvious.
6. Measured in 1 MHz, 26 mV ac, 1.9 pF in series.
7. Signetics EXtra secret.
8. See "Modern Production Techniques" by T. Arrieta (not yet written).

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100W GUITAR AMPLIFIER

(Feb 1973 issue)

A. Marshall & Son wish to announce that they have constructed and tested this amplifier. Having verified its excellent performance, they have conducted an extensive cost reduction exercise and are offering the kit of parts as a package for £23. 50 to readers of ETI —

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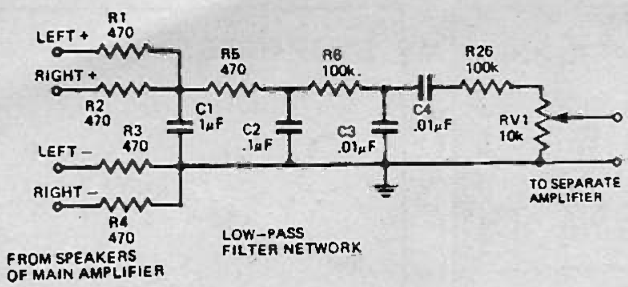


Fig. 1. This filter circuit can be used with an external amplifier.

BASS

ETI PROJECT 407

Many economy hi-fi systems have adequate mid-range and treble response — but sound as if the bottom has fallen out of the amplifier when they come to some good solid bass.

And when you calculate the amplifier and speaker capacity required for realistic bass response you begin to appreciate why.

But all is not lost — for here is a modification that will reproduce the very deepest of bass, at levels practically guaranteed to infuriate your neighbours for life!

Unlike the higher audio frequencies, bass is largely non-directional, and, because of this, the positioning of a bass speaker is not at all critical.

The bass booster described in this project exploits this principle. Whilst in no way affecting the normal output or stereo separation of the existing system the booster effectively combines the bass signals from the left and right hand stereo channels and, following amplification, reproduces them through a common bass speaker.

The system may be used in several different ways.

In its simplest form, the combining filter shown in Fig. 1 is connected to any spare mono or stereo amplifier (rated at 20 Watts or more) and played through a single speaker enclosure that has a good bass response.

In another form the same arrangement is used together with the speaker system specifically designed for bass reproduction (shown in Figs. 6 & 7).

But as few of us have spare high-powered amplifiers lying around waiting for a project like this — we have designed a very simple yet effective amplifier especially for this project. Note, that for this latter arrangement the design of the filter has been changed slightly.

CONSTRUCTION

If the booster is used in its simplest form — using a separate amplifier — the filter should be constructed on a small piece of perforated board or tag strips. The circuit is shown in Fig. 1. The layout is not at all critical.

In the form shown in Fig. 2, the amplifier and filter are constructed as one unit. This complete unit may be mounted within the new bass speaker enclosure (as we did with our

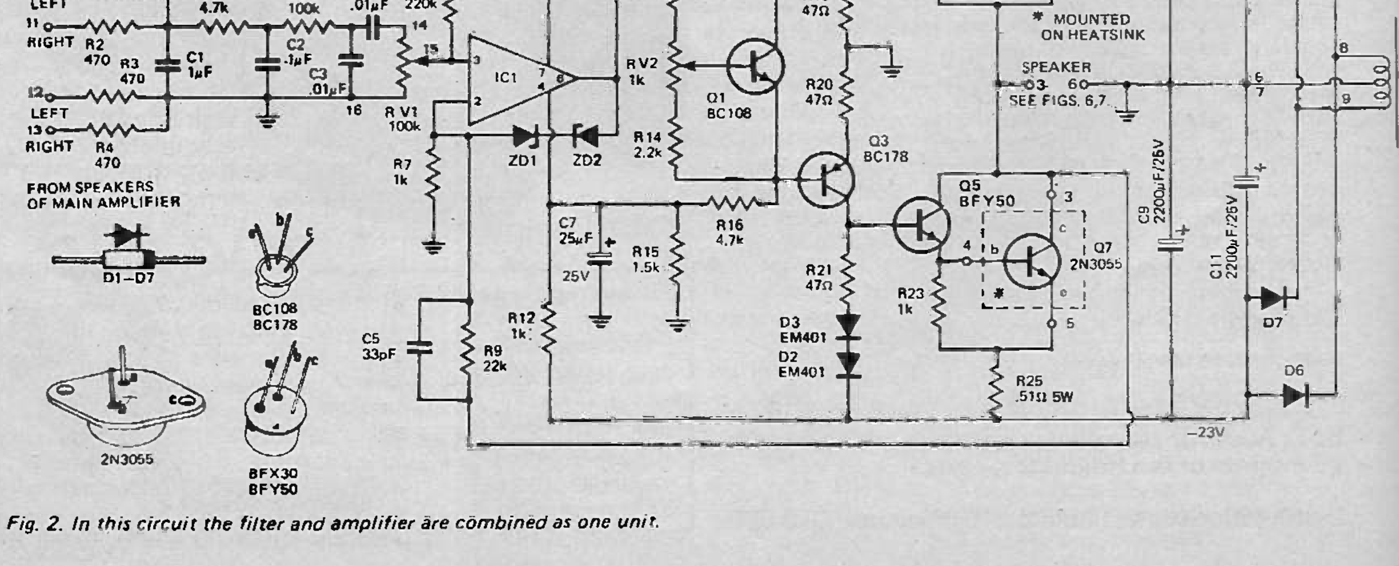


Fig. 2. In this circuit the filter and amplifier are combined as one unit.

BOOSTER

Modify your hi-fi system to provide some real bass performance.

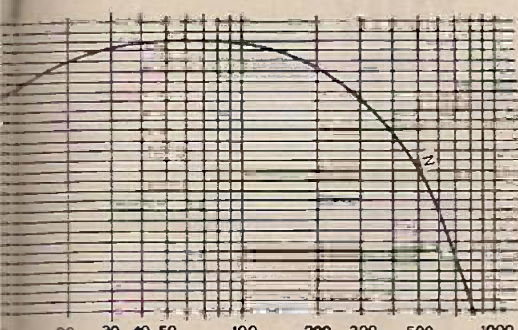


Fig. 3. This curve shows the frequency response of the filter.

prototype unit) or located in any readily accessible place.

Construction of the one-piece unit is quite simple as most components are mounted directly on the printed circuit board — shown full size in Fig. 4. The main power transformer, output transistors and control potentiometer are mounted externally — and connections to and from these components are made via the points numbered on both the component layout diagram (Fig. 5) and the main circuit diagram (Fig. 2).

Make sure that all components are orientated correctly before soldering them into the circuit.

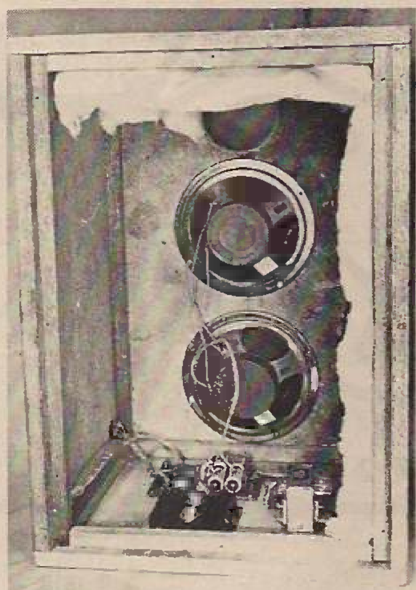
Transistors Q6 and Q7 are mounted on the heatsink — using insulating washers — and connected to pins 1, 2, 3, 4 and 5 as shown in Figs. 2 and 5.

If the amplifier is to be located within the speaker enclosure, the power transformer should be mounted on rubber.

The connections to the inputs and to the volume control should be made using screened cable.

When you are sure that all components have been wired correctly, set the wiper RV2 centre of its travel. Do not connect the speakers at this stage of the operation.

> This project is intended primarily to increase the bass response of economy hi-fi systems. There is little to be gained by using this system where adequate bass already exists.



All components can be mounted within the speaker enclosure.

Switch on the main 240 Volt supply and check the voltage across the speaker terminals. This should be less than 200 mV. If it is substantially higher than this, switch off and recheck all connections. (If a voltmeter is not available, connect one side of the speaker to one side of the amplifier and momentarily touch the second amplifier lead to the remaining side of the speaker. If all is well the speaker should remain practically silent or at most produce a slight 'click'. (If the speaker cone tries to fly across the room — then switch off at once and recheck all connections).

Next, if a milliammeter is available, disconnect the lead to pin 2 and measure the current in this lead. Adjust RV2 until the current is approx. 40 mA. If no milliammeter is available, leave RV2 in mid-position.

Connect the leads from the existing speakers to the filter input and connect the bass speaker to the booster amplifier. The power may now be switched on and the complete system checked out. Remember that the sound from the bass booster will be grossly distorted if this unit is used

PARTS LIST ET 407
(combined filter/amplifier)

R1	—	resistor	470	Ω	½W	5%
R2	—	"	"	"	"	"
R3	—	"	"	"	"	"
R4	—	"	"	"	"	"
R5	—	"	4.7k	"	"	"
R6	—	"	100k	"	"	"
R7	—	"	1k	"	"	"
R8	—	"	220k	"	"	"
R9	—	"	22k	"	"	"
R10	—	"	1.5k	"	"	"
R11	—	"	1k	"	"	"
R12	—	"	1k	"	"	"
R13	—	"	2.2k	"	"	"
R14	—	"	2.2k	"	"	"
R15	—	"	1.5k	"	"	"
R16	—	"	4.7k	"	"	"
R17	—	"	4.7k	"	"	"
R18	—	"	47	"	"	"
R19	—	"	47	"	"	"
R20	—	"	47	"	"	"
R21	—	"	47	"	"	"
R22	—	"	1k	"	"	"
R23	—	"	1k	"	"	"
R24	—	"	0.51	"	5W	"
R25	—	"	0.51	"	"	"
RV1	—	potentiometer 100k log				
RV2	—	preset potentiometer 1k linear				
C1	—	capacitor	1	μF	200V	
C2	—	"	0.1	"	100V	
C3	—	"	0.01	"	"	
C4	—	"	0.01	"	"	
C5	—	"	33pF			
C6	—	"	25μF,25V electro-			
C7	—	"	25μF,25V lytic			
C8	—	"	2200μF,25V "			
C9	—	"	"		"	
C10	—	"	"		"	
C11	—	"	"		"	
Q1	—	transistor BC108				
Q2	—	" BC108				
Q3	—	" BC178				
Q4	—	" BFX30				
Q5	—	" BFY50				
Q6	—	" 2N3055				
Q7	—	" 2N3055				
IC1	—	integrated circuit μA 741C— TBA 221				
D1-D3	—	silicon diodes type 1N4001				
D4-D7	—	diodes 100 PIV, 1.6A;				
(PL4002	—	Henry's Radio)				
ZD1	—	zener diode BZY88 C3V9				
ZD2	—	" " " "				
Transformer		220-250V Primary; 15-0-15V 1.5A Secondary; (MT3AT, Henry's Radio)				
PC	—	printed circuit board ET018				
Heatsink	—	type H11, Henry's Radio				

Insulating kits for 2N3055s
Three core flex and plug
Terminals
Shielded wire etc
Note: C1-C4 — single-ended Polyester
Mullard type C280 or equivalent

PARTS LIST FOR SEPARATE FILTER

R1-R4	—	resistor	470	Ω	½W	5%
R5	—	"	4.7k	"	"	"
R6	—	"	100k	"	"	"
R26	—	"	100k	"	"	"
RV1	—	potentiometer 10k log				
C1	—	capacitor	1	μF	200V	
C2	—	"	0.1	"	100V	
C3	—	"	0.01	"	"	
C4	—	"	0.01	"	"	
Tag strips	—	terminals etc				

(C1-C4 : See Note above)

BASS BOOSTER

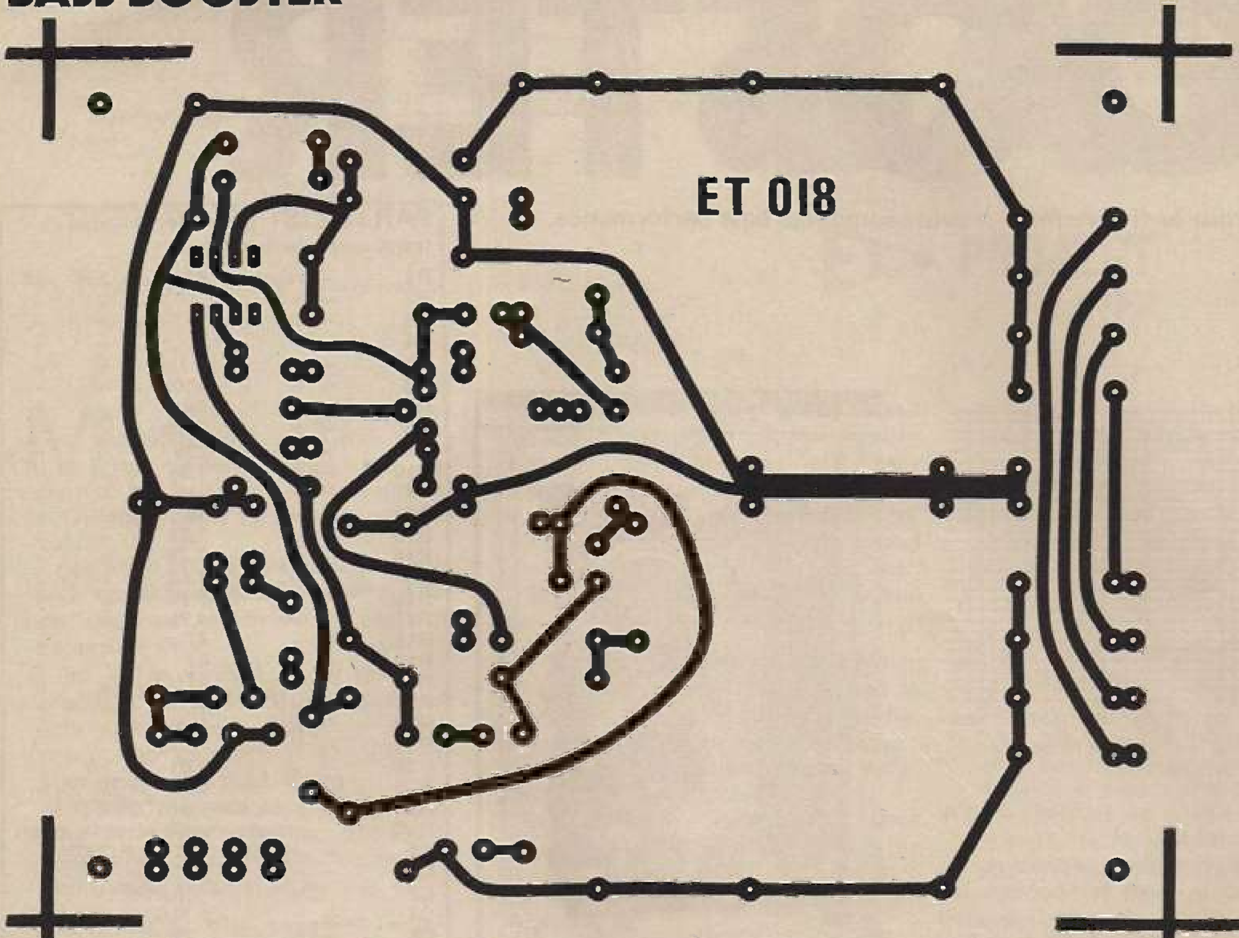


Fig. 4. Printed circuit board – shown full size

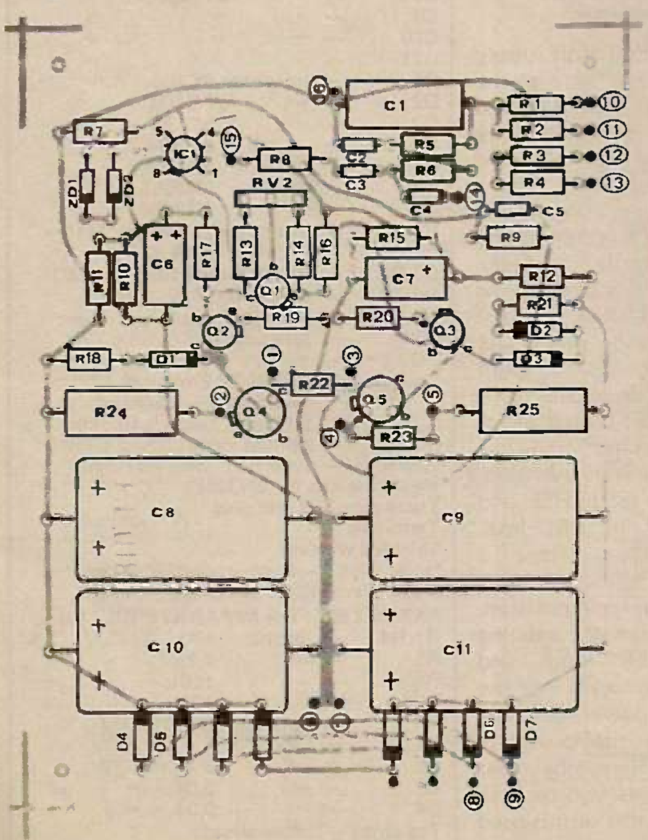


Fig. 5. How the components are located on the printed circuit board.

HOW IT WORKS

The output from each channel of the existing stereo amplifier is combined by resistors R1-R4. Resistors R5, R6 and RV1, together with capacitors C1, C2 and C3 form a low pass filter that has a cut-off frequency around 200 Hz and a final 18 dB per octave slope.

Capacitor C4 provides a high pass filter of approximately (30 Hz to protect the speakers from large transients and dc levels. (The filter shown in Fig. 1 – intended for use with separate amplifiers – has a 20 dB attenuator incorporated before the output potentiometer – this protects the following amplifier against overloads).

The amplifier shown in Fig. 2 has a voltage gain of 23 $\frac{(R9 + R7)}{R7}$, a power output of approx. 25 Watts into four ohms and a frequency response from 0Hz to approx. 50 kHz. However with the input filter incorporated, the frequency response of the amplifier is that of the filter – shown in Fig. 3.

The main voltage gain of the amplifier circuit is provided by IC1. Q2 and Q3. Q4 and Q5 provide the necessary current gain to drive the output transistors Q6 and Q7. Transistor Q1 stabilises Q2 and Q3 while D1 compensates Q4. D2 and D3 compensate Q5 and Q7.

Zener diodes ZD1 and ZD2 protect Q2 and Q3 by limiting the output voltage swing of the IC.

The amplifier described in this project may also be used – without the filter – as a straightforward 25 Watt mono amplifier – in this case diode D2 or D3 (but not both) should be removed from its location on the printed circuit board and relocated on the heat sink.

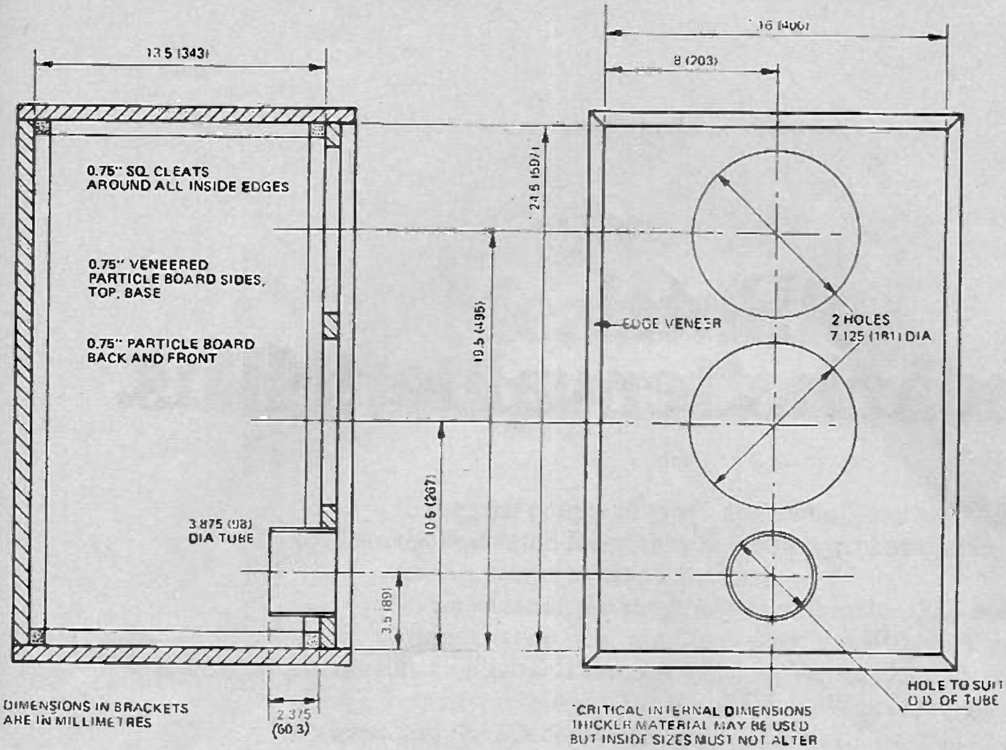


Fig. 6. Constructional details of recommended speaker enclosure.

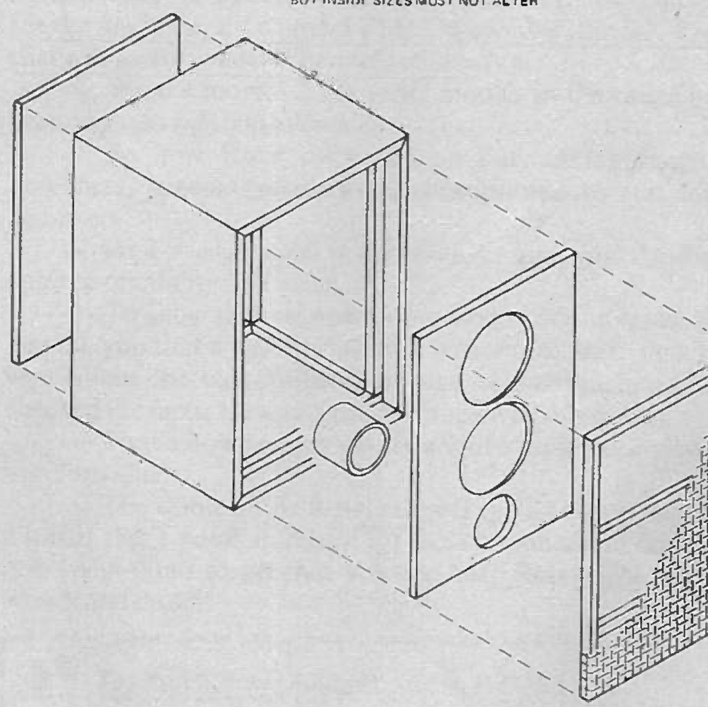


Fig. 7. Exploded view of speaker enclosure.

alone – but when mixed with the sound from the existing two speakers in your stereo system it sounds just great.

BASS SPEAKER ENCLOSURE

The enclosure tested for use with this system is shown in Figs 6 and 7. The speakers used were two 8 ohm Magnavox type 8W connected in parallel, thus having an effective impedance of 4 ohms.

The inside of the speaker enclosure was lined on at least three non-facing surfaces (eg side, top and rear) with absorptive material such as felt (see photo on page 45). ●

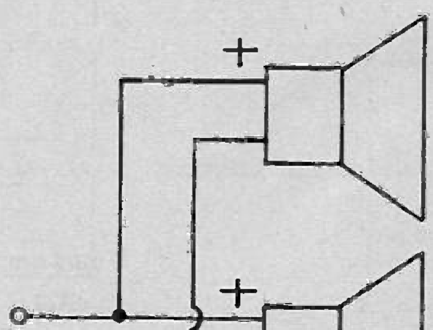


Fig. 8. How the speakers are interconnected.

