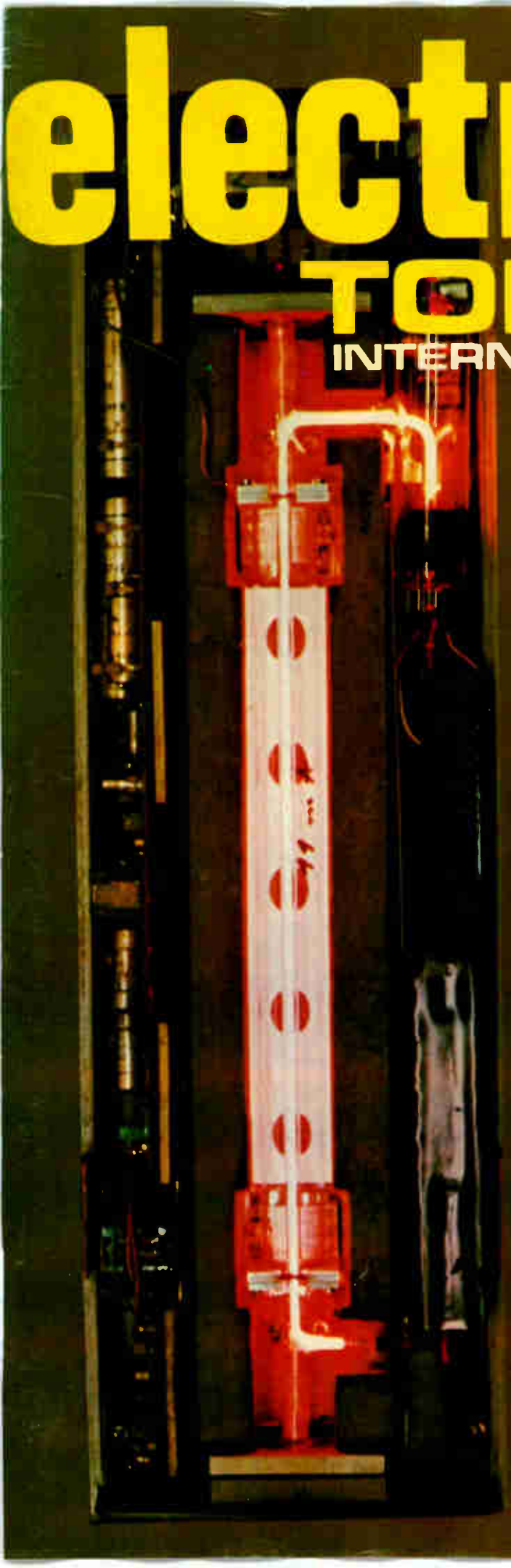
JUNE 1973
50c*

electronics TODAY INTERNATIONAL

HI-FI



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electronics TODAY INTERNATIONAL

JUNE 1973 Vol. 3 No. 3

main features

projects

product tests

reviews

news & information

COVER: Our picture shows internal view of Siemen's LG661 helium-neon laser. This laser generates 5mW (continuous power) and is used extensively in surveying and building work.

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LASERS WILL REVOLUTIONISE OUR LIVES

THE current uses of lasers may seem dramatic enough, but they will pale into insignificance compared with what is about to come.

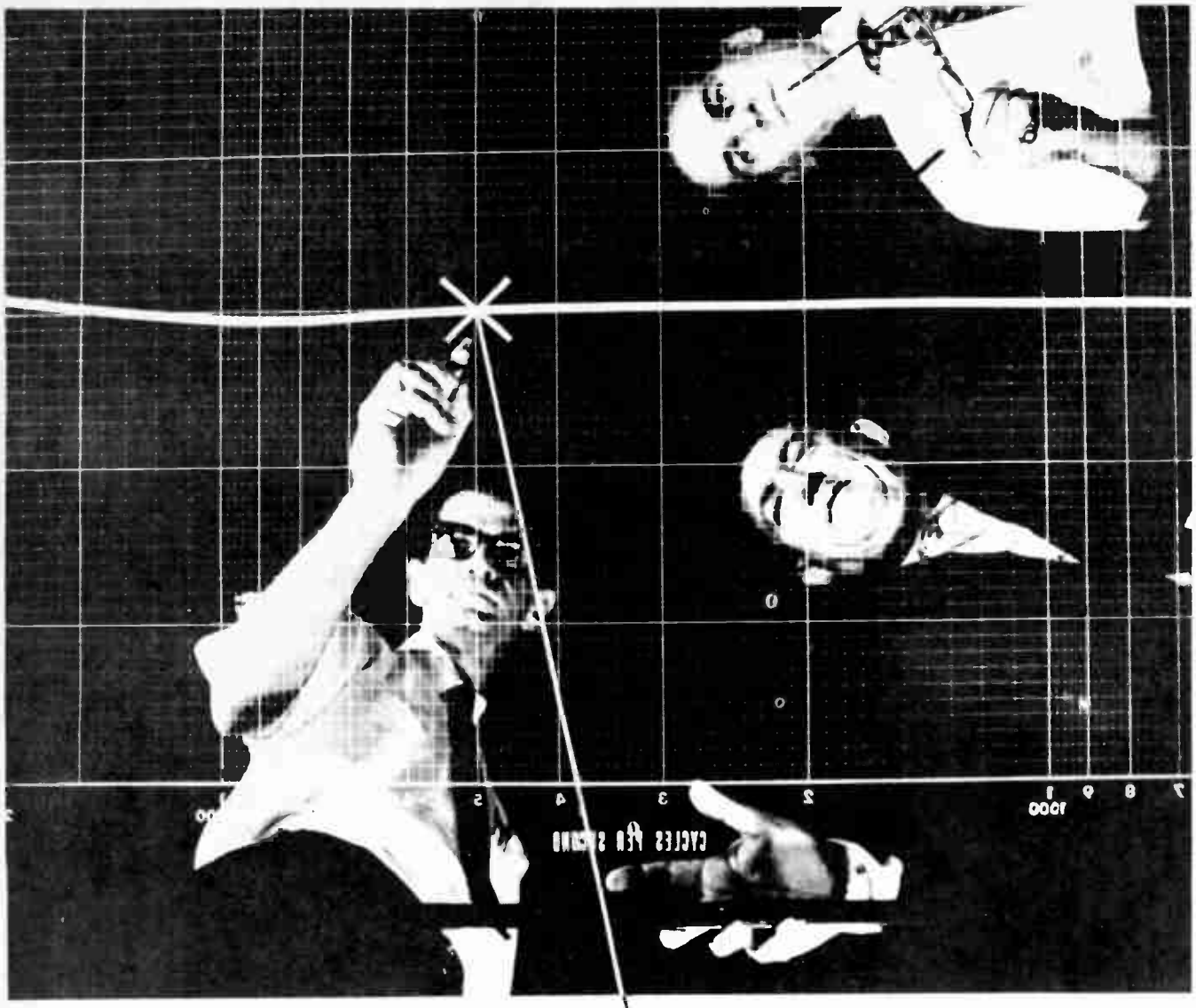
In communications, digital techniques combined with lasers will enable us to expand our transmission capabilities by an enormous amount – and virtually to eliminate noise and distortion. If a mere one percent of the visible and infra-red spectrum were to become available, we would have 150 times the channel space that is presently used in our entire communications spectrum – room for 500 000 TV channels, each 6 MHz wide!

In the generation of electrical energy, lasers may make atomic fusion reactors a reality. Fusion reaction takes place at extremes of temperature – 80 million degrees Celsius or more. At these temperatures the main problem is to contain the reactant gas plasma. Magnetic fields have been tried and largely failed. Now, it seems, high-powered lasers may be used to raise the temperature of nuclear fuel pellets almost instantaneously, without the need for a containing field – creating, as it were, a series of miniature H-bomb explosions in which the resultant energy is absorbed as heat within a container of lithium. It has been forecast that laser-fusion systems will produce electricity for less than one-tenth the cost of coal-powered systems.

In physical research, X-ray holography is realistically expected to enable us to view the electron structure of matter. Similarly, it will be possible to view the structure of bio-chemical matter and thus greatly expand our understanding of life processes.

Holography, while still in its infancy, may enable us to construct optical computer memories with truly fantastic storage capability. It is also predicted that this technique will enable us to build three-dimensional colour television systems.

Laser technology is perhaps the most exciting of current fields of endeavour. It may even be true to say that lasers will, in the next decade or two, reveal more physical knowledge than the entire previous efforts of mankind.



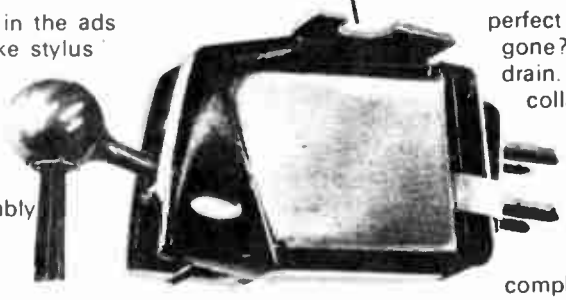
Stanton solves the X Factor

X IS THE UNKNOWN QUANTITY

It's what they don't tell you in the ads and specifications. Things like stylus life, distortion, resistance to hum, kindness to records, consistency.

Ever noticed how two identical cartridges sound completely different? Probably not, because few people have the chance to compare identical cartridges. But we do, and one thing we're proud of is a Stanton . . . is a Stanton . . . is a Stanton.

Ever paid out a small fortune for a pricey cartridge and had the stylus collapse after a few months? Diamond perfect but cantilever suspension gone? Forty odd dollars down the drain. Stanton stylii just don't collapse. If you happen to get one that does, we'll swop you a new one. So we can frame yours.



Then think how much longer your records will last with Stanton (remember **static** compliance doesn't mean a thing, but it's the only figure you're likely to get), think how clean your records will sound because you're not amplifying hum, and think of the distortion that's probably less than your amplifier. Think, and you'll agree—the X factor is the deciding one.

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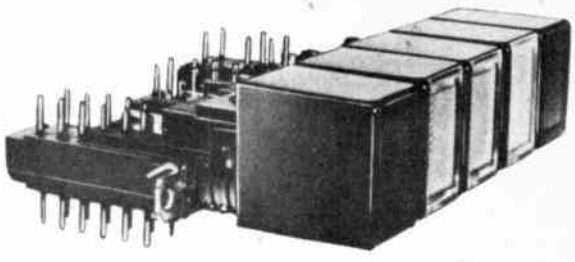
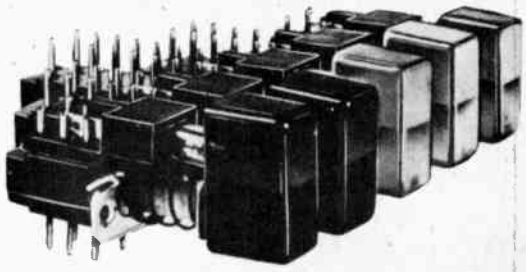
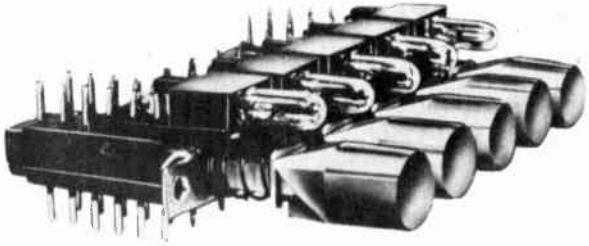


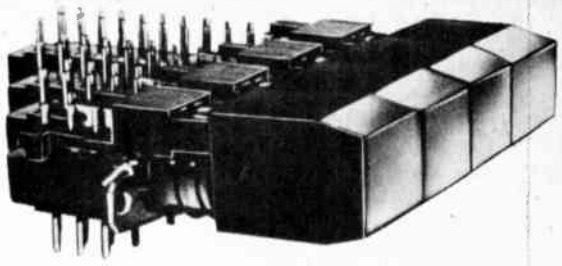
Style 2.
Button with snap-in lens 15 m.m. pitch.



Style 3.
Integral button frosted for maximum light dispersion 10 m.m. pitch.



Style 4.
Round button with rear prism for maximum light transmission 12.5 m.m. pitch.



Style 5.
Button with three sided snap-in lens 15 m.m. pitch.

Yes, we now have four NEW styles of Illuminated Push Buttons to suit the well known Isostat push button switch range.
You can make your choice of the exact style of illuminated buttons to complement your equipment styling.
Now, check all these features of Isostat Illuminated Push Button switches.

ILLUMINATION

By proven vibration-proof incandescent wedge-base lamps.
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Illuminated button pitch spacings; 10 m.m., 12.5 m.m. and 15 m.m.
Push on-Push off and Interlock (½ Million operations).
Momentary (1 Million operations).
Lockout and Solenoid operations available.
Can be mounted on Printed Circuit Boards or hand soldered.

QUALITY

Silver *Laminate* contacts, self wiping. Low contact resistance — low capacitance.
Sealed contacts impervious to solder, flux or dust.
Replacement contact shaft with new contacts can be quickly inserted from the front.

RATINGS

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- ☐ Inductance and storage factor, Q, of inductors
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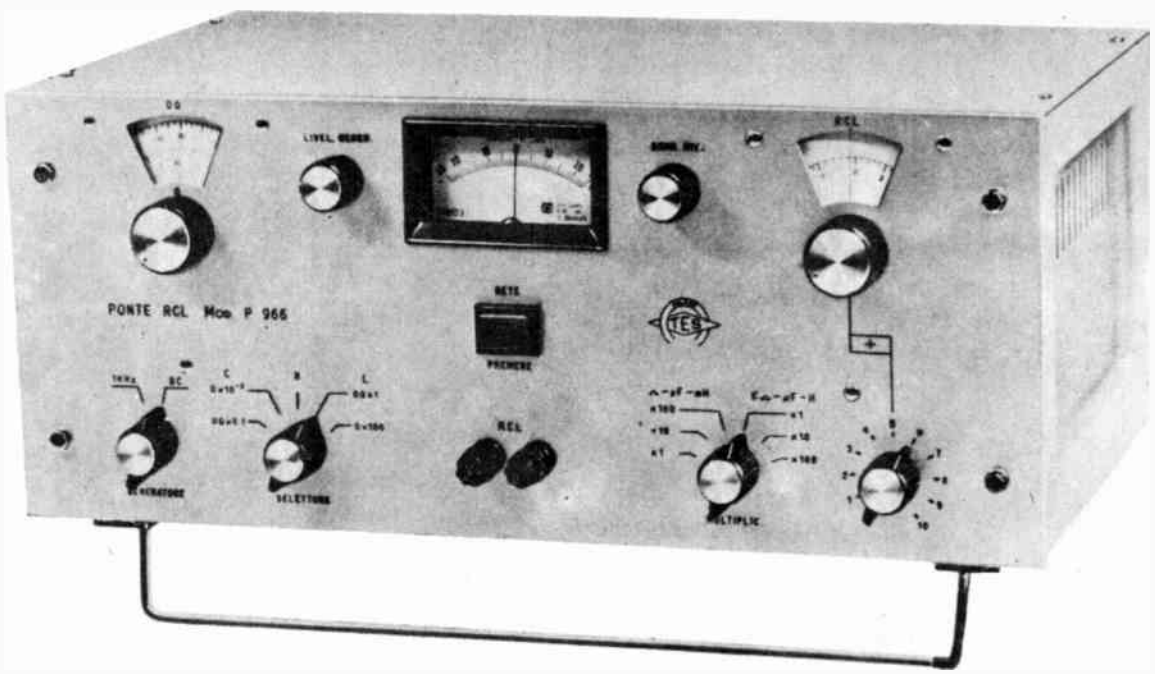
- ☐ DC resistance of all types of resistors

with Type P966 Technica Electronica

Impedance Bridge

. . . as well as measuring the circuit constants in experimental equipment, testing preliminary samples and identifying unlabelled parts.



SPECIFICATIONS: Resistance: from 0.1 ohm to 11 Megohms • Capacitance: from 1 pF to 1100 μF • Inductance: from 10 μH to 1100 H • D: from 1 . 10—³ to 50 • Q: from 0.02 to 1000 • Frequency: 1 Kc/s supplied internally; accuracy ±5% • R accuracy: better than ±1% from 1 ohm to 11 Megohms • C accuracy: better than ±1% • L accuracy: better than ±2% • Q and D: better than ±20% • Semiconductors: No. 17 • Power supply: 220 V 50 c/s • Dimensions: 40 x 16 x 23.5 cm • Weight: 8 Kg

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Incomparable 3 motor crossfield head recording system. Automatic and Manual Reverse, Automatic Stop and Shut-Off, Pause Control. Two large VU Meters. Response: 40-22,000 Hz (±3dB) at 7½i.p.s. 40-18,000 Hz (±3db) at 3¾ i.p.s.

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UNBEATABLE VALUE!

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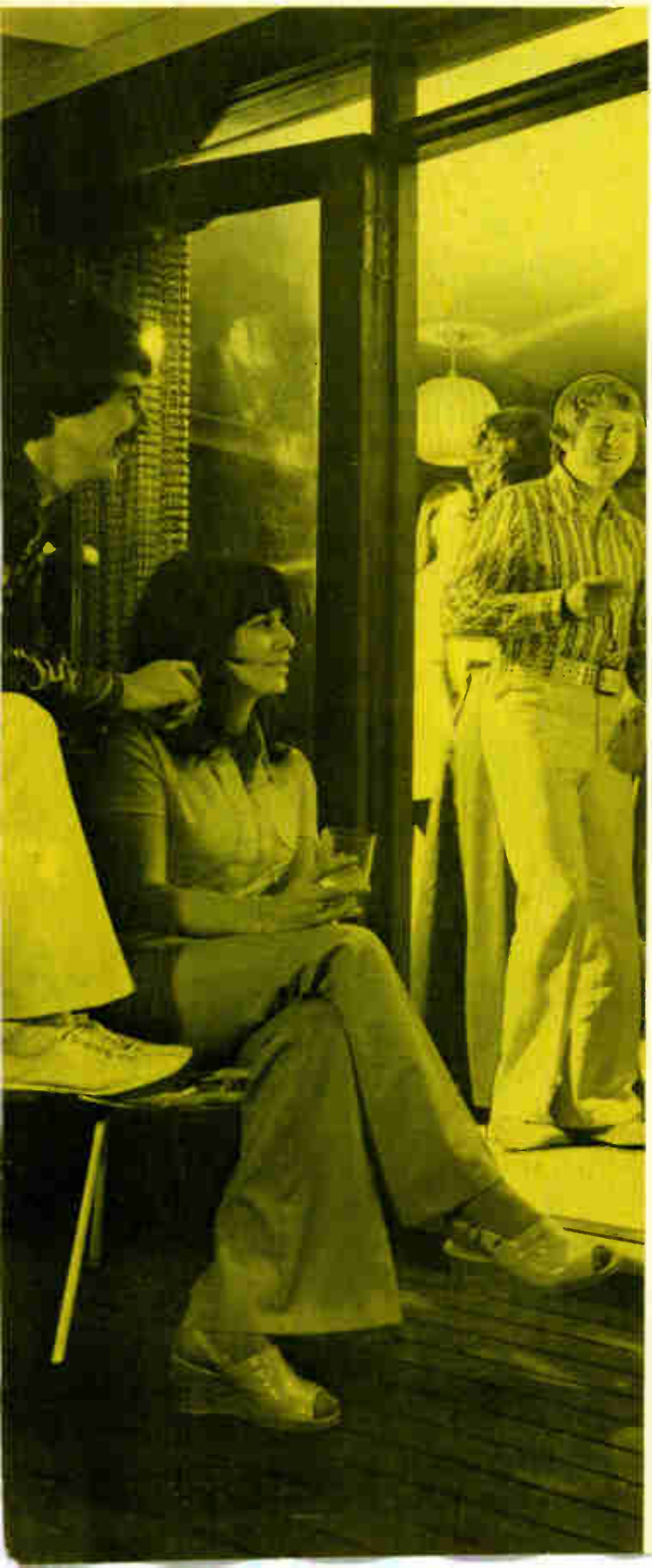
Your party sounds are great with unique KR-6170



One instrument becomes a group... with exciting rhythms and percussions

It's true. Your guitar becomes "a group" with the back-up of Kenwood's extraordinary KR-6170 Stereo Receiver. Your choice of *twelve* different rhythms from ballad to bossanova – the Electronic Rhythm Composer – will get behind your solo efforts at the push of a button. Five different percussions can be conjured up just as easily for extra depth and dimension . . . PLUS echo chamber effects. The effects you'll get are so amazing you wouldn't have thought them possible. They'll make your party – and you can practise your guitar in private, too. Don't forget KR-6170 is an AM/FM radio receiver as well; you can use the same way-out effects on broadcast material and records, too. It's the playalong/listening unit to set your hi-fi sound imagination ticking over as never before . . . and it's unique to Kenwood.

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STEREO RECEIVER

GIVE YOUR RECORDS A NEW DIMENSION

KR-6170 Stereo Receiver also has reverberation Unit Echo Sound Output Terminals for 4-channel reproduction, 4 sets of speaker terminals, 3 step power limiter and freq. response of 20-40,000 Hz.

JM/K-2473

NEW ERA III BEGINS

SHURE

V-15 TYPE III

Now after seven years of extensive laboratory research and development, the remarkable Shure V-15 Type III Phono Cartridge is ready for the connoisseur's high fidelity system. It clearly defines the outer limits of the state of the art of phono cartridge design. It is indeed the worthy successor to the world-acclaimed V-15 Type II Improved!

Among its brilliant innovations is an all-new laminated magnetic core structure, and an exquisitely designed stylus assembly with 25% reduction of effective stylus mass.

Result: (1) Higher-than-ever trackability at the ultra-light tracking forces of the 1970's; (2) an astonishingly flat frequency response with no noticeable emphasis or de-emphasis at any frequency; (3) an extended dynamic range even beyond that of our V-15 Type II Improved; and (4) all this without a reduction in output level.

We call the Type III the Synergistic Cartridge. It maintains all performance factors in perfect equilibrium to produce a total audio effect greater than the sum of its individual improvements.

All in all, the V-15 Type III offers an extraordinary listening experience.

$87.00 RECOMMENDED RESALE PRICE

V-15 Type III Specifications

Typical Trackability (at 1 gram in Shure-SME Tone Arm). Reference: Shure TTR-103 Laboratory Test Record
400 Hz (cps) — 26 cm/sec 5000 Hz (cps) — 35 cm/sec
1000 Hz (cps) — 38 cm/sec 10,000 Hz (cps) — 26 cm/sec

Frequency Response (using Optimum Load): 10 to 25,000 Hz (cps).

Output Voltage 3.5 mV per channel at 1000 Hz (cps), 5 cm/sec peak recorded velocity. Output from each channel within 2 dB

Channel Separation: Nominally 28 dB at 1000 Hz (cps) Nominally 20 dB at 10,000 Hz (cps)

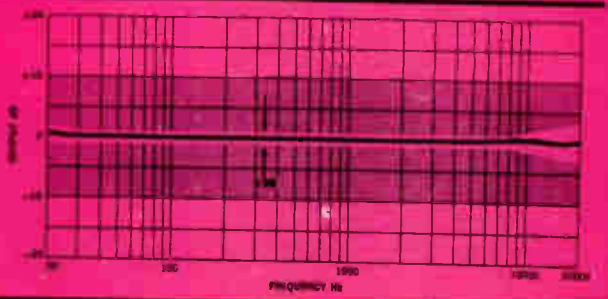
Tracking Force Range: ¾ to 1½ grams

Optimum Load: 47,000 ohms resistance in parallel with 400 to 500 picofarads total capacitance per channel. Load resistance can be up to 70,000 ohms with almost no audible change in frequency response. Total capacitance includes both the tone arm wiring and amplifier input circuit. (Most amplifiers and tone arms meet this requirement.)

Inductance: 500 millihenries nominal.

D.C. Resistance: 1350 ohms nominal
Output Terminals: 4 terminals
V-15 Type III Styli Available:
VN35E Biradial Elliptical Stylus, (as supplied in V-15 Type III Cartridge), Diamond Tip
18 microns (.0007 inch) frontal radius
5 microns (.0002 inch) side contact radii
25 microns (.001 inch) between record contact points
VN3-G Spherical Stylus (as supplied in V-15 III-G Cartridge), Diamond Tip 15 microns (.0006 inch) radius
VN78E Biradial Elliptical Stylus, Diamond Tip for monaural 78 rpm records.
Tracking Force Range: 1¼ to 3 grams
63 microns (.0025 inch) frontal radius
13 microns (.005 inch) side contact radii
89 microns (.0035 inch) between record contact points
NOTE: A small .8 gram weight on the molded grip of the VN78E Stylus Assembly allows it to be substituted for a VN35E or VN3-G. This .8 gram weight achieves the proper tracking force for 78 rpm records automatically and normally requires no manual adjustment of the tone arm's tracking force setting.
Mounting: Standard ½ inch (12.7mm) mounting centers.
Weight: Net Weight — 6 grams

A graphic representation of the audible spectrum, which illustrates the uniformity flat response you will achieve with your V-15 Type III cartridge. Under the Shure Quality Control Program, every Type III cartridge, whether it is purchased now or next year, in Chicago, London, Hong Kong or Sydney, must produce a flat response curve that fits within the extraordinarily narrow limits of the Type III response "output envelope" (the unshaded area at right) before shipment! The curve shown was made by a typical Type III, mounted in an SME tone arm, and tracking the STR100 test record, response corrected for 6 db/octave below 500 Hz.



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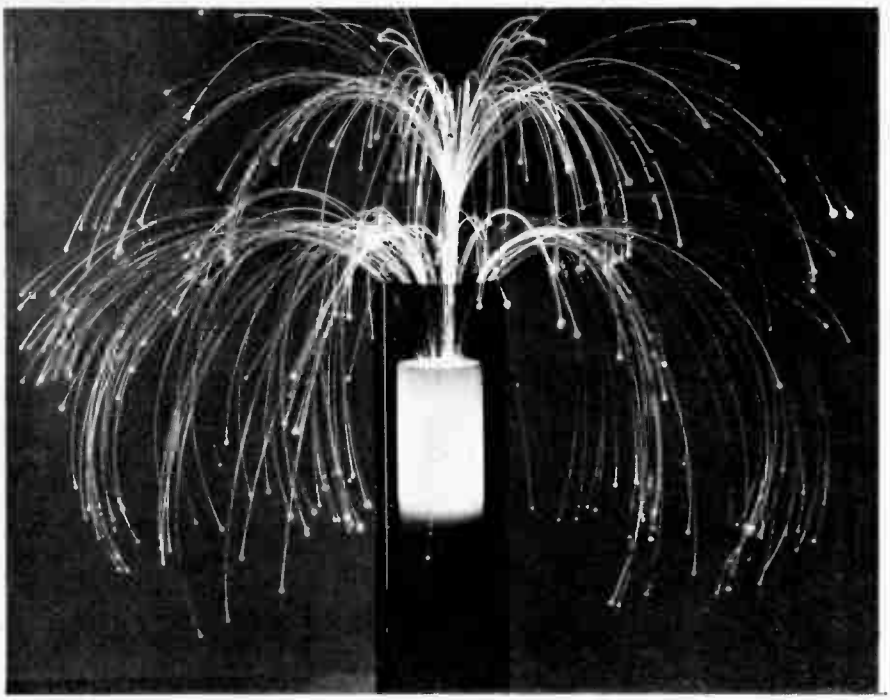

"SHOWER OF LIGHT" K1FP/1-ELECT WIRING APP.NO. V/C 5J K1FP

THE AMAZINGLY SENSATIONAL FIBRE OPTICAL LIGHTS THAT ARE SWEEPING THE WORLD WITH ITS BEAUTIFUL SOFT LIGHTING EFFECTS FROM HUNDREDS OF ILLUMINATED FIBRES IS NOW MANUFACTURED BY **ILLUMINATED FIBRE PRODUCTS**, A DIVISION OF **KIMBERLEY PLASTICS PTY. LTD.**, MELBOURNE.

"BARNEY THE WHALE" He spurts fibre optic light and his eyes light up. A fascinating children's night light. Available at all major retail stores, electrical and gift shops. Interstate trade enquiries invited.

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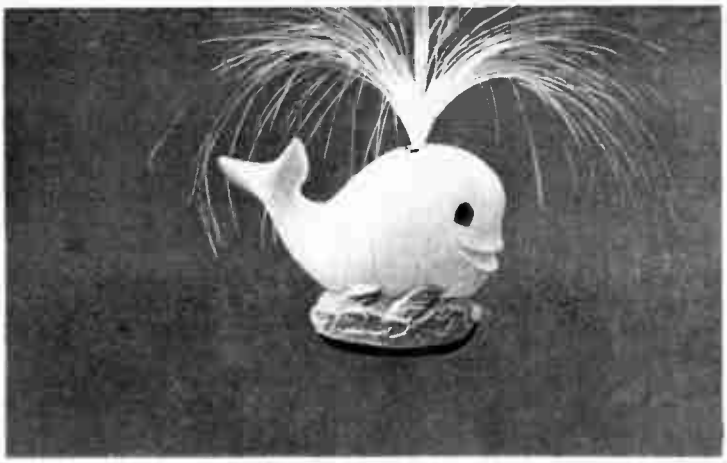
A division of Kimberley Plastics Pty. Ltd., Melbourne. Manufacturers of Fibre Optic products and maintenance service to Fibre Optic medical equipment.

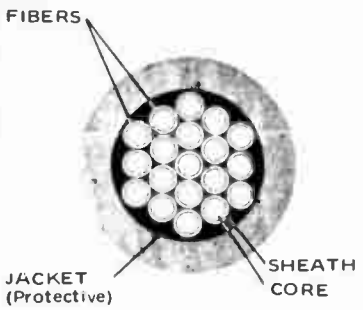
Fibre Optic Light Guides are available in all sizes from 0.020" diameter to bundles of 1.500" diameter in any length, and may be supplied with or without a protective outer sleeve.

Fibre Optic Light Guides may be used to transmit light from one point to another, just as copper transmits electrical energy and have been used for — Basic Illumination, Signalling, Electronic Equipment, Communication Equipment, Vending Machines, Surgical and Dental Equipment, Photoelectric systems, Aircraft and Automotive Tell-Tale systems, Home Appliances and Novelty effects.

Fibre Optic Light Guides is used to carry light from a single source to one or a number of outlets, and lends itself to bend around tight angles (without resorting to expensive Optical Lenses and prisms) to illuminate the most inaccessable areas.



"BARNEY THE WHALE" — KIFP/2



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For the audio enthusiast who would custom design his own system, ONKYO proudly offers this outstanding, group of components. All function at optimum performance levels in keeping with contemporary solid state technology. Unlike competitive products. Mark II speaker components are for specific use with solid state amplifiers and receivers. They achieve a tonal balance that can be considered the ultimate expression of *Artistry in sound*. Each component is individually tested before it is placed at your disposal. And, the original Bruel and Kjaer curve and trace is supplied with each speaker. All parts are precision designed and custom assembled by skilled craftsmen to exacting requirements. Only the finest materials are used. The quality of sound that you will enjoy surely engenders a very special pride of ownership. The following are brief details for each components. These units are covered by a three month warranty, labour and parts.

MK II series

15" woofer model W-38A Mk II

A true high fidelity woofer featuring a huge 4 lbs. 13,500 gauss magnet with an astounding low resonant frequency of 17Hz. Well below man's audible range. The results and full-bodied low frequency response that cannot be duplicated by competitive woofers. These high performance characteristics are maintained even at high volume levels.
*Impedance: 8 ohms *Max. Input Power: 80 Watts. *Fundamental Resonance: 17Hz *Frequency Range: 17—2,000Hz *Weight: 24.3 lbs. *Size: 16-5/8" dia. x 7" *Baffle Opening: 13-5/8" dia.

$170.00

12" woofer model W-30A MK II-F

This is a medium priced high performance woofer capable of handling 60 watts of power with a resonant frequency of 20Hz, a large 3-1/4 lbs. magnet and a Q of 0.27 it will faithfully reproduce the bass range with negligible distortion and true fidelity. The low Q permits perfect speaker housing design in a small enclosure.
*Impedance: 8 ohms *Max. Input Power: 60 Watts *Fundamental Resonance: 20Hz *Frequency Range: 20-2,000Hz *Weight: 16.5 lbs. *Size: 13-5/16" dia. x 6-3/8" *Baffle Opening: 10-3/4" dia.

$150.00

Horn midrange model HM-500A MK II

Excellent off-axis dispersion plus low cut-off for beautiful response that doesn't sound like a "horn".
*Impedance 8 ohms *Max. Input Power: 30 Watts *Cut-Off Frequency: 500Hz *Frequency Range: 700-20,000Hz *Crossover Frequency: more than 700Hz *Aluminium Castling Construction *Weight: 5-1/2lbs. *Size: 4-3/4" x 11-5/8" x 12-1/2"; Baffle opening: 3-3/4" x 10-3/4".

$83.35

Dome midrange model DM-500A Mk II

Perfectly balanced peak-free response with extremely wide unifrom dispersion, on-and-off axis. A must for 4 channel sound. With our Super-Hard Duraluminum Diaphragm.
*Impedance: 8 ohms *Max. Input Power: 30 Watts *Cut-Off Frequency: 500Hz *Frequency Range: 500-12,000Hz *Crossover Frequency: more than 700Hz *Weight 6.2 lbs. *Size: 4" dia. x 3"; Baffle opening: 5-7/16" dia.

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Horn tweeter model TW-8A MK II

Everything the audio purist demands in directivity and low distortion. With ONKYO's exclusive Super-Hard Duraluminum Diaphragm.
*Impedance: 8ohms *Max. Input Power: 30 Watts *Cut-Off Frequency: 2,000 Hz * Frequency Range: 3,000-20,000Hz * Crossover Frequency: more than 3,000Hz *Weight: 4 lbs. *Size: 4-1/16" dia. x 4-9/16"; Baffle opening: 2-7/8" dia.

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horn tweeter model TW-9A

A superb high range characteristic and distortion free tweeter. The equalizer is of precision finished aluminium die-cast. These total excellence features are an assurance of continuous quality.
*Impedance: 8 ohms *Max Input Power: 20 Watts *Cut-Off Frequency: 2,500Hz *Frequency Range: 4,000-20,000Hz *Crossover Frequency: more than 4,000Hz *Weight: 1.7 lbs *Size: 3-1/2" dia. x 4-1/4" *Baffle opening: 2-9/16" dia.

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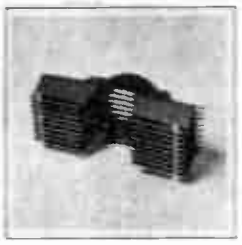

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TELEPHONE SCRAMBLER FOR COMMERCIAL APPLICATIONS

The risk of confidential information being accidentally overheard during telephone conversations has caused business executives to resort to slower and less convenient forms of communication offering more security. Now, a new electronic scrambler device from EMI, (UK) overcomes this problem by providing enhanced security for telephone calls.

Introduced by EMI Sound & Vision Equipment Ltd., Hayes, Middlesex, this equipment is known as the EMI 'Privateer' and is designed for use with both public and private telephone networks in countries where the relevant legislation permits.

RACAL RECEIVERS FOR EXPORT MARKETS

An order recently announced for 20 of its RA 7915 all solid-state receivers for use by the Belgian PTT takes to over 100 the number of this type of receiver ordered from Racal Electronics Pty Ltd by overseas customers in recent weeks. The company is also to supply equipment to facilitate remote control of the installation.

The RA 7915 is an advanced receiver operating in the MF/HF bands and provides coverage over the range 40 kHz – 30 MHz. In design, the receiver utilizes all the latest solid-state techniques and provides six high-stability crystal-controlled channels anywhere in the band. Frequency stability is such that operation over several months can be achieved without any need for frequency adjustment and, on a daily basis, this is better than 1 part in 10^7.

The receivers supplied to the Belgian PTT are being installed in coastal radio stations for ship-to-shore communication with shipping along the Belgian coast. Besides Belgium, other orders for the RA 7915 in this period have come from customers in Chile, Italy and Iraq.

STANDARD ELECTROTECHNOLOGY SYMBOLS

A new Australian standard sets out symbols for the quantities and units fundamental to the range of disciplines in the various fields of electrotechnology. Published by the Standards Association, it is issued as Australian Standard 1406, Part 1.

The standard specifies letter symbols for physical quantities and abbreviations, and symbols for units for general use in electrotechnology, and lays down general principles governing their use.

The standard, whilst largely in line with International Electrotechnical Commission (IEC) Publication 27, incorporates some changes in accord with the latest thinking of the General Conference on Weights and Measures, the International Union of Pure and Applied Physics and the International Organization for Standardization (ISO).

The symbols have been selected in order to make best use of the limited number of readily available alphabets and type founts.

Copies of AS 1046, Part 1 may be obtained from the various offices of the Standards Association for $3.20.

COMMUNICATION LIGHT-GUIDES A REALITY

As we predicted in ETI over 18 months ago, optical communication via glass-fibre light guides has now become a reality.

The Japanese Nippon Electric and Nippon Sheet Glass companies are now producing their Selfoc light guide cables in 100 metre lengths – price about A$1800 each.

Transmission loss is specified at a very conservative 48 dB/km, but in practice losses of 20 dB/km are achieved.

These measurements are quoted for the 0.81 – 0.85 μm wavelength that will probably become the standard for optical transmission systems. Nevertheless the cables operate satisfactorily at both the 1.06 μm wavelength of YAG lasers and at 0.63 μm for helium-neon devices.

CHANGES AT BLEAKLEY GRAY

The Bleakley Gray Corporation Pty. Limited now has one Consumer Division, encompassing both photographic products and high fidelity sound equipment.

Staff appointments include Mr. Clarrie J. Pearce as Division Manager, and Mr. John de Meur as National Sales Manager. Similarly, a Broadcast and Motion Picture Division of the Company has been formed with Mr. William K. Dougall as Division Manager, and Mr. Clive G. O'Brien as National Sales Manager.

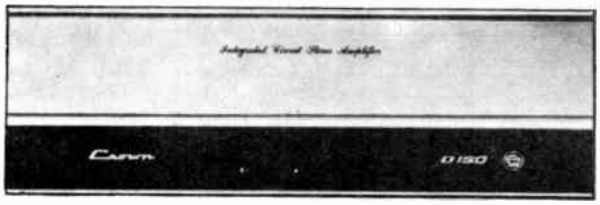
"If you can afford it the best is really worth the price"

That's how High Fidelity magazine summed up the Amcron IC 150 pre-amplifier after searching laboratory tests. Their review of its companion, the Amcron D 150 power amp said: "In testing the 150 CBS labs found itself working close to the limits of its test equipment. Every harmonic distortion measurement the lab made — even those for extremely low output power — was below 0.05%. Were the figures ten times as high we would still consider them to be excellent in most equipment. At half power most of the figures are below 0.02%."

After exhaustive performance tests of both units, Audio Magazine reported: "If you want the very best pre-amp and power amplifier we've ever tested in the power class, and can afford the price, our endorsement of the Amcron IC 150 and D 150 is completely given without any reservation."

Our philosophy at Amcron is that there's no such thing as good-better-best. Variations in product scope and function, yes, but deviation from the highest degree of perfection attainable — no! Our dedicated aim is to continue to produce audio equipment which sets the ultimate standard of reference. We cannot apologise for our prices. Because every item of equipment that carries our name has been designed by our engineers to be measurably and audibly superior to anything else available — regardless of cost.

AMCRON IC 150 PRE-AMPLIFIER is an experience in silence, and has set new records for IM and harmonic distortion. No other control unit, regardless of price, gives disc-to-tape recordings so free of distortion, hum and noise, and so perfect in transient response.
Audio Magazine said: "When it came time to measure IM and THD, our test set-up proved to be completely useless." Less than $430.



AMCRON D 150 POWER AMPLIFIER is engineered to provide maximum total performance in universal adaptation. Two massive specially designed heat sinks and the entire chassis are utilized to prevent thermal fatigue, the predator of most high power amplifiers. All components of the circuitry must meet the highest criteria for long term performance. After assembly each unit is tested and approved to meet or exceed our guaranteed specifications.
Audio Magazine said: "At a typical full output of 75 watts (8 ohms), IM has been measured by AMCRON as 0.002%. By implication, THD might be expected to be approximately 0.0005% which neither AMCRON nor we could legitimately measure." Less than $660. (Front panel optional)

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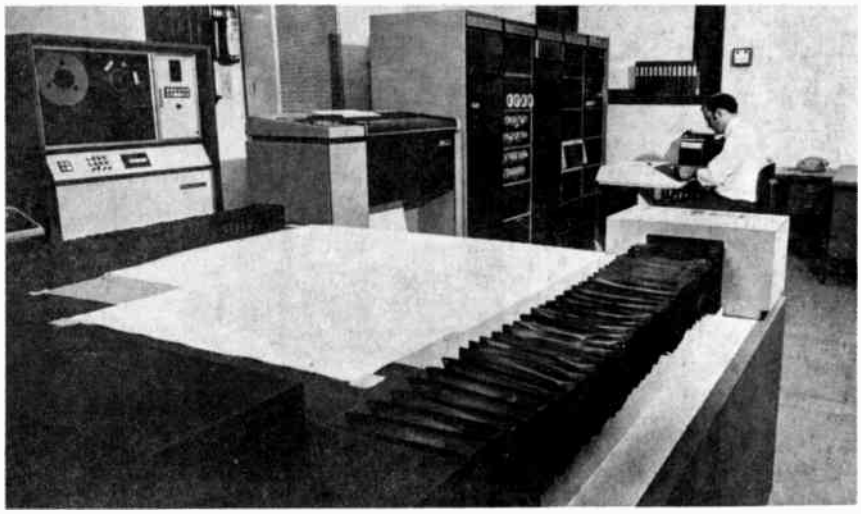
MINICOMPUTER FOR SURVEYING AND MAPPING



The modern minicomputer has dispelled many of the traditional notions about its limitations, and this is well illustrated by the new PDP-11/45 machine being used by the N.S.W. Lands Department for surveying and cartographic work.

The system supplied by Digital Equipment Australia Pty. Ltd. consists of a PDP-11/45 central processor with 32K words of core, and peripheral equipment including disk and tape units, and a card reader. The system also includes a small Calcomp 563 drum plotter and a large flat bed Calcomp 745 plotter supplied by Datamatic Pty. Ltd.

The Lands Department is responsible for the development of Crown land in N.S.W. for trigonometrical surveys, and for the maintenance of up-to-date maps of all parts of the state. Using FORTRAN as the main programming language, the system is used for complex survey computations, the generation of industry-compatible magnetic tapes for automated map and plan drawing on the Calcomp flat bed plotter, and for the interactive optimization of home site and road design in housing subdivisions. In addition to improving work throughput, the computer makes more effective and economic use of skilled manpower using improved optimization procedures compared with traditional methods.

Although not originally planned, the PDP-11/45 has taken over almost all work previously done by the H8200 at the Department of Treasury. Mike Elfick, the department's systems analyst and Ken Hungerford, DEA sales engineer, both consider that the Lands Department system demonstrates that modern minicomputers are capable of doing much of the work previously considered to be for large scale machines only. The effectiveness and relatively modest capital cost of the system have created considerable interest in other departments of the Public Service.

Mike Elfick sees the installation as a significant factor in simplifying the problems of introducing staff to the use of computers. He feels that those who were reluctant to learn to use a large computer in a service bureau are now more likely to be attracted to small machines in their own department. Before the installation, very few members of the Lands Department staff were directly involved in computer use, all computing and magnetic tape generation for the Calcomp plotter having been done on an H8200 at the Department of Treasury. It is intended in the future that the field notes of surveyors will be recorded in a form that can be entered directly into the computer system. In this way, surveyors will be able to control the operation of an entire project from field work to automated map or plan plotting.

Future plans for the expansion of the Lands Department computing facilities include the development of an on-line interactive data acquisition system based on a PDP-11/10. This computer will be used to store information taken from aerial photographs by precision photogrammetric machines, for the final production of map sheets.

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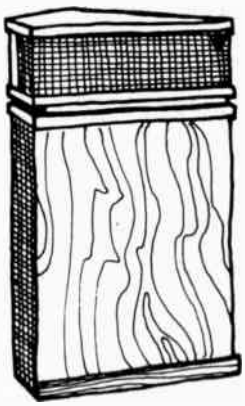
ACQUIRE YOUR OWN REFERENCE LIBRARY. Get more critical. Send $5.00 for a set of Klipsch technical papers, including Paul W. Klipsch's two latest on modulation distortion. With the set we'll also send reprints of Symposium on Audio Perspective from Bell Telephone Laboratories and Principles of Stereophonic Sound by William B. Snow.

You see, everything we do is documented by technical papers and supported by objective performance data.



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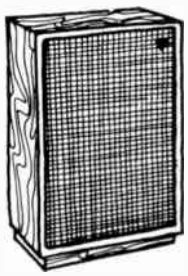

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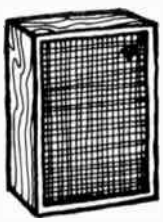

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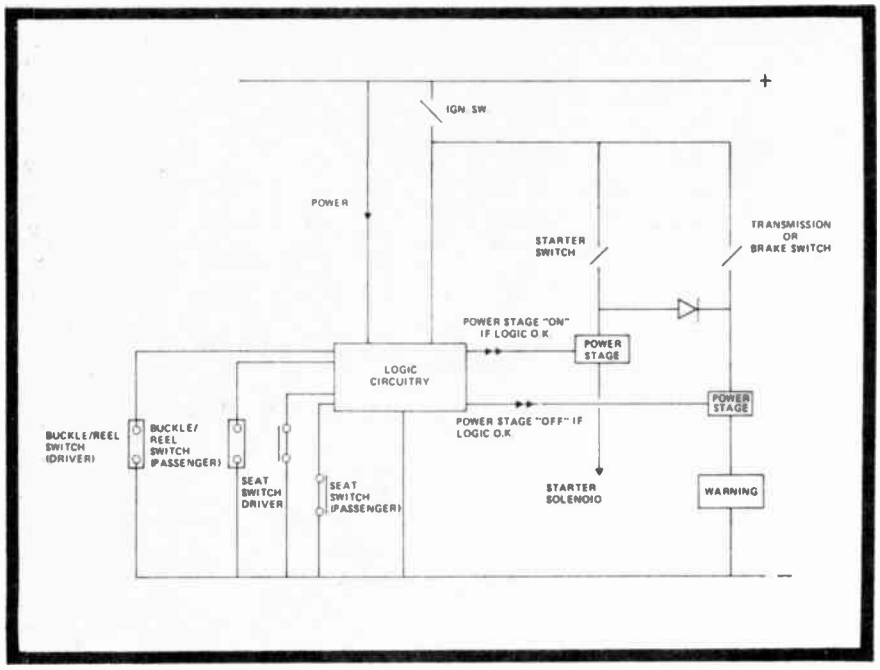
BELT INTERLOCKS



In an unexpected show of strength, the US Federal Highway Safety Authority, has refused Detroit's request to extend the 1974 deadline on seat-belt interlocks.

The interlocks, which prevent a car from starting unless the seat belts are fastened must be fitted to all cars manufactured in the USA after the beginning of 1974.

A typical system is shown above.

PHILIPS WIN COLOR TV CONTRACT FOR NEW ZEALAND

A contract to equip the N.Z. Broadcasting Commission's Avalon color studio centre, worth considerably in excess of $A3,000,000, has been awarded to Philips in Australia. Philips have won this contract against world-wide competition.

The package color TV system is to be installed in a new multi-million dollar studio centre, recently completed by the NZBC at Avalon, in Wellington.

Major items of Philips equipment include twelve of the newly-developed digital control LDK-5 color cameras, several photo-conductive telecine systems, and a range of multi-track audio recorders.

In addition, Philips will supply to the NZBC a comprehensive programme automation system, developed by Central Dynamics Ltd. Canada, which will be one of the largest and most modern systems in the world.

A large proportion of the studio equipment will be manufactured in Australia by Philips Vision & Sound. This specialised equipment, developed in Australia, will be produced at the newly established 80,000 sq. ft. factory complex at Oakleigh South, Victoria.

Equipment for the NZBC contract includes audio and communications systems, pulse generators, video and audio distribution systems, control desks and monitoring equipment featuring a new precision color monitor, type LDN-5006.

BEN FRANKLIN STRIKES AGAIN

Scientists from the Electricity Council Research Centre at Capenhurst, in Cheshire, (UK), are flying a kite balloon in North Wales in an attempt to trigger off lightning from thunderclouds artificially.

The work is part of a research programme which has been carried out during the past three years into problems associated with the effects of lightning on overhead electricity distribution lines. This is the largest single cause of loss of supply.

The artificial triggering will be achieved by an apparatus carried beneath the tethered balloon, which will be flown at a height of 2000 feet during storms. The triggered lightning is to beconducted from this apparatus to the ground at a point close to electrical recording equipment which, it is hoped, will give data unobtainable by conventional methods.

The experiment is being conducted at a remote site in Snowdonia.

BEN AGEN

Scientists from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) have announced that they have succeeded in their field experiments in suppressing the destructive force of lightning. If lightning is totally suppressed for example, about 75% of our forest fires could be eliminated. For those who maintain that such fires are necessary to maintain an ecological balance, at least the foresters will be in a position to defer storms in periods of extreme hazard, and eliminate them in the more dangerous geographical areas.

Project Thunderbolt was started in 1965 at Flagstaff, Arizona by NOAA's Atmosphere Physics and Chemistry Laboratory. Dr. Heinz Kasemir directed the project with five other NOAA scientists. In simple terms, lightning is the instantaneous electrical discharge between two oppositely charged storm areas. However, before lightning can occur the electric field in a thunderstorm must approach 500,000 volts per metre. To prevent the electrical field from reaching lightning strength, a phenomenon known as "corona discharge" is utilized.

If an electrically conductive pointed object is introduced into a strong electrical field, like that of a thunderstorm, it will develop a positive and negative pole. Electrically charged particles, called ions, then escape from the pointed pole of the same charge. The resulting streams of ions, frequently visible as a faint glow on the aircraft wing tips, ship masts and tree tops, increase the electrical conductivity of the atmosphere.

SCREENING PASSENGER BAGGAGE

A new X-ray system, designed to further tighten airport security while at the same time speeding passenger anti-hijack screening, has been produced by the Bendix Corporation.

Because quantity and location of such equipment is a security matter,

news digest

details on the number of units ordered and their location cannot be disclosed.

John E. Shields, director of operational safety at Eastern, said "The Bendix X-ray system will permit more thorough and faster screening of hand luggage and will eliminate the need for security guards to open each carry-on article."

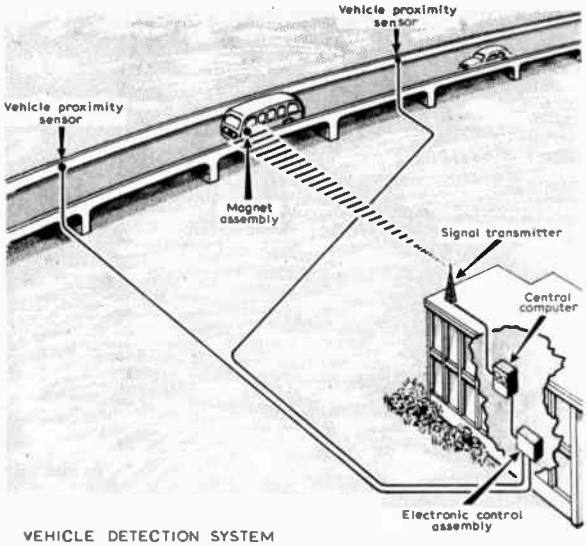
The Bendix system, also known as a radiographic system, uses an extremely low-dose, short-pulse X-ray to detect items in luggage which would be illegal for passengers to carry aboard aircraft such as guns, explosives, oversized knives and other dangerous objects. The device instantaneously produces an X-ray image of a suitcase and its contents on a television screen.

Radiation dose is not harmful to humans or animals and is so low that luggage containing photographic film, magnetic recording tapes or pharmaceuticals can be inspected without damaging them. Gift packages need not be opened to be inspected.

Developed by the Bendix Aerospace Systems Division, Ann Arbor, Mich., the X-ray can inspect a parcel or piece of luggage in less than five seconds. In 40 billionths of a second, an X-ray pulse penetrates the parcel and is converted to light. The light is then intensified and an image is received and stored in a miniature camera for presentation on the video screen.

PROXIMITY SWITCH AIDS TRAVEL IN TOWNS

Rapid vehicle transit through towns has, for many years, been no more than a dream for many drivers. Now, in Morgantown, West Virginia, U.S.A. a whole vehicle detection system has been designed using proximity switches for sensing purposes. These proximity switches, available from Elliott Relays, a division of Associated Automation Ltd., have sensing distances that are normally six inches but can be adjusted up to 12 inches.



VEHICLE DETECTION SYSTEM

In this detection system, proximity switches sense the presence of vehicles as they travel along a given track. The information obtained is then processed by a central computer to prevent collisions between the vehicles by retaining a specified distance between them through a 'block control' concept. The scheme functions by installing proximity sensors along the guideway at strategic points. The sensor outputs monitor vehicle presence on adjoining track sections or blocks. When the minimum spacing distance is reached, the central computer initiates either car braking or system shutdown.

A feature of the proximity system is that failure of a channel in the system will indicate a 'vehicle present' condition to the computer for that channel, thus initiating system shutdown and fault location.

The system comprises three basic components: the sensor assemblies located at various intervals along the guideway, the electronic assembly that provides the information for the central computer, and a magnet assembly that is mounted on the moving vehicle. No adjustment is required after the initial installation unless an electronic assembly or sensor replacement becomes necessary.

It is possible to avoid using the magnet assembly by using the vehicle structure for the target. But, in this particular application, the magnet assembly is used because of the existence of high ambient magnetic interference that could actuate existing vehicle detection systems. The magnet assembly is attached to the vehicle and provides a magnetic field to actuate the sensor in the road bed. The assembly enhances the signal-to-noise ratio of the system. It is oriented on the vehicle with its longitudinal axis parallel to the direction of travel and is perpendicular to the fields generated by the power rails which can interfere with the detector operation. ●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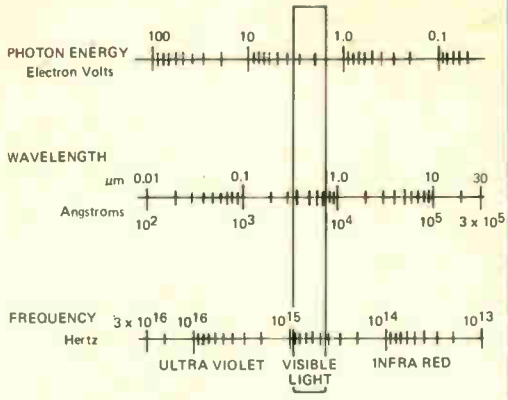
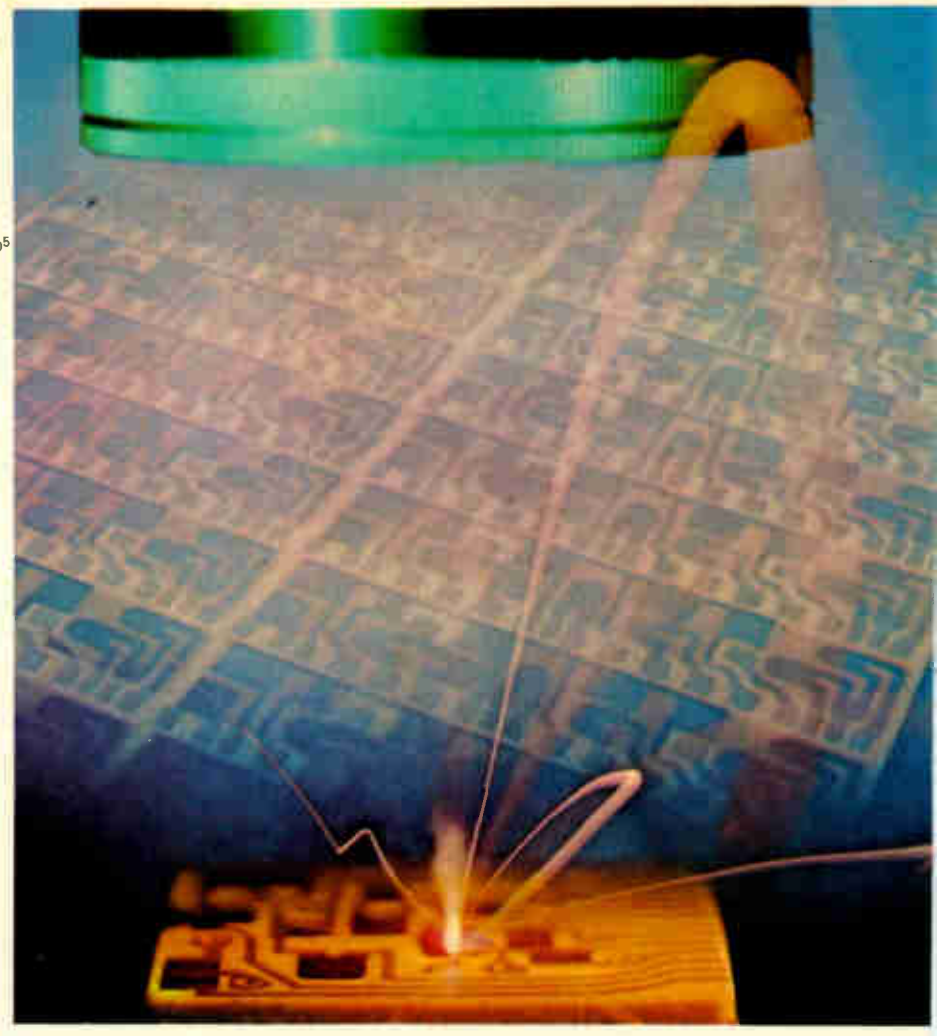


Fig. 1. Comparison of units used for electromagnetic radiation at optical frequencies. For example an energy change of 10 electron volts (ie $V = 10^{-19}$ joules) produces radiation at 0.1 μmetres or 1000 angstrom, which is equivalent to a frequency of 2×10^{15} Hertz. Another SI preferred unit of wavelength is the nanometre = 1000 micrometres.



In the fabrication of multi-layer printed circuits, N/C machine tools with SINUMERIK controls adjust the resistances. The circuits are located on a co-ordinate table which is moved under a CO_2 laser beam by pulse motors. The resistance is varied by cutting into the layers until the desired value is obtained. The laser beam subsequently divides the substrate up into the individual modules.

