

# electronics

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**HI-FI**  
ISSUE

## TODAY

INTERNATIONAL

December 1972 50c



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HI-FI**

**100 WATT  
GUITAR AMPLIFIER**

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**LOUDSPEAKER CONTEST**

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Clockwise from the top they're the compact TC-90A with built-in condenser microphone, the high performance TC-140 with "swing balance" mechanism to keep tape speed constant even when recording on the move; the handsome 1.5 watt TC-110B with excellent tonal quality and the beautifully functional TC-95A.

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# electronics TODAY INTERNATIONAL

DECEMBER 1972

Vol. 2 No. 9

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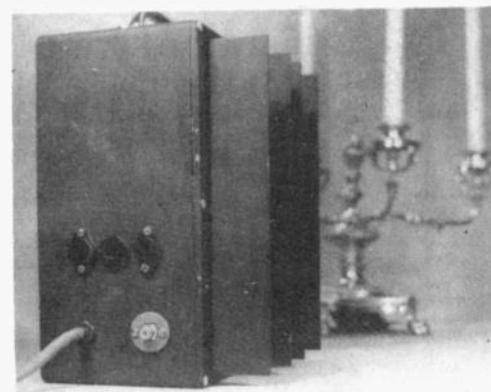
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*COVER: Our resident alchemist illustrates one way of obtaining hi-fi. A more reliable method is described in this month's main feature story — page 16. (Cover pix, and that featuring Sonab's OA-5 speaker and ELAC 1000T Quadra-sound tuner/amplifier on page 16, were taken by Kim Ryrja.)*



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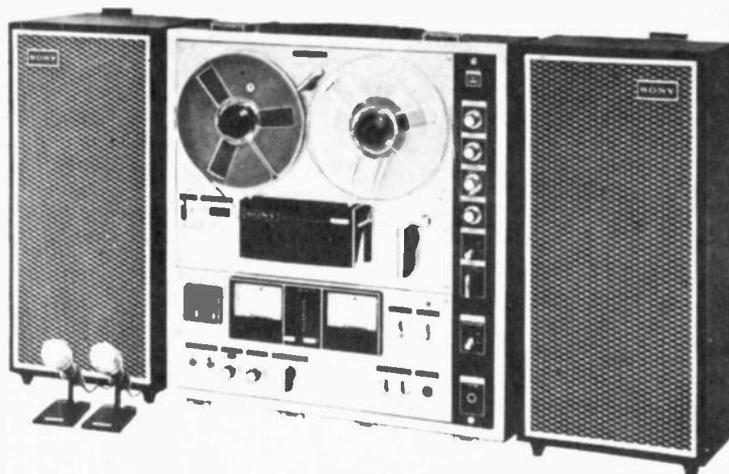
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# A RIGHT TO KNOW

Since way back, Australian governments have told as little as possible to those who elected them. This often leads to ironic situations.

An extraordinary example of this occurred recently when the Anglo-French Concorde airliner visited this country.

As there is reason to doubt the noise performance figures claimed by the manufacturers of this aircraft the DCA and the Commonwealth Acoustic Laboratory ran independent checks.

Both of these government departments adamantly refused to release the results to the media; in fact we were informed that they had received specific instructions not to discuss their findings in any way.

Fortunately we had anticipated this action and commissioned our acoustical experts to take noise measurements on our behalf. As we had expected, the results — published in our August issue — proved that the Concorde was indeed noisier than we had previously been told.

Another example occurred last August, when we described the R.A.N. submarine simulator which was to be installed in Sydney. No information at all, nor confirmation that the thing even existed, could be obtained from any local official source.

Yet all the information that we needed was freely available in England. It had been published as sales promotional material and was being given to anyone who asked for it — and we mean *anyone*.

An alternative government may well be elected later this year. If they are, let us hope that the present arrogant policy of all-encompassing official secrecy will finally be scrapped.

There are many things about which the general public have a right to know — and it is the responsibility of the media to ensure that they may.

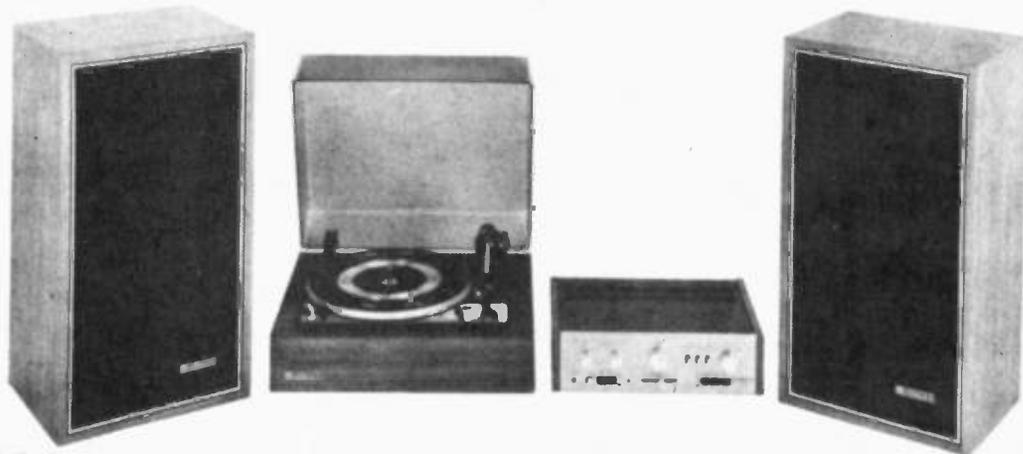


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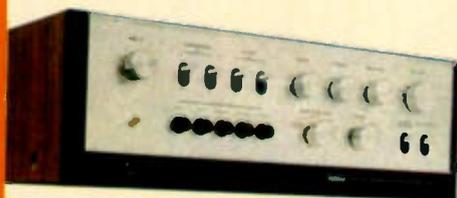


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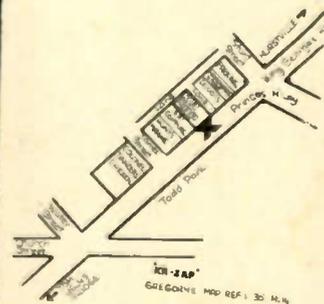
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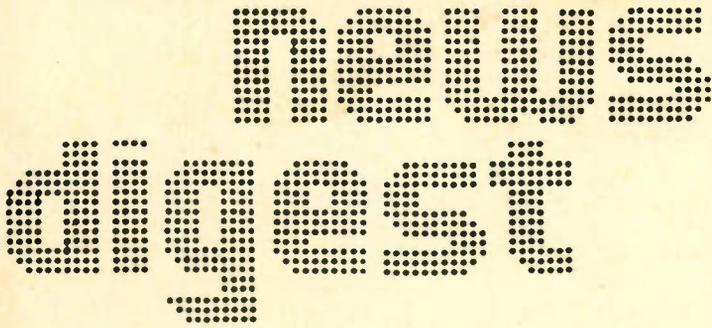
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The launch of this latest edition makes Electronics Today International the fastest-growing and biggest electronics magazine in the world outside the USA. It is now the world's third biggest on a circulation basis.

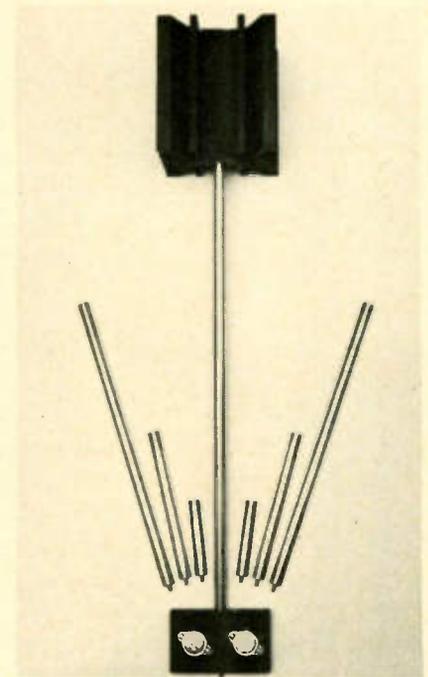
ELECTRONICS TODAY INTERNATIONAL — DECEMBER 1972

## SUPERCONDUCTORS LOSING THEIR COOL

Practical application of superconductivity to power transmission lines, electric motors and generators, electric railways etc has been held back by the very high cost of the refrigeration required.

But now, scientists at RCA's Princeton Laboratories have produced superconductivity in niobium gallium conductors at 20.3 Kelvin. Not only does the two-element material become superconducting at a relatively 'high' temperature, thus resulting a reduction in cooling costs of at least 75% — but it also can be superconducting in far more intense magnetic fields than existing superconductors.

## HEAT PIPES



Heat pipes represent a revolutionary approach to cooling techniques for electronic components and equipment. They are particularly suitable for cooling devices in inaccessible places, or where the use of a heatsink is impracticable, since they can transfer heat some 400 times more efficiently than a solid copper bar of equivalent dimensions.

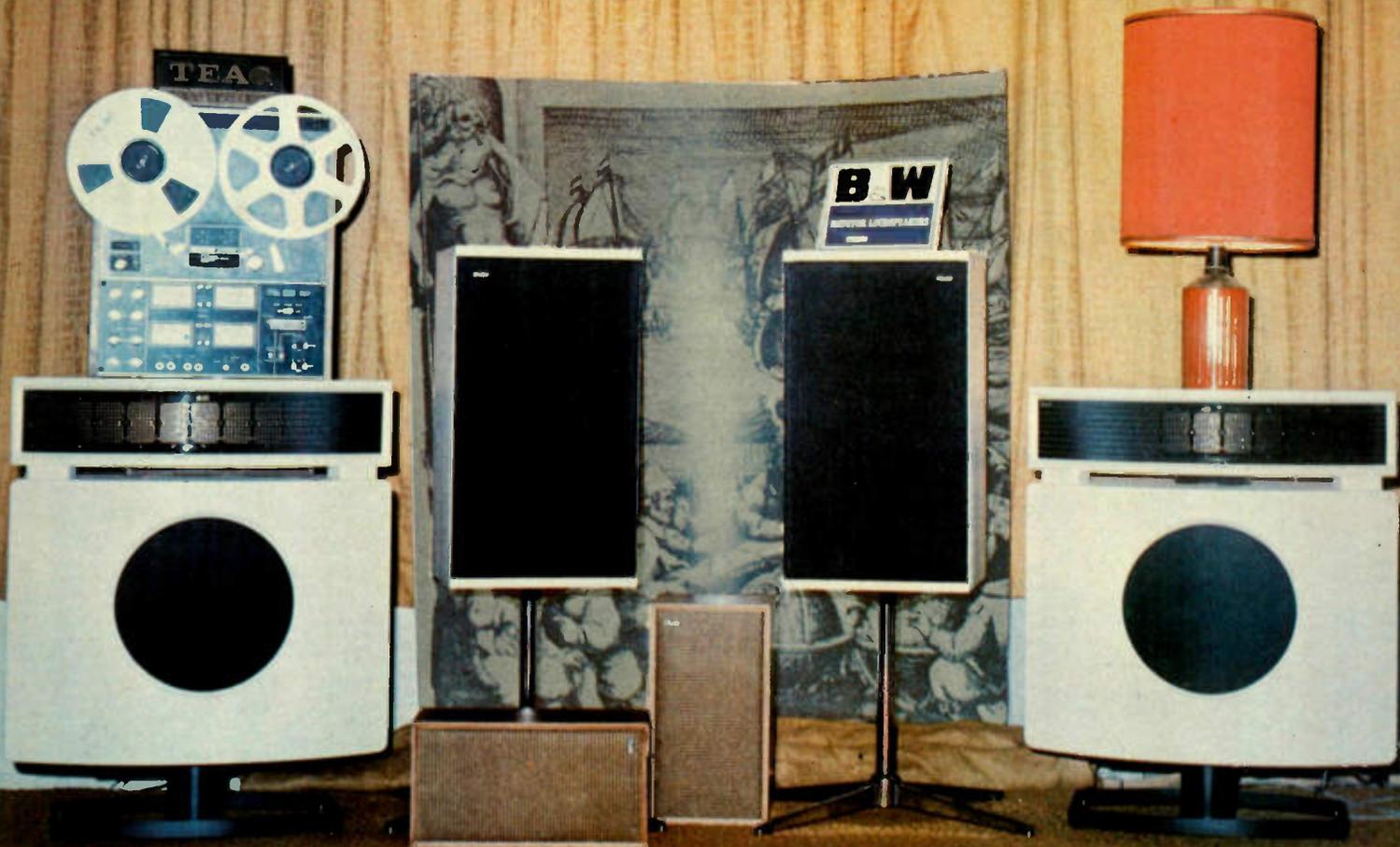
In operation, the heat pipe (which basically comprises an evacuated drawn copper tube that contains a special wick material and a small amount of working fluid) is mounted between the device to be cooled and an external heat dissipator. Typically, it will transfer heat from a 100 W source over a distance of 3 feet with a temperature drop of only 2.5°C per foot.

Units shown are manufactured in the UK by Jermyn Manufacturing Ltd.

Turn to page 148

# B&W, THE ULTIMATE IN SPEAKERS

For the discriminating listener who wants genuine Monitor realism. A selection of B & W Monitor speakers in the Connoisseur's room at the Convoy Technocentre of Sound, Sydney.



(LEFT AND ABOVE RIGHT) In white with black grilles, the fabulous B & W DM70 Electrostatic Monitor speakers (Continental version, also in Walnut). A combination of 11 Electrostatic units and one 30.5 centimeters Bass piston, with resonance below 40 hertz. Also available in Mayfair version below, teak or walnut. (CENTRE ABOVE) The entirely new B & W DM2 3-way monitor speakers with folded tapered pipe loading and third order Butterworth crossover. White, teak and walnut. Support available as shown. This is a



MAYFAIR

remarkably small speaker of less than two cubic feet with a performance approaching the larger DM70 electrostatic. Available in teak, walnut and white. (CENTRE BOTTOM) The B & W DM1 Monitor loudspeaker only a little over 1/2 a cubic foot. The most remarkable performance of all the smaller speakers. It has a big base sound with properly balanced high and mid range. (TAPE DECK) The TEAC AS30/40 Symulsync 4-track genuine quadrasonic tape deck.

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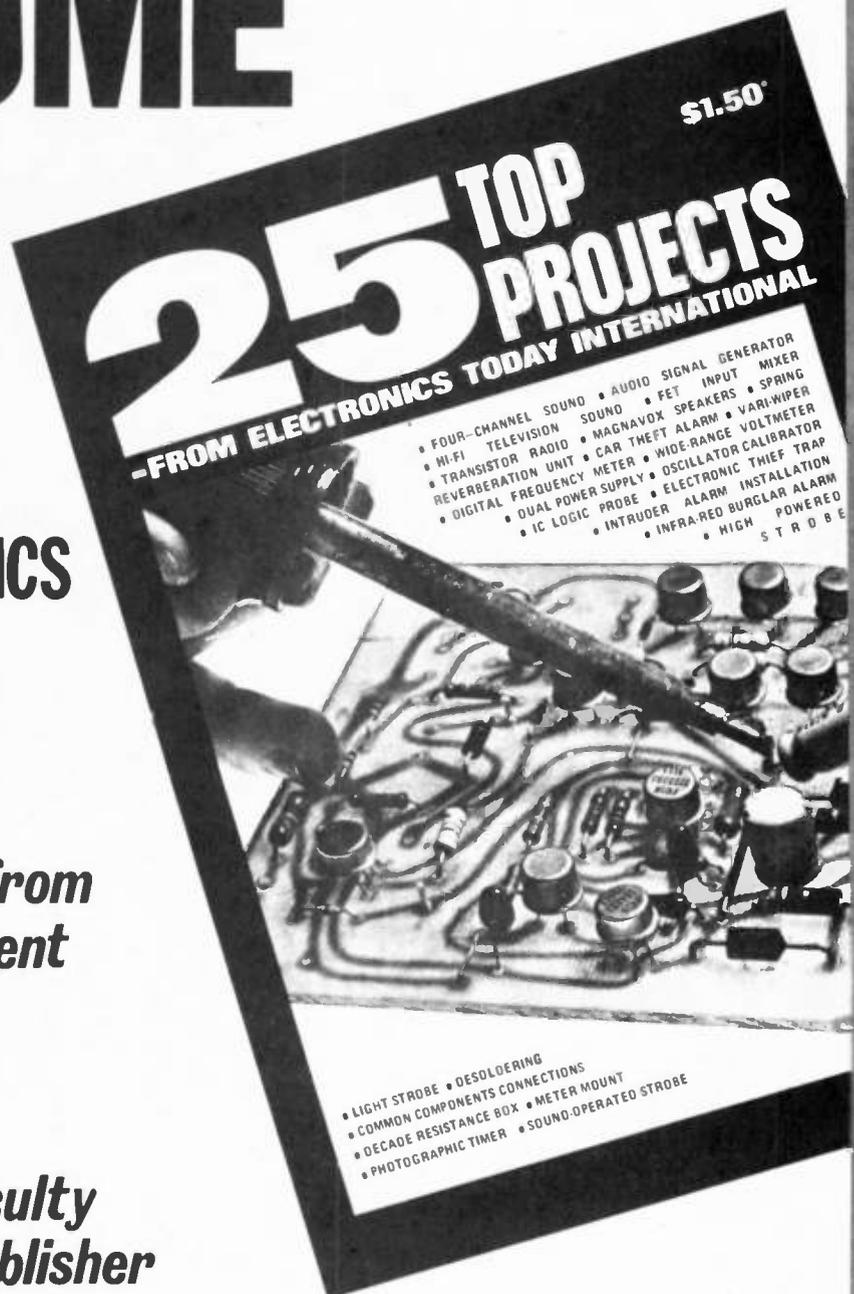
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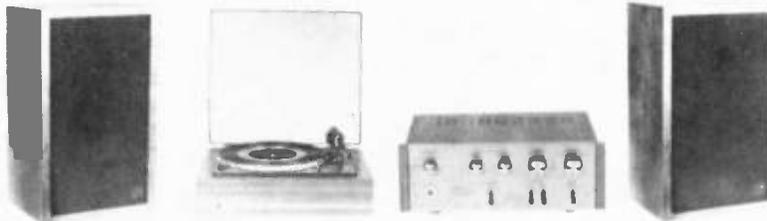
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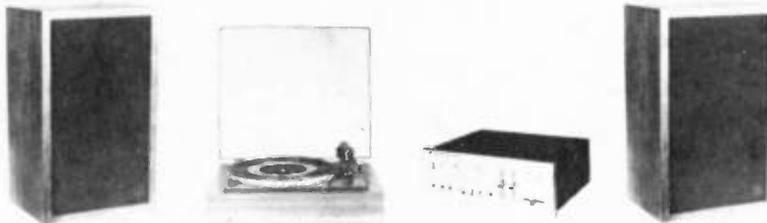


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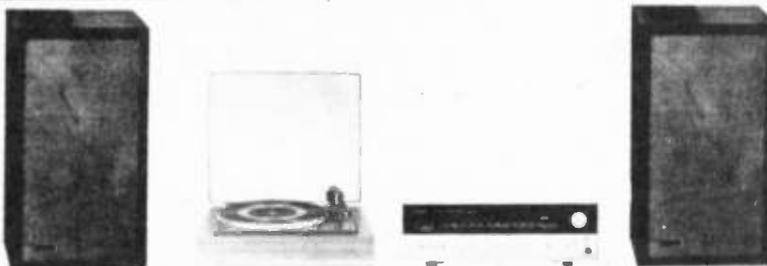
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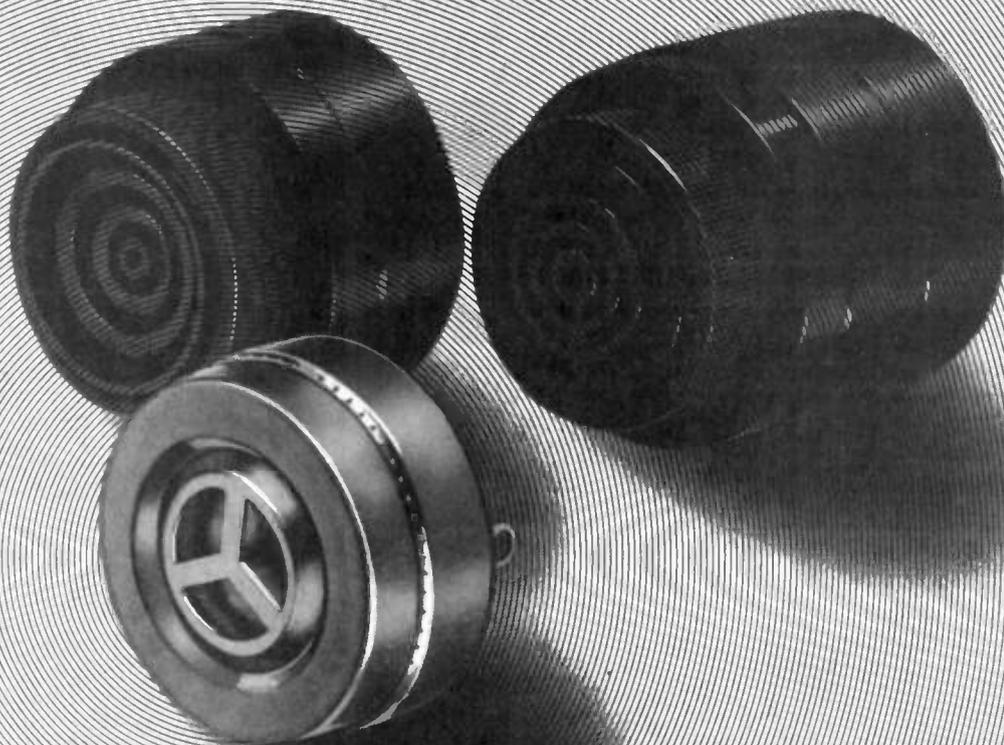
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AD57

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In its own laboratories, AR uses the most advanced scientific measuring techniques to evaluate the performance of a loud-speaker system. Obviously these are not available

**Stravinsky: "Marche Royale"**

The transparency of the recording permits the listener to observe the characteristic timbre of each instrument. The trumpet, bassoon, and percussion are particularly prominent.

**Sarasate: Zapateado**

The sound of the violin has been recorded with a minimum of room reverberation. Under such conditions any coloration in the playback equipment will be much more noticeable.

**Mozart: Quartet in D for Flute and Strings**

To the audiophile, the flute often seems like a musical audio oscillator. While it does produce a very pure tone, it nevertheless has many overtones which a good music system should capture without alteration.

**Albeniz: "Corpus Christi en Sevilla"**

The piano should almost appear to be in the room with the listener. The simulation of the bells, in particular, stresses the percussive possibilities of the piano (and will also test the trackability of a cartridge).

**Stravinsky: Three Pieces for Clarinet (11)**

A clarinet can sound like a saxophone. It can also have a peculiar nasal quality. Practiced hi-fi enthusiasts will surely want to point out how their equipment makes it possible to hear the artist breathing.