SCHOOL IN THE SKY

Brazil's imaginative proposal to use satellite-relayed educational TV.

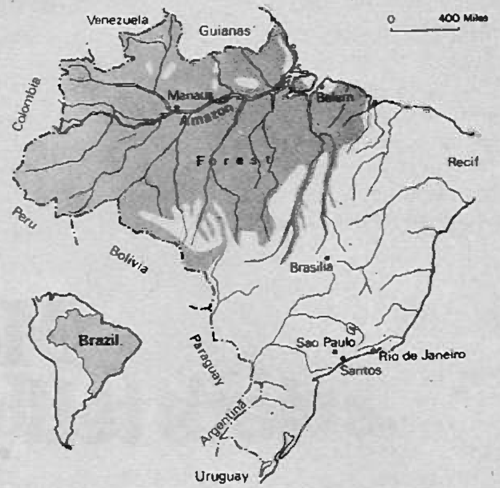


Fig. 1. – Brazil – more than half of South America and the fifth largest country on Earth.

Brazil is a large country – around three million square miles in size. Its population of about 100 million is settled in a few dense areas of intense activity with many widespread and sparsely populated smaller communities.

The nation, fortunately, speaks one main language, but to provide even the most basic education for such a large and growing (two million increase per year) community is a challenging social problem not easily solved by traditional methods.

For it is estimated that, of the 55 million people over the age of 15 in Brazil, around 16 million cannot read or write; and using traditional methods, half a million teachers will be needed – with a growth in number of 50,000 per year.

To solve this problem, some most imaginative techniques have been devised. For a start, the government has established a TV channel in Sao Paulo which transmits solely educational material from 6 p.m. to midnight every night of the week. Viewing centres exist for those not able to afford their own receivers.

TV CULTURA, as this is called, is unusual in many ways; its aim is to provide education for all, and by the best means possible, regardless of traditional patterns of teaching and learning.

Further evidence of the government's awareness of the need to provide education is that all other TV channels must provide 45 minutes broadcasting time per day for the government's purposes; this time is usually devoted to education.

Educational facilities and activities like the above are co-ordinated by the Space Research Centre (INPE) based near Sao Paulo.

But TV CULTURA is certainly not a complete solution to the educational problem faced by the nation as a whole. The CULTURA programmes, for instance, can serve only those areas currently served by the country's

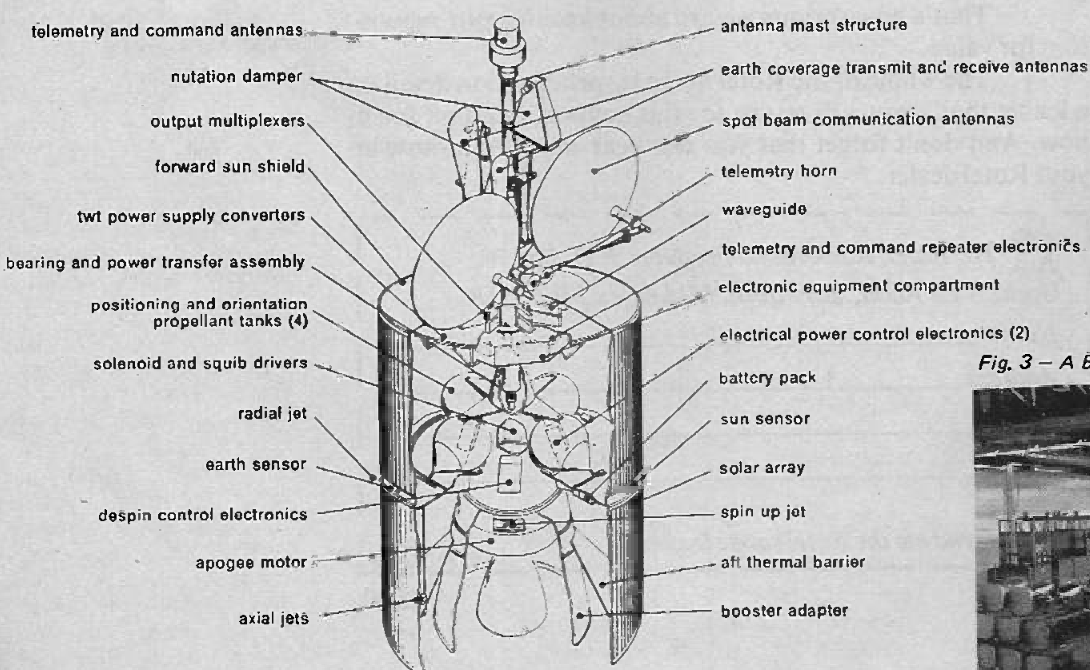


Fig. 2 – Intelsat IV telecommunications satellite with solar cells on its surface to provide power and, on top, the transmitting and receiving antennae and the earth-seeking sensor.

Fig. 3 – A Brazilian TV tube factory.

limited TV network.

Other methods, therefore have been sought to deal with this total problem, and a logical step was to consider nation-wide extension of the existing TV teaching medium and to institute the necessary studies to evaluate such a large-scale programme.

This report has been written by ETI correspondent Dr. Peter Sydenham. It was prepared from interviews and reports made available by Mr. Marcos Azumbuja, First Secretary to the Brazilian Embassy in London; and Professor Sparkes, of Britain's Open University.

TEACHING BY TV

In mass education, teaching by television has considerable merit especially if operated through a single transmitting station. At the broadcasting end, it enables the material to be better and more efficiently prepared, and a uniform standard to be maintained. At the receiving end, a teacher is still required to co-ordinate each class of pupils and ensure continuity of effort • but projectors, films, slides, record players and lesson planning are eliminated; so is the risk of non-arrival of lesson material.

INPE was founded and inspired by Fernando de Mendoza who has also been responsible for the project SACI (Advanced Satellite for Interdisciplinary Communications) described in this article.

The aim of SACI is to provide a method for relaying educational television by means of a stationary satellite positioned above Brazil. The British Aircraft Corporation (BAC) were consulted by the INPE to study the possibilities of teaching the entire country by television.

As a vast expenditure (£150 million) is involved considerable studies have been, and are still being, made to ensure that the final system is reliable and socially viable from both educational and economic points of view.

It is envisaged that the programme will be fully operational by 1976. In the meantime, a pilot project is under way to aid assessment.

In the early stages, there was considerable difficulty in assessing whether microwave links or a central satellite should be used to relay the programmes. The latter was found to be the cheaper. Firm decisions have been taken where possible and details of the transmission system have been more or less finalised. The satellite will be very like Intelsat IV (shown in Fig. 2). The launching rocket and nose-cone stage are already available. In fact the technology used at this end of the system is now regarded as more or less routine.

The problem is not so much how to *relay* the programmes as how to *receive* them at 200,000 stations with adequate reliability and at a low enough cost. The receiving antenna, sensitive head amplifier, power supply and picture unit must together cost no more than two or three times a domestic black and white receiver. Nevertheless, Brazil is able to build the equipment. It has a domestic TV production of 500,000 sets per annum and an additional 200,000 sets can be produced with only a temporary boost in production.

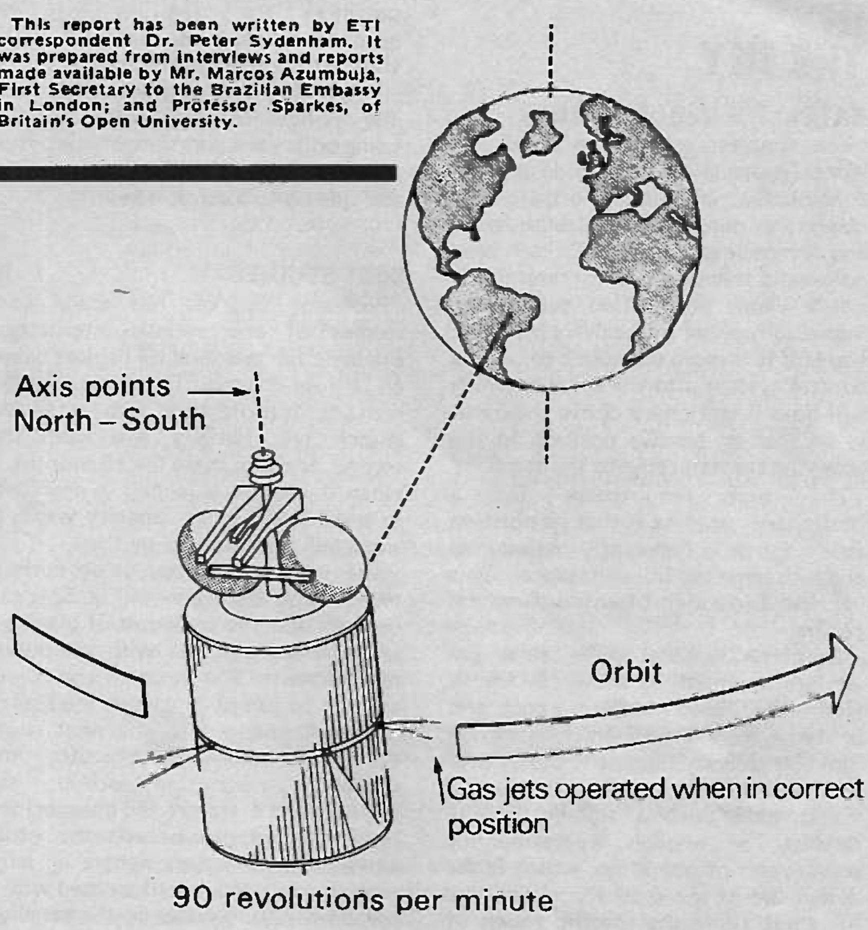


Fig. 4 — A spinning satellite with its 'de-spun' antennae platform.

Not all areas of Brazil have 240V ac mains supplies; so the sets will need to operate on 12V dc and 120V ac supplies as well. In areas without mains supply, bicycle-driven generators will be used. (In this respect, there is a strong resemblance to the pedal-wireless developed in Australia many decades ago — a concept that changed the pattern of life in the outback areas by enabling education and everyday communications to develop — as well as providing a means to summon medical aid).

Problems of tropic-proofing have been mainly overcome and a high standard of equipment and component reliability is expected. Since failures are nevertheless bound to occur, the receiving sets will be made on a modular basis to eliminate the need for specialist servicing.

The design of the receiving antennae has received special consideration. International agreements restrict the transmitted power of a TV channel from a satellite to around 340W. Calculations however show that a transmitted power of around 930W is needed if a reasonably small dish antenna is to be used. Compromises will therefore have to be made.

Main problem is that the power level of the received signal is minute. For example, a parabolic dish of 1 sq metre area captures only 10^{-15} of the power radiated by a transmission antenna covering the whole of Brazil. Reception problems will therefore exist and a specially sensitive pre-amplifier will be needed at the dish terminal.

To comply with the low-cost requirements, three antenna designs are being considered. First, an assembly of aluminium petals fastened together to form an approximate parabola; this is ideal for transport and easy to erect. Secondly, the dish could be formed by using wire-mesh moulded into an expanded polystyrene support. Finally, it is also possible to use pressed-steel dishes fabricated in the presses of the Volkswagen motor works in Brazil. In each case, for prolonged operation in the Brazilian climate, the design should have built-in corrosion resistance.

SCHOOL IN THE SKY

SATELLITE REQUIREMENTS

The simplest satellite to build and launch is one without attitude or orbit control. But, a changing orbit would mean the need for the transmission and receiving antennae to have automatic tracking systems, and this is not a viable proposition due to the immense number of receivers involved. Instead, it is more economic to build a control system into the satellite which will hold it stationary above the Earth — so that its relative position to the receiving stations remains the same.

The first requirement for a 'stationary' satellite is that its position above Earth is constantly maintained and it remains in one place. This involves correction of any drift which occurs.

To correct orbital drifts, small gas jets are operated, as shown in Fig. 4. Hydrazine is used for this purpose, and is stored as a liquid which is turned into the gaseous state as it passes over a catalyst in the nozzle. The normal liquid state enables storage, in the satellite, of enough hydrazine for seven years of operation, which is the design life of the unit. Hydrazine also has three times the specific thrust of the next nearest fuel. A remote link to the ground enables the controlling station to make the minor changes in orbit as required.

The next requirement for the stationary satellite is that its receiving and transmitting antennae remain pointed towards the earth. To do this, the main body of the satellite is made to spin at 90 rpm, providing a gyroscopic thrust that holds the satellite's axis in one orientation. The antennae do not spin with the main body of the satellite. Photo-electric detectors are used to lock the antennae towards the luminous disc of the Earth as seen by the sensors.

Power for the satellite comes from the by-now conventional method of using solar cells and the radiation from the sun. Some 45,000 cells are used to provide up to 1kW of power.

COST STUDIES

Professor Sparkes has made cost studies of the various alternatives available for this satellite project based on a four-channel TV system and a plan to manufacture two satellites, launch one initially and keep the second one as a spare for 18 months — when it will be launched in any case, to provide the extra capacity which is expected to be needed by then.

The estimated costs, using current technology, are shown in Fig. 5. It can be seen that the total cost of placing a satellite in orbit rises with the power requirements. The steps in the curves are due to jumps in cost as the launch rocket is changed to the next larger type available. The greater the available transmitted power, the smaller (and therefore the cheaper) the receiving end can be. At the other extreme is the case where a large receiving antenna could be used with a low-power transmitter in the satellite.

Combining all the costs, Professor Sparkes has derived a graph (Fig. 6) in which transmitted power of around 300W is seen to be an optimum value as it provides the cheapest cost per station. There are, however, other factors that must also be considered, as the cost figures given are, in fact, over-simplifications of the total economics. Our rapidly changing technology could also affect the decision overnight and continuous appraisal is required until the project design has to be frozen.

PILOT PROJECT

Paving the way toward the final 1976 plan is a pilot project that commenced in early 1972. This involves schools in the region near Recife where 20,000 pupils and 1000 teachers from 500 schools are to take part in an education by TV scheme. Another hundred schools in or near this area will be taught by conventional methods so that an objective study can be made of the effectiveness of teaching by TV.

Programmes have been prepared and the schools briefed. Parents have also been informed since they are also to be involved in the study. The first six months of programmes are being used to train the teachers.

Until 1973, microwave links will be used for transmission in this pilot area. Transmission in 1973 will be from the experimental ATS-3 United States satellite. Once the ATS-3 is available, the antennae will be redirected.

CONCLUSION

This report deals only with a possible technological solution to a real and growing problem in many countries of the world today. A solution in terms of educational technology itself may be inadequate since, in all such nation-wide problems, there is always a characteristic inter-dependence between the sociological and technological aspects and objectives.

The Brazilian project is being watched closely by many countries, as it may not only provide the answer for nation-wide integrated education, but could also indicate the way for global education and international co-ordination of many common aspects of life on this planet. ●

Fig. 5 — Cost comparison of two satellites and the necessary launching rocket.

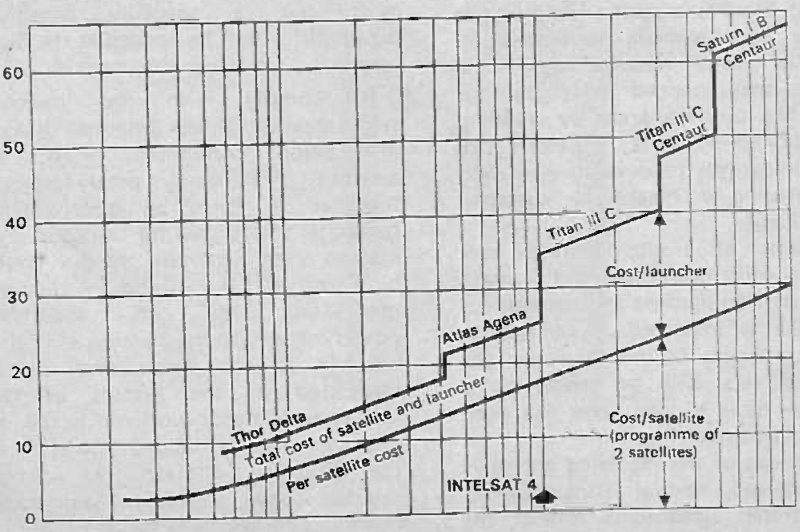
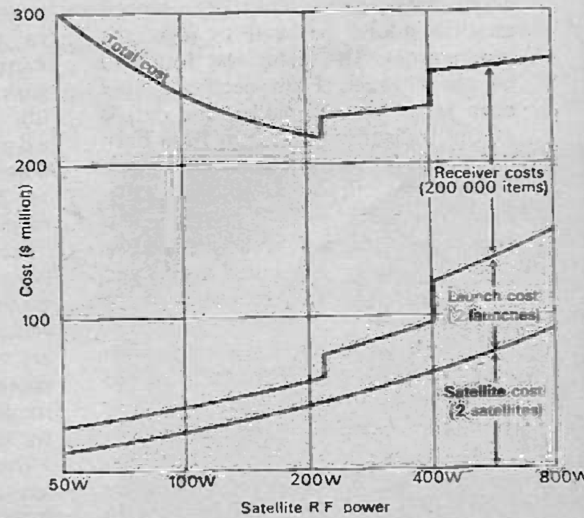


Fig. 6 — Overall costs for a 4-channel educational TV system



AUDIO DISTORTION

oscilloscope aids analysis

Although no substitute for a distortion meter, an oscilloscope can measure frequency, magnitude and phase of distortion components with reasonable accuracy.

Although the harmonic distortion meter and the intermodulation analyzer are *the* specialized instruments for measuring audio distortion, the oscilloscope can also be useful. A scope is particularly helpful in identifying the type(s) of distortion in various trouble situations. The scope may be used directly, or with a harmonic-distortion meter. Nearly all tests of hi-fi equipment place exacting requirements on scope characteristics, as will be explained.

SINE-WAVE DISPLAYS

Let's start with a review of sine-wave displays. Fig. 1 is the basic test setup. The load resistor should have a resistance roughly that of the rated amplifier output impedance and must also have a power rating at least equal to the maximum rated power output of the amplifier. Note that the audio oscillator must have a lower percentage distortion rating than the amplifier under test. Similarly, the vertical amplifier of the scope must have a lower distortion figure than the amplifier rating. Otherwise, the test results become meaningless — we will be measuring test-equipment deficiencies rather than amplifier performance.

Tests can be made at various levels of amplifier power output, but the most useful test is usually the one made at maximum rated power output. Most types of distortion show up most prominently at maximum output, although there are few exceptions. For example, crossover distortion is greater at *low* levels. Therefore, low-level performance must not be ignored.

Distortion must be appreciable before it becomes easy to see, when the method shown in Fig. 1 is employed. For example, Fig. 2 shows 1-kHz sine-wave patterns displayed when the output from the audio oscillator is fed directly into the vertical input terminals of the scope. Although high-quality instruments were used in this example, there is of course a slight amount of distortion. But even a highly experienced scope operator could not state the approximate percentage nor identify the types of distortion in the display.

A reference pattern like that of Fig. 2 should always be set up and observed before making measurements. Not only does it serve as a check on instrument condition, but it also establishes a standard for subsequent observations. Next, let us consider the pattern that is displayed when the 1-kHz sine-wave voltage is passed through an amplifier operating with 1% harmonic distortion. Fig. 3 shows the resulting pattern. Note that although this waveform contains 1% more distortion than the waveform illustrated in Fig. 2, it is very difficult to discern the difference.

When an amplifier operates at 2% harmonic distortion, the operator may be able to observe a departure from the reference pattern. For example, Fig. 4 is an example of 2% harmonic distortion. In this case, the distortion is caused by positive peak compression. This is one of the most common forms of audio distortion: it is caused by a nonlinear transfer

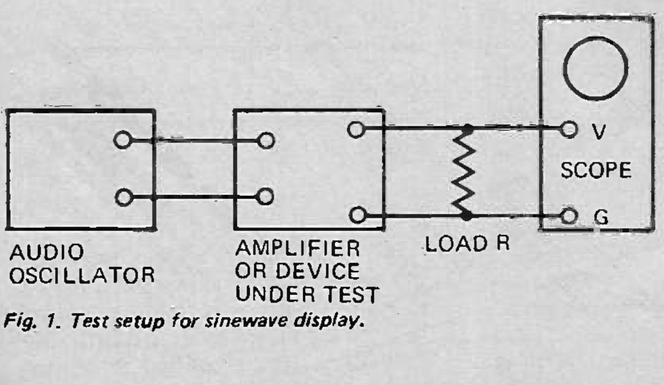


Fig. 1. Test setup for sinewave display.

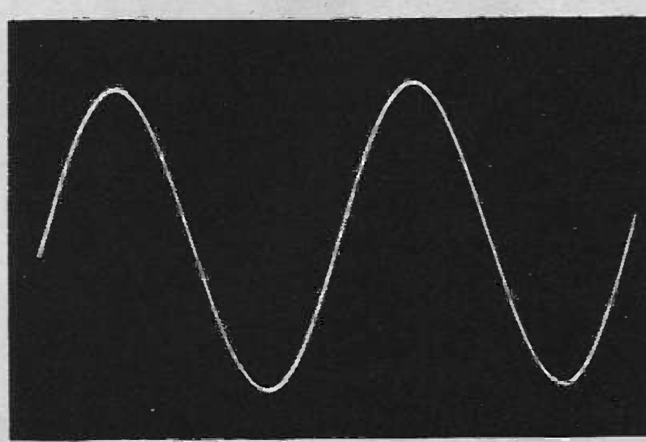


Fig. 2. Reference pattern produced by audio oscillator fed directly to oscilloscope.

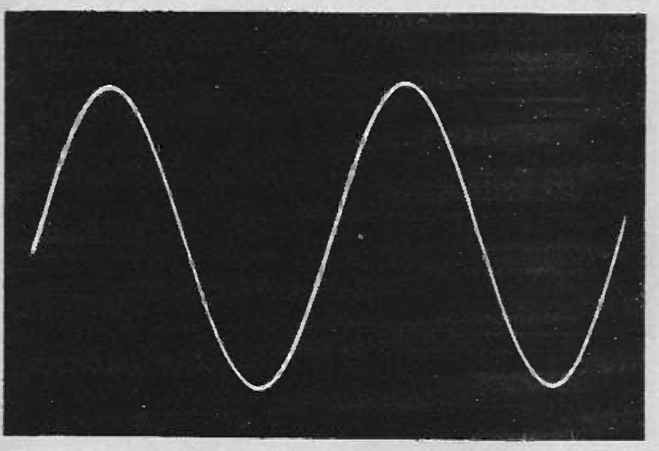


Fig. 3. This waveform has one percent more distortion than that shown in Fig. 2.

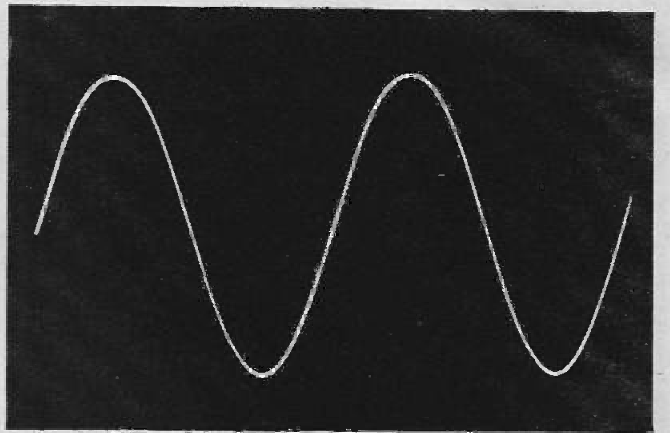


Fig. 4. Two percent distortion becomes noticeable.

characteristic, as depicted in Fig. 5. In this example, the bias point is incorrect. Note that even when the bias point is correct, overdriving inevitably results in double-peak compression or clipping, as shown in Fig. 6.

