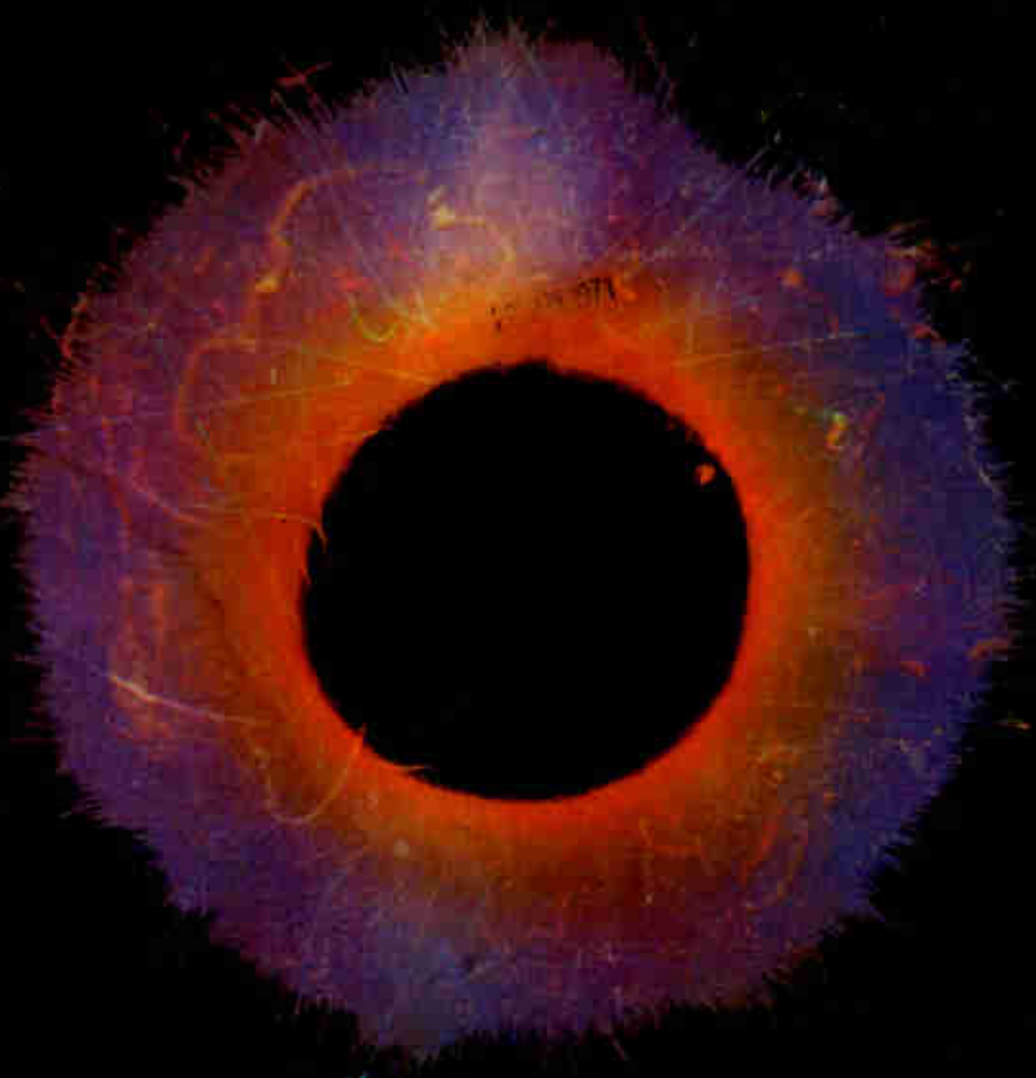
AUSTRALIA'S DYNAMIC NEW MONTHLY-NO. 2

electronics TODAY

MAY 1971 50c



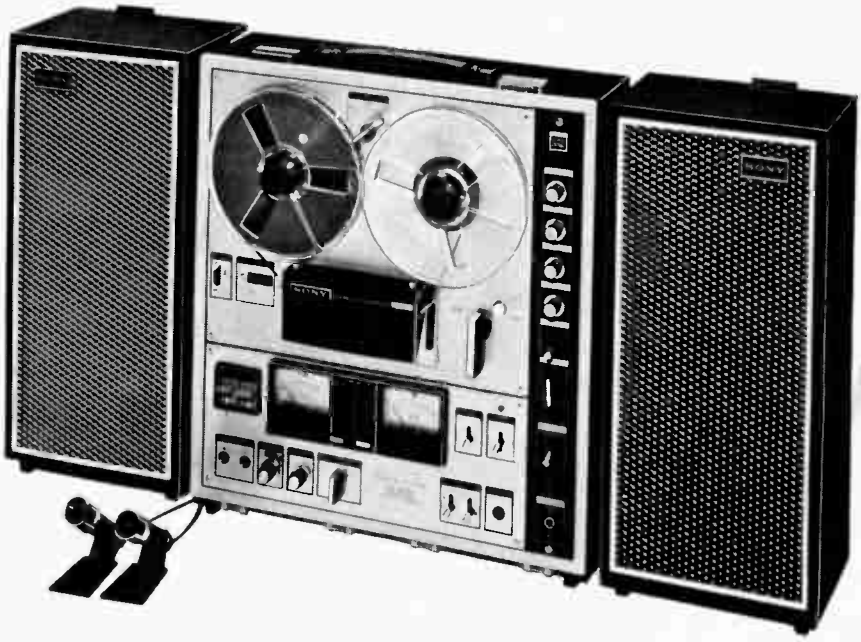
ALL ABOUT PRINTED CIRCUITS

7 HI-FI FEATURES

MOON CAR: FULL STORY

FIRST TEST: BOSE SPEAKERS

5 PROJECTS: FOR YOUR HOME, CAR, HI-FI, BOAT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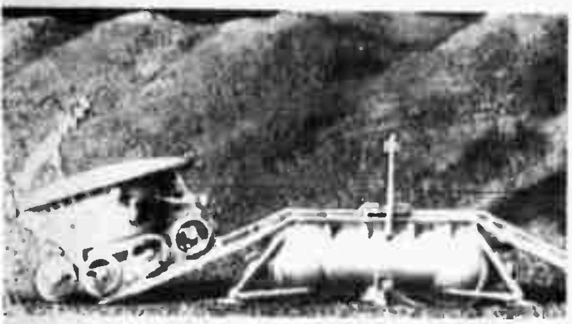
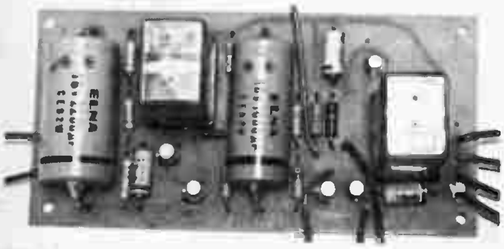
electronics TODAY

MAY 1971 Vol.1 No.2





main features

projects

product tests

hi-fi hints

reviews

news & information

COVER: Plasma or celestial phenomenon? – No, it's an electronically contrived photo of a fast-moving object entitled "Nova –2", created by Australians Wennrich and Mead for Fairchild's "World of Electronics Today" series.

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STEP UP IN-PUT QUALITY WITH FAMOUS MICRO EQUIPMENT AT ENCEL'S UNBEATABLE PRICES!

MICRO MR-111 TURNTABLE

Engineered throughout to the fine tolerances demanded for high-quality reproduction. Vibration free belt drive from 4-pole synchronous motor assures constant speed, at 33 1/3 or 45 r.p.m. Incorporates high-precision tone arm with gentle hydaulic lift and lowering control. In-built automatic low inertia shut off switch protects cartridge and prevents motor over-heating. A 'must' for hi-fi perfection at the low Encel price of $72.50 (without base, cover or cardridge). With base and cover only (cartridge of choice extra) $113.50.

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A 4-pole hysteresis, synchronous, outer-rotor motor and feather-touch selector gives positive 33 1/3 and 45 r.p.m. speeds. Static balance, S-shaped tonearm, fully compensated, accepts all standard ½" mounting cartridges. Oil-damped lift. Baseplate is matt silver finished and mounted in wooden base with plastic over. Encel price **$149.00.** (Cartridge of your choice extra).

MICRO MDP-3 DUST BUG

Dusts recordings completely and automatically ahead of the cartridge. Lengthens life of records and stylii. Encel price **$4.50.**

MICRO MSB-1 SHOCK ABSORBERS

For supporting baseplate to eliminate low frequency (50-200 Hz) vibrations (feedback) reaching tone arm and cartridge. Suits all types of turntable, adjustable height to permit accurate levelling. Encel price **$12.50** per set of 4.

* All prices include sales tax. Write for technical details and reviews.

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This is the top quality magnetic cartridge as used in broadcasting stations throughout Australia in systems that meet the Australian Broadcasting Control Board standards. Fitted with replaceable elliptical diamond stylus. Tracks effectively at 1.5 gm. The outstanding performer among cartridges at this price, **$26.50.** Write for copies of reviews.

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Stablemate of the 3100/e, but fitted with conical diamond stylus and slightly lower priced at Encel's — **$21.50.**

MICRO 2100/5 CARTRIDGE

At only **$15.50** this renowned cartridge offers high quality output, coupled with ruggedness and durability Replaceable diamond stylus. Encel can also supply the Micro 2100/6 cartridge. Write for full details.

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THANK YOU, one and all, for the great reception accorded the first issue of ELECTRONICS TODAY — as indicated by reports of excellent sales figures from our distributors, and numerous letters and phone calls of appreciation from readers.

Praise aside, some of the letters were most interesting. A correspondence section is definitely warranted in the magazine, so readers can express their view and needs, and we shall provide one starting from next month. Meanwhile, we announce the introduction of two new services:

1. A project evaluation service for readers (see details on page 116).

2. A test and evaluation service for users of electronic equipment other than hi-fi (already catered for). This second service, we believe, will be of benefit to many people in widely varied fields of life.

For electronics nowadays is involved with every aspect of science and engineering.

No longer the exclusive province of electronic engineers, it has become the working tool of all. Of biologists and astronomers, physicists and archaeologists, behavioural scientists and men of commerce.

These are the people who *use* electronics — who must be aware of the latest technology, of new ways to solve problems, of how a new technique can help them — but whose interest is in applications rather than specifications. What things do, and how well they do them.

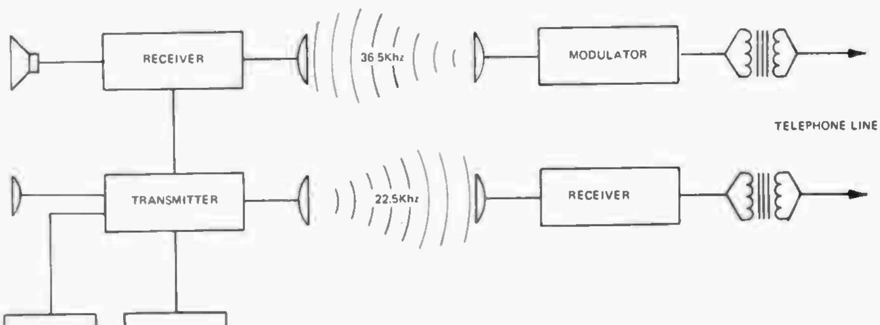
ELECTRONICS TODAY recognises this need and has instituted regular in-depth tests of sophisticated electronic equipment.

The first of these tests — an appraisal of the Hewlett-Packard 3721A Correlator — appears in this issue. Next month we shall feature the Wang Programmable Calculator. Subsequent tests will be on similar lines, generally featuring equipment which is of interest to a wide cross-section of readers, but occasionally testing more esoteric equipment, if the technology employed is of unusual interest.

These tests, commissioned and paid for by this magazine, are conducted by independent consultants who report accurately and objectively on what they find, for objectivity in testing is essential if a test is to have any value — for manufacturer and purchaser alike. An editorial policy of praise or silence is of value to no-one. We shall report what we find.

news digest

ULTRASONIC TELEPHONE LINK



Ultrasonics links cordless handset to line inter-face.

An experimental cordless telephone handset is being developed by an American company. Surprisingly, ultrasonic radiation is used to transmit speech and dialling tones over short distances.

The advantage of using ultrasonic rather than electromagnetic transmission is the ease with which ultrasonic radiation is confined within the walls of an enclosed space. There is little danger of mutual interference with similar units in adjoining rooms or buildings.

An experimental system has already been tested successfully. This consisted of a portable handset (and touch dialling unit) and a stationary ultrasonic transceiver mounted in the ceiling of a room 30ft. x 30ft. x 20ft.

The transmitting method is full duplex, using single-sideband suppressed carrier modulation. Separate ultrasonic carriers are used, with frequencies of 22.5kHz and 36.5kHz. Peak acoustical pressure at full modulation is 106 dB (referred to 2×10^4 microbars) one foot away from the transducer.

Further investigations may be made into ultrasonic noise environment, transducers, health and safety factors.

NEW COMPUTER'S 9 MEGABIT INTERNAL MEMORY

Japan's Hitachi Company has commenced production of an ultra-large computer which, it is claimed, corresponds to IBM's System 370.

The computer — Hitachi 8700 — has a main internal memory capacity of 0.5 Mega Bytes (approx 8 Megabits) with a cycle time of 0.9 μsec/8 bits.

Basic specifications include:

Word length — fixed point (32 bits) floating point (exponential code 7 bits, mantissa code + 24 bits) variable word length (256 byte max.).

Number of commands — 170.

Buffer memory cycle time — 210 nanosecs.

Buffer memory — 16K Bytes.

Address system — logic address of 32 bits.

Data transmission speed — 8MB/sec.

Hitachi's new 8700 should strengthen the company's position in the competitive market for ultra-large computers.

Operation board of HITAC 8700

LASER COMMUNICATION FOR SPACE SHUTTLE

Astronauts circling the earth in space shuttles may communicate with spaceships, leaving or arriving from places far beyond the moon, by means of a laser system designed by a division of International Telephone and Telegraph Corporation (ITT).

Possible use of the system is being studied under contract from NASA's Marshall Space Flight Centre.

ITT is investigating all major communications requirements of the shuttle, including links from booster to ground, booster to orbiter, orbiter to ground, orbiter to data-relay satellite, and orbiter to space station.

Communication ranges for the shuttle will be up to 4000 nautical miles from orbiter to space station and up to 30,000 nautical miles from the orbiter/space station complex to a data-relay satellite.

Laser power requirements will be 1/10 W to 1 W, with acquisition time less than 10 seconds and tracking accuracies better than 1/2 arc-second for the longer-range links.

Among several critical components are a single-mode (potentially diode pumped) Nd: YAG laser, and improved high-efficiency laser modulators.

An information bandwidth of 100 megabits per second is aimed at.

Many functions of the shuttle laser communication system are similar to those of the laser scanning radar that ITT is also developing under NASA contract for the rendezvous, guidance and docking requirements of the shuttle vehicle. The firm will examine the feasibility of expanding the laser rendezvous system to include the communications function as a means of improving reliability, efficiency, and operation of the shuttle electronics.

NAVIGATION BY SATELLITE

A low-cost receiver that will permit the average shipowner to navigate his vessels by satellite has been announced by ITT.

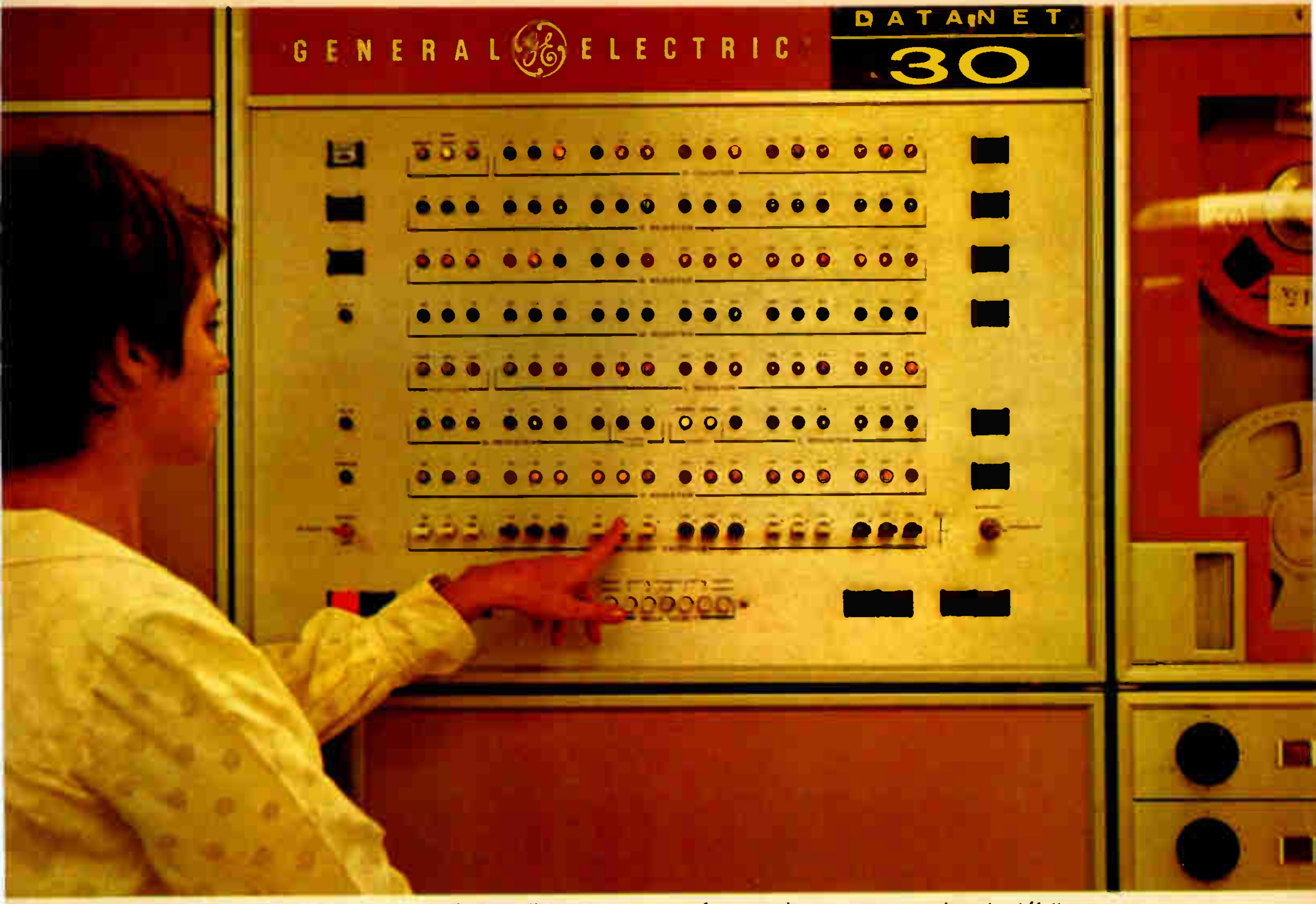
The new satellite navigation receiving system, model 6000, of ITT's Aerospace Optical Division (San Fernando, California), will give commercial vessels access to the signals of the United States Navy's Navigation Satellite System (NNSS), providing added safety, economy of operation and flexibility.

The position-finding aid will provide accuracies of a ¼ nautical mile or better with world-wide, all-weather, 24-hour coverage.

ITT is now installing the new system in two ships — the container ship 'Margaret Johnson' of the Swedish Johnson Line, and a Japanese container ship of the shipping firm Nippon Yusen Kaisha.

Previously a more complicated two-channel receiver (model 5000 system) has been available. This

(turn to page 11)



Computer time-sharing is fast gaining popularity in Australia — so we sent two of our associates to a programming school (full report on pages 39-45). Here Jan Vernon, of Electronics Today, inspects the GE Datanet 30 supervisory computer in Honeywell's time-sharing network.

Pye Unicam meter in Tecnico's quality control lab checks the pH of a photo-resist solution used in manufacture of printed circuits. Full information on printed circuits is in survey starting page 16.

Modular construction is a feature of Natronics' Australian-made range of digital instrumentation; this frequency counter becomes 0.02% dvm by interchanging function units (test report next month).

If you don't buy it at Douglas Trading you'll probably pay too much!

When Melbourne's sound equipment specialists release their special purchases, enthusiasts from all over Australia reach for their cheque books and save, save, save!

Low prices go hand in hand with high quality at Douglas Trading. We believe you CAN have the world's best without having to pay the world for it. Wherever you live, whatever you want, be sure to check the Douglas Trading price on ANY piece of equipment before you buy anywhere else. Call in, phone or write!

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Just Released! AKAI GX-365 Professional Stereo Tape Deck and Full Recorder. 3 motors, 3 heads, automatic continuous reverse, automatic shut-off, sound on/ with and over sound plus a score of other exclusive AKAI features including the "all new" glass and crystal ferrite head to give 150 000 hours guaranteed life! Price on application.

Sony Super Special Tape Deck — 630-D with 4 tracks, 3 speeds, 3 heads. Professional Full Control . . . . echo effects, sound on sound, truly a magnificent model. Exclusive to Douglas Trading.
$299 60 only for the whole of Australia.

Above:
It's hear before you buy at Douglas Trading — every piece of equipment is linked to pushbutton comparators!

New shipment!
New Low Price!
AKAI X-160D Tape Decks.
*World Patented Cross Field Head.
*Ultimate Hi-Fi 20-25,000 CPS ± 3 DB at $7\frac{1}{2}$ IPS.
*Integrated Circuit (IC).
*All Silicon Solid State.
Rush these at $229.

Monarch — the King of Hi-Fi Systems! Made to Douglas Trading specifications to give you the best Hi-Fi ever, at the price. Models range from a low $195 (like the one in the foreground above) and just look what you get for your money . . . Powerful solid-state amplifier. 20 WATTS RMS power. Bass and Treble controls. Loudness control. Top-quality magnetic cartridge, anti-skate diamond stylus. 2 heavy-duty wide-range speaker systems housed in attractive hand-crafted cabinets.
At Rear The Fabulous MONARCH Modular Console At $449.

Below: A visit to Melbourne would not be complete without a visit to Douglas Trading's first floor sound lounge. See $100,000 worth of equipment from speakers to stylus comparators and HEAR it in action!

provides accuracies of better than 0.1 nautical mile and is in service on oceanographic research vessels, oil survey ships and drilling rigs, and luxury liners. The single-channel 6000 system now affords all the benefits of precise satellite position fixing for less than one-half the cost of the two-channel system — an investment which, the manufacturers claim, can be recouped in one to three years through reduced operating costs.

Satellite navigation is a practical method providing reliable precise position fixes, anywhere on the globe. Latitude, longitude and time are computed and displayed automatically without the need for chart interpretation lane resolution or operator intervention. This precise navigation saves time and fuel and assures safety, both on the open sea and in coastal and harbour manoeuvres. Arrival and unloading times can be predicted accurately, ensuring more efficient turnaround.

WORLD'S SMALLEST ELECTRONIC CALCULATOR

A new 'Mini' calculator, claimed to be the smallest and lightest of its type in the world, is now available in Australia. Known as the Sanyo ICC-82D, the new calculator weighs less than 2 lb. and is almost as small as a paperback book.

It operates on a single rechargeable battery and is capable of handling the work of any regular-size desk calculator. The range of possible calculations includes the four rules, but successive divisions and multiplications, mixed calculations and problems involving automatic constants can also be handled on the machine.

The calculator can display a sixteen-figure answer within a fraction of a second.

The mini calculator was originally released at the recent Tokyo Business Equipment Exhibition, where it proved to be the major attraction of the show.

AUSTRALIAN SPACE STATIONS

Island Lagoon (Woomera) is one of three space stations around the world scheduled to support two Mariner spacecraft to be launched towards Mars in May. The spacecraft should go into orbit around Mars in November and will send back data for a considerable period.

As part of NASA's deep-space network, Island Lagoon and Tidbinbilla track, command, and collect data from deep-space probes. Both stations are supporting two Pioneer spacecraft which have been orbiting the sun for several years.

Tidbinbilla's role in the Mariner missions is mainly one of backing up Island Lagoon.

Maintenance and operating services at both stations have been provided by AWA since March 1 this year.

ICs ON TAPE

Currently under development by Philips Research Laboratories at Eindhoven, Holland, is a method of mounting integrated circuits onto a conducting path printed on polyimide film.

The technique avoids the necessity to attach connecting leads to the IC chip. The printed circuit film, complete with its bonded chip, can be attached to circuit boards or other suitable substrate.

The new technique is currently being tested in the form of a monolithic audio amplifier.

TEACHING BY SATELLITE

A symposium to study the use of telecommunication satellites for the broadcasting of educational programmes is to be held in Nice early in May.

Subjects to be considered include organization, pedagogical problems, technical problems and cost. Details can be obtained from:

Centre National d'Etudes Spatiales, Division des Relations Universitaires, 129 rue de l'Universite, Paris VII, France.

World's smallest Electronic Calculator.

news digest

NEW RADIO SYSTEMS AID TRAFFIC CONTROL

Three new mobile radio systems enable the N.S.W. Department of Motor Transport to maintain 24 hours-a-day contact with its 188 radio-equipped vehicles.

Commissioning of the AWA systems, was completed in April.

In the Sydney metropolitan region the radio system is based on the department's headquarters at Rosebery — and in the northern and southern regions, on Newcastle and Wollongong respectively.

The metropolitan system provides two channels, with radio base stations at Rosebery and Top Ryde. Each has main and emergency equipments to ensure continuity of communication; a control complex, with access to either channel, is located in the headquarters building.

This control system, which combines features of radio and automatic telephone working, enables each channel to be manned separately or combined in off-peak periods. Access to either channel is available to or from telephone extensions throughout the headquarters building and district offices. Night switching facilities are available for certain key extensions.

Facing the operators in the Rosebery control room are two maps — one of the inner city area and one of the entire metropolitan area — showing the location of the 696 sets of traffic signals currently installed, as well as pedestrian and flashing lights. Reports of malfunctions are channelled to the radio control room and, after confirmation of identification, to the maintenance crews in the field.

TANK LEVEL GAUGE USES RF PROBE

An accuracy of better than 1/16 in. over a range of 0-80 ft. is achieved by a new British tank level gauge using a tuned radio/frequency probe.

The gauge provides local and remote indication of liquid level or liquid/liquid interface level in open or closed tanks. It has applications in the petro-chemical industry and large liquid storage systems requiring high accuracy.

The gauge is available with up to four independently set switches and facilities for switching multielement resistance thermometers. Working temperature ranges are -40 to + 150 deg. C for the probes and -40 to +60 deg. C for the gauge.

The sensing probe is a tuned rf antenna, and the level is measured by detecting the sudden change of resonant frequency when the tip of the probe enters the liquid. The probe is raised and lowered by a servomotor and the level readout obtained from potentiometers geared to the motor.

Because the gauge is an active device which searches for the level, rather than a conventional passive float device, it has good repeatability, with resolution and repeatability better than 1/32 in.

Transistorised intrinsically-safe circuitry and flame-proof enclosure of the gauge ensure safe operation in hazardous environments.

The receiver provides remote digital display of levels and temperatures for up to 100 separate gauges, with high/low alarms for all gauges, irrespective of which gauge has been selected for display. The level readout is by two digit 'coarse' and three digit 'fine' displays fed from separate transmitting potentiometers, providing very high resolution with special precautions against ambiguous readings. Temperature is shown in degrees Celsius on a two-digit display with plus/minus sign.

BITER UNBIT!

Computer haters will be delighted to learn that an airport radar transmitter recently erased the U.S. Internal Revenue Services computer tapes, throwing Federal taxation records out of kilter.

The problem was blamed on inadequate grounding of metal shielding.

ON-LINE COMPUTER CONTROL SYSTEM FOR ICIANZ

An on-line digital process control system will shortly be installed at the Botany (Sydney) plant of ICIANZ Ltd. The system, first of its kind in the Australian chemical industry, will be supplied and installed by Kent Instruments (Australia) Pty. Ltd.

The order for a medium-sized K70 system follows careful investigation by engineers of ICIANZ, who drew on considerable experience from computer control systems installed in ICI plants in England.

The computer, with 12k words of core, will operate with Kent's standard software packages for industrial control and sequencing operations. There is also provision for inclusion of advanced control programmes that have been developed by ICIANZ.

The initial programme allocation permits direct digital control of a maximum of 22 loops, including interval cascade and ratio loops. All loops can be assembled and tuned on-line. The maximum can be increased without difficulty because of the expansible input and output interfaces of the system.

Two control panels and a teletype allow communication between operators and computer, which will operate on-off alarms and a two-channel trend recorder.

CONSUMER UNION SUED

Following an unfavourable test report on their speaker system, the Bose Corporation in U.S.A. has filed a suit against the nation's Consumer Union.

The Bose Corporation allege bias, technical incompetence and conflict of interest. Main cause for complaint is that Consumer Union's loudspeaker tester Arnold Seligson holds patent rights on an ionic speaker system. The suit alleges that Seligson slated the Bose speaker system to further his own commercial interests and claims damages of $500,000 plus costs, together with a retraction of the test report.

Consumer Union is contesting this suit, claiming that whilst Seligson does indeed hold patent rights to an ionic system, his speaker is not yet sufficiently advanced to be a commercial proposition — and adding that Dr. Bose (head of the Corporation) is acting out of 'pique'.

Interface module coupling analogue systems to a digital computer.

news digest

BOOTH TO MANUFACTURE

Components agents W. G. Booth Pty. Ltd. will shortly begin Australian manufacture of the 'AB' range of rotary switches. Included will be the model PYT, 12-position rotary wafer switch having specifications to suit applications in a variety of environments.

The PYT has moulded stators and rotors to provide high insulation resistance. Heavily silver-plated contact clips, and rotor blades of high-quality non-ferrous material, give low contact resistance. Wafers are of self-spacing design, with deep castellations that give complete support to the contact clips.

QUAD-WRANGLE!

Acoustical Manufacturing Co., British makers of Quad hi-fi equipment, appear to be less than pleased with the increasing use of their trade name as a prefix for other trade names — Quadphonic, Quadsound etc.

We reproduce a notice that has been published in a number of recent American journals.

QUAD®

For 20 years and throughout the world the trade mark QUAD has identified the high quality audio equipment made by this Company.

Because others are now seeking to use the name in other ways we have to make it clear that by itself or combined with other words or numerals, QUAD identifies only audio equipment, components and related goods of our manufacture or sponsorship.

All other use of QUAD in connection with such goods is either a misuse, abuse or infringement which must and will be prosecuted.

ACOUSTICAL MANUFACTURING CO. LTD.,
Huntingdon, England

REVIVING THE 78

Remember those old 78 rpm records — thick, heavy, with less than five minutes of play per side, and all too easily scratched or broken?

Believe it or not, they're due for a comeback — though only in a very small way.

The British Institute of Recorded Sound Ltd. plans to market exact replicas of carefully-selected old recordings, pressing them directly from the original master discs to ensure that sound distortions which mar most LP transfers of 78 rpm recordings do not occur.

The replicas will be issued under the HMV lable, and their only concession to modernity will be the use of vinyl as disc material instead of the original shellac.

The Institute claims that old-time greats such as Melba and Caruso will sound much more like their true selves when reproduced by this method.

Initial programme is to revive 20 discs a year — but this will be increased if demand warrants it.

BETTER THAN ORIGINAL

Did you spot this one? Describing an amplifier with so many watts that the power station would need prior notice, a recent press release stated: distortion ± .1%.

Minus .1%. The reproduction is .1% better than the original sound?

FERRITE-ING OUT?

A new type of metal detector (see photo) has been installed at Helsinki Airport, Finland. It is made by the Finnish firm Outokumpu Co. and is adjustable for sensitivity. It is probably the only detector able to indicate metal objects not containing iron.

INSTROL SAVES YOU UP TO 45% OFF WHARFEDALE SPEAKERS with new INSTROL kits

WHARFEDALE DOVEDALE 111 only $128.00

The new Unit 5 speaker kit by Wharfedale contains the 12in. bass, 5in. mid-range and 1in. tweeter that enables Dovedale to give the smoothest performance ever produced. The new Instrol enclosure kit is exactly to Wharfedale specifications . . . all timber parts are precision cut, fit together smoothly . . . panels are best-quality veneered in selected Teak or Queensland Maple. Check the following features:

● Three-way system for only $135.00 ● Unique Cross-over system ● 40 Hz to 20,000 Hz without any audible peaks.

● Power handling capacity of 35 watts R.M.S. ● Cabinet size 29½in. x 17in. x 11½in.

WHARFEDALE MELTON only $90.00

The Melton gives you the advantages of big speaker systems in a compact cabinet. Us ng the new Unit 4 speaker kit, a clear, firm bass response is achieved from the wide-spectrum 12in. bass unit and the acoustiprene low mass tweeter gives smooth treble performance. The electrical cross-over unit links bass and treble speakers at 1,500 Hz and it is at this point that each speaker is designed to roll-off mechanically. The result is smooth response from 45 Hz to 17,000 Hz. Power handling capacity is 20 watts R.M.S.
The new Instrol enclosure kit, in Teak or Queensland Maple, is exactly to Wharfedale specifications and measures 24½in. x 14½in. x 11½in.

WHARFEDALE SUPER LINTON only $49.00

Using the ever-popular Wharfedale Unit 3 kit, this system gives full-blooded bass response, astonishing for the size of the cabinet. Frequency response of 40 Hz to 17,000 Hz is achieved with an 8in. bass/mid-range unit that has a 4in. cast ceramic magnet weighing 3½lb., together with a treble pressure unit. Power handling capacity is 15 watts.

The Instrol enclosure kit is according to specifications laid down by Wharfedale and measures 21in. x 11½in. x 9½in. The kits are available in Teak or Queensland Maple.

INSTROL
HI-FI & ELECTRONICS CENTRE
91A YORK ST., (between King & Market Sts.), SYDNEY, N.S.W. 2000. Phone 29 4258

Please send me the illustrated descriptive leaflet on Instrol Record Storage Cabinets. I enclose herewith a 6c postage stamp.

Name..

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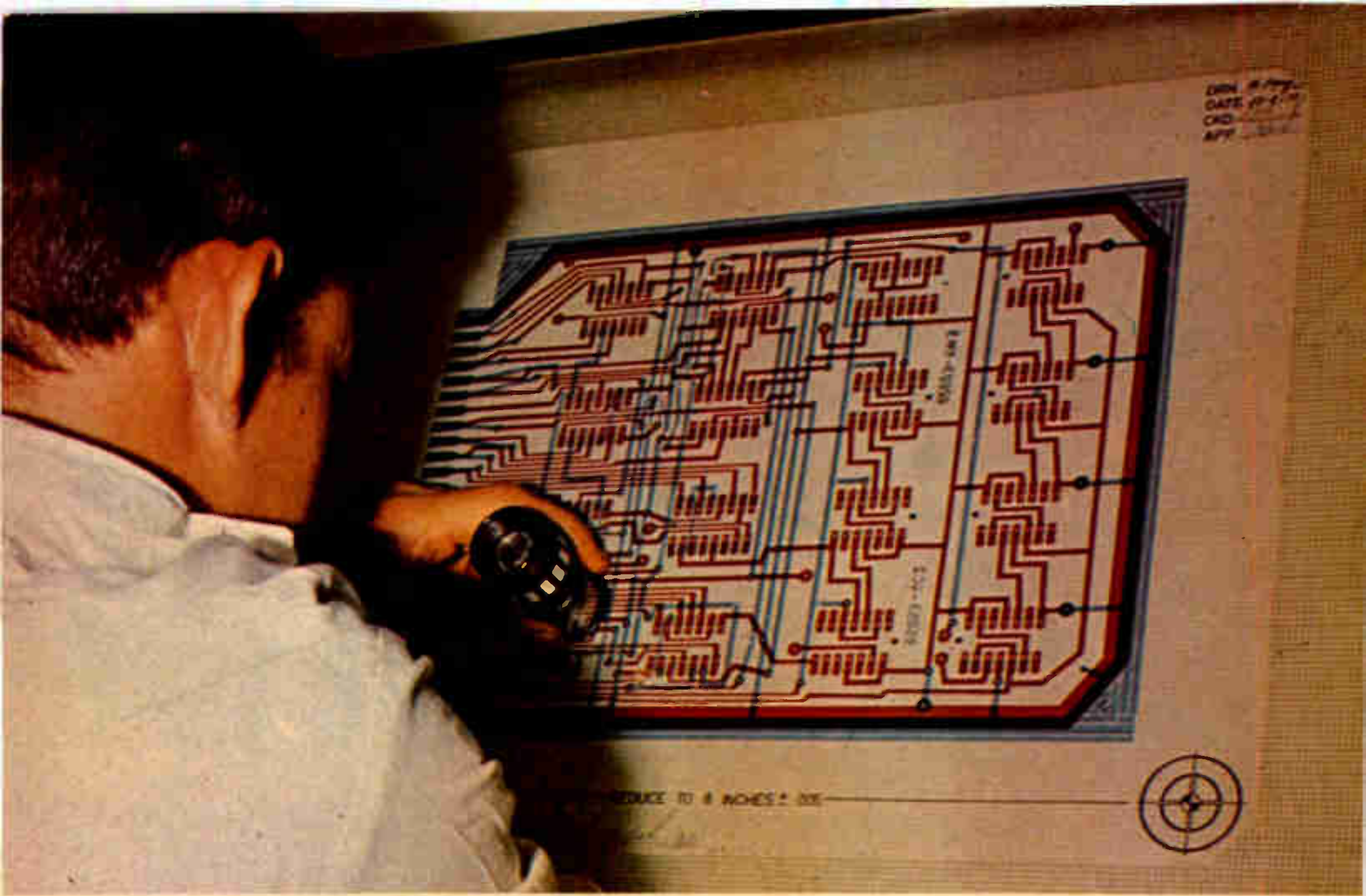
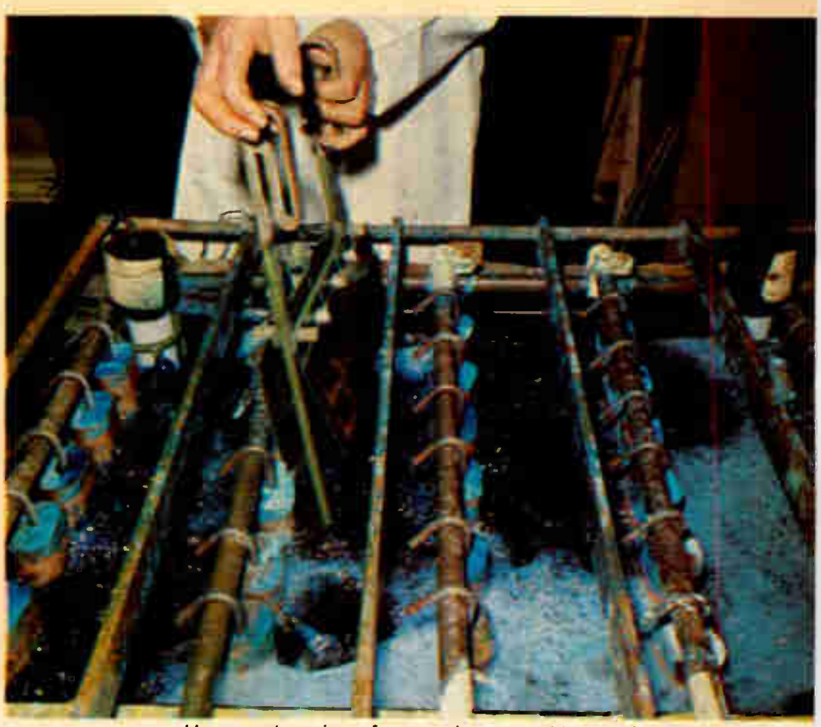


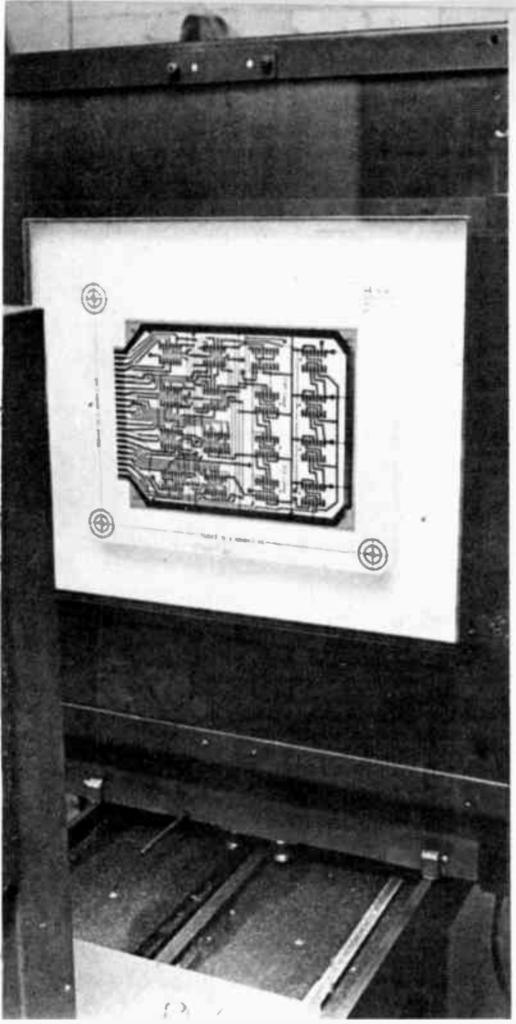
Master pattern is drawn over a grid accurate to ± 0.002" in 10 inches.

Silk screen process imprints circuit pattern onto board prior to etching.

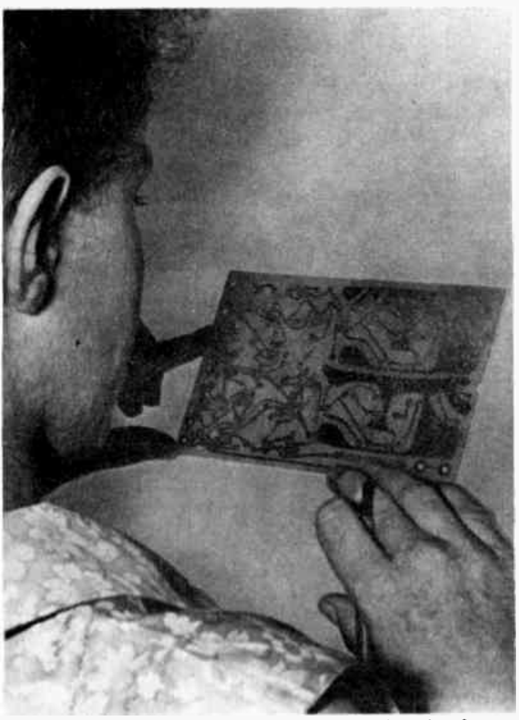


Unwanted section of copper is removed by etching in acid bath.

PRINTED



Precision camera reduces master pattern to required final size.



Finished circuit board is checked for faults.

Simply constructed and highly versatile, printed circuits have taken over the functions of earlier conventionally wired circuits. Brian Bork, of Tecnico Electronics, explains how printed circuits are designed and manufactured.

ANYONE who has had occasion to look into a modern electrical or electronic device will have noticed that very little wire is used to connect component parts. Indeed, the transistor radio has in the strict sense become a 'wireless'. This is largely due to the advent of the printed circuit – or printed wiring, as it is known by the semantically cautious.

Because of their simple construction and high degree of versatility, printed circuits have paved the way for automation and rationalised mass-production. Rapidly advancing semi-conductor techniques depend more and more on printed circuits as the interconnecting link. Virtually every electrical and electronic device produced today – be it a television set, a computer, a business machine, a scientific instrument or an entire telephone exchange – has as the backbone of its circuitry one or several printed circuits.

What is a printed circuit?

In broad terms, a printed circuit is an insulating board or card provided with conducting tracks on one or both surfaces. These tracks provide the connections or wiring between individual components whose leads are generally inserted into holes provided for this purpose.

Neither the conductivity of the copper conductors nor the insulating properties of the plastic board are perfect, which prompts the question:

What are the parameters of printed circuit design?

The starting material for the manufacture of a printed circuit is copper foil, or foils, laminated to a plastic base. The variations available on the current market are nearly endless, but most circuit boards are produced from laminate of either the paper-phenolic or epxoy-glass types. The most common thickness is 1/16" and material clad with .0014" of copper on one or both sides is readily available. In general the epoxy type materials are dimensionally more stable and have better electrical properties than their phenolic counterparts, which are correspondingly cheaper.

The conductivity of every conductor is limited. High current densities lead to overheating and consequent voltage drop, both of which can impair the efficiency of a printed circuit. The wider and thicker a conductor, the heavier a load it can carry. Thus, for special applications, laminates with .0028" and even .0042" of copper are available (Table 1 overleaf).

The electrical resistance of the insulating material must also be considered. Here again the epoxy glass materials are generally superior and thicknesses greater than 1/16" are also available.

The breakdown strength between adjacent conductors depends on both their spacing and the dielectric strength of the material itself. According to one specification, the standard spacing at 220V dc should be 0.1 inch between adjacent tracks.

Two conductors insulated from each other form a capacitor. The capacitance is dependent on the spacing and the effective surface area of the conductors. If printed capacitors are included in the conductor arrangement, such effects can be utilized. If, in addition, printed inductors are provided, perfect oscillating circuits can be produced for radio, television, aerials, etc., without the use of external components.

Certain mechanical considerations must also be kept in mind when designing a printed circuit. Large boards should be dimensioned so as to obtain best usage of available sheet sizes of laminate.

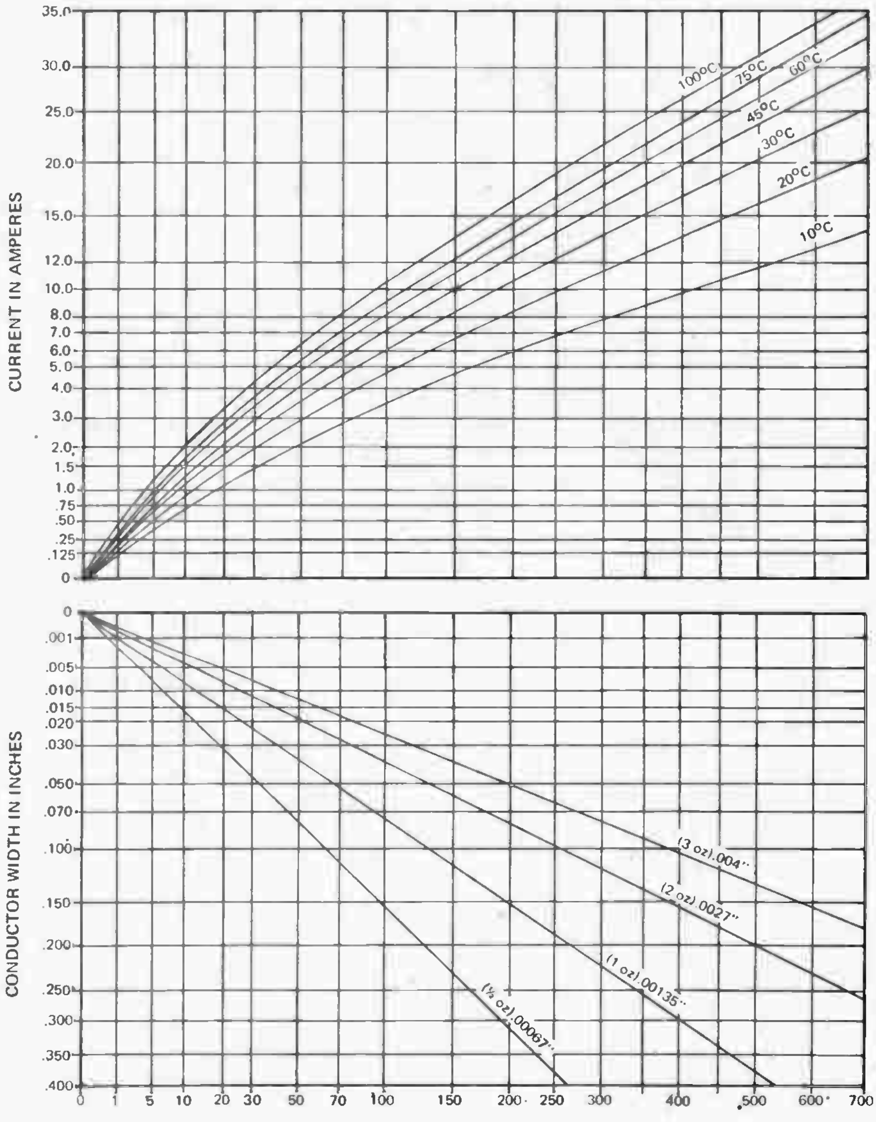
Square or rectangular blanks are recommended. Unusual and complicated shapes should only be adopted when they are essential to the design. Every contour which deviates from the normal rectangular form requires special tools and operations, and these factors invariably increase the price.

Having taken these variables into account, the printed circuit designer is ready to layout his master artwork.

CIRCUITS

PRINTED CIRCUITS

Table I (top) current carrying capacity and size of tracks for various temperature rises above ambient, (lower) conductor thicknesses and widths for different cross-sectional areas.



Producing the master artwork for a printed circuit

Simplicity is the key word in laying out printed circuit artwork. Components should be so arranged as to produce the simplest possible conductor pattern. In the majority of cases components are all located on one side of the board, while the reverse side is reserved for soldering connections.

It is not possible to cross conducting paths on a single sided board. On a double sided board this is achieved by taking the conducting path through the board, across the appropriate path and, where desired, back to the first side. The second and equally obvious advantage of a double sided layout is the greater packing density which can be attained.

It cannot be overemphasised at this point that every attempt should be made to keep tolerances as great as possible. The price of producing printed circuits to close tolerances rises very sharply. The designer will save himself or his firm a great deal if he makes track widths and spaces as wide as practical, pad diameters as great as possible, and tolerances on outside dimensions and registrations of the pattern to the holes or profile as large as possible.

For purposes of minimizing errors the conductor pattern is normally laid out at two, four, five or even ten times actual size.

The draftsman first produces an outline on the drawing board (Fig. 1). From this outline working drawings containing all the necessary machining details are developed. The last stage is the master conductor pattern, which is the 'tool' for the production of the printed board (Fig. 2).

The pattern is prepared on the basis of a standard grid of 0.1 inch or 2.5 mm. All holes for component leads should be accommodated to this grid Individual holes must be provided for each connection. This method presents advantages for the production of the original drawing and tools, as well as for subsequent fitting of the equipment. Special grid paper and plastic grids are available to assist the draftsman.

Conductor lines need not necessarily follow the grid. They should take the shortest route between solder lands, avoiding sharp corners (Fig. 3). It is common practice to reduce conductor widths only at unavoidably tight spots.

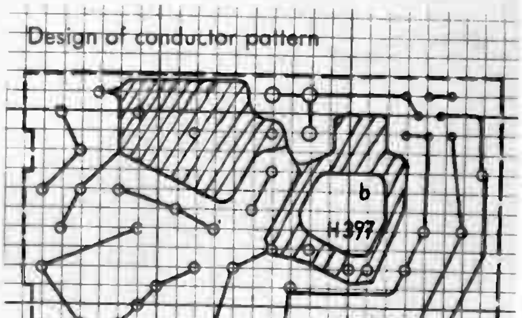
The copper ring around the wiring hole is known as a 'solder pad' or 'land' and is most generally round in shape. Pads should be a minimum of .060" greater in diameter than the hole wherever possible.

There are various options open to the draftsman for preparing the master artwork. In addition to the traditional method of ink drawing, there is also the cut and strip method and the stick-on method. In the stick-on method self-adhesive strips, pads, connectors and curves are used. A wide variety of shapes and sizes are available, and this method has become almost standard.

For double sided circuits it is possible to obtain 'stick-ons' in transparent red and blue as well as black. Pads common to both sides are laid out in black, while the conductor lines for one side are done in blue and those for the other side in red. At the photographic stage first one colour and then the other can be filtered out to produce separate films for each side from one artwork.

This method ensures proper side-to-side registration at least at the artwork stage.

Fig. I. Circuit pattern outline.



The step-by-step preparation of artwork is as follows:

1. Choose working scale.
2. A transparent or translucent Mylar sheet is placed over a standard grid.
3. Corner marks or an outline of the board profile are marked in or taped.
4. Place the pads accurately as to grid crossings.
5. Place connectors where necessary.
6. Tape conductors lines, starting in most crowded area first.
7. Check clearances, keeping manufacturing tolerances in mind. Cut back pads only when absolutely necessary.
8. Place coding or nomenclature where applicable. Pay particular attention to scale.
9. Reducing lines in both axes, external to the board profile and proportionately equal in length to the outside dimensions of the board, are drawn in to assist the photographer.

No printed circuit can be better than the master conductor pattern. Utmost care must be taken at this stage.

Multiple head machine drills four boards at once.

What must a master drawing contain?

Printed circuits cannot be prepared from the conductor pattern alone. Depending on the type required, additional patterns for soldering marks, component coding or other printed patterns might be required. Most important, however, is the master drawing. This drawing must contain all the details necessary for the production of the printed circuit. The following information is required:

1. A full-scale view showing contours and all holes. The grid spacing must be specified, together with the hole diameters and special tolerances where they occur. Symbols may be used to identify holes of different diameters.
2. References must be given for all associated artworks and drawings.
3. Surfaces must be specified — e.g., copper fluxed, tin flash, tin or tin/lead electroplated, nickel-gold, etc. Thickness requirements and tolerances are also essential.
4. The type and thickness of base material, together with the copper thickness, must be specified. Note: Material with .0014" cu is known as 1 ounce material. Similarly .0028" cu is 2 ounce material, and so on.
5. Holes not falling on the grid must be dimensioned separately.
6. Company name, part number and modification index are also generally required.

Armed with a master artwork or artworks and a master drawing plus any additional drawings or artworks necessary for the production of his particular board, the designer can confidently approach the production department. Printed circuit users without experience in printed wiring design will generally find suppliers willing and eager to assist at design stages, as well as with manufacture. In most cases much time and effort can be saved if liason between the designer (or user) and the manufacturer is established as early as possible.

Inspection of incoming artwork

The manufacturer, upon receiving the manufacturing documents, begins his effort with a careful inspection of the artworks and drawings supplied. This may seem an obvious or even trivial point, but in the printed circuit industry it is a point too often overlooked. We find that 80% of the incoming artworks are defective in some way so as to prevent manufacture of the boards to the customer's own drawings and specifications. In these cases the customer is alerted to the problem,

Fig. 2. Master conductor pattern.

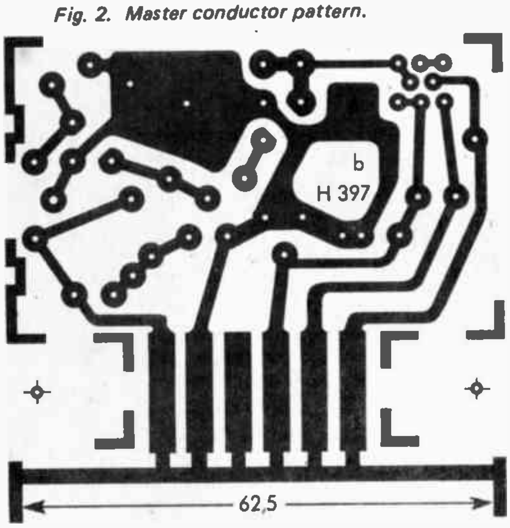
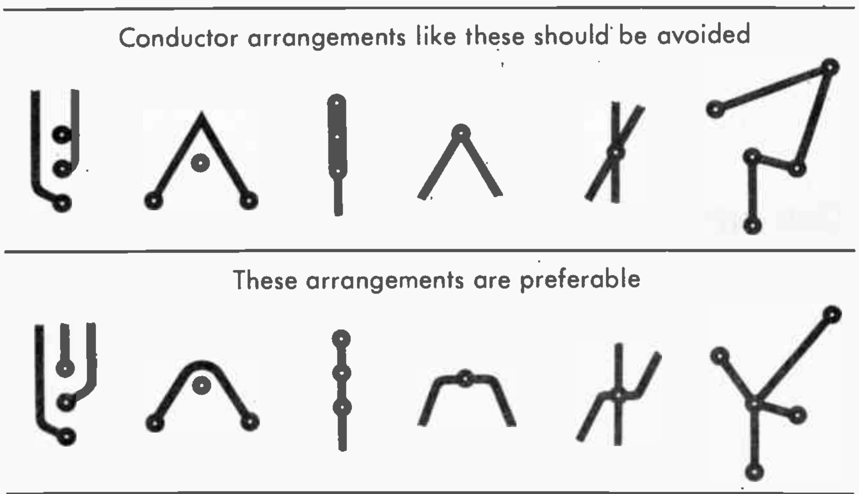


Fig. 3. Recommended pattern details.



PRINTED CIRCUITS

FIG. 4 (a). PHOTO–RESIST

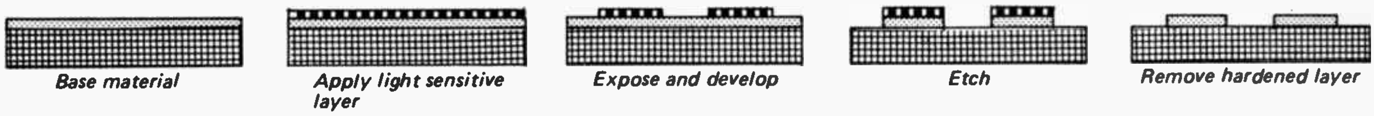
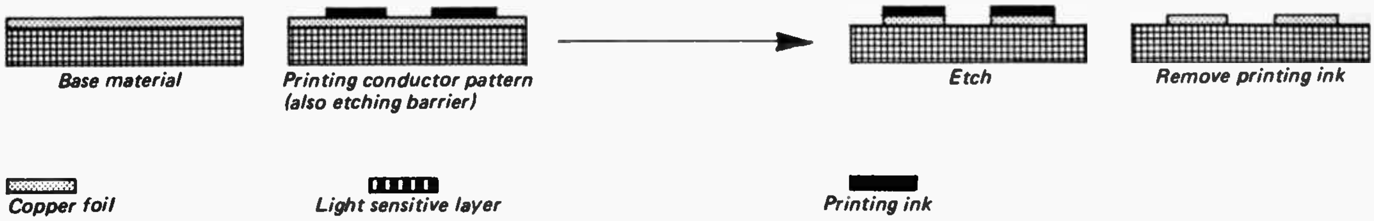


FIG. 4 (b). SCREEN–PRINTING



which may be solved by alterations to the artwork or perhaps by relaxation of tolerances.

Photography

From the master artwork a working film is produced. This is accomplished by photographic reduction, using a highly accurate process camera. With this camera, reductions of between 2:1 and 10:1 are possible to a consistent accuracy of ± .002" over 10 inches in the finished film. By applying special techniques even these accuracies can be improved upon. In view of the expansion coefficients of the available films, approximately .001"/10 inch/10°F, or .001"/10 inch/10% relative humidity, it is obvious that to obtain these accuracies one must work in airconditioned surroundings.

Production

The operations necessary for the production of printed circuits from the raw material stage have for the most part been taken over from other branches of manufacture and adapted to the purpose. The etching process is well-known in the manufacturing of printing plates in the graphic arts industry. Screen printing has also been previously employed in the manufacture of textiles, printing of signs, posters, and other fields.

Electroplating is an old-established process which found many applications in the electrical, automotive and jewelry fields prior to its use for printed circuits. All of the photographic methods were also known in principle before their application to printed circuits, as were the mechanical methods of milling, blanking, drilling, etc.

Image transfer

No matter what the final product is to look like or what approach is taken in manufacturing, the business of producing a printed circuit revolves around the transfer of the film image onto the board surface. The two methods for accomplishing this which have found nearly universal acceptance are screen printing and photo resisting.

In the screen printing process the so-called printing screen acts as a template. In practice the underside of a flat, rigid frame is covered with a taut fine mesh. This mesh was formerly of silk, hence the name 'silk screening'. However, since the advent of the polyester and stainless steel meshes, the term 'silk screening' has become a misnomer in the printed circuit industry.

Using one of several available methods, a 'stencil' is applied to the mesh. The stencil in its various forms comprises a light sensitive plastic layer which, when exposed to light at the appropriate wavelength, becomes hardened. By exposing through the working film and 'washing out' with water, the conductor image is transferred from the film to the stencil on the mesh. Using a rubber squeegee to force the 'ink' through the mesh, the image is again transferred from the printing screen to the printed circuit laminate.

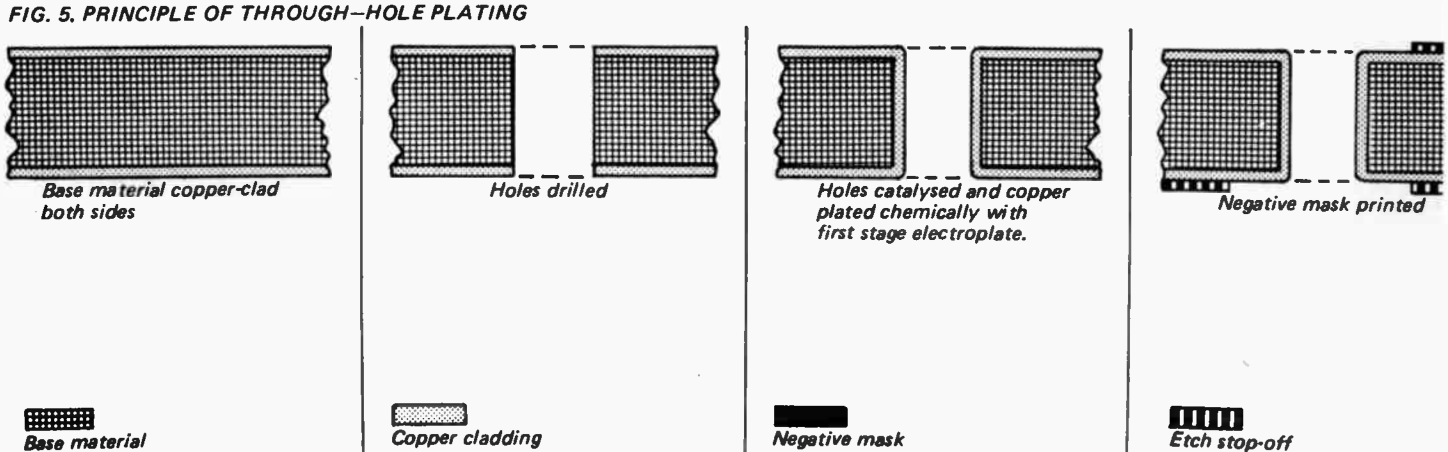
The screen printing process makes possible large-scale manufacturing with a simple tool which can be used many times.

