

AUSTRALIA'S DYNAMIC MONTHLY

JUNE 1972

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electronics

TODAY

INTERNATIONAL



SPECIAL ISSUE
**4-CHANNEL
SOUND**

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JUNE 1972

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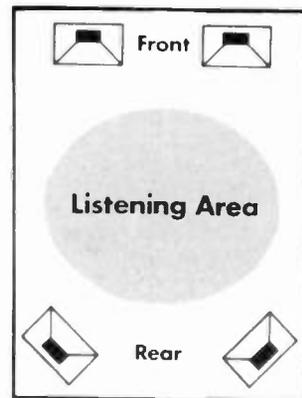
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COVER: Four-channel sound, and orchestral music — symbolized by this bronze cast of Beethoven surrounded by JBL's latest Lancer speakers



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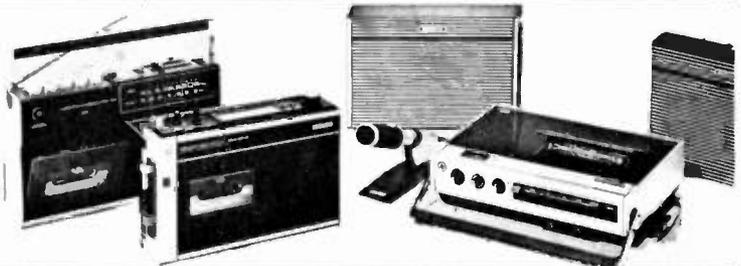
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FOUR-CHANNEL SOUND

an artificial 'need'?

To a large extent, four-channel sound is a 'need' artificially created by the manufacturing side of the hi-fi industry.

And providing this 'need' can be sustained, the benefits to the manufacturing industry are huge, for with the exception of simple matrix devices, the electronic equipment required for four-channel reproduction is complex and costly.

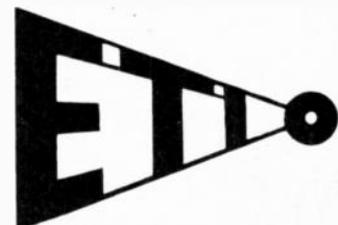
But the benefits are by no means one-sided, for few people who have listened to good four-channel sound — in the right acoustic surroundings — question its superiority compared with conventional two-channel systems.

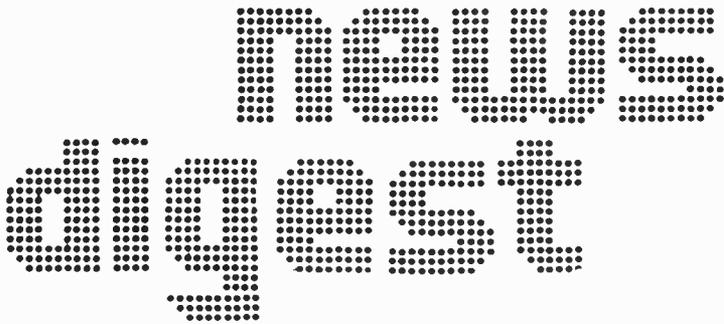
Until very recently however, the multiplicity of rival (and non-compatible) four-channel systems discouraged the recording industry from producing suitable programme material. Hence serious evaluation of four-channel systems on any but a purely theoretical basis would have been of little point.

But now it is fairly clear, that apart from the mainly compatible reel-to-reel and cartridge tape systems, the big marketing battle must be between JVC Nivico/RCA discrete four-channel records and the various matrix record systems of which the CBS Sony SQ appears to be current market leader.

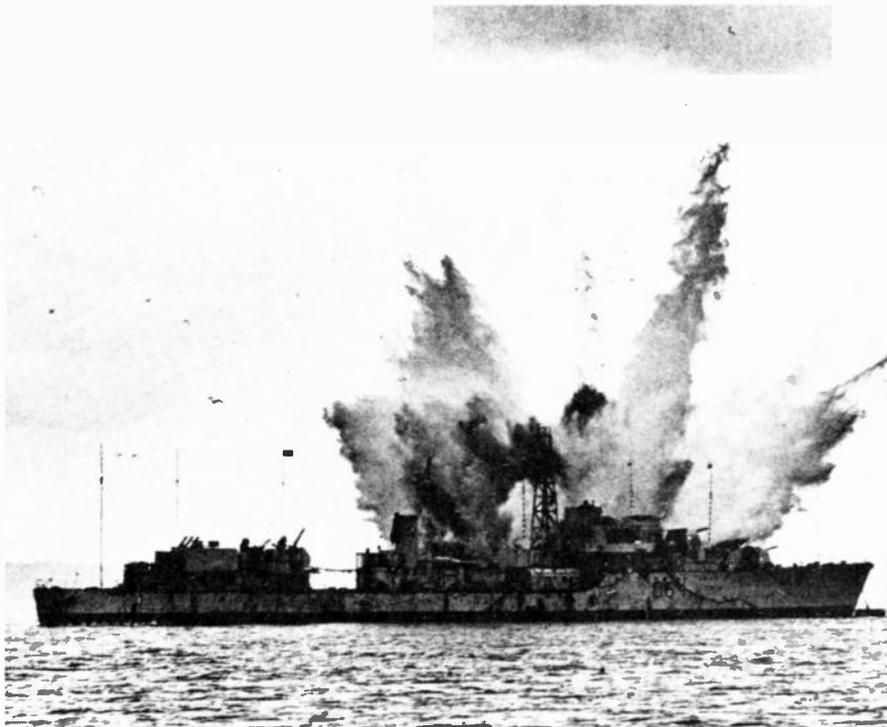
The major recording companies have aligned themselves with one system or the other and now a surprisingly large quantity of four-channel programme material is commercially available.

And so in this special issue of Electronics Today International, we have included independent evaluations of the two major competing systems — as well as tests of two other types of four-channel gear — plus our own evaluation of the total four-channel scene as we see it at present.





UNDERWATER EXPLOSIONS



It is of vital importance for warship designers to know exactly what happens to a ship under attack. This must include knowledge of the various stresses and strains encountered by the hull and superstructure.

Currently the Naval Construction Research Establishment at Rosyth in Scotland are researching the effects of underwater explosions to surface craft, as they have found that near misses tend to have a far greater effect than was previously supposed.

To carry out this research the NCRE is using an ex-naval warship extensively fitted out with transducers of their own design. The old-timer is then fired at and the readings from the transducers passed to a monitoring vessel via hard-wired cables.

It is from the monitoring vessel — a converted wartime torpedo recovery vessel — that the whole experiment is

controlled. Here four Bell and Howell VR3300 tape recorders simultaneously store 56 channels of information coming in from the target vessel. The data is conditioned by an array of amplifiers before being recorded.

When the results of the test have been recorded all the tapes are replayed on a shore based tape-deck, the exact time correlation being preserved by use of a 1 kHz reference signal on each of the five ship borne tape recorders. The data is then fed channel by channel into an uv oscillograph for visual analysis before being digitised and fed into a computer.

Although the efforts of the NCRE are primarily aimed at the defence effort, a vast amount of spin off is available to the civilian ship builder, especially in the design of super tankers — which tend to be a law unto themselves.

PIEZO PUMP

Britain's C.A.V. company have signed a joint development contract with Physics International of California to develop piezo crystals for use in diesel fuel injection systems.

The fact that crystals exhibit an almost instantaneous shape change when a voltage is applied could well lead to injection pumps more responsive than those in current use.

LIQUID CRYSTAL WATCH

NEW YORK — A major Swiss manufacturer of watch movements and components, Ebauches S.A. last week introduced a line of quartz electronic watches, including one unit with a liquid crystal digital time display.

The digital watch utilizes a quartz resonator and liquid crystal display developed in co-operation with Texas Instruments, Dallas, U.S.A.

Dr. Kurt Hubner, vice-president of Ebauches Electroniques S.A., said that the liquid crystal would last in "in excess of five years," but after that "no-one really knows" how long the crystal will retain its qualities or how it will show its age.

The new watch uses two bipolar chips measuring 6mm square and a small power cell claimed to last more than a year.

IBM MONOPOLY?

Speaking at the recent Infotech State of the Art Lecture '1980', Dr. Herbert Grosch of the US Bureau of Standards said that 'by 1980 most big names will have disappeared or withdrawn . . . from the computer field . . . 90 percent of the world computer market will be in the hands of one firm — IBM.

'The remainder,' said Dr. Grosch, 'will consist of small specialised companies outside IBM's sphere of influence.'

Dr. Grosch made a number of specific predictions. He forecast that Telefunken will retire from the market before the end of this year; Philips in 1973, Siemens in 1974, ICL perhaps in 1977. Nixdorf, he says may survive — but only if they keep in the 'visible records market.'

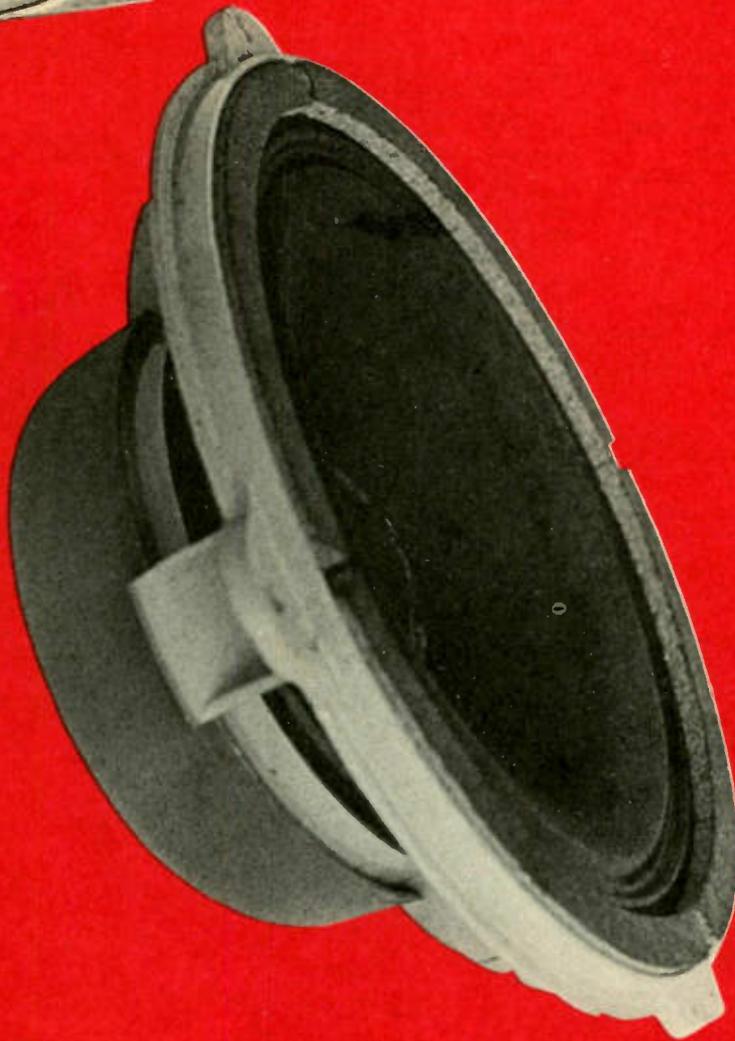
These assertions, says Dr. Grosch, are based on the fact that only IBM can continue to afford the enormous costs of developing new computing systems. Even at present IBM are known to spend over \$400,000,000 a year on research and development alone.

Pessimistic though they may be, Dr. Grosch's remarks are being taken

(Turn to page 11)



"The MAGNAVOX SPEAKERS ARE BETTER than any speaker system that we have tested costing twice as much and comparable to all imported units costing three times the price" Electronics Today.



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THE BRILLIANT NEW WHARFEDALE RANGE

From the very birth of the term "high fidelity", British manufacturers have set world standards for the design and fabrication of the most outstanding high fidelity sound reproduction equipment. Famous Wharfedale loudspeakers have outsold every other make of high fidelity loudspeaker manufactured in the United Kingdom. The long experience and the technical "know-how" of the Wharfedale organization combined with recent "state of the art" developments have been applied to the design of several completely new Wharfedale products... a complete range of fully compatible audio equipment which produces most effective and completely natural dimensional stereo sound reproduction. Let's look at the new era Wharfedale range:—

THE NEW ERA WHARFEDALE "LINTON" STEREO AMPLIFIER

The new era Wharfedale "Linton" stereo amplifier is attractively styled, power output is 15 watts R.M.S. per channel into 8 ohm speaker loads, and frequency is 30-20,000 Hz. ± 1 dB. at full rated output.

Sensitivity of the new era "Linton" amplifier suits magnetic stereo cartridges at 3.5 mV. and T.H.D. does not exceed 0.1% at 1 kHz. into 8 ohm speaker systems at full output.

Tone controls for bass and treble response offer unusual flexibility... piano-key switches are provided for mode, treble filter, tape monitor, tape input, phono input and tuner. Ask for a no-obligation demonstration at any Simon Gray dealer!

THE NEW ERA WHARFEDALE "LINTON" TURNTABLE

Designed to take records of 7", 10" and 12" diameter, the new era "Linton" turntable also features four speeds — 16 $\frac{2}{3}$, 33 $\frac{1}{3}$, 45 and 78 r.p.m.

You may adjust the "Linton" turntable for either Manual or Automatic operation, switch-off and return are automatic, stylus tracking pressure is fully adjustable, a bias compensator is incorporated and the arm lowering device is hydraulically damped to protect your records.

The magnetic stereo cartridge fitted is the well known Shure M44-7, complete with diamond stylus.

THE NEW ERA WHARFEDALE "LINTON 2" COMPACT SPEAKER SYSTEM

Featuring an entirely new 8" speaker with an oversize magnet which produces exceptional performance, the new era "Linton 2" is both attractive and compact.

Frequency response is 55-17,000 Hz. ± 3 dB. and power handling capacity is 20 watts DIN. Size is only 19" x 10" x 9 $\frac{1}{2}$ " and finishes available include oiled teak and polished walnut. A new 2" tweeter unit covers all frequencies from 1,200 Hz.

THE NEW ERA WHARFEDALE "LINTON 3" COMPACT 3-WAY SPEAKER SYSTEM

Identical in cabinet design and size to the 2-way "Linton 2", the addition of a 4" mid-

range speaker to the speaker complement brings smoother overall frequency response and added 'presence' to stereophonic playback.

Frequency response is 55-17,000 Hz. ± 3 dB., and power handling capacity is 25 watts DIN. Size is 15" x 10" x 9 $\frac{1}{2}$ ".

THE NEW ERA WHARFEDALE MODEL DC9 CASSETTE TAPE RECORDER With the Do by System™!

The release of the new era precision built Wharfedale Model DC9 Cassette Tape Recorder heralds a major breakthrough for cassette recording.

Precision tape transport mechanism is used in the new era Wharfedale DC9.

Frequency response 50-12,000 Hz. ± 2 dB., wow and flutter less than 0.18%, signal-to-noise ratio better than 50 dB.

NEW ERA STEREO HEADPHONES FROM WHARFEDALE!

For personal listening Wharfedale's new era stereo headset Model DD-1, is quite



SEE THE NEW WHARFEDALE RANGE AT YOUR SIMON GRAY DEALER!

WHARFEDALE RANGE!

unbeatable. Each 'phone is virtually a two-way speaker system in its own right. Impedance is 8-16 ohms and frequency response is 16-22,000 Hz. Distortion is less than 1%, an extraordinary figure for a stereo headset.

THE COMPACT NEW ERA WHARFEDALE "DENTON 2" AND "DENTON 3"

Although they measure only 14" x 9 3/4" x 8 3/4", both models of the "Denton" sound like much larger systems.

The "Denton 2" uses an 8" long throw voice coil bass reproducer and a 2" tweeter, with an electrical crossover at 1,400 Hz. Bass and mid-range performance is quite remarkable for an enclosure of these physical dimensions. Frequency response is 60-16,000 Hz. \pm 3 dB. and power rating is 20 watts DIN.

In the "Denton 3" a 4" mid range speaker is added. Frequency response is 65-17,000 Hz \pm 3 dB. and power handling capacity is 25 watts DIN. Crossover frequencies are 1,100 Hz. and 4,000 Hz. respectively.

TWO NEW MEDIUM SIZE, MEDIUM PRICE, HIGH PERFORMANCE SPEAKER SYSTEMS FROM WHARFEDALE... NEW ERA "MELTON 2" AND THE "DOVEDALE 3"

The Wharfedale "Melton 2" is a 2-way speaker system which sounds as if it costs much more. Measuring only 21" x 14 1/2" x 10" it incorporates a 12" wide spectrum bass reproducer and a specially designed 2" C.A.B. tweeter; power handling capacity is 25 watts DIN. Frequency response is 45-17,000 Hz \pm 3 dB. Impedance is nominally 6 ohms and finishes available are oiled teak and polished walnut.

With the release of the new "DOVEDALE 3" Wharfedale have produced the smoothest overall frequency response ever available in a Wharfedale enclosure. With a 12" bass reproducer, a 5" mid-range speaker and a 1" tweeter, frequency response of the "Dovedale 3" is 45-20,000 Hz \pm 3 dB. and power handling capacity is 50 watts DIN. Crossover frequencies are 600 Hz. and 5,000 Hz. Size of the "Dovedale 3" is 24" x 14" x 12".

THE NEW ERA WHARFEDALE "TRITON 3"

In the new era "Triton 3" an 8" bass unit is complemented by a 5" mid-range speaker and an effective 1" tweeter. The combination offers restraint-free bass response, smooth middle frequencies with remarkable "presence" and outstanding high frequency performance.

Here are abridged specifications: Size: 21 3/4" x 9 3/4" x 9". Frequency response: 55-20,000 Hz \pm 3 dB. Speakers: 8" bass, 5" mid-range and 1" tweeter. Crossover: 750 and 5,000 Hz. Impedance: Nominally 6 ohms. Power rating: 25 watts DIN. Finishes: Oiled teak or polished walnut.

THE NEW ERA WHARFEDALE "ROSEDALE"

Built to the highest standards without compromise, the new era Wharfedale "Rosedale" offers a wide frequency response of 35-20,000 Hz. without coloration and a power handling capacity of 45 watts DIN.

Few speaker systems can handle this power, and only a handful do it well. The new era Wharfedale "Rosedale" leads this select band.



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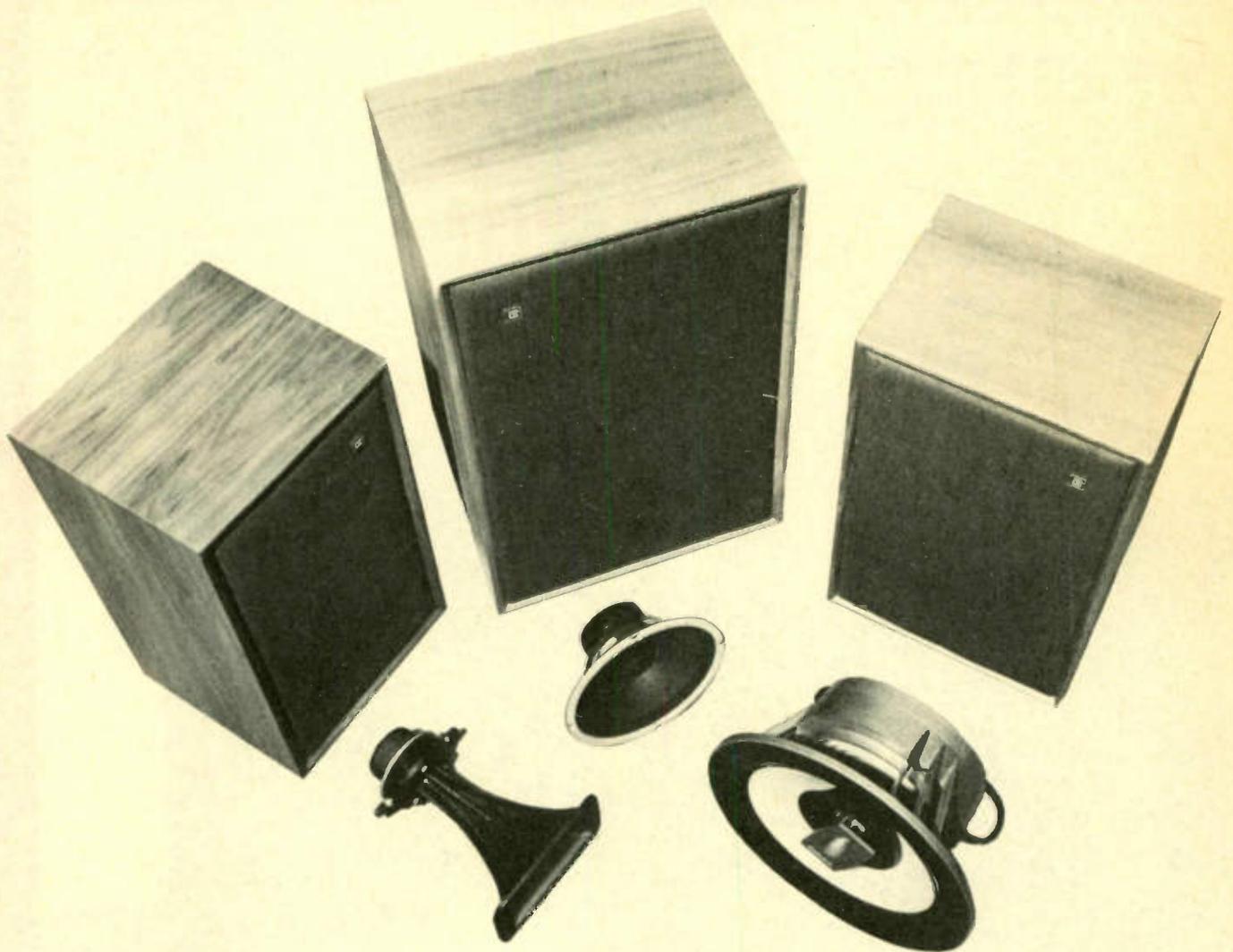
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THORN

news digest

very seriously by the industry. Formulator of the so-called Grosch's Law of Computing, Dr. Grosch predicted 18 months beforehand — and almost to the day — that RCA would cease computer production in late 1971.

It is interesting that since RCA pulled out of the computer business, that company's last quarter earnings increased by no less than 52.5%.

PHILIPS PROFESSIONAL DATA CASSETTE



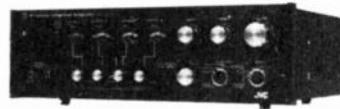
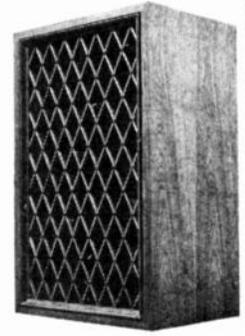
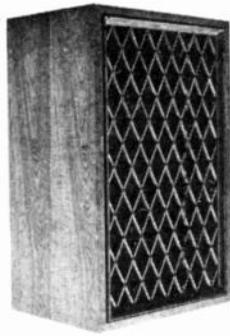
Philips are introducing a cassette for digital application. The Professional Cassette, LGH6003, has been specifically developed for the collection and retrieval of electronic data. Profiting from Philips' design and production knowledge in the field of the compact cassette, the Professional Cassette has outstanding qualities which it is claimed give it a marked superiority over punched paper tape and cards for digital data storage.

The cassette uses a precision metal frame with screwed-on side covers ensuring the highest possible precision in tape guidance. The metal frame eliminates static charges by providing a discharge path for any electro-static build up on the tape.

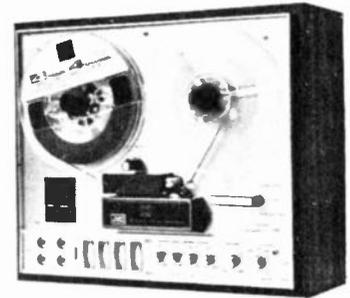
The precision metal reference surfaces are part of the frame and allow for an exact head-to-tape positioning. Lengthy tests have proved the performance and dimensional stability of the data cassette over long periods of use — more than 2,000 full passes and virtually unlimited storage.

Philips LGH6003 Cassettes contain 86 metres (approx. 300 feet) of high-grade splice-free computer tape, tested for signal amplitude. Each cassette is individually (and over the full tape length "in cassette") certified at 64 flux changes per mm (1600 f.c.p. inch) for drop-outs and drop-ins.

The tape is provided with a beginning-of-tape (BOT) and end-of-



MCAV7E



MTR-15M

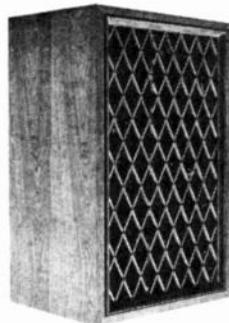
JVC NIVICO

four on the floor

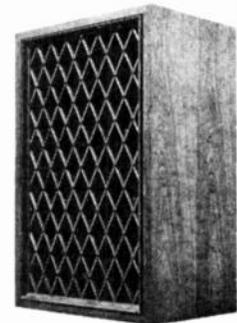
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perfection to protect . . . we cannot compromise on quality or fidelity in our products.

The Plessey Pacific group in Australia is part of the giant Plessey company based in the U.K. Their interests range over the broad fields of components, equipment and

systems for the telecommunications, electronics, aerospace, hydraulics and related industries.



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APP62

news digest

tape (EOT) marker by means of a hole for optical detection in the tape, which is attached to the hubs via specially strengthened non-magnetic transparent leaders.

Previously recorded data can be protected by removing the re-usable write-enable-plugs, individually recognised by an asymmetrical cut-out at the rear of the cassette.

The tape and cassette characteristics meet the requirements of the International Standard ECMA 34 for Data Interchange on Magnetic Tape Cassette. Consequently, the Philips data cassette is claimed to ensure trouble-free and reliable operation as well as interchangeability between information processing systems utilising the ASC11 7 bit code (American Standard Code for Interchange of Information).

We understand from Philips that this cassette may not be available outside the UK until later this year.)

MINIATURE TV CAMERA

Claimed by its makers to be the world's smallest, this underwater television camera, only 1 3/4 inches (44.45 mm) in diameter and 7 inches (177.8 mm) in length was exhibited on the Seer TV Surveys stand at the recent Oceanology International '72 conference and exhibition at Brighton. Called the Falcon VE12 it is a specially developed 1/2 inch (12.7 mm) vidicon in a pressure proof stainless steel housing that contains a remote focus facility. The use of encapsulated electronics in the camera head contributes to its robustness, and printed circuit modules of advanced electronic techniques are employed in the camera control unit for reliability. The camera has unrivalled versatility due to its small size and is currently being used



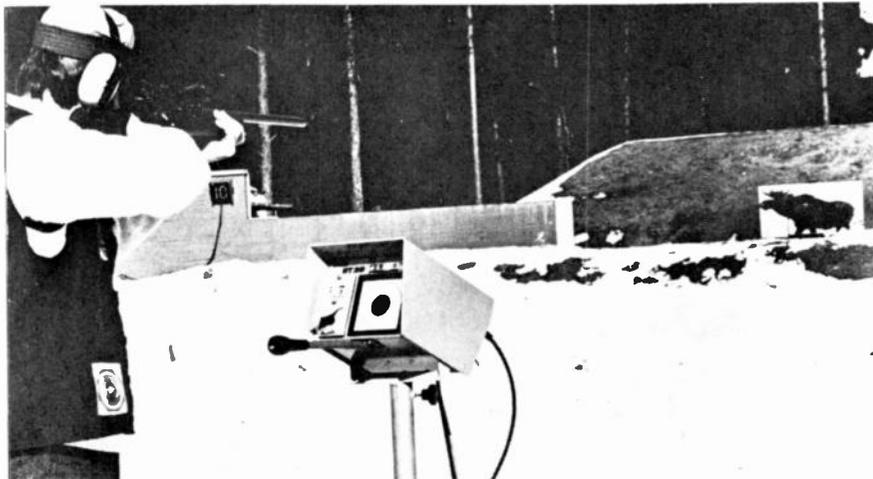
by BAC and Sud Aviation on the Concorde project. Seer TV Survey equipment is used in all parts of the world in oil rigs, submarine pipelines and cables, harbour defences, ship's hulls, boreholes and wells.

COMPUTERIZED SYSTEM GIVES MARKSMAN MOVING TARGET AND INSTANT REPORTS OF HITS

A new electronic shooting range system permits marksmen to manoeuvre targets from the firing point and simultaneously to receive results of their marksmanship. The system has been developed by the computer and electronics division of Sweden's Saab-Scania group, Lindoping.

The wholly automatic system features moving targets made of rubber — usually in the form of an elk, favourite quarry of Swedish hunters — which incorporate a layer of electrically conductive material.

The latter short-circuits each time the target is hit and causes an electric impulse to travel to a special registration unit immediately beside the marksman. Complete data on his performance and scoring is registered on this device and is also recorded with-in, on a punched tape. A larger unit

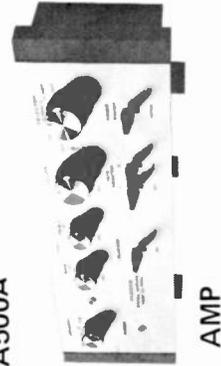


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news digest

beside the shooting range also performs this function.

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The targets used are said to be highly durable and can be hit "several thousand times" before needing to be repaired or scrapped. They are mounted on electrically powered wagons which move backwards and forwards across the range.

HEWLETT PACKARD EXPANSION

Hewlett Packard Australia Pty. Ltd., have acquired just over 3 acres of land in Joseph Street, Blackburn, Victoria, part of the City of Nunawading.

In announcing the acquisition, John Warmington, Managing Director of Hewlett Packard stated that the land would be used for the building of their new headquarters in Australia.

A three-storey building is planned which will be erected in stages, commencing with not less than 25,000 square feet. This will house the current sales and service operations and training facilities. Ample off-street parking will be available.

It is expected that the new premises will be ready for occupation within two years.

NEW CONSULTING ENGINEER

Ron Crook, formally General Manager of the Commercial and Advanced Electronics Division of EMI (Aust) Ltd. has entered into business on his own behalf as a Consulting Engineer in the fields of Industrial electronics, Electronic instrumentation, Automatic control systems and Vibration.

As Castle Laboratories Pty. Ltd. he will also supply Transducers, Vibration measuring and monitoring equipment and a Dynamic balancing service to manufacturers.

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SOUND

- THE STATE OF THE ART

All over the world, leading hi-fi equipment manufacturers and recording companies have committed themselves to four-channel sound. Collyn Rivers reports.

IN her book 'The Shadow of Man', Jane van Lawick-Goodall graphically describes how primates establish tribal supremacy by displays of aggression — generally stopping short of actual physical violence.

But these displays are nothing compared with the atavistic behaviour of the leading contenders for market supremacy in the field of quadriphonic sound.

For during the past twelve months we have seen major companies metaphorically beating their chests in order to impress upon the public that each manufacturer's particular (and deliberately incompatible) system is the system for all to follow.

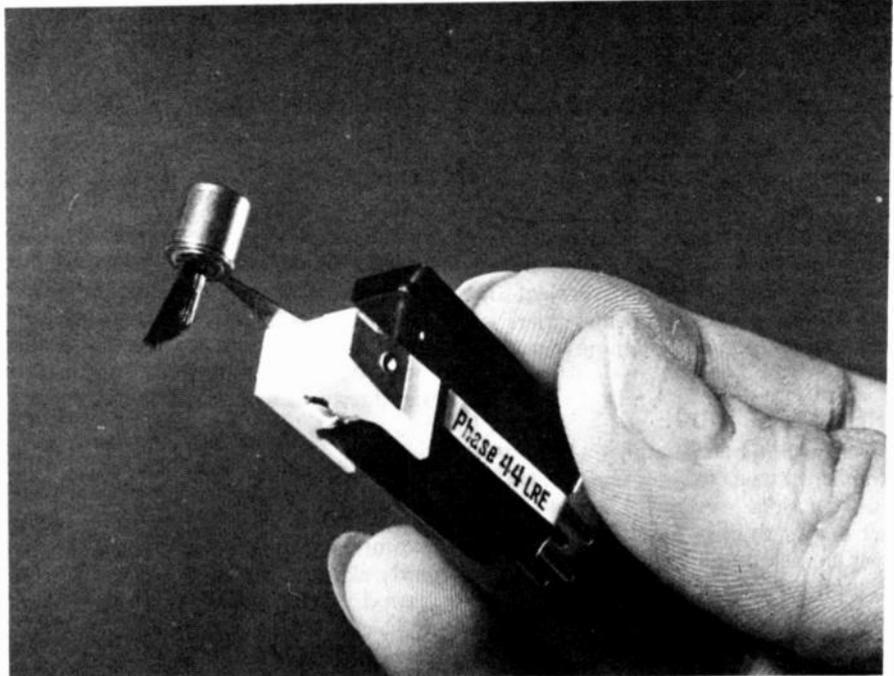
And in a similar fashion as Ms Lawick-Goodall's primates, the general public treated it all with a great big yawn — until all the donner und blitzen had died down and only the finalists remained.

But now we *have* these finalists — and very strong finalists they are.

Basically there are two approaches to quadriphonic sound. These are known as 'discrete' four-channel, and 'matrix' four-channel, and both systems use speakers placed in front and behind the listener — generally in each corner of the room.

WHAT DOES IT DO?

Quadriphonic equipment and programme material can create a number of different effects. For the listener to classical music — four-channel sound can to some extent re-create the ambience of the original concert hall. (Ambience, broadly speaking is the reverberant characteristics of a concert hall, studio, or room) Contrary to general belief this is particularly effective in small rooms when, if correctly applied, the room seems very much larger — one can almost imagine one is in a large hall. (Strangely, four-channel sound is less effective in large buildings. In fact one of the worst possible places to hear it is in the average hi-fi dealer's



Phase 44 pick-up cartridge is specifically intended for playing 'matrixed' records.

showroom.) So if you think it sounds impressive there — you will be positively ecstatic when you hear it at home.

For the 'pop' music enthusiast, four-channel sound can create a totally new experience in the reproduction of recorded sound. Many 'pop' fans have described it in McLuhanesque terms — as a total involvement with the sound. As a well-known American observer puts it 'the young use sound the way their elders use alcohol'.

An unexpected bonus for 'pop-haters' is that people listening to quadriphonically reproduced 'pop' music invariably select a sound level at least 6dB below that which they would use were the same sound to be reproduced using normal two-channel equipment.

For the jazz lover, four-channel sound is probably a matter of individual taste. Certainly it can provide one with an experience of being up on the stage as one of the group — whether or not this is as it should be is another matter.

DISCRETE FOUR-CHANNEL SYSTEMS

Discrete four-channel sound is a technique in which four quite separate

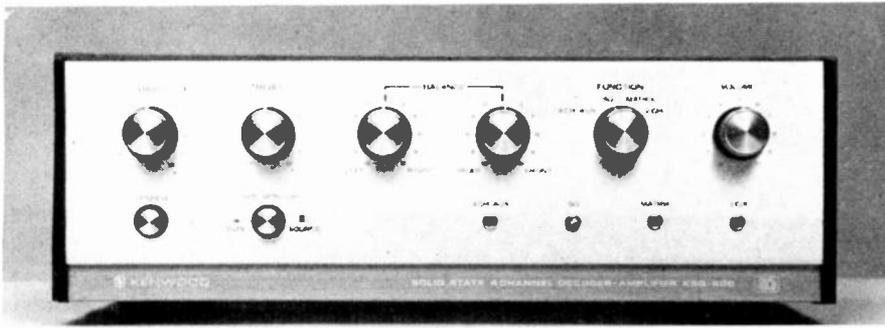
channels are recorded onto individual tracks on one magnetic tape, or by a process of frequency multiplexing, onto a gramophone record. During replay, each channel is detected and amplified individually so that each of the four speakers in the system can reproduce its associated programme material, without unintended interaction with or from any other channel.

REEL-TO-REEL TAPE

Reel-to-reel tape was the first medium used for discrete quadriphonic sound. Technically, it is still the best, for it can offer optimum conditions for both channel separation and sound reproduction. But against its technical superiority is its cost, for it is also the most costly of the competing quadriphonic systems. This is because it requires a tape deck with four heads (or at least a head with four gaps), four playback amplifiers and of course the mandatory four speakers.

Some excellent four-channel tape decks are currently available — these include models from Akai, Teac, Sony, Pioneer, Sansui, Kenwood, JVC etc. Nevertheless despite the almost unquestioned superiority of the reel-to-reel four-channel approach, this

FOUR-CHANNEL SOUND



Four-channel amplifier and decoder from Kenwood has decoding circuitry for both SQ and non-SQ matrix systems.

superiority is largely academic, for with the exception of a few tapes made by Vanguard, JVC, Project 3, and a few small US companies, there is little pre-recorded programme material available.

THE Q8 CARTRIDGE

From a commercial aspect a far more promising tape format is RCA's Q8 tape cartridge system. Like all tape cartridges, this is basically a sealed plastic case containing an endless loop of tape wound on a single hub and driven by a capstan shaft and wheel.

The Q8 system was originally known as Quad 8 — the name was changed following action taken by Britain's Acoustical Manufacturing Company, who feel quite strongly that the name Quad belongs to them. The Q8 format is in effect a logical extension of the standard stereo eight-track cartridge. The main difference between the Q8 and the standard cartridge is that whilst the standard eight-track cartridge has four pairs of twin-tracks running side by side, the Q8 cartridge has two pairs — each of four tracks, again running side by side. Thus the playing time of the Q8 cartridge is necessarily shorter.

At present most Q8 four-channel systems are being manufactured specifically for car installation — where as our test report of the Clarion unit shows — the format is extraordinarily (and unexpectedly) effective. Nevertheless Q8 cartridge players intended for home use are available from a number of leading manufacturers and at least one manufacturer (Akai) produces a deck that accommodates both reel-to-reel tapes and Q8 cartridges.

Many of these cartridge players can provide performance, that whilst not yet as good as can readily be obtained from gramophone records, is nevertheless at least as good as the majority of better class cassette machines.

The present performance limitation is simply that few of the very many

manufacturers producing pre-recorded Q8 cartridges attempt to extend the programme frequency response much beyond 8 to 10kHz. But this may well be merely a temporary limitation and no doubt Dolbyized chromium dioxide tapes will be produced.

Plenty of Q8 programme material is readily available. Regretably most of it is ineptly recorded and the benefits of quadriphonic sound are not really exploited. But this also was true of the early days of stereo and after a brief period of ping-pong type recordings the current well-balanced material became the norm.

Final contender in the tape format is the cassette machine. In Japan the JVC Nivico organisation claim that they have successfully developed a four-channel cassette system in which four channels are recorded on one-half width of the standard cassette tape.

As Philips hold world patents on the cassette system — and they have yet to make an official announcement on four-channel cassette material — the future of this system is currently unknown, however it is understood that JVC Nivico and Philips are jointly studying JVC's proposed format.

THE JVC NIVICD CD-4 SYSTEM

Technically, the most interesting and ingenious 'discrete' technique comes from JVC.

This is the CD-4 system in which four channels are recorded onto a disc using a multiplex process. In exactly the same way as with stereo records, each groove wall of the disc carries a single channel. However in the CD-4 technique each of these channels contains mixed front plus rear information — in other words left-front plus left-rear on one groove wall, right-front plus right-rear on the other. Apart from this each groove wall carries a 30 kHz sub-carrier that is frequency modulated by the left or right front-minus-back difference signal.

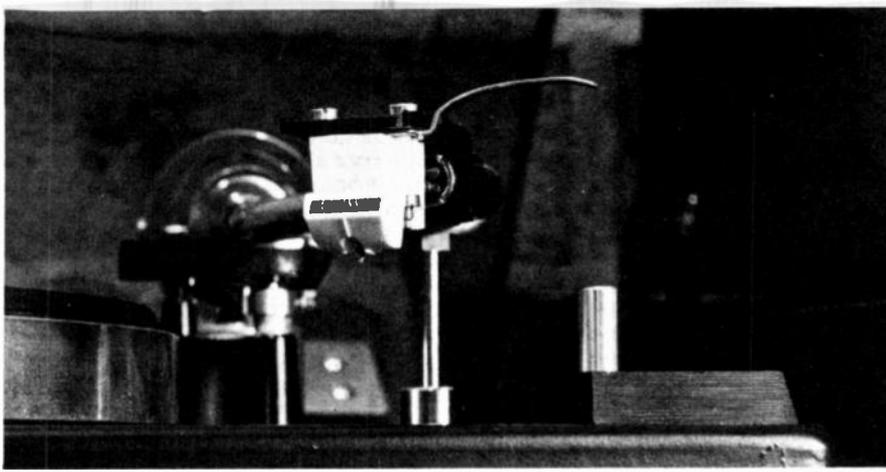
A decoder connected between the record player and amplifier sorts out the various signals and the resultant channel separation is more or less the same as between the two channels of a normal two-channel stereo system.

As the CD-4 discs carry signals at frequencies as high as 45 kHz (30 kHz carrier plus 15 kHz modulation) a special cartridge and stylus must be used. But despite many (uninformed) opinions to the contrary, the JVC CD-4 cartridge and Shibata stylus really does track signals of this high frequency (a frequency response graph of this unit is shown in our full review of the CD-4 system elsewhere in this issue). Apart from the special cartridge and stylus the CD-4 discs can be played on any otherwise conventional turntable. In Japan the JVC CD-4 system has been adopted by the Japanese Record Manufacturers Association as an industry standard, and RCA in America will be using CD-4 as their standard four-channel disc format.

The President of RCA Records, Rocco Laginestra says that RCA CD-4 records will be offered to the



Cartridge player from Pioneer accepts standard RCA Q8 cartridges.



Shibata stylus of JVC Nivico turntable successfully tracks 45 kHz signal of CD-4 records.

consumer at the same prices as normal stereo records — the company's director of record operations, Bill Dearborn says that 'RCA have offered a large quantity of a hard vinyl material and will start pressing quadriphonic albums at the end of April (on a mass production basis) for engineering evaluation.

The 'mothers' are produced in New York and shipped to the company's Indianapolis plant for pressing.

The RCA company have demanded that the CD-4 disc must be playable at least 100 times on a standard record player equipped with a standard stereo cartridge and stylus yet still subsequently be capable of reproducing high quality quadriphonic sound when played through a JVC system.

Apart from RCA, advertisements in the Japanese press indicate that CD-4 records will shortly be available from the Philips group i.e. Mercury, Deutsche Grammophon etc.

The CD-4 system — which includes a wide range of decoders, amplifiers and control units — is readily available in many parts of the world — including Australia.

One possible drawback of the CD-4 system is that because of its inherently wide bandwidth requirement the signal cannot be legally broadcast in countries having stereo FM.

MATRIX SYSTEMS

'Matrix' systems encode four signals into two channels by mixing them together in various complex phase and amplitude relationships. During replay a decoder is used to direct sound information to the 'correct' speaker.

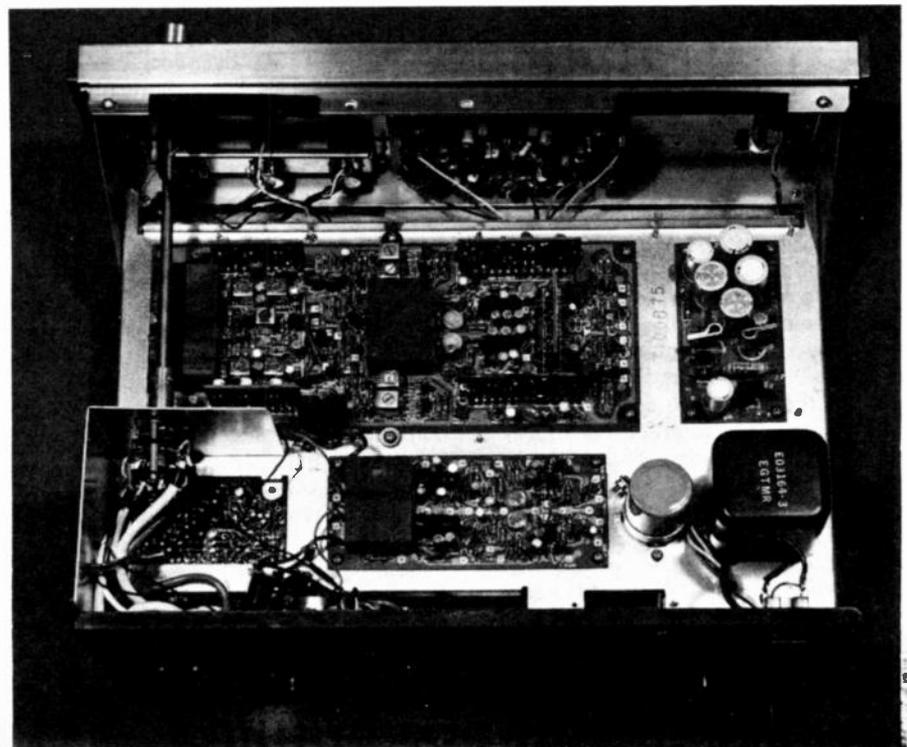
All records using matrix systems may be played on standard turntables. Again a standard cartridge and stylus may be used — but most manufacturers say that best results are obtained by using cartridges with fairly high compliance.

Matrixed records played through normal two-channel equipment sound just like two-channel records.

The fundamental limitation of matrix systems is that it is impossible to record four channels of information within the bandwidth used for two such channels without losing a certain amount of data. For this reason matrix systems cannot reproduce unique signals from any chosen speaker, indeed there is very considerable cross-talk — especially between diagonally opposed speakers — the separation may barely exceed 3dB. Despite this however, psychoacoustical factors — not yet totally understood — cause the theoretically doubtful matrix systems to be reasonably effective on a wide range of programme material.

A fairly large number of manufacturers produce matrix systems — and in theory nearly all are incompatible with one another. But in practice a record produced peculiarly for one manufacturer's system can be replayed with fairly good results on another. An exception to this, unfortunately, is the CBS-Sony SQ

This picture shows the complexity of a four-channel decoder — this is the JVC Nivico CD-4 unit.



system, and if non-SQ discs are replayed via an SQ decoder — or an SQ disc is played via a non-SQ decoder — there is considerable 'directional confusion'.

The major contenders in the field of matrix equipment include Electrovoice, Dynaco, Sansui, Pioneer, Kenwood and CBS-Sony.

Whilst the issue is far from clear the probable current market leaders are Electrovoice and CBS-Sony. Of these the CBS-Sony SQ — developed by Benjamin Bauer at CBS Laboratories — does seem to have a marketing lead over competitive systems.

CBS-SONY SQ

In a standard stereo record groove, modulations in the two groove walls transmit signal voltages to left and right channels through the pickup stylus.

The SQ system retains the two basic stereo groove modulations, (this is the reason for the SQ system's compatibility with all two-channel replaying equipment). But when the SQ record is made, the four channels of information from the quadriphonic master tape are passed through an encoder. This encoder preserves two of these four signals in their original form as signals for the two front speaker channels.

For the two rear channels, the encoder produces two additional modulations in the form of helices (spirals). As the record rotates and the groove advances under the stylus, a clockwise helix is produced for the left back channel and an anti-clockwise helix is produced for the right back channel.

Title	SQ Disc	Q8 Cartridge
Johnny Cash at San Quentin	CQ 30961	CAQ 30961
Santana/Abraxas	CQ 30130	CAQ 30130
Funny Girl/Original Soundtrack	SQ 30992	SAQ 30992
Ray Conniff/Love Story	CQ 30498	CAQ 30498
Ray Stevens' Greatest Hits	ZQ 30770	ZAQ 30770
Kris Kristofferson/The Silver Tongued Devil and I*	ZQ 30679	No Tape
Andy Williams/Love Story	CQ 30497	CAQ 30497
Janis Joplin/Pearl	CQ 30322	CAQ 30322
The Raiders/Indian Reservation	CQ 30768	CAQ 30768
Lynn Anderson/Rose Garden	CQ 30411	CAQ 30411
Ray Price/For the Good Times	CQ 30106	CAQ 30106
Percy Faith/Romeo and Juliet	CQ 31004	CAQ 31004
Jim Nabors/Help Me		
Make It Through the Night	CQ 30810	CAQ 30810
Barbra Streisand/Stoney End	CQ 30378	CAQ 30378
Walter Carlos/Switched-On Bach	MQ 31018	MAQ 31018
Simon and Garfunkel		
Bridge Over Troubled Water*	CQ 30995	CAQ 30995
Blood, Sweat and Tears*	CQ 30994	CAQ 30994
Subotnick/Touch	MQ 31019	MAQ 31019
No, No, Nanette/ Original Cast	SQ 30563	SAQ 30563
Leonard Bernstein/ Also Sprach Zarathustra	MQ 30443	MAQ 30443
Poco/Deliverin'	EQ 30209	EAQ 30209
Bob Dylan/Nashville Skyline*	CQ 31007	CAQ 31007
Tammy Wynette/ We Sure Can Love Each Other	EQ 30658	EAQ 30658
Sly & The Family Stone/ Greatest Hits	EQ 30235	EAQ 30235
Kooper, Bloomfield, Stills/ Super Session	CQ 30991	CAQ 30991
Leonard Bernstein/Verdi Requiem	M2Q 30060	QMA 30060
Ten Years After/A Space in Time*	CQ 30801	CAQ 30801
Johnny Mathis/ You've Got a Friend	CQ 30740	CAQ 30740
Chase	EQ 30472	EAQ 30472
Leonard Bernstein/Mass*	M2Q 31008	QMA 31008

*Coming soon

CD4B-5001E	WONDERFUL CD-4 SOUND
CD4B-5002E	NEW CREATIVE SOUNDS/THE DOCK OF THE BAY
CD4B-5003E	THE APRIL FOOL/THE LATEST FILM THEMES
CD4B-5004E	I DREAM OF NAOMI
CD4B-5005E	LDVE STORY AND OTHER GREAT MOVIE THEMES
CD4B-5006E	4 DIMENSIONS BY 4 SAXES
CD4B-5007E	TOSHIKO AKIYOSHI/THE PERSONAL ASPECT IN JAZZ
CD4B-5008E	LATIN RHYTHM FESTIVAL
CD4B-5009E	ROCK & DRUMS/ELEANOR RIGBY
CD4B-5012E	ROCK & DRUMS/FREE
CD4K-7501E	CARMEN SUITE (Bizet)
CD4K-7502E	CONCERTOS BY MAKOTO MOROI
CD4K-7503E	DEUTSCHE BACHSOLISTEN
CD4K-7504E	KHACHATURIAN : VIOLIN CONCERTOS in D Major
CD4K-7507E	FAMOUS ORGAN WORKS BY J.S. BACH



Simple but effective. This 'add-on' four channel unit — the QSP 10 from Sansui — is supplied complete with in-built amplifier and two bookshelf type speakers. Unit can decode 'matrixed' records and can also synthesize four-channel sound from standard stereo discs.

The SQ disc, then, carries in its grooves two different kinds of signals: vectored modulations for the two basic stereo or front speakers, and helical modulations for the two back speakers.

However, no special pickup is needed. All stereo pickup cartridges are capable of translating all of these modulations.

To decipher these four signals and recreate the quadriphonic sources, the SQ decoder is needed. The decoder senses the four basic modulations and produces four signals containing predominantly the sounds of the corresponding original four quadriphonic tape channels. These signals are then directed to power amplifiers and four loudspeakers placed in the respective corners of the listening area. (A complete technical description is included elsewhere in this issue).

A more complex decoder is also available for SQ records and this contains logic circuitry which by sensing relative strength and phase angle relationships can increase the effective separation between individual speakers.

At present SQ decoders are being manufactured by Sony (Sony and CBS have a joint operation in Japan for distributing recordings). Licencing arrangements to build SQ equipment are currently being arranged by CBS and a number of US manufacturers including Lafayette, Radioshack, Sherwood Electronics etc.

A major advantage that the CBS-Sony SQ system has over many of its competitors is the fairly ready availability of programme material. Already CBS have produced a quite comprehensive range of SQ discs and we found these readily available for sale in the USA. In the UK, CBS has licenced the giant EMI group to produce SQ records and we hear that these will also be on sale very soon in Australia. The quality of the CBS SQ discs is very high indeed and in most instances the four-channel format is intelligently handled.