Higher percentages of distortion are progressively easier to observe in sine-wave patterns, as in Fig. 7. These are also examples of positive-peak compression. The relation of second-harmonic distortion to peak compression or clipping is depicted in Fig. 8. Introducing a second harmonic results in reducing one peak amplitude and increasing the other in the resultant complex waveform. (In general, we can state that assymmetrical distortion is caused by even-order harmonics, while symmetrical distortion is caused by odd-order harmonics.)

Although the ear has little or no discrimination for phase distortion, the resultant waveform of a fundamental and second harmonic, changes greatly with phase shift, and is very prominent in a scope pattern. As an example, if a second harmonic is introduced into a sine-wave with the phase shown in Fig. 9, peak compression does not occur. Instead, a mirror-image type of nonlinear distortion takes place. Note also that a harmonic-distortion meter is "like" the ear in that it has little or no response to harmonic phase relations.

LISSAJOUS DISPLAYS

It is easier to discern small percentages of distortion in scope patterns if we use Lissajous patterns. Fig. 10 shows the basic test setup. A linear time base is not used. Instead, the amplifier input waveform is fed into the vertical channel of the scope, and the amplifier output waveform is fed into the horizontal channel. Although the amplifier roles could be reversed, we usually have more amplifier output voltage than input voltage; and since the horizontal amplifier usually has less gain than the vertical amplifier, the arrangement shown in Fig. 10 is generally most practical.

Note that the audio oscillator need not meet hi-fi standards to be useful in Fig. 10. That is, the test setup is largely immune to distortion in the audio-oscillator output waveform. On the other hand, the scope must have low distortion vertical and horizontal amplifiers. Otherwise distortion in the scope will be charged against the amplifier under test in most cases. It is advisable to make a preliminary equipment check by omitting the amplifier in Fig. 10 and driving the scope's vertical and horizontal amplifiers directly from the audio oscillator. If the scope has low distortion amplifiers, a straight diagonal line will be displayed, as illustrated in Fig. 11-a.

Since no scope can be absolutely perfect, there is a slight amount of distortion in the pattern on Fig. 11-a, although it cannot be discerned. Next when an amplifier operating with 1% harmonic distortion is checked, we note that this amount of distortion is evident, although it might be overlooked by the inexperienced observer. Note in Fig. 11-b that if a straightedge is held against the displayed line, a definite curvature is apparent. This is also the case if we sight along the displayed line from end to end.

Although no industry standards have been established, it is generally agreed that high-fidelity reproduction entails a harmonic-distortion figure of less than 1%. Thus, the examples shown in Fig. 12 exceed high-fidelity limits. These tests were made at 1kHz, which is the standard single-test frequency. The particular curvature in the patterns is characteristic of peak distortion, and is essentially independent of the test frequency. Fig. 13 shows similar patterns for

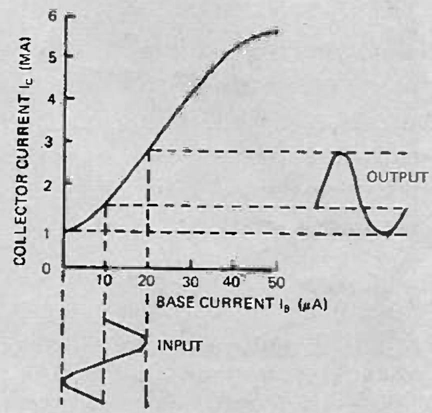


Fig. 5. Distortion due to incorrect bias.

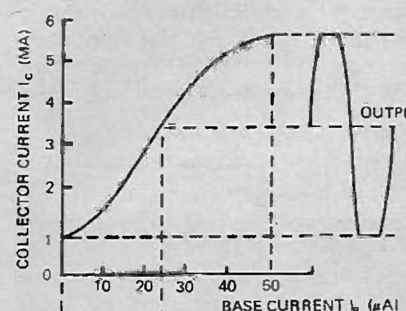


Fig. 6. Overdriving, even with correct bias, will cause distortion by clipping.

higher percentages of distortion. Note that the traces are visibly separated for the examples of 5% and 10% distortion. This is an indication of harmonic phase shift, in comparison to the foregoing photos.

Fig. 14 depicts the basic amplitude and phase-shift Lissajous patterns. We observe that clipping produces a sharp discontinuity in the pattern. All ac-coupled audio amplifiers shift phase in the vicinity of their high-frequency and low-frequency cutoff points. A dc-coupled audio amplifier exhibits

AUDIO DISTORTION-

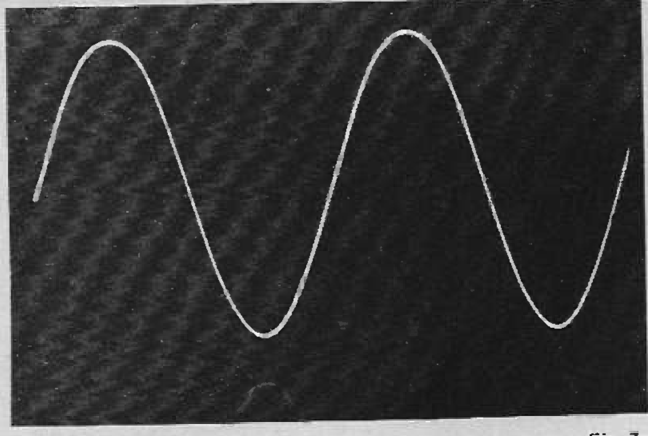


Fig. 7a

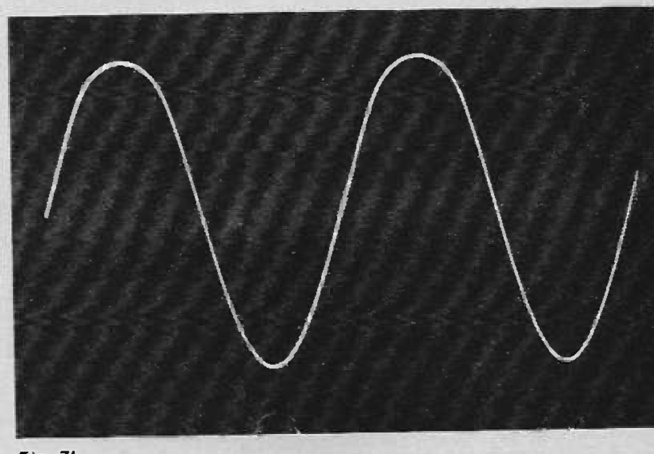


Fig. 7b

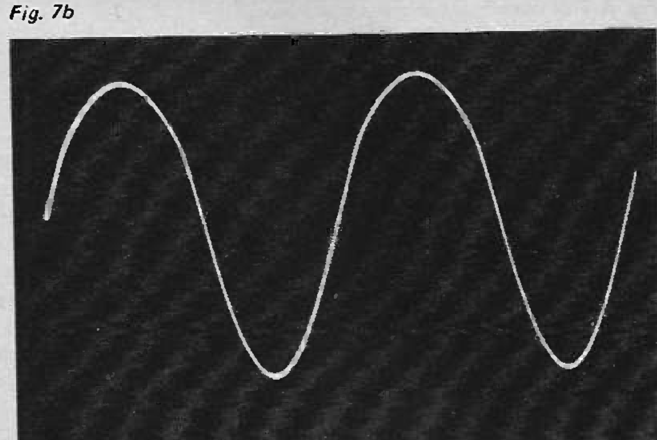


Fig. 7c

Fig. 7. Positive peak compression (a) 3% harmonic distortion (b) 5% (c) 10%.

phase shift only in the vicinity of its high-frequency cutoff point, since its low-frequency cutoff point is zero Hz. As noted previously, the percentage of harmonic distortion due to crossover distortion increases as the output power is reduced.

ANALYSIS OF DISTORTION PRODUCTS

An oscilloscope is also useful for checking harmonic-distortion products, as shown in Fig. 15. This application is least demanding on scope performance, and any service-type scope can be utilized. When the harmonic-distortion meter is adjusted to reject the test frequency (such as 1kHz), the scope then displays the waveform of the distortion products. This is very seldom a second harmonic alone, a third harmonic alone, or a mixture solely of second and third harmonics. In most situations, we will find a distortion waveform that consists of a number of even and odd harmonics. However, one harmonic, such as the second or the third harmonic, is usually dominant. This can be determined by using the scope to measure the frequency of the complex distortion waveform.

Frequency can be measured easily if the scope has calibrated sweeps. For example, if the test frequency is 1kHz, and the period of the distortion waveform is 500 μs, we know that the dominant distortion product is the second harmonic. On the other hand, if the scope does not have calibrated sweeps, a simple comparison test will determine the period of the distortion waveform. The scope is adjusted to display one complete cycle when the harmonic-distortion meter is set to feed the input waveform through. Then, when the harmonic-distortion meter is adjusted to reject the test frequency, we observe how many cycles of the distortion waveform are displayed on the scope screen. For example, if three cycles are displayed, we know that the dominant distortion product is the third harmonic.

Note that phase relations are not troublesome in most cases. For example, Fig. 16 depicts a distortion waveform made up of a dominant second harmonic with a subordinate sixth harmonic. In these two examples, the sixth harmonic has zero phase and 180° phase respectively, with respect to the second harmonic. However, the number of zero crossovers remains the same, and the

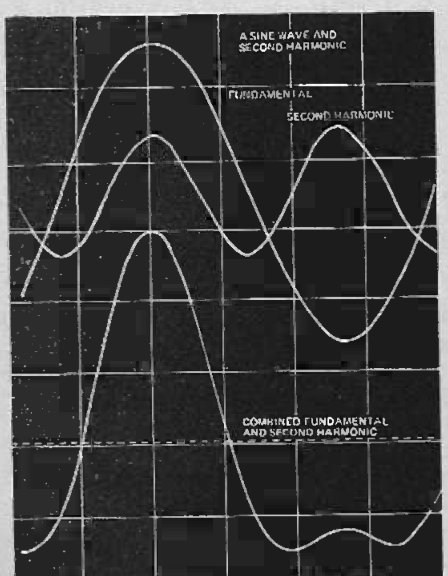


Fig. 8. Second harmonic distortion and its relation to peak compression or clipping.

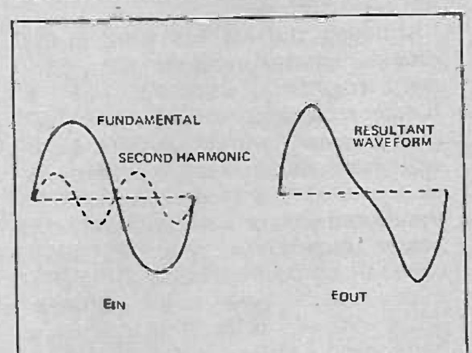


Fig. 9. Mirror image distortion due to phase of second harmonic insertion.

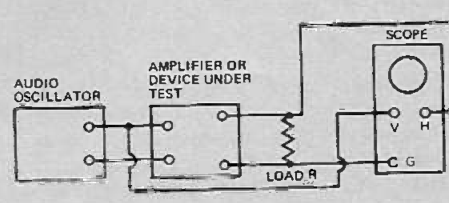


Fig. 10. Lissajous displays can be obtained with the test set-up as shown.

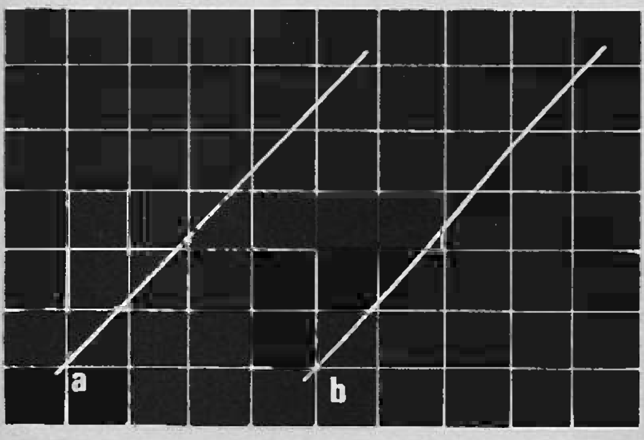


Fig. 11. Lissajous display of amplifier output. (a) negligible, (b) 1% distortion.

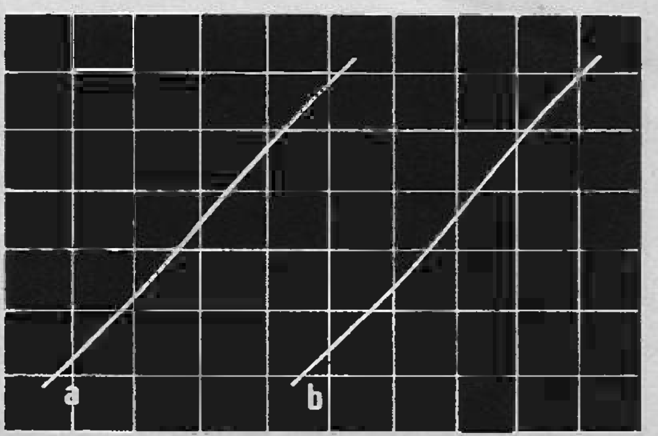


Fig. 12. Increasing distortion is easy to see (a) 1.5%, (b) 2% distortion.

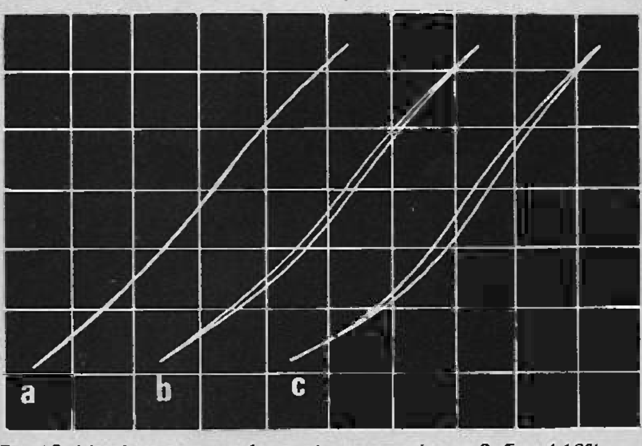


Fig. 13. Lissajous patterns for peak compression at 3, 5 and 10% harmonic distortion.

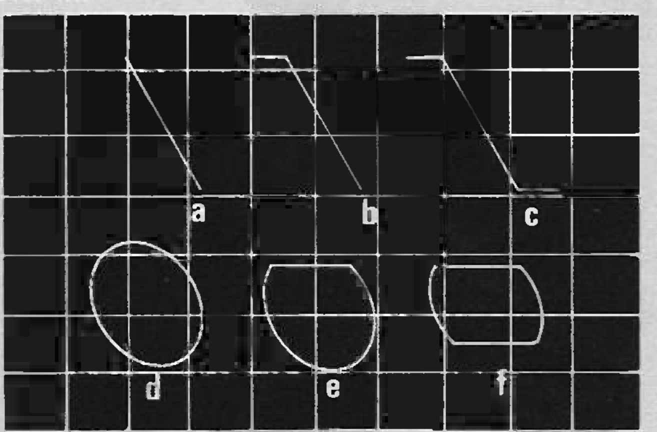


Fig. 14. Classic audio patterns. (a) no overload, no phase shift; (b) peak clipping, no phase shift; (c) double peak clipping, no phase shift; (d) phase shift no amplitude distortion; (e) phase shift and peak clipping; (f) phase shift and double peak clipping.

period of the complex distortion waveform is unchanged.

Finally, we may note that apparent harmonic distortion might be hum distortion in the whole or in part. In either case, scope analysis of the distortion waveform will quickly show whether 50-Hz or 100-Hz hum voltage may be present.

CONCLUSION

Although the harmonic-distortion meter is the basic instrument for measurement of audio distortion, the oscilloscope is a useful supplementary instrument. When an harmonic distortion meter is not available, a scope can be used for qualitative and even for rough quantitative analysis of distortion. The most useful approach is to display in input-output Lissajous pattern. To obtain meaningful results, both the vertical and the horizontal amplifiers of the scope should have low distortion. A scope is also useful for checking harmonic-distortion products in audio circuits when used with an harmonic-distortion meter. ●

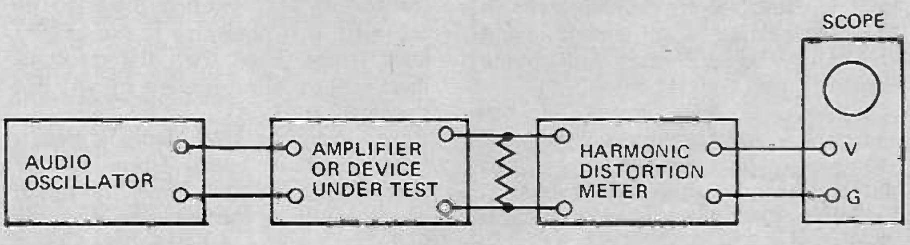


Fig. 15. Harmonic distortion test setup for analysing distortion products.

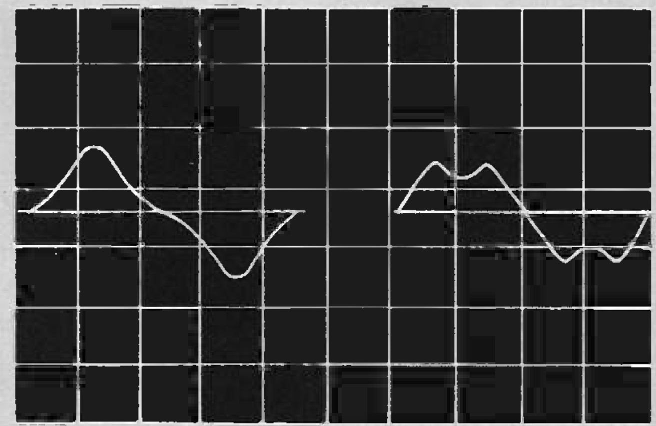


Fig. 16. These two distortion waveforms are alike except for relative phase relations.

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INVERTER FOR FLUORESCENT LIGHTING

Specifically designed for portable use, this 12V dc to 240Vac inverter operates at 2kHz for optimum efficiency.

ETI PROJECT 516

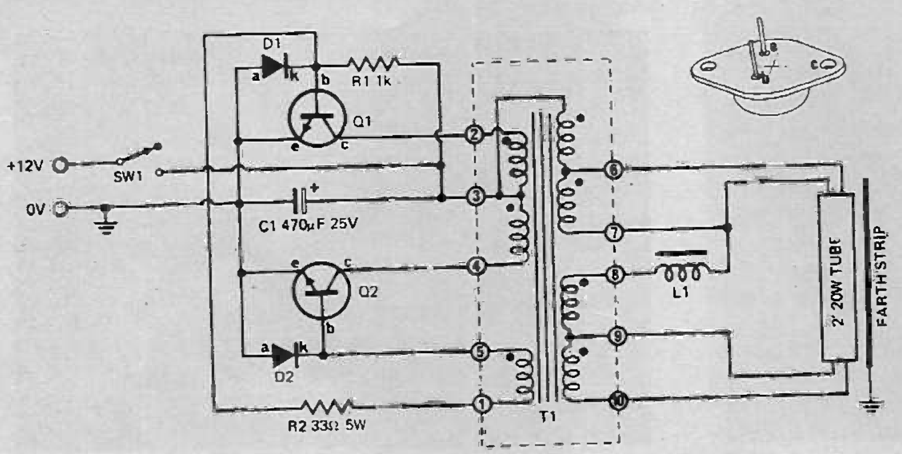


Fig. 1. Circuit diagram of complete unit.

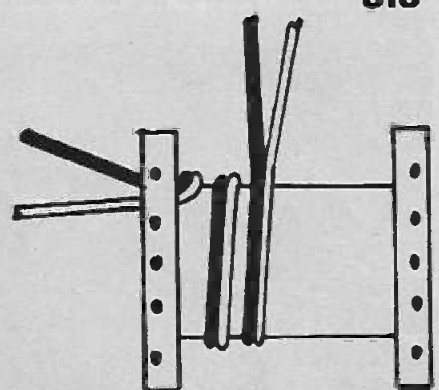


Fig. 2. Bifilar windings of the two primary windings of the transformer. These two windings must be wound in this fashion.

AN ever increasing number of people spend their leisure time camping, caravanning or boating. And recent developments in the associated equipment and technology ensure that few home comforts need be left behind.

Lighting is very much in this category – and for many campers and caravanners it is achieved merely by running an extension cord from their vehicle's 12V battery to a suitable globe.

This is of course very cheap and simple, but has a major drawback in that incandescent lamps are very inefficient generators of light. Hence, for comfortable lighting levels to be achieved, it is necessary to use 48W or 60W lamps. Even then the resultant light output is insufficient for any but the smallest space.

But even a 48W lamp draws a constant four amps from a 12V battery and many a camper has found himself with a flat battery after the light had been used for any protracted length of time.

Fluorescent tubes, on the other hand, are far more efficient. Typical outputs are 12 lumens per watt for incandescent lamps and 60 lumens per watt for fluorescent tubes (including ballast losses).

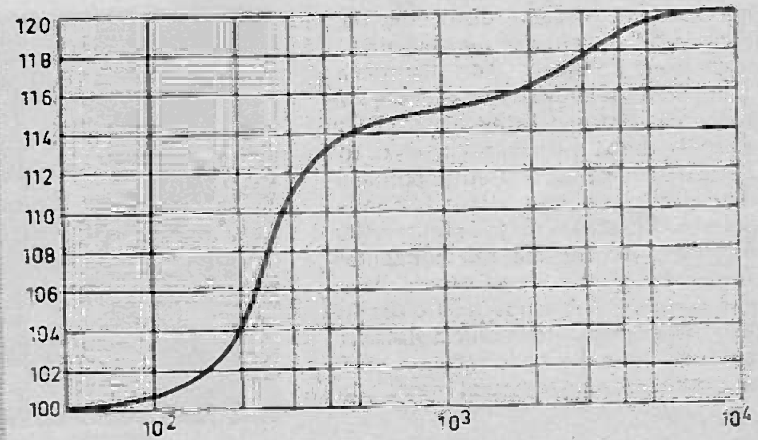
At frequencies higher than 50/60Hz, fluorescent tubes become more efficient still, in fact a further 15% to 18% output (for the same energy input) can be achieved by operating them at 2kHz to 3kHz.

We have taken advantage of this phenomenon in this constructional

PARTS LIST ETI 516

- R1 — resistor 1k, ½ watt, 5%
- R2 — resistor 33 ohms, 5 watt, 5%
- C1 — capacitor, 470uF, 25V. electrolytic
- Q1 — transistor 2N3055
- Q2 — transistor 2N3055
- D1 — diode, EM401, 1N 4005 or similar
- D2 — diode, EM401, 1N 4005 or similar
- T1 — transformer, see table I
- L1 — choke, see table II

2ft. 20 watt rapid-start fluorescent tube
insulating washers for transistors Q1 and Q2.
toggle switch.
diecast box (optional)
five pin 270° DIN plug and socket (optional)



This graph shows how light output increases with increasing supply frequency.