Photo resisting, the alternative to screen printing, employs a single transfer to the conductor image to the board surface.

Commercially available photo resists are light sensitive plastics which are applied in a thin layer to the base laminate by one of a variety of methods that include dipping, spraying, hot laminating and roller coating. Resists used are said to be either positive or negative working, depending on their reaction to light. Negative working resists harden on exposure; positive working resists become soluble. The sequence of operations is generally as follows:

1. Clean laminate.

FIG. 5. PRINCIPLE OF THROUGH–HOLE PLATING



2. Coat laminate.
3. Dry resist.
4. Expose resist through working film.
5. Develop image (i.e., solvent wash).
6. Touch up.
7. Bake.

Photo resisting is an especially valuable technique where a high degree of accuracy is required. Although it is impractical in high-volume production to screen print conductor lines narrower than .015", photo resisting is so accurate that the plating or etching steps become the limiting factors in the direction of narrower lines. Lines of .005" are easily produced.

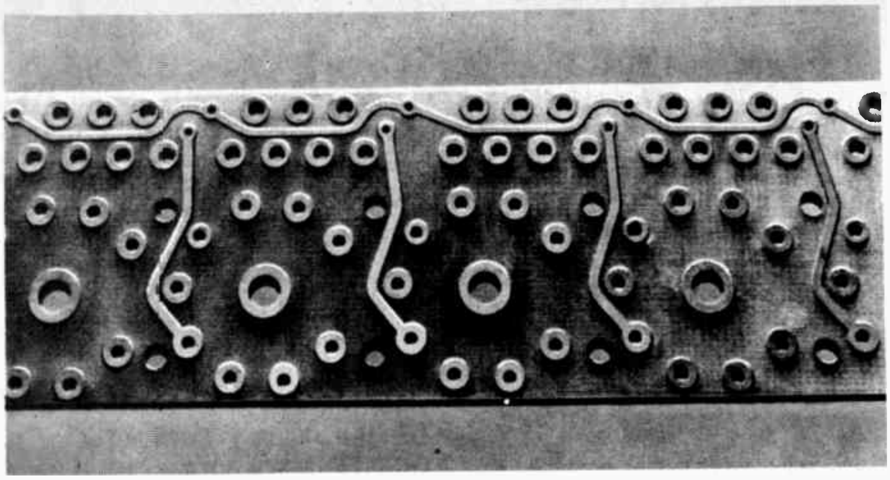
The second advantage of photo resisting is its ready application as a technique for prototype or short-run work. Because no tooling is involved, photo resisting invariably proves to be the quicker and more economical approach for small quantities of circuit boards. The cross-over point where screen printing becomes more economical depends on the board involved and the equipment available to the producer, but in general one can say that it will occur between 20 and 50 off.

Print and etch boards

The etching method has gained a secure place in the short history of printed circuits. This is known as the 'subtractive' method because the superfluous copper is removed from a fully clad base laminate by etching.

The base material (copper foil laminated to a plastic base) is provided via either screen printing or photo resisting with an etchant resistant pattern using the techniques already described. The exposed copper is then etched away (Fig. 4). This is accomplished either in vats or, in the case of more precise work, in spray etching machines. The etchant most commonly used for such work is a water solution of ferric chloride.

After etching, the protective resist or ink is removed and any necessary mechanical operations such as drilling, guillotining or blanking are performed.



Plated through holes allow component location on both sides of a circuit board.

Plate and etch boards

By altering the print and etch technique slightly, boards with electroplated surfaces can be produced. The choice of plated surfaces is based on the factors of solderability and economic feasibility. For conductor patterns in general, tin or tin/lead alloy is the usual choice. Both of these surfaces offer good solderability and are reasonably economic. Tecnico Electronics offers bright tin plating rather than tin/lead because it is felt that bright tin offers advantages in terms of appearance, shelf life before soldering, and simplicity of in-process control.

Contact surfaces for switches or plug-in connections which have been included in the conductor pattern are usually plated with hard gold or gold over nickel. For most applications .0001" of hard gold is sufficient. If, however, contact is to be made and broken repeatedly (as in the case of a printed switch or multi-insertion edge connector), it is advisable to have the added hardness provided by .0003" – .0004" of nickel under the gold.

In practice, the opposite image to that required for print and etch work is applied to the board. The conductor lines are left as exposed copper. After electroplating to the desired thickness with the specified metal, the plating resist (as such an ink or resist is known) is stripped from the board.

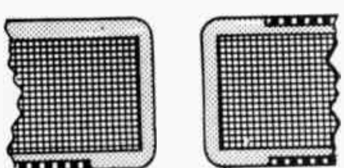
In this case the plated metal acts as an etchant stop-off, in exactly the same way as the printed resist did with a print and etch board.

Plated boards must be etched with etchants specially formulated for the purpose, because both tin and tin/lead would be attacked by ferric chloride. Since plated boards are usually made to finer tolerances in other regards, it is also common practice to spray etch them rather than use the less precise method of vat etching. Spray etching leads to less undercutting of the conductor line by the etchant and enables closer control.

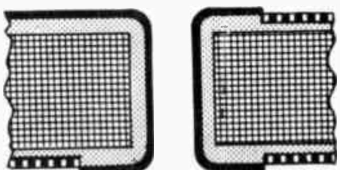
Subsequent mechanical operations are performed, and after strict inspection the boards are packed and delivered.

Plated through hole boards

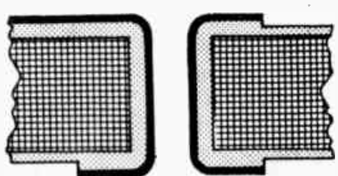
The next step along the road to sophistication, after the plate and etch board, is the plated through hole board. The plated through hole provides electrical continuity from one board surface to the other. This feature has obvious advantages in terms of design latitude – both sides of the board become one circuit. An added bonus that comes with through hole plating is that solder tends to fill in the hole around a lead, forming a more solid connection and contact.



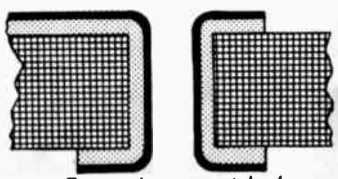
Thick copper plating build-up



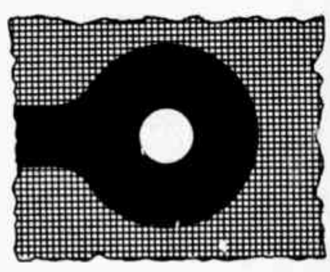
Exposed copper surfaces, tin, tin/lead or gold plated for etch stop-off.



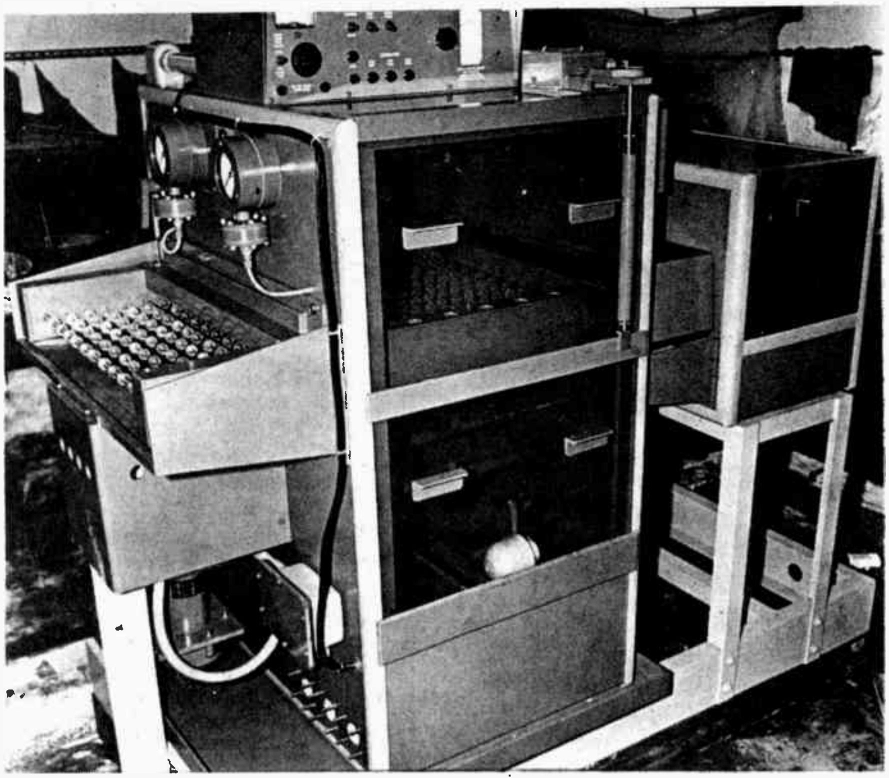
Negative mask removed



Exposed copper etched



PRINTED CIRCUITS



Spray cleaning machine speeds up manufacturing process.

The sequence of operations is somewhat different from other types of boards discussed (Fig. 5). The base laminate is first drilled and then plated. By immersion in a series of solutions the entire board, including hole walls, is first cleaned, then conditioned to accept a catalyst, then catalysed, and finally chemically plated (without current) with a thin layer of 'electroless copper'.

This layer is then built up with electroplated copper to a thickness that provides the thin electroless layer with a degree of stability. The rest of the process proceeds much as with plate and etch boards, except that additional copper is electroplated onto conductor tracks and hole walls in the so-called Stage II copper plating, which takes place after printing or resisting, and prior to plating of the metal to be used as etchant stop-off.

Testing and tolerances

The manufacture of printed circuits is an exercise in precision repetitive engineering and, as such, requires sophisticated controls throughout.

The importance of close control of incoming artwork has already been stressed, but 'in-process' control must be equally exacting. Tooling must be inspected and checked against drawings before being put into production. Drilled boards are inspected 100% for missing holes or extra holes. Printed and resisted boards are inspected 100% and touched up before etching or plating. Close controls on plating solutions and etchants necessitate an in-house laboratory, preferably with the facilities of testing metal thicknesses by microsection and also by non-destructive means. All of this, plus a close final inspection to ensure that the printed circuit meets the dimensional tolerances required, make its quality control and inspection as significant a part of its successful production as almost any product that could be named.

Future of printed circuits in Australia and the world

The immediate future of the printed circuit industry in Australia seems assured.

Small quantities of flexible circuits on very thin laminates have already been produced.

Next significant step will be in the direction of multilayer circuitry. Already a reality overseas, this technique laminates together the equivalent of several double sided circuit boards into a single board with up to 12 layers and more. Through hole plating techniques provide the interconnections from layer to layer.

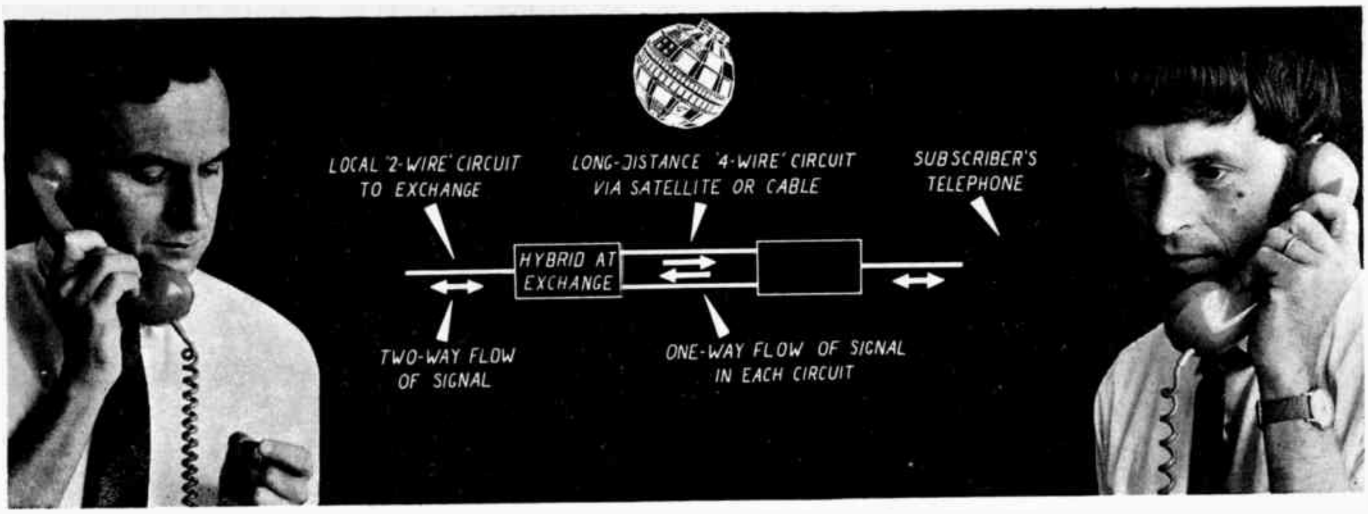
With multilayer technology in hand, it will be a simple step to flushed circuits where conductor lines are recessed into the board, flush with the surfaces, to provide a smooth running surface for switch contacts.

As for the industry overall, overseas reports are optimistic. Alfred T. Batch, special features editor of 'Electronic Packaging and Production', in an article in the December 1970 issue entitled "What's Ahead for Printed Circuits?", asks the question: "Think that microcircuitry and IC proliferation will spell the end for printed wiring?"

He answers his own question: "Not so . . . only the character of the PC has changed, while its dollar value overall has increased."

Brian Bork, the author of this article, is currently employed as Technical Manager of Tecnico Electronics' printed circuit department. Since receiving his Bachelor's degree in Chemistry from the University of Wisconsin in the U.S.A., he has spent seven years working in printed circuit technology.

At Siemens AG in Munich, Germany, he spent four years in the R. & D. Section, concentrating primarily on plating problems related to printed circuits and multilayers. Immediately before migrating to Australia just over one year ago, he was employed by the Allen Bradley Co. in Milwaukee, Wisconsin, U.S.A., where his time was split between managing the printed circuit prototype section and research into thick film technology.



Invention cuts phone echo

A novel, inexpensive device that automatically corrects for resistance imbalance in telephone circuits and so eliminates speech echos should prove very useful in long-distance circuits, particularly those involving satellite relays.

A DEVICE invented by Dr. E.M. Cherry, of the Department of Electrical Engineering, Monash University, Melbourne, takes the echo out of long-distance telephone conversations.

Echoes are caused by imbalances in the so-called 'hybrid' that converts telephone conversations from local two-wire lines on the four-wire system of long-distance networks. The local line carries a two-way conversation on one double wire, but longer transmissions require separate circuits for each direction. The hybrid is simply a bridge network of electrical resistances which separates the local two-wire signal into 'coming' and 'going' components, each of which travels by its appropriate long-distance circuit.

Complete separation of the two signals depends upon balance of the bridge network, one arm of which should have a resistance equal to that of the local line. But local lines vary in length and resistance and so upset the balance. The result is that signal separation is incomplete and 'leakage' occurs to the signal going in the opposite direction. The leak constitutes the echo.

Echoes only become a practical nuisance when the spoken words return in the earphone after intervals of about 1/10 second or greater. This occurs when telephone lines are longer than 2000 miles (such as Sydney to Perth), and in the growing number of situations where callers are linked bya 50,000-mile stationary satellite relay. If the echo is strong, the delay between a spoken word and its echo can make conversation almost impossible.

Dr. Cherry has devised a self-balancing hybrid network that automatically compensates for the varying resistances of local lines. It consists of two Wheatstone bridges connected to each other and to an amplifier whose output is a product of the input and output signals of the hybrid. This effectively eliminates leakage to the opposite speech line, and counters the objections to established echo suppressors, which tend to clip off occasional words or syllables at the ends of sentences. Other experimental units that overcome this disadvantage are up to 100 times as expensive as the Monash device.

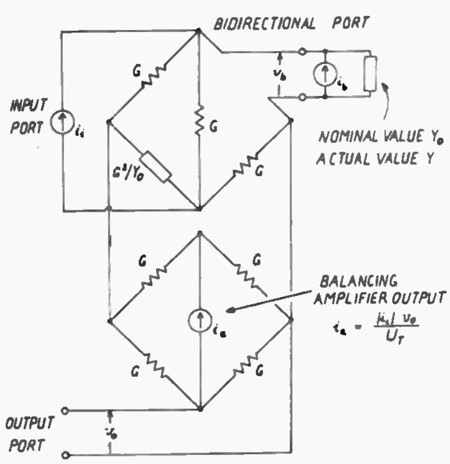
A possible application in Australia — in addition to trans-continental and overseas telephone circuits — is to rural telephone lines. These vary in length and cause difficulty in imposing constant 'side tone' — the faint built-in background echo which makes a telephone sound 'alive'. (Tap the microphone of a telephone part-way through dialling a number — you can hear it in the earphone.) The self-balancing hybrid would solve this problem.

If manufactured as an integrated circuit, a self-balancing hybrid could be sold for a dollar or so. The University has applied for patents in Australia and six other countries.

(Monash University News)

The unit could be very small if manufactured as integrated circuit.

Compensating circuit: two Wheatstone bridges connected to an amplifier.



One man's Bach is another man's blight

Noise is simply unwanted sound and few sounds are less wanted than 50 watts of hi-fi blasting through an adjoining wall.

Unwanted sound bothers some people more than others, as was shown by studies of subjective annoyance conducted in noisy areas of London and New York.

A quarter of those questioned were not bothered by noise at all — they could live happily in a discotheque. At the other end of the scale, one-tenth were troubled by any noise — no matter how faint — which was not of their own making.

The remainder were increasingly bothered by noise, or conversely said that they gradually became used to it.

The discomforting effect of noise should not be minimised. Like the discomforts of cold, hunger and thirst, annoyance may well be a physiological protective mechanism impelling the organism to avoid noise as it does other uncomfortable phenomena.

So, what of those 50 watts — can you have both Wagner *and* a social conscience?

You most certainly can — by reducing the level of transmitted sound. This article shows you how.

It is important to discern between materials that stop sound *transmission* and those which prevent sound *reflection*. A room lined with acoustic tiles, for example, seems less noisy because sounds originating in it are not reflected back to a listener in the room.

External noises, however, will penetrate the tiles. And noise from within the tiled room will penetrate to adjoining rooms. To prevent penetration, a sound barrier is required.

A good sound barrier must either be so massive that air pressure variations cannot cause any movement at all; or the barrier should have some mass but also be limp. In the latter case, any local movement will not affect the whole but will be dissipated within the material.

Lead is an obvious choice of a heavy limp material. Having a density two or three times that of common building bricks or concrete (and 10 to 15 times that of wood), it is a 'limp' material in the acoustical as well as the mechanical sense.

This combination of properties leads to the surprising conclusion that if two equally effective sound barriers are built, one of lead and one of any other common construction, the lead barrier will almost invariably be thinner and lighter — and in many instances cheaper as well! This is why lead is so often used for sound reduction in modern aircraft.

How much sound reduction?

The generally accepted level is that which will reduce offending noise to the level of the background noise in the adjacent area. For example, an 80dB noise impinging on a wall which has 30dB attenuation will generate a 50dB noise on the other side.

If the normal and accepted level of background noise in the quiet area is 50dB, no annoyance will be experienced.

If, however, the normal background noise level is 40dB, it will now increase to 50, indicating that the barrier is inadequate. In this case a wall attenuation of 40dB is called for.

In practice, recorded music is rarely played at levels exceeding 85dB (although music peaks may occasionally attain 90). Assuming that an acceptable noise level in an adjacent area is 40-45dB, then the noise reduction required is also 40-45dB.

Decibel ratings quoted for sound reduction are generally averaged over nine specified frequencies, from 125 to 4000Hz.

Averaging methods are used because high frequency sounds are more disturbing than low frequency sounds (the ear does not have a flat response) and the averaged measurements take these differing sensitivities into account.

As a corollary of the above, the noise barrier must be more efficient in the medium and high frequencies than in

Most people hate a noisy neighbour — and few of us want to be hated. This article tells how to soundproof your music room, so you can enjoy hi-fi without annoying others.

The Decibel (db)

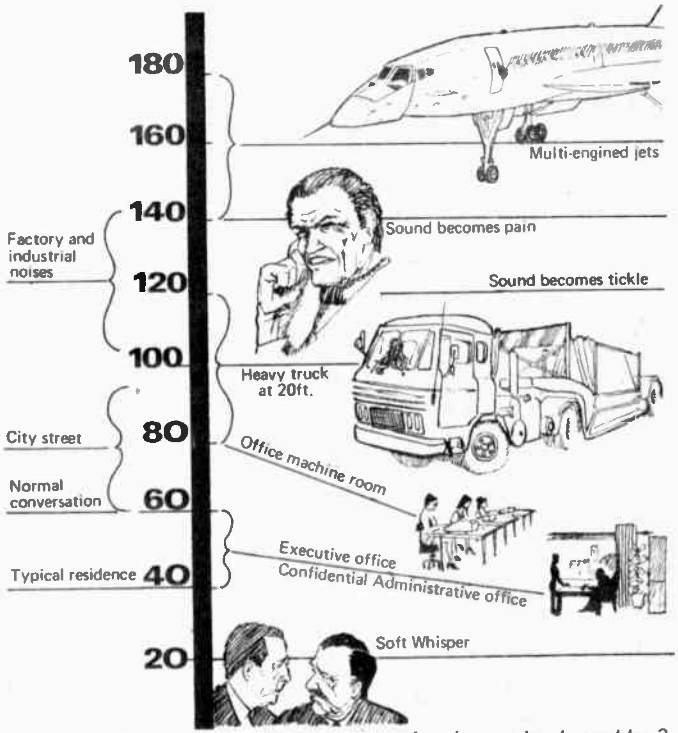
The ear can hear a sound power as low as 10^{-13} watt — this is a pressure of ·0002 dynes per cm^2. The ear drum moves an amount approx. equal to the diameter of a molecule of nitrogen. When sound is uncomfortably loud, the hearer "feels" a tickle, then pain in the ear; a power level of 1 watt. approx.

Engineers take the logarithm of the power ratio and call it the DECIBEL (db).

The db level is given by — $db = 10 \log 10 \frac{Watts}{10^{-13}}$

The sound pressure level is = $20 \log 10 \frac{P(dynes)}{\cdot 0002}$

Typical Decibel levels encountered



- *For a sound to be perceptibly louder or softer, it must be changed by 3 decibels.*
- *A noise twice as loud or ½ as loud is a change of 10 decibels.*
- *A reduction in noise of a few decibels in the low noise region (administrative office) is not significant. The same change at high sound levels (office machine room) is significant.*

the low frequency region. The most critical region is around 3kHz.

Although the sound insulation of a barrier depends largely upon its mass, single-leaf barriers of different materials of the same weight will not have the same noise isolating value. This is due to a 'coincidence' effect.

'Coincidence' occurs when the projected wavelength of the unwanted sound matches the wavelength of the natural resonance of the barrier. When this happens, a 'reinforcement' occurs and the barrier will transmit sound more readily. This is illustrated in Fig. 1, where the attenuation of different materials is plotted over a range of frequencies. The two building boards exhibit considerable 'coincidence' effects — note the dips at 1200/2400Hz and at 2400/4800Hz.

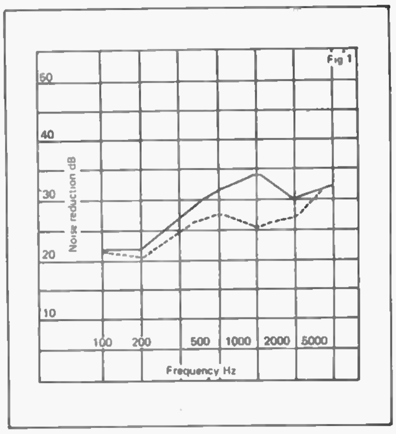
Because of its inherent limpness lead does not have any 'coincidence' — and by combining lead sheet and a suitable backing material a 'coincidence-free' acoustical barrier is obtained. It is, however, essential that the weight of lead in a laminate should equal or exceed the weight of the backing material.

Materials suitable for backing include hardboard, plasterboard and plywood. Comparative sound reduction figures (in decibels) are given below:

¼" hardboard	28
3/8" plasterboard	28
½" plasterboard	30
5/8" plasterboard	31
¼" plywood	22
3/8" plywood	24
½" plywood	26

The sound reduction required will probably be between 40 and 45dB — possibly 50dB in quiet areas, or if you run your hi-fi flat out.

Existing walls may have attenuations as low as 15dB or as high as 40. Measurements taken in a number of home units show that the average attenuation is 25-30dB.



To reduce sound transmission to acceptable levels we must (on average) provide a further 25dB attenuation.

At first sight it would seem that this can be achieved merely by adding half-an-inch of plasterboard. In practice 'coincidence' effects and increased wall stiffness will negate all but a few dB.

One man's Bach is another man's blight

The required reduction can most easily be obtained by adding a lead/plasterboard barrier spaced an inch or two from the existing wall. This partition should be constructed from 3/8" or ½" plasterboard plus 1 lb./sq.ft. or 2 lb./sq.ft. lead, bonded by contact adhesive.

Preparing and bonding the lead

Sheet lead is a soft, limp material and is usually supplied in rolls. It is easily flattened by unrolling it on any smooth, clean surface. Kinks and wrinkles should be removed by a roller.

If cast sheet lead is used, the surface will be chemically clean – other types of lead may have an oily surface. This can be removed with trisodium-phosphate or any heavy-duty alkaline cleaner. Traces of the cleaner must be washed off with warm water.

A viscoelastic bonding material must be used to adhere the lead to the backing material. This type of adhesive assists the damping action of the lead. Suitable types are rubber-based contact adhesives such as Bostik 400W Bostik 1450BB, Laminex 440TS, Behr Manning 600, etc. Rigidly setting glues must not be used.

Installation is simple

Cut the plasterboard to exact wall size. Ensure that the board fits tightly at floor and ceiling. Bond lead sheet to plasterboard following adhesive manufacturers' instructions.

Nail 2" x 1" battens to existing wall, preferably picking up existing wall studs, top and bottom plates, noggins, etc.

Attach laminate to battens, ensuring that it fits tightly around the perimeter. The amount of sound that can leak through the tiniest gap or crack is unbelievable. The penalty imposed by these leaks becomes much greater as the wall's performance is improved. When in doubt, use a gasket, tape, or caulking compound.

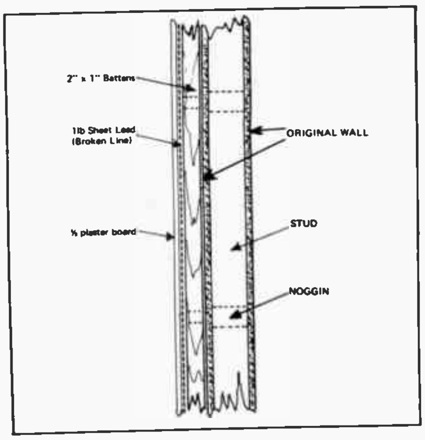
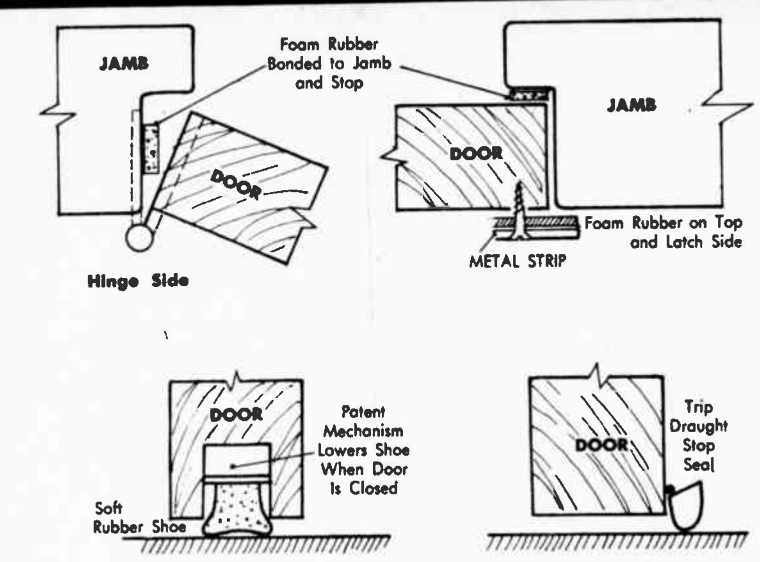


Fig. 3. Laminate fastened to wall.



Gaps around door edges.

Remedy: The simplest method of closing air gaps around the door is to fit strips of soft rubber against the door stop and rebate. Alternatively, fit a metal draught strip with a rubber seal on the top and latch sides of the door. For the bottom of the door fit a drop tongue or rubber cushion trip type draught excluder.

Treatment for doors

Two main factors determine the sound insulation provided by single doors – the mass of the door, and the amount of air leakage around the edges.

Typical figures for doors are –

Standard flush panel, ply or hardboard finish (1-2lb./sq.ft., 1 7/8" thick):

Normal installation	*With correct sealing*	*Maximum insulation*
18 dB	*21 dB*	*22 dB*

Ply/lead panels cavity type, absorbent infill (6-7 lb./sq.ft., 1 7/8" thick):

Normal installation	*With correct sealing*	*Maximum insulation*
21 dB	*30 dB*	*35 dB*

The inner faces of cavity doors should be lined with at least 1 lb./sq.ft. lead and the space between faces filled with an absorbent material if possible.

Every effort must be made to reduce sound transmission through gaps around door edges. Suitable methods are shown above.

Ceilings and floors

The sound insulation provided by concrete floors and ceilings is generally sufficient to attenuate all but the loudest noise. Wooden floors, however, may have an attenuation of less than 25dB. This is totally inadequate and treatment will be necessary.

Here again lead sheet is most effective. Thin lead sheet carefully overlaid on top of an acoustic tile ceiling will provide an adequate barrier to the passage of sound without materially affecting the performance of the acoustic tile in the job which it is intended to do – i.e., reduce the reverberation of sound within the room.

To summarise:

1. A heavy barrier is more effective than a light barrier.
2. A double wall or floor is more effective than a single one on a weight-for-weight basis.
3. Air spaces between skins should be filled with glass-fibre, mineral wool or other absorbent material.
4. The weight of lead in a lead/plaster plasterboard laminate should equal or exceed the weight of plasterboard.
5. Viscoelastic adhesives are better than rigid varieties for laminating leaded panels.
6. Sound transmission through small gaps is high. Wall and panel joints must be tight. Gaskets or caulking should be used where there is the slightest gap.
7. Cost of lead sheet will vary from area to area but is unlikely to exceed 20 cents per pound. ●

SPEAKING

Sophisticated pulse techniques, employing solid-state circuits, are making possible the reliable transmission of speech in digital form. Report by Sidney L. Silver.

The idea of transmitting voice signals in digital form was conceived many years ago — but, owing to the large number of active elements required, severe limitations were imposed on the design of a practical digital communications system.

These limitations were mainly associated with the use of vacuum tubes that were bulky, consumed too much power, and functioned poorly as switching devices. In recent years, however, the advancement of the solid-state art has provided new components and techniques that allow electronic circuits to become more complex, yet smaller and less costly than vacuum-tube circuits. The development of high-speed switching transistors and, more recently, integrated circuits, has made it possible to employ sophisticated pulse techniques which provide reliable, high-quality, digital speech transmission.

Formerly, voice communications over transmission lines was accomplished almost entirely with conventional analogue electrical waves. In analogue transmission, the audio wave-forms vary continuously in proportion to the original speech signals. As these signals propagate along the line, they experience attenuation losses which must be compensated for by high-quality repeater amplifiers. Unfortunately, analogue repeaters introduce some noise and distortion into the system, which accumulate as signals are passed through a chain of these devices. Moreover, any extraneous noise or interference picked up by the transmission cable, or coupled in from other lines in the cable, is amplified along with the voice signals.

A digital transmission signal represents a radically different method of communicating speech information. Using such techniques as pulse-code modulation, a given voice signal can be reduced to a stream of binary digits, whereby the intelligence of the speech signal is contained only in a particular pulse pattern, or code group. The binary pulses are transmitted in a fixed and predetermined time position and thus can readily carry the message over the transmission path with a high degree of accuracy.

During transmission, line attenuation will tend to obliterate most of the high-frequency components of the pulse waveform. In addition the presence of noise spikes on the line will further distort the digital signal. These problems are met by placing digital repeater circuits along the line, which are able to completely regenerate the pulse stream.

Since all the pulses are of the same size and shape, these devices are simply required to detect the presence or absence of an input pulse and to generate, as often as necessary, a new undistorted output pulse. This process allows a high signal-to-noise ratio to be maintained throughout the system, thus overcoming the problem of cumulative noise which characterizes analogue transmission systems. Finally, upon arriving at their destination, the regenerated digital pulses are reconstructed in order to recover the original signal.

Pulse-code modulation

At the present state of the art, the most advanced and efficient method of transforming band-limited voice signals into noise-free, wide-band pulse signals is the technique known as pulse-code modulation (PCM). The primary application of PCM is in multi-channel voice communications over wire circuits, although the digital pulse could, of course, be modulated on a carrier wave and then transmitted as a radio signal.

Fig. 1 shows a functional block diagram of the basic PCM system. Here

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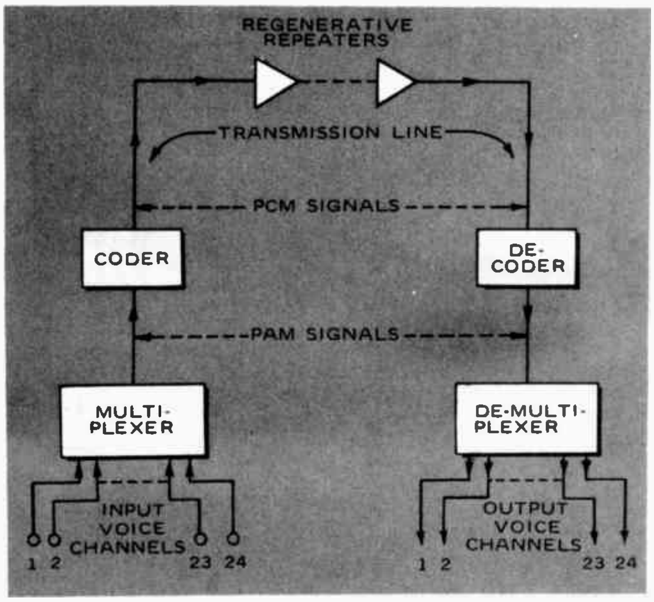


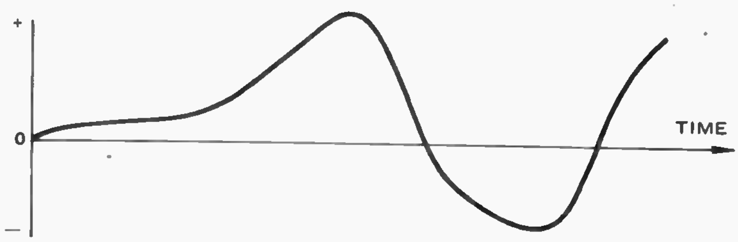


FIG. 1. Block diagram of a basic pulse code modulation system. Below is a normal speech signal.

BY NUMBERS

a number of voice channels (24 in this case), representing various speech signals, are sequentially sampled by a multiplexing device, producing an interlaced series of varying amplitude pulses. These pulse-amplitude modulated (PAM) signals, roughly analogous to the audio waveforms, are processed by a coding device which 'quantizes' or divides the sampled signals into incremental amplitude levels. Each finite value is encoded, or translated into a digital number, so that a string of constant-amplitude PCM pulses is delivered to the transmission line. At the receiving end an inverse process, involving decoding and de-multiplexing functions, reproduces a replica of the analogue voice signals.

With this brief general description, we shall now discuss in detail the three basic steps (illustrated in Fig. 2) which implement the PCM system – namely, the sampling, quantizing and coding operation.

Sampling

The initial operating step in a PCM process is to sample the voice signals at a suitable rate and measure the amplitude of the signals during the sampling time.

As shown in Figs. 2A and 2B, successive portions of the fluctuating signals are extracted at regular intervals to produce a sequence of uniformly spaced PAM samples; the magnitude of each pulse sample corresponding to the instantaneous voltage amplitude of the audio waveform at the moment of sampling.

In this process, the minimum allowable sampling rate is quantitatively related to the frequency spectrum of the audio signals, so that information can be lost if the sampling rate is not fast enough. This relationship is known as the *sampling theorem*, which states that, if a signal is sampled at a rate of at least twice the maximum frequency, the sample will contain all the information of the original signal. In other words, any complex waveform can be faithfully reproduced if at least two amplitude samples are generated for each cycle of the highest frequency component.

Since voice signals are usually band-limited to reject all frequencies

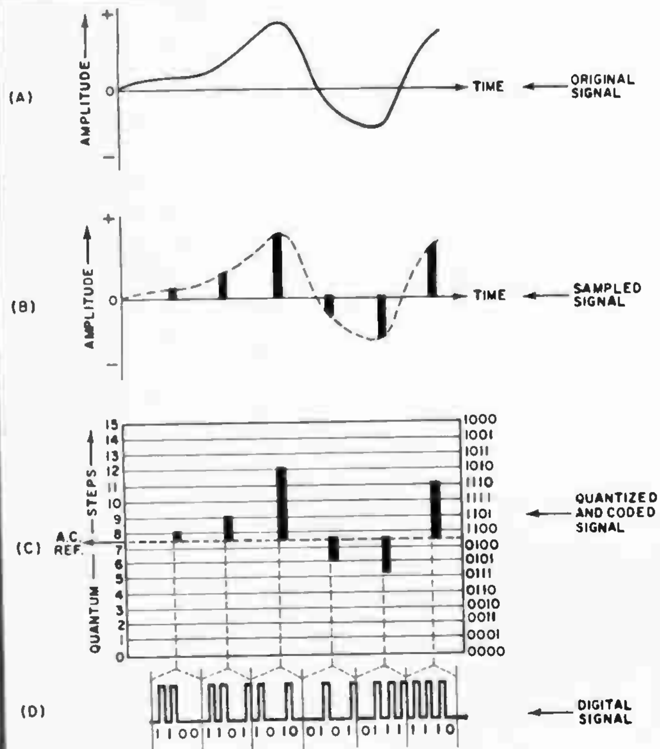


FIG.2. Basic steps. (A) Original speech signal is (B) sampled to produce pulses corresponding to instantaneous voltage amplitude of audio waveform which is then (C) quantized into incremental levels and (D) encoded into equivalent digital signal.

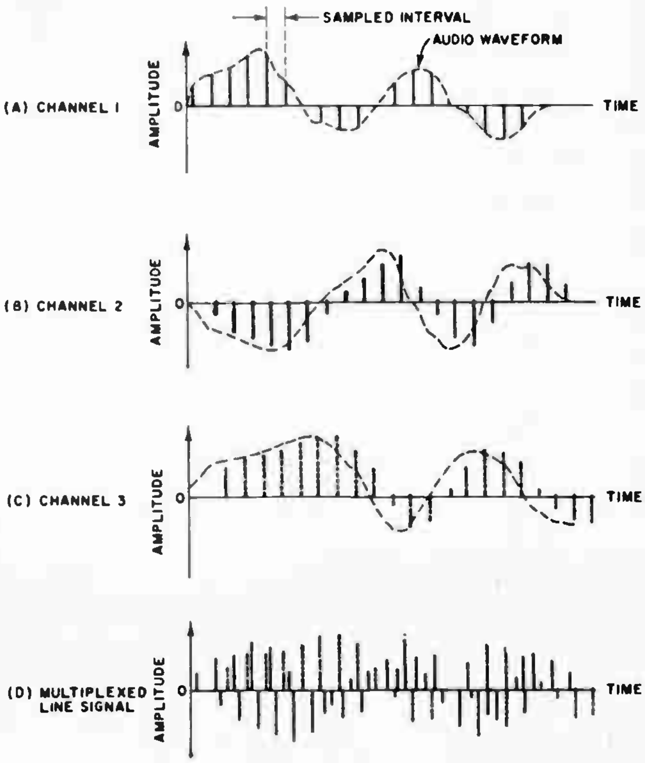


FIG. 3. Sample of time-division multiplexing using pulse-amplitude modulation showing how three (A, B and C) signal voice channels are (D) interleaved in time to form a single, higher-speed pulse train and fed to common line for encoding.

SPEAKING BY NUMBERS

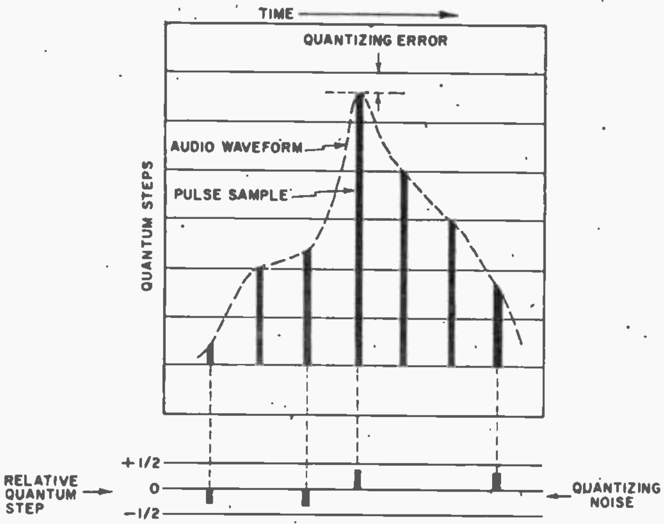


FIG.4 (LEFT). Quantizing noise, or the difference between actual and measured value of each pulse, is produced only in presence of voice signals whose amplitudes do not coincide with an exact quantum step. Maximum error per sample can't exceed one half size of quantum step.

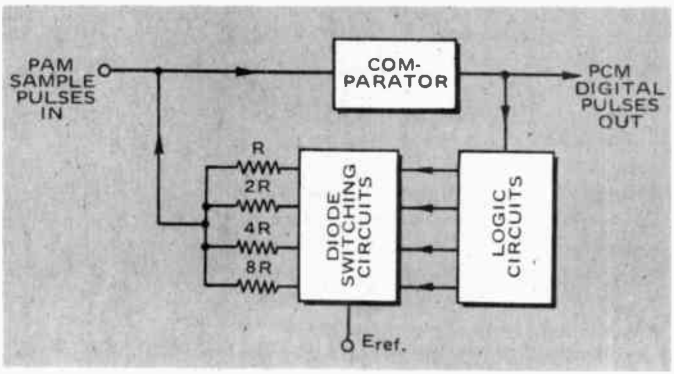


FIG. 5. Functional block diagram of a linear coder that uses the 'successive-approximation' technique to determine the digital number representing the amplitude of a PAM sample value.

above 4000 Hz, a sampling rate of 8000 pulses per second, or one sample every 125 microseconds, is generally employed. This rate is sufficiently fast to prevent the listener detecting any perceptible difference between sampled speech and normal speech. The effect is analogous to what an observer experiences when viewing motion pictures.

An important advantage of the sampling principle is that the discrete time intervals between the samples of a single voice channel can be allocated to other, independent channels by the technique known as time-division multiplexing (TDM). This is accomplished on a time-sharing basis by repetitively scanning each channel in a regular sequence and allotting a particular time position to each channel.

As shown in Fig. 3, the variable-amplitude pulse samples of one channel are interleaved in time between the samples of all the other channels, to form a single higher-speed pulse train. These multiplexed pulses are then applied to a common line for encoding.

The number of channels that can be multiplexed depends, of course, upon the duration of the time interval assigned to each sample; the shorter the time duration, the greater the number of channels that can be accommodated. For the sake of simplicity, a 3-channel TDM system is shown in Fig. 3, but in practice 24 voice signals are usually multiplexed at one time. Since each channel is sampled at 8000 times a second, there would be 192,000 samples per second on a 24-voice multiplexed line.

Quantizing

Upon completion of the sampling operation, the next step is to quantize the intensity range of the sampled voice signals into distinct amplitude levels, thus permitting binary digital coding. As shown in Fig. 2C, the magnitude of each sample is compared to a scale of discrete values, or quantum steps which are used to represent any level in the dynamic speech range. Each step actually represents a limited range so that, essentially, this process creates only an approximation of the magnitude of the sampled waveform.

The quantizing operation is performed by applying the quantum step nearest to the actual value of the pulse sample. For instance, a sample value of 8.21 would be represented by quantum step 8, a sample of 8.98 would be rounded off and quantized as step 9, etc. Obviously, the greater the number of steps, the closer the approximation to the sampled signals.

The difference between the actual value and the measured value of each pulse sample constitutes an error which gives rise to a phenomenon called quantizing noise, or quantizing distortion. This type of noise is inherent in PCM systems and differs subjectively from the continuous noise, e.g., thermal, normally encountered in analogue systems. As shown in Fig. 4, the error component tends to spread randomly over the speech range, producing quantizing noise only in the presence of voice signals whose amplitude does not coincide with an exact quantum step. Clearly, maximum error per sample cannot exceed one-half the size of a quantum step.

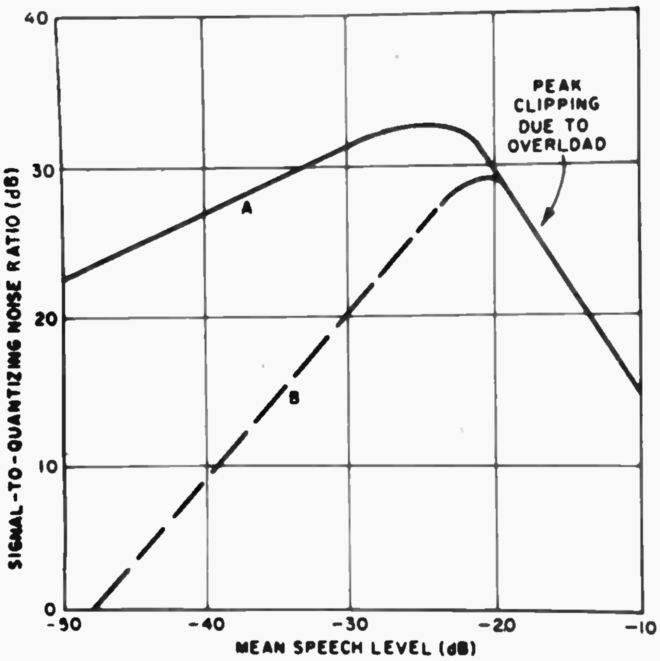
Ideally, it would seem desirable to quantize all the positive and negative peaks in the dynamic speech range, thereby achieving infinite resolution and thus completely eliminating quantizing error. Increasing the number of quantum steps, however, would add to the complexity of the system, since digital components with much higher switching ratios would be required. Moreover, the great number of amplitude levels involved would raise the bandwidth requirements of the coded signals.

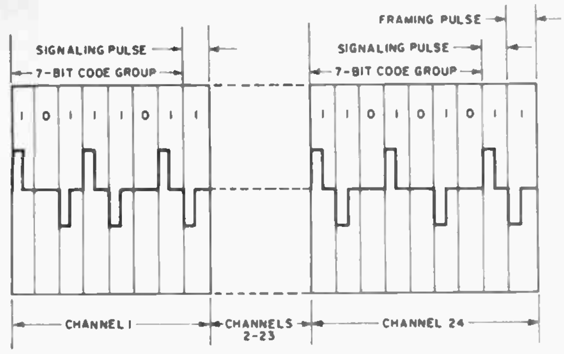
One method of reducing the number of quantum steps without sacrificing voice quality is to take advantage of the statistical distribution of speech amplitudes. For example, the normal distribution of voice signals is such that the probability of weak signals occurring is much greater than that of strong signals. Since most of the speech information is concentrated at low amplitudes, using quantum steps of equal size would result in the greatest amount of quantizing error for weak signals. By progressively tapering down the quantum steps so that very small increments are assigned to low levels and larger ones to the rest of the amplitude range, the total number of steps can be greatly reduced.

Another method of preserving voice quality with fewer quantum steps is to compress the magnitude of the pulse samples before applying uniform quantization, and then to expand the amplitude range back to normal at the receiving end. This technique, called instantaneous companding, achieves the same results as changing the size of the quantum steps. The companding action must be extremely fast in order to respond to the narrow pulse samples.

In the transmitting operation, the compressor effectively modifies the normal distribution of sampled speech so that preferential gain is given to low-level signals at the expense of the higher amplitudes. As a result, the signal-to-quantizing noise ratio is kept fairly constant, even though the input

SPEAKING BY NUMBERS





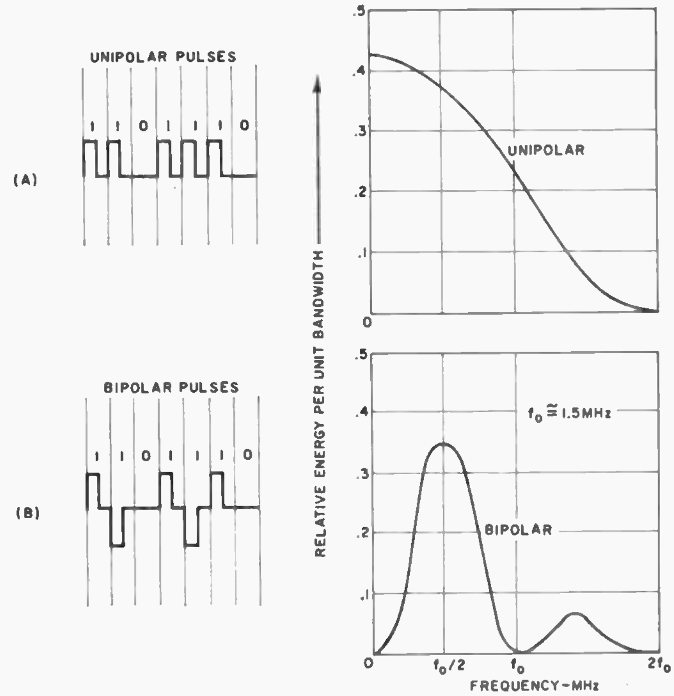


FIG. 6. Signal-to-quantizing noise ratio vs input signal level for 7-bit code using (A) logarithmic and (B) linear coding.

FIG. 7 (TOP RIGHT). Digital time slots for binary-coded pulses in typical pulse-pattern arrangement for a 24-voice-channel system.

FIG. 8 (RIGHT). Comparison of energy distribution between unipolar (straight binary) and bipolar signals with 50% duty cycle.

levels vary over a large portion of the speech intensity range. Usually, the intensity range encountered in voice communications is about 60 dB, which represents the ratio of the loudest to the weakest speech level. By using a compression characteristic that varies logarithmically with signal amplitude, this range can be reduced to about 36 dB while maintaining the same quantizing noise performance.

Coding

The first step in transmitting the PCM signal is to encode the discrete amplitude levels in binary digital form.

To form a digital code group, each quantum step is numbered in decimal form and a combination of binary 1's and 0's is used to represent each of the decimal numbers. The number of quantum steps that can be designated by the binary code is given by 2^n, where n is equal to the number of binary digits, or bits, required in each code group. Thus, the 4-bit code illustrated in Fig. 2C requires 2^4, or 16 discrete amplitude levels; with 8 quantum steps positive, 8 quantum steps negative, and zero reference (for the sampled signals) corresponding to the midpoint between steps 7 and 8. The first digit in the code group indicates whether a pulse sample is positive (binary "1") or negative (binary "0"), while the subsequent digits identify the voltage amplitude.

Fig. 5 shows a simplified block diagram of a linear coder which utilises a technique called 'successive approximation'. In this arrangement, the digital output is determined one digit at a time, starting with the most significant bit.

Initially, a comparison is made between the amplitude of each compressed sample input and a series of reference voltages; a voltage comparator making the decision as to whether a particular reference voltage is greater or smaller than the sample value. The output of the comparator causes the value of the reference to be changed until it approximates the amplitude of the input signal. This is accomplished by a diode switching network which progressively connects a number of precision resistors into the reference circuit; the operation being controlled by the logic elements. The process continues until all the digits of the binary code group are produced at the output.

The first comparison voltage is 50% of maximum amplitude, the second is 25%, the third 12.5%, etc., so that each precision voltage is one-half the value of the preceding one. Thus, when the pulse sample is compared to the first reference voltage, the most significant digit of the code is determined. If the sample is less than 50% of maximum, the logic circuits will generate a binary "0". If it is greater than 50%, the first digit will be a binary "1".

As an example, let us assume that the 4-bit code (Fig. 2C) is being used, and the sample of interest is 70% of maximum amplitude. Since this value is greater than the first comparison voltage, the first digit to be generated is a binary "1". Now the second comparison (25%) is combined with the first and the sample value is compared again. Since the sample magnitude is less than 75%, the second digit is a binary "0".

At this point, the second comparison voltage is switched out and the third voltage (12.5%) is switched in. The sample is then compared against 62.5% of full value, and since it exceeds this, the third binary digit is a "1".

Finally, the fourth comparison voltage is switched in and the sample is compared against 68.75%. The fourth digit is therefore a binary "1". Thus the digital number generated by the logic circuits is 1011, which represents the decimal number eleven (70% of

SPEAKING BY NUMBERS

the full-scale value of 16 amplitude levels).

Nevertheless, a 4-bit code group cannot handle the full range of positive and negative amplitudes, and is described here only for reasons of clarity. With this particular code, very weak signals would be completely lost while strong signals would be severely clipped. It has been empirically determined by listening tests that approximately 2^{10}, or 1024 linear quantum steps are required to adequately cover the dynamic speech range. This would call for a 10-bit code which, unfortunately, would be impractical for processing speech signals. However, by employing either instantaneous compression or nonlinear quantizing, this can be reduced to a 7-bit code representing 2^7, or 128 quantum steps.

Fig. 6 shows the variations of signal-to-noise ratio with input level for a 7-bit code, and clearly indicates the advantage of logarithmic (A) over linear (B) encoding.

Pulse transmission techniques

A fundamental requirement in PCM transmission is that the pulse stream must be held to extremely close timing standards, so that all voice channels can work together without interference.

Fig. 7 shows a typical pulse-pattern arrangement in which 24 voice channels are encoded in a 7-bit binary code group. Here the total 125 microseconds sampling interval, called a frame, is divided into a series of digital 'time slots' representing the speech information in each channel. The binary coded pulses have a 50% duty cycle, which means that the width of each pulse is equal to one-half the time allocated to each pulse. An extra time slot is added to the code group to carry supervisory and signalling information.

Each time the entire frame is encoded, a framing pulse is placed in the last slot of the 24th channel, in order to synchronize the end terminals. Synchronization enables the receiving functions of the system to 'lock' with the incoming digital signals, so that the pulses are sorted out and directed to their appropriate receiver channels. Altogether, there are 193 time slots per frame — and since the system uses an 8000 Hz sampling rate, the output pulse train fed to the transmission line has a maximum bit rate of 1.544 megabits per second.

An essential feature of the pulse pattern illustrated in Fig. 7 is that the polarity of alternate pulses is inverted to form a bipolar code group. There are several advantages in this arrangement over the straight binary, or unipolar, pulse pattern, in which all of the pulse amplitudes are positive-going.

In a unipolar pulse code (Fig. 8A), the average value of the digital pulses has an undesirable dc component which is difficult to transmit, especially if the pulse stream has to be fed through numerous transformers in the transmission line. However, with a bipolar pulse code (Fig. 8B) the signal is forced to change successively between positive and negative values, so that it behaves like an ac signal and permits transformer coupling at the repeaters. All digital pulses, of course, regardless of polarity, are processed as binary "1's" at the receiving end.

A useful parameter in determining the energy distribution of the PCM signals is an analysis of the power-spectrum density. In this measurement, the energy content is divided into narrow bands and swept across the frequency range of interest; the readings being averaged over the time interval.

According to the curve in Fig. 8A, the bulk of the spectral energy in the unipolar waveform is concentrated near zero frequency, thus producing unwanted dc levels. Furthermore, there are considerable energy levels near the pulse repetition frequency f_o, resulting in the coupling of energy (crosstalk) to other systems in the same transmission cable.

In the bipolar curve given in Fig. 8B, the energy spectrum is modified by shifting the peak energy level to one-half pulse repetition rate, $f_o/2$, so that nulls are produced at f_o and near zero frequency. Accordingly, not only are the dc levels effectively eliminated, but cross-coupling of the high-frequency energy is considerably reduced.

Regeneration

In the course of traversing the transmission line, the digital signals are subjected to the usual forms of noise and distortion, thus causing the pulse train to deteriorate rapidly. However, if the pulse waveshapes are still recognizable, they can be regenerated into their original undistorted form. This function is performed by digital repeaters (spaced about a mile apart) which equalize the line, retime the pulses and regenerate the pulse stream.

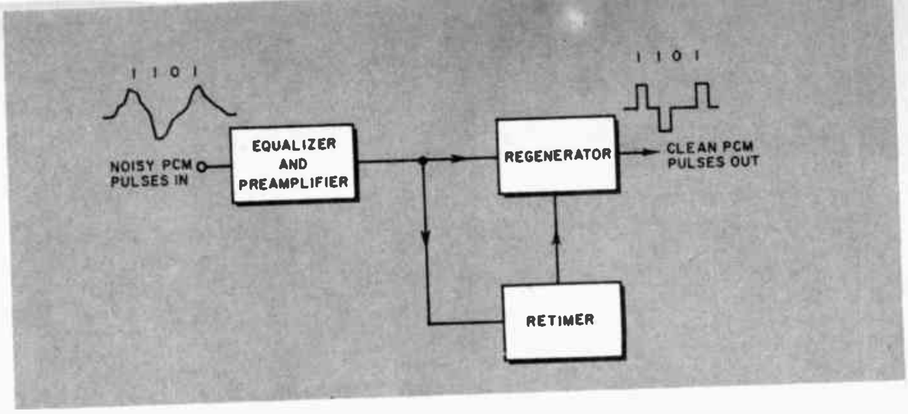


FIG. 9. Simplified block diagram of a digital repeater.

As shown in Fig. 9, the PCM signals are fed to an equalized pre-amplifier to compensate for the distortion introduced by variations in frequency response with line attenuation. By this means, the pulses are reshaped in order to reduce 'spillover' into adjacent time slots. The preamp output drives not only the regenerator but also the retiming circuit, which locks itself to the timing information in the signal. This allows the retimer to excite the regenerator when it is time to make a decision on the amplitude of an incoming pulse.

The regenerator establishes a reference level which is compared to the height of the received pulse. If the pulse in a particular time slot exceeds one-quarter of the received pulse height, a new pulse will be generated at the output. Thus, any noise spike picked up by the repeater whose amplitude is equal to or below this threshold level will be eliminated.

Occasionally, the presence of strong noise impulses can cause extra, or 'false', pulses to be generated, resulting in audible clicks in the speech signal. However, if the error rate is about 10^{-6}, or less than one error per million pulses, this impairment is usually not detectable.