LASERS

What they are, and how they work
— Technical Editor, Brian Chapman explains

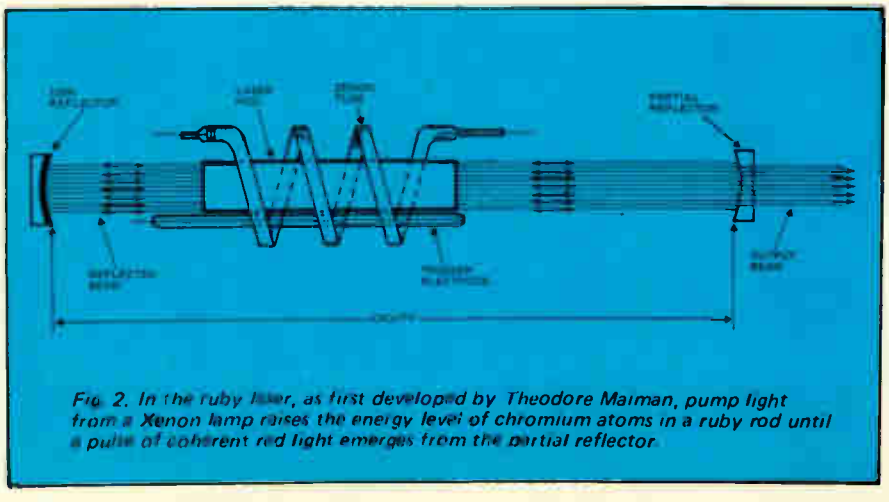


Fig. 2. In the ruby laser, as first developed by Theodore Maiman, pump light from a Xenon lamp raises the energy level of chromium atoms in a ruby rod until a pulse of coherent red light emerges from the partial reflector.

IN 1960 Theodore Maiman, then a scientist with Hughes Aircraft Corporation, successfully produced a beam of pure, red light by electronic means. Whilst the production of light in itself is not remarkable, the characteristics of the light produced by this new technique are remarkable indeed. The light is of a single frequency, the beam is coherent, in phase and very nearly parallel.

The new technique is yet another development based on quantum theory, the principles of which were first expounded by Einstein in 1917. The first application of these principles was the MASER — developed in 1954 by C. H. Townes and his students. (The word Maser is short for Microwave Amplification by the Stimulated Emission of Radiation.) The MASER operates, as the name implies, at microwave frequencies and makes low noise amplification possible at extremely high frequencies. The first MASER operated at 23 870 MHz but was of limited use as an amplifier as it could not be tuned. Nowadays tunable MASERs have been developed for

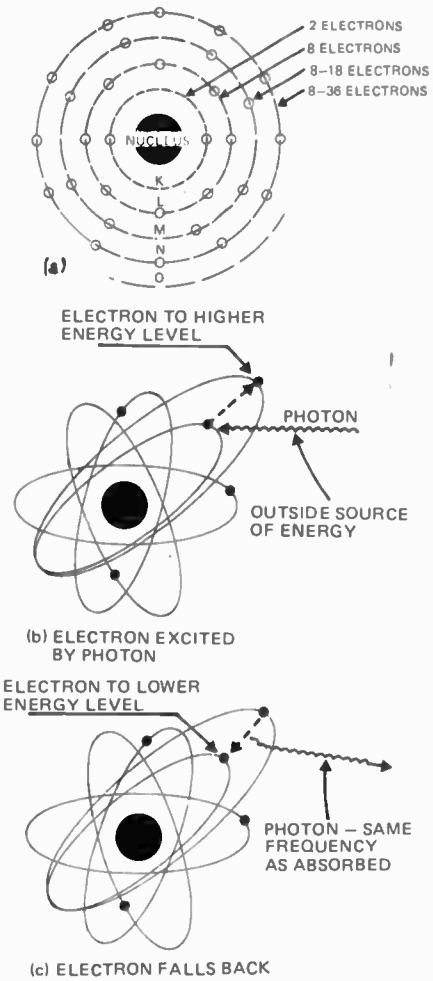


Fig. 3. (a) Simplified diagram (not typical of any particular element) of orbital levels of an atom. These levels are known as shells and are the only possible orbits.
(b) A photon of correct frequency will cause an electron to move to a higher shell.
(c) When the electron falls back to its original level in one jump it emits a photon of the fame frequency as that which caused the initial excitation.

operation anywhere in the range 1-100GHz (1GHz = 10^9Hz).

The extension of MASER action to the even higher optical frequency region was first achieved by Maiman who effected pulsed MASER action at 400 Tera Hertz (4×10^{14}Hz), i.e. a wavelength of 6943 Angstroms in a ruby rod pumped by a Xenon flash lamp. (Fig. 2). This new device was at first called an optical MASER but later this was changed to LASER (L for light).

The term LASER is somewhat of a misnomer as the majority of devices in use are oscillators not amplifiers. Hence at one stage LOSER was proposed as a name but this was soon dropped as it was thought no-one would invest money on a LOSER!

To understand LASER action it is necessary to review atomic theory to some extent. All other electronic systems make use of the energy of free electrons in the atomic system. Lasers, on the other hand, use processes within the atom itself to produce coherent radiation.

Figure 3 shows the now well known structure of the atom. This consists of a central nucleus orbited by one or more electrons. The complexity of the nucleus and the number of orbital electrons is unique to particular elements. The electron orbital paths are confined to discrete levels or shells (Fig. 3a), each shell corresponding to an energy level. An electron cannot exist in a stable state between shells and if subject to radiation that increases its energy it will jump to the next highest shell. The quantity of electromagnetic radiation necessary to just cause an electron to move to a higher shell is called a photon. Photons can be thought of as minute packets of energy which have the characteristics of both matter and electromagnetic radiation.

THE PHOTON

The photon is a fundamental concept in the quantum theory and the relationship of the photon frequency and the energy level to which the atomic system is raised is given by the equation where:

$E = h\nu$

E - energy level in ergs

h = Planck's constant (6.624×10^{-27} erg-sec)

ν = frequency of the photon.

A photon *of the right frequency* is therefore required to raise an electron of a particular atomic system to a higher energy level. When an atom is in its lowest energy state it is said to be in the ground state and when its energy has been increased by a photon it is said to be in an excited state.

From the excited state, a number of possibilities exist for the return to ground state. Firstly the electron may fall to an intermediate level and then to the ground state. A photon will be emitted at *each* transistion having a *lower* frequency than the incident photon (because each energy level jump is smaller) or alternatively it may jump straight to ground state and emit a photon of the same frequency as the incident radiation. These mechanisms are known as SPONTANEOUS PHOTON EMISSION and normally occur very rapidly (less than a microsecond after excitation).

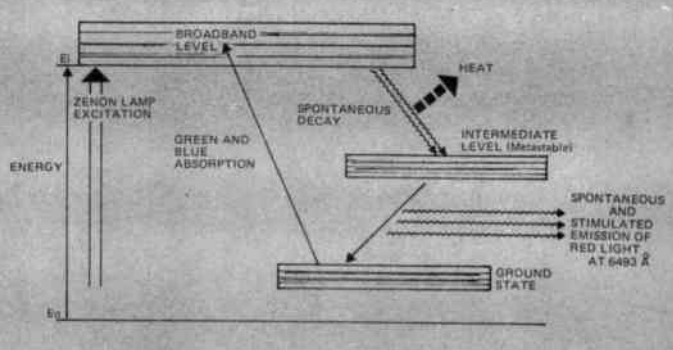
If a photon of the correct frequency is incident upon an atom already in the excited state, it will emit a photon having exactly the *same phase as the first photon, and travelling in the same direction.* This mechanism is known as STIMULATED EMISSION.

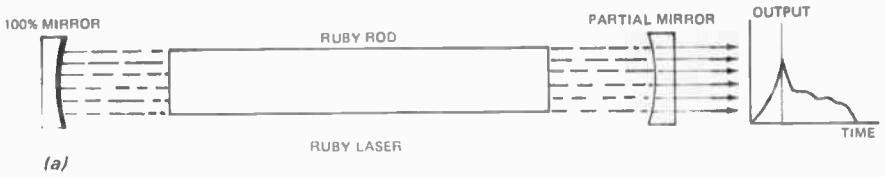
Siemen's stage laser as first used in a production of Mozart's "Magic Flute" in Munich's National Theatre (July 1970). Abstract light formations which turn and twist, flow apart and reconverge, take on new shapes, grow lighter and darker in innumerable shades are produced by laser interference patterns. One of the light forms, normally in colour, can be seen at the top of the photograph.

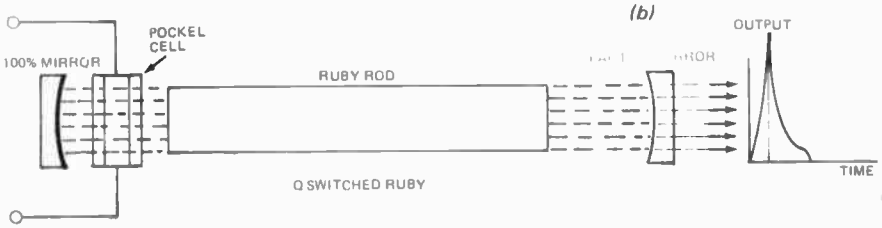
THE RUBY LASER

The original laser as built by Ted Maiman nowadays appears ridiculously simple. It consists of a ruby rod containing about 0.05% chromium (the chromium component gives the ruby its characteristic pinkish colour). The rod is surrounded by a Xenon flash lamp, as shown in Fig. 2. The purpose of the flash lamp is to provide excitation, called pumping, at 5600

Fig. 4. Energy level diagram for the ruby laser. The energy from the Xenon lamp takes the chromium atoms to the E_i level. They then decay in two steps back to ground state. The second transition provides coherent emission when population inversion has been achieved.







The "Q" switching technique prevents emission of laser pulses until higher population levels have been achieved. (a) shows conventional ruby laser and its typical output pulse shape. (b) shows method of inserting Pockel cell and the resulting increased peak power of the pulse.

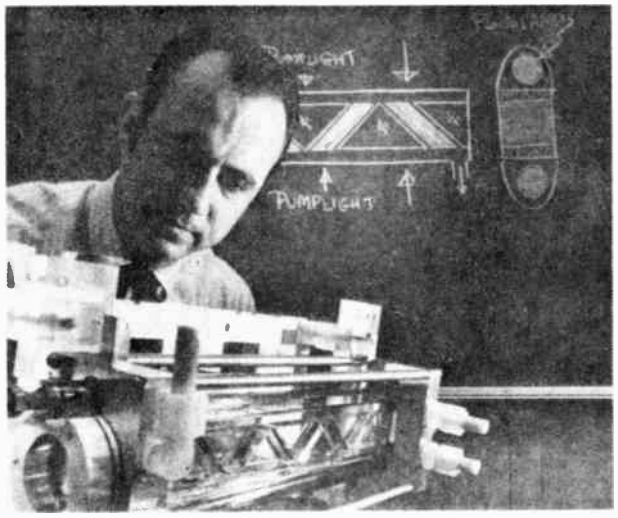


Fig. 6. The General Electric "Zig Zag" laser has eight slabs of neodymium doped glass arranged at the Brewster angle (57°). This technique eliminates beam non-uniformity and allows very high-power, high-repetion-rate pulses to be generated.

angstrom (blue green light) to which the chromium atoms respond.

The chromium atoms, once excited, will spontaneously return to ground state in two steps, as shown in Fig. 4. They first return to an intermediate level, known as the metastable state, with the emission of heat, and then to ground state with the emission of red light at 6943 angstrom.

At this point the ruby rod will glow with red light. The flash lamp continues to pump energy to the chromium atoms pushing more of them to upper energy levels until, *there are more atoms at the higher energy level than at the lower.* This is known as population inversion and at this point the operation suddenly changes. Now photons begin to interact with excited chromium atoms to a significant extent, with a resultant stimulated emission of other *identical* photons which travel in the same direction as the incident photons.

The ruby rod, which is several centimetres long and half a centimetre in diameter, will have some photons travelling parallel to its axis, and these will be reflected at the ends back into the crystal where they produce still more photons. Those travelling in other directions emerge from the sides and are lost. The build up of photons parallel to the rod continues until, at a critical point, some of the coherent radiation bursts out through the partially reflective end face. Thus, a laser pulse is born. The pumping process continues generating further pulses of coherent red light each having a duration of about one or two milliseconds.

Although such action is possible with a simple ruby rod having both ends polished and perfectly parallel to each other, it is far better to use external mirrors to do the reflection. These are specially constructed multilayer (dichroic) mirrors such that they reflect the frequency of interest with high efficiency. One of them is made partially transmissive to allow the laser pulse to emerge. For the laser to operate at maximum efficiency it is desirable to get as much light as possible into the ruby rod. For this reason the flash lamp is wound around the ruby in a helix.

Since Maiman's first laser began pulsing, some 13 years ago, enormous strides have been taken in the development of laser technology. Many new lasing techniques have been developed and both peak and average power have been increased to staggering levels. Average power of 100kW and a peak power of 10^{14} watts have been obtained in laboratory experiments, according to recent reports. And even these levels may well have been exceeded at the time of writing. Space does not allow a coverage of all types in detail but the following survey describes the major types currently in use or under development.

Before passing on to the survey of the different types of laser, we should mention two methods of increasing the peak pulse-output power. The first method, known as *"Q" switching* or "Q" *spoiling,* is achieved by interrupting the optical cavity, thus reducing losses due to lasing until a much higher population inversion is achieved, typically 70 to 80%. The Q switch then suddenly restores the normal cavity and a much more powerful and shorter pulse than usual is achieved.

The device used to interrupt the cavity is usually a Pockell cell. This cell is a crystal of ammonium or potassium dihydrogen phosphate cemented between two crossed sheets of polarizing material. Due to the cross polarization, light cannot normally be transmitted through the cell. The Pockel cell is inserted in the laser cavity, as shown in Fig. 5b.

When an electric field is applied to the crystal it rotates the plane of polarization of the incident light by 90° allowing it to pass through the cell. The "Q" of the lasing cavity is now suddenly increased and a very short, high peak-power pulse is produced.

The GIANT PULSE technique, although very similar, uses a cell containing a solution of any one of several metal-organic compounds known as phthalocyanines in place of the Pockel cell. The solution strongly absorbs red light and prevents laser action until a higher population inversion is achieved – just as for "Q" spoiling.

As the energy emitted by the ruby increases, the absorbing solution suddenly becomes perfectly transparent, and all the energy is emitted as a giant pulse. The cell then returns to its absorbent state until the ruby energy again rises to the critical point.

THE LASER FAMILY

The ruby laser belongs to a general class of lasers known as SOLID STATE (not to be confused with semiconductor lasers). These lasers are characterized by a crystalline or glass

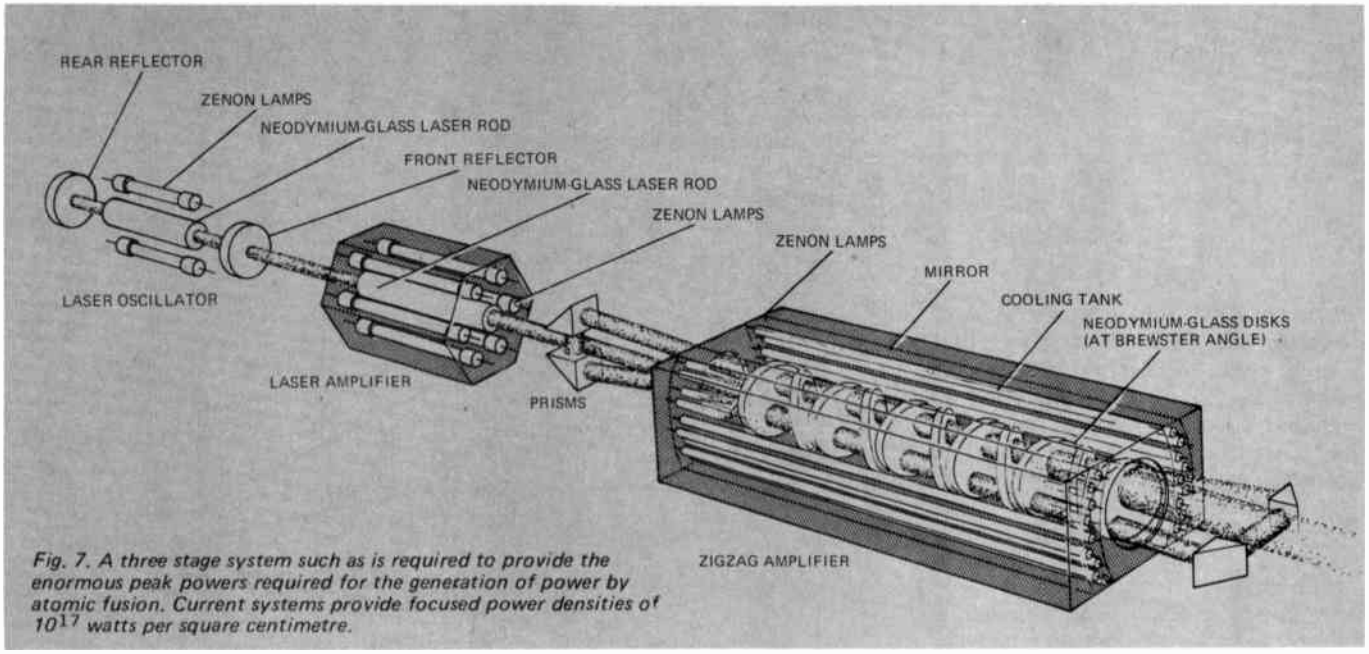


Fig. 7. A three stage system such as is required to provide the enormous peak powers required for the generation of power by atomic fusion. Current systems provide focused power densities of 10^{17} watts per square centimetre.

base material in rod form containing up to 2% of another impurity material which produces the laser action.

Ruby – Chromium doped aluminium oxide.

Nd:Yag – Neodymium doped Yttrium Aluminium Garnet.

Nd:Glass – Neodymium-doped glass.

Yalo – $YACO_3$ Yttrium Aluminium Oxide.

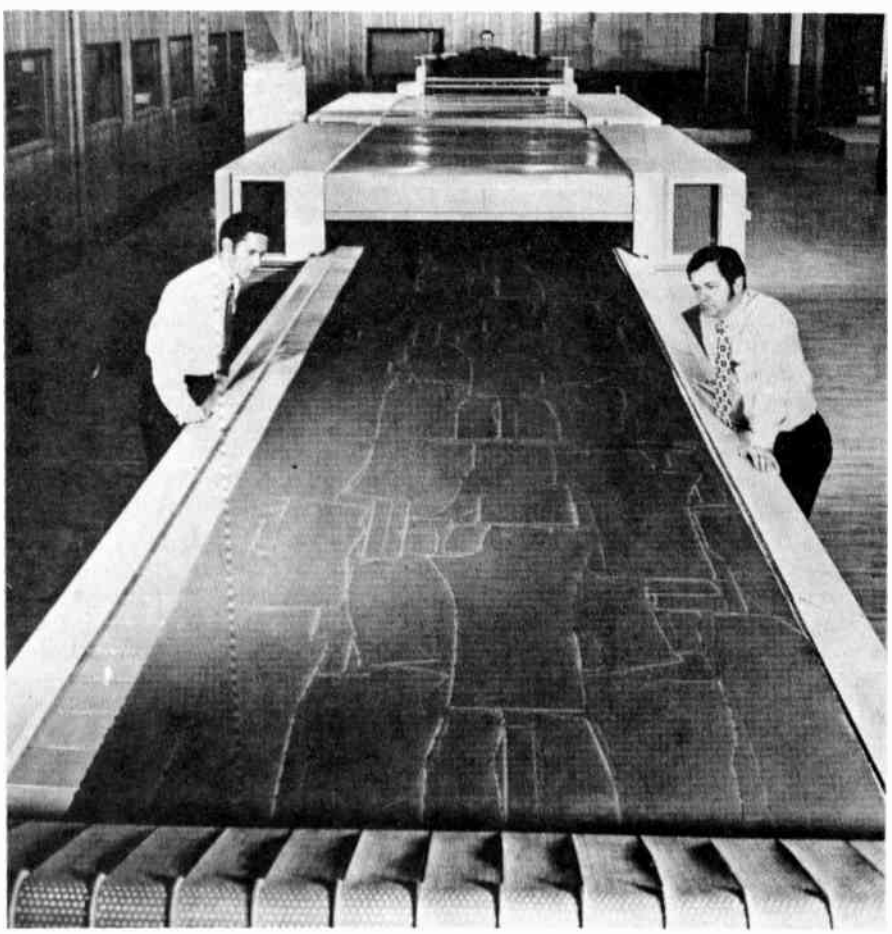
Nd:$CaWO_4$ – Neodymium-doped Calcium Tungstate.

Other dopants such as dysprosium and uranium have been used together with base crystals of yttrium gallium and gandolinium gallium.

Pumping limitations due to characteristics of Xenon lamps, and heat dissipation problems limited available output power and prevented continuous operation in early solid state lasers. In fact it was not until 1962 that a CW laser was constructed with neodymium doped calcium tungstate at Bell Telephone Laboratories. This was followed in 1964 by the Neodymium YAG laser which operates at 10.6μM (infra red). Nowadays there are many Nd:YAG lasers available commercially and one model from Holobean Inc., is capable of 1100 watts CW.

General Electric has developed what is known as a 'zigzag' laser. In the original prototype, eight neodymium-doped slabs are arranged in a zigzag pattern at the Brewster angle (approx. 57°). The assembly is cooled and is optically pumped by flashlamps (Fig. 6). The beam of a smaller laser is passed through the zigzag where it undergoes amplification thus producing an output of 30 nanosecond wide, 50-80 joule pulses. Although this power output is not tremendous, the technique is expected to provide average power levels of 100kW and a peak pulsed output of the order of 100GW (100 000 megawatt) in scaled up versions.

The technique of using one laser to amplify the output of another is commonly used to achieve higher output powers (see Fig. 7). Additionally some unusual pumping techniques have been used in an effort to further increase power. One method, devised by RCA in 1962, used a 12 inch hemispherical mirror to



Cloth being cut at high speed to complex patterns by a computer controlled laser beam.

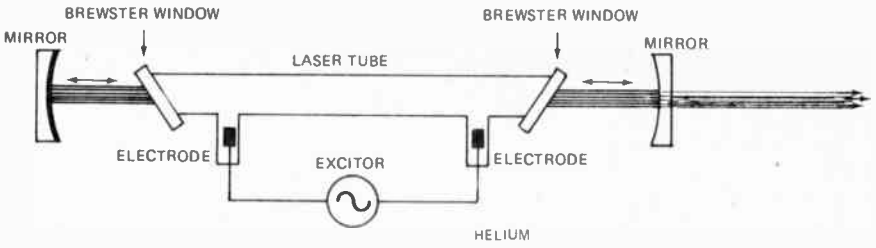


Fig. 8. Construction of a typical helium-neon laser. The gas mixture is contained in a glass tube and is excited by RF at 28 MHz or by a high voltage dc supply.

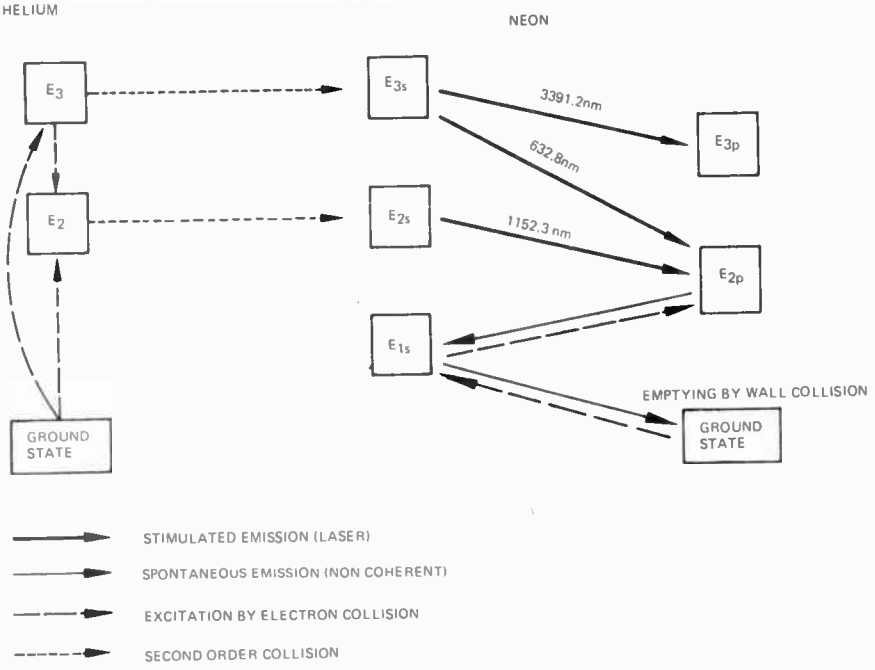
focus sunlight onto a laser crystal of calcium fluoride immersed in a bath of liquid neon. The laser produced a continuous output of 50 watts at 2.36 microns directly from solar energy and is thus particularly suited for satellite communication applications. This was the first device, ever, to use sun power direct without conversion to another form of energy, such as heat or electricity.

Another method of eliminating electrical power supplies is to use what is known as chemical pumping. In this method a chemical reaction or explosion is used to generate light in a flash tube which then drives the laser in the conventional manner. A typical light-producing reaction is that of aluminium and sodium perchlorate. In the explosion method the shock wave generated by a charge is made to travel through an argon filled box which has three sides silvered and one transparent. The resultant compression of the argon gas causes it to emit intense radiation in the ultraviolet region. This is then focused onto the laser rod.

A further method is to pass gas at high speed over aerodynamic surfaces which produce shock waves in the gas and hence population inversion.

The lower power applications of solid state lasers include optical ranging, materials processing (IC resistor trimming), microwelding and microdrilling. High power applications include satellite tracking, metal cutting and other stringent materials processing requirements. One very important area of application is in the heating of plasma for fusion reactions. Experiments have indicated that fusion reactions can be initiated and to some extent controlled *without a confining magnetic field* by focusing a powerful laser pulse onto a pellet of thermomuclear fuel. The pellet temperature must be raised to the vicinity of 80 million degrees Celsius for fusion to take place. Pilot plants have already shown encouraging results and the economics of the process are good.

Fig. 9. Energy level diagram of helium-neon laser.



GAS LASERS

Gas lasers may be subdivided into three categories:

(1) Neutral (atomic) gas
(2) Ionized gas
(3) Molecular gas

The neutral gas lasers, sometimes called atomic noble gas lasers may use helium, neon, argon, krypton or zenon. The most common laser is that using helium and neon. Indeed, it is the most prolific of all laser types.

The first helium-neon laser contained a mixture of 90% neon and 10% helium at a pressure of 1 to 2 millimetres of mercury in a quartz tube approximately 80 cm long and 1.5 cm in diameter. It emitted radiation at five coherent infrared frequencies, the strongest of which was at 11 530 angstroms. This laser was constructed at Bell laboratories in 1961. Helium-neon lasers have since been constructed to operate at two other prime wavelengths 6328 angstrom (red) and 3.39 um (infrared). Outputs range from 0.01 mW to one watt.

The operation of the helium-neon laser may be understood with reference to Figs. 8 and 9. The main difference between solid-state and gas lasers is the way the latter are pumped. In the gas laser an electric discharge is produced, within the tube, either by an RF generator (at typically 28 MHz) or, by a high voltage dc supply. Helium electrons and ions are accelerated between the electrodes and the faster moving electrons collide with other atoms and ions of neon increasing their energy to level E_3 as in Fig. 9. After colliding with the neon atoms the helium atoms fall back to

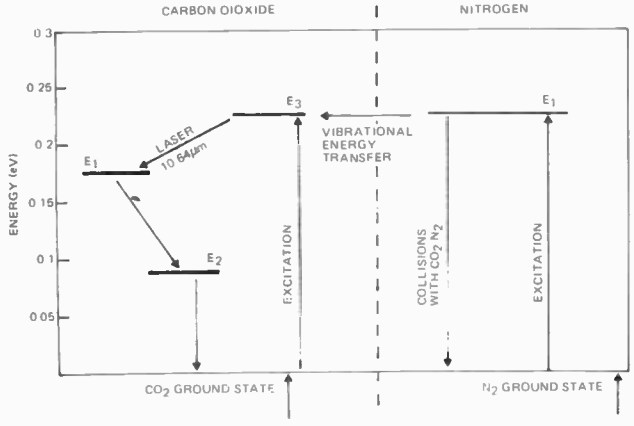


Fig. 10. Energy levels of a CO_2 laser.

ground state – having imparted all their energy to the neon. The neon atoms then fall to the metastable level E_2 emitting photons of coherent radiation. The other falls, from E_2 to E_1, and E_1 to ground state, produce incoherent radiation which is visible as the characteristic red glow of neon.

Since the level E_2 has ten possible energy levels very close together there are many different transitions possible and helium-neon lasers therefore have a wide line spectrum (several frequencies generated simultaneously in a narrow band). However since gas lasers as a whole can be made very frequency stable they are the most monochromatic light sources available.

Gas lasers have been constructed using 29 different neutral elements and have produced radiation at more than 450 frequencies within the waveband 0.41μm to 216.3μm.

ION LASERS differ from neutral gas lasers mainly in design and operating procedure, the emission being due to a drop between two energy levels of an ion rather than a whole atom. The most commonly used gas is argon with neon, krypton and zenon also being used. Outputs of an argon-ion laser may be in the region of tens of watts but the efficiency is very low – of the order of 0.001%. The most important emission being argon-ion lasers occur at 4880 angstrom (blue) and 5145 angstrom (green).

The most outstanding example of a MOLECULAR LASER is the CO_2 laser which currently provides the highest available CW power. Emission is in two groups of oscillation at 9.6 and 10.6μm. Maximum theoretical efficiency is 40% and efficiencies of from 10 to 33% have been obtained in commercial lasers.

Improved power output and efficiency may be obtained from CO_2 lasers by the inclusion of small quantities of nitrogen and helium. The energy level of a CO_2/nitrogen laser is shown in Fig. 10. In operation the nitrogen and CO_2 are both excited by an electric discharge. The E_1 level of nitrogen corresponds very closely to the upper laser level of the CO_2 and a rapid interchange of energy between the two takes place. The nitrogen thus provides additional excitation to that already given to the CO_2 by the discharge. The lower laser level E decays to ground via E_2 and, as E_2 lies very close to the ground state, it is possible for this level to be populated due to heat. The helium is present because it has a high thermal conductivity and thus helps to cool the gas. But further cooling may be necessary to prevent population of the E_2 level which would limit power output and decrease efficiency.

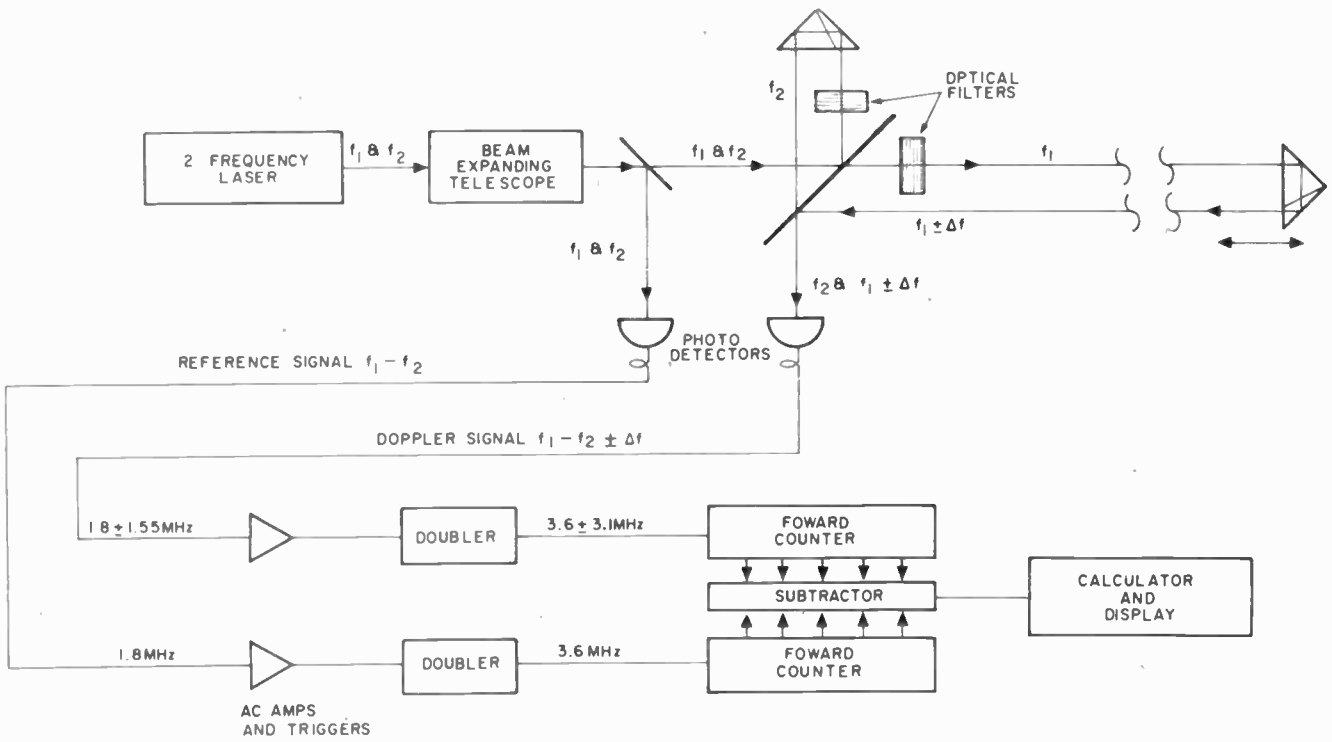
Conduction cooling is limited by the thermal conductivity of the gas mixture and to increase power output it is therefore necessary to remove the waste energy of the laser by flowing the gas through the tube. The structure of a conventional electrically excited CO_2 laser is shown in Fig. 11. The output, which is independent of tube diameter within the range 1.5 to 5cms, is proportional to length, and is about 70 watts per metre for lengths up to 10 metres. Above 10 metres the output falls to about 40 watts per metre. Obviously a 200 metre long laser would be somewhat impractical so the tubes are usually folded, using mirrors to bend the optical path. A commercial laser using this technique has five tubes, each 2.6 metres long, and produces 500 watts of continuous power.

Still higher powers may be achieved by increasing CO_2 pressure and flow. The flow characteristics may be improved by passing the gas through the laser transversely, as shown in Fig. 12. This results in better efficiency at low flow rates.

Much work is also underway on chemically excited gas lasers, where a chemical reaction supplies the energy required to achieve population inversion. No external energy source is required with a chemical laser, apart from pump power to achieve the fast gas-flow rates required. The main disadvantage is that the gases are corrosive, expensive and non-recyclible.

SEMICONDUCTOR LASERS

The semiconductor laser (also known as the injection laser) promises to be of great importance in the field of optical communications. Other lasers



An important application of helium-neon lasers is in distance and velocity measurements by interferometric techniques. This system, the Hewlett Packard model 5525A is capable measuring length with an accuracy of ±0.000 001 inch over 200 feet.

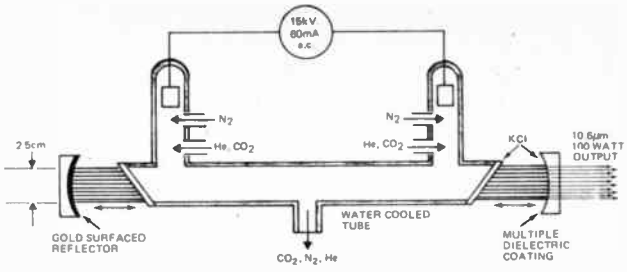


Fig. 11. Typical 100 watt CO_2 laser removes heat by flowing gases through the laser tube.

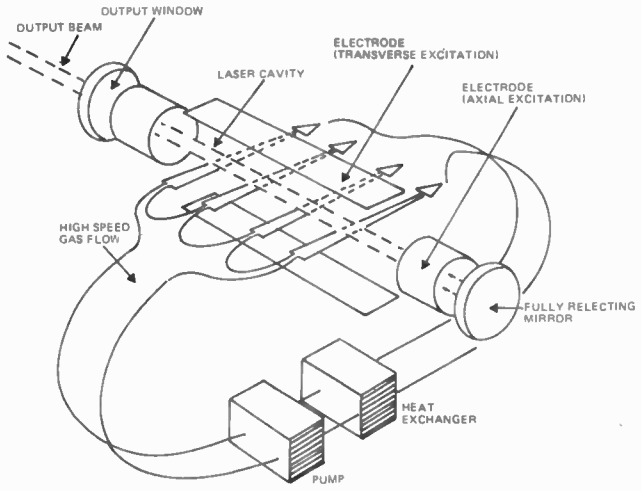
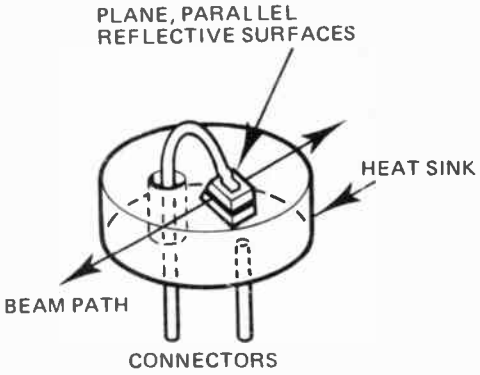
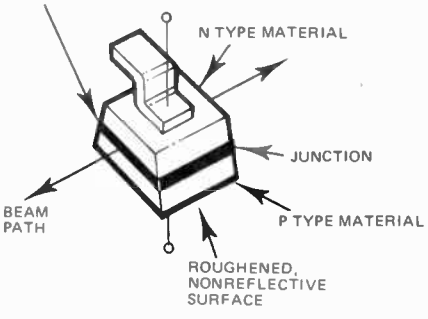


Fig. 12. Transverse gas flow reduces gas transit time and allows higher efficiency at low flow rates.

are not readily modulated at optical frequencies but semiconductor lasers are – quite easily – and over very large bandwidths. Power outputs are not high (about 1 watt with gallium arsenide) but efficiencies are the highest obtainable (between 40 and 70 percent) and materials are available which lase over a greater wavelength range than with any other type. In fact the wavelength coverage is from 0.33 micrometres (ZnO) to 31.2 micrometres (PbSnSe).

The gallium arsenide laser is one of the most commonly used types and consists of a semiconductor diode having "N" type (GaAs doped with tellurium) and "P" type (GaAs doped with zinc) layers as in conventional diode. When a forward bias is applied to the diode a large number of electrons and holes are forced towards a very narrow region (about 1/10 000 inch thick) on the "p" side of the junction known as the active region. The holes and electrons recombine in this region with each recombination giving rise to the emission of a photon





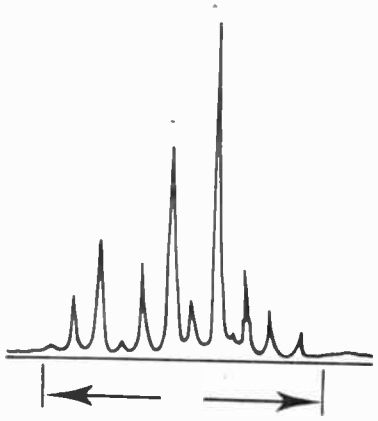


Fig. 13. Typical semiconductor laser
(a) The laser diode mounted on its heat sink
(b) Detail of the laser diode structure
(c) Output is composed of many narrow spikes

in the 8400 and 8500 angstrom region. These photons in turn stimulate the emission of more photons which are in the same direction and have the same phase as the first. Coherent radiation is therefore produced in a plane parallel to the junction.

The first semiconductor lasers had to be operated at cryogenic temperatures. That is, they operated immersed in liquid helium, hydrogen or nitrogen which removes heat very rapidly from the crystal. Operation at room temperatures in CW mode has now been obtained by improved construction methods.

As it is small, light weight and of greater efficiency than any other laser, the injection laser is ideally suited to space communication systems and terrestrial short-distance communications. It could also be used in computers to transmit enormous quantites of data at super speed between sub-assemblies. It has even been suggested that semi-conductor lasers may be integrated into large scale microcircuits as communication links within the chip. (For example in extra large scale integration of CMOS on spinel).

The main disadvantages of injection lasers are their low power output and wide beamwidth of a few degrees. This is a disadvantage in many applications as the received power intensity falls off very rapidly with increased beamwidth.

LIQUID LASERS

Liquid lasers are inexpensive and have characteristics similar to solid state lasers. Higher average powers are possible than with the solid state type, but liquid expansion with heat is a severe problem which must be allowed for.

There are two main types — the rare-earth chelate laser and the organic dye laser. The dye laser has the particular advantage of tunability within the visible spectrum and either CW or pulsed capability.

The coverage presented here is of the main types only. There are many others either available commercially or at an advanced experimental stage which we have been unable to cover in a necessarily brief article such as this.

Sufficient to say that lasers will have a profound impact on the technology of the future. At one time it was said that lasers were an interesting phenomenon awaiting application. This of course is no longer true as lasers have found countless applications in industry, medicine and as tools for fundamental physical research. It is still true to say however that laser technology is in its very early infancy and it is therefore impossible to forsee the marvels due to laser applications of the future. ●

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TRACKING WEIGHT -how it affects record wear

LAST YEAR we commissioned our acoustical consultants to determine whether or not gramophone records lose their 'brilliance' after a number of playings.

The results – published in our December 1972 issue – interested, and surprised many of our readers. So much so, in fact, that we asked our consultants to conduct further tests – this time on a very controversial subject indeed – the effect on record wear of different tracking weights.

Once again, the results were surprising, for whilst we have always held that too low a tracking weight will cause the stylus to bounce and perhaps damage the record groove, we did not realize just how much wear this causes.

Our tests proved conclusively that when a record is played at the lowest recommended tracking weight, the rate of wear is even higher than occurs at the highest recommended tracking weight.

At the lowest tracking weight wear is even higher than at the highest weight.

A second and most interesting finding was that the cleanest sound is generally obtained when the tracking weight is set somewhere between the nominal centre and the highest value of the recommended tracking weight range.

If your stylus is dirty as this one (unretouched photograph) then the wear caused by incorrect tracking weight is the least of your problems!

This finding was less surprising because a cartridge's compliance is a function of its tracking weight, and generally, all things being equal, the higher the tracking weight the more easily the stylus follows difficult passages.

A mediocre cartridge has best tracking at highest recommended weight.

A very good cartridge can achieve this in the lowest region of the range – but only when fitted to a first class arm. An average cartridge achieves it at a tracking weight about the middle of the recommended range, but a mediocre cartridge will only reach its maximum trackability at the maximum recommended weight.

For both records we set up an automatic record changer to play the centre 7" section of one side of the record, monitored in an A-B test against a new record after 2, 5, 10, 20 and 100 playings. You may ask why an A-B test? The A-B test was required because we found that even after 100 playings, a dust and scratch free record played with a good stylus, still sounds normal and acceptable, until compared with a *new* recording of the same record. Our testing demands such techniques in order to provide valid results.

In playing each of these two records over and over again at 'normal' tracking weights we found it impossible to discern any difference in the sound between two sequential playings. The reason for this is quite simple; loss of signal level in even one harmonic component is far less than 1 dB, and this is by and large below the smallest change in signal that the human ear can detect. Even the difference in audible content between 20 and 100 playings, except under the worst possible conditions, is difficult to discern, for what you hear are subtle changes in the relative component intensities of the higher order harmonics as well as a small drop in total signal level, that is almost impossible to detect, even in an A-B test.

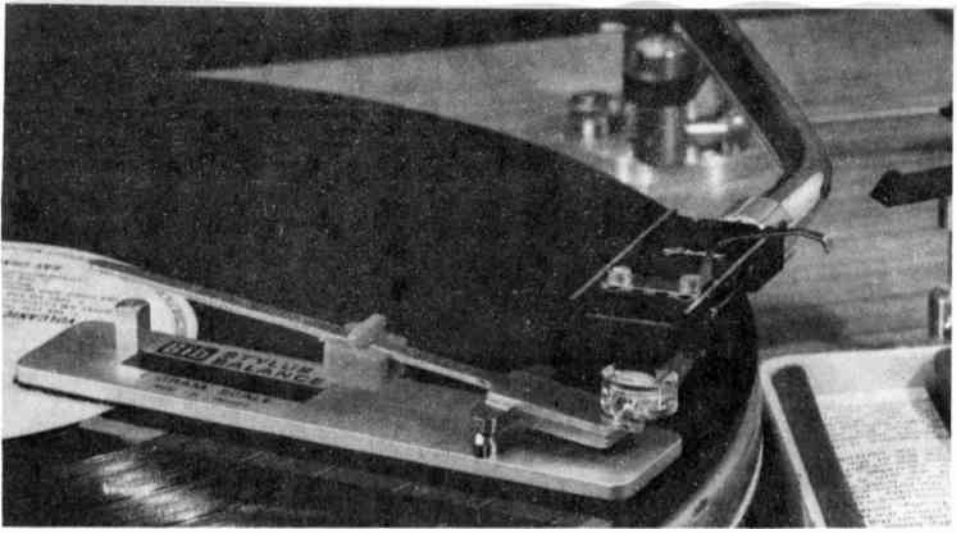
But where significant changes did occur were on the multiple playings with the stylus tracking pressure set at the lowest level. Then it was quite possible to detect what we can only describe as a general numbing or deadening of the clarity. This was evident even on the second playing, and resulted in a complete lack of listening ease after ten playings.

After 100 playings of the lowest tracking weight, the record sounded almost as if it had been made in a different studio and had utilised another orchestra! By contrast, the record that had been played at what we will loosely term the optimum tracking weight, sounded fairly normal, and apart from surface wear and signal to noise ratio, was by and large acceptable.

Having completed our subjective appraisal we were then faced with the difficult task of devising a set of instrumented tests which would allow us to qualify in precise terms that which we had heard.

Trackability measuring has plagued the technical press for years. In an article in "Electronics World" (June 1967), James Cogan of Shure Brothers in the U.S.A. dealt with this subject in some depth. He proposed a number of techniques for measuring trackability, including the use of variable speed turntables in order to provide any level of velocity that is desired so that the point at which mistracking occurs may be measured. The basic problem is that a cartridge that can track at a given velocity – such as 20 cm per second at a frequency of say 100Hz – may not be able to track at the same velocity at a frequency of 6000Hz or higher. This is because the dynamic behaviour of the stylus assembly varies so greatly with the range of frequencies over which it is expected to perform. The tracking ability of a cartridge should in fact really be specified over a wide range of frequencies.

Most commercial discs have average



Tracking weight may be set very accurately using stylus balances such as shown here.

recording velocities well below 10 cm per second, and only a few records have momentary peak velocities that exceed levels over 15 cm per second. Unfortunately, these high peak levels tend to occur at the highest frequencies, which are the most difficult for a cartridge to track. Whilst the trackability can be improved by using a higher stylus force. this in itself is not a solution, for trackability should be *designed* into the cartridge, not *forced* into it.

Most records designed for testing trackability, such as the excellent *Shure TTR101 — "An Audio Obstacle Course", and Shure TTR102* are not really designed for multiple playings, and even so the technical information they provide does not give a unique scale of merit completely suitable for what we had in mind. For that matter, however, neither does any record that we are aware of.

What we sought to achieve was to be able to measure the rate of change of the harmonic components on a record whose average velocity was in the range 5-10 cm per second, and to be able to monitor the small changes in harmonic content that occurred during many playings. Eventually we decided to use a square-wave test record (Ranger Records RRM-002). This is a 7", 45rpm disc that has on one side two bands of a 1 kHz square wave recorded at 7 cm/sec. This record was played 100 times and we recorded the output during the first, fifth, tenth and hundredth playing on to tape using as a preamplifier a Bruel and Kjaer type 2409 voltmeter terminated on the input in 47 kΩ and recording the signal on a Kudelski Nagra 3B tape recorder onto Scotch type 206 tape. We then formed a small tape loop on which we performed a narrow-band analysis using a filter with 30Hz band width, (we could have used a narrower band width, but this would have meant that the subsequent analysis time would have been ten times as long). A typical example of the recordings is shown in Fig. 1 where the dramatic difference between the first and 10th playing at 0.8 grams is clearly evident.

The results were particularly interesting. The first was that after 100 playings the fundamental signal level can drop by as much as 3 dB (at optimum tracking weight) and by as much as 6 dB with the tracking weight set at one extreme or the other.

At the maximum tracking weight the most noticeable feature is the attenuation of the higher order odd harmonic components above 13 kHz. These are directly attenuated and are modified by either the shape of the groove or by the stylus.

Providing the record is kept clean and the stylus is well profiled, the rate of change in wear rate for velocities below 10 cm per second (at maximum tracking weight) is neither excessive nor really a matter for concern. However, when the tracking weight is set anywhere between one half of the lowest level and the the lowest level *recommended* by the cartridge manufacturer, changes occur in a somewhat different manner. Firstly, the harmonic components rise due to the assymetry of motion of the stylus in the groove, and over only ten playings, these components could rise by as much as 5dB. However, it should be noted that these components are not readily audible even though the record is being rapidly worn out. Over 100 playings, the damage is extensive and the record is far from what it was originally in terms of the loss of high frequency components, and the very significant increase in the even order harmonics.

The cleanest sound is obtained . . . near the nominal centre of the tracking weight range.

At twice the nominal optimum tracking weight, the rate of wear is *less than observed at half the recommended rate*. There is no significant increase in the even order

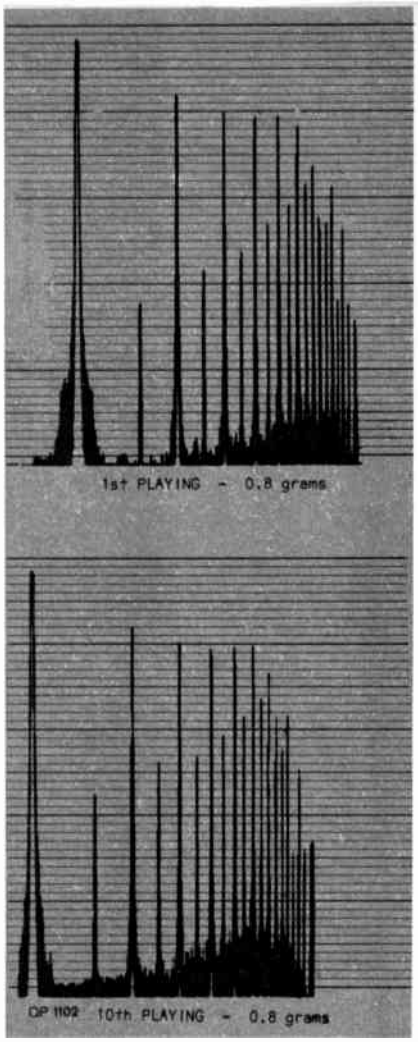


Fig. 1. Narrow Band Spectra of Square Wave Test Record on 1st playing and 10th playing with tracking weight of 0.8 grams.

harmonics, but there is still a significant loss of the odd order harmonics above 11 kHz. The rate of change of harmonic components between the third and ninth is not particularly high, and the record sounds very similar to when it was initially played, except for a slight loss of brilliance and lustre.

The conclusions that we have drawn from this are as follows:—

1. To minimize record wear and to obtain quality reproduction, do not set any cartridge tracking weight below the *middle* of the range recommended by the manufacturer.
2. It is preferable to track at a slightly higher tracking weight than optimum, if the tone arm is not one of the best available.
3. The damage done to a record by dust in the grooves or by a dirty stylus, or by a poorly profiled or badly worn stylus, is far greater than that which will result from playing the record under optimum conditions. ●

Electronics Today International would like to thank Fred A. Falk Pty Ltd for the loan of the Dual 1229 automatic turntable and Shure M91 series cartridge used in this test.

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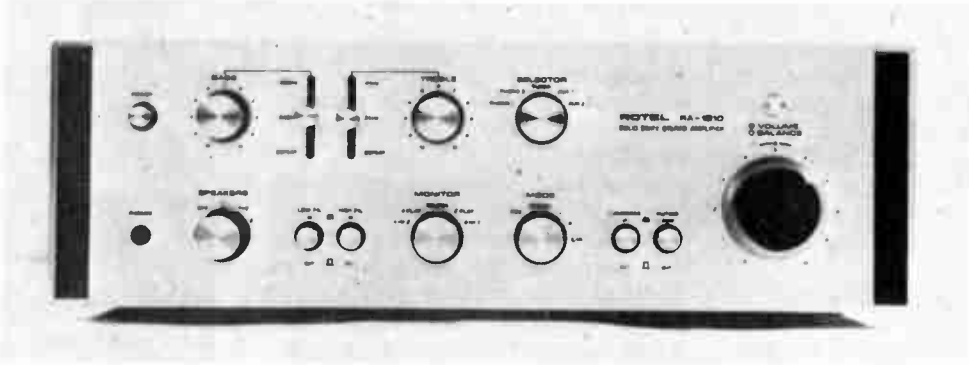

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Cryogenics and superconductivity Part II

THE SEARCH FOR THE COLDEST COLD.

by Dr. Peter Sydenham Ph.D., M.E., M.Inst. MC.

THE previous article dealt mainly with the work of the scientists who, over the years, explored the unknown domains of intense cold. Their interest was to discover more laws of nature – to find and explain any changes in behaviour that did not fit the existing theory.

This time it is the art of engineering that is foremost.

There is naturally, a lapse of time before applied scientists, engineers and technologists start to use new principles discovered by pure scientists. In the case of low temperature physics, many years passed. It is only in the last two decades that the use of superconducting effects have been considered for large-scale technological applications. There are many explanatory factors for this delay.

Onnes discovered superconductivity in 1911, but at that time the need for its modern uses was not so apparent, nor had low-temperature techniques advanced sufficiently for designers seriously to consider using them in day-to-day practice. An application must wait for suitable economic conditions – the costs of development, building and running the new way must be less than the old – it is, therefore, not surprising that superconductivity has only recently emerged from the science laboratory.

Cryogenics is the technology concerned with providing and applying low temperature devices working below 200K (73°C of Cold). Superconductivity is part of cryogenics, and is the most striking phenomena, but the use of cryogenic methods, in general, has enhanced the quality of many disciplines without the exploitation of superconductivity.

CRYOGENIC APPLICATIONS

Separation of Gases

The need for oxygen as an industrial commodity has steadily increased – from comparatively nil in 1900 to literally millions of cubic metres in 1973. Qther gases stored and transported as liquids in large industrial quantities include nitrogen, helium, methane, acetylene and hydrogen.

British road regulations limit tanker sizes to the liquid equivalent of 10 000 cubic metres capacity, but larger units are permitted in other countries. Methane storage plants of 2 000 000 cubic metres have been built. Today oxygen liquefier plants can produce 100 tonnes of liquid gas per day.

It was in 1956 that the first British plant capable of producing several tonnes of liquid oxygen per hour was built. Today the capacities available have been increased tenfold. Smaller plants of different design are used to separate the rare gases from the air (argon, krypton, xenon, helium and neon). In the oxygen plants, the air is first compressed to six atmospheres and cooled by water sprays. It is then reduced in temperature, by heat extracting refrigerators, to 100K. This cold air has two fractions, one rich in oxygen and heavy, the other rich in nitrogen and light. They are subsequently separated in a column as gases, with liquid oxygen also being available. (More details of the processes used are to be found in "Low-Temperature Techniques" by Din and Cockett, Newnes 1960).

It can be seen that the technological ability to produce large quantities of liquid gas is now highly developed enabling the use of cryogenic techniques to be seriously considered in a big way.

Measurement of Material Properties

Application of cryogenic techniques requires knowledge of the behaviour of materials at the temperature proposed. For example, stainless steel must be used for the inner wall of cryogenic containers as mild steel becomes too brittle. In the superconducting region (below 20K) there is need for more data on materials. At CERN, for example, a test facility has been built to test the tensile strength, to 8000 kg, of superconducting material whilst it is carrying 12 000 amps in a magnetic field of six Tesla. (60kG). In Fig. 1. a member of the Southampton University of Cryogenics Group is shown working on the measurement of the specific heat of solids in the superconducting region.

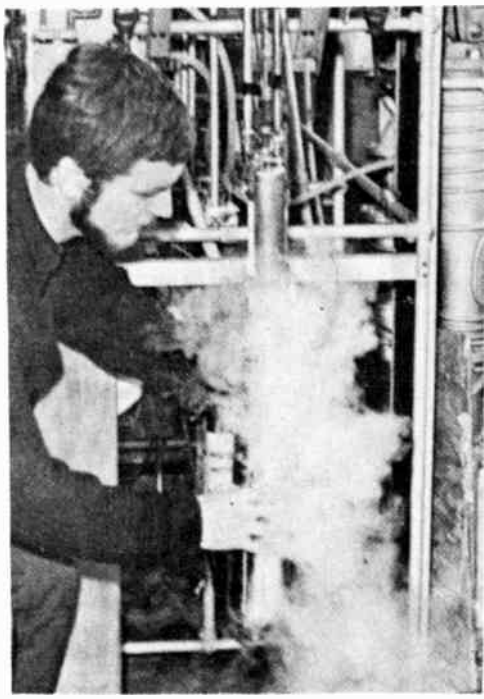

Fig. 1. Cryogenic research equipment in use at the University of Southampton.

Infrared Detection Systems

The detectivity of many infrared detector elements can be enhanced by cooling them to varying degrees of coldness, as shown by the curves given in Fig. 2. Cooling also enables a different response peak to be obtained. Generally, but not always so, the cooler the element the higher the detectivity. Cold shields are also used to limit the field of view: the detector sees a virtually non-radiant surface away from the viewing aperture.

Elements needing cooling range in

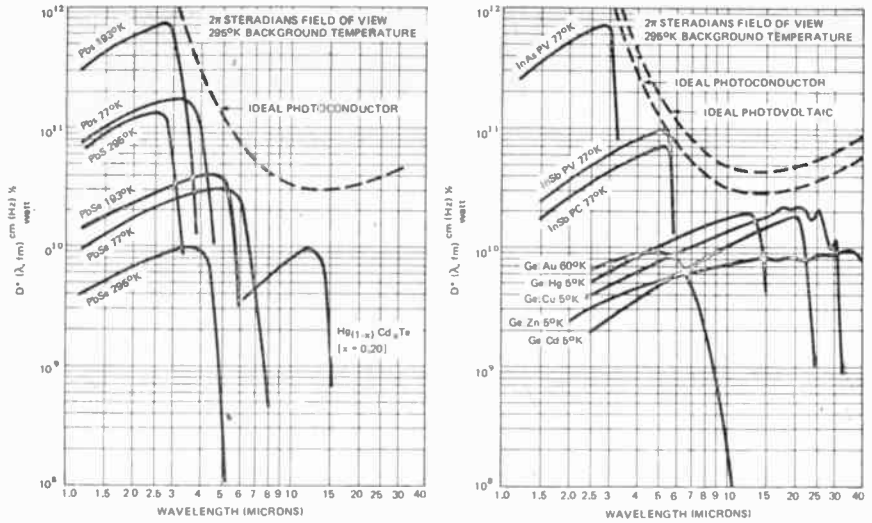

Fig. 2. Sensitivity of infrared detectors depends upon the temperature of the element as shown by these curves of Santa Barbara Research Centre (SBRC) devices.

size from 0.05mm to 10mm. Because of the convenience they are used at temperatures of commonly available liquid gases. To keep the detector cool for considerable periods, (the hold or dwell time) it is mounted in close thermal contact with one of a number of cooling methods.