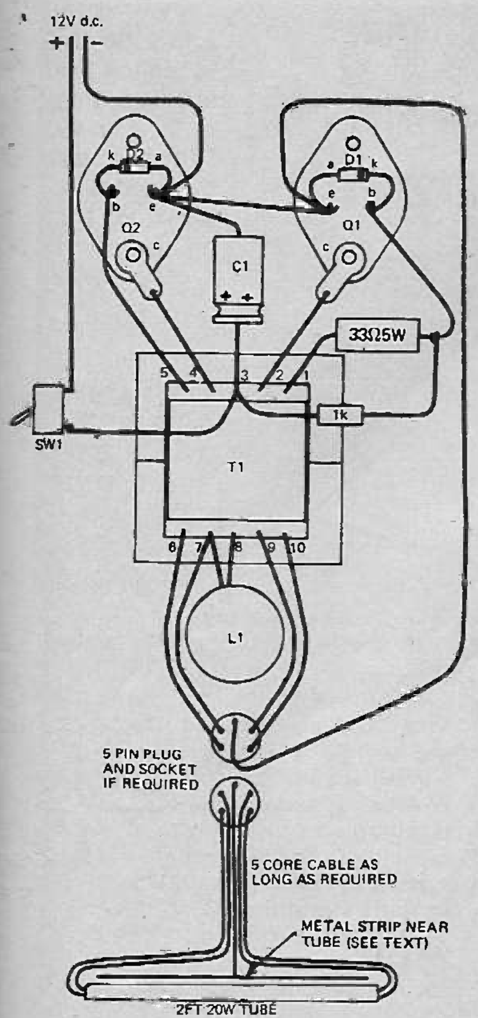


Fig. 3. This drawing shows how the components are interconnected. Actual mechanical layout may take any form required.

project. Hence this inverter operates at a frequency of approximately 2kHz with 12.6V input.

It is designed specifically for use with a 20 watt rapid start tube – in fact it should not be used with any other type. Power consumption is approximately 2.5 amps.

On a basis of light output for power input it is one of the most efficient light sources economically available. A light output of at least 68 lumens per watt should be achieved; and this will provide adequate lighting for the average caravan or yacht.

An unusual characteristic of the circuit is that light output is substantially independent of input voltage from 10 to 15V. The reason why this is so is explained in the 'How it Works' panel.

CONSTRUCTION

The circuit diagram of the complete unit is shown in Fig. 1.

Winding details of transformer T1 and choke L1 are given in Tables I and II.

The transformer winding is wound onto a 12mm x 12mm coil former. The actual winding is straightforward but rather tedious. The wire must be smoothly wound; otherwise it will not fit onto the coil former. Both primary windings are bifilar wound. (This is done by winding both primary 1 and primary 2 at the same time so that they are interleaved – each winding is literally adjacent to the other throughout the length of the windings – Fig 2).

The remaining windings are wound in the conventional manner – make sure that each is wound in the same direction and that the start and finish of each winding is soldered to the correct pins – as indicated in Table I.

Having finished the winding, insert the two halves of the 'E' core and hold the whole assembly securely together with sticky tape or a suitable cable-tie or metal clamp taking care that a metal clamp does not form a shorted turn in the same direction as the winding.

The choke L1 winding details are are given in Table II. The winding is then clamped between a pair of Mullard FX2242 cores held together by a 3/16" diameter brass bolt. A thin brass washer is interposed between the two cores – forming an air gap.

Editor's note: We understand from retail distributors that Plessey or Siemens or equivalent cores for the transformer and choke are on 4 to 5 weeks delivery.

Mechanical assembly details for the complete inverter have not been included in this article as it is possible to assemble the unit in many different forms. For most purposes the unit may be assembled in a die-cast alloy box about 4 3/4" by 3 3/4" by 2" – many will mount the components in the rear of an existing fluorescent light fitting (using the metal-work as a heat sink for the transistors), – other people may prefer to build it into an existing space.

Component interconnections are shown in Fig. 3. The actual layout is not critical. The five pin plug and socket are not essential of course and may be omitted if desired.

The transistors Q1 and Q2 must be mounted on a suitable heatsink, minimum size about 4" by 6".

Insulating washers must be used to electrically isolate each transistor from the heat sink. (Fig. 4).

All components should now be temporarily connected and the complete unit connected to a 12V supply. Take care not to touch the transistors or the secondary windings of the transformer as all are at relatively high potential and can impart a hefty kick.

(Continued on page 76)

HOW IT WORKS

Transformer T1 and transistors Q1 and Q2 form a self-oscillating inverter. Frequency of operation is governed by the core materials, the number of primary turns and the supply voltage. As specified, the inverter will oscillate at approx. 2kHz with 12.6V input.

The transformer secondary has two 4V windings to heat the tube filaments, an 80V winding to supply the discharge current through the tube and a 240V winding to create a static starting voltage.

Choke L1 is in series with the 80V winding to limit the current in the tube.

Apart from limiting tube current, the choke stabilises tube current against variations in supply voltage. If the operating supply voltage increases, the inverter frequency increases accordingly – and this causes the choke impedance to rise.

This self-adjusting impedance maintains lamp current substantially constant for changes in supply voltage from 10 to almost 15 volts.

TABLE I — Transformer Winding Details

Winding	Start	Finish	Turns	Diam	Notes
PRIMARY 1	Pin 2	Pin 3	28	0.8mm	Bifilar
PRIMARY 2	Pin 3	Pin 4	28	0.8mm	wound
FEEDBACK	Pin 5	Pin 1	20	0.4mm	
0.005" insulation					
SECONDARY	Pin 8	Pin 9	200	0.4mm	
FILAMENT 1	Pin 9	Pin 10	10	0.4mm	
FILAMENT 2	Pin 6	Pin 7	10	0.4mm	
0.005" insulation					
STARTING WINDING	Pin 3	Pin 6	600	0.125mm	
0.005" insulation					

Notes: Core — 'E' cores, Plessey type 41-44-12
Coil former: see note on page 76

COMPUTERS IN BANKING

(Continued from page 17)

and four in the provinces. This inheritance from a bank merger in 1970 (National-Provincial, Westminster and District amalgamation) is rapidly being phased out to leave only Woolgate House and Kegworth plants.

Layout in the centres differs somewhat. National-Westminster's Woolgate House has equipment installed on a three-dimensional plan using five floors. Lloyds use a single floor two-dimensional layout in their London Computing Centre.

On the seventh floor of Woolgate House are 100 punched card machines where 125 people produce 200,000 cards a week. Below on the sixth floor are 35 tape units, switching units and the main tape library with its 3500 tapes.

The fifth floor is used to site the central process units and the core of the four IBM 360/65 computers. Here, also, are eleven printers, racks of modems (the G.P.O. device for connecting lines to digital equipment), a rather older but still useful IBM 1800 computer used for scheduling work loads, and seven IBM 2703 polling devices. The latter continuously scan the incoming lines, sampling them and connecting them so as to use the computers at maximum possible efficiency.

Down yet another floor is an IBM 360/50 computer system that 'stands-alone'. This work horse, as it has been called, is a self-contained computing unit working quite separately from the main C.P.U. On this floor are 23 IBM 2314, direct-access, disk storage facilities and 8 unusual data-cell storage units also made by IBM. Each disk unit has nine packs of which eight are normally useable. Each pack stores close to 30 10^6 bytes (a byte is a term for an 8 bit long character) so in disks alone there are over 10,000 million bits of storage. But even this is overshadowed somewhat by the capacity of the data cells, for each stores over 3000 million bits in just 18 inches by 15 inch diameter. These revolutionary design stores consist of short magnetic strips that normally hang from one end. When needed they are lifted out, wrapped on a read/write drum for use and are then thrown back into storage. The eight units are used to store historical data not put onto disk. Also, on the fourth floor are two Datagraphics machines which transfer data from magnetic tapes onto microfilm at a rate equivalent to 65,000 lines per minute. These films go to a micro-film library.

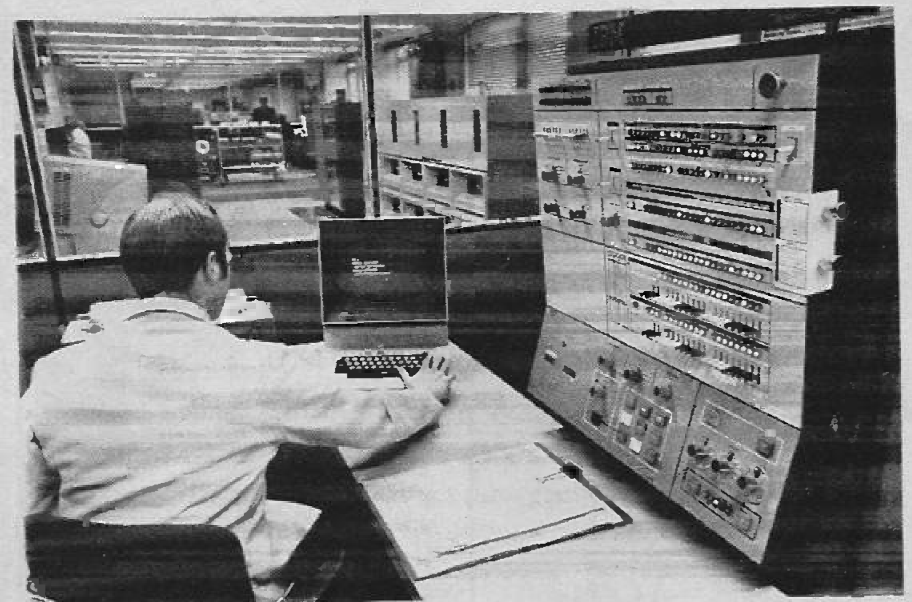


Fig. 6 – A view of Lloyds computing centre showing, in the foreground, one of the computers and an operator communicating with a VDU via a keyboard and, in the background, the disk stores and tape peripherals.

Finally, on the third floor are 17 cheque reader/sorters and the three IBM 360/40 computers that control them.

It is easy to see why this centre is regarded as the largest in Europe – it has twice the capability of that used to control a moon-shot!

A floor plan of Lloyds London centre is shown in Fig. 5. This equipment connects two IBM 360/65 units to the branches. Lloyds also have a separate cheque clearing operation.

THE COMPUTERS

It is interesting to look at the computational power available in these banking centres. It is not entirely correct to compare computers by simple definitions for no really common criteria exist. The peripherals and the way they are used very much decides the actual capability. For simplicity, however, a starting point can be made by stating the time it takes to cycle a storage bit, that is to read in and read out at a position. The other quality of general relevance is the quantity of storage available in the computer itself. The disks, tapes, data cells and punched cards are supplementary storage. It is more common to use a character size element (a number of bits defining say a decimal number using binary storage) rather than bits direct so most figures are quoted in decimal characters or bytes. Another factor is that cores can be interleaved so that the time constants of a store core are overlapped to obtain an effectively faster core cycle-time.

At present the best commercial cycle time is around 100ns but experimental units exist to operate in less than 1ns. The 360/65 units, used as the main computer, (see Fig. 6,) in both Lloyds and National-Westminster, have a cycle time of several hundred nanoseconds and some 2 million bytes capacity. A number are used together as a group to provide a work load as near as practicable to the theoretical machine capability. The 'stand-alone' 360/50 system, cycles in 500 ns and has half a million bytes storage.

Compare these figures with the early IBM 1620 machines with only 20k decimal (k here is the nearest binary equivalent to 1000 which is 1024) character storage and a cycle time of 20μs to carry out simple operations.

The 360 series has recently been superseded by a 370 series. The Kegworth centre of National-Westminster is currently being fitted with two 370/165 units which have the capability to do at least the task of four 360/65 machines.

SECURITY

Centralisation of data creates the need to provide utmost security of the plant and records. All data is duplicated, even triplicated, and the sets stored separately at different locations. Branches also have their daily records always available.

Getting into the centre at Woolgate House is like entering a top secret military establishment. Each entry is policed and those entering must wear an identification tag. Only those issued with magnetic door lock pass cards can open the doors.

WHAT ON-LINE BANKING MEANS TO THE CUSTOMER

As well as providing a cheaper and more efficient service, there are other benefits which spring from the on-line capability.

During the day the branches transmit

(Turn to page 76)

Awaken to the sound of Teleton

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There's a new world of high fidelity in a Teleton sound system, with the GA 202 amplifier at its heart to bring you new standards of purity, new heights of quality in the faithful reproduction of the world's greatest music.

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(280)

ELECTRONIC DECISION MAKER

ETI PROJECT 517

Be right at least half the time—electronically

IN quite a few companies, the standard of executive decision making is so poor that decisions settled on a purely random basis have a statistically greater chance of being correct than decisions made after executive deliberation.

If one is employed by such a company there is little one can do but leave.

But for up and coming young executives, decision making can also be a trial. For as no decision can possibly comply with all the conflicting policy statements and standing orders existing in a company, the young executive can never make a right decision which will please everybody.

The best he can hope for is to be right half the time.

Once this fact of executive life has been accepted, the next obvious step is make quick decisions on a totally random basis.

Hence the ETI decision maker.

Armed with this device, the man on the way up can earn himself an enviable reputation as a quick decision maker, and as often as not he'll be right!

Basically the device is an electronic coin spinner which provides a 'YES' or 'NO' answer a few seconds after a button is depressed and released — but this is not all — the device has sporting connotations as well!

As A. J. Lowe points out, that time-honoured Australian game 'TWO-UP' has never been the same since decimal currency — and whilst we are not for one moment suggesting that this device should be used for such a purpose . . .

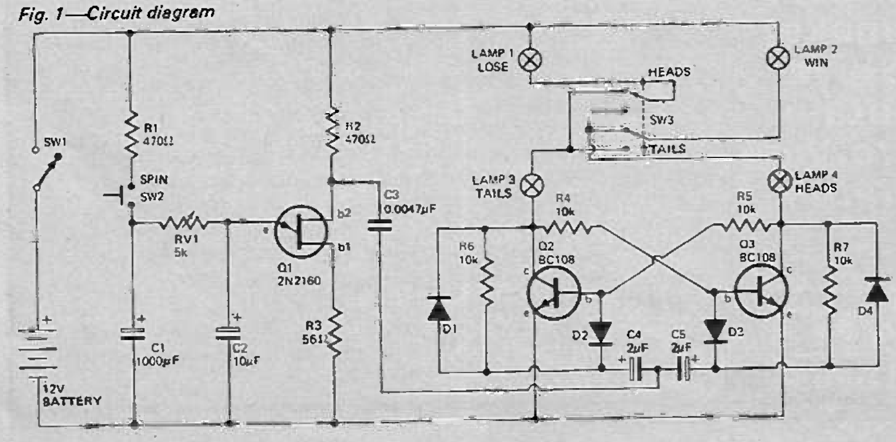
WHAT IT DOES

Have a look at Fig. 1. On switching on, two of the four lamps will light up — the 'Heads' or 'Tails' light, and the 'Win' or 'Lose' light. A call is made simply by moving the slide switch in the centre of the panel to the desired position. To spin, just press the 'Spin' button. The lights start to flash at an increasing speed, and will continue to flash as long as the button is held down.

On releasing the button, the lights will go on flashing but gradually they slow down, and then cease flashing. Two steady lights show — a 'Heads' or a 'Tails', and one to show whether you 'Win' or 'Lose'.

For simple decision-making between two alternative lines of action — ignore the 'Call' switch, and just equate Heads' with one action, and 'Tails' with the other.

Fig. 1—Circuit diagram



CONSTRUCTION

The device can be constructed in a plastic box measuring 5½" x 4" x 3" deep, all the works being attached to an aluminium panel.

The electronic components, other than lamps and switches, are mounted on veroboard the copper side of which is shown in Fig. 2 The component layout on the board is shown in Fig. 3.

The battery consists of eight pen torch cells (AA size), contained in two flat battery cases. These are held in another aluminium bracket, which is attached to the panel by the push button switch.

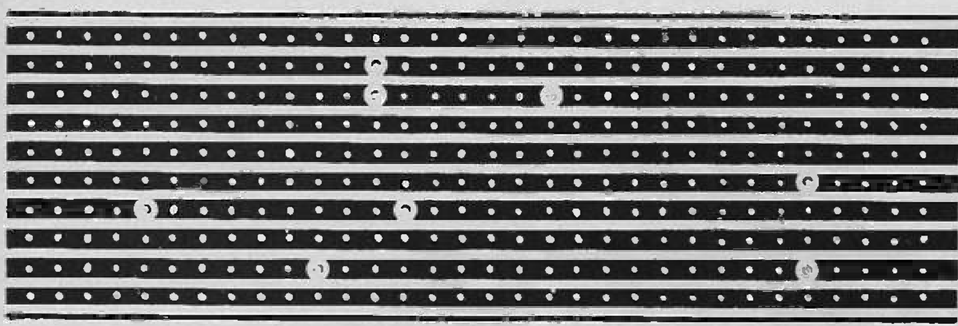


Fig. 2. Veroboard is shown here full size — a sharp drill should be used to interrupt the copper tracks where shown.

PARTS LIST ETI 517

R1, R2 — resistor 470 ohms ¼ watt
R3 — resistor 56 ohms ¼ watt
R4, R5, R6, R7 — resistor 10k ¼ watt
RV1 — variable resistor — preset 5k
C1 — capacitor, electrolytic 1000 μF 25 volts
C2 — capacitor, electrolytic 10 μF 10 volts
C3 — capacitor 0.0047 μF
C4, C5 — capacitors 2 μF 25 volts
Lamps 1,2,3,4 — six volt pilot lamps 60mA rating — colours red, green, blue, yellow
Q1 — unijunction transistor 2N2160,
Q2 and Q3 — NPN transistors BC 108 or similar
D1,D2,D3,D4, — small signal diodes BA 100 or similar
SW1 — on-off toggle switch
SW2 — push button switch
SW3 — double pole change-over slider switch
Battery — 12 volts
Battery case, box, veroboard etc.
Veroboard — 5" x 1 5/8" x 0.15" spacing.

Component values are not critical except the UJT (Q1) which must be as specified. Diodes D1 to D4 may be any small signal diodes, such as BA100 etc. Diodes from disposal computor boards should work satisfactorily. The lamps must be of a rating less than the rating of the BC 108 transistors — i.e. less than 100mA. The original unit used pilot lamps which take the LES bulbs — with a rating of only 60 mA. The low rating also helps to get the bulbs flashing at a high rate. Higher rating bulbs take too long to heat and cool and because of this have a limited flashing speed. ●

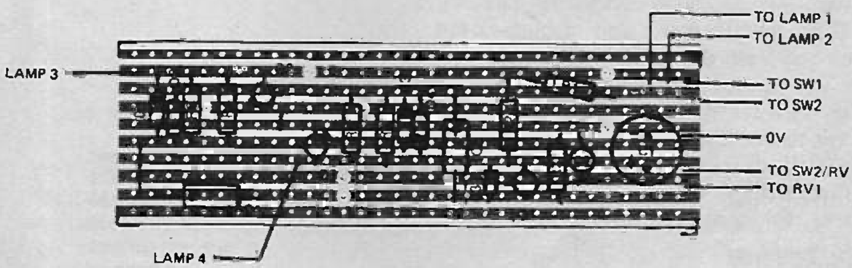


Fig. 3 — Component layout

> This unit may be constructed to provide just 'YES'/'NO' answers, i.e. without the 'TWO-UP' facility, by omitting lamps 3 and 4 and switch SW3.

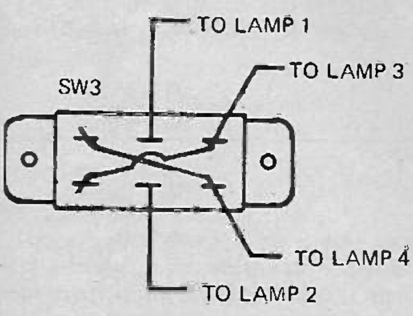


Fig. 4 — Wiring to SW3.

HOW IT WORKS

The device is a combination of two basic electronic circuits — (Fig. 1). Q2 and Q3 form a bistable. At any time, only one of these transistors can be conducting. Suppose Q2 is conducting and Q3 if off. This state may be reversed, so that Q3 is conducting and Q2 is off, by applying a negative-going pulse to the junction between capacitors C4 and C5. Each time a pulse arrives the bistable will change state.

Q2 and Q3 collector circuits each include two lamps in series. They are coupled through change-over slide switch SW3. This is the 'Call' switch, and it is arranged so that when it is in the 'Heads' position, and Q3 is conducting, i.e. the 'Heads' lamp is alight, then also the 'Win' lamp is alight. If the switch is in the 'Tails' position and Q3 is conducting, then the 'Lose' lamp lights up.

Q1, and associated components form a unijunction transistor relaxation oscillator, which provides pulses, via capacitor C3, to cause the bistable to change state. The oscillator generates triggering pulses shortly after SW2 is pressed.

The rate of oscillation, i.e. the rate at which pulses are generated and the bistable changes state, varies with the voltage at the top of C1, and the value of the variable resistor RV1. At first the pulses come slowly and then increase in speed as C1 becomes fully charged. At that time they reach the maximum (which can be set by RV1). This maximum rate should be adjusted so that the flashes are as rapid as possible but not so that each flash is so short that the lamps do not achieve adequate brilliance. When SW2 is released, pulses continue to be generated — the energy being supplied by C1. As C1 slowly discharges, the pulse rate decreases; The magnitude of the pulses also decrease until they are too low to switch the bistable. This then stays in a steady state with the 'Heads' or 'Tails' lamp showing, and the 'Win' or 'Lose' lamp showing — depending upon the setting of SW3. The run down takes several seconds — just like a well spun coin.

The flashing rate is so high that it is quite impossible to force a win by attempting to release SW2 at just the right moment — knowing that the run down takes so many seconds. Thus the device is 'random' and not biassed.

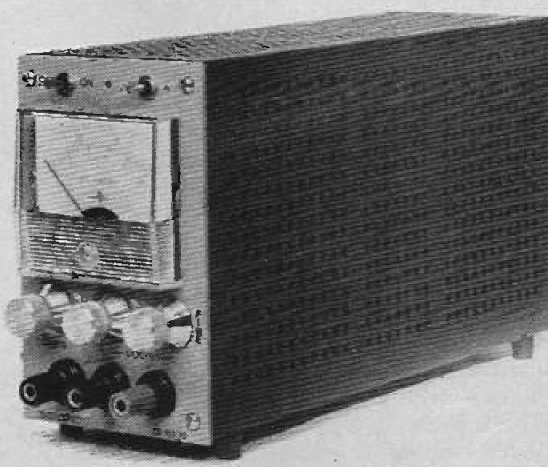
POWER SUPPLIES

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

THE usual first stage in a dc power supply is the transformer which converts the ac at mains voltage to the (usually) lower voltage required for semi-conductor circuits. The transformer also isolates the circuit from the ac mains (Fig. 1).

The output of the transformer is still ac, so a rectifier is required to convert this to dc. (Fig. 2).

The dc output is, however, a fluctuating direct current, so a smoothing, or filter, circuit is required. (Fig. 3).



Constant voltage power supply with variable current limiting and one meter to read both voltage and current (Coutant)

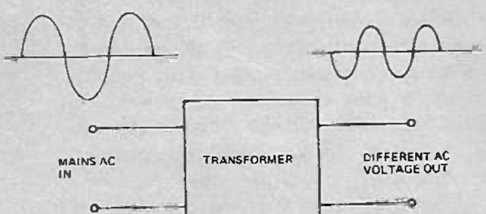


FIG. 1

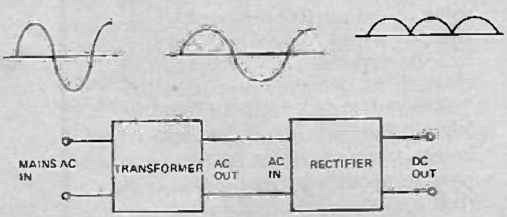


FIG. 2

This provides an almost steady dc, there remaining only the problem of being sure that the supply maintains a steady flow of power and does not allow fluctuations. For this, a control circuit is added to counteract fluctuations in supply or load.