**Britten (b.1913): Simple Symphony for Strings**

Britten's lively work is performed here by twenty-two stringed instruments. The English Chamber Orchestra is considered by many critics to be the finest string orchestra performing today.

to the music lover in his home or in a hi-fi studio. In determining the accuracy of a loudspeaker system, the listener must depend on his ears and his memory. Under these conditions, a great deal depends on the quality of the recorded material used for the demonstration.

AR has developed this record as a useful listening aid in determining the accuracy of a loudspeaker. The highest level of recording skill has been used to capture the sound of familiar musical instruments. Most listeners have heard live a piano or a trumpet or a violin. If the sound of these instruments as heard through a loudspeaker resembles the memory of the live sound, then, chances are, it is an accurate loudspeaker.

**Bach: Toccata in D Minor**

This particular recording has been a long-time favourite at high fidelity shows whenever anyone wanted to reproduce very low organ tones. You can now try to break your woofer or your neighbour's eardrums.

**Kodaly (1882-1967): Sonata for Cello**

A cello is a particularly apt instrument for disclosing resonances in the middle to lower frequency range of a speaker system. Often loudspeakers have pronounced peaks in this range creating a boomy or "barrel-chested" sound with either male speaking voices or double-bass.

**Goykovich: Ten to Two Blues**

Anyone in a jazz club is likely to be sitting on top of the musicians and will hear the mechanical buzz of the strings of the double-bass, the shimmer of the cymbals, and the almost piercing impact of the trumpet. All of these should be audible and accurately reproduced in this selection.

**De Vaqueiras: Kelenda maya**

Who should deny that the human voice is the most expressive of all musical instruments? Surely not when listening to this plaintive troubadour ballad from the middle ages, sung without accompaniment.

**Manitas de Plata, guitar**

The steely brilliance of the flamenco guitar as played by one of its most eminent practitioners, is an excellent test of a music system's ability to reproduce transients. The cascading and rapid-fire procession of notes must not blur. Each tone should be sharp and distinct.

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# HI-FI an initiate's guide

Specifically for the newcomer to hi-fi, this feature article by Collyn Rivers tells how to spend your money to the best advantage.

**F**OR the person knowing little or nothing about hi-fi, buying equipment can be a traumatic experience — for he is faced with spending anything between \$300 and \$3000 without knowledge or prior experience of that which he seeks.

He will be overwhelmed with conflicting advice from his friends, and a barrage of pseudo-technicalities from that (fortunately) small segment of the hi-fi retail trade who appear totally to have lost sight of what they are selling.

Fortunately the more determined purchasers eventually find their way to responsible hi-fi retailers — or one of the growing number of manufacturers' hi-fi demonstration centres — and receive expert advice and guidance on their proposed expenditure.

Even so a surprisingly large number seek advice from magazines such as ours — often as many as thirty or forty a week. But all we can do is to offer general advice. Only in very exceptional cases can we suggest specific makes of equipment.

The purpose of this article is to provide guidelines for such people. It is specifically intended for those who know little or nothing about hi-fi except that they want to listen to well-reproduced sound.

## WHAT IS HI-FI?

In essence, hi-fi is a term used to describe equipment capable of reproducing pre-recorded sounds with as much faithfulness to the original sounds as the current level of technology generally permits.

The only generally recognised hi-fi standard is the German DIN 45,500. Used throughout Europe — but rarely outside it — DIN 45,500 defines the minimum level of performance considered acceptable for hi-fi equipment.

This standard covers a wide range of parameters, including power output and distortion, and is administered on a go, no-go basis. Equipment either meets it or not. If it does, then it is described as meeting the requirements of DIN 45,500 and this fact will be prominently featured in the

manufacturers' sales literature.

A substantial segment of the audio industry considers the minimum level of performance laid down by DIN 45,500 to be too low, but for many purchasers seeking to spend as little as possible, this standard provides at least some protection.

DIN 45,500 is not officially recognised in Australia — nor are there any alternatives — nevertheless if one is considering purchasing low-priced hi-fi gear of European origin it is worth while checking whether or not it meets this standard.

## HOW MANY CHANNELS

The earliest audio equipment was monophonic. A single microphone picked up the original sound, which was then recorded and subsequently replayed via a single loudspeaker. Even when headphones were used, identical sound was reproduced by each earpiece.

No matter how good the equipment, monophonic sound always seems 'dead' by comparison with an original performance. This is because at an original performance there are loudness and time interval differences between the sounds arriving at each ear, and the brain, by analysing these differences, provides spatial information about the hall, the orchestra and the audience. It is this mechanism that enables us to pinpoint positions of various members of the orchestra — even with one's eyes closed.

This spatial information is totally lacking with monophonic reproduction.

Two-channel reproduction (stereo) uses two microphones and two independent recording and reproduction systems in an attempt to preserve the loudness and time interval differences that the listener would experience were he to be at the original performance. In this way an impression of the width of the original sound stage, and of the positioning of the various members of the orchestra will to some extent be recreated in the home.

Another, and to many people an unexpected advantage of stereo sound, is that it partially recreates the 'ambience' (acoustical atmosphere) of the concert hall.

The latest arrival on the hi-fi scene is four-channel — or quadraphonic — equipment. Here, four separate recording and reproducing systems are used, and the resultant sound is heard through loudspeakers which are placed in each of the four corners of the listening area.

The result is similar to stereo, only more so.

Four-channel gear will be described in greater detail later in this article.

## COMPLETE SYSTEMS

A stereo system is in effect two virtually independent monophonic systems, but with most components assembled within common housings.

The first stage is either a stereo record player or stereo tape deck. Whichever is used, the output from the device consists of two independent sound signal channels — corresponding to the sounds that each ear would have separately heard at the original performance.

As the energy levels of the two signal channels are too weak to drive loudspeakers directly, an amplifier is used to increase their power level.

Two loudspeakers are used — generally placed along one wall of the listening room — each is driven by the appropriate amplifier channel.

## RECORDS OR TAPE

For many years the traditional method of recording and reproducing programme material has been the gramophone record, and until quite recently would have been the almost automatic choice of most hi-fi enthusiasts.

It is of course true that the tape recorder has been with us for a long time, but, in non-cassette form it is an unwieldy format for those whose main interest is to listen to material rather than to record it.

The cassette tape recorder has changed all that, and in its latest form

# HI-FI

it is a serious rival to the traditional record player — with the added capability of being able to record programme material.

The tape cassette works on the same principle as the original reel-to-reel tape recorder — i.e. the tape is wound from one bobbin to another — but now it is fully enclosed within a small rectangular package that plugs into the cassette recorder in a quick and simple way.

Cassettes are classified by numbers related to their running time in minutes. Thus a C60 cassette runs for 60 minutes (30 minutes each side), a C90 for 90 minutes (45 minutes each side) etc.

At present the maximum tape length generally available is C180 — providing a total of three hours playing time.

The quality of reproduction obtainable from a cassette recorder is closely related to its price. At present for any given level of reproduction it is a more expensive sound reproducer than the disc record player. The gap closes as price increases and the very best cassette recorders offer performance very close (but not yet quite equal) to the best record playing systems. When comparing prices of record players and cassette decks one must bear in mind that a cassette deck can (generally) also be used to make recordings as well as reproduce them.

A problem common to all cassette players is random noise. This is generated by the tape at all times and can be annoying during quiet passages in the programme material.

One method devised to overcome this, is the Dolby Noise Reduction System. The Dolby system involves a special recording technique in which quiet passages are automatically raised in volume. Special Dolby circuitry incorporated within the cassette recorder then restores these passages to their original level — the overall effect being a substantial reduction in tape noise.

Conventional tape cassettes use an iron oxide based tape and these are useable in all types of cassette recorders.

Chromium dioxide based tapes are also available. Generally, these chromium dioxide tapes (often abbreviated to CrO<sub>2</sub>) are capable of better performance than the iron oxide variety but should only be used in cassette recorders specifically designed for their use. (There are also some highly specialised iron oxide based tapes claimed to have equal performance).

Some cassette recorders are built as self-contained units and do not require a separate amplifier. However these inbuilt amplifiers have a very low power output, and are rarely capable of driving loudspeakers at the sound levels desirable for true hi-fi reproduction.

A few cassette tape decks without recording facilities are currently available. They are suitable for playing pre-recorded cassettes only. But the majority of cassette units can be used for recording material directly from radios, record players, microphones, etc.

A headphone jack socket is usually provided to enable the user to monitor the material being recorded.

For top quality hi-fi reproduction one must use a machine with inbuilt Dolby (or similar) noise reduction system, and designed to be used with a high performance iron oxide or chromium dioxide tape. At the time of writing, machines of this sort cost from around \$200 upwards.

Quite satisfactory hi-fi performance may also be obtained from machines without the Dolby system, but do not expect a great deal from machines costing much less than \$150. Table 1 shows typical performance figures for three cassette players.

## RECORD PLAYERS

Despite the challenge now being offered by the cassette player, the long playing record and record player are far from dead, and at present a top quality record playing system is still marginally superior to a top quality cassette tape system.

Record players can be divided into two main groupings: manual or automatic. Manual units can accommodate only one record at a time, and will probably — but not necessarily — be fitted with an

automatic mechanism to stop the turntable and raise the needle at the end of the record.

Automatic players on the other hand, accommodate a stack of records, and these are changed automatically in sequence.

At one time, automatic record players were unpopular with hi-fi enthusiasts, as the lowering mechanism was liable to cause record damage. This is no longer a problem with any good quality unit, though some of the cheaper mass-produced record players are still suspect in this regard.

The turntable may be driven from the motor either by a rubber wheel pressing against the turntable rim, or by a belt. Both mechanisms have their good and bad points — the important thing is to choose a well engineered device — regardless of the design approach taken by its maker.

Some record players use very heavy turntables — to reduce short term speed fluctuations, others use light turntables and inherently smooth running motors to obtain the same result.

As with the drive mechanisms, both approaches have good and bad points. A heavy turntable will reduce fluctuations, but the increased load on the bearings tends to introduce a low pitched 'rumble' which may be reproduced through the loudspeakers. The lighter table will be less likely to

'rumble' but may have minor speed fluctuations unless the drive motor is speed controlled. But of the two best record players that we have ever used — one had a very heavy turntable — the other had a very light one!

The minimum price for a reasonably good quality record player is around \$100. Really good ones cost \$150 upwards and truly excellent ones around \$250.

A record player is a fairly straightforward piece of engineering and whilst some are obviously better value for money than others, one would be very unfortunate to choose a bad example if one keeps above our suggested minimum price.

## PHONO-CARTRIDGES

Generally a phono-cartridge will be supplied with the record player — however with top quality record players one may be offered a choice of cartridges.

There are two main types of cartridges. These are classified by their operating principle. Cheapest are the ceramic types in which the moving stylus applies varying pressure to a ceramic material. When squeezed, this material generates a voltage roughly proportional to the applied pressure.

A top quality ceramic cartridge produces quite acceptable sound — in

Table 1

Cassette Tape Recorders Parameter	\$130	\$175	\$300	Comments
Frequency Response (±3dB)	50Hz-9kHz	30Hz-11kHz	30Hz-14kHz	Wider the better
Wow and Flutter	Less than 0.5%	Less than 0.2%	Less than 0.1%	As above.
Distortion	Less than 5%	Less than 3%	Less than 2%	The lower the better
Signal/Noise ratio	+ 40dB	+ 45dB	+ 50dB	Higher the better

fact they are used by the million in low and medium quality record players. But at the present time this type of cartridge cannot compete with the higher quality magnetic cartridges. Nor does it pretend to.

Magnetic cartridges operate by causing the moving stylus to generate small electrical signals in coils placed near a small magnet attached to the moving stylus. Other magnetic cartridges utilize a magnet located close to the stylus and this causes magnetic energy to be coupled to the stylus and thence to the coils.

The weight imposed by the cartridge stylus upon the record is called the tracking weight. For good quality styli this will be between half a gram and three or four grams. Within reason the lower the tracking weight the better, but if the weight is less than two or three grams, further decreases in tracking weight have little advantage. In fact a record is more likely to be damaged by the stylus jumping around due to underloading than by excess loading.

Cartridges vary considerably in price, but as with nearly all hi-fi gear, quality is closely related to price.

Ceramic cartridges range from \$3 or so, up to \$20; magnetic cartridges from a low of \$8 to really superb units costing around \$100. As a rough guide a cartridge should cost around a third of the price of the record player with which it is used.

Table II shows typical specifications for three different turntables.

## RADIO TUNERS

Until the government's recent announcement of FM radio, this section would have been very short and simple. It no longer is.

The existing system of radio broadcasting in Australia uses a technique known as AM (amplitude modulation), which, whilst subject to interference from man-made and natural sources, is otherwise capable of adequate performance. The generally poor quality of sound from domestic radio receivers is due more to design compromises than the basic limitations of the AM system.

Any existing AM radio can be modified to enable it to be connected to an amplifier. The sound quality will not be hi-fi but will be better than most people suspect.

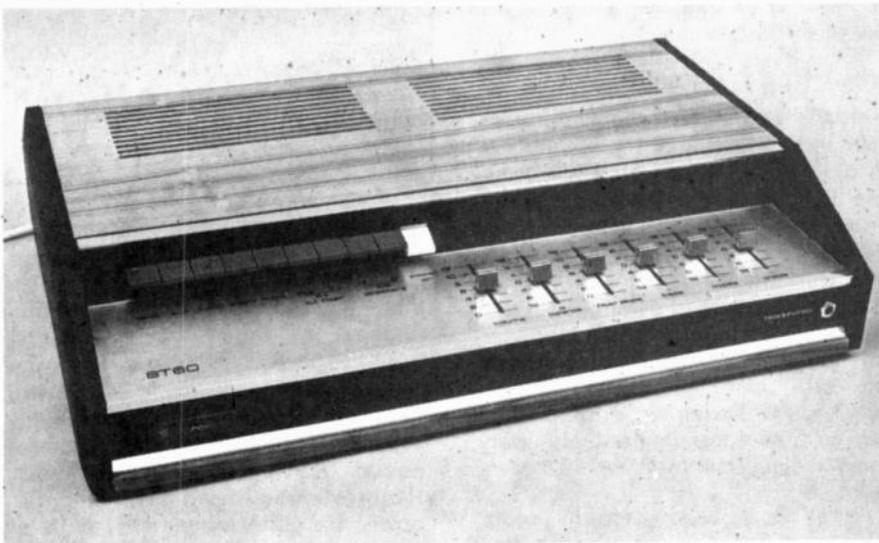
Very high quality AM radio tuners are available on the Australian market — and where there is adequate signal strength — these tuners provide outstanding sound quality. But before buying one of these units, check with your local dealer that reception conditions are adequate.

The forthcoming FM broadcasting system is inherently less prone to

## TURNTABLES

Parameter	\$120	\$175	\$250	Comments
Wow and Flutter (rms)	Less than 0.2%	Less than 0.1%	Less than 0.05%	Lower the better but not significant below 0.05%
Signal/Noise Ratio	+ 40dB	+ 50dB	+ 58dB	Higher the better

Table II



Shape of things to come? MetroSound's latest Model ST60 amplifier.

interference, and because there is more room in the available FM broadcasting bands, it can be used to transmit a wider audio frequency range than is currently permissible with AM. Because of this, improved sound quality is potentially available from FM systems.

FM systems are widely used overseas, but probably due to the Australian government's wish to promote the local electronics industry, our FM system will operate at a much higher frequency than anyone else's and hence our FM tuners must be specially built.

Thousands of hi-fi enthusiasts already own conventional FM tuners and — whilst these tuners cannot be directly used for the new system — we will in due course be publishing an article describing the construction of a cheap and fairly simple adaptor enabling them to operate on the higher frequency signals.

Initially, the Australian FM system will be capable only of transmitting a monophonic (single channel) signal. But the system is inherently capable of stereo operation and no doubt in time we will also have this facility. (FM stereo is regularly transmitted in several overseas countries).

All hi-fi amplifiers have provision for connecting a radio tuner. A switch mounted on the amplifier front panel then enables one to select record player and/or tape deck — or radio tuner, as required.

High quality AM tuners are

commercially available for around \$100.

## AMPLIFIERS

An amplifier is used to increase the power level of the relatively weak signal from the record player or cassette player — to a level adequate to drive a pair of loudspeakers. It will also have controls enabling one, selectively, to increase or decrease treble and bass frequency response.

In recent years a second class of amplifier has become increasingly popular. This is the tuner-amplifier, and, as its name implies, is a combination of power amplifier and radio tuner. Radio tuners will be discussed in greater detail later in this article.

The selling price of an amplifier is determined by its power output, its ability to amplify signals without introducing distortion, the level of noise that it develops internally, its suitability for use with other equipment such as microphones, tape recorders, extra turntables etc, and of course its quality of manufacture and after-sales service.

Table III shows typical specifications for three amplifiers in different price brackets. Note that for distortion, below 1% is good, below 0.5% is excellent. Anything below 0.1% is gilding the lily.

Amplifier noise may be checked in the dealer's showroom by turning the volume control fully up with the record player switched off, or

# HI-FI

preferably, disconnected. With a good amplifier only a very faint hiss should be heard with one's ear close to the speakers.

## HOW MUCH POWER

Perhaps the biggest problem facing the inexperienced hi-fi buyer is determining how powerful an amplifier he needs. Power output is measured in watts — often abbreviated to 'W'. It seems simple enough but isn't, for the hi-fi industry has an incredible practice of determining, and quoting, this output in at least six widely different ways. As a result, one and the same amplifier may be described as having an output from 10W to 60W depending entirely upon which measurement system has been used.

Output may be quoted in watts (rms), watts (continuous power), watts (peak), watts (peak-to-peak), watts (music power), watts (IHF), etc.

Only two ratings are meaningful for comparing one amplifier with another. These are watts (rms), and watts (continuous power). The former expression is technically dubious but has gained understanding and acceptance by common usage. Both terms are effectively interchangeable. Thus 10W rms is much the same as 10W continuous power. (From here on in this article, when we use the word watt, the rms (or continuous power) rating method is applied.

As we stated above, the price of an amplifier is closely related to its power output, and will usually be somewhere between \$5 and \$8 per watt. If the price is much less than this, it is a safe bet that the power output is not being quoted in watts (rms). If the price is substantially higher than \$10 a watt, it is either a unit of superlative quality — or it is overpriced.

Just how many watts you require from the amplifier depends on a number of factors, these include room size, loudspeaker efficiency, and just how loud you like your music.

Rather than introduce a mass of complicated mathematics we have prepared a simple graph — Fig. 1 which shows average power requirements for rooms of various sizes and for two different types of speaker. (The differing power requirements of speakers are explained later in this article).

As our graph shows, most listening requirements will be satisfied by amplifiers rated between 20W and 100W — and thus costing between \$100 and \$1000. If in doubt err on the

## AMPLIFIERS

Parameter  
Power Output

\$120

18W

## TABLE III

\$200

30W

\$350

60W

## Comments

Price should be between \$5 and \$10/Watt.

Total Harmonic Distortion (at 1kHz)

Less than 0.75%

Less than 0.5%

Less than 0.25%

Insignificant below 0.1%

Frequency Response (20Hz-20kHz)

±3dB

±1dB

±0.5dB

Generally adequate with modern amplifiers

Hum & Noise (with respect to rated power)

+ 50dB

+ 60dB

+ 70dB

Higher the number the better.

side of too *much* power, because bass response will be lacking if there is too little. It is important also to realize that, due to the ear's logarithmic response to sound levels, doubling amplifier power will not result in twice the apparent loudness. In fact it will only just be noticeable. To double apparent loudness one must increase power by no less than ten times. Hence minor differences in amplifier power are quite insignificant as far as loudness is concerned — over the mid-range part of the audio frequency spectrum at least.

Amplifiers have now been developed to the point where they are closer to the ultimate attainable performance than any other item in the hi-fi chain. As a result — and providing power

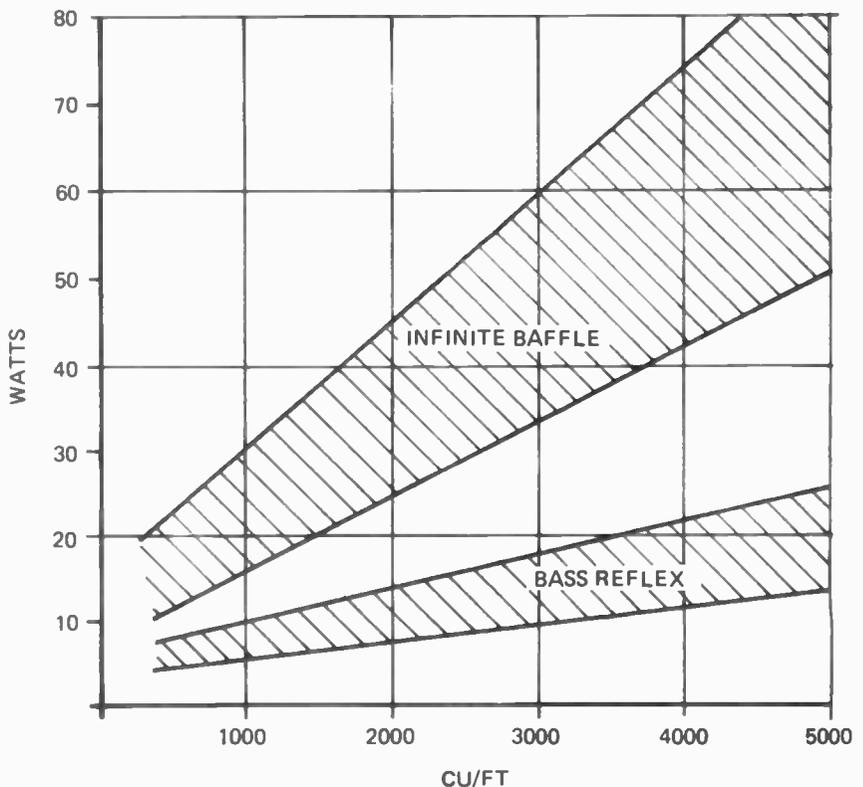
output is adequate — there is little audible difference between amplifiers of broadly similar specifications. These are probably the easiest items of hi-fi equipment to choose, for within the price range quoted previously, we have yet to see any bad ones!

## LOUDSPEAKERS

Speakers are individualistic animals, and there are clearly audible differences between speakers of similar specifications and prices.

Contrary to general belief, there is no relationship between the number of speaker drive units in any given enclosure and the resultant sound quality. One of the best units currently available uses nine drive units, one of the worst uses eight. It is

Approximate amplifier power requirements for various size rooms.



significant, that with rare exceptions, most really good speakers have only two or three drivers. (The term 'two-way' is often used to describe speaker enclosures using two drive units; 'three-way' for those with three — etc.)

A figure sometimes quoted by speaker manufacturers and salesmen is that for overall efficiency. This is quoted as a ratio of the electrical power input to the speaker (from the amplifier) and the acoustical power output from the speaker. The result is quoted as a percentage. Thus a speaker requiring 50W input for 1W output is 2% efficient.

These are enormous differences in efficiencies, from as low as 0.1% to a high as 50% — depending almost entirely upon the physical size of the speaker and the design approach used by the manufacturer.