Apart from the SQ matrix system, a number of other less complex matrix systems are marketed by companies such as Pioneer, Sansui, Dynaco, Electrovoice etc. Some of these are specifically intended only to decode the manufacturer's own brand of records — others are more versatile. The latest Dynaco and Electrovoice units have circuitry to enable them to decode nearly all 'matrixed' discs including those using the CBS-Sony SQ system.

These non-SQ type encoders operate by taking the four input information channels and combining them in a combination of in-phase and out-of-phase conditions. The decoders then take the two pairs of stereo signals and using a technique which is in effect the inverse of the encoding process, extract four separate signals. A resultant front-left plus front-right



DYNACO QUADAPTOR utilizes ambience information existing on many standard stereo records to produce a 'synthesized' four-channel effect. No other equipment is needed except of course two more speakers. Price? About \$48.

signal appears half-way between the two front speakers and an out-of-phase left minus right appears between the two rear speakers. The resultant apparent sound source can then be made to 'appear' somewhere between the front and rear speakers.

Generally speaking the apparent separation is not as good as with the CBS-Sony SQ technique but that system is far more complex and naturally more expensive.

SYNTHESIZED FOUR-CHANNEL SOUND

All matrix decoders have the ability to synthesize four-channel sound from two-channel records. This ability is limited to recreating the ambience of the hall in which the recording was originally made and varies very considerably from record to record. The technique works because complex phase and amplitude relationships on standard two-channel stereo records contains this data in otherwise 'hidden' form. It is there — but by accident. Some records — notably those produced by Dynaco — are

The records listed below are those we have found particularly effective in demonstrating the extra information-retrieval capabilities of the Dynaquad (and similar) simple matrix circuits. All these records will produce added ambience, those preceded by (*) exhibit substantial directional effects as well.

- * Beach Boys: "Sunflower" (Reprise S 6382) In *Cool, Cool Water* the back speaker seems to get wet.
- Beatles: "Let It Be" (Apple 34001)
- Berlioz: "Requiem" (Philips 6700.019) The acoustics of Westminster Cathedral are clearly evident.
- Bizet/Shchedrin: "Carmen Ballet" (Melodiya/Angel S 40067)
- Blood, Sweat and Tears (Columbia CS 9720) In *Spinning Wheel* in particular the soloists are decidedly in front, with unexpected instrumental effects in the rear.
- Boston Pops Orchestra: "An Evening At The Pops" (RCA Red Seal LSC 2827) and "Irish Night At The Pops" (RCA Red Seal LSC 2946) Both discs were recorded live.
- * Britten: "Noye's Fludde" (London OS 25331) Deleted, though according to London, current pressings on Argo ZNF 1 are presumably made from the same masters.
- Eileen Farrell: "I've Got A Right To Sing The Blues" (Columbia CS 8256) Deleted.
- * Fiddler On The Roof (Original Cast; RCA Victor LSO 1093)
- * The Last Night Of The Proms (Philips 6502.001) Stunning audience involvement, particularly in *Pomp and Circumstance* and *Rule Britannia*.
- * Lee Michaels (A & M 4199) *Heighy Hi* is recorded live, and the audience sings along.
- * Pink Floyd: "Ummagumma" (Harvest STBB 388) *Grantchester Meadows* and *Several Species of Small Furry Animals Gathered Together in a Cave Grooving With a Pict* are particularly delightful.
- Shakespeare: Macbeth (Caedmon SRS S 231) *Act 1, Scene 1* Jimmy Smith: "The Best Of Jimmy Smith" (Verve 68721)
- * Stereo Checkout — Demonstration Record (Westminster WSS 1) Deleted.
- * Stockhausen: "Electronic Music" (Deutsche Grammophon SPLM 138811) *Kontakte* has extreme four directional effects. It was originally recorded on 4-channel tape, then mixed down to two channels.
- * Simon and Garfunkel: "Bridge Over Troubled Water" (Columbia KCS 9914) *Cecilia* and *Bve Bve Love* especially.
- * Stockhausen: "Kurzwellen" (Deutsche Grammophon 2707045)
- * Wagner: "Siegfried" (London OSA 1508) *Side 5* in particular

ALSO

any disc recorded in the Electro-Voice 4-D matrix format (marketed in Australia as Quad-Spectrum Sound by Astor.)

especially recorded to enhance this effect.

A sub-group of matrix systems are designed solely to exploit this 'accidental' matrixing data described above. These are available from as little as \$10, and are produced by many companies including Dynaco, Lafayette, Koyo, Palm, EV, etc. The technique, which requires no other components except of course two loudspeakers — has been described as a constructional project in the August '71 issue. The technique is simple but very effective on many recordings. (It can also be used with stereo tape recorders).

The whole matrix technique (as we reported last month) been considerably snarled up by the recent award of US Patent No. 3,632,886 to Peter Scheiber covering encoding and decoding matrix techniques for four-channel recording and broadcasting.

This patent is said to be basic and 'will cover all present and future matrixing systems'. Peter Scheiber is now associated with the Electro-voice organisation. Howard Durbin, technical director of Electro-voice says

that 'Our basic interest is in establishing the four-channel concept as an industry with playback equipment in all price classes'.

IS IT ALL WORTHWHILE

A year ago we would have said 'no'. At that time most demonstrations of the new media were unconvincing — mainly because the programme material was so awful that it was practically impossible to judge whether the system was worth the trouble and expense.

Today the situation is rather different — a number of quite excellent four-channel recordings are commercially available and we state quite unequivocally that given the right surroundings (and programme material) four channel sound — discrete or matrix — adds very considerably indeed to one's enjoyment of music. Sometimes the difference is practically as marked as that between mono and stereo.

But this statement must be qualified by repeating that the room in which the gear is heard must be suitable for four-channel sound. The main requirements seem to be that the room

Three low-priced four-channel 'synthesizers', Unit (far right) is specifically intended for converting a car two-channel cartridge player to 'four-channel'. Like the Dynaco unit the only other bits required are two more speakers. Prices start at around \$10.



FOUR-CHANNEL SOUND

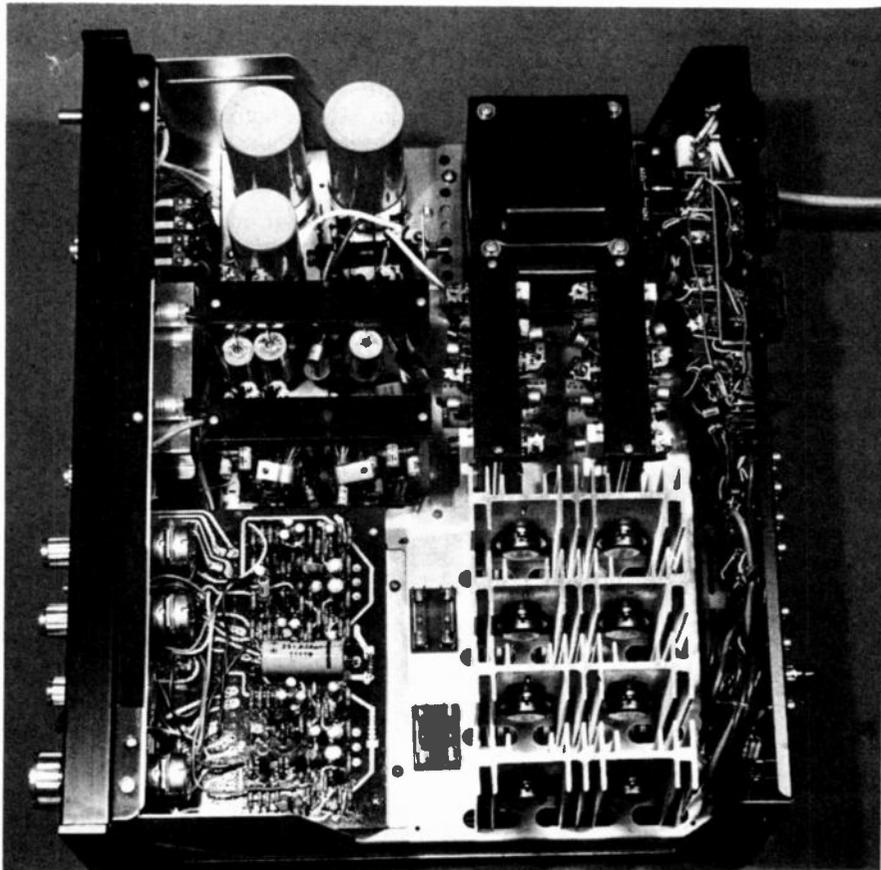
should not be overly large and acoustically should be fairly dead. The average domestic living room with normal soft furnishings, carpeted floor and curtained windows is just fine.

As this article has explained, there are various four-channel media — from reel-to-reel tape to gramophone records. Of these the best system technically must be reel-to-reel tape, for despite the cost of equipment this technique provides superb channel separation and excellent sound quality.

The reel-to-reel enthusiast has no problems if he can make his own material — if not his choice of ready made programme material is very limited indeed — although at the time of writing (April 28) there are rumours that a major US recording company may be entering this field.

The cartridge system will appeal to the car owner especially if he also has a domestic four-channel cartridge player in his home. At present few cartridge players can provide the sound quality of the other four-channel systems — but most of them provide at least 'medium-fi'! However as our review of the Akai 1800S combined open-reel and cartridge recorder (pages 56-59 of this issue) show — true hi-fi sound *can* be obtained from cartridges if good quality tape (and associated electronics) is used.

It is also quite probable that JVC Nivico four-channel amplifier.



EXPERT COMMENT

In the early days of stereo, it was customary to sit fairly well back from the loudspeakers so the angle subtended by the speakers to the listener was less than 90°.

With the introduction of four-channel, most of the manufacturers have suggested a square arrangement for the speakers. But this tends to produce a 'hole in the middle' and is possibly one reason why a few reviewers have commented that while four-channel sound great— it does not sound quite like the real thing.

If the speakers are arranged in a curve, the length of which is about 120° to 180°, the stereo image is vastly enhanced but the feeling of sound surrounding the listener is lost.

Another possibility, primarily when the rear speakers contain primarily reverberant information, is to point the speaker at the side or rear wall to provide a greater degree of diffusion by increasing the number of reflections.

I think that there is still a long way to go before we will really be able to tell how good four-channel will be.

Murray Wood, B.E., BSc, M.E.
Louis Challis & Associates.

cartridge systems will be available with circuitry suitable for chromium dioxide tapes — and inbuilt Dolby system.

The four-channel cassette is very much an unknown quantity at the time of writing — however developments in this new field are taking place so quickly that there may well be a four-channel cassette format

in the reasonably near future. It all depends on the Philips group. They hold all the patents!

It is extremely probable that both cartridge and cassette tapes will soon be produced in matrix form — if this transpires they will be reproducible through the same encoders that are now produced for gramophone record use.

For the record enthusiast the big question must be whether to go for the JVC Nivico/RCA system of discrete four channel sound — or rather to choose the CBS-Sony SQ or other matrix systems. The two systems are currently quite incompatible — their records and decoders can only be used with the system for which they were made.

Massive investments have been made by manufacturers backing both the JVC and SQ record systems and it is unlikely in the extreme that either system will become obsolete in the near future.

At present only JVC decoding equipment can be used to decode JVC CD-4 records and theoretically at least, an SQ decoder should be used for the SQ records. But if licencing arrangements permit, it is logical for companies to produce decoders that can be used for either type of record — it would not be too difficult for such decoders automatically to detect the ultrasonic carrier in the JVC disc and switch accordingly.

One problem, that whilst not yet too serious — may become more so in the near future, is the difficulty of broadcasting the JVC signal over stereo FM. This signal just cannot be accommodated within the existing frequency bandwidth allocations. Legal changes must be made if it is to be used. Apart from the legalities, FM broadcasting stations may well oppose transmitting the signal, for it would mean expense in modifying equipment to relocate the 38kHz stereo FM subcarrier etc. The SQ signal, on the other hand, can be transmitted without any changes at all, and in the USA, Lafayette's new model LR-440 stereo FM receiver has an SQ decoder inbuilt.

As far as record players are concerned the special JVC CD-4

QUAD-WRANGLE

Japan's JVC Nivico organization are reported to be seeking a way to use the term 'Quad' on its four-channel systems and RCA are also strongly considering the use of this name on their products — although a firm decision has not yet been reached. The problem is that the name 'Quad' is a registered trade name of a British manufacturer producing hi-fi amplifiers, tuners etc.

QUAD-QUESTIONS

Q. I appreciate that I need two further speakers for the rear channels — do these have to be of any particular type or quality?

A. The better the four-channel system then the better the speakers that should be obtained. This is especially true of discrete four-channel sound. Generally however it is not necessary for these rear speakers to have the power handling capability of the front units. About 50% is adequate.

For the simpler matrix systems use speakers with good bass and midrange response but preferably with not too much treble. If existing units are used it may be worthwhile disconnecting the tweeter. This is because such systems do tend to increase surface noise.

Many authorities suggest that omni-directional speakers be used for the rear channels — we agree with this. If only uni-directional units are available try them actually facing the rear wall, so that one uses reflected sound.

Q. Must the extra speakers be at the rear of the room?

A. Not necessarily. In fact an interesting effect is to place them about four feet behind the front speakers and facing toward them. This creates a 'sound stage' — most effective for orchestral music.

Q. I have only a limited budget — is it better to buy a medium quality four-channel system — or a good quality two-channel system?

A. This depends upon what you want from your equipment. If you are merely interested in music as a pleasant background experience then a medium price four-channel set-up may well be worth considering. On the other hand if you enjoy listening to music then without any doubt buy good quality two-channel equipment

and consider extending it to four-channel at a later date.

Q. Do you think that we shall see a single universally accepted four-channel disc?

A. No. But there may well be equipment made that will play both JVC and SQ discs. It's a matter of commercial politics — the engineering required is quite feasible.

Q. I have seen adverts for four-channel headphones. Are they for real?

A. Yes. Each earpiece contains two drive units — one in front of the other. They provide a four-channel effect to some extent but not to the same extent as do four speakers in a room.

Q. Is four-channel sound worthwhile in a very small room?

A. Definitely yes! The most impressive four-channel sound that we have heard to date was in a car.

Q. Conversely then is it worthwhile in a very large hall?

A. This depends very much upon the programme material. For organ music — such as Bach or Palestrina — it is as long as the rear channels reproduce only reverberant data. But in general most programme material will sound rather odd.

Q. Do four-channel records have the same playing time as normal LP's?

A. Yes — but at present only 12" discs are available.

Q. Can I play the JVC CD-4 discs with a standard stylus?

A. Not at present — but RCA say that when they commence production — which will be very soon they will not be damaged if a normal stylus is used to play them. The proper Shibata stylus of course must still be used if four-channel reproduction is required.

it is necessary to switch on as many as four separate units and adjust a multiplicity of controls. Many of these set-ups are an ergonomist's nightmare.

Four-channel sound really can do a great deal of what its protagonists claim for it. It cannot yet — and possibly never will — recreate the total ambience of a concert hall, for one cannot create a new ambience without first removing the old one. But it certainly does create a feeling of spaciousness that we have never obtained before from any two-channel equipment, no matter how costly.

Four-channel sound has too many positive advantages for it merely to be dismissed as yet another industry gimmick — although with little doubt it is a 'manufactured need' that people had not previously been aware that they required.

But like electricity it is probably here to stay.

FOUR-CHANNEL EQUIPMENT MENTIONED OR DESCRIBED IN THIS ISSUE IS MARKETED BY THE FOLLOWING COMPANIES.

AKAI AKAI Australia Pty. Ltd., 276 Castlereagh St., Sydney, NSW, 2000

CLARION United Car Radios, 152 Commercial Rd., Prahran, Victoria, 3181

DYNACO Danish Hi-Fi Pty. Ltd., 698 Burke Rd., Camberwell, Melbourne, Vic. 3124

HARMON KARDON Recorded Music Salon, 23 Collins St., Melbourne, Vic. 3000

JVC Nivico Hagemeyer (Australasia) N.V. 59, Anzac Parade, Kensington, NSW. 2033

KENWOOD Jacoby Kempthorne Pty. Ltd., North Rocks Road, North Parramatta, 2151

KOYO Radio Parts Pty. Ltd., 562 Spencer St., Melbourne, Vic. 3000

LAFAYETTE Electron Tube Distributors Pty. Ltd., 94 High St., St. Kilda, Vic. 3182

PALM Radio Parts Pty. Ltd., 562 Spencer St., Melbourne, Vic. 3000

PHASE 44 Radio Parts Pty. Ltd., 562 Spencer St., Melbourne, Vic. 3000

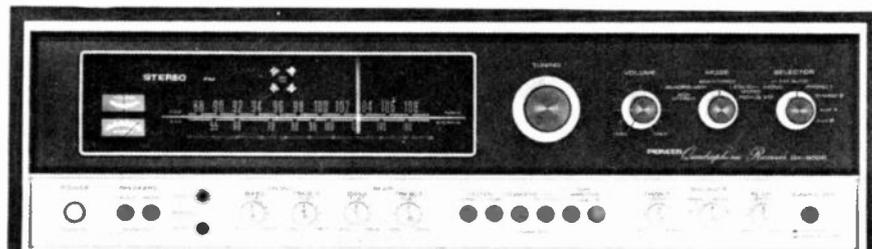
PIONEER Astronics Australasia Pty. Ltd., 161-173 Sturt St., South Melbourne, Vic. 3205

SANSUI Simon Gray Pty. Ltd., 28 Elizabeth St., Melbourne, Vic. 3000

SHIBATA Hagemeyer (Australasia) N.V. 59, Anzac Parade, Kensington, NSW. 2033

SONY Jacoby Kempthorne Pty. Ltd., 469-475 Kent St., Sydney, 2000

TEAC Australian Musical Industries Pty. Ltd., 155 Gladstone St., South Melbourne, Vic. 3205



For those countries that have it — stereo FM broadcasts can be synthesized into 'four-channel' sound by units such as this Pioneer QX 8000 receiver.

cartridge and Shibata stylus may be fitted to any record player — and of course can be used to play SQ records.

Currently some decoders have amplifiers in-built for the two rear channels — others rely on the user supplying a separate amplifier, or buying a special four-channel amplifier. Certainly if one is seriously considering present or even future investment in four-channel equipment one could consider purchasing a four-channel amplifier.

By far the cheapest way to try (rudimentary) four-channel sound is either to make or buy one of the simple quadriphonic synthesizers. These are obtainable from ten dollars upwards and unlike the more complex four-channel equipment, these synthesizers do not require a second amplifier. They connect directly to a second pair of speakers. This type of system has some major limitations but

at least it does provide a good idea of the possibilities of true four-channel sound, and if later one decides to go into four-channel sound 'totus porcus' one will still require the speakers anyway. The speakers should be of good quality, but unless one is definitely planning eventually to buy full 'discrete' equipment the speakers need not necessarily be of as high a quality as the front units.

This approach to four-channel sound will not for one moment provide the quality of a true four-channel installation but it does give some idea as to what is possible without spending a lot of money.

Having for the past month used practically every item of four-channel equipment currently available — one thing is clearly apparent. This is that with the exception of the simpler 'synthesizers', most of the hardware is far too complex to use. In some cases

ALL ABOUT 4-CHANNEL SOUND



THE SQ

by Benjamin B. Bauer,
CBS Laboratories.
Stamford,
USA.

A full review of the CBS-Sony SQ system is included in this issue (pages 50-55).

A record groove is a two-channel medium. It is possible to record on it only two "orthogonal", or independent channels. But the orthogonality can be chosen in various ways for example, with $45^{\circ}/-45^{\circ}$ or lateral-vertical stylus motions, and, as we have discovered during our matrix studies, with clockwise and counter-clockwise circles.

The two channels of any other orthogonal set one may choose will be independent of each other, but not from another set — some information will be transferred from one set into the other. This in essence, is the problem of placing four channels on a disc — how to minimize the effect of information transfer, and thus to portray a credible four-channel sound display.

STEREO COMPATIBILITY

Before describing the SQ record, let us consider briefly the philosophy that

must be adopted to produce a truly compatible stereo-quadrasonic system. We take it for granted that such a record must exhibit full frequency response, output level, and freedom from distortion and noise, which characterize the present high fidelity stereo disc and we believe precludes the use of carrier systems since they wear so rapidly and take up so much "modulation space."

For the moment let us return to our initial premise — that the SQ record in the quad mode should produce a sound which for all intents and purposes is the same as that of the original four-channel master tape. But what about the listener who hears the same record on a two-channel stereophonic system? What should be heard?

This question is an extremely important one if we are to attain full compatibility. Suppose a room is equipped with quadrasonic

loudspeakers in the corners and you are standing in the centre facing in the forward direction. The performance of a symphony orchestra spans the space between the front loudspeakers. The reverberant energy of the hall is reproduced by the whole system including the rear loudspeakers. Or perhaps the performance is a rock quartet with the artists placed in the corners. The general arrangement is shown in Fig. 1. How should we "fold", or transform, this performance from four loudspeakers to two with maximum listener satisfaction?

Before we answer this question we call to the attention of the reader that the sounds from the front loudspeakers in Fig. 1 are shown to follow straight-line arrows, while those from the rear loudspeakers appear to follow a bent path! This is not a physical perturbation, but rather a physiological one which we discovered during our psychoacoustic studies related to quadrasonic reproduction. The fact is that the width of a sound image in the back of us appears to be greatly contracted compared with that which we sense from the front with an

identical array of sources.

If you have a stereophonic components system you can prove this to yourself with very little difficulty. Stand in the centre facing the stereo loudspeakers while a record with good channel separation is playing and make a mental note of the image width; next, turn around rapidly and you will sense the image to collapse to perhaps 1/3 of its original width! The discovery of this phenomenon, which I call "back image contraction" has played an important role in determining the most propitious way of transforming a quadrasonic performance into one which is fully satisfying artistically in the stereophonic mode.

Keeping in mind the above-described experiments, only one method provides a satisfactory quad-to-stereo transformation: the orchestral stage must remain undiminished, i.e. the front channels should stay where they originally had been — in front,

spanning the full interspeaker space. Any discrete back channel sounds have to be transferred into the front channels in such a manner that a symmetrically located listener perceives a minimum change in the aspect of sound as a result of the transfer. This latter objective is realized if the sounds originally coming from the rear loudspeakers remain at full strength but are positioned in front as if they had been reflected from the front wall bouncing back toward the listener (as illustrated in Fig. 2). This latter aspect causes them to arrive at the same included angle from the front that they appeared to sustain when they originated from the rear loudspeakers. Any front centre signal, C_F in the quad presentation should, of course, remain at the centre of the stereo display. And if the "reflected" sounds carry with them a feeling of being more distant, a depth illusion is created which helps to provide a

quadrasonic identification to the stereo display.

With the quad-to-stereo transformation described above, a symmetrically placed centre observer notices the least change when the system is switched from quadrasonic to stereo, and this in itself is proof that a satisfactory "fold" has been achieved. As a matter of fact, the best place from which to observe the impact of quadrasonic sound is *not* at the centre of symmetry. One of the virtues of quadrasonic is that it frees the listener from the centre-of-the-room spot. Its impact is widely distributed over the listening area.

COMPATIBILITY REQUIREMENTS

We can set forth some of the requirements to be expected from a compatible stereo-quadrasonic record and from the playback system on which it is to be reproduced.

1. In the compatible stereo mode the record should exhibit full front-channel separation. This is in accord with the above-described experiments.

2. Since with the quadrasonic capability at hand the producer is able to place the performers everywhere and to "pan" the signals anywhere around a 360° circle, the system should possess *omnidirectional stereo fidelity*; which means that if a constant signal is panned around the encoder, the total sound power delivered to the stereophonic loudspeakers should remain constant regardless of the angle of pan.

3. Upon decoding into four-channels, at least the front pairs of channels should exhibit as complete a channel separation as possible. (Additionally, the greater the channel separation between the other adjacent pairs of channels, the better the quadrasonic illusion.)

4. For the same reason as in (2), above, the system should display *omnidirectional quadrasonic fidelity*, i.e. with a signal panned into the encoder around a 360° angle, the total encoded energy applied to the four loudspeakers should remain constant.

5. Since the signals recorded on the disc will be used to produce an unambiguous quadrasonic performance, there should be no ambiguity in the encoded signal as to direction with a signal panned around the encoder input over a 360° angle; or to put it in reference to the decoder, there should be no ambiguity in the set of decoded signals over the full circle of sound arrival.

6. In principle, the system should be able to handle at least single *discrete* channel sounds *discretely* through the corresponding loudspeakers. This, we will show,

RECORD

-how it works

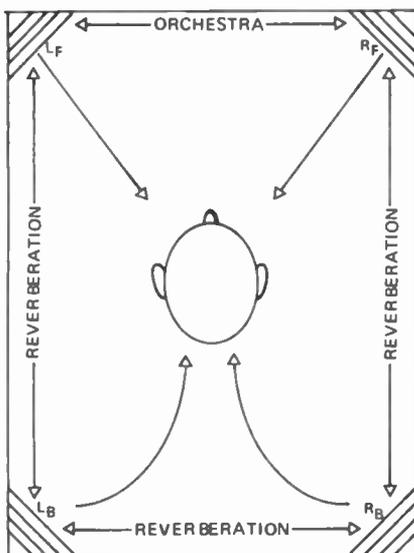


Fig. 1. Typical four-channel sound. For classical music the main sound appears from front speakers — rear speakers mainly supply reverberant sound. A 'pop' quartet however may well be recorded such that each performer is placed in a separate corner.

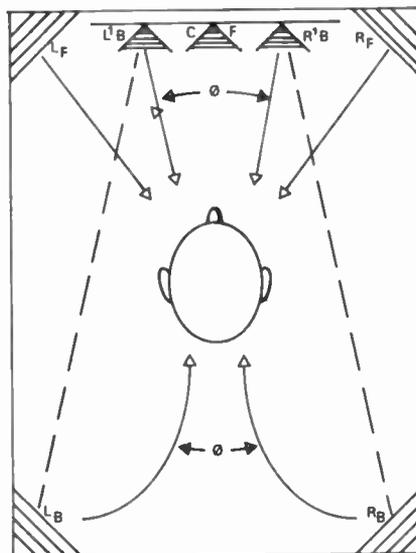


Fig. 2. How a quadrasonic record may be satisfactorily reproduced on a two-channel system. The two rear channels L_B and R_B have been transferred to the front channels and appear as a "reflected sound" from an imaginary front wall.

THE SQ RECORD

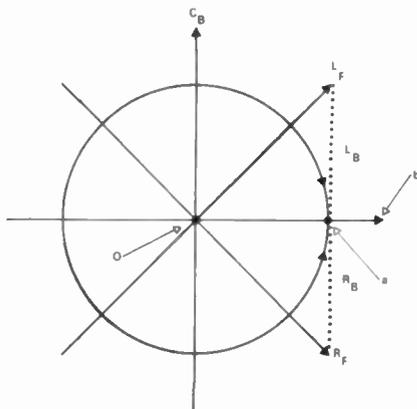


Fig. 3. SQ record modulations.

requires the use of a suitable electronic logic added to the matrix system. The logic is a rather expensive refinement which has proven to be unnecessary in the majority of home-type reproduction equipments. However, the matrix system should preferably be such that a suitable logic can be used with it.

7. When the matrixed signal is broadcast through an AM station or is played on a monophonic phonograph, all four channels should be transmitted without loss in level. In the case of the rock group it would not do for the back performers to drop in level significantly relative to the front ones, thus depriving the listeners of the full measure of performance.

THE SQ RECORD

We can now proceed to describe the SQ record system. Since we have decided to leave the front channel

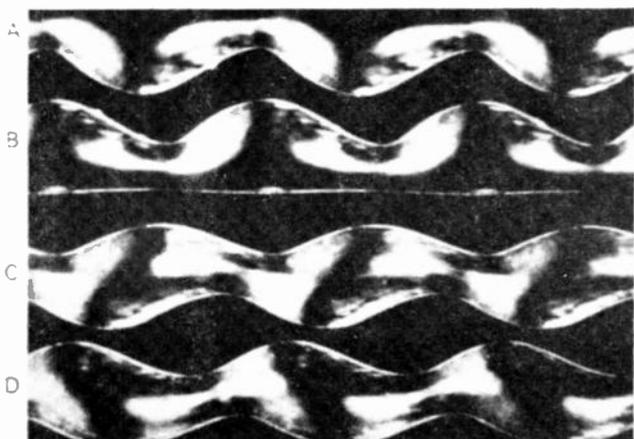
sounds unaltered when changing from quad to stereo, we cause our LF and RF channels to become the Left and Right stereo channels, respectively. This also means that any centre-front sound, CF, becomes equal to the centre sound of conventional stereo resulting in lateral modulation.

Next, we have to accommodate the LB and RB channels. During our investigations, we have discovered that two circular stylus motions, namely clockwise and counterclockwise, also form an orthogonal-set. It turns out to be favourable to assign to the LB channel the clockwise motion and to the RB channel the counterclockwise motion. The two motions, in combination with the longitudinal motion of the groove create a double helix, which then carries our back channel sounds. When a centre-back channel is recorded the two oppositely directed helixes combine into a vertical modulation. The above-described six cardinal modulations of the SQ record in vector form are shown in Fig. 3, and a microphotograph of a portion of the groove exhibiting the four principal modulations is shown in Fig. 4.

The method of encoding an SQ record is shown in Fig. 5. After the recording director has approved the edited version of the master tape which appears on four loudspeakers in the editing room, the corresponding channels, namely LF, RF, LB, and RB, of the master tape are connected to the SQ encoder, resulting in a pair of encoded signals defined by the phasor groups LT and RT. It is noted that LF and RF are precisely in-phase at the output terminals and are completely isolated from each other: that is, there is no LF present in RT, and no RF in LT. Thus, the front-channel separation

remains infinite, meeting our first condition for a properly performing stereo-quadrasonic system. The back channels, LB and RB, are in quadrature with the 0.707LB term at LT leading the equivalent term at RT, and the 0.707RB term at RT leading the equivalent term at LT. This quadrature relationship is what provides the circular stylus motion described previously. This quadrature relationship produces an unexpected benefit: introduced into the stereo loudspeaker they result in an image which is somewhat spread (suggesting distance) and predominantly placed to the left and right respectively, for LB and RB channels. This is precisely the format for quadrasonic identification in a compatible stereo-quadrasonic display, as prescribed from our previously-mentioned psychoacoustic studies.

At first glance the two phasor groups in Fig. 5, (LT and RT) appear to exhibit an asymmetrical phasor orientation. However, a bit of analysis shows at once that in practice this is not the case. In fact, since the signals of the four channels are all different or "incoherent," it is not in the best of orthodox tradition to display them all on the same phasor diagram. We can draw proper conclusions only with respect to phasor relationship between the equally named phasors. The grouping that we use is of principal value in performing mathematical analyses with respect to the SQ system. For example, if a signal is panned around the four channel positions in such manner that its power delivered to the encoder remains constant, we are readily able to calculate the relative voltages and phase positions at the output terminals of the encoder. This operation is best performed on a digital computer, and the readout corresponding to this condition is shown in Table 1. It is seen that as the signal is panned around 360° the total stereo power remains precisely constant at a 0 dB level. Thus, our encoding system also meets the second condition prescribed for a satisfactory compatible stereo-quadrasonic record.



Photomicrograph shows the CBS SQ groove with signals in (A) left front only, (B) right front only, (C) left rear only, and (D) right rear only. (Note that the groove is made visible by light reflected from its walls; black areas are the "land" between the grooves.) Grooves embodying the front channels show modulation only on the appropriate groove wall; each rear channel, however, employs both groove walls, one wall or the other "leading" depending on whether right or left rear is recorded.

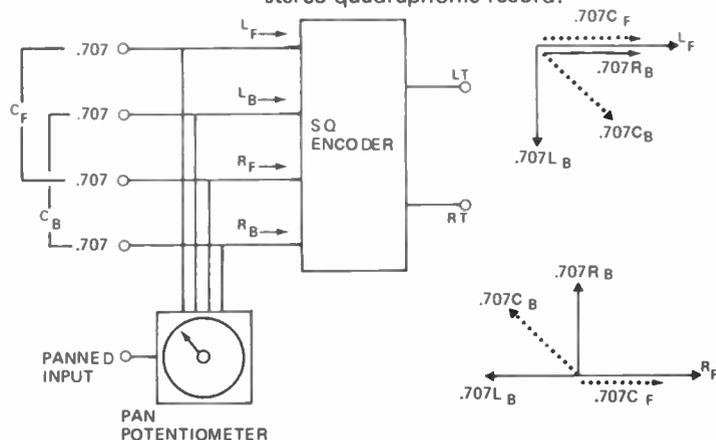


Fig. 5. How the SQ record is encoded.

BEARING (DEGREES)	LEFT TOTAL AMP (VOLT)	PHASE (DEG)	RIGHT TOTAL AMP (VOLT)	PHASE (DEG)	STEREO POWER (dB)
.0	.707	360.0	.707	360.0	-.00
22.5	.383	360.0	.924	360.0	-.00
45.0	.000	360.0	1.000	360.0	.00
67.5	.271	360.0	.963	16.3	-.00
90.0	.500	360.0	.866	35.2	-.00
112.5	.653	360.0	.757	59.5	-.00
135.0	.707	360.0	.707	89.9	-.00
157.5	.707	337.5	.707	112.4	-.00
180.0	.707	315.1	.707	134.9	-.00
202.5	.707	292.6	.707	157.5	-.00
225.0	.707	270.1	.707	180.0	-.00
247.5	.757	300.4	.653	180.0	-.00
270.0	.866	324.8	.500	180.0	-.00
292.5	.963	343.7	.271	180.0	-.00
315.0	1.000	360.0	.000	360.0	.00
337.5	.924	360.0	.383	360.0	-.00
360.0	.707	360.0	.707	360.0	-.00

Table 1 — Relative amplitudes and phases of output signals from SQ encoder, and total stereo power level as a function of the bearing angle of "panned" signal.

BEAR (DEG)	T.P.R. (dB)	LFAMP (VOLT)	LFPHA (DEG)	LBAMP (VOLT)	LBPHA (DEG)	RFAMP (VOLT)	RFPHA (DEG)	RBAMP (VOLT)	RBPHA (DEG)
.0	3.0	.707	360.0	.707	135.1	.707	360.0	.707	315.1
22.5	3.0	.383	360.0	.707	157.5	.924	360.0	.707	292.6
45.0	3.0	.000	360.0	.707	180.0	1.000	360.0	.707	270.1
67.5	3.0	.271	360.0	.654	179.9	.963	16.3	.757	300.4
90.0	3.0	.500	360.0	.500	180.0	.866	35.2	.866	324.8
112.5	3.0	.653	360.0	.271	180.0	.757	59.5	.962	343.7
135.0	3.0	.707	360.0	.001	180.0	.707	89.8	1.000	360.0
157.5	3.0	.707	337.6	.381	.0	.707	112.3	.924	.0
180.0	3.0	.707	315.1	.706	.0	.707	134.9	.707	.0
202.5	3.0	.707	292.6	.923	.0	.707	157.4	.383	.0
225.0	3.0	.707	270.2	1.000	.1	.707	180.0	.001	.0
247.5	3.0	.757	300.5	.962	16.4	.653	180.0	.271	.0
270.0	3.0	.866	324.8	.866	35.3	.500	180.0	.500	.0
292.5	3.0	.963	343.7	.757	59.7	.271	180.0	.653	.0
315.0	3.0	1.000	360.0	.707	90.1	.000	360.0	.707	360.0
337.5	3.0	.924	360.0	.707	112.6	.383	360.0	.707	337.5
360.0	3.0	.707	360.0	.707	135.1	.707	360.0	.707	315.1

Table 2 — Total power level, relative amplitudes and phases of output signals of SQ decoder as a function of the bearing angle of "panned" signal.

DECODING THE SQ RECORD

To decode the SQ record into four signals which correspond to the original four input channels into the encoder, a decoding matrix can be used. Each input signal is modified by two psi networks, which are all-pass networks shifting the phase of the signal as a function of frequency without in any way altering its frequency response or output level. The networks in each pair are similar, except that one of the pair provides a basic phase-shift $\psi + 90^\circ$ (f), basic phase-shift ψ (f), while the other provides a phase shift $(\psi + 90^\circ)$ (f). Networks of this type are commonly used in broadcasting practice to improve the modulation capabilities of radio transmitter. The outputs of the psi networks are combined linearly with two summing junctions and presented through four isolating amplifiers to the output terminals L'F, L'B, R'F, and R'B, respectively.

We observe the following facts: The principal decoded signals, L'F L'B R'B and R'F at the output terminals are precisely equal and in phase. This assures that high-fidelity capability is inherent in the decoded signal. We note further, that not only in the front channels, L'F, and R'F, are the original signals L'F and R'F completely isolated from each other, but also that in the back channels, L'B and R'B, the signals L'B and R'B are completely isolated from each other. This is because the two components of the double helical modulations are orthogonal and become completely isolated after SQ decoding. Thus, in the SQ matrix, both the front and the back channels exhibit total channel separation. This clearly meets the requirements of our condition 3 for stereo-quadrasonic performance.

We can further programme our computer to show what happens to the signals of any one decoded channel as well as to calculate the total power in all four channels as a signal is panned around the encoder. The result appears in Table II, demonstrating that the power remains strictly constant during the panning process — therefore, complete omnidirectional

quadrasonic fidelity exists, fulfilling condition 4 for high-fidelity stereo-quadrasonic performance.

With respect to unambiguity of directional response, we refer back to Table I and observe that in no sense are the pairs of output signals of the set identical or proportional in their amplitudes and phase angles, demonstrating that condition 5 is applicable. For each position of the panning potentiometer there is a unique set of phasors which characterizes the direction of the output signal from the encoder.

REPRODUCING DISCRETE SIGNALS

While there is total channel separation between the front and the back signal pairs, there is transference of signals between the front and back channels. For example, the presence of a front left signal, L'F in its proper channel, also results in two transferred signals of identical amplitude, 0.707 L'F, but in a quadrature position in the back channels. This means that in this signal condition there is also infinite separation between the left R'F and the R'B channels, but only a 3dB separation between the L'F and L'B channels. Similar signal relationship can be shown to exist for all the four individual channels.

The front-back channel isolation can be greatly improved by adding an electronic "logic" to the matrix. Such a logic can be described within the scope of this article only in general terms. Thus, if we provide a logic circuit which can detect the presence of equal in quadrature signals in the front and back channel pairs and equip the decoder outputs with gain control amplifiers, we can cause the circuit to diminish the gain of the channel pairs in which the transferred signals are found and correspondingly to raise the gain of opposite channels so that overall power remains unchanged; and this will leave the primary signal with the correct total power and at its proper loudspeaker only. The action is made rapid enough as to be inaudible

and is applicable equally to all four channels. The effect is precisely the same as if there existed four separate lines between the master tape and the loudspeakers.

In practice, however, quadrasonic signals seldom appear in isolation. Instead, there virtually is a constant interplay between the channels. As the sounds from various channels overlap in rapid sequence the action of the logic is less significant because the hearing mechanism becomes too confused assuredly to tell the direction from which a particular sound originates. With simultaneous and complex sound patterns the difference between the master tape and the reproduced matrix sounds becomes imperceptible even with diminution of logic action. Under all the conditions usually encountered, i.e., whether there are isolated discrete sounds or a constant interplay between the channels, the listener almost invariably is unable to differentiate between the master tape and the reproduced record.

Thus, condition 6 for stereo-quadrasonic reproduction of decoded sound has been met in the SQ record system.

MATRIX DECODER PERFORMANCE

While there is little doubt that the addition of a logic to the matrix produces superior performance, especially with discrete channel sounds, it is also true that with the majority of quadrasonic selections the four channels are operating more or less continuously, thereby justifying the possibility of omitting the logic circuit from quadrasonic reproducers in the moderate price categories. Many engineers and artists who have listened to the SQ system with and without the logic mode have indicated that the latter would be perfectly satisfactory in the majority of applications, even if discrete channels are not reproduced without a measure of dilution. With

RIPPLE CONTROL

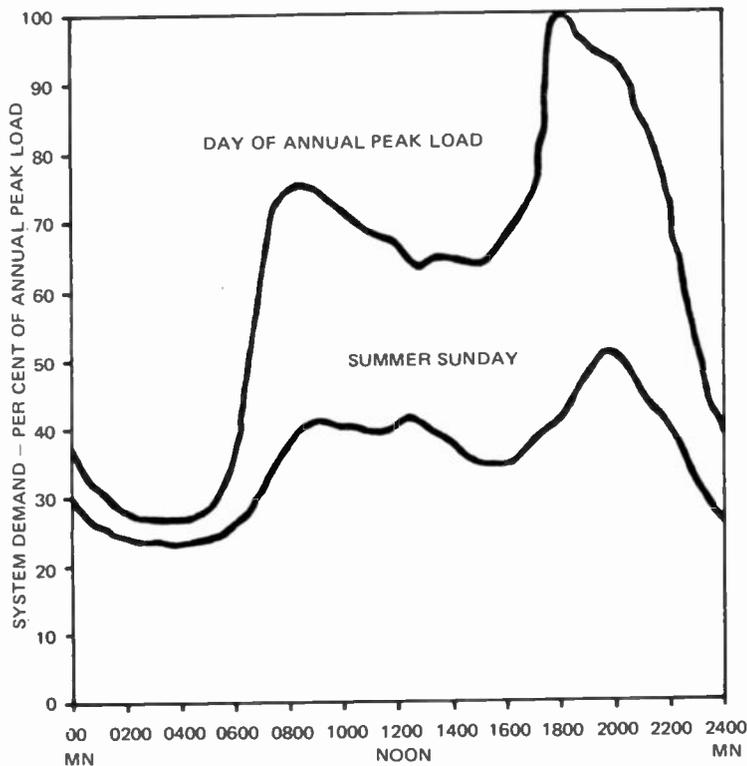


FIG. 1 DAILY LOAD CURVES

TIME OF DAY

THE total electric power usage throughout the world is increasing steadily at an annual rate of 3%, and according to some researchers the total power used in about 200 years time at this present rate of increase will equal that received by the earth from the sun. Such power usage if unchecked could seriously affect the thermal balance of the earth and give rise to ecological problems.

The control of power usage in the future is a problem that requires serious attention. Problems of power usage control, however, belong not only to the future, but to the present.

Fig. 1 shows the curves of peak load versus time of day for a typical electricity distribution system. The top curve shows the loading for a typical high load winter's day, while

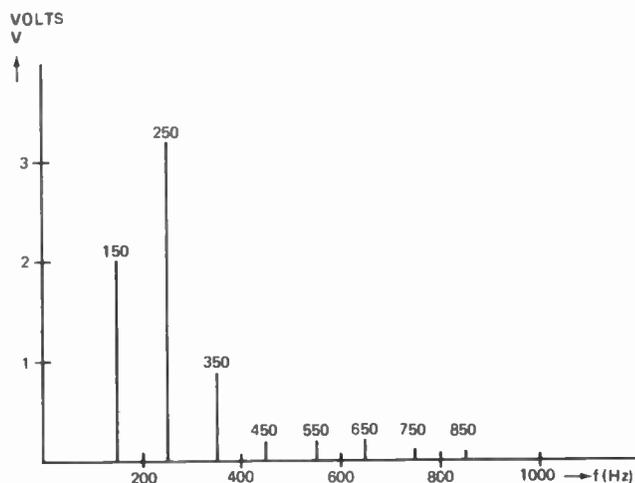
the lower curve shows the loading for a summer Sunday. Taking the maximum peak load as 100%, it can be seen that the average summer daylight load is about 40% of peak and that the average winter daylight load is about 70% of peak. Hence neglecting the hourly variations it can be seen that for a large part of the year, the generating plant is only operating at a low proportion of its total capacity.

As can be seen from the graph, the major factor affecting efficiency is the daily peak occurring about 6pm to 9pm. If extra plant were provided for the top 40% of the peak load, it would only produce about 3% of the total energy required throughout the year.

This inefficiency must naturally be passed on to the consumer in the form of increased charges, an obviously

unpopular course of action.

Fig. 2. Amplitudes of common harmonics normally found on supply mains.



There are, however, methods of minimising the peak demands, and one of these is Ripple Control — the subject of this article.

RIPPLE CONTROL

Ripple Control (Audio-frequency Injection Control) was introduced in Australia almost 20 years ago. Basically the system switches off certain apparatus in the consumer's premises which has some storage capability, a typical example being the domestic water heater which may be switched off for several hours providing it has sufficient storage capacity. Another major use of ripple control is in the automatic switching of street lighting.

The switching is performed by fitting

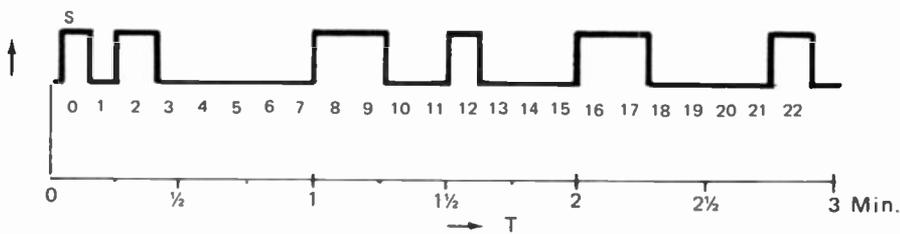


Fig. 3. Typical ripple control pulse sequence.

control relays to the subscriber's switch board, or in the case of street lighting, the local substation, which are actuated by coded audio-frequency tone bursts injected into the mains reticulation system. Subscribers subject to such switching, which effectively denies them water heating power during peak periods, are offered reduced rates. The net effect of such switching is to distribute the load more evenly over the day and thus obviate to some extent the necessity for peak capability plant. The installation of ripple control equipment and the reduced power rates naturally cost money, but it has been found that such cost is usually much less than half that required to instal and maintain plant with full capability.

The injected tone burst has a frequency that is carefully chosen with relation to several factors. Firstly, the tone must not have the same frequency as any of the supply mains harmonics which have amplitudes as shown in Fig. 2. This is why common

frequencies used are 175Hz, 200Hz, 300Hz, 500Hz, 750Hz and 1050Hz. A list of frequencies used by NSW Supply Authorities is given in Table 1.

Secondly the frequency must be chosen so that a sufficiently high level of tone voltage appears at each consumer relay in the network. Lastly the leakage of tone signals into the high voltage network must be limited in order to prevent mutual interference between neighbouring installations.

Generally the signal frequency is chosen such that the longest feeder in the network is less than a quarter wavelength at this frequency. That is, shorter than 40 miles for 1050Hz and shorter than 80 miles for 500Hz. Another consideration is that the higher frequencies require less injected power for satisfactory relay operation.

LEVEL OF INJECTION

Although injection could take place anywhere in the system, the most practical point in urban areas is into the 11kV level which provides a

conveniently sized group of controlled subscribers. In country areas the 33kV or 66kV levels may be more practical.

The control relay requires approximately two volts of ripple voltage for reliable operation and a 5-6 volt minimum is therefore chosen in order to provide adequate safety margin. The maximum levels are specified as 20 volts for injection frequencies below 500Hz, and $\frac{10,000}{f}$

volts where the frequency is above 500Hz. These limits for various bodies in NSW are also shown in Table 1.

INJECTION SYSTEMS

There are many possible methods of coding ripple control signals. There are two systems in use in Australia which use very similar coding systems. These are the Zellweger system and the Landis and Gyr system. The Zellweger system commonly known as the Impulse Interval system will be described first.

THE ZELLWEGER SYSTEM

This system uses simple encoders at the transmitter and decoders at the receiver, all of which are driven together by synchronous motors. Initially (Refer to Fig. 3) a start pulse 'S' is transmitted and this starts the motors of EVERY decoder in the field and these step through a 22 channel switching sequence. Each relay can be set to operate on any one of the specified channels. The encoder selects the channels required to be switched on by transmitting a block of tone

TABLE 1

AUDIO FREQUENCY INJECTION FREQUENCIES USED BY N.S.W. SUPPLY AUTHORITIES

Supply Authority	Frequency (Hz)	*Maximum Signal Voltage
Brisbane Water C.C.	1,050	9.5
Central West C.C.	492	20.0
Hartley C.C.	400	20.0
Illawarra C.C.	750	13.0
Mackellar C.C.	1,050	9.5
Macleay River C.C.	1,440	7.0
Macquarie C.C.	492	20.0
Murrumbidgee C.C.	300	20.0
Namoi Valley C.C.	390	20.0
Nepean River C.C.	1,050	9.5
Northern Rivers C.C.	291	20.0
Ophir C.C.	283	20.0
Peel-Cunningham C.C.	317	20.0
Prospect C.C.	1,050	9.5
St. George C.C.	492	20.0
Shortland C.C.	1,050	9.5
Sydney C.C.	750	13.0
Upper Hunter C.C.	500	20.0
Blue Mountains City C.	1,050	9.5
Broken Hill City C.	500	20.0
Mullumbimby M.C.	485	20.0

* Calculated from $\frac{10,000}{f}$ or 20 volts maximum and relative to 240 volts.

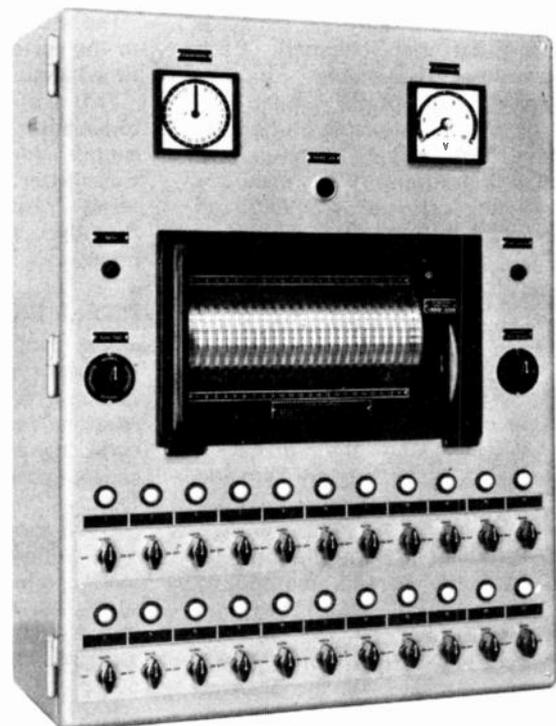


Fig. 4. Control panel containing encoder and programmer.

RIPPLE CONTROL

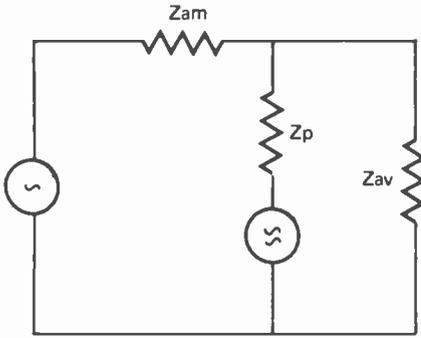


Fig. 5(a) Equivalent circuit of parallel injection system.

during the period that the encoder and all decoders are stepping through that particular channel. Synchronous motors operating on the common mains frequency ensure that encoder and decoders remain in step. When a block of tone corresponds to a receiving relay's preselected channel a relay is energized, switching on the subscriber's circuit. If it is required to switch off a subscriber's circuit, the tone is *not* transmitted during that channel and the relay drops out. Figure 3 shows a typical impulse diagram for a 22 channel system. Each channel has a duration of 7.5 seconds giving a total cycle time of 3 minutes.

The encoder/programmer unit (Fig. 4) resembles in many ways a mechanical music-box. It has a large programme drum with 22 segments (one segment per channel). Each segment has adjustable pins to programme the ON/OFF timing. The whole drum rotates one revolution per 24 hours. Command sequences may be generated automatically or manually and individual channel segments can be overridden by manual switching.