Conclusion

There is no doubt that the transmission of information in the form of binary digits will ultimately dominate the communications field. The main problem is to standardize the operating parameters so that all digital systems can be inter-connected successfully. Once this problem is resolved, it is possible to conceive that all types of PCM signals, including voice, television and data, can be intermixed in a vast international digital network. ●

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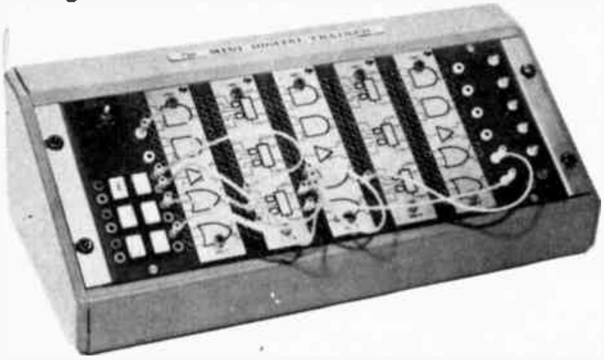

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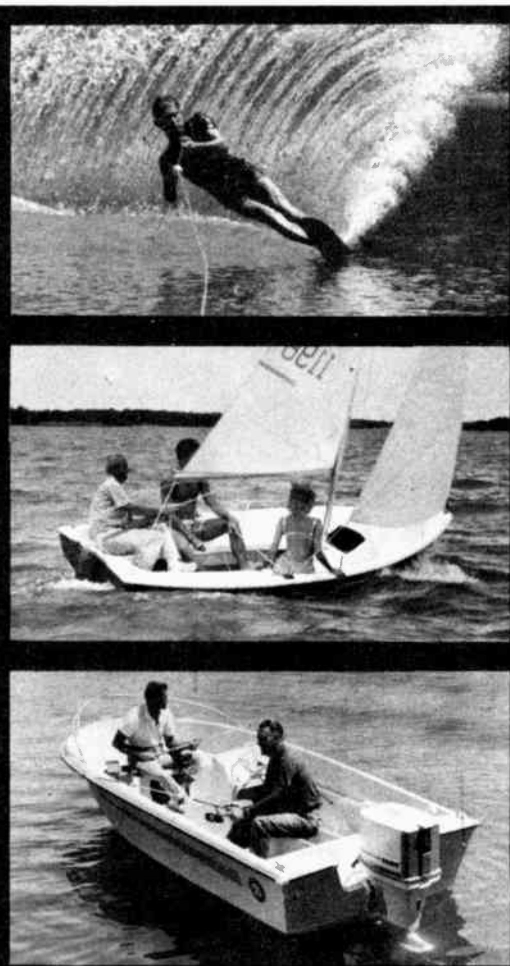

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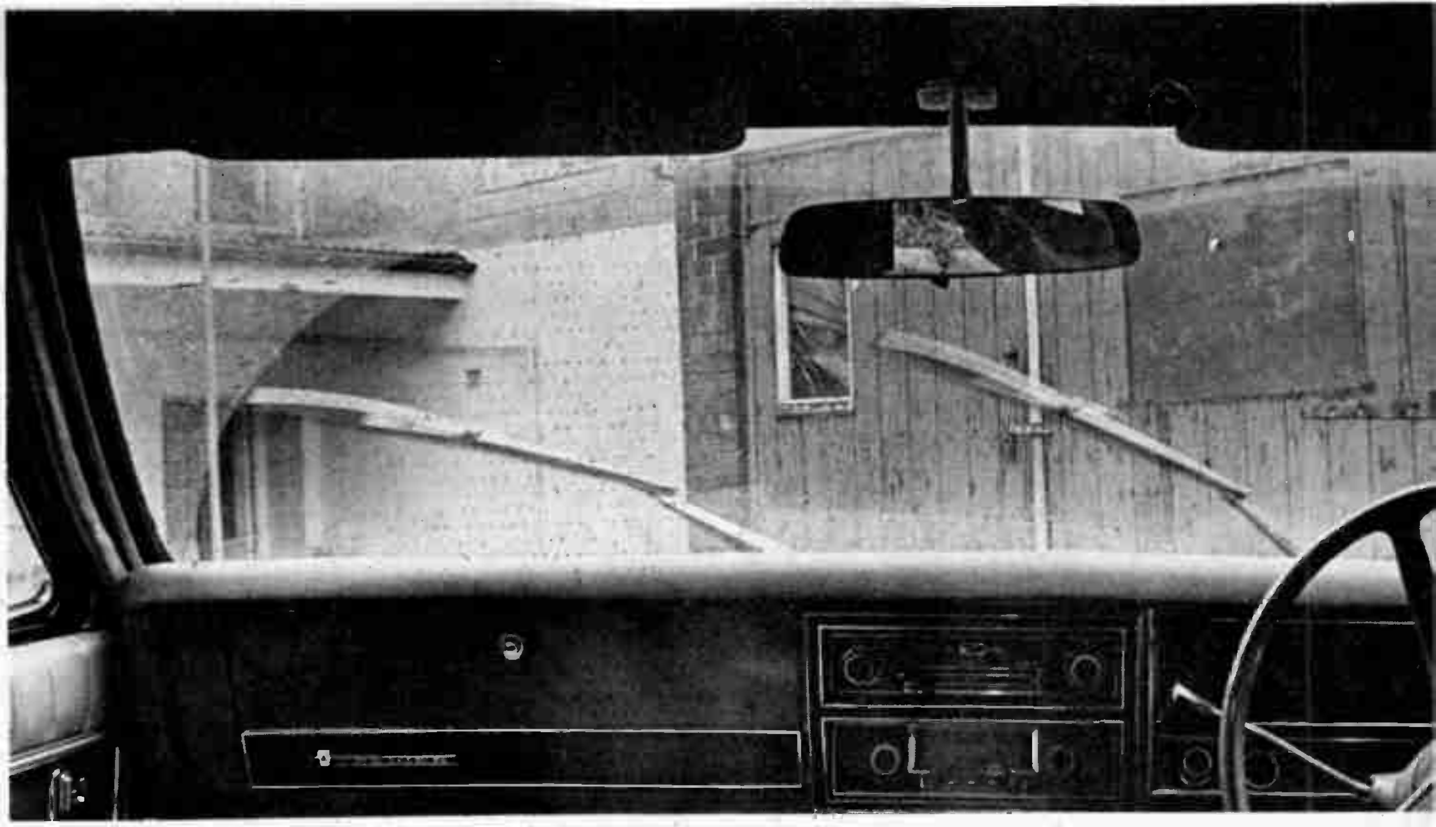

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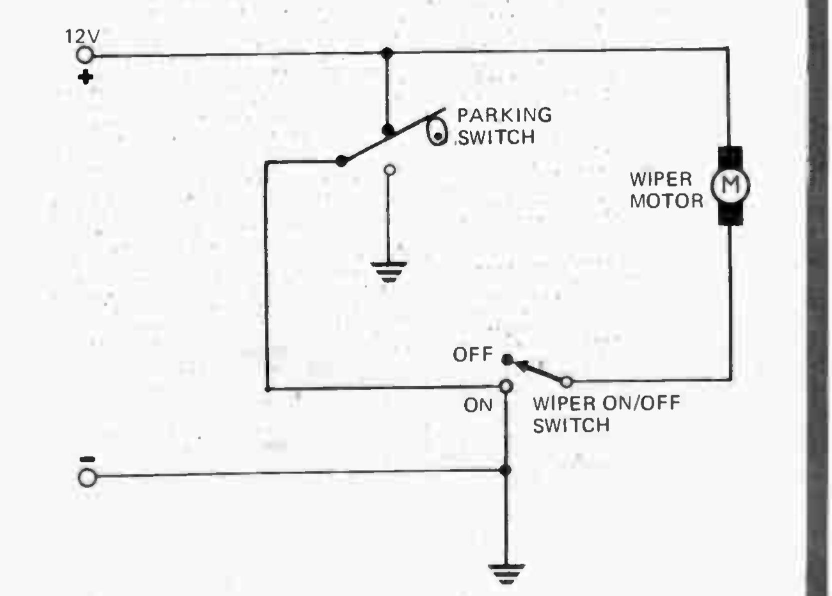


Fig. 1. Modern wiper assembly using permanent magnet motor.

During a rainstorm windscreen wipers are hard-pushed to provide visibility at all.

But during the more frequent occasions of light rain, or mist, all that is required is the odd sweep of the blades at intervals of a few seconds.

Turning them on and off repeatedly takes the driver's concentration off the road, increasing the accident hazard. On the other hand, if the wipers are kept working all the time in such conditions, the blades tend to scrape on the dry glass, wearing out the rubber inserts and – worse still – abrading the screen itself.

The answer, of course, is to have the wipers operate intermittently.

Several constructional projects providing intermittent wiper operation have been published during the past few years. These circuits were all much the same and consisted of a timing circuit and SCR output stage which gated the motor current at regular intervals.

Unfortunately, these projects failed

PROJECT

Here's a periodic screen-wiping system that really works with present-day permanent-magnet motors

to allow for one very important fact — namely, that most modern cars use permanent magnet wiper motors which, unlike their wound field counterparts, require dynamic braking during the parking sequence.

Dynamic braking is achieved by applying a short across the armature. However, as many constructors found to their cost, the short across the armature was also applied across the output SCR (which it resented bitterly for a microsecond or two before disintegrating).

The dynamic braking facility in the new motors is provided by a cam-actuated change-over switch synchronized with the wiper blades. When the wipers are switched off, the change-over switch shorts out the motor armature via the main wiper ON/OFF switch (Fig. 1).

ELECTRONICS TODAY'S Vari-Wiper unit uses a relay output to obviate damage to its solid-state components (though details are also given showing how solid-state output can be used if the wiper motor is modified).

The basic unit is suitable for negative earth vehicles fitted with permanent magnet motors. It has been extensively tested on a late-model Holden and will operate on any vehicle with similar circuitry.

The Vari-Wiper circuit is shown in Fig. 2.

NORMAL WIPER OPERATION

Conventional operation of the wipers is obtained by using the vehicle wiper switch in the normal way. Figure 2 shows the sliding contacts of this switch in the correct position for each function. Note that in the OFF position the switch shorts lead B to lead C. In the SLOW position the short is removed and an earth is extended to B, whilst in the FAST position the earth is removed from B and extended to A. For single-speed wipers slide contact A will be omitted.

In the OFF position the cam-operated parking switch shorts out the motor armature via RL1 and contacts B and C of the wiper switch. When the wiper switch is ON the short is removed from the motor armature as the slider on the wiper switch is moved across, disconnecting B from C and, by extending an earth to A or B, applying power to the motor.

DELAYED OPERATION

When delayed operation is required, the wiper switch is left in the OFF position and the timing circuit energized by operating switch SW1, which is part of switch/potentiometer RV1. This switch applies power to the unijunction/SCR circuit via the still-closed parking switch contacts.

Capacitor C1 charges via RV1 and R1, at a rate determined by the setting of RV1, until the unijunction 'fires', producing a positive going pulse which triggers the SCR into conduction. Resistor R4 ensures that the SCR latches on, thus energizing relay RL1.

Relay contacts RL1 (1) now change-over, removing the short circuit from the motor armature before energizing the motor by extending an earth via the now-closed relay contacts.

As the motor gathers speed, the associated cam-actuated switch changes over, removing power from the timing circuit (causing the relay to drop out) and extending an earth to the wiper motor via wiper switch contacts B and C, the now de-energized relay contacts, and the cam-actuated switch.

The wipers continue their sweep across the screen, but on their return the cam-actuated switch cuts in just before the end of the sweep. This removes power from the wiper motor and places a short circuit across the armature.

The motor is thus dynamically braked and remains stationary until the next relay closure from the timing circuit. When this arrives, between ½ a second and 25 seconds later (depending upon the setting of RV1), the sequence is repeated.

The Vari-Wiper unit described so far is suitable only for the permanent magnet wiper motors which are fitted to most modern vehicles. Provision has

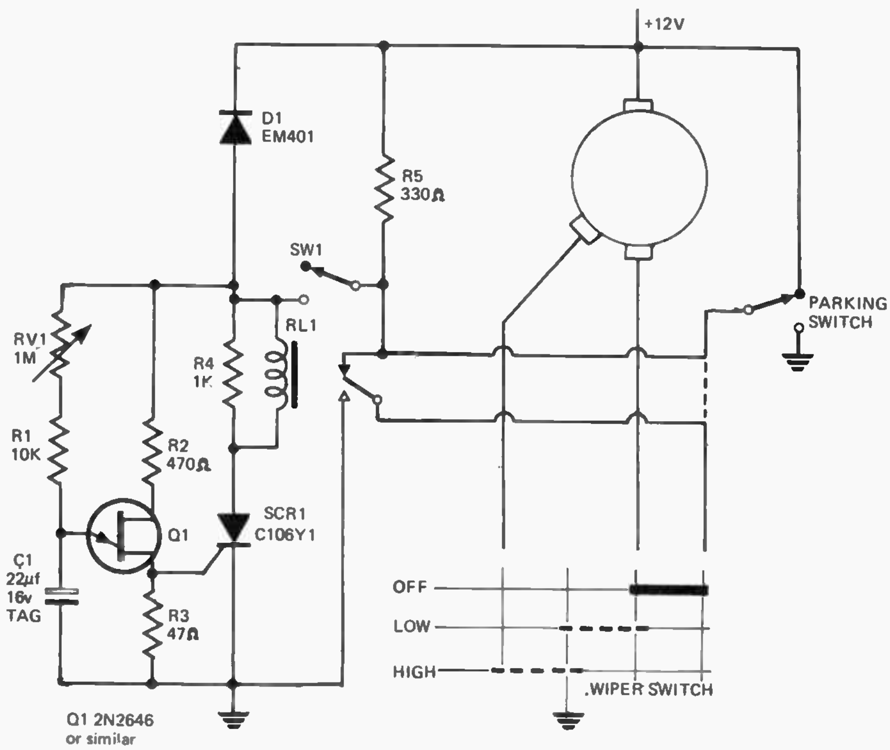
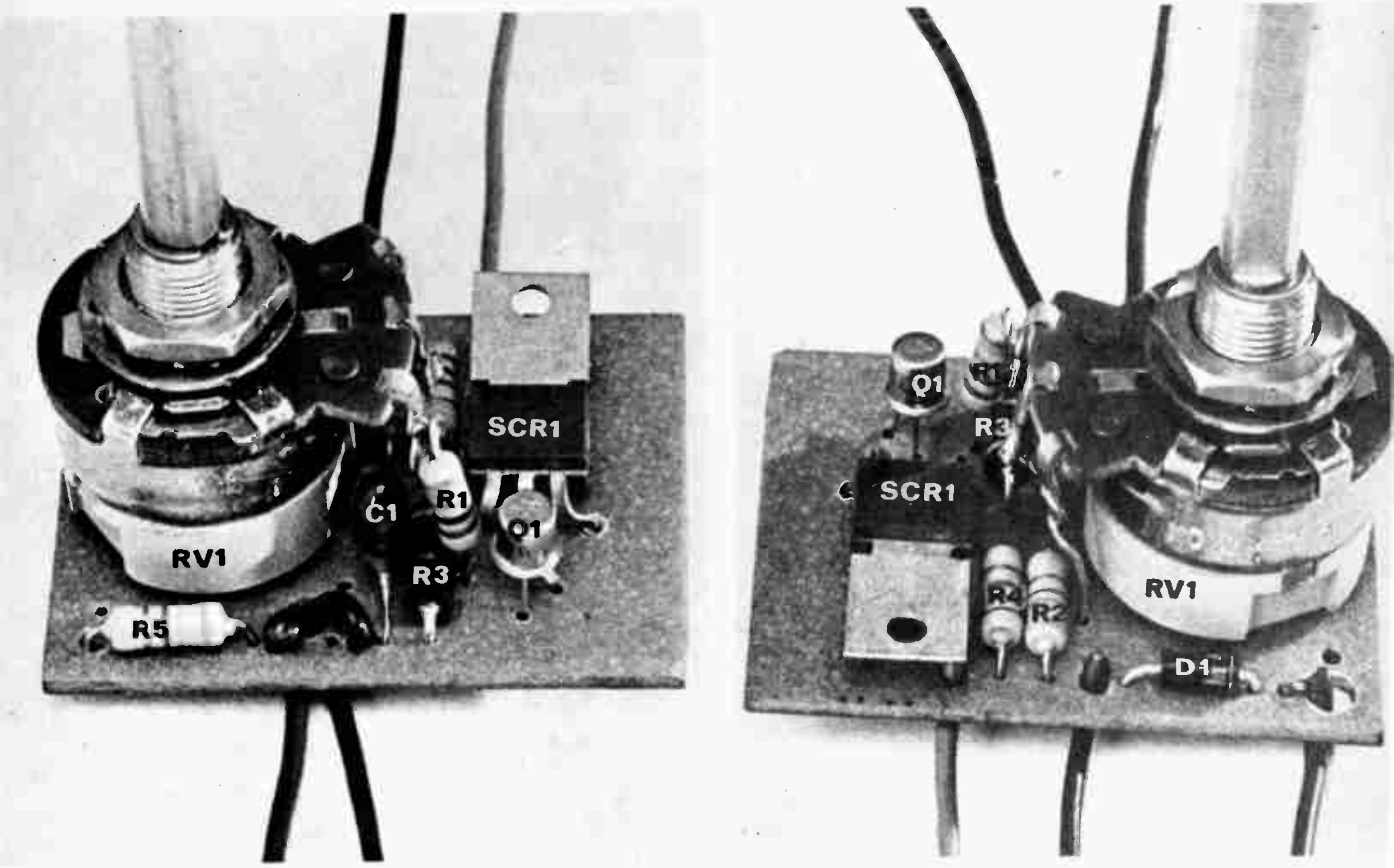


Fig.2. Vari-wiper basic circuit.



Figs. 4, 5. Vari-wiper components assembled on circuit board.

PARTS LIST

RELAY OUTPUT UNIT

R1	–	resistor ½ watt 5% – 10K
R2	–	resistor ½ watt 5% – 470 ohms
R3	–	resistor ½ watt 5% – 47 ohms
R4	–	resistor ½ watt 5% – 1K
R5	–	resistor ½ watt 5% – 330 ohms
RV1	–	switch/potentiometer 1 Megohm – IRC CTS45 or equivalent
DI	–	silicon diode EM401 or equivalent
CI	–	capacitor tag type 22 μf – 16 volt
QI	–	unijunction transistor 2N2646
SCR1	–	SCR – C106YI or equivalent
RL1	–	single pole change-over relay – 12 volt coil – contacts rated 12 volt – 10 amp minimum
PC	–	printed circuit board, control pot. knob, wiring etc.

SCR output unit

All components as above, except:

RL1	–	delete
SCR1	–	delete
SCR2	–	SCR C20A or equivalent
R5	–	delete
R6	–	resistor 3 ohm 10 watt heat sink for SCR

nevertheless been made for the unit to be used with the earlier type of wound field coil motor; the same circuit board and most components are used for all types of motor and also for the relayless version of the unit described later.

CONSTRUCTION

The printed circuit board mounts directly onto the switch lugs of an IRC potentiometer; if another make of potentiometer is used, the board may need to be modified to accommodate different switch lug positions.

As can be seen from Fig. 4, the relay is not mounted on the printed circuit board. It has been found advisable to locate the relay under the bonnet, close to the wiper motor, as the relay contact noise is irritating if the relay is mounted inside the passenger compartment.

Assemble and solder all components on the printed circuit board. Do not bend the lugs on the SCR too close to the SCR's case – leave at least 1/16" clear. Ensure that diode DI is inserted the right way round. The

Fig. 3. Veri-wiper foil pattern (full size).

circumferential line indicates polarity.

To connect the unit into the wiper motor circuit, the existing lead from the centre pole of the wiper motor change-over switch to the wiper ON/OFF switch (shown in dotted lines in Fig. 2) should be broken at points X and Y and these leads taken to the normally closed contacts on the relay. Ensure that point X goes to the fixed contact and point Y to the moving contact. Take a further lead from point X to SW1 on the circuit board.

Connect the relay coil and remaining relay contact to the appropriate points on the circuit board, and the diode DI to 12 volt supply.

The printed circuit board/potentiometer assembly can now be fixed in position, either by drilling a 3/8" diameter hole through the facia panel or by attaching it to a suitable bracket mounted in a convenient place.

SOLID–STATE OUTPUT

As mentioned earlier, the Vari-Wiper unit can also be used without a relay, to drive a permanent magnet wiper motor, provided the motor is modified internally.

To do this, insert a 3 ohm 10 watt resistor inside the motor housing between the parking switch and the supply rail — i.e., in series with the braking circuit. This resistor decreases the braking effect slightly, and the wiper blades may park a little higher on the windscreen than before.

As can be seen from Fig. 6, the circuit is very similar to the relay-operated unit. Switch SW1 is moved to a different position, but the main difference is that a higher current rated SCR is required, and this must be mounted away from the board on a suitable heat sink. The connections to the SCR can be made from the existing SCR holes on the circuit board. Fig. 7 shows the same unit for positive earth vehicles.

The circuit of Fig. 6 can also be used to control the earlier type of wound field coil motors; in this case the 2 ohm resistor (R6) is not required. ●

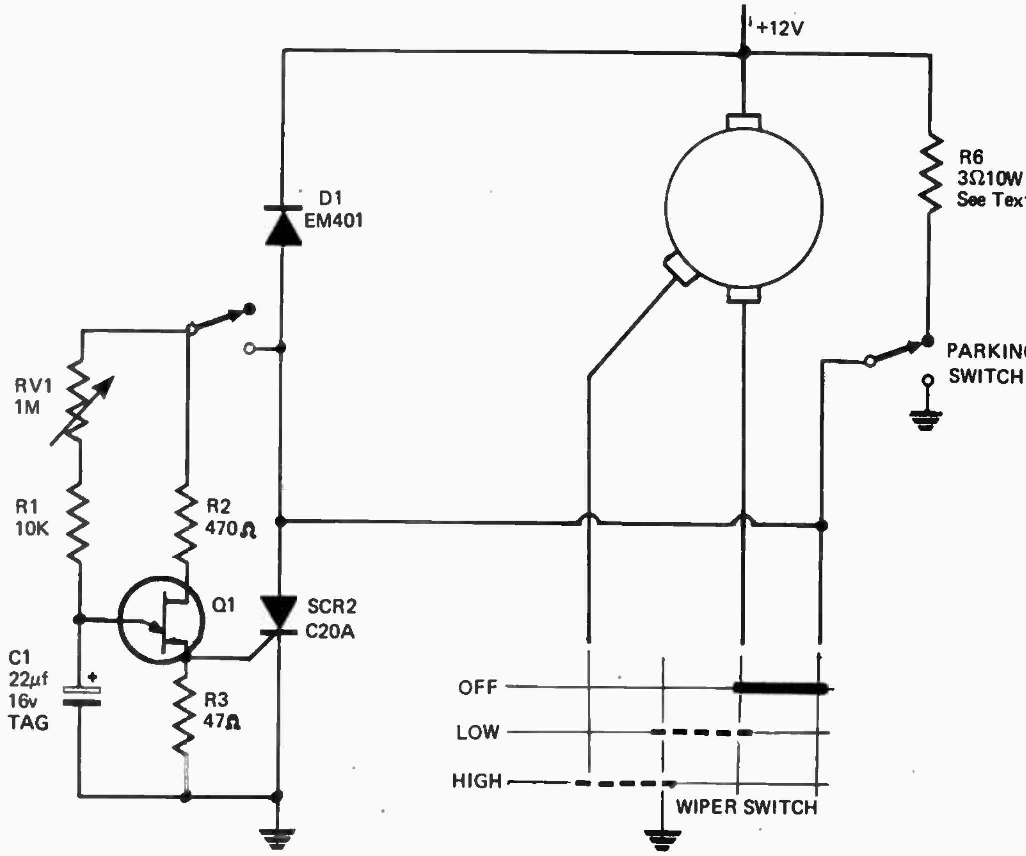


Fig. 6. Negative earth.

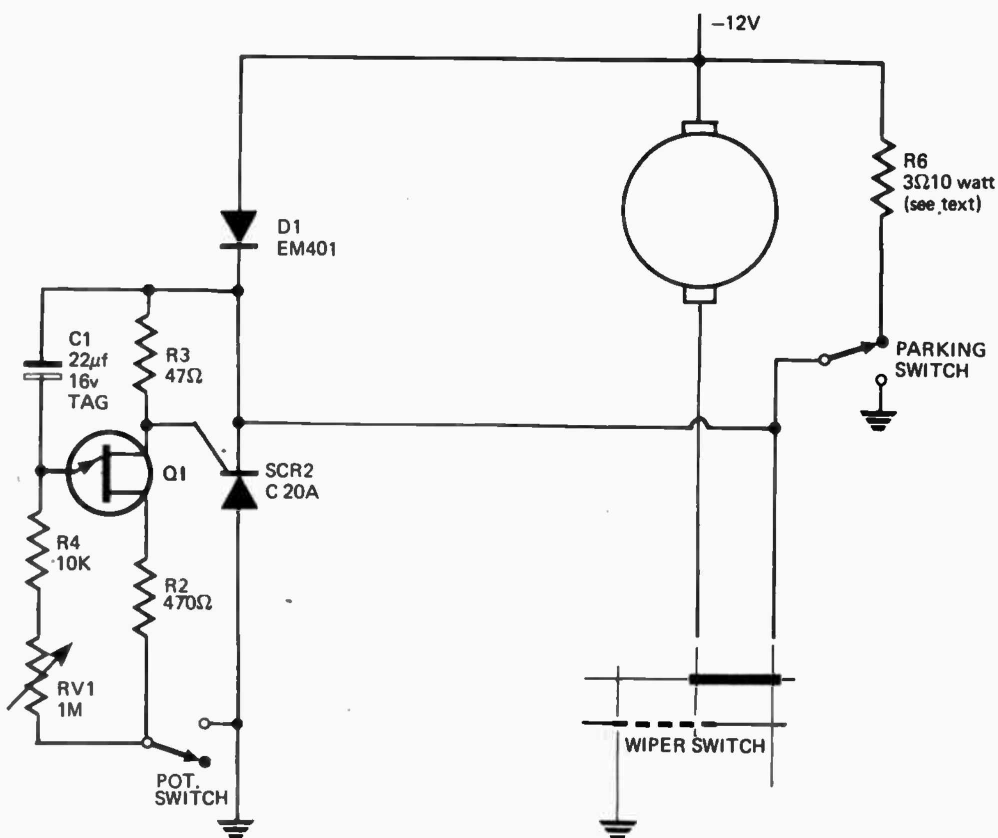


Fig. 7. Positive earth.

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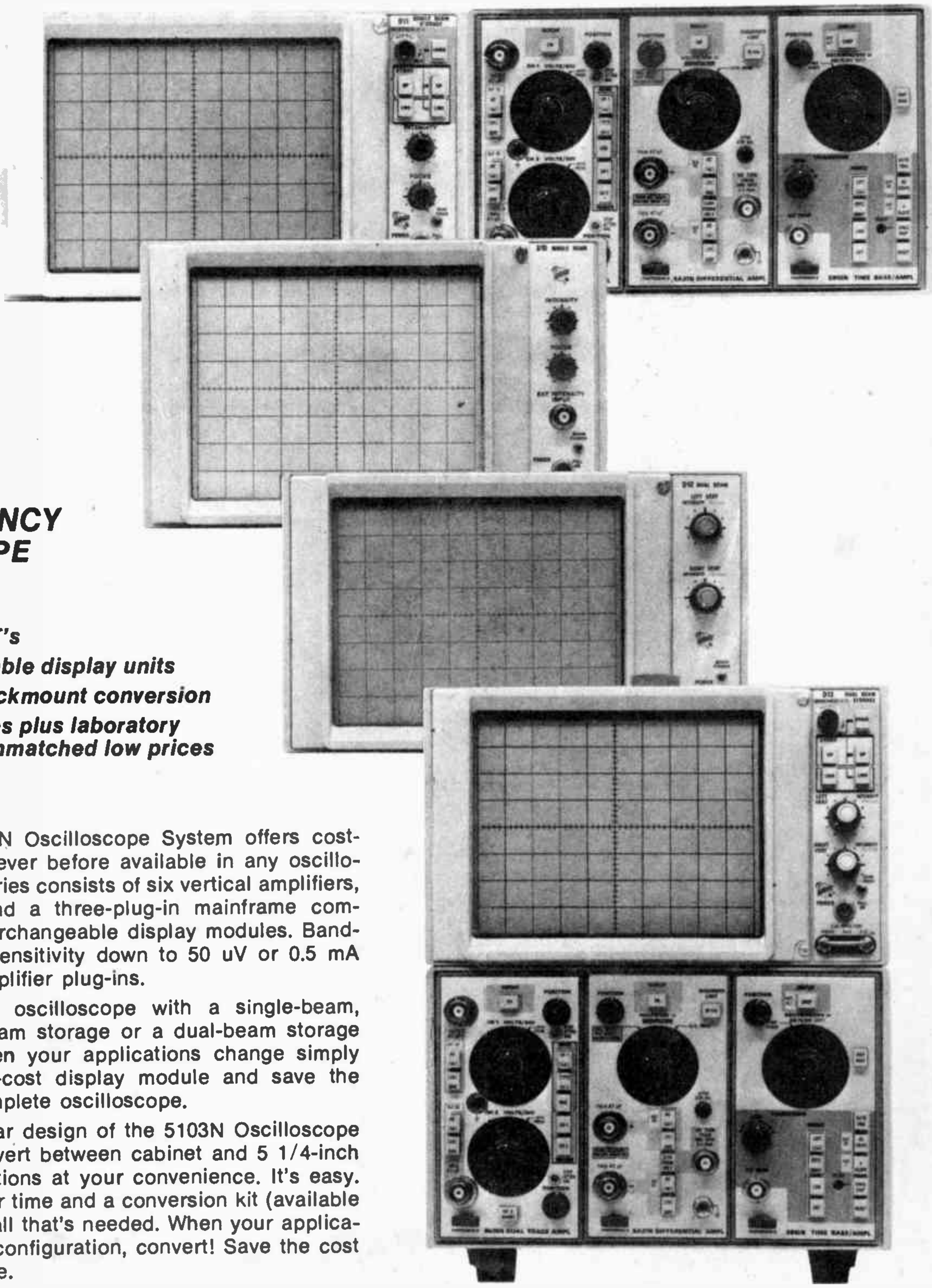

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By M. J. J. LONG
Manager, N.S.W. Time-Sharing
Information Systems Division
Honeywell Pty. Ltd.

Computer Time-Sharing

COMPUTER time-sharing is a relatively new form of computer usage in which time on a computer is shared between several users simultaneously rather than being devoted to one user at a time.

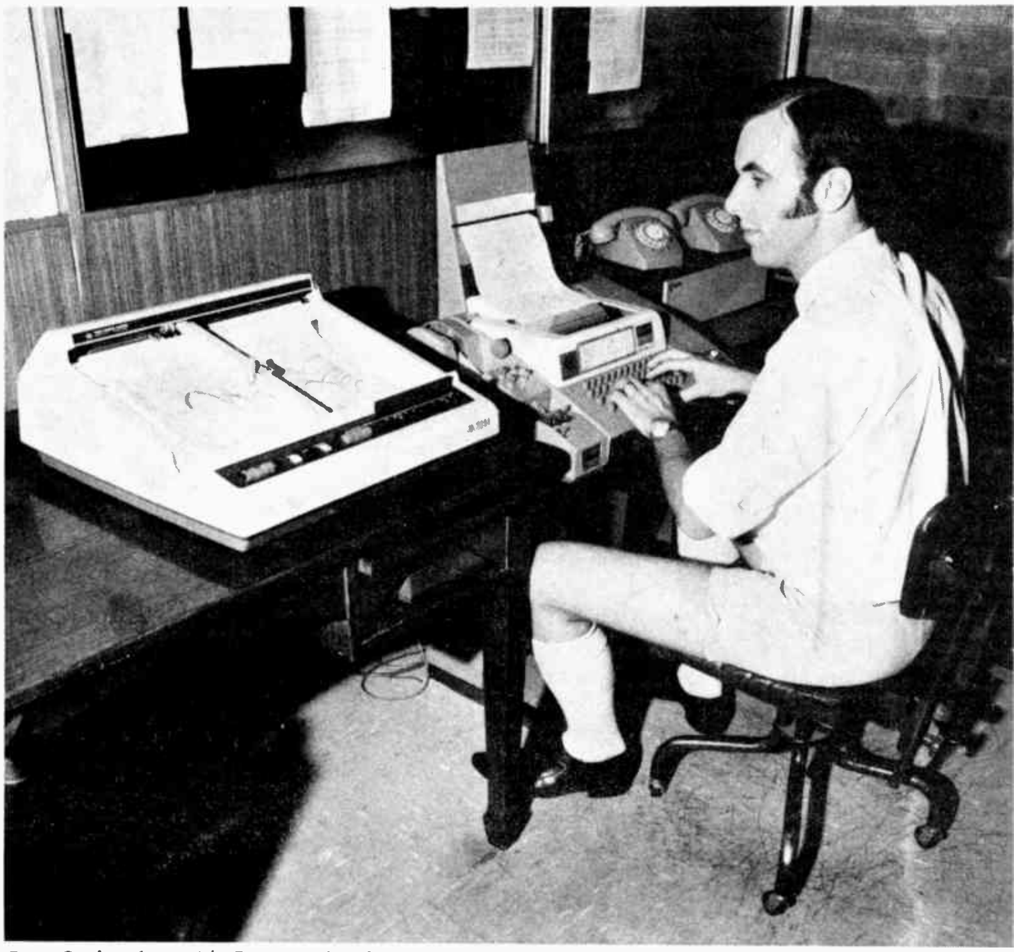
The advantages of this system are apparent if one examines the limitations of conventional computer usage.

First (and obvious) limitation is one of cost — not everyone can afford their own computer, especially one with the sophisticated facilities required to tackle complex engineering and mathematical problems in a manageable way. Nor is it always convenient to buy time on someone else's machine at a centre that may be miles away. By contrast, time-sharing, in its commercial form, makes it possible for an individual to buy computer time as he needs it. In his office he has a low-cost teletypewriter which is connected to an ordinary telephone line via a modem (a modulator/demodulator unit which converts data into a form acceptable to telephone systems). When he wants to use the computer, he dials its telephone number and proceeds to identify himself and outline his problem on the teletype terminal.

He gets back his answers almost immediately, as though the computer was his and his alone. Yet his financial commitment is but a fraction of that associated with computer ownership, in terms of both time and amount. Typically, it would cost around $100 per month to have these facilities in his office.

The second major limitation devolves around the human element. One must never lose sight of the fact that the computer has no intelligence of its own and needs to be told exactly how to solve a problem before it can proceed to solve it. This process of instruction, known as programming, typically involves, with a conventional computer, a fair amount of training and professionalism. Hence this function of programming has become a profession in itself.

This is not particularly satisfactory, because the person with the scientific problem is more often than not a professional



Don Craig of AWA's Engineering Products Division uses computer terminal and HP 7200A Graphic Plotter to determine polar response of loudspeaker columns.

Computer time-sharing provides the individual user with the sophisticated facilities required to solve complex engineering or mathematical problems. This article discusses the system's advantages and limitations.

Computer Time-Sharing

Computer terminal of Australian Aerial Mapping compares digital coordinates of scanned territory with known reference data to relate photographed stereo pairs with earth's surface.

himself – e.g., an electronic engineer. If the latter has to use a programmer to define the method of solution to the computer, several inefficiencies begin to make their presence felt.

The biggest is the communication problem – the programmer may well be unfamiliar with the terminology of the engineer. The second major one is time – instead of being able to think fairly directly in terms of computer solution of his problem, the engineer defines this in conventional terms, and the programmer then has to effectively translate this; the process tends to be, overall, much more time-consuming.

Computer time-sharing, on the other hand, considerably shortens the training period and relieves programming of many of the intricacies hitherto associated with it. In Australia, Honeywell alone has trained some 3000 people to use the computer; it generally takes two to three days to learn to write one's own programmes. *(The experiences of two persons who attended one of these courses with no prior computer training are described in a separate report following this article. – Editor.)*

The achievement of this reduction in training time from weeks to days reflects two characteristics of Honeywell time-sharing systems. One is that the user need have no knowledge whatsoever of how the system organises itself and does its tasks. The second is that the system has built into it the ability to conversationally interact with the user, and to recognise errors and ambiguities in the way he defines the steps necessary to solve his problem. The capability does not, of course, apply to errors such as mis-stating a formula, or misquoting a constant, but rather to what one might call grammatical errors. This means that a user can get going with only a short period of formal training – thereafter he learns as he uses the system.

Last major limitation lies in the nature of the sort of problem that can be usefully handled by the conventional computer. Many problems are just not susceptible to sausage-machine solution, i.e., data in – answers out. At an intermediate stage between definition and solution, the human being is called upon to make a decision which might be quantitative, qualitative, aesthetic, or even intuitive. For example, an electronic engineer, in designing a circuit, may have to make some decisions about component tolerances – is the narrowing of production spreads that would be achieved worth the additional cost?

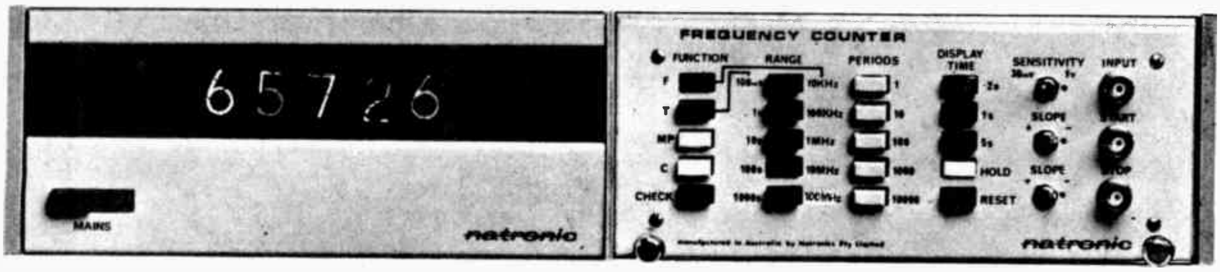
In order to run a conventional computer efficiently, it has to be kept fed with a queue of work. This often means that the user has to wait for his results. So, in the sort of situation outlined above, it would be very disruptive of the continuity of the solution of his problem if the electronic engineer had to wait ten hours or so between computer runs. Yet, if the computer were to stop to await his decisions, this would be very costly and inefficient – it would be like stopping a car production line to let a buyer decide whether he wanted a blue car or a white one.

This is where the ability of the time-sharing system to provide computing power to a user's terminal that is both instantaneous and capable of conversational interaction with the user really comes into its own. This is reinforced by the availability of over 1500 applications programmes in the system libraries, which very frequently enable the user to solve his problem without having to write a special programme for the job.

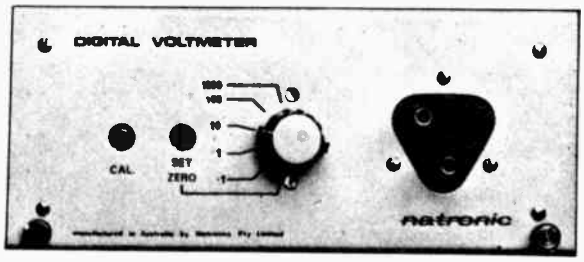
To sum up the comparison between the two types of system, the conventional computer is still the best and most economical solution for handling large scale data processing, and for problems large enough to demand the computer's undivided attention. Time-sharing terminals are inherently unsuited to handling large volumes of input and output information – they are relatively slow-speed devices. On the other hand, time-sharing is admirably suited to the analytical problem – particularly where time is vital, or where some conversational interaction with the user is helpful; it has done a great deal to bring computer power to the man with the problem, and to break down the notion that computers are mystical devices, and that mystical powers are required to use them successfully.

Having established, I hope, the concept of time-sharing, and where it stands in relation to other forms of computer use, let us

TWO FOR THE PRICE OF ONE



Frequency counter plug-in module type 5040 and basic main frame type 501



DVM plug-in module type 50410

Modular construction enables the Natronic 500 series of digital instruments to be used for accurate and repeatable measurement of a large number of variables. The instruments are constructed as a basic main frame with interchangeable plug-in modules.

Frequency counter plug-in module type 5040 and basic main frame type 501 combine to form a 100MHz frequency counter with facilities for period timing and event counting.

DVM plug-in module type 50410 and basic main frame type 501 combine to form a highly accurate integrating digital voltmeter. Principal features of the instrument include excellent zero stability, 0.02% accuracy maintained over a wide temperature range and good rejection of common and series mode interference.

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IRH — THE EQUIPMENT DIVISION OF IRH INDUSTRIES LIMITED now look at the system from the user's viewpoint.

USING THE SYSTEM

When he wishes to use the system, he dials the appropriate Sydney or Melbourne number on the ordinary telephone to which his terminal is connected. A recorded voice answers and tells him to press the data button, which switches the telephone line from the handset to the terminal. The time-sharing computer then establishes communications with the terminal and requests it to transmit its identity. This is the first item that appears on the user's printout (Fig.1).

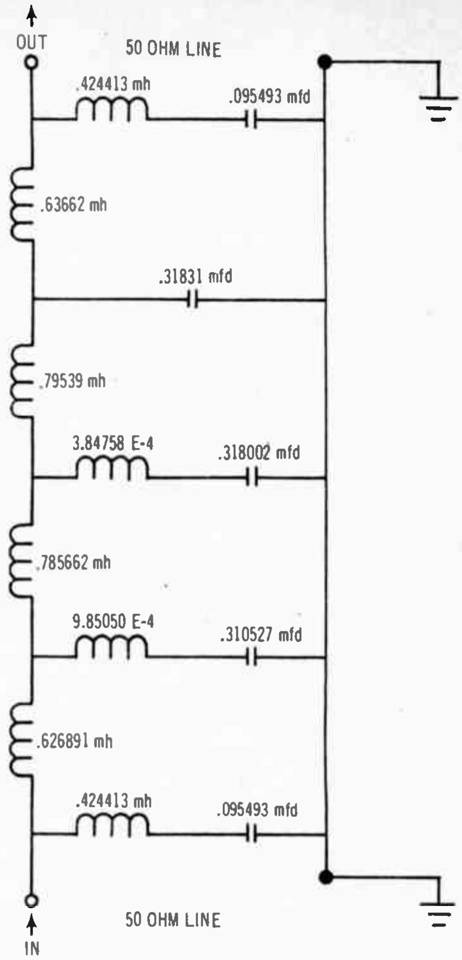
The system then announces itself and asks for the user's number, which it then checks against the terminal identity to establish whether a user is genuine or not. Obviously, in a system that may be used by organisations which are hotly competitive with one-another, security is important. So this means that Company A, in order to access the information associated with Company B's user number, must not only know the number but must also use the same terminal.

Once the system is satisfied the user is genuine, it replies with the user's name (if it is not satisfied, the system will cut off the terminal at this point). It then asks for the 'PROJECT-ID'; it maintains on behalf of the user, at his option, a monthly job cost system, and so it has to know the job cost heading to which the user wishes the costs of the current session allocated. The computer next asks what system he wishes to use – i.e., in what language he wants to define the solution of his problem.

The meaning of the term 'language' in this context deserves explanation. Computers 'think' in a language which is peculiar to a given make and model, and which is usually coded in binary, octal, or hexadecimal.

While an interesting subject for study in itself, machine languages are very remote from the way in which a human being thinks about his problem. So a number of languages intermediate between machine language and human expression have evolved. Each language consists of a set of modes of expression that the computer has been programmed to recognise, plus grammatical rules which have been defined to avoid ambiguities of interpretation. The languages vary enormously, as they reflect different aims and also different systems design philosophies.

Some of these languages are




```
SYD  0108


HONEYWELL GE-265 T/S SYD

ON AT  15:58   MONDAY 22/3/71     TTY 45

USER NUMBER--Z17561
    MARTIN LONG  .

PROJECT ID---DEPT 10 JOB 22
SYSTEM--BASIC
NEW OR OLD--NEW
NEW FILE NAME--TRIANG
READY.

10 PRINT"PLEASE TYPE IN LENGTH OF SIDES A AND B",
20 INPUT A,B
30 LET C=SQR(A↑2+B↑2)
40 PRINT "HYPOTENUSE=";C
RUN


TRIANG    16:01   MONDAY 22/3/71

PLEASE TYPE IN LENGTH OF SIDES A AND B        ? 3,4
HYPOTENUSE= 5


USED      2.50 UNITS.
```

FIG 1. A simple Time-Sharing programme to calculate the hypotenuse of a right-angled triangle. (user-typed information underlined).

```
OLD LPFILT***

READY.

10 DATA 50,20000,2,455000,91000
RUN


LPFILT     16:03    MONDAY 22/3/71

DESIGN FOR DESIRED LOW PASS FILTER:

0<-------------- 50            OHM LINE          -------------->0
I                                                               I
+-------- .424413 MH +          .095493        MFD -----------+
I                                                               I
>                .63662         MH                              I
I                                                               I
+-------------- .31831          MFD  -----------------------+
I                                                               I
>                .79539         MH                              I
I                                                               I
+-------- 3.84758E-04    MH +   .318002        MFD -----------+
I                                                               I
>                .785662        MH                              I
I                                                               I
+-------- 9.85050E-03    MH +   .310527        MFD -----------+
I                                                               I
>                .626891        MH                              I
I                                                               I
+-------- .424413 MH +          .095493        MFD -----------+
I                                                               I
0<-------------- 50            OHM LINE          -------------->0

TERMINATING SECTIONS GIVE MAXIMUM ATTENUATION AT 25000
CPS IN ADDITION TO THE SPECIFIED ATTENUATOR FREQUENCIES.


USED     4.00 UNITS.
```

FIG 2. Low-pass filter design (user entries underlined).

Computer Time-Sharing

very close to conventional human notation or phraseology, and also are capable of bridging the gap between different makes and models of computer. These are termed high-level languages and have several advantages: most are much easier to learn than low-level languages, and lead to a great improvement in the speed with which a person can define the solution of his problem to the computer. Also, they enable programmes written for one computer to be run on one of completely different type and make.

Three such languages are available on Honeywell time-sharing systems — BASIC, FORTRAN, and ALGOL — in addition to other, special-purpose languages. BASIC was developed in a university environment. It is very suitable for mathematical and algebraic problems and can be learnt in a few hours.

Returning to Fig.1, the user specifies that he wants to use BASIC in response to the computer's request 'SYSTEM--'. It next asks him 'NEW OR OLD--', meaning whether he wants to create a new programme or to call on one already stored in the computer. In this case he wants to write a new programme, so he replies 'NEW'.

Next step is for the computer to ask him for a name by which the programme may be referenced in future — he replies (for example) 'TRIANG'. Having searched the user's private library of programmes to ensure that this file name has not been allocated previously, the computer replies 'READY'.

Fig.1 is a typical example of a simple programme. It defines the calculation of the hypotenuse of a right-angled triangle, given the other two sides. The numbers to the left of the text provide a means of referencing and sequencing the user's instructions, to cope with the situation where he wants to make a later alteration or addition to his list of instructions without having to retype his programme in its entirety.

'PRINT' means what it says. 'INPUT' is one of the ways of getting variable data into the computer. When it strikes this, the computer prints a question mark and awaits entry of the data by the user. The conventional symbol for multiplication can cause confusion, so an asterisk is used. Some special symbols are tedious to type, as is exponentiation, so SQR is used in place of the square root symbol, and an up-arrow indicates 'raise to the power of'. The hypotenuse is termed C in the formula, while the other two sides are incorporated as A and B.

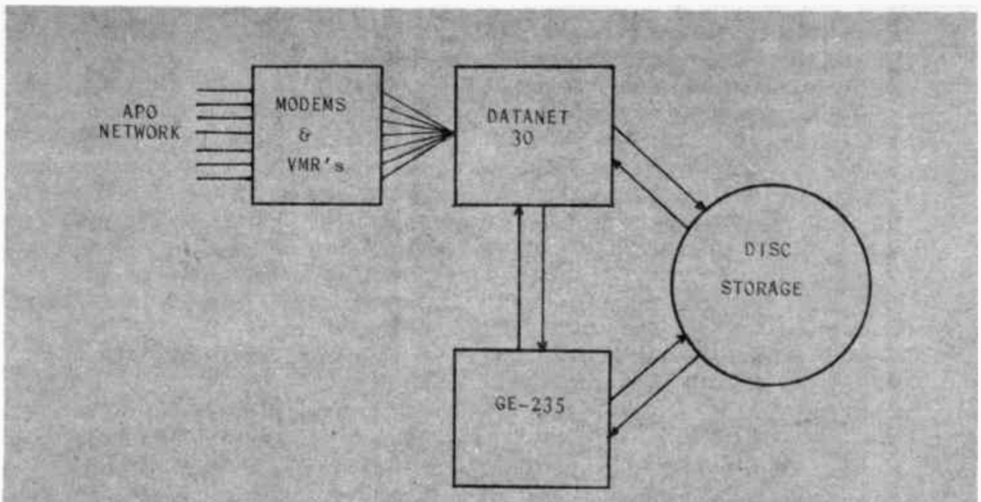
After defining the steps necessary to solve his problem, the user types 'RUN'. This tells the computer to translate the list of instructions into its own language, and then to execute the resultant machine code. It would tell the user at this stage if there was anything it failed to recognise, or if it detected any breaches of BASIC grammatical rules.

The computer goes on to print out the date and time, stops (after the question mark) to await entry of the lengths of the two sides, and then prints the answer; finally it prints out the computer usage involved in the run.

BASIC includes many other 'verbs' for handling logic decision-making, iterative procedures, matrix algebra operations, and the handling of large amounts of data.

Mention has been made of the availability of library programmes. In Fig.2, the user calls up a programme from the system public library to design an 'L' section low pass filter (OLD LPFILT***).

Following instructions contained in the documentation for the programme, he enters on line 10, preceded by the word 'DATA', the desired characteristic impedance in ohms (50), the cut-off frequency in hertz (20,000), the number of attenuators in the stop band (2), and their respective frequencies (455 and 92 kilohertz). He types 'RUN', and the computer produces a schematic of the filter with appropriate component values (top is line-out, bottom is line-in).



GE 265 schematic layout.

HOW SYSTEM WORKS

Let us now take a brief look at the way a typical time-sharing system is organised.

Fig.3 shows a chart of the GE-265 system. At Honeywell's time-sharing centres in Sydney and Melbourne, lines from the APO dial-up network are terminated at a modem rack equipped with automatic voice answerback facilities. On the other side of the modems, these lines are connected to the Datanet 30 communications computer, which, apart from handling the information flow on the lines, is also the executive computer of the system. Under its control it has a GE-235 computer to handle actual computation, and disc storage on which to file information. The Datanet 30 and GE-235 can communicate directly with one-another, and each computer has access to disc storage.

The Datanet 30 can handle 40 users simultaneously — and as each user feeds in information, it accumulates this on disc.

Time on the GE-235, which is only required when a programme is actually run, is achieved by allocating users short bursts of time in rotation.

The Datanet 30 is responsible for maintaining the list of active GE-235 tasks. So, when a user types 'RUN', his task is entered in this list; when, after a number of these bursts of time, his job is complete, the Datanet removes the task from its list. In between bursts, a snapshot of the state of completion of the task is captured on disc storage so that, when a task's 'turn' comes round again, the GE-235 can pick up where it left off on the previous burst. Similarly, the GE-235 puts any output generated during the burst onto disc, whence it is transmitted to line by the Datanet, back to the user's terminal.

The Datanet 30 also performs the very considerable amount of cataloguing of the user's own files and of the system libraries.

Next, let us turn to the question of who uses time-sharing, and what they use it for.

TYPICAL CUSTOMERS

Since its introduction to Australia in 1968 by Australian General Electric (whose computer business is now merged with that of Honeywell), time-sharing has met with an enthusiastic reception.

The diversity of user organisations and their applications makes classification very difficult. User organisations range from the very large to the very small. Time-sharing is intrinsically better suited to the analytical problem rather than to data processing. This is reflected in the major applications in the Honeywell time-sharing system libraries: these are Engineering Design, Surveying, Mathematics, Statistics, Operations Research, and Finance. Hence user organisations tend to be companies with a sizable volume of such work.

Amalgamated Wireless (Australasia) Pty. Ltd. are a good example of this. They have been users of time-sharing since its inception here, in March 1968. Initially they relied fairly heavily on library packages — but, after gaining experience on the system, they began to write their own; currently they use time-sharing for the optimisation of circuit design, using advanced iterative techniques and analysis of the effects of component tolerances. They have also recently acquired an HP7200A digital plotter, which is connected to the time-sharing system to plot design results; this means of obtaining a graphic picture, rather than just sets of figures, has proved to be of immense value in optimising circuit values. The system is also used to optimise logic for a sophisticated automatic test bed, and to produce its control tapes.

Australian Aerial Mapping, photogrammetric engineers and mapmakers, have also been with time-sharing since its introduction to Australia. They have found time-sharing to be a very effective solution to the problems of processing large amounts of data derived from ground and aerial surveys.

A major part of their work involves the production of detailed contour maps from aerial photographs. Precision distortion-free cameras are used to produce stereo pairs in an overlapping grid pattern covering the area to be mapped. These pairs are then viewed in a stereo photogrammetric machine to produce digital coordinate data. In order to relate the pairs to the earth's surface, the digital coordinate data is manipulated on the time-sharing system to join the pairs into a composite mathematical model. Then the composite must be adjusted by a series of highly complex mathematical procedures to procure alignment with control points previously established by ground survey. The operator next sets these adjustments up on the stereo photogrammetric machine; by viewing the stereo image he is able to follow a given contour — and as he does this, the instrument draws the contour map on an attached mapping table.

These profiles of two typical time-sharing users will help to explain why time-sharing is one of the fastest-growing fields of computer usage — its ability rapidly and easily to bring the capabilities of a powerful computer to bear on the problem, with no capital investment and a minimal commitment, is of obvious value in numerous applications.

Time-sharing promises to maintain its growth rate for two main reasons. First, the price/performance ratio tends to improve with the size of the computer. Secondly, telecommunications are inextricably linked with time-sharing, and recent developments in this field tend to open up a whole range of new possibilities.

For instance, Honeywell time-sharing in the U.K. has a satellite link to some of the giant G.E. systems which span North America. Thus a company with offices in London, New York and across the United States can use the one centralised information base that is always up-to-date, and always accessible for reference and alteration by any of the branch offices.

Datanet 30 computer controls operations of time-sharing system.

OUR 'STUDENTS' REPORT

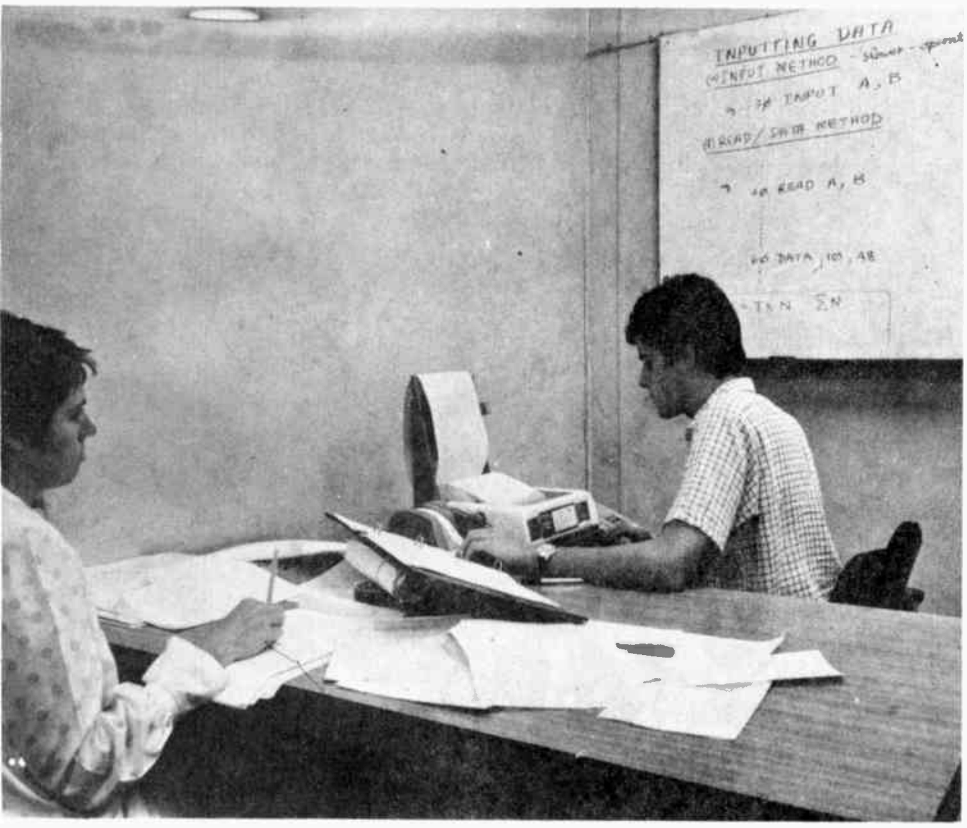
GIGO is a four-letter word.

It is an acronym emphasising that ultimately a computer is dependent upon the skill of its programmers. It stands for 'Garbage In — Garbage Out' and is known throughout the computer industry.

The growing acceptance of computer time-sharing has created the need for a whole new type of programmers — people who, as part of their normal jobs, are capable of writing simple programmes.

Time-sharing salesmen emphasize

Computer Time-Sharing



Electronic Today's staff learn BASIC programming at Honeywell's school in Sydney.

that the necessary skill can be learned in a few days, yet we know that a few potential users have reservations about these claims.

To obtain first-hand experience, we sent two of our staff to the Honeywell School for a three-day course in BASIC (Beginners All Purpose Symbolic Instruction Code).

Our pupils were:

Jan Vernon — Behavioural Science degree, two years' statistics.

Kim Ryrie — educated to Leaving Certificate standard including level 2 maths.

On completion of the course we tape-recorded their comments. This is how it went.

EDITOR: Jan — I believe you had a few initial problems. Did the course assume any particular prior knowledge?

JAN: I think one would need 2S maths; you need to be in practice, too. I wasted time trying to remember elementary things like the difference between those 'greater than' and 'less than' signs.

ED: How about you, Kim?

KIM: No particular problems, although I agree with Jan that you need at least level 2 maths.

ED: Jan, this is one for your specialised knowledge. Do you feel that any particular aptitude is necessary?

JAN: I think you need to be a very careful and methodical person — the computer doesn't look at your programme and think 'poor dear, she probably meant 6B, not B6' — it just coldly types out 'incorrect variable line 20'.

As far as aptitude is concerned, of course some of the commercial programming schools have aptitude tests. They test an eye for detail and the ability to see certain relationships. I'm certain you need an average to high I.Q. — you have to be reasonably bright to know what you're doing, to work out the problems we encountered during the course. As far as simple programming is concerned, I'm sure my ten-year-old daughter could be taught how to use the computer to do her arithmetic homework.

ED: How about some knowledge of how a computer works — would this be any advantage, Kim?

KIM: Not really. The basic principles were covered in the introductory part of the course — not the mechanics or electronics of the system, just general information about how data is stored and retrieved.

ED: During the course you both commented about the lack of a suitable textbook — would it have helped, had one been available?

JAN: Yes — I'd have liked a textbook to study at night during the course.

KIM: Yes — one needs a book containing examples of programmes — worked problems, etc.

ED: What sort of pace was set by the instructor — was three days sufficient to cover the syllabus?

JAN: We moved at a very brisk pace — I thought it was well organised. We were issued with notes and problems, and there was a good balance of instruction and practical work. I felt we crowded a lot into the three days — I would have been happier with a five-day course. But it was emphasized that Honeywell don't just turn you out into the cold after three days — you can always obtain help and advice.

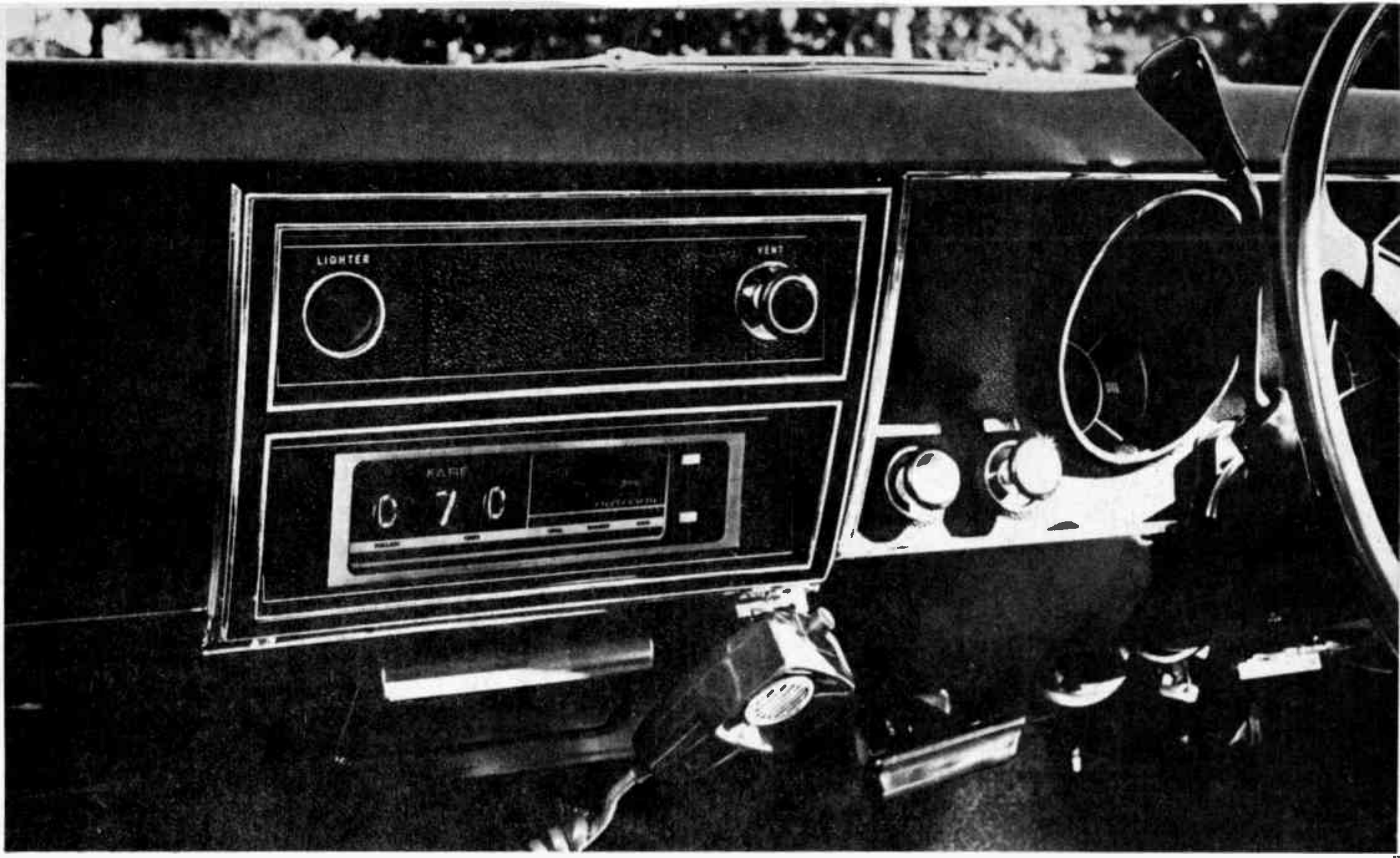
KIM: I would have liked a further day or two.

ED: Now for the big question. After three days, could you operate a terminal and prepare simple programmes?

JAN: Oh yes, I think so. Once again, though, a textbook with lots of worked examples and flow charts would be helpful, and I think I'd be on the phone to Honeywell saying 'help!' for a short time. But it's mainly a case of getting used to computer thinking, breaking a problem down to its logical steps and learning to be meticulous about things like commas and brackets.

KIM: I think I could prepare simple programmes.

(Honeywell have since informed us that a suitable textbook is now available. This is 'Basic Programming', by Kemeny and Kurtz). ●



Electronic taximeter is located in car radio aperture.

SOLID-STATE

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 20 cents in $2.00?

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. In N.S.W. these rates are $2.60 an hour and 21 cents a mile. The taximeters monitors both time and distance and automatically totals that rate which will produce the higher revenue at any given moment.

In the case of the fares quoted, the taximeter must change from distance to time when speed falls below 12.38 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 12.38 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 mechanical dog-clutch connects the fare-totalling mechanism to the clock mechanism at speeds below 12.38 mph and to the distance mechanism when this speed is exceeded.

Every time this happens the taxidriver loses 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.

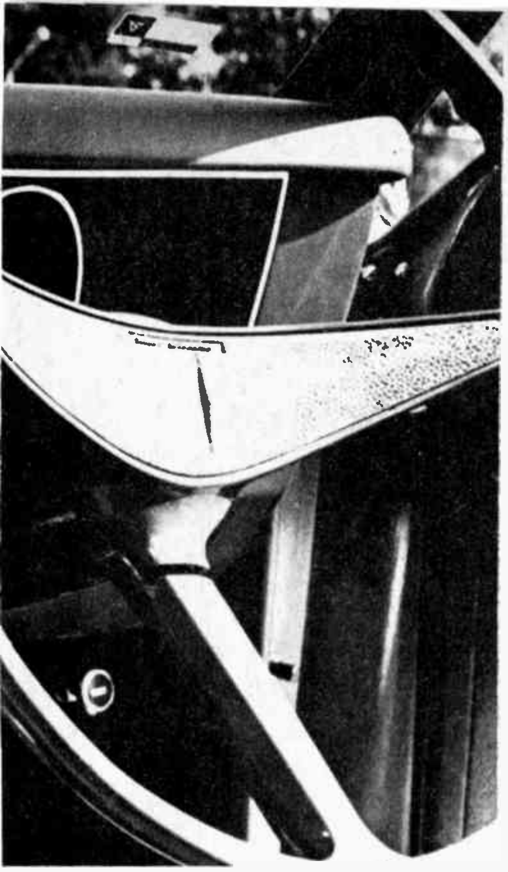
DOLLAR-A-SHIFT LOSS

Four seconds' lost revenue may not seem very much, but the average city-based cab accelerates and decelerates through the change-over point of 12.38 mph over 400 times during each shift. Four seconds multiplied by 400 is the equivalent of a dollar or so in lost income, every few hours.