Two types of speakers are commonly used. One, the infinite baffle type, consists of an enclosure that is totally sealed except for the speaker drive units. Bookshelf speakers are usually made like this. They have very low efficiency — from 0.2% to 1% or so. Most of them have a very good bass response if driven by an amplifier of adequate size, at least 20W is required — many need even more.

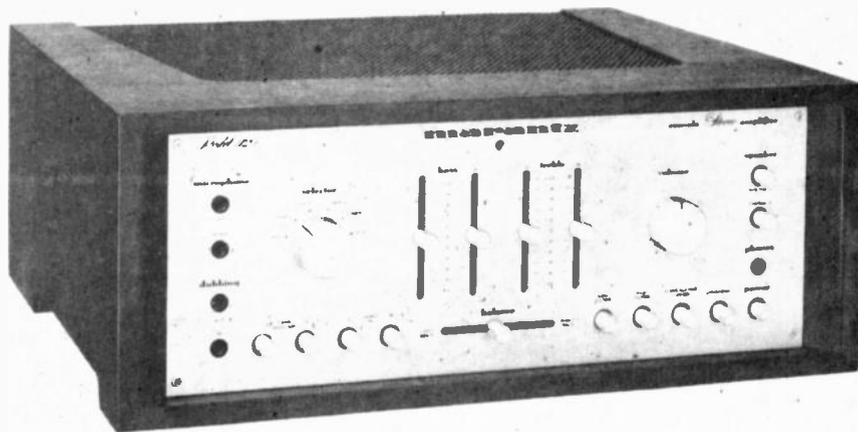
The second commonly used type of speaker is the bass-reflex cabinet. Generally larger than the infinite baffle speaker, they can easily be recognised (if the speaker grille is removed) as they have a circular or rectangular cut-out usually, but not necessarily in the front panel — venting to atmosphere. They are more efficient than the infinite baffle type of enclosure — 2% to 5% is typical. Because of this they do not require such a large amount of power to drive them.

Do remember when choosing speakers that the efficiency provides no indication whatever of that speaker's quality, merely of the power required to drive it.

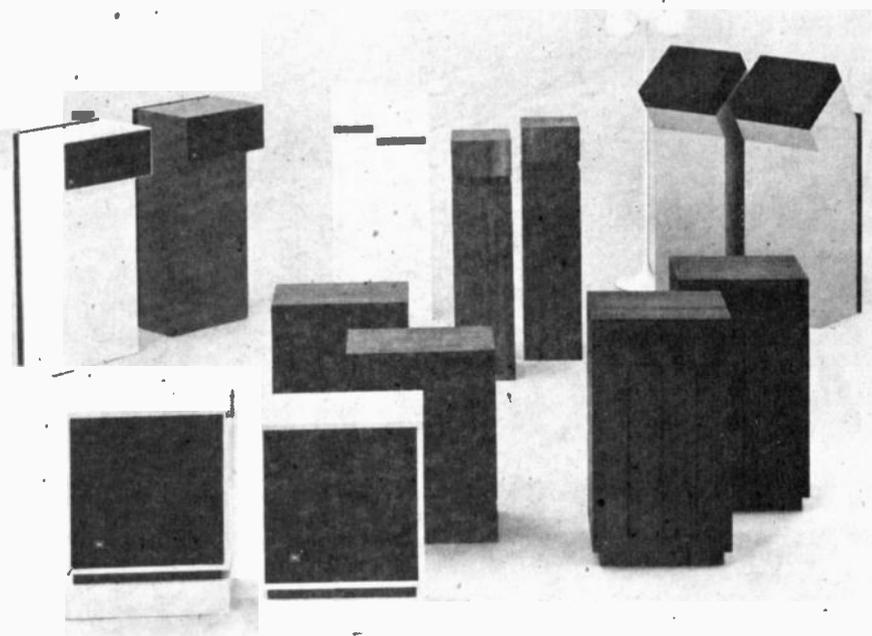
Magazines such as Electronics Today International publish tests of various makes and types of loudspeakers. Apart from publishing actual measurements of the speakers' performance, most journals also attempt to describe the quality and type of sound produced. An indication of relative value for money is included — at least in our magazine it is!

But no matter how much one reads about speakers, one can only make a final choice by listening to them.

Visit a reputable hi-fi dealer and ask him to demonstrate speakers in the price range that you have in mind. Don't try to compare more than three speakers in one day and always listen to the speakers at about the same sound level because the louder of any



Latest amplifier from Marantz has 120 watts output per channel.



Omnidirectional speakers from JBL.

two speakers will nearly always appear to have the better response.

Some hi-fi demonstration rooms have very odd acoustic characteristics, and speakers may not necessarily sound the same in your home as they do in the showroom. If at all possible try to arrange for a demonstration of your final choice of speakers at home — many dealers will oblige if you are a genuine buyer.

As we stressed throughout this article there is a positive correlation between the price and the standard of performance of most hi-fi equipment. This is true also of speakers — but possibly to a lesser extent than the remainder of the equipment, and it is well worth while listening to a number of different types and makes before making a final decision.

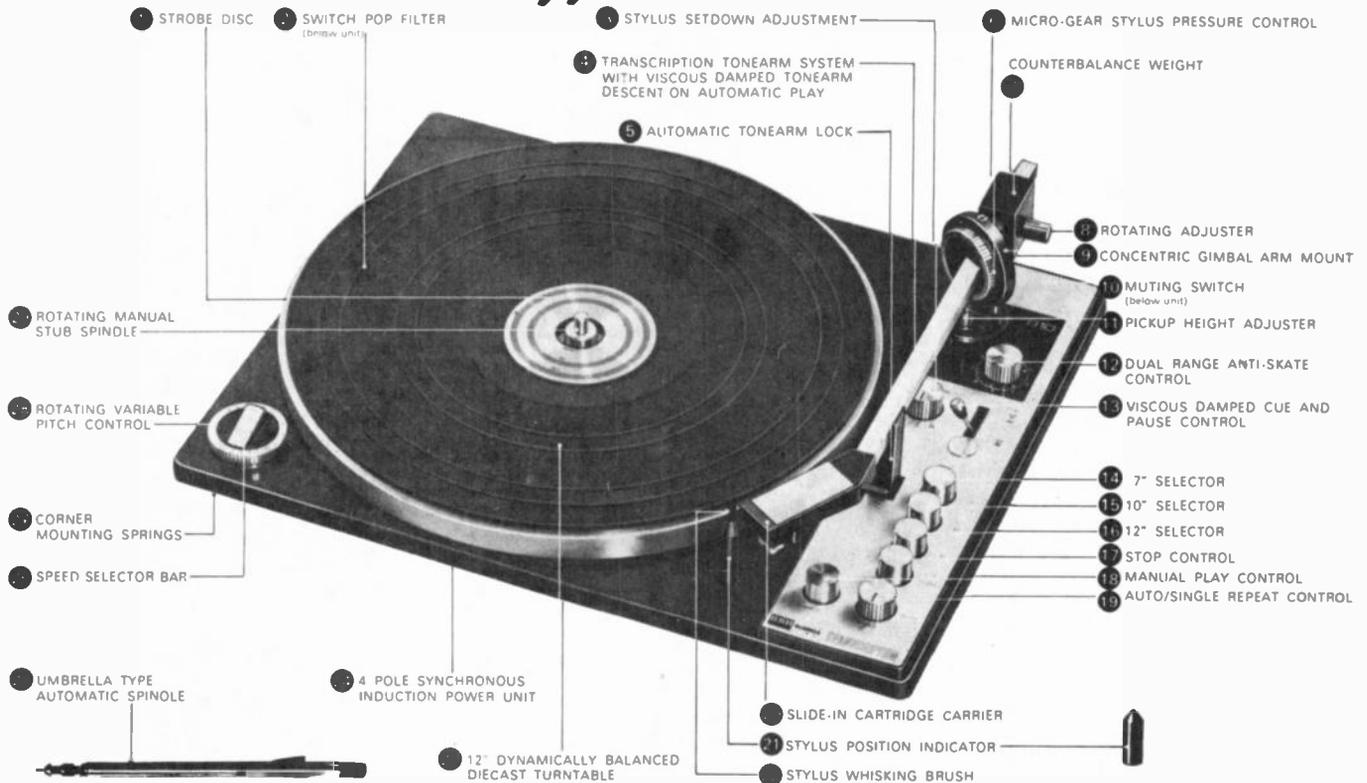
In general the more expensive speakers — i.e. \$150 upwards — have greater power handling capability, better bass response and less colouration than cheaper units. (Colouration sounds like speaking through cupped hands).

But good speakers demand an equally high standard of performance from the associated amplifier, record player and stylus, and if these items are not up to standard, the high quality speakers will merely highlight deficiencies elsewhere. A later section of this article explains how to balance the equipment so that this does not happen.

#### FOUR CHANNEL EQUIPMENT

There are several, currently non-compatible, systems for

“Taking it all together — performance, features, styling — the BSR 810 moves into ranking place among the best automatics we know of. And at its price, the others may well be in for a real contest.” Hi-Fidelity Magazine, May 1972.



# At \$149\* for the kit, the brilliant BSR/810 transcription turntable is hardly cheap. But your ears will tell you it's a bargain.

BSR, manufacturers of most of the world's turntables, have now turned the tables on expensive units.

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error to less than 0.5% per inch.

Viscous cueing is also standard on automatic as well as manual operation, and a unique anti-skate device is also featured for elliptical and standard styli. Speeds are 33½ rpm and 45 rpm. (Which are all you need today.)

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\* Manufacturers recommended retail price

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Mascot 2020 Telephone 669 6088

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BSR:117

# HI-FI

reproducing four-channel sound. Some use four-track tape recordings (and a special tape recorder), others use specially produced 'four-track' records, whilst yet another class of systems synthesize four-channel sound from normal two-channel recordings.

Four-channel sound usually sounds quite awful in a dealer's showroom — but can be very effective in the home. It seems to need 'dead' surroundings to be truly effective.

At present the market is in a state of confusion, four-channel equipment of several different types is commercially available but there is as yet no internationally recognised standard defining even basic formats. As a result, programme material recorded for any one system is not necessarily playable on any of the others.

The cheapest way to obtain a rough idea of what four-channel sounds like is to use the system described in *Electronics Today*, August 1971. This requires just a few feet of wire and two extra speakers and synthesizes four-channel from standard stereo material.

## WHAT IT COSTS

In December 1971 we suggested that one can relate the price one pays for hi-fi gear against motor cars. This comment is still valid.

We suggested that a basic Torana or Mini is the motoring equivalent of about \$300 spent on hi-fi. Good value

for money if one accepts some limitations of performance.

Four to five hundred dollars buys the hi-fi equivalent of a basic Holden or Falcon — sufficient power for most situations — some performance limitations but reasonably good quality.

Six fifty to a thousand dollars puts you in the Volvo 144, Peugeot 504, Rover 2000 class — and this expenditure probably provides the optimum in terms of value for money.

There are still substantial improvements to be found up to the \$1500 mark and you are now in the Mercedes 250 range.

Above \$1500 to \$2000, increments in performance are there, but less obviously. This is the realm of the Mercedes 600, and is for the connoisseur or the very rich.

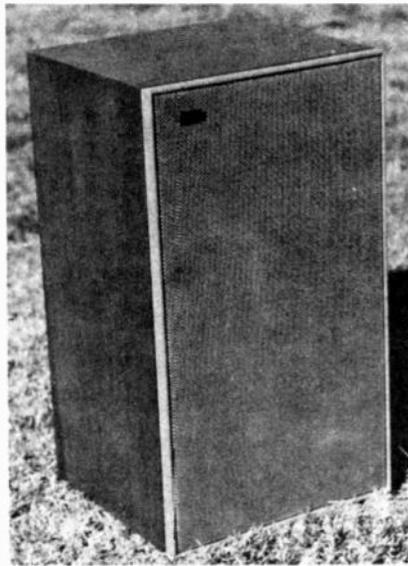
## HOW TO APPORTION THE MONEY

It is essential to apportion the money so that all items are of roughly equal quality. This is where many people go wrong and end up with a brilliant pair of speakers and an inadequately powered amplifier, or an excellent turntable and a lousy cartridge.

There is one practically infallible way of ensuring that everything is well balanced. This is to decide how much you can allocate, and then apportion somewhere between 40% and 60% for the two speakers, and split the remainder more or less equally between the amplifier and record player.

Bear in mind that speaker efficiency will affect the exact amount spent on the amplifier. The higher the speaker

*(Continued on page 120)*

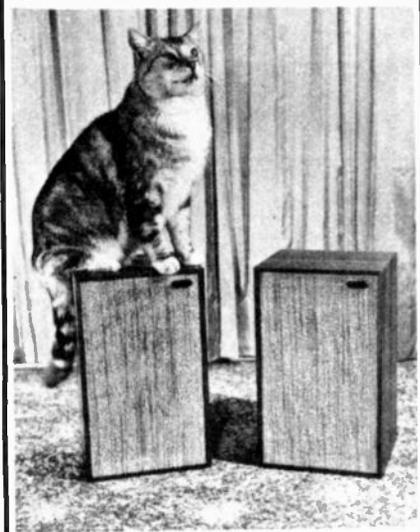


Well-known and respected in Britain, Leak equipment is now also manufactured in Australia. Photograph shows Leak 250 loudspeaker.



Hi-fi speakers do not have to be heavy as these 15 watt Denton units from Wharfedale prove.

## CATAACOUSTICS?



Catacoustics (kætākou'stiks). 1683. [mod. f. CATA- in sense £ + ACOUSTICS. Cf. CAT-OPTRICS.] The science of reflected sounds.

Audiosound's latest bookshelf speakers. Despite our caption, the sound does come through the grille!



Typical of the new generation cassette recorders is this unit from Pioneer. Machines such as this have performance very close to top quality record playing systems. (A review of this machine will be published in ETI very soon.)

# BUY STATE OF THE ART SOLID STATE COMPONENTS— Direct from the United States!

All listed prices are in Australian dollars, International Postal Money Orders (please send PO receipt with order for immediate shipment). Banque Chasiere check (preferably in US funds) and rated company cheques (with foreign exchange stamp approval affixed) will be accepted. Due to recent Australian government restrictions we are not able to clear personal checks... All goods are new unused surplus and are fully guaranteed. Orders will be shipped within two workdays of receipt of same. All customs forms will be attached. Minimum order amount is \$5.00, do not add postage — we pay postage. Surface mail for orders under \$10.00 and Air Mail for orders over this amount.

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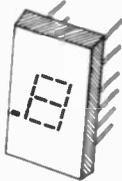
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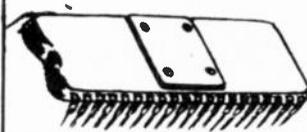
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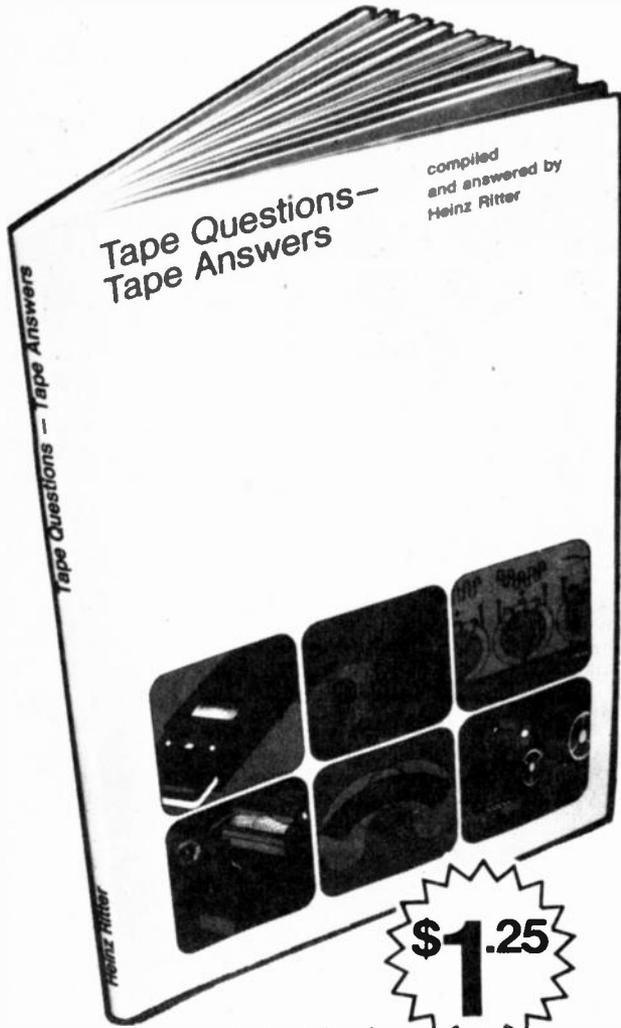
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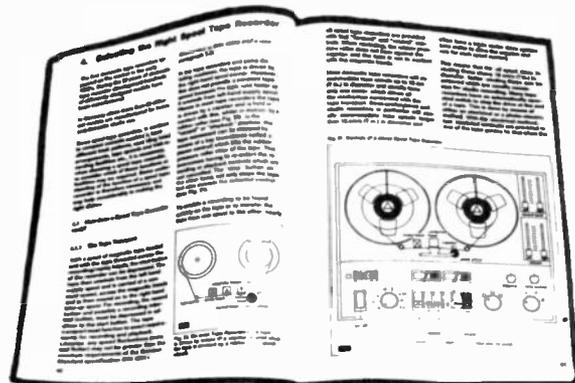
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# FREQUENCY MODULATION

## How it works and why it is used.

It is difficult to shout a message to someone a few hundred yards away. This is because sound is attenuated very rapidly in its passage through the air. Not so with radio waves. They do not require air, or any other physical transmission medium. They can be used to transmit signals over, literally, astronomical distances.

To use radio waves as a transmission medium, we must somehow impress the information we wish to transmit onto the radio wave. The process of impressing information onto the radio wave is called modulation, and the radio wave so modulated is called the carrier.

The carrier wave (assuming it is a pure sine wave) has two basic characteristics that are exploited in radio broadcasting systems. They are:—

(1) Amplitude; In Fig. 1a, the waves represented by the dotted and solid lines are the same in every respect except amplitude.

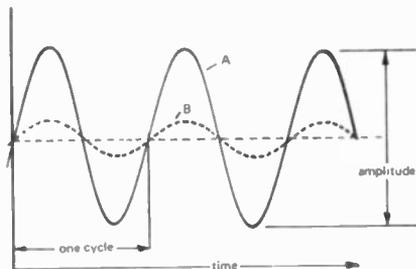


Fig. 1a. Two sine waves of same frequency but different amplitude.

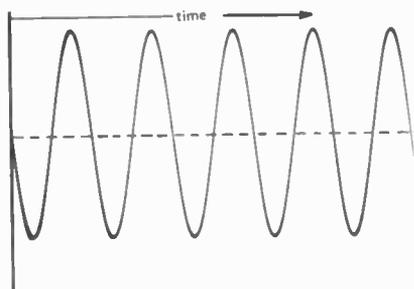


Fig. 1b. Sine wave having same amplitude as A in 1a but at twice the frequency.

(2) Frequency; In Fig. 1b, the wave has the same frequency as A in 1a but twice as many complete cycles occur in a given time.

To modulate the radio wave, we may modify either of these two characteristics linearly. Such modulation is broadly termed continuous modulation. Or we may chop up the

wave in accordance with a coded signal (e.g. Morse code transmission) and such modulation is broadly termed pulse modulation. We shall concern ourselves here only with continuous modulation.

### CONTINUOUS MODULATION

Only two methods of continuous modulation are in general use for radio broadcasting. These are amplitude modulation (AM), and frequency modulation (FM).

The differences between the two techniques may readily be understood by referring to Fig. 2a and 2b.

Amplitude modulation is depicted in Fig. 2a. Here, an audio waveform

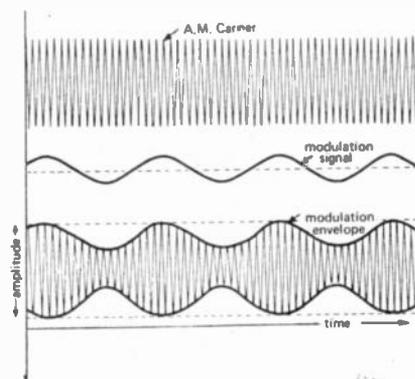


Fig. 2a. The amplitude modulation process  
(a) The unmodulated carrier  
(b) The audiotone  
(c) The modulated carrier

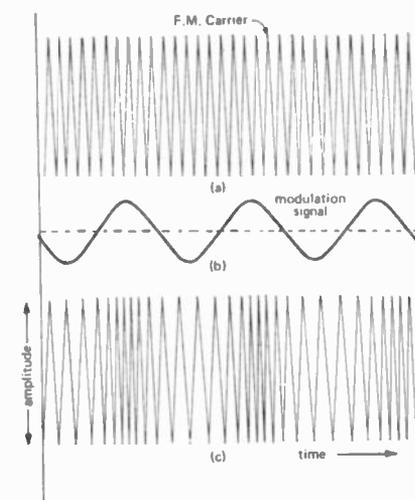


Fig. 2b. The FM modulation process  
(a) The unmodulated carrier.  
(b) The audiotone  
(c) The modulated carrier

causes corresponding changes in amplitude of the sine-wave carrier.

When the audio waveform swings

positive, the carrier amplitude is increased, and when the audio waveform swings negative the carrier amplitude is decreased. The amount of increase or decrease depends on the amplitude of the audio tone. If the audio tone amplitude is sufficient to just reduce the carrier amplitude to zero — the carrier is said to be 100% modulated.

Frequency modulation is shown in Fig. 2b. In this case when the audio tone swings positive — the carrier *increases* frequency, and when the audio tone swings negative — the carrier frequency *decreases*. The carrier amplitude always remains the same. So in effect, the carrier fluctuates in frequency around its nominal value at a rate determined by the modulating audio tone.

It should be particularly noted that frequency swing of the carrier is related to the amplitude of the modulation signal, not its frequency. The amount that the carrier swings in frequency is known as the deviation.

It may be thought that in comparison with the AM system, 100% modulation would now correspond to a reduction of the carrier frequency to zero. But assuming this were possible, one FM channel would occupy an enormous bandwidth (more than twice the carrier frequency) and this is obviously impractical. Again it may be thought that bandwidth could be limited to a few cycles whilst still retaining the capability of transmitting the entire audio spectrum. This would be wonderful if it were possible, but in fact the modulation products occupy a wide bandwidth in a very complex manner.

In practical systems the deviation is limited by licencing authorities to 75kHz above and below the carrier frequency, and as this implies a bandwidth of the order of 200kHz, operation in the VHF (very high frequency) or UHF (ultra high frequency) bands is necessary in order to provide room for a reasonable number of stations.

The internationally agreed band for FM radio transmission, as used in most countries, is in the VHF region from 88 to 108 MHz and were it not for a political decision, this is the frequency band that we would have used in Australia.

To understand the deviation process better, let us return to the AM system again. The modulation process is

## WILL HISTORY REPEAT ITSELF?

Will Australia use FM as fully as it deserves? Or will the errors committed in UK and USA be repeated?