TRANSMITTER

There are two basic methods of injecting tone bursts into the network — parallel (Fig. 5a) and series (Fig. 5b).

In these diagrams the impedance of the H.V. grid and the substation transformer is represented by Z_{am} and impedance of the controlled network by Z_{av} .

In Australia all installations at present use the parallel method of injection, a typical set-up being as shown in Figures 6 and 7. The transmitter itself is a three phase motor generator set — the motor being a low slip (less than 1% at full load) squirrel cage induction motor. The generator has windings only on the

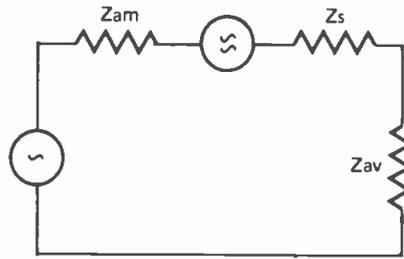


Fig. 5(b). Equivalent circuit of series injection system.

stator, the rotor being of toothed lamination construction. This simple construction ensures low maintenance and excellent reliability.

The power required depends on a number of system variables, but with for example a 20MVA capacity network, roughly 30kVA of ripple frequency power is required.

The output of the generator is switched by a contactor actuated by the encoder pulse train. The subsequent train of audio frequency tone bursts is then passed via an isolating transformer (to provide a galvanic break between the generator and the high voltage coupling equipment) which has a range of tapings to allow injection level adjustment.

The transmitter system is connected to the system busbars by a three-phase tuned circuit.

This circuit presents a high impedance to 50Hz thus preventing supply mains feedback into the transmitter. The circuit is tuned to series resonance at the injection frequency, and hence offers a low impedance to this frequency.

RIPPLE RECEIVERS

The ripple receiver is a most important component of the system. It must be reliable, simple, must not react to transients, must interpret all code signals correctly and must be capable of controlling loads of at least 5kW.

Fig. 8 shows the circuit arrangement of a Zellweger receiver which has its input connected direct to the 240 volt supply on which the coded signals are impressed. A double bandpass filter separates the tone signals from the 50Hz and at the same time provides step-up of the signal voltage. The tone signals are then rectified and charge a capacitor. As the control signal

duration is 7.5 seconds the capacitor will charge sufficiently to cause a neon to strike and hence discharge the capacitor through the coil of a relay — causing it to actuate. Because of the integrating effect of this circuit, transient voltages, which have a short duration and hence low energy content, will not actuate the relay.

When the start pulse is received and the relay closes for the first time, a contact starts a small synchronous motor which drives a timer mechanism. A numbered dial (Fig. 9b) allows the timer to be set for any one of 22 channels and should a further tone pulse be received when the timer reaches this channel, the relay operates again actuating a deflection mechanism which in turn actuates the load switch. If the motor is started again and passes through the selected channel without the receipt of a command pulse, the deflection mechanism will turn the load switch off.

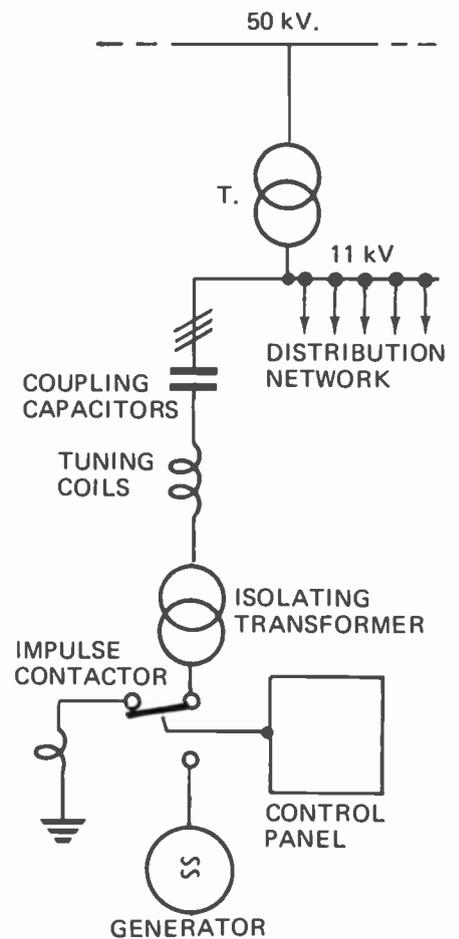


Fig. 6. Typical Zellweger system showing method of injection into 11kV system.

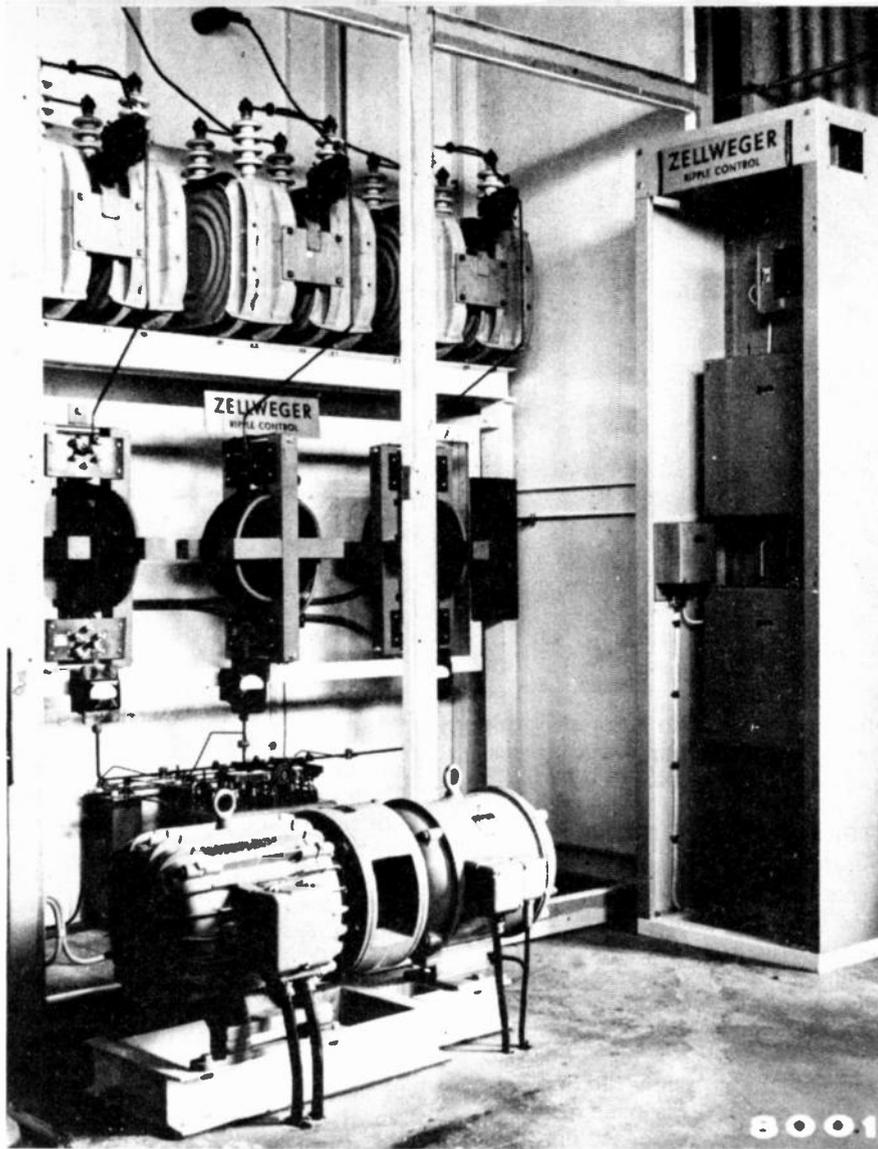


Fig. 7. Injection plant. Motor-generator can be seen at lower front.

THE LANDIS AND GYR SYSTEM

The Landis and Gyr system although very similar to the Zellweger system has several marked differences. The same impulse interval method is used but there are 25 channels which are scanned over a 30 second period. The scan commences with a 460 milliseconds long start pulse and the channel pulses are 100 milliseconds long in contrast to the $7\frac{1}{2}$ second long Zellweger pulses.

The transmitter utilises a static inverter rather than a rotary converter and Landis and Gyr maintain that this allows the tone frequency to be maintained much more precisely than is possible with a device locked to the supply mains. The advantages accruing from this tighter tone frequency control are:—

- 1) Receiver relay bandwidth may be reduced with consequent increase in sensitivity.
- 2) Increased relay sensitivity means that lower levels are required and hence lower injected power is required.
- 3) Reduced relay bandwidth also reduces sensitivity of relays to mains

borne interference, but this is counteracted to some extent by the use of a shorter pulse integrating time.

The Landis and Gyr system generally operates at injection frequencies less than 300Hz and usually injects at the 33kV or 66kV levels rather than 11kV.

INTERFERENCE

The value to the community of ripple frequency control cannot really be questioned, reducing as it does the

ultimate cost of power to the consumer. Unfortunately however, there are some disadvantages. Prime among these is interference with other equipment. Many complaints have been heard from Hi-Fi enthusiasts who have tried in vain to reduce ripple tone interference by improving amplifier dc filtering. Phase controlled equipment employing SCR's and TRIACs is also subject to interference.

Recently the patrons at an opera performance were startled by seeing the entire theatre and stage lighting flashing up to full brilliance a few times in the middle of a performance — the cause — ripple tone interference with phase controlled dimming equipment.

As was pointed out previously the normal injected level (at 1050Hz) is about 6 volts in NSW and we are told that in no case does it ever exceed 10 volts. This level is reasonable for reliable control relay operation and is claimed to be low enough not to cause any interference to other properly designed equipment. However, such interference *does* occur and both Zellweger and supply authorities claim that this is invariably due to inadequacies in the audio equipment rather than the ripple control equipment.

An International Committee was set up in Europe to establish suitable injection levels. The method of evaluation was as quoted in publication No. 1099 by Zellweger.

"The acceptable ripple control levels were arrived at by tests carried out on a number of electro-acoustic appliances of average standard. The volume controls of these were set to a position which, under normal operating conditions, corresponds to 50mW output. A ripple control signal of increasing voltage was then superimposed onto the supplying mains and the voltage of this signal measured at the point when the interference output of the appliance reached $0.25\mu\text{W}$. The acceptable ripple control levels were then set somewhat below the lowest values measured this way."

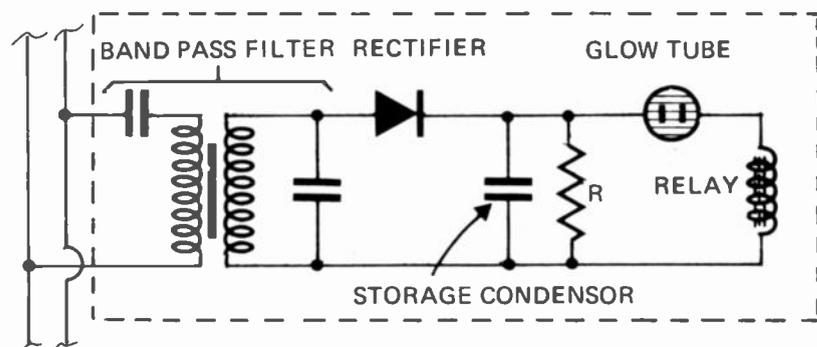


Fig. 8. Zellweger ripple control receiver schematic circuit.

RIPPLE CONTROL

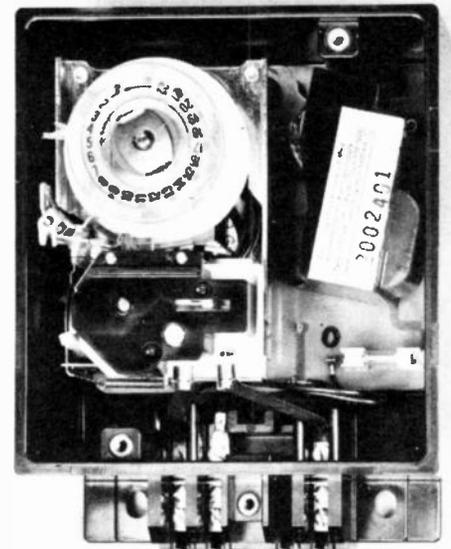


Fig. 9. (a) The Zeltweger ripple control, receiving relay as fitted to the consumer's switch board. (b) The same relay with the main and terminal terminal covers removed.

This corresponds to a level 53dB down from maximum power output, and at first sight would appear to be reasonable. However, most modern Hi-Fi amplifiers have hum and noise specifications of 60-70 dB down.

In the light of these specifications 53dB down is hardly a comparable noise level. In addition, an examination of Fletcher-Munson curves of subjective loudness shows that the ear at low power levels requires 45dB less power at 1000Hz, to produce the same subjective effect, as it does at 50Hz. In the case of ripple tones therefore a 1kHz tone at the same power level as the amplifier hum sounds very loud indeed and this effect is further aggravated by the pulsating nature of the tones.

We have therefore a conflict of interests. On the one hand the injection level cannot be lowered much further without affecting the reliability of the whole control system. On the other hand we have shown that the specification of maximum ripple frequency interference level is hardly adequate for modern Hi-Fi equipment.

The situation is rarely as bad as this however, the majority of Hi-Fi enthusiasts are not bothered by interference at all, and a further section are only bothered to a minor extent. But there have been instances of quite serious levels of interference which have been very difficult to reduce. Quite often, as mentioned

before, attempts to decrease this interference by improving power supply filtering have had no effect.

INTERFERENCE MODES

Interference may arise by means of magnetic coupling between adjacent mains wiring and audio signal wiring, electrostatic coupling, conductive coupling (due to common earth paths) and magnetic coupling between transformer flux and low level wiring. Interference is rarely due to inadequate power supply filtering.

In the case of magnetic coupling between adjacent cables, the only real cure is to provide adequate separation between them, which may entail repositioning of the equipment. Ordinary woven braid shielding has little effect and can only reduce magnetic coupling by about 1dB.

Electrostatic coupling is adequately reduced by the simplest shielding of cables and hence, the use of shielding on low level cables should be used as a matter of policy.

Conductive coupling is due to interference signal currents passing through the same earth sections as the audio signals. Such coupling may be reduced by returning all audio-signal-earths to a common point which is then attached to the main earth.

Magnetic coupling due to the field of the mains transformer will affect any earth loops which are formed. Therefore, as for conductive coupling, common earth points should be used as far as possible. The shields of low level cables should be earthed at one end only to avoid creating earth loops. In addition the free end of the braid should have all the individual conductors bonded together (but not earthed). Where wires are run in pairs, twisting them will also reduce pickup.

If the transformer is mounted on a

steel chassis, a non-magnetic plate should be fitted between the transformer and the chassis.

Finally a filter may be used on the input side of the mains transformer to reduce the ripple current passed through the transformer and hence reduce the possibility of magnetic coupling. A suitable circuit is as shown in Fig. 10. This circuit is suitable for equipment rated between 40 and 250 watts.

The 71mH choke should have a current rating of 1.6 amps and be wound on a 1.2 square inch core of Francor or Armco IV laminations. Wire gauge is 18 B & S and the capacitor is 4 μ F at 250 volt ac working.

To summarise, although the International Committee which established the injection levels was convinced that interference would not occur — in fact it does. The injection levels cannot be lowered without affecting ripple control systems reliability. Ripple control is obviously essential and in the future, perhaps even more signals will be imposed on the mains supply for various reasons.

It would seem, therefore, that audio equipment manufacturers will have to upgrade their equipment to provide increased rejection of mains borne interference and this must be accepted as one of the facts of life.

The whole subject of interference is being very seriously tackled by Universities, The Electricity Commission, PMG, ABC and the Standards Association in conjunction with similar bodies overseas. Ripple control is only one small factor in a large and ever growing problem of electro-magnetic pollution. The constructive and co-operative efforts of all involved are needed to ensure that such pollution is minimised as far as possible whilst still making the best use of our advancing technology. ●

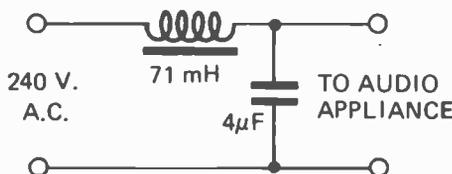
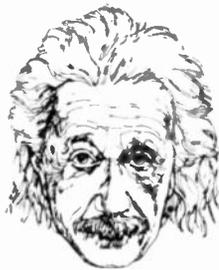


Fig. 10. Filter suitable for reducing ripple interference with audio equipment having input power of 40-250 watts.



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PART 3

TRANSDUCERS IN MEASUREMENT AND CONTROL

In this, the third article in this continuing series, Peter Sydenham, M.E., Ph.D., M. Inst.M.C., describes automatic angle measurements.

SO far in this series we have covered how lengths, ranging from microscopic to macroscopic, can be transduced into electronic signals using electrical, mechanical and optical techniques. We have discussed this parameter

thoroughly because length is a fundamental parameter often leading indirectly to the measurement of other secondary variables. In fact it has been said that some 85% of all measurements involve length.

Another very common transducer

group includes devices that convert rotation into the common electronic language with which technical systems are interconnected. Angle transducers go under a variety of names — the terms, resolvers, encoders, angle transducers, rotary transducers, digitisers, shaft position indicators and synchros, all are used depending upon the principle employed. Often the names are applied synonymously — and incorrectly.

Angle is dimensionless. It is defined as subdivision of a circle, in a number of ways. Commonly used units are the degree and the radian. There are 360 degrees in a circle (and 2π radians). The latter comes about by defining radian measure as the ratio of the arc length to radius for a segment of a circle. Radians are easily used when small angles are involved for they approximately express the deviation per unit distance, for example, a milliradian is a divergence of 1 part in 1000. There is another system, used extensively in Europe, which has 400 divisions, called grades, in a full circle. This gives a convenient 100 grades per quadrant. Grades are subdivided into centigrades and centi-centi-grades, i.e., subdivided in hundreds compared with sixties in the degree-minute-second system.

As angle is dimensionless, it is defined completely by a mathematical expression. No physical standards are needed from a theoretical viewpoint. (Compare this with length for instance, which uses quite arbitrary units, chosen by man to suit his convenience). However, it is more practicable to maintain angular standards in the form of divided circles, angle gauges and optically-worked multi-sided polygons made of metal or glass. A commercial

Calibration of precision turntable at Moore Special Tool Co, USA.



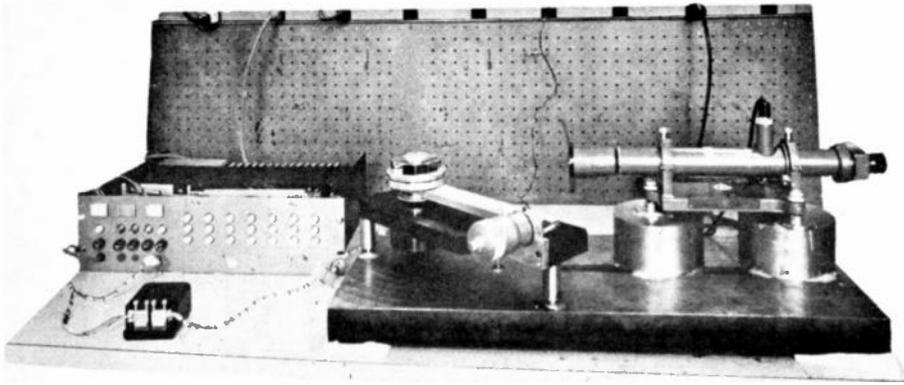


Fig. 1. Test set up used by Data Technology. The resolver is mounted underneath the plate holding the micrometer. On top is a standard angle polygon which enables the resolver to be rotated in exactly known angular steps. The autocollimator, on the right is used to set the rotation by an optical lever action on the polished flats of the polygon.

test set is shown in Figure 1 where a polygon is being used to check a resolver system.

As angle is defined in terms of two lengths, and it is clear that angle transducers generally use devices that measure displacements by fixing one length and measuring the other as it varies. There is, however, one important difference, for angular transducers can use mechanical components of rotation that can be manufactured more precisely than linear components for equal costs. This enables closer tolerances to be maintained between two measuring surfaces. Also it enables the simple incorporation of both spatial and time averaging to improve the precision of the device. These features will become clearer later.

As with length measurement, there is a distinct difference between the technique that may be used to measure small angles of less than say a few degrees and those required to cover greater angular excursions. A broad assumption is that the smaller the angle to be measured the higher the precision that can be obtained. At one end of the scale are devices capable of measuring 10^{-10} radians over a range of 10^{-6} radians (about an arc second). At the other are devices capable of arc second resolution with a continuous full circle range.

So much for a general background to angle measurements. Let us now consider the techniques that have proven practicable.

SMALL RANGE ANGLE TRANSDUCERS

The most obvious means by which a small angle can be monitored is to measure the linear displacement of the free end of a hinged arm of fixed length using one of the length

transducers described earlier in this series. This concept has been used in the force-balance principle, see Figure 2, used mainly in process control and weighing balances. In this a beam is hinged in the centre. The force to be measured is applied at one end of the see-saw beam. At the other end is a magnetic solenoid to which variable current is applied in order to balance the unknown force. The current in the coil at balance is then a measure of the applied force.

The beam is considered balanced when it is at reference position. To establish when balance is achieved, the small rotations of the beam must be

Fig. 2. The principle of the force balance.

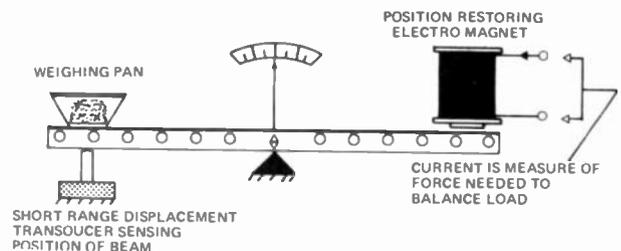
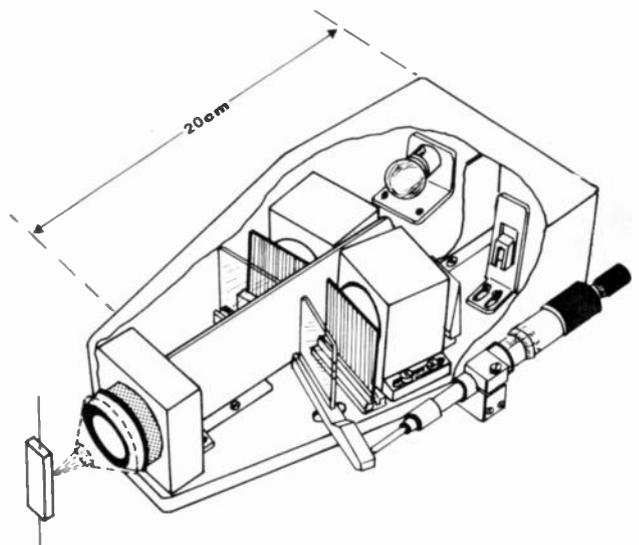


Fig. 3. Construction of the 'Jones' optical lever. Two grids are used as bar-space gratings to enhance the sensitivity. The micrometer rotates the optical parallel plate to displace the beam for fine adjustment.



transduced. Virtually all fine displacement techniques have been used to monitor the displacement of the beam, ranging from simple on-off contacts to devices providing a proportional output.

In some applications, such as torsion balance and galvanometer readouts, it is not permissible to load the driving force with a relatively massive lever that would be needed to operate a transducer. In these cases the optical-lever comes into its own.

The optical-lever is generally attributed to Poggendorf who described it in the literature in 1826. No doubt it was used even before that. In the days before electronics, that is before this century, the optical-lever was the only sensitive way to sense small angular movements and displacements. The principle is simple. A source of light, collimated to a near-parallel beam, is reflected from a mirror surface mounted longitudinally on the axis of rotation to be monitored. In the purely mechanical use of the lever the reflected beam impinges on the rear of a transparent graduated scale. The sensitivity of the method derives from the optical phenomena of angle-doubling at the mirror and from the ability to place the limited-resolution graduated scale at a considerable distance from the mirror.

In most modern applications, however, the aim is to provide an electrical recording readout and keep the size of the angle transducer down to small dimensions. In 1920, Wilson

TRANSDUCERS IN MEASUREMENT AND CONTROL

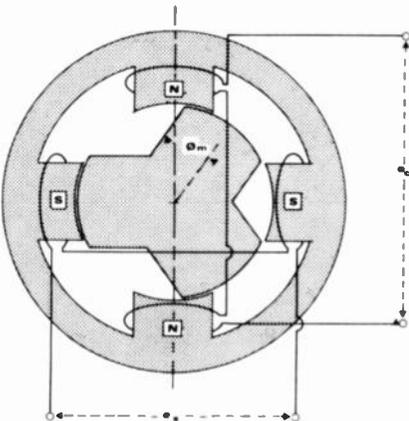
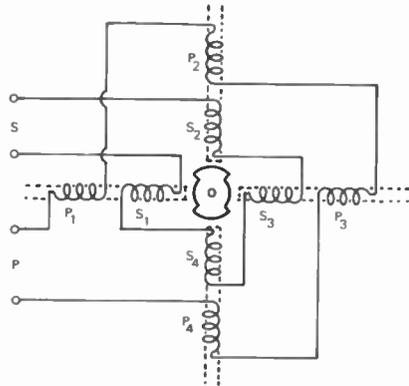
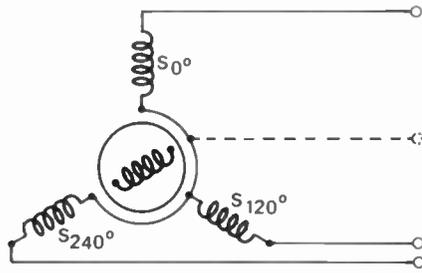


Fig. 4. Inductive rotary transmitters. a. The Synchro b. Reluctance resolver c. Vernier resolver (excitation windings are also on each pole).

and Epps proposed that two thermopiles be used to detect the position of the light spot instead of relying on the relatively poor resolution of the eye. (Thermopiles are a bank of thermoelectric elements cascaded in series to form a sensitive heat-sensing device). If the two thermopiles are connected in opposition, the resultant current flow would be a measure of the spot position upon them. Such a system was soon constructed and the first ultra-sensitive angle sensor was created. It was so sensitive, in fact, that it could detect the Brownian

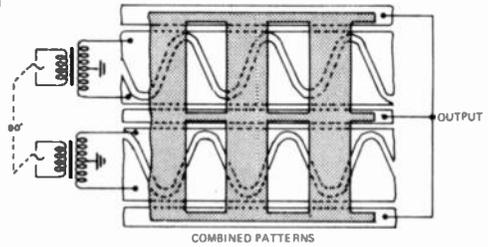
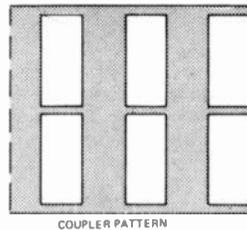
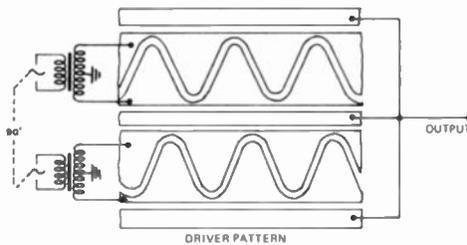


Fig. 5. Section of metallic pattern photo etched on glass supporting disk. The coupler pattern runs close to, but not touching the driver pattern, forming a capacitive bridge network.

movement of the mirror suspension. Then came photo-electric cells which were able to detect much smaller quantities of light energy. A great exponent and developer of the optical lever is Professor Jones and his colleagues of Scotland's Aberdeen University. They have built extremely elegant lever systems that can detect angular excursions of around 10^{-10} radians. One of these is shown in Figure 3. With these, Professor Jones has studied many interesting physical phenomena, including measurement of the radiation pressure of a liquid at atmospheric pressure (this is much harder than measuring it in a vacuum), determination of the length changes of an X-ray irradiated lithium-fluoride crystal, observation of an I-R energy level of 10^{-11} W, and verification that a light beam is not slowed by a magnetic field. The latter has been done to an extraordinary degree of precision. Most recently Professor Jones has used the optical lever to verify the Fresnel drag effect, (predicted by Fresnel many years ago).

Not all applications need such exacting stability and precision, so most optical levers are no more than a lamp, a collimating lens with spot aperture built in, a mirror, and a dual photo-cell position-sensitive detector. This simple arrangement has been used to provide electrical readout from a bourdon-tube microbarograph, from sensitive galvanometers, recording autocollimators (used in industry for alignment - to be described in our next article) and in sensitive microbalances, in other words, in applications where the angular excursion is small and the driving force cannot tolerate any load being imposed upon it by the transducer. The main disadvantage of the optical lever is that the light-source generates

a considerable amount of heat and this may cause error due to thermal expansion effects. The ever-reducing price of continuous wave laser sources (now down to \$180 for units suited to this work) makes them attractive, for the beam is as well collimated as would normally be required. A divergence of 1 mrad is typical.

Alignment devices for measuring deviation from a straight line involve the measurement of small angles. This class of transducers, however, deserve an article to themselves as they are extensively developed. The reader is, therefore, referred to the next article for many details of small angle measurement over long distances.

LARGE RANGES

It can be seen that the use of optical lever (or microdisplacement transducer) angle measurements cannot cover more than a few degrees of rotation unless mechanical angle amplifiers (gears, belts, friction wheels) are used. Other methods, therefore, have been devised to cope with larger excursions.

Early this century, divided circular scales could be made to a precision of better than one arc second. Geodetic-grade theodolites have glass scales of 100 mm diameter. These can be read to around 0.1 arc second (that is, the circle is divisible into 12,960,000 parts!) using a reasonably simple optical viewing system.

The majority of wide-range angle transducers can be grouped into those having mechanical movement no faster than their input slewing rate, and those in which continuous rotation at a speed higher than the slewing rate has been deliberately added. The reason for the latter will become clearer as we proceed. For simplicity these will be referred to as static and active systems.



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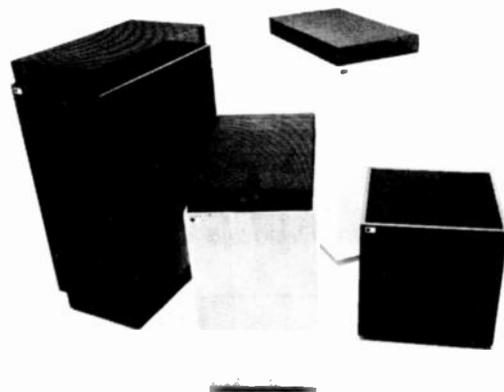
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TRANSDUCERS IN MEASUREMENT AND CONTROL

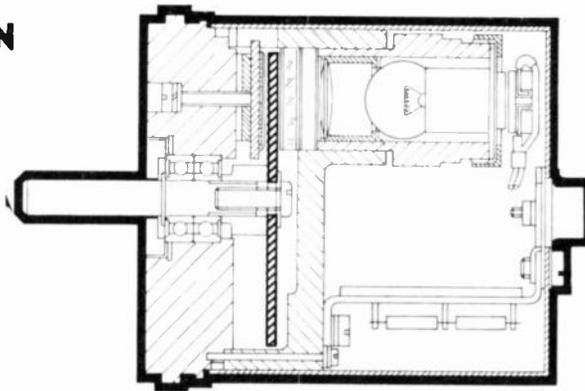


Fig. 6. Cross sectional view of optical shaft encoder.

RESISTANCE POTENTIOMETERS

Large-range angle is very simply measured with rotary potentiometers provided the contact friction and wear disadvantages can be tolerated. But it is difficult to produce a full 360°, continuously rotatable unit, as the wiper shorts the start and finish of the resistance track unless a dead zone is used. On top of this problem is the very rapid change of signal level at the end. Multiturn units are used if the order of a few complete rotations is needed but these cannot cater for infinite rotation.

The problem can be overcome by using a complete circle resistance track in which the end is joined to the start. If a supply is connected at diametrically opposite points, the track forms a bridge network. A single wiper will produce a signal varying from positive to negative without any abrupt signal level change. It is necessary, however, to add a system that can recognize which half the slider is on, for there are two positions giving the same output.

INDUCTIVE AND CAPACITIVE STATIC METHODS

A similar technique can be used with a toroidal transformer but again brushes are needed. Avoiding the need for sliding contacts leads logically to the inductive synchro (also known as a magstrip transmitter). Inductive resolvers are in this class being only slightly different in construction. The synchro consists of an armature made to be a simple rotating bar magnet which is fed with ac alternating current — via slip rings — see Figure 4a. The stator houses three, equally phase-shifted identical windings, similar to those found in a three phase induction motor. The ac excitation in the armature induces voltages in each of the rotor windings which are phase shifted with respect to each other. At any given position the amplitudes of the outputs from the stator are unique. Position is thus defined in an absolute sense. By feeding these signals

to a similar synchro receiver the position can be reproduced remotely (hence the name transmitter). This method still uses brushes but these are not in the measurement circuit. They are there to provide high-level ac energy to the system. Better quality synchros can resolve around 1 minute of arc — this is adequate for many tasks. To obtain greater precision, accurate gear trains may be used, and the designer has to decide whether a synchro combined with expensive gears is a better economic choice than the use of more sensitive direct methods. If the object whose rotation is to be measured is large, for instance a steerable radio telescope, the physical size of the transducer is of no importance and gears or a large diameter resolver can be employed. If a small size is essential then tea-cup size devices are needed. The need for brushes is avoided if excitation is provided by windings placed on the stator pole-pieces using the rotor to vary the reluctance and thus vary induced voltages, (as shown in Figure 4b).

Before leaving the synchro it is worth mentioning a development in 1956 which uses the variable reluctance transmitter combined with the Vernier principle. The latter effect (named after Pierre Vernier who lived at the turn of the 17th century) is a way to subdivide the minor divisions of a scale using a similar sized scale but having, say, 10 divisions when the main scale has 9. Whatever the position of the Vernier scale there will be one line upon it that is aligned with the main scale division. The Vernier scale line in coincidence gives the subdivision of the scale interval. In the Vernier resolver, shown diagrammatically in Figure 4c, the ac-fed armature has one less pole than there are stator poles. Processing of stator outputs enables the position within each electrical cycle to be resolved more finely than with a standard synchro. In units built with 33 rotor teeth a repeatability of ± 3 arc seconds was obtained.

One feature that gives the Vernier resolver high precision is that the

output signals are formed as the average of inductive coupling between many iron circuits around the multipole core. This is a powerful measurement principle and is termed spatial averaging. It also relaxes the centering tolerances needed for a given angular accuracy. Being an ac method, a measurement is available with each cycle of the driving frequency. In this case the system uses 400Hz. If the time response can be lengthened, the output can be time-averaged to gain further improvement again. A general law of errors states that such averaging processes (if they involve random errors) improve the precision as the square root of number of measurements involved, so in this case a hundred-fold improvement is theoretically possible for a 1Hz bandwidth and 30 odd poles.

Whereas time-averaging can be incorporated into linear transducer systems, complete spatial averaging over the whole measurement device usually cannot. For this reason angle-transducers can be quite small for a given performance. But more of this when active methods are discussed.

It can be readily seen that the more poles there are, the finer the resolution, so in cases where space permits, a circular form of the linear inductosyn (mentioned last month) can be used in which radial, rather than linear, fixed plated windings are inductively coupled with a rotating pickup plate. Radial systems have the distinctive advantage that they can be manufactured cheaply by contact photo-mechanical methods whereas cylindrical devices must be individually machined when high resolution is needed.

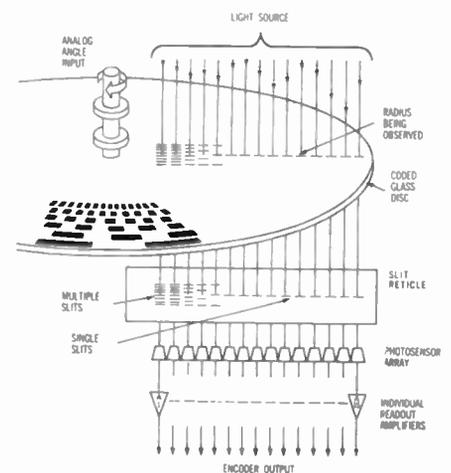


Fig. 7. The multiple slit optical encoder system used by Computer Control Company.

TRANSDUCERS IN MEASUREMENT AND CONTROL

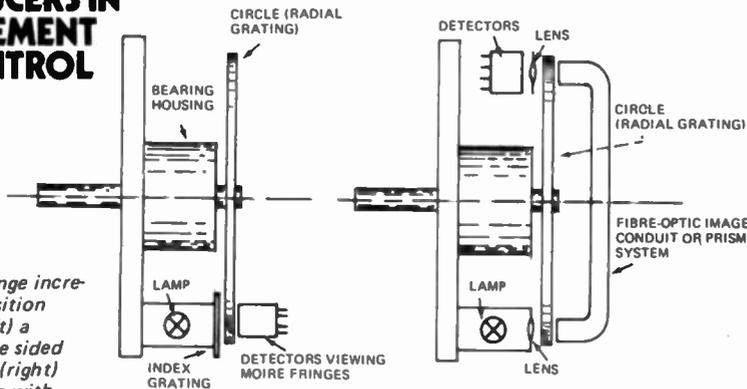


Fig. 8. Moiré fringe incremental shaft position transducers. (left) a conventional one-sided reading system. (right) optical averaging with transferred image.

Virtually all that has been said for inductive systems can be applied to capacitive coupling but, in the main, only the pancake radial method has been adopted for continuous rotation measurement. Figure 5 shows the construction of this.

STATIC METHOD – OPTICAL

Although the earliest angle measuring machine was the divided scale, it was not automated until the late 1950s. As inductive synchros could not provide arc second resolution at that time, attempts were made to read ruled scales automatically.

Mechanical contacts were far too large so it was logical to use optical sensing as this was the method by which the then available scales were read. At that time there was also a growing need for digital computers. One difficulty encountered with the design of fine resolution optical absolute-encoded binary disk systems (similar to the absolute digital length scale mentioned last month) is that the apertures of the lower significant-digit tracks are extremely fine, thus restricting the amount of light transmitted. A cross sectional view of a low cost encoder is given in Figure 6. Although expensive, absolute encoders are now available with around one arc second resolution. In these, discharge

flash lamps are used to illuminate photo-diodes positioned on the opposite side in order to read the code. One unit, shown in Figure 7, uses multiple slits to ease the illumination difficulty. It is, however, far easier to make a 21 bit encoder in rotary form than it is to produce satisfactorily in linear form as the disk can be made to rotate with adequately constant clearance more simply than in the latter case.

It is also quite practicable to use the linear moiré-fringe principle, originally devised as a length measuring method, in a rotary form. Numerous moiré-fringe shaft digitizers are available commercially. The optical gratings have radial lines produced around a disk by photographic or photomechanical methods. Full circle radial gratings having over 30,000 lines have been made, the main institutions responsible for their development being the National Physical Laboratory (NPL) and the National Engineering Laboratory (NEL) in Britain. The absolute grating method, using incremental gratings, is also available in rotary form (see last month's issue for illustration).

In the moiré fringe method, (Figure 8a), counting is necessary to determine angular movement, and hybrid systems have been marketed using

phase-analogue subdivision of relatively coarse gratings. The National Electrical Manufacturers Association of America (NEMA) has standardised the name of these and other incremented methods, as rotary incremental digital position transducers (RIDPT for short).

Theodolite scales are read to the highest precision by viewing diametrically opposite values simultaneously. This averages the bearing centering error. The idea has been used in some moiré-fringe resolvers by forming fringes at one radial position of the disk using the other side of the disk as an index grating. A coherent fibre-optic bundle, Figure 8b, or a prism system, transfers the image. Still further improvement is possible if the signals from four reading heads placed at 90° around the grating are averaged and this has been attempted at the NEL.

MECHANICALLY ACTIVE SYSTEMS

Taking it to the limit, the ideal therefore, is to have an infinite number of reading heads placed around the grating to produce complete spatial averaging. Practical limits are set on this idea by the accuracy of the grating lines, for spatial grating errors must lie within certain limits if the signals are to be useful in practice. Bearing eccentricity also enters the picture, for slop or out of roundness of the bearing support system will allow the main grating to move, radically changing the shape and pitch of moiré fringes quite considerably. This can be overcome by adding a continuous rotation to the system, a method that evolved first as a capacitive device.

In 1957 Richard Webb of the U.S.A., filed a patent application for a then quite unusual angle encoder. The device is shown diagrammatically in Fig. 9. A reasonably constant speed motor drives two toothed rotors each

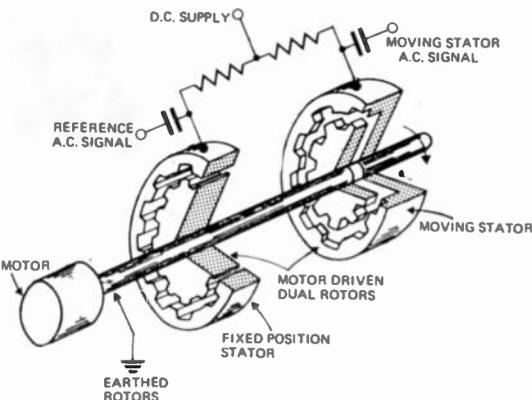


Fig. 9. The capacitive dual generator angle transducer (United Aircraft Corporation).

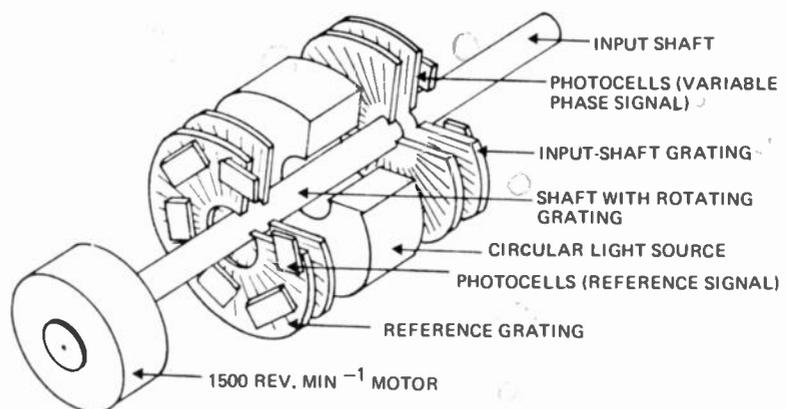


Fig. 10. Optical equivalent of capacitive system in Figure 9.

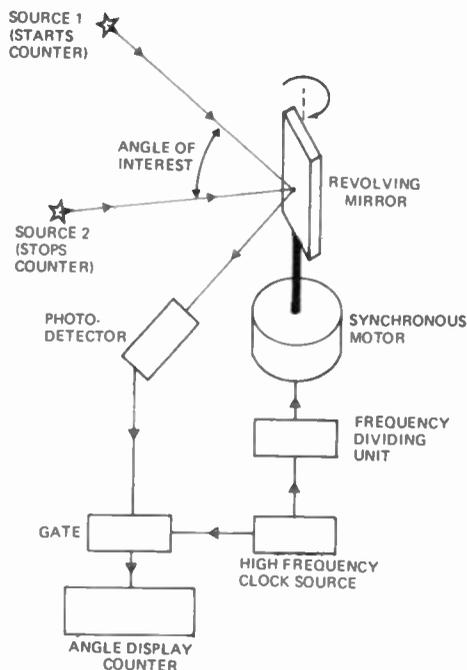


Fig. 11. Chronometric method of measuring angle.

spinning inside toothed stators. One stator is fixed, the other rotates as it is connected to the input shaft whose rotation is to be measured. As the stators turn, the capacitances between the electrically insulated stators and the grounded rotors vary. This is used to produce two ac output signals. If the input-shaft rotor is rotated with respect to the fixed one, the phase of its generated signal varies with respect to the other. Hence the phase difference between the two signals is proportional to the extent of rotation within one pitch of the stator teeth. This is in reality the phase-analogue technique and to complete the system, a coarse angle resolver is needed to form a complete hybrid arrangement.

The original device containing both fine and coarse resolvers was only two inches in diameter — but a rack of electronics was needed to interpret the device. To obtain direct degree readout, 360 teeth were cut. As each cycle could be subdivided into 1000 parts by electrical phase methods the transducer could resolve 3.6 arc seconds. The rotors were spun at 900 rpm. This method, therefore, incorporates both spatial and time averaging to advantage. The principle was subsequently used with inductive coupling and the makers of one device claimed 0.1 arc second resolution from a unit 5 inches in diameter.

It was obvious that an optical equivalent existed to these, and in 1967 an experimental unit using rotating radial gratings was made (Fig. 10). This crude unit used low quality 360 line gratings made on plastic sheet. The accuracy of subdivision over one degree of rotation was tested

and found to be ten times better than the known errors of the grating, thus showing the power of incorporating averaging. The advantage of the optical form is that optical gratings can be used with a far higher density of lines than magnetic or capacitive as the light rays are not as subject to fringing errors when coupling the two grids. Secondly, optical gratings have been extensively developed and are available with 1 arc second accuracy in 2 inch disks. Finally, but by no means the least factor, radial gratings can be copied inexpensively (as has been mentioned above). It seems that a well made optical dual-modulator angle transducer might realise 0.01 arc second accuracy using normal precision ball bearings instead of needing the hydrostatic systems that have been used in extreme precision experiments.

CHRONOMETRIC METHODS

Another interesting method for converting angular rotation into electrical signals is known as the chronometric method by which angle is transformed into time.

Consider a shaft being driven by a synchronous motor which is energized by a divided-down higher clock frequency (as shown in Fig. 11). If on the shaft is a trigger mechanism that responds to stationary objects (these could be two distant signal lights placed at different locations and for which the subtended angle is needed), then this trigger can be used to gate the clock source into a counter. As the speed is synchronously related to time the angle can be determined in terms of time, to high accuracy. Time averaging could be added if the system were driven fast enough.

This chronometric system is akin to another angle dividing and measuring system. A magnetic wheel is driven with a synchronous motor and the periphery of the wheel is magnetized from the same ac signal forming magnetic zones around the wheel which are exact integers of the circumference. It is then used to measure position using sensing heads.

The full potential of chronometric method has not been realised. Nano-second rise-time signals are now commonplace and a shaft driven at 600 rpm could probably be resolved into 10^8 parts — but that remains to be seen.

INTERFEROMETRIC METHODS

Interferometers can resolve extremely small distances and yet have an enormous range. Attempts have been made to measure angles with interferometers and one device capable of 0.01 arc second resolution over a

30° arc has been described. A schematic of this method is given in Fig. 12. A light source, such as a spectral lamp or laser, is used to illuminate the interferometer. As the reflecting corner cubes rotate together, the relative lengths of the two arms change and the fringes move.

Another recently devised laser method that shows promise is the ring laser. Instead of the laser having the usual linear cavity made between two end mirrors, it has a 'ring' cavity. The simplest approximation to the ideal ring is a triangular system. One feature of the cavity is that it can support independent oscillations in both the clockwise and anticlockwise directions. If the ring is rotated about an axis perpendicular to its plane, the two oscillations vary in frequency and upon square-law device-mixing a beat-frequency is produced that is dependant upon the velocity of rotation. The ring laser has been developed mainly for gyroscope applications but an angle transducer version is possible if use is made of this velocity signal output. One advantage of the method is that the centre of rotation is left clear and the ring can be built around a central object.

Next month we will consider ways to transduce a level line of sight or a vertical plumb-line and how to determine alignment along a line. It will then be possible to discuss how we combine these with angle and length transducers in order to determine position on a plane or in a three dimensional space. ●

FURTHER READING

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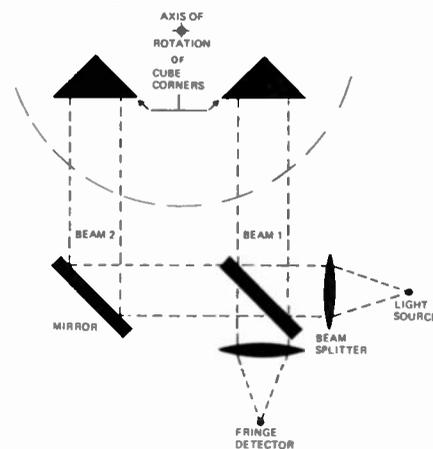


Fig. 12. Differential-length angle measuring interferometer.

ALL ABOUT 4-CHANNEL SOUND

THE JVC CD-4 QUADRIPHONIC SYSTEM

electronics
TODAY
INTERNATIONAL
product test

JVC Nivico's four-channel system provides true four-channel sound.



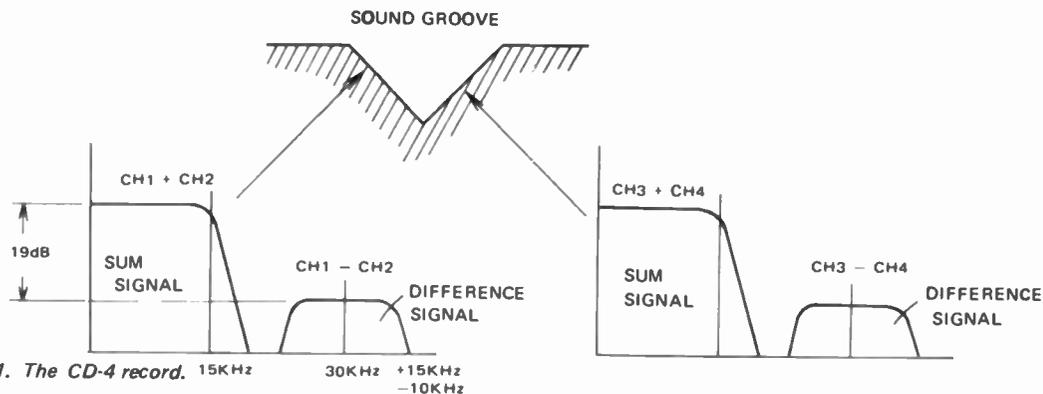


Fig. 1. The CD-4 record.

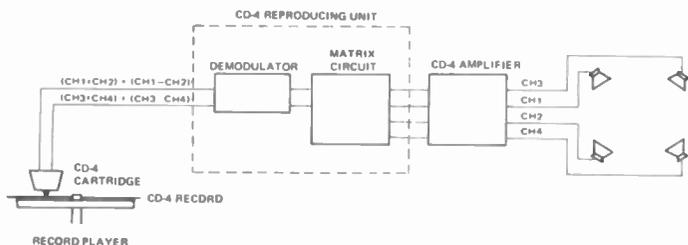


Fig. 2. How the signal is reproduced.

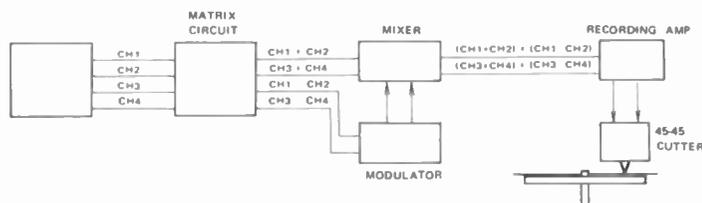


Fig. 3. The recording process.

UNLIKE the various matrix techniques, JVC's CD4 is a true four-channel system.

The record groove walls are each at 45° angles to the vertical, but, instead of one signal being recorded on each groove wall, there are two — in the form of a sum and difference signal.

One groove has the right-front plus right-rear signal together with the right-front minus the right-rear signal. The other groove contains the left-front plus the left-rear signal together with the difference signal for those channels.

Basically the system records the *sum* signals in the normal manner, whilst the *difference* signals are modulated on a 30 kHz carrier using narrow-band frequency modulation (ie — a modulation index of approximately 0.5). The difference signal is of course completely inaudible because its lowest frequency deviations lie well above the audible frequency range, (Fig. 1) To convert the signal into four usable channels a complex demodulator unit is inserted between the two output channels of the record player cartridge and the four channel amplifier, (Fig. 2).

THE RECORDING PROCESS

The recording process used for the CD4 records is rather interesting. Firstly, four-channel signals are converted into sum signals and difference signals through matrix circuits.