For laboratory work a special glass dewar is satisfactory: they come in many shapes and sizes. In the one illustrated in Fig. 3a, liquid nitrogen will hold the detector at 77K for four hours. Metal dewars are also made with similar hold times. Larger units like that shown in Fig. 3b can hold at 5K (liquid helium) for 12 hours.

Longer hold times in small dewars can be achieved by maintaining the liquid gas level with a transfer system. That shown in Fig. 4a uses nitrogen (stored in the cylinder) to provide

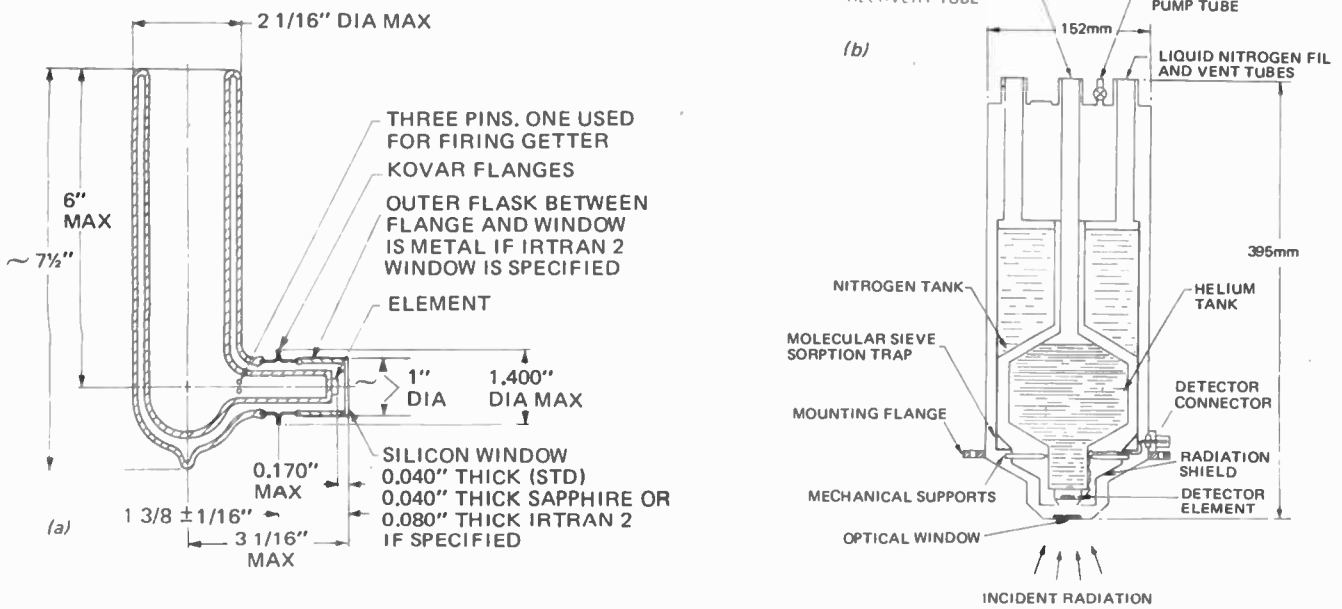

Fig. 3. Dewars used to cool infrared detectors: (a) A style 60A glass dewar made by SBRC. (b) Cross section of a Mullard stainless steel unit using helium.

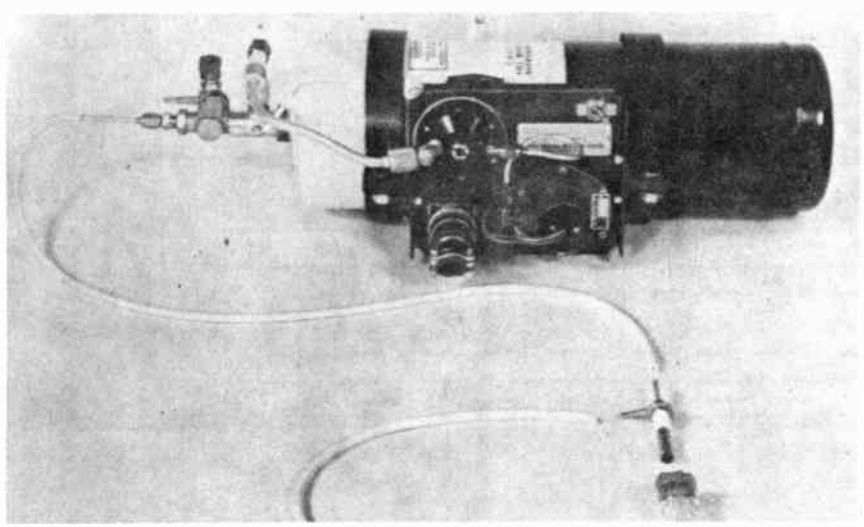

Fig. 4(a) Liquid nitrogen transfer system of SBRC. The standby time is 60 hr enabling a detector to be used virtually on demand.

cooling for eight hours. Alternatively a cryostat cooled by the Joule-Thomson principle can be inserted into the dewar. Compressed gas is fed to the cooling head, (one is shown in Fig. 4b) and expansion cools the body to the liquid gas temperature. The helical coils are the heat transfer link between the body and the contents of the dewar.

Thermo-electric coolers, using the Peltier effect, are also used to cool detectors, but only where moderate cooling is needed. They are able to provide up to 80 degrees of cold.

Medical Applications

Some medical operations require a device that can destroy a specific area of tissue on a very localised basis. In the treatment of Parkinsons disease a cluster of brain cells must be

cauterized; the removal of tumours is another example where an intensive burning probe is required. Radio frequency heating is one way to destroy cells but intense cold can also perform the task.

A probe, designed for neurological operations is shown in Fig. 5a. High-pressure nitrous oxide loses pressure in the orifice, producing cooling at the tip. This cryosurgical instrument will stay at -180°C when immersed in water. The same company also manufactures a urilogical probe for the removal of tumours. To obtain a greater degree of cooling, liquid nitrogen is used in this probe. The nitrogen (see Fig. 5b) is contained under pressure in the dewar flask. A solenoid valve controls the flow through the tip. This system will hold the probe of the unit at -180°C in tissue. A miniature heater is provided in the tip for rapid defrosting.

Heat Pipes and Switches

The concept of transferring energy via pipes is common in hydraulic engineering. The same idea can be used in heat transfer. A simple way to conduct heat is to use a solid copper (or silver) rod with one end at the source and the other at the sink. There is, however, a better device called a heat pipe. This can be as much as 500 times more efficient than a solid rod. A cross section of one is shown in Fig. 6. The tube has an outer capillary structure that acts as a wick. Inside this is a vapour space. In the evaporater section the heat input from the component to be cooled vaporises the fluid in the wick. This vapour automatically flows back to the other end where it condenses. A typical pipe might be 10mm across and 300mm long. The concept works at all

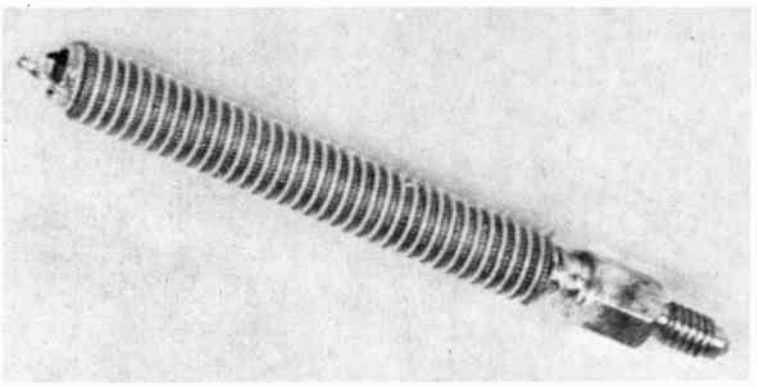

Fig. 4(b) A Joule-Thomson cryostat head. Cooling is by pressure release of argon or nitrogen gas.

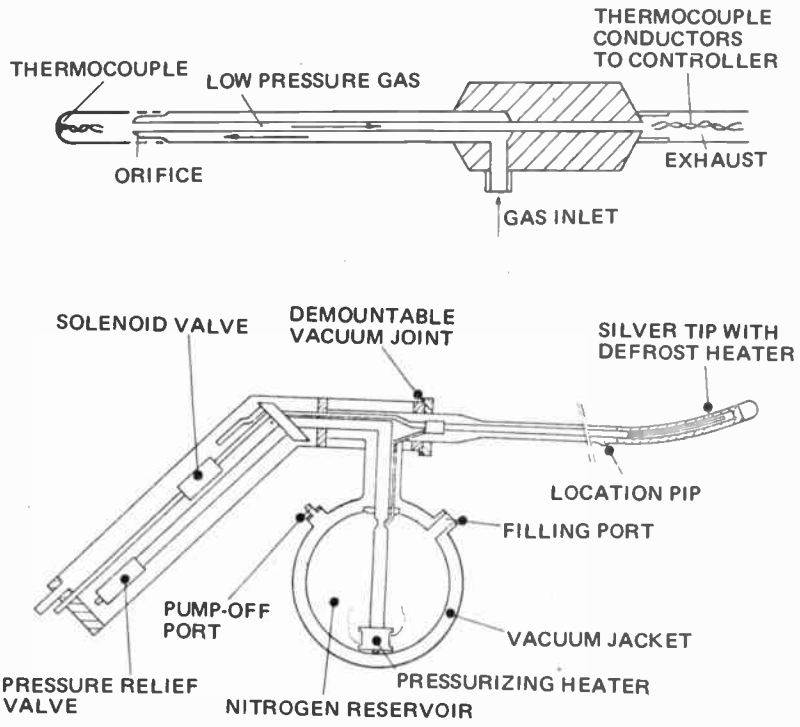

Fig. 5. Cryosurgical instruments by Spembly Products: (a) Neurological probe having a small active volume. (b) Urological probe for the removal of tumours.

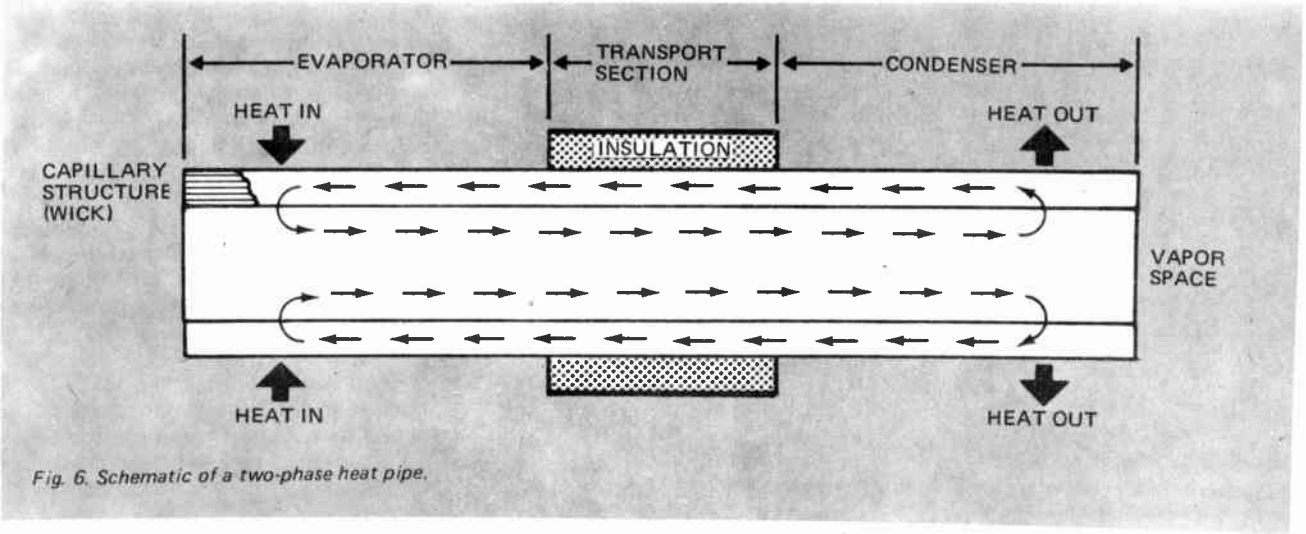

Fig. 6. Schematic of a two-phase heat pipe.

temperatures and cryogenic versions have been studied at the Goddard Space Centre for cooling detectors mounted remote from the central cooling unit.

In many cryogenic experiments it is necessary rapidly to isolate the stages of a cascaded cooling arrangement. Thermal switches have been proposed to do this. One form uses a conducting rod in a tube immersed in a lubricant of liquid helium. Pulling the rod up into the hotter end changes the thermal conductivity of the thermal path. Another switch makes use of the significant change in thermal conductivity of a superconductor when it changes from superconducting to the normal state. Altering the temperature of the field intensity will switch the rate of heat conduction.

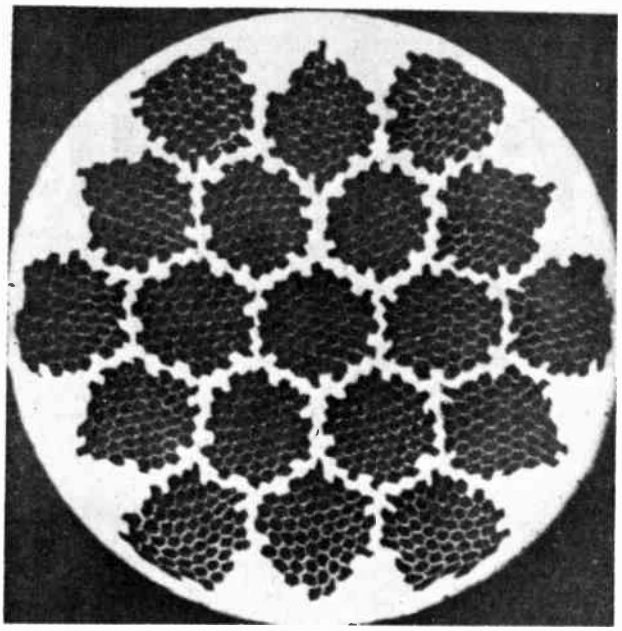

Fig. 7. Cross section of Imperial Metals Industries superconducting cable. It has 1045 filaments held in a copper matrix.

APPLICATIONS OF SUPERCONDUCTIVITY

Applications of superconductivity mainly exist where lossless current flow is an advantage. There are, however, others that make use of the altered physics of the conductor lattice.

Power Transmission

With few exceptions electric power is transmitted as an alternating current at high voltage. Transformers enable extra high voltages to be used on the lines with a proportional drop in the current carrying capacity needed. As power losses in a conductor are proportional to the square of the current flowing, the lowered amperages result in great cost savings. Voltages in the megavolt region are, however, quite unsuited for industrial and domestic use, so transformers are used to lower the voltage again. Now, new developments in efficient solid-state inverters and converters have stimulated considerable research into the use of extra-high voltage dc systems, as well as the ac method.

If cable had no resistance, there could be no losses, and thus current density could be high. Hence a smaller area of conductor could be used. Superconducting cables offer this feature. At present the location of a power station is largely decided by the line losses of the distribution network — these can amount to as much as 50% of the generated power. Lossless lines would enable the power stations to be located in remote areas. In the United States, the Tennessee Valley Power Authority recently started a research programme to test extra high voltage underground superconducting power lines. Their commonplace use will, however, be a while yet, for there are many practical problems to be overcome.

In all heavy-power applications the need is for mechanically strong, easy to manufacture cables that have a large degree of superconducting stability. (The field produced by the current flow, if too great, can turn the cable back to a normal conductor.) It is, therefore, obvious that a fault on the line could potentially vaporize the conductor unless protective measures are incorporated. To reduce this disadvantage, the superconducting filaments (they are fine to enable large field strengths to exist without destroying superconduction) are bonded to a heat and electrical conducting matrix such as copper. A cross-section of a multi- filament composite cable is shown in Fig. 7. Each filament is of niobium-tin sheathed in cupro- nickel.

Ensuring the supply of liquid helium is another major problem. Hell, the superfluid form of helium is preferred, as its thermal conductivity is thousands of times greater than copper. At present refrigeration plant is most inefficient; around 1kW of energy input is needed to produce 1W of cooling at liquid helium temperature (4.2K). The weights of the units are approximately 140 kg/watt. Well designed insulation methods fortunately gain very little heat, so the cooling load is small.

High-Field Magnets in Power Generation.

The problems discussed above apply equally well to the design of high field strength magnets, but solutions have been forthcoming and electromagnets of superstrength have been made using superconducting coils. Important heavy engineering applications are in power generation, nuclear research plants, motors and in vehicle suspension proposals.

Electric power is generated by using an energy source to move conductors across a magnetic field. The more intense the field, the greater the output power that is available. The limit in ac generation is more or less set at machines in the 1000 MW region. One way to improve efficiency is further to increase the size of the generator but manufacturing and transport difficulties have imposed limits.

Although the excitation of the field in a generator consumes only a small proportion of the output, the use of superconducting field-coils can reduce this loss, boosting the machine efficiency by about 1%. (99.6% compared with the present 98.6% is the estimate given by Westinghouse). Even this small improvement represents a saving of \$200 10^6 per annum in the output of a large machine so it is worthwhile.

There is talk of 2500MW machines using superconducting windings but to date prototypes of only 5MW are being tested (see Fig. 8.). Weight may also be reduced by as much as one half.

Superconducting dc machines are also being investigated. Applications include a 1MW naval motor-generator set, and industrial generators for smelting, plating and electrolysis plants. It is predicted that superconducting machines will be used in ships during this decade, and in power-stations in the next.

Magnetic Suspension Systems

High-speed trains have been developed that run on air cushion suspensions. Equally viable, but less promoted are the maglev, (magnetic-levitation) suspension schemes. These make effective use of

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Cryogenics and superconductivity

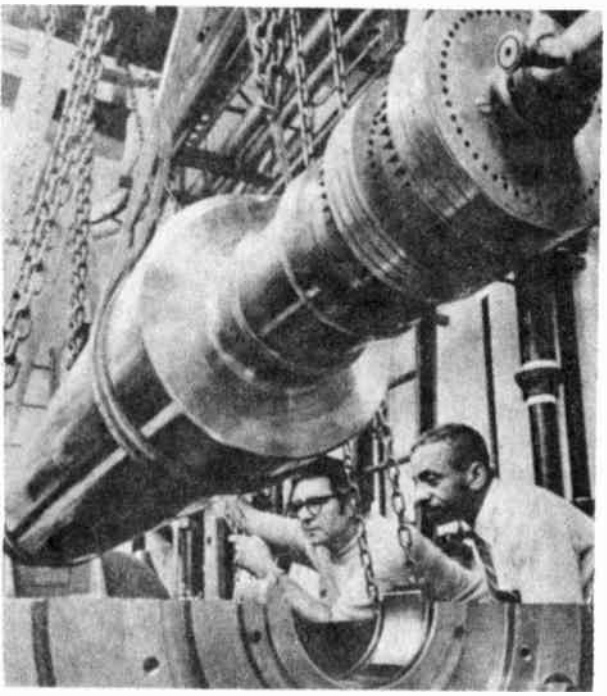
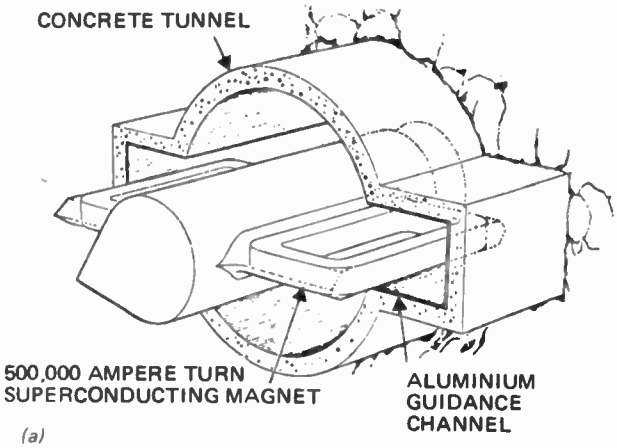


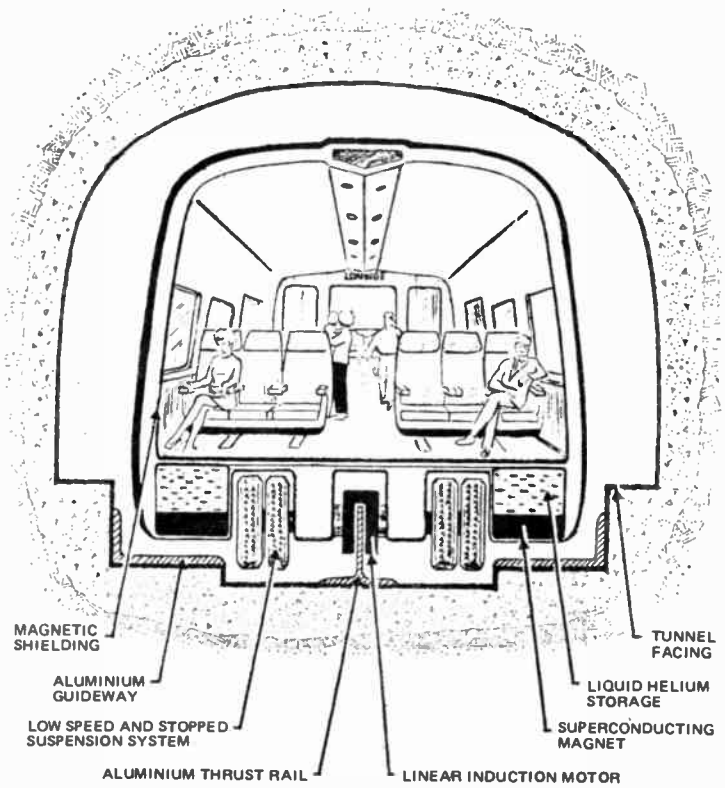
Fig. 8. Prototype 5MW superconducting rotor of a power generator made by Westinghouse.

superconducting field-coils to provide the lift needed. The principle of maglev is simple to demonstrate. If a permanent (or electric) magnet is moved across the surface of a good electrical conductor such as aluminium, it will be repelled by the field created by currents induced in the sheet. (It is as though there is an identical bipole magnet below the sheet that is interacting with the source magnet.) The faster the relative velocity the greater the lift.

Full-size vehicles using normal magnets have been built to demonstrate the maglev principle, but the probable cost savings of superconducting magnets cannot be overlooked for future transport systems. Superconducting magnets allow a higher field strength to be used and this ensures greater clearance for a given speed. In turn, the track tolerances can be relaxed, cutting costs. Another advantage is that a superconducting field cannot collapse at speed so a fault would lower the vehicle gently onto auxilliary wheels installed for such a purpose.

A number of vehicular ideas are being tried, see Fig. 9. Various institutions such as the Siemens Research Centre in Germany, the Cryogenic Group of the University of Warwick in England, Sandia Laboratories in New Mexico and the





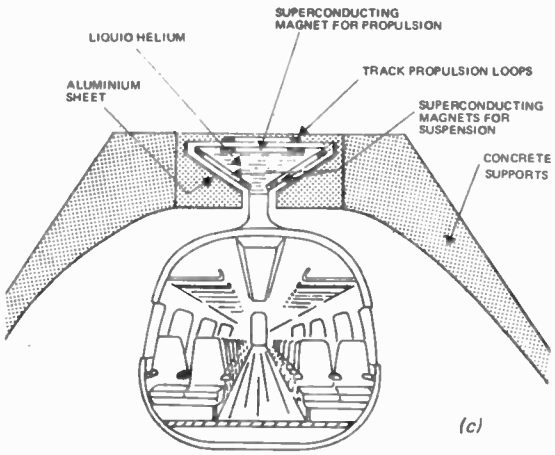


Fig. 9. Superconducting suspension arrangements of proposed maglev vehicles. (a) A high-speed rocket at 5000 m/s. (b) The Stanford concept for a 600 km/hr train. (c) University of Warwick proposal.

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Cryogenics and superconductivity

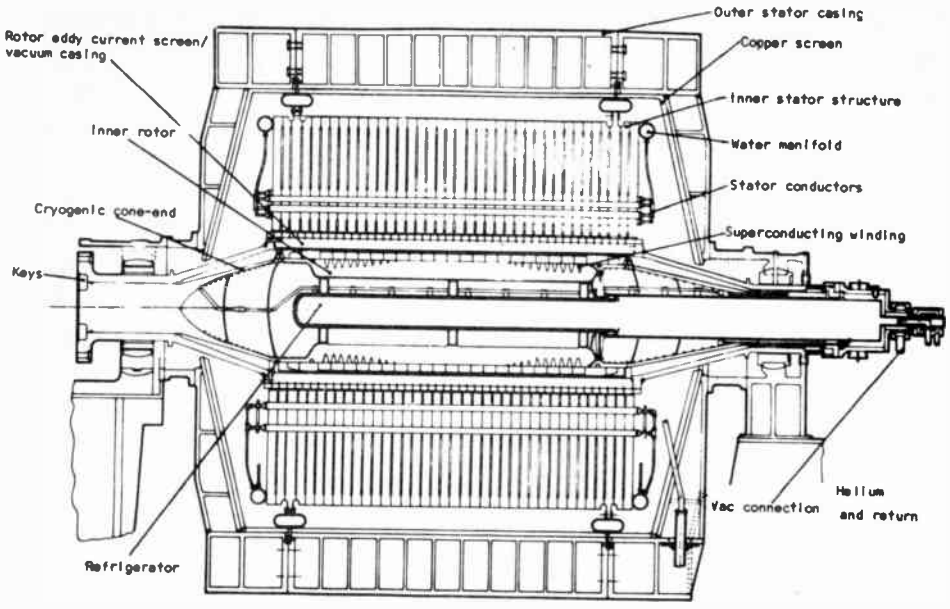
Stanford Research Institute in California are concerned with maglev vehicles.

Other uses of superconducting magents include magnetic field "crucibles" to contain extreme temperature plasmas (ionised gases) without a physical container, frictionless bearings in gyroscopes, suspension of a gravity meter mass, and in nuclear accelerators. At present, the normal magnet designs in such accelerators need magnet ring diameters of hundreds of metres. Superconducting magnets will reduce this size and enhance the resolution.

The advantage of superconducting derived suspension in instruments is that the persistent currents are less susceptible to external noise and an improved signal/noise ratio is obtained. In the superconducting gravity meter a 25.4mm diameter superconducting ball is suspended between the fields of two loops. The vertical position of the ball is sensed with capacitance micrometry. Drift of this instrument is of the order of parts in 10^{10} per day. A cross-section of the superconducting gravity meter installation is given in Fig. 10.

Superconducting loops are not perfect-joins and ac currents waste some of the energy – so with time the current decays and the magnet loses strength. It will be necessary in continuous-use applications to charge up the field periodically. Flux pumps are one possible way to do this. If a superconducting loop is made smaller, the same total magnetic flux must move into the smaller area presented by the loop. The field strength therefore rises. A simple way to achieve flux pumping is to successively slide shorting bars along a U-shaped loop. Each stroke will add more flux to the end of the loop. The limit is reached when the field begins to degrade the superconductivity.

So much for the power applications of superconductivity. Now considered are devices making use of superconductivity in other ways.



500 MW superconducting AC generator designed at IRD.

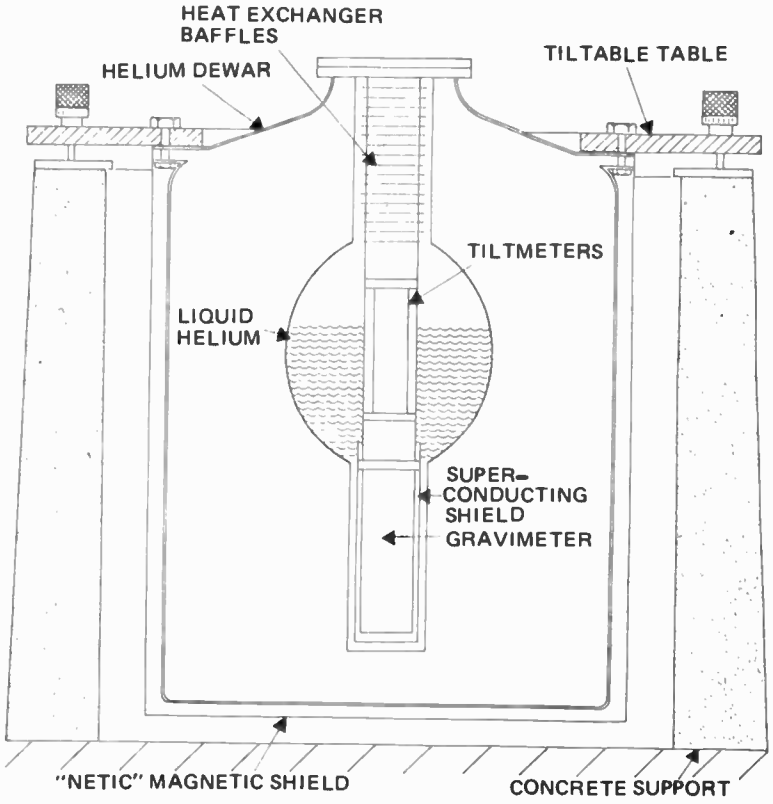


Fig. 10. Cross-section of a superconducting gravity meter installation. The tilt meters are used to correct records for inclination.

Computer Logic

In 1956 Buck invented the Cryoton computer logic element. This is a miniature superconducting switch that can be triggered by passing a control current through it. It consisted of a 0.25mm diameter tantalum wire with a 0.1mm diameter niobium wire wound around it. Field provided by the niobium wire is used to quench the superconductivity of the other, both wires being normally superconducting. The important feature of the Cryoton is that it consumes no power in its normal state. Speed is limited by the inductance-resistance time constant to about 10^{-5} sec in the wire-wound version. This is rather too slow for computer logic so research workers have developed deposited layer equivalents that can switch in 10^{-9} sec. The basic switch can be compounded to perform more complex logic.

A current induced in a superconducting loop persists without the need to supply energy. It is therefore, capable of acting as a memory element in a computer. These have also been developed. One cell that has found favour is the Crowe cell shown in Fig. 11. A drive wire is used to establish the current. The sense wire is used to interrogate whether there is, or is not, a current flowing, this determining the state of the memory bit.

Concluded on page 47

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Syntron	Surge Stop	SD1544 - -	SD2650 - -	SD2411 - -	SD2452 - -
Sarkes Tarzian	Klip Volt	2KV26 - - -	5KV26 - - -	7KV26 - - -	10KV26

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Cryogenics and superconductivity

Superconductivity and Standards Metrology

In 1962, Josephson, at Cambridge University, predicted that an alternating current would flow between weakly connected superconductors. This is known as a dc supercurrent. The significance of the effect to standards determination is that the frequency of this supercurrent is proportional only to the voltage across the junction, the constant of proportionality being the basic physical ratio 2e/h (e is the electron change, h is Planck's constant). Experiment has shown that the relationship holds to at least a part in 10^7. Another discovery was that the voltage-current relationship for such a junction is a series of steps when the junction is irradiated by microwaves. The steps occur at certain integral ratios of the supercurrent frequency and the irradiating frequency.

This effect is able to provide a new way to define voltage that will eventually overshadow the Weston standard cells used at present. An added advantage of the method is that the voltage function occurs as a frequency that is easier to measure than an analog voltage level. This constant has been measured by various groups in relation to the standard-cell voltage definition and is 483.59 megahertz/microvolt.

Assuming the voltage standard is satisfactory, the junction can be used to determine the e/h ratio with a precision 20 times better than that obtained by X-ray measurements used prior to this discovery.

In some determinations, at the National Standards Laboratory in Sydney for instance, a point contact junction is formed within a cryostat by moving a niobium point away from a niobium block. A junction holder is shown in Fig. 12a. The holder is mounted in the end of X-band waveguide that is cooled to liquid helium temperature. The characteristic voltage- current curve obtained is shown in Fig. 12b. Experiment has shown that the temperature used matters little – results at 2.2K and 4.2K are identical.

The Josephson effect is an excellent example of how the realisation of radically new and highly useful techniques can often result from the tireless pursuit of pure science having no immediate purpose or intention.

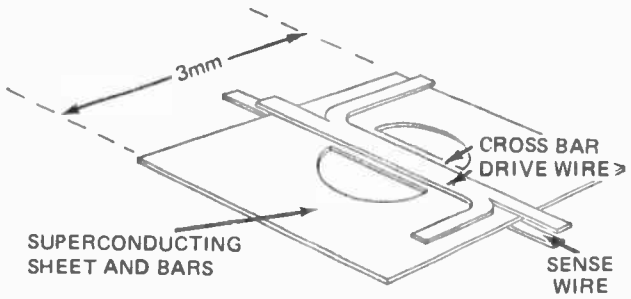


Fig. 11. The Crowe superconducting memory cell. The main disc is lead and all elements are superconductors.

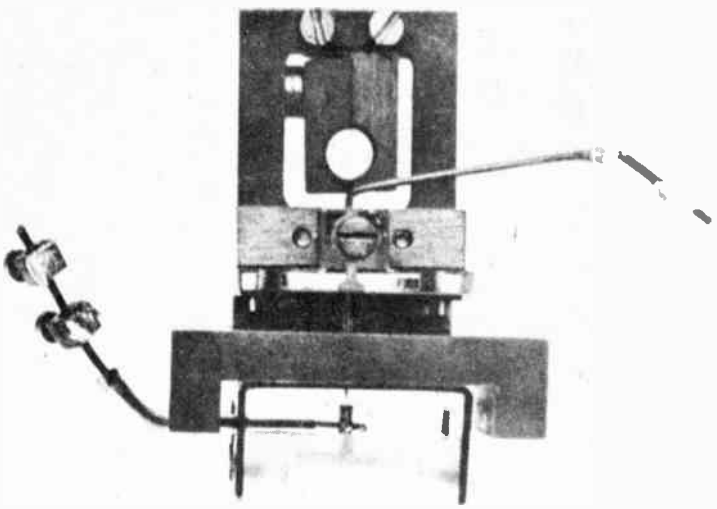
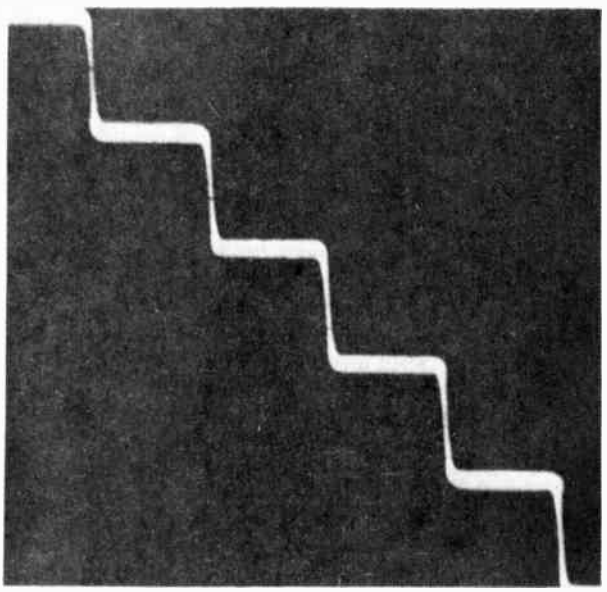


Fig. 12 (a) This niobium point contact is used at the NSL to determine emf by the ac Josephson method. (b) Voltage-current signal at 1mV levels.



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Santa Barbara Research Centre, Goleta, California, USA. (Detectors and instrument cryostats).

"Magnetic Suspension for High Speed Trains" R. G. Rhodes and A. R. Eastham, Hovering Craft and Hydrofoil, 1971, 11.

"High-Powered Future for Cold Generators" New Scientist, 1972, 54, p.564.

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"Earth-Tide Measurements with a Superconducting Gravity Meter"
W. A. Prothero and J. M. Goodkind, Jnl. Geophys. Res. 1972, 77, 926-937. (See also Rev. Sci. Instrum. 1968, 39, 1257-1262 for instrument descriptions).

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I. K. Harvey et alia, Metrologia, 1972, 8, 114-124.

electronics TODAY INTERNATIONAL
product test

Teac R740 professional tape recorder

Modular unit may be assembled to suit individual needs.

THE TEAC Corporation of Japan formed TEAC Audio in early 1972 and began production that same year. Previously both professional and domestic TEAC equipment was manufactured by the TEAC (Tokyo Electroacoustics Company Ltd.) Corporation which started approximately nine years ago.

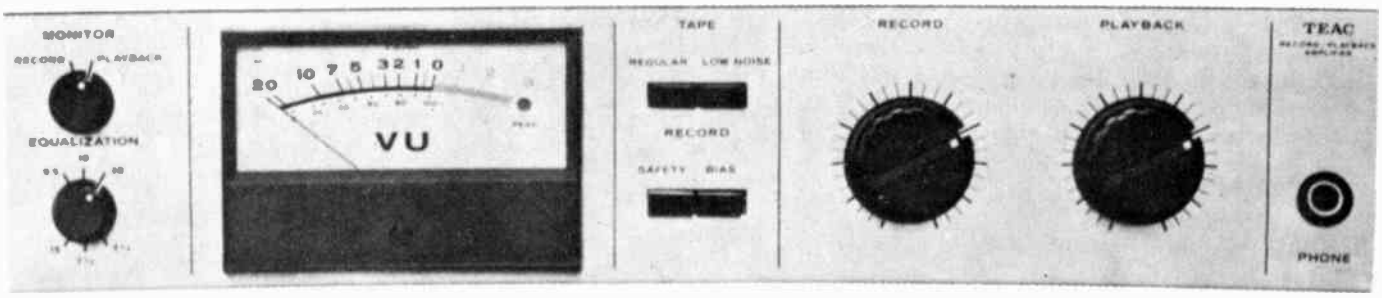
TEAC Audio together with TASCAM (TEAC Audio Systems Corporation of America), an American subsidiary, were founded for the purpose of providing a complete range of professional sound equipment for use in broadcast stations and recording studios. At present they are manufacturing three series of tape recorders, Series 50 – up to four track configuration on ¼" tape; Series 70 – up to four track configuration on ½" tape and Series 80 – up to four track configuration on ¼" tape, together with options such as console cabinets, remote controls and simul-sync. As well as recording equipment they also market mixing consoles with up to twelve channels in and four channels out, and shortly envisage manufacturing such accessories as limitors, suppressors, amplifiers and Dolby Noise Reduction units.

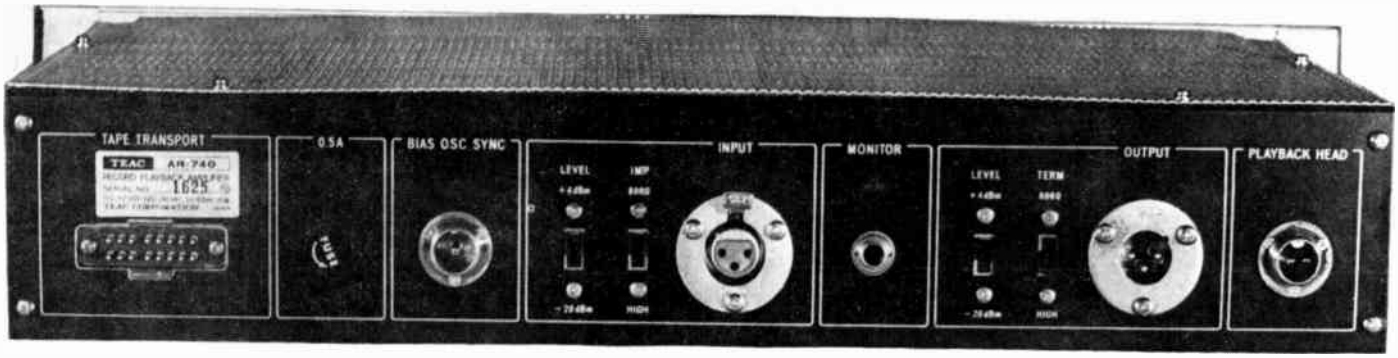
The TEAC R740 reviewed in this article is one of the Series 80 range. It is supplied as separate modules consisting of the transport model RD700 and two separate record/playback amplifiers model AR740 to allow the customer freedom of mounting. All interconnecting cables are supplied with the units and are each one metre long.

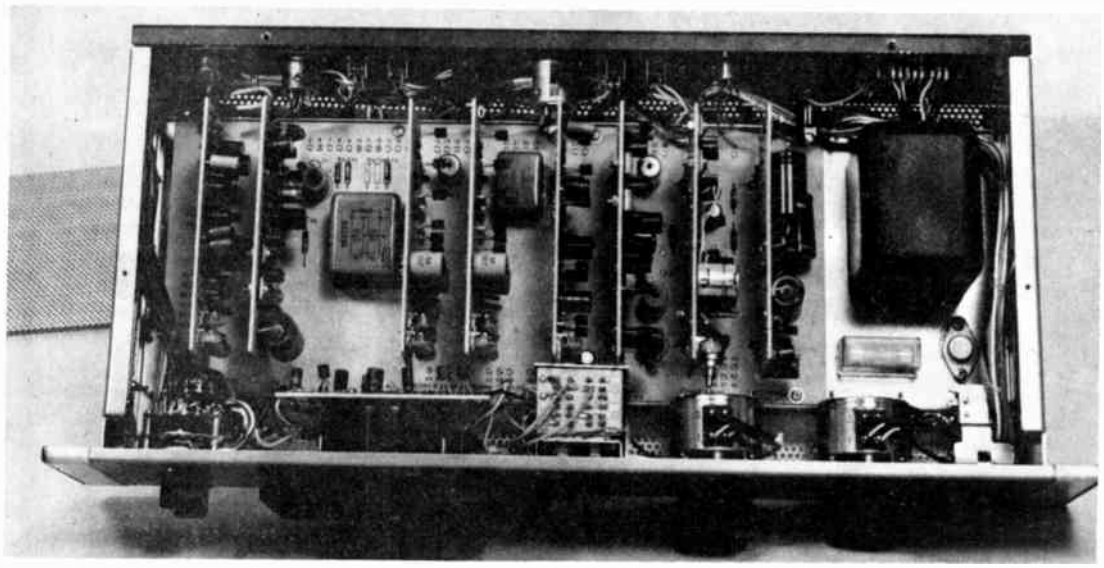
The tape transport arrived mounted in an oiled timber carrying case intended only to protect the unit against damage in transit. If anything the finish on this case was better than some permanent timber cabinets that we have seen!

MECHANICAL CONSTRUCTION

The front panel on which all the transport components are mounted is constructed from a single sheet of ¼" steel plate faced with a polished stainless steel plate. The bottom 10 cm is finished with a matt black panel containing all the control switches.







The large reel hubs, which are located at the top of the panel are mounted directly onto the two six-pole eddy current motors. Below the left hand reel hub is:

i) a tape tension arm
ii) a large impedance roller with a very heavy flywheel mounted on the rear. The solid flywheel measured approximately 12 cm diameter by 2.5 cm thick.
iii) a resettable four figure index counter.

The four high-density ferrite heads, which on this model consist of a half track erase head, a half track record head, a half track playback head and a quarter track playback head, are all located under a large matt black cover. A metal strip across the top of the cover has the TEAC name on the left hand end and a two position switch mounted at right hand end for half track or quarter track playback head selection. Just to the right of the head assembly is the capstan and pinch roller. The capstan is fitted with a removable sleeve for 9.5 cm/sec operation and a large pinch roller is supplied to match the smaller capstan shaft. A second tape tension arm with cut-off switch is located directly below the right hand reel hub.

The switch panel provides the following facilities:—

a) power on-off toggle switch.
b) large or small reel tape tension-select toggle switch.
c) high or low motor speed toggle switch.
d) cueing lever for monitoring during fast forward or rewind.
e) edit microswitch, which when used in conjunction with the play switch, allows the tape to be spooled off to the required editing or splicing point.
f) fast rewind microswitch.
g) fast forward microswitch.
h) stop microswitch.
i) play microswitch.
j) record interlock microswitch.

A raised brushed aluminium strip below the switches is engraved with the function of each switch. Symbols only are used for the rewind, fast forward, stop and play. When the edit function is selected, a small green bezel mounted in the aluminium strip is illuminated. Similarly a small red bezel in the aluminium strip below the record button is illuminated when the record mode is selected.

The record replay amplifiers are mounted in standard 19" rack modules 482mm long by 88mm high by 246mm deep. The brushed stainless steel front panel is engraved in black lettering and finished off at each end with black edging strips. The controls on the front panel are from left to right:

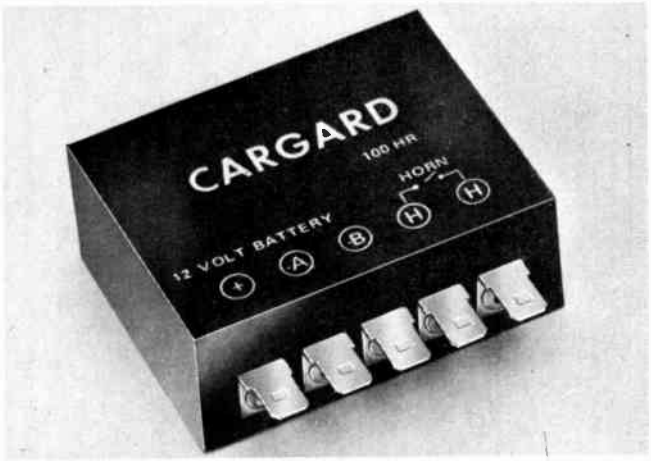
a) a monitor select switch with record and playback positions.
b) an equalization switch mounted directly below the monitor switch with three positions for 38 cm/sec and 9.5 cm/sec.
c) a large VU meter accurately calibrated at +3, +2, +1, 0, −1, −2, −3, −4, −5, −6, −7, −10 and −20.
d) two push buttons for "regular" or "low noise" equalization.
e) two push buttons mounted directly below the tape equalization push buttons to provide an electronic interlock for recording. One button is marked safety and the other bias. When the safety switch is in it is impossible to put the deck into the record mode. Pressing the bias button puts the deck in the recording standby mode and illuminates a small indicator above the button.
f) stepped record level potentiometer with thirty 1dB steps.
g) stepped playback level potentiometer with thirty 1dB steps.
h) tip and sleeve headphone sockets for monitoring the record signal or playback signal.

All of the input and output sockets are mounted on the back panel. These consist of:—

a) a Cannon type input socket with two switches, one for input level

CAR BURGLAR ALARM*

* Aust Patent 34882/71



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selection of +4dBm or −20dBm, and the other for impedance matching for 600 Ω balanced or 10KΩ balanced input.

b) tip and sleeve monitor output for driving a small monitor amplifier (−4dB, 10kΩ or higher unbalanced).

c) a Cannon type output socket with two switches providing output level selection and output impedance matching; the same as the input socket.

A separate 0.5 amp fuse is also fitted in each amplifier as well as the three amp AC fuse and the two amp DC fuse fitted to the deck. Interconnecting cables between the deck and the amplifiers consist of two multicore cables carrying power wires, control wires and record signal wires, a bias synchronizing cable between the two amplifiers to eliminate possible beating, and two playback signal cables between deck and the amplifiers.

One other multipin plug on the deck is for the ER-340 remote control unit which provides parallel facilities with the controls on the deck for rewing, fast forward, stop, play, and record.

The record button is protected by an aluminium ring and must be pressed with the play button to obtain the record mode, provided the bias buttons on the amplifiers have been pressed. This feature proved extremely useful when dubbing from this tape recorder to another, or vice versa. We also found it very useful for analysing data which had been recorded on magnetic tape in the field.

A 27 page instructional manual and a 70 page service manual are supplied. These are most comprehensive and include printed circuit board drawings and parts lists — 36 pages including 11 pages of exploded views of the deck.

Both the deck and the amplifiers were extremely well constructed. Six-pole eddy current motors were used for the reel drives and a four-pole/eight-pole hysteresis synchronous motor for the capstan drive. The power transformer and associated equipment were mounted at the top of the deck.

The printed circuit boards in the amplifiers were the best we have ever seen in terms of layout, ruggedness, and component identification. Tape equalization could be easily changed or adjusted by hinging down the front panel of the amplifiers, with the unit still mounted in the rack, to provide easy access to all of the boards for adjustments or service.

MEASURED PERFORMANCE

The measured performance was well within specification and agreed very closely with the calibration certificate supplied with the recorder.

(Continued on page 53)

MEASURED PERFORMANCE OF TEAC R740 PROFESSIONAL TAPEDECK SERIAL No.1625

Frequency Response

		OVU	−10VU
Scotch 200	38 cm/sec	30Hz to 26kHz ± 3dB	30Hz to 27kHz ± 3dB
	19 cm/sec	25Hz to 17kHz ± 3dB	25Hz to 22kHz ± 3dB
	9.5 cm/sec	25Hz to 6.5kHz ± 3dB	25Hz to 9kHz ± 3dB
BASF LP352H	38 cm/sec	30Hz to 27kHz ± 3dB	30Hz to 28kHz ± 3dB
	19 cm/sec	27Hz to 18kHz ± 3dB	26Hz to 21kHz ± 3dB
	9.5 cm/sec	27Hz to 7kHz ± 3dB	26Hz to 9.7kHz ± 3dB
TDK SD150H	38 cm/sec	30Hz to 28kHz ± 3dB	30Hz to 29kHz ± 3dB
	19 cm/sec	27Hz to 18kHz ± 3dB	26Hz to 23kHz ± 3dB
	9.5 cm/sec	27Hz to 7.5kHz ± 3dB	26Hz to 10.5kHz ± 3dB

Replay Equalization at 19 cm/sec with Respect to DIN Calibration Tape

Frequency Hz	Error dB
31.5	−1
40	−2
63	+2.5
125	+1
250	+1.0
500	+0.5
1k	0
2k	0
4k	+0.5
6.3k	+1.0
8k	0
10k	−1
12.5k	−1
14k	−2
16k	−3
18k	−3

Total Harmonic Distortion

	100Hz	1kHz	6kHz
+16dBm	4%	4%	4.5%
OVU	0.4%	1.0%	1.5%
−10VU	0.2%	0.3%	0.3%

Intermodulation Distortion 1kHz and 960Hz

OVU	−10VU
0.3%	0.1%

Tape Flux at OVU with Record and Playback Lever Controls Set at −9.
185 pWb/mm

Erase Ratio for 1kHz Signal Prerecorded at OVU (185 pWb/mm)
−74dB

Cross-talk OVU

100Hz	1kHz	10kHz
59dB	58dB	62dB

Wow and Flutter % RMS

38 cm/sec	19 cm/sec	9.5 cm/sec
0.1%	0.2%	0.2%

Signal to Noise Ratio re 1kHz OVU (185 pWb/mm Tape Flux)
Add 4.7dB for Correlation to Standard Tape Flux Reference of 320 pWb/mm)

	38 cm/sec	19 cm/sec	9.5 cm/sec
Unweighted	60dB	58dB	58dB
'A' Weighted	66dB	66dB	66dB

Speed Error Record to Replay

38 cm/sec	19 cm/sec	9.5 cm/sec
−0.15%	−0.05%	−0.1%

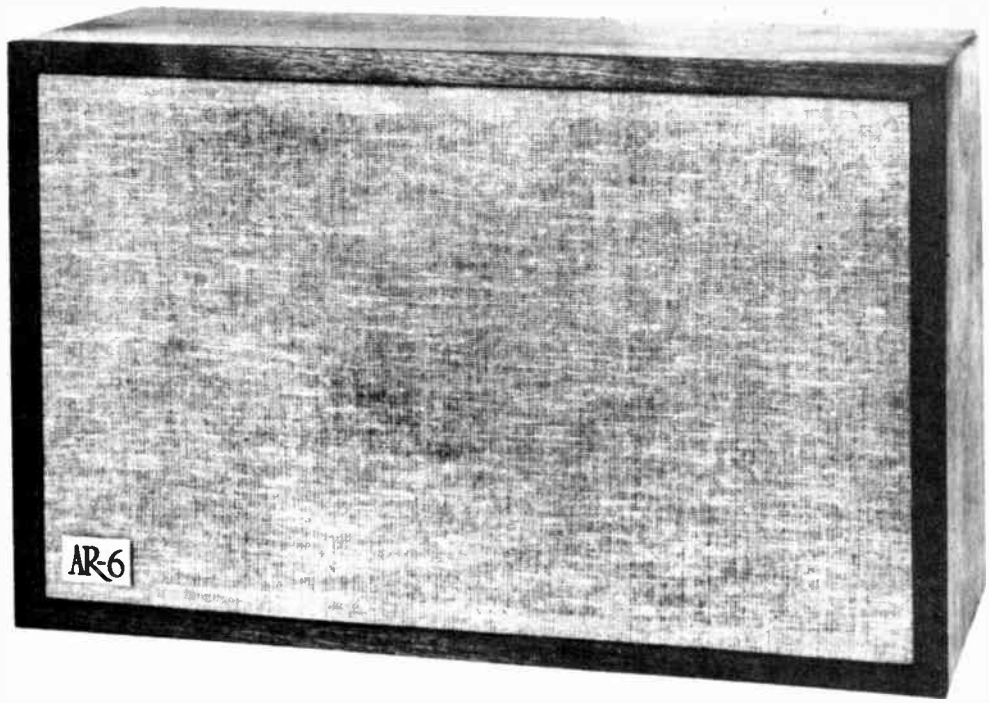
Line Input Sensitivity for OVU (Record & Playback level controls set at −9)

+4dBm	Setting	+3.85dBm
−20dBm	Setting	−20.2dBm

Line Output Sensitivity for OVU (Record & Playback level controls set at −9)

+4dBm	Setting	+4.00dBm
−20dBm	Setting	−20.1dBm

The AR-6 speaker system from Acoustic Research.



The least expensive speaker sold by AR (the AR-4x at $132) is also the most widely sold of all high-fidelity speakers, because it has provided maximum performance per dollar of cost. The new AR-6 offers significantly better performance for $180. It adds one-third octave of low distortion bass, and also provides superior dispersion and more uniform energy output at high frequencies. The seven inch depth of the AR-6 adapts it ideally to shelf placement, or it may be mounted directly on a wall with the fittings supplied with each speaker system.

Stereo Review says . . .

"All in all, the AR-6 acquitted itself very well in our tests. It was not quite the equal of the much more expensive AR models, whose sound it nevertheless resembles to an amazing degree, but on the other hand it out-performed a number of considerably larger and far more expensive systems we have tested in the same way. Incidentally, the AR-6 shares the AR characteristic of not delivering any bass output unless the programme material calls for it. If at first hearing it seems to sound "thin" (because it lacks false bass resonances), play something with real bass content and convince yourself otherwise. We don't know of many speakers with as good a balance in overall response, and nothing in its size or price class has as good a bass end."

High Fidelity says . . .

"Another great bookshelf speaker from AR . . . a really terrific performer. The AR-6 has a clean, uncoloured, well-balanced response that delivers some of the most natural musical sound yet heard from anything in its size/price class, and which indeed rivals that heard from speakers costing significantly more . . .

The response curves taken at CBS Labs tell a good part of the story. Note that across the largest portion of the audio spectrum and especially through the midrange the AR-6 responds almost like an amplifier . . .

Directional effects through the treble region, as evidenced by the average of 2dB that separates the three response curves, are actually less pronounced than we've seen in some costlier systems. Tests made of the effect of the tweeter level control show that it can vary the response from completely minus the tweeter to a steady increase in tweeter output of about 2 dB across its range. The design in this particular area is just about perfect . . . Pulse tests indicate virtually no ringing; in fact the AR-6 seems better than average in this regard too.

. . . a pair of AR-6s would be an excellent choice."

The workmanship and performance in normal use of AR products are guaranteed from the date of purchase; 5 years for speaker systems, 3 years for turntables, 2 years for electronics. These guarantees cover parts, repair labour and freight costs to and from the factory or nearest authorised service station. New packaging, if needed, is also free.

The AR catalogue and complete technical data on any AR product are available free upon request.

AR

Acoustic Research Inc.
Massachusetts, U.S.A.

All AR audio equipment is on demonstration at the AR *Music Room* in the Sydney showrooms of the Australian Distributors.

Australian Distributors

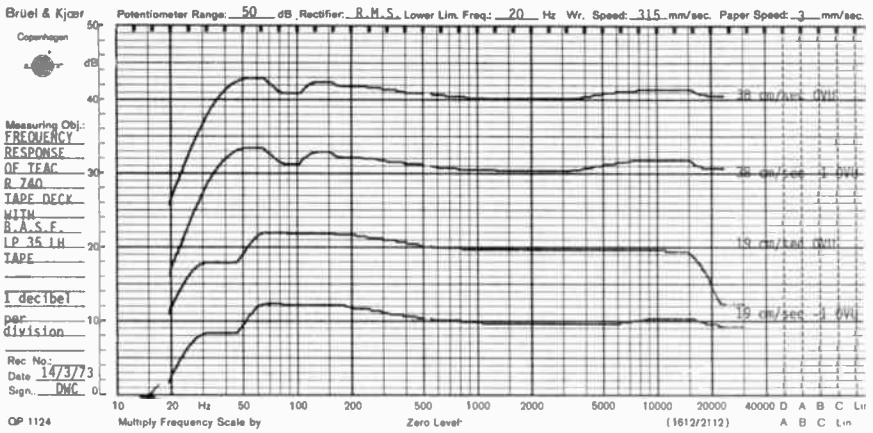
W. C. Wedderspoon Pty. Ltd.