The UK has had FM since the early '60s and the USA since the early '50s. In neither of these countries have the advantages FM has over AM reception been fully utilised, in fact the only advantage of FM that is really exploited is the absence of static, image and adjacent-channel interference.

High quality audio, with bandwidths up to 15kHz or so, is a feature inherently available with FM systems — but is rarely exploited in most receivers. Neither is economic use of transmitter power — another advantage which FM has over low-frequency AM. It is interesting to recall how this situation came about.

Until the mid '60s, miniaturisation of components and associated receiver design had not really got under way, and FM receivers were designed and destined for a connoisseur market able and willing to pay

the price for quality receivers with 'near hi-fi' audio stages and various refinements such as automatic frequency control etc. With the then prevalent discrete design, these receivers were expensive, and the market was limited.

The advent of miniaturised design in the mid '60s also coincided with the booming in the then affluent 'teen-age' market which devoured as many portable small receivers (mainly for AM) as could be locally manufactured and augmented by importers.

Market economics dictated a cheap and competitive price tag to such receivers. And, since it is more expensive to design and manufacture the front end (up to the discriminator/detector) of a cheap portable FM receiver than that of a comparable AM receiver, manufacturers economised on the audio stages where hi-fi design would have been out of place anyway due to the limitations of loudspeaker size alone. The continuing high sales potential of the portable set market since then has virtually put an end to high quality audio reception from FM

broadcasts in such receivers. Admittedly, full justice to the high quality audio available with FM is being given in table and console model receivers and radiograms but these account for less than 5% of the market, ignoring the specialist hi-fi field which is adequately catered for by an expanding market of FM and AM/FM tuners.

Portable FM receivers have also exposed another weakness of FM reception in practice. The telescopic and other forms of integral receiving aerials which could be (and were) cheaply provided with such sets are inadequate outside a small radius of the transmitter. Hence, since such receivers are mostly designed to receive AM broadcasts also, they tend to be used almost exclusively for AM where complementary AM transmission is available.

Such is also the situation in certain reception areas which are 'dark' for FM due to man-made or natural obstacles in the line-of-sight signal propagation paths.

How Australia proposes to tackle this market should be fascinating to observe.

essentially a multiplication process which results in a transmitted signal consisting of a carrier frequency and what are known as sidebands. These sidebands, of which there are two, are spaced above and below the carrier and are separated from it in frequency by an amount equal to the modulation frequency. Thus a 5MHz carrier, amplitude modulated by a 10kHz

signal, would have a spectra as shown in Fig. 3.

These sidebands shift in and out as the modulating frequency varies. Obviously if the audio modulation is limited to 15kHz, the total bandwidth would be limited to  $5\text{ MHz} \pm 15\text{ kHz}$ , i.e. 30kHz.

But with FM modulation, sidebands are produced spaced in frequency at multiples of the modulating signal frequency. For frequency modulation

by a tone of 10kHz the spectra will look something like Fig. 4. There is actually an infinite number of sidebands above and below the carrier

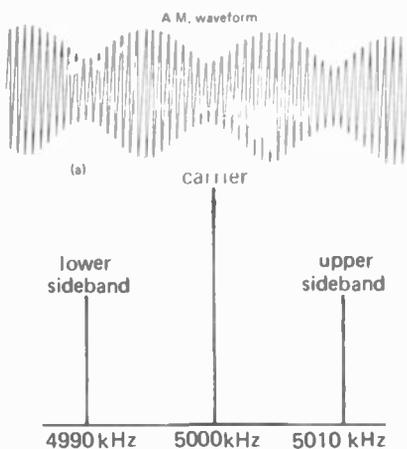


Fig. 3. An AM modulated wave may be considered as a carrier plus two sidebands above and below separated from the carrier by the audio frequency.

- (a) The modulated carrier (amplitude versus time)  
 (b) The spectrum of the modulated carrier (amplitude versus frequency)

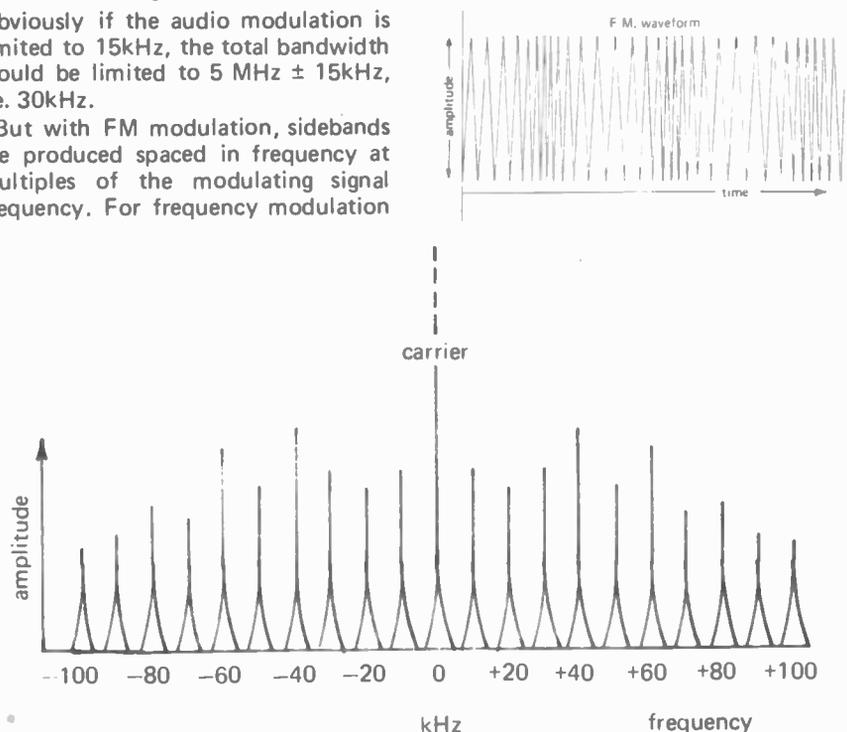


Fig. 4. (a) An FM modulated carrier (amplitude versus time). (b) the amplitude versus frequency spectrum of an FM signal with 10 kHz tone modulation produces pairs of sidebands separated from the carrier by integral multiples of the modulation frequency.

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# FREQUENCY MODULATION

From page 27

frequency but a 200kHz bandwidth will include all those sidebands with amplitudes of consequence.

The degree of modulation is dependent on the amplitude of the audio tone, and as the major sidebands must be kept within  $\pm 75\text{kHz}$  deviation, we need some factor by which we can compare relative modulations. This factor is known as the modulation index and is the ratio of the carrier deviation to the modulating frequency

$$\text{Mod index } M = \frac{\text{carrier deviation frequency}}{\text{modulation frequency}}$$

Thus with a 15kHz modulation and a maximum deviation allowable of 75kHz — the modulation index is equal to:—

$$M = \frac{75 - 5}{15} = 5$$

In this case as long as the modulation index of five is not exceeded, modulating frequencies 15kHz and below the FM sidebands will not cause interference with adjacent channels.

## ADVANTAGES OF FM

From what has been said before, it is

obvious that FM transmission has no advantage in terms of bandwidth over an AM system. In fact it requires so much bandwidth that operation in the VHF (or UHF) band is essential. So what is the point?

Well, first of all let us consider the problem of noise. In AM transmission, noise disturbances are superimposed upon the carrier wave in the form of sharp spikes. (Fig. 5)

These spikes have exactly the same format as the AM modulation and are

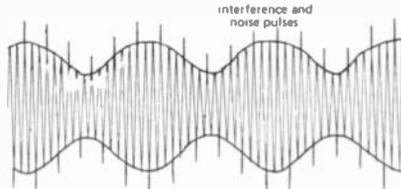


Fig. 5. Noise in an AM modulated signal produces spikes which pass through the receiver and appear in the output

hence amplified and detected in the normal manner thus giving rise to very unpleasant static and noise which is reproduced through the loudspeaker. Widening the AM bandwidth, to obtain better fidelity, also increases the susceptibility to noise.

Now let us consider FM. Here, noise again produces amplitude variations in the carrier, but in this case the information is not carried by

amplitude variations, but by frequency variations and hence is of an entirely different form.

If now we pass the signal through a clipping stage the signal will have the noise components clipped off but will still retain the full modulation information.

Another advantage of FM is its capability to reject unwanted signals within the passband. This is far greater than that attainable with AM. For example an unwanted signal which has half the amplitude of the required signal will not cause interference. In AM, the wanted signal has to be 25 times greater than the unwanted signal to achieve the same rejection.

To summarise, FM offers the capability of transmitting the entire audio spectra of a programme with much better noise performance and unwanted signal rejection than AM. It does not, however, offer saving on bandwidth requirements.

A further advantage of FM is the possibility of transmitting stereo music on the one carrier, and this process known as stereo multiplexing is a well established practice overseas. No doubt we will also see this in Australia at some time in the future.

In future articles we will discuss the circuitry required to transmit and receive the FM broadcasts. ●

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# Searching for the Antiworld

*An investigation of alternatives  
for half the universe*

by Mort La Brecque

**D**URING the 17th century, Gottfried Leibniz contended that this is the best of all possible worlds because God chose it out of an infinity of possible worlds for that very reason. Avant garde twentieth century physicists find such cosmological chauvinism as untenable as Voltaire did, for rather different reasons: they believe that existence could be at least as desirable in many of the infinite number of possible worlds — and perhaps is.

Within *our* world, cosmologists have not abandoned Leibniz' philosophical system: he proposed a harmonious hierarchical structure, in which even

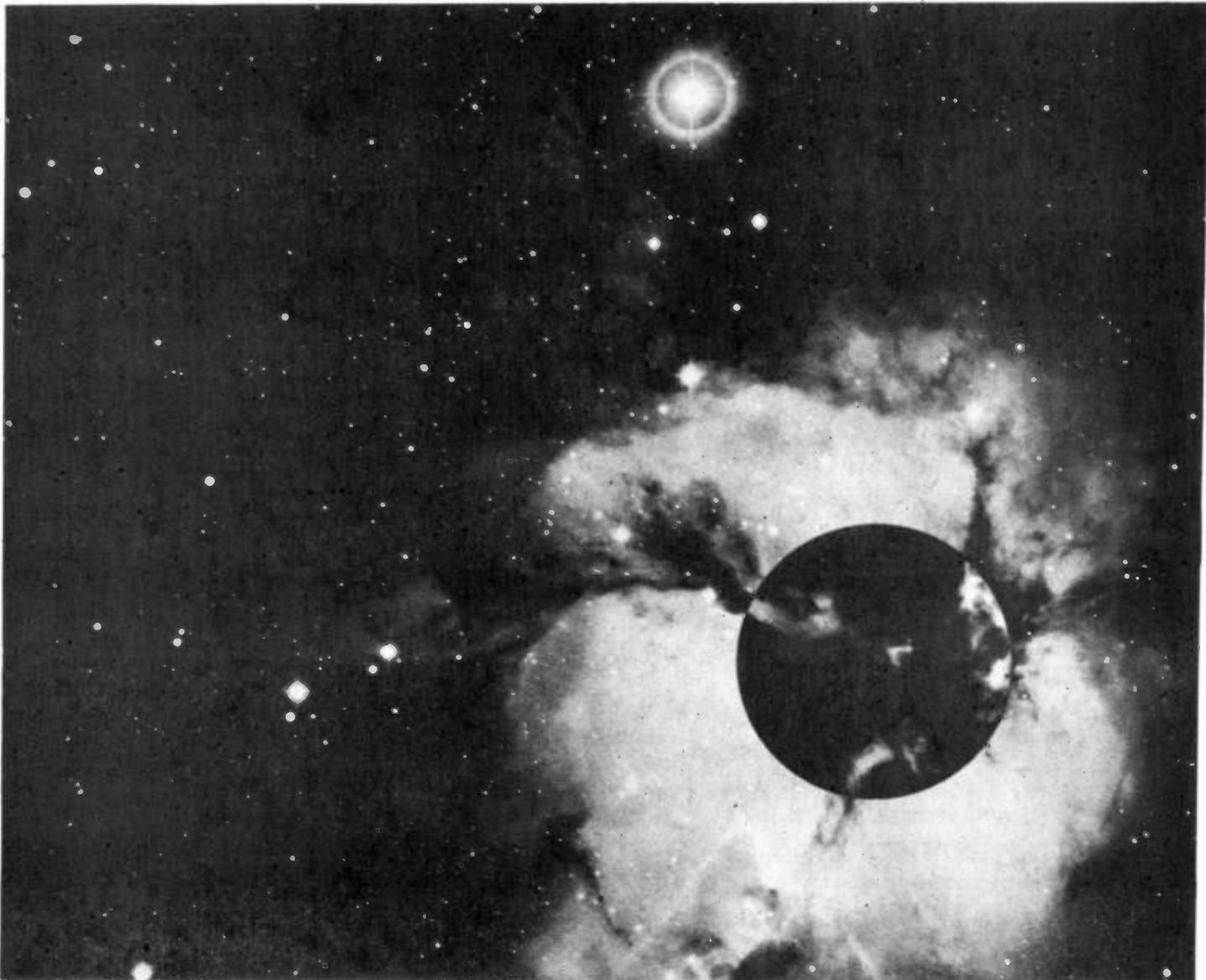
the smallest unit reflected the whole in microcosm. Over 200 years later, physicists seek an understanding of the Universe-at-large in the submicroscopic physical world. Current issues of interpretation in particle physics lead to very different cosmologies; cosmological theory may be firmly established only after clarification of these issues — and an advanced understanding of elementary particles.

## OFFSPRING OF THEORETICAL MARRIAGE

Paul Dirac accomplished one of the major feats of modern theoretical physics in 1928 by demonstrating that

Einstein's special relativity could be combined with quantum mechanics to describe particles. As might be expected, the consequences were profound. For every kind of particle, Dirac predicted the existence of an antiparticle, with equal mass but opposite electromagnetic and quantum properties.

Thus, for the negatively charged electron, there is the positively charged positron. In 1932, astronomer C.D. Anderson detected positrons in cloud chamber photographs of cosmic rays, confirming Dirac's prediction. Subsequent laboratory energy acceleration experiments have verified



the existence of antiparticles for all known particles except those, like the photon and the neutral pion, which are their own antiparticles.

### A VERY SHORT LIFE

Following conventional logic, physical objects should be composed of equal parts matter and antimatter, but this is not the case. Very little antimatter exists, at least within our solar system. Astrophysical observations indicate that, like Earth, the Sun and planets are composed only of matter: although antiparticles are created when high-energy light photons interact with matter, they have an extremely short life of picoseconds.

Dirac also predicted that if a particle collides with its antiparticle — a certainty in the crowded, fast-moving world of the very small — they annihilate each other, simply popping out of existence with either a trail of energy or of less massive particles left behind.

Laboratory confirmation of this prediction indicates a mechanism for the disposal of antimatter, and carries

another implication: matter and antimatter cannot coexist at very close spatial proximity without fatal radioactive consequences for physical objects. A homogenous mixture of particles and antiparticles would result in a universe full of the energy of annihilation, but without any life.

### THE BEAUTY OF SYMMETRY

While they accept this notion, some theoreticians believe that it raises troubling questions; their feelings are based on intuitive aesthetics as much as on careful observations. The scientific philosophers of antiquity proceeded from the assumption that natural principles are both simple and beautiful; heavenly bodies, for example, were perfect spheres moving in perfect circles. Although modern science has shown that such assumptions are simply naive, and that nature tolerates violent discordance as easily as sweet harmony, symmetry principles remain very attractive. Why should nature favor plus over minus, matter over antimatter?

During the last twenty years, it has been demonstrated that the symmetry laws of physics are violated — but only under special circumstances and very, very weakly even then: nature ordinarily obeys the dictum of symmetry. Thus, a number of physicists feel justified in asking whether matter and antimatter exist in equal quantities, if not in our solar system, then in the Universe.

Because matter and antimatter appear to obey symmetry principles in accelerator experiments, the crucial issue is whether the Universe began with equal amounts of matter and antimatter. Theoreticians proposing a charge-symmetric Universe all assume charge-symmetric initial conditions. Their theories differ in explaining the presumed matter-antimatter separation. In one theory, matter and antimatter are eventually grouped in different solar systems within each galaxy; in a second, they are contained inside or expelled outside galactic cores. And a third theory suggests a less homogenous but not less symmetric arrangement of separate-but-equal antimatter galaxies.\*

### A SYMMETRICAL COSMOLOGY

In 1963, Hannes Alfvén, Royal Institute of Technology, Stockholm, proposed with O. Klein a cosmological theory explicitly based on the concept of symmetry.

The Universe begins as a thin gas cloud diffusely filled with equal numbers of protons, antiprotons, electrons and positrons. As the cloud contracts under its own gravitational

attraction, particle-antiparticle annihilation occurs; the resulting radiation acts as a brake, reversing collapse into the presently observed expansion of the Universe.

A Leidenfrost effect — a process similar to electrolysis — in the primeval magnetic field, separates matter and antimatter, and limits annihilation during galaxy formation. Because the effect is on a very small scale, matter and antimatter bundles are not separated very far from each other. Thus, each galaxy contains equal amounts of matter and antimatter, distributed as discrete solar systems; although our solar system is made of matter, Alpha Centauri, our nearest neighbor, could well be composed of antimatter, according to Alfvén-Klein cosmology.

### HEART OF ANTIMATTER

Fred Hoyle, formerly of the Institute of Theoretical Astronomy, Cambridge University, also suggests that matter and antimatter may coexist within the same galaxy, but in a much different arrangement. Rather than solar systems made either of matter or antimatter, Hoyle says "we could have particles distributed in stars and interstellar gas, and antiparticles condensed as a compact nucleus at the galactic centre." (*Nature*, Nov. 1, 1969) Hoyle assumes that both particles and antiparticles are created in the condensed nucleus of our Milky Way Galaxy, but particles are expelled while antiparticles are retained; their roles could be interchanged, however, in other galaxies.

Hoyle acknowledges an obvious flaw in his argument: gravitational masses of galactic nuclei are usually at least an order of magnitude less than the total mass of surrounding stars, suggesting that the model does not produce equal amounts of matter and antimatter in each galaxy. He offers two ways out of this difficulty. The nucleus might fragment through explosions, the fragments showering out into

\*Physics is not the only discipline to raise questions of symmetry: biologists have an analogous situation in "left-and-right-handed" amino acids. Laboratory preparation of asymmetrical amino acids always produces an equal amount of levorotary crystalline compounds — which rotate light rays to the left — and dextrorotary ones. All known forms of life are composed almost entirely of levorotary amino acids; such a structure has been considered a requirement for identification of extraterrestrial life in meteorite studies. But as physicists speculate about the existence of cosmological antimatter, biologists do not rule out the possibility of carbon-based life, elsewhere in the Universe, composed entirely of dextrorotary amino acids.

# Searching for the Antiworld

intergalactic space, or the nucleus might radiate part of its mass as gravity waves.

But Hoyle has perhaps a more difficult obstacle to overcome. His

model shares another similarity with Alfvén's: it is consonant only with a problematic cosmology, in this case Hoyle's own Steady State theory, which calls for the continuous creation of matter and the infinite expansion of the Universe. Most theoreticians find that Big Bang cosmology — with a creation time of picoseconds and a finite expansion of the Universe — fits astronomical observations better.

## AN ARTIFACT OF CREATION?

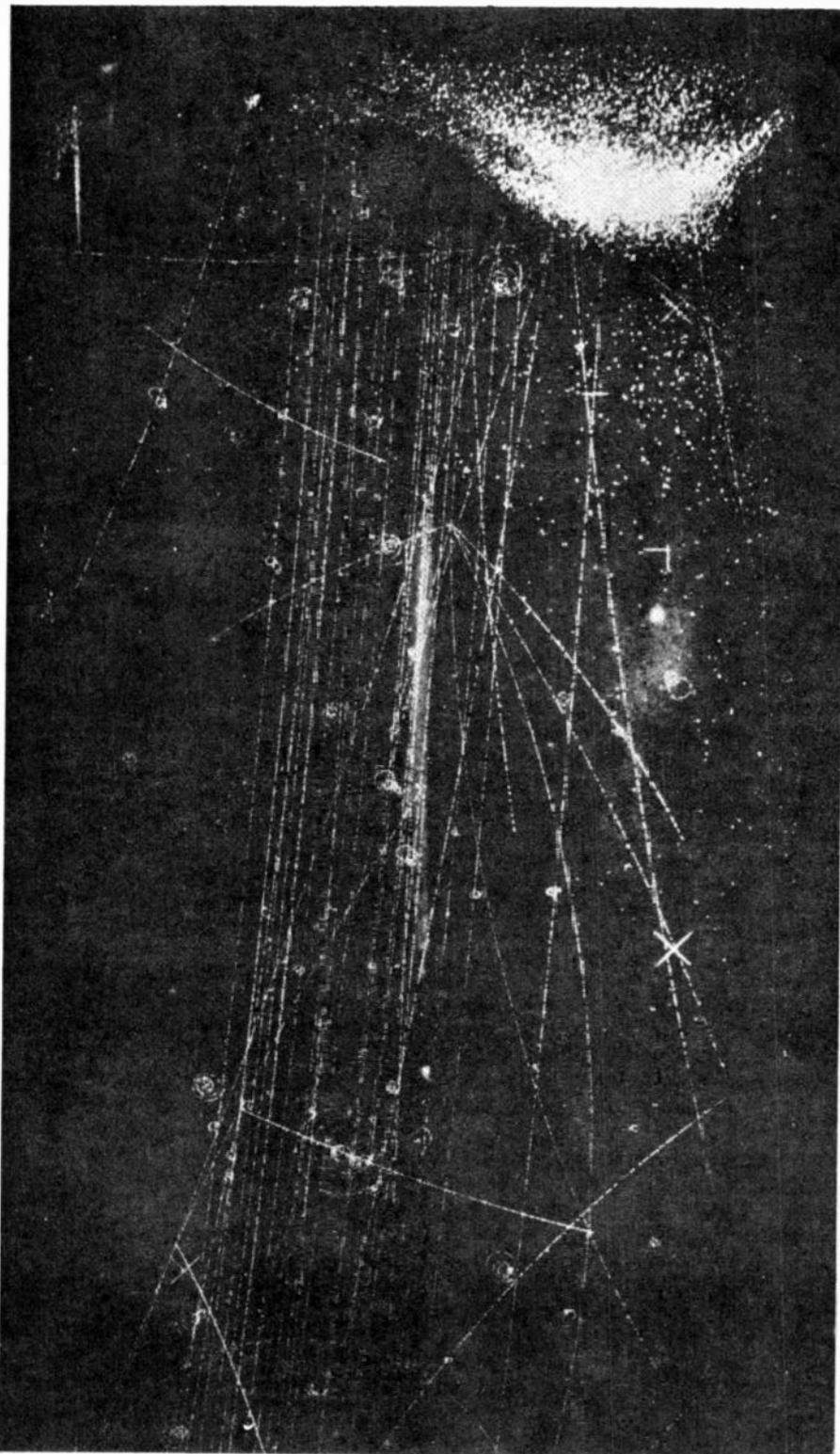
A model of cosmological antimatter compatible with — in fact, dependent on — Big Bang is offered by R. Omnes, Laboratoire de Physique Theorique et Hautes Energies, Universite Paris-Sud. Omnes agrees with most theoreticians that the recent discovery of a  $3^{\circ}\text{K}$  background radiation suffusing the Universe revealed an artifact of that colossal explosion. Ten to twenty billion years ago, time began, according to Big Bang adherents; in the first fraction of a second, the known Universe extended just the distance of a small solar system. Omnes says it contained only thermal radiation then, which must have generated plentiful and equal amounts of matter and antimatter.