The sum signals are recorded in the



same way as in a conventional two-channel record, while the difference signals are modulated (the carrier frequency is 30 kHz) and then added to the sum signals.

With regard to the difference signal, the ranges *lower* than 80 Hz and higher than 6 kHz are frequency modulated (FM) and the range *between* 800 Hz and 6 kHz is phase modulated (PM).

To enable the record master to be cut calls for a considerable amount of ingenuity. Firstly, most record cutter heads such as the Neumann 5 X 68 have a frequency response with the following (typical) linearity characteristics:—

- 40Hz to 16kHz ± 1dB.
- and is typically — 20 decibels at 8Hz and —4dB at 20kHz.

To maintain the linearity, or signal to noise ratio, above 16kHz is extremely difficult because of the equalisation problems in the cutter head feedback amplifier. To overcome these problems the CD4 disc is cut at the unusual rotational speed of 1/2.7 times the normal speed of 33-1/3 rpm. By this means the frequency range is reduced from 30Hz to 48kHz down to a far more tractable 11Hz to 16kHz using a system such as is shown in Figure 3. Apart from the possible vagaries in the range 11Hz to 30Hz (ie. true frequency 30Hz to 80Hz) the technique is in every way compatible with the normal cutter head characteristics.

In order to provide for the requirements and limitations of modulated side band components

THE JVC CD-4 QUADRIPHONIC SYSTEM

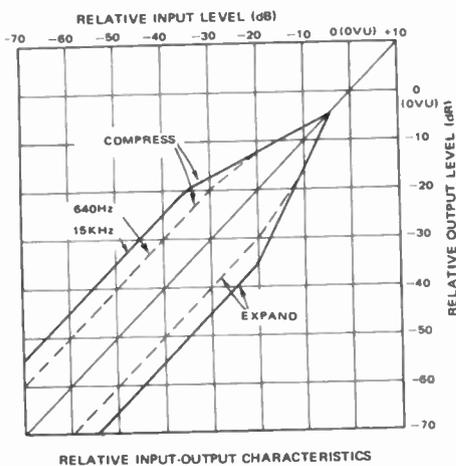
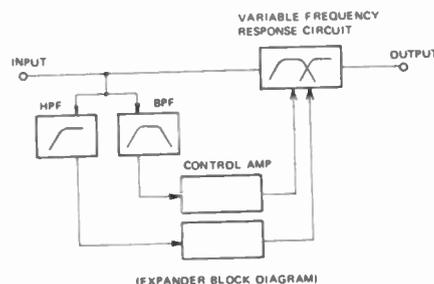
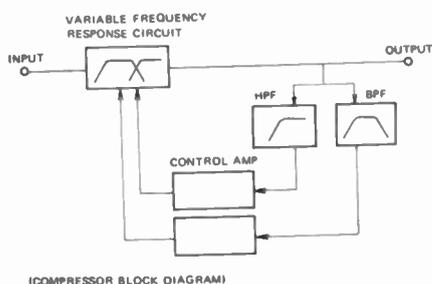


Fig. 4. Characteristics of record/replay compander.

above 30kHz, JVC had to undertake a massive research programme.

Primarily the aims were:—

Firstly, to reduce stylus velocity for the frequency components above 20kHz. This was necessary because stylus and record groove surfaces could not tolerate high velocities or accelerations without groove damage, or degradation of the linearity characteristics of the system. JVC's solution to this problem was to use a compressor/expander (compander) in the record/replay process. (Fig. 4). The compressor is used at the time of recording, whilst the expander is



incorporated within the replay demodulator unit.

Apart from the use of a compander, the level of the modulated 30kHz carrier is kept at least 20dB below the level of the primary sum signal components in the range 30Hz to 16kHz. This significantly reduces the peak velocities that the stylus has to follow during the replay.

Secondly, the vinyl materials used for the current generation of stereo records were too soft for the quadriphonic format. The JVC/RCA solution to this problem was the use of a harder vinyl.

This new material will be used for the range of RCA quadriphonic records to be released in the USA in May this year.

Thirdly, and possibly the most difficult problem, was the inability of standard stylus configurations to cope with the extended frequency range required for this system. Here the answer was the Shibata stylus which provides excellent frequency performance and good interchannel cross-talk characteristics when used

with the CD4 records. As the Bruel & Kjaer recordings — reproduced in Figs. 5 and 6 clearly show, the response of this cartridge is very flat from 20Hz to 15kHz and apart from a resonant rise at 24 kHz it is then essentially flat right up to 46kHz. The rising response of the cartridge in the ultrasonic region in no way detracts from the performance, and the trackability of the cartridge at the ultrasonic frequencies is apparently dependant on the Shibata stylus.

Other merits claimed for the Shibata stylus are very low stylus tip wear, better signal to noise ratio resulting from lower groove deformation, and lower phase distortion because of the improved shaping of the stylus tip. Surprisingly the Shibata stylus is claimed to be easier to produce in volume than an equivalent elliptical stylus.

HOW IT PERFORMED

The JVC company have produced an extensive range of four-channel equipment that can be used with their four-channel discs. For our subjective appraisal we selected the following:—

- JVC Nivico stereo player type SRP 473E fitted with a Shibata cartridge.
- Model CD4 — 1 Disc demodulator.
- Model MCA-V5E four-channel amplifier.
- Advent speakers — four matched units.

Unfortunately we were only supplied with one record — this was JVC's 4-Channel Sound Demonstration No. 1, 4-D-101 and as with so much currently available quadriphonic material this record is rather gimmicky. Nevertheless the record clearly showed the need for careful positioning of loudspeakers (and listeners) if a fully balanced four-channel effect is desired.

The JVC four-channel amplifier is supplied with a delightful joystick control that provides full level and balancing control simultaneously for all four channels. While this may at first appear to be a gimmick, it is, none the less worthwhile. In fact,





Measuring Obj.:
FREQUENCY
RESPONSE
OF J.V.C.
NIVICO
4 CHANNEL
CARTRIDGE
DIFFERENCE
BETWEEN
UPPER AND
LOWER CURVE
IS CHANNEL
SEPARATION

1 decibel
per division
Rec. No.:
Date: 5/4/72
Sign.: _____

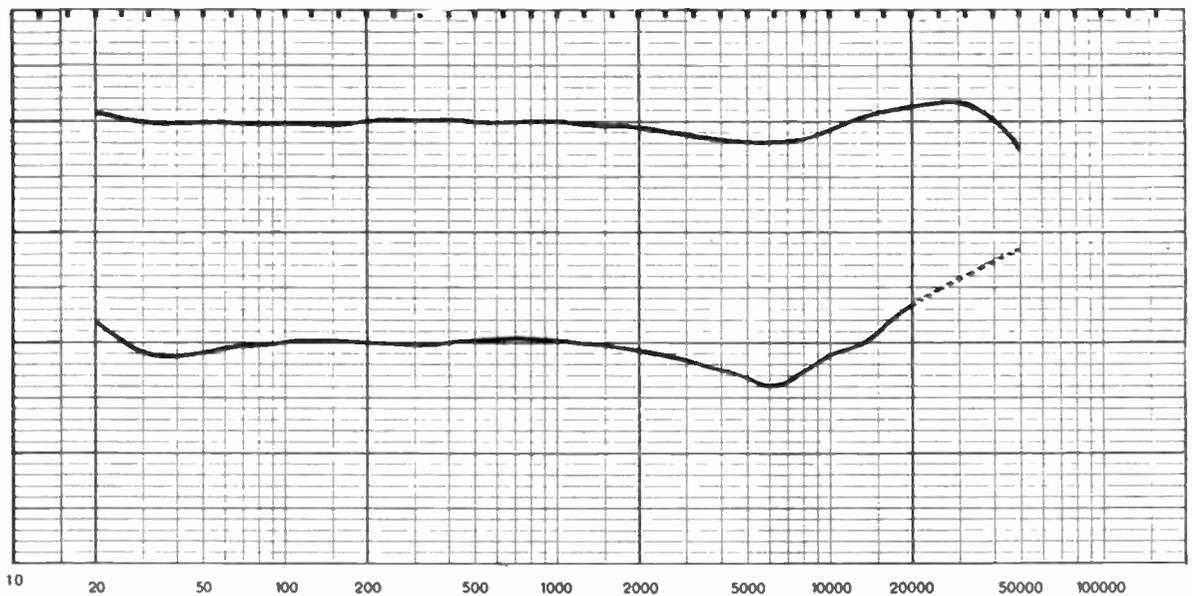


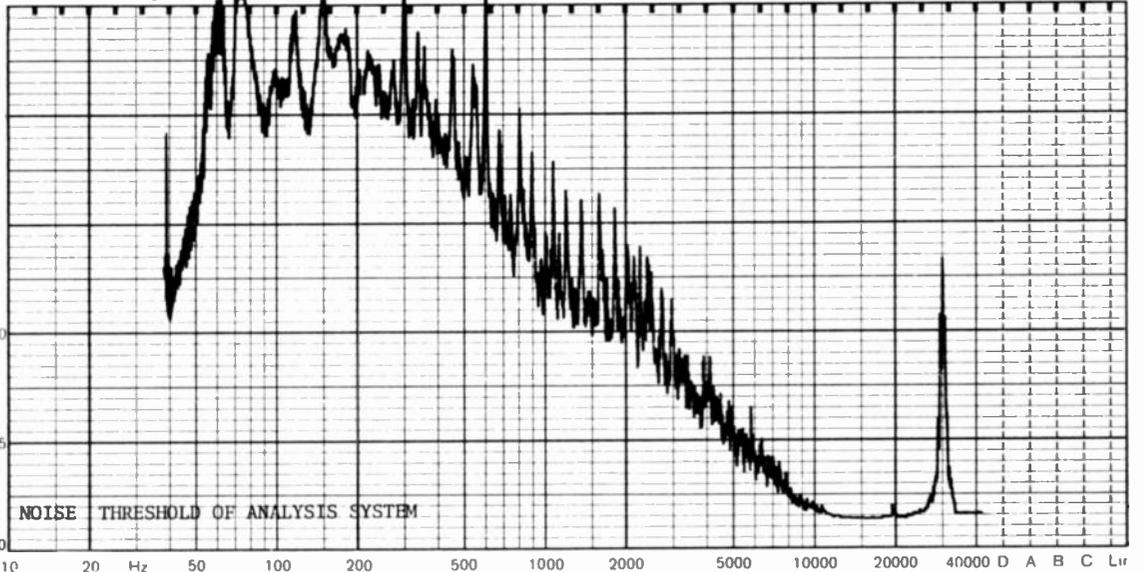
Fig. 5.

Fig. 6.



Measuring Obj.:
UNEQUALISED
SPECTRAL
CONTENT OF
15 SECOND
MUSIC
SAMPLE ON
J.V.C. CD4
RECORD
USING A
6.3 Hz
FILTER
BANDWIDTH

Rec. No.:
Date 5/4/72
Sign.: _____



without it, balancing the system would be very difficult.

The CD4-1E demodulator has a number of interesting features. One of the most valuable of these is a control that varies the front to back separation ratio. This is particularly useful for 'aged' records where it facilitates a reduction of the rear channel content (which tends to deteriorate with surface wear).

Performance of the amplifier was good and its frequency response and distortion was completely adequate for both four-channel discs and four-channel tapes.

CONCLUSIONS

Although our programme material was limited, our subjective impression is that the CD4 system is viable and compatible with standard stereo material. A switch is provided on the decoder to select either two or four channel material. If one tries to play a

normal two-channel stereo record with the switch in the incorrect position the results are most strange as the demodulator responds to surface noise in the 30kHz region and switches the signal between the four speakers more or less at random.

To describe how the system really sounded is akin to describing how a concert sounded to someone who was not there, but let it suffice to say that the quality of envelopment and realism, provided the speaker systems are good, is far better than can be achieved by a good two-channel stereo system. The feeling of being centrally placed in the concert hall is achieved, as is the feeling of realism in the music.

At the present time the CD4 quadriphonic system is the only disc system that is capable of providing discrete true four-channel sound. Whether this will be sufficient to guarantee its success when one

considers the cost of the equipment, the complexity, and - the strong promotion of the competing systems it is too early to say. However, we do believe that this system, or a very similar one, will be the eventual standard for four-channel discs. ●

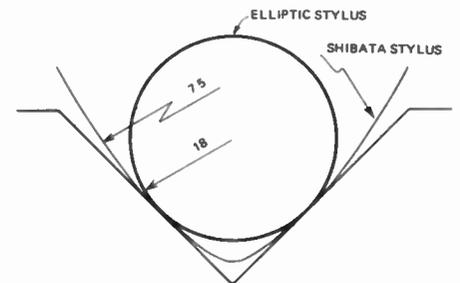


Fig. 7. The Shibata stylus - note the difference in contact area between the Shibata stylus and the elliptical stylus.

ALL ABOUT 4-CHANNEL SOUND

Brüel & Kjaer

Potentiometer Range: 50 dB Rectifier: RMS Lower Lim. Freq.: 20 Hz Wr. Speed: 315 mm/sec. Paper Speed: 3 mm/se

Copenhagen



Measuring Obj.:
FREQUENCY
RESPONSE OF
CLARION
4 CHANNEL
CARTRIDGE
PLAYER
MOUNTED IN
PEUGOT 504
SEDAN
1/2" Pressure
Microphone
at head
height on
driver's
seat

Rec. No.:
Date: 6.3.1972
Signal: *AG*

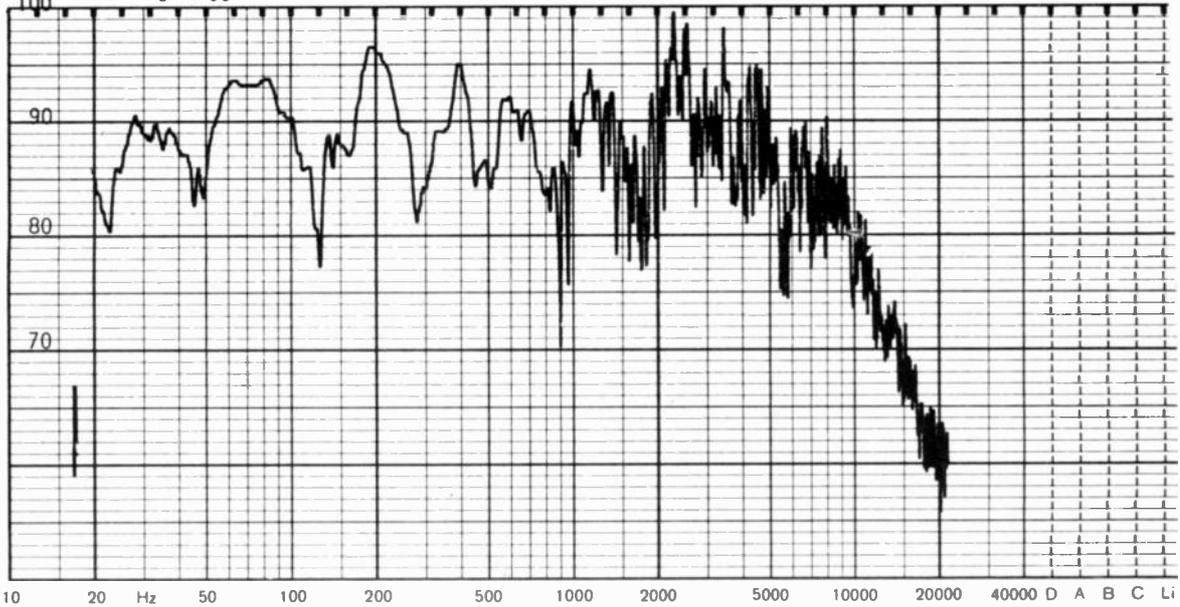


FIG. 1

FOUR-CHANNEL

electronics
TODAY
INTERNATIONAL
product test

The \$195 (plus fitting) Clarion unit was supplied to us for testing by United Car Radios, 152 Commercial Road, Prahran, Victoria.

It is little more than a year since the first four-channel or 'quadriphonic' tape recorders became commercially available, and changed what had been an interesting theory into practical reality.

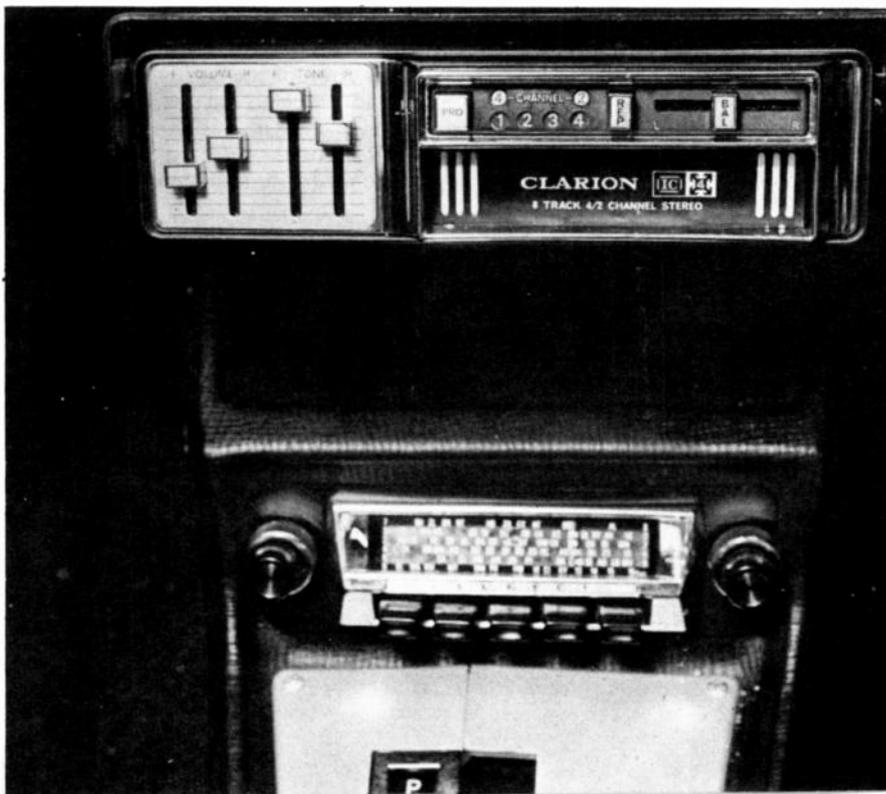
For many of the people who have bought quadriphonic reel-to-reel tape recorders, the concept has opened up a whole new dimension in high fidelity listening — but generally at a cost approaching twice that of normal stereo equipment.

Yet despite extensive and costly sales promotion, the general public has been slow to accept quadriphonic tape recording equipment. The reasons for this lack of support are largely obvious. There has been an almost total lack of commercial pre-recorded tape, and unlike 'conventional' two-channel recording, the ability to roll one's own is restricted.

Apart from this there are practical difficulties in housing four speakers, to say nothing of suitably arranging seating whilst still retaining the appearance of a living room.

Nevertheless despite the attendant problems, quadriphonic sound is well worthwhile in the home — and now the concept has been extended to cartridge recorders for use in cars.

Our first insight into this new medium came in an unexpected way, for we were provided with an automatic Peugeot 504 in which a



Brüel & Kjaer

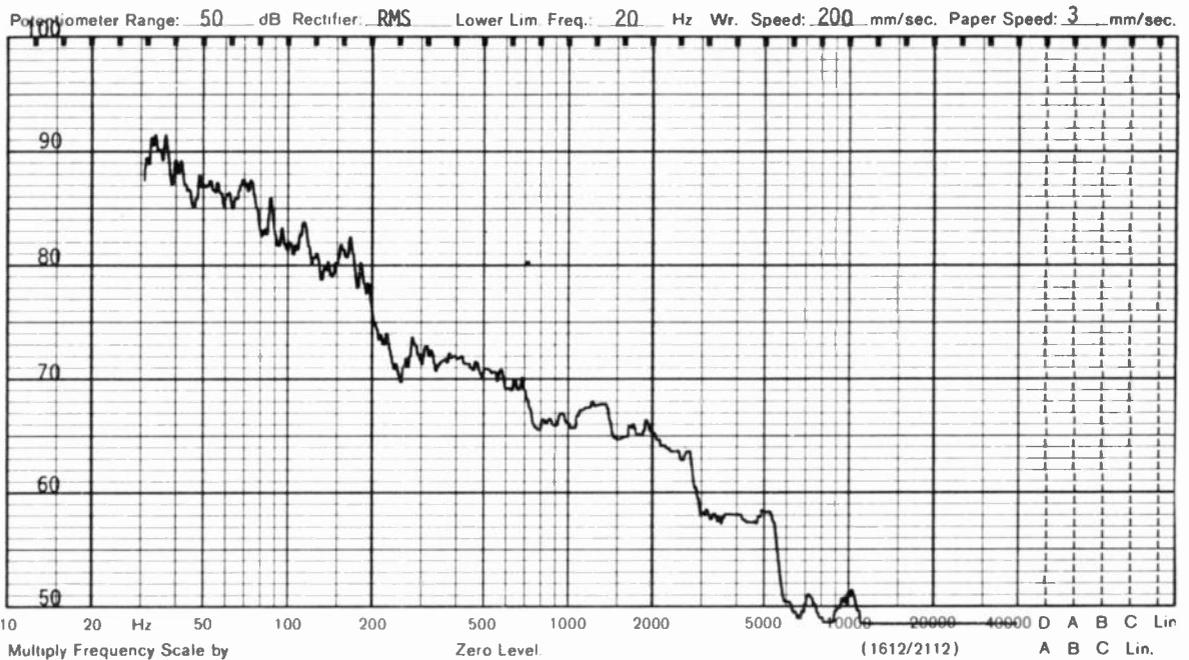
Copenhagen



Measuring Obj.:
OCTAVE
BAND
SOUND
PRESSURE
LEVELS IN
PEUGOT 504
AT 70 mph
Measured
in
passenger's
seat

1 decibel
per division

Rec. No.:
Date: 6.3.1972
Sign.:



SOUND — IN YOUR CAR

We test the Clarion PA-424A-01 quadriphonic cartridge player.

quadriphonic system had already been fitted.

The system — a Clarion Model PA-424A-01 quadriphonic cartridge player — was centrally fitted in the space below the dashboard in a locking cradle.

The cartridge player slides into this cradle — (a substantial lock deters thieves), and makes contact at the rear with an eight pin socket providing connections to the four speakers, earth, and the twelve volt vehicle supply.

Another cradle, shortly to be released, has a mains power unit inbuilt, thus allowing the cartridge player readily to be interchanged between car and home.

MECHANICAL CONSTRUCTION

Ergonomically, the Clarion unit is excellent, it is also exceptionally well finished.

The front panel is divided into three sections with the plug-in socket for the cartridge on the lower right side. Plugging in a cartridge switches on the power and starts the motor.

A normal stereo cartridge parallels the front and rear speaker channels for two-channel stereo and is identified by an illuminated bezel which lights up to show the number "2".

The insertion of a four channel cartridge (with its special notch) activates a micro-switch — this

switches the unit to four-channel operation and illuminates the bezel with the number "4".

The tracks selected are indicated by a set of bezels numbered 1 to 4. These bezels are flanked by push buttons labelled PRO for channel advance and REP for channel repeat. On the left of these is a slider control which simultaneously balances left and right signal levels of both front and rear channels. The only other controls are two pairs of slider attenuators for the front and rear volume and front and rear tone control (or treble cut). Nothing could be simpler, except for the circuitry which in keeping with the latest Japanese trend, uses only silicon integrated circuits.

These integrated circuits consist of four tape-head preamplifiers with three transistors in each IC. These boost the signal level of each channel before equalisation and are followed by four output power amplifiers with nine transistors and nine diodes in each IC. Each power amplifier can provide a clean three watts (average) power output with less than 5% distortion, and a maximum output of six watts each before the onset of clipping. In practice this output power is more than enough for the high efficiency speakers provided with the unit, and our only real complaint was that the volume controls were not sufficiently gradual, there was little

control range between inaudible and 'ouch'.

The design of the amplifiers and motor circuit is simple but, incorporates a very well designed noise filter network in the primary supply together with noise filters in each speaker lead. These prevent the entry of extraneous electrical noise. The use of integrated circuits on printed circuits provides a very high component density and the motor drive takes up nearly as much space as the amplifier electronics.

Apart from the player and the cradle, a radio and five speakers were installed, four for the cartridge player, and one for the radio. The rear speakers were mounted on either side of the rear parcel shelf whilst the front speakers were flush mounted above the arm rest in each front door. As it happened, either by accident or intention, the choice of positions was excellent — as evidenced both by the subjective and instrumental tests.

HOW THE UNIT PERFORMED

As part of our first subjective test we decided to take the car on a typical, extended journey. This was a morning trip to another city 70 miles away, with the return being made in the early afternoon. We played the recorder for the full distance in both directions, and frankly have never had a more pleasant journey in a car. The

LOW COST

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- Provides 6 or 9 volt DC at 300mA output to operate Cassette Tape Recorder, Transistor Radio, etc.
- Plugs into cigarette lighter socket on most current model cars.
- Incorporates a solid state voltage regulator to maintain output volts constant, irrespective of battery charging conditions.
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Enjoy unlimited playback of your favourite cassettes without high battery costs.

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FOUR-CHANNEL SOUND

music enveloped us and, quite apart from the quality of the commercial four-channel cartridges which were better than any two-channel material we have yet heard on eight-track cartridges, we were impressed by both the quality and dynamic range of the music and the unusually good frequency range of the music which audibly extended below the 50 Hertz region.

The material that we played consisted of the following J.V.C. Nivico Cartridges, all of which are impressive and show the value of the medium for both classical light orchestral music (and even choral work):—

- The Cat . . . NQH-1002
- L'Arlesienne (Bizet) . . . NQH-2002
- It's Love Time . . . NQH-1010
- Serenade for String Orchestra (Tchaikovsky) . . . NQH-2001
- La Macarena — Dynamic Latin . . . NQH-1009
- The April Fool . . . NQH-1003
- The April Fool — Latest Film Themes . . . NQH-1003

There were a number of factors which seemed to be at variance with the classical theory for car radios and vehicle noise. Firstly, most car radio speakers are designed to exaggerate presence with little treble or bass. This is to produce the optimum signal to noise ratio in vehicles, where engine exhaust and road noise dominate the low end of the audio spectrum, and where wind noise, road, and tyre noise usually dominate the high frequency end. We presumed that the speakers installed would provide this type of performance, but this could not be reconciled with our subjective appraisal. Because of the lack of agreement between what we heard and what we had expected we measured the frequency response of the speakers when driven in parallel by the same

in-phase signal. The results were a little surprising, as can be seen in Figure 1. The level recording of the frequency response was unusually flat from 50 Hz to 10kHz with less variation than we would expect to find in the average living room and far better than would be expected to be found in a car.

The reason for this we associated with the method of mounting the speakers in the door panels and the rear parcel shelf. These surfaces provide infinite baffles for each of the speakers and allow them to work effectively down to their cut-off frequencies.

Next we measured the frequency response of the noise level in the car between 40 and 70 miles per hour to compare the spectrum of the noise level with the spectrum of the frequency response of the recorder and speaker system. The results of this analysis (Fig. 2) showed that this car was unusually quiet and suitable for good listening at speeds of up to 70 miles per hour. (Many other cars in which we have performed measurements are less suitable. This may be borne in mind before selecting a car!)

The only technical criticism which may be levelled at the unit concerns the type of motor speed regulator used. The system used is not as refined as some of the latest transistorised speed controllers that are finding their way into modern tape recorders.

However, it is a conventional and proven design and should give good service.

In general it may be said that many of the most vexing problems of four-channel sound, including the mounting of the speakers, the problems of room acoustics and the location of the audience on permanent seats between the speakers are neatly solved in a car installation. If the price barrier and the thermal problems which have plagued cassettes are controlled we have no doubt that quadriphonic cartridges have as bright, if not a brighter, future in cars than they have in the house. ●



(Advertisement)



Henry Kloss

Not too terribly long ago in a quaint little New England town in the U.S.A., Henry Kloss and three other illustrious gentlemen founded a company for the manufacture of loudspeakers. They called it Acoustic Research. Perhaps you have heard of it. However, as often happens, the fields looked greener on the other side of the proverbial fence, so Henry Kloss and two of the illustrious gentlemen moved on down the street to form a company on the other side of the fence. The two others with Henry were Malcolm Low and Tony Hoffman. The company they formed took its name from its founders' initials. That's right: KLH. Perhaps you have heard of it?

Henry's job at KLH was to invent things, and he produced a stream of products the success of which stunned the home entertainment industry. Henry is directly responsible for a major portion of the important and lasting audio products for the home including roughly half the number of loudspeakers now in use across the country in component systems and high performance three-piece music systems, radios, and phonographs. His credits would be embarrassingly long to present in full, but they include, the longest lived, best selling component speaker system on the U.S. market (KLH model 6) and the development of miniature full range loudspeakers which assisted the three piece music system becoming the primary medium for home audio in the U.S.A.

KLH had a good deal of success which no doubt had some effect on Singer's (that small sewing machine company) decision to buy KLH. They bought KLH — lock, stock, and factory — but, Henry wasn't for sale! He again moved down the street to still more verdant fields and formed the Advent Corporation. Advent is now in the business of creating all sorts of new audio and visual products for the home, such as a life-size colour television projection system and new loudspeakers. We would like to talk to you about the new speakers.

Why are the New Advent Loudspeakers so good?

THE ADVENT LOUDSPEAKER

Upon first listening to the Advent speakers, we were struck by a small but very significant revelation: the Advent Loudspeakers didn't sound like Speakers, but rather like Music. "How pleasant" you say, and "How very clever of that Mr. Kloss". You continue: "But isn't that what all speakers sound like? Isn't that the name of the game?" Yes that is the name of the game (we answer) but unfortunately all speakers do not sound like Music.

Many speakers sound like Speakers; each prejudices the music in its own way. This is the phenomenon audiophiles call "coloration". We have come to expect this, much as we expect our friends to sound different over the telephone. "True" sound is, of course, a difficult quality to talk about and even more difficult for a speaker to reproduce. But the Advent Loudspeakers certainly seems to come close.

DESIGNING THE ADVENT SPEAKER

In designing the Advent Loudspeakers, the basic philosophy was this: Henry felt that it was now possible to design and produce the one speaker system which would be nothing less than the right, supremely satisfying choice for an unprecedented number of people with demanding interest in the natural reproduction of music. Working from this premise, Henry designed the Advent Loudspeaker to combine the following objectives:

- (1) To fit the highest performance category of loudspeakers with performance that is (at the very least) equal — in every audible and useful respect to the most expensive speakers available.
- (2) To do this at a cost that is roughly half of the average price of the speakers now considered to be the best available.
- (3) To be small enough, unobtrusive enough, and so uncritical in placement, that it would fit gracefully into any room.

HOW IS ALL THIS POSSIBLE?

To accomplish these objectives, Henry decided to employ a two-way system, and it is the successful exploitation of the two-way design, that is the key to understanding both the performance of the Advent speaker and the new level of value achieved. For home use, Henry lists four advantages of a two-way over a three-way design.

- (1) less interference between drivers than any other practical system, yielding more uniform characteristics over the listening area.
- (2) better transition between drivers, than the three-way system, because there is no need to sharply cut off the operating range of any driver.
- (3) one simple crossover network, instead of the two more complex networks needed in a three-way system.
- (4) finally, a cost significantly lower for excellent sound than that of any equivalent system of three-way — or any other — design.

WHAT IS THE RETAIL PRICE OF THE ADVENT LOUDSPEAKERS?

The Advent Loudspeaker — One hundred and sixty nine dollars The Small Advent Loudspeaker — One hundred and twenty nine dollars . . . roughly half the cost of comparable speakers.

JUST HOW GOOD ARE THE ADVENT LOUDSPEAKERS?

Very good. The Advent speakers are certainly the equal in useful performance of any speaker system now available at anything near the price, and it has significant audible advantages over many systems sold as the "best" on an absolute basis.

See the product reviews which appeared in Electronics Today in November 1971 and March 1972 on the Advent loudspeakers.

For more information about Advent, and the name of Advent dealers, write to: Auriema (A'asia) P/L. P.O. Box 604, Brookvale, N.S.W. 2100.

ALL ABOUT 4-CHANNEL SOUND



CBS-SONY SQ QUADRIPHONIC SYSTEM

electronics
TODAY
INTERNATIONAL
product test

This matrix system is compatible with existing record playing equipment.

Without doubt, the main difficulty that proponents of four-channel sound have had to overcome is that of compatibility of four-channel recordings with existing record players, tape recorders and, in some countries, F.M. stereo broadcasting.

It is for this reason that the basically compatible matrix systems have gained popularity, and of these, the CBS-Sony SQ system is one of the most promising.

The principle behind all the matrix systems is the "encoding" of four channels of information onto two

channels. Obviously the encoding cannot be perfect, since it is impossible to double the amount of information contained in the same bandwidth. Hence the matrix systems use the psychoacoustical effects of phase relationships to give a four-channel effect.

The CBS-Sony SQ System uses a fairly complex method of encoding which combines the two rear channels with each of the front channels.

The system is based upon the possible orthogonal sets of information that can be recorded on a single record groove. An orthogonal

FOUR
QUAD
TAPE
TRACKS

THE SQ
ENCODER

TWO CHANNELS
OF SQ DISC

THE SQ
DECODER

FOUR
SIGNALS
TO
SPEAKERS

set of co-ordinates is a choice of co-ordinates which are completely independent. Thus, on a sheet of paper one has an orthogonal set of two lines each of which can be chosen independently. These are the vertical and horizontal directions. If one wishes to draw a graph with more than two variables it is necessary to either plot them in three dimensions, or lose some of the data and plot the remainder as a family of curves (such as valve or transistor data). The limitation of a flat sheet of paper is accepted for its convenience, for it is obviously far easier to use paper than to mould transistor data in the form of blocks of plastic. Similarly, a record groove can only contain two-dimensional data in the form of suitably chosen orthogonal sets. The most obvious set is two components at 90° to each other, and this is the one which has been used for years for stereo recording.

The only other orthogonal set is a pair of helices with opposite directions of rotation. A helix consists of one component of the stylus motion in one plane combined with the same component phase shifted 90° in the other plane. Depending upon whether the phase shift is forward or reverse, a left handed or right handed helix results.

Such a set could equally well be used for stereo recordings. The reasons that it was not used originally is because of the complexity of the decoding required. The CBS-Sony system uses

both orthogonal sets. The conventional set contains the information from the front microphones, while the helical sets contain the information from the rear microphones.

A major problem arises because the helical co-ordinates are not orthogonal to the rectangular co-ordinates.

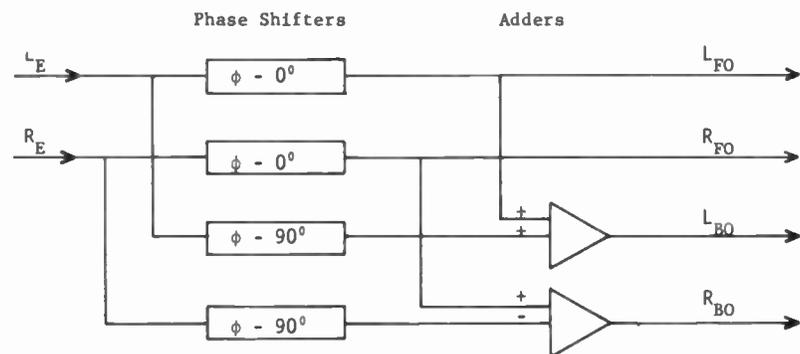
What does this mean in practical terms?

While the left and right front speakers can produce information separately and the left and right rear speakers can produce information independently, a signal which should appear in the left front speaker *will also appear, with 3dB attenuation (and a phase shift), in the left and right rear*

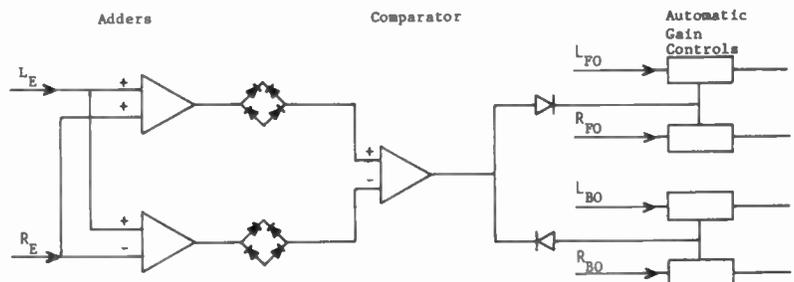
speakers. And similarly for the other signals.

Another major weakness occurs if a signal is supposed to appear in the front centre or rear centre, since, because of the lack of orthogonality, approximately equal signals will appear in all four speakers.

To improve this obviously poor channel separation, "logic circuitry" is incorporated in the more expensive decoders. This circuitry detects whether the vector sum of the signals to the front speakers exceeds the vector sum of the signals to the rear speakers. If it does, then the gain of the front channels is increased and the gain of the rear channels is decreased. The reverse situation occurs if the



Basic SQ decoder



Logic system to improve channel separation of SQ decoder.



CBS-SONY SQ QUADRIPHONIC SYSTEM

vector sum of the signals to the rear speakers exceeds the vector sum of the signals to the front speakers. This artificial enhancement can lead to some rather odd effects, especially on conventional stereo records.

Much has already been written on the psychoacoustical aspects of the various matrix systems, so for this review instead of our usual custom of thorough analytical testing, we spent an unusually large amount of time on the subjective evaluation of the SQ system using ordinary stereo records, mono records and SQ encoded records. This was necessary since based on the measured (or calculated) effects of the system, in terms of what goes in to the encoder and what comes out of the decoder, almost anything could happen.

Since this system relies heavily on the phase relationships of the signals, we used a four-channel amplifier rather than two stereo amplifiers or a combined decoder rear amplifier. As with our test of the JVC system published elsewhere in this issue, we also used four matched Advent speakers. The record that we used for most of our tests was a vocal solo with instrumental backing. This should, of course, have had the vocalist located in the front centre and the orchestra located fairly diffusely around him. Presumably the rear speaker content could be expected to reproduce reverberant sound, together with some sound from the outer instruments of the orchestra. However the result was quite unusual and not entirely satisfactory. When the vocalist was singing loudly he was located in the front centre; the orchestra was located between the front speakers and the

rear speakers did not appear to be producing any significant information. But when the vocalist sang quietly his voice tended to wander; sometimes coming from the right side, some of the time from the front.

We found that listening to such a fleet-footed vocalist tended to spoil the listening pleasure. On other less exacting music the results were pleasing, although rather diffuse.

We came to the conclusion that no demonstrations of ping-pong doubles matches or trains arriving at either side of a platform would be produced using the SQ system. Yet for music which is normally heard in a highly reverberant area, such as a church, the effect was outstanding. Since one did not expect to be able to pinpoint the instrument, the diffuseness enhanced the performance and provided a far more lifelike presentation.

One of the more spectacular

successes was with an ordinary stereo record of 'Switched on Bach' played on the Moog Synthesizer. Normally this record is rather poor as a test record for coloration and distortion because its effects are unnatural. Having heard a discrete four-channel reproduction of this record where the mixer had let his hair down and used movement as part of the performance, we wondered what the SQ decoder would produce.

The result was electronic music which was every bit as spectacular as the discrete four-channel material as a result of the apparently arbitrary manner in which it was recorded.

Similar results were obtained with other stereo material. Sometimes the effects were pleasing, sometimes distracting, depending very much upon the type of music.

Monophonic records were played to see how effective the logic circuits

MEASURED PERFORMANCE OF SONY DECODER MODEL SDQ-1000 SERIAL NO 801713A

FREQUENCY RESPONSE 20Hz to 20kHz ± 2 dB

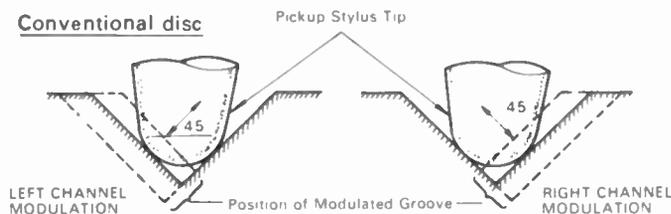
SOURCE	LEFT FRONT OUTPUT		RIGHT FRONT OUTPUT		LEFT REAR OUTPUT		RIGHT REAR OUTPUT	
1kHz Signal	Phase Angle	Relative Level	Phase Angle	Relative Level	Phase Angle	Relative Level	Phase Angle	Relative Level
Left Input	225°	1.00	—	—	135°	0.66	225°	0.76
Right Input	—	—	225°	0.98	45°	0.69	315°	0.72
Both Inputs	225°	1.00	225°	0.98	90°	0.31	270°	0.36
100Hz Signal								
Left Input	90°	1.00	—	—	In Phase	0.66	90°	0.76
Right Input	—	—	90°	0.98	270°	0.69	180°	0.72
Both Inputs	90°	1.00	90°	0.98	315°	0.31	135°	0.36

NOTE: All phase angles and output levels measured with respect to input signal, all phase angles are lagging with respect to input.

90% attack time on voltage controlled gain 200 msec.

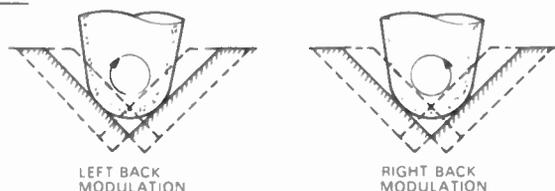
90% decay time on voltage controlled gain 15 sec.

Conventional disc



SQ disc

The stereo record has two channels for recording sound



Disc and stylus motion in the SQ system

The sound groove on an SQ disc meanders somewhat irregularly with its changing depth. As a cartridge stylus traces this sound groove, four sound components are picked up according to the four modes of stylus motions as illustrated right.

Such four motions are sensed out as two combinations of electric signals which are separated into four audio electrical signals by means of a decoder so as to finally drive four speakers installed in the left front, the right front, the left back and the right back. When playing the SQ disc with an ordinary stereo player, the two electric signals are led directly to the right and the left channels. In this case, neither separation characteristics nor the distortion factor is deteriorated at all so that the playback sound remains unchanged as in the case of the ordinary stereo system. Further, this SQ disc is also applicable to a monaural player.



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USED TURNTABLES**

When an AR turntable is packed at the factory it is, literally, slightly used. It has been run in for 48 hours, and then given a final workout in one of AR's test rooms.

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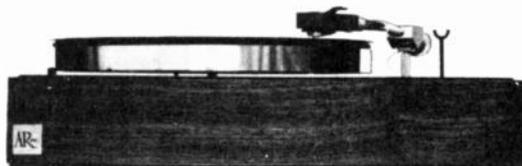
AR's quality control borders on the fanatical. It is one reason the AR

turntable has been rated number one by so many equipment reviews and comparison surveys, in a field of competing units costing up to twice as much.

The unique design of the AR turntable makes it insensitive to floor vibration or acoustic feedback. Its miniature synchronous motor and belt drive make the AR turntable inaudible during operation.

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\$169 RRP complete with arm, oiled walnut base and dust cover.



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

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10 watts R.M.S. per channel. Each channel has separate bass/Treble controls.

Inputs for magnetic or ceramic cartridge, crystal mic., radio, tape — tapeout stereo headphones. 8-16 ohms. Instruction booklet, circuit supplied. Timber cabinet. Dimensions: 14½" x 8" x 4". Price \$67.50. Pack & Post \$1.50. Interstate \$2.50.

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30 — 16000 Hz.

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8WR Mk.V	16 " "	\$10.75
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5", 8 ohms, 5 watts. Suitable for radio, cassette or cartridge. Also extension. \$7.75 each or \$15.00 pair. P.P. 75c.

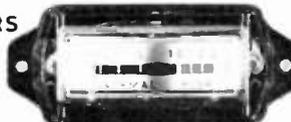
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Clear Plastic, Flush Mounting. Full range available. From 50uA 10A — DC, 15 VDC, 500 VDC, 300 VAC, VU and 5.

ALSO EDGEMETERS

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Complete, ready for use \$65.00
8-30 speaker only \$18.50
3TC Tweeter Only \$3.65.
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THE NEW BSR RECORD PLAYER

Automatic or manual operation. Latest modern style square section brushed aluminium tone arm — fully counter-balanced with calibrated stylus pressure control — anti-skate bias compensator — silicone damped cueing device — lightweight head shell takes any type magnetic cartridge. 11" diecast turntable — dynamically balanced 4 pole motor fitted with click & noise suppressor. Finish — Satin black with brushed aluminium trim. Available with ceramic cartridge and diamond stylus \$54.75. Or Magnetic cartridge and diamond stylus \$62.50.

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Lightweight — 2½ ozs. 240V A.C. Operation. No transformer required. Heating time 1.8 secs. 30 watts. \$7.50 — pp 35c.

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C141 — C142 — C142-A3

Current models, 4 speeds, automatic or manual operation. Deluxe model with 12in turntable. Cueing device, Ceramic cartridge, Diamond Stylus \$40.00
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Deluxe model as above with 12in. Diecast Heavyweight Turntable, 4-pole Shielded motor. Suitable for magnetic cartridge \$56.50



Model C142 and C142-A3 can be supplied with Magnetic Cartridge and Diamond Stylus at \$10.00 extra.

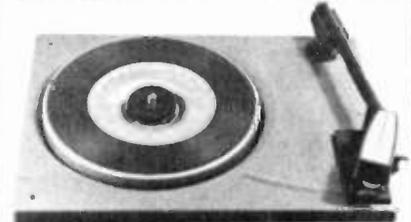
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Pre-cut to suit the above changers and BSR player or blank. 18½" x 15" x 3½" teak. \$9.00. P.P. 75c.

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GARRARD MODEL SRP-22 STEREO RECORD PLAYER



3 speed, 240v ac. 7" turntable aluminium p/u arm, adjustable stylus pressure, auto-stop, sonatone HiFi ceramic cartridge. \$15.50. P.P. \$1.00.

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50 watts R.M.S. 12" Speaker. 8-15 ohms. Frequency response 25Hz — 11kHz. Fundamental resonance 40Hz ± 5Hz. Special purchase — \$35.00. Pack & Post \$1.50.

We can offer at a special price the famous 12 UX50 (50 watts RMS) 12" twin cone extended frequency range hi-fi speaker. \$42.00 P.P. \$1.50.

CBS-SONY SQ QUADRIPHONIC SYSTEM

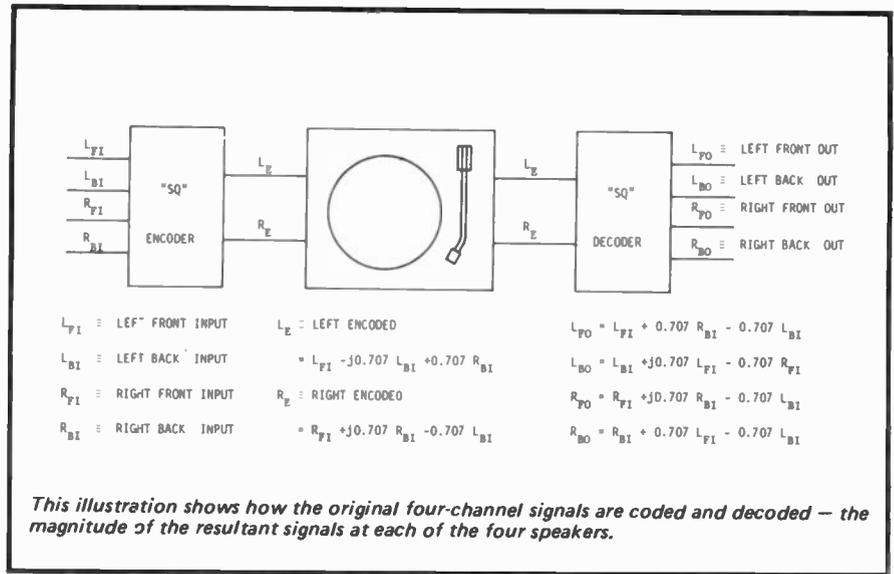
were in producing a fixed sound image. The result was quite effective and was, in fact, a reminder that monophonic records are extremely lifeless by comparison with stereo or quadrasonic sound of any sort.

A problem that exists with the SQ decoder is that sound with components phase shifted 90° appears in speakers other than the 'desired ones.' The system relies heavily on these components not being in phase with the desired signals. This is reasonable, for tests performed on subjects — with in phase and out of phase signals — have shown that out of phase signals do not reinforce each other to provide localisation of the source.

But while this is true, phase is relatively unimportant in acoustical phenomena since the phase of signals varies so much with distance.

Above 300 Hz, the position of a microphone need only be shifted less than one foot with respect to the source, to produce a 90° phase shift. Reflection from walls, floors and other objects can also readily create quite large phase shifts between speakers to produce channel separation.

Hence the major weakness in the matrix type quadrasonic reproducers is that, not being a completely



orthogonal set it is impossible to produce, from the available information, a given sound with a given location at will. The question which must be asked is whether the sounds that can be produced justify the matrix technique with its obvious advantages of compatibility with existing equipment and techniques.

This is a question that can only be answered in the end by the final user. It is the opinion of all the staff who were asked to comment on the tests that, in general, the effects were not significantly better than could be obtained from stereo records and a

synthesizer (such as the Sansui OS1) at about the same order of cost.

It would seem that either the goal is completely faithful reproduction of sound or something which is pleasing for its own sake. If the user wants completely faithful reproduction then the discrete system with its attendant disadvantages and limitations must be used. If it is a pleasing sound which is the goal then it would not appear to matter much whether a synthesizer or the SQ decoder is used.

In either case the sound has a more lifelike character. ●



This unit has an amplifier and decoder combined.

AKAI 1800S FOUR-CHANNEL TAPE RECORDER

electronics
TODAY
INTERNATIONAL
product test

This versatile four-channel recorder accommodates both reel-to-reel and cartridge tapes.

AKAI are one of the leading Japanese manufacturers of hi-fi equipment and have gained a reputation for advanced engineering techniques.

It is not surprising then that the company was one of the very first to enter the field of four-channel sound;

in fact their four-channel tape decks were probably the first four-channel units of any type to be commercially available on a wide scale.

The Akai Model 1800S combination recorder reviewed here follows the company trend. It is a four-channel machine that can accept both

reel-to-reel tapes and four-channel 8 track cartridges.

MECHANICAL CONSTRUCTION

Externally the unit is very similar to other Akai stereo tape recorders, the only immediately obvious difference is two additional VU meters.

The top section of the tape recorder has the characteristic head assembly and dual control levers of most Akai units. This head assembly panel, which is brushed aluminium, contains the speed selector switch in the top centre with the reel hubs on either side. Below the left-hand reel hub is the head assembly containing two erase heads (one full track, the other two track stereo) and one combination four-channel record/playback head, all covered with a black plastic cover finished with a silver trim.

Below the heads is the three figure index counter with reset button.

In the centre of the panel is a screw operated switch for 50Hz or 60Hz operation and below it the capstan and pinch wheel. Directly below the right-hand wheel hub are two control levers; the left-hand one with 'off', 'forward' and 'record' positions and the right-hand one with 'rewind', 'off', and 'fast forward' positions.

To the left of the first lever is a red transfer/record interlock button and between the two levers is an automatic shut-off switch. To the right of the second lever is the pause lever and the pause release button.