At the industry's average of 13 shifts a week, the dollars mount 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



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

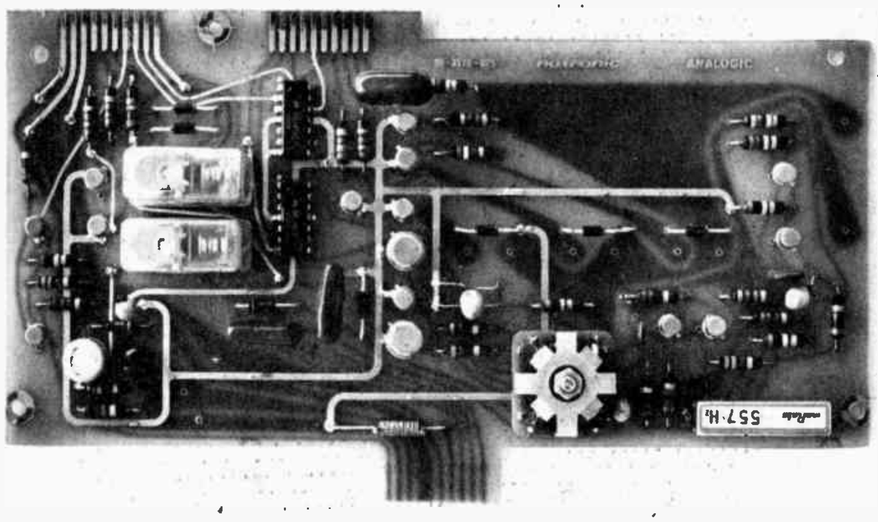
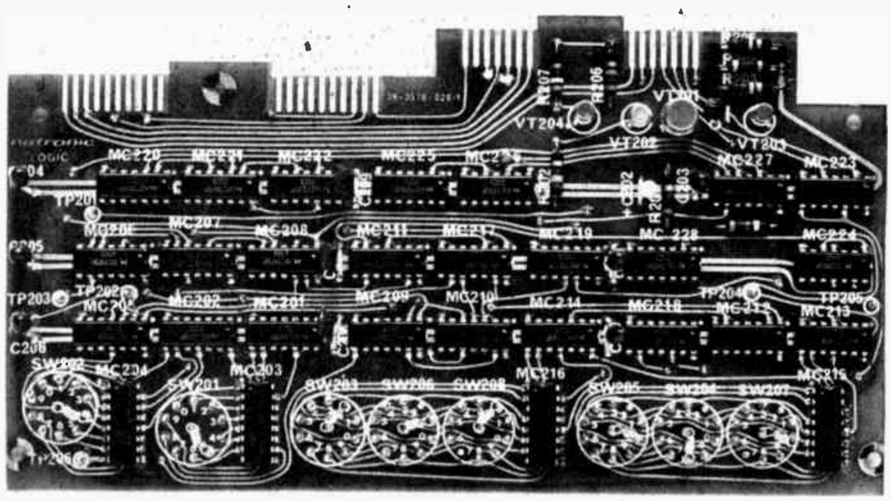


FIG. 1 ABOVE: Analogic board holds Murata piezo-electric tuning fork, relays (left), switch illuminated roof signs. FIG. 2 BELOW: Decade switches on logic board facilitates changing time, distance and flag fall rates.



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:

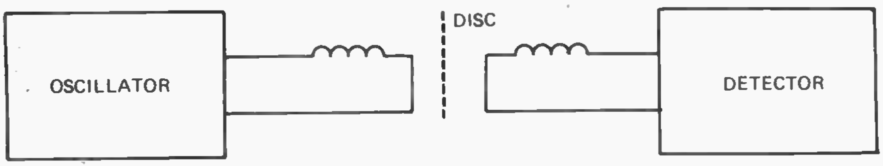
1. Distance transducer and divider stage.
2. Master oscillator and divider stages.
3. Multiple pulse generator and control gating.
4. Decade counter and display stage.
5. Control counter and gates.

Distance transducer and calibration divider

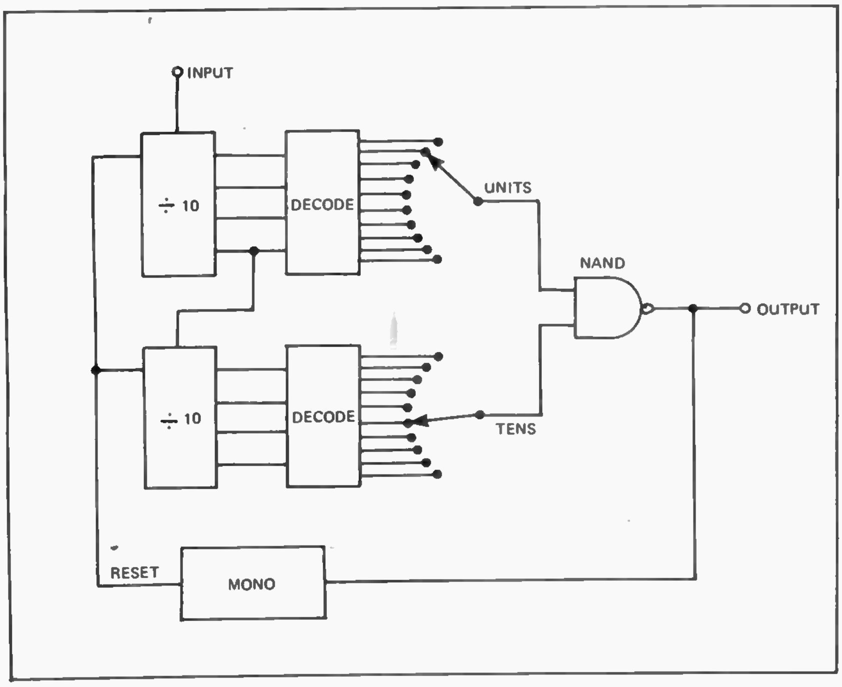
The distance transducer is fitted to the vehicle gearbox between the speedo cable and its housing. An oscillator in the transducer generates an electromagnetic field at a frequency of 7.5MHz in a ferrite-cored coil. This field is sampled by a similar ferrite-cored coil and detector stage. A slotted brass 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.

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

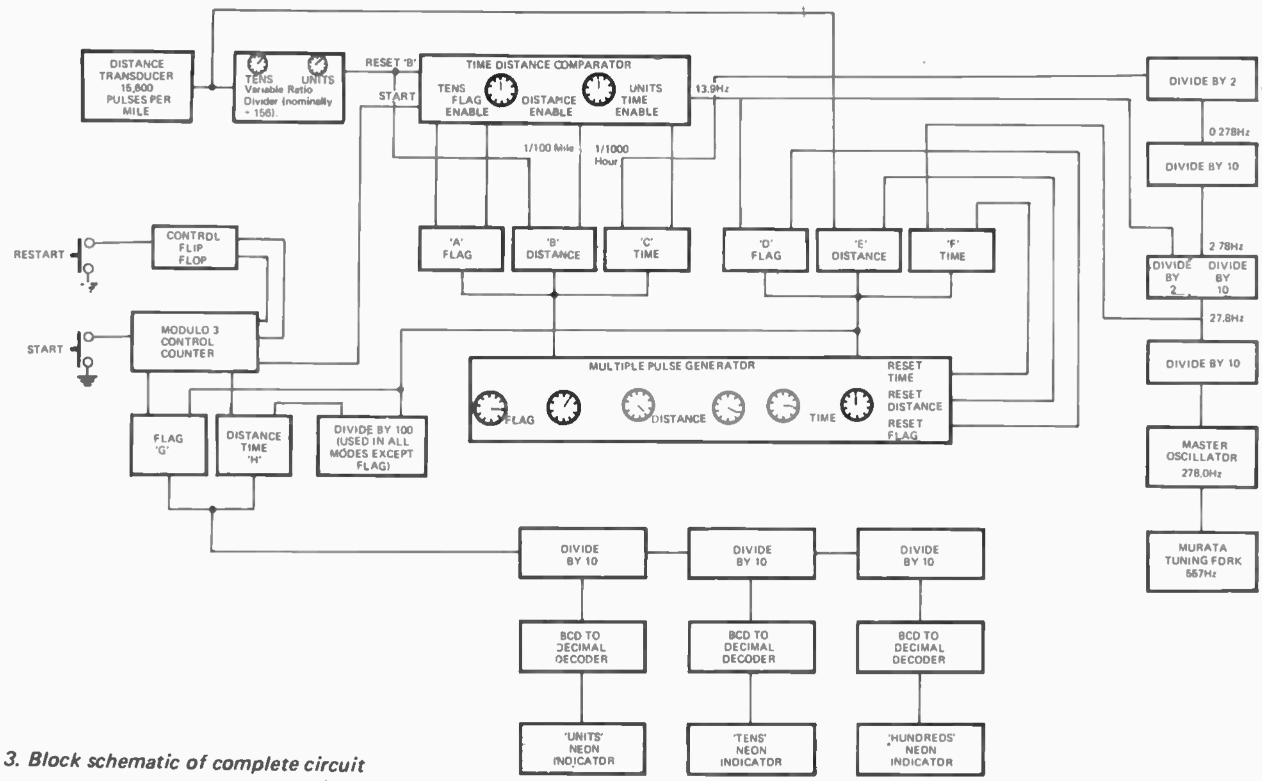


Fig 3. Block schematic of complete circuit

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.

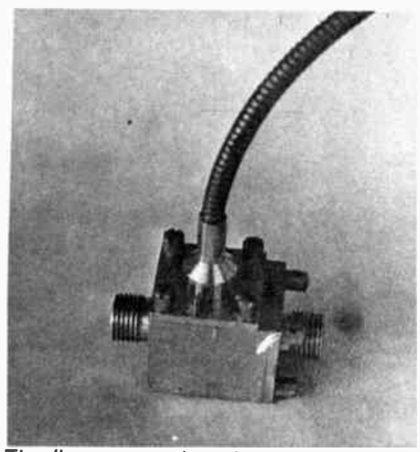
In addition to the indicator tube display there are three mechanical counters, displaying respectively 'total miles', 'engaged miles' and total cents'. These counters are non-resettable and provide a built-in tamper-proof method of counting.

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.

EMERGENCY FLASHER

Ultra-brilliant flasher unit for your car, boat or plane could save yor life in an emergency. Simple to build, uses little power.

Like the crash padding in your car, an emergency flasher is something one needs rarely. But when the emergency does arise, it can save your life.

If you motor in the outback, sail offshore or fly cross-country, this unit is for you. The unit produces flashes of light at 1–2 second intervals. The flashes are so intensely bright that during darkness they are clearly visible five to ten miles away.

The flashes are produced by a high-powered xenon photo-flash tube – the same type that professional photographers use in their electronic flash guns. The xenon photo-flash tube is energised at 1–2 second intervals by an electronic triggering circuit which derives its energy from any 12 volt battery or electrical system.

HOW FLASHER WORKS

The circuit is shown in Fig. 1. Power transistor Q1 and the low voltage windings of transformer T1 form an oscillator, the output from which is boosted by the high voltage winding of the transformer and rectified by silicon diode D1 to produce approx. 450 volts dc. Capacitor Cl is charged to this voltage, thus storing the energy required for the flash.

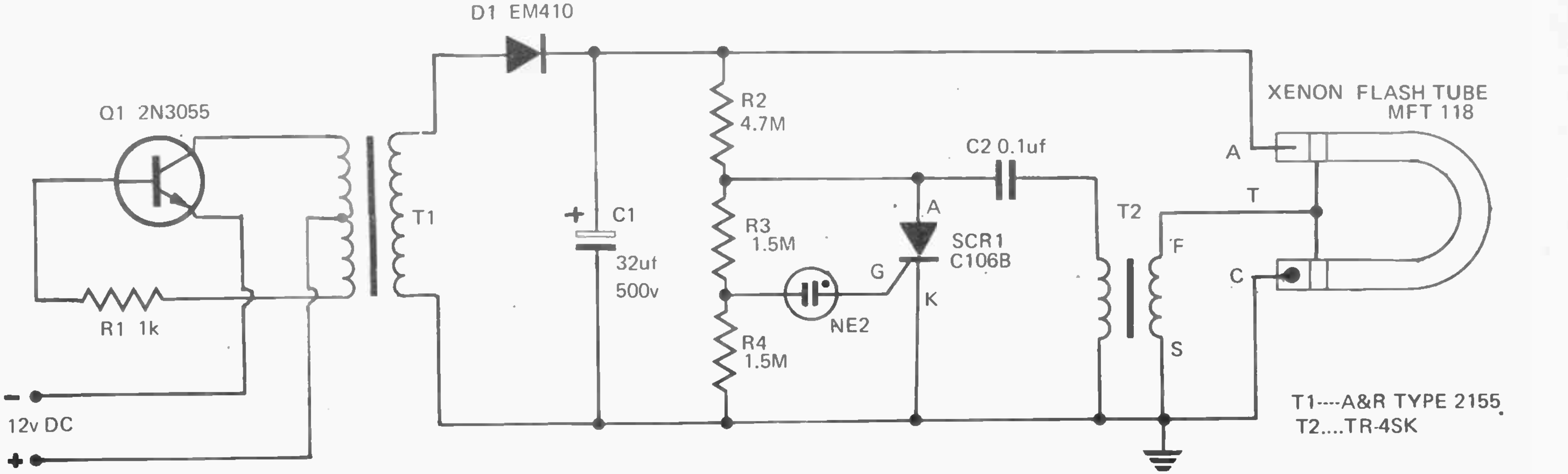
The xenon gas inside the photo-flash tube is normally an electrical insulator, but changes suddenly into an almost zero-resistance conductor when a high voltage pulse is applied to the trigger electrode. When this occurs, the electrical energy stored in Cl discharges almost instantaneously through the gas, producing an intense burst of light. The xenon gas then changes back to its insulating state, whilst capacitor Cl recharges.

The high voltage triggering pulse is produced by the action of silicon controlled rectifier SCR1 which periodically switches capacitor C2 across the primary winding of trigger transformer T2. This causes a 4000 volt pulse to be generated in the secondary winding of T2 which is connected to the flash tube's trigger electrode.

The silicon controlled rectifier SCR1 is switched into conduction by the neon bulb, which in turn is pulsed by the network of R2, R3, R4 and C2.

CONSTRUCTION

As with any equipment intended for emergency use, this unit should be soundly constructed – preferably in a waterproof steel or aluminium box. Our prototype unit utilised a die-cast aluminium box which, having cast-in gasket grooves, is ideally suited for this project.



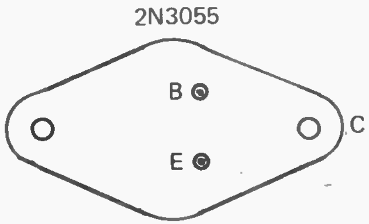
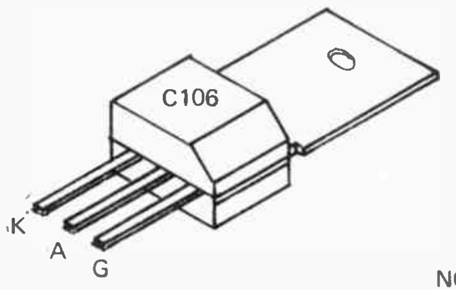
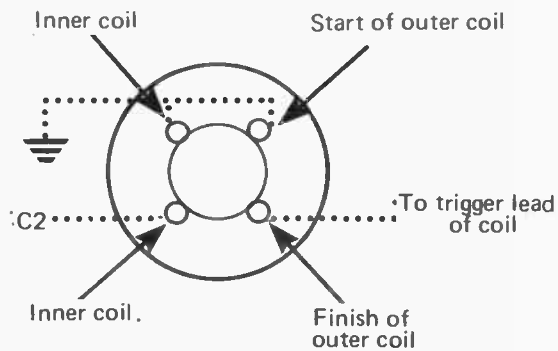


Fig. 1: Circuit of Emergency Flasher.





NOTE.

The trigger lead must be connected to the finish of the outer coil — 4KV pulse

EMERGENCY FLASHER PARTS LIST

R1	—	resistor 5% ½ watt 1K.
R2	—	resistor 5% ½ watt 4.7M.
R3	—	resistor 5% ½ watt 1.5M.
R4	—	resistor 5% ½ watt 1.5M.
C1	—	Capacitor (preferably computer grade) 32 μf 500 volt.
C2	—	Capacitor 0.1 μf 400 volt.
NE2	—	Neon indicator type NE2 or equivalent.
Q1	—	Transistor type 2N3055 or equivalent.
SCR1	—	SCR — type C106B.
D1	—	Silicon diode EM410 or equivalent (1000 volt).
T1	—	Filament transformer — secondary 0 — 6.3 — 12.6 volts or 0 — 7.5 — 15 volts at 1½ amps minimum — primary 0-240 volts, A & R type 2155 or similar.
T2	—	Trigger transformer Elevam type TR 4SK or equivalent.
Xenon	—	Xenon flash-tube Elevam type MFT118 or equivalent.
Sundries	—	1 multiway tag strip, 1 heat sink, insulating bushes and mica washer for transistor, 1 die-cast alloy box 4½" x 3½" x 2", 1 plastic or glass cover, sundry screws, washers, etc.

EMERGENCY FLASHER

The xenon flash tube projects through a hole cut in the top of the box. This hole should have ample clearance for the tube, and its edges should be padded with foam rubber to protect the tube against accidental damage.

A clear plastic moulding should be fitted over the hole. This is best held in position by an epoxy adhesive. Suitable plastic mouldings can be made from automobile, caravan or boat fittings, plastic containers cut down to size, etc.

The xenon flash tube and capacitor Cl should be mounted on the mains transformer T1 (Fig. 2.) If the transformer already has a tagboard, existing unused tags may be used for this purpose. (Note that it may be necessary to disconnect transformer tags terminating in these unused lugs; if this is done, ensure that continuity is maintained in the winding – see Fig. 3). Xenon flash tubes are electrically polarised – the cathode is the larger of the two electrodes and is marked with a C on the circuit diagram.

The complete transformer assembly is then bolted into position.

Power transistor Q1 should be mounted on a heatsink which is bent up from a piece of 16G or 18G aluminium approx. 1 13/16" wide by 4" long. The transistor must be insulated from the heatsink.

All remaining components are located on a tag strip, which in turn is fitted onto the heatsink (Fig. 4).

Finally complete all remaining connections. Connect the unit to a 12 volt dc supply, carefully observing the polarity shown on the circuit diagram.

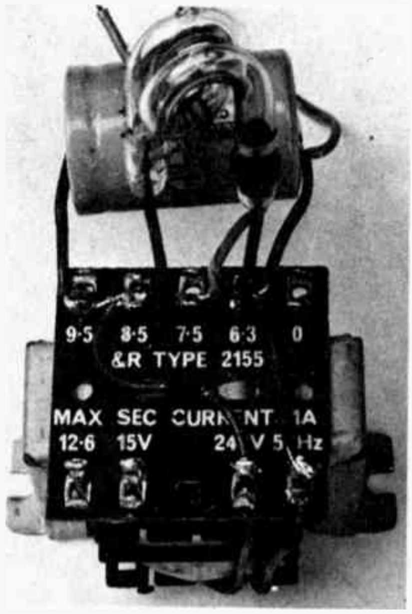


Fig. 2: Xenon flash tube and capacitor C1 mounted on mains transformer.

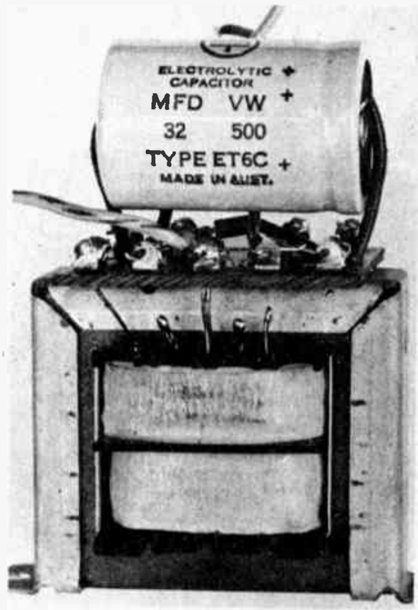


Fig. 3: Check that unused transformer tags are disconnected (maintain electrical continuity).

The unit should now flash at one- to two-second intervals. Try reversing the connection to the high voltage side of the transformer T1 and permanently connect leads for whichever polarity produces the faster flash rate.

Do not look directly at the flash at any time. The light level is very high and may cause permanent damage to the eyes. ●

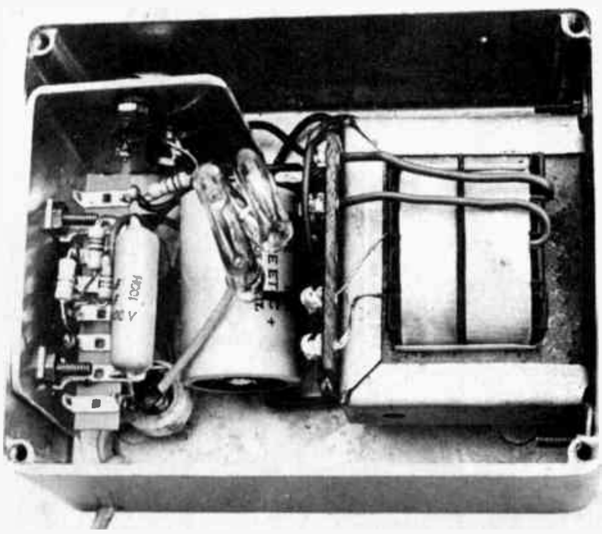


Fig. 4: All remaining components are mounted on tag strip located on transistor heat sink.

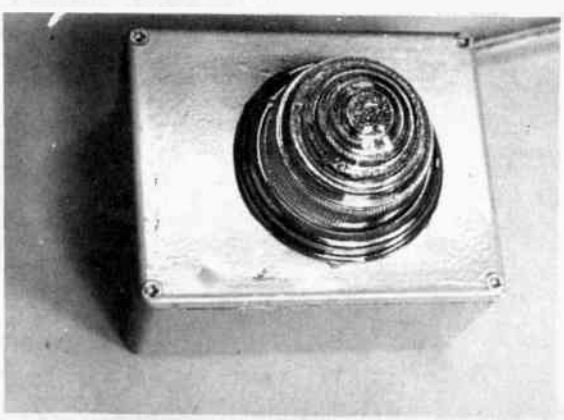
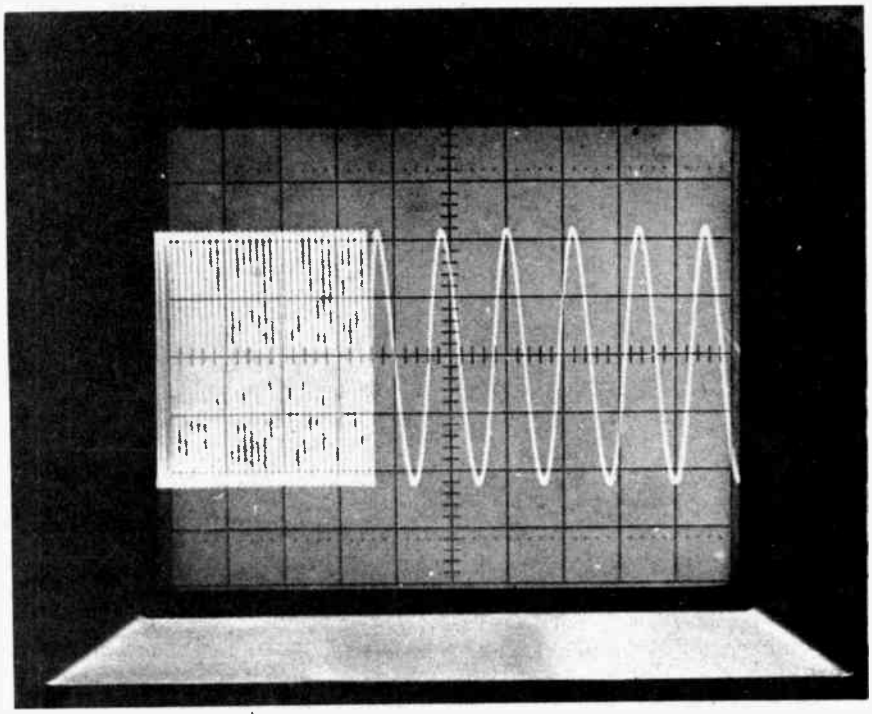


Fig. 5: Completed unit housed in alloy die-cast case.

Weight of evidence was overwhelmingly in favour of frequency modulation — now it's up to the politicians.

INQUIRY



THE Australian Broadcasting Control Board's 1971 inquiry into the desirability or otherwise of introducing frequency modulation broadcasting into Australia began in Sydney on March 1 and concluded in Adelaide on March 24. At the Sydney hearings, where most of the work was done, over 40 witnesses gave evidence during the five-day session.

THE WITNESSES

Those appearing before the Board represented a wide range of commercial, professional and private interests. The broadcasting industry was represented in Sydney by the ABC and Mr. D. Foster, of the Federation of Australian Commercial Broadcasters, (the PMG gave evidence at the Melbourne hearings).

Officials from AWA and the Australian Electronics Consumer Industry Association appeared on behalf of the manufacturing industry, while professional bodies with an interest in broadcasting included the Institute of Radio and Electronics Engineers – IREE (Aust). – the Institute of Engineers, and the Professional Radio Employees' Institute.

A feature of the inquiry was the strong representation from educational and cultural bodies with no vested interest in the present broadcast services. These included deputations from the Universities of Sydney and New England, the Workers' Educational Association, Musica Viva, and the NSW State Conservatorium of Music. There were in addition several valuable contributions from individuals. The most notable of these were from Mr. Ray Allsop – a prominent campaigner for FM and a former member of the Control Board – Mr. Harry Newton, who had flown direct from the U.S.A. to the inquiry to represent a group of 133 Australians at present resident in America and Mr. Bill Giorda, an American expert on educational radio.

SHORTCOMINGS OF PRESENT BROADCASTING SERVICES

There was substantial agreement among witnesses that broadcasting in Australia is in an unsatisfactory state, particularly in the country. Tape-recordings were submitted by several parties to the inquiry which demonstrated typical reception problems encountered by country listeners – such as sky-wave interference with consequent fading even of relatively strong signals; heterodyne 'whistles' due to interfering stations on nearby frequencies; static, both man-made and natural.

The value of broadcasts in the country was shown to be seriously compromised for all types of programmes, whether a symphony concert, pop music or TAB results. By comparison, audio signals (FM) from TV stations – even from transmitters more remote from the receiver than comparable AM radio stations – were shown to be remarkably free from interference of all sorts, and of higher quality as well.

In addition to the technical shortcomings of the medium frequency AM service, many witnesses expressed the opinion that the present 183 national and commercial stations (virtually the maximum possible without further severe lowering of standards) give inadequate service from the point of view of programme choice, even in the capital cities. Many objected that the ABC is, for all practical purposes, the only broadcasting authority prepared to devote time to minority interest programmes, including such essential services as schools, rural and children's programmes. With so many needs to cater for, the ABC is unable to serve any particular interest well, it was claimed.

GETTING FM OFF THE GROUND

It became clear early in the hearings that the Board was anxious to discuss the viability of FM in Australia in quantitative terms. Owing partly to the considerable difficulty of assembling facts and figures in this area and partly to the inability or unwillingness of many witnesses to present such data, much of the evidence submitted was qualitative and speculative – tendentious without being especially informative.

Many of the important broader questions – the cost of FM to the nation versus expected benefits to industry and to the people generally; the numbers of listeners likely to use the new services; anticipated rate of penetration of the new FM receivers into the market – these remain largely imponderable.

In this respect, perhaps the most significant contribution to the inquiry was the AWA submission – an extensive and impressive study of the technical and economic factors involved in developing and marketing transmitters and receivers for UHF-FM from the manufacturers' point of view.

Broadly speaking, the contentions of the AWA spokesmen (Messrs. Gabb, Dean, Penner and Craig) – supported by the other witnesses representing the manufacturing industry – were that the introduction of FM would greatly benefit the industry, and that it could be achieved at modest cost, both to broadcasters and to the public.

In order to encourage people to invest in FM receivers and use the new services, it was suggested that the Board might encourage the manufacture of dual-capacity (AM + FM) receivers, and that existing licencees of radio stations who wished to operate FM transmitters should be compelled from the start to broadcast different programmes from their two outlets.

The latter proposal was opposed by the Federation of Australian Commercial Broadcasters but supported by most of the other witnesses. As a further encouragement to rapid acceptance of the new medium, several witnesses also recommended that stereophonic transmisssions be introduced from the outset.

FAVOURS FM

UHF VS. VHF

There was some difference of opinion among the technical witnesses about the relative merits of broadcasting in the VHF (very high frequency) and the UHF (ultra-high frequency) areas of the broadcasting spectrum.

Since the decision made in the late 1950s to appropriate much of the 'international' VHF-FM radio broadcast band (90-108 MHz) for television use, there remains only a small amount of space for potential new services (e.g., 92-94 MHz). Any large-scale development would involve moving established TV stations – a solution naturally opposed by the proprietors of those stations affected, and likely to be very expensive. On the other hand, VHF-FM technology is well understood, and receivers/transmitters are immediately available (notably from Japan), whereas Australia would be pioneering UHF for radio broadcasting purposes (there is a certain amount of UHF TV broadcasting overseas).

AWA estimated that two years would be needed for the development of standards alone, which would put the introduction of new services at 3-4 years away at best. It seems at the moment that the UHF alternative is likely to be favoured by the Board – and will (at least initially) have the economic advantage of encouraging local manufacturers.

COLOUR TV?

Another imponderable factor in the submissions of technical and professional witnesses was the effect of the introduction of colour TV. Sir Robert Madgwick stated the ABC's present policy on priorities to be: first, the introduction of a second regional AM network (essentially the city '2nd network' relayed nation-wide), with colour TV competing with a proposed third city/third country network on FM for second place.

Most of the witnesses with no present commitments in broadcasting were unenthusiastic about colour TV; however, as was recognised by some, colour TV captures the imagination of the great majority of the public – and this, despite the much greater cost involved, is a significant factor in the future of the rival media. There seems to be agreement among the broadcasters and manufacturers that colour TV and FM should not be introduced together, although individual priorities do not appear to be by any means firmly established.

FM: A NEW MEDIUM?

Concerning the nature of the new services that might be possible should FM be introduced, the Federation of Australian Commercial Broadcasters was very conservative. Mr. Foster stated that commercial broadcasters do not consider FM to be a new medium: rather, he saw it simply as an extension of present broadcasting methods – a field in which those with the 'know-how' might expect to receive preferential consideration by the licencing authority. By contrast, many witnesses – viewing with interest the latest developments overseas – argued strongly for a new approach, and the creation of a third class of licence for non-profitmaking organisations, cultural societies, universities and other educational interests, and so on.

EDUCATIONAL AND CULTURAL RADIO

The contingent from the School of Education at Sydney University stressed the adaptability of radio to classroom, educational extension and teacher-training applications. Mr. Nield pointed to the Open University in Great Britain as one particularly relevant way radio might meet the educational needs of the many Australian students who are now being excluded from conventional tertiary institutions.

The needs of the disadvantaged and other special minority groups were highlighted by reference to language teaching and especially the difficulties of special broadcasts on educational channels. The popularity of the ABC's 'Learn Indonesian' series was put forward to illustrate the potential in this sphere. The need for high quality (both freedom from interference and wide frequency response) to enable adequate use to be made of educational speech programmes was also stressed by these witnesses.

University of New England speakers emphasised the special situation of the country listener confronted by the 'paucity of taste and lack of invention' of radio programmes for country consumption, both national and commercial. Although themselves expressing what must strictly be called minority views, they pointed out that it has been established that there is no significant difference between the tastes of city-dwellers and country-dwellers; yet country radio stations are of significantly lower standard in comparison with city stations.

The particular needs of the University's large number of external students were outlined, and the benefits these would gain from University-controlled radio outlets was discussed. The Professor of Economics at U.N.E., Professor Parrish, outlined a qualitative cost-benefit scheme in which he highlighted the potential value of non-profit broadcasting operations, and also argued that the increased competition among commercial licencees that would almost inevitably result when FM is introduced would benefit the industry rather than harm it.

The W.E.A. also entered a strong plea for the viability of radio stations operated on a subscription basis by groups of people for particular purposes.

THE HORIZONS OF FM – AN EXPERT VIEW

Mr. Bill Giorda, chief executive officer of the University of Texas radio station currently on loan to the ABC, gave evidence to the Board about the very latest trends in educational radio in the U.S.A. Mr. Giorda discussed usefully both the virtues of the system and the pitfalls to be avoided, should non-profit radio be introduced to Australia.

Chief among these pitfalls can be instanced the very low power (as low as 10 watts!) and limited funds of the majority of independent operations in the U.S. at present. However, Mr. Giorda also stressed that educational radio was considered of such value that it was commanding Federal Government attention and supplementary funds.

In discussing the horizons of educational radio, Mr. Giorda pointed to its advantages relative to 'voracious' and expensive TV. In particular, he mentioned the use to which the very much narrower FM radio bands can be put to transmit visual images – at the rate of one every minute or so – to illustrate lectures (in the manner of slides, now widely employed by lecturers). Since this is the use to which educational television is frequently put by universities and colleges, this technique using the radio bands represents a considerable saving, both in cost and in valuable spectrum space.

Other imaginative developments he discussed involve the use of multiplexed sub-carriers to transmit specialised programmes for which the general public has no particular need. Among those he cited were special broadcasts for the blind, using techniques to enable them to 'speed-hear' at rates up to 400 words per minute, and special channels which can subtitle ordinary TV pictures for the deaf. The University of Wisconsin was already transmitting 'speed-hearing' programmes 17 hours a day, 7 days a week, Mr. Giorda said.

FM – YEA OR NAY?

At the Sydney hearings of the inquiry there was not one voice raised in opposition to the introduction of FM. On the contrary, many witnesses expressed the view that FM should be an urgent priority for a variety of reasons, technical, economic and social. It was refreshing, for instance, to hear witnesses referring in evidence to such criteria as 'quality of life', 'highest standards of excellence' and 'education for living'.

However, the unenviable task the Control Board now faces is that of translating these ideals into the language of economic pragmatism understood by politicians. On their ability to do this, rather than on any of the issues outlined above, rests the success of this 1971 attempt to bring Australia back into step with the world in broadcasting.

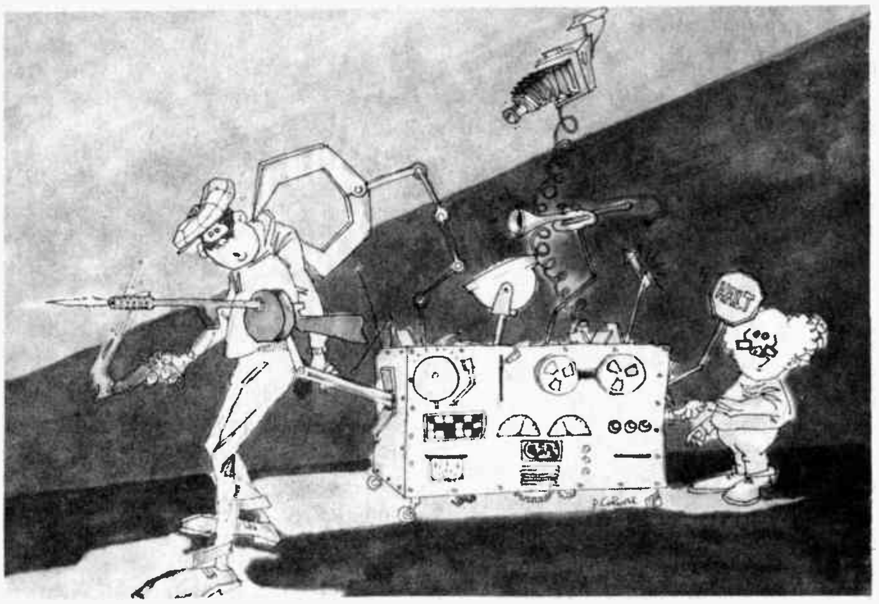
(Extracts from a precis of the evidence – prepared by Mr. T. D. Jarvie.)

ELECTRONIC THIEF-TRAP

To be burgled is a traumatic experience — yet adequate protection for your home and family can be provided for less than $40. This series of articles tells you how. Part 1, this month, covers construction of the basic control unit.

This project covers the construction and installation of an intruder alarm system which will provide adequate protection for homes and businesses of all types.

The system can be used with 'series loop' protection (as briefly described in last month's feature article 'Electronic Watchdogs') or as a main control unit accepting signals from a range of sophisticated intruder detection devices that will be described in future issues of ELECTRONICS TODAY. The unit is also suitable — without modification — for use in 'back-to-base' central bureau operations.



The unit is not the simplest device that will barely work. It is the least complex unit that will provide totally reliable, adequate protection incorporating *all* features which insurance companies, the security industry and the police regard as desirable.

These features are:

1. Versatility. The basic unit can be used for a wide range of installations, from simple home protection to high-risk business premises. It is triggered by the opening or closing of external contacts. These contacts can vary from simple magnetic reed switches fixed to doors and windows, to the relay outputs of sophisticated ultrasonic and microwave detection systems. The alarm output can be used to actuate bells, sirens, telephone dialling units or private 'back-to-base' lines.

2. Low current consumption — less than half a milliamp — enables a 12 volt lantern battery to provide power for at least 12 months.

3. Time-delayed operation, plus a memory circuit on one selected door, provides 'silent exit/silent entry' for authorized persons.

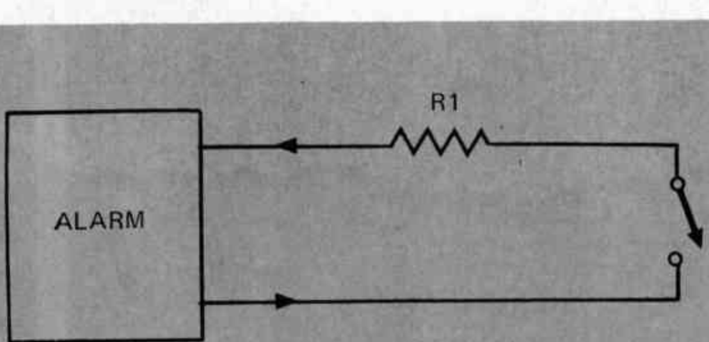


FIG. 1. Resistance R1 represents series resistance of loop (see text).

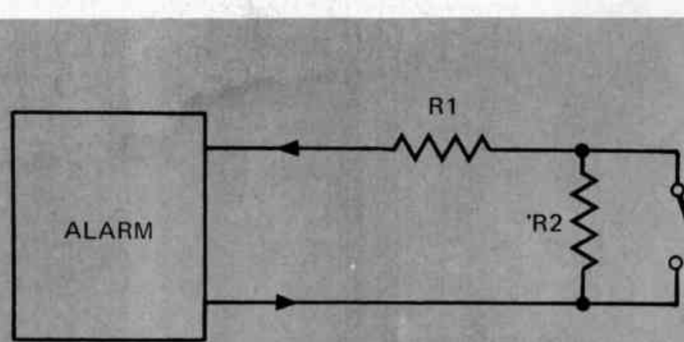


FIG. 2. Resistance R2 represents leakage path across alarm contacts.

When leaving the premises, the alarm unit is switched on and exit made within 20-30 seconds through the 'silent exit' door. At the end of the 20-30 second delay the 'silent exit' door is automatically switched into the main alarm circuit.

When this door is re-opened, an 'alert' signal initiates a second time delay, again of 20-30 second duration. The person entering the premises must switch off the alarm unit within this time. If he does not do so, the alarm will operate.

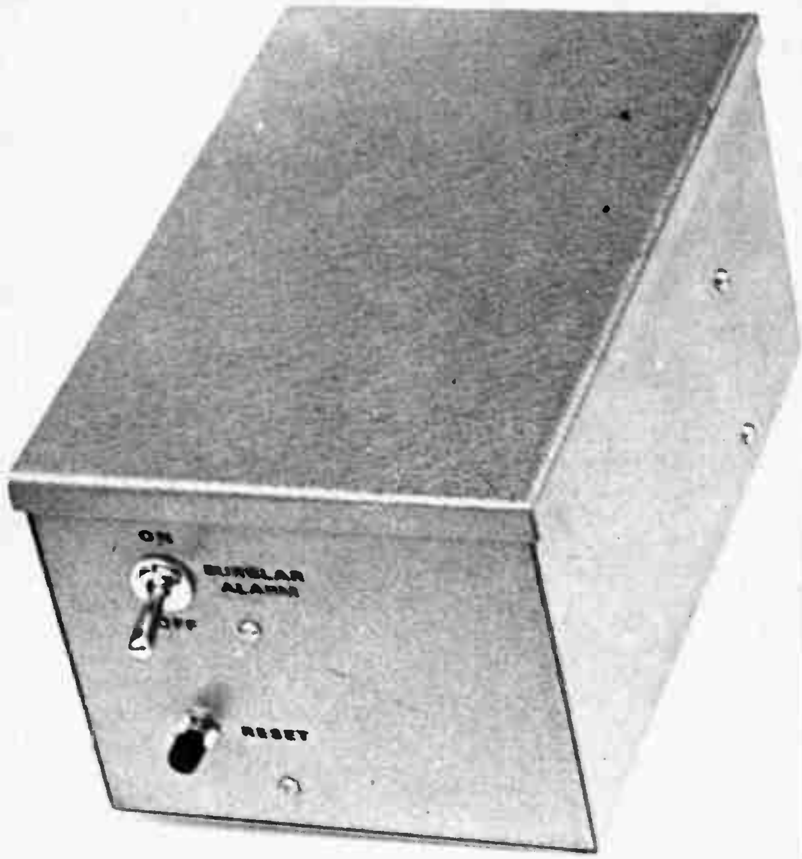
All other protected circuits are energized the instant the unit is switched on.

4. Provision is made for both 'normally open' and 'normally closed' inputs. (Throughout this project a 'normally open' contact is defined as one that is 'open' when in the 'guard' position — i.e., it closes in an alarm state. A 'normally closed' switch is closed in the 'guard' position and opens during alarm conditions. As far as possible 'normally open' circuits should be avoided for intruder protection as they can be rendered inoperative by cutting a connecting wire.)

5. The unit can tolerate a few hundred ohms series resistance in triggering leads without affecting reliability, but the alarm will operate if the series resistance exceeds 20 Kohms. This is an important feature, especially in areas of high humidity. If an alarm is installed in a boat or near the sea, it is essential.

Fig. 1 shows a typical alarm triggering circuit. Resistance R1 represents the series resistance of wiring, switch contacts, etc. This seldom exceeds 100 ohms. The switch shown in Fig. 1 represents some form of normally closed contacts which are opened by the intruder — i.e., magnetic reed switches, etc. Opening the switch will break the circuit and energise the alarm.

Now look at Fig. 2. This is the same circuit as Fig. 1, but humidity has created a high resistance leakage between the connecting wiring (and across the switch). This leakage path is shown as R2. It is in parallel with the closed contacts *and remains there if the contacts are opened*. The resistance is unlikely to be less than 20 Kohms, but may well be between 25 Kohms and 100 Kohms. If the alarm circuit will tolerate this level of resistance, 'protected' doors and windows can be opened *without energising the alarm*.



Suggested construction — front and back of alarm unit.

Yet the ability of alarm circuits to tolerate several hundred thousand ohms has been advertised as a desirable feature!

6. Energy induced in external wiring (as from lightning and mains transients) will not activate the alarm. Spurious triggering — particularly from lightning — is a common cause of false alarms, increasingly so since the adoption of solid-state circuitry.

Lightning induces short pulses in external wiring and, whilst the amount of energy induced is rarely sufficient to close a relay it will most certainly trigger an SCR. The problem can be overcome by filtering, integrating networks, or by a combination of solid-state components and electro-mechanical relays. In our experience, the latter approach is generally more satisfactory. Providing good relays are used, nothing is lost in reliability, whilst the circuit becomes more flexible in its ability to accommodate various output devices.

7. 'Emergency warning' push-buttons will be installed on door architraves to provide security against undesirable callers. The push-buttons actuate the alarms immediately and are operable at all times — i.e., they are not wired through the alarm on/off switch.

8. A fire warning circuit is included, and this again operates at all times.

9. The unit is ultra-reliable and maintenance-free. The mean time between failures of electronic components is accurately predictable, and consequently the probability of failure of an electronic assembly can be calculated. In the case of the ELECTRONICS TODAY intruder alarm, the mean time between failures is many years; furthermore, the probability of an alarm failure during the period when a burglary is attempted is again calculable. Even in high-risk areas it is hundreds of thousands to one against.

FALSE ALARMS

A frequent cause of false alarms is incorrect choice of actuating switches. Many installations include push-button switches originally designed for refrigerator doors, etc. These switches are more than adequate for their original purpose, but they are not suitable for security installations and are prone to intermittent operation after a year or two of exposure to the weather.

A more suitable switch for alarm installations is the magnetic reed switch which, if correctly installed, is virtually trouble-free. These switches will be described in detail later in this article.

SILENT ENTRY AND EXIT

The ELECTRONICS TODAY intruder alarm system is shown schematically in Fig. 3. The time delay and memory circuit (associated with the 'silent exit/silent entry door') is on the left-hand side. The centre section accepts instantaneously operating normally open and normally closed circuits, whilst the extreme right-hand section consists of the power supply and alarm output stage and the fire and emergency alarm actuators. These latter functions are wired directly to the battery side of the main on/off switch (SW1) — they are not disconnected when the alarm unit is switched off.

Power is applied to the switched circuit via contacts SW1(1) of double pole switch SW1. At the same time switch contacts SW1(2) connect the alarm output circuit to the switched section of the unit.

Initially the super-alpha pair Q1/Q2 is held at zero potential by C1/R2/R3 and relay RL1 is not energised. For 20-30 seconds after power is applied, the 'silent entry switch' (SW2) will have no effect — whether opened or closed.

Meanwhile capacitor C1 is charging through R1, providing an increasingly positive voltage at the junction of R2/R3. This potential rises to 1.2 volts after 20-30 seconds and will be applied to Q1/Q2 bases unless the 'silent entry' switch SW2 is closed.

If the 'silent entry' switch is now opened, the clamp is removed from

Fig. 3: Block schematic illustrates operating functions.

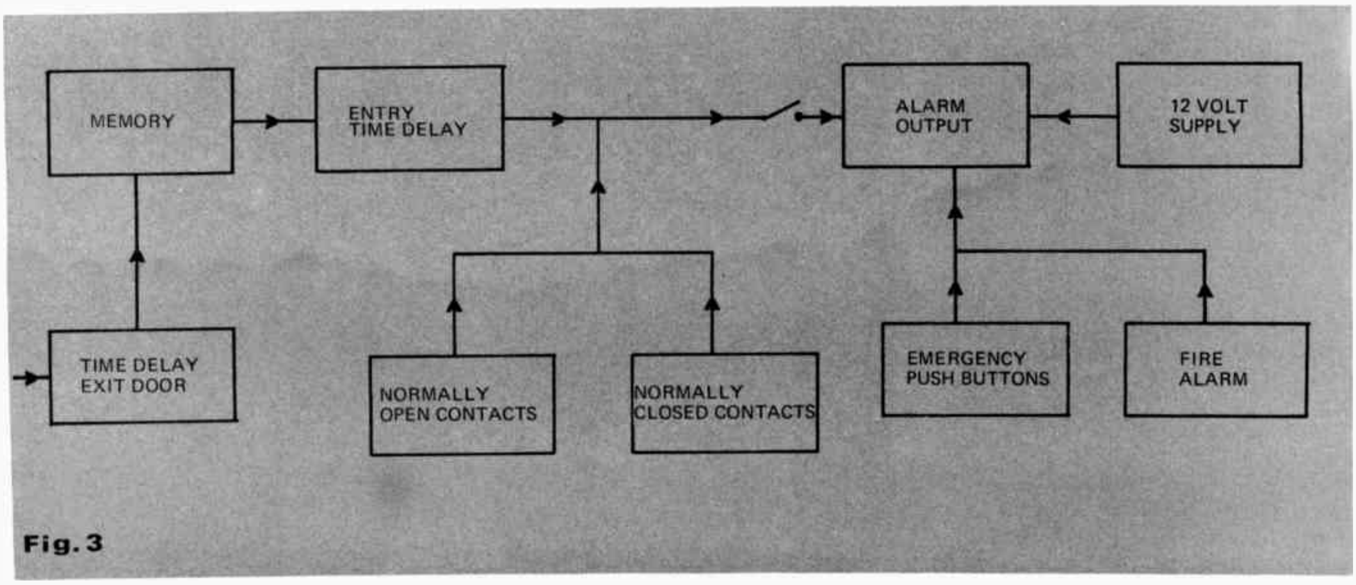


Fig 4

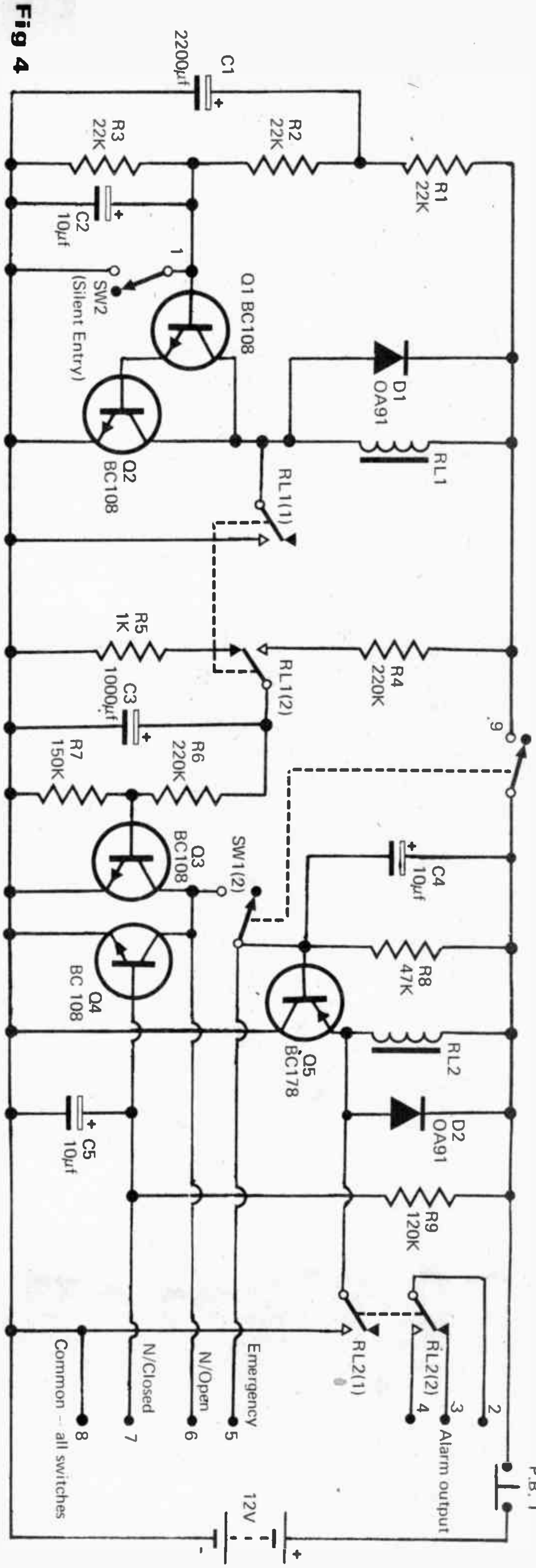


FIG. 4. Circuit of ELECTRONICS TODAY intruder alarm.

PARTS LIST

R1	–	Resistor 5% ½ watt 22k
R2	–	" " " " "
R3	–	" " " " "
R4	–	" " " " 220k
R5	–	" " " " 1k
R6	–	" " " " 220k
R7	–	" " " " 150k
R8	–	" " " " 47k
R9	–	" " " " 120k
C1	–	capacitor electrolytic 2200µf – 10 volt
C2	–	" " 10µf – 50 volt
C3	–	" " 1000µf – 10 volt
C4	–	" " 10µf – 50 volt
C5	–	" " 10µf – 50 volt
D1	–	diode OA91 – EM401 or similar
D2	–	" " "
SW1	–	double pole single throw switch – toggle or key operated (see text).
PB1	–	normally closed push button switch, (must be high quality with self-cleaning contacts) or single pole key operated switch.
Q1–Q4	–	transistor, silicon npn – BC108 or equivalent.
Q5	–	transistor, silicon pnp – BC178 or equivalent.
RL1–RL2		cradle type plug in relay double pole change-over Varley type VP2 (430Ω coil) or ITT type 240 AFO 430Ω, or equivalent, plus two printed-circuit mounting bases for above.

Printed circuit board.
Two batteries 6 volt type 509, or 731 (larger capacity).
Terminals, tag strips, etc.

Q1/Q2 base, the super-alpha pair conducts, and RL1 is energised, and is immediately latched on by its own contacts RL1 (1). Reclosing the 'silent entry' switch SW2 will not de-energize RL1.

Relay RL1 thus has a signal indicating that the 'silent entry' door has been opened. This signal can only be erased by switching off the alarm unit or momentarily depressing PB1.

Relay RL1 has a second set of contacts RL1 (2). These contacts have also changed over, connecting the base of Q3 – via the time delay network C3/R4/R6/R7 – to the positive rail. Capacitor C3 slowly charges, and after a time delay (again of 20-30 seconds) Q3 switches on and connects the base of silicon pnp transistor Q5 to the negative rail. This transistor immediately conducts, energising RL2, which in turn is latched on by its own contacts RL2 (1).

Relay RL2 has two sets of contacts, and the second set RL2(2) is used for the alarm output.

INSTANTLY OPERATING INPUTS

Transistor Q4 is held at zero potential via the external 'normally closed' circuit. If this loop is open-circuited – either by actuation of one of the protection switches or by an intruder cutting the wiring – a positive potential will be applied to Q4 base via R9; Q4 will conduct, thus

ELECTRONIC THIEF-TRAP

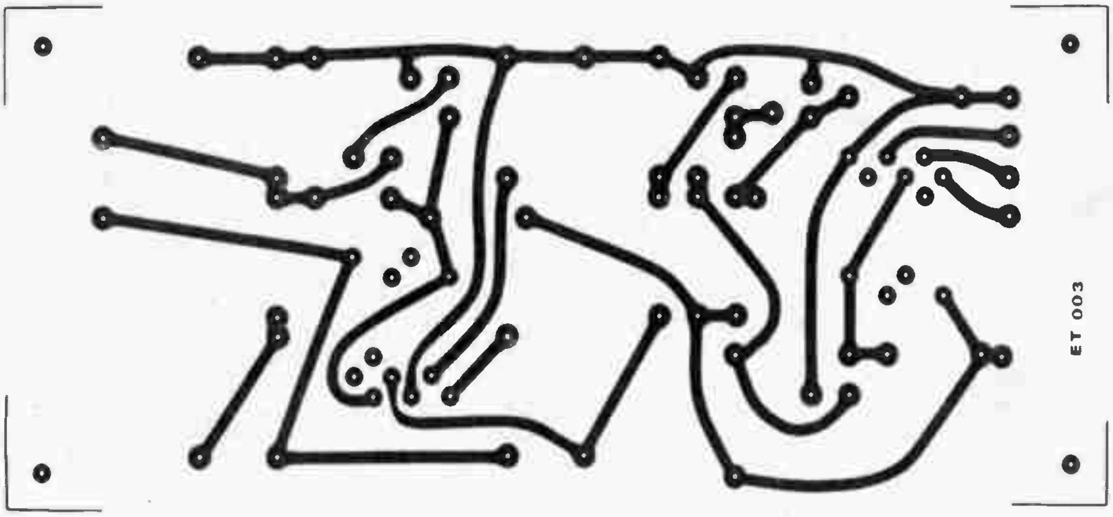
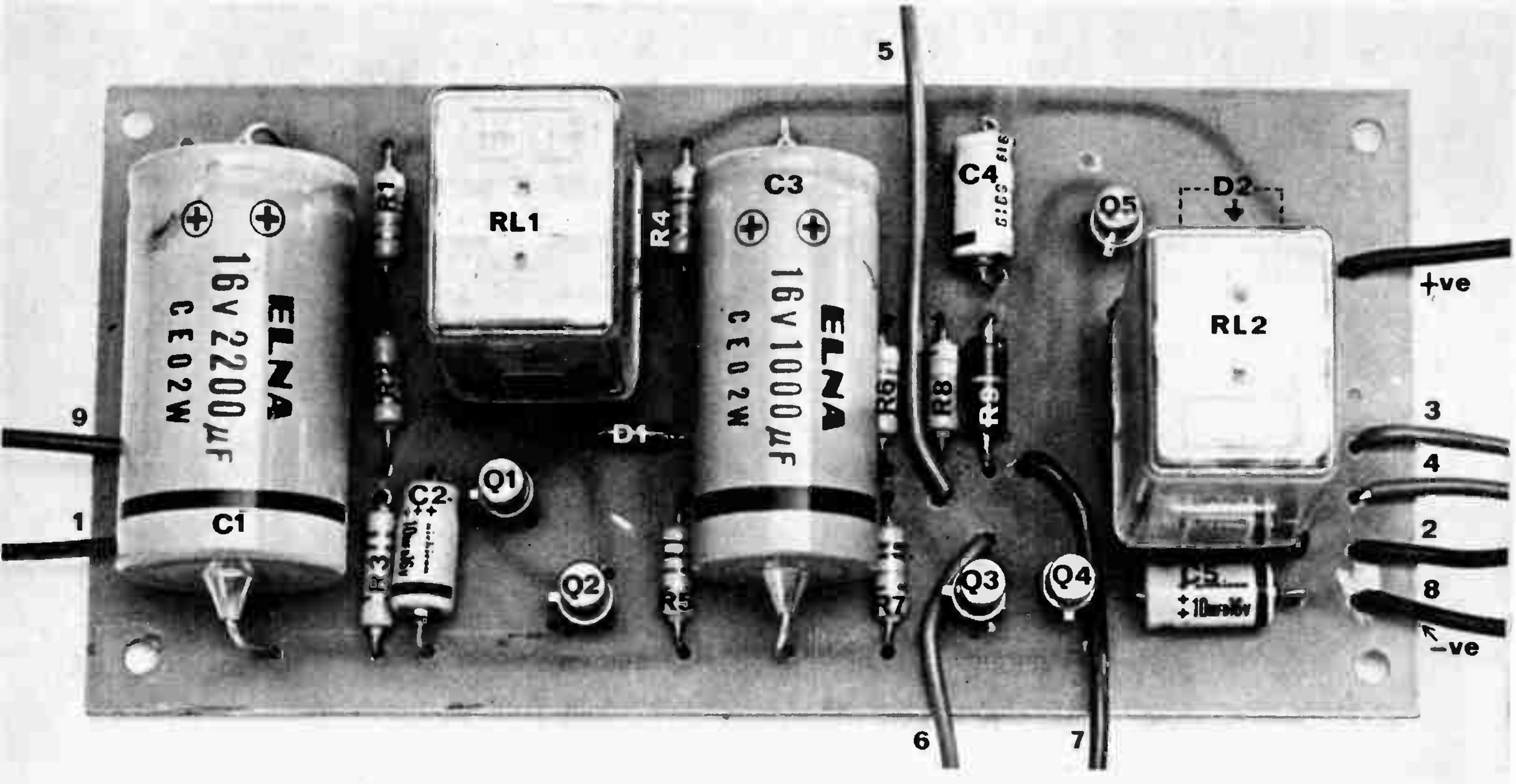


FIG. 5. Foil pattern (full size).

FIG. 6 (BELOW), Layout of components on printed circuit board.



connecting Q5 base to the negative rail, Q5 will switch on, and once again relay contacts RL2 (1) will lock the relay in the alarm condition.

The 'normally open' circuit is connected across the switched side of Q5 base to the negative line. A contact closure will thus cause Q5 to conduct.

As will be seen from Figs. 3 and 4, these last two inputs are instantaneously operative the moment the unit is switched ON from SW1. There is no delay between intruder detection and alarm actuation. Only the 'silent entry' door has a delayed operation.

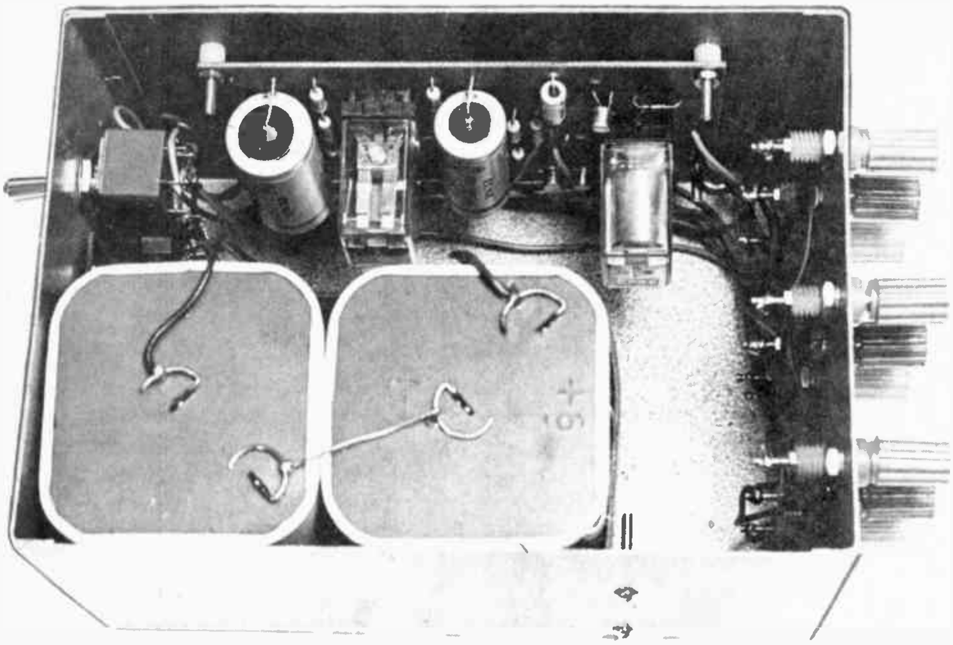
FIRE WARNING ALWAYS 'ON'

The remaining inputs are for fire and emergency warning. These are connected to the 'non-switched' side of Q5 base and are operative at all times. Both inputs are 'normally open' and, like all other inputs, the alarm output will latch on the instant a signal is received.