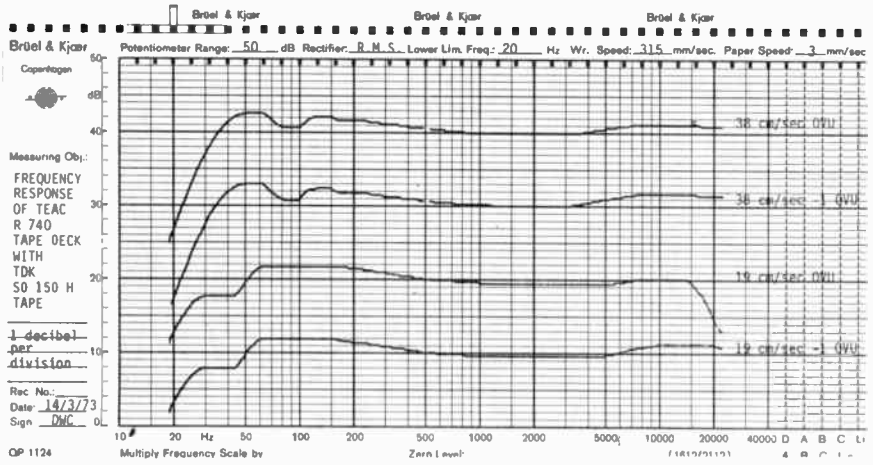
193 Clarence Street, Sydney. 29-6681

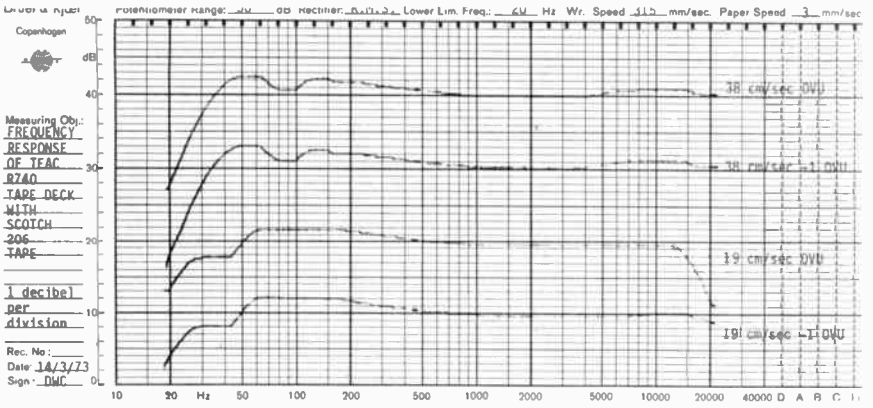
AR sound equipment may be purchased from the following Australian Dealers:

N.S.W.: Magnetic Sound, Sydney. 29-3371. Sydney Hi-Fi, Sydney. 29-1082. **VIC.:** Brasch's, Melbourne; Douglas Trading, Melbourne; 63-9321. **S.A.:** Sound Spectrum, Adelaide. 23-2181. **A.C.T.:** Homecrafts, Canberra. 47-9624. **W.A.:** Leslie Leonard, Perth. 21-5067. Alberts T.V. & Hi-Fi Centre, Perth. 21-5004. **QLD.:** Brisbane Agencies, Brisbane. 2-6931.

WD 21/FP







Wow and flutter was very good at 0.1% at 38 cm/sec, and 0.2% at 19 cm/sec and 9.5 cm/sec.

The signal to noise ratio although adequate was primarily due to motor hum which if reduced could improve the signal to noise by 6dB.

As this is a professional machine, we also measured the replay response with a DIN calibration tape. Generally, domestic machines are only adjusted to obtain linear record to replay frequency response, and if one records a tape on one machine and then plays it back on another machine with supposedly the same equalization, it is possible in some cases to obtain a noticeable boost or cut in bass response. This is due to the fact that the playback equalization is not necessarily correct.

Obviously in professional equipment, the playback equalization is critical so that tapes can be recorded on one machine and played back on any other machine without the spectrum being modified. The results (tabulated in our data panel) were very good.

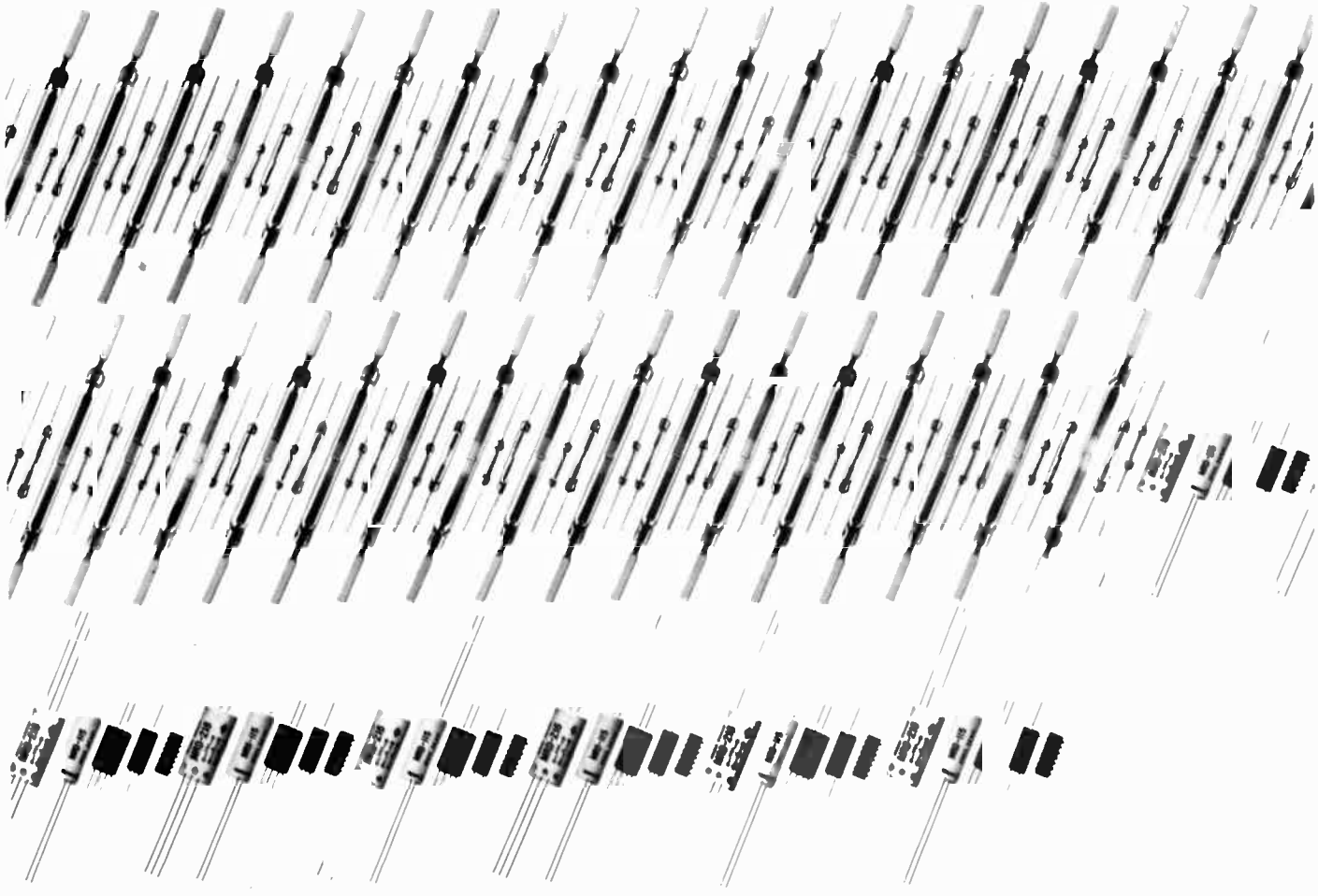
Another feature of professional equipment is the ability to set the record and playback level controls at a specified setting and obtain a known tapeflux density, in this case, OVU corresponded to 185 pwb/mm.

Total harmonic distortion was very good, and at plus 16dBm (re OVU) was still only 4% at 1kHz.

The Teac R740 professional tape combines all the necessary features required for professional use with a pleasing external appearance. The unit can be easily mounted to suit the clients' requirements, and provides adequate input and output selection facilities to correctly match it with any other ancilliary equipment. ●

OKI make 24 million dry reed inserts and 1,200,000 dry reed rel , y year

... d t 're all perfect



A standardised range of inserts and relays are available ex stock.
Comprehensive literature is available on application to the Professional Components Division.

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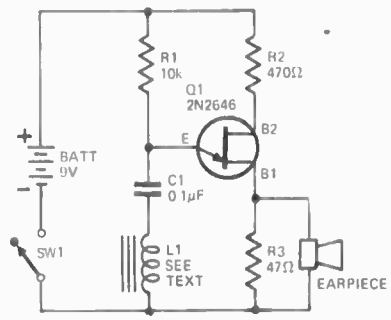
AC77

Fig 1. The completed unit together with earpiece and search coil.



UNIJUNCTION TRANSISTOR

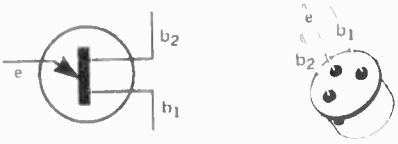


Fig. 2. Circuit diagram illustrates the simplicity of the unit.

The Revealer

Beat the crooked car-dealer at his own game with A.J. Lowe's metal detector.

'HONEST JOE', down at the used car yard, knows *all* the tricks, and uses as many as need be, to make his vehicles appear better than they really are.

Patching up rust holes, and filling up the dents from collisions – with putty, fibreglass, epoxy and paint, are just a few of the tricks for disguising the poor condition of bodywork. As bodywork is very costly to repair properly its condition is of vital importance to a used-car buyer.

Here's a little gadget – THE REVEALER, which will help to even up the game, by detecting what goes on below that beautiful but oh-so-thin coat of paint.

WHAT IT DOES

The revealer is an electronic test device to determine whether or not there is steel below the paint work. It comprises three elements – a search coil, the electronics, which are in a tin box, and an earpiece. The circuit generates a tone in the earpiece. When the search coil is placed over, and close to, steel, the tone changes significantly.

A would-be buyer of a used car can carry the tin box in his pocket, the earpiece in his ear, and the search coil discreetly in his hand. Tests can be made on door panels and mudguards and other places where rusting or filling is likely to exist. The best way to check a door panel, for example, is to hold the search coil at the top of the panel, where rust is unlikely, and then quickly transfer it to the bottom – where rust is more likely. If the note starts off – 'eeeeeee' and finishes up – 'mmmmmmmm', – look out! the bottom of the door panel has been filled with something that's not steel.

Of course a test can be made by simply moving the search coil over suspect areas, and listening for any change in pitch and tone.

Thus by listening to the frequency of the oscillator one can tell whether there's steel – or something else – under the coat of paint on a car.

While moving the search coil over the body work, the note should remain steady. If it fluctuates – take heed, all is not well.

THE SEARCH COIL

The search coil used in the prototype is a 1.5 henry choke of 85 ohms resistance and 10 mA rating, which happened to be on hand. The iron core is made of E and I laminations, with all the Es facing one way. After removing the choke from its mounting

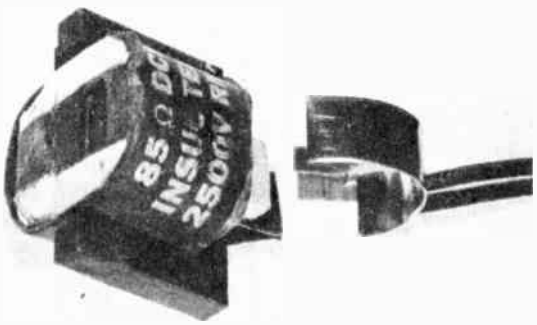


Fig. 3. The search coil may be constructed from an iron-cored coil having an inductance of 1.5 Henry and dc resistance of 85 ohms.

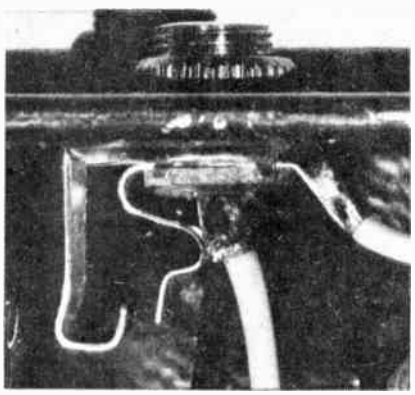


Fig. 4. The jack must be bent as shown so that the switch makes contact when the earpiece is inserted.

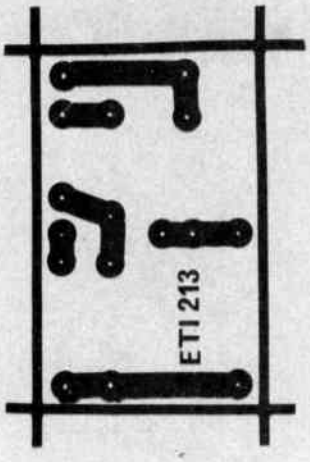
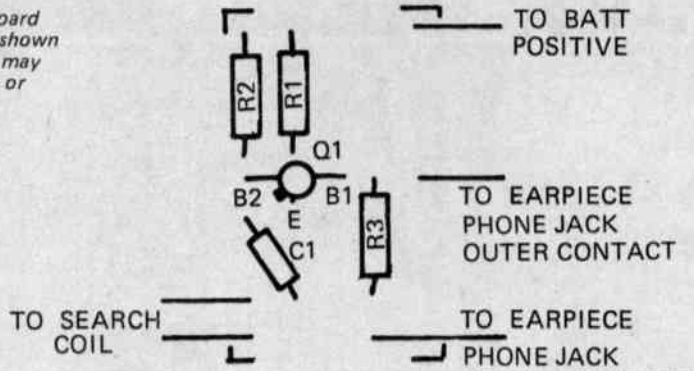


Fig. 5. A printed circuit board may be used (foil pattern shown here full size), or the unit may be assembled on tag strips or Veroboard.

Fig. 6. Component overlay



frame, the Is are discarded, thus leaving the choke with open-ended Es only.

The sensitivity of the search coil is increased by discarding about half of the E laminations, so that when the open ends of the remaining laminations are brought near any steel, then this steel makes a significant change in the inductance of the coil, and hence in the frequency of the oscillator.

On the prototype the remaining laminations were wedged securely with a wooden wedge, which also held a suitable small steel handle. See Fig. 3.

Constructors who do not have a similar choke on hand should experiment with similar chokes, or small transformers. An old transformer with one winding open-circuited would do, as long as the coil in use is continuous. Practically any small transformer will work just try whatever is to hand. Naturally the smaller the search coil the better able it is to locate small flaws beneath paint.

CONSTRUCTION

Construction is not in any way critical. In the original model the components were mounted on a printed circuit board measuring 1 7/8" x 1", and assembled with the battery in a small tin box which once held throat tablets.

The jack used for the earpieces was of the type used in some transistor radios, with three terminals, and fitted with a normally-closed switch. Before use, this was adapted, by bending the fixed contact of the switch, so that the switch became normally-open, and was closed by the insertion of the earpiece plug. Figure 4 shows the jack after adaptation. The battery negative lead goes straight to one of the terminals of the jack.

This switch is used as the battery on-off switch, SW1 in Fig. 2, so that the device is switched on simply by inserting the earpiece plug.

If constructors use a choke different from that in the original then they should experiment with the value of the capacitor C1 to adjust the frequency of the oscillator to a satisfactory value. The layout of the copper side of the printed circuit board is shown in Fig. 5. Fig. 6 shows the component positions on top of the pc board.

Constructors who are not equipped to make a little pc board could easily mount the components on a tag strip or on Veroboard.

Well there it is — a one evening low cost project, but it could save its maker hundreds of dollars on his next car deal. ●

HOW IT WORKS

The tone is generated by a unijunction transistor relaxation oscillator. This oscillator is quite conventional except – that, in addition to the usual capacitor between the emitter and negative rail, there is an inductor in series with the capacitor. (Fig. 2.).

The value of this inductance determines the frequency and tone of the note generated.

The indicator is actually the search coil, and its inductance is varied by the proximity of steel to the open ends of its iron core.

When the inductor search coil is close to steel the frequency of the note decreases, when there's no steel there it remains high.

River ohm micro resistors 1/16w

River Ohm micro resistors are eminently suitable for low power applications where long life, economy, microminiature size, high stability and close tolerance are required. The resistive element is of a CERMET construction encapsulated in a heat resistant insulating paint in standard international colour codes for ready identification.

Leads are of solder coated copper wire with a minimum 15 mm length and 0.3 mm diameter. Excellent solderability is ensured when using either manual or dip soldering techniques.

Characteristics
Resistance value: 30 ohm to 100 K ohm ± 5%, E-24 grid
Wattage rating: 1/16 W.
Maximum operating voltage: 100V/Maximum overload voltage: 100V/Temperature coefficient: + 700 p.p.m./°C

PLESSEY
Ducon

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Box 2, Villawood, N.S.W. 2163
Tel. 72 0133. Telex 20384

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AC76

Super-compact Automotive Stereo Cassette Tape Player TP-1042

Compare it with any other automotive stereo and you'll see how compact it is! Only 170 mm wide and 52 mm thick, it's no bigger than an automotive radio. Readily mounted under or built into the dashboard, or on the floor of your car, big or small. The simple, crisp design adds a functional beauty to your car's interior.
Operation is that easy one-touch Staar system; play starts with cassette insertion and cassette pops out at tape end, all automatically. The specially designed servo motor is tough and assures consistent tape speed unaffected by shocks or fluctuations of battery voltage. The high-performance amplifier of all silicon transistor circuitry built-in for superb tone and long-life performance. The built-in features include Balance Control, Tone Control, F.FWD and RWD.

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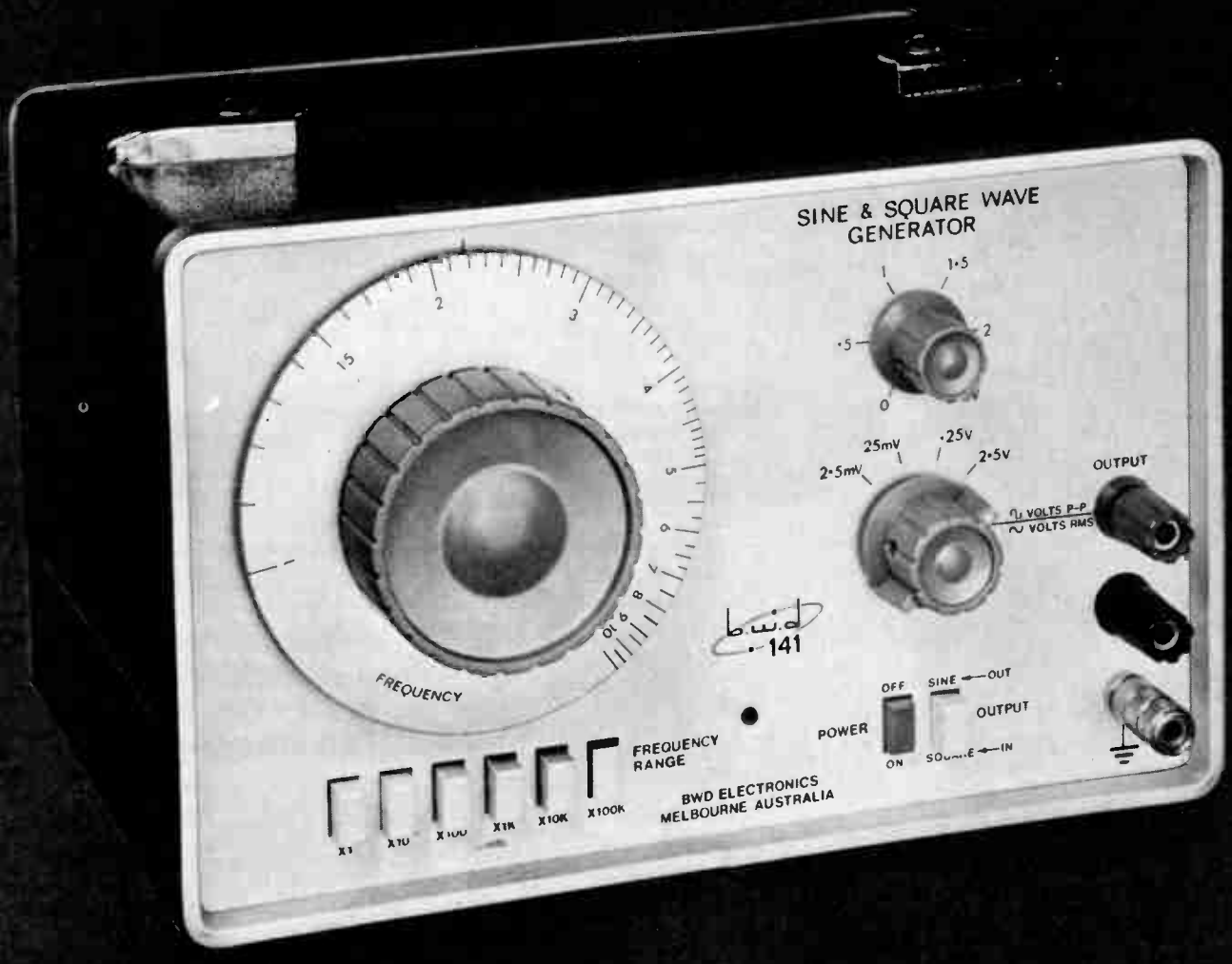
The bwd 141 with 99.9% purity of output is so beautiful.



Model 141 is a rugged, lightweight — go anywhere instrument that excels in all the characteristics required of a first class generator.

1Hz TO 1MHz SINE OR SQUARE WAVE
2.5V RMS SINE. 2.5V P-P SQUARE
<0.1% DISTORTION 100Hz-100kHZ
OUTPUT LEVEL 3% (0.25db)
100nSEC RISE & FALL SQUARE WAVE
CALIBRATION <5% ±1Hz
600Ω OUTPUT ATTENUATOR
BATTERY OR LINE OPTIONS

WINNER OF AWARD FOR OUTSTANDING EXPORT ACHIEVEMENT

Distortion is extremely low, being typically 0.6% between 200Hz and 50kHz and is less than 1% from 5Hz to 1MHz.
Frequency stability is a remarkable 0.001% per hour at normal room temperature for frequencies between 100Hz and 100kHz.
Output is isolated and may be balanced over the audio range by an external centre tapped resistor.
The alternative output is a fast rise time, no overshoot, no tilt square wave that is well suited for response and transient testing from D.C. to video frequencies.
$90 Battery operated **$102** A.C. operation **$130** rechargeable Battery.
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AMATEUR RADIO

Roger Harrison VK2ZTB

THE STATE OF THE ART

MICROWAVE DEVELOPMENTS

ENCOURAGED by the results of a 28 mile contact on 3-9-72 (reported ETI November '72), the old team of Dick Norman VK2BDN and Bill Cox VK2ZAC have just completed a six month rebuild of their 2304MHz equipment. The rebuild was directed towards higher RF power output and improvement in portability. A successful trial was conducted on Tuesday 24-4-73 over a path of 53.5 statute miles with Dick VK2BDN located at North Head near Manly and Bill VK2ZAC at Kings Tableland near Wentworth Falls in the Blue Mountains. Elevation of the respective sights were 250 feet and 2898 feet above sea level. The path was nearly optical. The contact was maintained for one hour.

Signal reports were 5 and 9+ both ways. This contact constitutes a new distance record for 2300MHz.

Bill Cox VK2ZAC created a mild sensation by removing the 4ft parabolic antenna and substituting a 1¼" high groundplane antenna; this resulted in a report of 5 and 6.

VK2BDN: Transmitter: Solid state 144mHz exciter and power amplifier delivering 28 watts output at 144MHz. Varactor doubler chain to 2304MHz. Estimated power output 2 watts. Modulation: NBFM. Antenna: 4ft dish with dipole feed. Receiver: Crystal locked converter using 1N21F mixer to a 144MHz mobile receiver.

VK2ZAC: Transmitter: 144MHz valve exciter and amplifier running 28 watts input. Varactor doubler chain to 2304MHz with 2 watts power output. Modulation and antenna as above. Receiver: Xtal locked converter using 1N21F mixer to a 52MHz receiver.

A fine effort by both! The above information was provided courtesy of Dick Norman VK2BDN.

MOONBOUNCE

Neil Sandford, VK1ZT, is active on 1296MHz moonbounce now. He has successfully recorded the signals of Ron Wilkinson VK3AKC and the Crawford Hill VHF Club W2NFA during their schedules. He has also been received by the Naval Research Laboratories station in New Jersey USA during recent schedules and tests by NRL.

Neil's transmitter runs 150W input to a pair of 2C39B tubes in a cavity amplifier configuration. His antenna is a homemade parabolic dish employing all-wood construction surfaced with wire gauze. The feed uses a circular wave guide horn made from galvanised metal sheet. Congratulations on your success Neil.

The Illawarra Moonbounce Group have made modifications to their receiving equipment and report improved performance. The R.F. preamplifier now uses a bipolar transistor type MT4578 and has a measured noise figure of 1.2dB — quite remarkable! The post-amplifier has a noise figure of 2.3dB and employs an MS175 bipolar transistor. Overall system noise figure is 1.6dB.

OSCAR 6

Present indications are that one year's life expectancy of Oscar 6 will be reached, perhaps exceeded. Amateurs in 50 countries have worked through the satellite so far, and Carl Meinzer DJ4ZC (Germany) has performed some simple ranging measurement experiments, using slow scan TV, for elementary orbit measurements.

TROPOSPHERIC SCATTER

Concerted efforts by Sydney stations to work into Victoria (over 300 miles) on 144MHz are starting to pay off. Schedules between VK2AM and VK3ANP have been enlarged to include VK2NN, VK2ZRH, VK1MP and VK3AJN. The two Victorian stations (VK3ANP and VK3ATN) are both located at Wangaratta. Signals have been heard both ways but no contacts have resulted as yet — although it appears to be only a matter of time.

The Sydney-Canberra scatter schedules has been joined by John Lauten VK1JL who runs less than 30 watts power and uses a 10 element Yagi. Communications mode is a mixture of CW and SSB on these schedules. Thanks to Mike Farrell VK2AM for these notes. ●

PUBLISHER'S NOTICE

ELAC COMPETITION

Publishers are legally obliged to obtain — from the Chief Secretary's Dept. — a permit number for certain types of competitions. The Elac competition run regularly in this magazine falls into this category.

The allocated number is normally printed adjacent to the competition details.

Due to a printing error the permit number for this month's competition (page 131) has been inadvertently omitted from that page.

The permit number is T/C 4108.

YAMAHA CA 700 AMPLIFIER

MEASURED PERFORMANCE OF YAMAHA CA-700 AMPLIFIER SERIAL NO: 3523

Frequency Response:	20Hz to 20 kHz ± 1 dB		
Power Output for Rated Input:	47 watts		
Channel Separation (at Rated Ouput of 60 watts):	100Hz	1kHz	10kHz
	76dB	50dB	45dB
Signal to Noise Ratio with respect to Rated Power (Auxiliary Input):	Unweighted		75dB
	Weighted		85dBA
Total Harmonic Distortion (at Rated Output):	100Hz	1kHz	6.3kHz
	0.25%	0.25%	0.2%
Tone Controls:			
Bass	9dB boost at 50Hz		
	10dB cut at 50Hz		
Treble	7dB boost at 10kHz		
	10dB cut at 10kHz		
Loudness Control	6dB boost at 50Hz		
	4dB boost at 10kHz		
Low Pass Filter	4dB cut at 10kHz		
High Pass Filter	4dB cut at 50Hz		
Dimensions:	40cm wide by 14cm high by 30cm deep		
Weight:	10 kg		

THE Yamaha Company of Japan started production of pianos back in the 1880's. Since then they have extended their range to include all orchestral instruments, and ten years ago commenced production of electronic equipment for the domestic market.

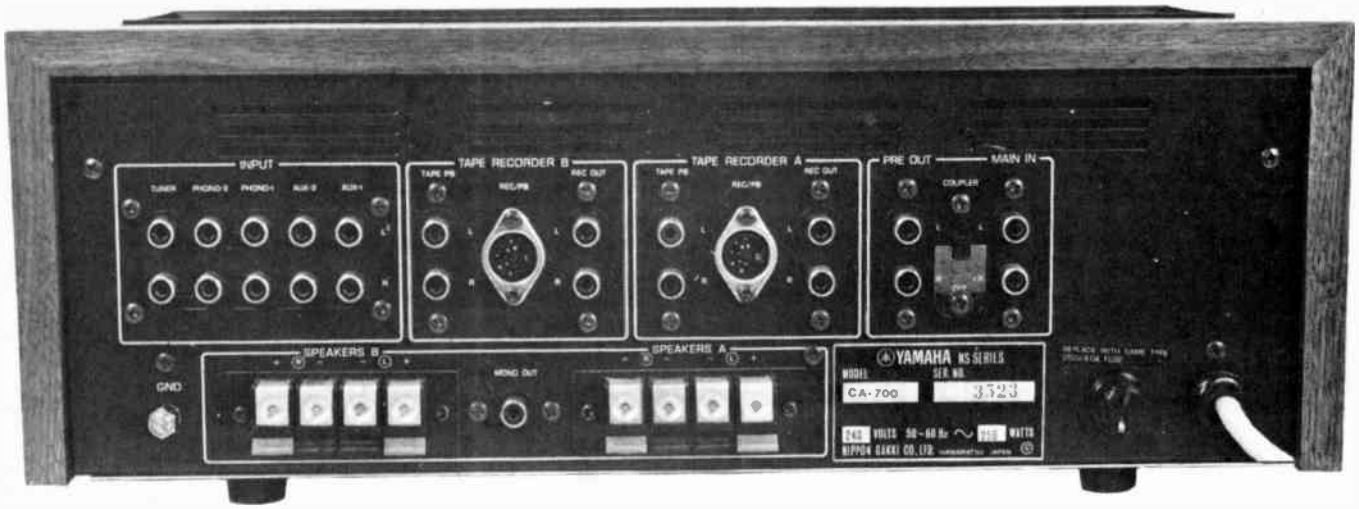
Yamaha have companies throughout the world. They are the largest single manufacturer of orchestral instruments, in particular, pianos, for which they are world renowned. The company also manufactures hi-fi equipment for other prominent audio organizations.

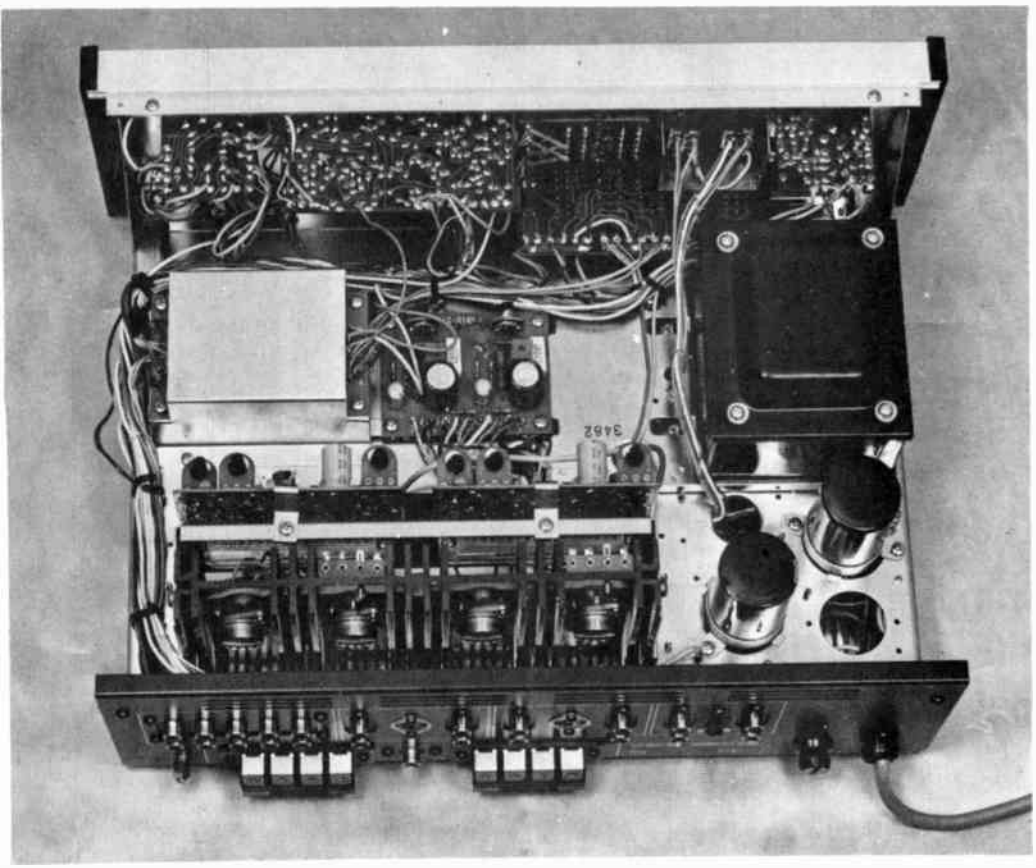
In the last six months, we have seen in Australia the introduction of Yamaha amplifiers, cassette decks, turn-tables and tuners. In this article we review the company's Yamaha CA 700 Amplifier.

The CA 700 amplifier has a very neat external appearance. It is housed in an oiled timber enclosure. The front panel is brushed aluminium with a black edging strip on each end, and has a small black panel across the bottom. The front panel controls are arranged in two rows consisting of the following:–

On the top row, left to right, we have:

(a) microphone input level control.
(b) two speaker-select toggle switches for speaker systems A and B.
(c) two filter toggle switches, one for the low-pass filter and one for the high-pass filter.





Medium-priced amplifier has many excellent facilities.

electronics TODAY INTERNATIONAL
product test

(d) bass tone control knob with five boost and cut positions.
(e) treble tone control knob with five boost and cut positions.
(f) balance control knob.
(g) volume control knob.

On the bottom row we have:

(a) a small orange bezel light.
(b) a set of five push on and off buttons for auxiliary 1 select, auxiliary 2 select, phono 1 select, phono 2 select, tuner select.
(c) tape monitor select switch with five positions, (i) dubbing A-B, (ii) A play (iii) source monitor, (iv) B play and (v) dubbing B-A.
(d) mode select switch with five positions for left channel, right channel, left and right channels, stereo and stereo reverse.
(e) two toggle switches, one for audio muting – providing a 20dB cut, and the other for loudness control.

On the left hand end of the black strip, across the bottom, we have a push on/off power switch, ring tip and sleeve headphone socket, and two tip and sleeve microphone sockets.

On the rear, we have input and output facilities, and these include 11 pairs of RCA sockets for tuner input, phono 2 input, phono 1 input, auxiliary 2 input, auxiliary 1 input, tape B play, tape B record, tape A play, tape A record, preamplifier output and main amplifier in. The phono 2 input is for moving coil cartridges only, and is fitted with a preamplifier to suit. Both tape record A and B also have DIN recorder playback sockets. The preamplifier and main amplifier may be separated by throwing a switch.

Speaker outputs are made via two groups each of four spring loaded terminals. A single RCA socket is also provided for mono output.

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YAMAHA CA 700 AMPLIFIER

Some of the facilities on the amplifier are worth noting, firstly because they are not normally included on amplifiers in this price bracket, and secondly, because they are features that, we feel, are very worthwhile on any amplifier. The first of these features is the microphone input level control which makes mixing of dialogue on to a tape with other source material a simple process controllable from the amplifier. Other mixing combinations are also possible using this control.

A second feature is the tape monitor switch which allows dubbing from one recorder to another.

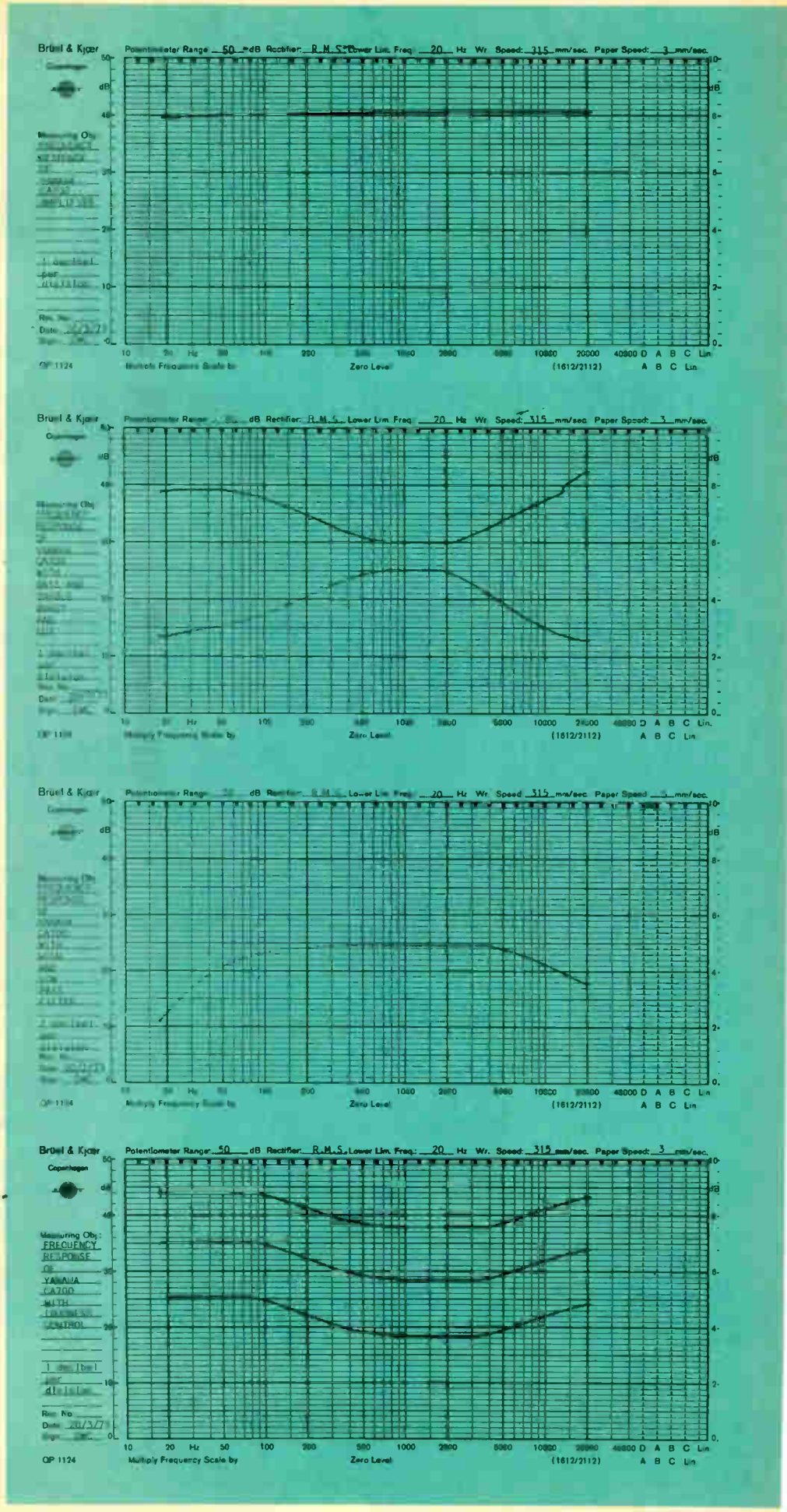
The internal layout is good with each circuit having its own printed circuit board. The filter circuits, tone control circuits and microphone preamplifier circuits are each mounted on the back of their respective front panel controls. The two power amplifier boards slide into multipin edge connectors. The four power transistors are on a common heatsink, mounted just inside the back cover. A large plastic grille is fitted into the top of the timber enclosure to allow adequate ventilation over the heatsinks. Two thermistors are also fitted on the heatsink to provide protection. As a circuit diagram was not supplied with the unit, we could not determine exactly how they operate, or what degree of protection was provided.

An instruction manual was supplied with the unit and gave basic information on the front panel controls and rear panel facilities. In addition, three pages gave information on various wiring connections.

The laboratory measurements were quite interesting. The signal to noise ratio was very good at 75dB. Total harmonic distortion was also more than adequate and dropped to less than 0.1% at 50 watts. The loudness control was unusual because the bass and treble boost did not diminish with an increase in volume, as is the general trend. The low and high pass filter characteristics were rather disappointing providing only 4dB cut at 10kHz and 50Hz respectively.

The Yamaha CA-700 combines a balanced performance specification with a number of worthwhile features not seen on most amplifiers. Its power output is more than adequate to drive most speakers, even low efficiency ones, to realistic listening levels in the average lounge room.

Recommended Selling Price: $299.00



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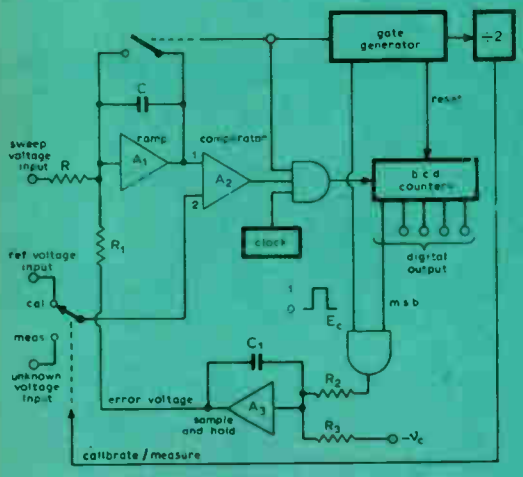

Fig. 1. Block diagram of A-to-D converter

A CIRCUIT has been designed by Jim Barnes of the Applications Department of Motorola, Phoenix, which allows greater accuracy to be obtained from single-ramp A-to-D (analog-to-digital) converters. The converter, for which a patent is pending, uses alternate Measure and Calibrate cycles to obtain 0.01% or 4½ digit accuracy.

A known analog input is measured and the resulting digital number is compared to the correct answer. If this digital number is not correct, the converter is automatically adjusted so that the correct answer will be produced. Since this calibration cycle is interlaced with cycles which measure the unknown analog voltage, compensation for all but the most rapid variations in converter accuracy is provided.

This new conversion method requires only one precision part which is the reference voltage used in the calibration cycle. This voltage must be maintained to within $\pm \frac{FS}{2\,(n+1)}$ where n is the number of bits of accuracy if ±½ least significant bit accuracy is to be expected, and FS is the full scale value of the converter.

In the conventional circuit, the output of a ramp generator is

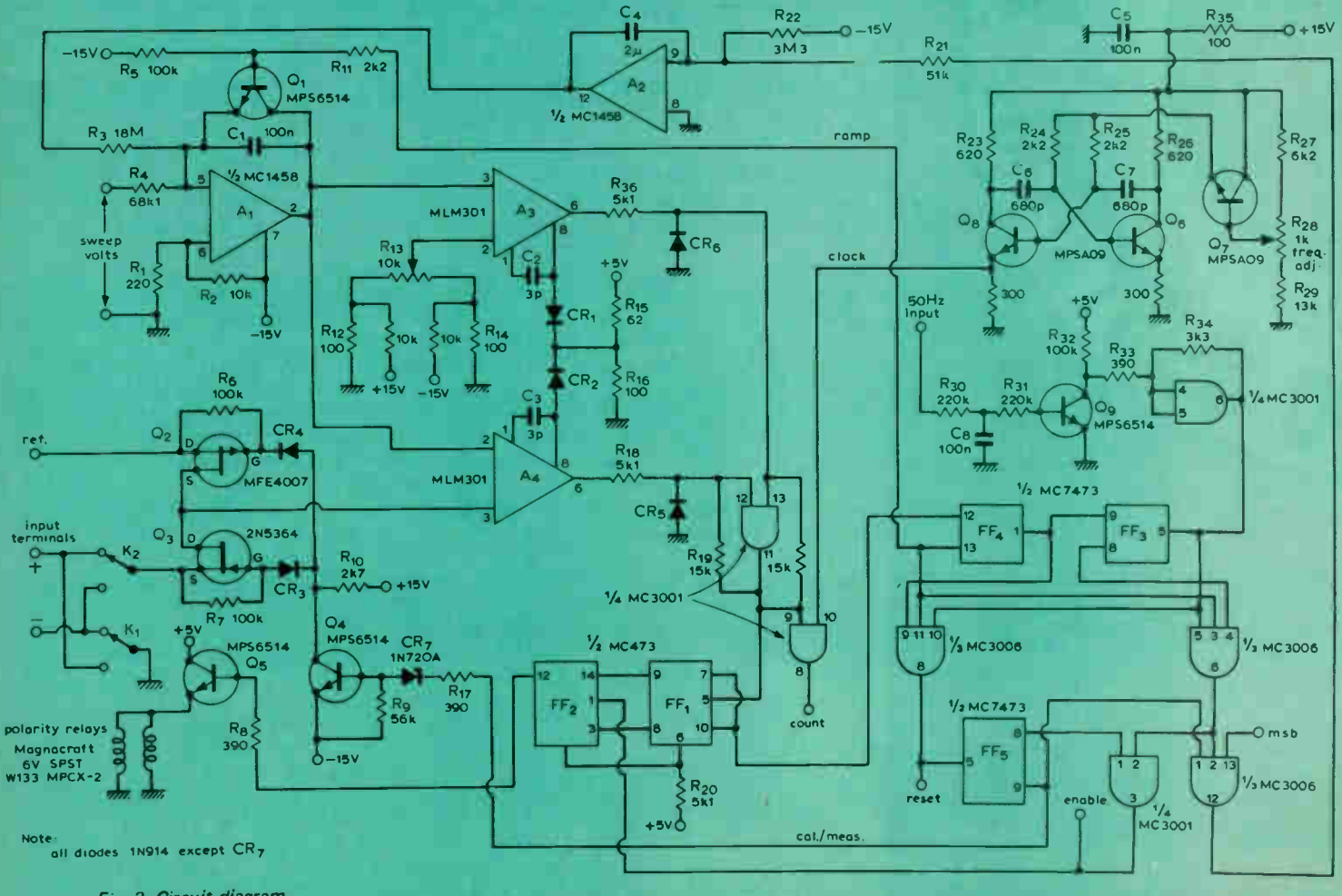

Fig. 2. Circuit diagram.

compared with the unknown analog input voltage. At the start of the ramp a gate is opened and, when the ramp voltage is equal to the analog input voltage, the gate is closed. It follows, therefore, that the gate is open for a time proportional to the magnitude of the analog voltage. When open, the gate allows constant frequency pulses through to a counter. After each gate cycle, the counter holds a number which is proportional to the input voltage; the contents of the counter can then be converted into a code to suit the particular application.

The prime cause of inaccuracies is the ramp generator which can suffer from two defects, incorrect slope, and wrong starting time. If the ramp starts late, too few check pulses will be registered. If the slope of the ramp is too steep, it will reach the unknown voltage too soon, with the same result. The clock frequency, of course, has the same effect on accuracy as the ramp slope – if the clock is too slow it will not produce a sufficient number of pulses during the gate interval.

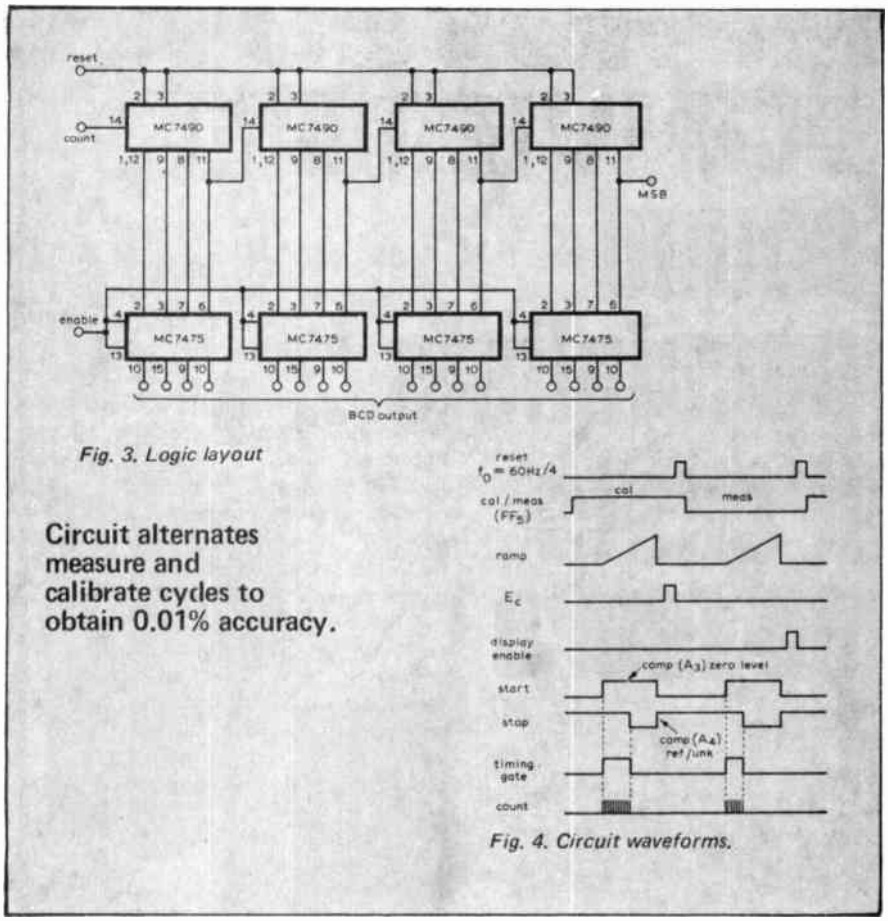

Fig. 3. Logic layout

Circuit alternates measure and calibrate cycles to obtain 0.01% accuracy.

Fig. 4. Circuit waveforms.

AUTOMATIC CALIBRATION

Figure 1 shows a block diagram of the system. The voltage reference is exactly 80% of the full scale value of the converter because, in a BCD counter, this corresponds with the switching of the most significant bit in the counter.

In operation, the comparator is switched alternately between the unknown voltage and the reference voltage. The most significant bit of the BCD output number is examined during the calibrate cycle, by means of pulse E_C so it can be decided if the ramp slope is too steep or too shallow, and to derive a dc control voltage which is used to vary the ramp slope. Since the error voltage is only present during the E_C pulse, a means must be provided to store the control voltage value when the signal is not present. In the system shown, an integrating operational amplifier is used in a sample and hold circuit. The capacitor and charging resistor values are selected so that the error voltage obtained during each calibrate cycle will correct the ramp slope an amount corresponding to the least significant bit divided by four.

Figure 2 is the circuit diagram of the converter employing the calibration method just described and Fig. 3 shows the counter and logic control circuits.

To avoid the need for precision parts in the loop, a potentiometer is used to adjust the frequency of the oscillator. This allows the oscillator to be set so that even if the ramp has been driven by the control voltage to its most shallow slope, no more than 10 000 clock pulses can reach the counter during the calibrate cycle before the ramp reaches the eight volt reference. The error signal will hence always be of the correct polarity to drive the ramp up until the proper 8000 pulses are reached when the ramp crosses the eight volt reference, at which point the loop locks.

The ramp generator (component B) and the integrating amplifier (component D) which provides the error control voltage are shown in Fig. 2. The error input to the integrating amplifier is single-ended, i.e. error pulses are supplied only when the gate count is too high, control in the other direction being provided by a fixed bias. With no error pulses, the integrated error signal drifts slowly positive, while with continuous error pulses, it steps more negative at the same average rate. Figure 4 shows the waveshapes generated for control of the A/D converter.

The error voltage changes rapidly during the E_C pulse and drifts slowly between pulses. With large errors, such as might be present for a short time when the unit was first turned on, a staircase error waveshape would be produced, but at near zero error, the most significant bit error decoder output will be toggling between a plus and minus value to produce a sawtooth wave.

The electronics to accomplish polarity sensing are implemented as follows (see Fig. 2): polarity is indicated by a J-K flip-flop, S, connected so that it will change state every time it receives a negative going pulse. The timing gate is connected to its input so that each occurrence of a timing gate signal will trigger the flip-flop

In operation, the flip-flop changes state at the end of each measurement of a positive voltage. The timing gate pulse, which is always present during the calibrate cycle (because the reference voltage is always positive), returns the flip-flop S to its original state, ready for the next measurement. However, if the input is negative or zero, only the calibrate cycle timing gate pulse will be present, so the state of flip-flop S would alternate for each cycle.

A second J-K flip-flop, T, is connected to flip-flop S in such a way that its state is forced to be the same as that of flip-flop S at the time of the display enable pulse. With two flip-flops connected in this way, the polarity relay (and readout) will only be activated under the conditions that the unknown input is either negative or exactly zero voltage. ●

COMPUTER GRAPHICS

Computer converts rough sketches into complete drawings

A computer to convert freehand sketches into fully proportioned drawings was announced this month at IBM's Thomas J. Watson Research Centre, Yorktown Heights, New York.

Placed at random on a special electronic tablet, a sketch and a paper keyboard are simply touched with an electronic pen to enter graphic or alphanumeric data and to initiate computer program functions.

"While the basic idea of automated graphics is not new, this experimental system embodies a number of concepts that significantly advance the way a person such as a draftsman can interact with a computer," said Robert N. Wolfe, who led the Research Centre team which developed the over-all system.

"For example, a rough drawing, no matter how out of scale, can be automatically turned into a finished product moments after the assignment of proper dimensions."

In addition to the tablet and pen, the graphics system includes control units and special programs for the IBM 1800 Data Acquisition and Control System to which the equipment is attached. A conventional television monitor and hard-copy plotter serve as output devices.

A user wishing to create a drawing can place a rough sketch and the paper keyboard anywhere on the tablet to suit his work methods. He can enter the sketch into the computer by quickly outlining it with the pen, and can point to the keyboard to specify such details as broken or dotted lines, arrows or circles.

To create a circle, for example, he would merely point to the keyboard's circle-drawing function and then, on the sketch, indicate the centre of the circle and any single point on its circumference.

The user can also add dimensions and labels by selecting the appropriate characters from the keyboard and pointing out where they should be placed on the sketch.

To check his work, the user can at any time have the sketch displayed on the television screen merely by pointing to the "display" function on the keyboard. Similarly, he can cause the sketch to be produced in hard-copy form by the plotter or stored by the computer for later work.

To convert the sketch into a finished drawing proportioned according to the entered dimensions, the user merely touches the "finished drawing" function box on the paper keyboard. He is alerted automatically if dimensions conflict or are incomplete.

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220	50	P.C.	39c
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330	10	P.T.	20c
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330	25	P.T.	29c
330	35	P.T.	39c
330	50	P.C.	60c
330	80	P.T.	90c
470	6	P.T.	24c
470	10	P.C.	29c
470	10	P.T.	29c
470	25	P.T.	41c
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LM307.	$2.25	$2.05
LM308H	$10.75	$9.50
LM308N	$3.20	$2.90
LM309K	$4.50	$4.20
LM370N	$4.50	$4.20
LM371H	$4.20	$3.80
LM372	$3.75	$3.35

LM373	$5.20	$4.80
LM380	$3.00	$2.70
LM381	$5.90	$5.50
LM565	$7.60	$7.00
LM709	99c	90c
LM723	$1.50	$1.35
LM741CN	$1.50	$1.35
LM741CH	$1.50	$1.35
LM748	$1.50	$1.35
LM1303	$2.95	$2.65
LM1458	$2.25	$2.05
LM3900	$2.10	$1.90

LINEAR DESIGNERS KIT

Featuring two new I.C.'s, this Kit contains a positive 15V Regulator LM340K, a negative 15V Regulator LM320K and a wealth of design and application data. These two new regulator I.C.'s will supply currents to 1A, have over-current and thermal shutdown protection and are supplied in a T03 case. Together they provide a complete plus and minus 15V power supply for experimental, prototype or full production use and you may never need to build a discrete 15V supply again.

Special Introductory Offer, one LM340K and one LM320K . . . $8.25, post 25c.

NATIONAL AND CMOS

CMOS using new technology now provides complex functions using perhaps hundreds of transistors at a fraction of the power normally required in standard TTL. In fact, current consumption is so low with CMOS that a small transistor battery may eventually be used to power all the electronics of a computer. All your favourite 74 Series Digital Integrated Circuits will soon be available in CMOS. Should you require specific information on CMOS, please contact our head office and we will be pleased to assist with data on NATIONAL CMOS.

NEW QUAD AMP LM-3900

This unique I.C. from NATIONAL SEMICONDUCTORS consists of our independent dual input, internally compensated amplifiers which will operate from a single power supply of 4 to 36V D.C. The LM3900 has seemingly endless applications possibilities as AC amplifiers, RC active filters, pulse waveform and squarewave generation circuits, tachometers and low speed high voltage digital logic gates. Data sheets supplied free.

Price – $2.20 each, post 10c.

NATION-WIDE COVERAGE FOR QUALITY ELECTRONIC COMPONENTS

PRE-PAK ...for the electronics in your life

If you want a job done properly, do it yourself.

Incredibly, more than half the money you spend on a "big name" Speaker System goes to pay for the name, the import duty, the sales tax etc. When you come right down to the nitty-gritty, the speakers themselves don't cost much at all. We have a simple solution to the problem; Do-It-Yourself.
Our speaker systems are easy to build and cost very little. Yet you will end up with the same quality as the higher priced systems you will find in the shops. Once the job's done, you will have nothing more to do but sit back and enjoy the music while you are counting your savings, and you will have the extra satisfaction of knowing there are still a few people around who can do a job properly.

SPEAKER KITS

PRE-FAB CABINET KITS

0.4 cu.ft. Bookshelf Enclosure (suits 6" speaker) vented or unvented, only $11.00 each, post $1.50. Size 14½" high x 8" wide x 8¼" deep.
1 cu.ft. enclosure (suits 6" or 8" speaker systems) vented or unvented, only $16.00 each, post $1.50. Size 21" high x 12" wide x 8½" deep.
1.6 cu.ft. enclosure (suits 8", 2 x 8", 10" or 12" speaker systems) vented or unvented, only $19.90 each, post $2.00. Size 24" high x 15¼" wide x 11" deep.
2 cu.ft. enclosure (suits 8"x 2 x 8", 10" or 12" speaker systems) tweeter and mid-range optional), only $22.50 each, post $2.00. Size 26" high x 15½" wide x 12" deep.
2.8 cu.ft. enclosure (suits 2 x 8", 10" or 12" speaker systems) vented or unvented only $24.50 each, post $2.50. Size 30" high x 18" wide x 11¾" deep. MAGNAVOX 8-30 System 1 cu.ft. only $16.00 each, post $1.50.
MAGNAVOX 8-30 System, 1.6 cu.ft. only $19.90 post $2.00.

PRE-FAB PA SPEAKER COLUMNS

"Mini" No. 1 suit 4" Speakers x 6, Size 27" x 6½" x 3½". Grey vinyl or teak veneer available. Price $12.00 each post $1.50.
"Mini" No. 2 suit 6" Speakers x 4, Size 33" x 8" x 5½". Grey Vinyl or Teak Veneer available. Price $16.00 each post $1.50.
"Midi" suit 8" Speakers x 4, Size 40" x 11" x 6½". Grey or Black Vinyl or Teak Veneer available. Price $20.00 each, post $2.00.
"Maxi" suit 12" Speakers x 4, Size 60" x 16" x 8". Grey Vinyl or Teak Veneer Available. Price $39.00 each, post $3.00.