The bottom section of the control panel is matt dark-grey and contains all the audio controls. These consist of four VU meters arranged in pairs (two for the front channels, and two for the rear channels) in the centre of the

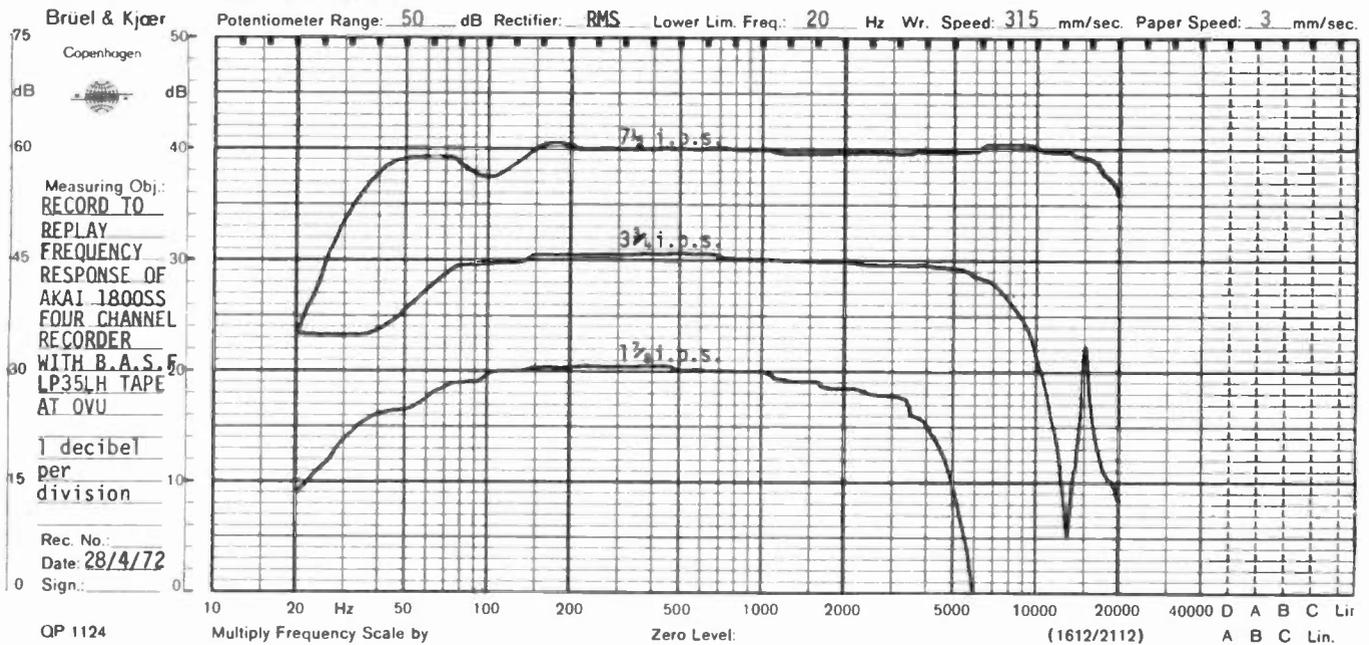




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panel. On the left of the VU meters is the power on/off switch and on the right the two channel/four channel select lever. Below the power switch is the equalization switch with three positions; 7½ i.p.s., 3¾ i.p.s. and 1-7/8 i.p.s. Below the front channel meters is the right front and left front combination record and playback level control knobs. An identical pair of controls are located under the rear channel meters. Between these two pairs of level control knobs is a dual concentric tone control for the left and right channels.

FACILITIES

On a narrow strip across the bottom of the recorder, defined by a silver trim, are the following facilities, from left to right:—

- a bias selection push button for standard or low noise tape
- four microphone input sockets
- four cartridge programme indicator lamps
- cartridge programme select push button
- cartridge mode select push button
- reel mode select push button
- transfer mode select push button
- stereo headphone output socket

All auxiliary input and output sockets are located on two panels recessed into the back panel. In the top left hand corner, opposite the forced draught fan air intake, is the on/off switch for the built in monitor speakers, one in each side panel behind hinged metal covers.

The second panel is located at the bottom of the back panel and contains:—

- a socket for remote cartridge programme select control

MEASURED PERFORMANCE OF AKAI 1800SS 4 CHANNEL TAPE RECORDER SERIAL NO 60721-0021

Record to replay frequency response (BASF LP35 LH tape)

	0VU	-10VU
Open reel 7-1/2 i.p.s.	35Hz to 20kHz $+1_{-3}$ dB	30Hz to 20kHz $+1_{-3}$ dB
3-3/4 i.p.s.	60Hz to 8kHz $+1_{-3}$ dB	60Hz to 10kHz $+1_{-3}$ dB
1-7/8 i.p.s.	60Hz to 3.5kHz $+1_{-3}$ dB	60Hz to 5kHz $+1_{-3}$ dB
Cartridge 3-3/4 i.p.s.	70Hz to 12kHz $+2_{-3}$ dB	70Hz to 17kHz $+2_{-3}$ dB

Total harmonic distortion at 0VU

	100Hz	1kHz	6.3kHz
Open reel (7½ i.p.s.)	1%	0.6%	0.6%
Cartridge	2%	1.5%	1%

Intermodulation distortion (1kHz & 960Hz signal at 0VU)

Open reel	7½ i.p.s.	1%
Cartridge	3¾ i.p.s.	1%

Signal to noise ratio (at 0VU re 1kHz unweighted)

Open reel	7½ i.p.s.	49dB
Cartridge	3¾ i.p.s.	38dB

Erase ratio (for 1kHz signal pre-recorded at 0VU)

Open reel	7½ i.p.s.	66dB
Cartridge	3¾ i.p.s.	58dB

Cross talk (re 1kHz at 0VU with respect to Channel 1)

Channel 2	52dB
Channel 3	50dB
Channel 4	63dB

Wow and flutter

Open reel	7-1/2 i.p.s.	0.1% RMS
	3-3/4 i.p.s.	0.12% RMS
	1-7/8 i.p.s.	0.2% RMS
Cartridge	3-3/4 i.p.s.	0.15% RMS

Line input sensitivity (for 0VU - 1kHz)

typically 250mV

Microphone input sensitivity (for 0VU - 1kHz)

typically 1.5mV

Line output sensitivity (for 0VU - 1kHz)

typically 500mV

Dimensions

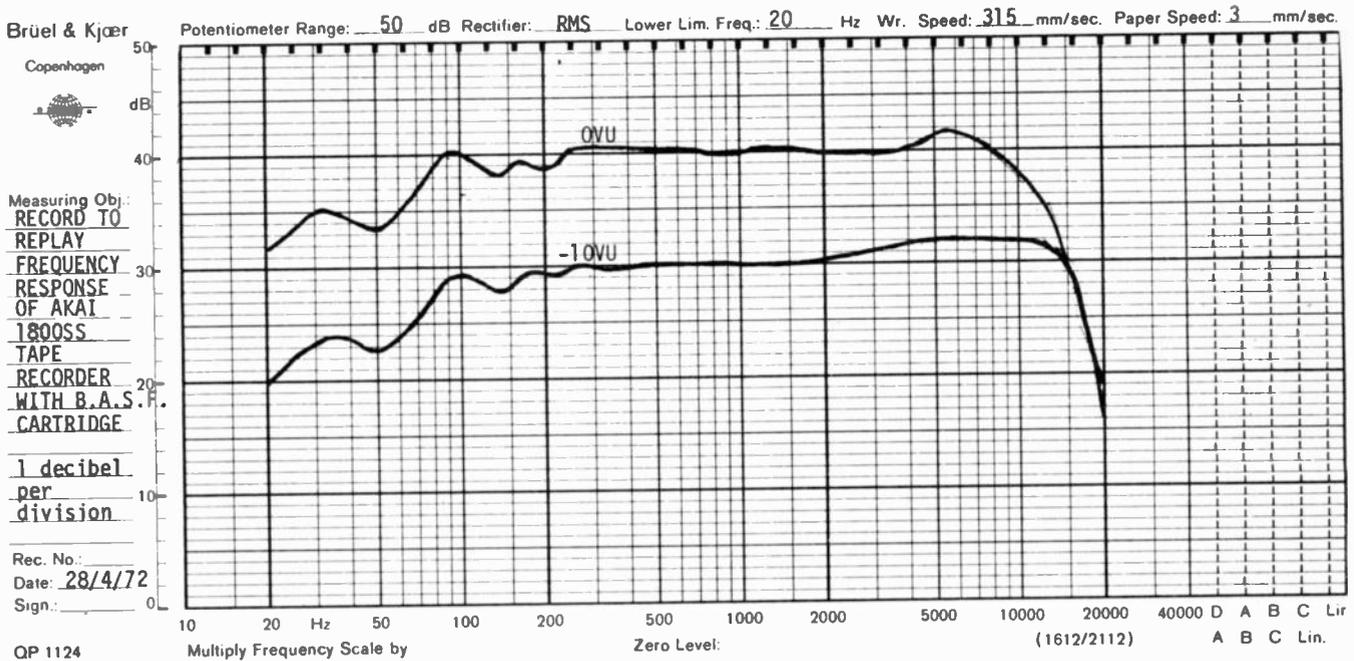
17.8" high x 16.8" wide x 9.6" deep

Weight

51 lbs.

Price

\$728



AKAI 1800S FOUR-CHANNEL TAPE RECORDER

- b) rear channel output tip and sleeve sockets (left and right)
- c) rear channel combination DIN input, output socket (left and right)
- d) rear channel input tip and sleeve sockets (left and right)
- e) DIN sockets, high or low switch to match input levels
- f) front channel input tip and sleeve sockets (left and right)
- g) front channel combination DIN input, output socket (left and right)
- h) front channel output tip and sleeve sockets (left and right)

The mains input voltage selector and fuse holder is located at the top right hand corner on a recessed panel which also contains a 50Hz/60Hz selector switch. Cartridge tapes fit into a deeply recessed opening in the right hand side panel just below the built in monitor speakers. These speakers are provided with hinged covers to improve frontal directivity at the higher frequencies. A switch located in the opening selects continuous play or automatic stop.

The accessories supplied with the unit included:—

- 1) two dynamic microphones with stands
- 2) a four channel demonstration tape (which is gimmicky & poorly recorded)
- 3) an empty metallic 7" take up spool
- 4) one DIN to RCA patch cord for two channel operation

5) an Akai ACT-200 blank cartridge tape

6) an operator's manual (17 pages of useable instructions)

The operator's manual includes descriptions of all the facilities on the recorder, together with comprehensive operating procedures. The first four pages detail the performance specification and the front panel controls. Two items not clearly discussed are the reel retainers and the dual tone controls. The reel retainers are spring loaded and must be stretched and twisted about 30° to retain the reels. These retainer were roughly finished at the rear creating difficulties with some spools. The tone controls are only effective on the inbuilt power amplifiers and do not affect the auxiliary outputs.

Operation of the tape recorder is rather complex and one has to be careful that all functions have been selected correctly, particularly when recording. However, this is the penalty one must pay if one wants a truly versatile machine — particularly one that also incorporates a cartridge recorder.

A typical setting-up procedure for recording could include the following steps:—

- 1) switch power on
- 2) select high or low speed on tape speed switch
- 3) select correct capstan and pinch roller to give desired reel tape speed

- 4) select desired equalization
- 5) select two or four channel record mode
- 6) select standard or special tape bias
- 7) press reel mode push button
- 8) switch internal monitor speakers on or off
- 9) *thread tape
- 10) push pause lever to hold position
- 11) press record button and simultaneously switch play lever to record position.

*Threading the tape was rather awkward, due to the positioning of the two main control levers just below the take-up reel.

SUBJECTIVE IMPRESSIONS

Our subjective impressions of this machine were obtained in several ways. Firstly we recorded a number of our standard test records onto cartridges — when these cartridges were replayed through the machine the resultant clarity and frequency response was most impressive.

We then used a number of pre-recorded JVC Nivico four-channel tapes and cartridges to evaluate each section of the recorder.

Providing four high-quality speakers were used, the resultant sound could only be described as truly exciting. However to obtain these results, four high-quality speakers must be used, for if the two internal speakers are used

there is a significant loss of sound quality.

The performance of the cartridge tape playing section of the machine was of particular interest. Here the general performance was exceptionally good — the wow and flutter figures in particular were better than the manufacturer's specifications by a considerable degree.

The frequency range of the machine on playback at 7½"/sec (reel to reel), or on cartridge is affected by the quality of the tape used. At 3¾"/sec it is necessary to use a high quality tape if an acceptable frequency response is desired.

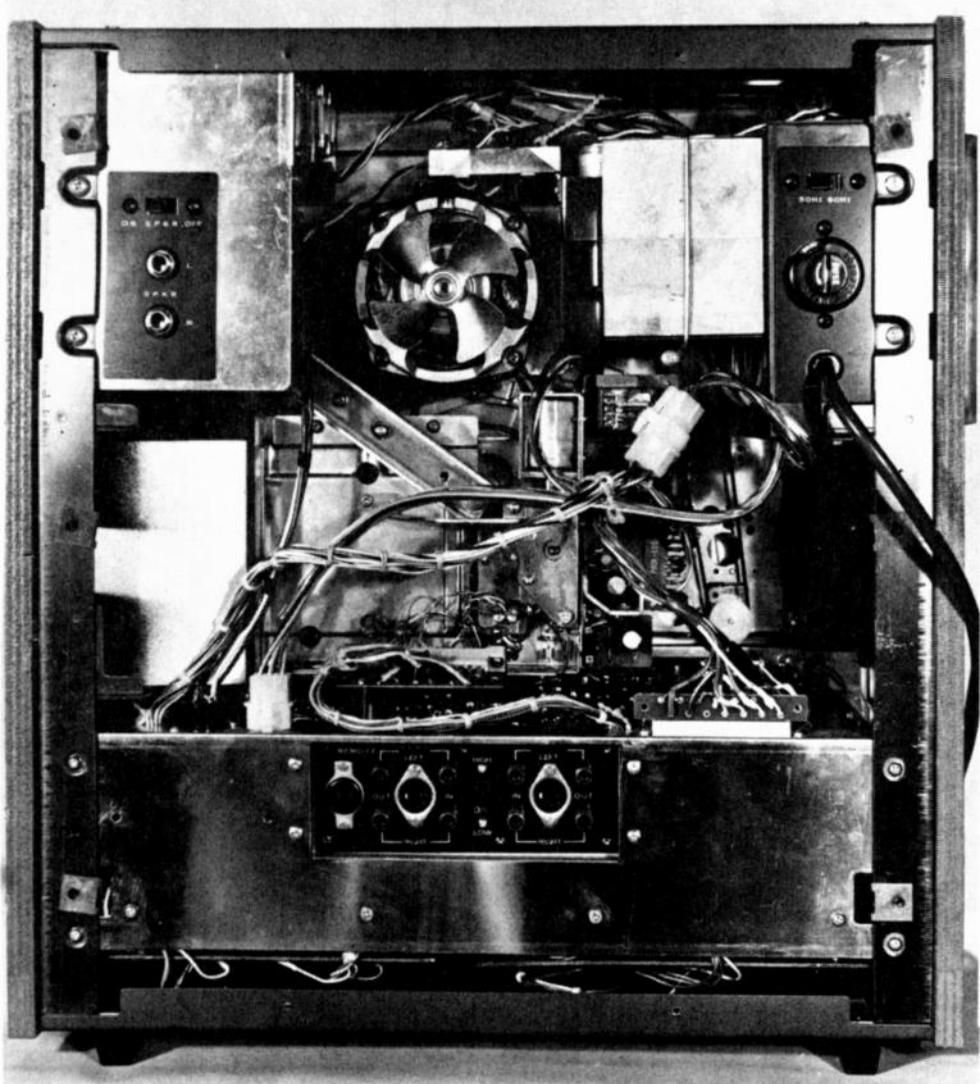
Laboratory measurements confirmed these subjective impressions and we found that with BASF LP 35LH tape loaded into a cartridge we obtained the rather remarkable frequency response of plus or minus 3dB from 70 Hz to 17 kHz (at -10VU). We

understand that BASF cartridge tapes will be available through Akai distributors in the near future.

One feature which we would have liked to have seen on the unit is a common output volume control so that once the four speakers were balanced it would be possible to adjust the overall level by a single control. This, of course, would not be necessary if the tape recorder was operated with an external four-channel amplifier.

The measured performance was good and exceeded the manufacturer's specification in most respects.

Akai's 1800S tape recorder is a truly versatile machine, and with the recent introduction of four-channel cartridge machines in cars, this unit will be an ideal 'centre' for producing four-channel cartridges from reel-to-reel tapes or from discrete four-channel records. ●



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A PRACTICAL GUIDE TO SCR'S

The final article in this series describes the way in which SCR's are used in phase control circuits.

PART III

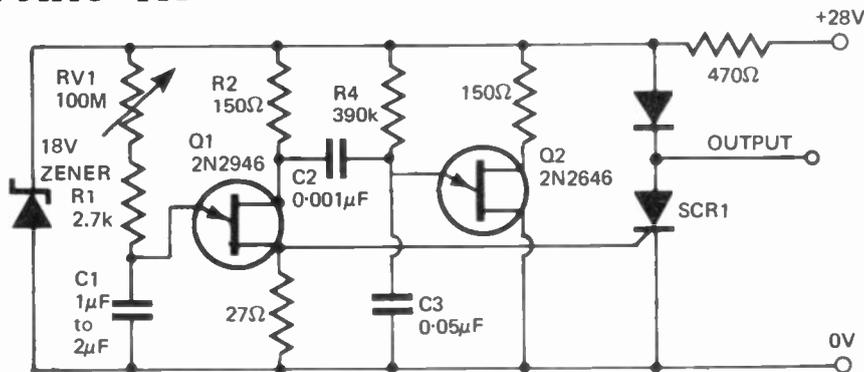


FIG. 1

The timing circuits shown in the second part of this series (ETI May 1972) provide delays which may be adjusted from less than a millisecond to approximately one minute. The upper time limit is determined by the amount of leakage in the UJT timing capacitors. It is possible to use special large value low-leakage computer type capacitors, but a more satisfactory (and certainly cheaper) solution is to use a circuit such as that shown in Fig. 1.

This circuit will provide precise time delays from about ½ millisecond to several minutes — in fact by using a 2µF mylar capacitor as C1 and a 2000 Megohm timing resistor as R1, the circuit will provide delays of well over one hour with excellent repeatability.

In operation, the peak point requirement of UJT Q1 is reduced to about 1/1000 of its normal requirement by pulsing its upper base with a ¾ volt negative pulse derived from the free running oscillator UJT Q2. This regular pulse momentarily reduces the peak point voltage of Q1 and thus allows the peak point current to be supplied from C1 rather than

R1, as it would be with the more conventional circuits of this type. The pulse rate of oscillator Q2 is not very critical but it should have a period that is less than one fiftieth of the overall time delay. Resistor R2 may be adjusted to provide optimum temperature stability.

An unusual timing circuit is that shown in Fig. 2. This circuit is often used in electrically powered stapling machines, impulse hammers etc, and causes load current to flow through the load for one complete half-cycle of the ac supply whenever SW1 is actuated (i.e. moved from its normal position (1) to energise-load position (2)). The circuit is arranged so that the SCR is always triggered at the beginning of a positive half-cycle of the ac supply, even though the switch may be closed randomly at any time during the previous two preceding half-cycles.

Resistor R1 and capacitor C1 should be chosen so that their series combination supplies just sufficient holding current for the SCR for one complete half-cycle.

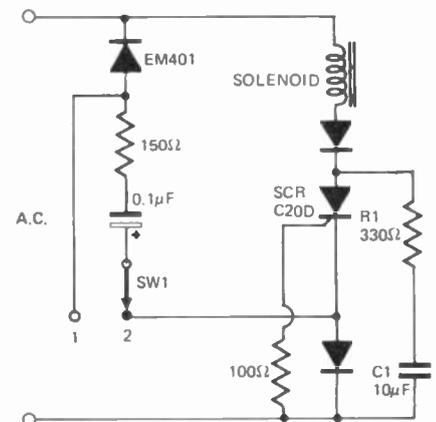


FIG. 2

PHASE CONTROL

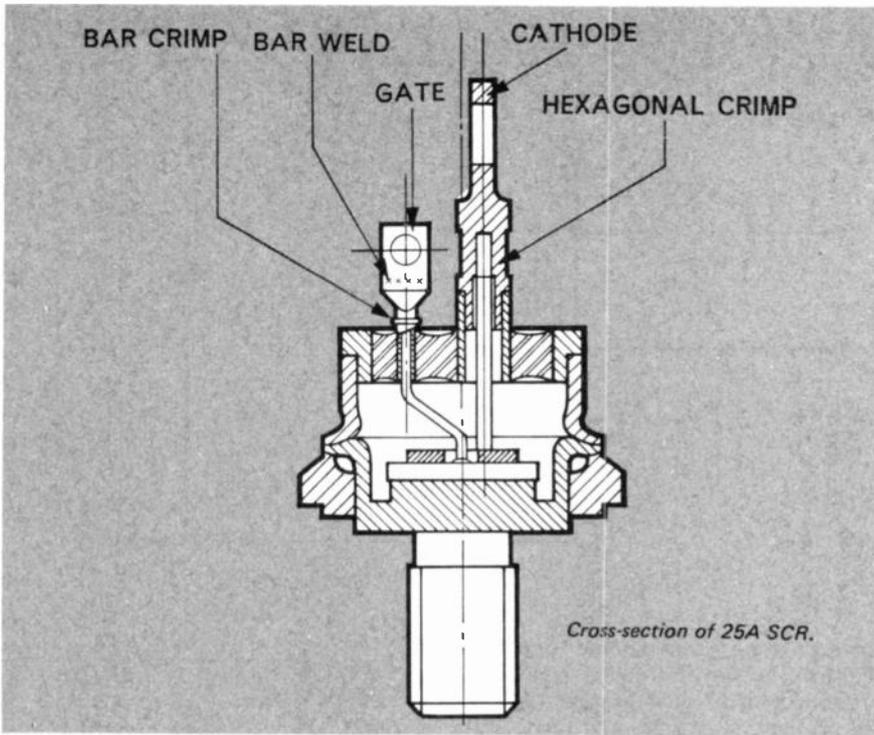
Phase control is a technique used for varying the effective power input to a load.

It is a process of rapid on-off switching in which the ac supply is connected to a load for a controlled (but adjustable) fraction of each cycle.

The simplest form of SCR phase control is shown in Fig. 3. This is a very basic circuit and provides control only from SCR full-on (100% of half-wave output) to SCR half-on (50% of half-wave output).

The addition of one capacitor and one more diode (Fig. 4) extends the range of the basic phase control circuit from SCR full-on (100% half-wave output) to SCR off (0% half-wave output). In this circuit, the values of R1 and C1 must be chosen to suit the characteristics of the particular type of SCR that is used.

By wiring a diode across the SCR (Fig. 5), the basic phase control circuit will provide a fixed half-cycle of power plus a variable half-cycle. Thus control can be obtained from full power to half power — but there will be a major dc component which will



If the motor is loaded, the speed reduces, thus also reducing the back emf — hence D2 becomes forward biased earlier in the cycle (triggering the SCR earlier in the cycle), and thereby supplying the motor with more power to offset the effect of the loading.

The component values shown in Fig. 7 are suitable for most fractional horsepower motors — for optimum results it will be necessary to adjust component values to suit the motor used.

The circuit described above will provide stepless speed control over a wide range of motor speed — but tends to cause jerky operation at low speeds.

This tendency can be almost entirely overcome by using the circuit shown in Fig. 8. As may be seen from the circuit diagram, it is necessary to bring out separate connections from the armature and field windings. This is generally a simple operation and providing it can be done the circuit will provide stepless speed control down to virtual standstill. In this circuit the 20V zener diode provides a constant voltage for the discharge of C1. Capacitor C2 and resistor R4 are connected from gate to cathode of the SCR to stabilize the circuit by preventing the SCR from being triggered by extraneous signals.

INDUSTRIAL APPLICATIONS

Silicon controlled rectifiers are in common use around the world for the control of very large dc motors —

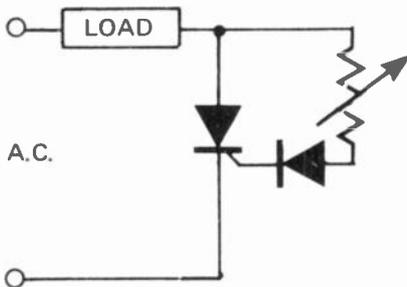


FIG. 3

HALF-WAVE CONTROL FOR UNIVERSAL MOTORS

One of the most common applications for SCR phase control systems is speed control of commutator motors — such as those used for food mixers, sewing machines, pottery wheels etc.

However one of the disadvantages of controlling motor speed by varying input power is that as the effective power input is reduced to slow down the motor — the torque available is reduced as well.

This may be overcome by using a feedback signal to advance the firing angle in proportion to the load on the motor — thus increasing the power input if more torque is required.

The circuit shown in Fig. 7 achieves this load compensating function by deriving a feedback signal from the armature back-emf (produced by the residual field of the motor). In this circuit, the SCR is triggered when the voltage on the wiper arm of potentiometer R2 rises to a high enough value to forward bias diode D2 — thus allowing gate current to flow. As the back emf tends to reverse bias D2, the firing point of the SCR depends largely upon the back emf and this in turn is a function of speed.



adversely affect many loads — especially inductive loads. In particular a half-wave control circuit should not be used to vary the power input to a transformer, variac, induction motor etc.

Full-wave control, over the full range from zero to maximum, may be obtained by connecting the basic control circuit inside a full-wave diode bridge. (Fig. 6). This arrangement may be used to provide either controlled ac, or controlled and rectified dc. Losses in the rectifier bridge reduce the electrical efficiency of this circuit, and generally it is preferable to use Triacs rather than SCR's if full-wave control is required.

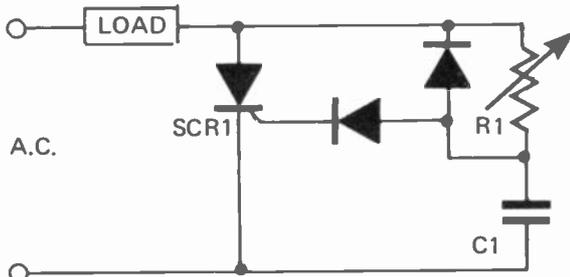


FIG. 4

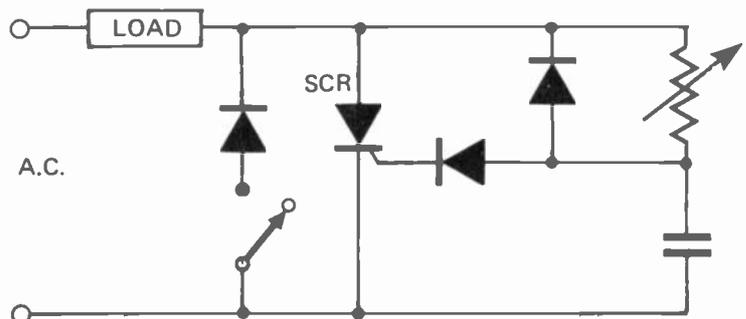


FIG. 5

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A PRACTICAL GUIDE TO SCR's

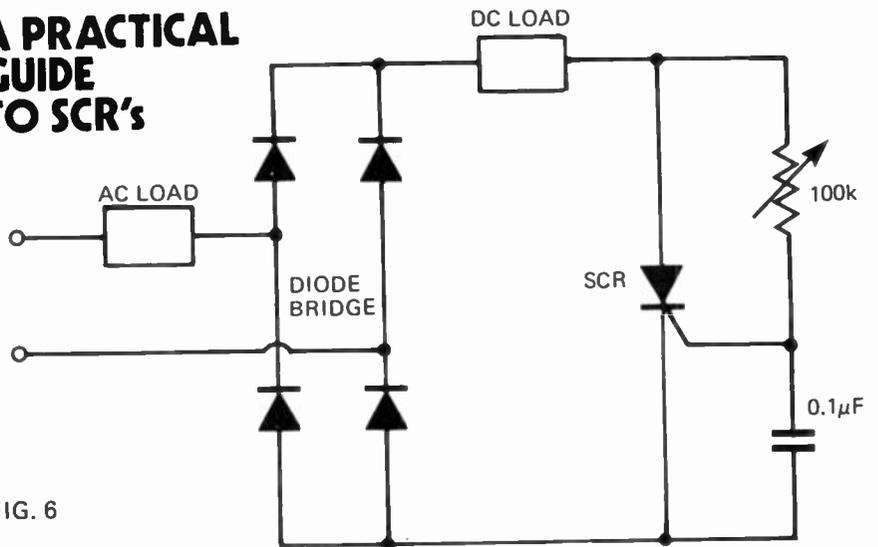


FIG. 6

often using tachometer feedback control to provide speed regulation. These control systems are built in surprisingly large sizes and single units exceeding 50,000 h.p. are by no means uncommon.

Another common use for industrial SCR's is in the control of heating loads - and here again very large loads may be steplessly controlled.

These two applications are outside the scope of an article of this nature - however we shall be publishing technical articles describing large scale SCR drive systems and also temperature control systems later this year.

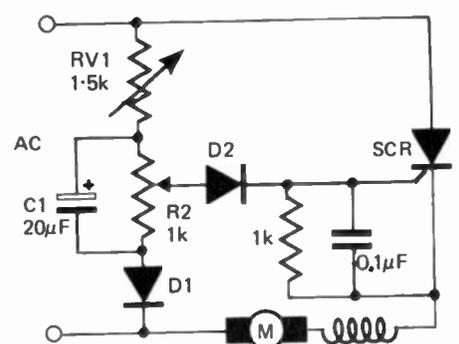


FIG. 7

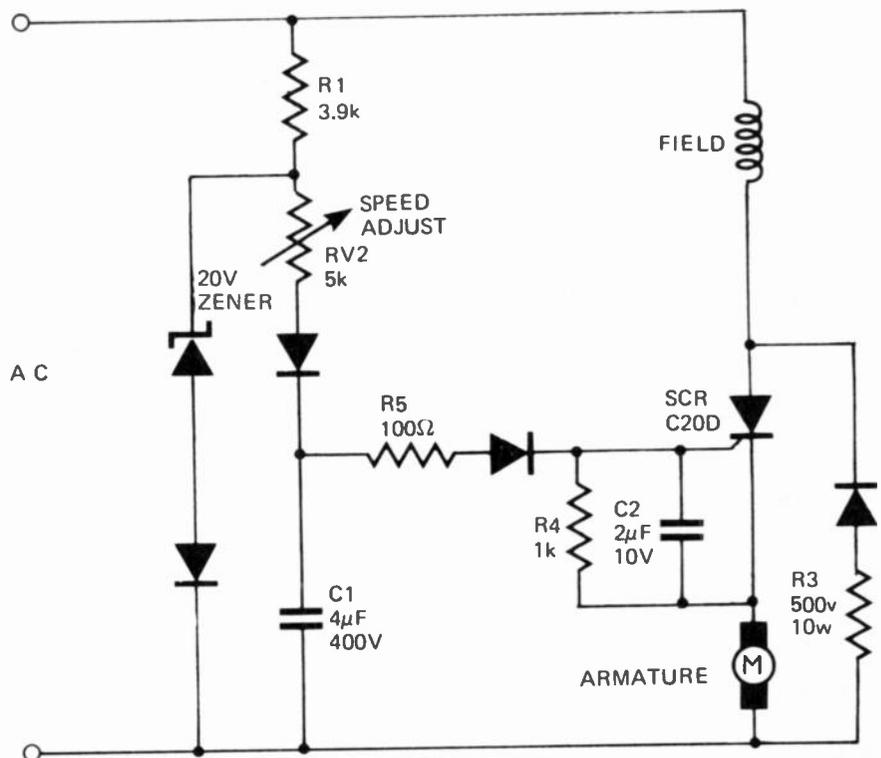


FIG. 8

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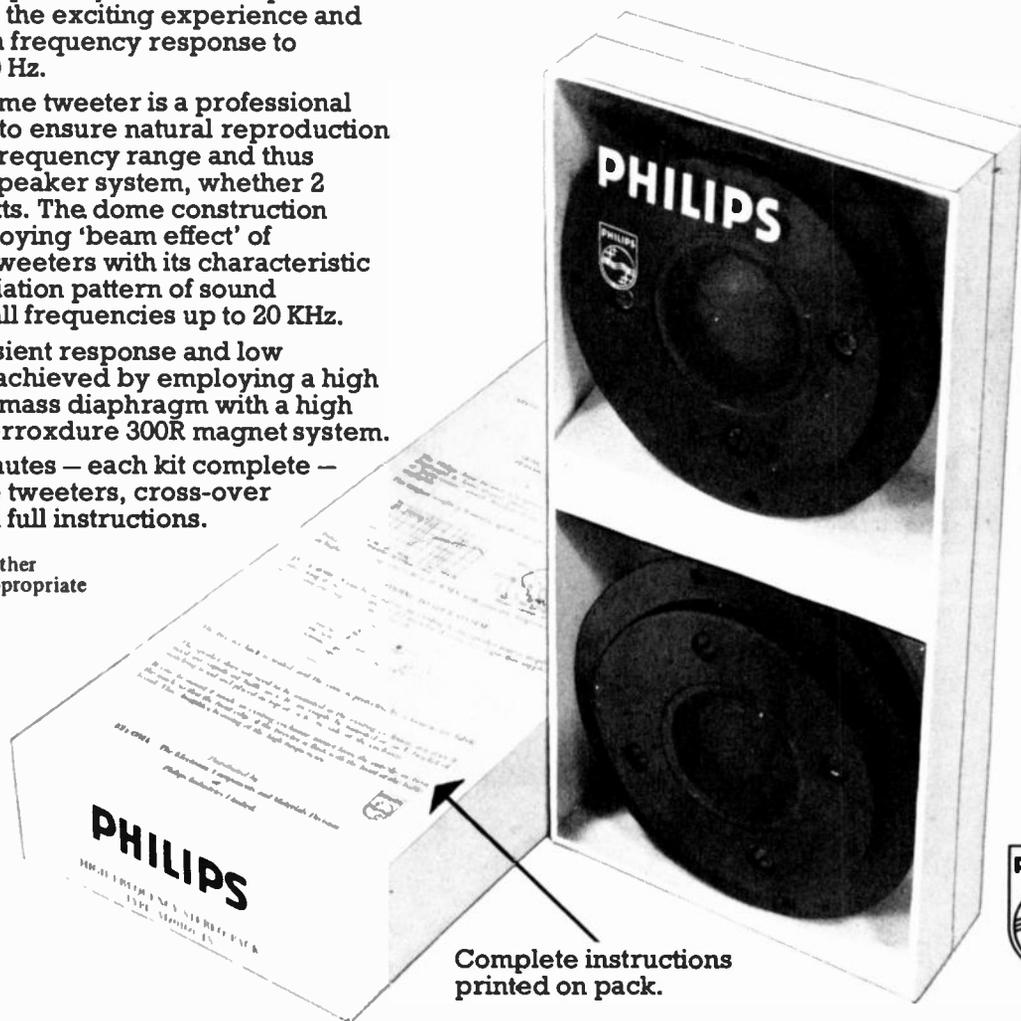
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BC108	.45
BC109	.80
BC177	.80
BD139	2.35
BDY20	1.65
BF115	.70
BFY50	.85
BPX29	1.10
BRY39	1.45
BT101 300R	3.60
BTY79 400R	3.60
BY126 400	.45
BY126 800	.70
BYX21L 200	1.05
BYX 21L 200R	1.05
BZX70 series	1.30
BZY88 series	.55
BZY93 series	2.10
BZY94 C12	.90
BZY95 series	1.40
BZY96 series	1.70
B8-320-01P/10E	.45
B8-320-01/50E	.45
C106F1	1.85
C106Y1	1.60
D13T1	1.35
EM401	.25
EM405	.30
EM406	.30
EM410	.45
EM506	.30
MB2	1.20
MB3	1.35
MB4	1.50
NE2	.25

OA90	.25
OA91	.25
OA95	.30
OA202	.40
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OC45N	.80
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2N4360	1.15
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RMG-2 10-415 PF	2.25
RMG-3 10-415 PF	3.10
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XL4-12	1.50
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XL-4-14	1.25
XL-4-14N	1.55
XL-4-31	1.65
XL-4-32	1.25
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XLP-5-12	1.95
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XLP-6-12	2.10
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XL-6-14	1.70
XL-6-14N	2.10
XL-6-15	6.30
XL-6-31	3.90
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XLP-7-11	2.60
XL-7-12	2.25
XLP-7-12	2.40
XL-7-13	2.45
XL-7-14	2.00
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C8.4L/15	5.25
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10.3G/15	6.05
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C3D/3.5	3.30
C4G/15	3.45
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C5G/3.5	3.95
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OPM7	8.70
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9 x 3 (1)	.60	
6 x 6 (.05)	.90	

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INTEGRATED AUDIO SYSTEM-ETI 425

With a genuine 25 Watts per channel, this combined record player/amplifier/radio tuner is truly portable yet has superb hi-fi performance.



TRADITIONALLY, hi-fi equipment is assembled from a number of separate units. And in a typical outfit these consist of an amplifier — without a separate preamplifier — a turntable, a radio tuner, and two loudspeakers.

If the equipment has been carefully selected this approach to hi-fi will result in magnificent sound, indeed many enthusiasts never consider purchasing (or building) hi-fi equipment in any other form.

But there are an ever-increasing number of people who are just not prepared to accept the inconvenience of units propped up everywhere, great festoons of interconnecting cables draped around the furniture, and multi-cubic-foot speaker enclosures determining the furniture layout in the rest of the listening area.

Apart from this, many people live a relatively mobile life — and have a need for possessions that are easily moved. Two JBL Sovereigns certainly have a superb sound — but have you ever tried taking them to a party in the back of a Mini Minor?

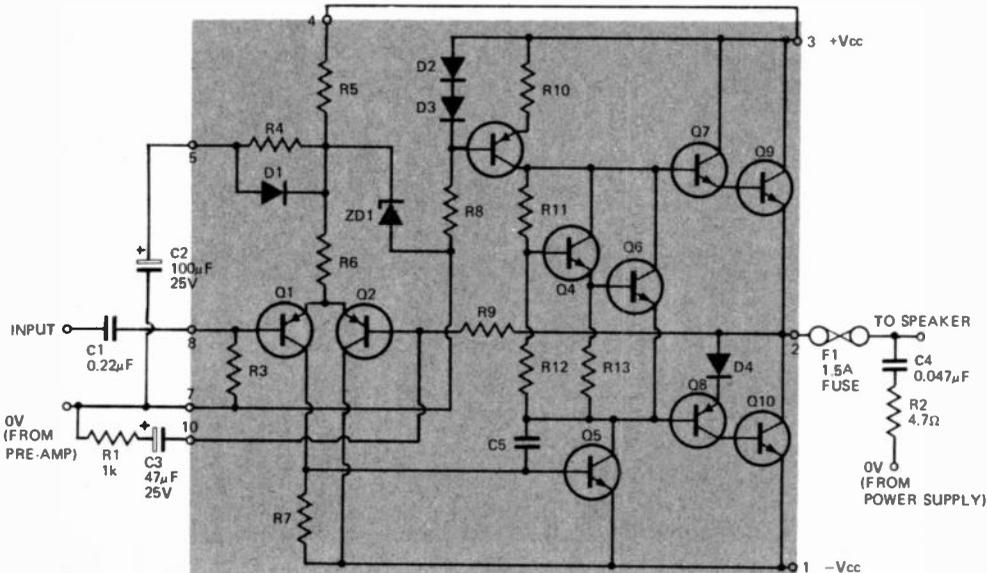
Hence the ever increasing demand for what the British call 'unit audio' hi-fi systems in which one unit contains record player, preamplifier and amplifier (with or without a radio tuner). A pair of small speaker enclosures complete the outfit.

There are many such units commercially available — but with a few exceptions most of them are built down to a very basic specification. Typically, they consist of a simple turntable, a stereo amplifier with (at best) a couple of watts output (tho' this may well be described in the sales literature as 25 watts. And so it is — by their method of calculation), and a pair of thin plywood speaker enclosures each containing a single five or six inch loudspeaker.

The better of these systems are excellent, but the performance of

ETI PROJECT 425

Fig. 1. Circuit diagram shows one channel of the main amplifier unit. Shaded portion is hybrid module.





MEASURED PERFORMANCE OF ET1 425 AMPLIFIER

Frequency Response 50 Hz to 20kHz \pm 1dB (controls flat)		
Total Harmonic Distortion (at rated output 50Hz to 20kHz) 0.5% (one channel driven)		
Input Impedance 50 kohms — all inputs		
Input Sensitivity for rated power at 1kHz		
Auxiliary		150mV
Magnetic pickup		2mV
Radio		150mV
Tone Control Range		
Bass boost	10dB at	100Hz
Bass cut	12dB at	100Hz
Treble boost	12dB at	10kHz
Treble cut	12dB at	10kHz
Channel Separation — better than 40dB		
Hum and Noise below 25W		
Auxiliary		70dB
Magnetic		(40dB — 50Hz 70dB noise)
Rated Power Output 25 watts into 8 ohms per channel		
Protection 1.5A fuse internal for each speaker.		

NOTE ON EARTHING

The shield on the inputs should be continuous and connect to both the power amplifier board where shown and also to the O line on the preamp. The preamplifier should have both +18v and O lines coming from the main amplifier board.

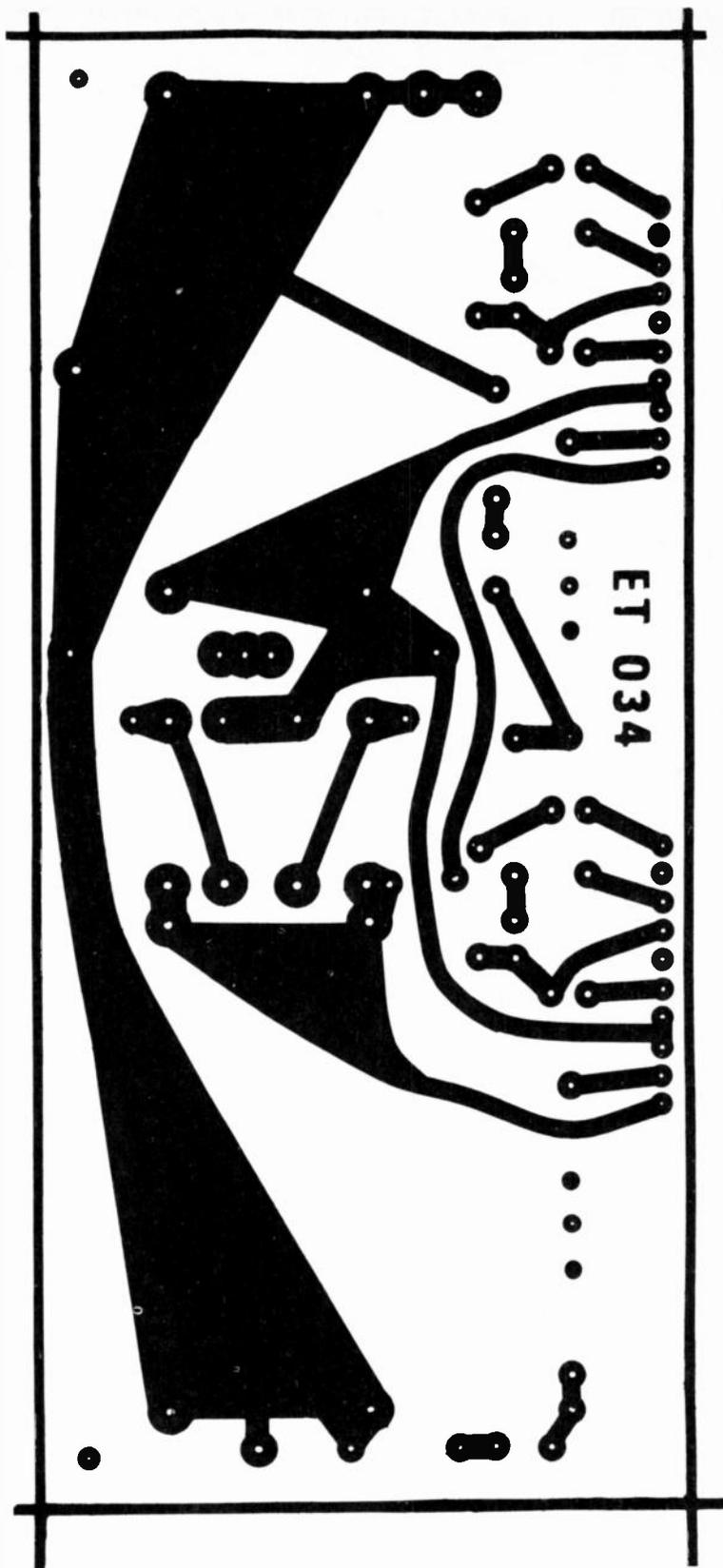


Fig. 2. Foil pattern of printed circuit board (full size)

the great majority could not reasonably be described as hi-fi.

There is a known and substantial demand for a high quality integrated audio system presented in project form. Here then is our ET1 425. The unit consists of a Silcron Mark IV turntable, preamplifier, a true 25 Watts per channel stereo amplifier (300 Watts by many US rating methods) and broadcast-band radio tuner.

BUILT-IN FOUR-CHANNEL SIMULATOR

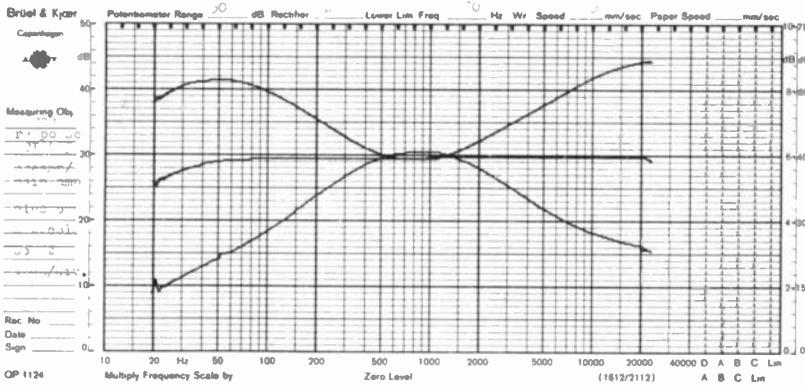
As those who have tried it will confirm, the technique of simulating four-channel sound by connecting two rear-mounted speakers differentially across the main amplifier output is surprisingly effective. So much so in fact that we have incorporated this facility within this unit. Hence the REAR

VOLUME control located on the left-hand side of the control panel.

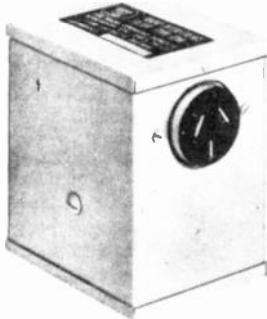
SPEAKER ENCLOSURES

For effective stereo separation, loudspeakers must be located at least six feet apart. This precludes building them 'in unit' with the amplifier/player section. Therefore two separate speaker enclosures must be used (together with a second,

INTEGRATED AUDIO SYSTEM-ETI 425



Parts List Power Amplifier ET425			
R1L, R1R	1 k ohm	½ watt	5%
R2L, R2R	4.7 ohm	½ watt	5%
R14	220 ohm	1 watt	5%
C1L, C1R	0.22µF	greencap 200V	
C2L, C2R	100µF	Elna type RB electrolytic 25V or equiv.	
C3L, C3R	47µF	Elna type RB electrolytic 25V or equiv.	
C4L, C4R	0.047µF	greencap 100V	
C6, C7	2200µF	Elna type RT electrolytic 35V or equiv.	
C8, C9	0.1µF	630 V	
C10			
ZD2	BZX70C18	18 volt Zener or equiv.	
D5, D6)	A15A rectifier or equiv		
D7, D8)			
ICL, ICR	Hybrid amplifier type TA25B (STC)		
main switch/indicator lamp		IRH type MLB-2065 R24	
Transformer A&R PT7778 40 Volts centre-tapped 1½ Amps (metal can) with electrostatic shield.			
PC board type ET 034			
Rear Panel/heat sink as per Fig. 5			
Sundries 3 core flex and plug, rubber grommet, cable clamp 4 double-screw speaker connectors John Carr type AT522 or similar 3 double RCA sockets John Carr type AT631 1 DPDT slide switch, sundry nuts & bolts.			



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smaller, pair if the four-channel facility is used).

Any top-quality commercially produced loudspeakers may be used with this unit — the smaller bookcase mounting units such as the Acoustic Research AR6 or the smaller Advent are ideal.

For those who prefer to build their own speakers we are offering the choice of two.

Firstly, we have a modified version of the Magnavox 8-30 system described (and reviewed) in our August issue.

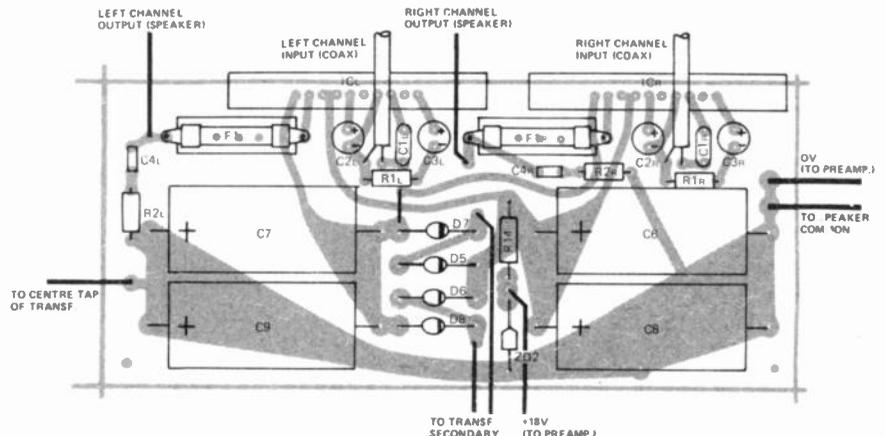
At that time our reviewer stated that "if it were not for the tweeter letting down the side a little above 5kHz, we would most probably have been able to equate them with the best speaker systems costing five to ten times as much."

We have now remedied this — by using a different type tweeter — and so, as part of this series we will describe the construction of the 'Modified Magnavox' together with details showing how existing enclosures of this type may be brought up to our latest specification.

Secondly we will describe the construction of a smaller enclosure (approximately one cubic foot) using the same tweeter and drive unit as the larger enclosure.

The performance of the smaller enclosures is excellent — and more than adequate for most users. The main difference between the two is the output in the extreme bass register — where the larger unit has a slight edge. Cost of the two units is practically identical, but in many

Fig. 3. How the components are mounted on the printed circuit board.



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JAYEM Model 100K



51 Ranges: DC Voltage—0-0.3, 0.6, 1.2, 1.5, 3, 6, 12, 30, 60, 120, 300, 600, 1200; AC Voltage—0-1.5, 3, 6, 12, 30, 60, 150, 300, 600, 1200; DC Current—0-15, 30 μ A, 3, 6, 30, 60, 150, 300 mA, 6, 12 A; Resistance—0-2K, 200K, 2m Ω , 20m Ω (centre scale 20); Decibels—20 to plus 63 in 6 ranges; Output—0-1.5, 3, 6, 12, 30, 60, 150, 300 volts • Accuracy: \pm 3% full scale, DC voltage and current; \pm 4% full scale, AC Voltage • Sensitivity: 100,000 ohms/volt DC (50,000 in VA/2 position); 10,000 ohms/volt AC (5,000 in VA/2 position); DC circuit sensitivity = 15 μ A, 300mV • Meter Movement: 5" meter, 9 μ A full scale • Batteries: Requires two type C cells for ohms function • Size: 2 3/4" x 5 1/4" x 7 1/2".

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22 Ranges: DC Voltage—0-6, 30, 60, 300, 600, 1200; AC Voltage—0-12, 60, 120, 600, 1200; DC Current—0-60 μ A, 30mA, 300mA; Resistance—0-2K, 200K, 2m Ω (centre scale 36); Decibels—10 to +63 (in 5 ranges) • Accuracy: \pm 3%, DC Voltage and Current; \pm 4%, AC Voltage • Sensitivity: 30,000 ohms/volt DC; 15,000 ohms/volt AC • Meter Movement: 3 1/2", 27 μ A full scale • Battery: Requires one, type AA Penlight cell for ohms function • Size: 2" x 5 1/2" x 3-1/8".