Capacitors C2, C4 and C5 prevent voltage transients induced in external circuits from triggering the alarm. Diodes D1 and D2 protect the unit's transistors against transients generated by the collapsing fields of relay windings RL1 and RL2. These two diodes must be 400 volt peak inverse voltage.

CONSTRUCTION

The unit is easily assembled on the printed circuit board, the foil pattern of which is reproduced full-size in Fig



Suggested layout of components in alarm housing.

5. Component layout is shown in Fig. 6. Remember that transistor Q5 is a pnp type – all others are npn.

Relays RL1 and RL2 are miniature cradle-mounted units. These are readily obtainable. Suggested manufacturers and part numbers are included in the parts list.

Key-operated switches may be used for SW1 and PB1. However, if the unit is installed in a cupboard or otherwise concealed, simple toggle and push-button switches will suffice. No intruder will search for the control unit whilst the alarm bell advertises his presence.

The completed unit may be assembled within a metal case together with the two series connected 6 volt lantern batteries – or mounted in a die-cast alloy box, with the batteries located externally.

Power consumption of the unit itself is less than ½ a milliamp, rising to 25 milliamps during the few seconds when RL1 is energized subesquent to the 'silent entry' door being opened. Battery life will be between nine and 15 months if the unit is used continuously.

The alarm bell can be powered by the same internal batteries if required. If this is done, it is good practice to replace the batteries every six months as a precautionary measure.

A mains-operated power supply with automatic changeover to standby batteries can be used but is rather pointless. The intruder alarm uses no more current than that determined by the shelf life of the batteries. Why not use the batteries all the time?

TESTING THE UNIT

To test the completed unit, short inputs 1 and 7 to the negative rail. Switch SW1 to ON and wait for one minute. Neither relay should close and current consumption should not exceed half a milliamp.

Remove the short from the 'silent entry' input (1). Relay RL1 should changeover within one second and should remain closed even if the short is now reconnected. Relay RL2 should changeover between 20 and 30 seconds later.

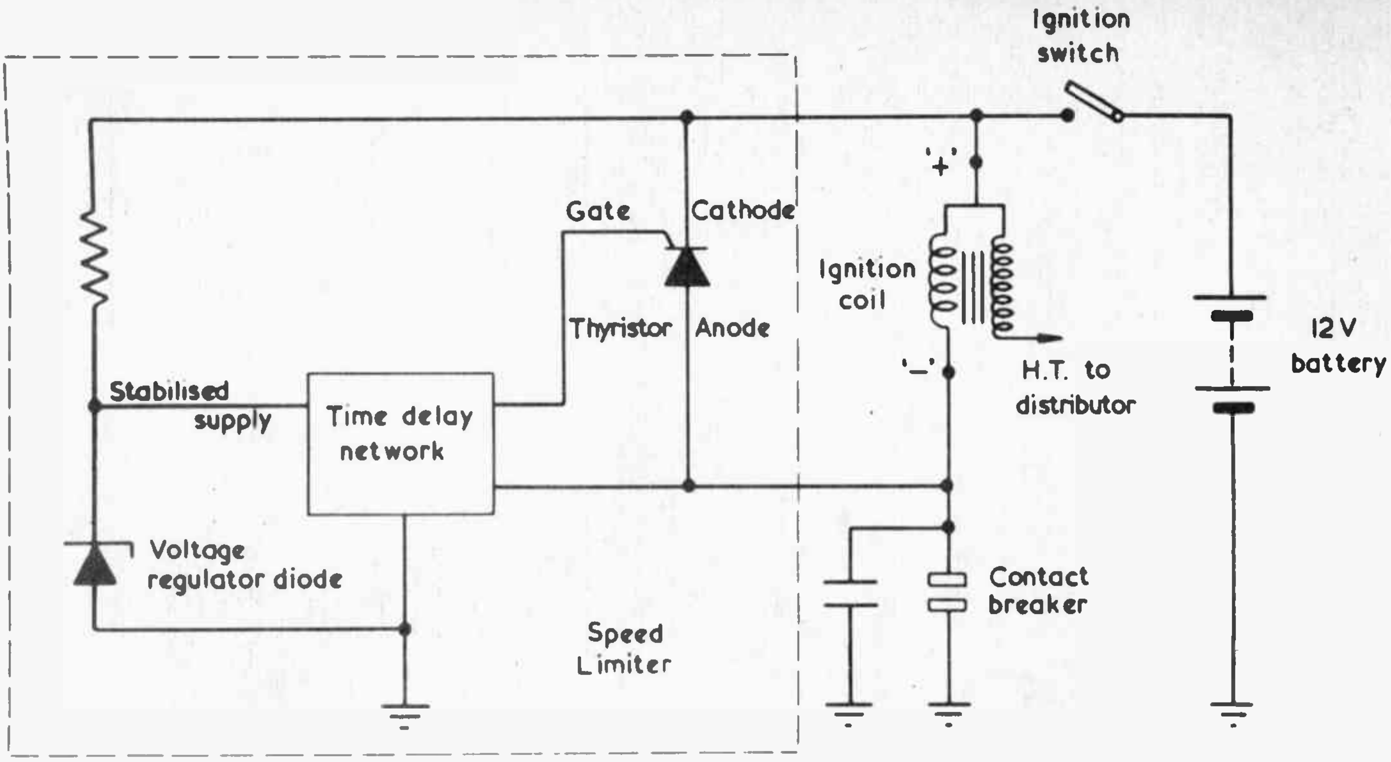
Reconnect the short circuit across the 'silent entry' input and unlatch the unit by momentarily depressing PBI.

Now remove the short from normally closed input (7). Relay RL2 should changeover immediately and again latch on. Reconnect the short and reset the unit via PBI.

Next momentarily short the 'normally open' input (6) to the negative rail, this again should cause RL2 to close and latch. Reset the unit.

Finally switch off SW1 and momentarily short the emergency/fire input (5) to the negative rail. Once again RL2 should close.

The unit is now ready for installation – details of this, and the way in which the various detection switches are used, will be given in next month's issue of this magazine. ●



Block schematic of the Lucas-developed engine speed limiting system.

Electronic Engine speed Limiter

The higher acceleration rates of some modern engines necessitate faster-response ignition inhibitors than those previously employed to prevent damage from excessive engine speeds.

A new type of electronic limiter has been devised for this purpose, operating from the ignition frequency signal and suitable for use with Lucas ignition systems of both 'contact breaker' and 'contact breakerless' types. It consists of a time delay network, and a thyristor connected across the ignition coil primary winding. The thyristor is switched on to short out the primary switch-off surge of the coil whenever engine speed exceeds the selected limit, preset by adjustment of a resistor.

Compared to previous systems, the completely solid-state device has the following advantages:

1. faster response: there is virtually no speed overshoot.
2. no hysteresis.
3. no environmental vibration problems.
4. no relay contacts.
5. the limiter is a single static electronic unit, conveniently mountable and enabled to function by simply making three wiring connections.

> *'Consider that men will do the same things nevertheless, even though thou shouldst burst'.*
> *— Marcus Aurelius.*

Briefly, the operation of the speed limiter is as follows.

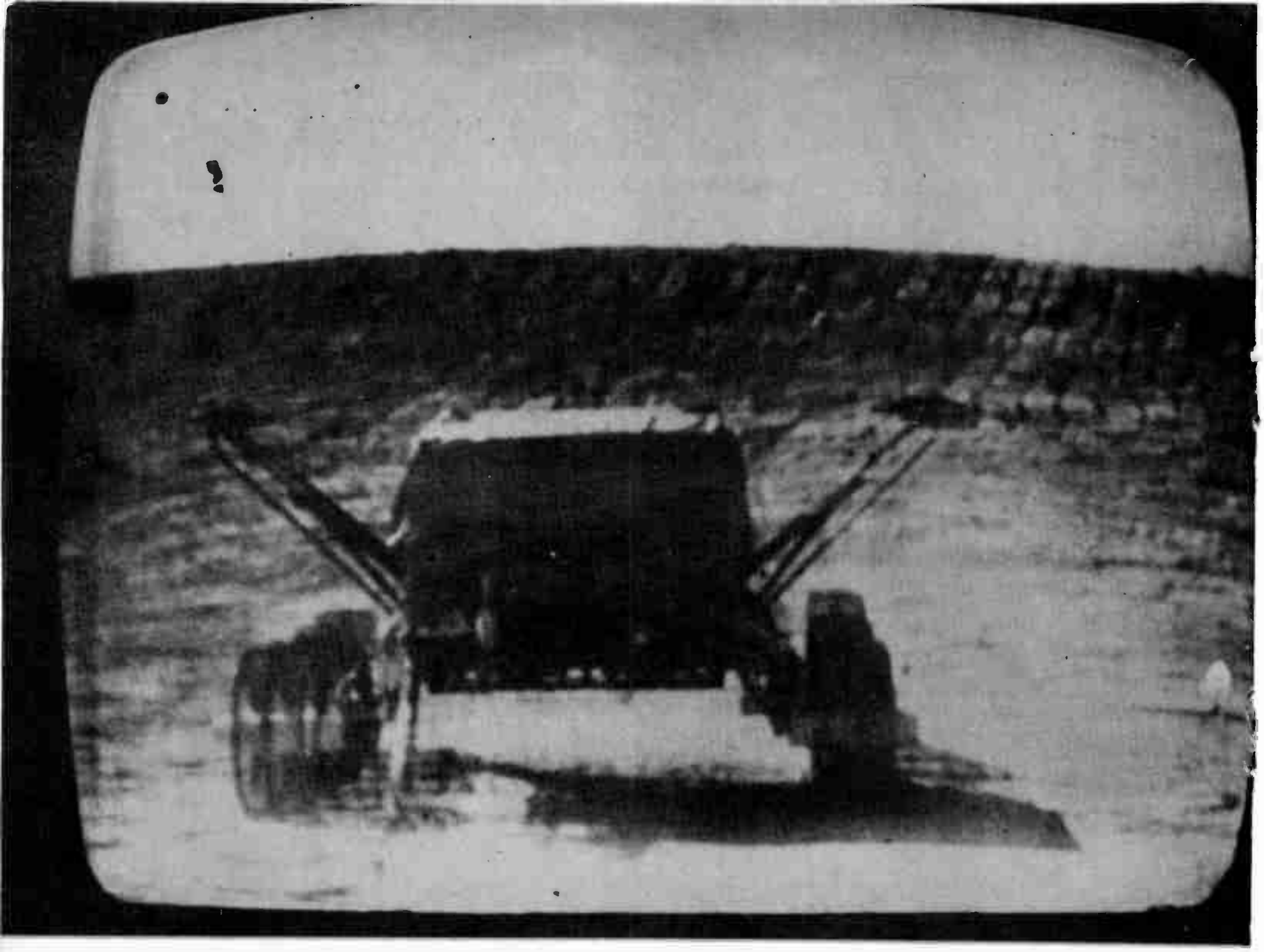
At engine speeds below the set limit, and with the contact breaker closed, the anode and gate terminals of the thyristor are both negative with respect to the cathode and the thyristor is therefore switched off. Current thus flows through the ignition coil primary in the usual manner.

Each time the contact breaker opens, an emf is induced in the ignition coil in the usual manner. In addition, a brief electrical pulse is propagated in the time delay network and applied to the gate of the thyristor.

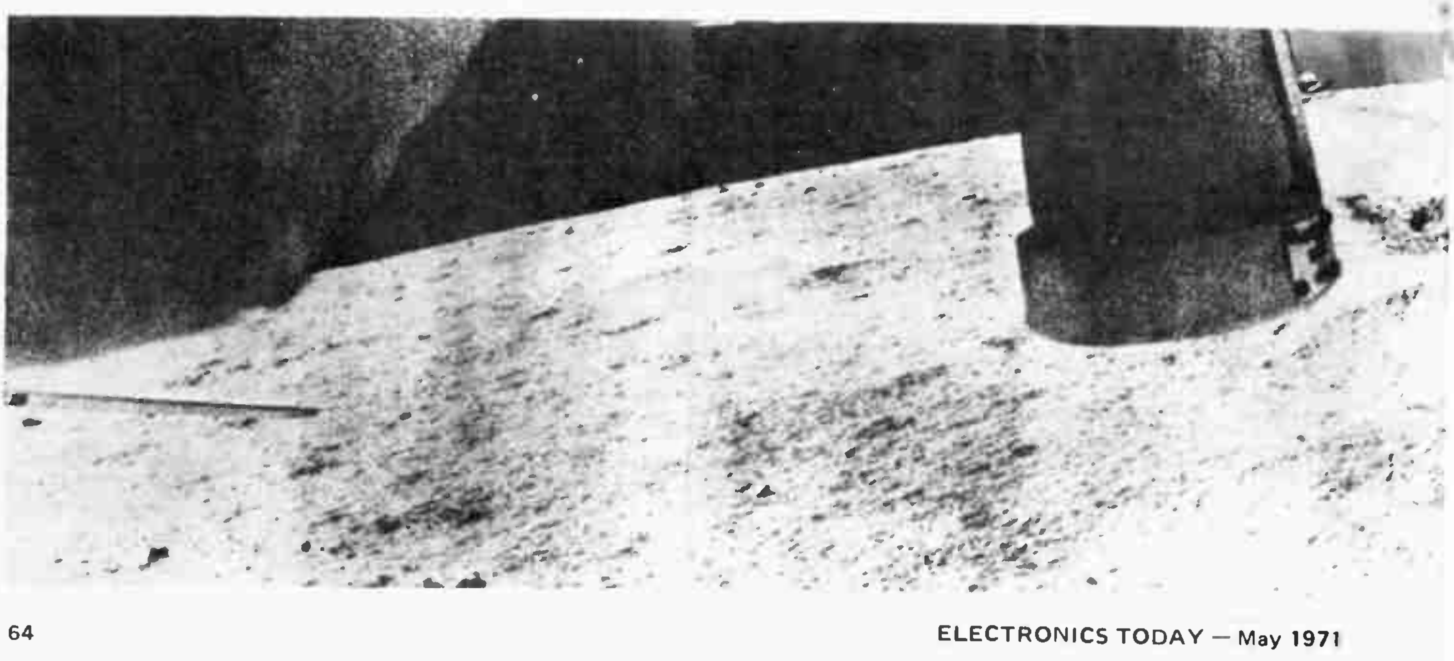
The emf induced in the ignition coil primary makes the thyristor anode positive with respect to its cathode — but because the delayed gate unclamping pulse produced by the previous opening of the contact breaker is already over, the gate is held at a negative potential and the thyristor does not fire. An ht voltage is thus induced in the secondary of the coil and a spark is produced at the appropriate plug.

To prevent system voltage variations from affecting the delay of the pulse through the time delay circuit, the latter has its supply voltage stabilised by a voltage regulating diode.

When engine speed rises to the set limit, the limiter operates in similar manner, except that the opening of the contact breaker occurs during the delayed unclamping pulse produced by the previous opening of the contact breaker. The thyristor therefore fires, preventing an ht voltage being induced in the ignition coil secondary. ●



Exploring the moon



ON Thursday, April 13, a brief news item from AAP-Reuter's Moscow office reported that Lunokhod-1 was on the move again after resting through yet another lunar night and was exploring a new crater in the Sea of Rains.

This meant that the odd, saucepan-shaped vehicle was still operational five months after it had rolled off its Luna-17 space ferry on November 17 last year — and a Soviet space scientist told AAP-Reuter he foresaw a whole fleet of Lunokhods (Russian for Moonwalkers or Moon-rovers) exploring the barren lunar plains and transmitting their findings back to earth.

The Luna-17/Lunokhod-1 mission marked the second stage of Russia's current remote-controlled programme of lunar exploration. Stage 1 was initiated on September 24 last year, when the recoverable module of Luna-16 returned to earth carrying a cargo of lunar soil samples. But more of this later.

DETAILS OF LUNOKHOD-1

Lunokhod-1 has an eight-wheeled chassis carrying a saucepan-shaped magnesium-alloy instrument compartment. A cooling radiator forms the top of this compartment. During the cold lunar night a double-sided 'lid' provides thermal insulation. This lid is opened during the lunar day, exposing the matrix of photo-voltaic cells mounted on the underside. The cells produce electrical energy which is stored in a bank of storage batteries.

The instrument compartment is protected against extreme cold by a nucleonic source which heats gas continuously recirculated through the area.

Testing equipment carried by the vehicle includes an X-ray telescope which, according to 'Iszvestia', covers the energy band from 2 to 10 KeV. Vladimir Kurt, of the Soviet Academy of Sciences, says that data from the X-ray telescope is amplified and stored in an on-board computer before subsequent transmission to earth.

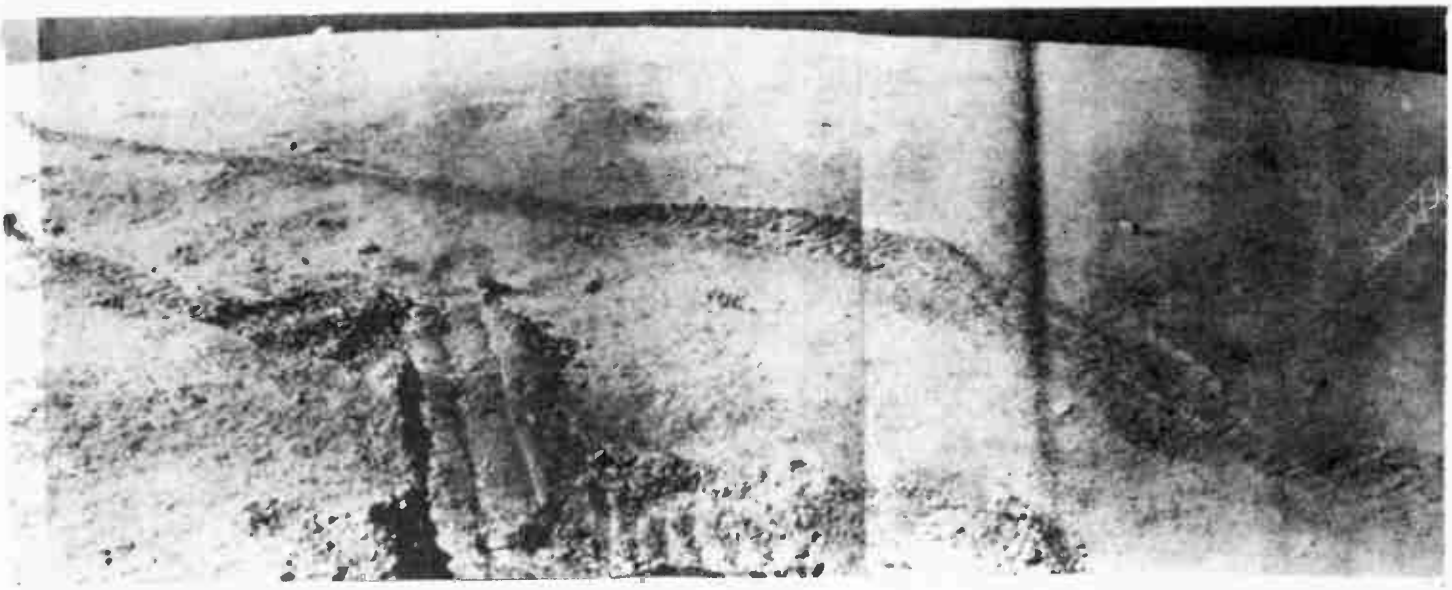
Lunokhod-1 also has apparatus for monitoring solar and galactic radiation.

America's manned space flights are superb technical achievements — yet it is questionable whether their information-gathering value surpasses that of Russia's less-costly, less-publicised unmanned programme.

In presenting this report on the Luna-16 and Luna-17 missions, and on the functions of Lunokhod-1 — the first car on the moon — ELECTRONICS TODAY acknowledges the assistance of the following news media: Izvestia, Pravda, TASS/APN, Novosti Press Agency, ITU Telecommunication Journal.

RIGHT: Control crew communicating with Lunokhod-1. BELOW: Picture strip televised from moon vehicle, showing its tracks on lunar surface.

n by remote control



Exploring the moon by remote control

A laser experiment to determine the precise distance between the earth and the moon has been successfully completed. This Soviet experiment — which appears to duplicate an earlier Apollo one — has been conducted in partnership with French space scientists.

The chemical composition of lunar soil is tested by an on-board X-ray spectrometer. So far this instrument has detected deposits of aluminium, calcium, iron, magnesium, potassium, silicon and titanium.

Additional soil-testing equipment includes an adaptation of a vane-shear apparatus used to determine the torsional shearing resistance of lunar soil. Other sensors monitor the continuous interaction between Lunokhod's wheels and the soil — probably to keep a check on the soil's load-bearing capacity.

The vehicle is remotely controlled from Earth by a crew of five — commander, driver, navigator, operator, and a flight engineer. The vehicle is not used during the lunar night — nor during the two-day lunar 'noon', as the high sun creates low contrast on Lunokhod's TV pictures of the lunar surface and the ground control crew find it difficult to evaluate the surface ahead.

The Soviet news agency TASS reports that to date Lunokhod-1 has surveyed an area 3.6 kilometres long by 50 metres wide in the Sea of Rains.

LUNA-16 MISSION

The automatic station Luna-16, despatched last September, consisted of a landing module with a soil-sampling device and a moon-earth space rocket with a recoverable module. At the time of the moon landing the station weighed 1880 kg.

The landing module is an autonomous multipurpose element of the rocket, operated by a liquid fuel drive and equipped with a system of propellant tanks and compartments housing instruments and the shock-absorbing supports for the moon landing. It is also fitted with the radio unit antennae.

The motor unit of the landing module has a variable-thrust main motor for braking and two autonomous low-thrust motors, actuated in the final stage of landing. The main motor of the landing module is designed for repeated starting.

The module's instrument compartment houses the computers and gyroscopic devices of the command and stabilizer systems, the electronic instruments of the orientation system, the radio transmitters and receivers of the radio measurement unit which operates on several frequencies, a timing programme for the automatic control of all the unit systems, the chemical batteries and current converters, the heat regulation system components, the autonomous radio devices for measuring altitude and the horizontal and vertical resultants of the speed at the time of the moon landing, the telephotometers for transmission of operating data on the drilling area, and instruments designed to measure the temperature and radiation intensity, both during flight and at the moon surface.

The landing module served as a launching platform for the moon-earth rocket.

Apart from the instrument compartments, the landing module is fitted, on the outer surface, with micro propulsion units for the orientation and stabilizer systems, the tanks containing the propellant for the motors, and the optical sensors of the orientation system.

The upper part of the landing module houses the moon-earth rocket.

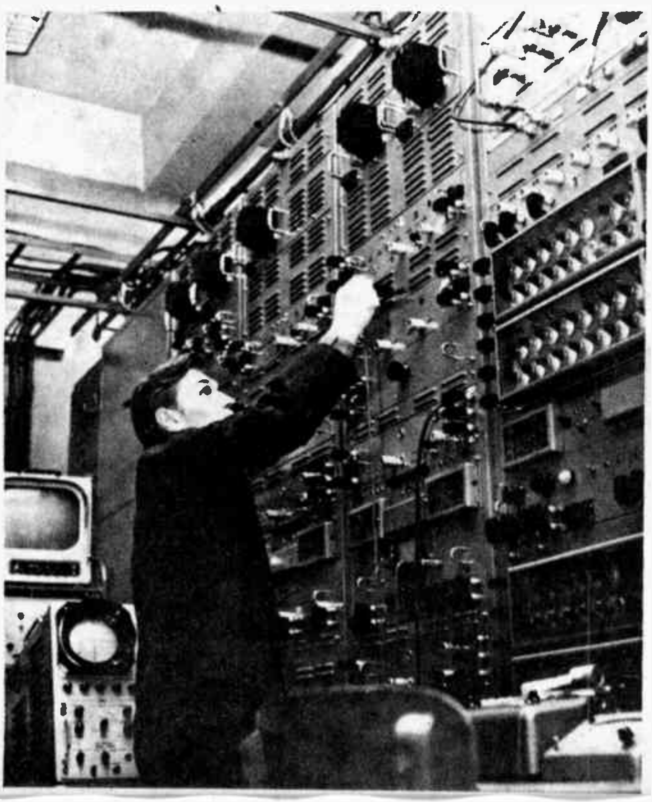
The moon-earth rocket is an autonomous unit equipped with a liquid propellant drive and a system of spherical tanks containing the propellant components.

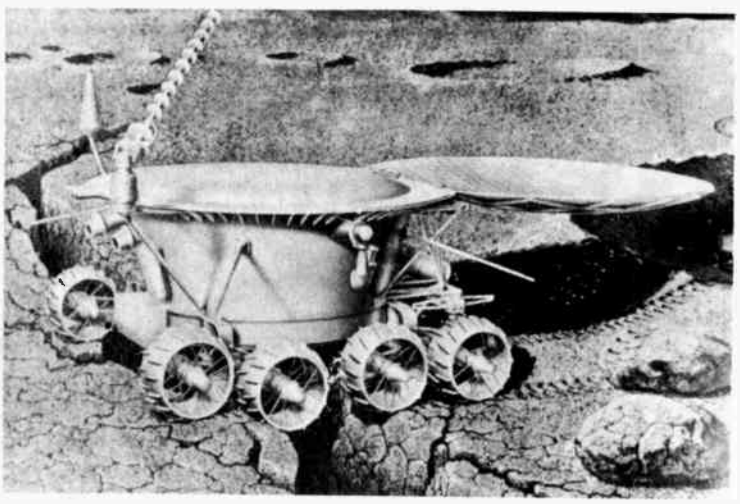
A cylindrical compartment housing the electronic instruments, computers and gyroscopic devices belonging to the rocket command system, the transmitters, receivers, decoders and timing programmes of the rocket's radio unit, the chemical batteries, current converters, electrical equipment and automatic devices, is mounted on the central tank.

Four transmitting and receiving rod antennae forming part of the rocket radio unit were fixed to the outside of the instrument compartment.

The recoverable module is fixed to the upper part of the instrument compartment by means of metal strips joined by a special explosive bolt, opened by a radio signal from the flight control centre when the rocket is approaching the earth.

The recoverable module is a metal sphere covered with a special heat-resistant coating, to protect the module and its equipment against the





Lunokhod-1 crossing a lunar crevasse, its lid open to recharge the batteries by solar energy (artist's impression).

LEFT: Co-ordination and computer centre — equipment for communication with Lunokhod-1.

high temperatures generated on re-entry into the earth's atmosphere.

The module is divided inside into three isolated compartments. The biggest contains the radio direction finding transmitters which enable the module to be located when dropping by parachute or after reaching the ground, the chemical batteries, the automatic components, and the on-board programme actuating the parachute system.

The second compartment houses a folded parachute, four flexible antennae for the radio direction finding transmitters, and two elastic cylinders which fill with gas to maintain the recoverable module in the required position on the ground after landing.

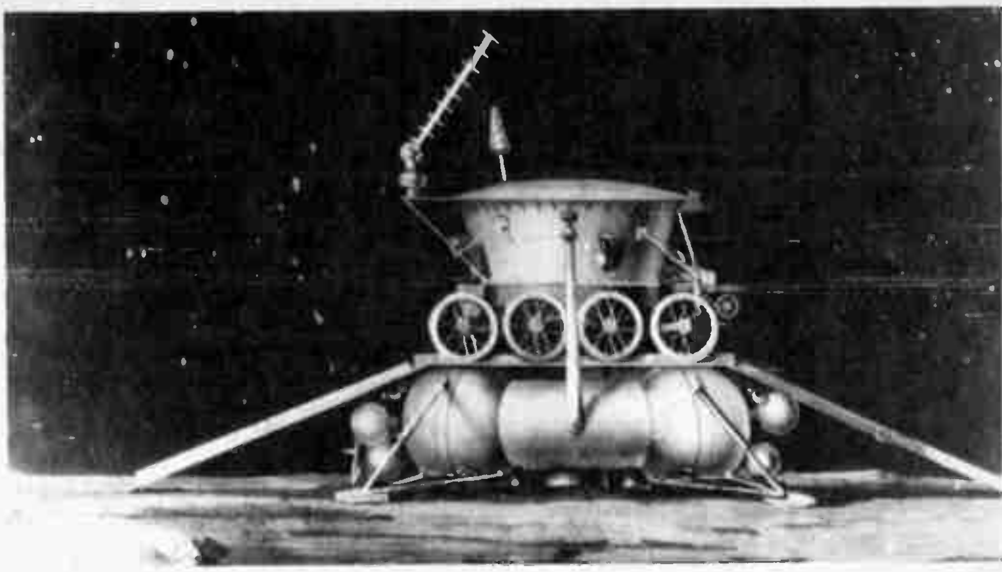
The third compartment is a cylindrical container intended for the moon soil samples. On one side of this container is an aperture which is hermetically sealed by a special cover after the moon soil is inserted.

The soil sampling device on the landing module consists of three main sections:

1. An electrically – driven drill and a drilling assembly;
2. The shafts on which the drill is fixed;
3. The drives for the horizontal and vertical movement of the shaft.

The object in the development of the sampling device was to devise an assembly capable of drilling and collecting moon soil samples of varying density, ranging from the most friable (powder) to the hardest materials, akin to terrestrial basalts or granites. Features such as minimum weight and minimum consumption were also factored into the design.

This device fulfilled its purpose admirably – to drill the samples out, lift them from the surface to the container in the recoverable module, and to place them inside.



Ramps down. Lunokhod-1 prepares to descend from Luna-17 space ferry (artist's impression).

FLIGHT PROGRAMME

The flight of Luna-16 can be split up into the following main stages: launching and flight to the moon, operations on the moon's surface, and return to earth.

Luna-16 was launched on September 12, 1970, and placed in orbit around the earth by means of a booster more powerful than the launchers of its predecessors.

Analysis of the trajectory measurement data showed the following parameters of the earth orbit from which the station was launched on its moon flight: maximum distance from earth – 112.2 km; inclination in relation to the plane of the equator – 51° 36′.

By a command from the timing programme, the motor of the last stage of the booster was cut in 70 minutes after launching to increase the speed of the station and place it on the moon flight trajectory.

During the moon flight, one of the two scheduled corrections was carried out to ensure that the station arrived exactly in the target area. The initial data for trajectory correction, force and direction of the correcting impulse, time of motor start-up, were calculated at the Co-ordination and Computation Centre after processing of the trajectory measurements. These data, in the form of special codograms, were then radiotransmitted to the station during a radio hookup phase and stored in the timing programme memory.

At the beginning of the correction phase, the command system and the optical sensors of the orientation system were used to orient the station accurately in space in relation to the sun and the earth, so that the motor adopted the position assigned for correction.

On September 13, after completion of all preliminary operations, the command system transmitted the signal starting up the motor for the scheduled period of 6.4 seconds to bring the station back on course. Subsequent trajectory measurements showed that the station should arrive exactly at the pre-assigned point of the circumlunar target area without a second correction being required.

This sole correction was designed to correct for the very slight deviations observed in relation to the preset trajectory.

To convey an idea of the precision with which the on-board systems operated, it is sufficient to explain that a deviation of 1 m/s from the set speed (i.e., scarcely 0.01%) when the last-stage motor is cut in causes an error of 300 km on the moon.

When the station reached the target area near the moon, the second firing of the landing module motor was prepared and effected to decelerate the station on the moon approach and bring it into orbit round the moon. The motor was fired at 0238 h on September 17 to place the station on a circular orbit at 110 km from the moon surface.

Another difficult operation was then performed: the placing of the satellite on a low-pericynthion (minimum distance from the moon) pre-landing orbit in order to create optimum conditions for the operation of the autonomous command system during the descent and landing stages.

For this purpose, two manoeuvres were carried out in the two full days during which the station was orbiting the moon. First, the orbit was made elliptical to culminate at 110 km, at a minimum distance of 15 km from the moon. In the next manoeuvre, the plane of the orbit in space was slightly tilted to culminate at 106 km, when the required position was reached.

At 0606 h on September 20, one of the most difficult stages was initiated – the preparation of the soft landing. Radio communication was blanketed during the preparatory operations from 0641 to 0731 h, when the station was on the far (dark) side of the moon.

After a number of programmed orientation and positioning operations, the landing module motor was cut in and the speed of the station reduced to a value permitting the transition to the descent phase, the station being maintained in a position determined by the command system stabilizers.

At the preset height and vertical descent speed, constantly measured by the on-board Doppler speed counter and altimeter, the landing module

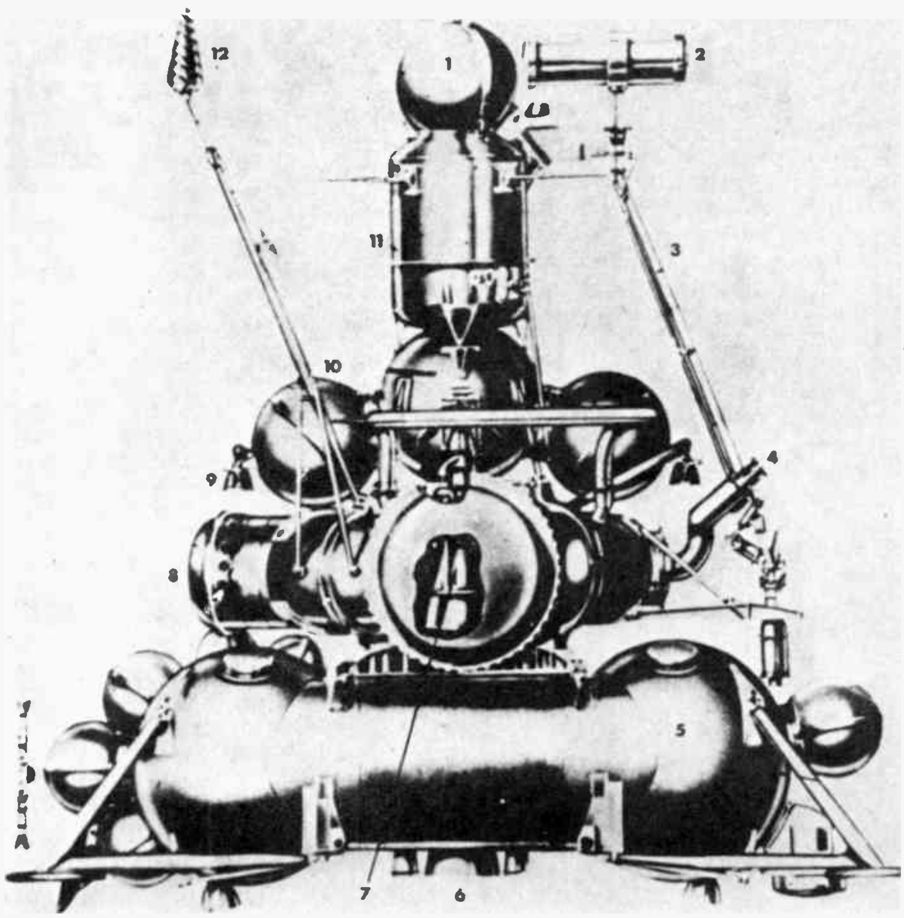
Exploring the moon by remote control

motor was again cut in. The speed of the station was reduced to about 2.5 m/s at an altitude of 20 m.

At this height, the station's main motor was stopped and the two low-thrust motors were cut in for the soft landing. They were stopped near the moon surface by a command from a gamma altimeter.

The station made a soft landing at 0818 h on September 20 in the Sea of Fertility, at a point with the co-ordinates 0º 41' latitude S and 56º 19' longitude E, at a slight distance from the centre of the target landing area.

The work of the earth-based command and measurement unit was extremely important for the success of the Luna-16 operation. The trajectory measurement data collected regularly by the instruments of the Deep Space Control Centre were continuously processed by computer, which permitted at all stages the precise determination of the Luna-16 flight trajectory parameters, the calculation and checking of lunar orbiting manoeuvres and the prediction and definition of the moon and earth landing point co-ordinates. The fault-free operation of all automatic systems on board Luna-16, and the precise flight control, enabled the station to land in the set target area on the moon and guaranteed the return of the moon soil sample container to the pre-assigned drop zone in the Soviet Union.



Mock-up of Luna-16 and its moon-to-earth rocket, as it would appear after moon landing.

1. *Spherical recoverable capsule containing lunar soil samples.*
2. *Drilling and sampling device.*
3. *Mechanical arm bringing drilling device in contact with ground in sampling area.*
4. *Telephotometer used to select drilling area.*
5. *Fuel and propellant tanks for the landing stage motors.*
6. *Main landing stage motor jet.*
7. *Propellant tanks enclosing the take-off stage motor jet.*
8. *Landing stage instrument compartment.*
9. *Attitude control jets.*
10. *Spherical tanks for take-off (return to earth) stage.*
11. *Take-off (return to earth) stage instrument compartment.*
12. *Antenna for telecommunication with earth.*

OPERATIONS ON MOON SURFACE

After landing, the on-board radio unit was switched on by command from earth. Analysis of the information received showed that the station and all systems were in good order. The station's position on the moon was also fixed.

The signal starting up the soil-sampling device was then sent out. The bolt retaining the device in flight was released and the shaft bearing the drill was raised to the vertical by the first drive system. An earth signal then switched on the telephotometer cameras, which transmitted earthwards information on the drilling area. The second drive system was then actuated to pivot the shaft 180° about its axis, so that the drill should point toward the moon surface when the shaft assumed a horizontal position. At the same time, an earth signal opened the drill cover. The shaft was lowered until the drill touched the moon's surface; a signal from the operator started the drill. All sampling operations were carried out automatically.

Once the main operation (collection of moon soil samples) was completed, the temperature of the structural elements of the station and the radiation level were measured and the measurement data transmitted to earth.

This phase was followed by the preparations for the return flight. The moon-earth rocket was launched. Its command system was programmed for the speed to be reached by the rocket on leaving the moon.

The moon-earth rocket was launched at 1043 h on September 21 by a command transmitted from earth.

RETURN FLIGHT

When the rocket attained the required speed of 2708 m/s, the motor stopped and the rocket headed towards earth with the recoverable module on an uncorrected ballistic trajectory. During the flight towards earth, the Deep Space Control Centre carried out regular trajectory measurements to determine the landing point in Kazakhstan.

At 0450 h on September 24, the recoverable module was detached from the instrument compartment of the space rocket; at 0810 h it entered the dense layers of the earth's atmosphere at a speed slightly above 11 km/s.

At an altitude of about 11 km, a signal from the barometric sensor released the braking parachute and then the main landing parachute. At the same time, the main radio direction finding transmitters were switched on.

At 0814 h, the recovery planes and helicopters massed in the scheduled landing zone intercepted the signals, and then the parachute descent was observed from a helicopter, which accompanied the module until the landing at 0826 h, 80 km south-east of the town of Dzheskazgan.

The Luna-16 flight was covered by an intricate network of measurement stations, both on Soviet territory and on board ships operating for the Academy of Sciences. Operations were commanded by the Deep Space Control Centre.

A preliminary analysis of soil samples brought back from the Sea of Fertility indicates that the samples are very similar to those collected by Apollos 11 and 12 – although the titanium and uranium content is smaller.

Dr. A. Vinogradov, Vice-President of the Soviet Academy of Sciences, says that Soviet scientists agree with the American conclusion that the moon was probably formed about 4,600 million years ago. ●

AMATEUR RADIO

FIVE amateur-built OSCARs (Orbiting Satellite Carrying Amateur Radio) have been launched by NASA as part of the payload in their space programme.

The latest of these, AUSTRALIS-OSCAR 5, was designed and built by members of the Melbourne University Astronautical Society. During its life of six weeks AO – 5 transmitted telemetry signals giving details of the condition of the satellite, which were received and interpreted by amateurs and sent to the project co-ordinators for evaluation.

Many useful things were discovered by AO – 5, such as the rate at which solar energy is absorbed by a satellite. Calculations predicted that AO – 5 would stabilise at a temperature of 22°C, but when in orbit the telemetry signals indicated that the actual temperature reached about 42°C. and after further investigation it was found that the coefficient of solar energy absorption which scientists had used for years was incorrect.

AMSAT-OSCAR 6

The next satellite scheduled for launch is AMSAT-OSCAR 6. This is by far the most ambitious amateur project undertaken and will provide contacts of up to 4000 miles on the VHF – UHF amateur bands. Pending approval by NASA, AO – 6 will be launched in late 1971 or early 1972 and put into orbit about 1000 miles up, with a period of slightly less than 2 hours.

Radio equipment for AO–6

AO–6 is a joint venture by American, Australian and German radio amateurs. Australia will contribute a four-channel FM translator which will receive on 145.8, 145.85, 145.9, 145.95 MHz and transmit on 437.2, 437.25, 437.3, 437.35 MHz.

The receiver achieves quite startling performance figures, using a combination of ICs and FETs which results in a noise figure of 0.8 dB and sensitivity of 0.18 µV for 20 dB quieting.

The transmitter uses bipolar transistors and IGFETs to produce an FM signal at 216 MHz and a small varactor to double to 432 MHz. The transmitter output is 1 watt, with an overall efficiency of better than 33%. Maximum deviation is ± 5 kHz.

Before being accepted by NASA, all equipment must undergo very rigorous testing. One of these tests is the RF susceptibility test, where the equipment is subjected to electromagnetic radiation over the full range of 20 kHz to 10 Ghz. If the equipment reacts adversely at any frequency, it is rejected.

Germany is contributing a linear translator which will receive any mode of transmission on the 430 MHz band and transmit on the 144 MHz band, with a band-width of 50 kHz. Receiver sensitivity is about 2 µV and transmitter power 10 watts. The unusual feature of this transmitter is its extreme efficiency.

A third translator has been proposed as a backup system, receiving on 2 metres and transmitting on 10 metres.

Telemetry and command system.

AO–6 will transmit 60 telemetry channels in standard radio-teletype code. The telemetry can be received by conventional RTTY machines, without need of special interpretation. This will be the first small satellite to incorporate real-time readout telemetry.

Thirty-five channels for command will be available also. AO–6 will have extensive remedial circuitry to track down the cause of a malfunction so that if, for example, a transmitter breaks down, the telemetry can be put into single-step mode to look at the voltage and currents of various parts of the circuit. By finding out the weak points of the system, similar failures can be guarded against in the future.

Another unique feature of AO–6 is the ability to take limited corrective action by command. Each piece of radio gear can be patched into each-other on command, allowing best use to be made of operational equipment.

The whole command and telemetry system uses about $24,000 worth of integrated circuits, which were donated by RCA, and achieves the very low power consumption of 5mA at 15 volts.

The satellite will be controlled by several command stations strategically located around the world.

Expected performance.

AO–6 is powered by a 6" x 6" x 6" nickel-cadmium battery pack which is charged by some 500 solar cells. When battery voltage drops below a predetermined level, the system shuts down to allow recharge. This may take up to two days after heavy use. When the battery voltage returns to a high enough level, operation resumes as before, except that a different translator is brought into operation.

The satellite uses 12 aerials. The receiver aerials are circularly polarised and the transmitter aerials are quarter-wave whips.

It is expected that a standard carphone type of 2 metre transmitter working into a simple dipole aerial will be sufficient to get into the translator, but for receiving, a high-gain aerial and a good receiver, preferably with a masthead preamp, will be required. The aerial must be circularly polarised, otherwise severe fading will be experienced as the satellite spins.

In view of the tremendous speed of the satellite, Doppler effect will be quite noticeable and single sideband signals, although very efficient and narrow-band in nature, will suffer considerably when the satellite is moving either towards or away from both transmitting and receiving

... Of course, working through the German translator will have some disadvantages.

IN ORBIT

stations. When it is in an intermediate position the shift will tend to be cancelled out by the fact that, if the satellite is moving towards the transmitter, it would be moving away from the receiver and vice-versa.

The maximum Doppler shift will be about 11 kHz on the downlink, which places limitations on the number of channels available when using the German translator and will make automatic frequency control desirable when using the FM translator. Morse is the best mode to use bandwidth-wise – but remember that contacts will only last about 5 minutes, which does not give you much to say if you are sending morse.

AMSAT-OSCAR 6 will no doubt open up a new dimension in amateur radio and prove a striking demonstration of the technical competence of the amateurs who have compressed the most modern advances in telecommunications into this amazing 14" x 13" x 10" package.

MARINE COMMUNICATIONS RECEIVER

A new transistorised marine communications receiver is available from R. H. Cunningham Pty. Ltd., with full coverage of the HF band from 1.5MHz to 30MHz in four ranges, together with a 300-550kHz marine band. Instant selection of the international distress and calling channel (2182kHz) is also provided, with a built-in crystal controlled converter unit. An audio filter (6dB, bandwidth of 180Hz) and tunable BFO are provided for CW reception.

Sensitivity on the AM band is 15μV for 15dB signal to noise ratio, and for all other ranges 5μV for 15dB S/N.

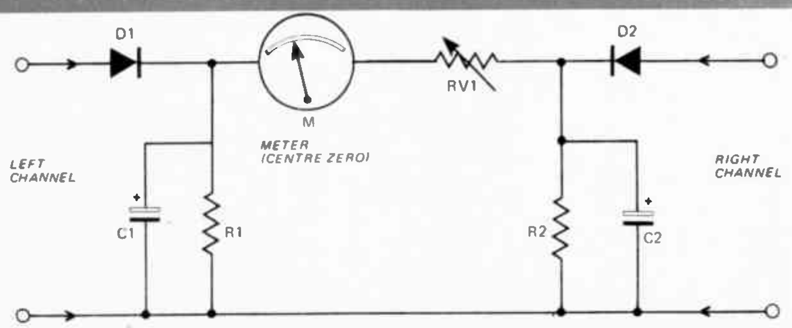
Thirteen transistors and seven diodes are used in the single conversion unit which has an efficient AGC system, with a characteristic of less than 12dB change in output for 80dB increase in input level. Audio output is via a 3Ω loudspeaker up to 1W, 600Ω balanced or unbalanced line for remote listening positions, or a low/medium impedance headset. Provision is made for desensitising when the EC10A2 is used with an associated transmitter.

The receiver can be operated from 12V or 24V dc supplies with positive or negative earthing. Zener regulation is employed throughout.

Three versions of the EC10A2 receiver are currently available – one for bench mounting and two suitable for installation in standard 19in. racking.

The rack mounting versions are available with one, or two, panel-mounted loudspeakers, one of which is available for use with ship intercommunications systems, etc. The internal loudspeaker is retained to facilitate conversion to bench mounting, should this be required at a later date.

The bench model EC10A2/1 is 12.5 in. wide x 6.37in. high x 8in. deep and weighs 14 lb. The rack mounting versions have a 19in. x 7in. panel and weigh 16.25 lb.



A BALANCE METER FOR YOUR STEREO

ETI PROJECT

THIS simple addition to your stereo amplifier provides a visual means of balancing the outputs from the two channels.

The output from each channel is fed via a blocking diode to a centre zero milliammeter. A series potentiometer provides an adjustment for total meter deflection, whilst capacitors C1 and C2 ensure that the meter responds only to average signal level — ignoring transients.

The balance meter can be built into existing amplifiers or located externally. Neither layout nor selection is at all critical.

PARTS LIST

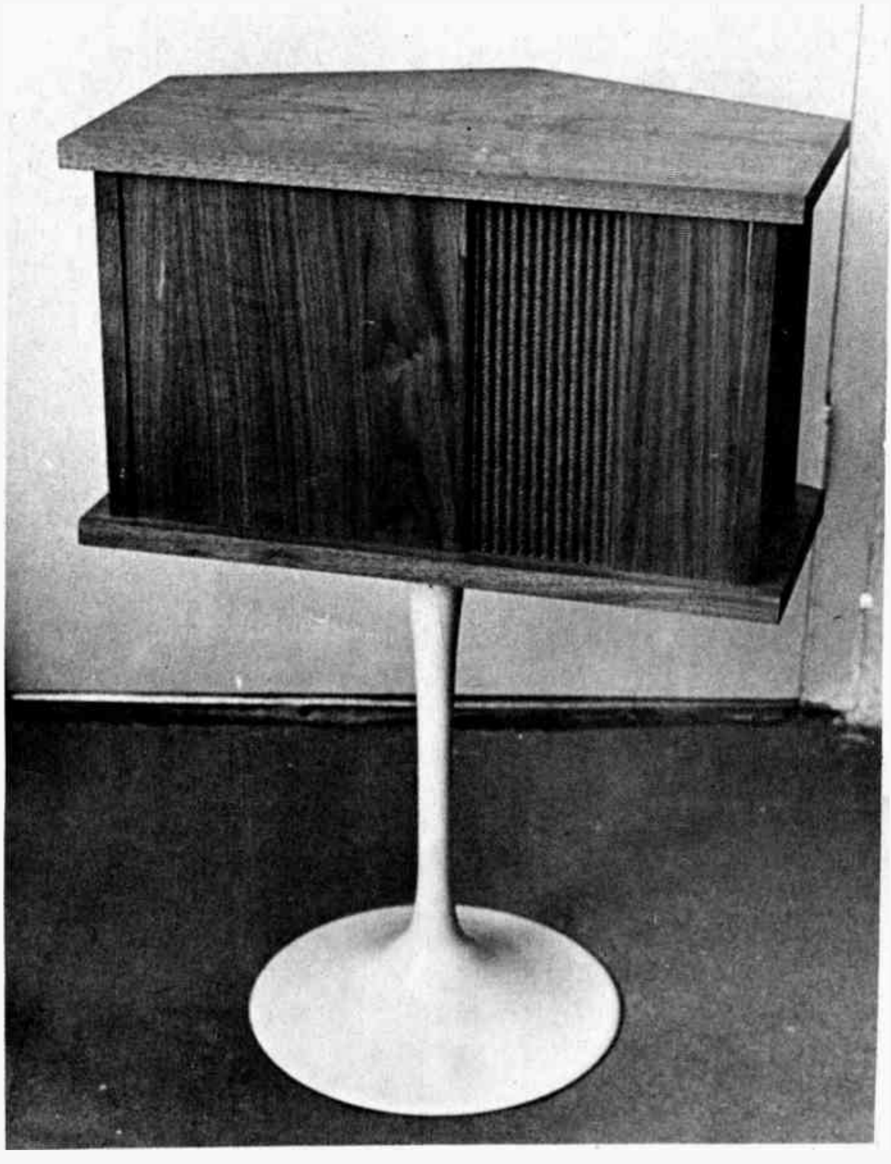
Meter	– *Centre zero milliammeter, one milliamp full scale deflection.*
RV1	– *Potentiometer — linear ½ watt 10k.*
R1	– *Resistor 4.7k ½ watt 5%*
R2	– *Resistor 4.7k ½ watt 5%*
C1	– *Capacitor 100 µf – 25 volt*
C2	– *Capacitor 100 µf – 25 volt*
D1	– *Diode EM401 or similar*
D2	– *Diode EM401 or similar*

SOUND ON THE REBOUND

electronics TODAY product test

First Australian test of Dr. Bose's revolutionary reflected-sound speaker system

Front of Bose 901 speaker enclosure, right-hand; left-hand unit has aperture at left.



The most talked-about speaker systems to be released in America in the last few years are undoubtedly the Bose 901's. There are those who swear they are the nearest thing to the original sound and others who say other things. For whoever heard of a speaker system of such minuscule size that can handle over 100 watts of continuous power and still provide an excellent bass response?

Developed by Dr. Amar Bose, a full-time lecturer in acoustics at the Massachusetts Institute of Technology, the Bose 901 is the culmination of over ten years of research into the problems of logical loud speaker design.

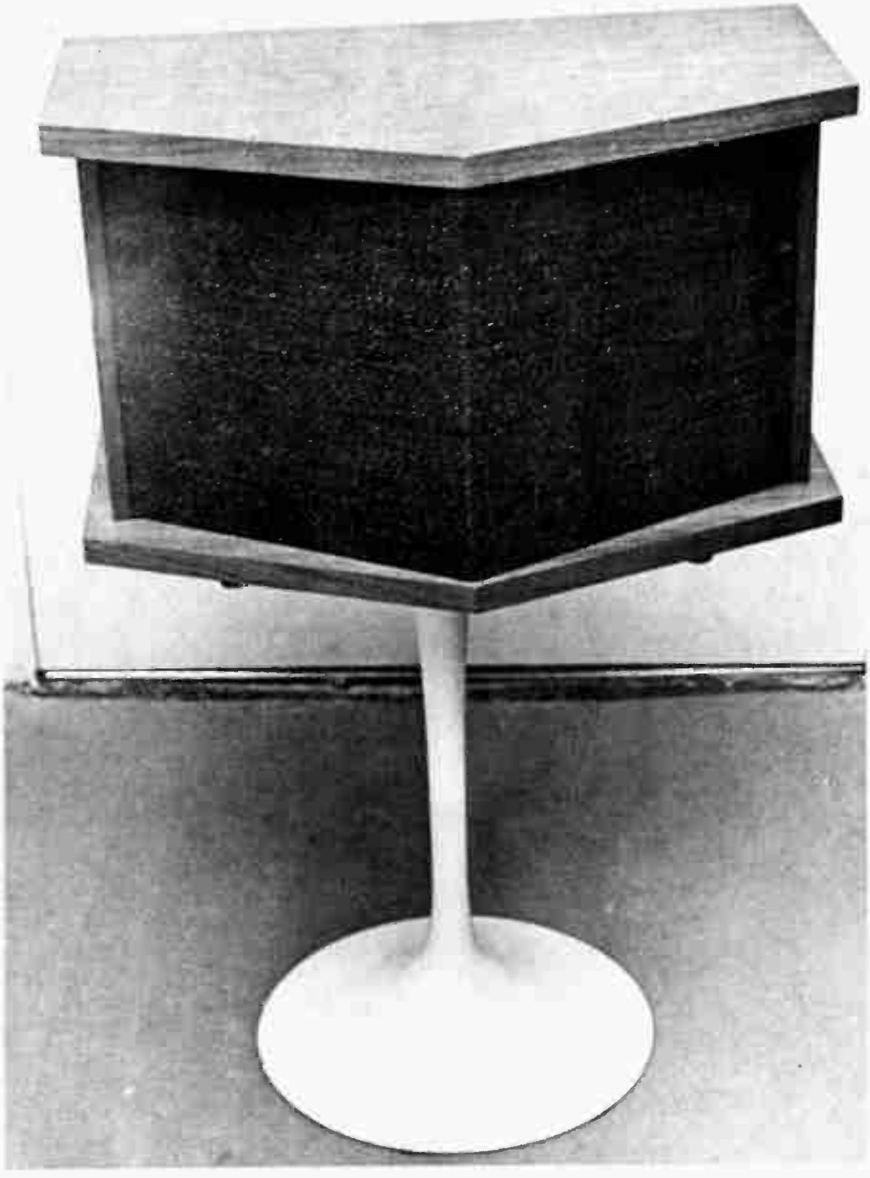
The Bose 901 speaker system is unusual and differs in design concept from all other conventional systems.

If we consider the construction of a normal high quality speaker system, it consists of three or more driver units in a tuned enclosure of relatively large dimensions, with all the driver units facing the same direction. The speakers are subject to the normal design constraints of cone size, enclosure volume, enclosure port dimensions and crossover networks.

In designing the Bose 901 speaker system, each of these constraints has been treated in a different manner. The initial assumption is that, in a concert hall situation, only approximately 10% of the sound perceived by the audience is radiated directly from the source — the remaining 90% is reradiated from the reflecting surfaces of the auditorium. The Bose 901 speaker system has therefore only one of its nine speakers directed towards the front of the

Control panel of active equaliser. The equaliser is inserted between the existing pre-amplifier and main amplifier.

Rear of speaker enclosure. Eight of the unit's nine speakers face rearward.



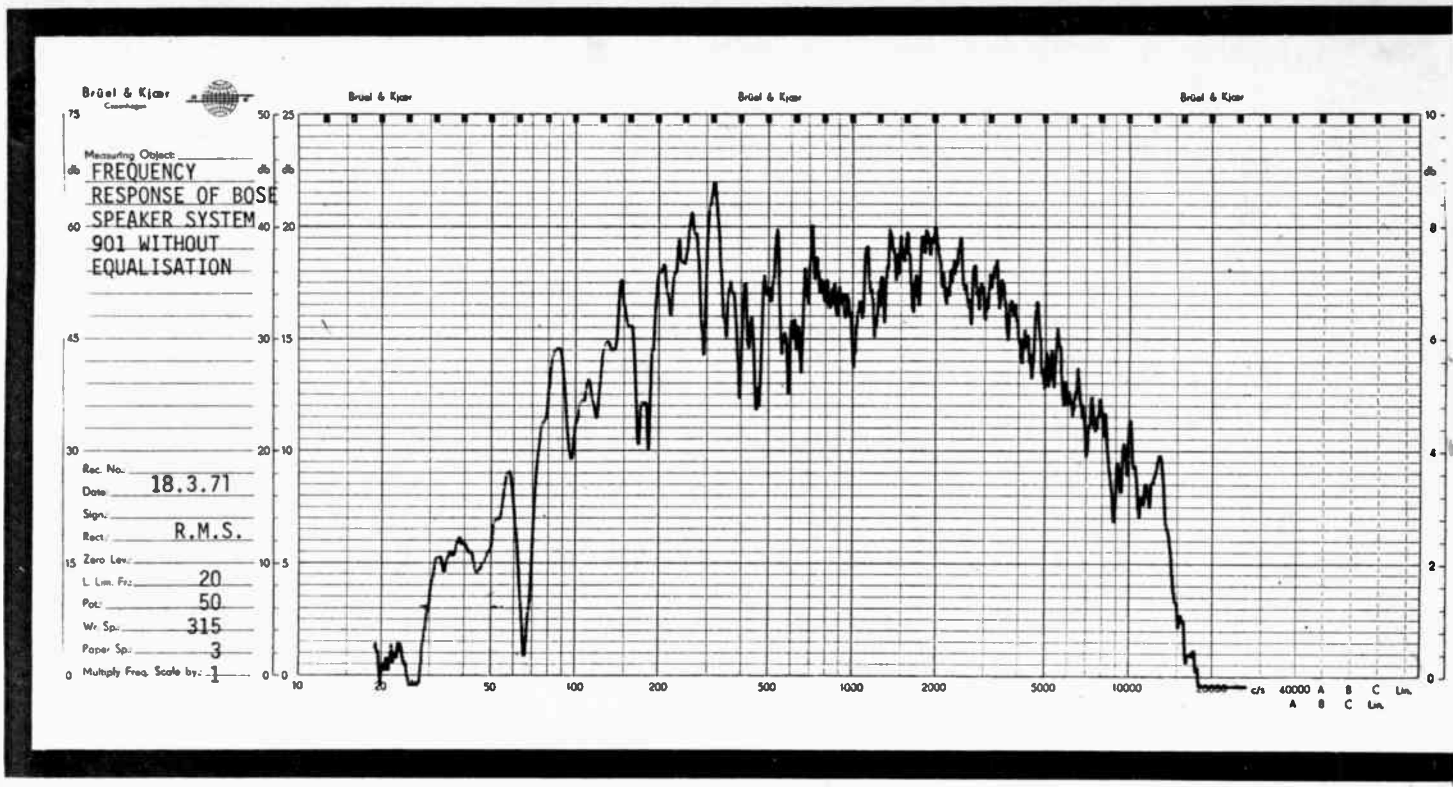
enclosure. The other eight are directed to the rear 'V' of the enclosure and rely on reflecting walls to transmit the sound to the listener.

It has been commonly held that a speaker system should contain a large bass radiator. In many systems the bass radiator is up to 15" diameter. The Bose system has only 4" diameter full range speakers, and the bass content is therefore only radiated from these small speaker cones. The cabinet has a volume which would normally use the speaker resonance to lie in the region above 100 Hz, yet our measurements did not show any real evidence of this.

In order to overcome the frequency limitations imposed on the system, an equaliser provides the signal level adjustment that is necessary to compensate for the inefficiency of the small enclosure at low frequencies. This is inserted in the amplifier chain; the equaliser also compensates for the inefficiency of the speaker diaphragms, which are fairly critical at the high frequencies. To check the effect of the equaliser, we performed measurements on the speaker system which proved that the equaliser provides up to 30 decibels boost at the high and low frequency ends of the spectrum.

SETTING UP FOR TESTS

The actual measurements of speaker performance posed many problems. Because of the reflected sound from the rear we could not test the speakers in the normal manner, which calls for a rear reflecting wall. Because of the mode of sound propagation, side walls are also an advantage. We finally



SOUND ON THE REBOUND

decided that, if the Bose literature was correct, the speaker should perform best in an average living room that was not too live and was without any severe acoustical defects. We therefore set up for testing in a normal living room. The setting up of the speakers proved to be fairly simple, although the instructions with the speaker hinted of possible difficulties:

'The distance of the speakers from the wall is very important . . . for best results . . . (the speakers) *should be between 12 and 18 inches from the wall and never closer than 6 inches, nor further than 24 inches.'*

Similarly, fairly tight restrictions were placed on the height from the floor.

INSTRUMENTATION TESTS

The measurements which we conducted indicated that consistently good results were obtained, provided the distances given on the instructions were adhered to. Strong opposition was voiced by the lady of the house regarding speakers which were not either in the corner or against the wall, but it was conceded at a later stage of the testing that maybe the sound obtained justified the disastrous effect on the room decor.

When testing, we tried several positions in the room to see how the response differed from place to place. It was found that response was consistently good, with a uniform high frequency response resulting under most conditions.