SPEAKER SYSTEM KITS

System 101 — 12 Watt Bookshelf enclosure 0.4 cu.ft. as above supplied with Magnavox 6WR and 3TC Tweeter, Crossover Capacitor, Wire, Instructions. Price $25.00 each post $2.00.
System 201 — 16 Watt 1 cu.ft. enclosure as above supplied with MAGNAVOX 8WR or ROLA C-80 and 3UC Tweeter, plus all accessories. Price — $31.00 each post $2.00. Plessey X-30 1" Dome Tweeter instead 3UC, — $4.50 extra.
System 301 — 16 Watt 1.6 cu.ft. vented enclosure. Speaker complement as system 201. Price — $35.00 each post $2.50. Plessey X-30 1" Dome Tweeter instead 3UC — $4.50 extra.
SYSTEM 302 — 16 Watt 2 cu.ft. enclosure, supplied with MAGNAVOX 12WR, 3UC Tweeter and all accessories. Price — $37.50 post $2.50.
MAGNAVOX 8-30 — 30W — 1 cu.ft. system, supplied with Model 8-30 Woofer and 2 x 3TC Tweeters or one Plessey X-30 Dome Tweeter, with all accessories etc. Price — $41.00 each post $3.00.
MAGNAVOX 8-30 — 30W — 1.6 cu. ft. system, speaker complement same as 1 cu. ft. above. Price — $45.00. each post $3.50. With Philips Tweeter as in revised design (crossover network and prescence control included). Price — $9.00. extra.
System 401. — 35W — 2 cu. ft. system, supplied with 12" rubber-surround woofer and Plessey X-30 Dome Tweeter with 2 way crossover network. Price — $67.50. each, post $3.50.
System 501 — 35W — 2.8 cu. ft. system, supplied with 12" rubber-surround woofer, 6½" mid-range, Plessey X-30 Dome Tweeter and 3-way crossover network. Price — $82.50. each post $4.00.

PRE-FAB HI-FI PRODUCTS (a division of Pre-Pak Electronics) 718 Parramatta Rd., Croydon, NSW

NATION-WIDE COVERAGE FOR QUALITY ELECTRONIC COMPONENTS

PRE-PAK ...for the electronics in your life

KITS FOR THE HOME CONSTRUCTOR

C.D.I. KIT (Olims)

Complete kit of parts to build this superior commercially made Capacitor Discharge Ignition system. All high grade components with pre-wound transformer, P.C. board, nuts, bolts, case, instructions, etc., 12V Neg earth only. For improved performance, fuel saving less pollution and less points wear this is a MUST. ONLY **$19.95** plus 50c post.

RADIO TUNER KIT

Easy-to-build, uses 3 transistor pre-aligned tuner module kit and is complete with AC power supply. Output 100mV. Assemble it in just 1 hour. Chassis kit only **$22.95** post 75c. With teak case anodised aluminium front panel **$27.95** post 75c.

NEW! IMPROVED MODEL — Now with plug and sockets for changeover to standard ignition

ELECTRONIC SIREN KIT

With the addition of an 8 ohm speaker and a 6 or 9 volt battery, you can have an attention-getting electronic siren with a rising and falling pitch. As used by Police, Fire Dept., etc. Hundreds of applications include party novelty, toy siren, warning device, Burglar alarm, for home, car or factory and many others. Full instructions and diagrams supplied. Price **$4.50**. Post 35c.

FLUORESCENT TUBE INVERTOR

An amazing 12v D.C. to 240V invertor designed to operate fluorescent tube to 13W max. Foolproof circuit, compact 4" x 1½" x 1¼". Easy to install. **$9.95**. Post 35c.

SPEAKER CROSSOVER NETWORK IN KIT FORM

A professional, laboratory designed crossover network of constant resistance with attenuation of 12dB/Octave both models.

MODEL CN1 — is a two-way L-C crossover with a crossover frequency of 4kHz at 8 ohms. Power handling 30 watts R.M.S. Chokes are prewound and full instructions are supplied. Kit Price. **$4.00** Post 60c.

MODEL CN3 — is a three-way L-C crossover for woofer, mid-range and tweeter with crossover frequencies of 500Hz and 4kHz at 9 ohms. Power handling 30 W R.M.S. Chokes are pre-wound and full instructions are supplied. Kit Price **$6.90** Post 75c.

PLESSEY 3 + 3 AMPLIFIER

Includes volume, bass and treble controls, power supply components (except transformer) and Plessey I.C.'s. Comprehensive instructions are included. Price **$27.50.**, post 50c. Transformer to suit **$4.75.**, post 30c.

STEREO 2 + 2 AMPLIFIER

This simple but effective amplifier features 2 x NATIONAL LM-380 2.2W Amp Kits with volume and tone controls, a power supply and metal chassis. Ideal for mounting under a turntable, our special price just **$17.50.**, post 50c.

I.C. SIGNAL INJECTOR KIT

This useful wide band signal injector is ideal for fault-finding in audio and RF circuits VHF. The kit is housed in a clear perspex probe housing and includes batteries. The output is a square wave signal at approx. 3kHz with harmonics extending to TV frequencies. Price **$4.95** plus 25c post.

POWER SUPPLY KITS

Comprising transformer, mounting plate, silicon bridge rectifier and smoothing capacitor plus screws, nuts etc. PS3 6V, 7.5V, 9V, 12V, 15V, 1A **$5.95** post 50c. PS4 18V 20V, 25V, 27V, 30V, 1A **7.80** post 60c. PS6 6V, 7.5V, 9V, 12V, 15V, 2A **$7.90** post 60c.

VARIABLE POWER SUPPLY KITS

PS8 Electronically regulated and protected, suit amplifiers etc., or general purpose use. Output adjustable 20 — 45V DC at 2 Amp maximum. Features adjustable current cut out and full regulation. Price: **$22.95**., post $1.00.

I.C. POWER SUPPLY KIT ETI III

An effective low voltage power supply using an LM123 I.C. voltage regulator to provide high regulation and current limiting facilities. The output voltage is adjustable from 3.5 to 15V DC at currents up to 3 Amp. Suitable for bench testing of radios, record players and experimental circuits. Kit price **$16.50**., post 75c.

DUAL POWER SUPPLY KIT ETI PROJECT 105

Specifically intended for powering experimental integrated circuit projects, this power unit features independent positive and negative supplies — but with automatic tracking when required. Price **$105.00**., post $2.00

VARIABLE LOW VOLTAGE POWER SUPPLY KIT. — PS2

Output voltage 1.5 to 30V, will give up to ½ amp output. Features adjustable current limiting for foolproof short circuit protection. Price **$12.50**., post 50c.

HIGH PERFORMANCE AUDIO OSCILLATOR KIT

Freq. range — 15Hz to 20KHz in one range.
Output Voltage — 0 1V and 0 50mV.
Output Impedance — less than 600 ohms.
Distortion — 0.1% from 60Hz to 20KHz — 0.2% from 15Hz to 60Hz.
Output level — flat within 0.5dB from 60Hz to 20kHz.
All parts, including battery $14.50 Post 25c.

KITS FROM ELECTRONICS TODAY INTERNATIONAL

Audio Signal Generator

Build this sine or swuare wave generator for home or workshop use. Frequency range 15 Hz to 150 KHz in 4 ranges, output IV max. with 3 position attenuator . . . Price **$29.00.**, post 75c.

One Transistor Radio

This simple but effective radio can receive inter-state stations. Price **$6.50.**, post 30c.

Automatic Car Theft Alarm

This ingenious simple-to-install car alarm is automatically "armed". Price **$22.25.**, post 50c.

Variwiper

This periodic wiper control works with modern permanent-magnet motors. Price **$7.90** post 25c.

Wide Range Voltmeter

This solid-state meter has 22 ranges — from 10mV to 1000mV AC/DC. Price **$59.50.**, post 75c.

Electronic Thief Trap

Complete intruder/fire protection for your premises. Price **$22.50.**, post 75.

UNIVERSAL COUNTER DISPLAY KIT:

Model EC1. Very compact in size — uses a 7 segment MINITRON Incandescent display in 16 PIN DIL package and socket, a 7490 decade counter and a 7447 decoder driver all on 3" x 2" P.C. Board with contacts for use with a 10 way edge connector (price 55c). Facilities include built-in decimal point, blank in and out, reset, carry and count. Operating voltage — 5V D.C. Applications circuits and instructions are supplied. This is your opportunity to experiment with digital circuits while building a fascinating electronic counter. Price: **$12.50.**, post 25c.

I.C. LOGIC PROBE

This probe appeared in Electronics Australia and uses an SN7400 and two LED's giving a visual indication of the logic state of any point in a circuit using digital IC's. The kit is housed in a clear plastic housing and includes P.C. board and instructions. A simple project to build in one evening. Our special price **$7.50** Plus 25c post.

PRE-PAK ...for the electronics in your life

SAVE MONEY — BUILD IT YOURSELF!

MUSICOLOUR COLOUR ORGAN (MK11) KIT

A pleasing colour-visual demonstration of sound for Discotheques, Parties, etc. Easily operated from any radio or stereo amplifier. The kit is supplied as described in Electronics Australia and will control 3KW of power. Instructions for assembly are supplied. Price without chassis $38,00., post 50c. Price (with chassis) $45.00.., post $1.00.

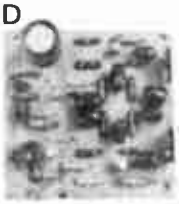
4 CHANNEL QUADRAPHONIC SYNTHESIZER KIT

Another 1st for PRE-PAK! This is your opportunity to build a high-quality, low-cost I.C. Synthesizer that uses active circuit elements and that, when used with a second stereo amplifier and speakers, will do an impressive job in converting 2 channels to 4. The Synthesizer also includes individual level controls and a set of phasing switches for the new channels so that the sound quality can be "tailored" to suit almost any listening environment and musical taste.

Specifications: Noise level — 92dB below 1V on any channel. Distortion — 0.05% or less at 1V rms output. Gain of +6dB on the two front channels, controllable from -7 to +6dB on the two new channels, and frequency response of ±0.5dB from 20Hz to 20kHz at 1V RMS output. It may be connected to any 2 Stereo Amplifiers and may be fed from a Magnetic Cartridge or other similar source.

Ideal for use with our MOD '73 series Stereo Amplifier Systems. Operates with a +15V and a -15V power supply. PRICE — $31.50. post 50c.

DECODER FOR FOUR CHANNEL SOUND



This simple Decoder Unit, which appeared in the November issue of "Electronics Australia", will allow you to go 4 Channel without going broke. Simply connect the input terminals to your present stereo amplifier speaker terminals and the output to a second stereo amplifier or tape recorder amplifier and the decoder will then synthesize rear channel signals either from existing records or the new quadraphonic pressings. A simple kit and very easy to assemble, it is complete with P.C. Board and all components. Requires 20V supply. Price $5.90 post 30c.

Rear Channel Amplifier/Speaker Kit. (2W per channel stereo with tone control) plus 2 x 8" twin cone high quality speakers. Includes mains power supply and instructions. Price $29.50., post 50c. As above, 10W per channel, Price $49.00., post 50c.

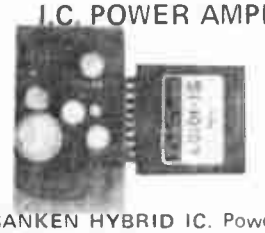
SCR DRILL SPEED CONTROL KIT

This project appeared in Electronics Australia in May '71 and has proved very reliable. It is suitable for household electric drills and small motors to 3 amp rating. The unit is housed in a sturdy plastic case and is fuse protected. Instruction diagrams are provided. Price $9.50. Post 40c.

PRE-PAK MOD '73 STEREO AMPLIFIER KIT.

STEREO PRE-AMPLIFIER — a superior low noise design featuring I.C. circuitry. Frequency Response 10Hz — 100kHZ. Total Harmonic Distortion — 0.1% at 1KHz. Channel Separation 60dB. Noise — less than 0.5uV total input noise. Operating voltage Range — 9 to 40 V.D.C. Supply current — Approx. 10mA. Input Sensitivity — 3mV for 2V out. Input Impedance — 100K. Complete Pre-Amp Kit with conventional Round or Slider Control (VOL, BASS, TREBLE, BALANCE). PRICE: KIT FORM $19.90., post 40c.

I.C. POWER AMPLIFIER



SANKEN HYBRID MODEL S1-1010Y 10W

SANKEN HYBRID IC. Power Amps, Type S1-1010Y, 10W R.M.S. output into 8 Ohms with 34V supply. Kit includes I.C., P.C. Board and all external components, (including output capacitors) (two required for stereo). PRICE $11.95., post 30c.

TYPE S1-1025E, 25W R.M.S. output into 8 OHms with 48V supply. Kit includes all external components (including output capicators) (two required for stereo). PRICE. $17.40., plus post 30c.

REGULATED AND PROTECTED POWER SUPPLIES

Regulated power Supply and Transformer to suit mono or stereo application. PRICE: 10W Amp — $19.00., post 75c; 25W Amp — $22.00., post $1.00.

"E.T." HIGH POWER STROBE

This project is a 'winner' at parties and theatrical productions and may be calibrated for checking speed of motors, etc. Light output is both high and intense, and, as an added attraction it will drive other slave units for even greater light output. The kit includes all parts, reflector and instructions. Price $19.50. Post 60c.

IC MAGNETIC CARTRIDGE/ TAPE PRE-AMP

A superior low-noise stereo pre-amp, available as Model MP-5, RIAA equalised for magnetic cartridge or MP-6, NAB equalised for tape head playback.

Specification: Voltage gain 34db, Input overload point 100mV rms, output voltage swing 5V rms, output noise level 70db below 10mV phono input, Voltage range 15V DC requires plus and minus power supplies or 30V DC single supply. Complete Stereo Kit price $6.50., post 25c. Power Supply Kit to suit, $6.95 post 50c.

MAGNETIC PRE-AMP KITS

Hi-Fi quality and proven performance make these kits one of the best buys today. Input 5mV, output 1V (approx.), 3 transistors per channel, correct equalisation.

MP-1 Mono Cartridge	$3.50
MP-2 Stereo Cartridge	$6.00
MP-3 Mono Tape	$3.50
MP-4 Stereo Tape	$6.00
A.C. Power Supply, suit above	$5.00.

PLAYMASTER 136 PRE-AMPLIFIER KIT

This high quality pre-amp, of modern design, features magnetic cartridge input, volume, bass, treble, balance controls. Price $15.00., post.

FET FOUR INPUT MIXER

ETI PROJECT 401

This four channel audio mixer, featuring high input impedance plus input isolation, offers up to 0db gain with a frequency response from 20Hz to 20KHz within 1db. An easy-to-build battery operated kit. Price $24.50., post 75c.

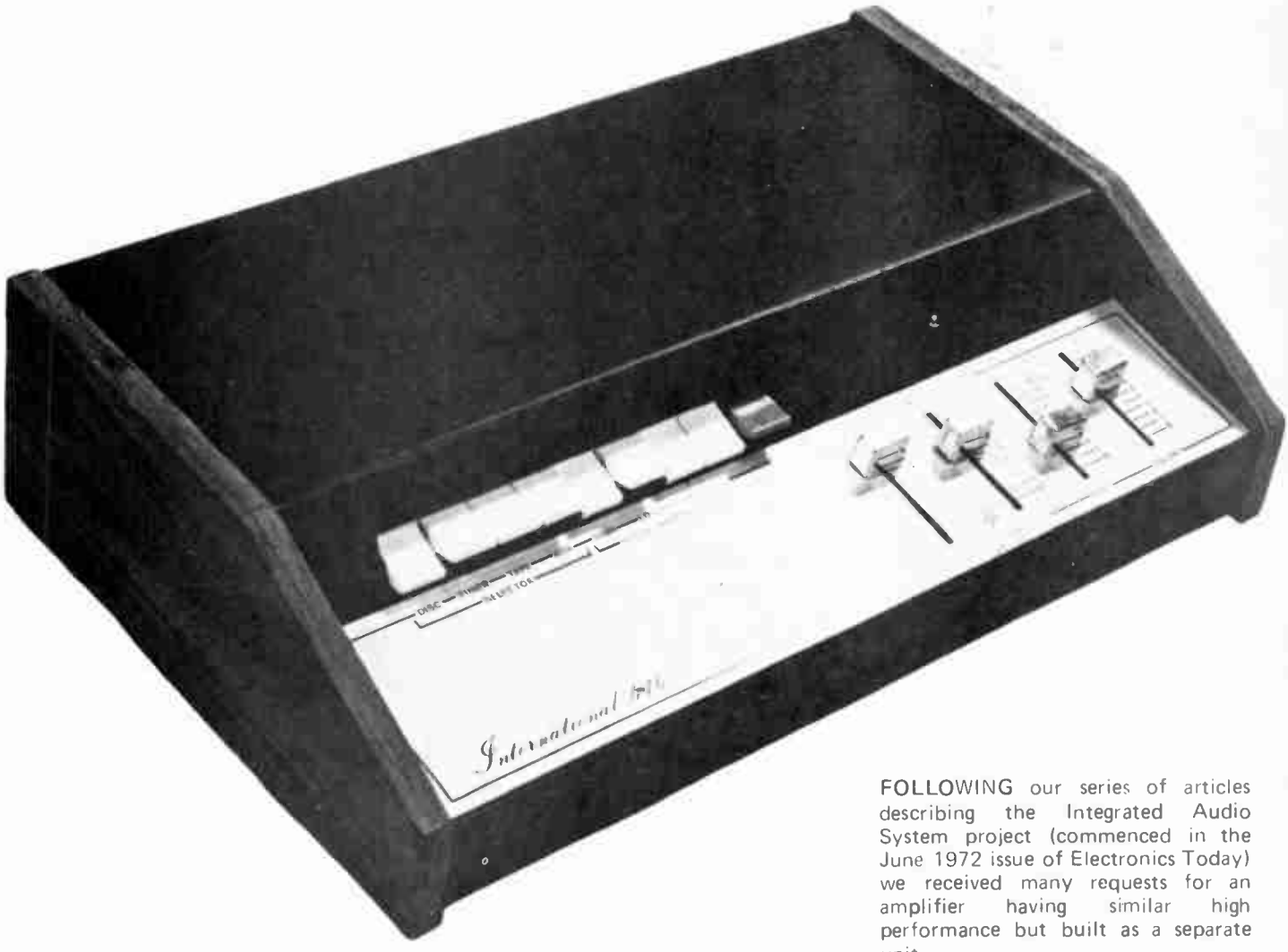
ETI MASTER MIXER KIT ET414A

A professional 8 input audio mixer featuring slider volume controls, tone controls, inbuilt equalizer, echo facilities and a variety of outputs, all at an economical price. Complete Kit, as in March/April issue, $188.00., post $3.00. Semiconductor Kit only $35.00., post $1.00. Pre-Amp/Tone Control Kit $21.75., post 75c., (complete for 2 channel). Mixer/Equalizer Kit $19.90. post 75c. Power Supply Kit $27.00., post 75c. All prices include semiconductors.

7 TRANSISTOR RADIO KIT

A very popular Pre-Pak exclusive. These normally sell in the stores at abour $14. Due to our large purchasing power, we can offer these kits at just $7.95 each. The kit is complete, less battery (small 9v).

INTERNATIONAL 416 AMPLIFIER



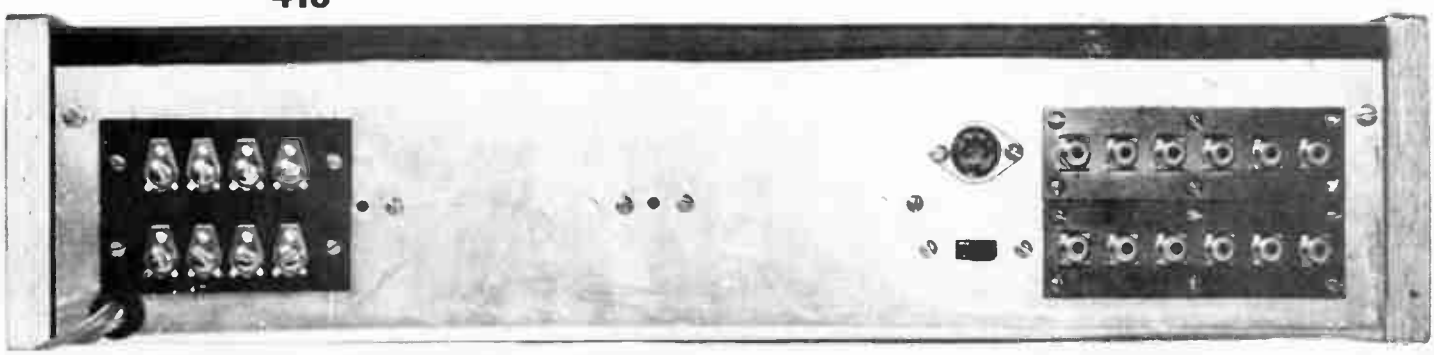
Modern styling plus 25 watts per channel make this amplifier pleasing visually as well as audibly.

FOLLOWING our series of articles describing the Integrated Audio System project (commenced in the June 1972 issue of Electronics Today) we received many requests for an amplifier having similar high performance but built as a separate unit.

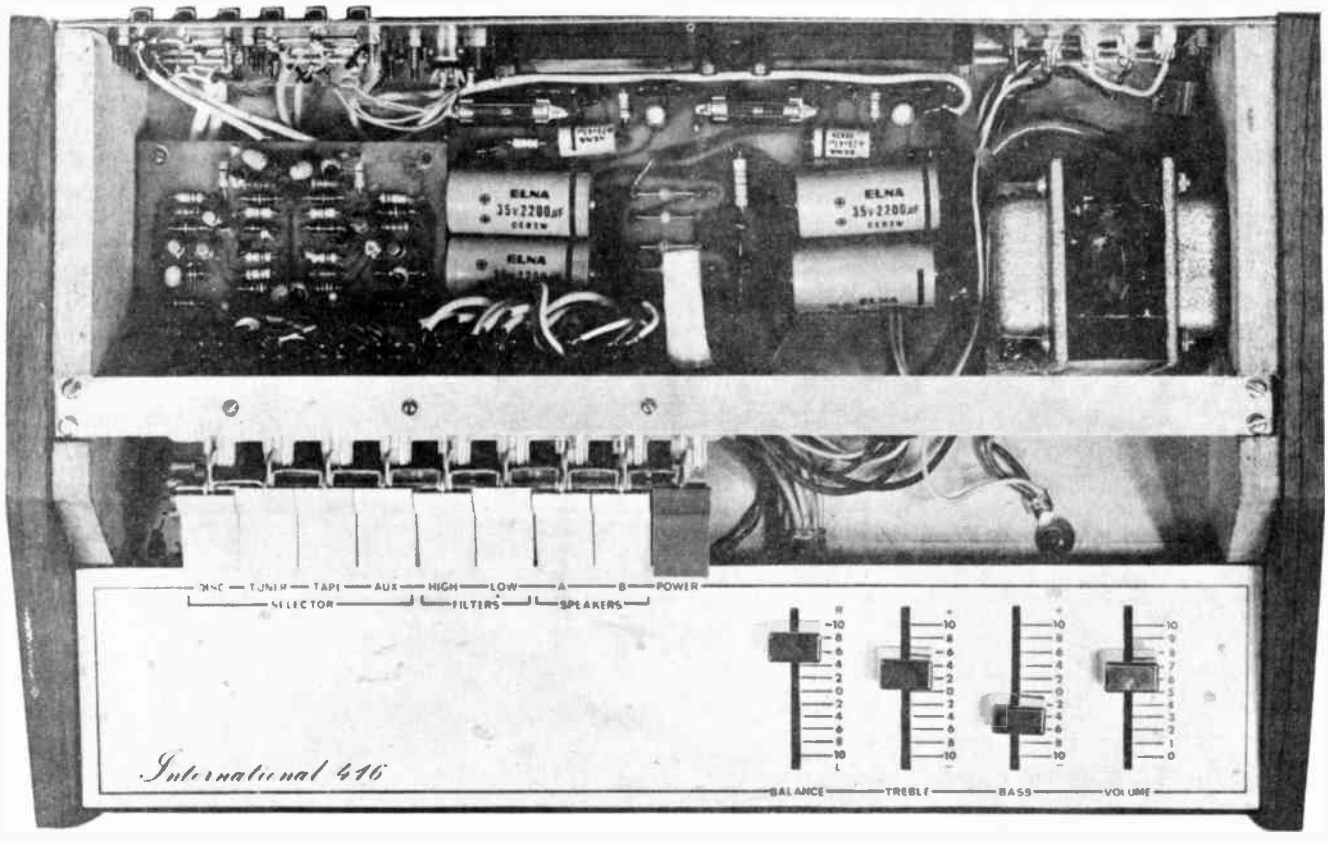
So here it is — an amplifier using the same STC modules and power amplifier circuitry as the Integrated Audio System. Now however, we have extended the built-in selection and filter facilities and have styled the unit into a very modern and unusually attractive case.

The amplifier provides a full 25 watts

ETI PROJECT 416



INTERNATIONAL 416 AMPLIFIER



rms per channel into 8 ohms and this will be found more than adequate for the majority of better quality bookshelf speakers. In addition the simple piano key function switching, coupled with slide controls for volume, tone and balance, make for an ease of operation which far surpasses that of most other amplifiers.

CONSTRUCTION

In this issue we have provided circuit diagrams, full size PC board layouts and component overlays for the preamplifier and main power amplifier boards. Using these diagrams for reference, assemble the components to the boards ensuring that all diodes, transistors and electrolytic capacitors are correctly orientated.

When mounting the hybrid IC power amplifiers, ensure that they are mounted vertically with their shiny metal heatsinks facing away from the PC board. In the final assembly, the complete power amplifier is screwed to the aluminium rear panel such that the panel acts as a heatsink. UNDER NO CIRCUMSTANCES SHOULD THE AMPLIFIER BE USED WITHOUT A HEATSINK PANEL IN PLACE. Such operation would damage the modules.

If an oscillator or preamplifier is available, the completed main amplifier may be checked out for correct operation by temporarily connecting the power transformer to the board and a pair of 8 ohm speakers. An input of 600mV to the main amplifier will provide 25 watts output.

The first stages of the main amplifier are earthed via the shielded signal cable from the preamplifier when these units are interconnected. The shielding of this cable must therefore be continuous.

Resistor R4 prevents damage to the main amplifier input stage should this earth be broken accidently, or under test. The resistor value is low enough to prevent such damage, but high enough to prevent hum due to earth loops.

It is suggested, however, that only the board assembly be carried out at this stage and that interconnections be left until full metal and woodwork details are published next month.

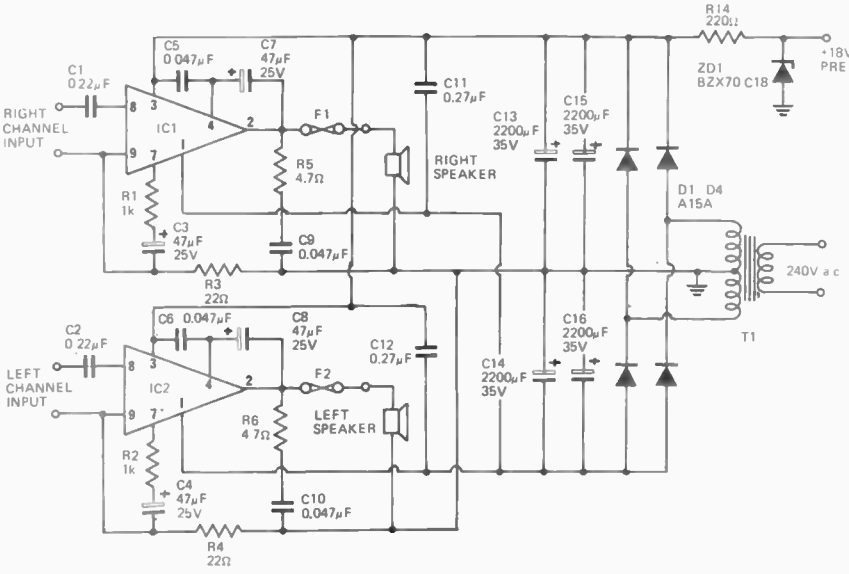


Fig. 1. Circuit diagram of main amplifier.

(Continued on page 82)

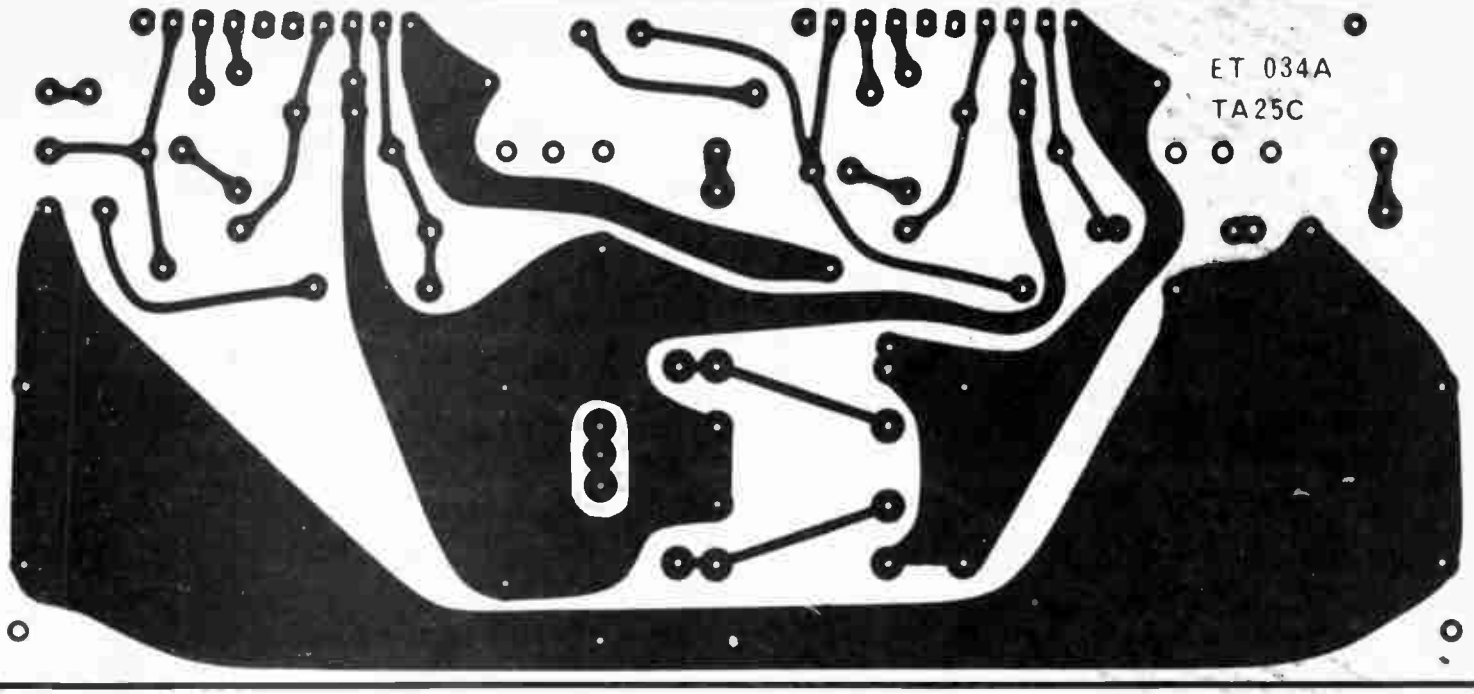


Fig. 2. Printed circuit board for main amplifier (shown full size).

PARTS LIST POWER AMPLIFIER

R1	Resistor	1k	½ watt	5%
R2	"	1k	½ watt	5%
R3	"	22ohms	½ watt	5%
R4	"	22 ohms	½ watt	5%
R5	"	4.7 ohms	½ watt	5%
R6	"	4.7 ohms	½ watt	5%
R14	"	220 ohms	1 watt	5%
C1	Capacitor	0.22µF	polyester	
C2	"	0.22µF	polyester	
C3	"	47µF	25V electrolytic	PC mount
C4	"	47µF	25V electrolytic	PC mount
C5	"	0.047µF	polyester	
C6	"	0.047µF	polyester	
C7	"	47µF	25V electrolytic,	axial leads
C8	"	47µF	25V "	"
C9	"	0.047µF	polyester	
C10	"	0.047µF	polyester	
C11		0.27µF	polyester	
C12		0.27µF	polyester	
C13		2200µF	35V electrolytic,	axial leads
C14		2200µF	35V "	"
C15		2200µF	35V "	"
C16		2200µF	35V "	"
D1-D4	Diode	A15A		
ZD1	Zener	BZX70C18		
IC1-IC2	Audio amplifier	TA25C		
PC	board	ET034A — TA25C		

2 fuse holders PC mounting
2 1½ amp fuses

Transformer A&R7778 Sec 40V centretapped
1½ amps (metal can with electrostatic shield).

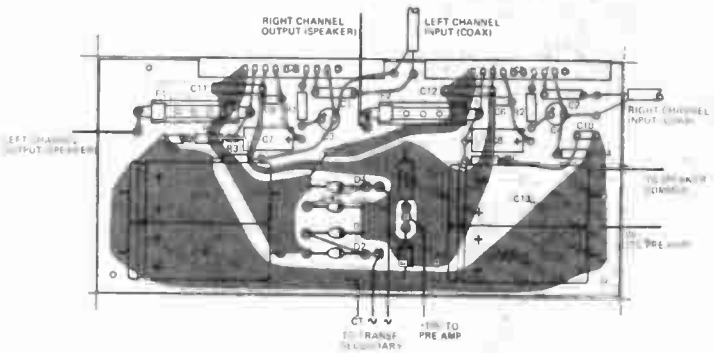
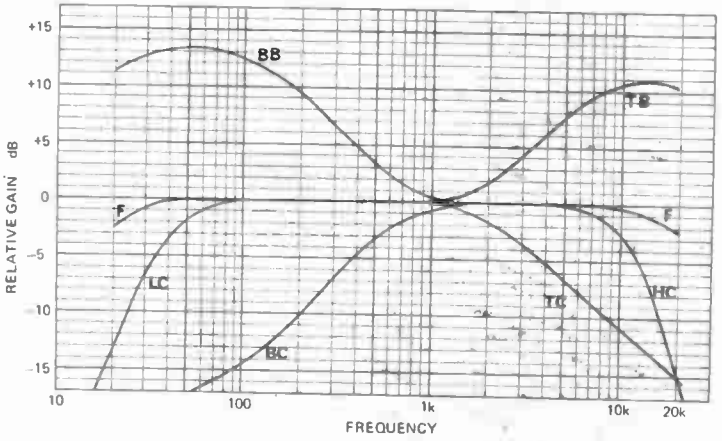


Fig. 3. Component overlay — main amplifier.

Fig. 4. Frequency response of amplifier — FF all controls flat BB base boost, BC base cut, TB treble boost, TC treble cut, HC scratch filter and LC rumble filter.

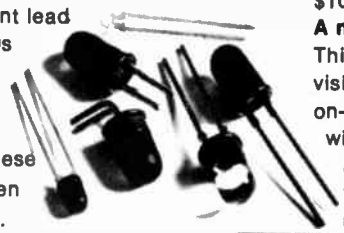


First we made them easy to use. Now we've made them easy to get.

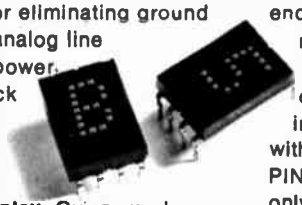
Yes, we now have distributors. The best there are in Australia. These distributors have in stock our complete line of LED displays and LED lamps.

Easy to use. All these products are solid-state and directly DTL-TTL compatible. And they are all designed for ease of application.

A complete LED lamp family. Our LED lamp family offers a complete selection of lens, lead and light output combinations. Our new T-1 Mini-LED is just 0.125" in diameter. This device offers high brightness over a wide viewing angle. And you have a choice of lenses; red diffused, clear or clear diffused. This little gem, known as the 5082-4480, costs just 45c in 100 quantities. The T-1¾ long lead wire wrappable 5082-4880 lamps start at 45c each in 100 quantities; the short or bent lead 5082-4440 LEDs start at 45c in 100 quantities. Higher volume prices on all these devices are even more attractive.

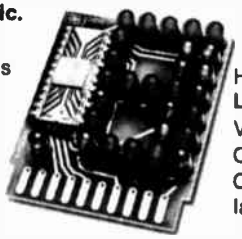


A new low-cost isolator. At 5 MHz bandwidth, it's 25 times faster than any other isolator on the market. It has a high DC isolation voltage of 2500 volts, and a high common mode rejection of 10 volts at 2 MHz, making the 5082-4350 ideal for eliminating ground loops in digital or analog line receivers, floating power supply and feedback networks. Prices start at $2.66 each in 100 quantities.

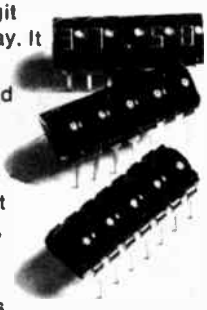


A low-cost LED display. Our numeric and hexadecimal displays have simplified your designs with on-board electronics, standard package configuration, and categorized light outputs. Best of all, the 5082-7300 numeric has a new low price of $10.80 in 100 quantities.

A new 1.5" LED numeric. This new LED display, visible from 60 feet, has on-board electronics, wide viewing angle, and is designed for edge mounting in a standard PC board socket. Solid-state reliability makes the 5082-7500 ideal where dependability is important. The price is $23.40 each in 100 quantities.



Small character LED displays. The 5082-7405 is a 5 digit end stackable display. It minimizes power consumption and offers ease of implementation with a standard 14 PIN DIP package. At only 7 mW per digit, this display is ideal for calculators, portable instruments and anywhere that low power and high brightness are important. The 5082-7405 is priced at $2.97 per digit in 100 quantities.



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RADIO DESPATCH SERVICE,
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Sydney, 2000.
Phone: 211 0816.

S.A.
GERARD & GOODMAN PTY. LTD.,
192 Rundle Street,
Adelaide, 5000.
Phone: 23 2222.

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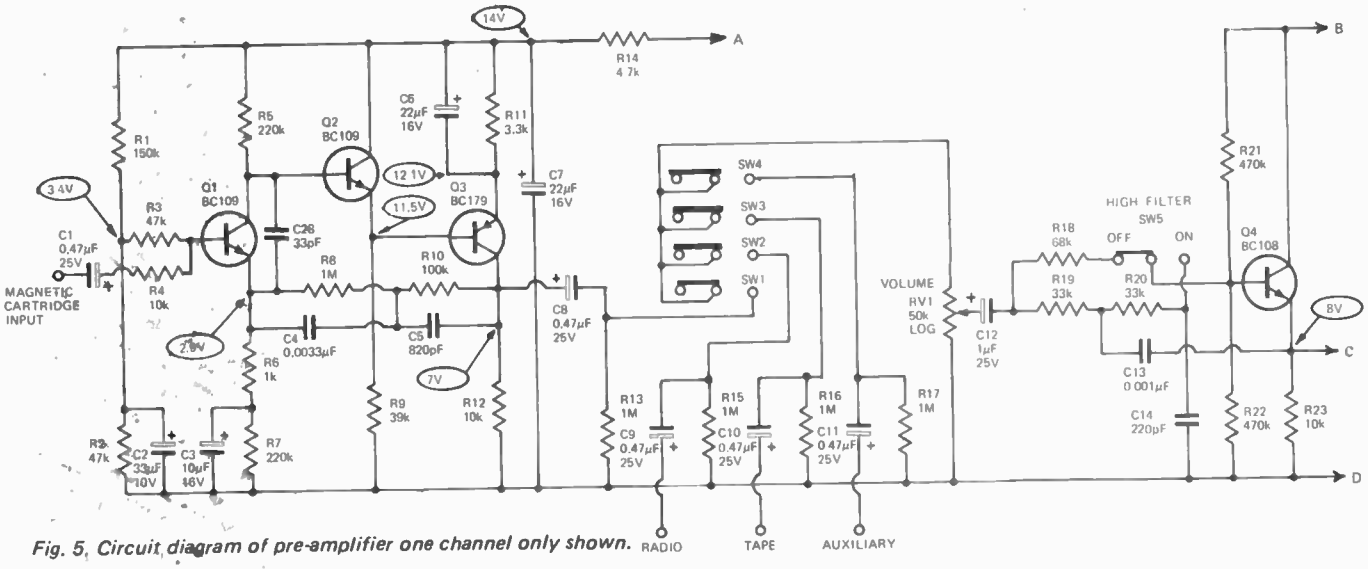


Fig. 5. Circuit diagram of pre-amplifier one channel only shown.

Continued from page 79

HOW IT WORKS

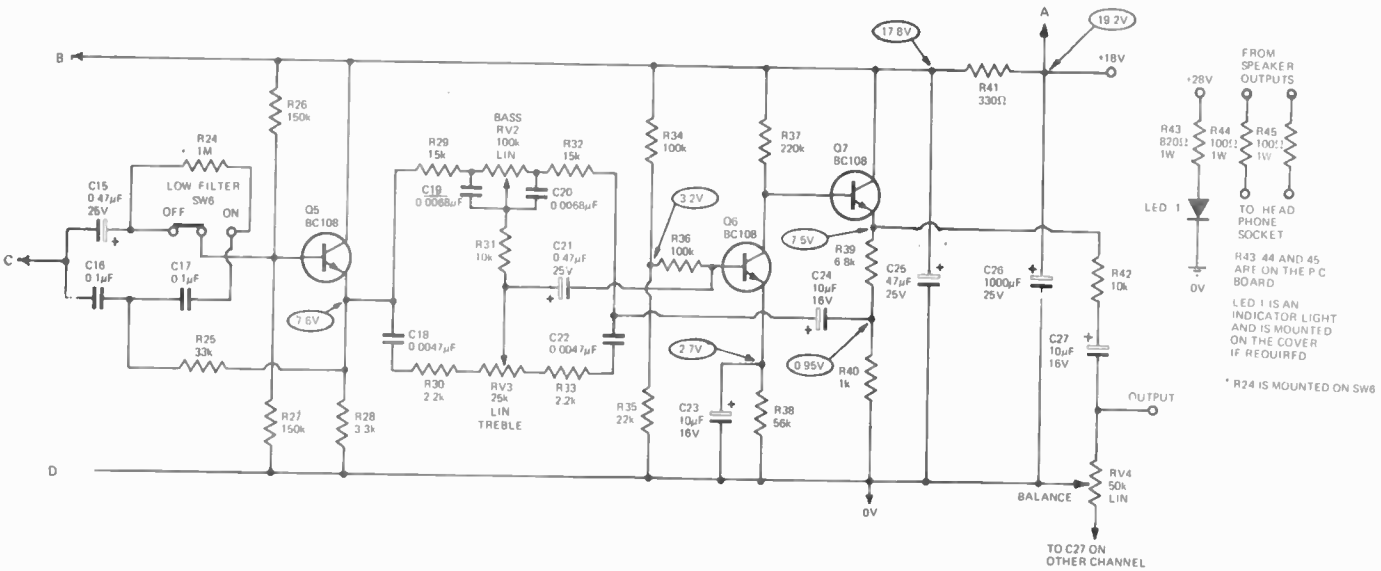
POWER AMPLIFIER

The power amplifier is based on the ITT 25-watt thick-film hybrid power modules. These amplifier modules are of fairly conventional design and contain practically all the necessary components assembled into one single sealed case.

The main amplifier circuit diagram is shown in Fig. 1.

A dual power supply is used for the module thus allowing the output to be connected directly to the speaker without the use of a capacitor. A 1.5A fuse is incorporated to protect the amplifier against accidental short circuits of the speaker leads.

The gain of the amplifier is set by R1, the low frequency cut off point (25Hz) by the input capacitor C1, and high frequency stability is ensured by R5 and C9. Capacitor C7 is simply a bootstrap capacitor that ensures correct bias current for the output stage when the output is driven high.



POWER SUPPLY

The power supply is a conventional dual full-wave circuit providing plus and minus 28 volts for the power amplifier, and via R14 and Zener diode ZD2, a supply of +18 volts for the preamplifier.

PRE-AMPLIFIER

When recording a disc the amplitude-versus-frequency response is modified so that stylus deflection is uniform with frequency. This is performed to a Standard due to the RIAA (Record Industry Association of America) which requires 13dB of cut at 100Hz and 13dB of boost at 10kHz.

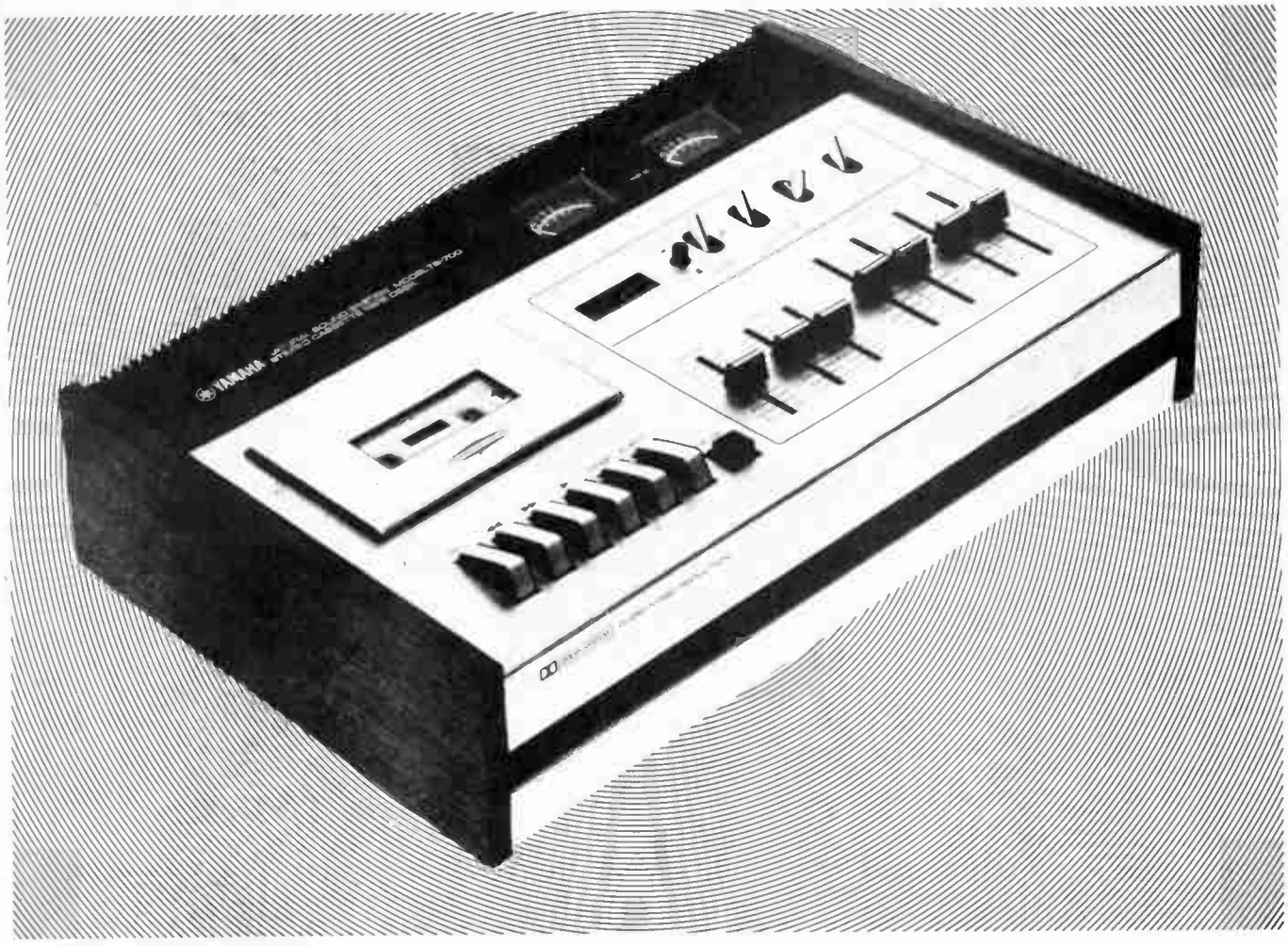
On replay of the disc the signal must be processed with the inverse of the recorded amplitude-versus-

Continued on page 85

SPECIFICATION INTERNATIONAL 416 AMPLIFIER

Frequency Response (at rated output)	+0 -3dB 20Hz to 20kHz
Output Power	25 watts per channel
Total Harmonic Distortion (at 25 watts 20Hz to 20kHz)	less than 0.5%
Hum & Noise at Rated Output	
Magnetic pickup input	-58dB
Tape, Radio, Auxiliary inputs	-70dB
Sensitivity for 25W Output	
Magnetic pickup input	1.5mV at 1kHz RIAA compensated
Tape, Radio, Auxiliary inputs	175mV
Main amplifier	600mV
Input Impedance	
All preamp inputs	50k
Main amplifier	27k
Channel Separation at 1kHz	48dB
Tone Controls	
Bass	±12dB at 100Hz
Treble	±10dB at 10kHz
Filters	
Low cut (rumble)	-5dB at 35Hz, 12dB/octave below 35Hz
High cut (scratch)	-5dB at 11kHz, 12dB/octave above 11kHz

Yamaha Natural Sound the music of the *Maestro* not the *Mechanic*



Yamaha Dolby System TB 700

When the Conductor subdues the Bass and accents the Strings he does it to produce the total musical effect demanded by the Composer Yamaha Natural Sound Stereo reproduces the Sound as it was played in its natural harmonic balance then leaves it to you to vary according to your own individual musical taste

The Yamaha *TB700* Tape Deck with variable speed plus a built-in DOLBY NOISE REDUCTION system, ensures the most perfect reproduction of sound yet achieved in Cassette Recorders.

For the first time you can enjoy the perfection of Yamaha Natural Sound in a Tape Deck

Specifications:

Dolby noise reduction system
S/N ratio better than 58 dB with Dolby Hot pressed ferrite head
D.C. Servo motor.
Wow and flutter less than 0.15%
Frequency response 30-16,000 Hz (chromium dioxide tape).
Line input and mic. mixing
Line input selector.
Three position tape selector (chrome, hi-energy/low noise, standard)
Recording limiter. Permits undistorted recordings.
Playback pitch control ± 5%
Auto stop.
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Expanded Vu meters—up to + 6 dB
OTL head phone amp., stabilised power supply.
Three digit tape counter, din connector.
Studio console layout real wood side panels.

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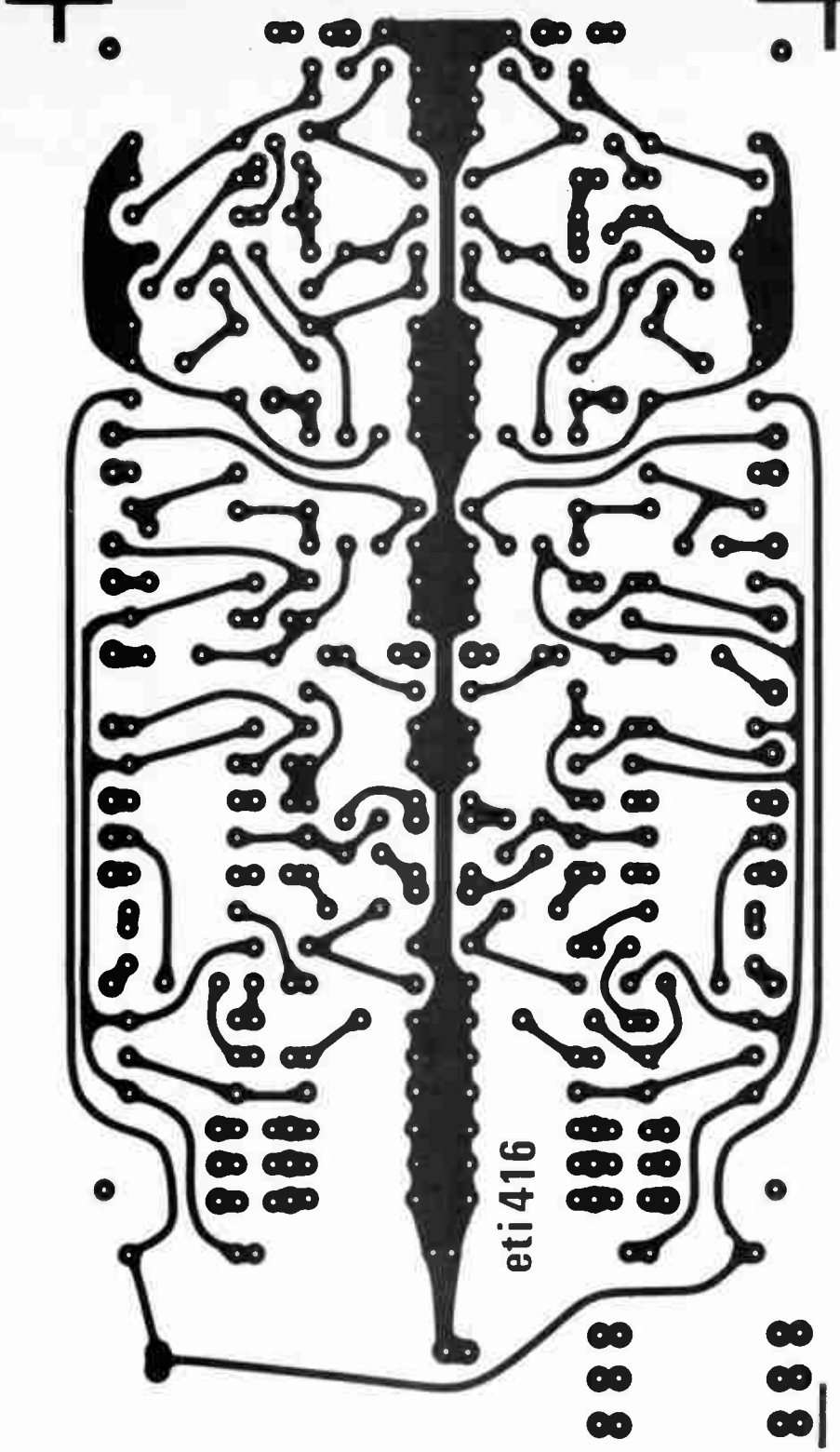


Fig. 6. PC board for pre-amplifier (both channels)

frequency characteristic in order to produce the original signal faithfully.

In addition, high fidelity magnetic cartridges may have an average output as low as 2 millivolts. A high voltage gain is therefore required to enable the amplifier to be driven to full output.

The first stage of our preamplifier provides both of the above functions, RIAA equalization and a gain of 100 at 1kHz. Transistors Q1, Q2 and Q3 form a high gain (open loop) non-inverting amplifier. The gain is controlled by the feedback network R8, R10, C4 and C5. The actual gain of the amplifier at any frequency is approximately equal to the impedance of the network at that frequency, divided by 1000 (R6). The network is designed to provide an amplifier gain characteristic which gives the required RIAA equalization.

Push button switches SW1 to SW4

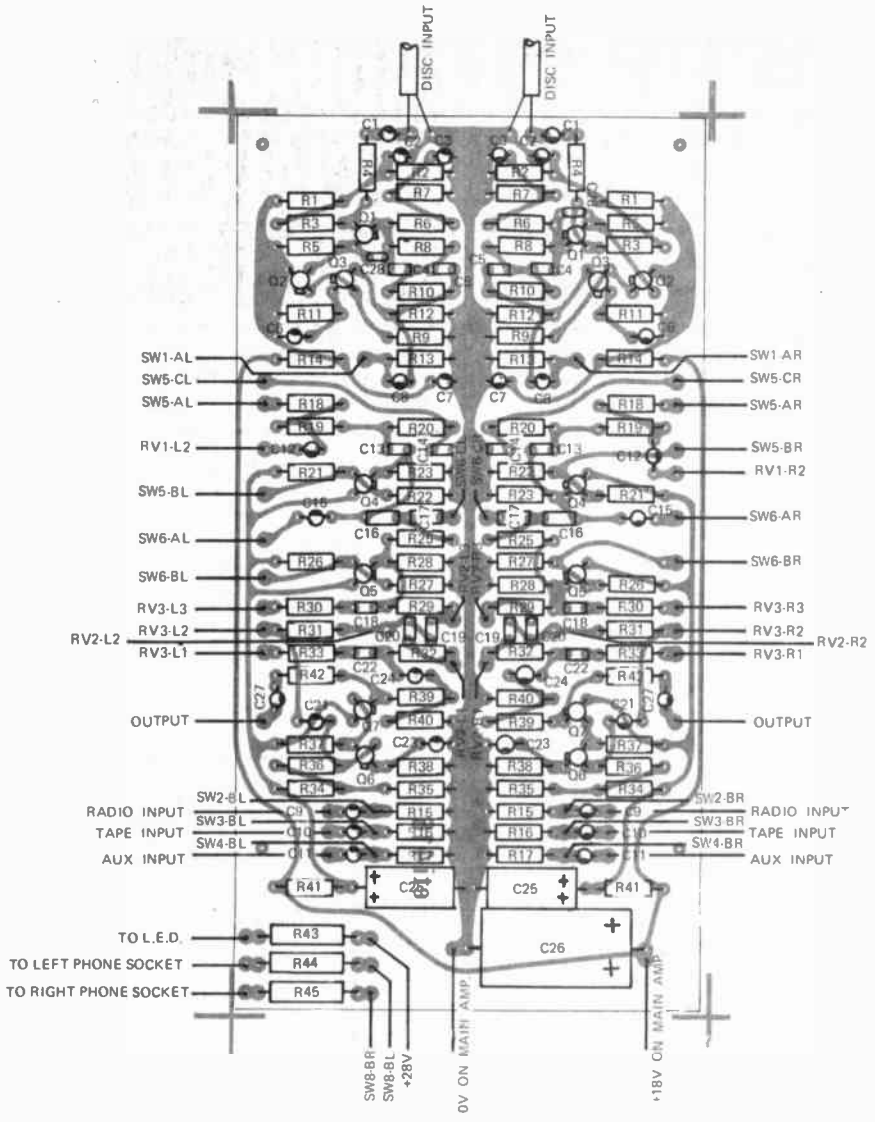


Fig. 7. Component overlay – pre-amplifier

PARTS LIST — PREAMPLIFIER

Two of each component are required except for those marked with an asterisk indicating one only required.