He contends that at the extraordinarily high initial temperature —  $3 \times 10^{12}\text{K}$  — particles and antiparticles effectively repelled each other, first avoiding annihilation and then separating to form proto-galaxies and antigalaxies; these worlds in formation interacted only at their boundaries, the annihilation there generating fluid motions by which matter and antimatter separately coalesced in different regions of space. As the Universe continued to expand, the bubble-like shapes contracted under their own gravitational attraction, precluding any radiation disaster through galaxy-antigalaxy contact.

## A CRITICAL TEMPERATURE

Omnes' theory of distinct antimatter galaxies rests largely on the critical assumption that particles and antiparticles do not annihilate each other at the very high initial temperatures of a Big Bang. Since such temperatures are unavailable in the laboratory, Omnes relied on extension of theoretical knowledge to formulate his proposal. Dr. Gary Steigman of Cambridge's Institute of Theoretical Astronomy says that Omnes' conclusion "is in contradiction with experiments on nucleon-antinucleon scattering," adding that "for the range of applicability of this theory, nucleons do not repel antinucleons, they attract [and annihilate] them." (*Nature*, Nov. 1, 1969)

However, Omnes believes he has reason to be confident. He states that other theoreticians encourage his research, particularly because coalescence and boundary annihilation relate two basic cosmological questions: the observed size of galaxies and the  $3^{\circ}\text{K}$  background radiation. At a recent meeting of the American Physical



Proton-antiproton annihilation in a liquid hydrogen bubble chamber.

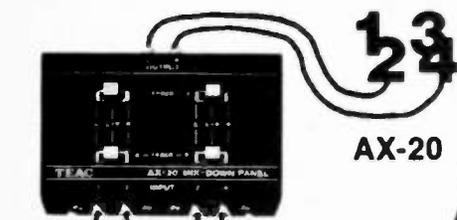
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## MOST CASSETTE MANUFACTURERS TELL ONLY HALF THE STORY

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Most cassette manufacturers tell you how great their tape is. What they forget to mention is that the tape is only as good as the "shell" it comes in. Even the best tape can get mangled in a poorly constructed shell.

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Unlike other cassettes that use fixed guide posts, Maxell uses nylon roller guides held with stainless steel pins. These provide virtually friction-free tape movement and eliminates a major cause of skipping, jumping and unwinding. The tape never comes loose from the hub because it is anchored in two places — not one. A tough teflon (not waxed paper) slip sheet keeps the tape-pack tight and flat. No more bent or nicked tape to ruin your recording. Maxell doesn't use a welded seal but puts the cassette together with precision screws.

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The answer to all your tape needs.

# Searching for the Antiworld

(Continued from page 32)

Society, Dr. Omnes said his theory presents "rather good answers to several basic questions," although he conceded that "a decisive test of the actual existence of antimatter is still to be found."

## SIGNALLING THE ANTIWORLD

The recent Conference on Communication with Extraterrestrial Intelligence urged that a serious program be undertaken to make radio contact with civilizations in nearby galaxies. If such a program were successful, Earth-based physicists might be able to determine whether these civilizations are anticivilizations (from our point of view) simply through a dialogue with possible antiphysicists: comparing results of a particular experiment conducted in the respective high energy accelerators. Charge-parity violation in  $K^0$  meson decay indicates a convention for signs of nuclei charge — and whether the civilization is predominantly matter or antimatter.

Until the probably distant day of interplanetary talk shows, we will have

to rely on more indirect methods of testing the proposed theories; these methods were discussed at "Astronomy from a Space Platform," a symposium held at the annual AAAS meeting and arranged by George W. Morgenthaler, Martin Marietta Corporation.

Noting the growing apathy with which people regard research programs of no apparent social relevance, Dr. Morgenthaler contended that such astronomical studies as the search for antimatter are "an integral part of the culture of mankind in the same category as art, music and literature. Astronomy... will help man understand his solar system, his Earth home and his evolutionary future."

## INTERSTELLAR MESSENGERS

The medium through which the antimatter message will be transmitted is interstellar. Cosmic rays, elementary particles which may be accelerated by stars in their last stages of life — during supernova explosions, for example — travel through interstellar space at near light speeds; their energy levels reach an incredible  $10^7$  billion electron volts — and perhaps higher.

Dr. Andrew Buffington of the Space Sciences Laboratory, University of California at Berkeley, told the Symposium that "measurements of

the isotope and momentum distributions for charged cosmic rays are of great interest in understanding their source... We cannot directly determine, using [optical astronomy], whether even our nearest neighboring star is made of the same kind of matter as we and our solar system, or if it is composed of the antimatter observed in accelerator experiments. The only practical way to find out would be to analyze an actual sample of material from the region near the neighboring star to see if the material has annihilation properties or reversed electric charge convention."

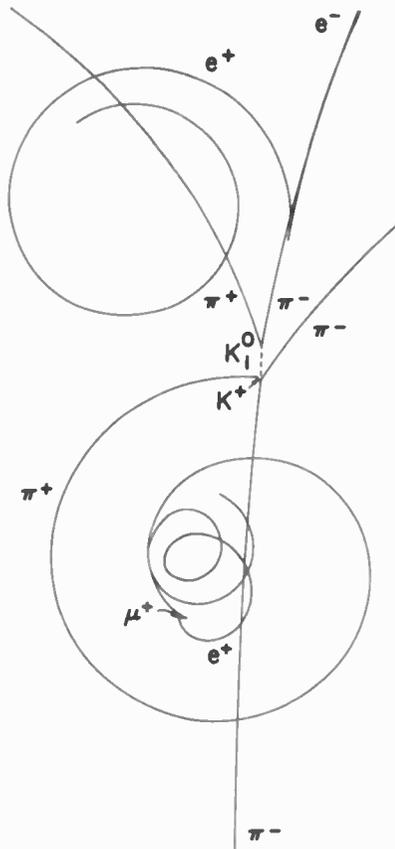
Astronomers will acquire their samples of material from outside the solar system — cosmic ray electrons, positrons, stripped nuclei and protons — with the High Energy Astronomical Observatory (HEAO): a series of four Earth-orbiting satellites designed to carry large, heavy instruments for interstellar X-ray, gamma ray and high energy particle astronomy without an interfering atmosphere. (Cosmic ray particles interact with atmospheric atoms to produce mesons and secondary particles.)

First in the series of experiment packages, HEAO-A is scheduled for launch by NASA in 1975. This flight, and other missions following in the late 1970s, will develop a branch of astrophysics begun during the last decade: high energy particle astronomy — a technical grouping of experiments similar to those used at large accelerators for investigating the properties of elementary particles. Because of advances in space satellite technology, many techniques for measuring accelerator particles can now be applied to cosmic ray particle measurement.

## COOLING DOWN COSMIC RAYS

For example, a superconducting magnetic spectrometer, conceived by Dr. Luis Alvarez of the University of California at Berkeley, will search for antimatter on HEAO-B; the instrument is basically a large, super-cooled superconducting magnet, which deflects cosmic rays, with two precision spark chambers at each end to measure their deflection. A spectrometer capable of more critical measurements is proposed by Dr. Buffington for later missions; it uses liquid Xenon proportional counters as trigger, charge identifier and spatial detector.

"The magnet coil is cooled with a liquid helium refrigerator assembly, which also maintains the liquid Xenon in the proportional chambers. When an incident particle with appropriate



Simultaneous creation of matter and antimatter: gamma ray decays into an electron ( $e^-$ ) — positron ( $e^+$ ) pair.

(Concluded on page 111)

# DUAL 1229 TURNTABLE

*"One of the best rim and pulley drive turntables we have seen to date."*

**D**ual have always manufactured their products in Germany. Their factory, situated at Schwarzwald, manufactures turntables, amplifiers, tape recorders, speakers and, of all things, electric shavers.

Locally they are well known for their rim and pulley drive manual and automatic turntables and, to a lesser extent, for their amplifiers.

The unit reviewed in this article is their top of the line model 1229 automatic turntable. It was supplied to

us already mounted on a well finished oiled timber plinth approximately 3 1/4" high. The only adornment on the base was a 1/4" wide silver strip across the front face with a tiny DUAL label engraved on it at one end.

The turntable layout is conventional, but impressive with its contrasting silver and black finish on the top panel and on the controls.

A more detailed inspection revealed a number of very interesting and practical features.

The cast turntable is 5/8" high and a full 12" diameter. It is fitted with a rubber mat with three raised concentric rings, approximately 1/8" wide, to support the records. An inspection of the reverse side revealed a well ribbed casting which would eliminate possible warping and distortion.

The main controls are grouped across the front of the pressed metal turntable base and consist of the following, from left to right:—



**electronics  
TODAY  
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- a) Speed control lever with three position, for 33-1/3 rpm, 45 rpm and 78 rpm. Around the lever pivot is a knurled knob for speed adjustment. This knob varies the position of the drive pulley on a tapered motor shaft, thereby changing the turntable speed by a small amount.
  - b) Strobe sight lens which can be adjusted to vary the line of sight.
  - c) Start-stop lever.
  - d) Record size select lever with three positions, for 7", 10" and 12" records.
- A cueing lever is located directly

behind the record size select lever. This is very well damped in the raising mode and partially damped in the lowering mode. Two further controls are located at the base of the tone arm pivot and consist of an antiskate adjustment and a lever for raising the gimbal joint to compensate for a multiple stack of records.

The antiskate adjustment consists of a knurled knob with two sets of graduations on it. These graduations consist of a red scale for spherical styli, and a white scale for elliptical styli. The red scale is applicable when the knob is turned anticlockwise and the white scale when the knob is turned clockwise. These scales are graduated from 0 to 3 grams.

Balancing and tracking force adjustments are effected by a main counterweight on the end of the arm and a graduated dial in the centre of the gimbal joint. The counterweight is fitted to a stub shaft which fits into the back of the tone arm shaft. This shaft can be moved in or out to provide a rough balance and locked in place by a screw. Fine balancing is then achieved by screwing the counterweight in or out.

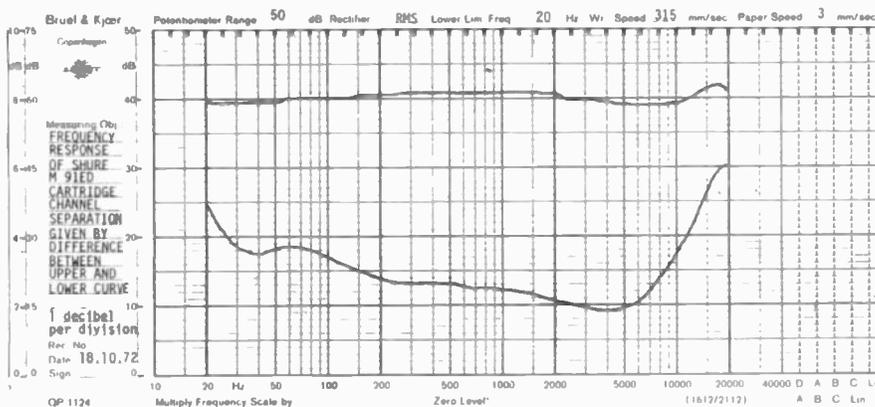
The correct tracking force is obtained by turning a graduated dial at the centre of the gimbal joint to the desired tracking weight. This dial tensions a spring by the required amount to produce the necessary tracking force at the stylus. Due to the design of the gimbal joint this arm can be balanced in all planes and, in theory, could play a record whilst upside down, or at any other angle for that matter. Screw adjustments are also provided for adjusting the height of the stylus tip over the record in the raised position, and for varying the lateral position in the automatic mode so that the stylus drops onto the "run in" groove.

A very practical feature is the tone arm support bridge which extends from the tone arm rest to the edge of the turntable. The tone arm can be rested on this bridge without operating the automatic stop, thereby simplifying the operations necessary for manual usage.

Operation of the turntable is very simple and only requires operation of the stop-start switch once the record size and speed selection is made.

The turntable was supplied with two multi-record spindles, one for conventional records with 1/4" diameter centre holes, and one for 45 rpm records with large centres. Another centre was also supplied for playing single 45 rpm records.

To facilitate and simplify the fitting of a cartridge, the cartridge mounting plate can be released from the tone arm headshell by moving a small lever. A gauge is also supplied to assist in



# DUAL 1229 TURNTABLE

correct location of the cartridge in the tone arm. This gauge is fitted with a notch and when the stylus tip is centrally located in the notch the cartridge position is correct.

The construction of the turntable is very interesting, particularly as all the levers in the lift and cueing mechanism are pressed metal, however, to eliminate any noise during operation, plastic wheels and bushes are used throughout.

The motor is rather large (3" diameter by 2½") but otherwise of a conventional synchronous type, located under the turntable platter in the front left hand corner.

## MEASURED PERFORMANCE

The measured performance was very good — in fact the unit is one of the best we have yet measured. The cartridge performance was interesting, particularly when the results are compared with the same model cartridge which we reviewed in the August 1972 edition of Electronics

Today International. The slight variation in performance is indicative of good quality control. It is interesting to note Dual manufactured their own crystal cartridge for some time, but now recommend the Shure M91ED as the ideal unit to complement the performance of the Dual Model 1229 turntable.

Wow and flutter at 0.05% is the best we have measured on any rim and pulley type turntable. Hum and rumble was also very good and one of the lowest we have measured.

The Dual is undoubtedly one of the best rim and pulley drive turntables we have seen to date. Its combination of simple yet adequate controls, with due emphasis on the more important components, such as the gimbal joint, gives the unit a wide market appeal.

The performance of this unit will satisfy the needs of most hi-fi purists.

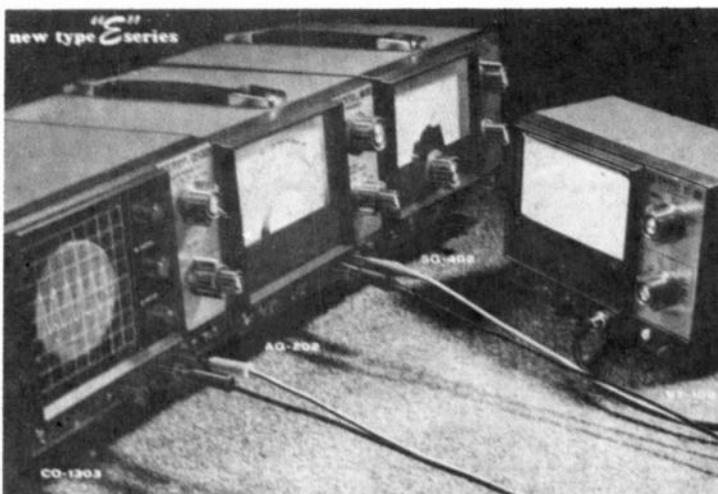
At a recommended retail price of \$304, the Dual model 1229 is competitively priced with other top quality turntables. ●

## MEASURED PERFORMANCE OF DUAL TURNTABLE MODEL 1229 SERIAL NO. 039721 AND SHURE M91ED CARTRIDGE

Frequency Response	20 to 20kHz ± 2 dB
Cartridge Weight	5.8 grams
Channel Separation at 1kHz	28 dB
Channel Difference at 1kHz	Less than ½ dB
Output at 1kHz re 5cm/sec	4.6mV
Wow and Flutter %rms	0.05%
Hum & Rumble Equalised but Unweighted re 1kHz at 5cm/sec	47dB
Speed Accuracy	Adjustable on tapered drive shaft
Turntable Weight	7 lbs.
Transverse Friction	30 mg
Vertical Friction	Less than 5 mg
Recommended Retail Price with Shure M91ED Cartridge	\$304

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who are very serious about their  
record collection...**



Model 1229

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But your records will**

**Dual**

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# DIGITAL REVERBERATION

Costing less than \$1000, these new concept units provide fully variable delays.

THE need to add echos to recorded material has existed since audio recording became a serious industry, for apart from the gimmicky use of echo to produce special effects, it is often necessary to add "life" to music which has not been recorded in natural surroundings.

An echo is a sound which is delayed by some period of time from the original sound. In an auditorium it is produced by reflections from a flat plane. Sound has a fairly slow propagation velocity (about 1100 ft/sec), hence a path difference of 50ft between the direct and reflected sound will cause a noticeable echo 55 m sec after the direct sound has been heard. If two parallel planes have a sound

source between them, then the sound will be reflected from one plane to the other, giving rise to a phenomena known as flutter echo. The name arises because the sound is heard in repetitive bursts.

The most desirable form of echo, the one which is striven for in acoustical design, is reverberation. In this case, the sound is composed of many random reflections with random time delays. The end result is sound decaying smoothly after the original source has stopped. Unfortunately, no two types of music require the same reverberation time, and the characteristics for speech are again different (hence the problems in the Sydney Opera House acoustics).

The designer of auditoria tries to make the auditorium excellent for one type of use and satisfactory for others. Recording studios on the other hand, are designed to be completely non-reverberant, and reverberation is added artificially to recordings made therein in order to obtain the desired sound.

But there are major problems in introducing reverberation artificially, using either acoustical or electronic techniques. The most obvious method is to re-record the program material using loudspeakers and microphones within a chamber having the required reverberation time. This method is used, but is not really satisfactory since it re-introduces the defects which would have been present had the music been initially recorded in that chamber. Apart from this it adds additional colouration due to the introduction of another microphone and speaker into the recording chain.

A second(acoustical) method is a reverberation plate. This consists of a metal plate which is vibrated by the electrical signals. The resultant vibrations are then detected. The plate is capable of sustaining many modes of resonance and, therefore, appears to have a fairly flat frequency response when excited by broadband signals such as music and speech. But reverberation plates are rather large

and very expensive, and, therefore, not commonly used.

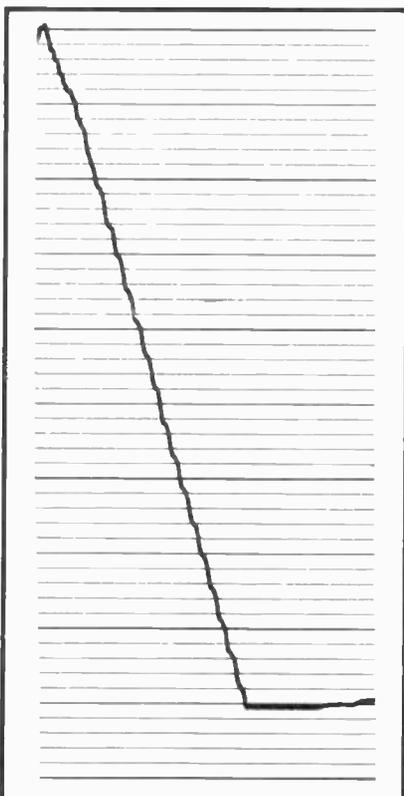
The most common method used a three head tape recorder in which a tape loop passes over an erase head, the record head, and then the playback head. The signal laid down by the record head is picked up by the playback head and mixed with the signal being recorded. When the loop gain approaches unity, that is, the signal level being re-recorded by the record head approaches the original signal level, the output from the system takes a long while to die away. If the loop gain *exceeds* unity the output signal increases, resulting in a sound not unlike feedback resulting from a microphone in a speaker sound field. It is at this point that the simulation of reverberation time becomes difficult. If the time interval between the echoes becomes too long, the resulting sound has the characteristics of a flutter echo. If the time interval between successive echoes is too short, the decay between successive echoes becomes difficult to adjust and the signal to noise ratio is seriously impaired, since there is some degradation every time the signal is re-recorded.

## DIGITAL TECHNOLOGY

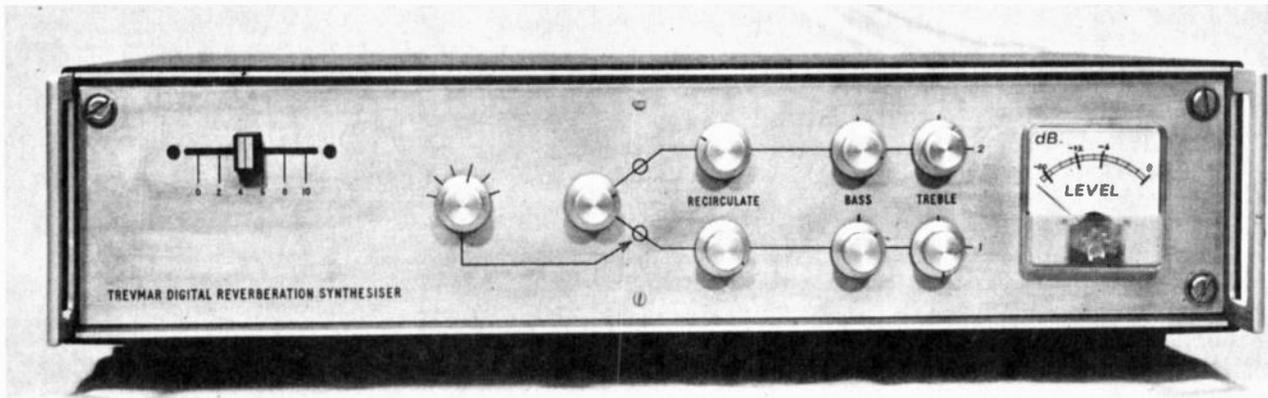
Recently, advances in digital technology combined with rapidly decreasing component costs, have made it possible to obtain the required delay times at costs comparable to tape delay units.

The advantage of digital processing is that the only degradation is the occasional loss of a "bit" and there is no significant degradation in signal to noise ratio caused by a large number of repetitions through the delay line. Rather, problems associated with digital delay lines are due mainly to the analog to digital and digital to analog converters which are, in effect, the heart of the system.

The Trevmar digital delay system has a simple delta modulator which uses a signal resynthesised from the digital output as feedback. In addition to



Decay response for 1kHz sine wave using minimum time delay setting. Loop gain approximately  $-1\text{dB}$ . Effective reverberation time 3.6 seconds.



this, it has a built-in digital "comparer" to improve the dynamic range. The de-modulator following the delay line is virtually identical to the modulator. The audio signal which is transferred along the delay line consists of a series of voltages representing logical 1's or logical 0's. (The actual voltages corresponding to 1 or 0 are predetermined by the original components' manufacturer).

The delay is achieved by controlling the frequency of a clock which determines the rate at which one "bit" is transferred from one memory unit to the next. The clock also controls the sampling rate of the input and output converters.

This is where the problems begin with the digital delay line.

If the clock frequency is high, then the analog to digital conversion will be accurate, and the signal re-synthesised

at the output will be a faithful reproduction of the input signal. The delay corresponding to a given number of delay stages will be relatively short.