Having experimented with all the parameters associated with speaker positioning, we tried the real test — the frequency response. We found that, with the equaliser in its nominal 'flat' position, the high frequency response was slightly lacking. We attributed this to the relatively large area of lined drapes in the room, which provided acoustical absorption at the high frequency end of the spectrum but virtually none at the mid

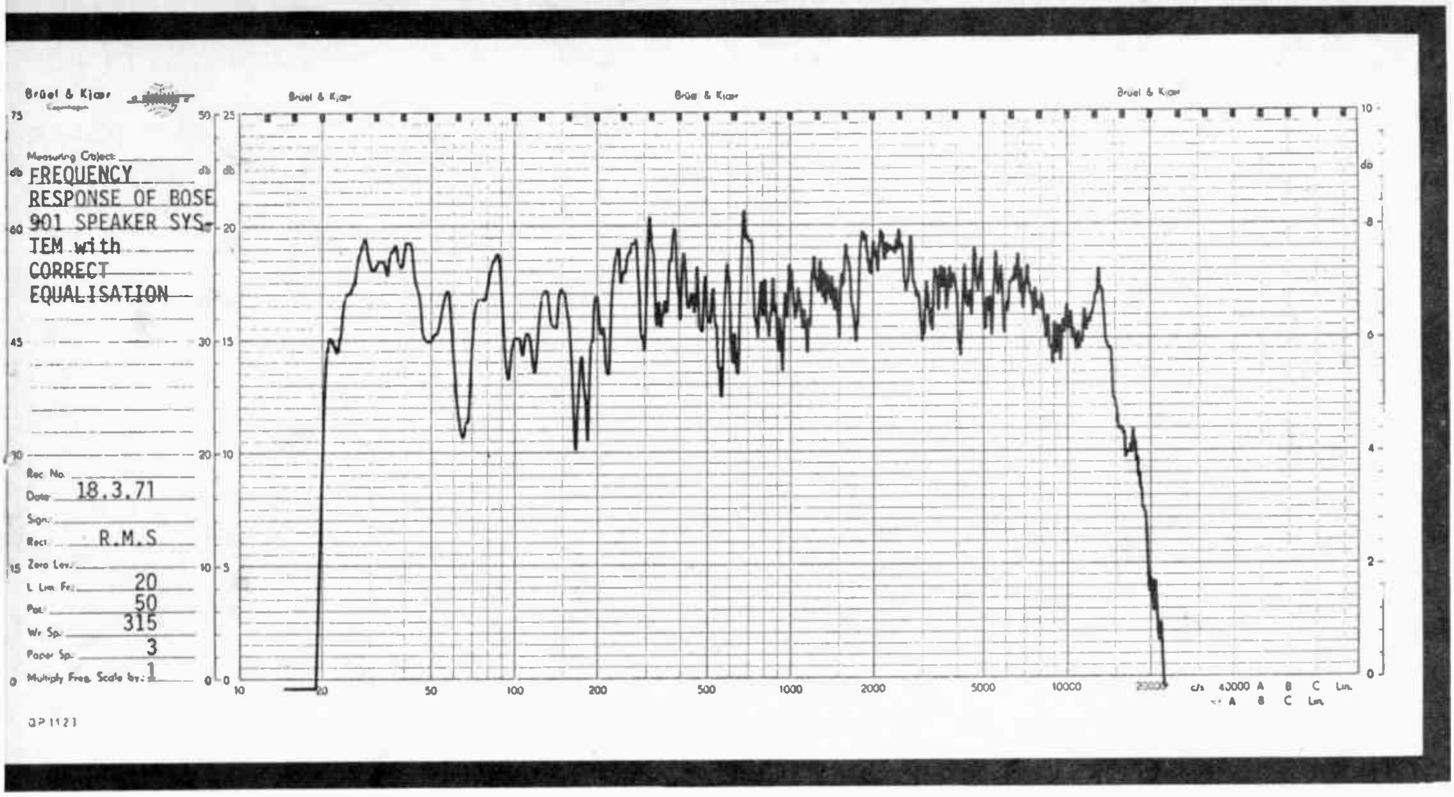
MEASURED PERFORMANCE OF THE BOSE 901 SPEAKER SYSTEM

Frequency response unequalised in room with 0.6 seconds reverberation time:	100 Hz - 7 kHz ± 10 decibels
Frequency response optimally equalised in room with 0.6 seconds reverberation time:	25 Hz -14 kHz ± 10 decibels

Distortion: less than 3% at frequencies between 100 Hz and 10 kHz.
Sensitivity: Due to active equalisation prior to the final amplifier, this figure has little significance when compared with other speaker systems.
1 watt equals 92 dB re 0.0002 m.bars at 6' on axis at a frequency of 1 kHz.

Power handling capacity:	not measured but greater than 100 watts at frequencies above 100 Hz
Directional characteristics:	truly diffused in a home living room environment.

Price $845 pair



frequencies or low frequencies. In other rooms the high frequency performance would probably have been very satisfactory with the equaliser in its 'flat' position.

By using the boost on the equaliser, we obtained a frequency response which was extremely flat to 15 kHz and then began to roll over rapidly. While this falls short of the 20 kHz performance which is strived for and seldom achieved by speaker manufacturers, if you are over 40 you will probably never know the difference, due to the limitations of your hearing — and even if you are under 40, the lack of programme content above 15 kHz will mean that the difference would be barely audible to the most devout audiophile.

The low frequency performance was very clean down to 20 Hz. The performance in this region was really excellent for any speaker system and totally unexpected for a system of the size of the Bose 901.

LISTENING TESTS

Having performed purely instrumentation tests so far, we decided to try a full listening test. First record we tested was 'Switched on Bach' — Bach played on a Moog Synthesizer. This record, being a purely electrical creation, has a spectacular tonal range and is usually rather a good test record. Expecting great things, we were disappointed when the first really low frequency note was hit and came out sounding like the noise from a jackhammer. A quick mental calculation showed the reason why.

If you like your music fairly loud, you probably have about 100 milliwatts of power at the mid frequencies. With the Bose speaker system, this means that you will need 100 watts at 20 Hz to produce the same level. The amplifier we were using to drive the Bose speaker system was only capable of delivering 40 watts. The message was clear: the Bose system requires a very large amplifier to deliver the goods under all conditions.

We retested the Bose speakers with a twin 150 watt amplifier, and the power handling capacity of the speakers proved to be beyond expectations. The low frequency performance was flawless and the sound rich, without any trace of coloration at deafening levels of sound.

Accepting the limitation of the low-frequency end of the spectrum, due to the amplifier, we tried some more conventional music through the system. The lower level of very low frequency components enabled the amplifier to cope. The end product was music that was almost as good as the original.

The diffuse sound from the rear of the speakers was above average and, in our opinion, is the major advantage of the Bose as it provides a sound field which seemed to fill the 'hole in the centre'. We subsequently performed additional laboratory tests with our amplifier with an output damping factor of greater than 1000 at frequencies up to 1000 Hz. Whilst this may seem to be gilding the lily, the effect on the low frequency response at high power levels was even more marked than that achieved by using a more powerful amplifier.

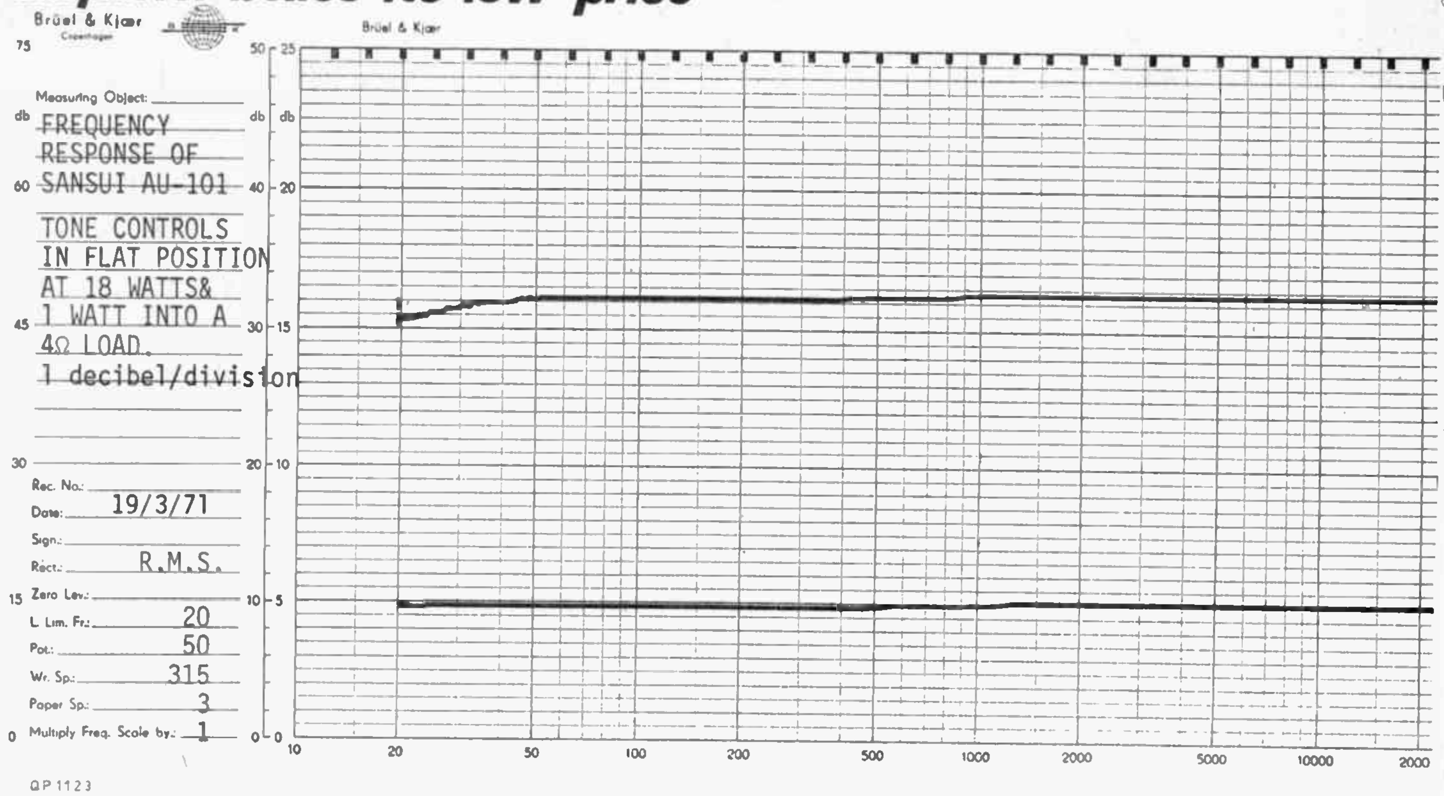
The advertising material on the Bose 901 speaker system maintains that it is impossible to measure the quality of the Bose speakers. We would strongly disagree with that statement. On both instrumentation and listening tests, the result was the same — a first-class performance from remarkably small speakers.

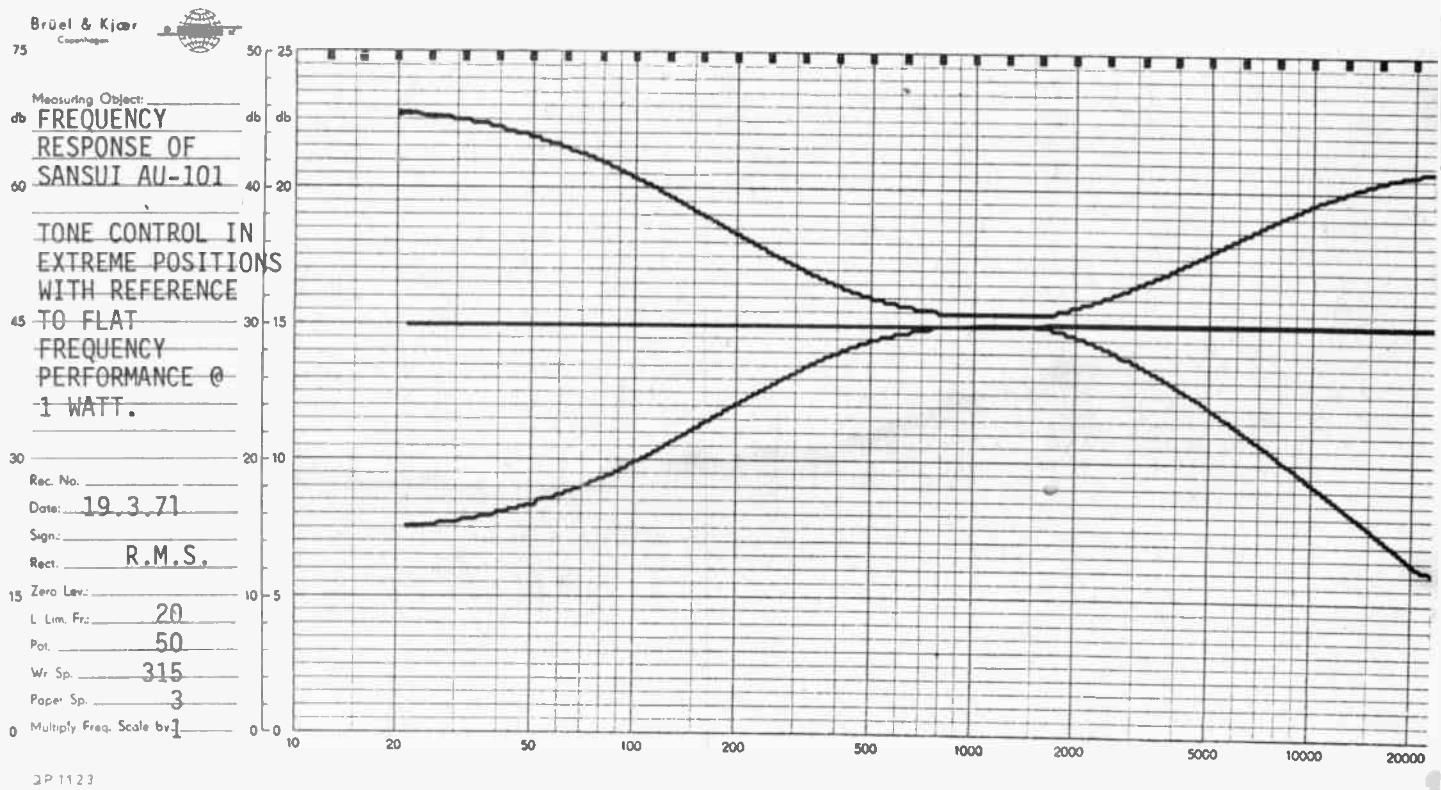
Our summation of the performance of the BOSE 901 speaker systems is that these speakers are a cleverly designed solution to a number of the most perplexing problems of loudspeaker design. They effectively achieve what they set out to provide — that is, better acoustics in the normal home environment. In order to achieve their optimum performance you will need an amplifier with not less than 30 watts R.M.S. output capability under optimum conditions, and normally 60 watts R.M.S.

These speakers sound better than they look — and so they ought to at the price. ●

SURPRISE

Performance of Sansui AU-101 stereo amplifier belies its low price





PACKET

electronics TODAY product test

There is an old saying that looks can be deceiving, and the Sansui AU-101 amplifier is a fine example of how one can be caught out. Having been told that this amplifier is the cheapest of the manufacturer's range, we made the mistake of thinking that the performance would be poor in comparison to the rest of the range.

Sansui are currently one of the best-known Japanese hi-fi manufacturers, and the release of the AU-101 marks a departure from what we have previously regarded as their forte – namely, the manufacture of expensive equipment.

The AU-101, which came packed in a simple cardboard carton, is what can only be described as a 'no frills' amplifier. The case is matt-black painted steel, with veneered wooden ends and black anodised aluminium face. The bright anodised aluminium knobs for the six main controls of power, bass, treble, balance, volume and microphone and auxiliary selector, are set in a row in the upper half of the panel, whilst the minor controls for speakers on/off, loudness control and tape monitor are effected by black aluminium levers placed in a row below.

The other facilities provided are a headphone plug, a microphone plug, and a tape monitor playback DIN plug. The rear panel contains R.C.A. plugs for phone (magnetic only) auxiliary input, and record and playback plugs for a tape recorder or tape deck.

The speaker outputs are provided by large, well-spaced screw terminals with slots large enough for a five-cent piece. The only other facilities are one switched and one unswitched American (or Japanese) type mains outlet, a fuse, and the mains voltage selector for 100, 117, 220 and 240 volts ac. The mains cord is two metres long and comes fitted with an Australian 3-pin plug.

The inside of the amplifier is an eye-opener, for the circuitry boards used are so small that it makes one wonder why such a large case is necessary. However, there is method in this madness, for this has obviously been done to facilitate stacking of multiple units of the same basic dimensions, such as the QS1 Quadphonic Synthesizer and other units in the Sansui range.

The circuitry is neat. All the transistors, apart from those in the output stage, are silicon planar. The preamplifier stages are mounted on a printed circuit directly under the main controls. This is a logical and practical step, for with such high gains (70 dB) poor layout would easily result in instability even at ultrasonic frequencies. The main amplifiers have a single-ended push/pull configuration, using 5 N.P.N. transistors and one P.N.P. capacitively coupled to the speaker.

The main amplifier and its associated heat-sink is placed on the bottom of the chassis and provided with a demountable cover underneath for rapid access to the underside of the printed circuit. This seemingly simple step will save up to an hour or more in a fault-finding exercise.

Amplifier thermal stability is well provided for by two compensation bias diodes mechanically clamped to the output transistor heat sinks. Finally, overload protection is effected

SURPRISE PACKET

by two fast-blow 1½ amp fuses in the main supply to each amplifier, and whilst very simple, they proved to be extremely effective against over-driving short circuits, and every other abuse that we tried.

The measured performance of the amplifier is very good. The frequency response is exceptionally flat under all conditions of loading and the distortion is exemplary, being less than 0.8% under all conditions of testing.

The intermodulation distortion was particularly good, being 0.3% at full load and less than 0.1% at 1 watt output.

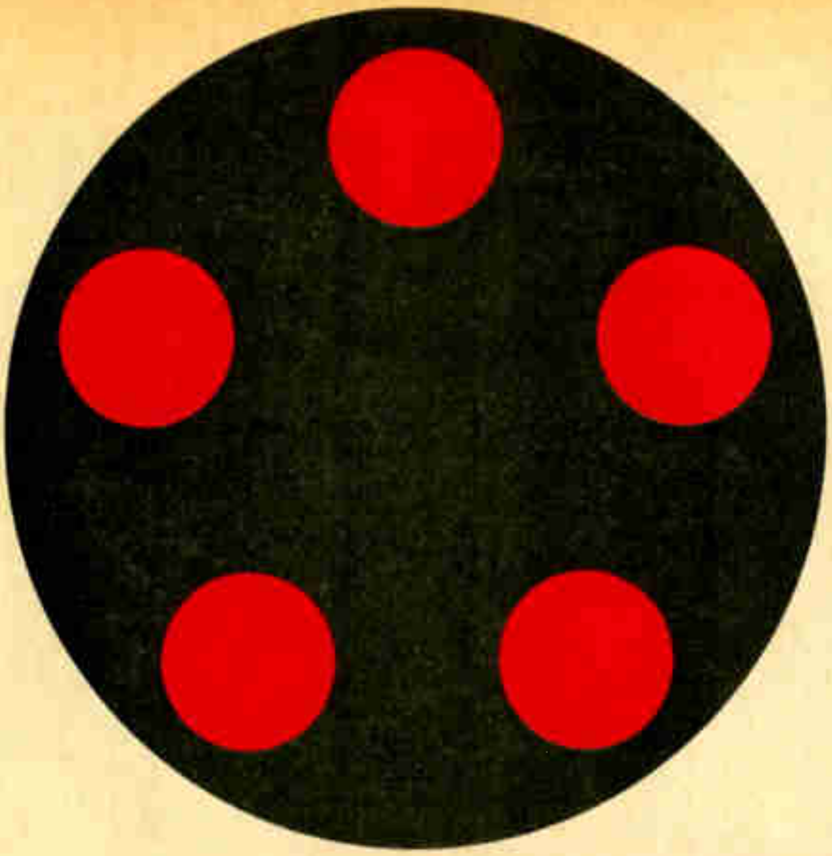
One of the features we liked best was the output damping factor of 70. This is the best damping factor we have seen in any amplifier under $300, and there are many amplifiers at $600 which don't have as good a damping factor. This means that both the base and transient response of the loudspeakers attached to the amplifier is immeasurably improved when compared to that provided by an amplifier with a damping factor of, say, only 20.

The hum and noise performance are both very good and better than most other amplifiers at twice the price.

By now it must be clear how wrong our original impressions were. Not only is the amplifier good, but it took all the abuse (both verbal and accidental) that we gave it and came out on top. The Sansui AU-101 is a very good buy, particularly at the price – and with the money saved by buying this amplifier you can afford better speakers or a better cartridge.

MEASURED PERFORMANCE OF SANSUI AU-101 AMPLIFIER S/N 020100203

Power output	18W + 18W rms into 4Ω load		
	15W + 15W rms into 8Ω load		
Frequency response:			
At 1 watt output:	20 Hz to 20 kHz ± 0.5dB		
At 18 watts output: (into 4Ω load)	20 Hz to 20 kHz +0–2dB		
at 10 watts output:	20 Hz to 20 kHz +0–2dB		
Channel separation at maximum power:	100 Hz at 38dB		
	1 kHz at 48dB		
Hum and Noise compared with Rated Power	Volume control – minimum gain		–82dB
	Max. gain phono input		–68dB
	Auxiliary input		–82dB
Input sensitivity – 1 kHz	Phono 2.5 mV		50 kΩ
	Microphone 3 mV		50 kΩ
	Auxiliary 190 mV		
	Tape monitor 190 mV		
Total harmonic distortion	20 Hz	1 kHz	10 kHz
at 1 watt	0.3%	0.2%	0.5%
at 18 watts	0.6%	0.7%	0.8%
Intermodulation distortion			
at 1 watt			0.1%
at 18 watts			0.3%
Tone controls	+14dB at 50Hz		
	–14dB at 50Hz		
	+9db at 10kHz		
	–12db at 10kHz		
Loudness control	+8dB at 50Hz		
	+3dB at 10kHz		
Power consumption	79 watts at 18 watts + 18 watts output		
Amplifier dimensions:	16" wide 4 9/16" high x 11" deep		
	Weight: 13 lbs.		
Price	$138.00		



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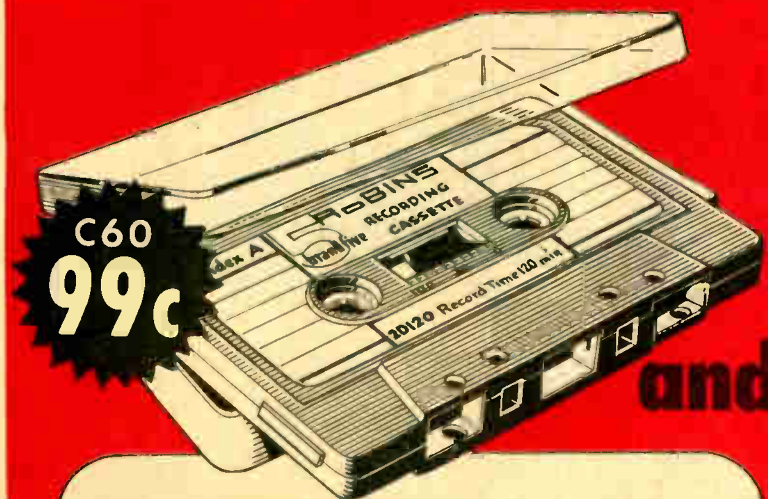

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Colour TV from moon

electronics in Space

A COLOUR television camera capable of transmitting pictures from space under all extremes of lighting has been developed in U.S.A. by the RCA Corporation.

Weighing only 4.53 kg. (just under 10 lb.), the camera has been built for NASA and is smaller, lighter and more sensitive to low light levels than any other television camera previously used in space flights. Sensitivity is such that the camera will attain full output when highlights of the image have a brightness of only 10.278 candelas/m^2.

The camera is immune to damage from sunlight, even when pointed directly at the sun.

This immunity to sunlight, and the ability to operate in low light levels, are due mainly to a Silicon Intensifier Tube (SIT) recently developed by RCA Electronic Components.

The image surface of the SIT consists of almost 400,000 individual silicon diodes, giving the tube a brightness magnification of 150,000. Normal television tubes have a smooth image surface of photo-conductive material that can be burned by bright light or damaged by vibration and is less sensitive to low light levels.

The SIT also enables the camera to provide fine detail on both very dark and very bright objects in the same scene — a capability not possible with previous tube technology.

The camera has been designed to survive the physical shock that might be encountered during the extended exploration of the moon. It measures 101 x 165 x 418 mm., including lens, and has a power consumption of only 13 W.

The camera's ability to operate automatically and to withstand temperatures from −157°C to 121°C allows it to be left on the lunar surface for moon-to-earth transmission of the lunar module lift-off and other lunar scenes, even after the astronauts leave the moon. If teamed with a transmission system and power source, it could survive the cold lunar night to monitor experiments or natural lunar phenomena without human attention.

The zoom lens fitted to the camera is variable from f2 to f22, providing a minimum focus distance of 1220 mm. at f2 and 460 mm. at f22. Transmission is at the United States standard commercial rate of 30 frames per second, 525 lines per frame. The system utilizes the technique whereby a series of one-colour filters (red, blue and green), carried on a revolving wheel, are passed sequentially in front of the lens and the images transmitted in the same sequence. *(Telecommunication Journal).*

A lamp to simulate the sun is directed towards the camera lens.

MESSAGE FROM VENUS

OFFICIAL Soviet sources confirm that the space probe Venus 7 continued to send data for 23 minutes after the calculated landing time. The report states that data signals received after the soft landing were 20 dB less than those received during descent (i.e., 100 times less).

The data indicates that the surface temperature of Venus is 475°C ± 20°C, and pressure is 90 kg/cm^2 ± 15 Kg/cm^2 (five to six times that of Earth). Atmospheric density is stated to be approx. 60 times that of Earth.

Hewlett Packard Correlator Model 3721A

An appraisal
By Murray Wood, BE, BSc, ME.
and Louis Challis, BE.

Correlation is the process of relating one object, phenomenon or quantity with another. It is a process of establishing similarity. To correlate two items, we might compare their physical dimensions, appearance, response to stimuli and so on, and assess the degree of correlation between the two. More formally, correlation is a statistical technique used to establish the connection between seemingly unrelated phenomena — for instance, is there a valid relationship between liver disorders and the use of aluminium saucepans? Or, say, productivity and weather conditions?

As applied to waveforms, correlation detects periodic signals buried in noise, establishes coherence between random signals, and establishes the sources of signals and their transmission times. It is a measure of the similarity between two waveforms. Its applications range from engineering, radar and radio astronomy to medical, nuclear and acoustical research, and include such practical things as determining noise transmission paths in buildings and measuring the speed of hot sheet steel in a rolling mill.

This article explains the methods and uses of correlation — in this case with the Hewlett Packard Model 3721A correlator.

Hewlett Packard Correlator Model 3721A

PROBABILITY DENSITY FUNCTION

We shall discuss two ways of describing a signal — the power spectrum and, its equivalent in the time domain, the autocorrelation function. Neither of these, however, gives any indication of *waveshape*. Power spectrum and autocorrelation function describe a signal's frequency content, but do not characterize its waveshape.

No problem arises if the signal can be described by a simple expression (such as $y = a \sin \omega t$) but, unfortunately, this is not always the case.

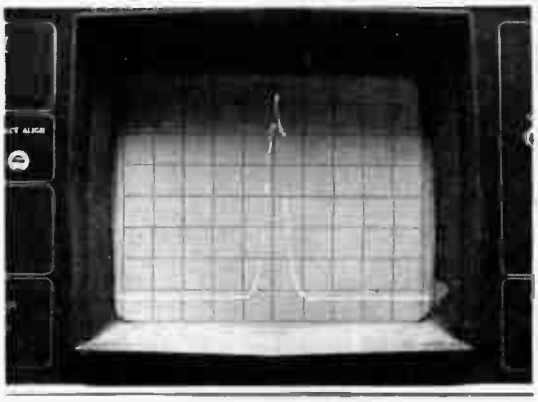
How can we describe a random signal (that is, noise) for which no expression can be found? Noise, by definition, is non-periodic and therefore cannot be specified by a simple time-varying function.

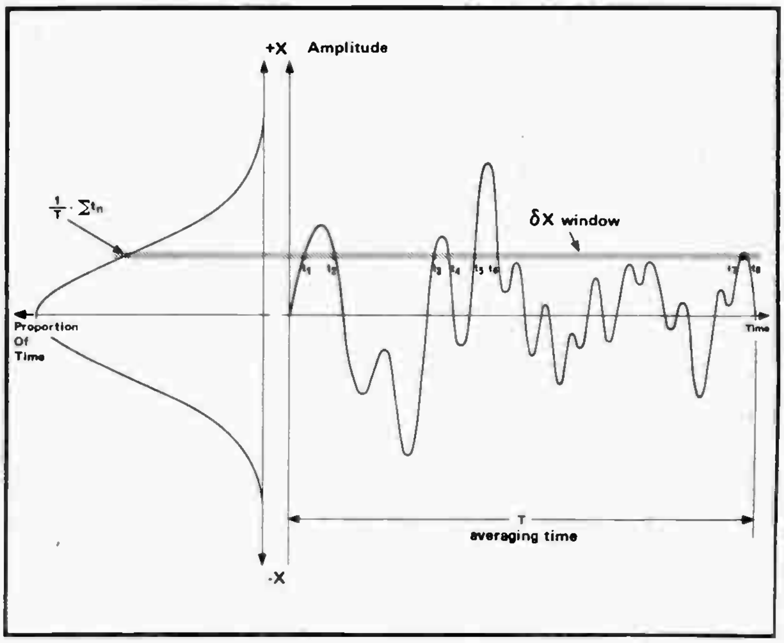
We can establish the power spectrum — and hence autocorrelation function — of a random signal just as we can that of a periodic signal. The spectrum alone may be all that we need to know about the signal in many instances but, for some purposes, we must have a means of characterising a random signal's amplitude behaviour.

To do this, we determine the *proportion* of time spent by the signal at all possible amplitudes during a finite period of time. In practical terms, this means totalising the time spent by the signal in a selection of narrow (δx) amplitude windows, and then dividing the total for each window by the measurement, or averaging, time (T). The curve obtained by plotting the window totals against amplitude is known as the *probability density function* (pdf) of the signal.

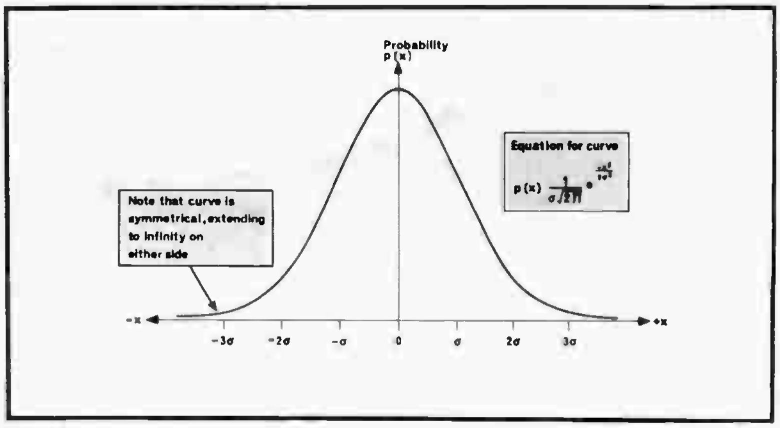
The most commonly encountered pdf (for naturally occurring signals) is a curve which has a particular mathematical function known as the *Gaussian* (that is, normal) distribution.

The amplitude (horizontal) scale of the pdf is calibrated in terms of sigma (δ), a symbol used in statistics to denote *standard deviation;* a measure of the spread of a set of values about their mean. In general δ is equal to the rms amplitude of the ac component of the signal. Power contained in the signal is therefore proportional to δ^2. We see from the pdf in Figure 2 — 10 that a Gaussian-type noise signal spends most of the time between $\pm\delta$, and hardly ever exceeds $\pm 3\delta$ (in fact, it exceeds this value less than 0.1% of the time). Theoretically, however, it is quite possible for very large peaks to appear, although at very infrequent intervals.





Probability density function of a noise signal



Gaussian probability density function

The process of correlation has long been known as a technique for improving the *signal-to-noise ratio* of a signal. The practical use of correlation techniques has been limited, however, because of the difficulty of performing the correlation.

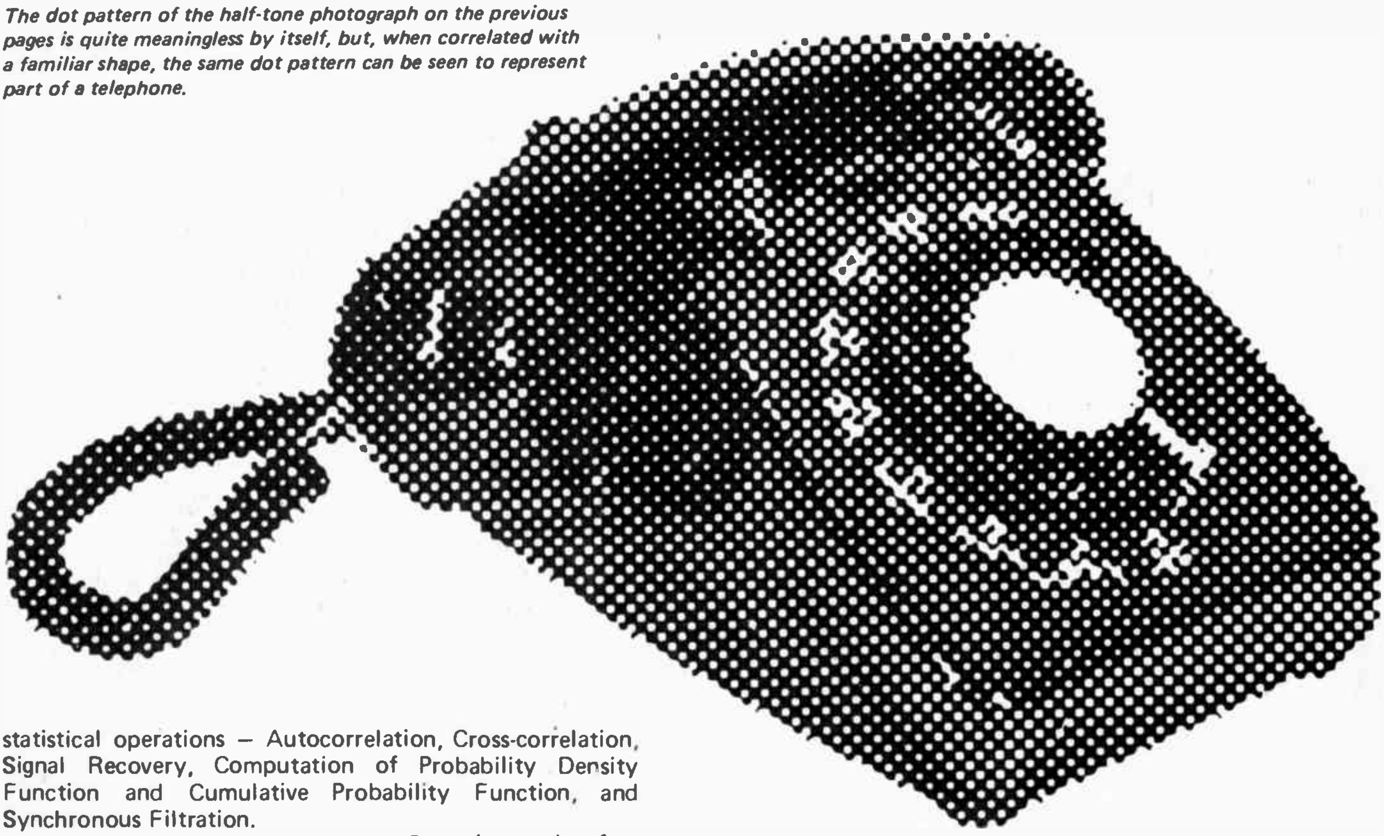
The advent of digital computers has made the technique more practical, but using a computer requires that the signal be recorded in the field and analogue to digital conversion performed before the correlation function can be obtained.

This technique is not practicable, except in the most specialised application.

Recently Hewlett Packard released a new time correlator which allows correlation measurements to be performed in the field. The theory and methods of using these techniques to obtain information about a statistical process involves the *ergodic hypothesis.* This hypothesis requires that the statistical properties of a signal remain constant over an infinite period. Although this hypothesis cannot be valid for any man-made signal, in practice it often applies with sufficient accuracy over a typical observation interval to allow its use.

The Hewlett Packard correlator can perform five distinct statistical operations — Autocorrelation, Cross-correlation, Signal Recovery, Computation of Probability Density Function and Cumulative Probability Function, and Synchronous Filtration.

The dot pattern of the half-tone photograph on the previous pages is quite meaningless by itself, but, when correlated with a familiar shape, the same dot pattern can be seen to represent part of a telephone.



The Autocorrelation function, $R_{xx}\ (t_1,\ t_2)$ of a waveform x(t) expresses the similarity between a waveform and a time-shifted version of itself, as a function of the same shift. The cross-correlation function, $R_{xy}\ (t_1 t_2)$ expresses the similarity between two different waveforms.

While the autocorrelation function and the cross-correlation function contain information about the spectral content of the signal, they do not give any information about the signal amplitude. The probability density function gives the proportion of time spent at all amplitudes, while the cumulative probability function gives the probability that the signal is less than a given amplitude at any given time.

Mathematically the autocorrelation function is defined as:

$$R_{xx}(t_1,t_2) = \lim_{T\to\infty} \left[\frac{1}{T}\int_0^r x\,(t_1)\;x\,(t_1 - t_2)\;d\,t_2\right] \qquad (1)$$

Or, using the ergodic hypothesis:—

$$R_{xx}(t_1) = \lim_{T\to\infty} \left[\int_0^r x(t)\;x\;(t-t_1)\;d\;t\right] \qquad (2)$$

Equation (2) is often written as —

$$R_{xx}(t_1) = \langle x(t)\;x\;(t\text{-}t_1)\rangle \qquad (3)$$

Although equation (2) implies a continuous averaging process, in practice it is usually necessary to use a form of discrete approximation.

There are two methods of discrete approximation commonly used. The most obvious method is to assume that the signal is composed of rectangular pulses of width Δt and height equal to the average height of the actual waveform over the interval Δt. The resulting approximation to $R_{xx}(t)$ is given by:

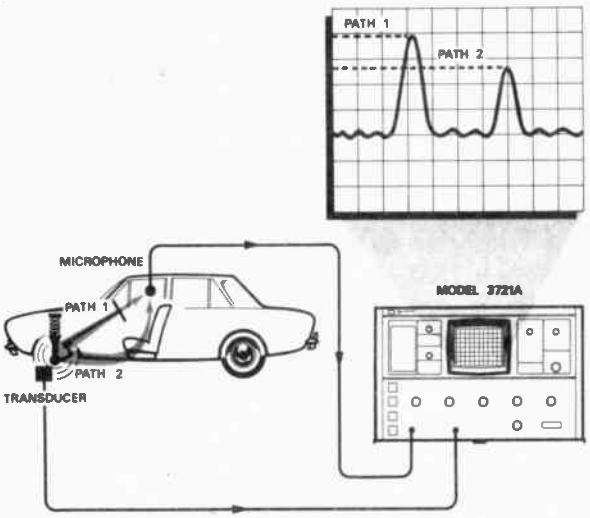
$$R_{xx}(t) \simeq \frac{1}{N} \sum_{i=1}^{N} x\;(i\Delta t\text{-}t) \qquad (4)$$

This is the principle used in a digital computer and in real time analyser computations.

In the Hewlett Packard correlator, the actual method of computation is designed to give an incomplete answer at each stage of computation. This is necessary because, in the slowest mode, the final answer may take days to obtain and it is advantageous to know that all is working correctly in the meantime and whether the answer will be meaningful.

There is a choice of two modes of summation: the first is a straight summation, while the second is an 'exponential' summation. The exponential mode is not truly exponential but a digitally computed equivalent.

Hewlett Packard Correlator Model 3721A



DETERMINATION OF NOISE TRANSMISSION PATHS BY CORRELATION

Unwanted noise and vibrations often travel via several different paths. If these paths can be determined, steps can be taken to minimize or eliminate their effects. Correlation techniques can be used to determine these paths.

For example, in the automobile industry, it may be desirable to determine the noise transmission path from the suspension of a car to the driver. This can be done by placing a transducer on the suspension and a microphone inside the car in the vicinity of the driver's head, and crosscorrelating the outputs of the transducer and the microphone.

In the example illustrated, the noise from the suspension is transmitted primarily through the steering column (path 1) and via the floor and driver's seat (path 2). The correlogram displays two peaks with time delays representative of the individual transmission path delays. Examination of the amplitude of the peaks will give a measure of the relative amounts of noise transmitted by each path.

The algorithm used for the computations in the averaging mode is —

$$R^{i}_{xx}(t) = R^{i-1}_{xx}(t)+\frac{1}{N}\left| x(i\Delta t) \ \times \ (i\Delta t\text{-}t)\right| \qquad (5)$$

Where $R^{i}_{xx}(t)$ is the computed function after i time intervals of Δt.

As can be seen, after N time intervals, the resulting correlation given by equation (5) is the same as would be given by equation (4). The algorithm used in the 'exponential' mode is slightly different, in this case —

$$R^{i}_{xx}(t) = R^{i-1}_{xx}(t) + \frac{1}{i}\left| x \ (i\Delta t) \ \times (i\Delta t\text{-}t) - R^{i-1}_{xx}(t)\right| \qquad (6)$$

In the case $R_{xx}(t)$ approaches the 'true' value given by equation (4) in a time which is often greater than N Δ t. The advantage is that in low noise situations it can approach the value faster, and in high noise situations it enables the required observation time to be determined while the computation progresses. The intermediate answer is the correct amplitude on the screen, whereas the amplitude on the screen with the straight summation is proportioned to the ratio $\frac{i}{N}$.

The autocorrelation function has the following properties:-

(i) It is symmetric about $t_1 = o$, i.e. $R(t_1) = R(-t_1)$.

(ii) The maximum value occurs at $t_1 = o$, i.e. $R(o) > R(t)$ for all t_1

(iii) The value of $R_{xx}(o)$ is equal to the standard deviation of the signal, i.e. $R_{xx}(o) = \langle x^2 \rangle$.

(iv) $R_{xx}(t)$ is uniquely related to the power density spectrum of the signal by the following Fourier Transform pairs:

$$R_{xx}(t) = \int^{\infty} \phi_{xx}(f)\cos 2\pi ftdf \qquad (7)$$

$$\phi xx(f) = 2 \int_{-\infty}^{\infty} R_{xx}(t)\cos 2\pi ftdt \qquad (8)$$

Because of equation (7) expressing the autocorrelation function in terms of the power density spectrum, it is difficult to justify the increased complexity of this equipment if it is solely required to obtain the autocorrelation function. Simpler equipment is readily available to determine the power density spectrum. In theory, any information which may be obtained from computing the autocorrelation function may be obtained by narrow bandwidth filters. In some applications it is more convenient, however, to use the autocorrelation function. This is particularly true when the signal is immersed in high level noise and is of unknown spectrum.

A further possibility is that the frequency components of interest may be as low in frequency as $^{1/10}$ of a cycle per hour. To design a conventional filter that will work at these frequencies is not practicable.

The cross-correlation function between two signals x(t) and y(t) may be expressed mathematically as:

$$R_{xy}(t) = \langle x(t_1)\ y(t+t_1)\rangle \qquad (9)$$

The methods of computing the cross-correlation function are similar to those employed to compute the autocorrelation function. The approximation being:

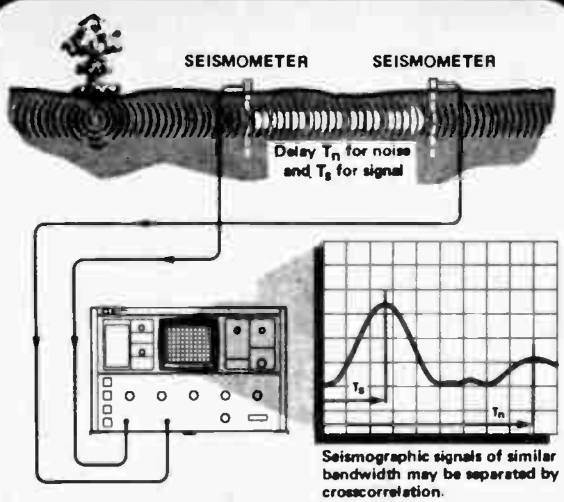
$$R_{xy}(t) \simeq \frac{1}{N}\sum_{i=1}^{N} x\ (i\Delta t)\ y(i\Delta t\text{-}t) \qquad (10)$$

Unlike the autocorrelation function, there is in general no relationship similar to equation (7) between the cross-correlation function and any measurements that may be made in the frequency domain.

The cross-correlation function does not have the clearly defined properties which the autocorrelation function has, its properties being determined by the properties of the two waveforms being cross-correlated.

The choice of summation or exponential averaging is also available is the Synchronous Filtration or Signal Recovery Mode. In this case, a cross-correlation between the incoming signal and an impulse which is repeated with the same period as the desired periodic signal is computed. Thus, the result of the cross-correlation is a replica of the periodic signal which is immersed in the noise. The spectrum of the filtered input signal may then be obtained by Fourier transformation. In this mode also, straight summation or exponential averaging can be chosen.

The Probability Density Function is simply obtained by

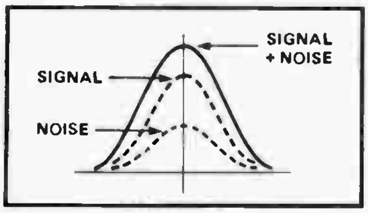


Seismographic signals of similar bandwidth may be separated by crosscorrelation.

CORRELATION DETECTION OF UNDERGROUND DISTURBANCES

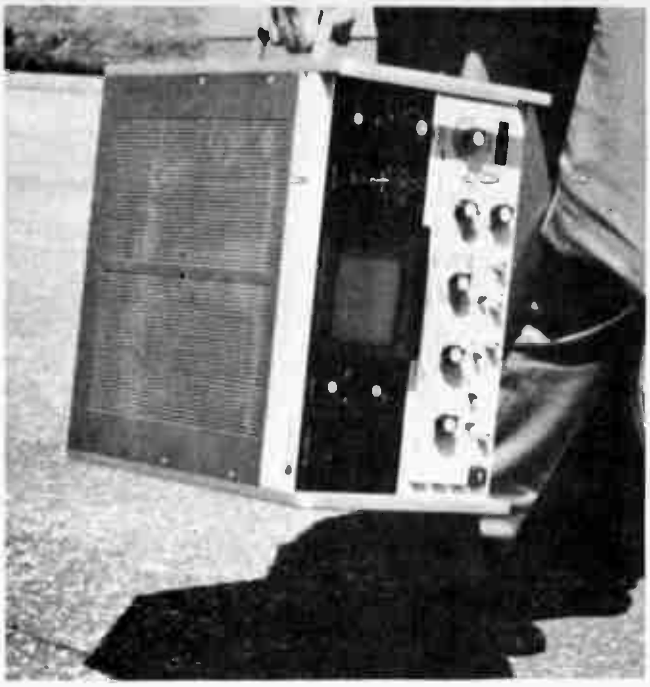
Correlation techniques can be used to detect (at great distances) underground disturbances such as nuclear explosions, earthquakes, etc. One approach is to autocorrelate the ground vibrations detected by a seismometer and inspect the autocorrelation function.

In practice, measurements of this kind are limited because of the natural background (microseismic) noise of the earth. The autocorrelation function of this noise adds directly the autocorrelation function of the signal (See



inset figure) and the resulting function is difficult to interpret.

It has been observed, however, that the earth transmits different modes of vibration with different velocities, and the difference in the time taken for the vibrations to travel between two seismometers may be used to separate signal from noise. Crosscorrelating the outputs of the two seismometers will yield a correlog ram with two peaks; one representing the noise and the other representing the signal. That is, the noise autocorrelation function will be shifted by an amount proportional to the difference in transmission velocities.



sampling the voltage input at the internal clock frequency and adding 1 to the appropriate register.

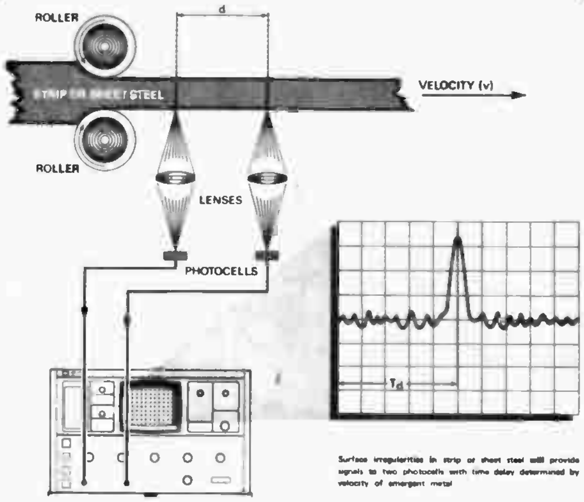
In the computation of the Cumulative Probability Function the same process takes place, except that one unit is allocated to the appropriate level and all those above it.

EVALUATION REPORT

The uses of this machine are vast. It can be used equally well in the design of missiles, in steel mills and in medical research; however, since we are primarily interested in acoustical and vibration phenomena, it was in these fields that we evaluated the instrument.

Our first task was to determine whether or not a high level of vibration that was occurring on a steam turbine, was due to a pressure pulsation known to occur in the control oil line.

The method used was to place a quartz crystal pressure transducer in the oil line and a vibration transducer in the affected part of the 'machine. The electrical outputs of the transducers were fed into charge amplifiers and then into the inputs of the correlator, to determine the influence of the pressure pulsation on the turbine vibration.



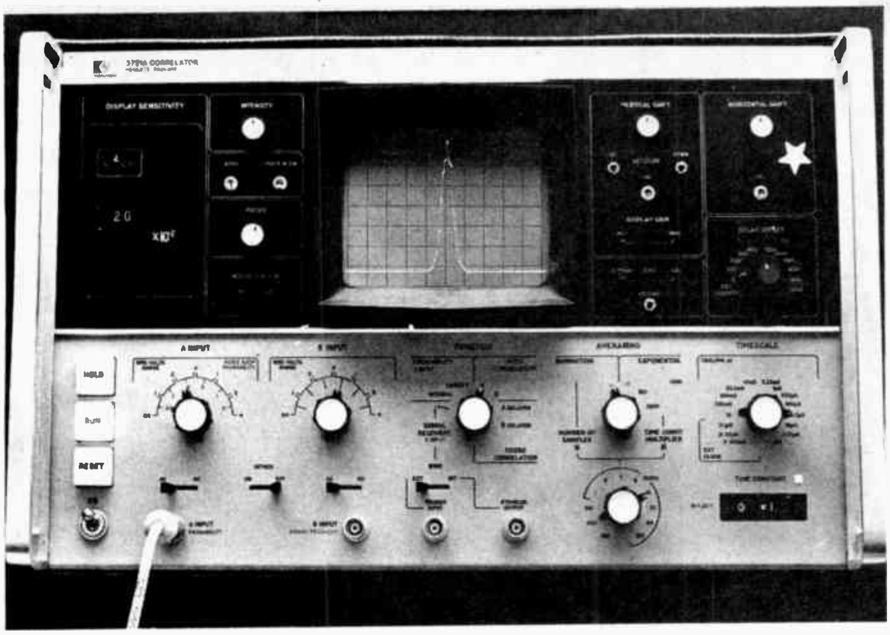
Surface irregularities in strip or sheet steel will provide signals to two photocells with time delay determined by velocity of emergent metal

CONTACTLESS VELOCITY MEASUREMENT USING CORRELATION

Measurement of the velocity of steel strip or sheet from a rolling mill is a difficult problem when the metal is cold, but when the metal is white hot, the difficulty is increased greatly. Contactless measurement of the velocity is possible, however, using a crosscorrelation technique.

When metal is rolled, its surface is not perfectly smooth and any irregularities will affect the output of a photocell which is focused on the surface. After a finite time, each irregularity will pass the focusing point of a second similar photocell placed downstream from the first one. Crosscorrelation of the two photocell output signals using the correlation will indicate the time delay T_d directly. If the photocell separation d is known, the velocity v of the strip or sheet leaving the rollers can be determined simply from:

$$V = \frac{d}{T_d}$$



USE OF CROSS CORRELATION TO DETERMINE THE TRANSMISSION LOSS OF A PARTITION

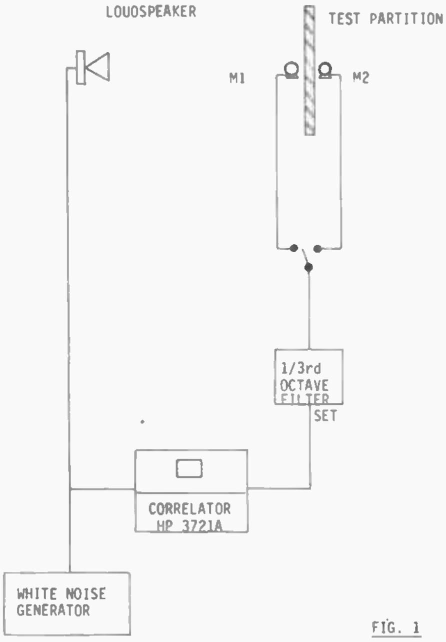


FIG. 1

The task of determining the influence of the oil pressure pulsation upon the machine without the correlator would have been extremely difficult and time-consuming. With the correlator we got our answer quickly – and the cross-correlation between the pressure pulsation and the vibration components proved conclusively that the vibration level on the turbine was not caused by the pulsation in the oil line.

Next field problem on which we decided to try out the correlator was to determine the transmission loss through a partition which had been installed in a new building. Because it had not been correctly installed, there was a large amount of sound leakage around the edges of the partition.

While it is possible to measure the transmission loss of the system as a whole, the data so obtained would be of no use to the manufacturer of partitions who wants to improve his product. We therefore set up the correlator to obtain the transmission loss of the partition itself.

The measurements rely upon there being a path difference between the most direct path (through the partition) and the less direct path (flanking the partition). We could, therefore, discriminate between the initial or wanted sound and the components which arrived later. While this

DETERMINATION OF THE ABSORPTION COEFFICIENT OF A REFLECTING SURFACE USING CROSS CORRELATION

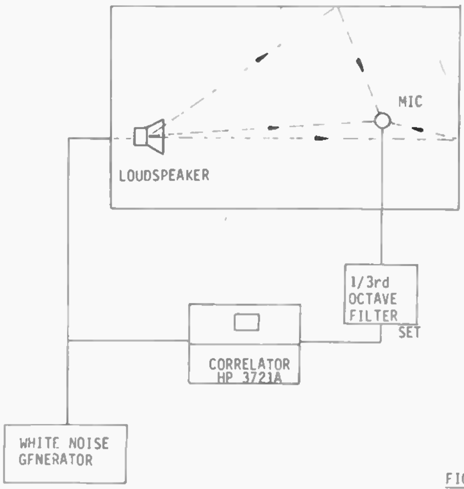
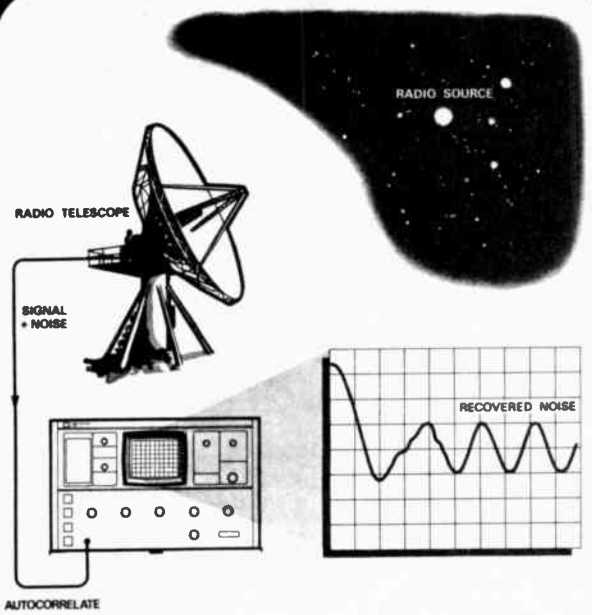


FIG.2



CORRELATION IN RADIO ASTRONOMY

The detection of very weak and very distant radio sources in space is carried out by high-gain radio telescopes. These telescopes are extremely sensitive to interference from random electrical disturbances, which tend to mask the small signals of interest. However, in some cases – e.g., pulsars – the signals of interest are periodic, and by using autocorrelation techniques, the periodic component of the received signal can be extracted from the noise.

The method is based on the principle that, after an appreciable delay, the autocorrelation function of the noise component will have died away to zero, but the periodic component will have a periodic autocorrelation function which will persist at all delays.

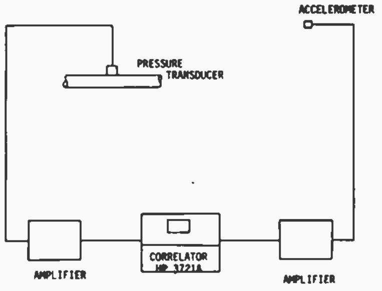
technique has some limitations (which are related to the size of the partition), it enables answers to be obtained where they would otherwise be unobtainable.

Third test we tried was the measurement of reverberation time of a studio. Normally this is performed by using a starting pistol or other impulsive noise source. In the current problem we could not use a pistol because of the likelihood of causing interference in adjacent areas. We therefore used white noise and the correlator to determine the impulse response. This technique does not require a high sound pressure level and is consequently less likely to cause interference. Since the white noise is continuous, it is less objectionable than a pistol shot even if it is audible.

While performing the reverberation time measurements, we were also able to determine the absorption of each surface of the auditorium from the echoes. This allowed the corrective treatment to be determined with the minimum of measurement time.

Our chance came to try the Signal Recovery mode when we wanted to determine the level of pressure pulsation in a gas line which was related to the pulsation created by the reciprocating compressor. The aim of the exercise was to determine the effect of treatment we had recommended. Because the gas flow velocity was very high, there was a considerable amount of turbulent noise generated in the piping which was, after treatment, far higher than the pressure pulsations from the compressor.

Normally we would have used our narrow band filter set, but on this occasion we decided to try the correlator in its signal recovery mode. To trigger the correlator, we used an accelerometer (or vibration transducer) and associated amplifiers and wave shapers. The pressure was detected using a pressure transducer and a charge amplifier.



EQUIPMENT USED FOR DETERMINING PRESSURE PULSATION & VIBRATION

FIG. 3

Using the Signal Recovery mode, the random components of the pressure variation are averaged out over a period of time while the components which are related to the triggering pulses are reinforced. Although in this test the same information could have been readily obtained with standard equipment, where phase relationships must be preserved, the signal recovery mode is more accurate than the use of narrow band filters because of the largely unknown phase distortion introduced by Tchebyshev or Butterworth filters (those most commonly used).

We did not test the Cumulative Probability Function and Probability Density Function facilities. While we use these frequently in our work, we require that these functions be done on a logarithmic basis. As our linear-to-logarithmic converter is not compatible with the Hewlett Packard correlator, we could not process information in the required form. Hewlett Packard do have an excellent linear-to-logarithmic converter, but we did not have time to obtain one. We tried the standard tests as suggested in the handbook, using a sine wave, square wave and white noise. Each produced the required pattern on the screen.

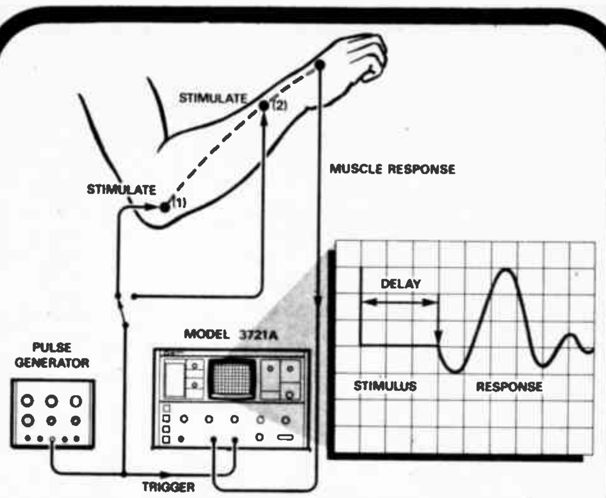
While we have only described the use of the correlator in one sphere of activity, there are countless uses for it which will be determined by the end user. The uses have one thing in common: when it is desired to determine a cause and effect in the presence of masking phenomena, particularly where there is a time delay between the cause and effect, the most logical solution is to use statistical techniques.

To date, the Hewlett Packard Model 3721A correlator is the best unit we have seen in terms of human engineering, the speed of computation and flexibility of use. The greatest limitation placed upon its use is the inflexibility of the person using it to adapt to a new method of analysis. We found that, after familiarising ourselves with the machine, the number of possible uses that came to mind was far greater than we would have at first imagined.

Realising the limited experience of time domain analysis, Hewlett Packard have produced an excellent instruction manual. The manual contains 120 pages divided into 5 major sections. The first section contains the basic ideas of the various modes of operation. The second section provides some theory of the techniques. The final three sections cover the computation system used in the correlator, how to use the correlator, and some of its possible applications.

The Hewlett Packard Model 3721A correlator is admittedly expensive (about the same price as a small digital computer) — but within the design scope of its computations, it is particularly efficient and accurate. It provides numerical (BCD) output to a computer, continuous outputs to an external oscilloscope or x-y recorder, and a built-in display unit. In places such as large manufacturing organisations, hospitals and organisations carrying out research it will prove to be far more efficient than a large digital computer for examining random phenomena, yet it is truly portable.

In the next few years we expect to see many of these units sold throughout Australia — and we forecast that correlation will become a basic research tool rather than the highly sophisticated and complex technique it is today. ●



SIGNAL AVERAGING IN THE STUDY OF NERVOUS DISEASE

Many diseases characterized by restriction of movement or paralysis are due to some failure of the nervous system rather than failure of the muscles themselves. A valuable indication of the 'fitness' of a nerve is its conduction velocity, i.e. the rate of transmission of electrical signals along its length. The simplest way to measure this velocity is to stimulate a nerve and measure the delay before the appropriate muscle contracts. A pulse is applied at point 1 and also is used to trigger the correlator which measures the response of a muscle in the hand.

By repeating the stimulus a number of times, the average response and delay time are measured. The stimuli are then applied at point 2 and the difference in the delay times gives the transmission time of the nerve between 1 and 2. If the distance between the points is known, the conduction velocity can be determined.

Electronics in Education

COLOUR TV AT MONASH

Monash University, in Melbourne, recently took delivery of a complete educational colour television unit, valued at $250,000.

The unit was a gift from Smith, Kline and French Laboratories (Australia) Ltd., pharmaceutical manufacturers. It includes colour cameras, monitors, projectors, a portable studio, lighting equipment and a mobile control unit.

DIPLOMA ELECTRONICS COURSE

A graduate diploma in Electronics will be available from Macquarie University next year. The diploma course will consist of a full year of full-time study, starting in February and ending in November.

Courses to be covered in the first half of the programme include the design of simple and multistage circuits for dc, audio, video, and band-pass applications in signal processing, logic circuits, etc.