R1	Resistor	150k	½W	5%
R2	"	47k	"	"
R3	"	47k	"	"
R4	"	10k	"	"
R5	"	220k	"	"
R6	"	1k	"	"
R7	"	220k	"	"
R8	"	1M	"	"
R9	"	39k	"	"
R10	"	100k	"	"
R11	"	3.3k	"	"
R12	"	10k	"	"
R13	"	1M	"	"
R14	"	4.7k	"	"
R15	"	1M	"	"
R16	"	1M	"	"
R17	"	1M	"	"
R18	"	68k	"	"
R19	"	33k	"	"
R20	"	33k	"	"
R21	"	470k	"	"
R22	"	470k	"	"
R23	"	10k	"	"
R24	"	1M	"	"
R25	Resistor	33k	"	"
R26	"	150k	"	"
R27	"	150k	"	"
R28	"	3.3k	"	"
R29	"	15k	"	"
R30	"	2.2k	"	"
R31	"	10k	"	"
R32	"	15k	"	"
R33	"	2.2k	"	"
R34	"	100k	"	"
R35	"	22k	"	"
R36	"	100k	"	"
R37	"	220k	"	"
R38	"	56k	"	"
R39	"	6.8k	"	"
R40	"	1k	"	"
R41	"	330	"	"
R42	"	10k	"	"
*R43	"	820	1W	5%
*R44	"	100	"	"
*R45	"	100	"	"

RV1	Potentiometer	50k Dual log 45mm slide (Soanar)
RV2	"	100k Dual lin " " "
RV3	"	25k Dual lin " " "
*RV4	"	50k lin 45mm slide

C1	Capacitor	0.47uF	25V TAG Tantalum
C2	"	33uF	10V " "
C3	"	10uF	16V " "
C4	"	0.0033uF	polyester
C5	"	820pF	ceramic
C6	"	22uF	16V TAG Tantalum
C7	"	22uF	16V " "
C8	"	0.47uF	25V " "
C9	"	0.47uF	25V " "
C10	"	0.47uF	25V " "
C11	"	0.47uF	25V " "
C12	"	1uF	25V " "
C13	"	0.001uF	ceramic
C14	"	220pF	ceramic
C15	"	0.47uF	25V TAG Tantalum
C16	"	0.1uF	polyester
C17	"	0.1 uF	"
C18	"	0.0047uF	"
C19	"	0.0068uF	"
C20	"	0.0068uF	"
C21	"	0.47uF	25V TAG Tantalum
C22	"	0.0047uF	Polyester
C23	"	10uF	16V TAG Tantalum
C24	"	10uF	16V " "
C25	"	47uF	25V electrolytic
*C26	"	1000uF	25V "
C27	"	10uF	16V TAG Tantalum
C28	"	33pF	Ceramic

Q1	Transistor	BC109
Q2	"	BC109
Q3	"	BC179
Q4	"	BC108
Q5	"	BC108
Q6	"	BC108
Q7	"	BC108

* LED 1 light emitting diode NSL5032
* Printed circuit board ETI416
* SW1-SW9 key switch assembly McMurdo 2271-9
* SW10 slide switch DPDT
* 5 pin DIN socket
* Stereo phone jack
6 way RCA Socket John Carr AT-636 or similar
4 way screw terminal strut John Carr AT-524 or similar

select equalization amplifier output, radio, tape or auxiliary inputs as required to the volume control. With SW5 in the 'OFF' position Q4 acts as an emitter follower. With SW5 'ON' Q4 and its associated components acts as a low-pass scratch filter, selectively attenuating signals above 8kHz at 12dB for octave.

Similarly SW6, Q5 and associated components provide a switchable rumble filter which attenuates frequencies below 50Hz at 12dB per octave.

Transistors Q6 and Q7 are a high gain (open loop) buffered amplifier with feedback provided by the tone control networks. With both tone controls set to mid position, the impedances Z1 (emitter Q5 to base Q6) and Z2 (base of Q6 to junction R31 and R32) are equal. In this condition the overall gain from Q5 emitter to the junction of R39 and R40 will be unity at all frequencies, and to the emitter of Q7 the gain will be about four. As the tone controls are varied, the ratio of the impedances Z1 to Z2 will vary with frequency, and hence stage gain will vary with frequency.

Control RV2 provides either bass boost or bass cut, and RV3 provides treble boost or treble cut. The control RV4 differentially varies the channel gains to provide balance. ●

VHF TRANS-EQUATORIAL PROPAGATION

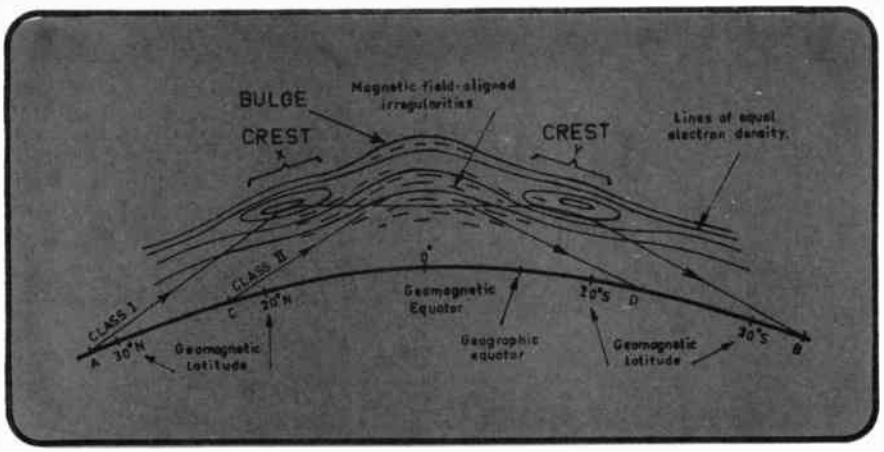


Fig. 1. The propagation modes of class I and class II TEP.

RECEPTION of VHF signals over very long paths that cross more-or-less transversely to the equatorial zone have been frequently reported in the last 25 years. The frequencies involved are generally far in excess of the predicted maximum useable frequency, and signal strengths sometimes approach free-space values. Path lengths reported are usually greater than 5000 km – with a few up to 18 000 km. These signals are generally regarded as having arrived by "anomalous" transequatorial propagation.

Throughout the remainder of this article the letters TEP are used to denote this form of propagation.

A SHORT HISTORY

The first intercontinental VHF contacts were reported in QST by Ed Tilton in "The World Above 50 Mc", May and October 1947 but the discovery of TEP by radio amateurs did not receive a great deal of attention in the scientific world until the late 1950's (and the IGY in 1957/58).

Contacts between Australia and Hawaii, Mexico and Argentina, and the U.S.A. and Peru were fairly common between 1947 and 1951. There was then a sharp decline during the sunspot minimum but new reports began to appear again in 1955, reaching a maximum during 1957 – 1960, and again during 1968 – 1971. Some contacts were reported over extremely long paths, ranging from 9 860 km to 18 760 km.

The first scientific paper to appear on TEP was by Ed Tilton, published in the Proceedings of the Second Meeting of the Mixed Commission on the Ionosphere, in Brussels 1951.

Observations made between 1950 and 1966 of the characteristics and propagation modes of TEP along with research into the equatorial ionosphere, brought to light a lot of very interesting information. In addition to collecting amateur observations, a number of experiments were set up involving HF and VHF scatter soundings, oblique incidence ionosondes, observation of beacons and TV and FM stations in Korea, Japan and Russia, and topside ionospheric sounding by satellites. This led to a better understanding of the structure of the equatorial ionosphere and to suggestions regarding the various modes that support TEP.

Further research is currently being carried out in Australia by the Department of Supply, the Ionospheric Prediction Service Division and the Physics Department of the James Cook University at Townsville.

GENERAL CHARACTERISTICS OF VHF TEP SIGNALS

There appears to be two distinct types of TEP, distinguished by times of peak occurrence, fading characteristics, path lengths, and principal mode of propagation.

One mode, designated Class I, exhibits the following characteristics:–

(a) a peak occurrence around mid-to-late afternoon (1200 to 1900 local mean time, measured at the point where the path crosses the magnetic equator).
(b) normally strong, steady signals with a low fading rate and, more specifically, a small Doppler spread (around ± 2 to 4 Hz).
(c) path lengths of 6000 km to 9000 km and sometimes longer.

The proposed propagation mode for Class I TEP is generally termed the "super-mode" or FF mode. As can be seen from Fig. 1, the ray, transmitted from A, "skips" from the crest in the equatorial ionosphere at X, across the crest at Y and is refracted down to earth at B. These "crests" are a feature of the equatorial ionosphere (about which I shall have more to say later).

The other mode, designated Class II, shows the following characteristics:–

(a) a peak occurrence around 2000 hours to 2300 hours local mean time
(b) high signal strengths but with deep, rapid fading (typical rates are 5 Hz to 15 Hz) accompanied by a Doppler spread much greater than for Class I, generally in the order of ± 20 to 40 Hz (i.e. ten times that for Class I).
(c) path lengths are usually shorter than for Class I, being around 3000 km to 6000 km.

The propagation mode or mechanism for this class of TEP is not fully understood, but it is believed that irregularities (dense "clouds" of electrons having a certain specific shape) in the equatorial ionosphere –

By ROGER HARRISON
VK2ZTB

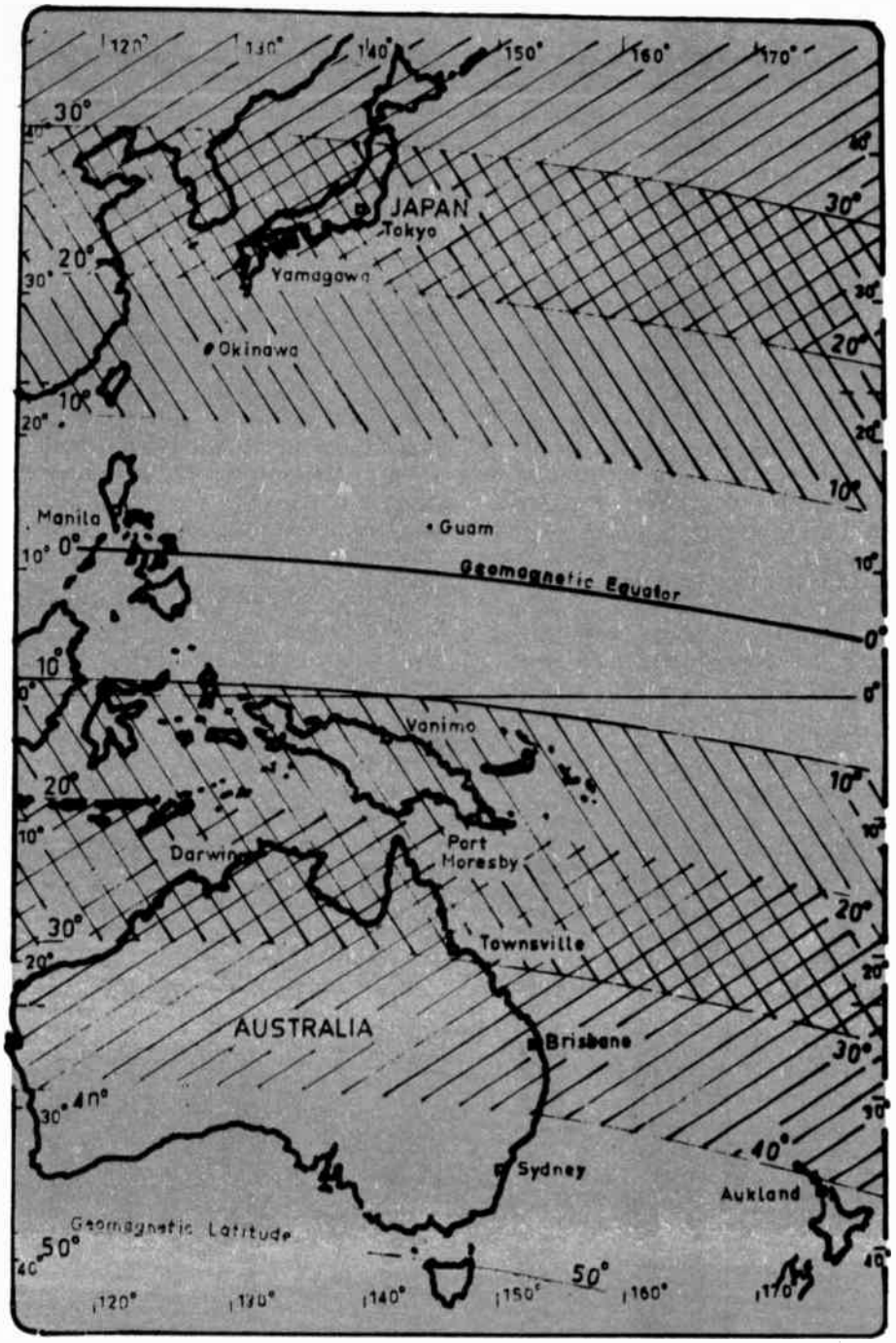


Fig. 2. Australasian sector of the world showing terminal zones for class 1 TEP (20° to 40° geomagnetic latitude) and class II TEP (10° to 30° geomagnetic latitude).

aligned with the earth's magnetic field – are responsible for "ducting" or efficiently "scattering" the signal such that the path geometry looks like that in Fig. 1. (from C to D).

Additionally, Class II will support much higher frequencies than Class I; signals have been observed up to 102 MHz. This does not imply that 102 MHz is the maximum frequency that Class II TEP will support. It is just that *nobody has reported an authentic case any higher in frequency*. Who will be the first to make Australia-Japan on 144 MHz via TEP? No upper limit has yet been proposed for Class II TEP.

Class I TEP is sometimes called "afternoon-type TEP" and Class II is sometimes called "evening-type TEP", for obvious reasons.

THE EQUATORIAL ANOMALY

The equatorial ionosphere does not have an even distribution of electron density. As can be seen from Fig. 1., the F-region iso-electronic contour lines (lines of equal electron density) show a depletion of electrons, together with a rise of the F-region height, above the magnetic equator. Roughly symmetric, north and south of the geomagnetic equator, are two "crests" that represent an increased electron density in the F-region. These crests are located between 10° and 20° (geomagnetic latitude) north and south of the geomagnetic equator. The location of these regions are shown in Figs. 2, 3 and 4.

This region of the ionosphere (within approximately ± 20° geomagnetic latitude) is generally referred to as the equatorial *anomaly* region. It is a regular feature and not a transient phenomena.

If the electron density within the crests increases sufficiently, it will be possible for a signal, incident upon one crest at a very small angle, to be refracted across the geomagnetic and geographic equators to the opposite crest and hence to earth as illustrated in Fig. 1.

DIURNAL VARIATION OF THE EQUATORIAL ANOMALY

From what little data is available, it appears that the equatorial anomaly starts to develop between 0800 and 1000 LMT, the crests moving away from the magnetic equator between 0900 and 1500 LMT.

When the sun sets on the base of the equatorial ionosphere (about 1½ hours later than ground sunset, i.e. 1930 hours LMT, the base of the layer generally rises and the equatorial anomaly begins to break up into large "blobs". This does not always happen, the base of the layer may not necessarily rise and, on occasion, is found to fall or remain at the pre-sunset height. Sometimes the anomaly does not break up into distinct blobs and the electrons appear to diffuse back over the magnetic equator. The ionosphere is generally like this during early morning and late evening. The detailed behaviour of the decay phase of the equatorial anomaly has not yet been fully established.

THE EQUATORIAL ANOMALY AND MAGNETIC ACTIVITY

On magnetically disturbed days, the equatorial anomaly is not as well developed as it is on magnetically quiet days, and it is known that, in the Australasian sector, the bulges are

VHF TRANS-EQUATORIAL PROPAGATION

closer to the magnetic equator on disturbed days than on quiet days.

SEASONAL VARIATIONS OF THE EQUATORIAL ANOMALY

The crests lie very nearly symmetrically either side of the magnetic equator at equinox and asymmetrically at solstice. The electron densities of the bulges are greater at equinox than at solstice and this, combined with the anomaly symmetry at equinox, favours Class I TEP at the equinoxes. The separation and overall width of the crests varies seasonally also, being greatest at equinox.

"Tilts" in the base of the F-layer are known to be associated with the crests and are most pronounced between 1200 and 2000 LMT and at equinox. These tilts which are departures of the iso-electron density contours from concentricity with the earth, enhance the tangency of a radio wave with the layer, consequently increasing the maximum for useable frequency for suitable circuits and improving the chances of propagation via a supermode (Fig. 1).

SUNSPOT CYCLE VARIATIONS OF THE EQUATORIAL ANOMALY

At sunspot maximum the break up of the crests is generally later than at sunspot minimum. This appears to be the major effect of the sunspot cycle on the equatorial anomaly.

There is an increase in the number of electrons in the crests at sunspot maximum and an increase in the presence of tilts, increasing the maximum useable frequency.

The crests of the equatorial anomaly are present for fewer hours during sunspot minimum, and their height, size, associated tilts and ionisation density decrease with decrease in sunspot number.

All these factors contribute to the observed dependence of Class I TEP on the sunspot number. The dependence though, is not great.

"SPREAD-F" or "RANGE-SPREADING"

On some days, irregularities start to appear in the base of the F-layer by 2000 hours LMT and cause what is termed "range-spreading" or "spread-F" on vertical incidence ionograms. An illustration is given in Fig. 5., comparing an "unspread" ionogram to one showing spread-F for different times on the same day at Cocos Island. The cause of these irregularities is not yet known. They are not necessarily associated with the decay phase of the equatorial anomaly. There appears to be a connection between spread-F and evening-type TEP.

The duration of spread-F is quite variable, sometimes lasting for less than an hour and at other times lasting until 0600 hours the next morning.

The occurrence of spread-F is more common on magnetically quiet days, in periods of sunspot maximum, and is more common in areas where the

Fig. 3. The American sector of the world showing terminal zones for class I TEP (20° to 40° geomagnetic latitude) and class II TEP (10° to 30° geomagnetic latitude).

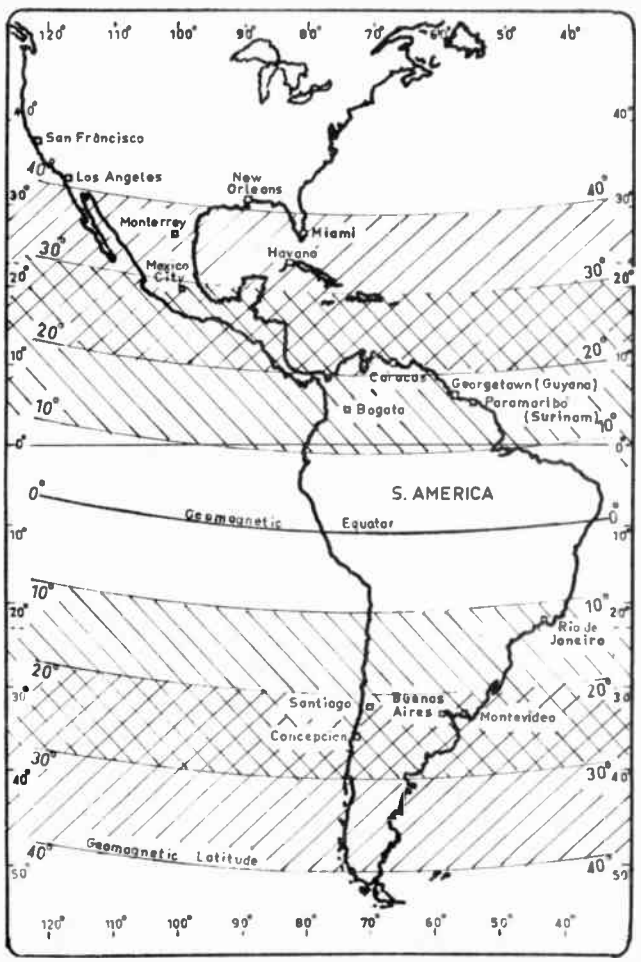
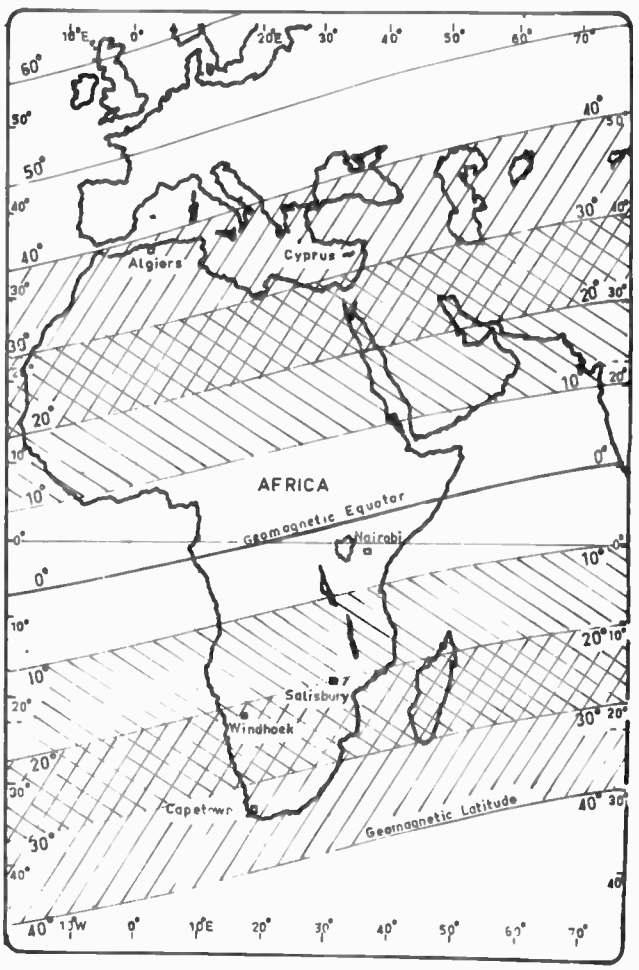


Fig. 4. The African-Mediterranean Sector of the world showing terminal zones for class 1 TEP (20° to 40° geomagnetic latitude) and class 11 TEP (10° to 30° geomagnetic latitude).



geomagnetic and geographic equators are widely separated. There appears to be no correlation between magnetic activity and spread-F at sunspot maximum.

The occurrence of spread-F favours the equinoxes, particularly in the Australasian sector, except at sunspot minimum where it favours the summer solstice. This effect is not so pronounced in the American sector.

Spread-F appears to be dependent on the post-sunset rise of the F-layer base which is most pronounced at sunspot maximum.

CLASS I TEP – CAUSES AND CHARACTERISTICS

It is now well established that Class I TEP depends on the equatorial anomaly. All the observed variations and characteristics of the equatorial anomaly influence Class I TEP in a predictable manner. However, what is the cause behind the cause, or, what causes these two crests that are a feature of the equatorial ionosphere?

THE FOUNTAIN EFFECT

During the day, electrons from the base of the F-layer move upwards, in the region of the magnetic dip equator (where the magnetic field lines are horizontal), under the combined influence of the earth's magnetic field and the electric field that exists between the E-layer and the F-layer. These electrons then diffuse along the magnetic field lines and accumulate at two places, either side of the magnetic equator, forming the crests of the equatorial anomaly. The effect is illustrated in Fig. 6.

This explanation is, of necessity, simple and perhaps not entirely accurate but should serve for the purpose of this article. For those who wish to know more, reference 15 provides more data.

The effect of the equatorial anomaly on foF2 (critical frequency of the ordinary ray at vertical incidence for the F2 layer) for the area either side of the geomagnetic equator is given in the inset of Fig. 7. As can be seen, foF2 reaches a peak where the crests are located and a trough over the magnetic equator. This partly accounts for the high maximum useable frequencies observed when supermode propagation is used.

DETAILED CHARACTERISTICS

Now I will discuss the characteristics of Class I TEP in detail with reference to its dependence on the equatorial anomaly. The reader can refer back to particular paragraphs in the discussion of the equatorial anomaly, if necessary, to elucidate the dependence of various characteristics on the associated characteristics of the equatorial anomaly.

OCCURRENCE TIMES

There is a peak occurrence of Class I TEP between 1200 and 1900 LMT for all sectors. Individual circuits will have slightly different peak occurrence time somewhere within these limits. The peak occurrence times coincide with the stable phase of the equatorial anomaly which is generally well developed after 1100 LMT and begins to decay around 1900 LMT. Occasionally it remains stable after this time, particularly at equinox at sunspot maximum and observations bear this out, signals remaining stable for several hours after 1900 LMT before experiencing the flutter fading of Class II TEP.

Paths that are normal (or nearly so) to the geomagnetic equator and symmetrically located either side are favoured, experiencing earlier start times, longer durations and a greater number of occurrences – especially at sunspot minimum.

I might add that TEP can occur at any time of the night or day but it is most infrequent between 0400 and 0800 LMT for either Class I or Class II TEP.

Occurrence times are generally dependent on:–

(a) Suitable path geometry, including tilts which allow supermode propagation.

(b) Build up of sufficient ionisation density in the crests of the equatorial anomaly such that foF2 of each crest is sufficiently high to increase the maximum usable frequency above that normally expected.

(c) Sunspot number – (b) is obviously dependent on sunspot number but this is not the only factor involved. This dependence is not as great as one would imagine and is much less than for Class II.

(d) Season.

PATH CHARACTERISTICS

As class I TEP is propagated via a supermode (Fig. 1.) the path geometry can be determined for the maximum and minimum range possible for the observed parameters of the bulges of the equatorial anomaly. The parameters affecting the path geometry are the height and location of the virtual reflection points, foF2 for these points and incidence angles to those points. Knowing these, it becomes possible to predict the maximum and minimum ranges. These work out to be between 5000 and 9000 km. This was calculated

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assuming that the path and equatorial anomaly were symmetrical about the geomagnetic equator.

The 'best' paths are those which are located symmetrically about and normal (or nearly so) to the geomagnetic equator and the terminals of which lie in areas between 20° and 40° geomagnetic latitude north and south of the geomagnetic equator. These areas are marked in Figs. 2, 3 and 4 (cross hatched to the right). These paths tend to experience Class I TEP more often than oblique or asymmetrical paths.

Very long paths (greater than 10 000 km) are always oblique and some other form of propagation appears necessary to assist the signal in being favourably incident on the bulges of the equatorial anomaly. Sporadic E (Es) is the most likely cause but this has yet to be confirmed.

An observation by Roger Hord, VK2ZRH, (private communication) appears to support this. On the 8th of November, 1970, he reported hearing WB6KAP on 50 MHz from 1310 to 1435 EAST. At the same time he reported sporadic E signals from New Zealand. Now WB6KAP is located in California some 12 200 km from Sydney. For this signal to have been refracted across the equator via a supermode, it must have struck the southern crest of the equatorial anomaly somewhere above Western Samoa which is some 4500 km from Sydney. A ray, leaving the earth tangentially, would strike the F-layer some 2000 km away at the most thus some other form of propagation was necessary for the signal to reach Sydney. It works out that it is possible for sporadic E, located under the Tasman Sea east of Australia, to refract the signal sufficiently for it to arrive at the equatorial anomaly over Western Samoa. Southern California is located sufficiently close to the geomagnetic equator for a ray to strike the anomaly at a favourable angle.

TEP over paths which are fairly oblique to the geomagnetic equator (65° or less) tend to be reasonably long (greater than 8000 km), rare, short lived and tend to occur mainly some weeks after the equinoxes. Many of them are asymmetrically situated with regard to the geomagnetic equator but this bias is probably due to observer station distribution. Very long range TEP is generally observed one to two years after a sunspot maximum and rarely, if ever, during the sunspot minimum.

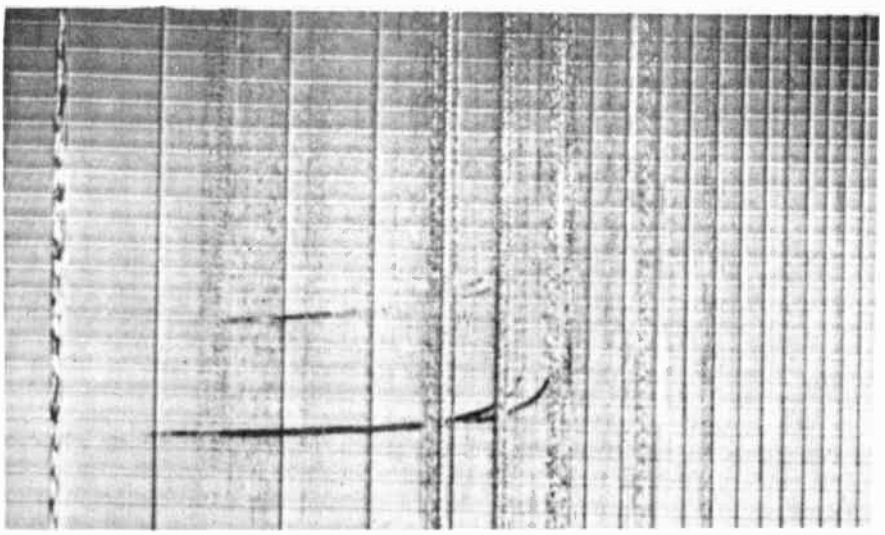

Fig. 5. (a) Vertical incidence ionogram from Cocos Island, 1900 hrs LMT, 5th August 1970, showing typical F-layer trace without range-spreading.

RAY TRACING

If a series of rays from a transmitter in one hemisphere is traced, using computer simulation through a model of the equatorial ionosphere, it is found that much of the low angle radiation travels via the supermode of propagation and experiences a large degree of focussing at the receiver.

In Fig. 7., a computer printout illustrates this ray-focussing effect. The inset shows the variation of foF2 with geomagnetic latitude assumed for the particular circuit. The printout is reproduced by kind permission of Mr. B.C. Gibson-Wilde of the James Cook University of North Queensland.

Ray focussing is a very important characteristic of Class I TEP as it provides the strong signals and "area selectivity" (signals being heard in one narrowly defined area and not in others) that is often noticed as being associated with afternoon type TEP (also reported by D. Tanner VK8AU, private communication).

Many observers have noted that, from their location, TEP signals are observed first from the most eastern area and thence move west — following the sun. For example amateurs in the eastern states of Australia first hear amateurs in the eastern regions of Japan. The eastern stations gradually disappear and are followed by stations in central Japan, then western Japan, then Korea. Japanese amateurs first hear stations in the eastern states (Qld, N.S.W., Vic.) and then stations in Central regions of Australia (N.T., S.A.) followed by stations in Western Australia.

SEASONAL CHARACTERISTICS

There is a maximum number of occurrences around the equinoxes for all sectors of the world. This is due to the more favourable conditions that exist in the equatorial anomaly at the equinoxes. Reference to the seasonal variations in the equatorial anomaly will show that the important parameters satisfy the best conditions for Class I TEP at the equinoxes. The attitude of the earth with respect to the sun and the ecliptic plane is obviously the major controlling factor on the symmetry of the equatorial anomaly at equinox.

There is always a greater number of occurrences of Class I TEP near the sunspot maximum than during the minimum. It is well known that sunspot number affects the maximum useable frequencies of the F-layer and peak electron density for the crests of the equatorial anomaly follow a similar pattern. However, the greatest number of occurrences of Class I TEP lags behind the sunspot maximum by one to two years. The reason for this is, as yet, unknown. The noise flux emitted by the sun at a wave length of 10cm reaches a maximum one to two years after the sunspot number maxima and is most likely more representative of solar activity.

Contacts can be had almost daily around the equinoxes with Class I TEP — as was evidenced by the openings reported in "Amateur Radio" and "QST" during 1970 and 1971 as well as earlier in QST. Similar results are recorded by oblique ionosondes operating on transequatorial circuits between Okinawa and St. Kilda (S.A.) and Okinawa and Townsville (Qld.).

SIGNAL CHARACTERISTICS

Apart from the frequencies involved, the most extraordinary characteristics of Class I TEP signals are their strength and steadiness (absence of fade). Signal strength can sometimes

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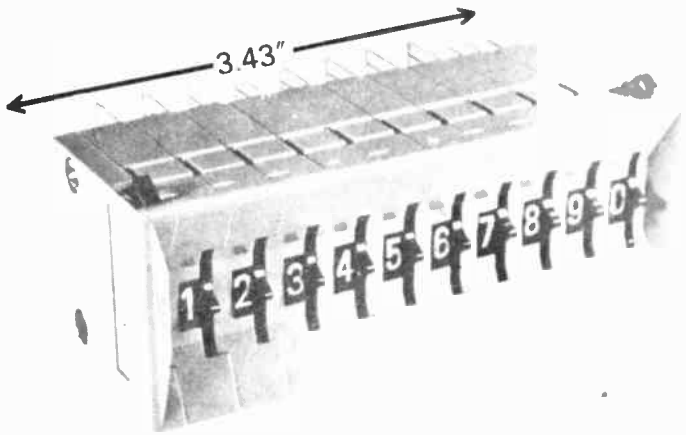

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approach free space values, and the fading rate is normally quite low and not very deep. This is explained by the fact that rays strike the tilts associated with the crests of the equatorial anomaly very near to tangency and are efficiently refracted; this, combined with ray focussing, and the same absorption for a one-hop path, leads to very little signal loss.

Many amateurs report good results running only medium to low power (under 20 watts) and small antennas. (Also confirmed in private communications).

The maximum useable frequency for Class I TEP appears to be around 60 MHz which places the 6 metre amateur band in a very fortunate position.

The frequencies involved in Class I TEP will always be above the predicted maximum useable frequency, for the path involved, by a considerable factor. Thus Class I TEP affects the HF region as well as the lower VHF region. Contacts on the HF bands via Class I TEP have been reported, but are not often recognised by amateurs.

The MUF for oblique paths is generally lower, owing to unfavourable "look" angles on the equatorial anomaly, and consequently the MUF for these paths exceeds 50 MHz less often than for paths which are more nearly normal to the magnetic equator.

Although Class I TEP provides fairly stable signals, wideband system will suffer distortion due to multipath effects (see Fig. 7). Voice transmissions will not appreciably suffer, especially narrow band FM, but television picture signals will be of very poor quality.

It must be understood that Class I TEP is not a "normal" F2 mode of propagation as many VHF amateurs seem to think, but it is certainly not "anomalous" within the definition of the word. The maximum useable frequency of the F-layer for 1F or 2F modes in general rarely exceeds 50 MHz so that Class I TEP cannot be classed as "normal" F2 skip on these grounds alone. Secondly Class I TEP travels via a two-hop ionospheric mode *without intermediate ground reflection.* This supermode or FF-mode is sometimes referred to as "chordal-hop" propagation.

CLASS II TEP – CAUSES AND CHARACTERISTICS

The characteristics of Class II, or evening-type TEP, are generally well known but the mode of propagation is not yet known or completely defined. Several different explanations have been put forward, based on the correlation observed between night-time TEP observations and the occurrence of equatorial spread-F. Experimental results, when applied to the various theories, have shown them to be incorrect, but it is well established that there is some definite connection between spread-F along the paths considered and the occurrences of Class II TEP.

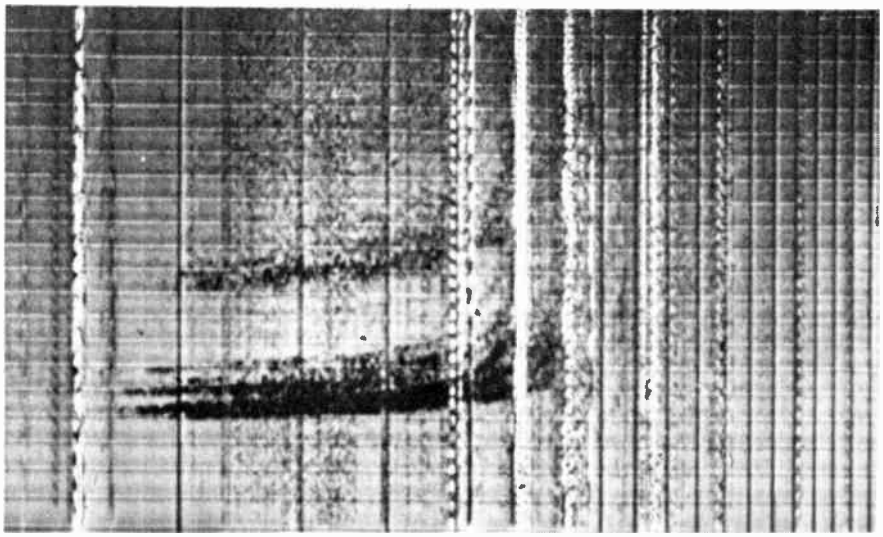

Fig. 5. (b) Vertical incidence ionogram from Cocos Island, 2200 hrs LMT, 5th August, 1970, showing typical equatorial spread – F or range spreading. Range spreading is caused by oblique incidence reflections from irregularities in the base of the F-layer.

The higher frequencies propagated by Class II TEP offer some interesting possibilities to the communicator. There is a maximum occurrence between 2000 and 2300 LMT with a pronounced peak somewhere in this range for different seasons and particular paths. This means that just about every circuit has an individual peak occurrence time for different seasons but it will be somewhere between 2000 and 2300 LMT. This coincides well with the occurrence of equatorial spread-F, but the duration of TEP signals is usually less than the duration of spread-F. This is probably due to the reduction of peak electron density in the F-layer after midnight.

Class II TEP has been observed to last until the early hours of the morning, but only on lower VHF. The occurrence of Class II TEP openings is greatest during the equinoxes as is spread-F – this is more pronounced than in the case of Class I TEP. These openings are fewest during the winter solstice over the magnetic equator. This occurs during December – January for the Asian and African sectors and June – July for the Americas (7).

Start times for openings via Class II TEP are less dependant on path geometry than for Class I TEP as also are the times of duration. Class II is much more tolerant of asymmetrical path geometry than Class I.

Usually contacts are dependent on

(a) Appearance of equatorial spread-F at an appropriate geomagnetic latitude.
(b) Season of the year, i.e. proximity to the equinoxes.
(c) Sunspot number.

PATH CHARACTERISTICS

Path lengths for Class I TEP are generally from 3000 km to 6000 km and terminals are quite often asymmetrically and obliquely situated with regard to the magnetic equator. Some very long night-time paths have been observed but these can be explained by the occasional continuance of the Class I TEP mode after sunset, or another mode of propagation assisting in extending the range of signals. Again, sporadic-E is likely to be the reflector at the lower end of the VHF range. Tropospheric ducting could extend the range in a similar fashion at the higher frequencies but little work has been reported in this direction. Nielson mentions Es in this regard in his paper.

There is a zone where stations (or circuits) will experience both modes, and zones where stations will only experience one or the other. The area between 20^{o} and 30^{o} geomagnetic latitudes (Figs. 2, 3, 4) is common ground for both Class I and II TEP. Stations located in these areas will encounter both modes from time to time with perhaps a gradual transition from Class I to Class II (evidenced by an increase in flutter fading after 2000 hours) or a signal dropout of up to an hour's duration.

Stations north and south of about

VHF TRANS-EQUATORIAL PROPAGATION

30° geomagnetic latitude will tend to see only afternoon-type TEP while those stations closer than about 20° to the geomagnetic equator will tend to see only evening-type TEP.

The westward movement of contacts via Class II TEP is not generally noted as it is for Class I TEP. The irregularities that occur in the base of the F-layer, are certainly known to move westward but their longitudinal "spread" is usually considerably wider than for the queatorial anomaly. As Class II TEP appears to depend to a large extent on these irregularities, the westward movement may be masked by their longitudinal width and the tolerance to asymmetrical paths that is noted.

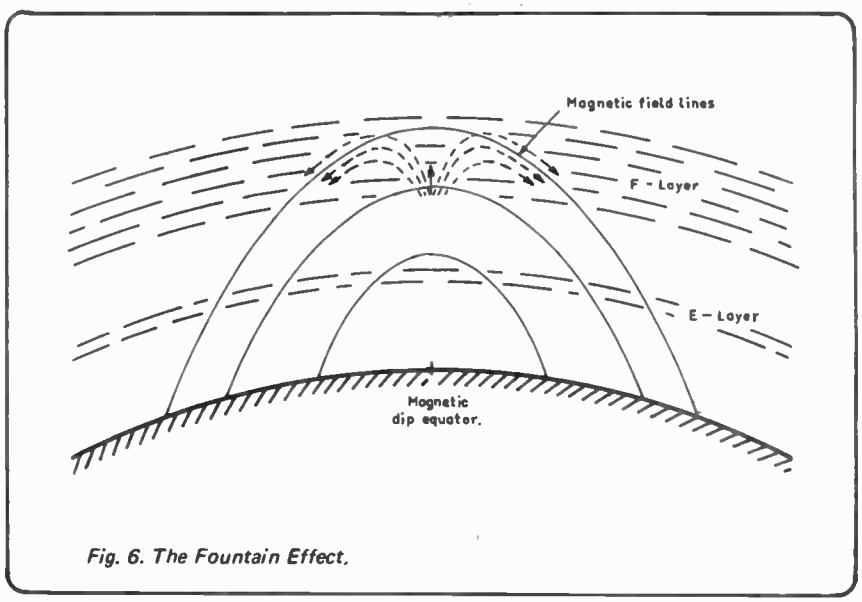

Fig. 6. The Fountain Effect.

SEASONAL CHARACTERISTICS

There is a marked dependence of Class II TEP on the equinoxes and sunspot number. The same dependence is noted for equatorial spread-F.

Class II TEP has a maximum number of occurrances which lags the sunspot maximum by a year or so – as is noted for Class I. The reasons for this are not yet clear but further research should elucidate the causal mechanisms.

Similarly to Class I, contacts can be had almost every night around the equinoxes during peak occurrence years. There is a rapid drop off in the number of occurrences after this time, few contacts being noted during the solstices and the years spanning the sunspolt minima. Observations carried out using oblique sounders and beacon transmitters also bear this out.

SIGNAL CHARACTERISTICS

The most surprising aspect of Class II TEP signals are the high frequencies that it will support and the high signal strengths that are recorded.

Beacon transmissions on 102 MHz from Darwin have been recorded in southern Japan on many occasions, but, as yet, there have been no reports of higher frequency signals. No upper frequency limit has been proposed for Class II TEP as the mechanism by which it is reflected or refracted in the ionosphere is not yet known.

Here is an opportunity for enterprising amateurs who would like to try for some exotic DX on 144 MHz – and make a contribution to a body of scientific knowledge on a phenomenon about which we know little. Unfortunately 144MHz contacts might have to wait till the next sunspot maximum. But don't let me discourage anyone from trying.

Generally speaking, high signal strengths are experienced having a considerable amount of flutter. The flutter rate is mostly between 5 and 15Hz and Doppler shift is mainly between ± 40Hz. This means that, at times, A3 (DSB or SSB) signals will be seriously degraded. The effect on wideband systems (FM or PM) would be much less but TV would suffer owing to the spread of time delays experienced.

Paths whose terminals are magnetic conjugates (have the same angle of magnetic dip but the opposite sense i.e. 25°N and 25°S) experience the higher frequencies more often and with greater reliability. The signal strength for these paths is higher than for the less favourable asymmetric paths and path lengths are generally shorter.

As Class II TEP is probably supported in some way by field guided ionization, the closer a ray can be launched to tangency with the magnetic field, the more favourable are its characteristics, i.e. higher frequencies will be supported, higher signal strengths will be guaranteed and greater reliability will be obtained than for less favourable rays.

Many people refer to class II TEP as transequatorial scatter. This is quite wrong for a number of reasons. Scatter propagation involves incoherent reflection from tropospheric or ionospheric irregularities of a size smaller than the wavelength in use. Signal strengths are weak and have a considerable flutter component. Transmitted and received angles of elevation from the ground are much greater than for a field guided mode and signals are not necessarily received over a great circle route. Ranges for scatter propagation are much less than for Class II TEP. It appears that the considerable flutter component often observed on evening-type TEP leads to a confusion involving the modes of propagation. Class II TEP is dependent on many factors (season, sunspots, geomagnetic latitude, etc.) that seem to have no bearing on true scatter modes.

CURRENT RESEARCH

The Ionospheric Prediction Service (Australia) is currently conducting research into TEP, particularly the evening-type or Class II. Equipment has been set up to examine the signal characteristics of VHF beacons located in Japan (JA1IGY) as part of this research which is aimed at elucidating the propagation mechanism of the evening type TEP and eventually predicting its occurrence. The ionosonde located at Vanimo, New Guinea, is almost ideally situated to study the equatorial ionosphere. It has been equipped with an interferometer system to assist in studying the irregularities that cause spread-F.

Armed with this information, and making reference to the maps in Figs 2,3 and 4, any keen VHF man in the right location can work some quite exotic DX.

Relatively simple equipment gives good results with TEP, most people, who have worked this mode, running less than 20 watts input. Antenna requirements are also minimal; many people using a 3 or 4 element yagi and some only a dipole or ground-plane antenna.

Run-of-the-mill receiving set-ups involving a converter to tuneable IF or converted carphone give good results as signals are usually quite strong. AM, FM, PM, DSB, SSB, CW or FSK (RTTY) can be used with the advantage going to CW and SSB.

Predicting TEP on a daily basis in not yet possible, but keeping a watch on a suitably located beacon will indicate when the band is open.

Suitable beacons are generally listed in various amateur journals (QST, Amateur Radio, etc.) but a suitable

beacon service is not available in many places. Perhaps this could be investigated by the amateur societies in the areas where such a service does not exist.

ACKNOWLEDGEMENT

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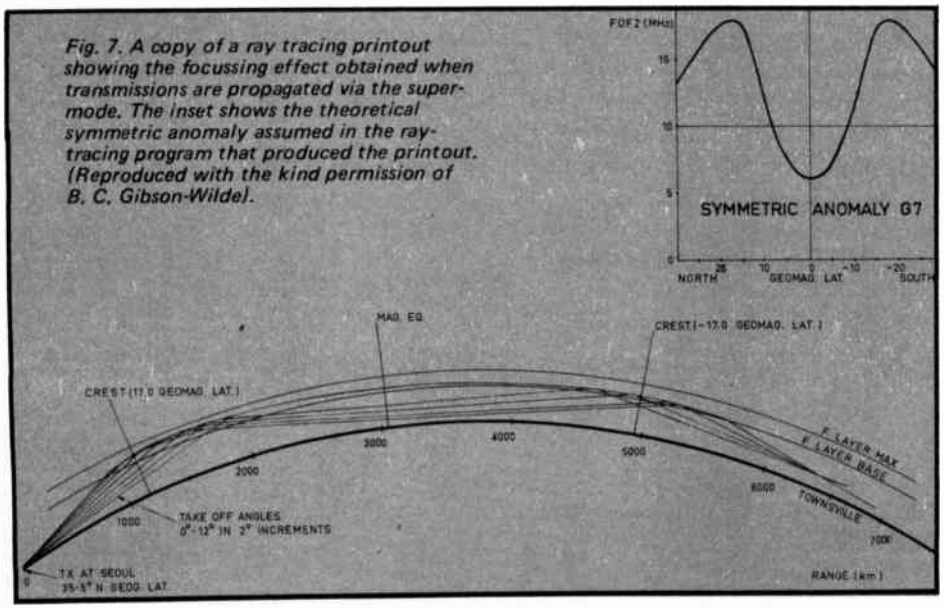

Fig. 7. A copy of a ray tracing printout showing the focussing effect obtained when transmissions are propagated via the super-mode. The inset shows the theoretical symmetric anomaly assumed in the ray-tracing program that produced the printout. (Reproduced with the kind permission of B. C. Gibson-Wilde).

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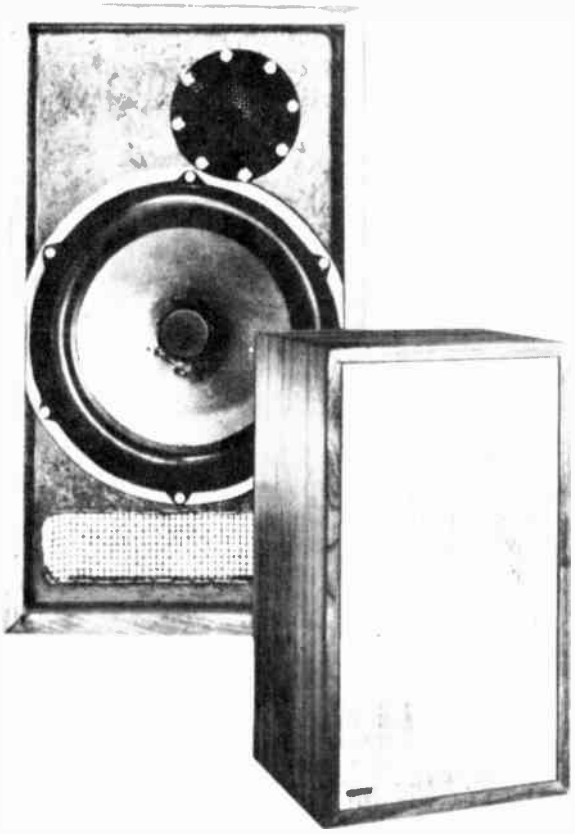

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Transducers in measurement and control

In this, the final article in this series, Dr. Sydenham discusses the continuing need for new types of transducers.

WE have looked at many ways by which the common physical variables are sensed and transduced into equivalent electric signals. The methods that we have described are well developed and are reliable and often extremely precise. Because of this it might be thought that there is a sensor available to monitor any possible variable and that the sensor design aspect of measurement systems engineering is now simply a case of applying commercially available devices in a routine manner. This is not the case – many highly desirable sensors are still not developed sufficiently to use, some have not even been realised; the need for inexpensive small transducers is paramount.

The task of the transducer designer continually includes the creation of new sensors (in-use tyre wear, leaf area increase rate on a tree, grass height monitor for automatic lawn-mowing, an education effectiveness monitor, an elasticity modulus meter for structural foundation bore-holes – these are all current problems awaiting solutions). The task is not always to provide a parts per million precision. As illustrations of these difficulties, two areas of measurements are now outlined: the first being an old discipline where progress has been slow – photometry – and the other, viscosity, a relatively new automatic measurement need.

Following innumerable requests, Electronics Today International are reprinting a revised edition of the Transducers in Measurement and Control series in book form.

An announcement will be made in a future issue of ETI advising availability and price.

PHOTOMETRY

Photometry is the science of measuring visible radiation in relation to its ability to produce visual sensation. (Sometimes the definition is extended to include radiation bordering on the visible, namely, infrared and the ultraviolet regions). This is a psychophysical parameter, for determinations are related to the human eye and what it appears to see. Therein lies the difficulty – a standard average eye response is needed to allow for the biological variation in eyesight between observers.

We have already dealt with a better way to measure a radiation variable when black body radiation was discussed. These radiometric measurements do not rely on psychophysical factors. Photometry had its birth in the days before the work of Plank when scientists wished to quantify the effects of light. They created their own standards of brightness and illumination intensity using firstly, standard size candles and later standardised flames in which the gas jet orifice, the gas pressure and composition were carefully specified so that different constructors obtained much the same standard. The response of the eye varies with wavelength and the individual, so attempts were made to define a standard observer as the average of a large number of people. In 1951 this became accepted reality. A graph showing the agreed response is given in Fig. 1.

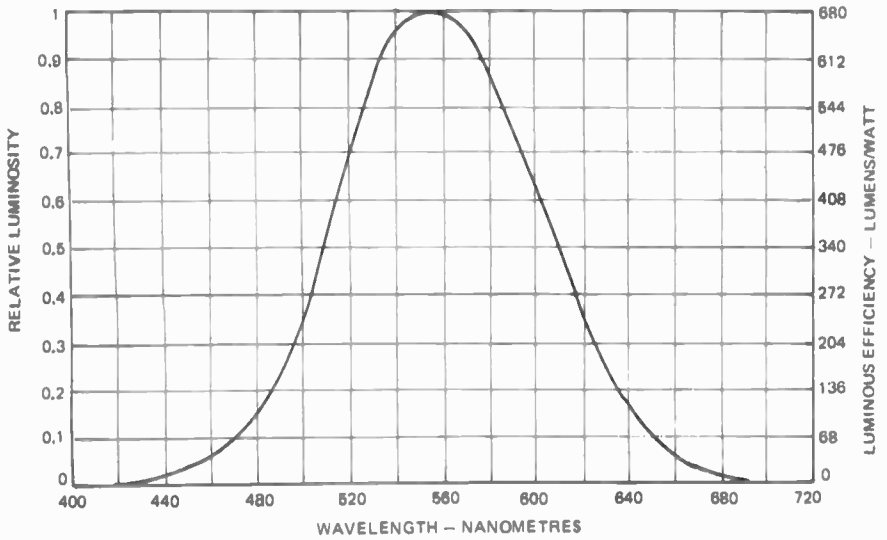

Fig. 1. Response curve of 'standard eye'.

It is not feasible to employ a person with such a standard eye response, so photo detectors are used, in conjunction with fresh liquid-filled optical filters to modify the response accordingly. Coloured glass filters are avoided as these degrade with time. Detectors used include phototubes and selenium cells. But even with careful filter design, agreement with the standard response cannot be made accurately so a residual error curve is

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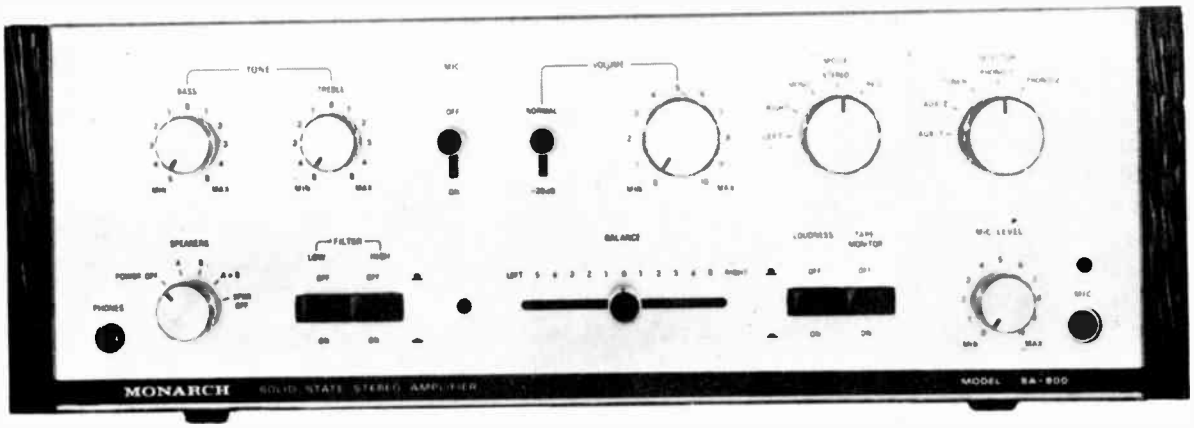

MONARCH SA 800 (80 watts RMS)
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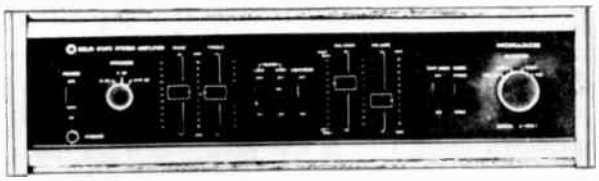

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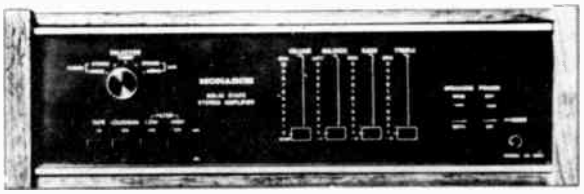

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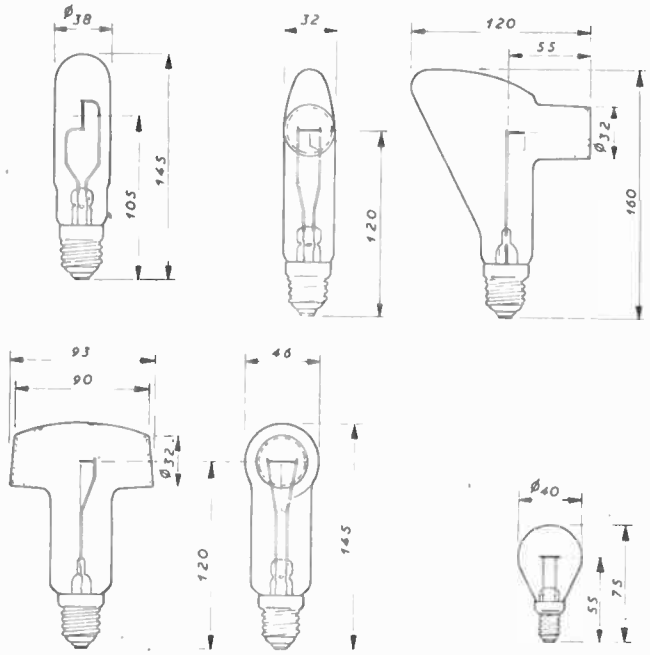

Fig. 2. Tungsten ribbon lamps especially designed to produce a uniformly radiating surface. The windows are ground plane-parallel from quartz or heat-resisting glass and must have their spectral energy transmission calibrated before manufacture.

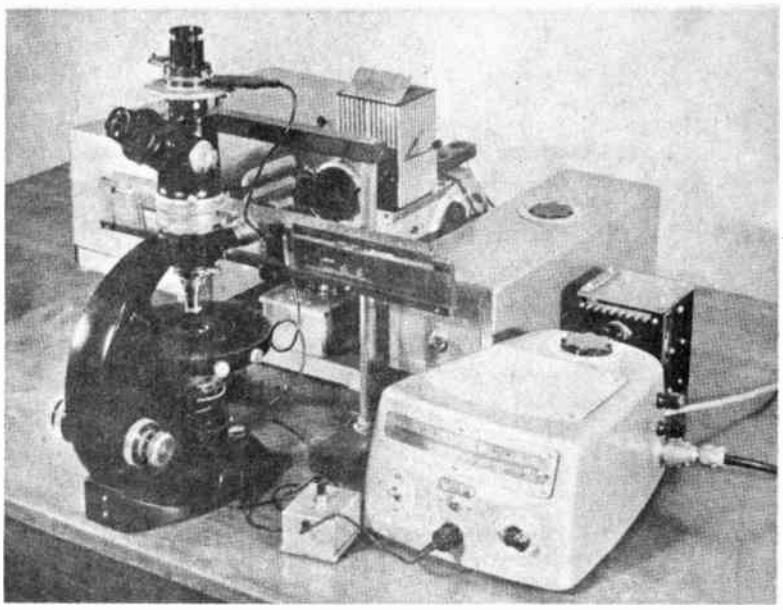

Fig. 3. EEL apparatus for measuring the reflectivity of ore minerals (using microphotometry).

Transducers in measurement and control

used to correct readings when extreme accuracy is required.

An alternative method to obtain the response disperses the broad band white light source separating out the colours. These are then passed through a shaped aperture allowing the correct amount of light through at each wavelength. The colours are then recombined. It can be seen that these procedures require a high skill content and a lot of tailoring to obtain accurate results. Where feasible, photometric measurements are made on a relative basis as the eye is more sensitive to differences in brightness than to the absolute level of radiation. Radiometric measurements, not being based upon a subjective test, are usually to be preferred, but the extensive use of the photometric units in applications such as illumination engineering, in visually used optical instruments, in astronomy and in television prevents the total abandonment of the latter in favour of a radiometric alternative.

Luminous intensity, the 'candle-power' of a source, is now standardized as the candela (dc) a unit defined in terms of the luminous intensity of black-body radiation. To make life easier in day-to-day measurements, secondary standards – tungsten lamps of special design like that shown in Fig. 2 – are used. Luminous flux has units of lumens (lm) and relates to the flow of light fluxing away from the source. The candela is ideally a point source radiating into a spherical space around it. Allowing for this, a candela source emits 12.57 lumens of light flux. Illumination is the luminous flux falling on a surface and is expressed in lumens per square metre, units called lux (lx). The fourth unit, luminance, is similar to the lux except that this is the luminous intensity of an extended surface – not a point source. Its unit is the nit (nt) which is candelas per square metre.

Numerous other photometric units exist from the past (lambert, foot-candle, apostilb, phot, skot, talbot, metre-candle) but only the four, candela, lumen, lux and nit are to be used in future (Definitions and conversion factors for these units were published in ETI, September 1972). As both radiometric and psychophysical measures relate to the same thing it is possible to equate luminous flux with radiated power once the standard eye is defined. In Fig. 1. the luminous efficiency of a source is represented on the right-hand axis. For example, a source radiating at 0.56 μm will produce 680 1m/watt.