If the clock frequency is low the delay will be greater, but the accuracy of the re-synthesised signal will be poor.

It is a trade-off between cost and effectiveness.

Trevmar produces two digital delay lines, the first being simple in operation and a reasonable compromise between conversion accuracy and delay time; the second, at approximately double the price, has double the clock frequency and similar delay time (maximum 0.22 secs). These two units, hope Trevmar, will cover the entire potential market — from domestic users and 'pop' groups, to the broadcasting and recording studios.

## TESTING THE SYSTEM

Testing a digital delay line posed some interesting problems.

The first of these was that distortion introduced by the analog to digital conversion process is not harmonic (until quite severe overloading occurs), but broadband noise. It cannot, therefore, be assumed that the summation of the first few harmonics will result in an accurate estimation of the distortion.

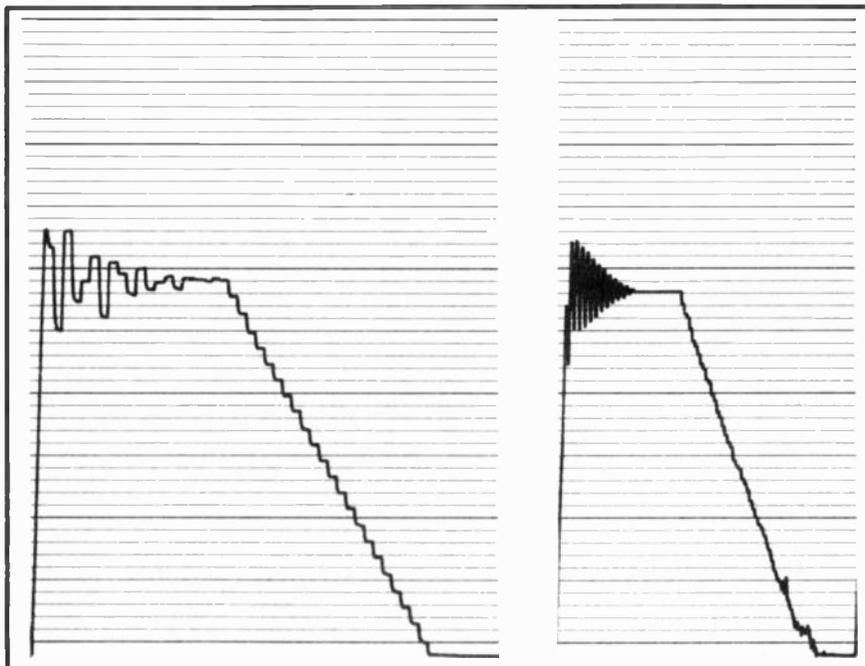
The second problem is that, since the analog to digital conversion is velocity sensitive, distortion generated is both frequency and level dependent. (The level meter on the Trevmar unit is basically a signal velocity meter).

The next basic problem in testing was that we anticipated that peculiar effects could be expected when the input frequency was a sub-multiple of the clock frequency or simply related to the delay time.

Both these effects were found to exist, however in a normal situation neither of them would be expected to cause trouble, but in a test set-up where pure tone signals are applied, they can and did.

Since the digital delay circuiting cannot introduce any distortion or noise to the signal, our testing of distortion was performed on a modified unit which had the digital delay components removed. This enabled us to obtain accurate tracking between our oscillator and the output of the system under test. If this were not done it would have taken approximately 10 hours for each level recording.

The first tests were performed using the Trevmar units as a straightforward delay line. The input level was set so that, at the maximum input velocity (at 20 kHz) the meter on the delay line indicated the maximum reading. This meant that at the minimum frequency (20 Hz) the input was 60 dB below the allowable input. This test is a little harsh since the spectral content of music and speech is not



Response of reverberation synthesizer to tone burst when two delayed signals are used for feedback. This produces overshoot on initial attack. LEFT. 0.22 seconds delay. RIGHT. 0.05 seconds delay.

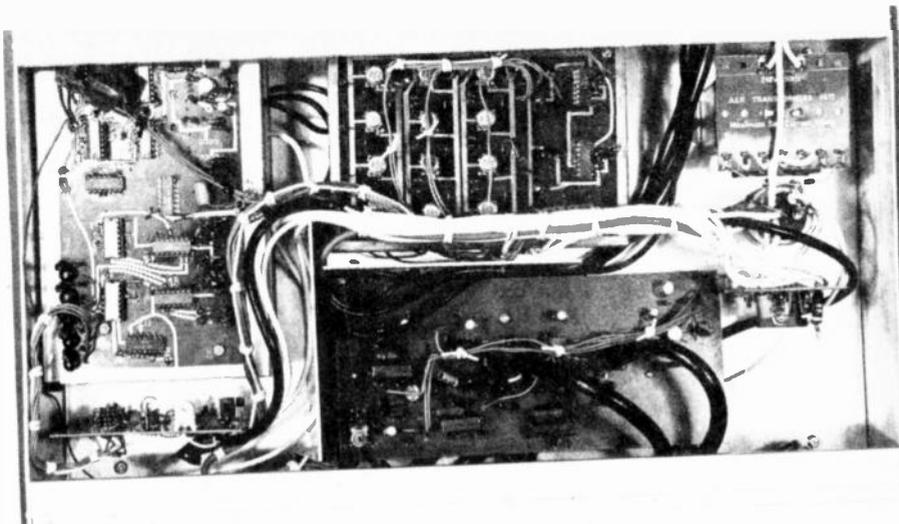
# DIGITAL REVERBERATION

uniform. However, it does illustrate the problems that occur on listening tests, particularly when the music has significant high frequency content.

On the minimum delay setting (0.05 seconds) — corresponding to the maximum clock frequency — the distortion was less than 1% over the entire frequency range. The distortion was higher at the low frequency end of the spectrum due to the analog to digital converter being under-driven and higher at the high frequency end of the spectrum (above 5 kHz) due to inaccuracy in the analog to digital conversion. In the mid-frequency range, the distortion curve exhibited a number of resonances, apparently related to the clock frequency.

The maximum delay (0.22 seconds) produced a distortion curve with the effects of analog to digital conversion error showing up at approximately 150 Hz instead of approximately 5 kHz. With this delay the distortion was considerably higher than at the maximum clock frequency, (i.e. minimum delay) with the distortion exceeding 1% above 2 kHz and rising to 50% at 20 kHz.

The subjective effect of the distortion is difficult to describe, since the distortion introduced is dissimilar to other systems. It is like a variable signal to noise ratio. When there is high level high frequency information present, the output sounds noisy — rather like poor signal to noise ratio on



Underside of Trevmar digital reverberation synthesizer.

a tape recorder. When the input signal contains low level high frequency information, the quality improves. The noise spectrum is dependent on the input frequency and so changes continually with differing program content.

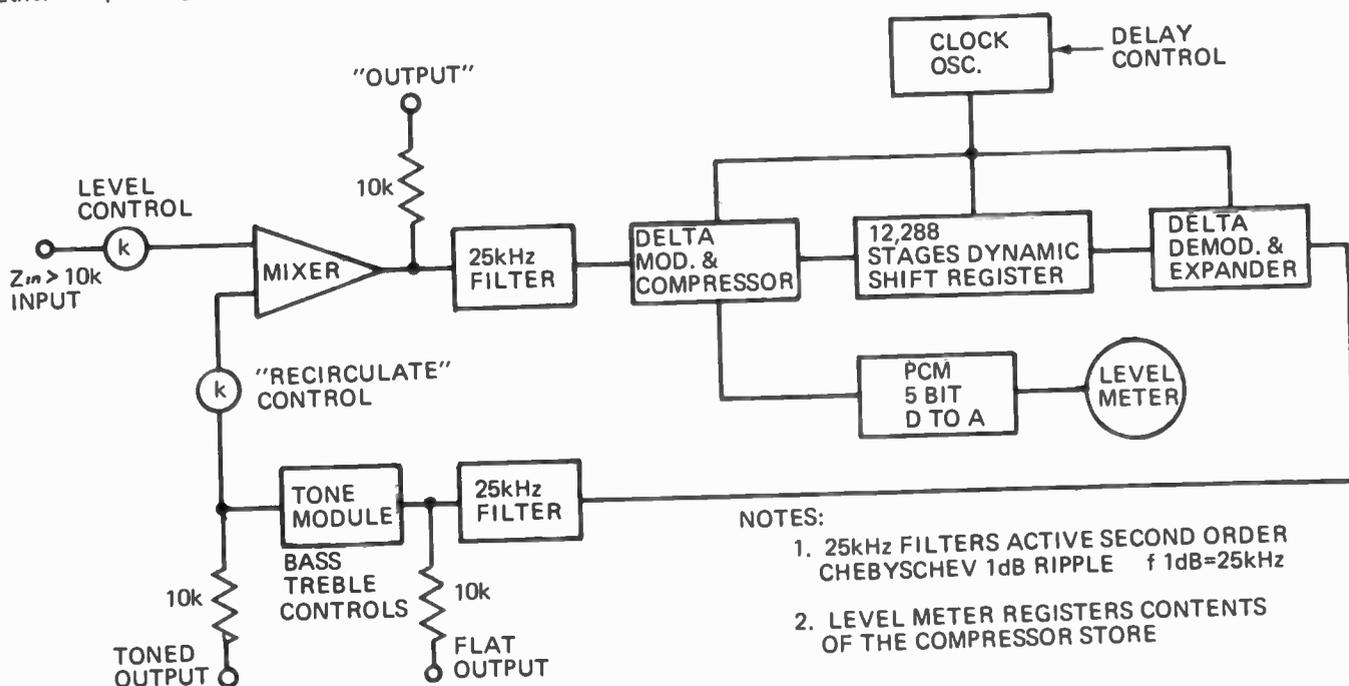
## FREQUENCY RESPONSE

The frequency response is essentially independent of the clock frequency, and, although not flat, it is probably adequate. In any event, the low frequency roll-off is determined by the input R — C circuit which could be altered to provide a flat response down to dc. The high frequency performance is governed by interaction of the input with the clock oscillator, and by the small bumps introduced by the low-pass-filter which blocks any components generated by the clock oscillator from entering subsequent equipment.

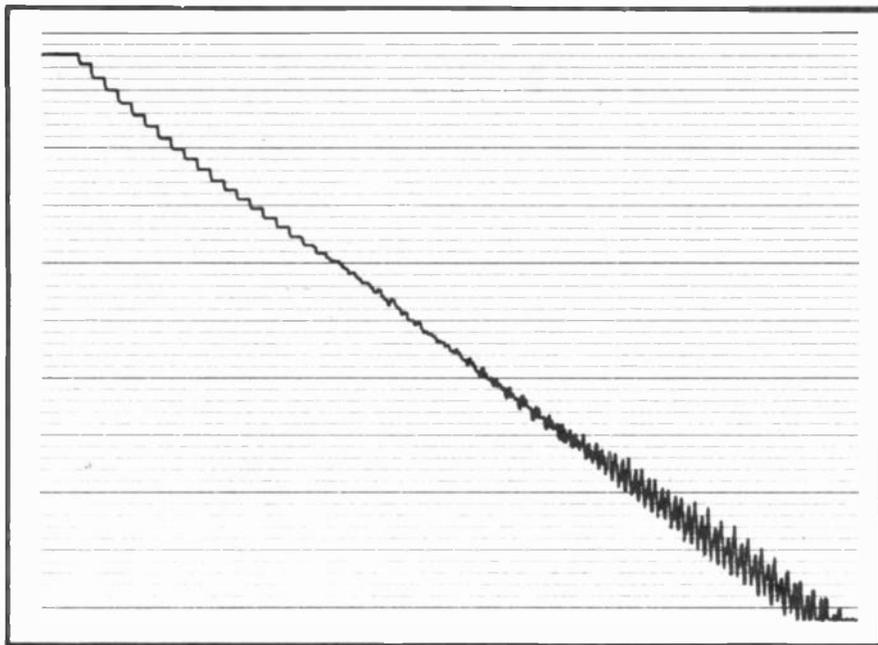
The next problem was to simulate echo using the reverberation synthesiser mode. In this mode, a switchable tap onto the delay line enables a signal to be derived with several discrete fractions of the total delay and this signal can be added, together with a signal derived from the end of the delay line, to the incoming signal. This provides a two step approximation to the idealised concept of reverberation time.

As with the tape recorder method of obtaining reverberation, the best settings for signal to noise ratio are with minimum delay time and maximum feedback level (consistent with stability).

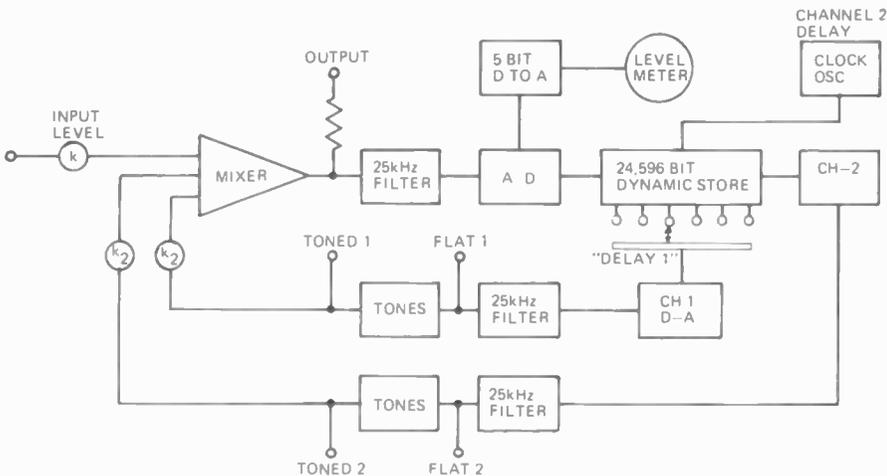
We found that it was possible — although very difficult — to obtain a reverberation time much greater than two seconds using the minimum delay. With maximum delay, reverberation



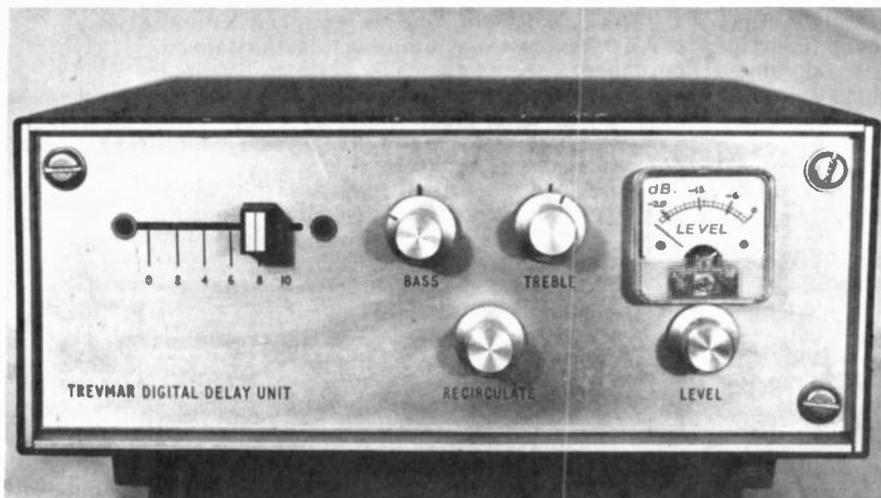
Schematic of simpler delay unit.



Decay response for 1kHz sine wave using maximum time delay setting. Loop gain approximately  $-1\text{dB}$ . Effective reverberation time  $12\text{ seconds}$ .



Reverberation synthesizer — schematic drawing.



Economy version has fully variable delay from 20 msec to 200 msec.

(Concluded on page 46)

Even if  
you don't  
have the  
No.1  
recorder  
you can  
still use  
the No.1  
cassette!

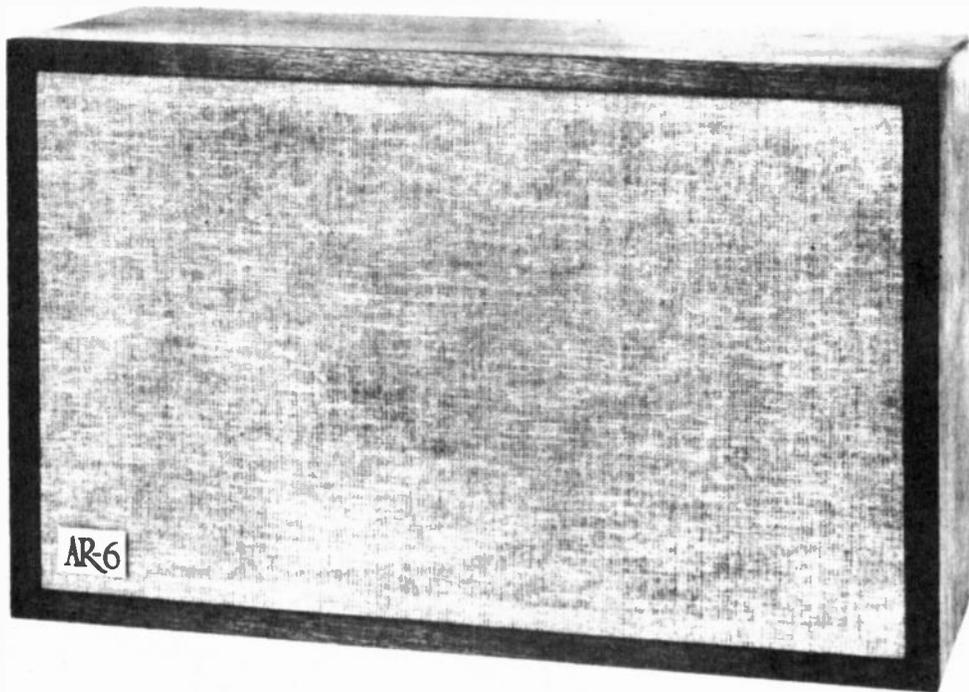
And it's surprisingly  
inexpensive.



SONY

SN4206

# The AR-6 speaker system from Acoustic Research.



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

#### **Stereo Review says . . .**

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

#### **High Fidelity says . . .**

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

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

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

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

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

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



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

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

Australian Distributors

**W. C. Wedderspoon Pty. Ltd.**

193 Clarence Street, Sydney. 29-6681

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

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

WD 31/PP

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Compact  
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came at a rich price.  
Here's the first high quality  
cassette at a moderate price!

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Low noise  
Screwed Cassettes  
in hinged  
plastic boxes

# TRY THEM



# DIGITAL REVERBERATION

times of 10 to 15 seconds were possible, but the distortion and the discrete steps in delay were very noticeable.

In addition to the method we used for testing, it is possible to set up the two delays with differing frequency responses using the independent tone controls in each delayed channel. This enables the reverberation time to vary

with frequency, thus duplicating room conditions or producing special effects.

While we have discussed at length only the most expensive unit, the cheaper unit will duplicate the performance of the more expensive unit with approximately half the delay time and with only one delay signal in the reverberation mode.

Both units are produced in standard, commercially available rack modules, and have simple but neatly engraved aluminium front panels. The appearance is consistent with low production specialised equipment and, therefore, rather less impressive than

the average hi-fi enthusiast has come to expect, particularly from American and Japanese equipment manufacturers.

The Trevmar digital delay lines offer a new concept in the generation of reverberation. The performance should be compared with the units which the manufacturer hopes they will supercede; namely magnetic tape delay units. When compared with these, the performance characteristics are favourable and, in many cases, better. For example, harmonic distortion which is unavoidable using magnetic tapes is eliminated.

Considering the unit has no moving parts to wear or require maintenance it is competitively priced, if considered on a long term basis.

With the addition of a noise reduction device a reduction of 10 decibels in noise is possible. Subjective tests on a modified unit which arrived, after the laboratory tests were performed confirmed this can in fact be achieved.

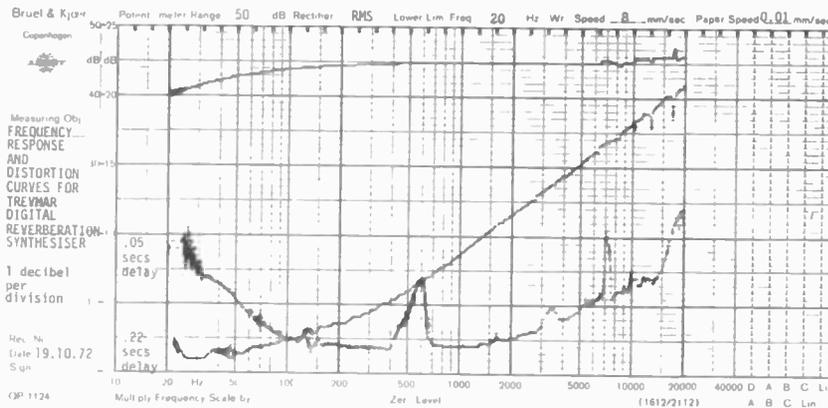
## TREVMAR COMMERCIAL UNIT

Price — approximately \$450.

## TREVMAR STUDIO UNIT

Price — approximately \$1000.

Manufacturer — Trevmar Sound Services,  
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Dernancourt,  
S.A. 5075.



# AMBASSADOR N<sup>o</sup> 32

*The Ambassador No. 32 Record Player is an attractively designed and presented model featuring four speeds (16, 33, 45 & 78 R.P.M.), ceramic turn-over type cartridge and automatic power cut off. Most suitable for the simpler stereo system. Complete with anti-vibration mounting. For 240V. 50 Hz.*



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your nearest  
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# At last. Stereo for fidgets.



Up till now, listening to stereo has been tough for people who can't sit still.

Because with conventional speakers the only place to sit has been at the apex of the critical sound paths. And two inches to the left won't do.

But now there are Carlsson speakers.

They function quite differently.

They're omni-directional. The very first that really work. The sound comes out of the top.

They were created by Stig Carlsson, formerly Professor of Acoustics at the Royal Institute of Technology in Stockholm. After years of research into sound reproduction.

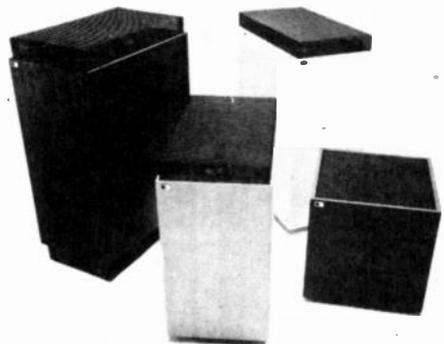
What are Carlsson speakers really like?

They fill a whole room with stereo sound. Wherever you sit, however much you move around, you're

surrounded with stereo sound. Immersed in it. No other speaker anywhere in the world will give you that.

Carlsson speakers were introduced into Australia barely a couple of months ago.

Write or phone us and we'll send you the Sonab literature and the name of your nearest dealer.