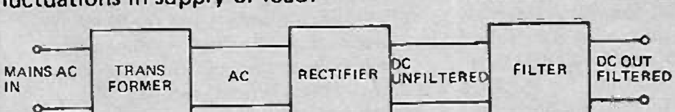


FIG. 3

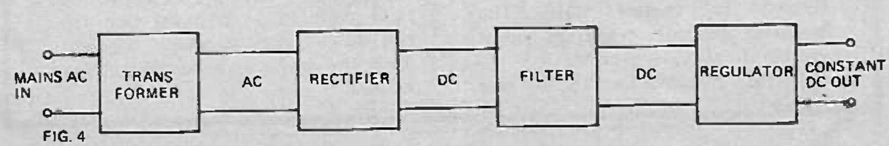


FIG. 4

The block schematic of a complete power supply is shown in Fig. 4.

Power supplies may be required to supply either constant voltage or constant current.

A constant voltage power supply acts to maintain its output voltage constant, in spite of changes in load, line, temperature, etc. Thus for a change in load resistance, the output voltage of this type of supply remains constant while the output current changes by whatever amount is necessary to accomplish this.

A constant current power supply on the other hand, acts to maintain its output current constant in spite of changes in load, line and temperature. And thus for a change in load resistance, the output current remains constant while the output voltage changes by whatever amount is necessary to accomplish this.

The differences between the two types of power unit are shown graphically in Figs. 5 and 6.

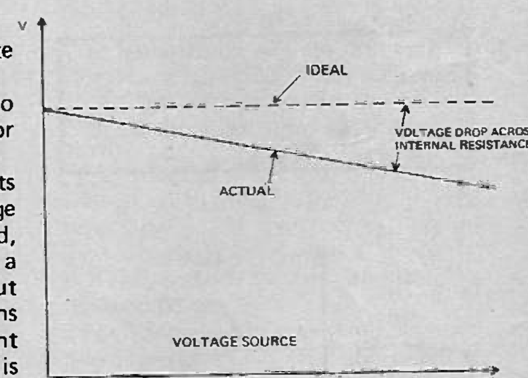


FIG. 5

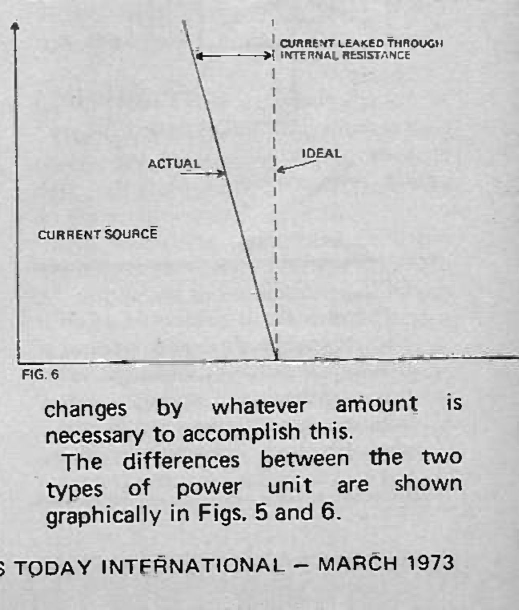


FIG. 6

The internal resistance of an ideal voltage source will be zero, so that there is no voltage drop across the internal resistance, and the internal resistance of an ideal current generator will be infinite, so that there is no current lost internally. This is perhaps clearer if we look at the circuit of practical voltage and current generators (Figs. 7 and 8).

In both cases the actual source consists of an ideal source (Fig. 7) with an internal resistor connected so as to introduce an imperfection before the terminals (Fig. 8).

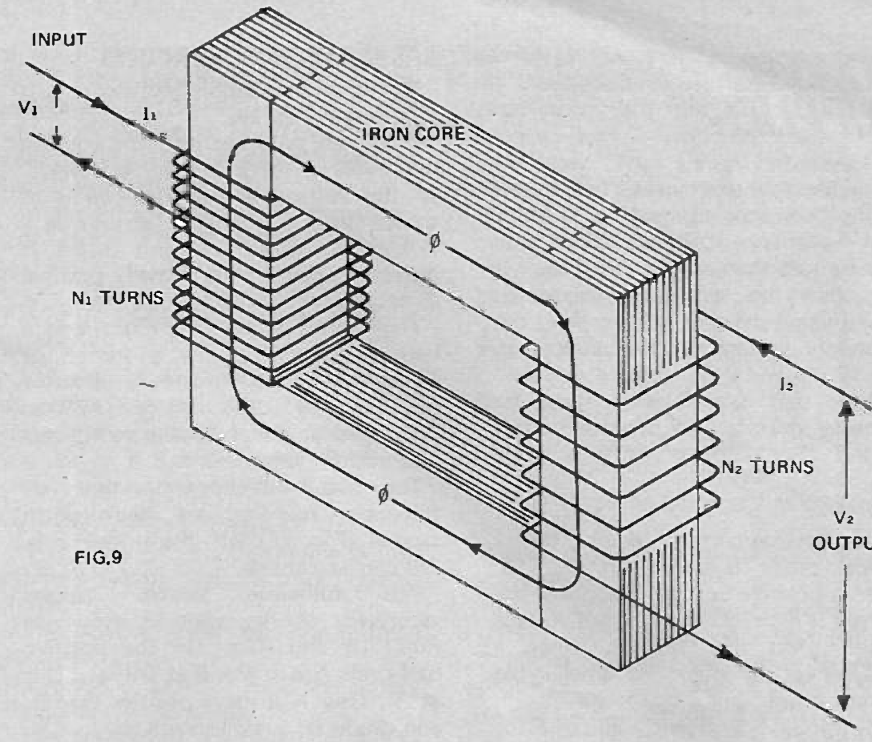


FIG.9

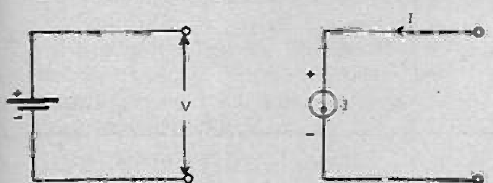


FIG. 7

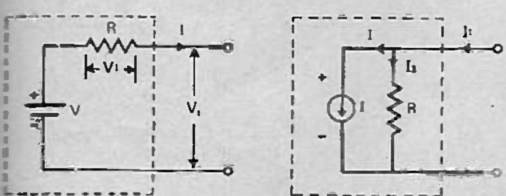


FIG. 8

THE TRANSFORMER

The transformer (Fig. 9) operates by creating a magnetic flux (ϕ) in the iron core by passing a current into the primary, then the passage of the magnetic flux through the secondary generates a voltage in the secondary (Faraday's law).

Note that the coupling between the primary and the secondary is magnetic only — there is no electrical coupling.

The ratio of primary and secondary quantities is determined by the turns ratio. Thus

$$\frac{V_2}{V_1} = \frac{N_2}{N_1}$$

$$\frac{I_2}{I_1} = \frac{N_1}{N_2}$$

Theoretically there is no power loss in the transformer, so the principle of conservation of energy, requires that the input power is equal to the output power

so $P_1 = P_2$
i.e. $V_1 I_1 = V_2 I_2$

It is from this product of $V_1 I_2 (= V_2 I_1)$ that the volts/amps of a transformer is derived.

In practice of course, there are losses in the transformer which mean that the power in the secondary is less than the power in the primary.

The relation between primary current and magnetic flux is as shown in Fig. 10.

Note that the relation is linear from 0 to A, but after A no matter how much the current is increased the flux remains approximately the same. This phenomenon is called *saturation* (of the iron core) and occurs when the great majority of the magnetic dipoles in the iron have been aligned with the flux.

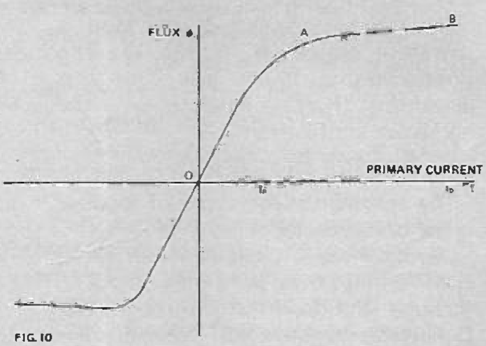


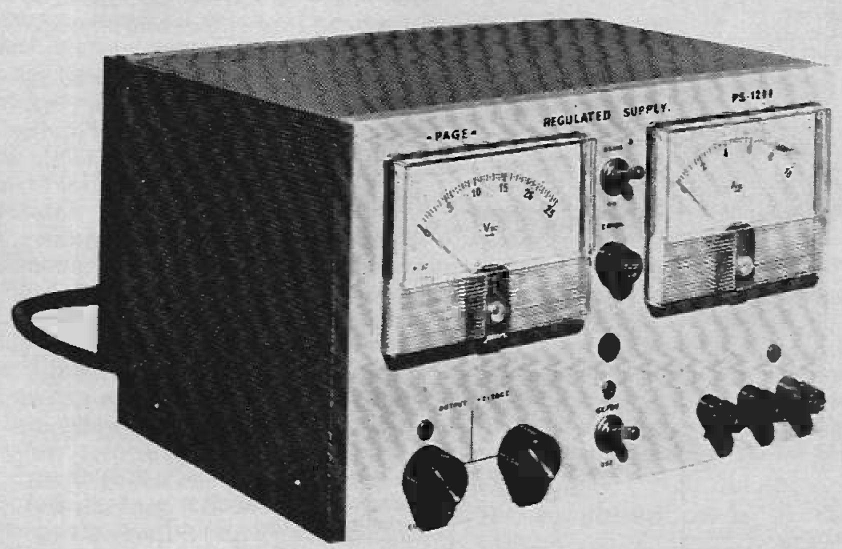
FIG. 10

The segment AB is called the saturation region.

If the primary current is derived from the ac mains it will have a sinusoidal waveform. If the peak of the sinusoid is less than I_A, the flux produced will be an exact replica of the input current, because as current goes up, flux goes up and vice versa.

The secondary voltage will be approximately proportional to the flux, and will therefore also be sinusoidal.

There is however a renewal of interest in the type of transformer where the peak of the primary current moves well into the saturation region. In this type of transformer the peak primary current is I_B. The flux varies directly with primary current until A is reached, then it remains approximately constant over AB as the sinusoid rises to a peak then falls.



This regulated power supply provides outputs adjustable from 9 to 16 volts at currents of up to 15 amps.

POWER SUPPLIES

When the primary current falls below A, the flux once again varies directly with primary current. The flux waveform is then as shown in Fig. 11, and since the secondary voltage is roughly proportional to the flux, the secondary voltage is as illustrated in Fig. 12.

(Note that transformers must be specially designed to operate in this mode.)

DIODES

The voltage/current graph for a typical diode is shown in Fig. 13. When a positive voltage is applied, the current is high and the forward voltage drop is less than 1 volt. When a negative voltage is applied, a negligible current flows.

The diode is eminently suitable for use as a rectifier because of its ability to pass current only in one direction.

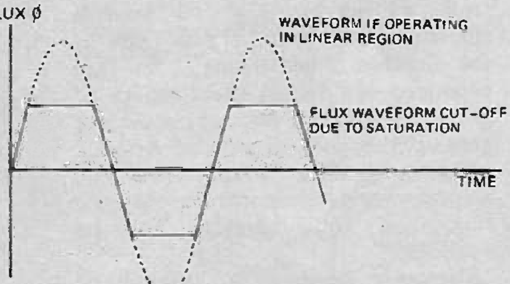


FIG. 11

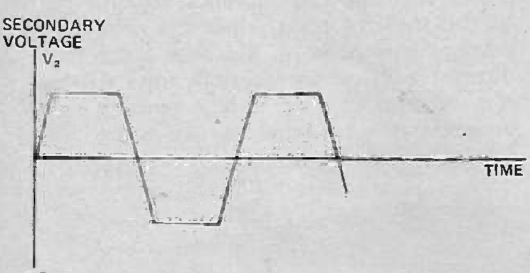


FIG. 12

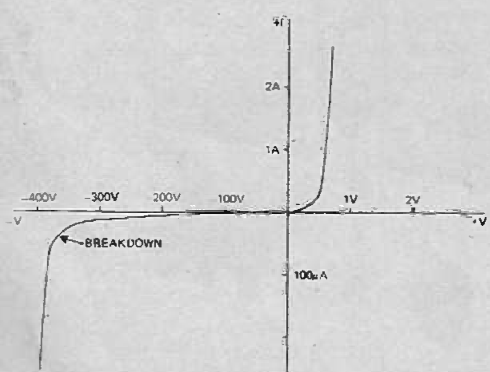


FIG. 13

BASIC RECTIFIER CIRCUITS

The simplest possible rectifier circuit is shown in Fig. 14.

The diode will pass only the positive half cycle of the secondary ac voltage, so the voltage across the load is as shown in Fig. 15. The output is a fluctuating direct current (since it moves always in the positive direction).

The circuit shown in Fig. 14 is a half-wave rectifier. As a source of direct current it is not very effective because of the large voltage fluctuations. The full-wave rectifier is a substantial improvement.

The two most common types of full-wave rectifier are the centre tapped (Fig. 16) and the bridge (Fig. 18) configurations.

The full-wave centre tapped secondary configuration is shown in Figs. 16 and 16a. On the positive half-cycle A is at +V, B at 0V, and C is at -V. Thus A is more positive than B, and diode D1 conducts via the load in the direction shown. Diode D2 has a negative voltage across it and does not conduct.

On the negative half-cycle, A is at -V, B is at 0V, and C at +V. Thus C is more positive than B_1, so diode D_2 conducts via the load in the direction shown. Note that it conducts in the same direction as did D_1. Diode D_1 now has a negative voltage across it and does not conduct.

The voltage applied to the load is therefore as shown in Fig. 17. The fluctuation is much less with this waveform. (Half as much as with the half-wave configuration.)

THE BRIDGE RECTIFIER

The second common type of rectifier is the bridge rectifier. (Fig. 18).

During the positive half-cycle, current flows from A to B through D1, through the load, and through D3. During the negative half-cycle, current flows from B to A through D2, *through the load in the same direction as before* and through D4.

The voltage applied to the load is, therefore, the same as in the centre-tapped circuit shown in Fig. 16 above.

VOLTAGE DOUBLERS

Another type of rectifier-filter commonly used in low power applications where the load is relatively constant is the voltage doubler (Fig. 19).

When A is at +V and B is at 0V, diode D1 conducts and charges C1 up to the peak of the ac voltage. Diode D2 has a negative voltage across it and does not conduct. When A is at -V and B is at 0V, diode D2 conducts and charges C2 to -V peak. Diode D1 has negative voltage across it and does not conduct.

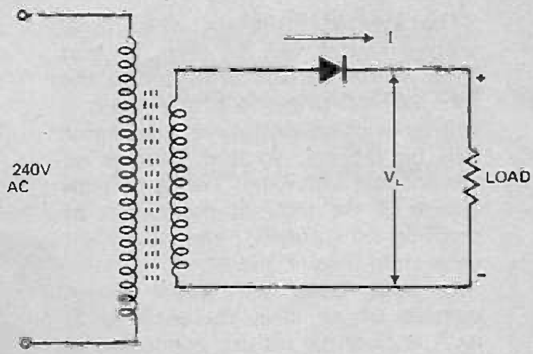


FIG. 14

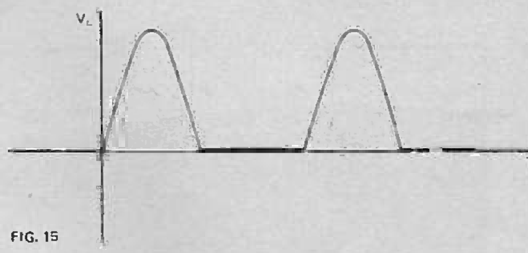


FIG. 15

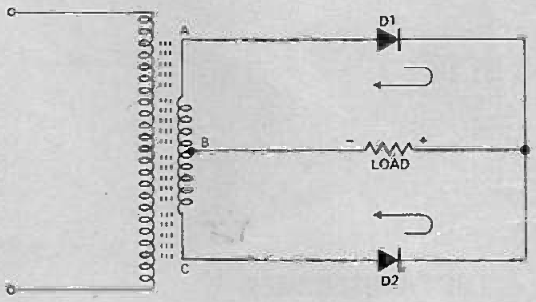


FIG. 16

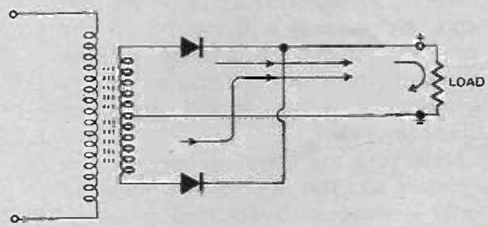


FIG.16A

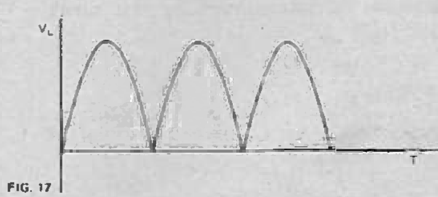


FIG. 17

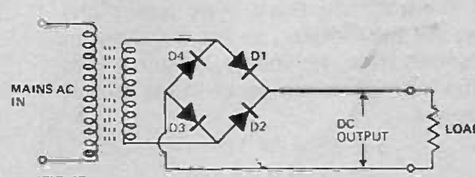


FIG. 18

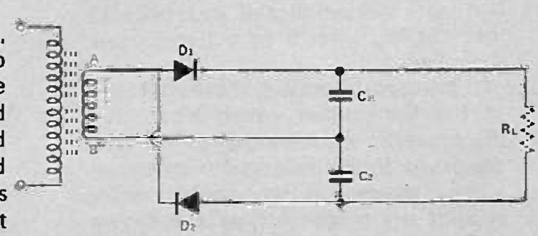


FIG.19

Since capacitors C1 and C2 are in series, the voltage across them (off load) is twice the total peak ac voltage, hence the term voltage doubler.

When a load is applied to the voltage doubler circuit, the output voltage will be less than twice the peak voltage. The actual voltage will depend on the value of the capacitor and the load current drawn from the circuit.

VOLTAGE MULTIPLIERS

The voltage multiplier shown in Fig. 20 produces high voltage at lower power levels.

Off load, the output voltage of this configuration is twice the peak ac voltage multiplied by the number of stages used. Both diodes and capacitors must be rated as twice the peak ac input voltage.

DIODE SELECTION

The important factors in selecting suitable diodes are the current they must carry, both peak and average,

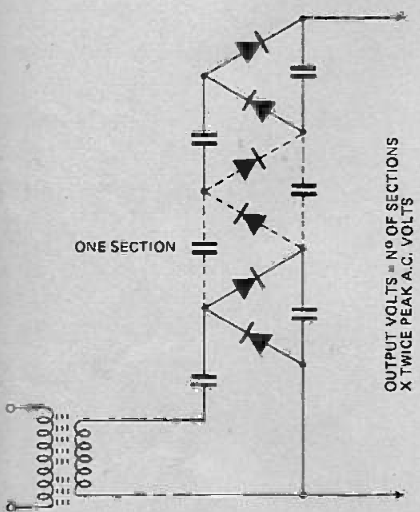


FIG.20 VOLTAGE MULTIPLIER

and the negative voltage which will appear across them when they are non-conducting. If the permissible maximum currents (as determined from the manufacturers' specifications) are exceeded for even a short time the diode will be destroyed, and if the negative voltage exceeds the Peak Inverse Voltage (P.I.V. — once again found from manufacturers' specifications) the diode will probably be destroyed by avalanche breakdown.

In the half-wave circuit the single diode must carry the full current and the full secondary voltage (the *peak*, not the rms which is normally specified at the secondary). For a sinusoid, the peak voltage = rms voltage x $\sqrt{2}$. If capacitors are used to filter the output, the diodes must be rated at twice peak voltage.

In the centre-tapped secondary or circuit, the voltage of the transformer is usually quoted as half the total voltage — 0 — half the total voltage; thus if the total output voltage is 650V, the transformer specification will be 825-0-325 volts.

The diodes must be rated for the peak of the *total* output voltage, and half the output current.

In the bridge rectifier the diodes are rated for the peak of the ac voltage and half of the full amount.

FILTER CIRCUITS FOR POWER SUPPLIES

A full-wave rectifier output may be shown to be equal to a constant voltage *plus* an alternating voltage, by the use of a Fourier series. Thus the output voltage is expressed by

$$V_o = \frac{2\,V_m}{\pi} + \frac{4}{3\pi}\cos 2\,wt + \text{negligible terms}$$

where Vo is the rectifier output voltage

V_m is the peak rectifier output voltage

$w = 2\pi f = 2\pi \times 50$ Hz is the supply frequency in radian/sec.

The purpose of the filter circuit is to remove the ac component of the rectifier output but allow the dc component to pass through. The ac component is termed "ripple" (and in audio work "hum", from the 100 Hz signal produced in the speakers by the ripple voltage).

The ripple will be an important factor in deciding the performance of a power supply, so we must establish an accurate means of measuring and recording it. For this purpose we introduce the "ripple factor", which is defined by —

ripple factor, r equals

$$\frac{\text{rms value of alternating components of output}}{\text{dc value of output}}$$

For a good power supply the alternating component is small in relation to the dc component, so the ripple factor will be small.

The dc and ac components may be measured quite readily using a dc reading meter for the dc component, and an rms reading meter (with a capacitor in series) for the ac component.

With a sinusoidal input, the ripple factor of a half-wave rectifier is 1.21, and for a full wave rectifier it is 0.482. In other words for a half-wave circuit the ac component is larger than the dc component by about 20%, while for a full-wave circuit the ac component is less than half the dc component. Thus full wave rectification clearly provides a substantial improvement in ripple factor, and hence it is almost always used where the quality of the dc supply is in any way important.

The simplest filter circuit is a choke or inductance connected in series with the output. The reactance of the choke is $2\pi fL$, where f is frequency (in Hz), and L the inductance of the choke (in Henrys). The ac component of the waveform sees this as a high impedance, but the dc component, having zero frequency, sees no impedance. Thus a high impedance is inserted for the ac component, but has no effect on the dc component. (In practice there will be a small dc resistance due to the copper wire used to wind the choke).

A typical circuit arrangement is shown in Fig. 21.

The ripple factor with a choke filter is approximately

$$r = \frac{1}{3\sqrt{2}} \quad \frac{R_L}{2\pi fL}$$

Thus ripple is increased as the load increases and as the current falls (Ohm's Law), i.e., low ripple at high currents.

A substantial improvement is obtained with the capacitor filter (Fig. 22). The capacitor value must be large

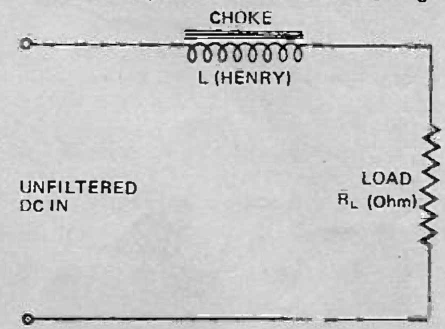


FIG. 21

to provide as low an impedance path around the load as is possible for the ac components. Of course, no dc passes through the capacitor.