The practical difficulties of creating a standard eye response, the primary standard black-body and secondary standard lamps are considerably greater than those encountered in many other forms of standard. The best precision attainable is barely better than one part in 100. Similar problems exist in ultra-violet and infrared 'photometry'.

Creating and maintaining photometric standards are seldom the tasks of the transducer user: acquaintance is more likely to be with photometer instruments of one kind or another. The microphotometer is an instrument incorporating photometric measurements with microscopy in order that the light magnitudes of very small areas can be measured. A common use of these is to determine the degree of blackening of photographic emulsion records from a spectrograph, a field of stars or interferometer fringes. In the automatic scanning photometer a narrow beam of light is passed through the emulsion to impinge on a photodetector. The photographic plate is then slowly moved across, recording the detector output with position.

Another application of the microphotometer is for measuring the reflectivity of mineral grains in order to investigate the composition and nature of an ore. One such equipment is shown in Fig. 3. Light of constant amplitude and wavelength composition is directed onto a cut and polished specimen held on the microscope stage. The reflected radiation is first viewed visually through the eyepiece to identify the area being measured; a thin slide containing a flat photocell is then inserted under the eyepiece to measure the light flux reflected. The cell is connected to the galvanometer via a preamplifier in order to amplify the microampere signals. Added sensitivity

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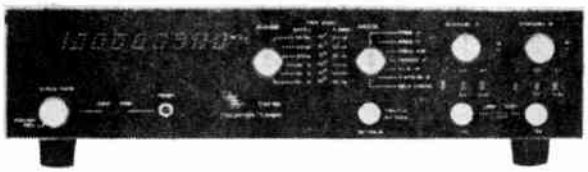

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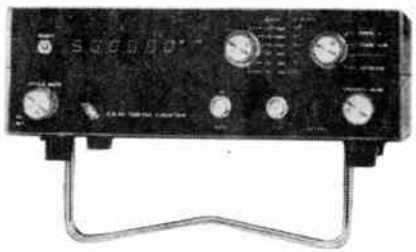

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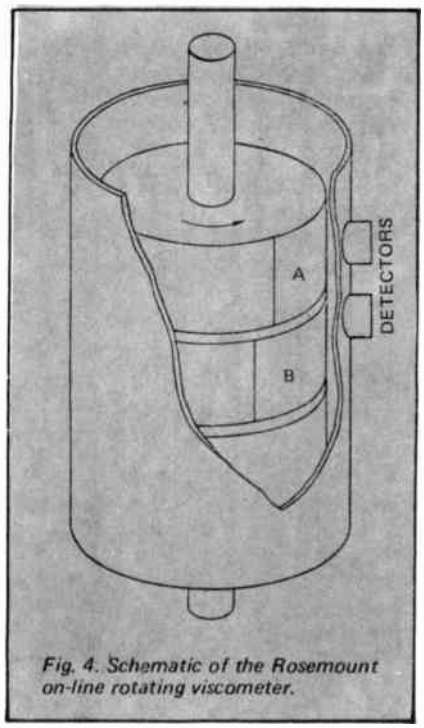

Fig. 4. Schematic of the Rosemount on-line rotating viscometer.

Transducers in measurement and control

can be obtained with a split-photocell position-sensitive detector arrangement. This is clipped onto the scale of the galvanometer to amplify the movements of the light spot. The same apparatus can also be used to determine exposure times in microphotography. This example shows how a seemingly simple measurement can become impossible as precision is increased, if the basic principles are inappropriate.

VISCOSITY

A fluid's resistance to the tendency to flow is called its viscosity. Instruments for measuring it are called viscometers or rheometers. Most viscometers make use of the viscous drag upon a rotating or oscillating cylinder turning in the fluid. In the unit shown diagrammatically in Fig. 4. the upper and lower cylinders are solidly connected and turn in the container filled with the fluid to be measured. The central bob, as it is called, is connected to the outer two by a taut ligament that allows it to lag behind the outer pair depending upon the viscous drag on its surface. External detectors sense some form of mark on the cylinders producing two pulse trains whose phase will depend upon the angular difference. Fluids fall generally into two classes of viscosity, those in which it is constant with shear rate (called Newtonian fluids) and those in which viscosity depends on shear rate (the non-Newtonian fluids). Examples of the latter are paints, creams, polymers and emulsions. In the illustrated viscometer, the pulse rate is a measure of shear rate so it can also be used to investigate the change of viscosity with speed. (In viscosity measurements it is vital to control the temperature of the fluid as viscosity depends on it).

Until the recent adoption of the SI systems of units, viscosity was measured in poise (after the 19th Century scientist Poiseuille). The SI unit to be used in future is the Pascal.second (Pa.s). One centi-poise is equal to 10^{-3} Pa.s.

An unusual challenge arose in the on-line measurement of the viscosity (regarded as consistency in this case) of bread dough, sponge batter and pastry fat used in automatic baking production by the J. Lyons catering company in London. In the chosen solution, see Fig. 5. the highly viscous dough ($5\ 10^{2}$ Pa.s. compared with 10^{-3} Pa.s. for water) is forced from a mixing stage out of a proportioning batching head. Resistance to shear within the dough is determined by the torque needed to continuously rotate a paddle immersed in the dough. A differential gear unit is used to sense the torque exerted by the paddle. This mechanical computing element provides a turning moment on the output shaft when a torque exists on the paddle being driven at constant speed. A strain-gauge load-cell converts the output torque into an electrical signal. It is appropriate in this industry to refer to the 'tightness' of 'slackness' of the dough, so they use a special off-line instrument called a Farinograph to calibrate the consistency meter in their own kind of units. It is able to handle products with viscosities in the range, 500 to 0.1 Pa.s. when suitable paddles are used.

This example well illustrates the need for inventive designers in transducer development.

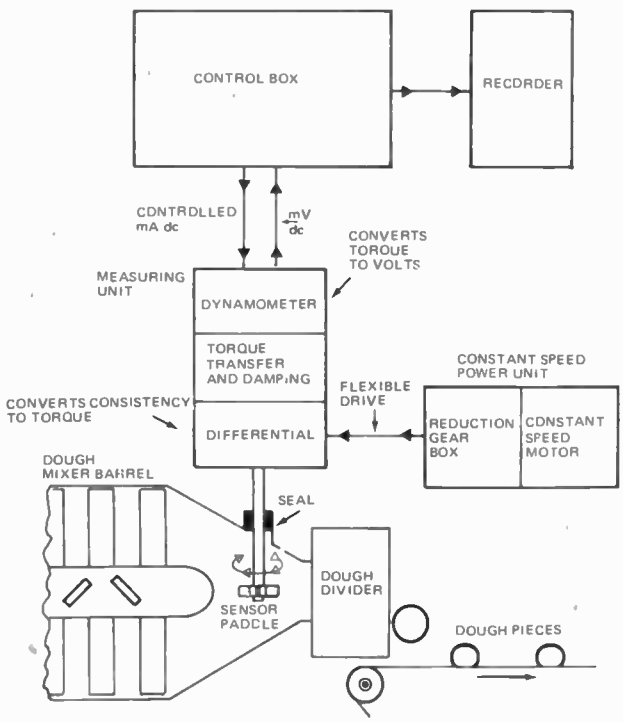

Fig. 5. Basic system components of consistency measuring instruments used in automated bread making.

TRANSDUCERS AND PROCESSES

Automatic measurement and control of processes could not be realised if transducers did not exist. They are the essential communication link between the physical attribute of interest and the recorder or controller. The number of applications for sensors is infinitely large, ranging over disciplines such as medicine, power generation, marine survey, weapons, food-stuffs processing, oil refining, scientific research, pollution control, television and communications.

In many cases the need is for a large

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Even the best tape can get mangled in a poorly constructed shell.

That's why Maxell protects its tape with a precisely constructed shell, made of lasting heavy duty plastic. No fixed guide posts are used. Instead Maxell uses nylon rollers on stainless steel pins thus eliminating the major cause of skipping, jumping and unwinding.

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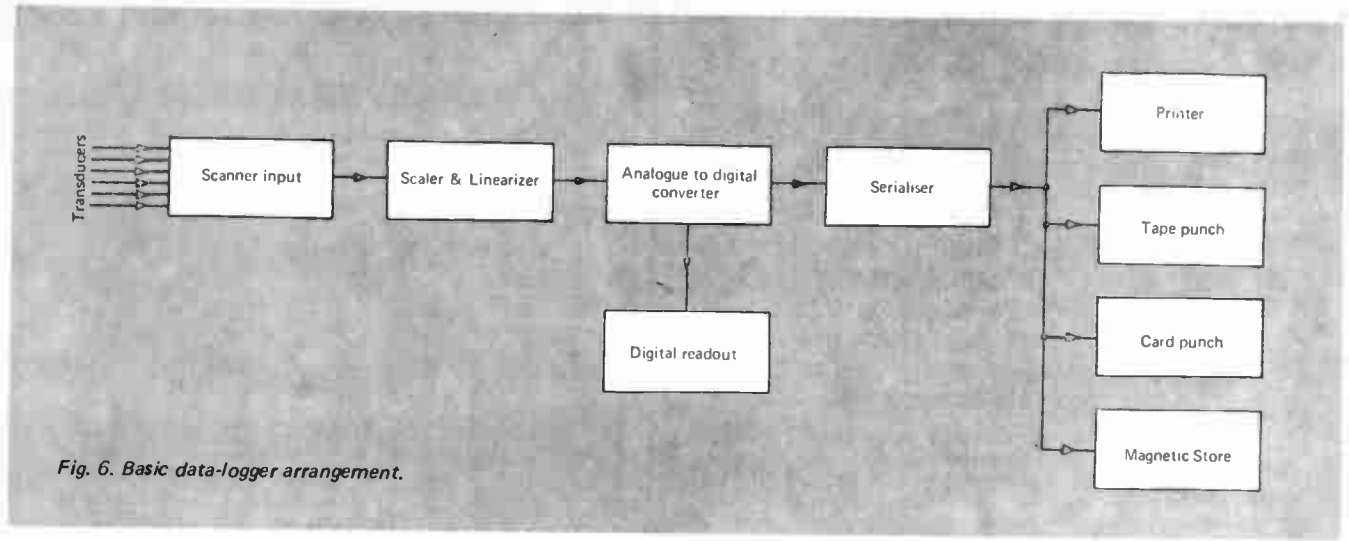

Fig. 6. Basic data-logger arrangement.

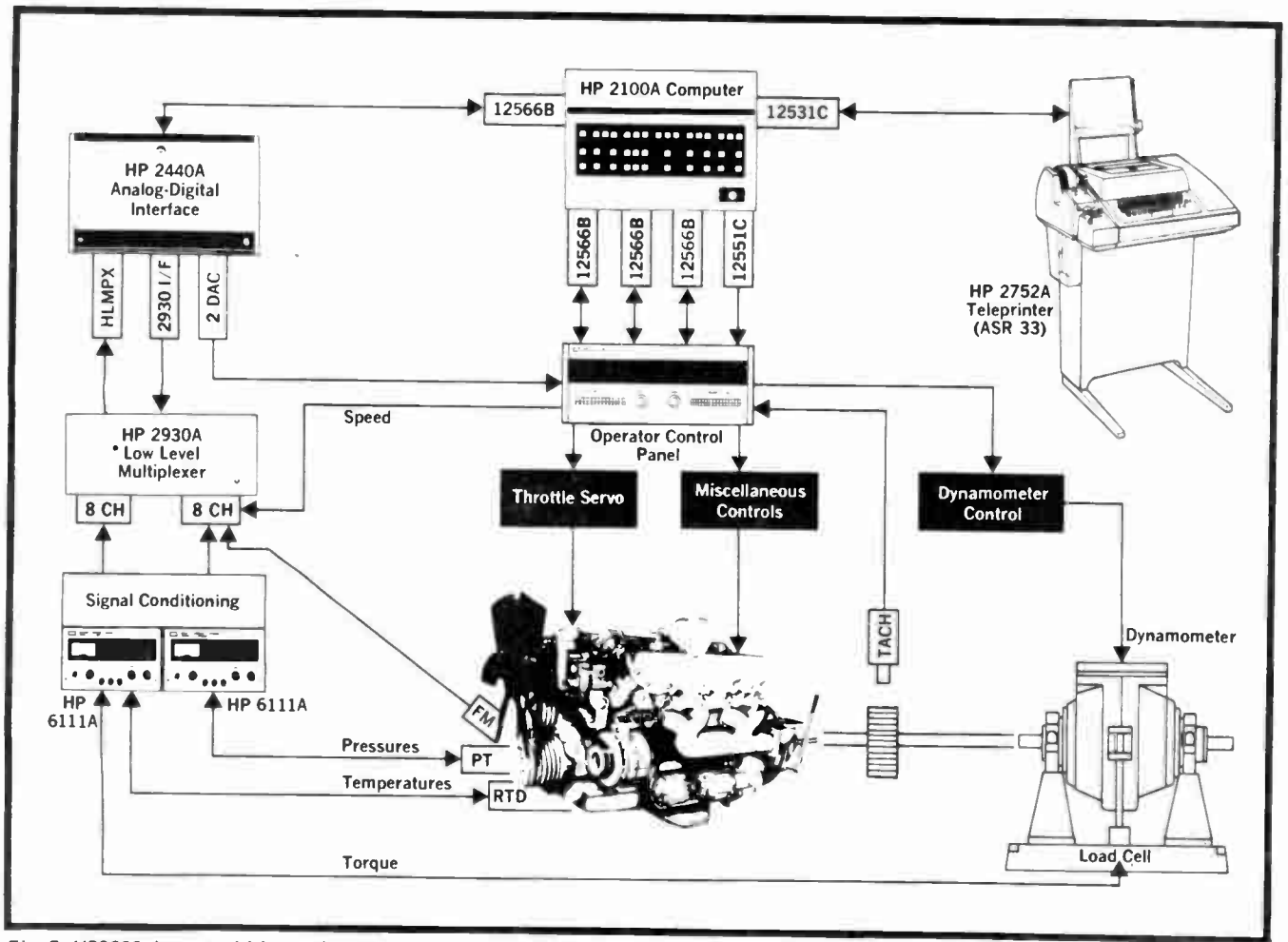

Fig. 7. HP9600 data acquisition and control system applied to engine testing.

Transducers in measurement and control

number of parameters to be monitored requiring the use of a diverse arrangement of sensors as we have seen exist. Sometimes they are of the same kind but at different locations, for instance, as in the structural testing of a ship at sea using strain gauges, or they may be of different kinds as in a process plant where temperatures, pressures, moisture content etc., must be monitored. When data from each is not needed continuously, they can be switched sequentially onto a common line feeding a single time-shared recorder – as shown in the data logger schematic of Fig. 6. When automatic data processing is used, a digital form of output is preferred – some transducers are designed to produce digital signals directly. For visual monitoring, analog chart records are best. It is common practice to use

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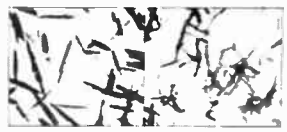

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TDK particles are densely and uniformly packed into the tape coating. Mirror-smooth lubricated surface means less wear on the recorder head.

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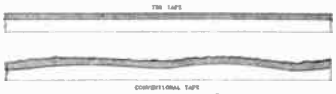

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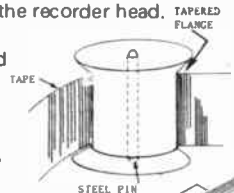

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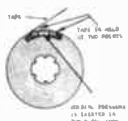

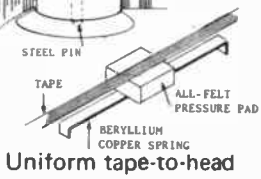

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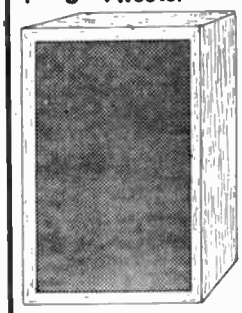

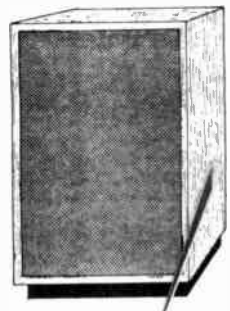

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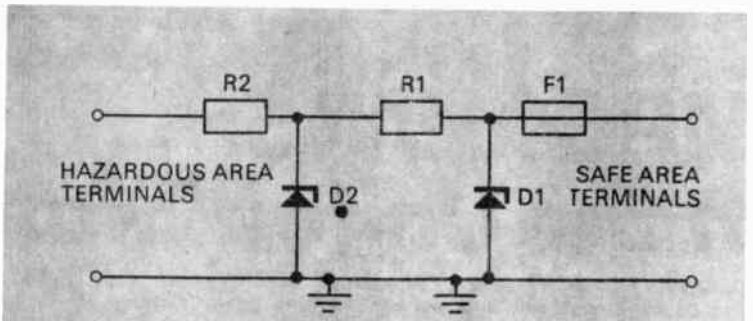


Fig. 8. Circuit used in a Zener barrier.

Transducers in measurement and control

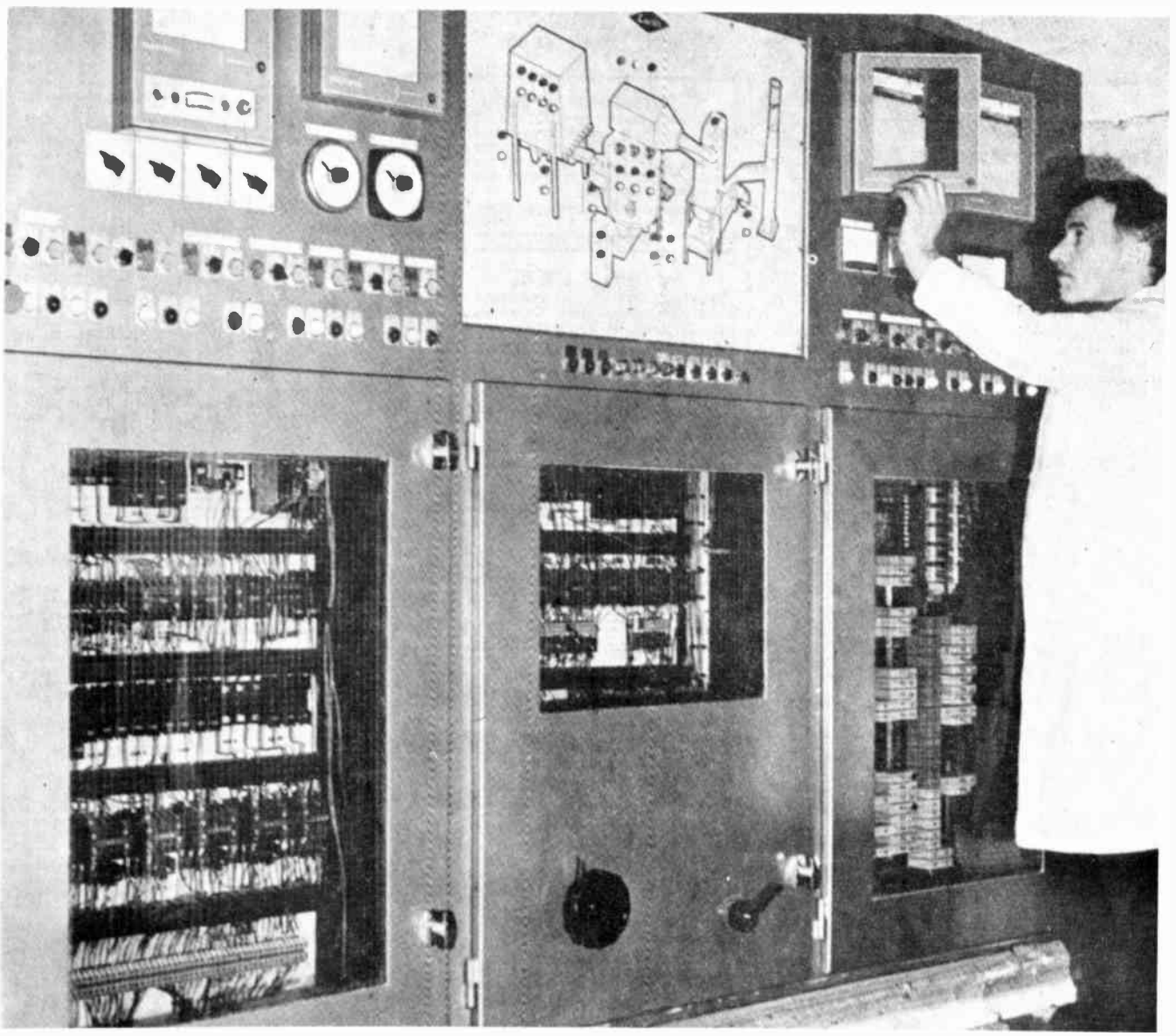
Fig. 9. Control console of Lucas automatic incinerator features indicating mimic panel.

both to satisfy both needs. An essential requirement in large-scale development is that each sensor delivers signals that are compatible and uniformly ranged to make best use of the dynamic range of the recorder. Many instrument manufacturers now list data acquisition systems as product lines: the Hewlett Packard 6900 system is shown in Fig. 7.

To assist the design of large, complex process-control systems, makers of transducers and controllers use a number of standardised transmission signal ranges, examples being the 4-20 mA dc and 0-10 mV dc systems, but these are not universally adhered to; recalcitrant manufacturers claiming that their particular output range is more satisfactory.

SAFETY MEASURES

Often sensors must be situated in hazardous areas where explosion could result from a spark or excessive heating of the sensor circuits. The obvious way to reduce this risk is to contain everything in flameproof enclosures of great strength. There are disadvantages to this method, namely, that the cost is high, and that testing and maintenance are made difficult,



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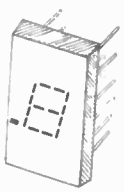
LED DISPLAY

The MAN1 is a seven segment diffused planar GaAsP light emitting diode array. It is mounted on a dual in line 14-pin substrate and then encapsulated in clear epoxy for protection. It is capable of displaying all digits and nine distinct letters.

FEATURES:



- High brightness, typically 350ft.-L @ 20ma.
- Single plane, wide angle viewing, 150°.
- Unobstructed emitting surface.
- Standard 14-pin dual in line package.
- Long operating life, solid state.
- Operates with IC voltage requirements.

ONLY $4.00

"UTILOGIC" SPECIAL

Ten (10) pieces of LU321 dual JK flip flops and four pages of application information describing ripple counters (3 to 10) and divide by 12 up/down binary and decade counters, shift registers and self-correcting ring counters.

Complete package only $3.60

LINEAR SPECIAL

Ten (10) 741 fully compensated operational amplifiers with data sheet and two (2) pages of application notes covering the basic circuits for op-amps.

EACH $0.65 PACKAGE $6.00

8 pin DIL Only 35c each
$2.75 for ten.

LM309K—5 volt regulator

This TO-3 device is a complete regulator on a chip. The 309 is virtually blowout proof, it is designed to shut itself off with overload of current drain or over temperature operation.

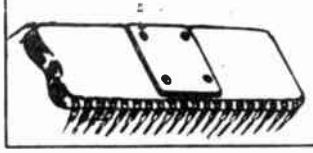
Input voltage (DC) can range from 10 to 30 volts and the output will be five volts (tolerance is worst case TTL requirement) at current of up to one ampere.

EACH $2.50
FIVE for $10.00

LSI—CALCULATOR ON A CHIP

This 40 pin DIP device contains a complete 12 (twelve) digit calculator, Add, Subtract, Multiply, and Divide. Outputs are multiplexed 7 segment MOS levels. Input is BCD MOS levels. External clock is required. Complete data is provided with chip (includes schematic for a complete calculator).

Complete with data $9.95



Data only $1.00

COUNTER DISPLAY KIT—CD-2

This kit provides a highly sophisticated display section module for clocks, counter or other numerical display needs.

The RCA DR-2010 Numitron display tube supplied with this kit is an incandescent seven segment display tube. The .6" high number can be read at a distance of thirty feet. RCA specs. provide a minimum life for this tube of 100,000 hours (about 11 years of normal use).

A 7490 decade counter IC is used to give typical count rates of up to thirty MHz. A 7475 is used to store the BCD information during the counting period to ensure a non-blinking display. Stored BCD data from the 7475 is decoded using a 7447 seven segment decoder driver. The 7447 accomplishes blanking of leading edge zeroes, and has a lamp test input which causes all seven segments of the display tube to light.

Kit includes a two sided (with plated through holes) fibreglass printed circuit board, three IC's, DR-2010 (with decimal point) display tube, and enough Molex socket pins for the IC's.

Circuit board is .8" wide and 4¼" long. A single 5 volt power source powers both the IC's and the display tube.

CD-2 kit complete only $9.95
Assembled and tested $12.00

Board only $2.50

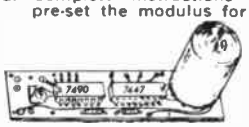
RCA DR2010 Numitron digital display tube. This incandescent five volt seven segment device provides a .6" high numeral which can be seen at a distance of 30 feet. The tube has a standard nine pin base (solderable) and a left-hand decimal point. Each $5.00

SPECIAL 5 for $20

UNIVERSAL COUNTER OISPLAY KIT CD-3

This kit is similar to the CD-2 except for the following:

a. Does not include the 7475 quad latch storage feature.
b. Board is the same width but is 1" shorter.
c. Five additional passive components are provided, which permit the user to program the count to any number from two to ten. Two kits may be interconnected to count to any number 2-99, three kits 2-999, etc.
d. Complete instructions are provided to pre-set the modulus for your application.



CD-3 board only $2.25
IC's 7490, 7447 2.75
RCA DR2010 tube 5.00

Complete kit includes all of the above plus 5 programming parts, instructions and Molex pins for IC's. Only $8.95

The MAN3M is a seven segment diffused planar gallium arsenide phosphide readout. It is capable of displaying 10 digits and 9 distinct letters and is encapsulated in a high contrast red epoxy package.

- 0.127" high led 7 segment display.
- Bright red 400 ft-L at 10ma per segment.
- Compatible with standard digital IC's.
- Compact spacing 5 digits per inch.

$3.00 each. Ten or more $2.50

Babylon Electronics Inc.

Post Office Box J, Carmichael, California. 95 608 U.S.A.

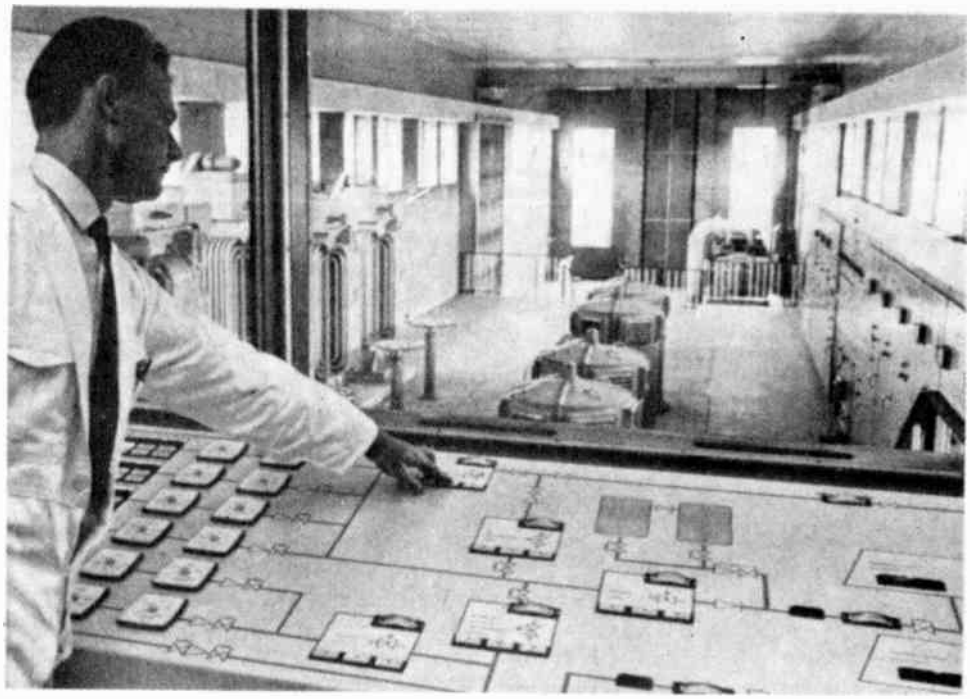


Fig. 10. Human engineered control panel of computer-controlled water distribution station – controls are laid out in the mimic diagram.

for the power must be shut-off when the enclosures are opened.

The alternative, and more recently adopted method, is known as intrinsic safety. Inflammable vapours require a specific level of energy to bring them to the flash point. Limiting the amount of power available from a sensor circuit under any condition will eliminate this risk. No enclosures are needed and the sensor can be adjusted with the power on.

Originally the concept was implemented by ensuring that the circuit could not draw or give up greater than a specified power in the event of a fault. (This amount is found by testing in a special test chamber filled with inflammable vapour). A marketed Philips pressure transducer system is maintained intrinsically safe by limiting the inductance to 33 mH (at the most) and the capacitance to 180 nF. It uses the 4-20 mA standard (representing 0-100% signal swing) to provide power from the quiescent 4 mA value. This method works but suffers from the need to individually check each circuit for safety. A plant having hundreds of transducers would take a considerable time to inspect.

A recent improvement (it was introduced around 1960) is to use a circuit placed on the boundary of the hazardous area and the non-hazardous area that can ensure that all electronic circuits connected after it in the unsafe zone are isolated with regard to high power levels. The Zener barrier does just this. Basically it uses a Zener diode connected across the two-wire line and a fuse in series on the unearthed safe side line. A power surge attempting to pass the barrier (perhaps as the result of a sensor or wiring fault or a fault at the supply end) and thus attempting to raise the voltage at the sensor, is diverted to earth by the diode. Faults of long duration that might destroy the Zener diode are eliminated by the fuse blowing. In practice, a Zener barrier uses a pair of diodes, (see Fig. 8.) to reduce the risk of losing protection by an open-circuit diode (that would not be detected). Zener barriers, complying to Standards, are available commercially as ready-made units. As yet, their use is not internationally accepted. For further details consult the article listed in the suggested reading.

CONTROL ROOMS

Today, extremely complex processes and large power plants can be operated by a staff of only two or three people. This is achieved by monitoring all essential parameters with transducers feeding their signals back to a control room. By making the controllers and recorders small enough and of standard shape it is possible to mount them together on a control console.

Well designed layouts are the result of considerable thought, for the operator must instinctively know what to do in an emergency. Two basic arrangements are as follows: The layout can contain a schematic or mimic diagram of the plant on which lights operate to show failure or correct action. The console of a computerised refuse disposal system is shown in Fig. 9. Alternatively, the controls themselves can be placed in the mimic layout covering the whole panel as shown in Fig. 10. Row after row of exactly similar knobs and dials are to be avoided if each has a different purpose. Often a multi-channel closed-circuit television monitor is incorporated to enable the operator to view the proceedings at selected places.

SOURCES OF INFORMATION AND SERVICES

Anyone who has had to select or make a sensor for a specific task will know the frustrations involved – does such a sensor exist on the market; where does one buy it; are the specifications realistic in light of current technological achievement? Often a sensor is built from scratch (at great cost) because the task of researching the literature and manufacturers' catalogues for information appears prohibitive. Because the sensor may be cheap does not imply easy purchasing. It is, therefore, appropriate to outline where assistance is available in this regard.

If the sensor is known to be in common useage, the relevant Standards Association leaflets, kept in most libraries, will describe what is accepted and attainable practice, for the Standards are reached by considering current *practice, not future hopes.* This study may also reveal specifications of the sensor that may have been overlooked. Manufacturers' data sheets also assist

we give you the auto features the rest try to sell

fully automatic stereo turntable
BFU-121

apan
MUSIC MAKER

The BFU-121 boasts perfect record tracing; quiet, constant speed, 4-pole synchronous motor; feather-touch cue-control lever; 12 months warranty and after sales service.

And all for around $125 . . . ready to operate, with no hidden extras. All the auto features that you normally associate with a much higher priced unit. All the quality that a discerning hi-fi enthusiast demands.

AUTO PLAY: Flip the lever to auto and the turntable begins to rotate. Upon reaching the required rpm, the arm leaves its rest and gently lowers the stylus to the disc.
AUTO RETURN: On completion of the record an oil-dampened precision lifter is actuated to automatically return the arm to the rest, switching off the power.
AUTO REPEAT: When the repeat button is depressed slightly, the arm will repeat automatic operation. By pressing the reject button, the auto-repeat function is released, thus stopping the record wherever required.
AUTO CUT: When it is desired to stop the record mid-way through, gently touch the reject lever and the arm will return to its rest, cutting off power.

Manual and semi-auto models also available.

RALMAR
agencies pty. ltd.
431 Kent Street, Sydney Tel.: 29 4338

AGENTS:
QLD: Tallerman & Co. Pty. Ltd., Robertson St., Valley, Brisbane
VIC: K.J. Kaires & Co. Pty. Ltd., 4 Hill Court, Macleod
S.A.: Wm. M. Matthew & J.A. Dunn Pty. Ltd., 251 Hutt St., Adelaide

STATE DISTRIBUTORS:
W.A.: G.K. Cameron & Co. Pty. Ltd., 246 Churchill Ave., Subiaco
A.C.T.: Sonny Cohen & Son, 20 Isa St., Fyshwick
TAS: W. & G. Genders Pty. Ltd., Launceston, Burnie, Hobart
N.T.: N.T. Musical & Electrical Wholesale Pty. Ltd., 54 Cavenagh St., Darwin

Transducers in measurement and control

in understanding the pros and cons of a device, but read more than one maker's literature for it is not totally unknown for a manufacturer to be biased in favour of his own product!

If you are not fortunate enough to have a good technical literature library at your disposal, assistance may be available from places such as the Standards Laboratory (NPL in Britain, NSL in Australia, NRC in Canada, NBS in the States, etc.) of the country concerned, and also from the government laboratories.

To help ensure that marketed instruments (and other products) are up to specification, each country has a national testing authority that inspects and registers testing laboratories who have the necessary facilities. In Britain the British Calibration Service, BCS. In Australia this is the National Association of Testing Authorities, NATA. Only laboratories maintaining the required standard of equipment and excellence of use can obtain registration. Consequently, a study of the index listing the certificated laboratories may reveal a manufacturer in the field of interest. These laboratories can test equipment for buyers as well as manufacturers, at a reasonable charge.

Specialized services exist in technological sophisticated countries. The association in Britain concerned with instruments being the Scientific Instrument Research Association (SIRA). They operate a service called SIRAID on behalf of their numerous member companies. Enquiries regarding makers, suppliers and data of instruments are attended to promptly, free of charge. a phone call, letter or telegram asking for a list of potential suppliers of a named transducer will result in a letter by return. The service goes further, for reasonable rates, to provide assistance in design and testing, consultation services, and for specific research into instrument problems. SIRAID is not confined to British residents; their address is South Hill, Chislehurst, London, U.K.

Australia has a peculiar problem due to the high content of imported equipment – this is the task of locating the agent representing the manufacturer. A simple way is to contact the respective Embassy or special office of each country, such as the British High Commission for British products. The staff are well informed and usually maintain an up-to-date library of products and trade journals supplied by air mail.

Sources of aid often disregarded are Universities and Technical Colleges. It is a common feature in many countries that industry shuns consulting the academics. It is true that some tertiary research is esoteric and not relevant to day-to-day problems, but in general these institutions contain a wealth of free information. The staff are usually willing to assist for this is one of their roles in society.

If the interest is research orientated, it might pay to subscribe to one of the personal abstracting services such as iSi (Institute of Scientific Information). For a modest fee they will regularly supply selected abstracts, from numerous journals, in which the title includes key words chosen by the subscriber. iSi also publish the Science Citation Index, a series of volumes in which authors referred to by writers of articles are listed. This rapidly assists the reader to find out who else is working in the same field, and thus find other information on a technique.

We have now reached the end of this series. It has been our intention to promote awareness of the many techniques and their limitations. No *universal* sensor appears to exist, so the task of selection will continue to be a matter of careful consideration. There will, however, always be a universal need for sensors to convert the real-world phenomena into a language suited to our automatic communication methods.

FURTHER READING

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"Photometry" – J.W.T. Walsh, Constable, London, 1958.

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"Functional Modularity Helps Designer and User of New Measurement and Control Subsystem" – J.M. Kasson, Hewlett-Packard Jnl. 1972, 23, 12, 13-19.

"The Nerves and Brains of Modern Industry" – L. Finkelstein, "Improvement", 1972, George Kent Group, Luton, England. 22-23.

"Safety Barriers Around the World" – D.J. Gaunt and A.T. Mead Kent Technical Jnl. 1972, No. 7. May, 28-31.

SENSORS ON

A new, regular monthly feature by 'Talus'

A QUICK look around any Australian laboratory or field-station will show that almost all their scientific equipment is made overseas. Our imports of instrumentation and other scientific equipment exceed $100 10^6 per annum.

Why is this so?

Various manufacturers' agents, and officials of companies serving overseas' products, tell me our markets are too small and our costs too high for it to be economically viable to produce more Australian made and designed products. Could it not be that the agents are on to a good thing and their middleman's cut provides a nice secure living without the need to risk capital in a production venture.

Some agents represent literally hundreds of overseas' companies – no wonder they do not know enough about the products to really assist the buyer. Only last week we encountered an only too typical purchasing problem. Agents were contacted for data sheets and prices of an electromagnetic vibrator so that a suitable model could be ordered. A data sheet arrived and an apparantly suitable unit ordered from the catalogue numbers given. When the vibrator arrived it was quite different to that ordered. It was eventually discovered that the makers had changed their literature and identification numbers in 1969 and the sheet we were sent was four years out-of-date. This is an experience many of us have been through more than once. And what about the representative who doesn't even know the list of products in his master catalogue!

There really is no simple justification for disregarding our own potential. Australia has only one-fifth the population of, say, Britain, but pro-rata we have a similar number of Universities and other schools. Internationally we are accepted and have few export entry problems. Our natural resources abound. There is political unity within the continent.

Australia is a technological country – not merely a large garden for growing wheat, meat and wool. Yet our production of instrumentation is almost non-existent.

In the CSIRO, Department of Supply and tertiary educational institutions, thousands of scientists, engineers and technologists churn out new designs upon new designs of instruments, many through to the production stage. In the CSIRO alone there are over 2,000 professionals, many involved in this area.

It is common practice in Germany, Britain and the United States for such people to be directly involved with a commercial enterprise, especially the staff of Universities. There *are* examples of success – the development and marketing of the absorption flame spectro photometer, ac measurement bridge, resistance standard and colour Xerox process come to mind as examples where government research has gone to the market place. So it can and has been done. Everyone who has been involved in research and development of instruments knows of the high ratio of development to production costs. By combining the government establishments, commercial developers can select products already close to sales with considerably less risk than starting afresh. There are some companies who do this, but they are few and far between.

A common and successful way by which instrument industries grow is for small teams to start up on their own, making and marketing a modest product. They have the advantages of low overhead costs, high enthusiasm and extreme devotion – the ingredients of a goer. The problem is that in many such cases they run out of expertise somewhere.

If it is a craftsman (who has the instrumental know-how) who sets the idea into motion he may lack insight into sales promotion. It is a sad fact that a product does not sell itself very often – it has to be promoted at a cost probably exceeding the production expenditure. The same craftsman may lack the theoretical knowledge that is instilled (hopefully) into the trained graduate, and may soon be limited in directing worthwhile expansion.

On the other hand, the graduate trained person going it virtually alone will, more often than not, lack the skills and cunning involved in producing reliable, low cost products.

But put together the right team and the path to success is opened.

Another factor often lacking is market research information. I am amazed at the number of sales managers and technical representatives who try to sell products inferior and more costly than those of their competitors – without even knowing of the existence of the other products.

One factor limiting the growth of an instrumentation industry is the lack of suitably trained persons There are few extensive courses in instrument design available in Australia – not one at a degree level, only one as a diploma.

By contrast, Britain offers twenty-odd graduate courses, and many more at the College of Advanced Technology level. People there think and breathe instrumentation to a greater extent than here in Australia. For example, there is, almost, a lecture a day somewhere in the U.K. on instrumentation – here, perhaps it occurs once or twice a year!

But did you know that Australian-produced equipment made in the workshops of places like Weapons Research Establishment are regarded as equal to the best anywhere; that our National Standards Laboratory staff has created a greater than average number of new Standards accepted internationally; that Australian research workers are highly regarded when they visit overseas institutions to work; that we achieve more per dollar in research than the more (so-called) highly developed countries?

It is a chicken and the egg problem. Whilst we continue to import equipment we are not providing enough training experience for original equipment designers. We also bear the distinct disadvantage of not being able to get at the designer to ask questions when things go wrong or need small and frequent changes to suit individual applications. How useful it would be to ask a responsible person *why* a certain circuit was used; how to change a range most easily, etc.

A curious thing about people everywhere is their enchantment by

Instrumentation – give the Aussie manufacturer a fair go!

products of any other country than their own. In the U.K. they prefer American equipment. In Canada there is ready acceptance of Australian goods. It is true that in many cases our own industries just do not compare. But, some do. Many Australians reject the home-grown product outright, finding all sorts of trumped-up excuses for not considering it.

At least take the trouble to compare the performance, cost and delivery with the imported alternatives. Then consider the possible advantages with an air of optimism (faster delivery, perhaps, access to the maker, readily available replacement, patriotic encouragement of a needed industry).

Next time you have to choose an instrument, give the Aussie manufacturer a fair dinkum go! ●

EQUIPMENT NEWS

FREQUENCY COUNTERS USE MOS LSI.

The FB 2600 series of frequency counters recently released by the Schlumberger group use advanced MOS LSI circuit techniques. Three models currently available are type FB 2601 (50 MHz counter/timer), type FB 2603 (520 MHz counter/timer) and type FB 2602 (50 MHz counter/timer with comprehensive time interval measurement facilities). The A – B time interval mode with the latter counter features a time hold-off facility on the B input to eliminate spurious trigger effects due to relay contact bounce, etc. The series uses a modular construction system allowing simple conversion from one type to another.

Common characteristics of the range include a seven digit variable intensity LED display, high stability temperature compensated crystal oscillator, and ac mains or 12 V dc operation as standard. 250 V rms input overload protection is provided.

A rechargable battery pack is optionally available giving five – eight hours continuous operation. Other options include a high sensitivity preamplifier for the 520 MHz version.

Further details from Schlumberger Instrumentation Australia Ltd., P.O. Box 138, Kew, Vic.

FEEDBACK DATA BID FOR FLEXTIME MARKET

The publicity currently being given to the benefits of flexible working hours, or Flextime, coincides with an announcement by Feedback Data, the UK-based data systems company, giving details of their new equipment designed specifically to provide a comprehensive solution to this growing requirement. Feedback Data say that their equipment has the additional advantage that it is the most economic method of handling normal attendance recording applications. Moreover, the use of personalised identity badges overcomes staff objections to the use of conventional clock cards.

Feedback Data introduced their attendance time recording system in 1969. Basically, each employee has a plastic badge which he inserts into a badge-reading terminal to record attendance. A number of these terminals are connected to a central unit which produces either a paper tape or a magnetic tape in computer-compatible form.

The justification for this method of attendance recording was, and is, to save the cost of wages office and data preparation staff. For customers who are already users of Feedback Data's shop-floor data collection equipment – and who thus already possess a central unit – the addition of attendance recording terminals is inexpensive.

Such was the interest in attendance recording by this simple method, that several sales were made based on attendance recording only, and a slightly modified – and less costly – central equipment was developed to meet this demand.

As Jack Hale, Managing Director of Feedback Data commented, 'There the matter would have rested; but inherent in this method of attendance recording is the fact that it is a simple matter to programme the computer handling payroll to print out each employee's accumulative hours when required – and this makes our system ideal for Flextime applications. It is tempting, but untrue, to claim that we foresaw this demand. In truth, we are lucky in now having the right equipment at the right time, coupled with three years field experience'.

Since, with the introduction of Flextime, the potential market for attendance recording systems is now rapidly increasing, Feedback Data have designed, and are now able to offer, a new low-cost central unit dedicated to attendance recording only.

The basic system is limited to 15 terminals, but for the larger user various enhancements and extensions are possible, such as the addition of a concentrator to double the number of terminals and the replacement of the paper tape output by a magnetic tape output. Where maximum system security is required, the output device may be duplicated.

Further details from: Ronald J.T. Payne Pty. Ltd., 385-387 Bridge Road, Richmond, Vic. 3121.

PORTABLE MONITOR SERVICES ANY FM/AM/SSB EQUIPMENT

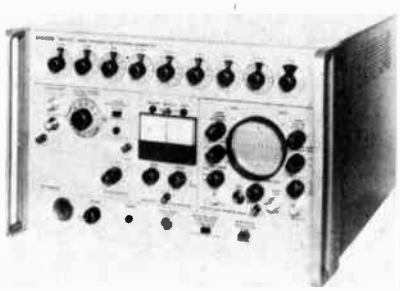
A portable, battery-operated communication monitor claimed to be able to service all FM/AM/SSB equipment in the range 50kHz to 512MHz is announced by DC Electronics Pty. Ltd.

Designated the Singer Model FM-10C, it is claimed to be the world's first portable service monitor capable of measuring and generating FM and AM modulation. Its high resolving power and accuracy also equip the FM-10C for single-sideband work. This instrument is the only available monitor with instant-on operation and power flexibility (12Vdc and 240 Vac).

Three plug-in modules are immediately available for the FM-10C and others are to be introduced in the future. The existing plug-ins provide oscilloscope and meter readout of FM deviation frequency and oscilloscope readout of % AM modulation.

The FM-10C has five search sweeps of 0 – 100Hz, 0 – 1kHz, 0 – 10kHz, 0 – 100kHz, and 0 – 1MHz. Carrier frequency and modulation can be measured simultaneously, a further feature which increase servicing speed. External/internal time base and IF output are provided for.

Further details from: DC Electronics Pty. Ltd., 32 Smith Street, Collingwood, Vic. 3066.



(Turn to page 116)

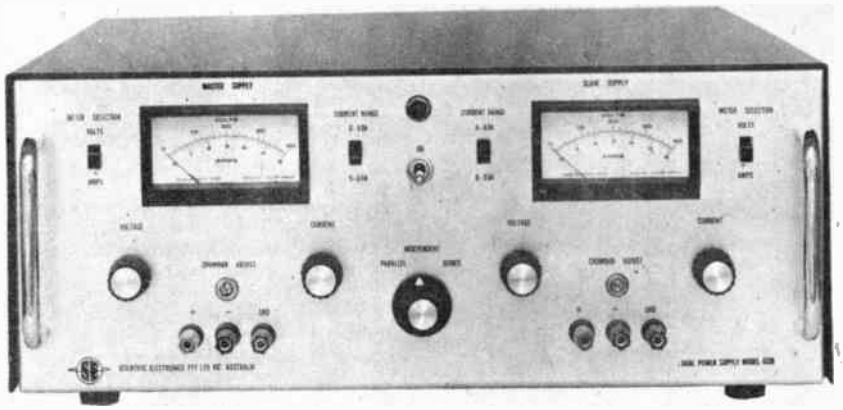
DUAL POWER SUPPLIES

A new range of high-performance Dual Power Supplies are available from Scientific Electronics Pty. Limited. The power supplies are constant voltage/constant current type and can provide output voltages fully adjustable to 60 volts and output currents to 6 amps.

Other features include ten-turn controls on both voltage and current, fully adjustable overvoltage crowbar protection, independent, series or parallel operation, dual current ratings, remote sensing and programming and auto series, parallel or tracking.

The manufacturer states that line and load regulation is less than 0.005%, ripple and noise is less than 2mV p-p, auto recovery overload and reverse and overvoltage protection are provided.

Further details from Scientific Electronics Pty. Limited, 42 Barry Street, Bayswater, Vic.



DIGITAL VOLT-OHMETER

Scientific Electronics have announced the release of their Model DVM 100 digital volt-ohmeter.

The unit has five dc voltage ranges and six resistance ranges. It is of hybrid design and makes use of a number of standard linear and digital integrated circuits enabling low cost replacement of components.

Three digits, plus an over range digit are displayed in a bright buffered display 0.55" (22mm) high which can be easily read at 40 feet (12 metres). A circular polarised filter provides high contrast for all ambient light conditions. The ranges are calibrated for full scale of 1000. Over-ranging to 1999 is available on all ranges.

Dual slope integration is the conversion technique used. Sampling at 200msec intervals gives high rejection of mains frequency noise disturbance of the displayed reading. BCD output direct from the buffer state in complement form is available as a wired in option. Accuracy or voltage ranges is claimed to be 0.1% of reading ±1 digit. Input resistance is 10 megohms on all ranges.

Further details from Scientific Electronics Pty. Ltd., 42 Barry Street, Bayswater. Vic.

SOLVENT SIMPLIFIES CLEANING OF SOLDERED PCB

A halogenated solvent, specifically developed by ICI for cleaning soldered printed circuit boards offers significant advantages over other methods – including ultrasonic cleaning.

The solvent is used to best effect in a boiling process (perfected by ICI) and removes rosin-based flow and hand-solder fluxes and activators without damage to the polymeric materials of the boards. It is

(Turn to page 118)

forget our rave reviews and our research and sit in judgement on two fascinating experiments....

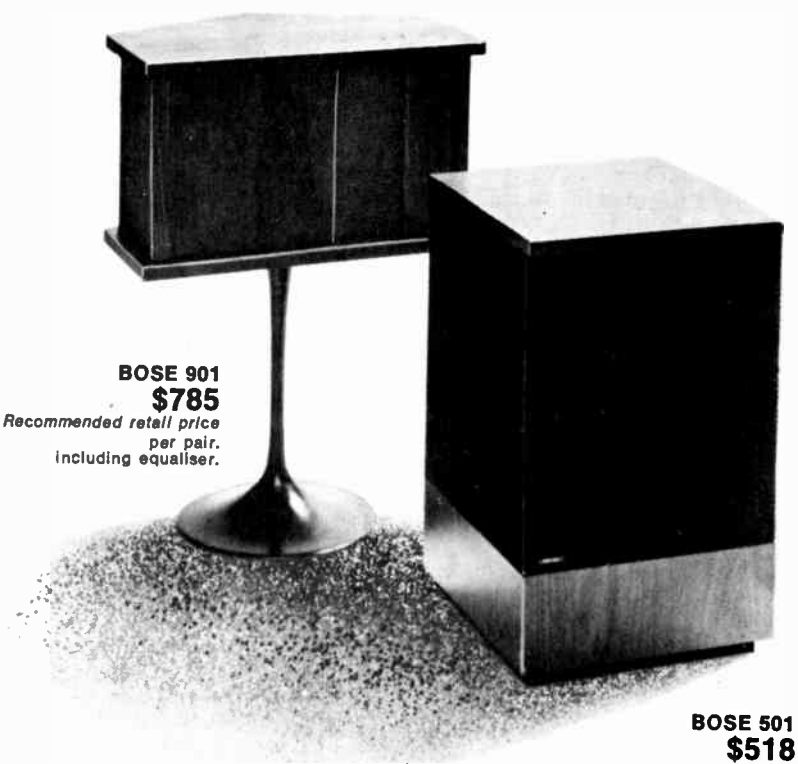
Take your most exacting records to your nearest Bose dealer and . . .

1 Place the BOSE 901's directly on top of any other speakers, regardless of their size or price, and make an A-B listening test with your records.

2 Place the BOSE 501's beside (with at least 2 feet clearance) any other speaker using woofers, tweeters and crossovers and perform the A-B listening test. (Don't ask the price of the 501 before the test).

Then just enjoy your records. When you finish you will know why we get much more satisfaction from our work than could ever be derived from profits alone.
We enjoy telling you about our continuing research in sound reproduction and the rave reviews of our products, but the research and the reviews are of only academic interest unless the speakers really are audibly superior. YOU are the ultimate judge, for you are the one who lives with the sound you choose.

....unless they're audibly superior to you, it's all academic



BOSE 901
$785
Recommended retail price per pair. including equaliser.

BOSE 501
$518
Recommended retail price per pair.

You can hear the difference now BOSE®

Australian Distributors
WEDDERSPOON
W. C. WEDDERSPOON PTY. LTD.
193 Clarence Street, Sydney. 29 6681

Bose systems may be purchased from the following Australian dealers:

NSW: Sydney Hi-Fi Centre, 83 York Street, Sydney. 2000
ACT: Homecrafts, Petrie Street, Canberra. 2600
WA: Leslie Leonard, London Court, Perth. 6000
VIC: Douglas Trading, 191 Bourke Street, Melb. 3000
TAS: P. & M. Distributors, 87 Brisbane Street, Launceston. 7250
QLD: Stereo Supplies, 100 Turbot Street, Brisbane 4000
SA: Sound Spectrum, 33 Regents Arcade, Adelaide. 5000

claimed to be effective even after an interval of several weeks between soldering and cleaning, although the more usual interval encountered in actual production would be about one week.

Ultrasonic irradiation of the cleaning solvent is unnecessary thus giving a significant saving in capital equipment cost. Instead, the halogenated solvent (containing 1:2:2-trifluoroethane and 25 per cent by weight of isopropyl alcohol) can be used in conventional cleaning plant with minimum modifications. One of these is the fitting of an additional thermostat sited in the saturated vapour zone between the boiling liquid and saturated vapour/air interface.

This thermostat ensures that the cleaning liquid is regularly topped up with the halogenated solvent since it shuts off the plant heaters if the alcohol concentration in the system rises beyond a certain 'safe' point.

Another significant advantage offered by 'Arklone' K is that is can safely be employed for sensitive components that might be damaged by ultrasonic vibrations.

Boiling occurs at a temperature of only about 50°C and the vapour produced by the boiling mixture is condensed to provide a reservoir of clean solvent for rinsing assemblies that have been cleaned. If the workpieces have a particularly complicated configuration or many holes, a second rinse – preceded by draining – is recommended. Cleaning time is on average two minutes and each rinse takes about one half to one minute.

Eventually the boiling mixture becomes excessively contaminated with flux and oil and must be replaced. However, more than half the volume of the dirty liquor can be recovered by distillation and used for topping up.

As supplied, the halogenated solvent is non-flammable. Correct fitting of the additional thermostat to the cleaning equipment ensures that its alcohol concentration is always kept to safe (non-flammable) levels however large a work throughput may cause heavier than usual evaporation of the solvent.

Further details from: ICI Australia Ltd., ICI House, 1 Nicholson St., Melbourne, 3001.

LEVEL TRACER (200 to 4000 Hz)

The K 2001 level tracer (200 to 4000 Hz), newly developed by Siemens for the Hanover Fair 1973, measures all principal parameters of the VF facilities of telephone transmission systems. This complete test setup, consisting of a sweep generator, a receiver and additional circuits, is suitable for measuring voltage/power levels, net, insertion and return losses as well as impedances. The measurement result is immediately displayed on the face of the cathode-ray tube as a stationary trace. Horizontal deflection via frequency meters permits combination with any sweep generator that works in the same frequency range, without synchronization.

The K 2001 level tracer contains the transmitting and receiving facilities for all measurements on four-terminal networks that can be reduced to voltage measurements. It also incorporates additional circuits for making measurements on two-terminal networks. The measured values are displayed in the form of a curve as a function of frequency; they can be directly read from a graticule with level and frequency divisions. The sweep method considerably cuts down the measurement

times during service supervision of telecommunications system and telephone lines.

With very little work, the level tracer represents the condition of subscriber-to-subscriber connections, no matter whether these are run on a VF basis from end to end or whether they are transmitted via multiplex lines or radio links. Much time is also saved during measurements required in the development, production, testing and installation of telecommunications equipment.

Siemens offer two models of this level tracer to provide maximum economy for the different applications. In addition to the basic model with all operational features, there is also a model made more versatile by a modification set. A module with two electronic switches and a control generator enables a frequency marker to be formed. The settable marker frequency is inserted into the display as a stationary pattern and therefore appears with the screen trace at the same time. The display range is accordingly increased by a 40-dB preamplifier; an input level as low as -80 dB suffices to produce full-scale deflection and a level of -104 dB can still be read on the scale. This makes the instrument suitable for crosstalk measurements too.

Further details from Siemens Aktiengesellschaft, ZI/Presseabteilung Technik, Joachim Ullmann, Telephone (09131) 7-3394, D-8520 Erlangen 2, Postfach 325 Federal Republic of Germany.

RACAL HF/VHF SELECTIVE ANALYSER MODEL 9056 IMPROVED

Racal's new selective analyser, designed to measure individual sideband components of complex waveforms encountered primarily

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Battery	:	H-7D/A9.1V

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Impedance	:	600 OHMS
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Freq. response	:	50-15000 HZ
Battery	:	1.5.V (UM-3)

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in AM, SSB or FM transmitters, now has an extended frequency range to at least 100 MHz.

The instrument's principle of selective tuning enables the user to check accurately, and within seconds, the relative ratios of carrier to individual sidebands, and the ratios of wanted to unwanted components, in particular the 3rd order and 5th order distortion products generated in single sideband equipment.

Measurements are precise and unambiguous, whilst dynamic range approaches 80 dB. Additionally the included 'two-tone' audio generator now provides a variable output from 0 dBm to -20 dBm into a balanced 600 ohm load, with distortion of better than -70 dB.

The instrument may also be used as an accurate microvoltmeter, particularly for return loss measurements. Designed for simplicity of operation, the 9056 is housed in a lightweight portable case and weighs only 3.5 kg (7.7 lbs).

The price of the instrument is approximately only one sixth that of the more complex, heavy and expensive spectrum analysers which previously were necessary to effect such measurements.

Further details from: Racal Electronics Pty Ltd, 47 Talavera Road. North Ryde 2113 N.S.W.

NEW RACAL COUNTER IMPROVES LF RESOLUTION

Racal experience and expertise in designing and manufacturing high performance counter timers is exemplified in the latest addition to their range, the Model 9523 VLF Counter Timer. A unique reciprocal computing capability is used at low frequencies to improve frequency measurement resolution up to 1,000 times, in four ranges covering 0.1Hz to 1kHz. An example of the improvement in resolution is that a 50Hz signal would be displayed as 5000Hz in little more than a second, or as 50 000Hz in about ten seconds.

A compact, lightweight digital instrument, the 9523 measures frequency, frequency ratio, time interval and totalized counts in the 0.1Hz to 10MHz range. The fully variable digital timebase enables the instrument to be used in a wide variety of industrial applications where the presentation of measurements in 'engineering units' is often vital, and direct readings in terms of rpm., litres per minute, miles per hour etc. can be obtained by selection of the correct gate time.

Three input channels are provided, two for direct frequency and frequency ratio readings and the third for VLF measurement and as a gating channel for time interval measurements. In timer applications the start/stop signals may be electrical, or contact closures with incorporated circuitry to avoid false operation due to contact bounce.