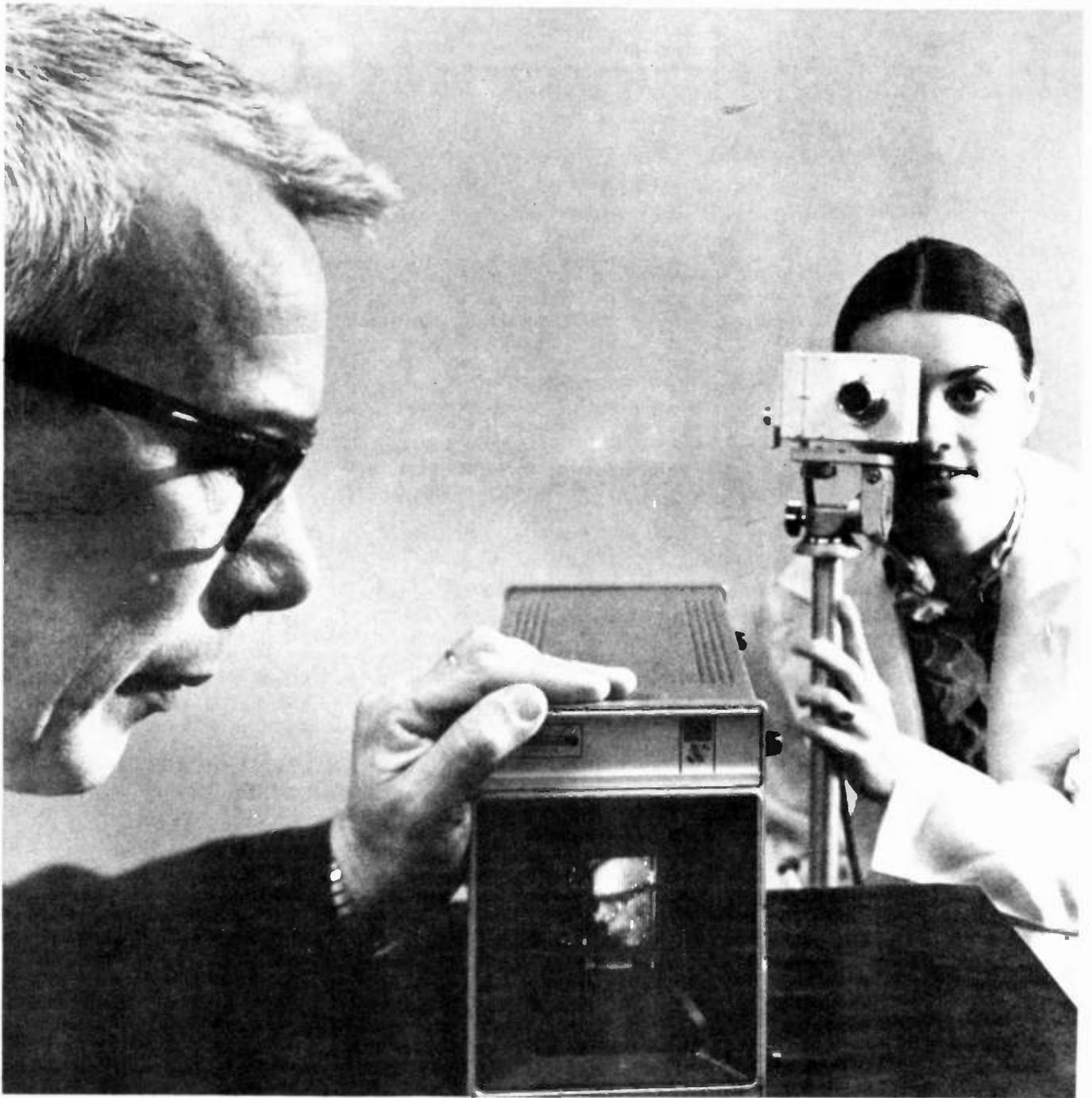


## Sonab

Sonab of Sweden Pty. Ltd., 114 Walker Street, North Sydney, N.S.W. 2060. Telephone: 929 4288/4554.

# POCKET-SIZE TV CAMERAS

Solid-state TV cameras may become as small as a wrist-watch — Shaun Kannan reports.



*Fig 1 — RCA's experimental video camera in demonstration*



Fig 2 — Sample picture from a CCD camera (Bell Labs)

**E**XPERIMENTAL all-solid-state video cameras as small as a palm-held electric razor have been developed — independently — by RCA and Bell Laboratories.

Both cameras use the basic charge-transfer technology described in our May issue.

The image sensing devices used in these cameras do not need the high voltages, electron beam scanning or vacuum envelopes used in conventional TV cameras.

And, since the cameras have the associated electronics built into the sensor integrated circuit, further developments could result in cameras with sensors and electronics much smaller than the lens itself.

### BUCKET BRIGADE DEVICE (BBD)

RCA's camera has a 0.2" sq image sensor on a silicon integrated circuit. The 1408 photo-sensitive elements are arranged in a 32-row matrix with 44

elements in each row. The elements are spaced 0.003" apart. The device can be visualized as rows of isolated-gate FETs with sources and drains connected and with the gates coupled to the drains.

The electrical charges representing bits of stored information are transferred from one element to the next by means of clock pulses that raise the level of each element in the correct sequence — in the same way as a fire-fighting brigade passes a bucket of water down the line.

On the same chip, the BBD has a 32-stage shift register also operating on the bucket brigade principle. This is used for the vertical scanning and a-line-at-a-time read-out to give the picture signal. Only nine connections are enough to feed control signals to, and take the video signal from, the sensor.

Image resolution is not as good as a conventional TV camera which has nearly 400,000 picture elements but it is sufficient to give a recognisable picture of a foot-square object.

The device uses horizontal transfer scanning. Stored charges from each row are successively transferred into a continuously operating output register; see Figs 3 and 4. Each row of sensors is a BB register in which the sources and drains of MOS transistors are reverse-biased to act as photo-diodes. In the in-between-scan 1/60 sec period, the horizontal clock voltages are disconnected from all rows, allowing a charge pattern to be built up on the sensor, corresponding to the image being viewed. The horizontal clock is then re-connected via transmission gates, and the 32-stage BB scan generator switches the gates 'on' sequentially. The charge pattern in each line is transferred to the output register which again is a similar BB and delivers the charge patterns in sequence to an output amplifier also integrated on the same chip.

### CHARGE-COUPLED DEVICE (CCD)

Bell's camera has a 4.8x6mm sensor with 13568 light-sensitive elements in a matrix of 128 rows. Bit density is 0.0016" square per element. The operation is essentially as outlined in our May issue but only one 64-row area is used for imaging; the other 64-row area is used for storage and read-out. The imaging (charge accumulation) period of about 1/60 sec is followed by a frame transfer sequence which shifts the charge pattern from the imaging area into the storage area in about 1m sec. While a new frame is being integrated in the imaging area, the image in the storage area is shifted down, one line at a time, so that lines of information enter the horizontal serial register in sequence. The horizontal register then shifts each line of information to an output diode to give the video signal in a serial form.

The frame read-out is completed by the time a new charge pattern is formed in the imaging area, and the storage area is then ready to have the new frame transferred into it. The cycle is repeated 60 times a second.

### CHARACTERISTICS

At this admittedly experimental stage, some tentative characteristics for such systems can be formulated.

For example, there are two scanning schemes: line-by-line horizontal transfer (HTS) as used by RCA, and vertical transfer with separate store (VTS) as used by Bell. Also there are two charge transfer techniques: the bucket brigade technology used by RCA, and charge coupling as used by Bell. In principle, either VTS or HTS can be used with either method of charge transfer.

Both systems of scanning and both systems of charge transfer are capable

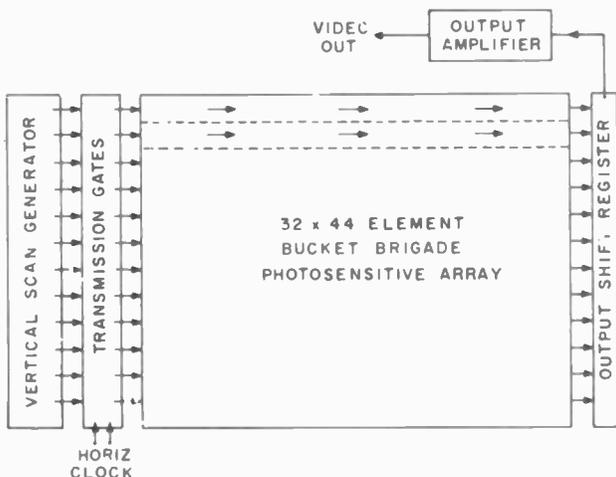
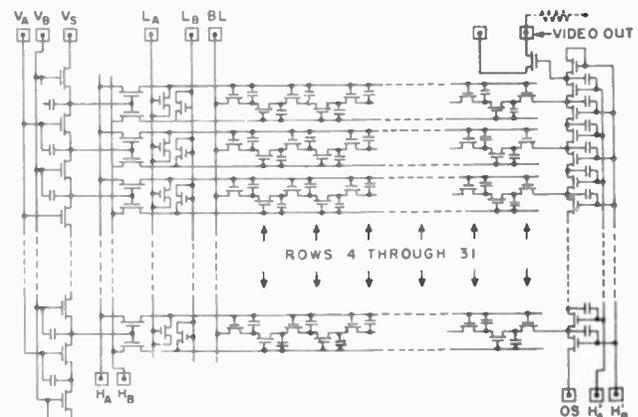


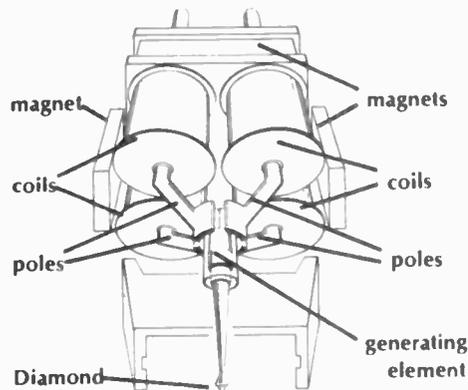
Fig 3 — Block diagram of a BBD charge-transfer sensor  
Fig 4 — Circuit Diagram for the BBD sensor (To aid clarity, the two photo-diodes associated with each element are not shown)



# empire

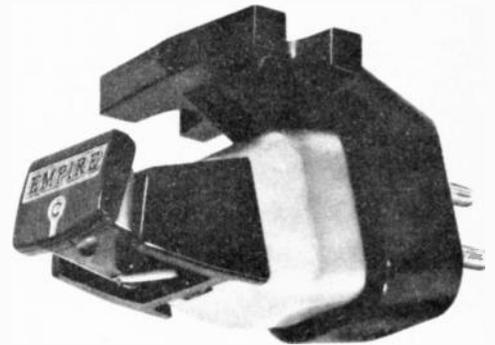
## for the music loving Perfectionist

### The Empire Cartridge — How It Works



Every Empire long playing cartridge is fully shielded. Four poles, four coils, and three magnets (more than any other brand) produce better balance and better hum rejection. There are no foreign noises with the Empire Cartridge. Perfectly magnetically balanced, with a signal to noise ratio of 80 dB, it features a moving magnetic element and stylus lever system .001 inch thick. The entire cartridge weighs only 7 grams — the ideal cartridge weight for modern compliance requirements.

### The Empire 1000ZE/X Stereo Measurement Standard



The measurement standard 1000ZE/X stereo cartridge was designed to provide professional users such as recording studios, radio stations, scientific and engineering laboratories as well as serious audiophiles with the ideal standard for record playback evaluation.

With the ability to track effectively at stylus forces as low as .1 gram, the 1000ZE/X never subjects the disc whether it is a vinyl pressing or a master lacquer to any visible wear or groove deformation.

The Empire 1000ZE/X Stereo Measurement standard at \$99.95 recommended for professional users or serious audiophiles only.

*For further information and price list please write*

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# POCKET-SIZE TV CAMERAS

## CHARGE COUPLED AREA IMAGING DEVICE FRAME TRANSFER PRINCIPLE

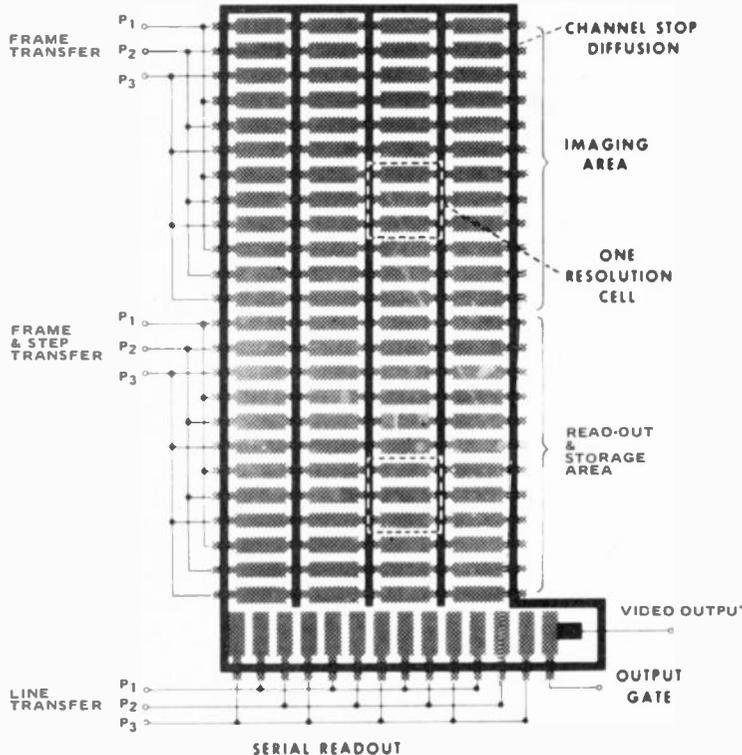


Fig 5 - Frame transfer principle in Bell's CCD sensor

of roughly the same overall performance although, comparing the two experimental devices, the Bell chip has nearly 10 times as many elements as RCA's chip but its image definition is only five times better since half its elements are used for transit storage.

The VTS requires three clock supplies: vertical transfer from sensor to storage, vertical transfer from store to output register, and horizontal transfer to read-out. The HTS requires two clocks: vertical line-by-line and horizontal 'read' each line.

Total chip area required is less with the HTS. Total transfer operations are also less with the HTS but the VTS could use a lower frequency for the vertical transfer.

For comparable picture quality, permissible dark current in the VTS is about half that for HTS. But a standard vertically interlaced signal at 60/sec frame frequency is provided in the HTS, with full 1/30 sec integration time for each field.

An integrated vertical scan generator is required for the HTS whereas the VTS requires no scan generator.

## FUTURE DEVELOPMENTS

In an internally scanned charge transfer sensor of the RCA type, transfer loss at the operating frequency determines the maximum number of picture elements that can be used. Current developments indicate that, while a 150x150 element array scanned at 30 frames per second does not represent a final upper limit, this size is somewhat smaller than sensors envisaged for the charge-coupled variety.

The Bell Lab device is basically an analog shift register and Bell scientists are confident that their CCD technique can also be used to make devices for diverse information storage and processing applications such as: computer memories, telephone switching systems, echo suppression and bandwidth reduction in transmission lines, filter network synthesis, and an audio or similar delay requiring storage of a large number of information bits. In this last application, a 128x106 CCD array could, for example, delay an analog signal containing frequencies up to 13 kHz for a period of half a second. ●

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**ELECTROLYTIC CAPACITORS.** 500  $\mu$ F. 50 volt. 50 cents. 640  $\mu$ F. 16 volt. 25 cents. 32  $\mu$ F. 350 volt. 35 cents, P/P. 10 cents.

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**SPECIAL - CURLY CORDS.** 25 cents ea. P/P 15 cents.

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	Sens. DC	Sens. AC	PRICE
C-1000	1,000 o/v	1,000 o/v	\$6.75
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AS			
100D/P	100,000 o/v	10,000 o/v	\$34.50

Add 60 cents for pack/post

**WIDMAIER SWITCHES.** 2 sets, change over contacts. \$2.00 each. P/P 20 cents.

**DENSHI CONSTRUCTION KITS,** no soldering required. There are 16 Projects, including Transistor Radio, Morse Code Oscillator, Continuity Tester, Signal Injector, Transistor Wireless Microphone, Transistor Reflex Radio and numerous others. These kits are priced at only \$11.50. P/P 80 cents.

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**SILICON DIODES.** 100 P.I.V. -145 amps. \$4.50 ea. P/P 40 cents.

**PHONE JACKS** 3.5 and 2.5mm 10 cents ea. P/post 6 cents.

**COMPUTER BOARDS.** Size 1. Contains 4-0c45, glass encapsulated. 2 mln. toroids. 10 diodes \$1.00 ea. P/P 20 cents. Size 2. Average 10 Transistors, 30 diodes, resistors and capacitors. All components have long leads. \$2.50 ea. P/P 40 cents.

**RECORD PLAYER MOTORS - c/w speed control.** 6v - \$1.00 each. 9v \$3.50 each. Plus 40c. P/P.

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**TAPE RECORDER MICROPHONES** c/w switch, lead and double pin plug. \$6.00 each plus 40c P/P.

**2 SB407 TRANSISTORS - 30 watt.** \$1.25 each plus 20c P/P.

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# SPEAKER

No reader can afford to miss this Speaker Competition. Not only do we have a first prize of two Rectilinear XII loudspeakers, donated by Leroya Industries of Perth, but we also have a prize for EVERY ENTRANT. In other words, you just can't lose!

All you have to do to enter is to fill in the entry coupon, place the speaker characteristics listed in order of priority and tell us in a few words why you placed them in this order.

The speakers being given by Leroya Industries as the first prize are two bookshelf models finished in American walnut veneer. The vented enclosures of each unit includes a three-way speaker system consisting of a ten inch woofer, a five inch twin cone mid-range speaker and a three inch tweeter.

Apart from the main prizewinner, the runner-up will receive \$50 worth of Memorex recording tape, the third prizewinner will receive \$25 worth of Memorex tape and every other entrant in the competition will receive a copy of the 36 page Bib "Hi-Fi Stereo Hints and Tips". This booklet is a splendid guide to the use of audio equipment, explaining in lucid terms the functions of each component, various technical terms, installation of equipment, tape subbing, etc. It is written by John Borwick, B.Sc., an internationally acclaimed audio expert. Being a British publication, there are several points irrelevant to Australian audiophile's needs, such as wiring of plugs and lists of English periodicals. But this in no way detracts from the usefulness of the booklet.

## YOUR ENTRY

Choosing a loudspeaker is never an easy task as so many considerations have to be taken into account. It is to some extent a matter of individual taste as to what is required from a loudspeaker and what is believed to be the salient points of any one speaker system.

There are certain characteristics which every speaker system must possess. But the decision as to whether the point of prime importance is the appearance, the size or the frequency response is often a matter of the individual buyer's personal requirements.

The purpose of this competition is to find a sequence of priorities to act as a guide when buying a speaker system. We would like you to mark down the features we have listed in order of preference and then to write in thirty words or less why you have placed them in that order.

Send your entry as soon as possible to: Speaker Competition, Electronics Today International, 21-23 Bathurst Street, Sydney, N.S.W. 2000, together with the entry coupon. Any entry not accompanied by a coupon will be considered invalid.

The competition closes on January 31st, 1973, with the winner being announced in a later issue.

A panel of judges appointed by the magazine will decide the winning entry.

## Contest

All entries must be accompanied by the coupon from Electronics Today International. There is no entrance fee, but any entry not accompanied by a coupon will be deemed invalid by the judges.

The winner will be decided by a panel of judges appointed by the Editor of Electronics Today International. The judges' decision will be final and no correspondence will be entered into concerning the outcome of the contest.



# COMPETITION

## Conditions

All entries should be addressed to: Speaker Competition, Electronics Today International, 21-23 Bathurst St, Sydney, N.S.W. 2000.

Ensure that your name and address is printed clearly on your entry coupon.

Closing date for the competition will be January 31st, 1973.



Mark your order of preference in the boxes, i.e. 1 for first choice, 2 for second choice, etc.

- High efficiency
- Low distortion
- Wide frequency response
- Smooth frequency response
- Wide polar response
- Attractive appearance
- Reasonable size
- High power handling capacity
- Parts and labour warranty
- Moderate price
- Superior transient response

Explain in thirty words or less the reasons for your order of preference.

.....

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### ENTRY COUPON

#### ELECTRONICS TODAY INTERNATIONAL SPEAKER COMPETITION

21 Bathurst Street, Sydney, N.S.W. 2000

Herewith, please find my entry for your Speaker Competition. I have read the rules of the contest and agree to abide by the judges' decision.

SIGNED ..... DATE .....

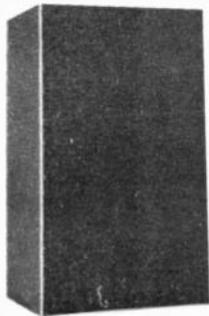
NAME (block letters) .....

ADDRESS .....

A separate coupon must accompany each entry.  
Closing date for the Speaker Competition is January 31st, 1973.

**DARLINGHURST HI-FI Stereo Centre Pty.Ltd. 31-6786**  
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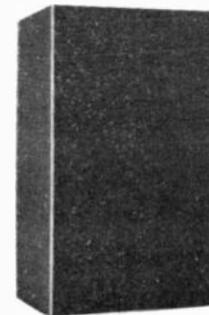
Leak Mk III



Kenwood 5002

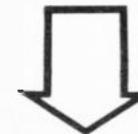


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Leak Mk III

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**KENWOOD KX-700 SPECIFICATIONS**

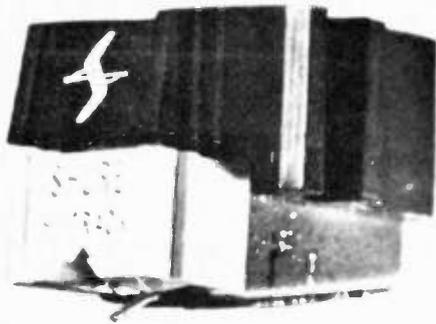
Head ..... Super Ferrite Head (SFH)  
Recording & playback, erase  
Tape Speed ..... 1-7/8 ips (4.75 cm/sec)  
Frequency Response ..... 25 ~ 16,000 Hz (CrO<sub>2</sub> tape)  
25 ~ 13,000 Hz (Regular tape)  
Signal to Noise Ratio ..... Dolby in: better than 58 dB  
(CrO<sub>2</sub> tape) better than 55 dB  
(regular tape) Dolby off: better  
than 48 dB (CrO<sub>2</sub>) better than  
45 dB (regular tape)  
Recording Bias Frequency .. 85 kHz  
Separation ..... better than 40 dB (between  
tracks) better than 40 dB  
(between channels)  
Wow/Flutter ..... less than 0.13%  
Total Harmonic Distortion . less than 2%

**KENWOOD 5002 SPECIFICATIONS**

Total Power Output: ..... 140 watts ±1 dB at 8 ohms  
Continuous Power Output .. 50%50 watts at 8 ohms  
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20 Hz to 20,000 Hz  
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output  
Frequency Response ..... 20 Hz to 50,000 Hz ±1 dB



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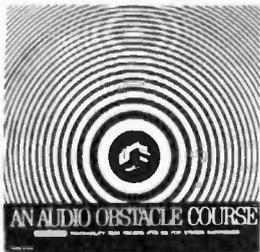
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M44-7-EP	\$19.50
M44-C-EP	\$19.50
M44-G-EP	\$19.50

## 'An Audio Obstacle Course'

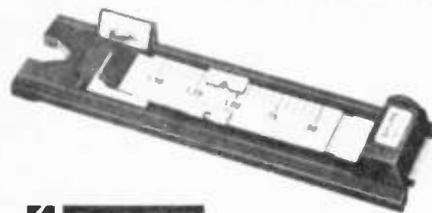
The trackability test



This Recording is unique. Its purpose is to demonstrate a heretofore neglected factor in phono pickup design – namely, the ability of the pickup to stay in contact with the groove modulations over a wide range of frequencies and intensities; in other words, to track the groove. Most cartridges should be able to effectively track the mildest level at their rated needle force, but only a truly exceptional pickup will track the 4th level without breakup. Each level is 4db or 58% higher than the preceding one, and consequently the 4 steps encompass a total increase of 400%! Actually the recorded levels are so high and the velocity increase so great that it seems a near miracle that any cartridge could successfully track level 4 – but the V-15 type II does so, and well at 1¼ grams in a Shure SME Tone Arm with a professional quality turntable. Side 1 is designed to test tracking ability at very high and very low frequencies and is recorded in both channels. Side 2 has single channel stereo tests for 1,000 cycle level, channel balance, phasing and tracking ability using several musical instruments. This attractively styled cover and recording only

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# BLOWING BUBBLES

Radio beam creates giant heat bubbles in ionosphere

United States Department of Commerce scientists are creating immense, invisible, short-lived bubbles in the upper atmosphere in a new kind of investigation made possible by an advanced radio transmitter.