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JAYEM Model 50K (not illustrated)

43 Ranges: DC Voltage—0-0.3, 0.6, 1.5, 3, 6, 12, 30, 60, 150, 300, 600, 1200; AC Voltage—0-3, 6, 15, 30, 60, 120, 300, 600, 1200; DC Current—0-30, 60 μ A, 1.5, 3, 15, 30, 150, 300mA, 6, 12A; Resistance—0-3K, 300K, 3m Ω , 30m Ω (centre scale 15); Decibels—10 to +17 db; Output—0-3, 6, 15, 30, 60, 120, 300 volts • Accuracy: \pm 3% full scale, DC voltage and current; \pm 4% full scale, AC voltage • Sensitivity: 50,000 ohms/volt DC (25,000 in VA/2 position); 5,000 ohms/volt AC (2,500 in VA/2 position); DC/circuit sensitivity = 30 μ A, 120mV • Meter Movement: 4" meter, 20 μ A full scale • Batteries: Requires three type AA penlight cells for ohms function • Size: 2-3/4" x 4" x 6".

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INTEGRATED AUDIO SYSTEM-ETI 425

rooms the smaller units are far easier to house. Remember that it is impossible to reproduce extreme bass in small rooms — and for most of us the ability of some speakers to reproduce a 30Hz note is of purely academic interest.

MODULAR CONSTRUCTION

As there is a known demand for a simple high performance stereo 25 Watt amplifier for separate use — the main amplifier/player unit has been designed as a number of separate 'modules'.

The main amplifier and power supply system have been combined on one board — with the power transformer located separately — and in this form the module may be used as a self-contained twin 25 Watt amplifier.

The preamplifier and the radio tuner are also designed as separate units — and like the main amplifier may be used independently, provided a suitable power supply is available.

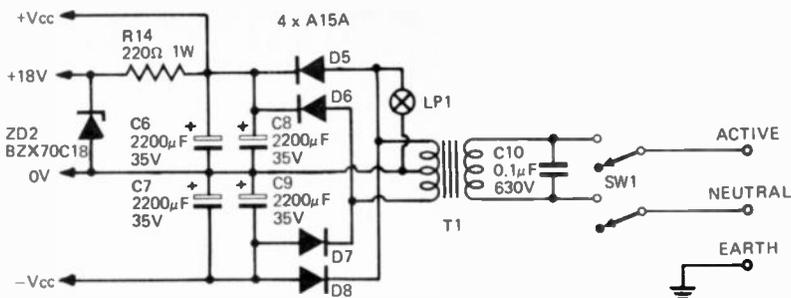


Fig. 4. Power supply.

As this is a fairly complex project, constructional details will be published over a period of several issues. In this first section we describe the construction of the power supply and main amplifier. Subsequent issues will cover the preamplifier, radio tuner, metal work, woodwork, speaker systems, etc.

MAIN AMPLIFIER

The main amplifier is built around a pair of 25 Watt TA 25B hybrid modules, and as can be seen from the component overlay drawing (Fig. 3), there are few other components except for capacitors and four diodes — and most of these are part of the power supply!

The complete circuit diagram of

(one channel) of the main amplifier is shown in Fig. 1. Note that everything shown within the shaded area is in fact contained within the hybrid power amplifier module. The full circuit, and component numbers are given purely to assist understanding of the 'How It Works' section.

CONSTRUCTION

As with most projects of this type, correct component layout is necessary to ensure optimum performance. For this reason, as well as that of easier construction, we very strongly recommend that printed circuit boards be used.

Figure 2 shows the foil pattern for the main amplifier board. This has been drawn full size to assist those who wish to make their own boards — however printed circuit boards for this project will be commercially available from a number of the suppliers listed in our 'Suppliers Guide' (on page 124 of this issue). In order to reduce cost and simplify construction, the rectifier bridge, smoothing capacitors and zener diode forming the power supply are all located on the main amplifier printed circuit board.

Assemble all components on this board, paying particular attention to ensuring that diodes and capacitors, are the right way round for correct polarity (Fig. 3 refers). The two hybrid amplifiers are mounted vertically with their shiny metal heat sinks facing away from the board. In the final assembly, this complete unit is screwed to an aluminium panel that forms the rear section of the amplifier/player case. Under no circumstances, should the amplifier be used without a heat sink panel in place. Such operation would damage the modules.

The power transformer is mounted apart from the board — in the base of the amplifier/player assembly.

If an oscillator or preamplifier is available, the completed main amplifier board and power supply may be checked out for correct operation by temporarily connecting the power transformer to the board and a pair of eight ohm speakers to the amplifier outputs.

The next instalment of this project will describe the design and construction of the preamplifier. ●

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.

Those components within the shaded panel are within the module and those external to the shaded panel are the additional components mounted on the printed circuit board. Values for external components, only, are provided on the circuit diagram.

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 module output stage is of the type known as quasi-complementary symmetry. Transistors Q9 and Q10 are both NPN types whereas in a normal complementary output stage Q10 would have to be a PNP type. High power PNP transistors are expensive to make and therefore the driver transistor for Q10 (much lower power) is a PNP type giving the output stage the same overall characteristics. Diode D4 is included for temperature compensation.

The output stage bias is provided by Q4 and Q6, there normally being approximately 2 volts across Q6, dependant on temperature.

Transistors Q3 and diodes D2 and 3 are a constant current source for the bias network and the base of transistor Q7, whilst Q5 provides voltage drive to the network. The bases of Q7 and Q8 are thus driven simultaneously but at different dc levels by Q5.

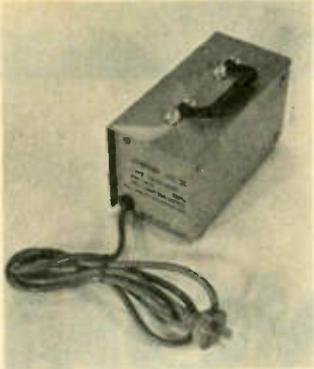
Transistor Q1 and Q2 are a differential pair with drive for Q5 being taken from the collector of Q1. Negative feedback is applied to the base of Q2 from the output, via ac divider network R9, C3 and R1.

The input is applied to the base of Q1 and the differential amplifier always tends to keep the bases of Q1 and Q2 at equal potentials, by supplying drive to the output amplifier and hence the feedback loop, until coincidence is reached.

The current through Q1 and Q2 is stabilised by ZD2 (approx 15V) and C2, R4 and D1 protect the amplifier on switch-off. When the power is switched off the differential pair continues to operate on the power stored in C4 thus preventing speaker "clicks" and damage to the amplifier modules.

POWER SUPPLY

The power supply is a conventional dual full-wave circuit with R14 and zener diode ZD2 providing a supply of +18 volts for the preamplifier.

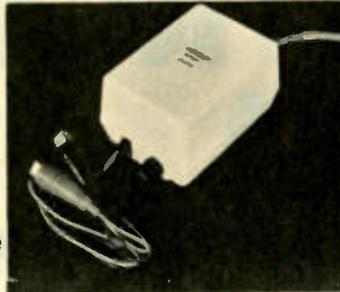


Step-down transformer

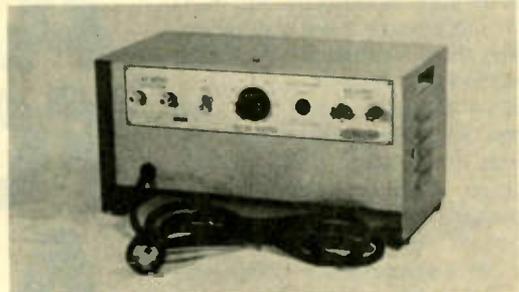
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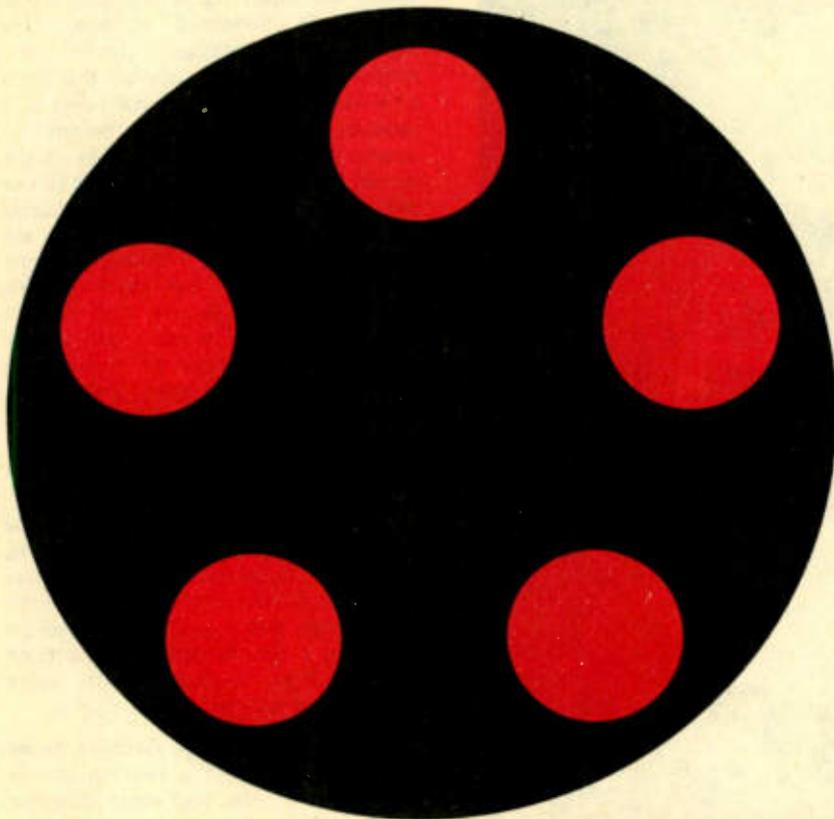
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THE basic detector system for a radiometer uses the principle of envelope detection. This technique can be realized by various methods.

If you are using a communications receiver, or a commercial or government surplus IF strip, then most likely it will already have a detector. All that is then required is to connect it to the recording system.

Individual detectors have their own advantage and disadvantages and you may wish to modify your existing detector or, if you are building your own receiver, then you will want to decide which detector to use. Here, a number of detectors are described, along with their advantage and disadvantage when used with a radiometer.

The series diode half-wave configuration shown in Fig 12a is in common use as an AM envelope detector. It is simple, and provides a

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a series - by Roger Harrison VK2 ZTB (ex VK3 ZRY)



dc output proportional to the input when the input signal is greater than the diode threshold voltage. This threshold voltage limits the weak-signal performance of this type of detector but the internal noise of a receiver is generally sufficient to overcome the threshold voltage of the diode. The most sensitive diodes to use are the microwave silicon mixer diodes (i.e. types IN21 or IN23) which are readily obtainable through some surplus stores, or the more modern hot-carrier type diodes such as the HP2800 (but these are more expensive). The use of the diodes mentioned above is only a refinement and ordinary germanium diodes such as the OA70, OA81, OA90, etc, or valve diodes such as the GAL5 or 6H6 are generally quite adequate.

The major advantages of the diode detector are simplicity, good linearity and high signal-handling capability. The main disadvantage is non-linearity — although this may be improved by providing a few hundred millivolts of forward bias. However with valve diodes, hum may present problems.

The full-wave voltage doubler diode detector shown in Fig 12b has all the advantages of the half-wave detector plus a greater output voltage. This is probably one of the best detectors to use in a radiometer as the sensitivity of this detector is much greater than the half-wave type. Overall receiver sensitivity is consequently improved

and higher output voltage is available to drive the chart recorder.

The infinite impedance detector shown in Figs 13a and 13b combines sensitivity, linearity, simplicity and high signal-handling capability, but has the disadvantage that a slight dc component appears across the cathode resistor or source resistor or the output. This requires either offsetting or dc blocking, using a capacitor and rectifier to recover the ac noise component. This increases the complexity of the detector but the sensitivity and linearity is better than a diode detector.

If your chart recorder has its own rectifier and dc amplifier circuits then the choice of the infinite impedance detector is a very good one. It can be coupled to the recorder via a 0.1 μ F capacitor.

But if you are building your own systems the choice is yours — one may wish to experiment. On the other hand, if you are using an existing receiver, then the detector system may be left as it is.

If you wish to modify a valve diode detector to use solid-state diodes, try to obtain the best diodes you can afford. In general, solid-state diodes are to be preferred. Be careful when handling microwave mixer diodes (such as the IN21 or IN23) as they are prone to break down from static charges or high leakage currents. Do not solder them in to circuit but make up a spring clip mounting to hold them.

Typical values for R1 in Figs 12a and 12b are between 100k and 270k. The values of capacitors C1 and C2 should be between 100pF and 1000pF for IF frequencies from 30MHz to 455kHz. For IF's in the VHF range, C1 and C2 should be between 22pF and 100pF. (Note that — as shown in several circuits in Part IV of this series — the secondary winding of the last IF stage need not be tuned.)

In Fig. 13a a valve having a medium amplification factor (about 20 to 50) should be used. Types such as the 6C4, 6J5, half of a 12AU7, etc, are excellent. The value of C1 should be 100pF to 100pF for IF frequencies from 455kHz to 30MHz. The value of R1 can be between 27k and 220k depending on the H-T supply voltage. The higher the supply voltage, the higher should be the value of R1. The value of C_a can be between 0.1 μ F and 0.01 μ F.

In the circuit shown in Fig. 13b the FET can be any inexpensive junction type such as the 2N3819 or 2N4354. The value of C2 may be the same as C1 in Fig. 13a and the value of R2 may be between 27k and 68k for supply voltages between nine and 12 volts. Some adjustment of R1 and R2 may be made in individual

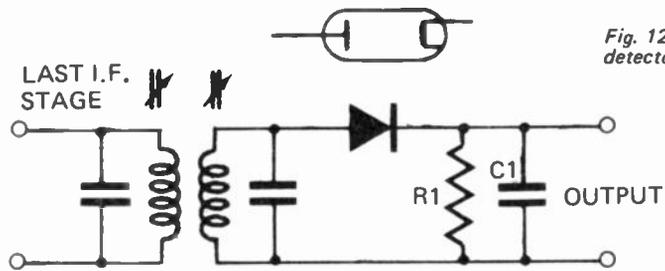


Fig. 12a. Typical series-diode detector (half-wave).

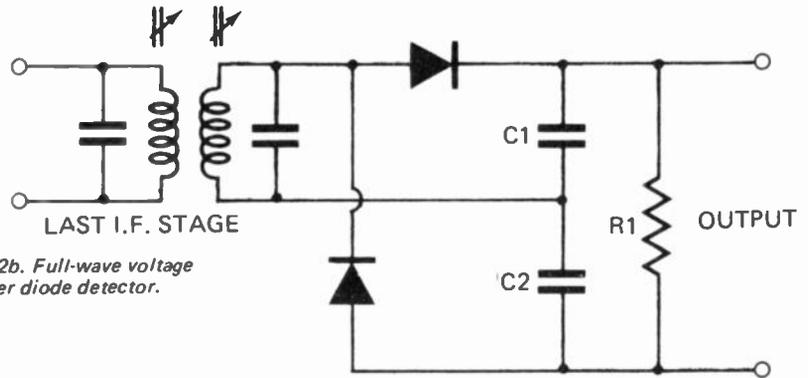


Fig. 12b. Full-wave voltage doubler diode detector.

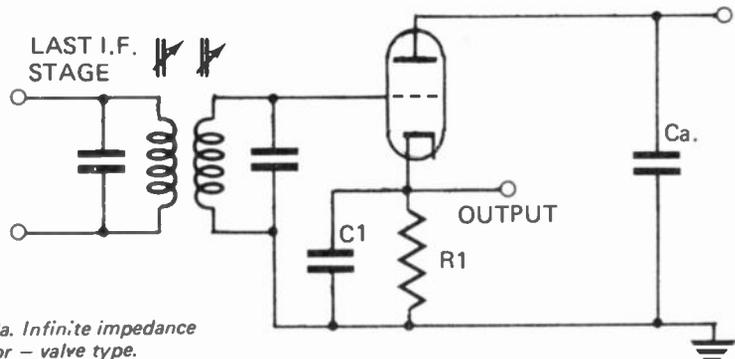


Fig. 13a. Infinite impedance detector — valve type.

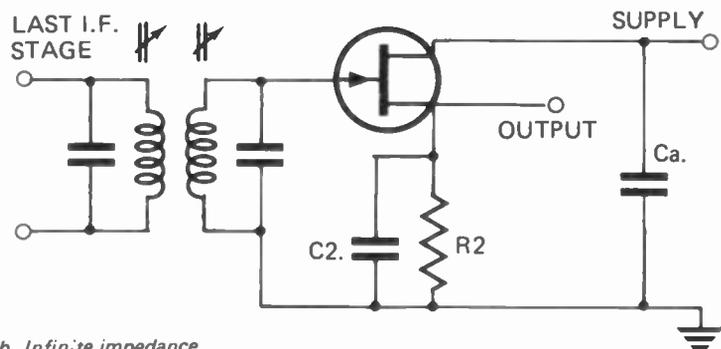
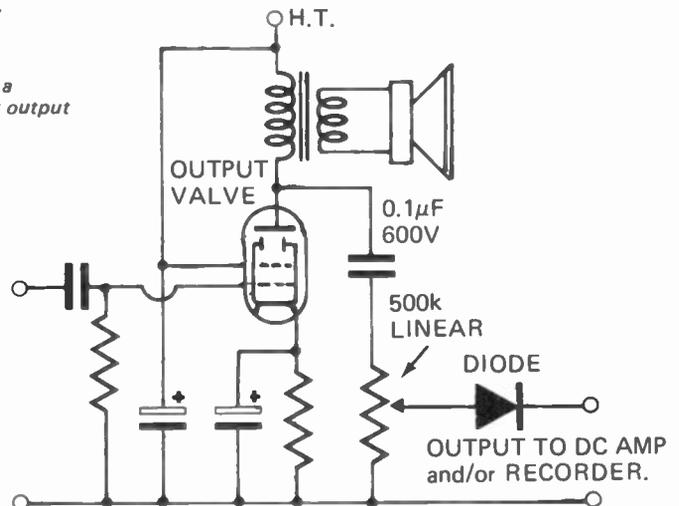


Fig. 13b. Infinite impedance detector — FET type.

Fig. 14a. Connecting a recorder to a receiver output stage.





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circumstances to optimize results. The value of C_a should be between 0.1 μ F and 0.01 μ F.

THE OUTPUT STAGE

The audio output of a receiver can be rectified and coupled to the chart recorder as shown in Fig. 14a or 14b. Figure 14a shows a typical valve output stage. In this circuit the audio signal at the anode of the output valve is taken off by a dc blocking capacitor and appears across the 500k potentiometer. This signal is then rectified and applied to the dc amplifier or chart recorder (if sensitive enough). Quite a high voltage is available here so that a potentiometer is needed to reduce the level to that desired, depending on the sensitivity of the chart recorder.

An alternative arrangement is shown in Fig. 14b. Here, the audio voltage appearing across the speaker terminals (or across a dummy load having the same value as the speaker impedance) is rectified and applied to the chart recorder. Much less voltage is available here but this scheme can be used with either valve or transistor receivers or where it is difficult to gain access to the existing detector in the receiver — or to the output stage. The hum and noise output of the receiver's audio section must be very low, otherwise weak signals will be masked and will not appear on the recorder. Voltage doubling rectifiers can be used in this application if desired.

The disadvantage of rectifying the audio output of a receiver is that the output is controlled by the audio gain control which must be set constant if measurements are being taken — and the sensitivity of the receiver calibrated at this setting.

The circuits shown in Fig. 14a and 14b may be added to a tape recorder so that chart recordings can be obtained from the magnetic tape.

MODIFYING AN FM DETECTOR

A typical FM detector is shown in

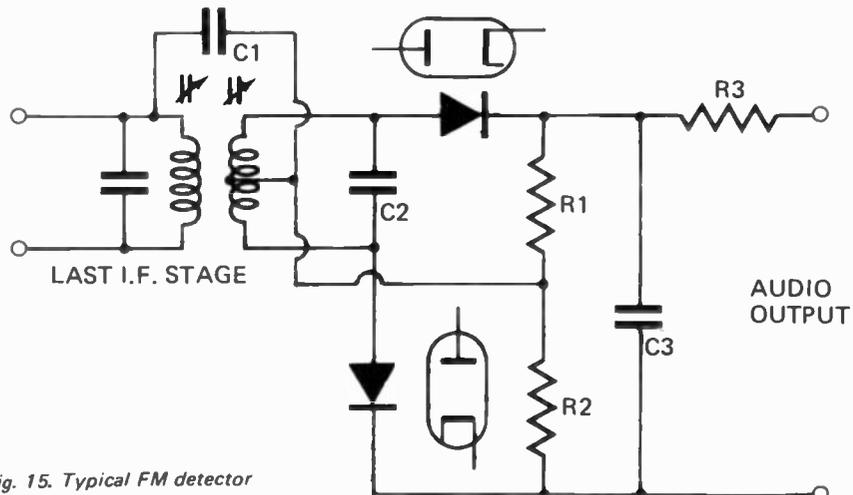


Fig. 15. Typical FM detector (discriminator).

Fig. 15. This type of detector is found in most FM receivers, particular mobile VHF transceivers. Their IF systems can be readily converted for use in a radiometer.

Capacitors C1 and C3 should be removed and the circuit changed to that shown in Fig. 12a or b. The resistor marked R1 in Fig. 15 may be used as resistor R1 in Fig. 12. The diodes may be used and the other components (R2 and R3) discarded.

The FM detector is usually preceded by one or two limiter stages. These should be modified so that the circuit values are the same as for the preceding amplifier stages. Any AGC circuit should be disabled and the AGC line grounded.

This should complete the modification. The linearity of the IF strip may be checked with a signal generator having a stepped attenuator in the output and a reasonably sensitive multimeter to measure the output voltage.

Starting off with a very low input signal (10 μ V for example), increasing the input signal voltage should result in an equal proportional increment of output voltage — continuously up to the point of overload.

To be continued . . .

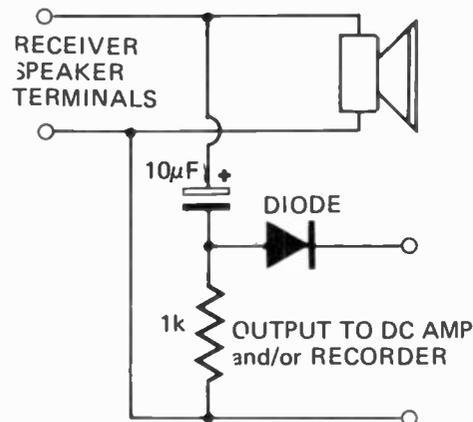


Fig. 14b How to connect a recorder across receiver's speaker output terminals.

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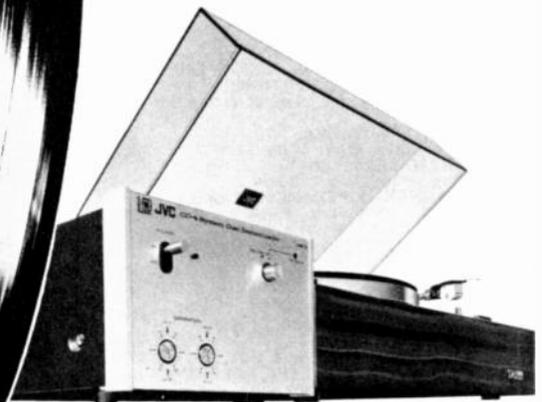
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Other than a basic 4-channel reproducing system and quality turntable, the only equipment you need to hear JVC discrete 4-channel records are the JVC 4MD-10X 4-Channel/2-Channel Playback Cartridge and JVC 4DD-10 Disc Demodulator. This equipment is now available at all JVC dealers.



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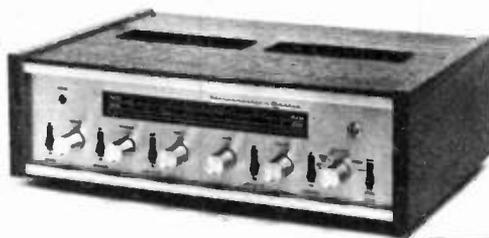
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DESOLDERING MADE SIMPLE

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

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

You need to buy some 1/8" copper braid as shown in Fig. 1. It costs about 11c a yard and can be obtained from electrical trade houses — preferably those who sell winding wire. Buy a few yards and cut it into lengths of about a foot.

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

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

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

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

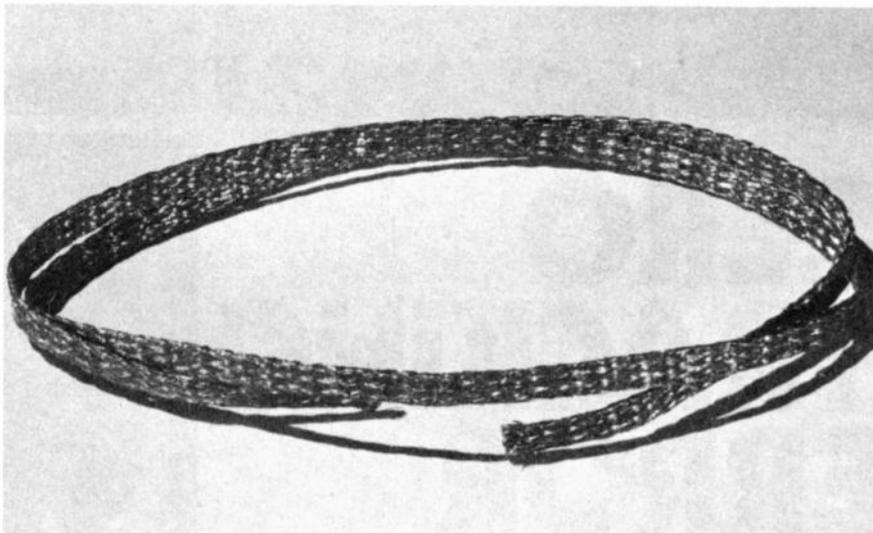


Fig. 1. The 1/8" copper braid.

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

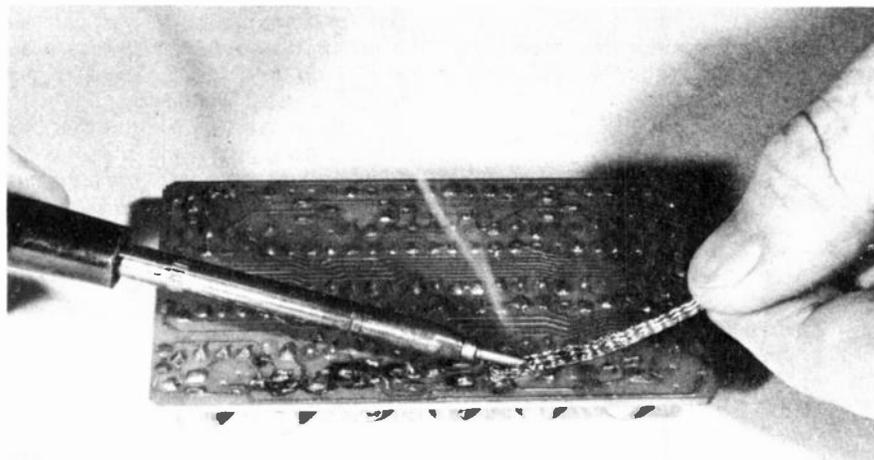
If you are desoldering devices whose leads have not been bent over at the back of a p.c. board, but pass straight through, first pierce a hole in the braid with a scribe and then surround the device lead with the braid.

This method with braid works very

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

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

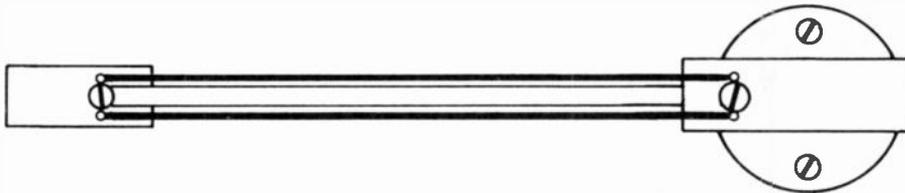
Fig. 2. Desoldering a computer board.





ZERO TRACKING ERROR

This zero tracking error turntable was designed over 40 years ago!



Our May issue featured a test of Garrard's Zero 100 turntable — which as readers will be aware has a pick-up arm designed to minimize tracking error.

Following publication, we received the following letter from Mr Jim Davis of Latrobe (Tasmania).

Dear Sir,

Your article on the Garrard Zero Tracking Error Arm is exactly 41 years late!

I have just added to my collection a magnificent Radiogram which was built in 1931 for a client in Tasmania.

The turntable of this unit consists of one of the very earliest crystal pick-ups and features a ZERO TRACKING ERROR ARM. I've never seen one like it before — but there it is!

The main pick-up arm is pivoted at both ends, that is, on the head shell at

one end — and on the balance weight at the other. The two parallel arms are also pivoted at either end. Thus there are six pivot points. As you can see from the photographs, the balance weight does not move sideways with the pick-up arm, it's a fixture to the base, it pivots up and down.

Now the interesting thing is that, no matter where you place the pick-up needle on any position of the arc from the outer edge of the record to the inner edge, the pick-up head always remains parallel to the fixed counterweight. The device provides the most perfect tracking I have ever seen.

Unfortunately I have been unable to discover the name of the company that built the machine — whoever they were it is a first class bit of engineering and the person concerned must have had a fantastic foresight into the future when he designed it. ●



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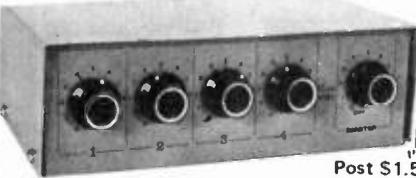


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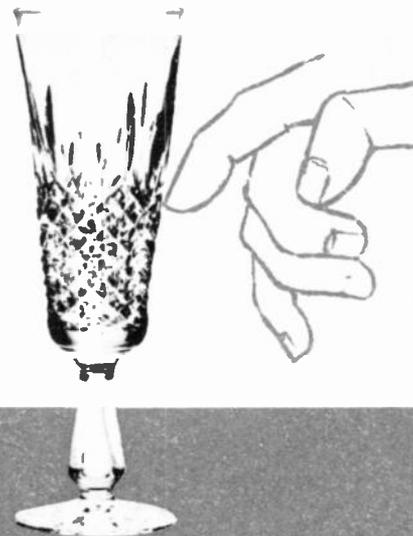
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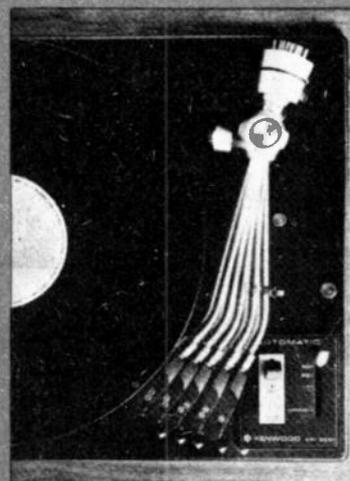
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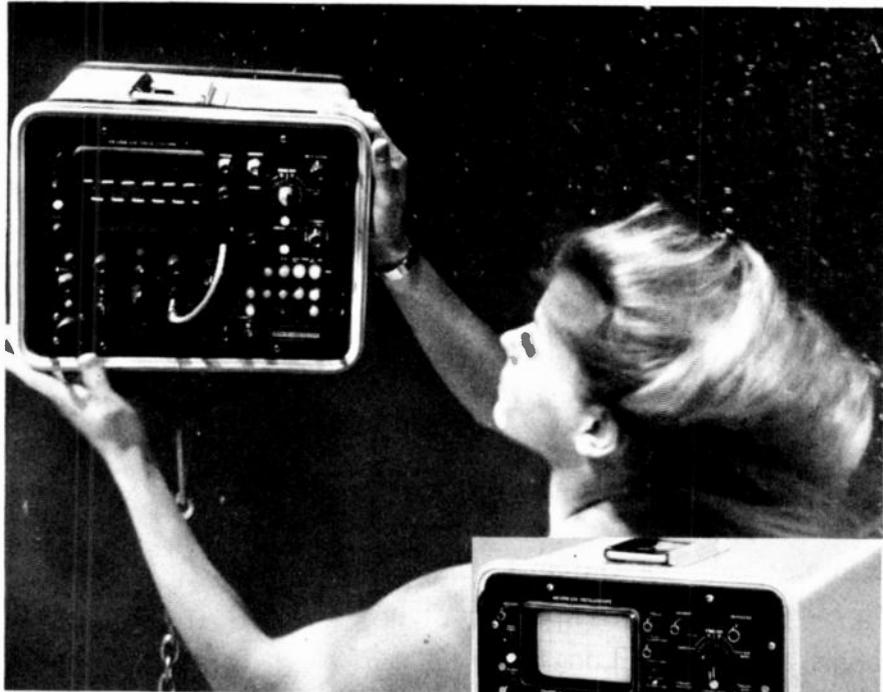
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Postcode

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EQUIPMENT NEWS

ENVIRONMENT-RESISTANT OSCILLOSCOPE



An oscilloscope to use where 'scopes ordinarily couldn't go is new from Hewlett-Packard. Model 1700E (for Environment-resistant) can be used on shipboard, for example, with no concern for what salt spray can do. Or it can be used in dusty environments, or in a chemical plant, refinery, or any other place where adverse atmospheres abound.

The new Model 1700E is able to go beyond the capabilities of earlier ruggedised oscilloscopes mainly because of the low power consumption of HP's series-1700 equipments. On ac mains power, these units consume less than 25 watts; then on their optional internal battery pack or on dc operation, power consumption is only 18 watts. Hence, no vent holes are required. The majority of components within the oscilloscope operate at only 10-20% of their rated power maximum, which assures low heat build-up and also favours reliability.

The Model 1700E has the capabilities normally associated with laboratory type instruments. The amplifiers have 10 nanosecond rise-time (35 MHz response) and a 10 millivolt/division deflection factor. It is a dual channel instrument with time-base capabilities suited as well for digital testing as for analogue measurements. Maximum sweep speed is 10 nanoseconds/division.

This is the first commercially designed oscilloscope capable of meeting the full Class 2 environmental requirements of MIL-T-21200. This means that the case, loaded with a weight equivalent to the oscilloscope, can withstand 14 drops from

30 inches on to concrete (once on each corner and once on each side) without losing its watertight integrity. The instrument can operate at temperatures between -40 and $+55^{\circ}\text{C}$ at altitudes up to 10,000 feet, and it can also survive 20 minutes operation at $+71^{\circ}\text{C}$. It withstands 15g shocks, applied as 11 millisecond ± 1 millisecond sawtooth, 18 times. It meets the specification requirements for the military oscilloscope AN/USM-339.

In designing the instrument to meet the MIL-STD-108 drip-proof requirement, HP engineers claim that they have succeeded in making it completely drip-proof - with front-panel cover removed! Gasketing is used around the front panel and around the cathode-ray tube face. Each pushbutton is covered by a self-sealing transparent plastic glove on the front panel. External ac/dc power is brought through the front panel so no additional holes need be made in the water-tight enclosure. If dropped in the water, the instrument would float, since the amount of water it displaces is greater than the 35 pounds it weighs.

Further details from Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, Victoria. 3146.

TWO NEW MODEMS FROM RACAL-MILGO

Two new high speed modems will further extend the Racal-Milgo range to what is probably the largest in the world.

New standards of performance at 4800 bits per second and greatly increased ease of operation are provided by the modem 4600/48.

System adjustment and check-out can be accomplished by one man at one end of a point-to-point data link. This modem is also particularly suitable for multi-station polled systems since remotely controlled equalisation and testing facilities are incorporated.

The other new modem 4800/72 uses a new modulation technique to provide data transmission at 7200 b.p.s. An automatic adaptive equalizer ensures that optimum performance is maintained under varying line conditions and also eliminates operator intervention. This modem, which incorporates comprehensive self-test features, is optionally available with three 2400 b.p.s. ports or one 4800 and one 2400 b.p.s. ports.

It is expected that 7200 b.p.s. data transmission will emerge as a standard speed for use on lines freely available throughout the world.

Further details: Data Communications Division, Racal Electronics Pty Ltd, 47 Talavera Road, North Ryde, NSW. 2113.

IRH AWARDED MONSANTO AGENCY

Natronics Pty Limited, the equipment division of IRH Industries Limited, has been appointed sole Australian agent for the Monsanto range of digital instruments.

Produced by the electronic instruments section of the U.S.-based Monsanto Corporation, the range comprises a wide selection of frequency counters and specialised communication instruments, including plug-in options.

Original users of electronic equipment in the United States ranked Monsanto in second place in a recent survey of the most widely recognised and accepted brands, conducted by the influential journal, "Electronic Design". The same result was achieved by Monsanto in a similar survey the year before.

Acquisition of the Monsanto instruments agency complements the activities of Natronics in the design and manufacture of digital equipment.

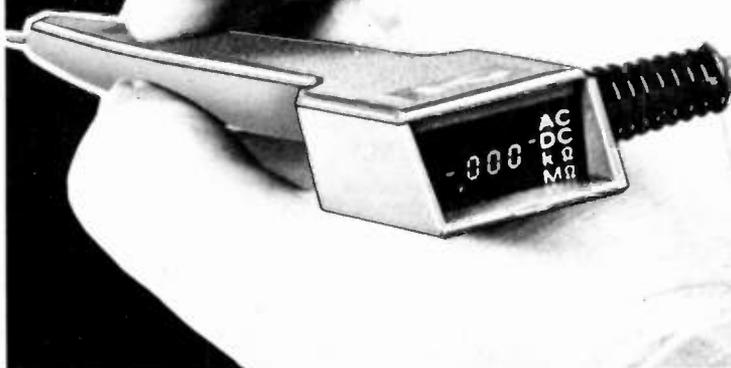
Further details: Natronics Pty Limited, The Crescent, Kingsgrove, NSW. 2208.



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EQUIPMENT NEWS

LOW COST COMPUTER WITH OPERATING SYSTEM



The PDP-8/F with OS/8 bulk storage operating system now offers the minicomputer user an economic alternative to paper tape with a complete system for less than \$13,200.

The operating system which makes this possible is a monitor that allows user or system programmes to be called from the system bulk storage device (disk or DECTape). It permits assemblies and compilations to be done from and to any I/O device handlers for the standard PDP-8 family of peripherals, allowing the user to call for input or output with simple read and write commands.

Available from Digital Equipment Australia Pty Ltd, the lowest cost configuration is built around the PDP-8/F computer, Digital's latest addition to the PDP-8 family. Core memory of 8,192 words is included in the OS/8 configuration.

Bulk storage is provided by the independent DECTape units, an extremely reliable magnetic tape system that has pre-recorded block and timing information. Digital has provided these units since 1964 and over 2,000 DECTape systems are now installed.

First deliveries of the complete system are planned for April 1972.

Further details from Digital Equipment Australia Pty Ltd, 75 Alexander St, Sydney, NSW. 2060.

ISRAELI-BUILT MEMORIES

Israeli-made disc memories are being incorporated into a stored-programme-controlled Telex Exchange which Hasler AG (Switzerland) is supplying to Australia's Overseas Telecommunications Commission. The equipment, to be installed in Sydney,

will form a vital part of Australia's modern and highly reliable overseas telecommunications facilities.

The disc memories are made by S.D.S.I. - Scientific Data Systems Israel Ltd - of Haifa, a company formed as recently as 1968 and specialising in the development, manufacture and marketing of rotary disc memories.

Two families of fixed-head disc storage devices are now being made by S.D.S.I.

They are the 720 Series RAD (Rapid Access Disc) and the 77 Series MINIDISC (entirely developed and designed by S.D.S.I.).

The 720 RAD Series comprises 11 standard models, providing fast-access data storage at low cost.

Capability of the models ranges from 6.42 Mbits to 51.3 Mbits on 64 to 512 data tracks. Fixed head-per-track magnetic heads offer an average access time of 20 milliseconds (at 50 Hz power) to the data stored on any of the tracks.

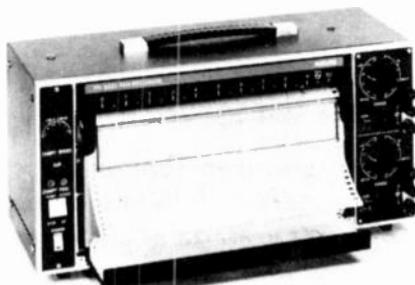
Range of application of the system covers such areas as communications and message switching systems and industrial process control. The storage systems are particularly suitable for on-line, time-sharing and other real-time application.

The S.D.S.I. MINIDISC is a memory device providing storage capacity of up to 6.4 Mbits on up to 128 tracks, at the short average access time of 8.4 msec. The compact unit allows for 19" rack mounting and it is available with standard or customized interfaces.

The Israeli company, despite its relatively small size, is geared to meet specific market requirements, by tailoring different versions of the basic equipment, to solve individual - and often highly complicated - engineering problems.

Further details from Australian-Israel Chamber of Commerce & Industry, Sydney, NSW.

MULTIPURPOSE DUAL-LINE RECORDER



A new two pen recorder has been added to the Philips range of chart recorders. The PM 8221 multi-purpose recorder is a dual-line vertical instrument, combining reliability with low cost. It has a 0.5% accuracy with a maximum sensitivity of 10 mV f.s.d. and a chart width of 250 mm.

Suitable for most laboratory applications, the PM 8221 will find particular application

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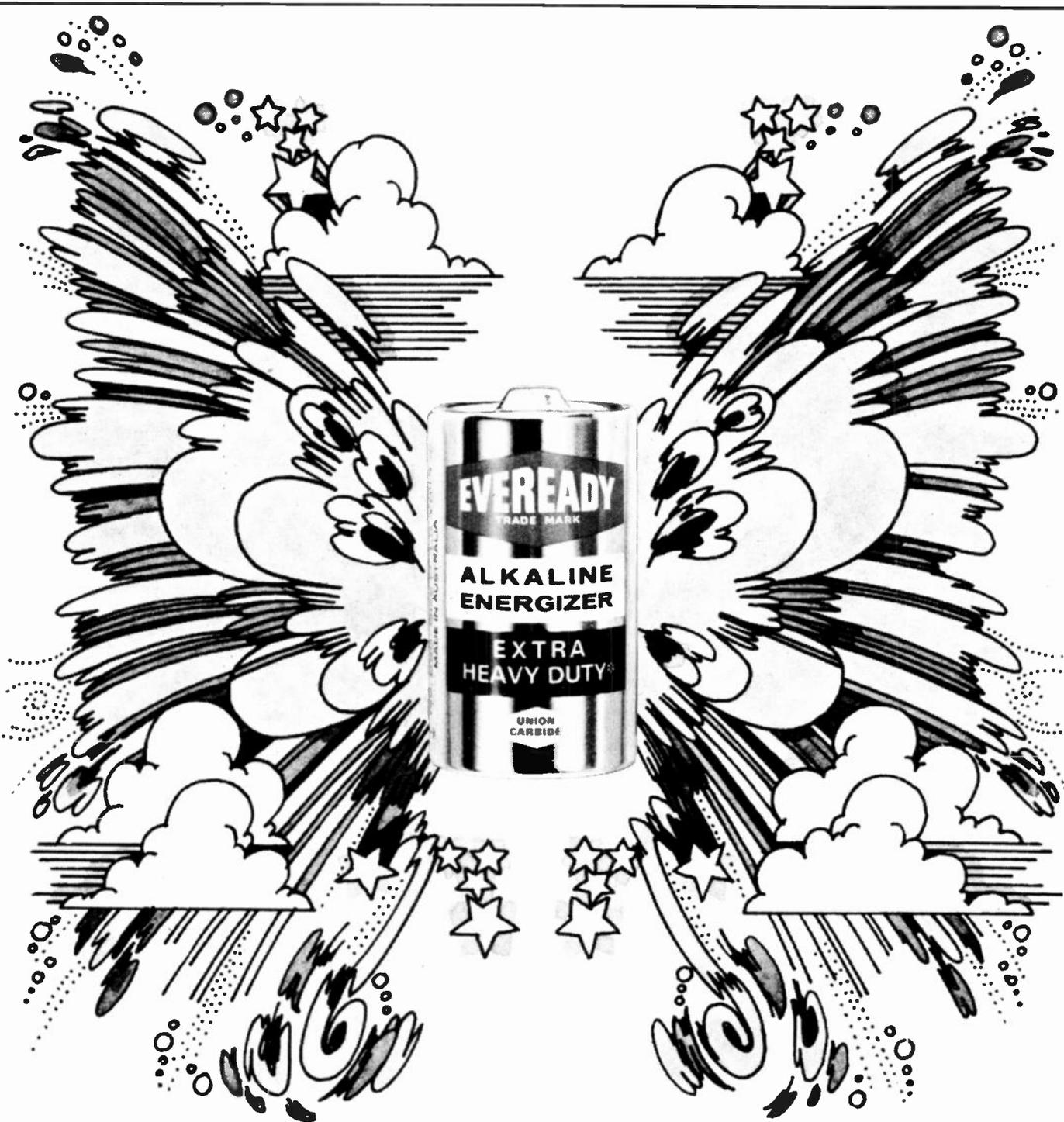
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EQUIPMENT NEWS

in the medical and chemical fields where there is a need to record interrelated signals simultaneously. Normally available as a bench model, it can be adapted for 19" rack mounting and can be easily rested on other test and measuring instruments when necessary. Its addition to Philips recorder range, complements at a relatively low price, the performance of existing flatbed models.

With six front-panel selected chart speeds of 2.6 or 18 cm per minute or hour respectively, the instrument features a special folded-chart magazine that is said to simplify chart access and checking. It permits the chart to be quickly unfolded to

locate a particular section of interest, and the resulting concertina-type folding ensures that used charts can be easily stored.

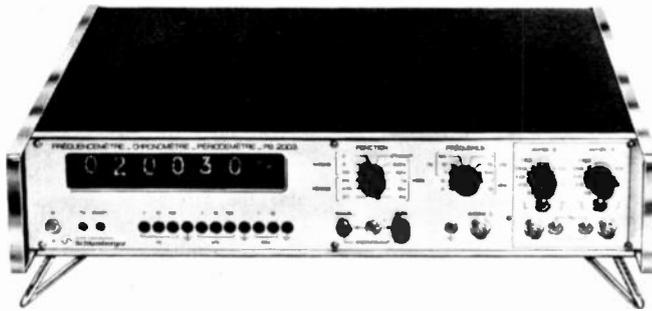
Another feature of the instrument is the sapphire pen tips, ensuring long recording life and consistent line-thickness with ink-flow adjustments made from its front panel, via pressure ducts. Further, large red and blue ink cartridges are employed eliminating repetitious filling operations and minimizing the chance of non-recording during long-term or life-test type runs.

The compact, lightweight PM 8221 makes extensive use of high stability components to ensure good reliability with a claimed

reproducibility (including long-term drift) of $\pm 0.15\%$ f.s.d. and an accuracy variation of only $\pm 0.2\%/10^\circ\text{C}$ at an ambient reference temperature of 25°C . Use of a dust-protected potentiometer in its null-balance system ensures maximum reliability in this area, and the instrument's modular construction simplifies any servicing need.

Input ranges available on the PM 8221 cover 10, 20 and 50 mV f.s.d. true potentiometric and 100, 200 and 500 mV, 1, 2, 5, 10, 20, 50 V f.s.d. via an attenuator input. A zero-check switch permits rapid checks to be made on zero accuracy and the range zero can be continuously adjusted over full scale.

Further details from Philips Industries Ltd, 95 York St, Sydney, 2000.



PRECISION DIGITAL COUNTER

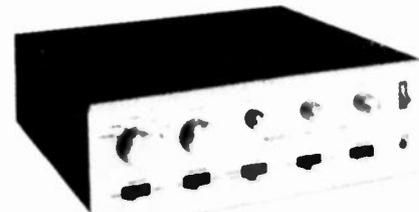
The Schlumberger/SIS Digital Counter FB 2003/0, with a bandwidth of 0-40MHz, measures frequency, periods, multiple periods, positive or negative pulse duration, duration of a short circuit and time intervals with a typical stability of 3.10^{-8} per day.

High reliability is achieved with TTL integrated circuits, and the six digit display is enhanced by the use of non-blinking indicator tubes.

Various add-on modules are available to

DYNACO 4-D AMP

the same cost as 2 channels



The SCA-80Q
kit
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The most logical choice for a compact, powerful control amplifier is the new Dynaco SCA-80Q. The SCA-80Q not only is a one-piece stereo preamplifier and power amplifier, but it includes built-in Quadaptor™ circuitry for 4-dimensional stereo. No decoder is required.

The SCA-80Q is the same price as the SCA-80 which already has established a reputation for unexcelled value. The SCA-80Q has all the features as its predecessor and exactly the same performance. And you can connect either two speakers to it for conventional stereo, or four speakers for 4-D sound now (or later).

A 4-D system including the SCA-80Q and four full-range Dynaco speakers is the most economical and compact way to realize the full potential of your existing stereo library and FM stereo broadcasts. And as recordings made specifically in the 4-D format become more available, your enjoyment will be greatly increased.

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NEW DYNACO AMPLIFIER

EQUIPMENT NEWS

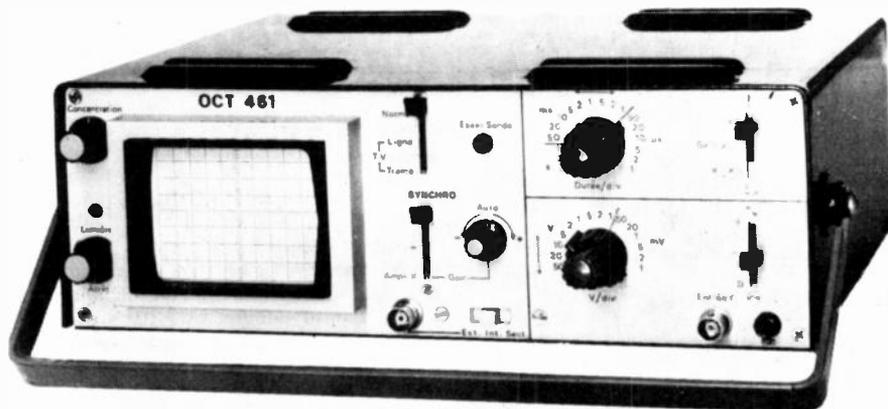
increase the operational flexibility of the counter — a 160 MHz divider, a 520MHz divider, a voltage to frequency converter, a preset divider and a drift expander.

The FB 2003/0 incorporates two independent inputs with shaping networks and trigger level and slope selection for noise rejection.

Further details: Schlumberger Instrumentation Australia Pty Ltd, PO Box 138, Kew, Victoria, 3101.

LIGHTWEIGHT PORTABLE OSCOPE

Recently released by the Schlumberger group of companies is the OCT 461 'ultra-portable' oscilloscope manufactured by Schlumberger CRC. Weighing 6 kg this transistorised instrument is designed to operate from both ac and dc power sources. An accessory battery pack provides eight hours independent operation. Bandwidth of the 461 is dc to 10 MHz at 1 mV per cm



sensitivity. Comprehensive timebase facilities include TV line and field synchronization, X expansion and automatic stability control. CRT screen size is 54 MM x 68 MM. Overall case dimensions of 12" x 12" x 4½".

Further details from Schlumberger Instrumentation Australia Pty Ltd, PO Box 138, Kew, Victoria, 3101.

NEW WESTON 551 FM RADIOTELEPHONE

Weston's Electronics new 551 VHF FM Radiotelephone is a frequency modulated transceiver unit designed for installation in motor vehicles or other mobile situations. The unit operates on fixed crystal-controlled channels in the bands 70-85 MHz, 92-94 MHz or 148-174 MHz. In association with a 240 Volt regulated power supply it may also be used as a Base Station.

The equipment is all solid state and incorporates integrated circuits and a dual protected gate MOS FET receiver front end.

The transmitter is claimed to be capable of sustained operation at 25 watts full output and is protected against the effects of antenna short or open circuits. The set as a whole is completely guarded against accidental reverse polarity connection, and also the effects of operation in ambient temperature and conditions exceeding the designed limits.