The capacitor charges up to the peak of the unfiltered dc output, and when the output voltage falls, the capacitor discharges through the load, thus

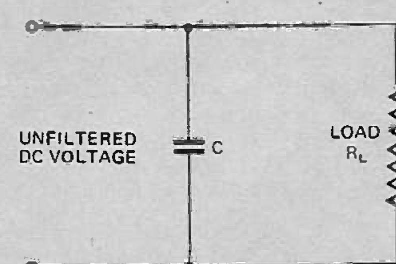


FIG. 22

tending to keep the voltage across the load up to its peak value.

The major drawback of the capacitor filter is that with each peak it recovers the lost energy, and this results in a high current inrush as the capacitor starts charging (Fig. 23). Because of the voltage stored on the capacitor the diode has only a positive voltage across it for the time periods shown in Fig. 23.

The peak diode current is

$$I_{peak} = V_m\sqrt{(2\pi f)^2\,C^2 + \frac{1}{R_L^2}}$$

POWER SUPPLIES

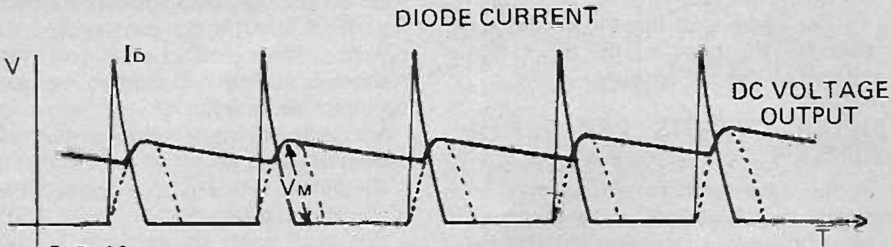


FIG. 23

This is the peak current which the diode will conduct on each fluctuation. The diode peak current rating must, therefore, be in excess of the value which is calculated from the above.

For a single capacitor filter the ripple factor is given by

$$r = \frac{I_{DC}}{4\sqrt{3}\ f\ C\ V_{DC}} = \frac{1}{4\sqrt{3}\ f\ C\ R_L}$$

A substantial improvement is obtained with one of the more commonly used circuits, the pi-section filter (Fig. 24).

The ripple factor for this circuit is

$$r = \sqrt{2}\,\frac{X_c}{R_L}\quad\frac{X_{c1}}{X_{L1}}$$

It is possible to replace the inductor with a low value resistor (with a sufficiently high wattage to allow it to carry the full load current).

The ripple factor is then

$$r = \sqrt{2}\,\frac{X_c}{R_L}\quad\frac{X_{c1}}{R}$$

The use of the resistor in place of the choke is quite common because of the expense, weight, and bulk of the choke.

VOLTAGE STABILIZATION

There are three main factors which may cause the output voltage to vary. The ac supply may fluctuate by up to ± 10%, the load current may range from zero to the full load current, and the temperature may have a further effect, particularly with semi-conductor devices.

The main source of variation in output voltage is the variation with load current. This is because the resistance of the copper wire used in the transformer, the forward resistance of the diode, filter resistance, and the like, cause a voltage drop which is proportional to the load current.

It is possible to represent a voltage source by an ideal voltage source in series with the internal resistance (indicated above) as shown in Fig. 25. The voltage appearing across the load is then the voltage of the ideal voltage source *less* the voltage drop across the internal resistance.

i.e. $V = E - I\,R_i$

So as I increases, V falls.

The measure of the stability of the output voltage is the *regulation,* defined as

per cent regulation =

$$\frac{\text{no load voltage} - \text{full load voltage}}{\text{no load voltage}} \times 100$$

Devices which stabilize the output voltage are, therefore, frequently called regulators.

Regulators fall into two categories. These are the shunt regulator (Fig. 26) and the series regulator (Fig. 27).

Both type utilize the fact that Vo = Vi = Vf. If Vi alters and Vf can be made to alter by an equal amount, then their difference (i.e. Vo) will be unchanged.

With the shunt regulator the output voltage is compared with a fixed reference voltage V_R, and a greater or lesser current is drawn by the regulator in proportion to the difference.

This either increases or decreases V_f depending on whether Vo has increased or decreased.

The series regulator has V_f dropped over the regulator itself and the voltage-drop over the regulator is made inversely proportional to current by comparison of Vo and V_R.

The second part of this article will consider actual regulator circuits, protection, transients, saturating core transformers, control of power flow, output voltage control, and cooling. ●

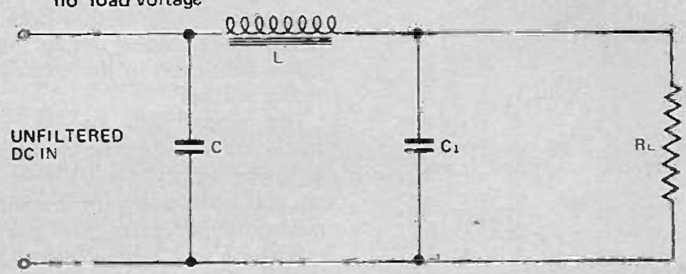


FIG. 24

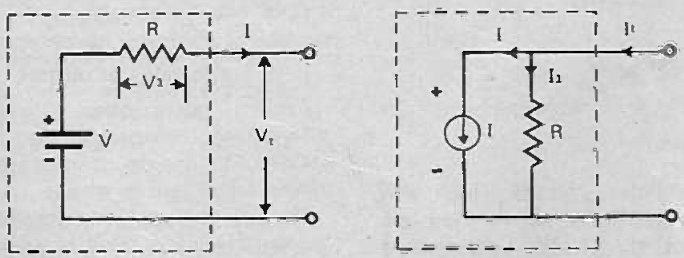


FIG. 25

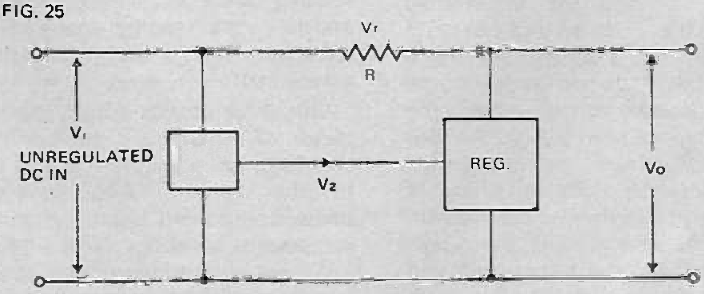


FIG. 26

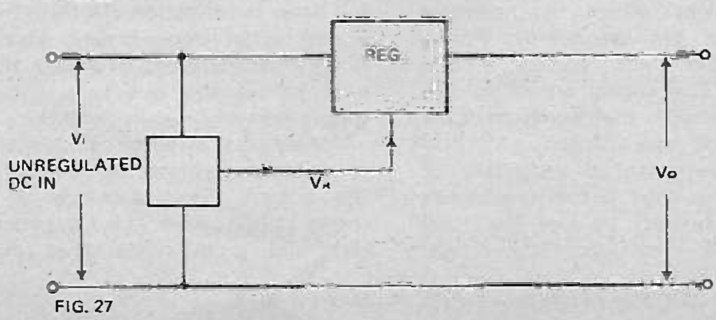


FIG. 27

AUDIO NEWS

SPEAKER TESTING

To supplement tests in the laboratory or in the showroom and give a measure of speaker performance in the home (which is what matters most to the customer) under 'living room' conditions, and to try out new design theories, Philips feed pink noise into a 'living room' furnished in the conventional way, via an audio generator, amplifier and sound source (the speaker under test). Making certain the speaker is placed reasonably with regard to the layout of the living room, Philips measure the average sound pressure by one-third octave steps throughout the audible frequency range in the listening area, using an omnidirectional microphone. A microphone amplifier, real time analyser and oscilloscope equipped with 'memory' and recall facilities, is then used to give the average sound pressure over a 32 second period.

A curve is plotted on an X – Y recorder, and finally an average curve over the entire listening area is measured and recorded. Additionally the reverberation time as a function of the frequency is also plotted.

This advanced technique, using equipment valued at approximately £1 million, means that, probably for the first time, engineers and designers can get immediate results when testing new and existing equipment or theories. By using the memory and recall facility, one speaker can be directly compared with another by showing both curves on the same display.

Philips Electrical Limited, Century House, Shaftesbury Avenue, London WC2H 8AS. (248)

NEW FROM CROWN

Crown International/AMCRON of Elkhart, Indiana, have announced a new version of

their DC300 power amplifier (reviewed in the Aug '72 issue). The DC300A will now operate into 1 ohm loads, and is said to be able to drive and load including totally reactive loads without fuss, and without the previously incorporated 'Hysteresis/Normal' switch. Also done away with are the DC protection fuses as a new sophisticated protection circuit has been developed which is said to exhibit no flyback pulses, thumps, or shutdown.

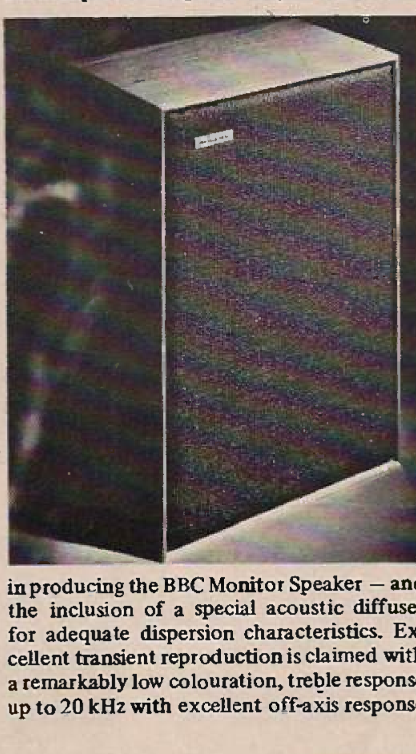
The DC300A is rated to deliver 425 W rms into 2 ohms, 500 W rms into 2.5 ohms, 350 W rms into 4 ohms, 200 W rms into 8 ohms, and 110 W rms into 16 ohms from each of its two channels, and provide 100 W rms into a 1 ohm load which will be welcomed by vibration engineers.

Harmonic distortion is now specified as being below 0.05% from DC to 20,000 Hz, and IM distortion below 0.05% from 0.01 watt to 150 watts; hum and noise 110 db below 150 watts level. When converted for Mono operation, which is now effected by means of a simple internal plug-in, the DC300A is rated to deliver 650 W rms into 4 or 8 ohms loads. Price: £380.

MacInnes Laboratories Limited, Stonham, Stowmarket, IP14 5LB. (249)

MONITOR QUALITY

Rogers Developments have announced their new Ravensbourne Compact which supersedes their Ravensbrook 3-speaker system now withdrawn from production. At around £65 per stereo pair, these speakers use the same method of cabinet assembly and include individual doping of the bass drive cone – a technique resulting from Rogers' experience



in producing the BBC Monitor Speaker – and the inclusion of a special acoustic diffuser for adequate dispersion characteristics. Excellent transient reproduction is claimed with a remarkably low colouration, treble response up to 20 kHz with excellent off-axis response and, with average room loading, bass response down to 40 Hz.

Rogers Developments (Electronics), 4-14 Barmeston Road, London SE6 3BN. (250)

STEREO DISCOTHEQUE

Squire Electronics has announced a new range of stereo discotheque units specifically designed to meet the growing demand among DJs for high quality stereo discotheque equipment.

The standard Square Stereo Unit (retail £245) comprises the usual twin turntable arrangement with built-in 100 watt amplifier but with the added refinement of push-button turntables and slide fader controls and is largely modelled on radio equipment. The De Luxe Unit (extra £90) also includes a futuristically designed front complete with Dream Screen Facia and Chromosonic Lighting Unit, power meter, light controls, limiter and automatic voice over system.

Probably to many people's surprise, Squire have found a considerable interest also by ordinary members of the public in having a Discotheque Unit for their own homes, and a special unit has been designed with a teak finish which simply connects to the existing domestic Hi-Fi system. Radio style programmes can then be produced at home and get togethers held at home can then go with more of a zing! Cost: around £215.

Squire Electronics, 176 Junction Road, London N19 5QQ. (251)

SOUND LEVEL METER

The Department of Employment's 'Code of Practice for reducing the exposure of employed persons to Noise' has high-lighted the use of Sound Level Meters. Although, for many applications a simple Sound Level Indicator will perform the initial survey, eventually the need for a more precise unit having more measurement capability shows itself. CASTLE ASSOCIATES have just introduced their CS17A for this purpose. While being in the price range usually reserved for indicators, this General Purpose Sound Level Meter is said to fully comply with the BS 3489, and has both 'A' and 'C' weighting with provision for the connection of recorders and oscilloscopes or even a noise dosemeter.

CASTLE can also supply a new calibrator for the CS17A, the PSQ 101, a miniature falling-ball calibrator with a good low frequency spectrum.

The CS17A can measure from 24 dB to 140 dB using the same microphone type as is fitted to the most expensive British units and thus microphone accessories are interchangeable. Prices: £68 for CS17A and £19 for PSQ 101.

Castle Electronic Associates, North Street, Scarborough, Yorks YO11 1DE. (252)

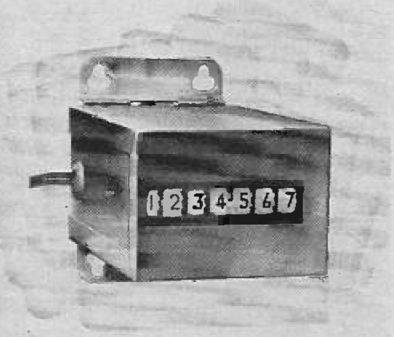
EQUIPMENT NEWS

VANDAL-PROOF IMPULSE COUNTER

A new shock-resistant 7-figure electrical impulse Counter, series 4460, is announced by English Numbering Machines as a major advance in counting devices.

Designed to resist shocks in any plane, the 4460 is said to be particularly suitable for fitting to vending and amusement machines as these are often subject to vibration caused in normal operation or vandalism.

With a service life of 3 million counts at a counting speed of 600 counts per minute, the 4460 is claimed to maintain accuracy and trouble-free performance for at least 20 million counts when operated at the usual vending and amusement machine speeds. In addition, with the counter's 7-figure capacity, machine operators are provided with actual readings up to 10 million counts.



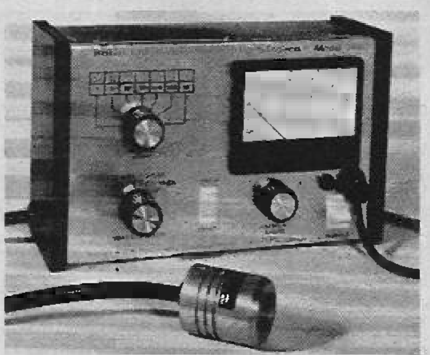
Either base or panel mounting can be specified. Usual operating voltages, 48V or 230V, 50Hz are standard, whilst non-standard voltage coils can be supplied to minimum quantity order.

English Numbering Machines Limited Queensway, Enfield, Middlesex, England. (230)

LASER EXPOSURE METER

The new Model 7490 Exposure Meter from Rofin Ltd measures the energy density from a pulsed laser in a well defined plate which would be occupied later by a photographic plate. The energy density is displayed directly on a meter. Wavelength and temperature compensation are incorporated. The instrument can also be used for measuring cw (continuous wave) power densities (assumed to be uniform over the receiving area). Also, because the area is well defined, pulsed energies and cw powers may be measured as well. The ranges have been chosen to correspond to those of interest in safety measurements for pulsed and cw lasers as well as pulsed holography. The detector is mounted in a head with a 6ft cable leading to the display unit.

The instrument comprises a wavelength selector, energy/power range switch, pulsed/cw selector, a back-off control to compensate for ambient light and a self-illuminated meter scale so that readings can be taken in the darkroom under low light conditions. The complete unit is packed in a wooden instrument case for protection and storage.

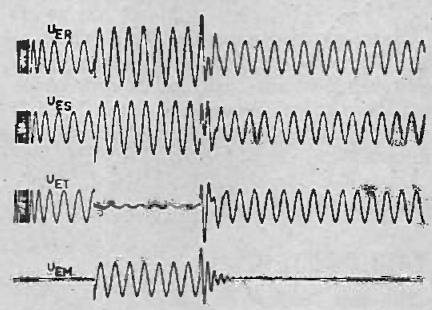


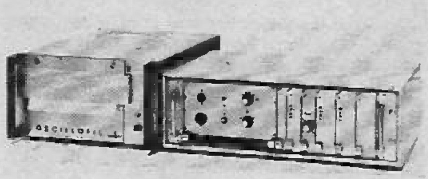
Each unit is fully calibrated by the National Physical Laboratory (NPL) before despatch. Once calibrated, the unit can be permanently set up and should require no further attention or checking. A complete user manual with circuit diagrams and application notes is supplied with each instrument.

Rofin Ltd, 3 Windhill, Bishops Stortford, Herts. (231)

OSCILLOSTORE

It is not easy to analyse functional faults in operating sequences after the occurrence of a fault. However, with the Oscillostore system for fault recording, developed by Siemens, the traces for important measured variables can be continuously stored and then accurately reproduced after a delay of roughly 300mS. The uv (ultra-violet) recorder is triggered before the termination of the delay and can thus provide a precise picture of the start of the fault as well.





The frequency range for the electronic delay module is roughly 1kHz for six measuring channels and is said to be fully sufficient for most fault analyses. The operating state before, during and after the fault can be continuously recorded by one single recording unit with a uniform resolution. Since the delay module stores electronically the traces of the measured variables involved, and the uv recorder is not in active operation when there is no existing fault state, the Oscillostore system is not subject to wear in the steady state. The signal issued after a delay of 300mS can be accurately reproduced after the start-up of the recorder.

The recorder is started by a trigger circuit which can be adjusted for limit values and has a response time independent of the set sensitivity. With this universal response function, the half-waves following each other are compared and the limits for the set amplitude and curve form are monitored. The hold-in time for the excitation, and thus the running time for the recorder, can be preselected.

All measured variables which can be represented by a voltage can be processed. Because of modular design, the system can be used for numerous applications, for instance, to simulate system phenomena (arcing short-circuits or the starting characteristics of high-power loads under fault conditions), process sequences, endurance tests and natural phenomena.

Illustration shows the acquisition unit with the light-beam oscillograph and typical oscillograms for fault recording.

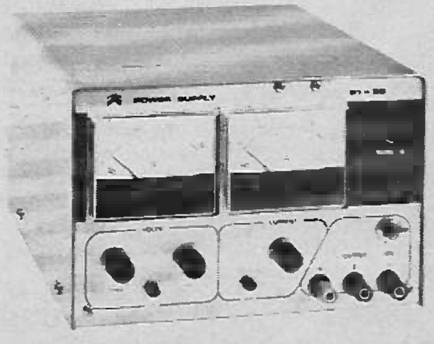
Siemens (UK) Limited, Great West Road, Brentford, Middlesex. (232)

LAB POWER SUPPLY

The B1-30 is a low-cost (£35) laboratory bench power supply with separate meters for output voltage and current and with adjustable current limiting. A separate switch associated with the output circuitry interrupts the output of the unit enabling voltage and current limiting controls to be set or altered with the load disconnected from the power supply.

Output voltage is adjustable from 0 to 30V; the meter has a divide-by-five switch, enabling voltages of up to 6V to be accurately set. The output current capacity of 1A which is monitored on a second meter. A constant current variable control can be set to limit the output current anywhere between 250 mA and 1.3A short circuit.

Line stabilisation is said to be better than



EQUIPMENT NEWS

0.01% (+1mV) for a 10% change in input voltage and the load regulation is such that a change from minimum to maximum load will not alter the output voltage by more than 0.05% +3mV. Ripple on the output is less than 1mV.

Elliott Relays (A Division of Associated Automation Ltd), 70 Dudden Hill Lane, London NW10. **(233)**

VORTEX FLOWMETER

The *Hagan* Ultrasonic Vortex Flowmeter is a new product suitable for recording, totalising and/or control. It utilises ultrasonic detection of vortex shedding, and generates proportional (digital and analog) signals.

Flow velocities up to 30ft/sec, equivalent to flow rates of 80, 300 and 700 gallons per minute for the three versions of the meter, can be measured with a claimed accuracy of ±0.5% full-scale.

It has no moving parts and is said to be suitable for clean homogeneous liquids with viscosities of 0.5 to 2.0 centipoise.

The vortex flowmeter operates unlike any other type of flowmeter. A cylindrical, stainless steel strut is inserted in the flow stream, with its axis perpendicular to the direction of flow. This strut creates vortices downstream which modulate the amplitude of an ultrasonic signal beamed through the fluid. A solid-state amplifier-transmitter monitors these modulations and provides both a pulse frequency and an analog (4-20mA dc) output.

Flow measurement is said to be unaffected by variations in either density or temperature or conductivity of the measured liquid. The amplifier-transmitter is explosion-proof – Class 1, Division 1, Groups C and D.

Westinghouse Electric Corporation, Computer and Instrumentation Division, PO Box 402, Orville, Ohio 44667, USA. **(234)**

PHOTOMULTIPLIER POWER SUPPLY

EMI is now offering a new stabilised 100-2,500 volt power supply unit designed for use with photomultiplier tubes in all types of application. Designated type PM25A, it is said to incorporate advanced features ensuring high photomultiplier tube performance.

Measuring only 8½in x 5in x 9in, the unit provides 100V to 2500V at 5mA from a dual output socket which allows polarity selection by the use of alternative leads. The hybrid circuitry incorporates automatic overload current limiting for a fast response time and freedom from high voltage transients on switch-on.

The output stability is one part in 10^5 for 10% mains change, regulation one part in 10^5 for 0-100% load change, ripple content 1mV pk-pk and mains input 100/125V or 200/240V, 48 to 66Hz.

Output voltage adjustment is by a rotary switch and a multi-turn potentiometer.

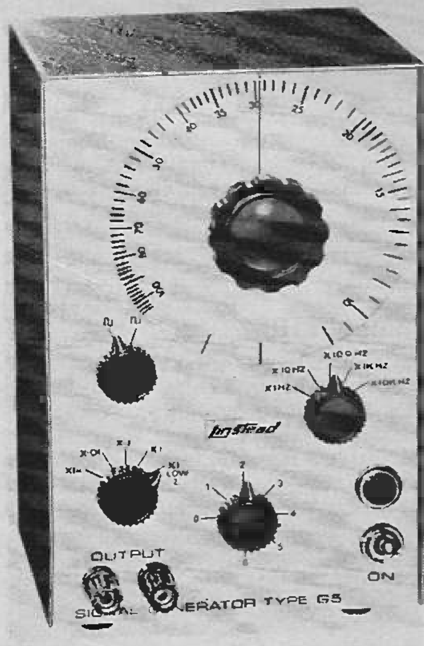
EMI Electronics Ltd, Blyth Road, Hayes, Middlesex. **(235)**

WIDE-RANGE SIG-GEN

The G5 is offered at £32 as a stable solid state signal generator covering a wide frequency range with high accuracy. The output may be attenuated at 600ohm or driven into low impedence loads giving substantial power. The vertical styling is designed for minimum bench space.

Frequency range is 10Hz to 1MHz (±2%, ±1Hz) and is covered in five decades controlled by switched close-tolerance resistors and a variable capacitor. The dial is geared for 330° rotation giving a total scale length of 130cm. The calibration is approximately logarithmic giving an open scale and even variation of frequency with rotation.

Sine-wave outputs are: (a) 0 to 6V rms continuously variable at low impedence to drive loads up to 30ohm over the whole frequency range (2 watts into 5ohm with low distortion and up to 3 watts with 10% distortion); this output will drive loudspeakers or a vibration generator such as the Linstead VI for examination of mechanical vibrations; and (b) 0 to 6V rms via 600ohm continuously variable and through step attenuator of x1, x0.1, x0.01, x0.001.