Among subjects to be studied during the final half of the course are digital systems, computers, and control system theory. Students will also undertake the design and experimental development of an item of electronic measuring equipment.

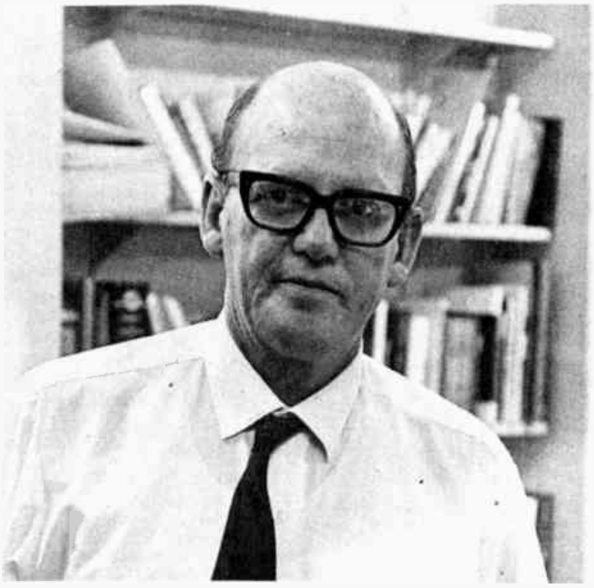
Responsible for the courses will be Professor R.E. Aitchison, who is at present Associate Professor of Communications Engineering at the University of Sydney.

Professor Aitchison graduated as Master of Science from the University of Sydney. In 1949 he undertook research in solid-state physics at the H.H. Wills Physical Laboratory at the University of Bristol, and in 1959-60 he spent a year at Stanford University, California, teaching and researching in that field.

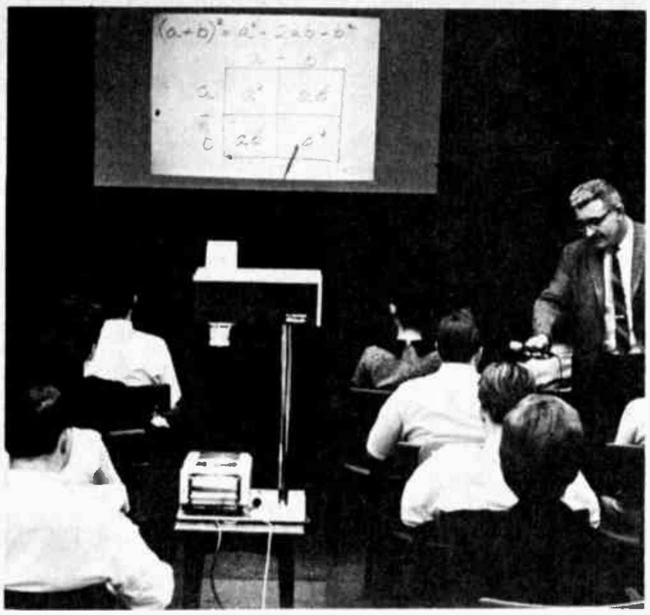
In his present position, held since 1959, Professor Aitchison is responsible for the direction of electronics and communication engineering teaching in the School of Electrical Engineering.

He is a Fellow and immediate past president of the Institution of Australia and also a Fellow of the Institute of Physics, the Australian Institute of Physics, and the Institution of Engineers (Australia).

Professor Aitchison will take up his new appointment at Macquarie in June this year.



Appointed head of the new Electronics department at Macquarie University – Professor R. E. Aitchison.



Typical Electrowriter VERB system similar to that installed by Plessey at the South Australian Institute of Technology

REMOTE LECTURING SYSTEM

Communications equipment installed by Plessey Communication Systems has helped the South Australian Institute of Technology to overcome the problem of having to give the same series of lectures at two widely separated locations.

This has been done by installing a Victor Electrowriter Remote Blackboard (VERB) system linking SAIT headquarters in Adelaide, or the new campus at Poorooka (an Adelaide suburb), with the Whyalla branch of the Institute, 245 miles away.

VERB is based on the familiar Electrowriter by means of which material written or drawn on the transmitting instrument is instantaneously reproduced on a receiver connected to it by PMG-type lines. At the remote end of a VERB system projectors associated with the receivers throw an image of the transmitted material on to a screen which can measure up to 9ft. by 13ft.

The system allows the same series of lectures to be given simultaneously from either Adelaide or The Levels Campus, Poorooka, to Whyalla – or from Whyalla to either Adelaide or The Levels.

Apart from overcoming the shortage of suitably qualified lecturers, the system enables specialist lecturers to maintain close contact with all their students at any of the three locations serviced by the network.

At Whyalla many subjects are being conducted for very small numbers of students who are finalising old courses, and the system allows these students to receive simultaneously the same lectures as those in Adelaide, thus releasing resident lecturers for more individual instruction.

Each SAIT location is equipped with an Electrowriter receiver and transceiver connected to the same telephone extension. An overhead projector displays the receiver writing area on a large screen. A Plessey LS10 loudspeaking telephone is connected to another telephone extension installed in the lecture room.

The lecturer's voice is picked up by the telephone and relayed over the PMG trunk line network to a loudspeaker connected to the telephone in the remote classroom.

Students at the remote area may also ask questions over the same channel. The use of the LS10, which incorporates a 'voice switching circuit', eliminates the need for 'press-to-talk' operation and prevents acoustic feedback.

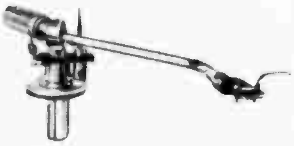
To illustrate his remarks, the lecturer writes diagrams or formulae with the pen of the transceiver which are repeated at the remote location and displayed on the screen. Similarly, students may be asked to 'fill in' missing parts of diagrams or formulae. The lectures are reinforced with prepared transparencies for overhead or slide projectors which are screened at the same time as in the originating location.

The system may also be used between locations for staff conferences or discussions.

MADE FOR EACH OTHER . . .

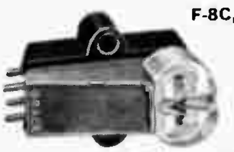
Grace G 840 Arm and Grace F-8C Cartridge

Encel offers this famous Hi-Fi duo at the unbeatable price of **$99.00** (including sales tax). The ultra-lightweight headshell accepts all standard ½" mounting cartridges. There is no better arm than the renowned G 840. It is specially shaped and tapered for torsional and resonant stability and fully compensated for side thrust. It moves with minimal friction on high precision gimbal mountings and is fitted with inbuilt oil damped lift and lower control. A calibrated rotary counter-weight gives perfect adjustment of stylus pressure.
For maximum performance team the G 840 with the top-ranked Grace F-8C magnetic cartridge (Encel price for cartridge alone, **$49.50**, including sales tax). This fine unit, with easy replaceable elliptical diamond stylus, has virtually flat frequency response and is ideally suited for laboratory testing of audio equipment. It maintains excellent separation well above 10kHz and tracks at minimal stylus pressure of 0.5-1.5 gms. Frequency range 15-25kHz—2.5 dB—1 dB; with cross talk less than –30dB (1kHz).
Write now for full technical specifications of these top-line components.



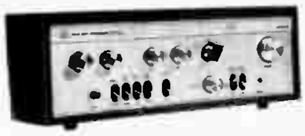
G 840, $49.50.

F-8C, $49.50.



ENCEL HAS FAMOUS LUX AMPS AT THE LOWEST PRICES

Take a close look at the Lux SQ 507 — one of the highest quality solid state amplifiers in the famous Lux range. Powerful RMS rating of 120W total (8 ohms) — 60/60W per channel from improved circuit design. Frequency response is 20-50,000Hz, less than –1dB. Total harmonic distortion less than 0.08% (50W, 8 ohm, 1kHz). Reviewing the SQ 507, Australian Hi-Fi magazine says: "We recommend this as the Amplifier for the person who wants superlative performance with flexibility and power. Electronically the amplifier was found to be well within the manufacturer's specifications in every parameter. The Lux SQ 507 amplifier is best described as electronically superb." Exterior finish is as attractive as its Hi-Fi performance. Hear the SQ 507 soon at Encel, the best-equipped centres for audio comparison.
Encel price $350.00*.



The Lux SQ 503 amplifier offers Hi-Fi with real economy. Built to the same exacting standards as the SQ 507, this unit has a rating of 60W RMS total (8 ohms), 30/30W per channel. Low harmonic distortion and frequency response 20-50,000 Hz, less than –2dB. A full range of controls is provided, and the amplifier is housed in attractive wood cabinet.
Encel price $269.00.

Note: All prices include sales tax. Write for full information on all these items. Technical reviews available on items marked *.

UP-GRADE TO CONNOISSEUR from Encel

Connoisseur BD2 integrated Transcription Unit. "An attractive, medium-priced turn-table with a highly satisfactory standard of performance — well-made and beautifully finished—robust enough for all domestic requirements." The authoritative magazine "The Gramophone" describes the Connoisseur BD2 in these glowing terms in a recent review. Encel offers you the BD2, complete with Connoisseur SAU2 high-precision arm, for only **$82.50** (including sales tax). Price, complete with base and acrylic plastic cover, **$99.50.** Inbuilt stop and start control knob and hydraulic lift control set at front edge of baseplate. Special precision ground rubber belt drive from synchronous motor.

Connoisseur BD1 Turntable. Similar 'no-compromise' speci-fication as the BD2, but without tonearm and fitted with smaller baseplate to permit simple mounting of any type of arm. Available ready to play **$39.50** (including sales tax), or in easily-assembled kit form, only **$34.50** (including sales tax).

Stax SR-3 Stereo Headphones and SRD-5 Adaptor—Encel price, $76.50 (incl. sales tax). World's finest electrostatic headset, with a frequency range of 30-25,000 Hz and maximum sound level of 115 dB. Adaptor suits any amplifier of more than 5W outputs at 4-16 ohms. Some experts say they are better than the best speakers! Write for full review and technical data now. The authoritative Hi-Fi News Review states, "response is very smooth, with no obtrusive peaks or colouration . . . a sense of realness about the sound . . . comfortable to wear for extended periods. They are by no means expensive and are probably better than any other headphones at present available; certainly better than any we have tried."

ENCEL ELECTRONICS PTY LTD

■ AUSTRALIA'S GREATEST HI-FI CENTRES

MELBOURNE: 431 BRIDGE ROAD, RICHMOND, VICTORIA. 3121. TEL: 42 3782.

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AUDIO NEWS

MUSIC BROADCASTING SOCIETY

The Music Broadcasting Society of N.S.W. is a non-profit organisation seeking to improve the quantity and quality of music broadcasts.

Its objectives are:

a. To obtain a broadcasting service devoted exclusively to serious music.

b. Build a membership large enough to influence the appropriate authority to grant the society a licence to broadcast on a reasonably accessible frequency.

c. Establish a listener-owned, cooperative station for the broadcasting of serious music programmes.

d. Press for the introduction of FM broadcasting.

Those interested in the society and its objectives can obtain further information from The Music Broadcasting Society of NSW, Box 176, The Union, Sydney University.

PHOTOELECTRIC PICK–UP

A new type of photoelectric pick-up has been announced by the Japanese Toshiba Company.

A lightweight vane, rigidly attached to the stylus, is caused to vary the illumination – from a dc powered miniature globe – incident upon a pair of phototransistors.

Thus movement of the stylus will result in changes in voltage output from the emitter-follower connected phototransistors.

Output signal from this low impedance source is over 14mVcm/sec, and frequency response is said to be within ± 1dB from 20Hz to 40kHz.

Toshiba claim that channel separation is 33dB at 1kHz and is not less than 25dB at any point from 20Hz to 20kHz.

UNIT AUDIO IN AUSTRALIA

The trend toward unit-audio systems is becoming apparent in Australia.

Two recently introduced units from Audiosound are their Linz and Prague systems.

Both systems are designed around Audiosound's LD30 amplifier which, the makers state, has an output of 25 watts rms per channel with less than 0.15% total harmonic distortion between 30Hz and 20kHz.

The loudspeaker enclosures are fitted with an 8" long-throw woofer and a treble unit and are claimed to provide very smooth response from 35 to 20,000Hz.

NEW HAMMOND ORGAN

The Hammond X-66 organ features two 61 note manuals with newly designed overhanging keys.

A 25 note radiating pedalboard includes pedal vibrato and three degrees of string brass.

Tonal controls include 39 control tablets, nine pre-set keys and two sets of 11 adjustable drawbars for the orchestra manual. Nine preset keys and two sets of 10 adjustable drawbars are included for the accompaniment.

A special effects panel features reiteration rate control, console light switch, soft volume control, microphone jack with switch, and volume control.

The speaker enclosure is a separate unit rated at 200 watts music power. It contains one 15" bass speaker, four 8" dispersion speakers, two 8" treble channel speakers and two horns.

The console is 56" wide, 51" deep, 42" high and weighs 574 pounds with pedals and bench.

The speaker enclosure is 33" wide, 25" deep and 53" high. It weighs 188 pounds.

PLASTIC DIAPHRAGM IMPROVES STABILITY OF LOUDSPEAKER

A plastic diaphragm, providing greater stability than conventional paper, is featured in a new bookshelf loudspeaker introduced by the British Company, KEF Electronics Ltd.

The 18½" x 11" x 8-5/8" enclosure incorporates an 8" diameter speaker employing a diaphragm made from Acoustilene, a rubber modified polystyrene with a visco-elastic damping layer of polyvinyl acetate/polyvinyl chloride co-polymer.

Similar units are installed in monitoring loudspeakers made by the company for the British Broadcasting Corporation.

The unit is claimed to reduce to a negligible level the colouration caused by uncontrolled vibrations or resonances in the cone and enclosure. Plastics are used because they are acoustically 'dead' and inherently free from resonances, giving a clear, true sound.

The reduction in colouration and unwanted resonances gives smooth even frequency response throughout the range. Plastics also give less variation in performance due to changes in temperature and humidity and less physical and chemical deterioration with age.

Reproduction of the higher frequencies is handled by a small super tweeter with a Molinex ¾" domed diaphragm.

Frequency range is 35 to 30,000 Hz, with the dividing frequency at 3500 Hz. The loudspeakers are available in walnut, teak, or white finishes with brown, grey or beige grille cloths, and weight 17lb 10 oz.

FOUR–CHANNEL RECORDS

Latest in four-channel sound is a phono record and matching decoder from Japan's Victor Company.

In the recording process a matrix circuit is used to encode the four separate channels into the record groove side-walls.

One side-wall carries the sum of channels one and two and also the difference between channels one and two. These are modulated onto a 30 kHz carrier. Channels three and four are impressed in a similar manner onto the opposite side-wall.

The play-back equipment uses an elliptical stylus with a frequency response up to 45 kHz.

It is believed that many record companies are currently negotiating licencing agreements to produce these discs.

COMPONENT NEWS

THE NUMBERS GAME

The once-ubiquitous neon-indicator tube is now challenged by a whole new range of numeric and alphanumeric readout devices.

Top competitors are display units utilising either solid-state light emitting elements, or liquid crystal elements recently developed by the chemical industry.

Competition is made fiercer by other devices such as Burroughs' new 'Self-Scan' Nixie tubes, and fluorescent electron tubes such as the Itron, made by Ise Electronics.

Main struggle appears to be between the light emitting elements and the crystal elements.

Liquid crystal display

The light emitting elements are made of semiconductor compounds of gallium arsenide with admixtures of phosphor and aluminium. They have a semi-permanent life, extremely rapid response, and are readily driven by integrated circuitry. It is expected that driver ICs will eventually be incorporated within the light emitter.

The liquid crystal element is an organic material with the property of changing colour in accordance with changes of voltage or temperature. These elements can be readily miniaturised. On the debit side, they require a high operating voltage and are not compatible with existing integrated circuits.

Cost comparisons between light emitting elements, neon indicator tubes and liquid crystal are 2.8, 1.0, and less than 1.0 respectively.

NEW MINIATURE EDGE SWITCHES

The Professional Components Division of Plessey Component Group announces a new miniaturised range of edge switches. This range is a smaller and more advanced version of the well-known Plessey 50 Series.

They are economically priced, and intended for both military and industrial applications in such fields as machine tool control, computer switching systems and instrumentation, and frequency setting arrays where read-out legibility and superior reliability are important.

A wide range of switching codes includes decimal, binary, and binary with complement, while multi-pole switching is achieved by coupling together a switch and up to four slave modules, with plain or marked drums.

Terminations may be for direct wiring, or for edge connectors, and are numbered to facilitate correct connections. Extended printed circuit boards are also available for mounting diodes or other miniature components. Gold-plated tracks on epoxy glass laminate, with precious-metal wiping contacts, ensure reliable operation.

The 33 Series has contact rating of 100mA at 50 Vdc, with a maximum current carrying capacity of 1A; temperature range is -20 to + 70°C. The switch meets H5 to DEF 5011 climate specification, and life is given as not less than 10^6 indexing operations.

Commercial enquiries to Professional Components Division, Plessy Ducon Pty. Limited, P.O. Box 2, Villawood, N.S.W. 2163.

PROTOTYPE CIRCUIT BOARDS

A new method of producing prototype printed circuit boards has been developed by Circuit-Stik Inc., of California, U.S.A.

Their system consists of conductive circuit sub-elements mounted on thin substrates which have a pressure-sensitive adhesive backing.

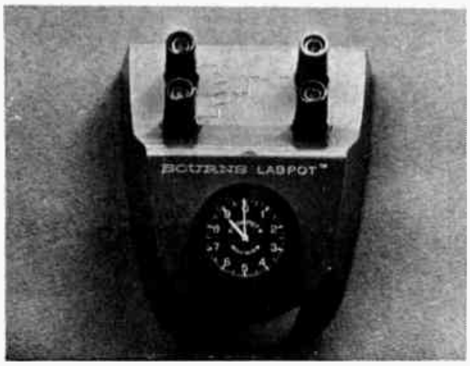
These circuit elements are designed to withstand soldering temperatures.

A wide variety of circuit-element patterns are available. These include mounting pads for TO-5 and TO-18 transistors, 14 and 16 lead dual-in-line packages, and connectors of various types.

At first sight the cost of these elements seems very high; however, they are obviously intended for the professional engineer who would use them for prototypes and limited production only. For this type of application their cost would be more than justified.

Details from Tecnico Electronics, P,O. Box 12, Marrickville, N.S.W. 2204.

PRECISION POTENTIOMETER



A ten-turn precision potentiometer mounted in a rugged plastic case is now available from Bourns Inc. Intended for circuit development or educational use, the units are available with a choice of analogue or digital readout.

Large binding posts facilitate fast hook-up of leads. Each unit is fused for protection against burn-out.

The units have a reading accuracy of better than 0.2% and a repeatability of ± 0.5% of voltage ratio. Power rating is 2.5 watts at normal ambient temperature.

Details from W.G. Booth Pty. Ltd., P.O. Box 131, Richmond, Vic. 3121.

MINIATURE AIR VARIABLE CAPACITORS

The U.S. Defence Supply Agency has issued QPL (Qualified Products List) approval to JFD Electronics Corporation's Components Division for two of their MVM-type air dielectric variable capacitors, which are now available from Plessey Ducon.

These JFD pf units will appear on the Qualified Products List 14409. This certifies that they have been tested to Military Specification MIL-C-14409C for piston type tubular capacitors.

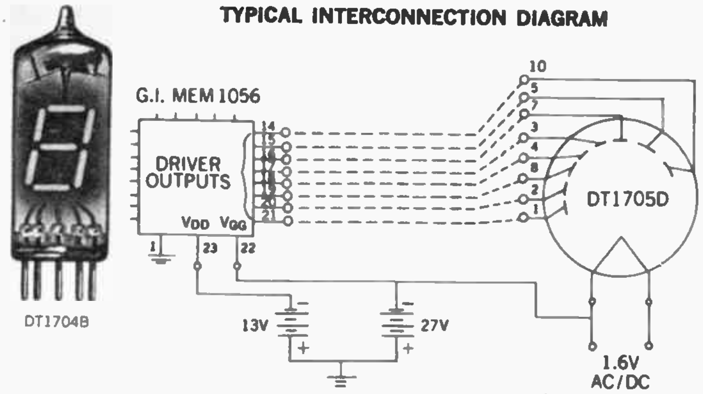
The QPL-approved air dielectric capacitors are JFD types MVM010M (panel mount with lug terminal) and MVM010W (for printed circuit applications). Both are adjustable from 0.8 pf to 10 pf. Their Q factors exceed 3000 at 100 MHz and 10 pf. (Higher Q's are available on special order).

Insulation resistance is 10^6 megohms, measured at 25°C and VDC. The temperature coefficient of capacitance is 0± 20 ppm/°C, measured through an operating temperature range from -55° to +125°C. Working and test voltages are 250 vdc and 500 vdc respectively.

The MVM series features a unique internal guiding element to keep the rotor centred under shock or vibration. The manufacturers claim that large integral spring contact elements in the rotor ensure very low minimum noise levels as well as a smoother, more constant torque far beyond the standard life test requirements of 600 turns.

JFD Electronics Corporation is represented in Australia by Plessey Ducon Pty. Limited, Professional Components Department, P.O. Box 2, Villawood, N.S.W. 2163.

TYPICAL INTERCONNECTION DIAGRAM



SMALL FLUORESCENT READOUTS

A new Digivac S/G readout in the T5½ configuration meets high density design requirements for multi-readout displays in a minimum of space. Smaller package size is achieved with no reduction in display character size. The new device is electrically and optically identical to, and interchangeable with, the original Digivac S/G readout.

The makers claim it has the same IC compatibility, the same low power requirements, and meets MIL specifications for shock and vibration.

The readout tubes are vacuum fluorescent devices designed for low signal-level applications. The seven-segment display forms characters in a single viewing plane. Characters are of inherently uniform brightness that is claimed to be highly stable.

The parallax-free viewing angle, with visibility in excess of 40ft., means surer, faster reading.

Digivac S/G readouts can be switched with less than 12 volts, but typical operation for high brightness would require about 25 volt. Energizing voltage of the cathodes is claimed to be only 1.6 volts ac or dc at 45 ma.

Details from Royston Electronics, 22 Firth St., Doncaster, Victoria 3108.

THREE NEW MSI DEVICES

SGS continues to add to its range of professional digital IC's. Three new MSI monolithic devices have appeared in the 74 Series – the T7441A, T7490 and T7493.

The T7441A BCD to decimal decoder incorporates high performance output transistors designed to drive gas-filled cold-cathode indicators. TTL circuits select one of ten decimal output drivers. Physical placement of the BCD inputs coincides with the BCD output of the T7490 decade counter. The ten high breakdown NPN transistors have a maximum reverse current of 50μA at 55V over the operating temperature range.

The T7490 high speed decade counter features internal interconnection of four dual-rank, masterslave flip-flops, providing both decade and divide-by-two and divide-by-five counters. A gated direct reset line inhibits count inputs and returns all outputs to logical zero or to a BCD count of nine.

The T7493 4 bit binary counter provides high speed divide-by-two masterslave flip-flops internally interconnected. The provision of a gated direct reset line inhibits count inputs and simultaneously returns the four flip-flop outputs to logical zero.

The three circuits are TTL and DTL compatible.

Details from Warburton Franki, P.O. Box 182, Chatswood, N.S.W. 2067.

MSI 8 BIT MULTIPLEXER

SGS has added an 8 input digital multiplexer to its range of bipolar MSI-elements. Applications are many, including multiplexing digital signals, a comparator and a high speed switch in practically any kind of digital logic system.

Designated T163, the circuitry of this CCSL-compatible multiplexer has on-chip logic decoding, and fully buffered complementary outputs. It also features an active low level input enable (increasing its logic flexibility), active pull-up on the output for high speed operation, and input clamp diodes to reduce the effects of line reflections.

Details from Warburton Franki, P.O. Box 182, Chatswood, N.S.W. 2067.

NEW SILICON GATE MOS I/C RANGE

Announcing a new range of silicon gate products, Plessey Microelectronics now claim to offer MOS integrated circuits as complex and advanced as any commercially available in the world today.

The new additions are:

SILICON GATE MOS MEMORIES

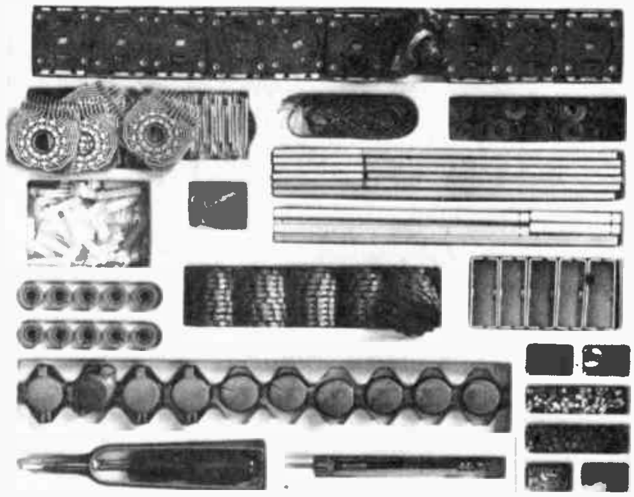
MP11011	256 bit Static Random Access Memory. Access time 500 nS.
MP1101	256 bit Random Access Memory. Access time 1μS.

SILICON GATE MOS SHIFT REGISTERS

MP 1402	Quad 256 bit Dynamic Shift Register.
MP 1403	Dual 512 bit Dynamic Shift Register.
MP 1404	Single 1024 bit Dynamic Shift Register.
MP 1405	Single 512 bit Dynamic Shift Register with recirculate.
MP 1406	Dual 100 bit Dynamic Shift Register with free-drain outputs and temperature specification – 55°C to +125°C.
MP 1407	Dual 100 bit Dynamic Shift Register with 20 k ohm resistor from V_{DD} output and -55°C to +125°C temperature specification.
MP 1506	Dual 100 bit Dynamic Shift Register with free-drain output and 0 to 70°C temperature specification.
MP 1507	Dual 100 bit Dynamic Shift Register with 20k ohm resistor from V_{DD} output and -25°C to +70°C temperature specification.

Commercial enquiries to Professional Components Department, Plessey Ducon Pty. Limited, P.O. Box 2, Villawood, N.S.W. 2163.

NO MORE CHRISTMAS TREES



A kit of parts featuring a printed circuit stator board enables the designer of prototype multi-bank switches to avoid the 'Christmas Tree' phenomenon.

Plessey's new 'Printswitch' eliminates the confusion of wiring and soldering in the multi-bank assemblies associated with the smaller and more complex equipment now being used.

This is achieved by the use of a universal printed circuit stator board that starts the design engineer off with a large number of circuit possibilities.

Required circuit configurations are obtained by removing unwanted interconnections from the printed circuit. This, the makers claim, is the only general purpose switch that can have shorting and non-shorting circuits in combination, with the same contact.

Any possibility of misalignment between rotor and stator contacts is averted by the design of the rotor contacts, which may be specified in any of 12 positions.

Hard precious metal clad phosphor bronze rotor contacts switch up to 10 VA and the low, consistent pressure maintained between them and the specially processed printed circuit switch pads on the stator, are claimed to ensure that specification parameters are maintained throughout normal life.

The true wiping action of the switch reduces electrical noise and prevents contact bounce.

Details from the Professional Components Division, Plessey Ducon Pty. Limited, P.O. Box 2, Villawood, N.S.W. 2163.

EQUIPMENT NEWS

PORTABLE STANDARD CELL

THE AUSTRALIAN-made Elmeasco portable standard cell enclosure is a precision air bath accommodating four saturated standard cells.

The unit comprises an outer wooden cabinet housing a heated container in which the cells are mounted. A polyurethane foam jacket surrounds this oven, providing thermal insulation, and a solid state controller maintains constant temperature despite wide ambient changes.

In the standard unit nominal temperature is maintained at 30°C, with a long term stability of ± 0.005°C for 12 months in a laboratory environment.

There are two independent thermistor bridge circuits in the instrument; one controls the temperature of the oven, the other detects any deviation from the nominal temperature. Terminals on the front panel provide a connection for an external null detector to the temperature monitoring bridge. Bridge current is limited to prevent self-heating of the thermistor. A variable resistor shunts one arm of this bridge and is calibrated for temperature deviation from nominal over a range of ± 20 millidegrees.

Because the cells are calibrated at operating temperature inside the enclosure, it is necessary to know only that the temperature is constant. Temperature correlation between the user's laboratory and the calibration laboratory is not necessary.

An inbuilt rechargeable battery pack is capable of powering the unit for at least five days. Changeover to battery operation, in the event of mains failure, is automatic and instantaneous. The battery is maintained in charged condition during normal mains operation by an inbuilt constant voltage current-limited charging circuit. A front panel indicator lamp glows when the unit is operating from mains power and the battery is being charged.

The manufacturers state that each standard cell is calibrated at their factory against cells that are in turn checked periodically by the National Standards Laboratory. The EMF of each cell is measured to within ± 0.1 μV and a test report is furnished quoting EMF to ± 2 μV by Elmeasco. An NSL report can be supplied at an additional charge.

Full details from Elmeasco Instruments Pty. Ltd., 7 Chard Rd., Brookvale, N.S.W. 2100.

LIGHTNING FLASH COUNTER

A NEW instrument of interest to meteorologists, radiophysicists, telecommunications engineers, explosives workers, etc., is intended for use in thunderstorm occurrence.

The mid band for input signals is 500 Hz and time constants are arranged to record lightning flashes at one-second intervals. Multiple strokes occurring in a flash to ground thus count as one stroke.

The counter is battery-operated and may be set up in remote locations and left unattended. Frequency range is 100-2500 Hz (– 4.5 dB points). The message register is a four-digit Post Office counter.

Manufactured in England by F. C. Robinson & Partners, the instrument is approved as a Counter No. 2 by CIGRE Study Committee No. 8.

Details from Natronics Pty. Ltd., The Crescent, Kingsgrove, N.S.W. 2208.

THE MOVING FINGER LIGHTS...

A LIGHT PEN unit has been introduced by Tektronix Australia. It operates with TV displays to generate a movable video cursor and corresponding X and Y position information. The location of the cursor is chosen with a hand-held light pen. The manufacturers say it is an ideal tool for anyone instructing, lecturing or commentating in a television environment about advertisements, sports, weather, news, medical or educational TV presentations. Also, it is useful for computer process control and computer-aided design and education applications.

With the hand-held 4551 Light Pen, a user can direct viewer attention to any point of a TV display and can supplement the information viewed with drawings, sketches and words. The user's presentations are improved by elimination of physical pointers, views of himself and surroundings, from the information he wants examined.

The 4551 Light Pen unit can generate any of three movable cursors (+ or ▭ or ⊟) when used in any 525/60 or 625/50 line TV systems. The cursor tracks the pen point as the user moves the pen on the TV screen.

Information may be written on TV displays when using the 4551 Light Pen is placed against the display CRT and moved while the user's finger depresses the 'touch switch'. Writing stops when the user's finger is lifted. Corresponding information is displayed on all TV displays in the system.

Any area of the display selected with the light pen may be magnified up to five times when using the 4551 Light Pen with the 4501 Scan Converter. Also, the magnified and original non-magnified areas can be presented as superimposed, alternating displays by using a mixed mode feature. The viewer can analyze any part of the picture in magnified detail and still visually reference it to the original unmagnified picture.

Analogue and digital X and Y coordinate information, directly corresponding to the pen's point position and movement, is available. This coordinate information is especially useful in computer controlled and computer aided applications.

The 4551 Light Pen (especially when used with a scan converter) provides a convenient and effective means of enhancing communications with large groups or widely scattered audiences in the education, medical and broadcast industries.

Details from Tektronix Australia Pty. Ltd., 80 Waterloo Road, North Ryde, N.S.W. 2113.

DIGITAL METERS MONITOR HEARTRATE

Heart rate of up to six patients is monitored by a bank of Natronic digital panel meters at Sydney's Royal Prince Alfred Hospital.

The units – installed in the cardiac special care unit – integrate the heart rates over a period of one minute and display the results numerically.

The panel meters are modified versions of Natronic's standard units which have an accuracy of 0.25% + one digit.

Full details from Natronics Pty. Ltd. The Crescent, Kingsgrove, N.S.W.

WIRE STRIPPERS

Wire strippers which automatically adjust for a variety of wire gauges without damaging the conductors are available from Haycolec Industries Pty. Ltd. The precision tools will self-adjust over a wide range of multi and single-core conductors of PVC, vinyl, polyethylene and similar insulation, although use for PTFE covered wires is limited to small gauges and thin insulations.

The 'AB' Mk. 1F wire stripper features a 'Flexi Jaw' which consists of a large number of leaf blades assembled in the jaw housing with a resilient backing, so that the cutting edge surrounds each conductor offered for stripping independently. As the blades are self-adjusting, there is no need to know the wire size, and a wire stop can be positioned to control the stripping length required.

The Mk.1F can be used for single or multiple, round or flat conductors, and will automatically adjust to all standard conductors from 0.01 to 0.1 overall diameter insulation – and with adjustment the range is extended from 0.005 to 0.15; maximum 7 x 0.029.

A similar model, the 'AB' Mk.1S, designed for single round conductors only and fitted with a solid jaw to accommodate tougher insulations up to 0.2 dia. only, with automatic adjustment from 0.01 to 0.15 diameter insulation; maximum 7 to 0.036.

The 'AB' Mk.1 is a lightweight instrument specifically designed to suit a woman's hand, and conversion from one type of jaw to another can be simply effected by withdrawal of a single split-pin and replacement of the alternative jaw.

Heavy-duty wire strippers, for use where heavier gauge wires have to be stripped in a single operation, are available with all the features of the Mk.1.

Full details from Haycolec Industries Pty. Ltd., 10 Amsterdam St., Richmond, Vic. 3121.

FAST CURRENT AMPLIFIER

A UNIQUE, new, high-speed current amplifier is now available from Keithley Instruments Inc. The Model 427 features wide dynamic range – up to 90 dB – resolution to 10^{-4} amperes and rise times as fast as 15 microseconds.

These characteristics make the Model 427 current amplifier ideal for use in automated testing of IC's, MOS devices, capacitors, or any other item requiring low-current detection.

The amplifier is also suited to analytical applications such as mass spectrometry and gas chromatography. Its wide dynamic range results in a high degree of resolution – even with large signal levels.

The Model 427 has sensitivity from 10^{-14} ampere to 10^{-3} ampere. Gain is selectable in decade steps at 10^{11} volts per ampere to 10^{4} volts per ampere. Output is ±10 volts. Switch-selected variable rise times permit the user to optimize the 427 for highest speed or widest dynamic range (lowest noise). Built-in current suppression is provided to cancel ambient current levels when small changes are the signal of interest.

As an example of the 427's performance capability, it enables resolution of 20 picoamperes out of a 10^{-8} ampere signal with a 100 microsecond rise time. Trading rise time for lower noise, 0.5 picoampere can be resolved out of the same 10^{-8} signal with a rise time of 10 milliseconds.

Details from Warburton O'Donnell Ltd., 372 Eastern Valley Way, Chatswood, N.S.W. 2067.

EQUIPMENT NEWS

INDUSTRIAL EVENT RECORDER

THE AUTOVISOR, manufactured by F. C. Robinson & Partners, provides an automatic record, on one chart, of the periods of operation of up to 20 machines or processes. The chart moves at a speed applicable to the machine or process being monitored. Electrically operated pens are actuated by the closing of external contacts.

The pens use no ink and require no attention.

The Autovisor is said to be invaluable for preparing records of machine operating times, machine stoppages, times of morning start, processing time and sequences, periods during which pressures, humidities and temperatures are within predetermined limits, heat treatment periods, flow of liquids, engine tests, life tests – and, in fact, the frequency and duration of any random occurrences.

Details from Natronics Pty. Ltd., The Crescent, Kingsgrove, N.S.W. 2208.

ANY SCOPE A STORAGE SCOPE

A TRANSIENT recorder manufactured by Biomation, of Palo Alto, California, enables any oscilloscope to be used for storage purposes.

The Model 612 recorder captures single shot signals, holds them indefinitely, and presents them for viewing on conventional devices at a slower speed and any required amplitude.

Applications will include the recording of laser-excited material response, high-speed chemical reactions, pulsed NMR results, observation of transients in digital circuitry, capture and comparison of individual audio frequency signals, and as digital computer buffer storage – especially in time-sharing applications, where it can be used to perform A/D conversions of fast input signals and then store them until the CPU is ready.

The 610 recorder has differential inputs with a full scale range of 50mV to 50V. The input amplifier has a response of up to 2.5MHz at the 3dB point, depending upon the input range.

The signal is converted at a word conversion rate from 20Hz to 10MHz (depending upon sweep time selected) with 6 bit resolution in a high speed A/D converter. This throughput rate allows ten complete samples to be taken per cycle on a 1MHz input signal. The manufacturers claim that this number of samples introduces less than 5% error on any point

Model 610 captures a transient waveform on oscilloscope.

of the reconstructed waveform at 1 MHz, and less at lower frequencies. The 6 bit A/D converter provides a resolution of one part in 64, an error of less than 2% full scale.

The digital information is temporarily stored in an input buffer register, then transferred into the proper location in a constantly circulating 128 word, 6 bit MOS shift register memory.

Time base control is provided by a 20 MHz oscillator through a time base divider and sweep control circuit. Triggering is provided externally, or from the amplified input signal through a trigger amplifier.

A variable trigger delay of zero to ten times sweep setting (to a maximum of one second) allows the record sweep to occur at the desired time relative to the trigger. Three delay modes are provided and are selected by a three-position switch.

In Mode 1 – Trigger Hold-Off – a new trigger is not accepted after completion of a sweep until after a delay period. In Mode 2 – Delayed Sweep – a trigger begins the delay and the sweep starts after the delay period. In Mode 3 – Pre-Trigger Recording – the input signal is digitized constantly and information collected before receipt of the trigger plus the delay period is recorded. This is a unique measurement technique not available on oscilloscopes.

The stored data can be output on command in digital form at TTL levels, 6 bit parallel to a digital recorder at a rate of 2 microseconds per word, or with a 256 μs latency for slower asynchronous rates on external command.

A digital to analogue recorder with an analogue smoothing circuit reconstructs the original input signal for presentation on an oscilloscope in a sweep time of 0.2 μs or on a chart recorder in a sweep time of 10 sec. with an output level of one volt full scale.

Although 128 samples are taken and recorded, only the first 100 of these are taken in the sweep time selected on the front panel. When displayed, the first 100 points are output in 0.2 μs or 10 sec. The full 128 words are available for outputting digitally.

Details from Elmeasco Instruments Pty. Ltd., P.O. Box 334, Brookvale, N.S.W. 2100.

PORTABLE OSCILLOSCOPE

A SMALL, lightweight 10 MHz oscilloscope is now manufactured in Tokyo by the Sony/Tektronix Corporation.

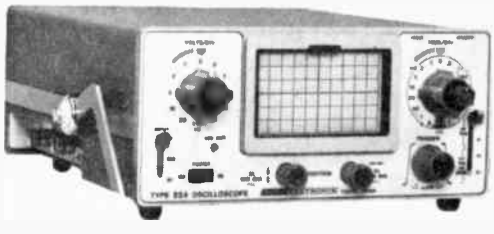
The new Sony/Tektronix Type 324 is all solid-state. Its small size and weight, together with low power consumption, make it a natural choice for 'one site' maintenance applications.

Internal rechargeable batteries provide up to 3 hours' continuous operation. Power consumption from an external dc source (6.5 V to 16 V) is 8.5 watts maximum and 20 watts when powered from the AC line (115 or 230 VAC).

10MHz bandwidth is provided at 10 mV/div deflection factor. For low signal level applications, 2/mV/div deflection factor is provided with 8-MHz bandwidth. Sweep rates are 1 μs /div to 0.2 s/div. An X5 sweep magnifier extends the fastest sweep rate to 0.2 μs/div.

A single control knob provides automatic or manual level sweep triggering, positive or negative slope. With no input the automatic trigger mode provides a bright baseline reference at all sweep rates.

The CRT uses a low power direct heated cathode, providing a useful display 2



seconds after turn-on. A 6 x 10 div (¼-inch div) internal non-illuminated graticule permits parallax-free measurements.

The environmentalized Type 324 is designed to meet temperature, altitude, humidity, vibration and shock tests which 'portable' instruments are likely to encounter.

Dimensions are 10 5/8 inches by 8¼ inches by 4¼ inches; weight, including batteries, is approx. 8 lb.

Details from Tektronix Pty. Ltd., 80 Waterloo Road, North Ryde, N.S.W. 2113.

LOW-COST 50 MEGAHERTZ PLUG-IN OSCILLOSCOPE

ANOTHER mainframe and two more plug-ins have been added to Tektronix Australia's 7000-Series oscilloscope system. The 7403N mainframe with 7B53N time base and 7A18 amplifier plug-ins offers a 6½ inch CRT, 5-mV dual-trace, delaying sweep, 2% accuracy, and a third plug-in compartment.

The 7403N and R7403N (5¼ inch rackmount) oscilloscopes feature:

1) Three plug-in compartments (2 vertical, 1 horizontal). Only one vertical compartment need be occupied. The second may be used when required.
2) 6½ inch CRT. 8 x 10 div (1.22 cm/div) display area, providing 50% more viewing area than most other 50MHz oscilloscopes.
3) Vertical mode switching.
4) Versatile trigger source selection.
5) Push-button switches.

The addition of a 7A18 amplifier and 7B53N time base provides:

1) 50-MHz bandwidth.
2) 5-mV dual trace.
3) Delaying sweep.
4) Mixed sweep.
5) 5-ns sweep rate.

By electronically switching between vertical plug-ins, the 7403N provides measurement options which are only available with 7000-Series oscilloscopes. The makers claim that other single-beam scopes do not allow the simultaneous use of different kinds of plug-ins in a single mainframe.

With the 7403N oscilloscopes the user can select from 10 vertical amplifiers. Offered are: two dual-trace units, a differential comparator, an AC current probe amplifier, two single-trace units, a 10-μV differential, a low-capacitance FET probe amplifier, sampling (to 14 GHz) and TDR units. Any two of these amplifiers can be used simultaneously – the only exception being that sampling and conventional units cannot be used together. Electronic switching in either ALTERNATE or CHOP modes time-shares the CRT beam between channels.

Since the output amplifier is in the mainframe, the vertical amplifier plug-ins need only contain a preamplifier. This means that the 7000-Series amplifier units are generally lower-priced than those with comparable performance offered by manufacturers who choose to place the complete vertical amplifier in each plug-in.

The 7A18 dual-trace amplifier plug-in

EQUIPMENT NEWS

features 50-MHz bandwidth, 5 mV/div to 5 V/div deflection factors and five operating modes. The operating modes are alternate, chop, add, channel 1, and channel 2. Two 7A18's can be used in a 7403N mainframe to obtain four-trace capability at very low cost.

The 7B53N dual time-base plug-in features calibrated sweeps from 5 s/div to 50 ns/div (5 ns/div with X10 magnification), triggering to 100 MHz and four display modes. The display modes are main sweep, intensified sweep, delayed sweep, and mixed sweep.

Details from Tektronix Australia Pty. Ltd., 80 Waterloo Road, North Ryde, N.S.W. 2113.

SYNTHESIZED DIGITAL SIGNAL GENERATOR

FREQUENCY setting by digital controls is particularly valuable in production line applications and industrial processes, as reading errors inherent in analogue presentation are avoided.

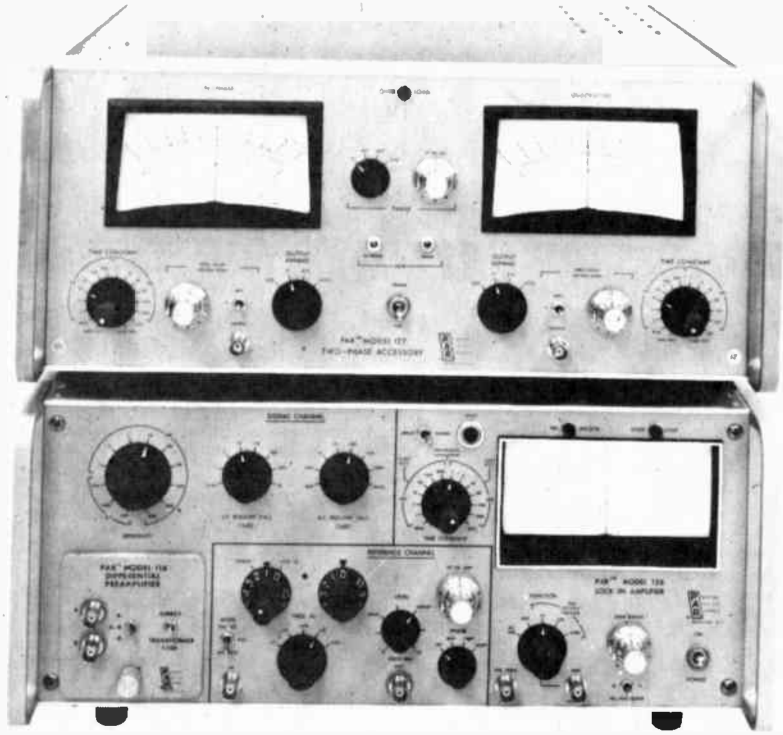
A synthesized digital signal generator – the Green TG1800 – is claimed by its manufacturers to be two orders of magnitude more accurate than otherwise competitive signal generators; and to replace LF, AF, and video oscillators, and the signal generator/counter units, hitherto necessary to obtain high degrees of stability and accuracy.

Basic specifications include:

Frequency	–	1 Hz – 10 MHz
Accuracy	–	1 ppm
Stability	–	3-10^9 per day
Resolution	–	1-10^4 to 1-10^5
Output	–	1mV – 10 volts rms
Sine	–	50 ohms – 600 ohms
Square	–	100 ohms max
Op. stability	–	0.5dB
Spurious	–	50dB down (hum, noise)

These parameters can be improved by fitting the optional WWV receiver/divider; e.g. accuracy -1-10^{10}

Details from Green Electronic and Communication Equipment Ltd., 5-15 Thorold Road, London N22, England.



PAR model 126 Lock-In amplifier (bottom) and model 127 two-phase accessory.

MEASURING NOISY SIGNALS

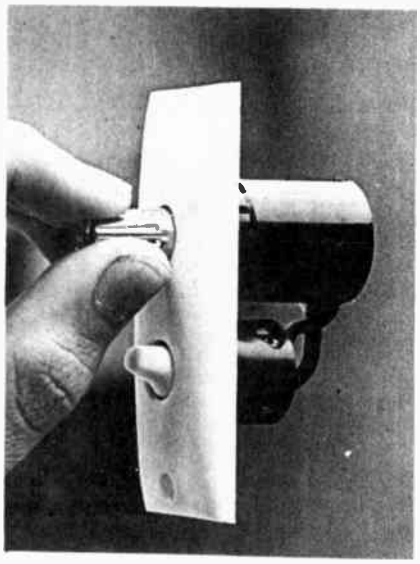
MEASUREMENTS of the phase and amplitude of signals buried in noise are simplified by Princeton Applied Research Corporation's new lock-in amplifier Model 126.

The instrument will find application in fields such as the determination of capacitance and conductance in semiconductors, and in biological studies.

Signals as small as 1 nanovolt can be measured. Full scale sensitivity on the lowest range is 1 mV. Frequency range is 0.2Hz to 210 kHz.

A two-phase accessory Model 127 enables simultaneous measurements to be made of phase and amplitude of the quadrature component of signals buried in noise.

Details from Tecnico Electonics, P.O. Box 12, Marrickville, N.S.W. 2204.



TG1800 synthesised digital signal generator.

FINGERTIP-CONTROL DIMMER

THE TREND 500 light dimmer pictured here is said to provide fingertip control of incandescent and fluorescent lights to a maximum of 500 va and is intended for domestic and commercial use.

The unit – claimed by the manufacturers to sell for a fraction of the price of previous models – replaces the standard architrave switch and takes about three minutes to install.

A feature stated to be unique to this type of dimmer is that current consumed by the controlled lights is almost directly proportional to the set level – i.e., reducing light level reduces electricity consumption accordingly.

Details from Natronics Pty. Ltd., The Crescent, Kingsgrove, N.S.W. 2208.

EQUIPMENT NEWS

VERSATILE INTERFACE

TWO new instrument modules that eliminate interfacing problems between scientific equipment and computers are now available from Princeton Applied Research Corporation.

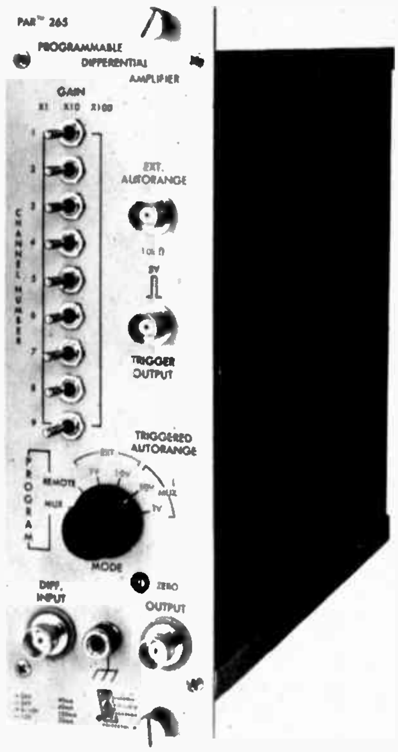
The Model 265 programmable differential amplifier serves as an interface between an analogue multiplexer, or similar device, and an A/D converter. It receives data corresponding to the outputs of up to nine analogue instruments, and automatically provides a gain of 1, 10 or 100, as required, to scale each output data segment to the optimum range for driving the A/D converter.

The instrument has three operating modes in which gain can be programmed by setting toggle switches, or by an external (BCD) command, or through automatic selection of optimum gain.

The Model 267 logic level converter interfaces instruments with non-standard logic levels to equipment with standard DTL/TTL input levels. The instrument converts up to 24 parallel data lines and six control lines in the forward direction, and up to six control lines in the reverse direction. It can function with either ground-true or ground-false logic.

Both modules are NIM-compatible.

Details from Tecnico Electronics Pty. Ltd., P.O. Box 12, Marrickville, N.S.W. 2204.



COMPUTER-BASED SYSTEM FOR THE PRICE OF A TERMINAL

ON-LINE data reduction and computer control of processes is available for as little as $4.00 an hour – using Hewlett-Packard's 2570A Coupler/Controller and a time-sharing system.

The manufacturers state that this facility provides all the mass data storage and computational power of the most sophisticated computer without the large capital outlay required for a dedicated computer system.

Key to this new instrumentation system is the 2570A's 2-way communication capability. It enables instruments or peripheral devices to communicate with each other and with a computer. Using ASCII, the code enables the 2570A to communicate with any computer that can drive a teleprinter – via direct cable or telephone link to any time-sharing system with an ASCII port. These include GE's Mark II and Mark IV, TYMshare, and Hewlett Packard's 2000A/B.

It is claimed that the 2570A/time-share combination enables the user to accumulate large historical data files and store sophisticated programmes at low cost.

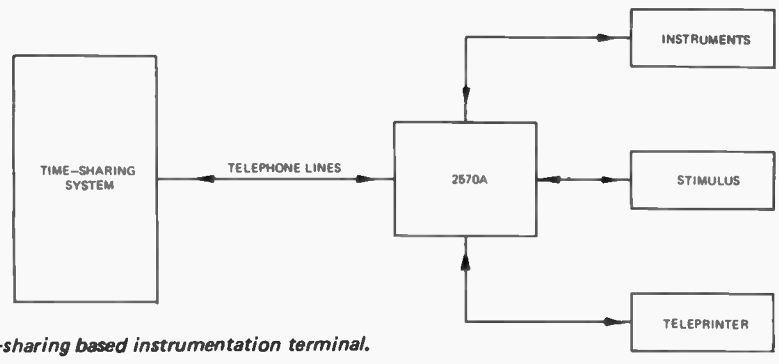
If the user's application does not presently demand data reduction, or if data is generated too slowly for continuous use of a time-share terminal to be practical, the 2570A as a stand-alone unattended data acquisition system can compact the data off-line on punched tape for subsequent processing directly into a time-share terminal. Hewlett-Packard say the 2570A makes it possible to eliminate manual data logging and reduce turn-around time for processed data, whilst at the same time maintaining around-the-clock monitoring of processes.

The 2570A is the basis of an inexpensive programmable and expandable system. The mainframe includes a plug-in control card and 8-input/output slots for plug-in interface cords.

The modular concept is claimed to provide for immediate need whilst allowing for system growth if subsequently required.

A number of plug-in interfaces are available to enable the system to be used with dvm's, frequency synthesizers programmable power supplies, counters, analogue scanners, teleprinters, high-speed tape readers and punches, digital recorders, etc.

Details from Hewlett Packard Australia Pty. Ltd., 61 Alexander St., Crows Nest, N.S.W. 2065.



Time-sharing based instrumentation terminal.

RECORDINGS... CLASSICAL

REVIEWERS: John Araneta, John Clare, Christopher Wagstaff

DEBUSSY — Three Nocturnes; RAVEL — Pavane; Daphnis and Chloe Suite No. 2. Claudio Abbado, Boston Symphony Orchestra and New England Conservatory Chorus. DGG 2561012. Stereo.

The disturbing financial situation of the American record industry has caused a number of U.S. orchestras to either cease recording activities for the time being or seek contracts with European companies. The Boston Symphony has fortunately elected to continue recording for DGG – and while at first this seemed to have grotesque consequences (Fiedler on Polydor), the debut issue of this excellent disc finally dispels all irrelevant associations.

Further, DGG's choice of works for this first album (Debussy and Ravel) indicates a refreshing and enterprising attitude with regard to repertory. Previously DGG had not been especially noted for recordings of modern or contemporary works (a glance at the Stravinsky they have recorded is informative enough). There have been recordings of contemporary material presumably of interest in Central Europe – i.e., Stockhausen, Ligeti, Henze – but where, one asks, is Messiaen or Boulez?

A great part of the problem has been the absence of forces that are capable of presenting these works well and also possess some reputation to attract a listener to their efforts. The Boston Symphony does have the reputation; it also has a long tradition of performing French, Russian and modern compositions in general. One can immediately note how well the orchestra can overcome DGG's limitations in these directions. We should now hope to hear more Debussy and Ravel, Satie perhaps, Honegger, not to speak of Prokofieff (a Boston favourite), Britten . . . one could go on.

That in fact this is what DGG most probably has in mind is clear from another disc due to be released soon: one that contains W. Schuman's 'Three Places in New England' and, more interestingly, C. Ruggles' 'Sun Treader' – both rather important American works. For those interested in modern music in general, it has always been a source of irritation that American compositions have been generally unavailable outside the U.S., either because of copyright restrictions (American Columbia or Decca) or simply because such compositions would in most cases be available on small American labels not normally encountered here. Let us hope DGG will continue its enterprising intentions, as it can well benefit not only the listener but the composer as well.

The 'Nocturnes' and the suite from 'Daphnis' receive excellent if traditional performances. One must not expect to find the originalities to be had in, say, a Boulez performance; but sound quality is far superior, and this is of primary importance in works such as these. Only in the 'Pavane' does Abbado seem curiously sluggish, but this is a minor blemish in an otherwise fine production.

The Boston has, to my mind, been given for the first time that airy and breathing quality which marks its sound in a live concert. Strings are especially luscious, as indeed they are when heard live. More important, there does not seem to be that brassy quality which used to mark its recordings for RCA, and which again the Boston seldom has in concert. The 'Sirenes' will illustrate these points perfectly.

The fine box comes with a very informative essay on the history of the Boston, the works, and Claudio Abbado. – J.A.

BEETHOVEN — Symphony No. 5. Ferenc Fricsay, Berlin Philharmonic; Heliodor, Stereo 2548028.

Beethoven is terribly difficult, and unsuccessful interpretations of the Fifth, in particular, abound.

Fricsay has conducted it much as one might Tchaikovsky. Again there is that excess of romantic rubato which so often mars interpretations of the first movement. One has a heavily armour-clad passage, a senseless pause, then a light whirling passage. The late variations of the opening chords are taken into a different rhythm for overemphasis.

I know that there are many who will like this, but I would ask them to acclimatise themselves to the way Klemperer integrates it all over an unfailing pulse. In the end you must agree that this is what Beethoven is about.

It is the first movement, however, which suffers least from the ridiculously slow tempo. A martial tune played by the brass early in the second, never a particularly good melody, is reduced to a parody of itself and sounds almost out of tune, mainly because one can visualise the players straining to keep their notes from sagging.

From here on one cannot really take it seriously. Some things sound quite impressive taken so slow, others sound dreadful. I think we can assume that it was never meant to be played like this. Sound is hollow and echoic. There are some good recordings in this low-price series. This is not one of them. – J.C.

BEETHOVEN — Symphony No. 7. Herbert von Karajan, Vienna Philharmonic Orchestra. RICHMOND STS-15107. Stereo.

Decca has recently been re-releasing Karajan's Vienna Philharmonic recordings, most of which appeared under the RCA label – and I might say that it was about time, for, to be quite honest, I do not feel that Karajan's efforts with the Berlin Philharmonic on DGG enhance his reputation as a great conductor. There are fine readings, to be sure – even great ones – but in most cases, particularly with regard to the classics, he has developed a remote and facile approach, often uninterested, that belies the great conductor that he is. One hopes that EMI will take note and reissue some of his excellent performances with the Philharmonia Orchestra.

This recording of the Beethoven Seventh originally appeared on RCA. Reissued on Decca's cheaper label, it is an example of how relaxed and spontaneous Karajan could be with the VPO. The warmth of the great orchestra is particularly apparent. Curiously, however, this is one work which Karajan does better in his Berlin Philharmonic recording for DGG. There is finer precision and excitement, and the way the last movement is taken is unbelievably good There is less warmth and spontaneity in the Berlin recording – but it is, I feel, finer than the one with the VPO. Nevertheless, let me say that I would rather have this Karajan performance than Decca's later recording with Schmidt-Issertedt. That reading is inept and sluggish, and I cannot find what some people have purported to see in it. Rather good sound for a recording of about ten years ago. – J.A.

J.S. BACH — Sonatas for Clavier and Violin. Helmut Walcha (cembalo), Henryk Szeryng (violin). PHILLIPS 802910-11 LY. Stereo.

"Bach's sonatas, like Beethoven's, depict soul states and inner experiences, but with force in the place of passion." (Schweitzer.) This recent recording of Bach's 'Six Sonatas for Clavier and Violin' is certainly an affirmation of this statement. The performance is an amazing feat – amazing because of the linking of two different interpretations of Bach's music into one satisfying whole.

Szeryng's violin playing is faultless: bowing and phrasing superb (the last movement of the third sonata is quite breathtaking), and his double bowing, especially in the Adagio of the fifth sonata is outstanding. The ornaments are clear and correctly played and the accents, such as the syncopation in the second movement of the third sonata, are well defined. Szeryng's playing is expressive throughout – perhaps slightly too expressive for my liking – but the music is never sentimentalized.

This expressiveness is not due to excessive vibrato but to the many crescendos and diminuendos. I am, however, perfectly content to hear a violin played expressively (within reasonable limits); sooner than to hear a baroque violin played constantly out of tune and without feeling. Baroque performances of Bach's music concentrating on original sound and tempo, even acoustics, are fine (I am all for them) – provided there is feeling: Bach's music necessitates it, and it is what makes his music so outstanding in the Baroque era.

Walcha's cembalo playing is, on the whole, very good. The trills are well controlled and correctly played (notably in the second movement of the first sonata) and the fast passages are delivered with precision. Registration is really excellent – e.g., his use of the lute stop for the bass on the upper manual and the 8' and 4' on the lower manual for the upper counterpoint in the Andante of the second sonata. Phrasing, good though it is on the whole, does sound slightly pedantic in places (the Adagio of the third sonata), but it forms a good contrast to Szeryng's expressive playing and as such does not become tiresome.

There are one or two places where Walcha's phrasing gives the impression that the cembalo is used merely as continuo and this is NOT how it should sound. The cembalo has its own importance – so much so that it plays unaccompanied in the third movement of the sixth sonata (also, why did Bach call them 'Sonatas for Clavier and Violin' and not 'Sonatas for Violin and

Clavier'?). The solo movement ot the sixth sonata is played very cleanly but without the impetus I would prefer it to have. There is the suggestion in a few places that Walcha does not have absolute control over his instrument – very slight irregularities in note lengths – and this occurs in the slower movements only (the Largo of the fifth sonata, for example).

Balance between cembalo and violin is excellent – so far the best balance I have heard for these works. Playing together, both performers seem to have a mutual understanding of each other's interpretation, with the result that there is great continuity. Pauses as well as ritardandi at movement ends are extremely well controlled and the instruments are always together on time. The contrasts in movements are well premeditated – notably the bold allegro entry after the melancholy 'Siciliana' (which is played most movingly) of the fourth sonata. Each sonata is very different in mood from the rest, and this is how they are treated – the performance of each never sounds stereotyped.

The harpischord used by Walcha is (as the brief notes tell us) a copy of an 18th century instrument by Pascal Taskin (1723-1793). Its beautiful tone is outstanding and, although not large, stands up admirably to the violin.

The recording (on two records) is exceptionally clear, and the wonderful balance between the two instruments is also doubtless due to the ability of Philips' engineers.

Altogether an excellent and interesting performance of the Six Sonatas. – C.W.

PETER SCULTHORPE — Tabuh Tabuhan for wind quintet and percussion; NIGEL BUTTERLEY — Variations for wind quintet, piano, recorded piano. The New Sydney Wind Quintet, with Barry Heywood, Albert Setty (percussion) Joyce Hutchinson (piano). PHILLIPS Stereo S508001.

A much greater variety of timbre can be produced by a wind quintet than by a corresponding number of strings, for instance, yet most people become distracted and lose interest more quickly when listening to the former instrumentation.

Strings all vibrate in basically the same way. That is, the same patterns of simultaneous vibrations at different frequencies make up the string tone, or harmonic recipe. Length of strings and other factors dictate the depth of the sound. The sounds of the various wind families, on the other hand, are all produced in quite different ways: different reeds, vibrating lip muscles, etc., which resonate in chambers constructed in different shapes and of different materials.

As Roger Covell suggests in the cover notes, "... the very speed with which the ear recognises these different characteristics ..." may account for the corresponding promptness of their palling, if we may paraphrase.

The two Australian composers here working in the idiom have added percussion and tiny bells (in the case of Sculthorpe), and piano recorded and played back at different speeds, and sometimes backwards (Butterley), to help hold your attention.