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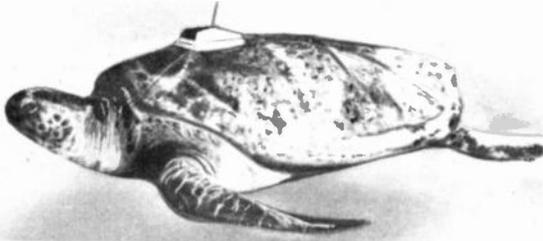
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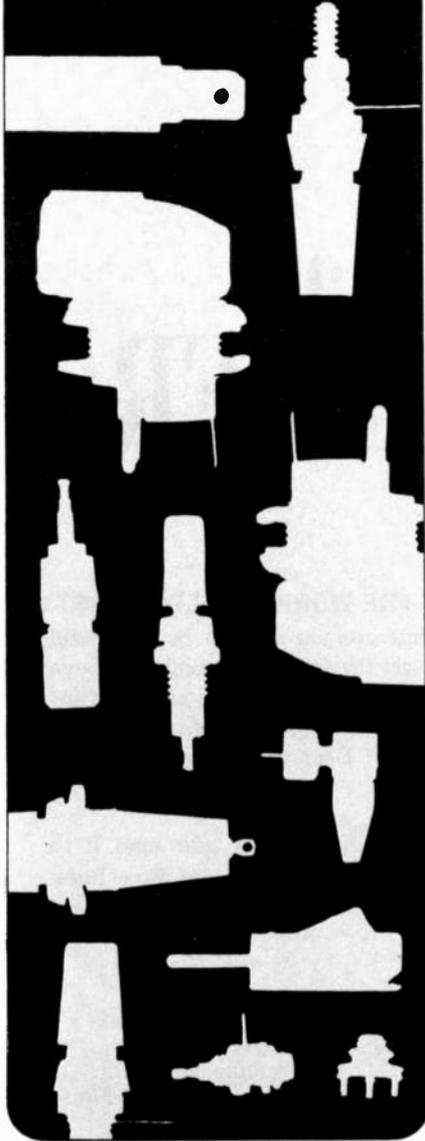
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EQUIPMENT NEWS



and either side may be externally grounded if desired. An internal electronically regulated power supply is provided for all critical circuits.

Construction is completely modular with plug-in printed circuits being used for both rf and dc circuitry. Separate oscillators are used for each receive channel, and both transmitter and receiver oscillators are trimmer adjustable for frequency netting purposes. Electronic switching is featured for remote channel selection.

Mechanical construction is of light weight, vinyl-clad aluminium combined with injection mouldings, ruggedised against extreme shock and vibration.

The 55 is claimed to exceed all requirements for 30 kHz channelling in accordance with P.M.G. specifications RB207 (high band) and RB206 (low band).

Options available include selective call (quiet channel) by modules fitted internally. Remote operation is by special dash mounted controller and included channel changing and talk through repeater capability.

The 551 is completely Australian designed and built.

Further details from Weston Electronics Pty Ltd, 376 Eastern Valley Way, Roseville, NSW. 2069.

TIME MARK GENERATOR FOR OSCILLOSCOPE AND RECORDER CALIBRATION

Hewlett-Packard have released a new Time Mark Generator, the Model 226A, which supplies narrow one-volt pulses at precise time intervals for calibration of time bases of oscilloscopes and recorders.

Any of 30 time intervals from 2 nanoseconds to 10 seconds in a 1-2-5 sequence can be selected by front panel control. An interval accuracy is claimed of $\pm 0.002\%$ after only $\frac{1}{2}$ hour warm-up, assured by a crystal controlled clock. The marker output impedance is 50 ohms.

Additionally, a 1 volt trigger output pulse is available. This can be used to externally trigger the oscilloscope being calibrated, or other equipment. The trigger rate is coincident with the markers up to the 100 nanosecond range. On faster ranges, the trigger is automatically counted down to 10 MHz.

A TTL-compatible programming option makes all ranges programmable with a 6-bit binary instruction. This option requires 6 parallel lines plus 2 timing lines. Use of the programming option permits computer control of oscilloscope calibration for example.

Further details:— Hewlett-Packard Australia Pty. Ltd, 22-26 Weir Street, Glen Iris, Victoria, 3146.

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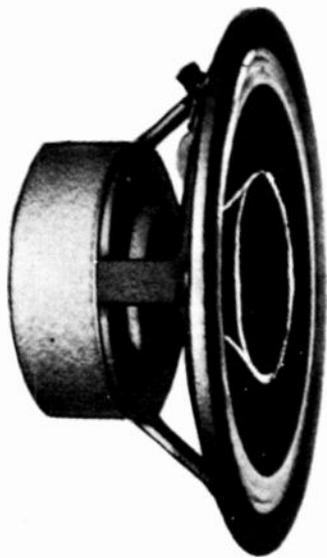
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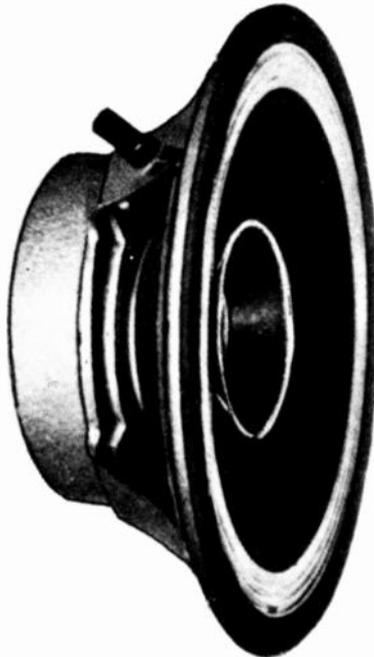
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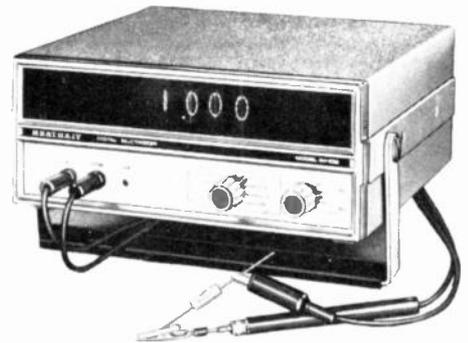
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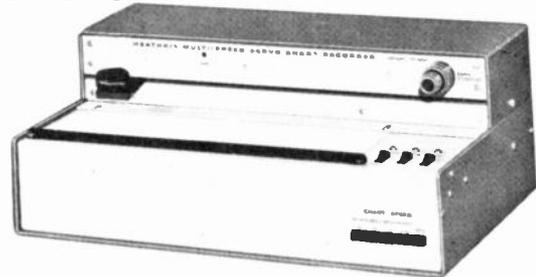
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- * Price Duty Free in Kits \$316.00 Wired \$446.00 Duty Paid kits \$401.00 wired \$531.00



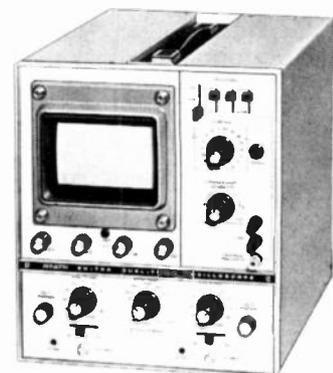
NEW SCHLUMBERGER/HEATH KIT MODEL IR 18M CHART RECORDER FEATURING:–

- * 12 chart speeds 5 seconds/inch to 200 minutes per inch
- * Two ranges 1mV and 10mV full scale
- * High input impedance
- * Floating input
- * Price of Kits Duty Free \$176.42 Wired \$219.22 Duty Paid in Kits \$247.34 wired \$400.14



NEW SCHLUMBERGER/HEATH KIT MODEL IO – 105 OSCILLOSCOPE FEATURING:–

- * DC – 15Mhz dual trace plus XY operation
- * 8 x 10 cm rectangular flat faced CRT
- * Automatic triggering
- * 18 position time base plus XS magnification
- * Price Duty Free in Kits \$470.54 wired \$547.54 Duty Paid in Kits \$659.69 wired \$776.69.



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(INCORPORATED IN N.S.W.)

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P.O. BOX 138, KEW, VICTORIA 3101. TELEPHONE: 86 9535. CABLES: SINSTRAL, MELBOURNE

ANNOUNCING THE *Sansui* HI-FI STEREO "SANSUI FORD ESCORT" COMPETITION!



\$5000 PRIZES TO BE WON!

*IN CONJUNCTION WITH
MODERN MAGAZINES (HOLDINGS) LTD.

The Sansui Ford Escort competition being run in conjunction with Modern Magazines offers you the chance of winning two car stereo players at each of six race meetings in the 1972 Series . . . and two fabulous Sansui Four Channel Quadphonic Sound Systems . . . all in all worth \$5000! All you have to do is estimate the fastest lap time of Bob Holden's Sansui Ford Escort - and you've won yourself a new car stereo. Twelve car stereo systems will be given away! And two lucky race enthusiasts will win a Sansui Quadphonic System! Get an entry form now!

HOW YOU ENTER:-

Get your entry form from any dealer who sells Sansui hi-fi equipment. Entry forms will also be available at each of the six race meetings specified for the Sansui Ford Escort competition . . . look for the Sansui marquee!

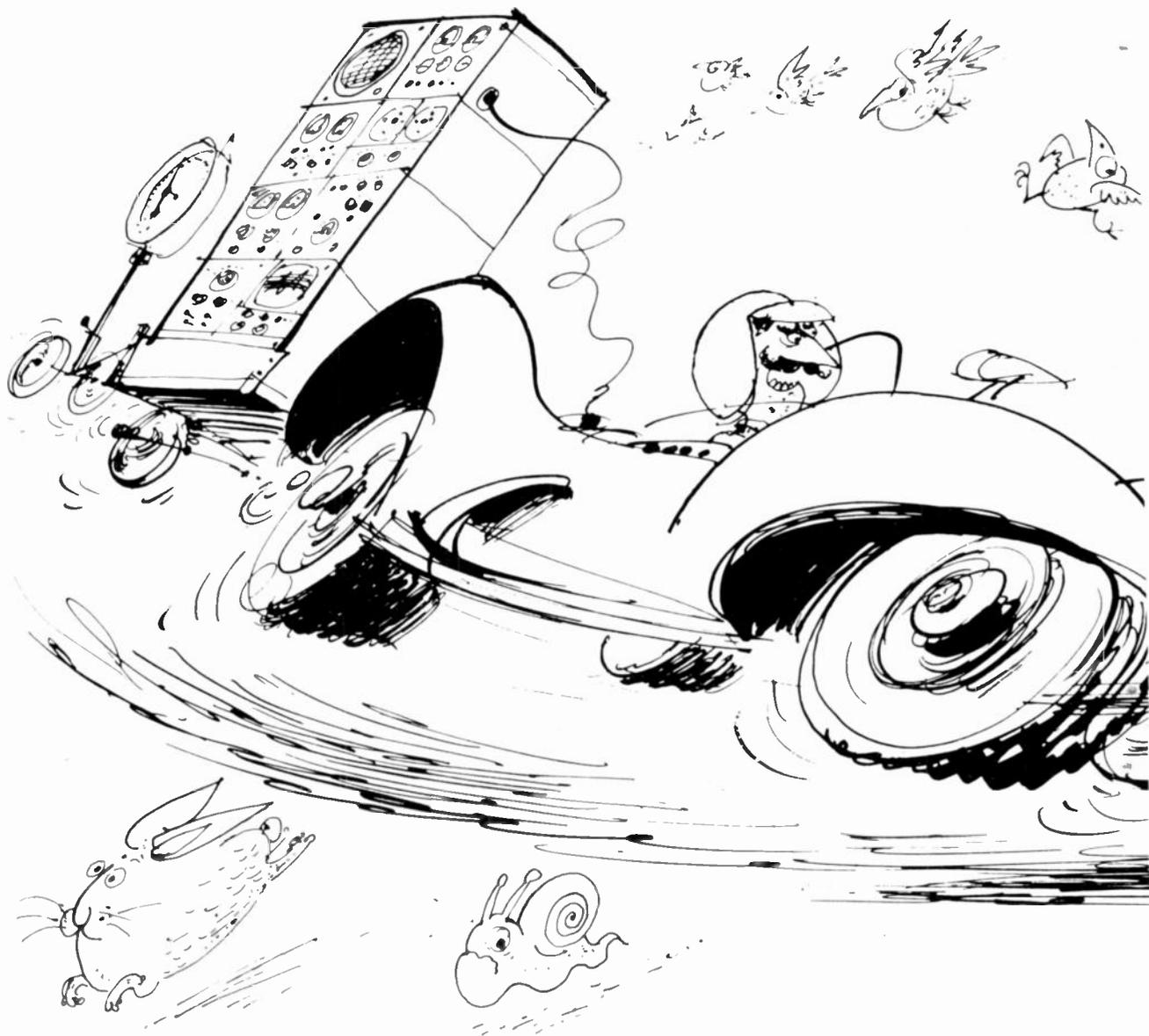
CONDITIONS:-

- Only one entry per person at each meeting.
- The judges decision is final and no correspondence will be entered into concerning judging.
- Winners will be advised in writing after each meeting.



Measuring small, rapid changes in stress is just one thing our DVM's do.

May we tell you about some others?



We match DVM techniques to your requirements. If it's accuracy and noise rejection that you want, we use integration. For speed, successive approximation. For low price, ramp conversion. For flexibility plug-ins or options to give more functions and operational improvements. You have problems: we have answers. Some outlined below.

For the ultimate in value

Because of its plug-in design, our new 3480A measures dc, ohms, true rms, ac, with high accuracy and with great flexibility. Add programming capability and a measurement speed of 1000 readings per second, and you have an instrument as ideal for systems as it is for bench applications.

For the ultimate in accuracy

5 digit resolution and 145 dB common mode noise rejection make our 3460B one of the most precise dc digital voltmeters available. Add a 3461A ac/ohms converter and you have a programmable system capable of accurately measuring dc, ac and resistance.

For the ultimate in versatility

Our 3450A digital multi-function meter performs 12 tasks equally well: dc - true rms - ac - ohms - dc ratio - dc limit test - ac ratio - ac limit test - ac ratio limit test - ohms ratio - ohms limit test - ohms ratio limit test. More versatile than this, they don't come!

The ultimate in resolution

Our 3462A reads 1 microvolt in 1V, or 1mv in 1000 V. In other respects, similar to our 3460B.

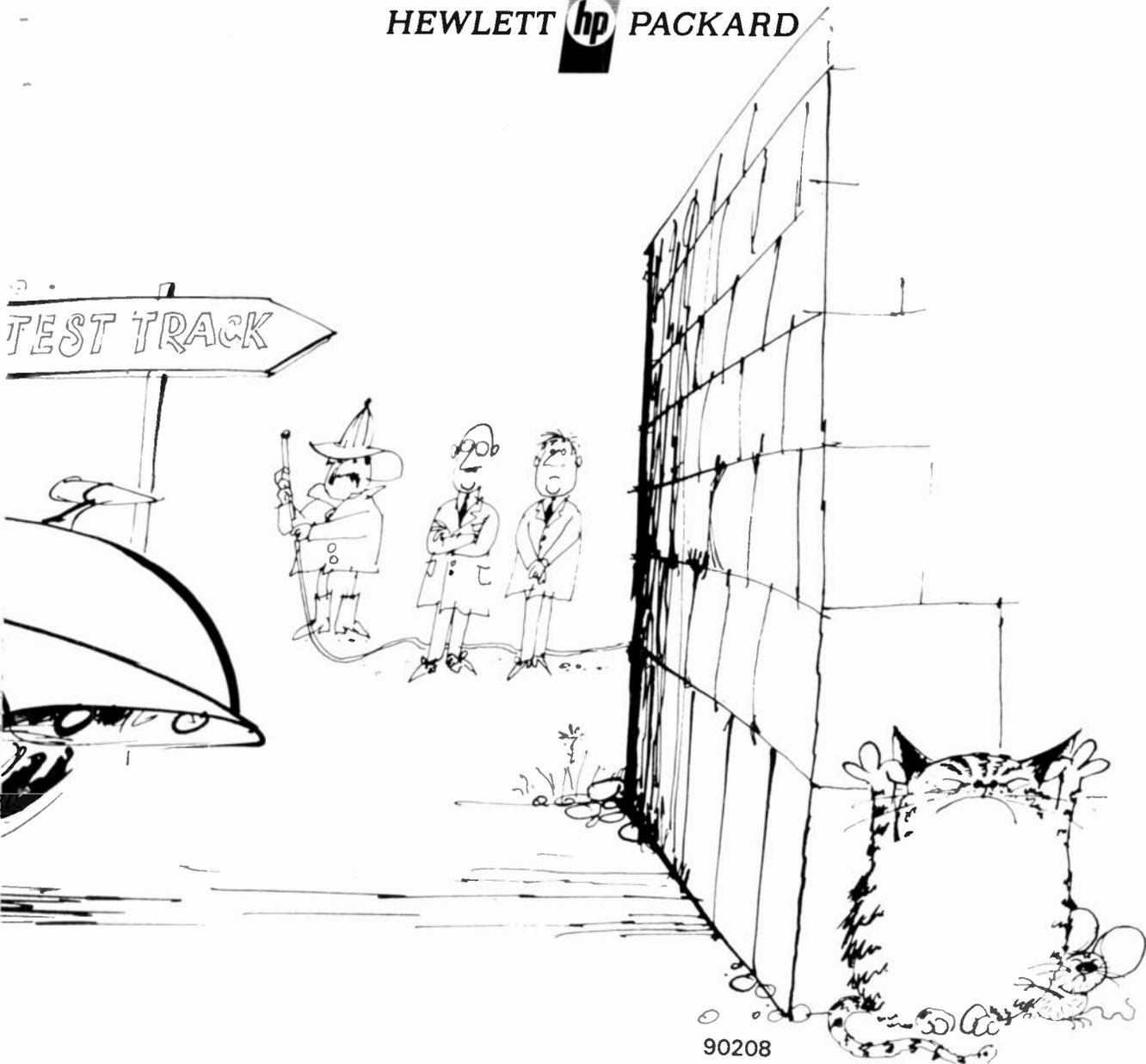
For precision and economy

Our 3430A and 3440A offer a wide choice of measurement capabilities at moderate prices. They make ideal instruments for bench and production applications.

Whatever the task, we've got a DVM to match it. Let us help you make the right selection.

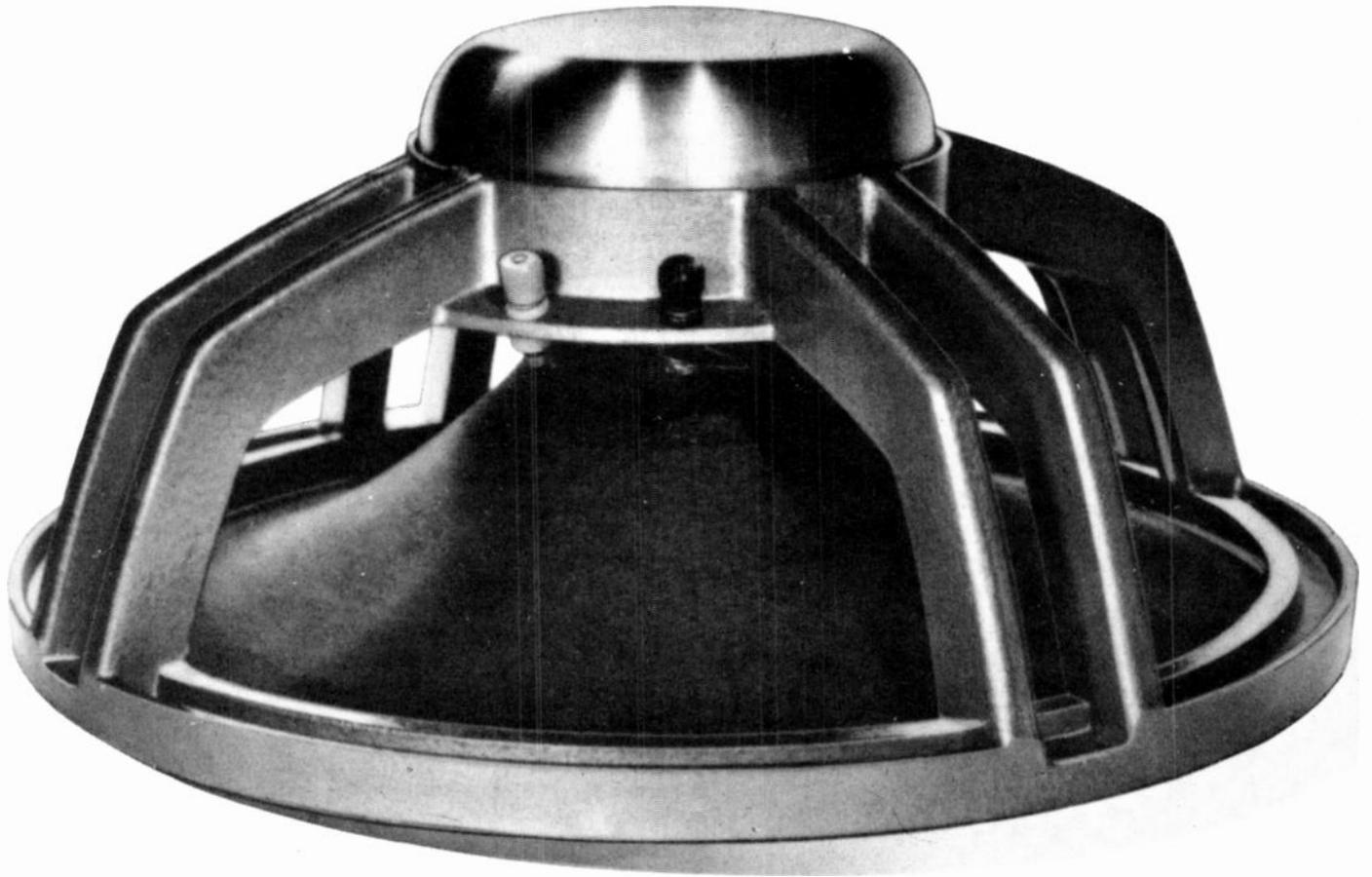
For complete data just write or telephone Hewlett-Packard Australia Pty. Ltd., 22-26 Weir Street, Glen Iris, Vic. 3146. Telephone: 20 1371.
Branches in Adelaide, Brisbane, Canberra, Perth, Sydney. Also Auckland and Wellington (N.Z.)

HEWLETT  PACKARD



COMBINATION

-par excellence



MSP 15" Woofer model 15VAC fulfils a requirement where high power handling and quality reproduction of bass frequencies are of prime importance. It features a nominal 35Hz resonance and this coupled with an exponential cone form allows smooth frequency coverage from 30Hz to 6kHz.

2" Tweeter model 2MBC is designed to cover the range from 5kHz to 20kHz.

The overall response is substantially flat to 20kHz, and the inherent low frequency roll-off below 5kHz permits the use of a simple

2mfd capacitor in series with the tweeter to accomplish a perfect crossover between bass and treble speakers. Complete speaker specifications & recommended enclosure designs are available on request.



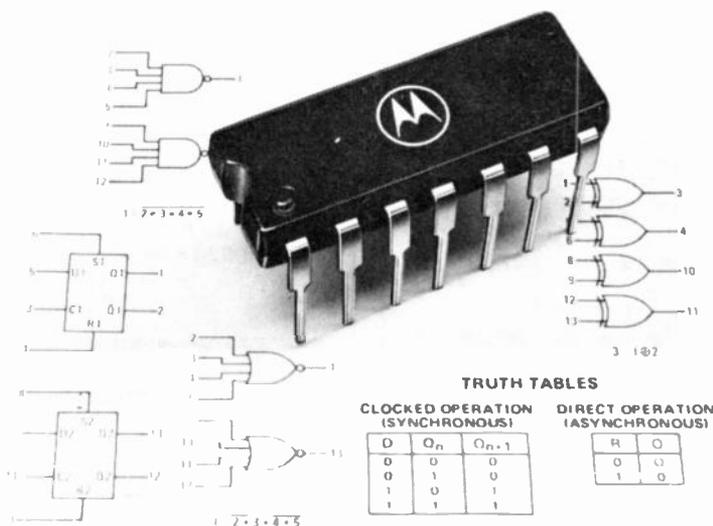
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COMPONENT NEWS

HIGH RELIABILITY CMOS LOGIC FAMILY



Motorola is now offering an improved family of low power CMOS logic elements. Previously known as the MC14000L series, the new MC14000AL and CL devices are claimed to allow equipment design processes to proceed smoothly, mixing and matching logic functions as needed.

Uniform output drive current specifications make possible direct interface with low power TTL. Propagation delay is consistent for all gates in the logic family which further facilitates design at the system level.

All devices in the MC14000AL series guarantee 100% high reliability processing. This includes stabilization bake; temperature cycling; constant acceleration; and hermeticity, ac, dc, and functional tests for the full temperature range -55°C to +125°C. The logic of the MC14000 series is available in a commercial, or CL designation, for the temperature range of -40°C to +85°C.

The seven logic devices currently being offered are:

- MC14001AL/CL Quad 2 Input NOR Gate
- MC14002AL/CL Dual 4 Input NOR Gate
- MC14011AL/CL Quad 2 Input NAND Gate
- MC14012AL/CL Dual 4 Input NAND Gate
- MC14013AL/CL Dual Type "D" Flip-Flop
- MC14015AL/CL Dual 4 Bit Static Shift Register

MC14507AL/CL Quad Exclusive OR Gate

Specific parameters for the MC14000AL/CL Logic family include:

Supply Voltage Range 3 Vdc to 18 Vdc (AL)
3 Vdc to 16 Vdc (CL)

- Noise Immunity 45% of V_{DD}
- High Fanout >50
- Input Impedance 10¹² ohms typical
- Symmetrical Output Resistance 750 ohms typical

The extremely low power consumed by

this CMOS logic family makes the devices especially suited for use in aerospace equipment, remote station instruments, portable instrumentation and control devices, and other battery operated equipment. High noise immunity and a wide operating power supply range make the MC14000AL/CL family especially suited to noisy industrial environments.

Further details from Motorola Semiconductor Products, 37-43 Alexander St., Crows Nest, NSW 2065.

WIDEBAND AMPLIFIER CIRCUITS TBA120 AND 140

Siemens integrated circuits TBA120 and TBA140 are FM-IF amplifiers primarily for use as TV sound or FM broadcasting IF amplifiers. The circuits, it is claimed, operate to 40 MHz and can be used as limiting amplifiers, controlled demodulators and modulators (with efficient suppression of the input signals). Both integrated circuits are claimed to have outstanding limiting performance and high frequency stability of the conversion characteristic. Within an operating voltage range of V_B = 5 to 14V the limiting action begins at 70 μV. AM suppression of more than 60 dB is attained at 10 mV. Within the range of supply voltages (5 to 14V) there is no change in IF gain and limiting performance, and audio overloading is absent. The external circuit requirements (particularly with respect to filter capacitors) are very moderate.

Further details from Siemens Industries Limited, Melbourne, Sydney, Brisbane, Perth and Newcastle.

ALNICO ALLOY PERMANENT MAGNETS

A new eight-page illustrated booklet from Plessey Rola discusses the manufacture, properties and applications of the range of Alnico alloy permanent magnet materials produced by the company.

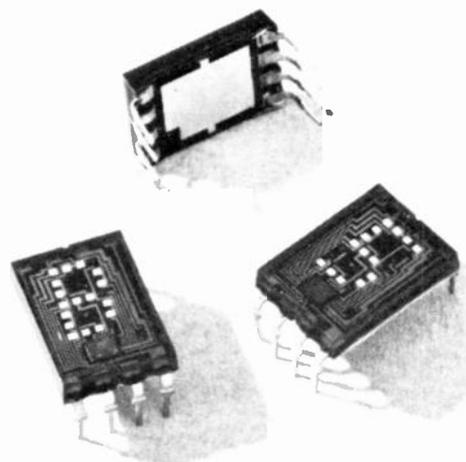
The properties of each of the five Alnico alloys are fully tabulated and the corresponding demagnetising and energy product curves are given.

This new booklet, together with the existing Caslox Ferro-ceramic Materials publication, provides technical data on the wide range of magnetic materials in common use throughout the world and manufactured by Plessey.

In addition to the published information, full laboratory facilities, staffed by experienced technicians are available to assist manufacturers with specific applications or design problems.

Further details from Plessey Rola Pty. Limited, Magnetic Materials, Browns Road, Noble Park, Vic. 3174.

LOW-COST HEXADECIMAL INDICATOR



A low-cost solid-state light-emitting diode (LED) display from Hewlett-Packard converts binary information to a base-16 number system automatically. The display, Model 5082-7340 Hexadecimal Indicator, shows digits from 0 to 9, and letters A to F inclusive. Decoder/driver/memory electronics are built in.

For computer applications, this single character display replaces four lamps required to show the binary contents of an accumulator or register when programming or trouble-shooting computer systems.

The display is also suited to applications other than computers, wherever more than 10 states need to be shown and where a standard positive logic input is available. The operator need not convert from binary

What...under \$100?



True! The best "value for money" amplifier ever to hit the Australian market! When Rotel built this one, they designed it to the same tradition of excellence as all the other Rotel amplifiers. Only the price has been cut. Would you believe — \$95? It's a solid state 20 transistor, 30 watt pre-main amplifier with tape recorder output. 8 watts RMS channel at 8 ohms. Harmonic distortion less than 0.5% at rated output. Handsomely presented in a timber cabinet.

If you like to look at genuine specifications and **imagine** performance, fine. But if you want to **hear** performance regardless of figures, then there's only one thing to do. Hear Rotel 210 at your nearest specialist interdyn agent! And marvel!

yes! new **ROTEL** 210

Available at these specialist Interdyn agents:

- N.S.W.: Encel Electronics Pty. Ltd., 260 Elizabeth St.
- Q'LD.: Stereo Supplies, 100 Turbot St., Brisbane, 4000.
- S.A.: Challenge Hi-Fi Stereo, 6 Gays Arcade, Adelaide.
- TAS.: Audio Services, 72 Wilson St., Burnie, 7320.
- VIC.: Encel Electronics Pty. Ltd., 431 Bridge Road, Richmond. 3121.
- W.A.: Albert TV & Hi-Fi, 282 Hay St., Perth. 6000.

SOLE AUSTRALIAN DISTRIBUTORS:

INTERDYN

International Dynamics (Agencies) Pty. Ltd.,
P.O. Box 205 Cheltenham, Vic. 3192.

to hexadecimal — this conversion is performed automatically by the device.

An important feature is blanking control. The display may be turned off, but contents of the memory maintained. Information may be stored in the on-board memory with the display off, to conserve power. The read-out is turned on only when needed.

Power consumption for a typical character is only 470 milliwatts. Each character is a 4 by 7 dot array yielding very readable shaped characters. Light output for the character "B" is 10.5 millicandelas.

The 5082-7340 is DTL and TTL compatible. It comes in a standard 0.600 by 0.400 inch dual-in-line package with the contrast filter included.

A point of note is that the unit is IBM compatible.

Price per digit for quantities of 100 is \$17.10, falling to as low as \$11.64 per digit for quantities of 1000.

Further details: Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, Vict.



PRE-PAK ELECTRONICS

Previously in Pitt Street, Sydney, kit and parts suppliers Pre-Pak Electronics have recently moved their head office and components division to new and much larger premises at 718 Parramatta Road, Croydon, NSW.

The company — formed some four years ago — had rapidly outgrown their original premises, to such an extent that on occasions (as Pre-Pak are the first to admit), their mail order service became a little disorganized.

However concurrent with their move, the company has instituted new procedures which they say will ensure rapid handling of customers' orders.

The disposals division of the company will remain at 95-97 Regent St., Redfern, NSW.

CARBON FILM RESISTORS

1.4^c each*



**1/2 WATT IRC BTS RESISTORS ARE NOW THE LOWEST
PRICED AND AUSTRALIAN MADE.**

Best quality—NATA lab. tests confirm long term electrical test results surpass the requirements of U.S. mil. specs, U.K. def. specs, and IEC standard specs.

world sell over 6 million BT resistors each day.

What other sophisticated technical product made in Australia can you buy for 1.4 cents?

Best by world opinion—IRC licensees around the

Available ex stock from Australian production.

IRH Components Pty. Limited

Wholly Australian owned and the largest manufacturer of resistive components in the Southern Hemisphere.

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INTERSTATE DISTRIBUTORS

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W.A. Simon Holman & Co.Pty.Ltd.
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Tas. W.P.Martin Pty.Ltd. (Launceston).
Telephone 2-2844.

Q'land. K.H.Dore and Sons.
Telephone 21-1933.

Tas. W.P.Martin Pty.Ltd. (Hobart).
Telephone 34-2811.



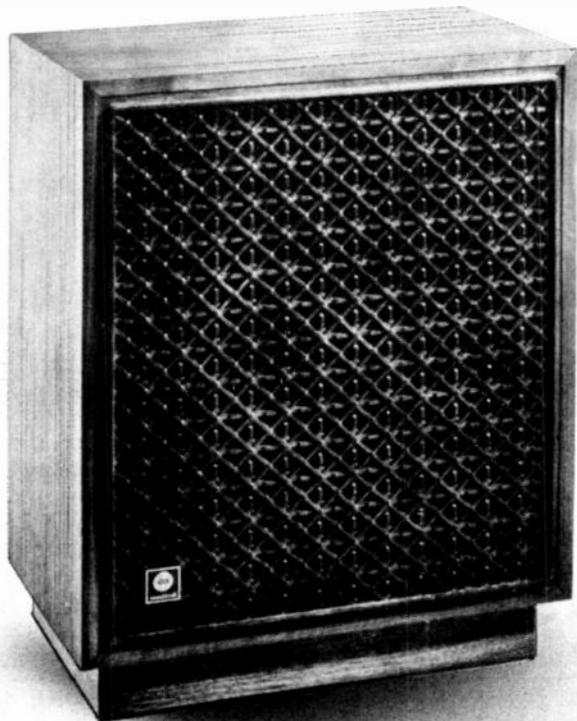
*Our selling price in 1000 lots 10% tolerance.

1001

**“The finest loudspeakers
I’ve ever listened to, regardless
of price, type or size. . . . ”**

Rectilinear III

Rectilinear High Efficiency
loudspeakers flatter your amplifier . . .
because they don't make it work so
hard.



“They produce beautiful bass tones without boom, accurate midrange tones without a trace of coloration, and crystal-clear treble tones without a hint of harshness. And they do it at any volume, including ‘window-rattling’ sound levels”.

That's how **Ronald M. Berney**, electronics editor of *Popular Science* described a pair of Rectilinear III speaker systems in an article “The Stereo System I wish I owned”.

Julian Hirsch (of Hirsch-Houck) wrote in “Equipment Test Reports” in “Stereo Review”, “In our opinion we have never heard better sound reproduction in our home from any speaker of any size or price”.

Other rave reviews include:

“The transient response of the speaker is superb . . . The overall quality is extreme in its fidelity to ‘live’ music. The bass is solid and firm, the midrange is clear and neutral, and highs are bell-like in their cleanliness”.

“It all comes down to this: there are only a handful of speakers that I find completely satisfactory . . . I have had these Rectilinear III units for a month now. Lately I have found myself listening to them just for the pleasure of it. They are among the very best speakers on the market today”.

“American Record Guide”.

“Rectilinear III . . . has had tremendous impact on the hi-fi industry . . . This speaker's virtue is the fact that it is the first and only full-range dynamic speaker system that possesses sound quality which is directly comparable to electrostatic speakers. . . . Flute and violin concertos as well as string quartet were reproduced with honest clarity . . . Piano and organ music were effortlessly reproduced in a manner that suggested the instruments were being performed live. Jazz and rock music were unpretentious and true sounding . . .”

“Buyers Guide”.

The Rectilinear III has four small brothers, priced from \$129.00, with the same superb sound, high power handling capacity and 5 year parts and labour warranty. Make sure you hear them.

SOLE AUSTRALIAN DISTRIBUTORS

Leroya Industries PTY. LTD.

266 HAY STREET, SUBIACO, W.A. 6008

AUDIO NEWS

FOUR-CHANNEL HEADPHONES



A number of companies are now producing four channel headphones – containing two drive units laterally spaced in each earpiece.

The leading manufacturers in this field are – Koss, Sonic, Mura and Superex, others are said to be investigating the field. We have tried several models, but whilst subjectively they are interesting and add some spaciousness to the sound, they are not as effective as four-channel sound reproduced through loudspeakers.

NEW CARTRIDGE REPLAY UNITS

The ABC has ordered a batch of completely new and revolutionary cartridge tape replay units from Plessey Electronics.

This new unit, the Rapid-Q Triple-Play, is claimed by the manufacturers to be remarkable because of its small size. Three replay modules housed in one cabinet take up less than 1/5 of the panel space required by three conventional cartridge replay units.

Another unusual feature of the unit ordered by the ABC is the fast forward Rapid-Q tape drive facility which can be initiated automatically, when an end-of-message cue tone is detected, or manually by push button. This allows fast checking, bypassing spots, and makes testing simpler and faster.

Fully compatible with the CT80 series of cartridge tape units, the Rapid-Q Triple-Play features CCIR/IEC or NAB equalisation.

Individual direct-drive servo-controlled motors are provided for each of the three replay modules which operate independently of each other.

The complete unit is available with three separate outputs or one common output. For the common output version there is an inbuilt programme switcher.

Fast and positive programming is guaranteed by an exclusive dual solenoid cartridge engagement system.

Further information from: Plessey Electronics Pty Ltd, P.O. Box 289, Richmond, Victoria, 3121.

COMMERCIAL AUDIO AMPLIFIERS



A new range of solid state modular construction amplifiers specifically intended for commercial applications has been developed in Australia by Seeburg Pty. Ltd.

The equipment is stated by the manufacturers to be suitable for a wide range of applications including background music systems, paging, and high fidelity requirements of auditoriums.

Further details: Seeburg Pty Ltd, 136 Nelson St., Annandale, NSW.



STA

ELECTRONICS PTY. LTD.

Manufacture – Sales – Service
392 Centre Road, Bentleigh, Vic., 3204
Telephone 97 4832 A.H. 97 5539



CHANNEL SOUND



THIS IS YOUR INVITATION
TO SEE AND HEAR THE
LATEST IN SURROUND STEREO.
ALL MAKES AND MODELS
AVAILABLE AT A PRICE
YOU CAN AFFORD!

feel the beat through your feet and hear the lyrics too



enjoy both with **BASF LH-hifi** recording tape

Sure, with any tape, you can turn the volume up until the floor shakes. The difference is the quality of the sound produced. When you are playing a BASF LH-hifi tape there is less distortion, more clarity and realism. The gradual narrowing of track widths and lowering of tape speed on domestic tape recorders place, above all, great demands on tape to head contact and magnetic uniformity. A natural consequence of this development appeared to be background noise which became more audible during sound reproduction. To counter this, BASF engineers have introduced low noise equalisations and eliminated the background noise, increased sensitivity and achieved a dramatic improvement in signal-to-noise ratio of as much

as 8dB over other quality tapes. Now you can keep the swingers swinging with wall to wall sound while the neighbours enjoy the lyrics.

BASF LH-hifi tapes also available in Compact Cassettes.

Playing times:

C30 = 2 x 15 minutes = 30 minutes.

C60 = 2 x 30 minutes = 60 minutes.

C90 = 2 x 45 minutes = 90 minutes.

C120 = 2 x 60 minutes = 120 minutes.

BASF Compact Cassettes available everywhere in your choice of either "Trans," "Snap" or "Plastic Pack."

BASF HAS THE QUALITY—YOU MAKE THE MUSIC—BASF FOR ENOLESS PLEASURE



Australian Distributors:
Maurice Chapman & Company Pty. Ltd.,
276 Castlereagh St., Sydney. Phone: 61 9881.
146 Burwood Rd., Hawthorn, Vic. Phone: 81 0574.



BA1371C

AUDIO NEWS

RAYMOND C. ALLSOP, O.B.E.

It is with deep regret that we announce the death of Raymond C. Allsop — one of the early pioneers of radio and electronics in Australia.

Raymond C. Allsop was born March 11, 1898 and in 1913 was apprenticed to Shaw Wireless Co. He commenced activities as a radio experimenter in 1911, and during the first world war served as a radio operator in the Naval Wireless Works at Randwick NSW.

From the commencement of broadcasting in Australia until 1929 he was responsible for the construction, operation and maintenance of station 2BL in Sydney.

In 1929 Mr. Allsop founded Raycophone Ltd and produced a range of theatrical sound equipment which was recognized as of world standard.

During the first world radio convention — organized by the IRE in Sydney — in 1938, Mr. Allsop demonstrated a stereo sound system using two photo cells scanning respective halves of a twin film sound track.

Mr. Allsop served in the RANVR during the second world war — primarily in the development of radar and anti-submarine warfare.

Since then Mr. Allsop acted as a private consultant in electronics. During 1953 and 1954 he served as a member of the Australian Broadcasting Control Board. Recently he was a strong and outspoken advocate of FM broadcasting in Australia.

Mr. Allsop became a Fellow of the IRE in 1940 and served as President in 1947/8. He was awarded the O.B.E. in January 1971 in recognition of his pioneering services in electronics.

During the first few months of publication of this magazine Mr. Allsop was a frequent visitor to our editorial offices and gave us advice and assistance for which we shall be ever grateful.

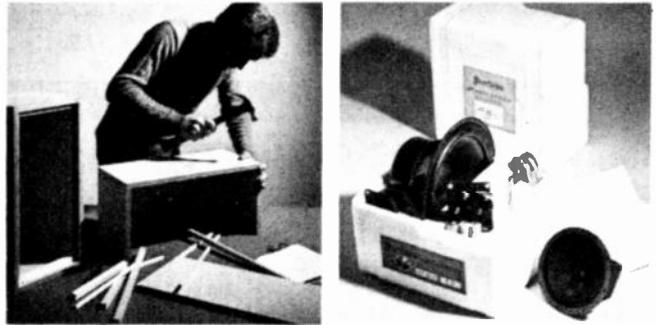
Raymond C. Allsop is survived by his widow and two daughters.

Convoy Technocentre

For Sound Satisfaction A Division of Convoy International Pty Ltd.

STOCKTAKING SAVINGS MONTH

- Peerless 2-3 way Kits from \$43.00. Easy to build.



- Pioneer SA500A Amplifier — Two speaker systems, Big Sound, Low Price Jorgen Amplifier Mighty-Mite Full Controls \$69.00. Also 32 watts RMS Model — special Low Price. Over 100 Amplifiers to choose from.
- Turntables, Philips, GA 202-208-300 Elac and Dual changers, Bases, Covers and Accessories. Sony, Pioneer, PL12 — 15's, Sonab, a full range.
- Cassette Decks and Recorders, Teac, Sony, Pioneer etc. Also Portable Mono Cassette Recorders from \$35.00. Remarkable Prices.
- Biggest range of Selected Speakers to High Quality standards but prices start from \$50 pair. B & W, JBL, Sonab, Pioneer, Peerless, Teac etc.

SERVICE CLINIC — FREE HI-FI CHECKS

Bring in your gear for a test on Convoy Specialist Hi fi instruments. Service for all makes.

SPECIAL DEMONSTRATOR PRICES

Many of the above items are available at special Demonstration Prices — new condition full-guarantee.

TRADE-INS WANTED

We have many Buyers who want quality Hi-Fi equipment. Trade your system up to the very latest with big Trade-In allowances.

Where you hear and buy the world's top equipment!
Free Customer Parking!

Convoy Technocentre

For Sound Satisfaction A Division of Convoy International Pty Ltd.

Now at corner of Plunkett & Maclean Sts., Woolloomooloo, Sydney, 357-2444 (past Astor Motel).

LAFAYETTE GUARDIAN "6000" 6-Band

AM — Marine — FM — Aircraft — VHF — Portable Radio
With Radio Direction Finder

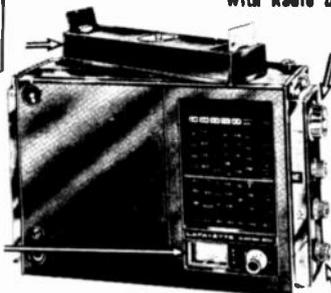
Rotatable Antenna for LW, AM and MB reception & Direction Finding

Tunes 6 Bands

\$179-50

including Sales Tax

Signal Strength Tuning/Battery Meter



Squelch Control

BATTERY OR 240V AC OPERATION

(1) 180-380 KHz (2) 540-1600 KHz Broadcast (3) 1.6-4.0 MHz Marine (4) 88-108 MHz FM (5) 108-136 MHz Aircraft (6) 147-174 MHz FM VHF.

The Guardian "6000" is Lafayette's most advanced deluxe Portable Battery/Electric Radio for top reception plus Direction Finding.

LAFAYETTE ELECTRONICS 94 HIGH ST., ST. KILDA, VIC., 3182. Phone: 94 6036

ELECTRONIC KITS

CAPACITOR DISCHARGE IGNITION KIT

Superior design, fantastic improvement for any make or model of car. Specially extruded black aluminium heatsink/case, fibreglass printed circuit board, pre-wound transformer, easy to assemble with full instructions. PRICE: \$27.75, Post \$1.00.

7 TRANSISTOR RADIO KIT

This very popular kit now available once again. A good performer and easy to build. Can be built easily in one evening. Our special price \$7.95 . . . 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-3 Mono Tape \$3.50
MP-2 Stereo Cartridge \$6.00 MP-4 Stereo Tape \$6.00
A.C. Power Supply, suit above, \$5.00

SINCLAIR MODULES

20W R.M.S. Amplifier Z-30 \$14.50 Reg. Power Supply PZ8, 45V, 2A \$27.50
40W R.M.S. Amplifier Z-50 \$17.50 Transformer for PZ8 \$12.00
Pre-Amp/Control Unit 60 \$34.95 Active Filter Unit \$24.30
Power Supply PZ5, 30V, 1.5A \$16.95 Case/Chassis—teak panel \$12.00
Reg. Power Supply PZ6, 35V, 1.5A \$29.90

TRADE PRICES ON APPLICATION

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 \$7.90 post 60c
PS6 6V, 7.5V, 9V, 12V, 15V, 2A \$7.90 post 60c
PS8 Electronically regulated and protected, output 20-45V DC at 2 Amp maximum. Adjustable current cut-out. \$22.50 post \$1.00.

CASSETTE RECORDER KIT

Latest Model—push-button controls. Battery-operated with remote on-off switch on microphone. Mechanical and electronic sections pre-assembled and tested. Fully imported. Price \$29.95. Post \$1.00.

RADIO TUNER KIT

Easy-to-build, uses Philips pre-assembled and pre-aligned tuner module 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.

SPECIALS

5	BC107 Transistors	\$2.00
6	BC108 Transistors	\$2.00
5	BC109 Transistors	\$2.00
3	2N3638 Transistors	\$2.00
2	TT3643/2N3643 Transistors	\$2.00
2	D13T1 Transistors PTT	\$2.00
2	TT800 Transistors	\$2.00
1 Pair	TT800/TT801 Transistors	\$2.00
2	40408/TT801 Transistors	\$2.00
2	40409/TT798 Transistors	\$2.00
2	40410/TT797 Transistors	\$2.00
1 Pair	TIP29A/TIP30A Transistors	\$2.50
10	EM401, 100PIV, 1A Rectifiers	\$2.00
8	EM404, 400PIV, 1A Rectifiers	\$2.00
5	EM408, 800PIV, 1A Rectifiers	\$2.00
4	IN3491/R 50PIV, 18A Rectifiers	\$2.00
3	MR751, 6A, 100PIV, Rectifiers	\$2.50
1	2N4443, 400PIV, 8A, S.C.R.	\$3.00
2	C106Y1 S.C.R.'s	\$1.80
1	MB1, 100PIV, 2A, Bridge Rectifier	\$1.20
2	2N2646 U.J.T.	\$2.50
2	2N3054 Transistors	\$3.00
2	2N3055 Transistors	\$3.00
1	AC06DT, 400V, 6A Triac and Trigger Diode, complete Kit	\$2.50
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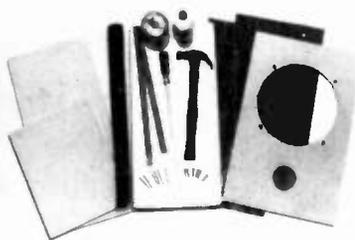
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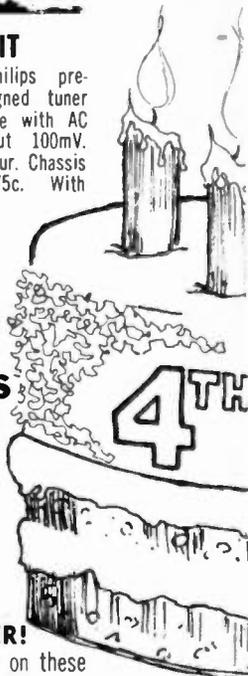
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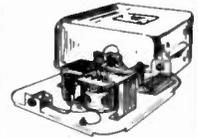


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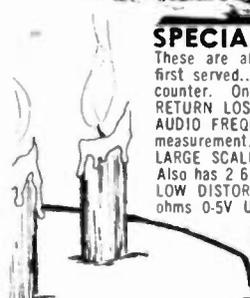


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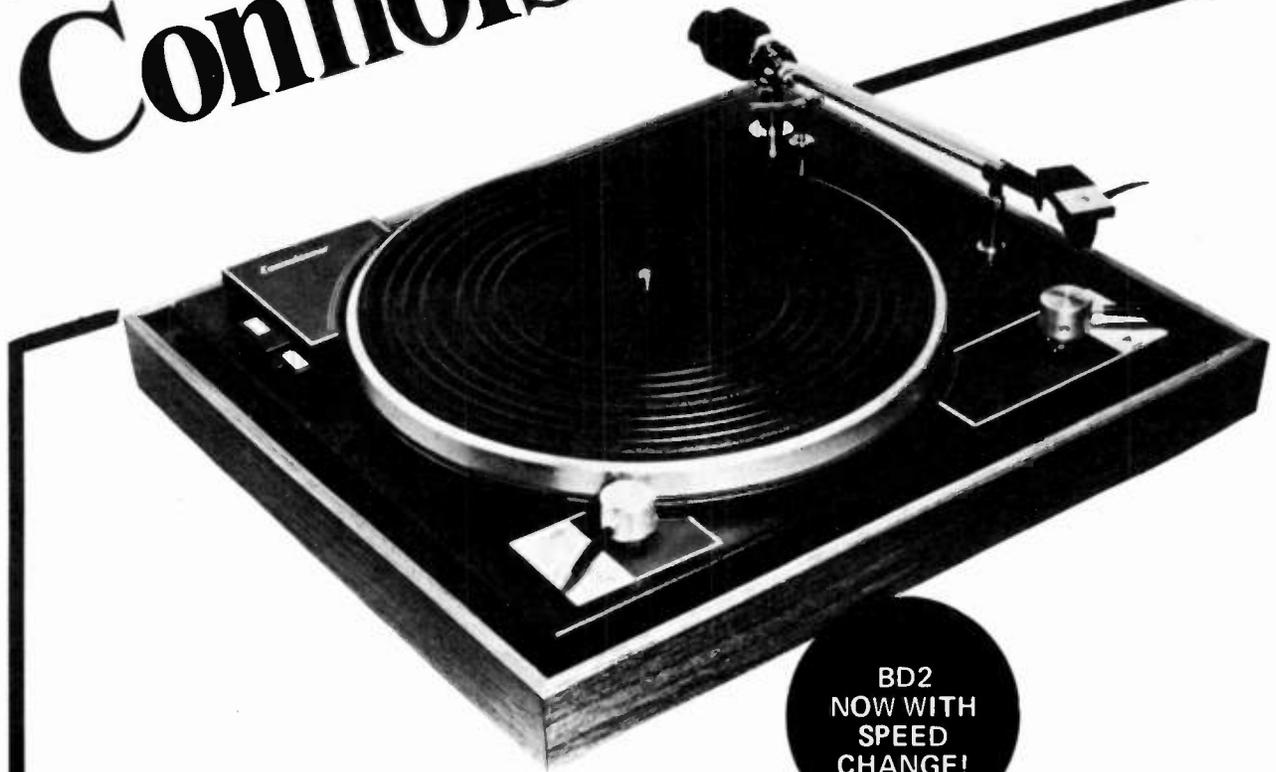
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RECORDINGS... CLASSICAL

REVIEWER: John Araneta



LISZT - HUNGARIA, MAZEPPA, HAMLET - Haitink, London Philharmonic Orchestra. PHILIPS 6500 046.