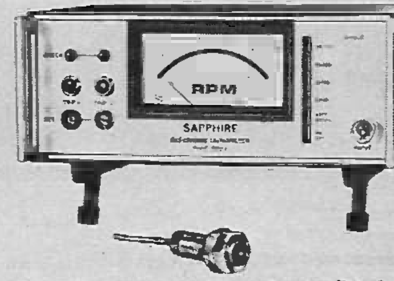
Square-wave output is 0 to 9V pk-pk up to 100kHz with rise time at high frequencies less than ½ microsecond, and dc coupled for no droop at low frequencies; output via 600 ohm continuously variable and through step attenuator of x1, x0.1, x0.01, x0.001.

Linstead Electronics, Roslyn Works, Roslyn Road, London N15 5JB. **(236)**

TACHOMETER

The new 700L series Tachometer is a laboratory version of Sapphire's 700 series Industrial Tachometer and is offered in different models to cover any speed range and scaled in any suitable units for rotary, linear or flow measurement and control. Up to 3 speed trips for command or alarm purposes are available, with latching facilities if required. Illustration shows the 702L with 2 speed trips. A full range of inductive, magnetic and photoelectric sensors are also available.

The instruments are fitted as standard with 4 push-button selected speed ranges and an integral pivotless 120° movement meter of



5in scale length, and can also be fitted with separate and ajustable outputs for driving slave meters, chart recorders, counters etc. Accuracy of the instrument is said to be ±1% FSD. A version with rechargeable batteries is also available.

Prices range from £65.

Sapphire Research & Electronics Limited, Sapphire Works, Ferndale, Glam. **(237)**

BATTERY CHARGES

The Avostat thyristor rectifier unit is primarily intended for the charging of traction lead-acid batteries used, for example, in industrial trucks and electric locomotives.

To ensure rapid, yet safe, charging of the batteries, ASEA has designed the charger for fully automatic two-step charging accomplished with the aid of thyristors in the main circuit, voltage and current control, and timers. The battery is initially charged with the highest permissible current until the cell voltage reaches 2.4V. The charger then changes over to constant-voltage duty with a steadily decreasing charging current until the time set on a timer – four to five hours – has elapsed. At the end of the first step, the battery is charged to about 80%.

Finish charging commences with constant current charging at 20 to 30% of the highest permissible current and with an upper voltage limit of 2.7V/cell. When this limit is reached, constant voltage charging continues at 2.7V/cell until the time set on the second timer – approximately three hours – has elapsed. Finish charging serves to fully charge the battery and to restore the capacity of the individual cells which may have deteriorated.

If the battery is left connected to the rectifier after the expiry of the finish charging, the rectifier switches automatically to trickle charging, which compensates for self-discharge. The battery is consequently fully charged whenever it is taken into use again.

Automatic charging of this type ensures a long battery life while reducing the charging time to a minimum. The timers and current limit setting allow one to select a suitable charging programme for each application.

The rectifier is available in a number of sizes for outputs between 1 and 15kW, for battery voltages of 24, 36, 72, 80, 110V and a charging current of 30 to 150A.

ASEA (Great Britain), Villiers House, 41 Strand, London WC2. **(238)**

INVERTERS

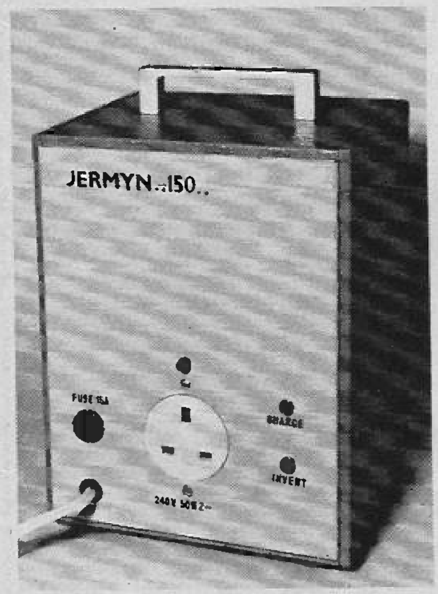
An inverter unit for providing a 250V supply at 50Hz from a car battery has been announced by Jermyn. Available in two models, for 150 watt and 300 watt operation; the former version operates from a 12V battery, whilst the latter requires a 24V power source.

These units have been specially designed to charge the 12/24V batteries when plugged into any household power socket. Should

EQUIPMENT NEWS

the mains supply fail for any reason, the unit automatically goes into its inverter mode, thus providing a 240V emergency supply immediately.

Should the inverter be accidentally overloaded, the unit's drive is automatically adjusted so that the output voltage falls completely, protecting the unit. In-built circuitry ensures that the unit's 15A fuse will blow if the battery leads are connected incorrectly, thus giving added protection to the inverter. In addition, indicator lights show if the unit is charging the battery or if it is providing a 240V 50Hz output.



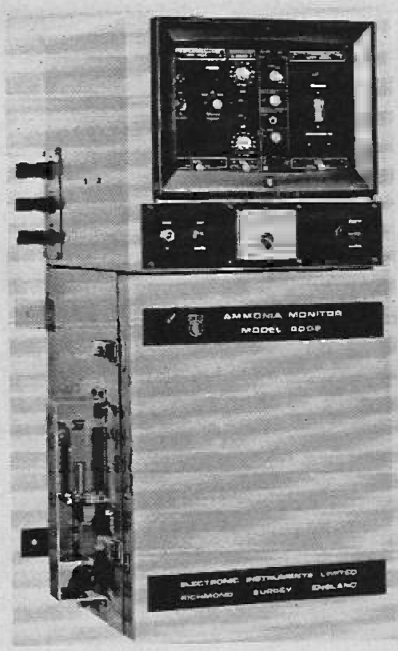
Both versions of the inverter are available from Jermyn as a kit of parts or built up units; prices range from £25 to £39.

Jermyn Distribution, Vestry Estate, Sevenoaks, Kent. **(239)**

WATER ANALYSERS

The 8000 Series of Automatic Selective Ion Monitors designed for continuous operation in industrial environments, are analytical instruments using an ion-selective electrode – housed in a special flow-cell receiving controlled flows of sample and reagent – as the basic sensing element for on-line analysis of boiler water, potable and river waters, process liquors, sewage and industrial effluents. The use of ion-selective electrodes enables a wide dynamic range and high resolution to be achieved at low concentration. For example determination of ammonia concentrations from 0.05mg/litre to 1000 mg/litre with an accuracy of better than 0.01mg/litre in the region of 0.1mg/litre is claimed.

Each 8000 series monitor employs one of 24 ion-selective electrodes for monitoring, for example, fluoride, ammonia, sodium, chloride, water hardness, nitrate, cyanide, ammonium etc. A particular feature of these monitors is said to be the little need for



routine maintenance, weekly replenishment of the reagent reservoirs and three-monthly inspection of the liquid handling system being the only requirements.

The electronics unit includes automatic standardisation facilities which may be initiated on demand or automatically at set intervals. The output signal is displayed on a local indicator. Interface facilities can also be provided for data-logging.

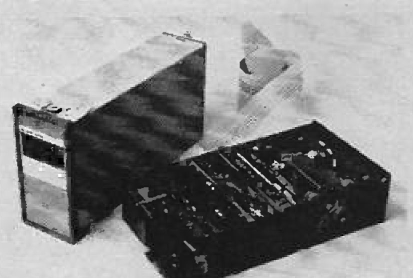
Electronic Instruments Limited, Hanworth Lane, Chertsey, Surrey. **(240)**

TEMPERATURE CONTROL

A general purpose temperature module which can become a complete thermal system controller has been introduced by Advance Electronics.

Designated the 9000 series, the units in the range will accept almost any sensor input, offer BCD output, and feature high and low alarms easily adjustable by simple removal of the front bezel. They also have variable range and visual overrange indication.

The neon seven segment digital readout is said to be clearly readable from 40 feet in daylight and the units may be vertically or horizontally mounted. Isolation is provided by opto-electronic coupling.



Local or remote compensation is offered and the units will work on a 2, 3 or 4-wire system. All units are to standard DIN size (138 x 68 cut out) and power requirements are 100-125V or 200-250V rms, 50-60Hz 16VA.

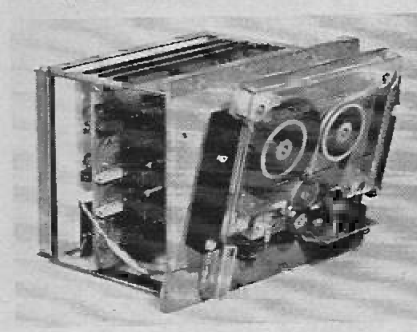
Advance Electronics Limited, Raynham Road, Bishops Stortford, Herts. **(241)**

MINI TAPE DRIVE

A new cartridge tape drive designed for use with mini computers, terminals and other data processing applications which require maximum capability in minimum space is now available to OEM customers from MDS Data Processing. Known as the MDS 2021 cartridge tape drive, it incorporates the 3M DC 300A Data Cartridge, to provide a compact precision tape handler. Prices start at £100 and the new handler is available as a desk-top console, a panel mount assembly and a mechanism-only configuration.

The cartridge consists of two quarter-inch wide tape reels, 300 feet of magnetic tape and a drive system. The tape is not touched by hand – the cartridge needing only to be inserted when preparing a read or write data. A rotatable plug prevents writing on the tape. Data is recorded at densities from 800 at 1600 bits per inch. The cartridge transport writes forward, reads forward and backspaces at a speed of 30 feet per second. A fast forward search operation moves tape at a speed of 90 inches per second. Tape rewinding is also at 90 inches per second.

The recording format used to store data on the magnetic tape is determined by the controller. The recording head is a dual gap, read after write device with a spacing of 0.15 inches between gaps. Input receivers and output drivers are TTL circuits. No ac power is required, dc power (12 volts) being supplied through the interface.



The three versions of the MDS 2021 – table-top; rack-mounted; and mechanism-only – are all available in either single, dual or four-track units are also available.

Without casework, the 2021 is 8in wide x 5½in high x 7½in deep.

MDS Data Processing Ltd, Mohawk House, 50 Vauxhall Bridge Road, London SW1 2RT. **(242)**

RECORDER CHART DRIVES

Environmental Equipments Ltd are now marketing the WR700 Series of 1 & 2 channel Chart Drive Mechanism, complete with pen motor and heated stylus writing on thermal sensitive paper. These units are intended for original equipment manufacturers and engineers who have a requirement for fast response recording and wish to incorporate recorder readout as an integral part of their equipment.

Four models are available with recording widths of 4cm and 5cm, having a frequency response from DC to 75Hz. The total range of chart speeds covered by these drive mechanisms is 3mm/min to 100mm/sec. The pen motors can be supplied as separate items if desired and drive amplifier printed circuit board assemblies are also available.

Environmental Equipments Ltd, Eastheath Avenue, Wokingham, Berks. **(243)●**

COMPUTERS IN BANKING

(Continued from page 60)

data as it is collected to the centre where it is processed and stored. During the early hours of the morning each branch is sent the balance statements and other information for the guidance of the branch staff. So each day a detailed statement can be called up in no more than 30 seconds: a statement of account takes 3.5 seconds. The manager can request a detailed list of over 50 particulars about an account to aid his judgement. He also gets a list of overdrawn accounts as matter of course. Staff are, therefore, released from many of the monotonous tasks of traditional banking.

Other novel procedures can be introduced if on-line operation is generally available. Take, for instance, the automatic cash dispenser facility soon to be launched by Lloyds at branches which are on-line. At present most banks in Britain operate a cash card system whereby a special plastic card is used to obtain cash from a machine. The difficulty is that it is hard to ensure that the system is not cheated and equally important from the bankers' point of view that there is money in the account to cover the withdrawal. To prevent fraudulent use, the service is restricted to only small sums of money.

The new Lloyds dispensing units (shown in Fig. 7), overcomes most of the objections because it is on-line coupled to the central records. A customer inserts his personal card into the slot. If accepted, the keyboard on the left is uncovered ready for use. He then keys in his personal four-digit number (known only to him and his bank) and the amount required. Within forty seconds of starting the process he has his money which appears in a tray. In that time the amount required has been checked against the account, the account updated and a signal sent to operate the cash tray. This facility will enable withdrawals at any time and at any branch, provided the balance is there. Initially, not all branches will have them, but by 1974 all banks could be offering this service. A later plan of Lloyds is to enable deposits to be made the same way.

The impact of data processing is very apparent in this application for already we see the routine work of banks being put onto machines without the need for bank officials on a counter. So far the computer has enabled us to keep up with expanding business in banks but there are those who feel that something superior to the cheque system is needed to further stream-line finance.

Hargreaves, the Director of Public Affairs at IBM in Britain, gave a talk in 1969 entitled "Computers in the world of change". In it he brought the fast changing nature of our existence into meaningful terms. One of his examples is a fitting end to this report. He said:— "We can represent the history of the last 50,000 years by the life-span of some 800 people. Of these, 650 would have lived in caves, only 70 would have had some proper means of communication, six would have been acquainted with the printed word and just four would have been able to measure time accurately. The majority of the discoveries which contribute to our material well-being have been made in the life-time of the 800th, and the 801st can expect to experience more changes in his life-time than in those of all preceeding 800." (A similar comment is also made by Alvin Toffler in his book "Future Shock" — Ed). ●

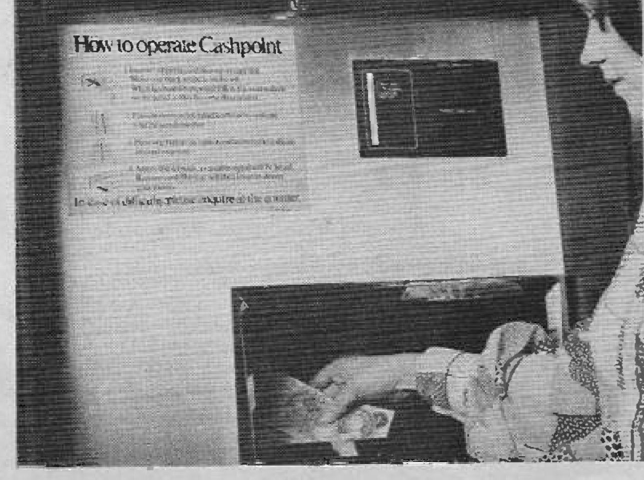


Fig 7 — Lloyds automatic cash dispenser

INVERTER FOR FLUORESCENT LIGHTING

(Continued from page 59)

With the fluorescent tube alight, check the current drawn from the 12V supply. It should be 2.5 amps ± 0.2 amp. If it is outside these limits vary the choke air gap until it is correct. Increasing the gap increases the current — and vice-versa.

Now disconnect the transformer and dip it into varnish or model-aircraft dope to insulate and solidify the winding and core.

When the transformer has totally dried out, reconnect all components.

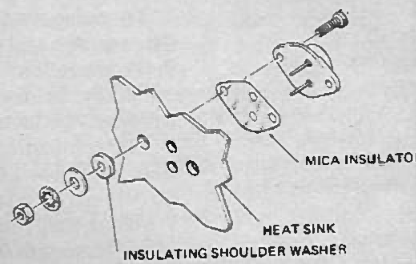


Fig. 4. Insulating washers must be used to electrically isolate each transistor from the heat sink.

TABLE II — Choke Winding Details
Core — 2, Mullard type FX 2242
Coil former: see note on page 76
Note — coils are held together by 3/16" brass bolt and nut— a 3/16" brass washer is used to form an airgap.
Winding: 250 turns of 0.4mm diam wire.

The fluorescent tube must have an earthed metal shield (i.e. connected to the negative side of the 12V supply) close to it and running the full length of the tube. If the tube is mounted in a normal metal light fitting this in itself will form the earth. In the case of our prototype unit — in which we housed the tube in plastic for mechanical protection — four lengths of copper wire running the full length of the tube were used.

As this unit operates at 2kHz there will be some noise at this frequency from the transformer and choke. This may be reduced by encasing the main components in heavy felt — further reduction may be obtained if necessary by encapsulating the transformer and choke in epoxy resin ●

EDITOR'S NOTE: Formers for the choke and transformer windings should be available from: Hurst Ford Ltd, 12 Dalston Gardens, Stanmore, Middlesex.

NEW LITERATURE

● Brochure describing the Multitone Universal pocket paging system which can locate up to 100, 538 or 870 key personnel by selective call, on sites of any size or complexity, is ideal for offices, hospitals, factories, etc and can be coupled to an automatic telephone exchange to dial 'bleep' calls from any telephone extension.
Multitone Electric Company Ltd, Underwood Street, London N1.

● Brochures giving a wide range of Sodeco impulse counters and ancillary products with a wide variety of uses – from counting the parts produced by a machine, to recording the number of articles through an automatic vendor, and some able to provide simple solutions to automation problems such as level and position control (counting up and down).
Landis and Gyr Ltd, Victoria Road, North Acton, London W3 6XS.

● The latest issue of the Semtech silicon rectifier catalogue giving details of the Semtech range of 'Metoxilite' rectifiers and voltage regulators, high voltage silicon rectifiers, bridge rectifiers, silicon power rectifiers, high current rectifiers, high voltage modules, multipliers and 'Tubepac' plug-in replacement part for most popular mercury and vacuum glass rectifier valves.
Bourns (Trimpot) Limited, Hodford House, 17/27 High Street, Hounslow, Middlesex.

● A striking wall chart plus 1972-74 calendar which briefly describes Coutant's thick-film custom design and manufacturing services and showing, in simple terms, how thick-film circuits are made, the advantages to be gained by 'going thick-film' and the services Coutant can offer in this field.
Coutant Electronics Ltd, 3 Trafford Road, Reading RG1 8JR.

● Technical Data Sheet on the Venture Miniscript 6-colour dotted-line Recorder.
Smiths Industries Ltd, Industrial Instrument Division, Waterloo Road, Cricklewood, London NW2 7UR.

● A new 72-page catalogue containing complete listings, engineering drawings, specifications, operating characteristics, and technical data on switches and keyboards, including snap-action switches, lever-wheel/thumbwheel switches, keyboard switches, matrix selector switches and keyboards.
Cherry Electrical Products (UK) Limited, Lattimore Road, St Albans, Herts.

● A quick-reference wall chart of the Motorola range of McMOS integrated circuits, with the logic diagram of each of the 47 devices in the family and providing pin-out details and some of the parameters common to all devices.
Motorola Semiconductors Limited, York House, Empire Way, Wembley, Middlesex.

● A new catalogue covering Crouzet's recently extended range of standard and miniature Limit Switches, all of the same basic construction and either single, double or 'plug-in' double pole, the first two types fitted with Crouzet 15A and 5A microswitches respectively and the 'plug-in' version fitted with a special 16A switch which plugs in to the wiring terminals on the switch body; and the eight interchangeable actuator heads for versatility of operating functions.
Crouzet, Thanet House, High Street, Brentford, Middlesex TW8 8EL.

● Leaflet ('Tech Tips 5-2') in the Westinghouse high-power semiconductor series explains and illustrates the major causes of voltage transients in typical thyristor converter circuits and the basic approaches to transient protection to prevent malfunction or device failure and discusses suppression schemes for relative size, cost and complexity.
Westinghouse Electric, 80 Avenue Victor Hugo, 75 Paris 16e, France.

● A new leaflet describing the recently introduced Moore Reed Colour Telemetry Video Display as an interface between the operator and the process he controls or monitors.
Moore Reed & Company Ltd, Walworth, Andover, Hants.

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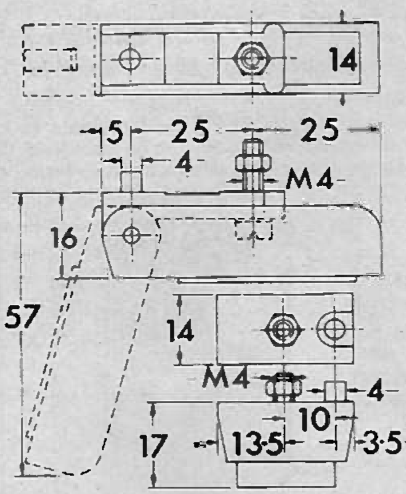
COMPONENT NEWS

TILT FEET

West Hyde Developments are supplying instrument manufacturers with a new means of tilting the viewing end of instruments upwards to facilitate reading by the user. As an alternative to the usual handle/stand arrangement, or bent chromed rod, the Contil 'scope' feet are said to provide a low cost, easily fitted attractive means of tilting an instrument.

'SCOPE' FEET



The feet are moulded in a grey material with black anti-slip inserts. In the extended position, the far end of the instrument can be raised by at least 39mm whilst, when not in use, the instrument rests on the anti-slip inserts in a level position.

West Hyde Developments Limited, Ryefield Crescent, Northwood Hills, Northwood, Middlesex, HA6 1NN. **(253)**

LASER RODS

Polycrystalline ceramic laser rods with optical quality said to be three times better than ceramics now on the market have been produced at General Electric Company of the USA's Research and Development Centre in Schenectady, New York.

Yttralox (Trademark of GE, USA) polycrystalline ceramics are prepared from yttrium oxide plus thorium oxide. In laser applications, the doped material is said to offer a potentially higher average power output than neodymium-doped glass, and could be made inexpensively in large sizes and useful shapes, since it is produced by conventional cold pressing and sintering techniques.

The undoped Yttralox ceramics may find applications as infrared 'windows' for carbon monoxide lasers and other devices that could make use of their optical transparency from the ultraviolet to the infrared, their high temperature capability, and their chemical inertness.

Yttralox laser material has previously been limited in usefulness by high scattering losses. Research has however shown that the two most conspicuous optical defects – pores and a variation in the refractive index called 'orange peel' – can be virtually eliminated by changes in processing of the ceramic material.

The composition of the Yttralox laser material is 89 mole percent yttrium oxide, 10 percent thorium oxide, and one percent neodymium oxide. In earlier fabricating techniques, the constituent powders that compose the ceramic had been manipulated as little as possible in order to avoid contaminating them, since impurities are a serious problem in laser rod materials. Researchers at GE (USA) found, however, that milling the powders in a rubber-lined ball mill for several hours was an important step in achieving high optical quality in the finished rods.

As a result of sharply reducing the pore density and 'orange peel' in the material, the optical quality of the rod is improved to the point where it is possible to sight through a rod and resolve an object several miles away. With material that has not been ball-milled, it is hardly possible to resolve an object at the end of the three-inch rod.

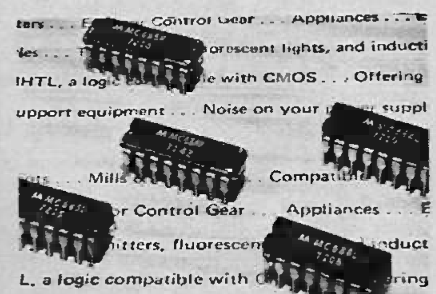
The development, which is continuing, has been partially supported by the Defence Department's Advanced Research Projects Agency.

Asten Associates, 4 St. John's Hill, SW11 1RU. **(254)**

HIGH THRESHOLD LOGIC

MHTL, Motorola High Threshold Logic, is intended for use in areas where the high level of electrical noise would cause faulty operation of logic circuits.

The high noise immunity achieved by HTL is due to the modified DTL structure of the basic gates; zener diodes are used to replace normal forward-biased diodes in the gate circuitry; HTL is designed for use on a 15V power supply and is claimed to have about three times the noise immunity of TTL.