Designed and built to operate under arduous industrial environments the 9523 is of half-rack dimensions, only 100mm (3.15/16 inches) in height and weighs only 2.7kg (6 lbs). Optional additions include BCD data outputs and rear mounting input sockets.

Further details from: Racal Electronics Pty Ltd, 47 Talavera Road, North Ryde 2113 N.S.W.

salute the Sansui models

210A and AU-101

SIMPLY THE MOST OUTSTANDING (AND BEST VALUE) STEREO AMPLIFIERS AVAILABLE IN AUSTRALIA TODAY.

Both are in great demand — both have received "rave" reviews in highly respected technical publications . . . and it's not surprising, for in terms of sheer performance, the Sansui models outclass similarly priced equipment, and even effectively penetrate the market of some products *twice the Sansui price.*

MODEL 210A.

Sansui designed and manufactured the Model 210A stereo tuner/amplifier specifically for Australian conditions — yet the maximum price you will pay is $213.50. Output is 22 watts R.M.S. into 4 ohm speaker systems and the conservatively quoted frequency response is 25-30,000 Hz. ±2dB. Distant stations are received easily, for the 210A is the *most sensitive tuner/amplifier ever made by Sansui!*

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HEAR – COMPARE – AND BE MORE SATISFIED WITH SANSUI!

MODEL AU-101

In the review in "Electronics Australia" (August, 1971) you will read . . . "the best comment we can make about the AU-101 is that few amplifiers, regardless of price, give an overall test result as good as this". Need we say more?

The most you will pay for the AU-101 is $148, and it could well be less than this when you visit your franchised Sansui dealer . . . for trade-in solutions can make a world of difference.

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Power output: 30 watts R.M.S. at 4 ohms, 32 watts R.M.S. at 8 ohms.

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T.H.D.: Less than 0.3% at full rated output.

Channel separation: Better than 45dB. Input sensitivity: 2mV.

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Sansui equipment is manufactured by: *Sansui Electric Co. Ltd., 14-1 2-chome, Izumi, Suginamiku, Tokyo, Japan.*

COMPONENT NEWS

NEW COMPONENTS STORE

"M.S. Components" have recently opened a branch at 188-192 Pacific Highway, Greenwich.

The company's range of merchandise includes the latest and newest in componentry, mixed with an attractive and varied range of disposal electronic gear, plus a bit of vintage to add interest.

Their new complex is a bright and attractive showroom with an electronic supermarket atmosphere, where one can spend a pleasant half-hour or so browsing through the wide and varied range of goods, with an ever changing accent on disposal merchandise.

NEW "MINI-SONALERT"

Half the size of the original "Sonalert" audible signal generators from P.R. Mallory & Co. of Indiana, U.S.A., a new range of "Mini-Sonalert" devices is now being marketed in Australia by Plessey Ducon Pty. Ltd., of Villawood, N.S.W.

Mini-Sonalert units produce a penetrating sound by purely electronic means. They are compact, lightweight and highly versatile. They consume less current than normal indicator lights and can be used to complement visual signals.

Circuitry is solid state for maximum efficiency, lowest current requirement and highest reliability. There is no arcing, RF noise or mechanical wear.

Common applications include, fault alarms for computers, fire signals, instruments, appliances, communications and medical electronic equipment.

Further details from: Plessey Ducon Pty Ltd., Christina Rd., Villawood, NSW.

THREE-DIGIT LED DISPLAY

National Semiconductor has introduced the NSN-33, a three digit LED display aimed at the calculator and digital instrument market and a pin-for-pin replacement for the Litronix DL33.

Each digit in the NSN-33 is 1/8 inch high and is made up of seven segments and a right hand decimal point. Segment and decimal point anodes of the three digits are internally connected in parallel making multiplex operation easy. And the digits are spaced on 0.200 inch centres for easy end-to-end stacking of 6, 9, or 12 or more digits.

The NSN-33 comes in a dark red, 12-pin dual-in-line package which provides excellent visual contrast and a wide viewing angle for the display. A low current drive of only one milliamp average per segment provides adequate brightness in typical applications. Maximum average current per segment is 8mA., and the maximum reverse voltage rating is five volts.

A modified version of the display, called the NSN133 is also available. The NSN-133 is identical to the NSN-33 except that a minus sign replaces the leftmost digit, and it is connected to pin 12, which is unused in the NSN-33. Thus an 8-digit calculator display is easily made up by employing one NSN-133 and two NSN-33 displays.

Further details from NS Electronics Pty. Ltd., Cnr. Stud Road & Mountain Highway, Bayswater, Vic. 3153.

HOW TO USE PIN DIODES

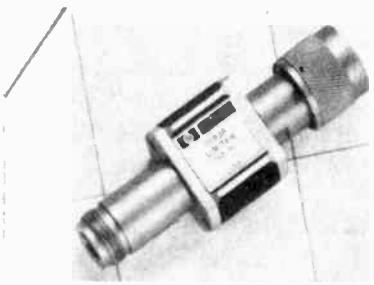
The most important property of PIN diodes is that they appear as an almost pure resistance at radio frequencies. Their resistance can be varied over a range of about 1 to 10 000 ohms by applying direct current or low frequency ac. This property and others are discussed in detail in Hewlett-Packard Application Note 922, "Applications of PIN Diodes."

In addition, this 14-page booklet contains detailed application information on subjects such as design of switches and attenuators, and design of PIN diode phase shifters.

Concluding the booklet is a section discussing power handling capability of PIN diodes.

Hewlett-Packard Application Note 922, "Applications of PIN Diodes", is available free of charge. Apply on company letterhead to:– Marcom Department, Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, 3146.

BROADBAND OVERLOAD PROTECTION



Sensitive microwave instruments can be protected from overload damage with a new limiter (Hewlett-Packard Model 11693A) which nonetheless has minimal effect on lower-level measurements. The 11693A typically introduces frequency response variations of less than ±0.5 dB across the range 100 MHz to 12.4 GHz.

Limiting action begins at signal levels around 5 milliwatts even with applied levels of 1 watt CW (or 75 watts peak), the output from the limiter stays well below 100mW. Very often this can mean survival for an expensive mixer diode, sampling circuit, or amplifier front end, after inadvertent overloading.

The limiter can be especially valuable when connected at the input of an instrument that's looking at signals from an antenna, such as a spectrum analyser or receiver, since the antenna could be picking up very strong signals, not apparent to the operator. One of the limiter's most attractive performance characteristics is that it does not constrict the dynamic range of sensitive instrumentation like spectrum analysers. For example, when the limiter is used ahead of the HP 8555A Microwave Spectrum Analyser, the analyser's 70 dB distortion-free dynamic range is preserved for input signals below –40 dBm.

Further details from: Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, 3146.

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WITH AM RADIO AND BUILT-IN DIGITAL CLOCK WITH TIMER

Model SE4308

The system is a combination high quality deluxe AM receiver, a precision stereo cassette recorder with a digital clock and a timer, and a matched pair of dynamic microphones. It is designed for optimum re-production of program material from Radio Broadcasts, Cassette Phonographs and any other Audio Source. Full facilities are provided for recording directly from Radio receiver, live program from microphones, external equipments such as record players, 8 track cartridge players, etc. For your added pleasures and conveniences, AUTOMATIC RECORDINGS, WAKE UP and GOOD NIGHT SLEEP services can be made.

# Total Power Output:	15W(1HF) 10W (RMS @ 8 ohm .8% distortion)
# Frequency Range Tuner:	AM 535-1605 Hz
# Frequency Response:	20-20,000 Hz at -3dB or less
# Stereo Separation:	30 dB
# Stereo Cassette Deck:	4 Track 2 Channel
# Clock and Timer. Clock:	Made by Copal, Auto. off/on w/Sleep Switch.
Time:	Up to 3 hour time set.
Auto Recording:	Up to 1 hour with C120 Cassette
# Voltage:	AC 240V, 50 Hz
# Dimensions: Main Unit:	17" (W) x 4-3/8" (H) x 9-7/8" (D)
Speaker Enclosures:	8-1/8" (W) x 9-7/8" (H) x 5¾" (D) (with 6½" speakers)

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AUDIO NEWS

METALLIC SPEAKER DIAPHRAGM

Pioneer of Japan has announced the successful development of a metallic beryllium diaphragm for tweeters and a magnetic circuit for drastic reduction of distortion in mid-range speakers and woofers.

These developments will revolutionize speaker systems, claim Pioneer. Compared with conventional titanium or duralumin diaphragms, the new metallic diaphragm gives tweeters higher physical and mechanical properties, conversion efficiency is accelerated and high frequency reproduction is enhanced.

The Pioneer magnetic circuit incorporates oriented magnetic materials, which they claim, drastically reduces distortion caused by magnetic circuits in mid-range speakers and woofers. It has been dubbed the 'Super Linear Circuit' by the company because of its remarkable performance. The circuit uses a piece of silicon steel to minimise the magnetic distortion.

LASER VIDEO IN AUSTRALIA BY 1975

MCA will import their laser disc unit – the Disco-Vision – from mid-1974, says Mr Ron Brown, Managing Director of the Australian division of the company.

The system, launched in Los Angeles just before Christmas, consists of a playback unit which can be attached to the VHF antenna input terminals of any standard home television receiver and which may be tuned to a channel not used by regular TV programmes.

There is no pick-up stylus as the playback unit employs an optical system with a non-physical contact, low-powered helium-neon laser read-out which picks up the images and relays them electronically to the screen.

The disc being prepared for market in the US is 0.010 inches thick and provides full colour and black and white pictures for a maximum of 40 minutes playing time each side. Density of the material is 12,500 tracks per radial inch.

The playback unit, which also has multiple disc facilities, is standard NTSC, 525 lines, 60 fields. The disc drive speed is 1,800 r.p.m. and there are more than 300 lines of colour resolution. Audio and video signal-to-noise ratios are each greater than 40 decibels with two channels of audio available for stereo and special applications.

"MCA technicians have been working on this project for three to four years," Mr Brown said, "and when we presented to the American trade recently we took eight television sets made by different leading brands and demonstrated the system on each set simultaneously."

"The retail price in America will be around the US$500 mark," said Mr Brown, "and it should be marketed in Australia for not much more. Already we have albums of films such as "Spartacus" and "To Kill a Mocking Bird" retailing from US$1.99 to US$8.99, and we have made plans for 11,000 movies to be put on record."

The first machines to be sold in America will appear at the beginning of 1974 and Mr Brown expects to introduce the system to Australia a few months later.

Disco-Vision will be marketed through established television outlets, together with audio specialists and stores. Discs will be sold through record bars, audio retailers and present music dealers.

DOLBY ORDERS

Dolby Laboratories has announced the largest order for professional noise reduction equipment yet received from a broadcasting organization – 96 A-Type processors to be supplied to R.T.B., the national radio and television service of Belgium.

The order indicates the growing importance of Dolby noise reduction in providing broadcasting service of high quality.

Many radio and television authorities already employ the Dolby system for audio recording, videotape sound tracks, and land-line applications; such users include the B.B.C., the European Broadcasting Union, and broadcasting organisations in Australia, Canada, Czechoslovakia, Denmark, France, Germany, Hungary, Iceland, Japan, Netherlands, Norway, Spain, Sweden, United States, U.S.S.R., and Yugoslavia.

About ten thousand Dolby A-Type (professional) channels of noise reduction are now in use throughout the world in recording studios, film studios, broadcasting stations, and communications links. Use of the system provides an unweighted 10 dB of improvement in signal-to-noise ratio without effect upon the original program material, through a unique form of compression and expansion applied during recording or transmission and playback.

20 MILLION TAPE RECORDERS

Matsushita Electric producers of the famous NATIONAL PANASONIC brand product announced that on Wednesday 21st March their cumulative production reached the record figure of 20 million Tape Recorders.

It is believed this is the highest record set by any manufacturer in the world.

Production of NATIONAL Tape Recorders began in 1958 with the first million taking four years to produce.

NATIONAL PANASONIC Tape Recorders are now sold in over 120 countries throughout the world, and are distributed throughout Australia by Haco Distributing Agencies Pty Ltd.

WRIGHT TUNERS TO P.M.G.

Following laboratory and in-field evaluation of their LDT-3A AM broadcast tuner by the P.M.G., Wright Audio Developments tell us that an order for the supply of tuners has been received from that department.

CAR NOISE LEVELS

This instrumented robot is being used by the Ford Motor Company's research laboratories in the UK to assist in a study of interior noise levels in cars.

Instrumentation of this type is necessary because individual subject impressions of vehicle noise are not reliable.

In developing the system, Ford engineers designed their own tape noise reduction technique, which they claim "provides the automotive research engineer with the same standard of background silence as the Dolby system has brought to commercial music recordings".

Apart from this, Ford are looking at increasingly sophisticated ways of processing their results. "We want to simulate the way in which the brain assesses noise", said a company spokesman. "No-one else in the motor industry has investigated the matter before, so we will have to be pioneers again".

BOOK REVIEWS

REVIEWER: Brian Chapman

MEASURING OSCILLOSCOPES Edited by J.F. Golding. Published by Butterworth & Co. Ltd. 1971. Review copy supplied by publisher. Hard covers, 236 pages 8½" x 5½". Australian price. $7.15

This book has been prepared as a fairly comprehensive guide to the usage and general understanding of the modern oscilloscope. It has been compiled from the collected contributions of a number of instrument engineers from Marconi having specialized knowledge in the application and design of oscilloscopes.

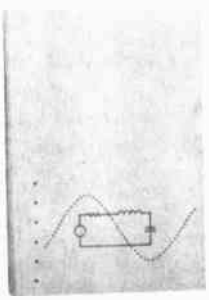
It is surprising how few technicians and engineers have a comprehensive understanding of oscilloscope measurement techniques. The modern measuring oscilloscope is without doubt one of the most versatile instruments in existence and a careful study of its capabilities would be well repaid.

Most text books on oscilloscope techniques seem to treat the subject from the state of the art 20 years ago and do not adequately discuss the improved performance of modern instruments. This is not the case with this book. Being written by a team of designers of modern instruments, it deals with features of oscilloscopes which are of practical significance in present day technology.

Although circuitry is given, the main accent is on instrument characteristics and measurement techniques and limitations. The oscilloscope applications section of the book leaves simple everyday topics to other texts and concentrates on the additional applications opened up by new instrument capabilities.

The discussion is limited to general purpose real-time oscilloscopes and does not deal with special purpose instruments such as sampling, storage or travelling wave oscilloscopes as these differ considerably in design from the conventional.

A point worthy of mention is that the discussion is not limited solely to Marconi equipment. That of other manufacturers is freely mentioned where noteworthy. Worth having. – B.C.



CIRCUIT THEORY WITH COMPUTER METHODS by Omar Wing. Published 1972 by Holt, Rinehart and Winston Inc. Hard covers 529 pages 9" x 6". Review copy supplied by Holt, Rinehart and Winston (Aust) Pty. Ltd. Australian price $15.00.

The computer is now a standard tool which is used extensively by students in most electronic engineering or allied degree courses. So much so that university computers tend to run 24 hours a day and there is sometimes considerable waiting time before your program is run, only to find it needs debugging, and hence there is still further exasperating delay.

The only answers to the above problem are the use of more advanced time-sharing computers which provide multi-terminal capabilities, and better education of the student in economical and accurate programming. The first measure can only be solved by the university concerned. The second measure – better education in computer methods is adequately catered for by this book under review.

The components of this book are a presentation of basic circuit theory, a logical method of analysing electronic circuitry and a selection of computer programs.

The circuit theory commences right at the beginning by developing, from first principles, mathematical models of standard components. These are then used to develop equations describing the behaviour of circuits. Circuit analysis progresses through simple linear circuits using Kirchoff, Thevenim, superposition etc., to first and second order differential equations, simple non-linear circuits, sinusoidal steady state, frequency characteristics of circuits, time domain analysis and multiterminal circuits. The book therefore can be seen to contain all the essential topics in circuit analysis.

The computer programs range from one for finding a 'tree' in a graph, to one for the frequency analysis of a general linear circuit. All programs are written in Fortran IV and are completely documented. The fundamentals of programing are not given and it is assumed that the student has already done a programing course.

At the end of each chapter a good selection of problems are given to develop the student's appreciation of the subject and these are divided into three categories; exercises to develop experience and confidence in circuit analysis, 'fun' problems which have no practical use – but are interesting and difficult, and simple design problems to develop engineering practice. Answers to selected problems are provided in the rear of the book. The text is profusely illustrated by means of worked problems and gives a very thorough mathematical treatment of the whole theory of circuit analysis, with computer methods of implementing such analysis.

The book should be extremely useful to undergraduates who wish to gain expertise in this very vital subject. – B.C.

IC PROJECTS FOR AMATEUR AND EXPERIMENTER – Edited by Wayne Green. Published by TAB Books 1971. Soft covers, 189 pages 8½" x 5½". Review copy supplied by Grenville Publishing Company Pty. Ltd. Australian price $4.95.

This book contains an anthology of some 34 of the more interesting IC construction projects from the excellent US ham radio '73 magazine'. The projects are selected to be of value to the radio amateur. Although the book is supposedly also for the general experimenter I feel it fair to say that in reality it is directed solely to the amateur. Most of the projects are test and ancillary equipment specifically applicable to the ham shack.

Integrated circuits are making ever-increasing inroads into electronic equipment practice of all disciplines. It is not surprising therefore that they are also finding considerable application in the amateur radio field.

This book therefore admirably fills a need by amateurs to learn how IC's can be used to advantage in their equipment and is a source of many excellent circuits. – B.C.

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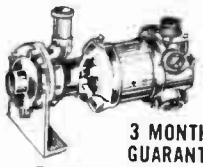

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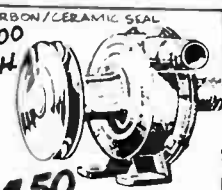

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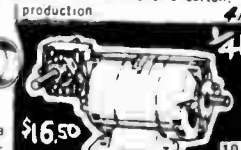

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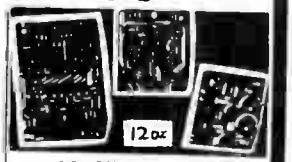

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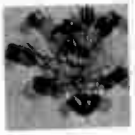

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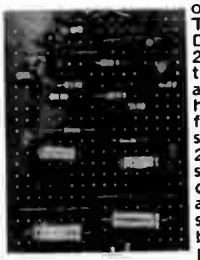

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RECORDINGS classical

REVIEWERS: Tanya Buchdahl
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BACH: Complete Orchestral Suites BMV 1066-69. English Chamber Orchestra/Raymond Leppard. Philips 6500-067/8 (two records, available separately, $6.20 each). Coupled 1 and 4; 2 and 3.

There are thirteen complete sets of Bach's Suites in the current British catalogue alone, and despite a line-up of heavies like Menuhin, Dart, Marriner or Harnoncourt, I would be surprised if any of them better this issue. Occasionally records appear which just plain make you feel good all over when you listen to them, and these are two more. My respect for the ECO and Leppard grows with every record they produce; without a doubt they are one of the finest orchestras anywhere – even better, I think, than the Academy of St Martin-in-the-Fields, for the former sound more spontaneous and the latter more smug.

The best feature of this orchestra is its remarkably fine violin section (for a better example of this, listen to the ECO/Leppard sampler, Philips 6833-035, $2.75) but here the woodwinds are certainly no less fine.

The third suite is perhaps the best of the sides – I have rarely heard such dazzling performances, particularly from the trumpeters Philip Jones, John Wilbraham and Michael Laird. The first side is notable for its precision of expression and technical balance, which bring through all sorts of patterns and beauties I have never noticed before, particularly concerning the bassoon. The least satisfying side is the second suite for flute; Richard Adeney's solo flute-playing is gentle and very neat but also a little colourless, which serves only to reinforce my feeling that only the French can *really* play the flute. There is a nagging feeling also that someone other than JSB himself had a hand in this suite (leaves me feeling just a little ratty at the end).

If you feel that $12.40 is a bit too much to pay, there are two other recommendable and much cheaper sets around. One is the Musi-disc version at $6.50 with the Saar Chamber Orchestra under Ristenpart (RC 748/9), with a Grand Prix du Disque, which despite its excitement is conventional and has dreadfully starved surfaces; the other is the Paillard Chamber Orchestra on WRC which also offers the "5th Suite" BWV 1070, a work of highly spurious origin – its exclusion would have been very little loss. Despite the merits of these two sets (including price) I am still inclined to opt for the Leppard edition, both for its very subtle but incisive originality (probably musicologically grounded) and its rich, typically Philips sound – brilliance of performance quite apart. – T.B.

VAUGHAN WILLIAMS – Fantasia on a Theme of Tallis, Fantasia on Greensleeves, The Lark Ascending. 5 Variants of Dives & Lazarus – Iona Brown (solo violin), Academy of St. Martin-in-the-Fields Neville Marriner (director ARGO ZRG-696.

One had better beware of looking on this record as just one more treatment of some of Vaughan Williams' best known music. The Academy's approach is refreshingly unpretentious; they strongly resist the tendency to sentimentalize, definitely understate the 'swell effects' so much a part of this music, while vibrato is tastefully kept to a minimum. The Academy's size is naturally in part the reason for all this, but also since none of this music is of true chamber quality (the chordal writing quite precluding this), still, just because one can better distinguish voices, there is less reason to object to the blurred textures often associated with such writing. In the Tallis Fantasia, one hears, for once, the bass line which here has an almost springing quality to it. Clarity, while it does give this music a stronger, unassuming quality, curiously exposes the often naive character of the writing. You may object to my being somewhat disturbed by a friend's comment while listening to the *Tallis Fantasia*, but I must agree it seems obvious Vaughan Williams had the English organ in mind here. It is disconcerting in that one does often fail to realize how superficial is Vaughan Williams' relation to Tudor music. Clarity and the absence of augmented mass effect can also hardly hide the banality of the final pages of this same work. One notices too, especially in *Greensleeves* and the *Five Variants* the often amateurish contrasting of orchestral sections. The evocative power of these pieces remain, however, despite the sometimes halting treatment of their ideas. At any rate, I will prefer to return to these works in these performances, if only for the fresh sound they present. Iona Brown's solo in the *Lark Ascending* definitely makes this recording the best ever.

J.A.A.

MENDELSSOHN – 7 Motets. Soloists, Westphalian Kantorei, Wilhelm Ehmann. Three Centuries of Masick – 3C 323.

Recording companies have been giving us a lot of trash from the 19th Century (Henselt, Tausig, etc.) and it is good to see them looking now not at some third rate composer but attending to little known works by the better known composers of the period. The 19th century does have less surprises in store than most people would suppose. The present record is a fine example in a more fruitful direction.

There is, of course, nothing in the rest of Mendelssohn's output that would reverse the well-known judgment that he wrote nothing to equal the Midsummer Night's Dream overture. Biased and incomplete this picture may be, it remains only too true of the composer's position in the 19th century. There are at the same time a few areas in Mendelssohn's music that deserve revival, especially chamber and church music. Protestant church music after the death of Bach suffered a severe decline lasting almost a century. We remember Mendelssohn today for his revivals of earlier religious music, of Lassus, Leo, Bach and Handel, and if we do associate Mendelssohn with religious music, it is unfortunately in connection with his uneven and often banal oratorios. In his works written for both Anglican and Prussian State Churches, however, Mendelssohn emerges as the first important composer in the modern Protestant tradition. It is in fact impossible to listen to these spare and tasteful settings without thinking of the composer's enormous influence on Brahms, Reger and more recent Protestant composers such as Distler.

Most of Mendelssohn's church music dates from the last seventeen years of his life. On this record we are given the Three English Church Pieces, Op. 69 for solo voices and unaccompanied chorus, composed between April and June of 1847, Psalms 2, 22 and 43, Op. 78 completed in 1844 and an undated Psalm 91. Psalms 2 and 22 are once again for voice and choir, Psalms 43 and 91 for 8 part choir alone. There are few moments here when one is reminded of the cloying style of the Oratorios. Significantly perhaps, these moments are to be found in the settings written by Mendelssohn for the Anglican Church, in the Magnificat, Op. 69 no. 3 and the final moments of the Nunc Diminittis, Op. 69 no. 1, reflecting perhaps Mendelssohn's awareness of English preferences in this period. At his best, in Psalms nos. 2 and 22, one is struck especially by Mendelssohn's awareness of Schutz, which is remarkable in that few if any musicians would have even been aware of Schutz at this time, the first modern edition being published only in 1885.

The performances from both soloists and choir are on the whole quite good, though one senses in the Magnificat moments when precision and attack lag a bit. Thoroughly recommended. – J.A.A.

J.S. BACH – The Six "Brandenburg Concertos" Academy of St. Martin-in-the-Fields/Neville Marriner PHILIPS SAL 6700 045 (2 discs).

This new set is the result of many years of intensive study by the late Thurston Dart and probably represents his last thoughts on the concertos. He prepared the scores on which these performances are based but unfortunately died during the process of recording them. We have evidence of his fine continuo playing therefore, only in selected movements (all of no. 3 and the first movements of nos. 2 and 4).

What can one say about Dart's ideas? Certainly, he has made some audacious and contentious decisions and their success will probably depend on the individual listener.

CLASSICAL

Modern research indicates that these concertos were not composed for the Margrave of Brandenburg but were written some years earlier during Bach's period as court musician to the Duki of Cothen. Dart has based his scores on copies of these earlier manuscripts (mostly by Christian Friedrich Penzel).

I cannot discover Dart's *reasons* for going to so much trouble when we already have Bach's Dedication Copy (D.C.). Sure, it's most interesting to have the "original Cothen Concertos", fascinating to see how the later copy differs, but is this the only reason? The programme notes here often suggest that it is not – "Not all revisions, even when made by the composer himself, are improvements": is this to suggest that the D.C. is *not* an improvement? This final copy more likely than not represents Bach's last views on the concertos, even though it reveals a few slips of the pen; yet these programme notes reveal – "Since only some of these (mistakes) were corrected, the D.C. cannot claim the same validity as source material which he (Bach) would give to an autograph copy made for the composer's use." Really! Anyhow, let's take it that this set was prepared just for an interesting experiment.

Concerto 1 differs from the D.C. in a number of ways, the most radical changes being the absence of the third movement (Allegro) and the polonaise of the last movement (both are played as an appendix). The second trio (last movement) differs in that the third line of counterpoint (a delightful darting figure) is played by violins and violas in unison as against an entirely different oboe part of the D.C. There is also no "violino piccolo" part.

In Concerto 2 we are unfortunately denied the opportunity of hearing some spectacular trumpet playing due to Dart's interpretation of "Tromba o vero corno da caccia." Surprising how well the horn balances here, though its sound is a little too big (especially in the lower register) – certainly it's no corno da caccia! Pace Erik Smith it should perhaps be borne in mind that the baroque clarino blended with its ensemble far more effectively than its modern counterpart. (Some exceptional trilling by Barry Tuckwell in the third movement.)

The most striking aspect of Concerto 3 is the inclusion of a second movement. Dart's arguments for such an inclusion are sound enough but why this particular movement (the Adagio from the Sonato in G for violin and continuo)? None of the sources indicate Bach's intentions on the matter and Dart himself gives no explanations (or at least there are no reasons given in the accompanying notes). The various manuscripts (also Bach's D.C.) reveal simply two chords – would this not more likely indicate a small improvised cadenza (this is done beautifully in Harnoncourt's version for TELEFUNKEN)? Please don't think I'm criticising the inclusion of this sonata movement – just the reasons, or rather lack of reasons for it. The Penzel score lacks the third 'cello part and thus is omitted here. Just a brief criticism of the notes at this point: Erik Smith thinks three 'cellos (and violone) – "thunderous and overwhelming competition to the six smaller instruments"; is he thinking of modern instruments? Harnoncourt's performance sounds extremely well balanced to me.

In Concerto 4 Dart believed that "fiauti d'echo" was another name for the flageolet. But since these instruments (and performers) are hard to come by he compromises by substituting sopranino recorders playing an octave higher. Even if Dart is correct about the use of flageolets, I wonder if they were as penetrating (piercing) as sopranino recorders. Erik Smith thinks the musical effect "like the merry noise of the Baroque organ with its bright 4ft. stops" – perhaps he should say 1 ft. stops. Certainly, "they are for once (I question the "for once") clearly audible throughout" – so clearly audible that I find it difficult to concentrate on the other parts. No other major differences from D.C. here.

Concerto 5 differs in that it has a much shortened cembalo cadenza (19 instead of 65 bars). I must confess (for a change) that I find this shortened version more in keeping with the overall balance of the movement and probably more suitable stylistically. The chromatic flourishes at the end are quite exciting. Its overall effect then is perhaps more dramatic than the extended version. Some fairly substantial differences in the 'cello part.

Concerto 6 is probably the least "realized" in Dart's copy of the set. Organ (rather than cembalo) continuo is used here and makes good sense, especially in the first movement with its rather long unchanging bass line and harmonic structure (a little more elaboration on the organ would probably not have gone amiss). Ornamentation is abundant and consistent in all parts, and does sound effective.

Something now of the performances. Here is Marriner at his most meticulous. Also very rhythmic and emphatic (Concerto 3 may just be a little too rhythmic) and often extremely fast – the last movement of Concerto 4 breaks the record (the reiterated notes of the violin episode become *very* hard to differentiate). We have the usual impeccable intonation and pitch control from this group. Balance could be better at times: both cembalo and organ sound on the whole rather distant (a pity we can't have this group with period instruments). Tempos and dynamics are a little too Marrinish – it might have been better to stick just a little closer to Baroque practice. Incidentially the sudden broadening of the final bars of Concerto 6 is quite inappropriate. The solo playing is often simply staggering (even though speeds are far too fast for the period).

An interesting if somewhat misleading second set to have.

C.M.W.

INPUT GATE

LETTERS FROM OUR READERS

RECORD QUALITY

Some time ago you ran an editorial in which you criticised the quality of many Australian-made records.

Whilst I agree completely with your comments my recent experience with a number of overseas recordings is that their quality is not what it used to be either.

— J.T. Paddington, NSW.

This is our experience too — at a time when the cassette is becoming a serious rival to the long-playing record it is surprising that record manufacturers allow so many poor quality pressings to slip through.

IC POWER SUPPLY

I have found difficulty in obtaining the precision voltage regulator specified for your IC Power Supply design published in ETI, November 1972.

After a lot of trouble I was sold an FU 6A7723393 7220. This is a dual-in-line unit with 14 connectors.

Can you tell which connections I should use.

— J.N.M. Darwin, N.T.

The IC you have is a uA723 and has the pin connections as detailed in the circuit diagram on page 49 of the September, '72 issue.

If you look at your number you will se FU6A (723) 393 7220. The first group of four numbers 7723 is the type number with the prefix 7 referring to the country of manufacture.

This is a Fairchild numbering system and is confusing for those not in the know.

RECTILINEAR REVIEW

Thank you for your review of the Rectilinear Mk XII speakers.

I do notice however that Louis Challis feels that Rectilinear's design goals "have been met with the exception of electro-acoustic efficiency, which was relatively low for a vented enclosure."

This qualification, "for a vented enclosure", missed the point. Rectilinear's intention was to make a "bookshelf speaker having high sensitivity to enable it to perform well with low to medium power amplifiers".

Note that they did not intend making a vented enclosure with high efficiency, but a bookshelf speaker with high efficiency!

When you compare the Rectilinear XII efficiency figure of 0.5% with the following, taken from your reviews, I think you will agree that they succeeded.

Dynaco A25	0.4%
Smaller Advent	0.15%
Goodmans Dimension 8	0.16%
Sonab 0A-5	0.3%
AR6	0.2%

— John Browne,
Manager,
Leroya Industries Pty. Ltd.,
Perth, W.A.

READERS' LETTERS

It is our policy to reply to all readers' letters — but not necessarily via these columns. Please ensure that you write your full name and address on your letter. We have a number of letters — mostly from our younger readers in which not even the writer's initials are included.

We try to reply to letters as quickly as possible — however on occasions there may be some delay. But please don't think that your letter has been ignored.

ELAC PUZZLE COMPETITION NO. 3

Rules as per previous ELAC Puzzles. Prize — an ELAC STS. 244-17 Cartridge First — the Solution to ELAC PUZZLE NO. 1

There were 207 Voters at the meeting. At first 115 voted for the motion and 92 against. The majority of 23 being just a quarter of 92. But when the 12 who could not sit down were transferred to the other side, 103 voted for the motion and 104 against. So it was defeated by 1 vote.

The first correct entry opened, was sent in by J. Faulks, 13 Daisy Street, Fairy Meadow, N.S.W. 2519.

Congratulations!! You have been awarded the prize of a great ELAC magnetic pick-up cartridge. We are sure you will be very pleased with its outstanding performance.

Now on to ELAC PUZZLE NO. 3 — This is much more difficult and we advise you to think carefully, just as you would when choosing a new turntable for your Hi-Fi System. Of course in that case the correct decision, based on reliability, performance and outstanding features, would be for one of the magnificent models made by ELAC.

Place in the empty squares such figures (different in every case and no two squares containing the same figure) so that they shall add up to 15 in as many straight directions as possible.

Post entries to
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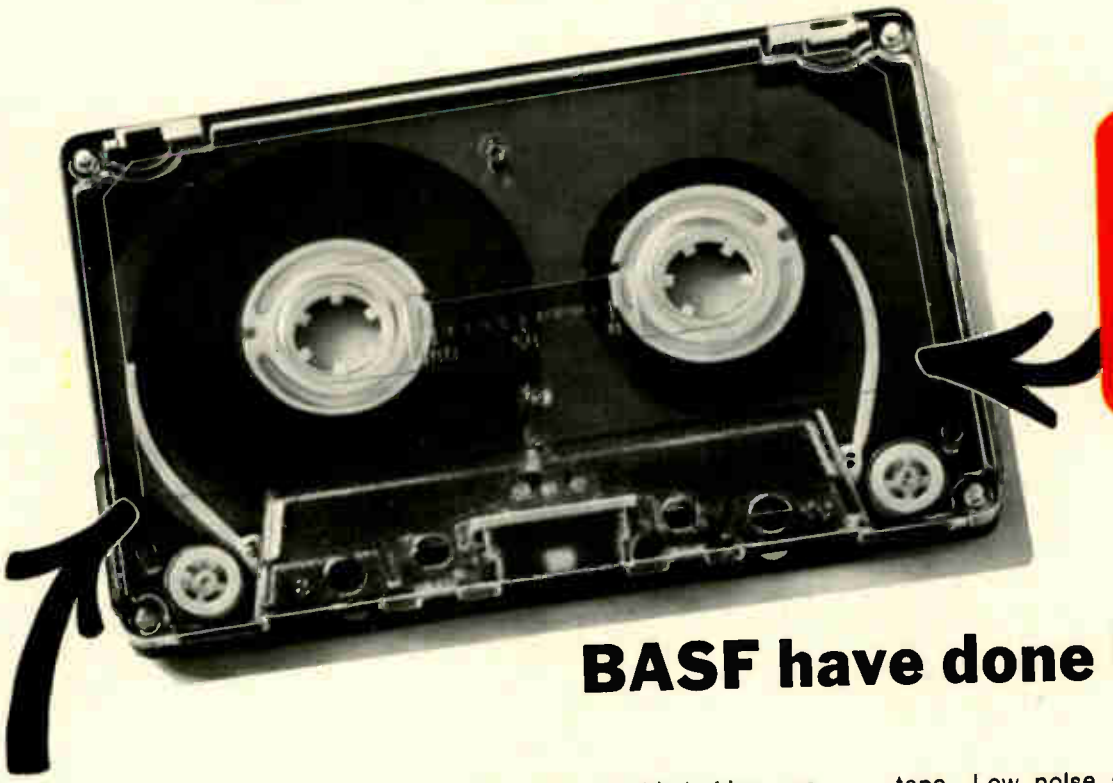
P.O. Box 150, Crows Nest, N.S.W. 2065

the jamproof cassette



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RECORDINGS POP

REVIEWER: Mike Delaney

"GREETINGS FROM L.A." – Tim Buckley. W.E.A. Stereo. BS.2631. "Honkey-Tonk Stardust Cowboy" – Jonathan Edwards. W.E.A. Stereo. SD.7015. "Third Down – 110 To Go" – Jesse Winchester. W.E.A. Stereo. BR.2102. "O'Keefe" – Danny O'Keefe. W.E.A. Stereo. SD.8404. "Casey Kelly" – Casey Kelly. W.E.A. Stereo. EKS.75040. "My Time" – Boz Scaggs. C.B.S. Stereo. SBP.23412.

First off, Tim Buckley – the rest can wait. Jonathan Edwards and Boz Scaggs later.

"Nothing in rock, folk-rock, or anything else prepares you for a Tim Buckley album, and it's funny to hear his work described as blues, modified rock 'n' roll and raga-rock when, in fact, there is no name yet for the places he and his voice go. He is a singer, writer and often a lyricist . . . the voice is not a voice so much as it is a musical instrument of incredible range and sweetness. His albums are easily the most beautiful, beautifully arranged and produced . . . wildly passionate and pure at the same time." Lillian Roxon said that.

Tim Buckley is one of the few great American artists to have come along after Bob Dylan. He's also one of the most important and unknown. Like David Crosby, and to an extent, Neil Young, he represents all the best, most characteristic and evocative forms from what first went down in California around '65-'67. Not so much in just musical terms, but in that awareness of himself – his total ability to communicate, to evince the growth and changes of an entire generation. Words ultimately mean nothing when you come up against Tim Buckley.

So far, he's had over five albums spanning a period of roughly six years – three phases. "Goodbye & Hello", "Tim Buckley" and "Happy/Sad" drew from acoustics – folk style. But more expansive, more hypnotic and tortuous. As a performer he was more expressive, sinister) like a fallen angel. "His whole thing is a walk on the high wire, juggling insights." Intensely poetic, far too obscure and involving for those who, at their best, could just handle Jim Morrison.

Phase two was jazz-like: "I was as close to Coltrane as anyone has come. I even started singing in foreign languages – Swahili for instance – just because it sounded better. It was refreshing." Several albums, including the wonderful "Lorca", followed. Outrageously sensuous, complex and unconventional in its lack of form. His voice found new dimensions working well outside white music. Dylan listened. So did David Crosby, The Byrds, Zappa. Everybody else stuck to Jefferson Airplane.

"I listened to the radio a lot before writing "Greetings From L.A.". There's a lot of radio music on it. It's full-out, blues-type barrelhouse rock. The album really rocks. I'm pleased with it." Two years after he retired from gigs, he took up with producer Jerry Goldstein and started over again. A comeback at twenty-three.

Essentially, Buckley hasn't changed. His music is more open, direct – but the character is the same; bitter/poignant and totally commanding. More sexual – explicit images, breathless, overwhelming and elongated. Poetic too. David Crosby parallels a lot of the things Buckley does, in a very subtle way. Both arouse incredible passion – ecstasy and pain. David is sensual/passionate; Buckley is sexual/passionate. There's a huge difference!

"Greetings from L.A." is simply one of this year's best records. Buckley likes it too. His voice has no inhibitions, being one of the most distinctive and emotional in all of rock. Passion through Gospel, Soul, rock 'n' roll – occasionally the blues. Multi-directional. In form, the music is without limit, taking in, changing, disregarding and renewing itself over and again from pop to Afro chant. It's all there: "Move With Me", "Nighthawkin'", "Get On Top" – pulsating in and on without vaseline; "Sweet Surrender" and "Hong Kong Bar" – endlessly undulating; voice crazy, demented.

Like Lillian said: "His albums are easily the most beautiful, beautifully arranged and produced." They're also among the most convincingly effective, vivid and dynamic in all of contemporary rock. Very personal yet extrovert; sombre, dark – warm and inviting. "Greetings From L.A." is each hour of the day in any mood. You can't afford not to hear it.

There's Stephen Stills, Neil Young, David Crosby, Randy Newman, Leon Russell, James Taylor and Van Morrison. There's also Tim Buckley, Jonathan Edwards, Loggins & Messina (*much* more on them next month), John Prine, John Sebastian and Boz Scaggs. Bob Dylan naturally. With any and all of them you can't go wrong.

Jonathan Edwards almost had a hit about nine months ago with a song called "Sunshine". His first album, "Jonathan Edwards", followed soon after – a more interesting and varied first up I've seldom heard. Right from the start, he had it over most others in the Gospel/Country vein because he's also a fine poet – a fine poet

with a beautiful voice, an ear for lilting melodies and their arrangement, and a fluency as a performer both articulate and sure.

"Honky-Tonk Stardust Cowboy" is his second album – better than the first by at least half again. Above everything, Edwards is a strong songwriter, his efforts going into small details, presenting each song as its own. As a performer, he is most thoughtful: each lyric is a story; each melody a landscape. His voice puts in the colour, ties in the extra dimension, touches and holds, prolongs feeling.

Less finicky than Seals & Crofts but with the same sense of the delicate; more atmospheric, descriptive than Kristofferson; more open than the Taylors; less restricted than Neil Young in approach – Edwards' sensitivity isn't as limited/affected in style because his influences are more varied, more even – accessible. He's a folk singer who came in through Gospel and Country – both of which die hard. He *doesn't* rock 'n' roll – the reason why he's possibly a bit more receptive, convincing with his bluegrass than most others. He doesn't *need* to rock 'n' roll.

Edwards is the 'Honky-tonk stardust cowboy' that he sings about. That's as good a definitive as you'll find. His songs range from bounce to blues – each is as fine as the other. Each is different. Consistency and excellence are the only two things they have in common. There's "Ballad of Upsy Daisy", "Sugar Babe" and "Stop & Start It All Again" – rollicking, vital tunes full of old-fashioned charm; "Dream Song", "That's What Our Life Is" and the title track – weeping ballads, deeply and thoroughly moving; "Give Us A Song" – a hymn: 'Give us a song to sing Sweet Jesus/Make it as long as the day's work before us . . .'; "Morning Train" – a rhythm piece with mouth harp, choogling indefinitely.

Edwards is also a fine guitarist, doubling on mandolin and occasional bass. His

POP

control, inventiveness and taste sez it all. No mood or tone is over-looked if it enhances the song in any way. A more explicitly satisfying musician you won't find. "Honky Tonk Stardust Cowboy" is another album of the year.

In the same or similar vein to Edwards is Jesse Winchester and Danny O'Keefe – two Canadians with backgrounds in both folk and country. Winchester's "Third Down – 110 To Go", produced by Todd Rundgren who also handled the Band and Badfinger, is an album of fairly low-key songs – some of them almost sombre. His material, particularly the ballads, is just fine: personally stated, under-played and mostly filled with pain. Not bitter, just hurt real bad.

Winchester plays it all down, sort of earthy and looking in instead of out. He's also a poet, but only most of the time. Only most of his music is good/great – the rest is merely competent, somewhat less magnetic. He's great at projecting the songs that really count, so it doesn't matter that much. His ballads are what makes him important.

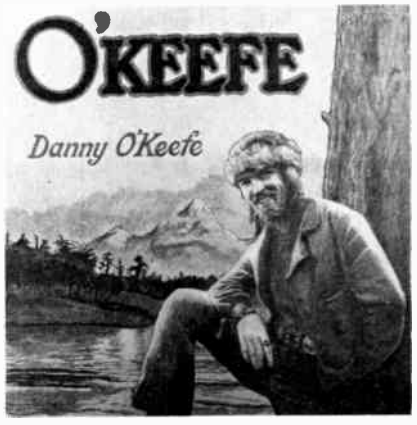
As a singer, Winchester has an effective range – not great, but very honest. He sings about experience and his music portrays it well, divided between acoustic folk and boogie. Some are Gospel tunes – inquiring spirituality and saying things like "Isn't That So?"; some are fully stated as in "Glory To The Day" and "God's Own Jukebox". Sometimes it's like James Taylor, but mostly it isn't. What it is, is Canadian folk, almost: sometimes very funky, always involving and sophisticated. It feels warm and very caring – the way good country should: feel being the only real thing.

"Glory To The Day", "All Of Your Stories", "Do La Lay", "Silly Heart" are love songs – disarmingly beautiful, romantic. They're good because they're humble – just like everything Winchester does. To be constantly genuine is an art – Winchester has this special gift in the way he goes about his music, keeping it simple. Naturalness is one of his most appealing qualities. His feel flows – relaxed, generous; even rich. Always gentle.

'Rolling Stone' wet their pants over "Third Down – 110 To Go", but more because of Winchester's potential than on the absolute strength of where he's up to now. He *is* exceptionally good – mostly for the way his character gives everything such a unique and personal feel. "Third Down" is his best yet.

Danny O'Keefe is from the same musical school as Winchester. The similarities are in their style: both are low-key performers, most expressive/committed with ballads, so-so when it comes to anything much beyond. Both write memorable songs, O'Keefe is possibly a bit more varied and adventurous; Winchester is more consistent.

O'Keefe's first album, "O'Keefe", is a good'un, producing one hit in "Good-Time Charlie's Got The Blues" – a song that made it the same way as "Mr. Bojangles". And another with "An American Dream". He's everything that Winchester is and more, but not as thoroughly. Nowhere near it. His feel goes deep in places with more humour; his melodies are fairly apparent, lighter, more energetic; the backings more demanding. But the over-all effect isn't as personable. He gives much less of himself, writing a bunch of good songs without that



indelible mark. The thing that makes Winchester and Buckley a cut above the rest is their all involving character: O'Keefe just misses it.

O'Keefe is always fully in command, but it's not as total as Winchester. Like Paul Siebel, Jesse Winchester is inseparable from his music because they're both one and the same. Not so Danny O'Keefe. Partially, but not fully. As I said, deep in places. Perhaps he's listened to a lot of other people, and he's more susceptible to what other people do. No matter, what he does is still very good.

"Goodtime Charlie's Got The Blues", "Shooting Star", "Louie The Hooker vs The Preacher", "The Road" and Hank Williams' "Honky Tonkin'" are some of his best cuts. Ranging from slow country thru to rock 'n' roll, he does it all competently with style.

His sense of rhythm gets a bit repetitive, and his voice could do with some variation – but "O'Keefe" is great for his first. He's got plenty of time and lots of imagination.

"Casey Kelly" is the first from a guy with the same name. He's minor league stuff, lacking almost fully a recognizable character. As an album artist he falls short as a result. His songs cover too wide a spectrum to give him the chance to develop his own personality. With "Casey Kelly", you get a great selection of solid, catchy songs – each of which could qualify as a single; but nothing that says 'This is Casey Kelly's music'.

It matters who Jesse Winchester is. And Boz Scaggs and Tim Buckley and, to a point, Danny O'Keefe, because they're into style. Casey Kelly, unlike Jackson Browne – his closest comparison, is a great songwriter who writes nothing of himself into his music. That's very bad. He might get big by everybody else recording his stuff, but he won't do it himself. At least, not for a while yet. "Silver Meteor" is the best track. Everything else sounds like everybody from Paul MacCartney to early Byrds.

"Casey Kelly" is great, just so long as you're interested in separate songs sounding great. These days, that's just not enough. He's a good musician though, with a fine voice and excellent backings. Pretty too.

Boz Scaggs immediately brings Van Morrison to mind. Not because he's ripped off, but because it's a natural parallel. Scaggs is more vivacious, outward-going – even commercial; Van doesn't worry too much about settings, about the way each song sounds. That's not the point with his stuff. With Morrison the thing that matters is the song itself – the fact that he wrote it and he sang it and he produced it.

Scaggs does everything for his music, whether he wrote it himself or not. With Scaggs, the crux of the whole thing is his total, unflinching command. He's Boz Scaggs like Van Morrison is Van Morrison. He understands music from several different levels – as an artist, songwriter, performer, arranger, producer and listener. Each is considered because, with Scaggs, each is the same.

(Concluded on page 138)

NEW POWER

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I_C Max	15	15	15	15	Amps
I_B Max	7	7	7	7	Amps
P_t (25°C case)	117	117	117	117	Watts
h_{FE} I_C=10A, V_{CE}=4V.	⩾5	—	—	⩾5	—
h_{FE} I_C=4A, V_{CE}=4V.	—	—	⩾40	—	—
h_{FE} I_C=3A, V_{CE}=4V.	20-70	—	—	20-70	—

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FROM

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POP

(Continued from page 136)

"My Time" is his third (fourth) album – an album so elating, so perfect in itself that it does the whole C.B.S. label proud. And that covers a lot of great artists – Santana, Byrds, Dylan. Recorded at Muscle Shoals Sound, Alabama, this fine album comes the closest I've heard to fully integrating pop with rock with Gospel with country; Black and White Soul inseparably together. And more. The songs, ranging from anything to everything, go as one – as an album. Each is simply great, but their feel/nature remains unbroken as a program. An album by Boz Scaggs.

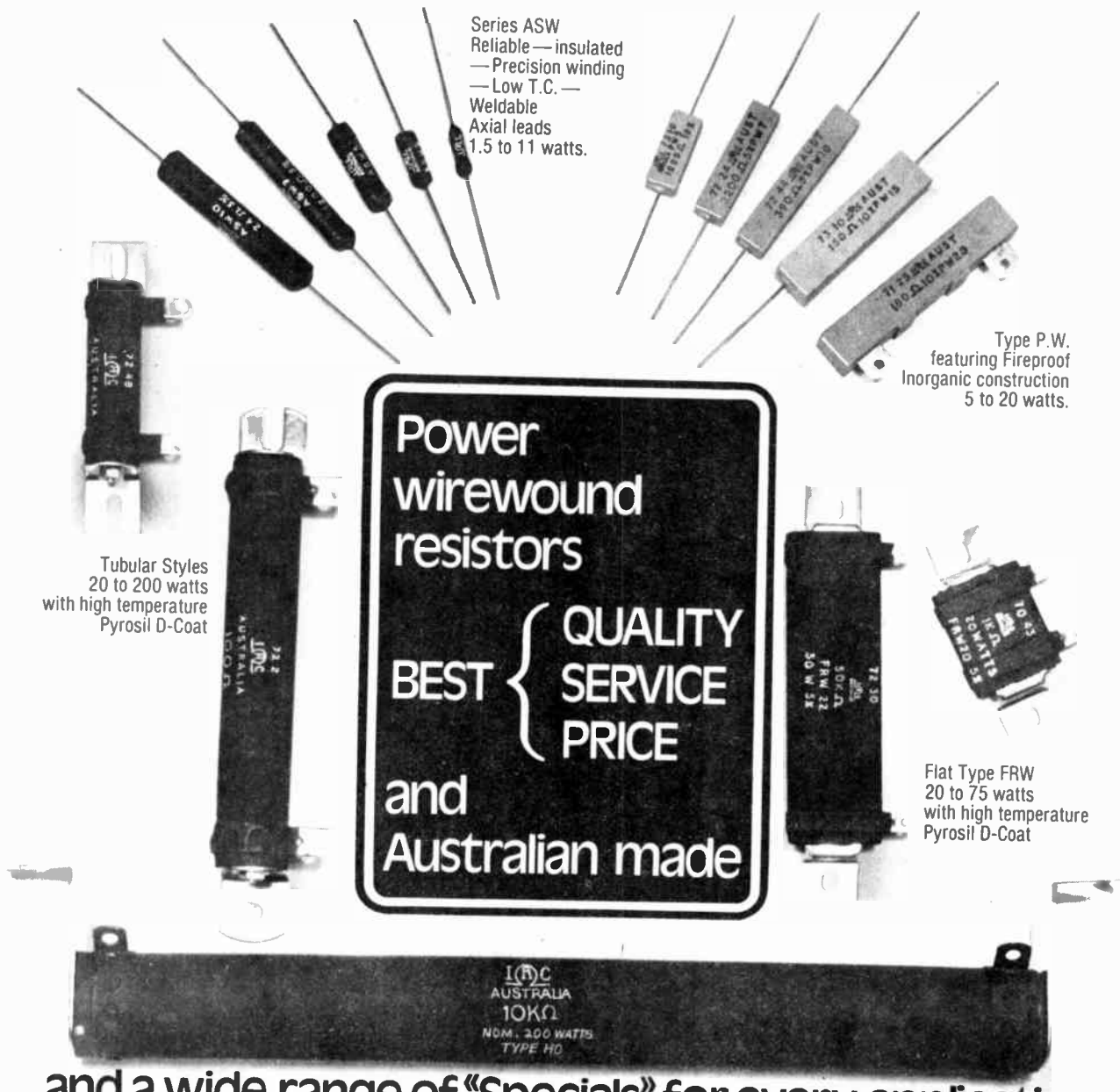
"My Time" covers slow soul, Gospel, up-tempo rock, pop and popular, blues and country. Scaggs moulds each song into something ultimately personal, something ultimately his own creation. Like I said, it just doesn't matter if he wrote nothing or everything. His spirit is the thing. It overwhelms.

"Dinah Flo" is slickest pop – top 40 dynamite; "Full Lock Power Slide" is just as the title implies – blister rock, pungent/dirty and hot, hot, hot; "Old Time Loving'", "Freedom For The Stallion" are sort of Gospel-Country, but real infectious – instant V.D.; "My Time", "Might Have To Cry" are both into popular soul – popular because the impact is expert, total; soulful because it's black as coal and twice as punch-packed.

On record, Scaggs comes across in this order: Arranger, Songwriter, Singer, Guitarist. As a producer, he's one of the very best currently working in America. He's a single artist, but he's spent the best part of ten years slogging it up from band to band, working with the Steve Miller Band (featuring on their first two albums, "Children Of The Future" and "Sailor") and many others – Duane Allman, Buffalo Springfield (mostly separately); James Taylor's backing band, Nicky Hopkins, Stax/Volt singers, Otis Redding. More too.

Scaggs has this thing for feel. He doesn't change to suit each song – each song he's felt.

Another album of the year. That makes three and, possibly, four. Jesse Winchester is still sort of worrying me. – M.D. ●



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TECHNIPS

WIDEBAND AMPLIFIERS

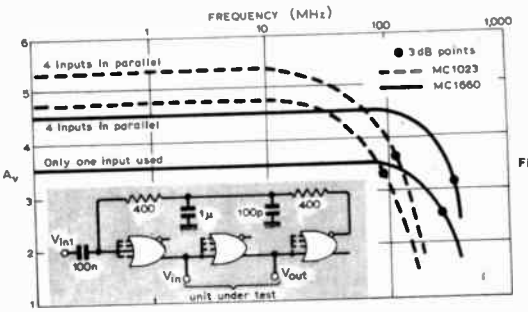

Figure 1

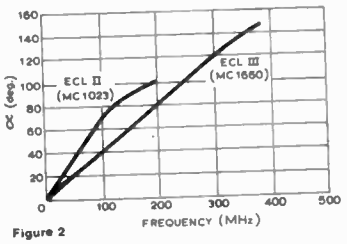

Figure 2

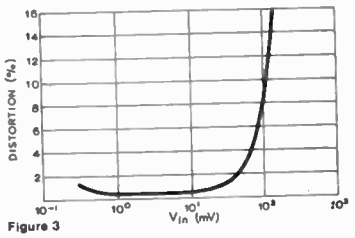

Figure 3

IT IS not commonly known that some digital ICs can be used in the linear mode to obtain performance equal, or superior, to some more conventional components.

A typical example is the use of a MECL logic gate as a wideband amplifier. Such an amplifier based on the Motorola MC 1023 of the MECL 2 family provides a gain of 5.2 over a frequency range from zero to 125 MHz (at the 3 dB points). A still wider bandwidth of zero to 350 MHz may be obtained by using the MC 1660 from the MECL 3 family.

The method used to bias MECL gates for linear operation is shown in the inset of Fig. 1. The NOR output is connected back to the input. This can be done over one, or over several, gates. The external 'self-biasing' network feeds back only the dc component of the output signal. Therefore the dc input current is furnished by the output of the same gate. Assuming that the voltage drop across the biasing resistors is small, the input and output voltages are identical. This is only possible in the centre of the gates' transition region. The main advantage of this very simple biasing method is that the circuit automatically compensates for all offset and bias voltage variations. In addition, the method is very economical, especially when a cascade arrangement of gates is needed.

The response depends on how many inputs are connected in parallel, there is a disadvantage however in connecting several inputs together to increase gains. The offset voltage between input and output increases with the number of inputs that are paralleled. It therefore depends on the individual application, if a slightly higher offset voltage can be tolerated then a higher gain can be achieved.

Fig. 2 shows the phase shift curves for the two gates and Fig. 3. is a plot of distortion against input voltage.

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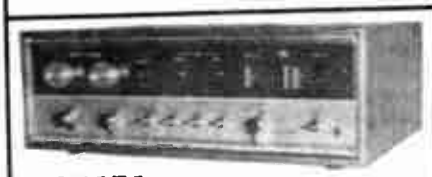

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50uA	$5.75	$6.40	$7.00	$8.15	$10.25
100uA	5.45	5.80	6.40	7.65	9.60
500uA	4.60	4.85	5.50	6.65	8.50
1mA	3.95	4.45	5.00	6.40	8.00
10mA	3.65	4.25	4.85	5.80	7.65
50mA	3.65	4.25	4.85	5.80	7.65
100mA	3.65	4.25	4.85	5.80	7.65
500mA	3.65	4.25	4.85	5.80	7.65
1mA'S'	4.25	4.65	5.25	6.40	8.50
V.U.	4.50	5.25	5.60	6.65	9.50
15V DC	4.40	4.85	5.35	6.40	8.50
500V DC	4.40	4.85	5.35	6.40	8.50
300VAC	4.75	5.25	5.80	6.65	9.00
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But with the recent introduction of the low noise/high output tapes, it's no longer permissible.

Which brings us to a new generation of decks by TEAC. And TEAC calls them Superior Sound/Low Noise decks: decks designed to get the most out of the low noise tapes as well as the conventional types.

Five of these new generation decks are described here. If you'd like to know more, write to us and we'll send you further information (catalogue, dealer list and price list) on the unit(s) that interests you.

Sterec Tape Deck Model A-3300
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Stereo Tape Deck Model A-1230
● 3 heads-4-head function ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB

Automatic Reverse Stereo Tape Deck Model A-1250
● 3 heads-4-head function ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22.000 Hz at 7½ ips ● S/N Ratio 55dB

Combination Head Stereo Tape Deck Model A-1030
● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● One motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB ● Auto. Shut-off

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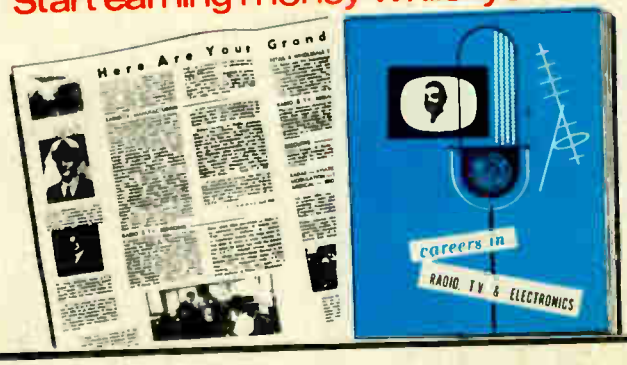

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