This disc represents the second in an admirable series that aims to record all thirteen Liszt symphonic poems. While I can hardly emphasize enough the importance of such a venture, especially in view of the fact that Liszt is not exactly well represented on records, and despite that I consider myself a rather avid Lisztian, I must admit to finding some of these symphonic poems very hard going. Hungaria, for instance, is I am sure, a bad joke which only seems to conjure up elaborate westerns of a historical variety. Mazeppa is a bit better, and not much at that, but I suppose if this is the only way to get some of the better works heard, one must submit.

Philips has rather intelligently coupled the dross works with the infrequently heard good ones and I can hardly blame them. On this disc, we do get a fine work, the Hamlet, unfortunately not better known. Haitink, whom I would not ordinarily associate with Liszt, does very well by these symphonic poems, presenting them in straight-forward fashion. But I do wish at times a Stokowski were at the helm. These works must be played with all the storm and fury possible for them to be effective. Such a performance would certainly be closer to 19th century practices, at least with regard to these works. Even a terrible work like Mazeppa can sound effective if not good under a Mengelberg. A bit more rubato would surely not go amiss here. Haitink does seem a bit restrained for these works, although I could not say he is uncomfortable in the performance of them. But better than not at all, and I doubt very much someone else can and would do better these days. - J.A.A.

SMETANA - MA VLAST Kubelik, Boston Symphony. DGG 2Lp 2720032.

Personally I must admit finding most of Ma Vlast far too bombastic a la Liszt, especially Vysehrad and Sarka. Or perhaps as in the case of Liszt's symphonic poems one seldom gets performances of conviction that also avoid superficial emphasis. Of

three other recorded performances I have heard, only Ancerl's on Supraphon seriously competes with this new recording. Ancerl is exciting, but also somehow frenetic, especially in Moldau. I have not heard the Neumann, Leipzig Gewandhaus performance available on (Am.) LONDON, and it might be useful to hear that set first before any purchase is made.

This DGG recording makes Kubelik's third recording of Ma Vlast. By and large, his most exciting performance was his first with the Chicago Symphony (now deleted). His second recording, until recently available on DECCA ACE OF DIAMONDS preserved a rather sluggish performance, and in any case, the recording was rather wiry. In this third recording, with the Boston Symphony, Kubelik opts for generally reflective tempos. He is perhaps at his best in Bohemia's Woods and Fields. In more fiery moments, Sarka, for example, he is either not fiery enough or the vulgarity of these pieces are hardly minimised. But the latter problem may have a lot to do with the music itself. I find Moldau, the only still fresh piece in this cycle but here Kubelik is strangely out of control. The brass playing in the Waldjagd (Eulenburg p.19) especially is hardly impeccable. In the TEMPO I (commencing on p. 61) his treatment of the accents on the first violin is strangely mannered. Finally, there is unprepared rush at the start of the coda which is rather out of place and Kubelik does slow down a bit later. The sound on these discs may well be the best we have had for this cycle but it does lack definition while percussion seems muffled but curiously prominent at times as far as the rest of the orchestra is concerned.

In sum therefore, not the best performance available, and if you agree with me that Moldau is perhaps the appealing section of this cycle, certainly there are any

number of other recordings preferable to the one here and one might try to get the Szell-Cleveland performance (now on Classics for Pleasure). That recording preserves a fiery and remarkably virtuoso rendering while the sound makes for still acceptable sound. - J.A.A.

MOZART - Symphony No 41 "JUPITER". HAYDN - Symphony No 103 "DRUM ROLL".

Formerly available on RCA, this reissue on Ace of Diamonds is very welcome. For one thing, Karajan's older recordings with the Vienna Philharmonic and Philharmonia orchestras are with few exceptions finer than his remakes with the Berlin Philharmonic. The latter are often lush and carefully made but they also seem to me pretentious, and in any case, disturbingly lacking in spirit. A case in point is last year's reissue of his Vienna recording of the Mozart Fortieth. His recent recording for HMV is by comparison fussy and antiseptic. The older performance, however, paid special attention to the peculiar atmosphere of unrest which is very much part of even Mozart's earliest music. This approach is, I feel, closer to Mozart than the numerous "classical" or musicological renditions now in fashion. I am all for emphasizing chamber music qualities in Mozart and the observance of 18th century practices, but Mozart is not simply a "child of the Encyclopedie", as Dent would have it, any more than Blake is just another 18th century writer.

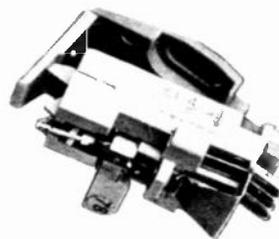
Between the fashionable high Baroque masters and the ever popular Romantics we usually hear mainly Mozart and Haydn. Perhaps when we get to play more "gallant" music and play it with more "affect" we shall come to understand that Mozart is neither an extension of the "affect" school

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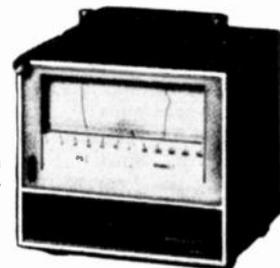
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nor as classical as his contemporaries. The literary term "pre-romantic" may be in disrepute today but used with caution it may perhaps illuminate certain aspects of Mozart's position in music.

Karajan's approach to the so-called "Jupiter" is dictated by the same terms with which he approached the G minor. He is not prepared to take all the joy and order that this symphony projects, without reservations. He invests his performance with a sense of regret and uncertainty. This, I feel, is correct. Mozart may use high Baroque forms in this work but it is almost in the spirit of one looking back to a more assured age. Thus, while the first movement definitely harks back to the older Overture-Suite style, in Karajan's reading we also get already a feeling of the uncertain. The second movement is not an incarnation of the simple "aristocratic pathos of the mature Viennese classicism". Karajan plays it as an intense expression, which it is. The minuet is not just a dance, while the fugue-finale seems ironic in this performance. One must admit that Karajan's intentions met with greater success in the G minor Symphony. There are times here when one feels he is not quite certain what to do, or how to look at this work. But it is good to see someone trying to grapple at the dualities inherent in this work, rather than passing it off as the olympian work everyone likes to think it is. The Vienna Philharmonic plays beautifully but this Mozart hardly prepares one for the aural splendours in the Haydn. What playing! Once again musicologists might well quibble at the style of performance and the largish orchestra: one does not get any notion of the concerto grosso manner in the opening allegro, for instance. Nevertheless, this is a performance of power and grace. Nor is Karajan immune to the work's wit and irony. The opening adagio is very serio indeed. Does Karajan think that "all is not well" in this symphony as well? Perhaps a little more sparklè would not have been amiss. But there is certainly a melancholic quality to this symphony which Karajan sees fit to project.

A rather unusual approach to this work but very successfully conveyed. In sum then, two rather unusual interpretations, worth listening to particularly for those who think these works are "all sunshine and grace". — J.A.A.

WAGNER — TANNHAUSER (Paris Version). Soloists, Vienna St Opera Chorus, Vienna Boys Choir, Vienna Philharmonic, Georg Solti (conductor). DECCA SET 506-9.

After a somewhat disappointing Boris it is good to see DECCA accomplishing an opera project more in keeping with its past achievements. Let me say at once that this is probably as fine a recording of Tannhauser, as we shall ever get, simply magnificent in almost every aspect, and certainly superior to any other version available. In deciding on the Paris version, DECCA has, of course, hit on a fine commercial advantage but it is performing a fine service in showing everyone, once and for all, the superiority of the Paris to the Dresden text.

Tannhauser in its original Dresden version (1845) was Wagner's first opera to make headway in the musical world of the time. It

was after a performance of Tannhauser in 1846 that made, of all people, the young Hanslick write of Wagner as the only real hope of German opera. It is intriguing to wonder what Hanslick would have thought of Wagner's revisions but in any case, for the Paris production of 1860, Wagner was undoubtedly aware of the greater resources of the Paris Opera as compared to those of his Dresden. On the other hand a production in Paris meant a ballet in the middle of an opera (a convention not even flouted by Verdi), and generally a less free hand over the forces involved. With the rich experience of Tristan behind him, Wagner recomposed the opening Venusberg Scene, transforming it into a moment of richness and power. The insertion of a ballet at this point made strong dramatic sense but it also made a rude reception for the opera a foregone conclusion. Elsewhere Wagner revised numerous details and, also substantially revised the Singing Contest.

Solti and DECCA have obviously gone to great trouble determining which sections of the Paris version were to be used, but they have commendably gone back to the Dresden text when this seemed to conform to Wagner's intentions more exactly. Thus, Walther's aria is included although Wagner deleted it because the Paris Walther was not good enough, while Wagner's other revisions here are kept to because they heighten the situation. But the very musical management involved in this production goes further than a study of Paris and Dresden alternatives. An augmented percussion score later used by Wagner for the Bacchanale is used. Boys are used for the shepherd, the young pilgrims, and pages. The shepherd-boy is heard to play a shawm-sounding instrument.

The production efforts involved for this recording are in fact nothing short of staggering. Recording is gorgeous: for once the vision of Venus in Act III is plausible. But I am glad to say the performance is on the whole on the same high standard. Solti conducts with power and precision, and his orchestra (Vienna Philharmonic) plays beautifully. Solti does his best to minimise the banality of Wagner's themes in the overture by his rather unusual phrasing. His choruses are excellent and for once quite believable and well differentiated. As for the singers, one must immediately put Christa Ludwig's Venus at the top of the list. Here is a Venus with not only ravishing voice but also temperament. Helga Dernesch projects a dignified and human Elizabeth not a Valkyrie. Her "Dich, teure Halle" sounds a bit taxed, and I do not find her Prayer moving enough but her characterization and singing elsewhere is first rate. Rene Kollo (Tannhauser), I would never consider a heldentenor as many seem to these days. He sounds more like the young Set Svanholm. Be that as it may, he does deliver a very fine performance of Tannhauser, fine enough to make me forget at times that Wagner wrote some very tiresome passages for the role. His outbursts particularly in the Rome Narrative are dramatically convincing. Hans Sotin has the right ring of authority in his voice for the Landgrave. The Minnesingers are generally well sung, if rather light weight sounding. At "O du mein holder Abendstern" it was quite impossible for me not to think of Fischer-Dieskau, but one cannot have everything, and this set does give us a great deal. This Tannhauser is a definite necessity for any Wagnerian. — J.A.A.

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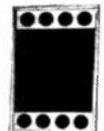
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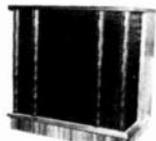
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RECORDINGS... JAZZ

REVIEWER: John Clare.



LOUIS ARMSTRONG – Very Special Old Phonography. Volume Two. Side one: Louis Armstrong and his Hot Five (Lonesome Blues, Sweet Little Papa, Jazz Lips, Skid-Da-De-Dat, Big Butter and Egg Man etc). Side Two: Louis and his Hot Seven (Willie The Weeper, Wild Man Blues, Chicago Breakdown, Alligator Crawl, Potato Head Blues, Melancholy Blues, Weary Blues, Twelfth Street Rag). French CBS 62 471.

This is one of eight in the V.S.O.P. series which covers most of the essential Armstrong from 1925 to 1932. Swaggie records have covered most of the same territory, but it's damn good to see these classics around in the bigger record shops again.

Jazz buffs need only glance at the titles to know everything I could ever say about them, but a few words might be of interest to newcomers to the amazingly diverse world of jazz music.

This is Armstrong in the first full flowering of his genius. The Hot Five recordings are much poorer in sound quality than the Hot Sevens but the attentive listener will experience the full glory of the music as it were through the haze of time. In fact there is a strange magic in hearing Armstrong's cornet burning through the acoustic sediment, which is akin to watching the genius of Chaplin or Keaton on grainy old film.

Armstrong and clarinetist Johnny Dodds are the giants who unify the often quaint and primitively simple contributions of trombonist Kid Ory, banjo man Johnny St. Cyr and pianist Lil Armstrong, and lift the whole into the realms of great art. One would not wish to change a single note.

The Hot Seven side (Chicago Breakdown is in fact by Louis Armstrong and His Stompers, a group which includes the great Earl Hines on piano) contains two of the most astonishing Armstrong performances of all time. They are Wild Man Blues and Twelfth Street Rag. Beneath Armstrong's and Dodds' solos on Wild Man the piano accompanies for two bars, stops for two, and so on. Armstrong's trumpet pours into the silences with a combination of emotional force and musical brilliance that

is a profound experience to this day. Dodds, completely uncowed, follows Louis with everything he can muster, and by the end of his solo he has made almost as great an impression as Armstrong.

Twelfth Street Rag begins with Louis playing the melody in a perky, almost corny fashion which is both foil and basis for the brilliant embellishments which begin to flower, spilling into double time and back, until the melody finally disappears, is virtually shattered by an explosion of musical ideas. The lurching trombone solo which follows this is hysterically funny by comparison. To cap it all off, before Dodds' final break Louis leads the ensemble by playing the melody backwards. Too much altogether. – J.C.

ART ENSEMBLE OF CHICAGO – Art Ensemble with Fontella Bass. America 30 AM 6117. "How Strange, Ole Jed, Horn Web, Joseph Jarman, Malchi Favors, Don Moye, Lester Bowie, Roscoe Mitchell, Fontella Bass.

Friends who heard this before I did, told me that it was even better than The Chicago Art Ensemble Phase One – also on America. I just can't quite see it. Phase One was such a complete recording to me because it had one side of the best straight ahead jazz blowing you could reasonably expect to hear (albeit in the style generally called avant garde) and one side of fascinating textures and melodic fragments, which though largely improvised on the spot by the ensemble sounded almost orchestrated in their cohesive development.

Side one of this recording consists largely of a strange recitative by Singer Fontella Bass. The words "How Strange" and "Old Jed Fell into the Well" are sung over and over again with sundry additions while all the ensemble members interject or create exotic mosaic effects on their many and varied instruments. Though the point of it all eludes me, the performance is full of delights, notably the shattering trumpet blasts from Lester Bowie and the fantastic drumming and chanting which precede the main vocal. Towards the end the bass begins to walk and Bowie plays a marvellously satisfying, forceful but contained trumpet solo, the beat dissolves again and everyone, swapping about between flute, bass sax (what a glorious sound that makes) and clarinets, joins in a brilliant free conversation.

Side two begins with a drum solo, but after a couple of odd punctuations, figures which seem unresolved in the more conventional sense come and go over a slow barely felt pulse or replace each other in an unmeasured drift, moving space, in contrast to the softly clattering thicket of percussion which surrounded the solos, cries and instrumental conversations on the Phase One recording. Where the latter seemed at times like a brooding distillation of jazz, this has more of the limpid stealing motion of



some recent classical music (sometimes I am reminded of Carl Ruggles) though it is all improvised and jazz intonation is brilliantly employed.

Favors' bass, used like a deep dark guitar is most effective. Bowie here demonstrates just how directly much avant garde trumpet playing stems from Miles Davis, particularly his work on Sketches Of Spain. An instrument which sounds like the chanter from a bagpipe provides some textures and soft bells create an ethereal effect.

It's all great stuff, though obviously many will find it somewhat alien at first. You can't half listen to it. You've got to relax and shut everything else out. It's worth it. J.C.

B. B. KING – B. B. King Live At The Regal. EMI Stereo SPBA 3034. Every Day I Have The Blues, Sweet Little Angel, It's My Own Fault, You Upset Me Baby, Worry Worry, Woke Up This Mornin', You Done Lost Your Good Thing Now, Help The Poor etc.

If ever you felt that Cream or Grand Funk or the Rolling Stones generated a bit of excitement, just drop everything and listen to this! That this record has remained in obscurity since 1964 is testimony to the efficiency of the big publicity machine in getting people to hear only what suits its purposes at the time.

This is what the blues are about. Not dull clubbing riffs repeated ad nauseum, not interminable exhibitionist guitar solos, but tremendous rolling oratory, full of ominous pauses (in which the audience nearly wets its pants in anticipation) and ecstatic climaxes.

Now that the white listening public has discovered B. B. King (after about twenty years), he has seen fit to put out several good, but somewhat restrained studio recordings – Indianola Mississippi Seeds was one to which Leon Russell and Carole King contributed. This one records King's approach to a live audience in the ghetto of Chicago nearly eight years ago. The two approaches cannot be compared. This is, as they say, something else again. At times the audience sounds to be frothing at the mouth

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JAZZ

with excitement, and if anyone had a heart attack at the Regal Theatre that night, I should not be at all surprised.

The band is a bit under-recorded, but it is right off the ground at all times. There is a wailing tenor sax solo on 'You' Upset Me Baby' — otherwise all the solos are taken by King's guitar. His guitar is what had always impressed me until I heard this album and the recent 'Live At Cook County Jail'. In fact, I would not have rated him as being an outstanding blues singer on the strength of his studio recordings. Here he is much rougher, more rhythmically daring, and he uses the kind of freezing hoarse falsetto which Buddy Guy employs to such great effect.

My only complaint is that some of the songs are cut rather short, by King himself: sometimes we only get three choruses and they are into the next one.

My favourite in this area is still Buddy Guy, but I wouldn't be without this record by the truly great B. B. King. — J. C.

THE BLUES IN MODERN JAZZ — The Blues in Modern Jazz. Atlantic 1337. Blues performances by Dizzy Gillespie, Charles Mingus, Thelonius Monk, Art Blakey, Jimmy Giuffre, Milt Jackson, Lennie Tristano, Ray Charles, The Modern Jazz Quartet.

There have been a lot of pretty scrappy jazz anthologies over the years, most of them garnered from record companies' cutting room floors, so to speak. A good general rule is to look with suspicion upon records which sport about two dozen big names. This is one of the exceptions.

Obviously what makes this collection so satisfying is that each track has been chosen to complement and contrast with everything else on the record, and most tracks are masterpieces or near masterpieces. Here is some of the very best jazz played in the late fifties. I think many of us who bought it when it was first released will be buying it again to replace worn copies.

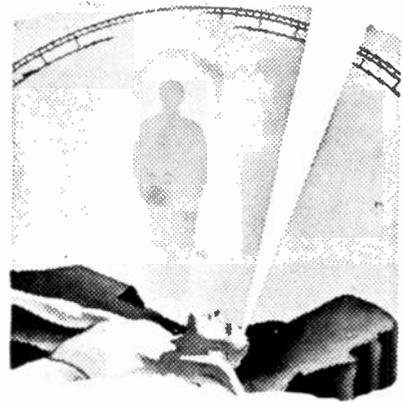
The first thing that strikes one is the great range of highly personalised expression that the blues will support. The next thing is the great range of highly personalised expression that jazz musicians have been able to create within apparently limited forms.

Mostly this is a totally different approach to the blues than that of musicians who play nothing but the blues. It is less predictable, less cathartic, more arrogant mostly, more take it or leave it. You do not get the feeling that you could get up on the stage and do the same thing with a few under the belt. But most of these men are black men, many of whom have played with blues bands, and they know what the blues is. The blues is there beneath it all, and if you want to listen you may hear in the angular harried flights, the sudden scornful virtuosity, the real meaning of the blues for that particular man.

But when I think about it, everything I've said is true of some of the most traditional blues. All this is, is the blues. Dig it.

The rechanelling for stereo has taken something from the sound, as usual, but not enough to disqualify this record as an essential buy. — J.C.

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RECORDINGS... POP TRENDS

REVIEWER:
Michael Delaney.



KILLER – Alice Cooper. Kinney. Stereo. BS.2567. Under My Wheels, Be My Lover, Halo Of Flies, Desperado, You Drive Me Nervous, Yeah, Yeah, Yeah, Dead Babies, Killer.

Alice's total environment theatre has finally found the perfect compromise between stage presentation and punch drunk rock'n'roll. This Detroit quintet uses all the old tricks from aggressive volume through to feedback and still makes them work like thunder. Their approach is completely flexible, integrating the dynamism of pop with an intense dramatic appeal otherwise distorted out of all belief by such acts as Grand Funk Railroad. It's neither obscene nor self-indulgent. They keep a healthy balance no matter what the cost.

Alice Cooper plays mainstream rock with a technical resourcefulness that removes the least threat of repetition. This band is determined to fill the gap left by the Stones. That's their charisma in a nutshell. They have that self same chemistry needed to produce commercial songs – solid stuff build on the verse/chorus frame. Alice's music has a real horny edge capable of the excitement once generated by Mick Jagger. "Under My Wheels" should be a hit single. It hurtles along a stylized riff/rhythm similar to the classic "Jumpin' Jack Flash – gruff and cocksure. Yeah. Alice Cooper actually contains the potential needed to shape a large chunk of the forthcoming attitudes toward rock as a consistent art form.

Each song rocks off with guts and ends with gusto. They're loud and brutal. "You Drive Me Nervous" is one of those pacey speed raves locked in range by the strutting instrumentation. "Yeah, Yeah, Yeah" and "Halo Of Flies" follows in much the same way with a slightly less manic arrangement geared to the standard triple guitar front. Alice has the prestige to make Grand Funk appear as weak as supermarket shandy. "Killer" and "Dead Babies" are the two standout cuts specializing in the dutiful hypnotic atmosphere that only this crew could ever hope to get away with. "Desperado" is the archetypal mood piece complemented by mellotron and

counterpoint strings. I'll leave the rest to you. This latest album – the second for Kinney – helps to assess the dual career as both a guitar-oriented rock band and a modern theatrical troupe. It's not going to be long before Alice will be splattered all over top forty radio. Get in now and beat the hype. – M.D.



"FARTHER ALONG" – The Byrds. C.B.S. Stereo.SBP.234060. – Tiffany Queen – Get Down Your Line – Farther Along – B.B. Class Road – Bugler – America's Great National Pastime – Antique Sandy – Precious Kate – So Fine – Lazy Waters – Bristol Steam Convention Blues.

The Byrds are simply wonderful. You would've expected them to have split years ago what with all those hassling character/personnel alterations but the thing is that they didn't. And isn't it just fine. I for one couldn't have coped half as well with the current pace had McGuinn not decided to keep doing his level best to survive and continue and create and make people warm inside.

The Byrds stand as an ever faithful reminder of the niceties that one can find in music if an effort is made without demanding immediate return. Their songs kind of settle gently around a need to communicate. They make you serene. "Farther Along" balances their harmonic tradition with a more spatial grasp of straight rock'n'roll. This revised concept has given the band a greater idea of how to project instrumental freedom without detracting from the voice capacities.

"Antique Sandy" and "Precious Kate" are two of the loveliest tunes only because both seem to attach themselves more to your emotional response than anything McGuinn has done since "Chestnut Mare". His sense of melody tends to be roughneck detailed and broken beyond repair and that's the reason they're so beautiful. "America's Great National Pastime" parallels "I Wanna Grow Up To Be A Politician" from the "Byrdmaniax" album for pointed humour: the theme is pretty much a typical message

concerning split generation loyalties. It's nothing new apart from the remarkable lack of dual guitar. "So Fine" is an ultimate rip-off not so much because the band couldn't handle its interpretation but because the song itself is just nowhere to start with.

The personalities behind the band seem to have lost that programmatic closeness with regard to their individual identity: each has cleared the rubbish from his own backyard. McGuinn and Battin complement Gene Parsons whilst Clarence White has retrogressed back behind a veneer of bluegrass phrasing. The range is more definite. "Get Down Your Line" follows "Tiffany Queen" and "America's Great National Pastime" to form the first recognizable blend of Chuck Berry/Byrds Memphis rock. The wait has been worthwhile. The group is no longer subject to the whims of four separate statesmen.

"Farther Along" holds a certain majesty because it's captured the band undergoing style change. It looks set that their rural era is about to be phased out as part of a massive reorganization with McGuinn abdicating as dictator and spokesman. The general temperament is less esoteric. "Lazy Waters" and "Bugler" would be the two most stable tracks as both seem to fit securely into the White/McGuinn tribute vein. They seem to come closest in design to the Byrds as an electric folk group a la "Oil In My Lamp". The latter is an animal song that completes the trilogy with "Old Blue" and "Chestnut Mare" – precocious yet submissive. McGuinn endures. As a lyricist he leaves little to be desired: "Can I Sing Your Praises From The Bottom Of My Heart/Perhaps I Want You Too Much/At Times I've Tried So Hard/But I've Been Lonely Too Long/Just Let Me Say I Love You... There's nobody who can touch this group called The Byrds. Oh Yeah! – M.D.

"The Morning After" – J. Geils Band. Kinney. Stereo. SD.8297. I Don't Need You No More – Whammer Jammer – So Sharp – The Usual Place – Gotta Have Your Love – Looking For A Love – Gonna Find Me A New Love – Cry One More Time – Floyd's Hotel – It Aint What You Do.

The trouble with the most recent American blues has been its inability to project pure feeling. Both Paul Butterfield and The Allman Brothers Band have sublimated all their muscle in favour of virtuoso gymnastics that gain in excellence an equal to the loss in personal magnetism. They've started to play super musicians instead of settling down into their role as dedicated bluesmen. I guess they just got tired and didn't feel angry enough to belt it out anymore. Butterfield has become an introvert whereas The Allmans have found themselves a rather questionable niche somewhere between rock and pop/jazz a la Brian Auger's Trinity. The results have been

(Continued on page 115)

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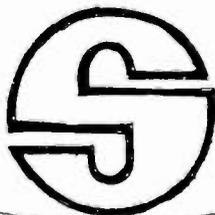
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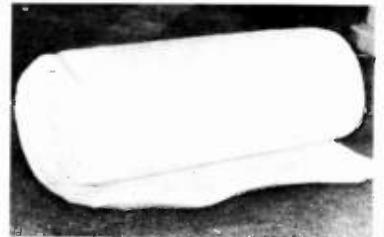
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POP TRENDS

far too clinical in outlook. It's simply a case of bluffing the blues and that's not the way talent was meant to be handled.

The J. Geils Band has come along at a crucial point. They're an American sextet whose basic style directly parallels the Butterfield band of some six years ago. This group gets their kick from playing root blues with just a touch of musical ego mania thrown in to pressure-seal each song. The arrangements are total energies geared to highlight the incisive and vigorous aspects of their composite approach. Geils and his band have an intuitive skill at being themselves. Their music commands with authority and penetrates with ease. It swings like mad and never lets up right from the first chord.

"The Morning After" is an unqualified success because it features that essential spontaneity so much a part of good music whether it be Chicago blues or showbiz bubblegum. "I Don't Need You No More" and "Whammer Jammer" find the group at its most energetic - pungent rhythms diced with superlative guitar/harp. "The Usual Place" is the typical mid-tempo performance documenting their transition from urban blues through to the less stylistic attitude much in the vein adapted by Steve Miller. "Floyd's Hotel" and "Gonna Find Me A New Love" tend to sound more like the obligatory 12-bar - all form and function with the emphasis on their dues. Both communicate.

The greatest thing about J. Geils is their belief in blues as the ultimate music transcending all other characters with regard to both sensibility and depth of motion. They've fused the most vital elements of Chicago phrasing with the strength of loud rock'n'roll. "So Sharp" realizes their potential as a group joined together by the will to stir that self-same excitement once left up to Negroid soul. They've served an apprenticeship based on the earlier white exponents without trying to prove anything outside their own worth. Their style is brisk; the images passionate and mean. J. Geils Band has a gut appeal evolved from their fluency in coping with mood. Their message is shouted with heaving flashes of brimstone

and hellfire that lay it right down home the way that blues should. It's such a good album. - M.D.

"THE VERY BEST OF ARLO GUTHRIE"
- Arlo Guthrie, Kinney. Stereo. RS. 5258.
Washington County - Percy's Song - Highway In The Wind - Oklahoma Hills - Alice's Restaurant - Valley To Pray - Ballad of Tricky Fred - The Motor Cycle Song - Living In The Country - Shackles & Chains - Running Down The Road.

Perhaps one of the most satisfying things for any musician to achieve is to bend the rules and still succeed. Arlo suffered an immediate handicap due to the mystique that surrounds his father. The late Woody Guthrie has been acclaimed as the legitimate founder of modern American folk-blues and a huge slice of the associated tradition. It wasn't until Arlo recorded the classic "Alice's Restaurant" that his career started to look as though it'd give dad a run for his money. This one track held critics in complete awe with its wry social comment. It served as a catalyst for what has since developed into one of the most articulate contemporary rock figures this side of Peter Seeger.

"The Very Best Of Arlo Guthrie" is a somewhat misleading title as the content does more to paraphrase his style than to offer a selection of so-called greatest hits. "Valley To Pray" has been his one Australian chart success disregarding the gold certified "Alice's Restaurant" album. Guthrie draws most of his character from a combination of related forms not the least of which is mainstream folk and gospel. He likes to play the satirist thus pushing the acknowledged musical boundaries a little further away from straight country. His style contains a depth drawn from the continuous contrast between the spiritual and political aspects. He places a great deal of merit behind the choice of subject matter especially as the basic form adheres to the talkin' blues first made commercial by Bob Dylan.

The songs that evoke a response detached from the lyric make their mark by virtue of the fine arrangements. "Running Down The Road" plus the instrumentals "Living In The Country" and "Washington County" fall into this area. All three owe impact to the crisp guitar accompaniments - subtle and concise. "Ballad of Tricky Fred" is the up-tempo paranoia song all about the current American climate - violence; lack of foresight. Guthrie tries to incorporate as many facets of thought into his music as possible. "Percy's Song" is traditional Dylan whilst "Oklahoma Hills" has firm root within Nashville progressive. This album is recommended to the mild rock fiend who's yet to pass beyond the record of the month. Arlo Guthrie should not be missed. His distinctive vocals add an extra sheen seldom found on similar exercises within the country format. - M.D.



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BOOK REVIEWS

REVIEWERS: Brian Chapman,
Jan Vernon.

INDUSTRIAL ELECTRONICS: PRINCIPLES & PRACTICE by Alfred Haas. Published by TAAB Books 1971 (book No 583). 416 pages 8½" x 5½", soft covers. Review copy supplied by TAB books, Australian price \$5.95. (soft cover) \$8.95 (hard cover).

Industrial electronics — the use of electronics in the control of industrial processes is an exciting and challenging discipline. This is where theory really meets the crunch of practice. In a process control environment even relatively occasional errors cannot be permitted. The process, which may be subject to a large number of variables and which may be taking place in a dirty environment must be fool-proof and fail-safe.

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This book by Alfred Haas makes a very creditable effort of providing a basic introduction to the entire field of industrial electronics. The author states himself in the preface that the book only gives a bird's-eye view and makes no claim to exhaustiveness. Rather, the treatment is to sift out the fundamental principles of industrial electronics and to show approaches to problems encountered.

Heading of the various sections give an indication of the coverage. These are: Industrial electronics — purpose and means; Transducers; System building blocks; Automatic inspection; Sorting and counting; Digital process control; Electronic heating; Welding and machining; Electronic safety services; Power conversion and control.

As introductory material, it is doubtful that a more suitable book could be found for the modest price. Even if the reader is not directly involved in process control, he would find this a source of instruction in the methods of putting electronics to work, and interfacing with non-electronic systems. — B.C.

BEGINNER'S GUIDE TO TRANSISTORS by J. A. Reddihough. Published by The Hamlyn Publishing Group for Newnes Books 1968. 160 pages 7¼" x 5", hard covers. Review copy supplied by Butterworth (Australia) Pty Ltd. Australian price \$3.55.

As the title indicates, this is a book for beginners who wish to acquire a knowledge of the application of transistors.

The book opens with the usual sections on the operation and physics of semiconductor devices, basic transistor circuits and characteristics and then provides a reasonably extensive treatment of the operation of transistors in various types of circuitry. The explanations are non-mathematical and describe the operating principles rather than the design procedure.

The book is quite adequate for those who wish to gain a knowledge of transistors and transistor circuits but do not have a great deal of background in electronics. — B.C.

(Turn to page 118)

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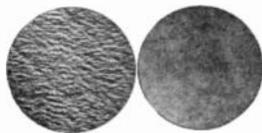
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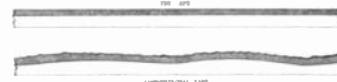
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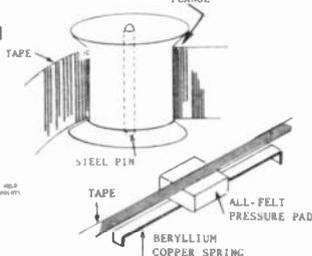
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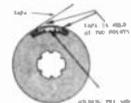
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THE POPULATION BOMB, by Dr Paul R. Ehrlich. Published 1971 by Ballantine in association with Pan Books Ltd, London. Paperback. 141 pages 4-5/16" x 6-15/16". Australian price 95c.

POPULATION/RESOURCES/ENVIRONMENT by Paul R. Ehrlich and Anne H. Ehrlich. Published 1970 by W. H. Freeman and Company, San Francisco. Hardcover, 383 pages 7" x 10-3/16".

Two books on the same subject by the same authors but different in style and approach. The first, "The Population Bomb" by Dr Paul R. Ehrlich is a paper back written in a very readable almost light style.

But Dr Ehrlich is the Professor of Biology and Director of Graduate Study at Stanford University and is an expert on the subject of ecology. The book is deliberately written in this way because Ehrlich is more than an author, he is an active campaigner for ZPG, the society formed to press for Zero Growth of the world population. His book sets out to convince and convert the reader to the society's viewpoint.

Despite Ehrlich's non-academic style, his message is serious. The world, especially the undeveloped world, is rapidly running out of food. We will not be able to prevent large-scale famines in the next decade or so and the only way to control the spread of famine is immediately to start world wide programmes of population control. Otherwise the world's population will continue to grow as long as the birth rate exceeds the death rate. The growth of population will cease eventually because food supplies and medical resources will run out. We will be unable to train enough doctors and nurses, nor provide enough services such as transport, power supplies and communication to meet the needs of the population.

And this will not only happen in countries like India. It will happen in the United States. It will happen here.

Ehrlich backs this argument with some very convincing facts and figures. He says that the two things which we can do to make the future a lot more secure for children and grandchildren is to decrease the world population and to increase food production. He has a lot to say about present methods of food production and the detrimental effects of DDT on the environment. He also discusses our present attempts at regulating the birth rate and points out the difference between family planning and population control.

Family planning aims at helping parents to have the number of children they want and feel they can care for (they might decide on any number from three to 12) but population control is the conscious regulation of the numbers of human beings to meet the needs not just of individual families but of society as a whole. At present Ehrlich says, two children per family is enough.

Ehrlich has been lecturing on this subject for some time and seems to have encountered every possible argument against his proposal. He sets out his answers to these arguments in his book. Suggestions that we can farm the sea, cultivate the deserts, grow artificial food from petroleum, grow better quality food, migrate to another planet, all are possible in the future but too far in the future to be of value in the present crisis. Nine years is all the time we have says Ehrlich before population increase outstrips our ability to produce food.

"Population, Resources and Environment" is more or less the same book but Anne H. Ehrlich who is a Biological Illustrator and Research Assistant at Stanford University has collaborated with Paul Ehrlich this time and there are many more tables and figures, graphs and illustrations. It's a larger book and goes into each aspect of the subject in greater depth. It can be used as a source book for facts about the subject as well as a textbook for courses in environmental science and related social and scientific issues.

Both books offer constructive proposals for putting programmes of population control into action. Providing the world with a safe method of contraception is only part of the problem. Convincing people that they don't want more than two children will be the most difficult, especially in a society where each new baby is viewed as a consumer to stimulate an ever-growing economy.

The main opponents of population control at the moment appear to be theologians. James Schall, a Jesuit priest (Time magazine 23/8/71) believes that to limit the population is wrong and that the man of the future will be capable of solving the problems of the future, perhaps by purposefully expanding his numbers to provide the large intellectual base needed for a more complex and technologically advanced society. But if Ehrlich's figures are right we don't have time to wait and see if this will happen.

Dr. Ehrlich, in the Population Bomb discusses the possibility that he himself is wrong: "Someone in 2051 may invent a machine that will produce vast quantities of nutritious food." However, if we don't heed his words it seems we can expect a miserable and hungry existence until that day. — J.V.

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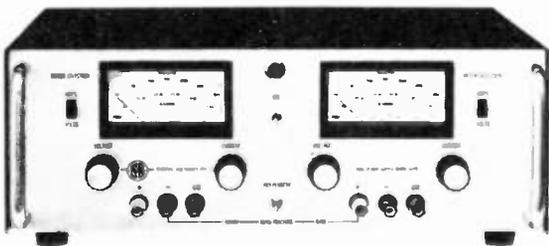
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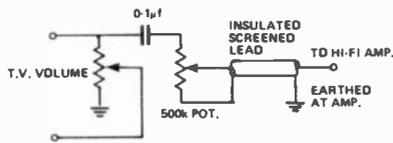
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TO

INPUT GATE

LETTERS
FROM
OUR READERS

TV SOUND



In your March issue you describe a method of upgrading the sound quality of TV receivers by connecting the audio stage to a hi-fi system.

One small problem that I encountered when I did this some years ago was hum caused by an earth loop formed by the TV and hi-fi amplifier mains supplies.

This was overcome by leaving the screen of the connecting lead — between the TV and the amplifier — disconnected at the divider resistances — as shown above.

I would also like to draw your readers' attention to the possible dangers if the mains earth connection is removed from the TV set in an attempt to reduce hum. For should a fault to earth develop in the TV — and if the earth via the hi-fi equipment is open circuit — the TV aerial terminals could become alive. This is very dangerous to anyone attempting to adjust the aerial.

Certainly the improvement in sound quality that can be obtained by following the suggestions in your article are very worthwhile.

LATERAL THINKER

Motivated by the noise of the Income Tax boys axing down my front door to get at me, and further by a wife who sees her Credit Card at the business end of a Cornucopian horn; I have therefore decided to enter your Swimming Pool Alarm Contest. Admittedly this application is somewhat belated, but as you read further I am certain you will agree, this is of no consequence whatsoever.

It was only after a full fifteen seconds in-depth study that I knew the solution would not lie in the mini world of transistors etc. So, with this consideration in mind that I present to you the following two solutions to your contest, which my modest personality limits me in describing as superlative, brilliant, breathtaking, and cortex warping:—

(1)

Taking into account the following profound truth viz. 'Only a cockroach drowns in a cup of water' (which I coined myself last week) I realized that the answer lay in designing a pool one foot square, three inches deep which would prevent the most suicidal toddler from hastening his demise. As far as the other advantages are concerned, imagine for a moment the estatic satisfaction of owning the ultimate status symbol: an outdoor heated, filtered footbath. Also, when not in use it would provide refreshment to our feathered friends (go ahead and sneer you farmers) thus gaining you the affection of bird lovers around the world also the curses of aforesaid farmers.

(2)

Conformity, that self-righteous guardian of the status quo, is never so evident as in the liquid chosen to fill swimming pools. Why only water, when we have an almost unlimited choice of exotic fluids? Let us explore the advantages of . . . whisky.

Whisky filled swimming pools would mean at least two or three neighbours in the pool, twenty four hours a day. Thus, should baby's explorations result in the dunking aforementioned residents of the pool would raise the alarm. An alarm of this nature would definitely use less than 6 milliamps whilst the operative parts i.e. drunks, would be undisturbed by leaves, earthquakes and World War III. Should the efficiency drop, all one need do is threaten to turn on the chlorinating plant.

By now you will have doubtless consigned the rather quaint ideas of the finalists mentioned in your last issue to the waste paper basket. About my prize; considering the present inflationary trends of our society I would appreciate your sending me the \$1,000 as gold bars. — R.S. Cooma, NSW.

*Delighted to accept your brilliant entry despite your adage quite obviously plagiarized from the well known saying of Gareth Powell 'When the cuckoo flies upside down . . . who then shall water the daffodils?'

Entry one (1) is obviously impracticable — what if one's child is two foot square?

Entry (2) have you considered fire hazard, evaporation, theft, etc. if not we must scotch your entry.

ADVOCATE CROLYN TAPE

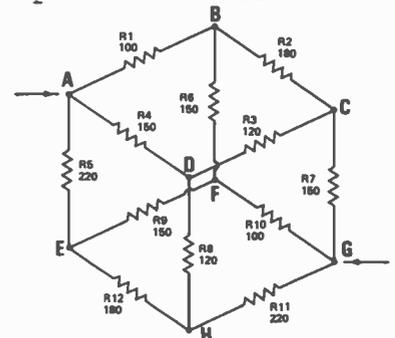
Dear Sirs,

Could you please advise us who the

agents are for Advocate Crolyn Cr02 tape. Although used by your testing authority we have not noticed any sources mentioned in your publication.

*Importer is Aureima Pty. Ltd., P.O. Box 604 Brookvale, NSW, 2100.

PIECE de RESISTANCE



For several years I have been attempting to obtain an answer to a puzzle involving a rectangular square frame each rail of which consists of a ten ohm resistor.

The problem is to establish the total resistance, from one corner, to the corner diagonally opposite.

Every time I attempt this problem I come up with a different method and a different answer. It's driving me up the wall!

Many thanks for a wonderful magazine — I enjoy every issue.

K.H. Woy Woy, NSW.

*Believe it or not there is quite a simple way of solving this one — apart from an AVO and a handful of 1% resistors!

We're sure that many of our readers would like to have a go at it — but we have made it just a bit harder by using a number of different resistor values — so a year's free subscription to the first ten letters containing the correct (within one ohm) *mathematically obtained* answer to the question — what is the resistance from point A to point G on the drawing below.

Also included in the answer must be a very brief description of the method used to obtain the answer.

To give our country readers a fair go we will not open any entrants' letters until June 1st.

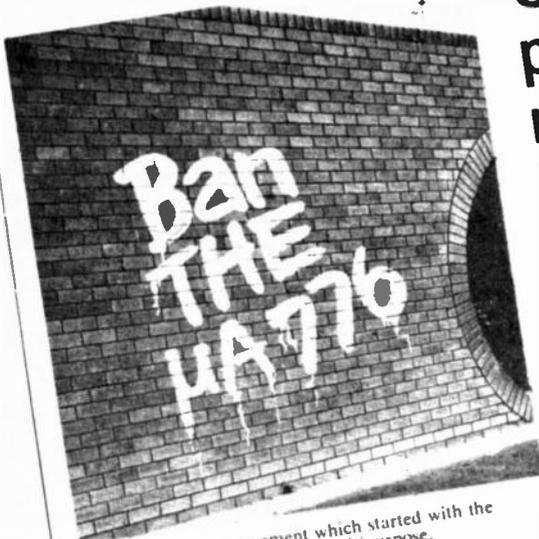
Just draw an ohm sign on the rear outside flap of the letter and address to Electronics Today International, 18 Bathurst St., Sydney, 2000.

Remember that we need the answer *plus* a brief description of how you obtained it.

How about having a go yourself KH!

BAN THE μ A776

Opposition mounts protest campaign against new Fairchild weapon in the IC War



Ban the μ A776, a movement which started with the Fairchild introduction of this multipurpose, programmable, low cost op amp — see story



A.P.P. Fri.: Increased tension and concern are reported from all opposition following Fairchild's successful introduction of the μ A776 Multipurpose Programmable Operational Amplifier.

Latest reports indicate growing support among the enemy to have the μ A776 totally banned. The enemy is particularly worried by the extreme versatility of the μ A776, because users will be able to programme their own particular requirements.

Further concern mounted when more was learned about the precise features of the μ A776 op amp. With the addition of a simple external resistor, user can select his own slew rate, frequency response, input bias current, input resistance, drift performance, open loop gain and a power supply range

down to $\pm 1.2V$. The μ A776 has all the features of an earlier Fairchild weapon — μ A741 — plus 'programming capability'. It's also pin-for-pin compatible with the μ A741.

Additional support for the Ban the μ A776 movement has been gained since it was realised that Fairchild

have included the μ A776 in the LIC Selection Guide which fully describes all their general and specific purpose op amps. When questioned by A.P.P., a Fairchild spokesman showed confident disregard for the Ban the μ A776 campaign. He predicted total victory for the Fairchild μ A776.

FOCUS

FURTHER developments in the Ban the μ A776 campaign are expected following the growing realisation that the versatile μ A776 has unprecedented economical factors. Cost is less than half the price one would normally expect to pay for a product with similar specifications. In particular, its low voltage operation is taking an unfair advantage, a disgruntled rank-and-file protester said.

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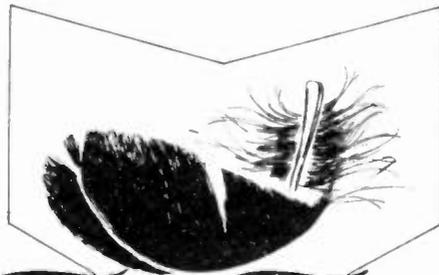
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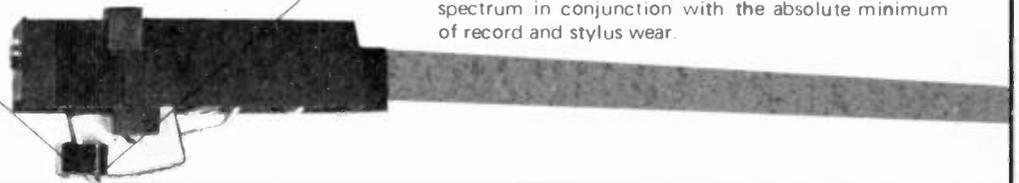
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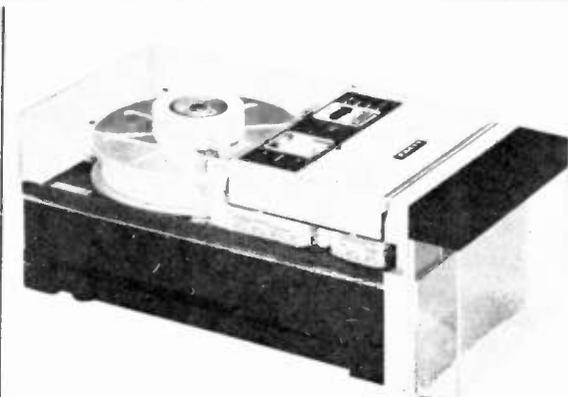
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If you are thinking about buying a tape punch, then ask yourself these ten questions . . . then compare !

	FACIT 4070	BRAND X
1. Does it operate at all speeds up to 75 characters per second asynchronously?	YES	
2. Does it have built-in supply and take-up facilities of compact design?	YES	
3. Does it have a low noise level? 0 dB when idling?	YES	
4. Does it feature integral control circuitry, which guarantees troublefree connections to different systems?	YES	
5. Do plug-in components facilitate service and maintenance?	YES	

	FACIT 4070	BRAND X
6. Does it automatically indicate tape supply and tape running low?	YES	
7. Are versions available for TTS tape?	YES	
8. Is a 24 volt version of low power consumption obtainable?	YES	
9. Does it feature automatic dc checking?	YES	
10. Is a choice offered between stand mounting and desk top versions?	YES	



Please send me more detailed information about your FACIT 4070 tape punch
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(Continued from page 27)

this qualification it is possible to provide excellent quadrasonic sound even in the most modest home reproducers.

COMMERCIAL APPARATUS

A typical SQ decoder as for example produced by the Sony Corporation, first CBS licensee in Japan, is described in detail on pages 50-55 of this issue. This decoder works in combination with any components-type stereo phonograph. The stereo output is connected to the decoder, from which four new outputs emerge. Two are plugged back into the existing stereo preamplifier, while the other two are connected through suitable power amplifiers to two additional loudspeakers in the back of the room. A deluxe model with a comprehensive logic also is available.

BROADCASTING SQ ENCODED SOUND

An SQ record or an SQ encoded two-channel tape can be transmitted directly through an FM-multiplex transmitter, being heard in a normal FM-multiplex receiver as conventional stereo. With the addition of a decoder and two loudspeakers to the receiver output, reproduced quadrasonic sound is obtained.

The question arises, what does the listener to an AM broadcast hear? The answer is readily obtained by inspection of Fig. 3. The circular modulation of L_B and R_B channels intersects the horizontal axis at point *a*. The L_F and R_F signals are projected on the axis also falling on *a*, as shown in broken lines. Therefore, the four corner sounds are reproduced at full strength. The centre front sound, C_F, is reproduced at a 3dB higher level as in conventional stereo. The centre back sound, C_B, which has a zero projection on the axis disappears unless special recording procedure (outside the scope of this article) are used.

Therefore, while the centre back channel is reproduced fully in both the quadrasonic and the stereo modes, we advise our producers not to place soloists at the dead back of the audience.

With the understanding on part of the producer of the capabilities of the SQ system, totally satisfactory monophonic broadcasting and reproduction of SQ program are obtained, thus fulfilling the seventh and last condition set forth in our qualifications of stereo-quadrasonic systems. ●

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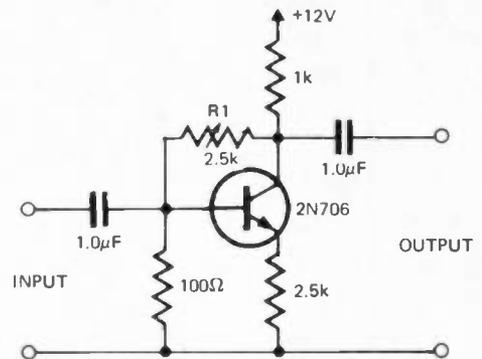
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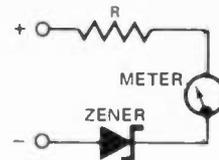
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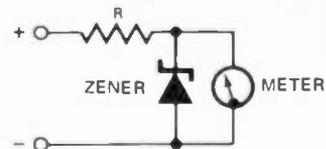
AUDIO DOUBLER

Audio frequencies may be doubled by this circuit which relies on the non-linear characteristic of a transistor to provide half-wave rectification. R1 is a feedback control and is adjusted to obtain a pure output waveform.



SUPPRESSED ZERO METER

A Zener diode placed in series with a voltmeter will prevent the meter from reading until the applied voltage exceeds the Zener voltage. Thus a 10 volt Zener in series with a 5 volt meter will allow the condition of a 12v car battery to be monitored with much greater sensitivity than would be possible with a meter reading 0-15 volts.



METER PROTECTION WITH ZENER

A Zener diode may be used to protect a meter from overloads without greatly reducing its accuracy. The Zener is connected in parallel with the meter and under normal circumstances has such a high impedance that the accuracy of the meter is not affected. If the meter is overloaded, the diode breaks down and the meter is shunted by about 10 ohms, preventing damage to the bearings and pointer of the movement.

Breakdown voltage of the Zener should be about 1.5 to three times the full scale deflection voltage of the meter.

The Zener also prevents the meter from reading on reversed voltages and thus gives dual protection.

TECH TIPS

Circuits described and illustrated in this section are derived from manufacturers' application notes, readers' letters etc. They have not necessarily been tested by this magazine.

The section is intended primarily as a source of ideas for electronic engineers.

Because of the nature of the information we cannot enter into any correspondence concerning any of these circuits, nor can we provide any constructional details.

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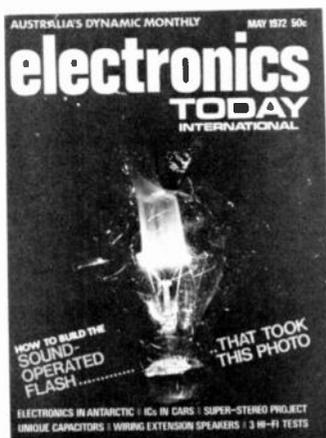
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