The four new devices which have just been added to the family are: MC686, a four-bit shift register (the first shift register in the MHTL range); MC684, a decade counter; MC685, a binary counter (the first two counters in the family) and the MC688, a dual J-K flip-flop in a 16-pin package.

The new devices are available in plastic or ceramic packages for operation over the temperature range -30 to +75°C, or in ceramic packages only for -55 to +125°C.

MHTL should be ideal for use in machine tool and process controllers, computer peripherals and the like.

Motorola Semiconductors Ltd, York House Empire Way, Wembley, Middx. **(255)**

ELECTRONIC SECURITY KEY

New from Distloc is a portable electronic key to give only accredited people access to secure buildings, machinery, safes, filing cabinets, cash registers, vans, data-processing rooms and other restricted enclosures which can be protected by solenoids that are normally locked. The action of bringing the electronic key within about one metre of its fixed probe operates the solenoid and unlocks the enclosure to give free access. Key and probe interact by electro-magnetic induction, without the need to remove the key from the user's pocket. After the door or drawer or till has been reclosed, the removal of the key to a distance greater than one metre automatically ensures re-engagement of the locking solenoid or removal of the power supply. Being a fail-safe system, low battery voltage in the key, mains failure in the control-unit supply or tampering with any of the circuits will make unlocking impossible. Incorrect signals from a key produce a warning tone to discourage further attempts to use it.

For security reasons, the only information released is that the standard oscillator key is roughly the size of a 10-cigarette packet and contains a PP3-type battery of about 6 weeks life. A rechargeable battery unit is

(Continued on page 80)

Announcing the Tripletone twins.

Two brand new stereo amplifiers with a lot in common.

ADVANCED FEATURES: Both models feature the best of previous designs while taking advantage of the latest advances in circuit technology. Characteristic tripletone facilities such as middle, bass and treble dual concentric controls are presented in an all silicon design using plastic transistors and two field effect integrated circuits presenting a 2 Mohm input impedence for ceramic cartridges.

INCREASED FLEXIBILITY: Both models have input facilities for magnetic and ceramic cartridges, tuner and tape and incorporate a low pass (scratch) filter.

The extra control given by the three dual concentric potentiometers (bass, treble and middle) allows an effect similar to stereo to be produced from mono records and gives more flexible reproduction of stereo material.

VALUE FOR MONEY: Attractively presented in a low line teak cabinet with extruded aluminium control panel, both models cost a lot less than you'd expect.

The HI-FI 1818 costs only **£46.50** while the HI-FI 77 is of equally good value at **£36.50** meeting the requirements of lower powered systems.

TRIPLETONE HI-FI 1818
Power Output Each Channel – 18 watts RMS 1 KHz. 8 ohms
Tone Controls Bass ± 15dB @ 30 Hz. Middle ± 12dB @ 1 KHz Treble ± 15dB @ 10 KHz
Inputs Magnetic 3mV. – 47 KΩ (RIAA)
Ceramic 80mV.(2Mohm)
Tuner 100 mV. 100 KΩ Tape 100 mV. 100 KΩ
Outputs Speakers 8–16 ohms Headphones 8–16 ohms
Tape 200 mV (100 KΩ)

TRIPLETONE HI-FI 77
Power Output: Each Channel – 7 watts RMS 1 KHz. 8 ohms
All other specifications are same as the Hi-Fi 1818 model

Please send for further details of these models

Name ....

Address ....

....

Tripletone Audio Equipment is Manufactured by
K & K Electronics Ltd., 60, St. Marks Rise London, E8. Telephone 01-254 9941/4

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(Continued from page 78)

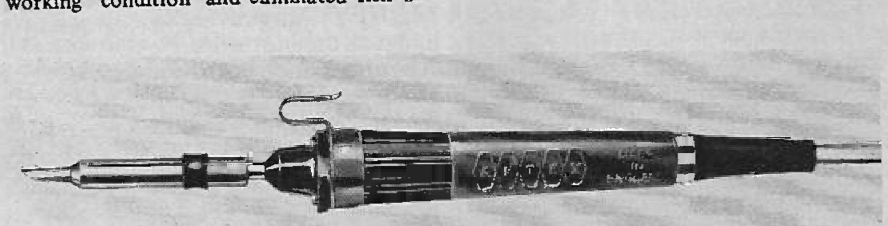
COMPONENT NEWS

under development. Linking components include the inductive probe that picks up the oscillator's field, a control box to check that the signal's coding is correct, an electric door staple for strong-room and other doors, and a range of solenoids for locking cabinet drawers and immobilising machinery. Machinery, and cash registers, can also be controlled, without modification, by making Distloc switch off the electrical supply.

A Distloc cash-register protection system, with two standard electronic keys, costs £45.70; and an electronic door staple £20. For agents' names and addresses, and other details, contact Distloc, 91A High Street, Camberley, Surrey. **(256)**

SOLDERING IRON

The new and improved Antex X25 soldering iron, with an increased heat capacity, is said to be capable of soldering up to 60 joints per minute. Large volume bits absorb and store the rapid heat production of the 25 watt element without over heating. The X25 design makes efficient use of heat transferred from the element to the tip of the bit and is said to achieve a heat capacity equivalent to that of conventional irons of much higher wattage. By fitting a high grade ceramic tube within the stainless steel shaft of the element, Antex claim to have reduced current leakage to less than 5 microamps at working condition and eliminated risk of



damage when soldering integrated circuits or transistors.

The iron weighs only 1¾ ozs and there are three iron-plated, precision machined bits which are easily interchangeable: No. 50 tip size (2.4mm) 3/32", No. 51 tip size (3.2mm) 1/8", No. 52 tip size (4.7mm) 3/16", No. 51 is supplied as standard.

Antex (Electronics) Ltd, Mayflower House Plymouth PL1 1BR, Devon. **(257)**

HV MODULES

A type 512 module working at its full rated voltage of 6.3kV under water in a goldfish bowl without harm either to itself or the goldfish, illustrates Brandenburg capability in designing high-voltage modules to operate in almost any environment.

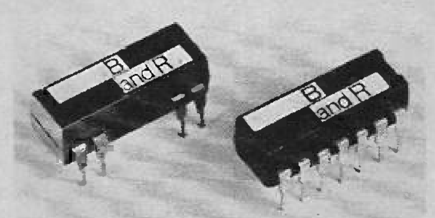
Other severe environmental conditions such as extremes of temperature or mechanical shock can also be catered for, so Brandenburg claim, due to the use of solid-state components and a silicon rubber encapsulant.

Modular supplies are available with outputs of up to 30kV and 500μA for use as component sub-assemblies in equipment such as oscilloscopes, aircraft head-up displays, crt displays, etc.

Brandenburg Ltd, 939 London Road, Thornton Heath, Surrey CR4 6JE. **(258)**

DIL REED RELAYS

A complete family of dual-in-line reed relays has just been launched by B&R Relays.



Relays with one normally open, two normally open and one changeover switch are now available with standard coils for 5, 12 and 24V dc. Specially sensitive versions, operating at less than 50m watts for IC and solid-state logic systems, can also be supplied.

The pins are identical to the standard 8 or 14 spacings: internal clamping diodes and electrostatic screens are available to order.

All standard relays are said to be obtainable on B & R's 24-hour despatch service.

B & R Relays Limited, Temple Fields, Harlow, Essex. **(259)**

HEARING AID AMPLIFIER

Hybrid microcircuit NMC 500 is claimed to be a completely self contained, subminiature amplifier designed for use in high quality commercial hearing aids, requiring only the volume control/switch, microphone, earpiece, case and battery to complete the system.

Planar silicon transistors and operational amplifier techniques are employed throughout to ensure consistent gains and stable output stage bias currents. The low and high frequency response is tailored internally but the capacitors concerned may be altered to meet individual customer's requirements.

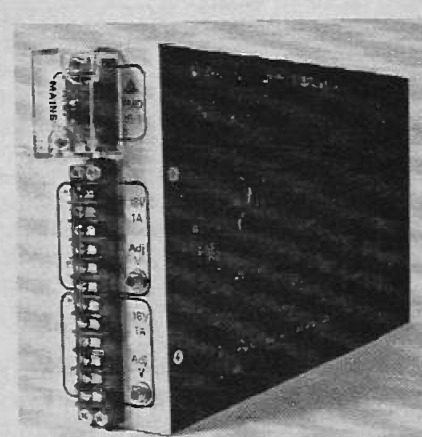
The quiescent current is adjusted during assembly to a nominal 3mA in the output stage, using 100 ohm passive load, to enable it to be used with earpieces of the order of 100 ohm dc resistance.

Pye of Cambridge Ltd, St Andrews Road Cambridge CB4 1DP. **(260)**

POWER SUPPLY

The PMD 18-1 is a compact power module offering two output channels, each channel supplying 18V dc at currents up to 1A. A front panel potentiometer permits a fully variable voltage output down to 1V. Constant voltage and current stabilisation are featured on both channels and facilities are available for external programming of both current and voltage.

Line voltage regulation (constant voltage mode) is said to be typically 0.015% + 1mV for a total change of ±10% of supply voltage, and similarly for load voltage regulation (constant voltage mode) for a 0-100% load current change.



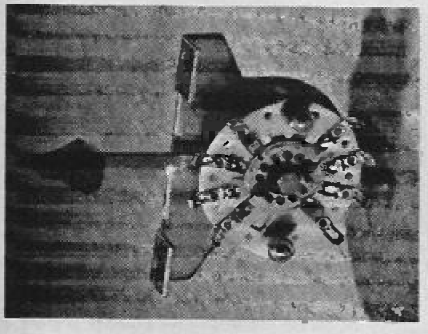
Load current regulation claimed is 0.2% + 1mA dc for a 0-100% load voltage change, and an operating temperature range of 0 to 60°C ambient and an output impedance of less than 0.25Ω at 100kHz. Power input requirements are 100-125V ac and 200-250V ac, at ±10% of 48-450Hz.

Constant current overload protection is set to 105% ±2% of rated output and is variable by a simple internal resistor change. Size of the unit is 50 x 130 x 228mm and weight 2.73Kg.

Advance Electronics Limited, Raynham Road, Bishops Stortford, Herts. **(261)**

LEVER SWITCH

Type TLS lever switch, made by the French company Usine Jeanrenaud, is available from ITT with 2, 3 or 4 positions at 30° indexing angle with the alternative of 22½° on the 4-position. Spring return (biased action) can be supplied on the 30° models only.



The switch wafer used on this series has an overall diameter of 28mm with either silver-plated brass contacts for commercial applications of 3μm gold on brass for professional use. Mechanical life is in the region of 20,000 complete switchings, ie 80,000 positions on the 4-position version.

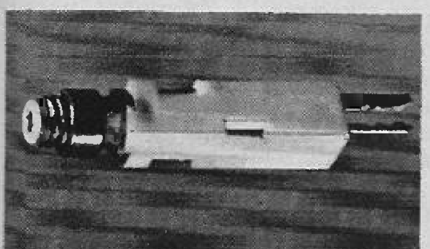
Nominal voltage rating of the TLS is 150V. Current carrying capacity is 135mA with a maximum switching power of 20W. Contact resistance is said to be less than 20 milliohm.

ITT Components Group Europe. Electromechanical Product Division, Edinburgh Way Harlow, Essex. **(262)**

MINIATURE TWO-POLE JACK SOCKET

Sealectro claim to have developed the MJS/1, a miniature two-pole open-circuit jack with a high electrical and mechanical performance in a minimum of panel space. The MJS/1 can be mounted on ¼" centres adjacent to each other in both the x and y planes, resulting in a packing density of 16 to the square inch.

Manufactured from moulded polypropylene, the body has a threaded bush and ret-



aining nut at one end and houses two beryllium copper, gold flashed contacts rated for 230V rms at 1A maximum, and contact resistance of 10 milliohms maximum. Mating plugs, common to the Sealectroboard Matrix Plugboard System, can provide functions such as shorting, independant connection to either or both contacts or the interpositioning of diodes and other components. Reasonably priced and available from stock, the MJS/1 Jack should have numerous applications for test or patching purposes where panel space is restricted.

Sealectro Limited, Walton Road, Farlington, Portsmouth, PO6 1TB. **(263)**

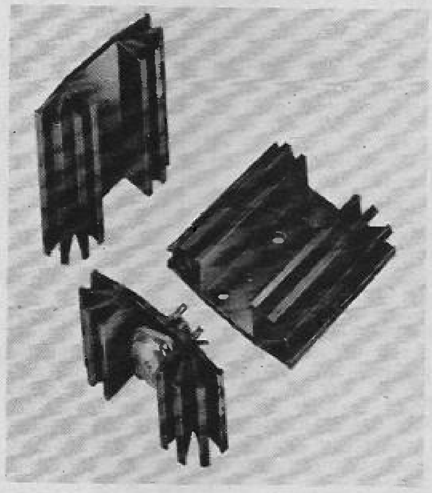
TO-3 HEATSINKS

A new addition to Jermyn Manufacturing's extensive range of heatsinks and heat transfer devices.

The 'MC' series TO-3 heatsinks, intended for direct printed circuit board mounting, have a low-profile (22.5mm) and measure 76mm wide overall and can be supplied in standard lengths of 38mm, (for one device) or 76mm (for two devices), either drilled or undrilled. Thermal performance is said to be typically 4.5°C/W for a single TO-3 device on a 38mm heatsink.

For engineers who would like to use transistor sockets the drilled heatsink is suitable for use with Jermyn Manufacturing's own TO-3 transistor socket type A1303.

To cater for customers who require heatsinks to non-standard sizes for PCB mounting, Jermyn can also supply unfinished heatsink extrusion in 0.92 metre (36")

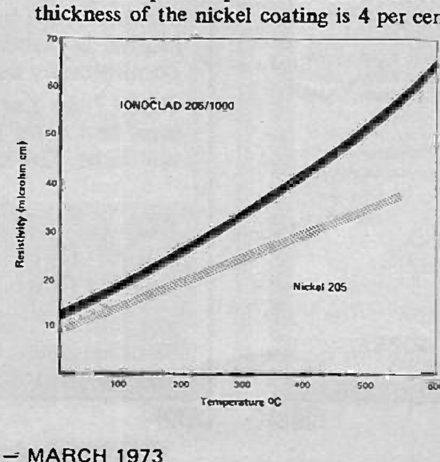


lengths.

Jermyn Manufacturing, Vestry Estate, Sevenoaks, Kent. **(264)**

NICKEL-CLAD WIRE

Incoclad 205/1000 is offered by Wiggin as a cheaper alternative to pure nickel wire for applications such as leads and terminations in the electrical and electronic industries. It is a nickel-clad iron wire produced by a powder metallurgy process, and has a better bond between the nickel and the iron core than plated products. The nominal thickness of the nickel coating is 4 per cent



of diameter. The nickel is the equivalent of Wiggin's commercial grade of pure nickel, Nickel 205, while the core is of low carbon iron.

Incoclad 205/1000 can be used for electrical leads and terminals, support wires and rods and similar applications at all temperatures up to 600°C. It is supplied in reels, coils or pay-off packs, and will normally be in the bright annealed condition.

Henry Wiggin & Co Ltd, Holmer Road, Hereford, HR4 9SL. **(265)**

BRIDGE RECTIFIERS

Semitron have introduced a series of bridge rectifiers in the 4, 5, 15 and 25 amp current range. Housed in a high conductivity alloy case with a nickel finish, the RB range of rectifiers has been designed for easy installation and maximum thermal conductivity.

The 4 amp version is available with tinned copper leads only ('A' outline) whereas the 5, 15 and 25 amp versions have universal terminals ('B' outline) for push on connectors, wire wrapping or standard soldering. General applications include power supplies, AC/DC converters and motor control circuits. An avalanche version is also available for critical applications.

Maximum thermal impedance is claimed to be 1.5°C/watt with maximum operating and storage temperature −55°C to +150°C. Overall dimensions of the 'B' outline bridge rectifiers are 29mm x 29mm x 10mm. Terminals are 13mm (maximum).

Semitron Limited, Cricklade, Swindon, Wiltshire. **(266)**

15W ZENERS

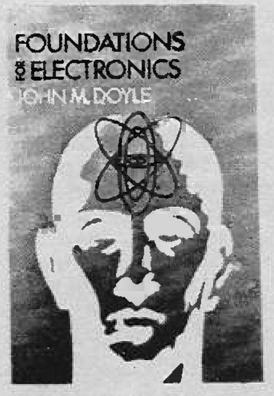
A new family of zener diodes with a dissipation rating of 15W is announced by Mullard. Type BZV15. The diodes, type BZV15, have operating voltages that follow the E24 logarithmic series of preferred values from 10 to 75V ± 5%.

The diodes have a rectangular encapsulation with a metal plate on one side to aid dissipation; diodes with normal polarity have the plate connected to the cathode, but those with reversed polarity – BZV15R – have it connected to the anode. The BZV15 diodes can be used with the metal plate at a temperature between -55 and +85°C; maximum permissible junction temperature is 150°C. The diode pins are spaced to provide a 'drop-in' fit on printed wiring boards. The diodes are said to be particularly suitable for use in a wide range of industrial equipment as well as the regulating circuits of medium power supplies as used in television receivers and similar applications.

Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD. **(267)**●

BOOK REVIEW

REVIEWER: Brian Chapman



FOUNDATION FOR ELECTRONICS by John M. Doyle. Published by Rinehart Press San Francisco. Hard cover 455 pages 9½" × 6½". Price £6·50.

"Foundation for Electronics" is a basic text on dc, ac, magnetic and network theory, suitable for use in the first year of a university course in electronic engineering or other allied fields.

Although the opening chapters of the book require only a knowledge of basic algebra, the level of mathematical knowledge required increases as one progresses through the book. This increase is consistent with a concurrent course in mathematics extending to matrices, determinants and complex algebra.

An unusual feature of the book is an opening paragraph to each chapter entitled "Highlights of what you will learn" the aim of which is to encourage the student to browse through the book before undertaking a detailed study. This device, I feel, is largely unnecessary; what student does not browse through the text anyway – usually horrifying himself in the process. Nevertheless it may create some additional interest.

All the conventional topics are treated – current and voltage, resistance, network theorems, magnetism and inductance, capacitance, ac circuits, basic electrical measurements, mesh-current analysis and node-voltage analysis. The treatment is good, with plenty of worked examples and scads of problems at the end of each chapter. Tables of trigonometric and exponential functions are provided at the end of the book and in all the whole is a well rounded presentation of the basics of electrical-network theory.

It should be a very useful addition to the standard texts of any student engineer. – B.C.

ADVERTISERS INDEX

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INPUT GATE

LETTERS FROM OUR READERS

AUDIOPHILES

Nearly full marks for the Nov '72 issue of your magazine. However, why do all audiophiles exhibit symptoms similar to those of a man whose vision is only down a microscope? To allow four pages of such detail in 'Designing a 700 Watt Amplifier' and only a tenth of the space for Mr Stewart's letter advocating current feedback in audio systems! The latter seems to raise issues ten times as important as tbose in the former. D Watts, Lincoln

As we state in our editorial this month, we try to cover the whole electronics spectrum, including certain topics in depth where necessary. As for Phase Linear's Mr Carter's article, although it was a reply to our review of their amplifier in the Sept issue, we felt there was some interesting material in this feature — and many readers have appreciated this. (See below). Re current feedback, we have realised its importance and plan to publish a feature on this subject shortly. Ed

700 WATTS AND RIS

Robert Carver's defence of his amplifier I found very informative and made very interesting reading...The ingenuity of the Nov '72 editorial was marred by a misprint—actually 0.25 for yellow.
M V M Herchenroder, FIS, Mauritius

NEVER TOO YOUNG

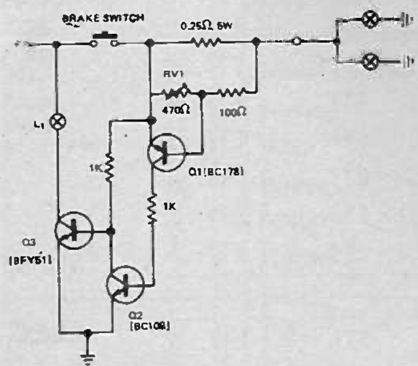
I think your articles such as 'A Practical Guide to SCRs' and others invaluable to us hobbyists who are self-taught. I get your magazine every month and have just noticed, in the November '72 issue 'Input Gate', the items titled 'Amateur Electronics' and 'Never Too Young', and think your suggestion very good. Keep up the good work!

PS: Am I your youngest subscriber?
D Heydon (age 13), Co Kildare, Ireland

So far, yes. But we live in hopes! Ed

BRAKE LIGHT WARNING

Some readers may be interested in a modification to the indicator circuit (October '72) to ensure that the warning light is lit only when there is a bulb failure. The warning lamp being normally off and lighting only under fault conditions may be preferred by some drivers as less distracting under



normal conditions and more noticeable under fault conditions. RV1 is for setting up the 'turn on' point for Q1.
A Thomas, London N8

In any warning light application, there is a case for the argument in your last sentence. However, for preferred 'fail-safe' operation, indicators of this type are designed to be normally on and to go off to indicate fault. Your modification is quite in order if there is some other indication on the dashboard to show that the warning lamp being off is not due to its own failure or the failure of the battery supply to its circuit. Ed

Q FACTOR

Is there not a mistake on page 11 of your December '72 issue? If the Q of a tuned circuit is increased, the bandwidth narrows and the selectivity improves. Also, if my memory serves me right, the 3 dB bandwidth is a function of frequency and is equal to f/Q. Thank you for an interesting magazine and wish you all success in the future.
N A Currey, New Malden, Surrey

Should not your sentence read "Higher Q will give better selectivity and less bandwidth"?
H Lipschutz, Glamorgan

Our thanks to the many readers who have written about this. We boobed! Ed

SCOPE CALIBRATOR

I am a student at the Strathclyde University, Glasgow. I do like the form of your magazine but wish you would give possible sources for the integrated circuits used in your projects. A point about the scope calibrator (April '71 issue). Readers with scopes which do not have dc coupling may find that, due to the poor low frequency response of the input amplifier stages, the square wave output of the calibrator appears on the trace with a severely sloping top which makes calibrating difficult; the gradient of this slope depends on the scope gain control setting. This difficulty can be overcome by using a higher frequency signal to the chopper transistor base, either from (say) a 1kHz signal generator or a suitable multivibrator.
S Carter, Troon, Ayrshire

Your point taken — and thank you for your appreciation of ETI's format. However, we do wonder if there are many scopes about these days without dc coupling or with such poor response at 50Hz. Ed

TEMPERATURE SCALES

Some inaccuracies in the box item on page 57, Nov issue. The internationally agreed scale (1954) is based on the thermodynamic absolute scale. The only one fixed point necessary was chosen as the temperature at which water exists in the solid, liquid and vapour states in equilibrium. The number assigned to this point was 217.16 and the unit, represented by °K (degree Kelvin) till 1967, was fixed at 1/217.16 of this value. In 1967 it was agreed to change the representation to simply K; so it is incorrect to say °K now.

The odd fraction was chosen so that the difference between the melting point of ice and the boiling point of water would be 100K; this is true to within 0.005K. On this scale, the melting point of ice under standard conditions is 217.15K. The Celsius thermodynamic scale uses the same interval as the Kelvin scale.

The older scales were dependent on the thermometric property used in measuring the temperature, and linear interpolation was always used regardless of the property used, eg 40°C on a constant-volume hydrogen thermometer is equivalent to 40.11°C on a mercury in glass thermometer or 40.36 °C on a platinum resistance thermometer.

For more information, see 'Temperature — its measurement and control in science and industry' by the American Institute of Physics, Reinhold 1941, '55 and '62.
C J Pye, Norfolk

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