There is a very clear distinction which can promptly be made: Sculthorpe's work is consciously atmospheric, Butterley's is formal, linear and intellectual. Not that Sculthorpe's does not have properties of the other, nor Butterley's a certain placid, clear lyricism.

Butterley's 'Variations' are based on a twelve-note sequence, but he does not adhere strictly to serial methods, though he uses those methods as a constant point of reference and as a means of keeping his linear shapes and textures mainly clear of the distractions of tonality. He is thus able to achieve a delightfully intricate and pure counterpoint.

Sculthorpe will use serial devices too, when it suits his purpose, but he will as readily use conventional harmony. His work manages at different times to evoke Debussy of both 'Images' and 'La Mer' as well as Mahler song settings and Balinese music, which is fairly remarkable for a work for wind quintet. I have not heard so clearly derivative a work by Sculthorpe before, though it is anything but a displeasing one. Butterley's work, too, contains a number of familiar phrases, often quite intact, though I wonder how much this has to do with the form he has chosen. This, too, is physically and intellectually – though hardly emotionally – highly enjoyable.

Mr. Sculthorpe's inspiration is an Indonesian poem about a boy who would like to take his girl to the best hotel on the island. Or, loosely translated:

"Were I rich, I'd give you
A roll in the Ritz."

Seriously, I think he has succeeded in imparting the feeling of a pleasurable contemplation of the erotic which never quite becomes raw or violent desire. By using bells and percussion, and having the players produce exotic variations of their instruments' orthodox sounds, he makes you forget that this is a wind quintet. With Butterley, your attention is focused on the nature of the instrumentation – and there lies the appeal of each. For myself, I can listen to a lot of wind music through some eccentric ability to remain fascinated by each tone.

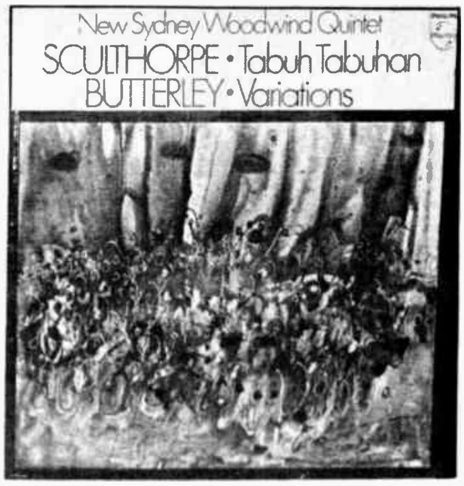
The playing of the New Sydney Woodwind Quintet is quite exceptional – but the recording is rather noisy on the surface, and at moderately full volume some of the instruments begin to boom slightly. Pity, because armed with Roger Covell's detailed and instructive notes, you should be able to enter two distinct and fascinating worlds of sound. Balance is good, all instruments are clearly delineated. – J.C.

RICHARD STRAUSS — Till Eulenspiegel; Don Juan; Tod und Verklarung. Herbert von Karajan, Vienna Philharmonic Orchestra. TELEFUNKEN—DECCA SMD-1207. Stereo.

These three tone poems were all written before the composer was thirty-two (indeed 'Don Juan' was written when Strauss was only twenty-five) and already showed great maturity of writing in this form – a maturity which makes the tone poems not only Strauss' greatest achievements but probably the finest ever written.

The record is a reissue, having been recorded nine or ten years ago when Karajan was chief conductor of the Vienna Philharmonic. Telefunken has certainly improved the sound and this disc is quite indistinguishable from present releases.

What Karajan can do with these compositions is truly outstanding. Not only story but character itself comes to life before us. He has the ability to give Don Juan the perfect touch of irony, to make



Till the vagabond hero he really was, and to present a Transfiguration that can only be described as glorious. From the opening phrase of 'Don Juan' Karajan's control over the Vienna Philharmonic is supreme, but this does not in any way interfere with the beautiful phrasing of the orchestra.

Where there are changes in mood (especially in 'Tod und Verklarung'), Karajan is always firmly determined to emphasize these changes and the orchestra responds with full accord – listen, for instance, also to the way Karajan builds up the various episodes in 'Till Eulenspiegel', climaxing with the judgement section. It often seems conductor and orchestra are one with these changes of mood. Pauses have that control which comes only from mature conducting and understanding of the works. The orchestra always enters "spot on" and without any hesitation: listen to the pause before the final section of 'Don Juan' and try imagining how this could possibly be bettered. The Vienna Philharmonic probably seldom sounded better.

The string section has a glorious tone (e.g. strings at the end of 'Tod und Verklarung') and solo playing is always most moving. Balance between the different sections of the orchestra is superb. Altogether an excellent record and fully worth its price. I can only hope that more of the Karajan-VPO recordings will be reissued. – C.W.

SATIE — Piano Music (Volume 2). Aldo Ciccolini (piano). HMV OASD-2603. Stereo.

For those who delighted in Ciccolini's first volume of Satie's piano music, this second instalment may prove hard going for any but confirmed Satie fans. Selections on this disc range from the pre- 'Gymnopedies' 'Trois Sarabandes' (1887) – quite boring, really – to several of the so-called Post-Schola pieces (at the age of 39 Satie resumed his musical education by entering the Schola Cantorum run by d'Indy and Roussel, hence the term) and finally a number of pieces from his final period.

Perhaps the only really important piece on this disc is the Post-Schola 'En habit de Cheval' (1911). The other pieces have the usual funny titles-subtitles-commentaries, the last reproduced on the jacket, but I hardly think any of them are that interesting to listen to more than a few times. This is certainly no record to play through in one sitting. The effect is not calculated to make one appreciate Satie's (now-elusive) harmonic boldness. Ciccolini plays very well, even when he plays all four hands, though he does not seem to enjoy this music as much as the more well-known pieces in the first volume. Good enough sound. – J.A.

REVIEWERS: Graeme Bell, John Clare

ERIC DOLPHY WITH CANNONBALL ADDERLEY. Vedette 8091. Stereo. Jitterbug Waltz, Music Matador, Juggin' Around, Little Ditty, Awful Mean. Dolphy, flute, bass clarinet; Cannon, alto; Nat Adderley, cornet; Benny Green, trombone; Frank Foster, Frank Weiss, tenors; Tommy Flanagan, piano; Paul Chambers, bass; Philly Joe Jones, drums.

This is one of a series of attractively packaged, budget-price reissues which you can get from, or through, most larger record stores. Sound on these recordings is not always the best, which is only to be expected. On side one you get that peculiar feeling of music heard underwater, which probably indicates re-channelling from mono. As it happens, the two tracks are such odd ones that the effect is not at all displeasing.

Fats Waller's 'Jittering Waltz' is a very beautiful, strange and remote little piece which begins with a series of upward hops, dropping away down the scale. Here is the key to the odd playful sadness of the piece. It's almost like someone hopping up a downgoing escalator, not quite fast enough. At the end of each descent is a blues phrase which is whirled away by the revolving waltz rhythm.

Dolphy's lovely flute solo expands the subtle feeling without destroying the balance of pleasure and faint melancholy. Matador is, I think. a Rumba – I can never remember which Latin rhythm is which. It is exceedingly old, capturing perfectly that mad, disjointed gaiety of a South American carnival parade. Cannon gets the rhythm and the feeling right on in his solo. He sounds very much like Charlie Parker. The naturalness of Dolphy's inventions, once considered arty and weird, is in this setting particularly evident. His second solo is on alto, and he gets some wonderful squawling and buzzing sounds from it. In fact it sounds like an extension of his bass clarinet.

So far as I can tell, Dolphy does not solo on the second side, and he may not even be in this larger group. However, the music is excellent – bop emerging from swing. Frank Foster, Frank Wess and Gene Ammons each plays an inventive, muscular and exciting tenor, but it is Nat Adderley who is right on the top of his form. The influences of early Miles, Clark Terry and Dizzy Gillespie are well integrated in solos of great intelligence and power.

So derivative is Nat in many ways, yet he has a feeling for the horn that is all his own (the same might be said of, say, Pete Candoli). I particularly like the quirky inflections and the bite he imparts to notes above the stave.

Philly Joe Jones is the most relaxed cat who ever sat behind drums. It's surprising how busy he is when you really listen. He lets it all get so loose it almost unravels, but he's always there – sock! – when you want him.

An exceptionally good blowing session. On the second side the sound is hard, grainy and immediate, the way jazz should be. I could not detect much stereo separation, and in fact, when I switched to mono mode, it sounded scarcely any different. – J.C.

PARIS 1945 — Django Reinhardt with the Glenn Miller All Stars; The Ray McKinley trio with Mell Powell. CBS 63052. Side 1: If Dreams Come True, Stompin' at the Savoy, Hallelujah!, How High the Moon, Hommage a Fats Waller, Hommage a Debussy. Side 2: After You've Gone, Shoemaker's Apron, China Boy, Sugar, Don't Blame Me, Poor Miss Black.

After World War II some of the members of Glenn Miller's Orchestra stayed in Paris for a while, and these tracks were made 'in the happy atmosphere of post-liberation France.'

Django Reinhardt's name is used as a selling point, for this famous Gypsy guitarist appears only on the first four titles of side 1 and his solitary full solo is on the first track. Apart from this, he is only permitted a couple of introductions and the bridge of one title.

Stars of the album, in my opinion, are that wonderful drummer Ray McKinley who solos on 'Hallelujah!' and pianist Mel Powell.

Many pianists have included in their repertoires numbers of medleys played in the manner of Fats Waller – but although Powell lets us hear many of the master's tricks in his 'Hommage', his playing seems to lack the forceful bounce of other imitators. His homage to Debussy sounds more to me like a Bix Beiderbecke piano composition which in turn contains a Debussy influence.

These two tracks, plus the last two numbers, on side 2, are unaccompanied piano solos, and in 'Don't Blame Me' and 'Poor Miss Black' Powell plays in his own glorious style which made this blond, bespectacled and intellectual young man something of a boy wonder in his day.

On the Django tracks Bernie Privin plays trumpet and Peanuts Hucko plays tenor. Usually known for his clarinet playing, Hucko reminds one of Bud Freeman, and Privin, who takes a fine solo on 'Hallelujah!', sounds like the early Roy Eldridge.

For my money, the first four tracks on side 2 top the bill. Mel Powell, who gives Teddy Wilson more than a run for his money, teams with Hucko on clarinet and Ray McKinley to do a Goodman Trio bit.

Even the tunes themselves, apart from Hucko's composition – 'Shoemaker's Apron' – were all Goodman hits.

I remember well that, when Powell first hit the scene, his technique had the same devastating effect on pianists as when (many years later) Oscar Peterson first made his presence felt. 'After You've Gone' and 'China Boy' display, as well as anything I have heard before, the brilliance of Mel Powell's piano playing. Add this to the great drumming of McKinley, who was way ahead of his time, and the warm jazzy playing of Hucko, and you have a trio which to my mind overshadows the other tracks on this album.

The recording was made under the supervision of French pianist Yvonne Blanc – whoever she is – and the quality is adequate. – G.B.

MARTIN BOTTCHER AND HIS ORCHESTRA — Moonlight Guitar. Telefunken (Royal Sound) stereo SLE 14576-P. Guitar soloist, Siegfried Schwab. The Breeze and I, Yesterday, Strangers In The Night, Carnival, Moonlight Guitar, Fascination, Charade, A Man and a Woman, The Shadow of Your Smile, Scarborough Fair, etc.

Strictly for unwinding. If you wanted to catalogue shortcomings, you could go on for quite a while. Mr. Schwab, the guitar soloist, plays all the right notes, but his sense of rhythm is rather stodgy. There are no flights of imagination in the orchestrations, which stay mainly in the middle register, and we have come to expect rather better sound than this from these inexpensive import records. Poor definition in the middle and lower registers.

For all that, the record is eminently pleasant and soothing, the credit for which must go mainly to the fine melodies they have selected. Everything is played very straight and subdued, mainly by strings, and the melodies do all the work. – J.C.

B.B. KING — Indianola Mississippi Seeds. EMI (Probe) SPBA3010, Stereo. Nobody Loves Me But My Mother (And She Could Be Jiving), Until I'm Dead and Cold, King's Special, etc. B.B. King, vocal and guitar; Leon Russell, piano; Carole King, piano; Bryan Garofalo, bass; Russ Kunkel, drums Strings and brass arranged by Jimmie Haskell.

There is very little to say about this except that it's mainly the blues – and it's mainly very good indeed. The basic feeling is that of a small blues band, at once relaxed and tough, full of humour and passion, with horns and strings used only to swell a climax here and there. Kunkel's admirably crisp and propulsive drumming keeps everything rolling powerfully.

Instruments in the foreground are well recorded – very sharp and exciting – while the orchestral backings are a bit diffused;

but that is probably the way it should be.

King's performance could not be faulted if one were hearing him for the first time, but I have heard him singing and playing with more fire than here.

As a whole, the record will swell the good feeling through your house. – J.C.

CHARLIE PARKER — Charlie Parker Volume 2. Vedette, stereo VPA 8098. Cheryl, Salt Peanuts, How High the Moon, Street Beat, Big Foot, Out of Nowhere, Perdido. Miles Davis, Kenny Dorham, Fats Navarro, trumpets; Al Haig, Bud Powell, pianos; Tommy Potter, bass; Max Roach, Roy Haynes, drums.

Usually, where I have been able to hear both the original and the rechannelled-for-stereo versions of a recording, the practice of rechannelling has seemed to me indefensible. There have been a couple of recordings, the originals of which I did not have at hand to compare, which have sounded quite fine in stereo. 'Andy Kirk and His Clouds Of Joy' and a recording of Earl Hines's band in Chicago, to be almost precise.

Where the original was badly recorded, as was the case with so much material from the bop era, I always get the feeling that a half-hearted effort at restoration has been made and then the whole lot – all those splinters and hoary textures – wrapped in cellophane. The sound on most of the solo instruments here has not been too badly smothered and diffused, but you get an unpleasant bathroom ring if you turn it up too much. The rhythm section is of course barely audible at times, and Fats Navarro's brilliant trumpet suffers very badly. Parker, on the other hand, slices through effortlessly.

Actually, I found the best way to listen to much of this was to switch to mono, turn on the loudness contour and then increase the volume. Almost nothing is lost in mono, except that hollow resonance. To be fair, it could all have been unlistenable before.

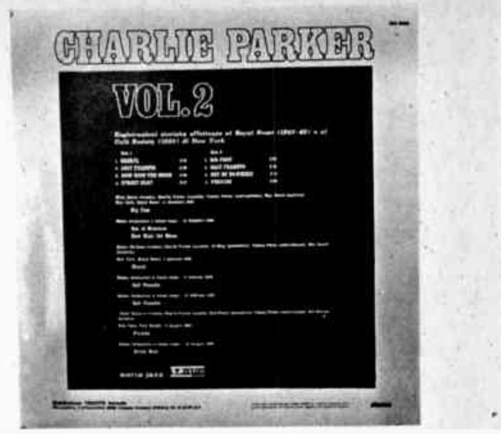
According to the cover notes, this is 'the best Parker has ever done with a microphone present.' Now, suh, thet wus jest a lie! Some of the tracks on 'Jumping with Symphony Sid' and 'Jazz at Massey Hall' (both on Saga) are at least the equal of these – just to name the last two great Parker recordings I bought – and the sound is much better, to boot.

However, there are some outstanding performances here, particularly the two breakneck versions of 'Salt Peanuts', both with Kenny Dorham. I remember a passage in William Faulkner in which a dog running became a blurred shrugging fleece. That is what Parker sounds like, improvising the odd six-bar break. His main solos on both versions are dizzying flights. Hearing him is so much like watching a swallow, grazing the grass so swiftly that stones, twigs, matchsticks become streaks, reaching thirty or forty feet in seconds with a series of flicks and glides. It is undoubtedly one of the most beautiful experiences available.

Kenny Dorham sounds amazingly like Dizzy Gillespie, but he is well enough recorded to be distinguished by his almost cornet-like sound. Sometimes Miles, also sounding like Diz, plays so well that I am inclined to doubt the accuracy of the credit. He shows a lot more technique than is generally believed he had in those days.

Bud Powell often sounds to be down the other end of the hall on this recording, but he is up front and on form on 'Street Beat'.

Budget-priced, nicely packaged. Recommended, with all the obvious qualifications. – J.C.



MANFRED MANN — "Chapter Three (Volume Two). Vertigo 6360012. Side 1: Lady Ace, I Ain't Laughing, Poor Sad Sue, Jump Before You Think, It's Good to be Alive. Side 2: Happy Being Me, Virginia.

Understandably enough, many English records are now saturated with the influence of what Miles Davis did in1968 with 'In A Silent Way.' They are all in one way or another a dilution of the original rather than a development.

Although the long-track 'Happy Being Me' is the only one on this record that is heavily Miles-influenced, it is interesting to note that Mann seems to have missed the points that Miles' stuff is essentially a jazz interaction between a small group of men, and that it develops organically despite its use of a simple, montuna-like base. Certainly Miles's work is now so intricate and complete in itself that the interpolation of a choir chanting Hollywood Aztec or Hollywood Navajo phrases, as occurs here, would be disastrous.

The track is effective enough on Mann's terms, which are to get a hypnotic thing going that will make his listeners good and stoned. You can get stoned on Miles too, but its values are firstly musical. Even the tenor solo, which displays a lot of technique and uses well several avant-garde jazz devices, has little individual life of its own, and could as well be a mere effect as a personal utterance in the jazz idiom.

Elsewhere the songs are fair to ordinary, as is the singing. 'Poor Sad Sue' and 'Virginia' are very Beatles-influenced, and 'It's good to Be Alive' could be Grand Funk Railroad material. The orchestral parts vary from banal and repetitive on 'Lady Ace' to quite inventive and rather manic on most of the others. On 'Virginia' there is a shivering dissonance very similar to Bartok's parody of Shostakovich in the 'Concerto for Orchestra', and the baritone plays against it something like the Batman theme. Quite mad, and a good bit with which to show off your equipment.

Recording is fair, after the manner of this kind of thing. In the recorded sound, as in the orchestrations, they have gone for a kind of buzzing density rather than richness or clarity of detail. Drums are often a bit muffled. The level of the recording, incidentally, is rather low, and it needs to be turned up if you are to see any daylight through the music at all.

The jazz solos are highly accomplished, though they still seem a little characterless to me. Clive Stevens is certainly very good on tenor and soprano. On the latter his ripe, piercing sound is a delight.

All-in-all, Mann has got a lot of things together, and they are all done well and all are effective. I have not yet found the heart of it, but I find myself enjoying it more each time I play it. If you want some interesting sounds, some quite exciting jazz which will not offend your children too much, Manfred is your man. – J.C. ●

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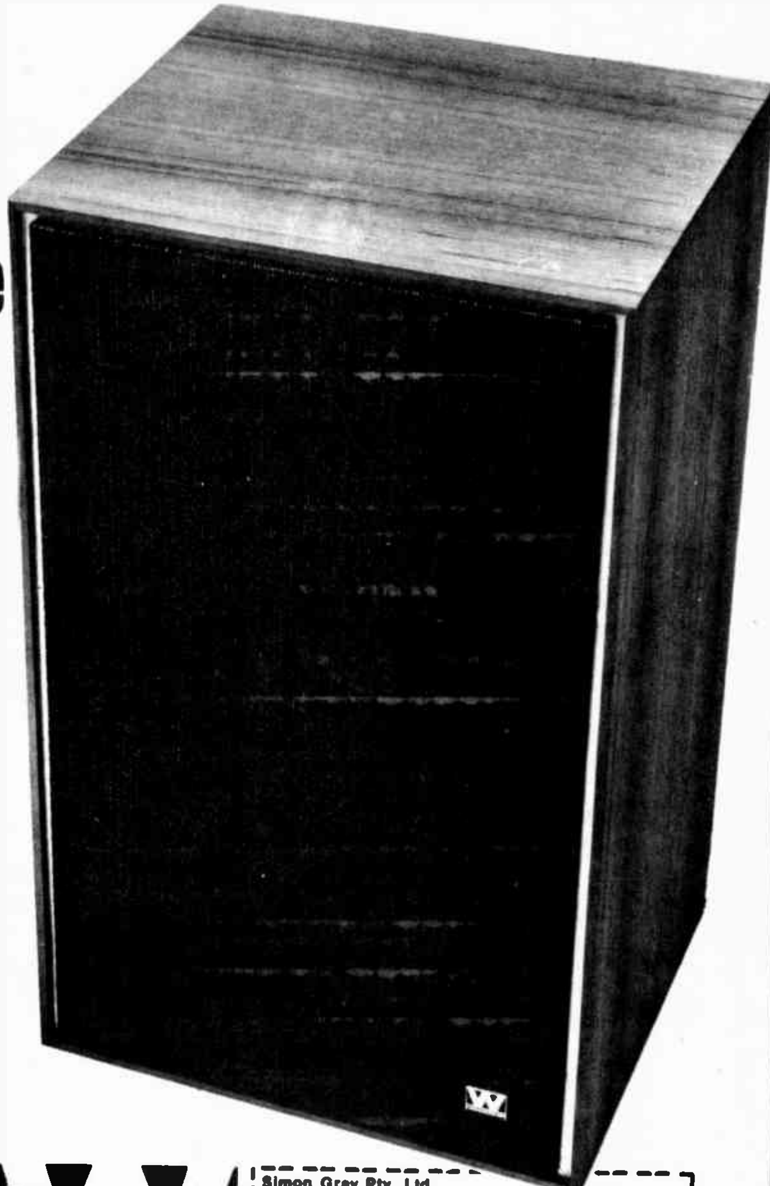

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POP TRENDS

ON THE SCENE WITH JOHN CLARE

BILL MOTZING

Blood Sweat & Tears sound man

Almost every comment one heard following the remarkable Australian tour of Blood Sweat & Tears carried the ecstatic rider: " . . . and the sound!"

Of course, much of the credit must go to the equipment itself and its manufacturers – we shall list some of the components later on – but you must have someone who knows music mixing the sound if you are to achieve anything like the spectacular success of BSW&T.

We were not all that surprised, then, to find that their sound mixer, Bill Motzing, is a musician and composer who obtained his Master's Degree in music from the Manhattan School of Music in New York City, and has played trombone with the Eastman-Rochester Symphony Orchestra under Howard Hanson, the Pittsburgh Symphony with William Steinberg, and in jazz groups with Gerry Mulligan, Bill Russo, John Lewis and others, as well as the dance bands of Larry Elgart and Ray Eberley.

Bill went into sound mixing partly because it would allow him spare time in which to write music, but he takes the job very seriously. We were a little surprised to find that he may come back to settle in Australia. He has been thinking about this for some time – prompted mainly by smog and stratospheric prices in the U.S.

Trevor Graham spent some time showing Bill around Sydney, as well as conducting an interview with him for Music Maker magazine. Bill came out to my home one evening and stayed until about 1.30 listening to records and talking. He came into Music Maker the next day to pick up a back issue containing a story about Charlie Munro, whose records I had played for him.

Both of us were impressed by his knowledge, humility and easy friendliness. We were naturally gratified by his sincere admiration of two Australian musicians whose praises we have been singing for some time now to little avail: Bobby Gebert and Charlie Munro.

Hearing a tape Trevor Graham has of Gebert, Bill said, 'That is some of the very best piano playing I have heard.'

Of Charlie Munro's 'Eastern Horizons': 'What a musical mind this man has. You can hear his thinking through the freest of free jazz sections. Also, he plays each of his instruments as though he were a specialist.'

Bill gave us a brief rundown on the equipment used by BSW&T:

'We have nineteen microphones which are mostly Shure, although in Tokyo we bought two Sony condensor mikes, each one of which replaced two Shure mikes. We had two over the drums, but one Sony condensor now pulls up at least that much coverage. We also had two on the piano which we have now replaced with the other Sony condensor mike.

'I usually keep the windguards off everything except the flute and harmonica mike because playing these two instruments creates a tremendous amount of wind, so the retention of guards cuts this noise down. At Randwick (where the Sydney concert was held) I had put windguards on the horn mikes – although by the time the concert started the wind had dropped, the spotlights attracted a variety of large moths. Also I do not use a guard on the vocal mike, except when David is playing guitar, because he works very close to the mike.

'We have five monitor speakers on stage. Two for the horn section through which the horn players only get themselves. We then have one for the lead singer, one for the bass player and one for the drummer, all of which get the full mix. These monitors are driven by two 300 watt SAE amplifiers, two of which are attached to SAE graphic equalisers to pull out any frequencies that may cause feedback.

'The output from our five Altec mixers, each of four channels, goes into Roy Clare's power amplifiers – a total of 2400 watts output – and on tour we use Crown amplifiers, although we usually use SAE amps in the States. These 2400 watts go into bass enclosures custom-built by Roy, and there is no reverb or vibration. It is as though they were made of steel, but in reality they are solid wood. The ones you saw at Randwick were made to Roy's specifications out of pressed board because our boxes in the States are too big to transport overseas.

'Roy has a three-way sound system – low, mid and high range – and has built his own dividing or crossover network. The bass speakers go up to 500 cycles, the mid range takes over up to 7000 cycles, then the high range moves in. Each bass box contains two JBL 15" speakers, so at Randwick we had twelve 15" speakers going for the group. The mid range goes through Altec multi 10 Cell horns and the ultra high frequencies through, I believe, a JBL small speaker system.

'Another point of interest is that there was no additional P.A. gear in the stands or anywhere on the racecourse at Randwick, because they would have made nonsense out of the sound from halfway back.'

Although Miles Davis has been less than enthusiastic about Blood Sweat & Tears (always pretty sparing with the kind words, Miles said of trumpeter Al Hirt, 'Does he think he has to play that way because he's fat?'), Bill was enthusiastic about what Miles is doing now. We were listening to the extraordinary way the keyboard players anticipated each other's every move, and I pointed out that a local critic had described this rather diversely as 'tinkling backgrounds' and 'chaos'.

'Oh, well,' said Bill, 'if you can't follow it, I guess it might sound that way.'

Bill said that, when the great innovator Ornette Coleman arrived in New York in the early sixties, Miles was about the only musician who kept his mouth shut, neither damning nor praising, though he was there listening to him every night. Bill was there too, having heard Ornette sometime earlier in a school conducted by John Lewis. Said Bill:

'A friend of mine came up to me and said – "Hey, there's this guy I'm trying to play with because I think he's got something." He took me to stand outside Ornette's room (he knew Ornette would be playing, he always is) and when I heard Ornette's saxophone, I thought – that's it, that's the way it's going to go.'

More than I have since – well, since I last saw Charlie and Bobby Gebert – I felt in touch with the world of musical ideas.

MUSIC AND ELECTRICITY

Two Sydney Concerts

1: TELETOPA

David Ahern's electronic music improvisation group, Teletopa, was physically attacked when it performed at the Sydney Town Hall during this year's Prom Concerts.

I suppose that there are interesting psychological implications in an attack of this kind when exits are readily at hand, though I imagine that such a reaction must be the self-respecting avant-gardist's dream, but I did not allow myself to dwell on either of these considerations. Unswayed by sympathy or suspicion, armed with a determinedly open mind (this is what we all say), I attended the second public performance by the group at the Sydney Conservatorium of Music in March.

The performance had begun when I arrived, but according to their literature it would be quite normal for them to begin warming up before the advertised starting time. 'Teletopa improvisation has no beginning, ending or interval,' says their pamphlet, 'for the music is a continuous sound environment.'

There was quite a good crowd, though two people left even as I arrived. Two electric string instruments, one a violin and the other probably a viola (the player kept his back to the audience and the sound was distorted electronically) were being played, while a third musician – Roger Frampton as

POP TRENDS

it turned out, one of the best jazz altoists and pianists in Australia – knelt at a control console on the floor. The hum of an amplified vacuum cleaner persisted throughout the performance.

At first I was conscious only of a shrill flagellation of the air. I don't think the amplifiers at the front of the stage were particularly powerful, but there was a great deal of penetrating 'rough' sound and mainly shrieking upper harmonics from David's violin. An electronic device produced rising and falling siren cadences, also at a very high frequency level. This went on for quite a while without much discernible variation. Three or four more people left.

Roger now played his saxophone into a microphone. In place of the bright piercing sound I am accustomed to hearing him produce, there emerged a dull, peculiarly uninflected sound, which was perfectly in keeping with the improvisation at this point. I gave up waiting for anything to 'happen', shut my eyes and began to experience it quite pleasurably as a screaming rainforest of sound. The hooting and barking sounds Roger had now begun to produce, with occasional pizzicato and rapping of bows from the strings, supplied other levels beneath the constant frozen hysteria of the upper branches.

It was all extraordinarily complex and hypnotic, though it seemed to me to run through a rather desultory cycle, and it fell at this stage into an emphatic four beats to the bar. As it went through more rather gradual transformations, I found myself alternately fascinated and bored, depending partly on how much I let myself subside into it. The sounds were not 'random'. There was a definite interaction taking place, and most often it worked best when it achieved something near the stasis of a picture, which yet changed subtly, almost indiscernibly, as you watched. In a sense, too, it was very like watching some organic process through a microscope, on a speeded-up film.

The performance ended with the electricity being turned off and the players sitting for a couple of minutes in total silence. Our ears were encrusted with the painful jewels of remembered sounds – or, to put it in another way, our ears were ringing.

2: BOB GEBERT and TAMUM SHUDD

Sydney pop group Tamum Shudd held a joint concert with Bobby Gebert's jazz group at the Cell Block Theatre at the beginning of March. Discounting the unfortunate ending, it was the most satisfying concert by local artists I have attended in many months.

Tamum Shudd began with their amplification at an eminently sensible level. Everything was sharp and clean. The music was fast and lyrical, ethereal and exciting. Folk and rock elements were admirably combined, and Larry Durea's conga playing gave it all an intricate rhythmic dimension that no other group of this kind has, so far as I have heard. I had no idea that they could play this well. Particularly fine was the work of seventeen-year-old guitarist Steve Gaze.

Bobby Gebert's group took the excitement up a few notches. Playing to Bob's system, which uses an underlying figure plus inversions and other permutations which all the musicians must know thoroughly, the group was amazingly tight despite the uninhibited nature of their group and solo improvisations. Gebert's electric piano and Jack Dougan's drums maintained a terrific intensity throughout every bar; in fact, the whole thing hummed like a dynamo.

Jazz has so often suffered from the kind of blockheaded thinking on the part of sound mixers which leads to solos being turned down and submerged in the mixture that it was a delight in itself to hear how well the group had arranged its own balance. Keith Barr and Keith Sterling, on tenor and trumpet, were able to stand well back from the mikes as they blew the themes together. That whole area was sensitive, and piano bass and drums were kept out of it to either side. Sterling did not even have to move to have his ringing solos stand everyone's hair on end. Occasionally he seemed to run a little short of ideas, but this was his first performance with the group. Suffice to say that Keith Barr was on form. He is one of the very best in this country, and everyone who has the opportunity should hear him.

Unfortunately, Tamum Shudd came back after intermission, showing their heavy rock face. All amps were up, all subtlety gone, and a couple of the brutal, clumpish things they did were among the worst I have ever heard.

Rough-hewn lumps of crude energy collided amid fearful distortion. All right, perhaps you are supposed to let it all pound around and around in your head, but for that I would rather hear something less related to conventional music (Teletopa for instance). The forms here – exceedingly simple-minded rock-and-roll at times – were so ordinary, so banal, as to fight the freaky effect it was all supposed to have on you.

Sorry about that. I would never have known that it was the same group.

Simple check for turntable speed

ELECTRONICS TODAY's stroboscopic disc enables the 50 Hz mains to be used as a reference for checking turntable speed.

Simply cut out the printed disc and paste it onto a piece of stiff card.

Cut out the centre hole so that it locates accurately over the turntable spindle

Use the disc by placing it over a record, which should have the pickup stylus following the grooves in the normal manner.

View the disc under a 50 Hz incandescent or fluorescent light. If the speed is correct, the relevant markings on the disc will appear to be stationary.

If the speed is incorrect, the disc will appear to move either forwards or backwards (according to whether the speed is fast or slow).

Adjust the turntable speed adjuster until the stroboscopic disc appears to be stationary.

DRAFT STANDARDS

THE Standards Association of Australia is seeking comment on four draft Australian standards on electro-magnetic interference limits. They are: Doc. 1693, Limits of Electro-magnetic Interference for Electrical Appliances and Equipment (revision of AS C321); Doc. 1694, Electro-magnetic Interference Measuring Apparatus for the Frequency Range 0.15 MHz to 1000 MHz (replacement of AS C348 and AS C349 which are endorsements of Part 1 of CISPR 1 and CISPR 2 respectively; Doc. 1695, Radio Interference Limits and Measurements for Television and Radio Receivers; Doc. 1696, Electro-magnetic Interference Limits and Measurements for Semi-conductor Control Devices.

Doc. 1693 establishes limits for electro-magnetic interference emitted by a variety of electrical equipment intended for both domestic and general industrial or commercial use. Examples of the type of equipment covered by the specification are included.

Doc. 1694 specifies the characteristics and performance of quasi-peak, peak and sine-wave detectors for measuring electro-magnetic interference voltages and field strengths in the frequency range 0.15 MHz to 1000 MHz by defining mandatory fundamental parameters.

Doc. 1695 is intended to protect the reception of sound and television signals and prescribe limits of permissible radio interference characteristics for broadcast television and sound reception. Methods of measurement for testing for compliance with these limits are also prescribed.

Specific comment is being sought on the question of immunity of television receivers to both radiated interference (particularly local oscillator radiation) and conducted interference. Methods of measurement are also required.

Doc. 1696 prescribes limits of electro-magnetic interference from equipment employing semiconductor control devices to control the operation of electrical appliances operating on low or medium voltage. It also specifies the method of measurement to be used to demonstrate compliance with the limits.

Specific comment is sought on the ability of the measuring equipment specified to cope with the measurement of interference generated by such devices.

Copies of Docs. 1693-96 may be obtained, without charge, from the various offices of the Standards Association of Australia in all capital cities and Newcastle.

Comment on the provisions of these drafts is invited from persons or organizations experienced in the problems of electro-magnetic interference and should reach the head office of the Association, 80 Arthur Street, North Sydney, N.S.W. 2060, or any branch office, not later than May 31.

BOOK REVIEWS

TRANSISTOR CIRCUIT DESIGN — By Texas Instruments Incorporated. Published by McGraw Hill. International Student Edition, 1963, by Kogakusha Co. Ltd. Hard covers, 523 pages. $8.70 nett.

In our fast-moving world, electronic components and techniques are changing so rapidly that most textbooks are out of date before they reach the bookshops.

Take a look at the bookshelf in any modern electronic laboratory – chances are that you will find very few standard texts. Most books will be applications data and catalogues from various component and equipment manufacturers. These are, and must be, continuously updated in order to 'stay with it'. They often are the only source of reference data on how to do it and what component to use. Standard texts are generally several years behind current practice, due to the time it takes to write, publish and distribute them.

The book under review was prepared by some 40 members of the Texas Instruments Incorporated engineering staff and was written in response to thousands of requests for assistance with circuit design problems. The book is aimed at the practical circuit designer and offers solutions to a wide range of basic electronic engineering problems. However, its publication date (1963) inevitably means that in some aspects the book is out of date.

For example, the chapter on digital logic circuits only mentions the RTL and DTL families of integrated circuits and not the now most commonly used TTL family. Further, an excellent section on parameters treats open circuit impedance parameters (z), short circuit admittance parameters (y) and hybrid parameters (h) quite thoroughly and a complete table of parameter inter-relationships is given at the end of the chapter. However, in modern high frequency transistor circuits it is often difficult if not impossible to obtain a perfect short or open circuit. For this reason, scattering parameters (s) were introduced and are measured with the device correctly terminated by the proper impedance. These parameters are now used almost exclusively for high frequency measurements on transistors and amplifiers. Automated analyser systems are now on the market utilising 's' parameter techniques.

Apart from these inevitable shortcomings which are certainly not the fault of the authors, the book definitely falls in the category of those that belong on the shelves of design laboratories.

The subject matter is wide-ranging, from transistor numbering systems and specifications to digital servo systems. The treatment is extremely clear and lucid, even though all necessary design equations are included. Most chapters begin with a simple explanation of the requirements, characteristics and problems in the design of the type of amplifier, etc., under consideration. This is followed by detailed treatment of the various factors, with explanations (where necessary) of the equations used. Following this is a design example which is set out so that each step is plainly understood.

For example, chapter 16, on Class A Driver and Output Stages, begins with a short general statement, a discussion of the requirements of the ideal amplifier, followed by one on the practical amplifier. This is followed by detailed sections on bias point considerations, power dissipation, thermal considerations and output power conditions. Finally a nine-page design example is given, which leaves no doubt in the reader's mind of the necessary procedure.

At the date of publication this book would have been one of the best texts available on the design of transistor circuitry. Even today this would still be true, in spite of the eight-year lapse. – B.C.

ELECTRONIC DESIGNERS' HANDBOOK — A practical guide to transistor circuit design. Second Edition, 1970, by T. K. Hemingway. Published by Business Books Limited, London. Soft covers, 296 pages. $10.60.

The author is head of Electronic Technology at the Guided Weapons Division of the British Aircraft Corporation and has been associated with the design of transistor circuits since 1954.

This enlarged edition of his book provided an up-to-date introduction to transistor circuit design. The basic techniques of design are emphasised, rather than trying to convey a superficial knowledge of a great number of circuits. The book is divided into three parts: Basic Circuits, Special Circuits, and Useful Techniques.

In Part 1, (Basic Circuits) emphasis is placed on designing circuits to operate correctly in spite of ambient temperature variations and spreads in transistor parameters. Only a few circuits are dealt with, but these are examined in great detail and have been chosen to cover those most commonly used – e.g., simple voltage

PROJECT EVALUATION SERVICE

Any reader who has recently completed an unusual or otherwise interesting project is invited to submit it for evaluation by our experts.

There is no charge for this service, but we reserve the right to publish details and comments if the subject is of sufficient general interest.

Information accompanying the project must be supplied typed, with the lines triple-spaced to allow correcting if published. Address to Projects Division, Electronics Today, 18 Bathurst Street, Sydney 2000. Enclose a stamped, addressed envelope.

REVIEWERS: Brian Chapman, Collyn Rivers, Peter Vogel.

amplifiers, dc amplifiers, negative feedback and constant current circuits. Some novel designs are dealt with in Part 2 (Special Circuits). This section is intended to show how designs can be put into practical form.

Part 3 deals with practical difficulties in the design and testing of circuits. In particular, a section of prototype testing brings out many points which are not normally covered in standard texts.

Quite a good book – but there are some technical errors in the text which seem to point to a lack of thorough proof-reading. For example, on page 149, when speaking of the loop operation in a voltage stabiliser, the author states that making the base of a silicon npn transistor more negative increases the collector current and therefore makes the collector more positive.

Although in general the expression is correct, the usage leads to obscurity of meaning. On occasions a paragraph has to be read two or three times to determine the meaning. The above criticisms, however, do not detract from the fact that the book is certainly of value to those students or newly graduated engineers who need guidance in the methods of practical transistor circuit design. – B.C.

RADIO CONTROL HANDBOOK, Third Edition — by Howard G. McEntee. Published by TAB Books; obtainable in Australia from Grenville Publishing Co., Sydney. $7.40.

This book is for radio control enthusiasts who have some knowledge of electronics – it is of little use to the novice. Its greatest value is the large number of circuit diagrams illustrating many different types of control systems.

Considerable emphasis is placed on designs utilising proportional control.

Printed circuit layouts are given for some circuits, but the standard of reproduction is very poor and the majority are illegible.

The book contains many photographs, but here again the reproduction is very bad. A number of proprietary items are quoted which may not be readily available in Australia.

Contents include: Sequence control systems, pulse proportional control systems, engine speed control, multi-control systems, radio control servos, power supplies, relays, installation.

The final chapter contains details of radio control system installed in model cars, sailing boats, speedboats, etc.

Despite the poor reproduction of some details, this is nevertheless a most interesting book, and to a radio control enthusiast it would be worth its price for the circuit details alone. – C.R.

THE RADIO AMATEUR'S HANDBOOK, 1971 — By Doug De Moir. Published by the American Radio Relay League (Newington, Connecticut). Obtainable in Australia from Technical Book and Magazine Co., Melbourne. 630 pages. $6.95.

This handbook deals with every aspect of amateur radio, from crystal sets to amateur satellites, both in theory and in practice. Using it as a guide, a hobbyist with a reasonable understanding of electrical principles can learn enough about radio theory to gain his A.O.C.P. and then make use of the constructional projects which include transmitters, receivers, aerials, test equipment, and many other accessories useful to the amateur radio enthusiast.

Although it is an American publication, the handbook is quite applicable to Australian amateur radio. Some transmitters described run more power than the Australian legal limit, but in general the standards are quite similar. Some shy away from American publications because of difficulties involved in obtaining specialised parts locally, but this edition of the handbook is quite good in this respect and enough details are given to facilitate substitutions.

This year's edition places much more emphasis on semiconductors, VHF, FM and specialised communication systems than in the past, which makes the book worthwhile even for those who already have an earlier edition.

The first section is devoted to an introduction to amateur radio and theory of operation of the various components used. In many cases simple circuit diagrams are used to illustrate how the components are used in practice. The rest of the book discusses theory, design considerations and construction of radio equipment, aerials and test gear, and features many practical designs. Several chapters are devoted to such things as operating procedure, interference prevention and construction practices.

Certainly one of the best books available to those who are interested in radio, on both theoretical and practical levels. – P.V.

1971 WORLD RADIO-TV HANDBOOK. Published by O. Lund Johansen. Available from Technical Book and Magazine Co., Melbourne. $5.40.

A comprehensive guide for the serious short-wave listener. 320 pages are devoted to an alphabetic listing of radio and television stations of every country in the world. Full details of the transmitting stations are given, such as postal address, operating schedules, programmes, frequencies and power. A listing of stations by frequencies is also given and is very useful when trying to identify a transmission.

The first 40 pages of the book are devoted to world time charts and other data of interest to the short-wave listener. This handbook would no doubt make the listener's hobby more enjoyable but would probably be of little interest to others. – P.V.

FOOTNOTE: Some readers have been unable to obtain copies of AMATEUR RADIO TECHNIQUES by Pat Hawker, reviewed last month. Technical Book and Magazine Co., Melbourne, advise that they have this book in stock.

NEW LITERATURE

DID YOU KNOW that the failure by householders to lock doors and windows accounted for more than 37 percent of all house robberies in N.S.W. last year?

Do you know how to act if your or your staff are victims of an armed hold-up?

A series of five pamphlets issued by the Crime Prevention Dept. of the N.S.W. Police Force provides invaluable data on protecting your car, money, shop, business premises and home against crime.

The pamphlets, titled, 'The Thief and You', are obtainable from the Crime Prevention Dept., Police Headquarters, Sydney.

CURRENT ISSUE of R. H. Cunningham's Technical Library Service Bulletin includes details of the Eddystone EC 958 professional class communications receiver. The unit covers the frequency range 10kHz to 30MHz.

Also included in the bulletin are details of Sennheiser headphones and microphones, and a new miniature rotary switch from Jeanrenaud.

R. H. Cunningham Ltd., P.O. Box 4533, Melbourne, 3001, Vic.

SEMIKRON have produced a 160-page catalogue illustrating their range of silicon rectifiers, thyristors, selenium rectifier diodes and bridges, etc. The catalogue includes a page of design equations for various single and three phase rectifier configurations.

Our catalogue was supplied by the Australian agents for Semikron – General Equipments Pty. Ltd., 375 Pacific Highway, Artarmon, N.S.W. 2064.

RECEIVED – the revised edition of Library of Congress Publications in Print, superseding the March 1969 issue.

The list consists of 362 publications, varying from a selective list of Yugoslavian abbreviations to a checklist of directories in science and technology. The list would be of particular interest to scientific librarians.

Library of Congress, Washington, DC 20541, U.S.A.

A BROCHURE from Solartron/Schlumberger describes their frequency-synthesizer signal generators. These instruments provide crystal accurate output frequencies which can be set in small increments over a very wide range.

Solartron Australia, P.O. Box 138, Kew, Vic. 3101.

A SUPPLEMENT to the Tektronix Products Catalogue, 1970, includes the company's new 150 MHz oscilloscope, transducer amplifier, TDR sampler, digital multimeter and digital counter, spectrum analysers, etc.

Tektronix Australia Pty. Ltd., 80 Waterloo Rd., North Ryde, N.S.W. 2113.

BROCHURE describing Sony's new colour and monochrome video tape recorder is available from the Australian agents, Jacoby Mitchell. The unit is particularly suited for use in industry, education, medicine and science, where professional quality is required.

Jacoby Mitchell & Co. Pty. Ltd., 469 Kent St., Sydney, N.S.W. 2000.

AVO LTD. have published a four-page leaflet describing their range of electronic measuring instruments. The range now includes both analogue and digital Avometers, transistor test sets, universal bridges, a new LF generator, an RF generator, etc.

Electrical Equipment of Australia Ltd., 86 Liverpool St., Sydney, N.S.W. 2000

KENT INSTRUMENTS have produced a 40-page brochure outlining a cross-section of products from the Kent Group. The items are briefly described and each product is illustrated.

The range of products includes recorders, electronic and pneumatic process controllers, process and control instrumentation, a range of electrical and electronic products from meters to miniature computers, and a wide range of scientific instruments.

Kent Instruments (Australia) Pty. Ltd., Box 333, P.O. Caringbah, N.S.W. 2229.

ALSO AVAILABLE from Kent Instruments are two 12-page brochures describing the complete range of Flexair series indicating and controlling equipment.

Flexair equipment includes continuous and trend recorders, indicating, batch and secondary controllers, integrators, square-root and other function generators, and various pneumatic/electronic interfaces.

Address as above.

ADCOLA PRODUCTS offer a most valuable booklet entitled 'The Application of Solder in the Construction and Servicing of Radio and Electronic Apparatus'.

The booklet includes chapters on the nature and use of solder, and the care and maintenance of soldering bits. No-one reading this book should ever again make a dry joint.

Adcola Products Pty. Ltd., 17 Burwood Road, Burwood, N.S.W. 2134.

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HOW MANY WATTS?

CHOOSING AMPLIFIERS AND SPEAKERS TO MATCH YOUR ROOM SIZE

"I am thinking of buying some hi-fi equipment and have visited a few dealers and studied a number of brochures.

"So far I have seen quite small amplifiers rated at 150 watts music power, others much the same size and price rated at 60 watts, and now a salesman tells me that his best unit has only 50 watts output yet is the most powerful of them all.

"He also says that small speakers need lots of power whilst big speakers may need much less. He seems competent enough, but what he tells me just doesn't seem to make sense.

"I am thoroughly confused. Please advise me."

This letter is typical of many received by electronic and hi-fi magazines. The puzzled correspondent has a very good point — the situation he describes IS confusing; yet what the salesman has told him is generally true. To obtain equivalent sound levels a small speaker may need 25 watts, whilst a larger one will get by with 10 watts.

The hi-fi industry has several different ways of expressing power output. Like the old English chaldron, the watt has become a remarkably flexible unit.

WHAT'S A WATT?

Engineers speak in terms of watts rms, this being the effective amplitude of an ac waveform, equal to the dc level that would produce the same power in a given load.

Outputs quoted in watts peak, or peak to peak, are mainly a copywriter's way of convincing you that an amplifier produces more power than it really does. One watt peak is two watts rms.

Amplifier power output, whether expressed as rms, peak, or peák to peak, is generally measured with a steady sine-wave input, and quoted as that level when waveform clipping is apparent when viewed on an oscilloscope.

A power rating quoted at a constant sine-wave input does not necessarily imply that an amplifier can handle peaks exceeding this level. For this reason the industry often quote a music power rating — this is a measure of an amplifier's ability to handle musical peaks without falling apart at the seams.

Thus one and the same amplifier can be rated from 10 watts rms to 45 watts music power without actually telling any lies. It is also not unknown for an amplifier of 20 watts *per channel* to be described as a 40 watt amplifier.

To compare power ratings, the easiest way is to convert peak, or peak to peak, ratings back to watts rms. This is readily done by dividing by what Europeans call a 'TransAtlantic Factor'. In this case it is 2 and 4 respectively.

No conversion is possible with music power ratings — but when such a rating is given, another figure will nearly always be quoted for continuous power output. Find out from the salesman, or the manufacturer's literature, what this rating is and whether the figure is rms, peak, or peak to peak.

Independent test reports such as our own — invariably quote output power in watts rms, as do many manufacturers. Unless stated to the contrary, watts rms are the units implied in this article.

Having to some extent, at least, determined what is meant by the different systems of power rating, we can now try to find out how many watts we need.

DYNAMIC RANGE

We start by determining the sound level (or rather power level) actually produced by a musical instrument. The dynamic range of these instruments is extraordinarily wide: a study undertaken by Bell Telephone Laboratories showed that a 75-piece orchestra playing flat-out creates 66.5 acoustic watts, whilst a solo violin played very softly produces less than 0.000004 watts. This is an intensity ratio of 18 million to one.

Table 1 shows the acoustic energy of various orchestral instruments played at peak intensity. Note that a piano produces less than half an acoustic watt, and that an orchestra, even at peak intensity, will generate less than 70 watts.

Full orchestral sound reproduced at concert hall level in the average living room requires half an acoustic watt.

Why, then, are amplifiers made that can deliver 100 watts or more?

The reason is that loudspeakers transduce electrical energy into acoustical energy very inefficiently. In fact, many totally enclosed systems have an efficiency of only 1%, meaning that they require 50 electrical watts to produce half an acoustic watt. The Bose speakers tested in this issue were even less efficient, requiring closer to 100 watts for the same acoustic power output.

The range of efficiencies extends from the 20% to 30% of exponential horn loaded speakers to less than 1% for the smallest totally enclosed bookshelf units. Thus the horn loaded speaker will need only two electrical watts to reproduce an orchestra at full volume, whilst (assuming it had the power-handling capacity) the bookshelf unit would require 30-50 watts to achieve the same result. (Table 2 indicates the approximate efficiency of various types of speaker enclosures.)

Low efficiency should not for a moment be taken as a disparagement of totally enclosed speakers, for the efficiency of a speaker is solely the ratio of acoustic output to electrical input. It tells you nothing at all about how the speaker will sound. Some of the world's finest speakers use the totally enclosed principle — as do some of the worst.

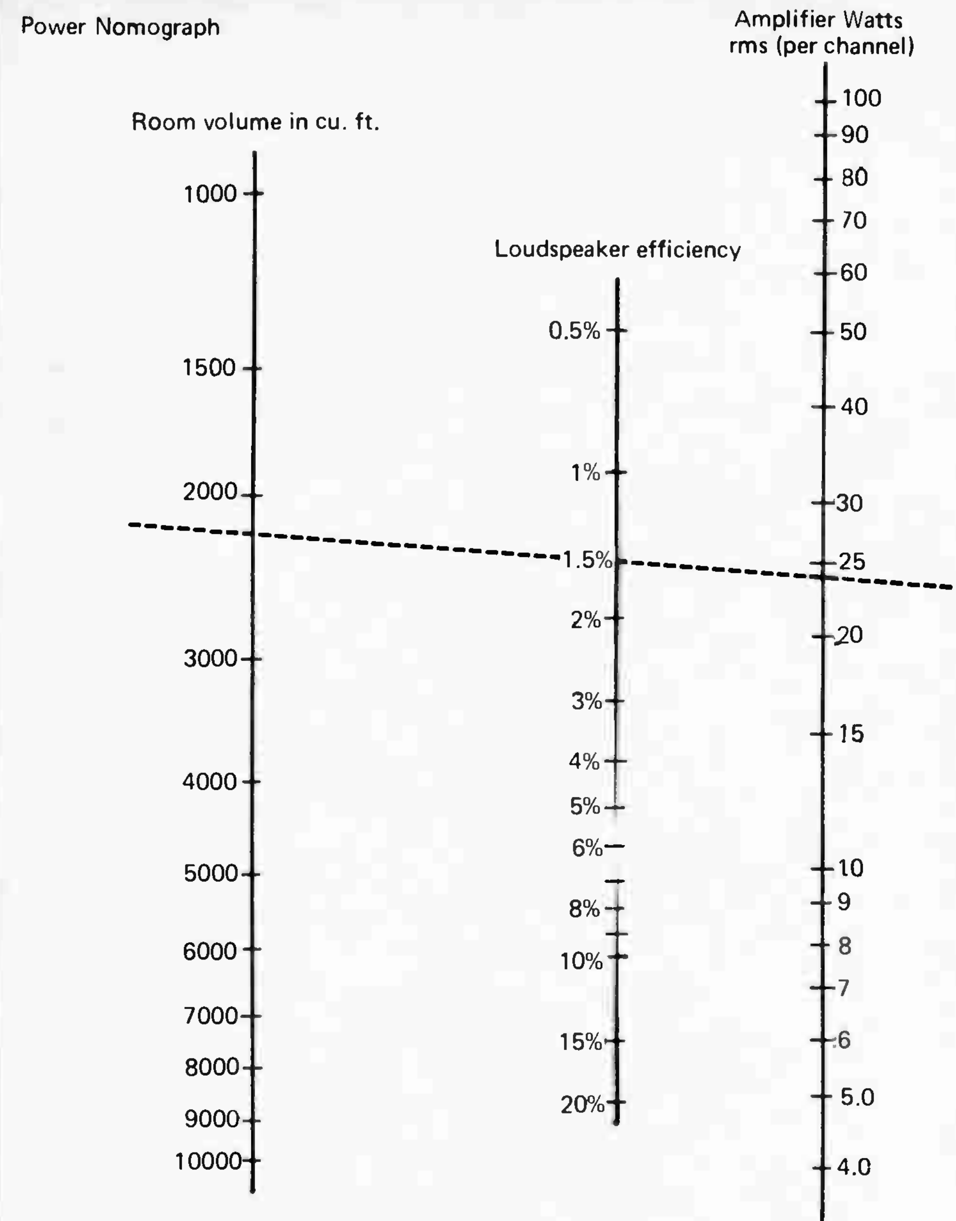
The power required from an amplifier is thus a function of the type of speaker — but it is also affected by the size of the listening area, the furnishings in it, and, to some extent, by the type of music you intend to reproduce.

CALCULATING YOUR REQUIREMENTS

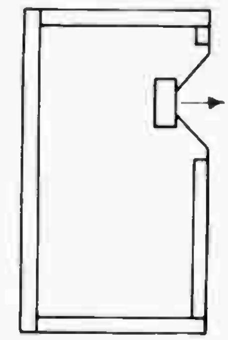
We have reconciled these various parameters into the nomograph reproduced with this article. The nomograph indicates the power

TABLE 1. Energy of orchestral instruments played at peak intensity.

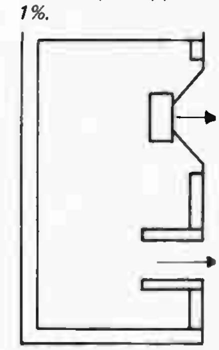
Instrument(s)		Acoustic watts
Bass drum	–	24.6
Cymbals	–	9.5
Double Bass	–	0.156
Trombone	–	6.4
Piano	–	0.437
15 piece orchestra	–	9.0
75 piece orchestra	–	66.5
Pipe organ	–	12.6



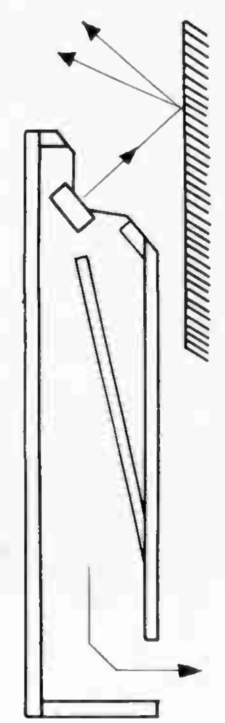
A rule bisecting any two parameters will give you the third. In example dotted line indicates that medium sized totally enclosed speaker in room of 2250 cubic feet requires 25 watts/channel.



Totally enclosed (also called infinite baffle or acoustically suspended). Efficiencies vary between ½% and 2%. Small enclosures are generally less efficient than large one. Most enclosures of this type have an efficiency of approx. 1%.



Bass-reflex. Efficiencies vary between 3% and 5%.



Horn loading. There are many versions of this type. Efficiency? — assume 20% and you won't be far out.

required to drive different types of speakers in different size rooms. It can also be used to determine whether the power rating of a speaker is sufficient for the size of room. Amplifier/speaker combinations calculated from the nomograph will reproduce peak orchestral sound at concert hall levels. If discotheque levels are required, the amplifier power output should be at least doubled.

The nomograph shows that a lot of power is required to drive totally enclosed speakers, especially if used in a large room. Full bass reproduction in a room 20ft. by 15ft. by 10ft. would require over 40 watts per channel and if the totally enclosed speakers were on the bookshelf type, 40 watts could well exceed their maximum dissipation.

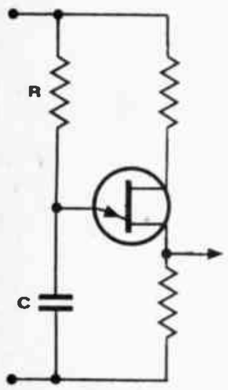
The maximum safe dissipation of loudspeakers is invariably quoted from measurements of constant sine-wave inputs. Many manufacturers claim their loudspeakers can handle musical peaks exceeding their constant input ratings — often quoting a figure of two. However, our acoustical consultants advise that in their experience — which is very considerable — a speaker should not be driven by an amplifier with a power output higher than the speaker's input rating.

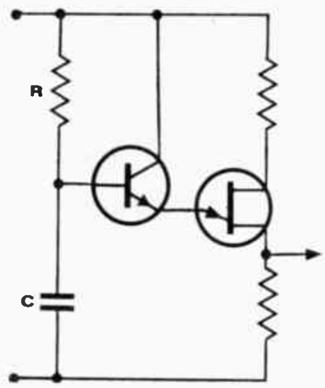
If you follow this advice, you will not overload your speakers.

Nor will you be likely to emulate a certain pop group who, on one never-to-be-forgotten occasion last year, ended a concert with their two bass speakers on fire!

TECH-TIPS

EXTENDED TIME DELAYS



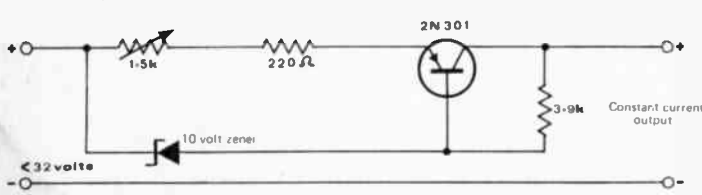


The maximum time delay obtainable from a simple unijunction timing circuit (Fig. 1) is limited by the maximum values of R and C; R cannot generally be increased beyond 3 Megohms, and space, cost and leakage limit the practical size of C.

Very long timing intervals can be obtained by the addition of a silicon npn transistor connected as an emitter-follower (Fig. 2). The current multiplication of this stage permits the size of the R/C components to be much greater than in the normal configuration, and as a result time intervals can be increased at least ten times.

The emitter-follower circuit can also be used to reduce the size of the capacitor if short timing delays are required.

SIMPLE CONSTANT CURRENT SUPPLY



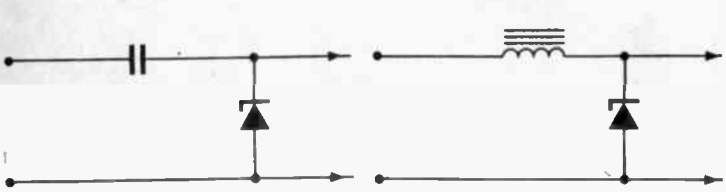
A series transistor is used as a variable resistor in this simple constant current regulator.

The circuit will maintain constant output current (within 10%) into loads varying from a short circuit to 500 ohms.

The current level required is set up by placing a milliammeter across the output and adjusting the 1.5K potentiometer to the required current.

(Submitted by reader B.S. – Penrith, N.S.W.)

REACTIVE BALLASTS IN AC ZENER APPLICATIONS



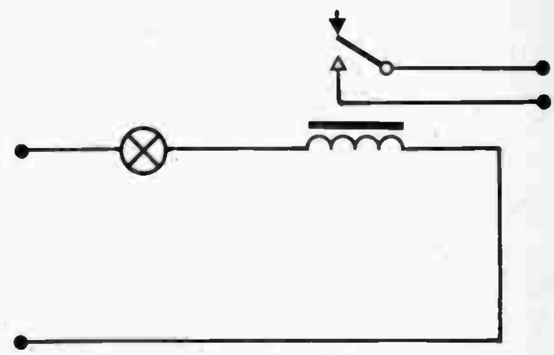
When zener diodes are used in ac applications, power loss can be reduced by using a reactive element in place of the conventional series resistor.

CAREER OPPORTUNITIES

CAREER OPPORTUNITIES

TECH-TIPS

SPEED RELAY CLOSING TIME



Relay closing times can be substantially reduced by overdriving the relay coil.

This can be achieved both easily and safely by utilising the change in resistance of a filament lamp connected in series with the relay.

The relay coil should be rated at approx. half the circuit voltage, and a lamp chosen that will have a series resistance (when warm) equal to the relay coil resistance.

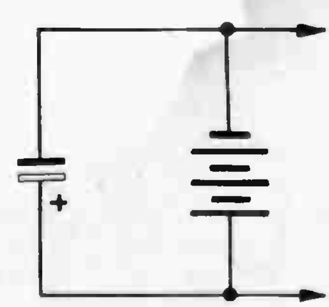
In the example shown, a 12 volt lamp and a 6 volt 50 ohm relay coil are in series with a 12 volt supply. The lamp when cold has a resistance of 10 ohms which rises to 45 ohms within half a second. (A 12 volt lamp was chosen to increase reliability)

When power is first applied, the voltage drop across the cold filament is low and almost the entire 12 volts will be applied across the relay coil.

As the lamp heats up its resistance increases, thus reducing the voltage across the relay coil, until at full brilliance both lamp and relay coil have 6 volts across each.

The characteristics of filament lamps vary from one type to another and some experimenting may be necessary to obtain a lamp with the required resistance.

50% HARMONIC DISTORTION?



It will never compete with a Bose, but your transistor radio's sound reproduction *can* be improved.

The battery's effective ac impedance rises as voltage decreases, and interstage coupling becomes probable.

A substantial improvement will be obtained by strapping a 100 to 1000 μF electrolytic across the battery, as shown.

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