The heated bubbles are formed in seconds at altitudes up to 320km by the action of a 100MW radio beam.

They grow to their full 80 to 160km size in about 20 min under the influence of geomagnetic forces. Composed of the electrified gas of the ionosphere, the bubbles elongate upward and downward under constriction of "tubes of force" that are generated and shaped by the earth's magnetic field.

Within minutes or hours, depending on time of day and conditions in the high-level environment, the modified region of the ionosphere rebounds to its natural state.

Observations of these effects on the upper atmosphere should lead to better understanding of the ionosphere, to improvements in long-distance radio communications, and to the advancement of plasma physics.

Results of the first year of research were reported recently in the journal *Science* by two Department of Commerce scientists — Mr. William F. Utlaut, Deputy Director of the Institute for Telecommunications Sciences (ITS), Office of Telecommunications; and Mr. Robert Cohen, consultant to the Aeronomy Laboratory, National Oceanic and Atmospheric Administration (NOAA) — both located in Boulder, Colorado.

The two scientists had originally expected the intense radio beam only to heat electrons, but they found that they were also producing a variety of ionospheric instabilities. They regard this mixture of expected and unexpected events as genuine modification of the ionosphere.

Chief among the non-surprises was a finding that the radio beam raised temperatures of the ionospheric electrons by as much as 35%. But a prediction that the expected temperature change would cause slightly enhanced reflection of radio signals sent up to diagnose the modified region of the ionosphere turned out to be the reverse of what occurred.

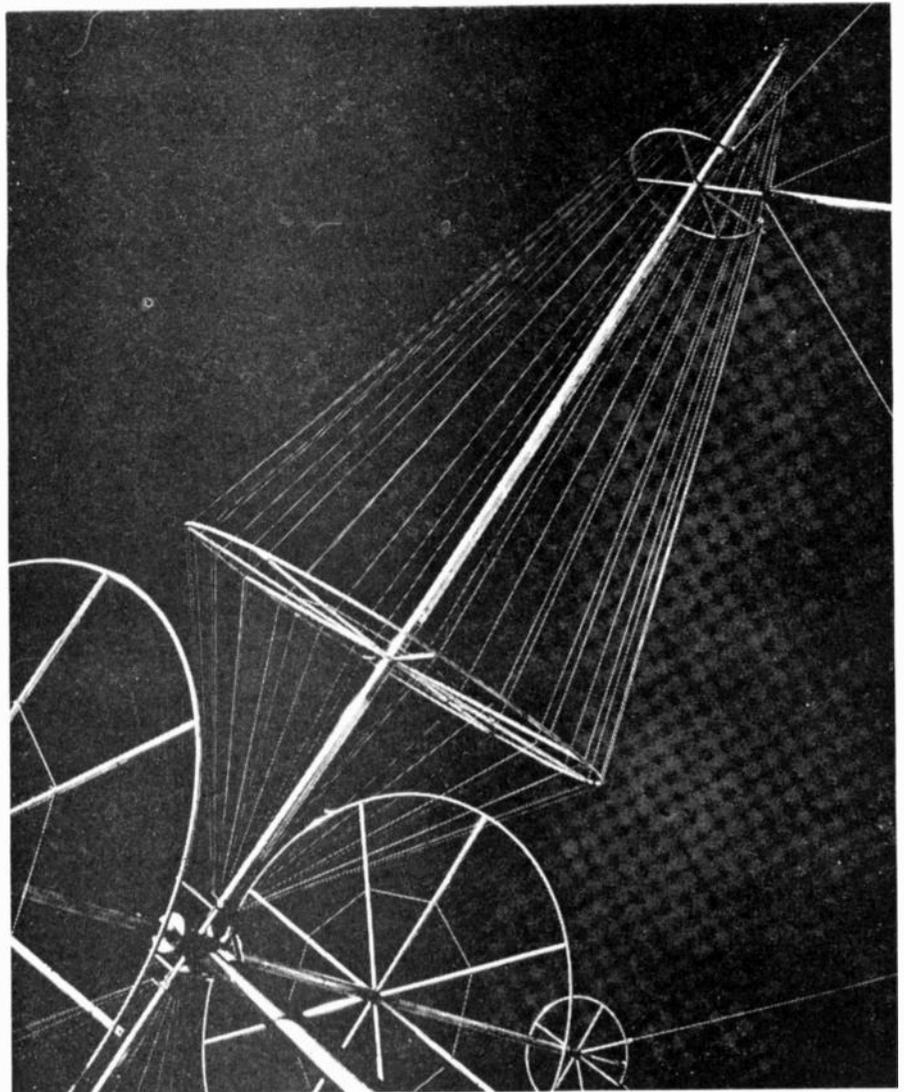
Another major surprise was the artificial creation of a natural

phenomenon known as spread F — "F" referring to the upper layer of the radio-reflecting region of the ionosphere and "spread" describing the patchy pattern of reflected signals.

"Since the advent of rockets and satellites", say the scientists in their *Science* report, "man has employed artificial modification of the ionosphere as a method for studying it. Modification has been accomplished by such means as chemical releases, atomic bombs, and small electron-beam accelerators. The possibility of active experimentation with the ionosphere by temporarily modifying it using high-power, ground-based radio transmissions has

long been a desire of researchers. By contrast with the other techniques, ionospheric modification using radio transmissions at frequencies that interact with the ionosphere represents an attractive and hygienic alternative, in view of its relative controllability, repeatability, and rapid reversibility."

The natural ionospheric plasma has scientific advantages over laboratory plasmas, such as those used in nuclear fusion research. Chief among the advantages is the ionosphere's unbounded nature, as opposed to the experiment-disrupting walls of laboratory containment devices. This outdoor plasma now can be simultaneously modified and observed



One of the ten elements of the 110m diameter radio transmitter array.

(Continued on page 59)

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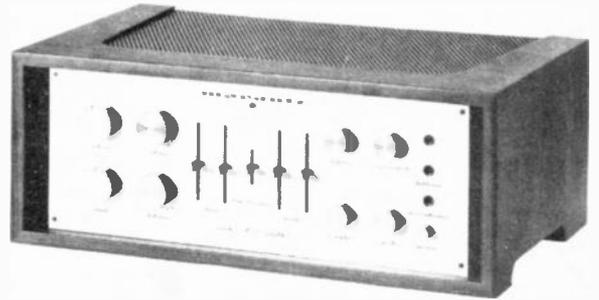
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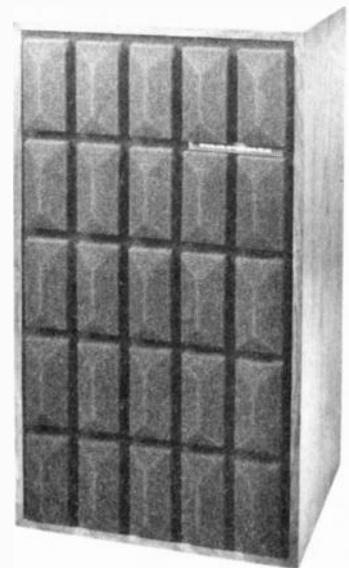
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from ground sites.

The new Department of Commerce transmitter located at Platteville, Colorado, 64km east of Boulder, employs a 110m ten-element circular array of antennae, with an additional element in the centre for beam focusing. It is capable of projecting effectively a 100MW radio beam that is tunable between 5 and 10MHz, the usual range of ionospheric penetration frequencies.

The intense beam is transmitted straight up at very close to the penetration frequency — the frequency at which a radio wave passes completely through the ionosphere. The purpose here is to deposit a maximum of radio energy in the ionosphere. The closer the transmitted beam approaches the penetration frequency, the higher it reaches before being bent back to earth, the more it is slowed down, the longer it remains in the ionosphere, and the more its energy is absorbed by the ambient electrons. Absorption in the F region is maximized at the penetration frequency.

The electron heating takes place in about 20s. The heat bubble expands more slowly, however, because the negatively-charged electrons must drag the heavier, slower-moving positive ions with them, in order to maintain

the electrical neutrality of the ionospheric plasma. Within 20 min or so, the dimensions of the heat bubble may grow to 80 or 160km.

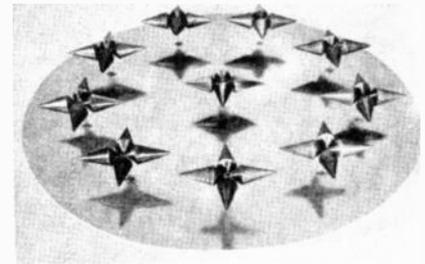
When the transmitted beam was given left-circular polarization, airglow observations of excited oxygen atoms at the Å wavelength showed a predicted suppression, indicating a 35% electron temperature increase. Observations of the effects of transmissions with right-circular polarization, on the other hand, showed an enhancement of the 6300 Å emission. This unforeseen result implies, according to Utlaut and Cohen, that another process is also occurring, an increase in airglow produced by collisions of oxygen atoms with very hot electrons. The hot electrons are presumably activated by a plasma instability in the ionosphere. Because of the unstable condition, the powerful radio transmissions at ionospheric frequencies "pump" the electrons to high energy states.

Still another surprise noted in the airglow observations was the enhancement of infrared emissions from excited oxygen molecules (as opposed to atoms) by an unexplained mechanism.

Under certain natural and as yet theoretically unexplained conditions, F region echoes become diffuse,

suggesting instabilities in the ionospheric plasma. If they do appear, it is almost always at night, generally after midnight. No one had predicted that the Platteville transmitter was capable of generating this spread F. But that is what the ionograms repeatedly revealed, in daytime as well as night.

Still another surprising observation experienced by the Boulder scientists was a large attenuation in radio-wave reflectivity from the regions of heated electrons. They had expected their diagnostic signals to undergo enhanced reflection from the modified portions of the ionosphere.



Model showing the geometric configuration of the 110m diameter antenna near Boulder, Colorado, used in transmitting a 100MW radio beam that modifies the ionosphere.

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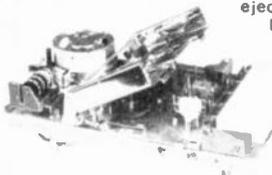
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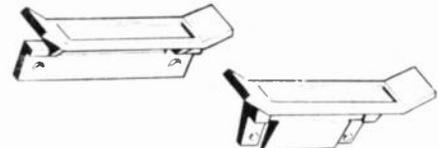
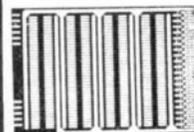
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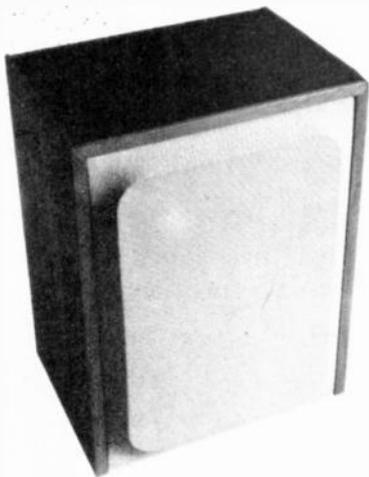
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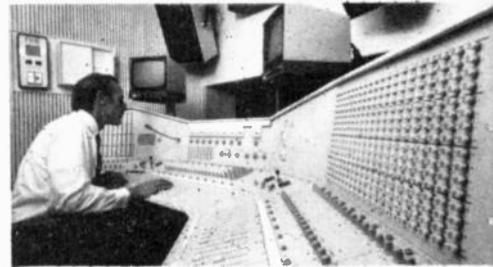
The Prince Philip Prize for the Australian Design Certificate of Merit in the "building systems and components" group has been awarded to Amalgamated Wireless (Australasia) Ltd. for its electro-acoustic system for the Sydney Opera House.

Initiated by the Industrial Design Council of Australia, the prize is given annually for a product or system of original Australian design closely associated with Australian life and industry. The award recognises basic design qualities with emphasis on economy and inventiveness. The primary aim of the award is to recognise a product which either has made or is likely to make substantial economic contribution to Australia's industrial advance.

The award was presented by the South Australian Governor, Sir Mark Oliphant, to Mr. Wesley Moon, (AWA Engineering Products Division) at a ceremony in Adelaide.

Designed and manufactured at the Company's North Ryde works, the electro-acoustic system consists of eight major sound systems which may be coupled together as required. These include five control consoles which incorporate state of the art solid-state equipment of extremely high performance specially developed for this application.

In their comments on the AWA entry, the judges said they had considered not only the design of the



control console but also the acoustic controls associated with the building in which it was installed. The equipment to be effective had essentially to be integrated with the Sydney Opera House. The acoustic performance of the five systems was believed to exceed anything hitherto produced in Australia and was at least equal to known equivalent installations overseas.

The judges went on to say: "The console is of excellent design with a massive array of controls for monitoring and mixing the incoming signals; arranged within easy reach of the operator and grouped for easy recognition."

A unique aspect of the system is in the design of the speaker columns which beam the sound to the audience in such a way that the frequency distribution is even throughout the audience. Previously, speaker columns tended to project the high frequencies to the centre only. The speakers, up to 19 in one column, are spaced in a geometric progression with variable filters on each speaker.

Another innovation is the all-round sound system for special effects which simulate sound source movement in any direction relative to the audience." ●

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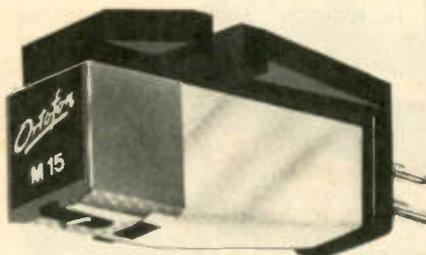


## Invest in the Swiss made Thorens turntable.

There are two models . . . the TD-125 and the TD-150 Mk. II. Why Thorens? Read these opinions from leading overseas reviewers: "the best three-speed manual we've ever tested" — High Fidelity. "wow and flutter were as low as we've ever tested" — Stereo Review. "a favourite contender in the best turntable category" — Audio. "it would be hard to imagine a unit that performs better" — Electronics World. Now look at these brief Thorens specifications:

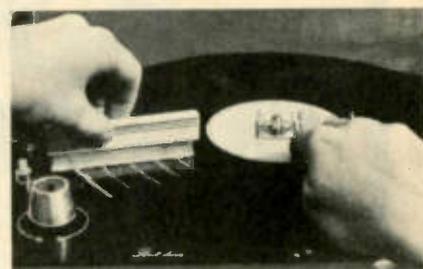
- TD-125.** • Transistor governed 16 pole synchronous motor • Three speeds •  $\pm 2\%$  speed control on all speeds • Belt drive • 7 1/2 lb. 12" diameter turntable • Wow and flutter  $\pm 0.08\%$  • Rumble —68dB.
- TD-150 Mk. II.** • Same precision manufacture as the TD-125 but at a lower price • 16 pole synchronous motor • Belt drive • 7 lb. 12" diameter turntable • Two speeds — 33 1/3 and 45 r.p.m. • Wow and flutter  $\pm 0.09\%$  • Rumble —65dB.

So your Thorens turntable represents your help from the fastidious Swiss . . .



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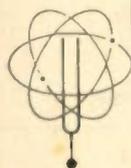
**THE ORTOFON M15.** Featuring entirely new principles, the Ortofon M15 stereo cartridge maintains the professional reputation of the makers in every way . . . for over 80% of recording studios as well as radio and television stations specify Ortofon . . . on a world wide basis! When you see your Bleakley Gray franchised dealer, you can choose from the Ortofon M15 Super, the M15 or the MF15 cartridges. These are all attractively priced . . . Typical specifications are:  
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 Recommended load 47 k ohms.  
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**Brenell Mk 6 hi-fi stereo recorder.** Unquestionably one of the world's most versatile tape recorders for semi-professional users, it is available for two-track or four-track stereo or as a complete monaural unit including inbuilt speakers. Fully transistorised, three motors, three heads, four tape speeds, full mixing and A/B comparison facilities. 15 watts RMS per channel output, 40 Hz to 22 kHz  $\pm$  3 dB frequency response at 15 ips, wow and flutter less than 0.05%, signal to noise ratio 56 dB unweighted.

**Separate tape decks and amplifiers.**

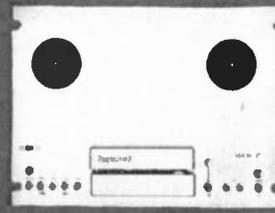
For specialists wanting to build up their own systems, Brenell offers high quality tape decks and amplifiers as separate components. The Mk 6 deck is for hi-fi systems, the professional, solenoid-operated Type 19 deck handling up to 10½" reels is designed for industrial and scientific use. Transistorised hi-fi tape link amplifiers for stereo or mono operation are also available.



Brenell Mark 6 stereo recorder



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Brenell tape link amplifier



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AV51

# INTEGRATED AUDIO SYSTEM-ETI 425

(Revised power amplifier) Latest version uses new amplifier module.

## ETI PROJECT 425

One of the most popular projects we have published so far has been our Integrated Audio System. Many hundreds of people have successfully built this unit and several commercial organizations will shortly have it available in fully assembled form.

The main power amplifier for this project was based on a Sanyo module which was marketed in this country by STC's Component Division. (STC catalogue number TA25B)

Before commencing publication of this project we received a firm assurance from STC that supplies of the TA25B module would be readily available at the time of publication and that supplies would continue to be available.

However, as many of our kit set suppliers and readers soon found, supplies of the module were not available until six to eight weeks after publication, and, as if that were not bad enough, we have since been advised by STC that — contrary to their earlier assurances — the TA25B module is no longer in production. Instead it has been superseded by the TA25C.

Incredibly, the new modules are not pin interchangeable with the earlier version. But at least we now have an absolute assurance from STC's Deputy Sales Manager, their Chief Engineer and their Technical Editor that this module will remain in production for a long time. In the light of this assurance we have redesigned the printed circuit board to accept the TA25C.

All changes are confined to the main

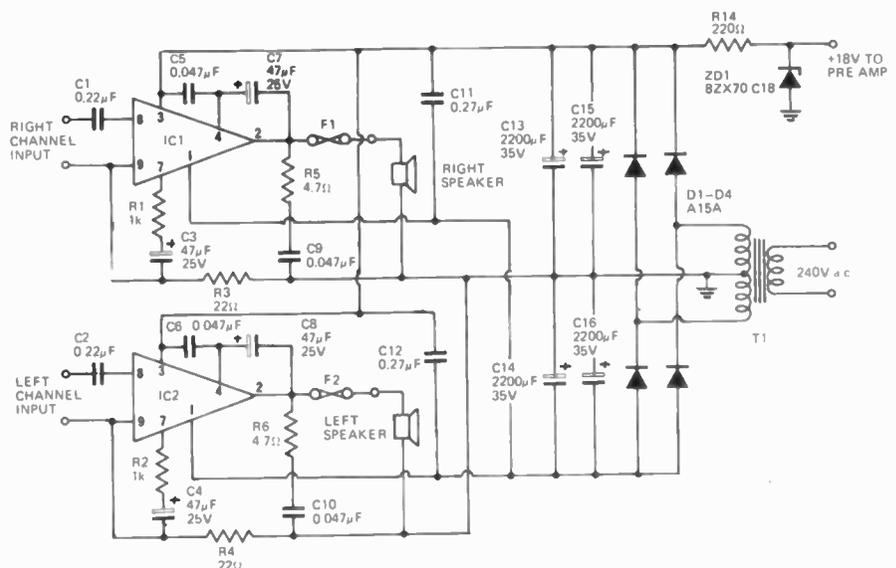
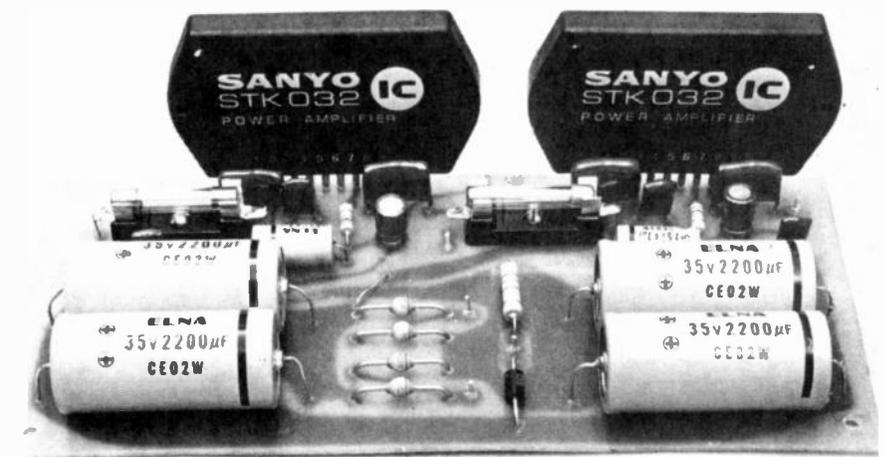


Fig. 1. Circuit diagram of the complete amplifier (both channels).

power amplifier board and the components mounted thereon.

The new board is exactly the same size as the original and the modules are located in the same position on the

board. All existing metalwork will fit both old and new modules.

The new modules require a larger number of external components and because of this it has been necessary to

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# INTEGRATED AUDIO SYSTEM-ETI 425

renumber the components on the printed circuit board. Note also that the original parts list is no longer applicable.

In the original project we showed

only one channel of the stereo pair. As this puzzled one or two novice project builders we have taken the opportunity to publish a circuit showing the complete amplifier. (Fig. 1).

## CONSTRUCTION

The general method of construction remains the same as before and readers are advised to consult the original article (June 1972) before continuing.

(Continued on page 66)

### PARTS LIST ETI 425 (revised)

R1	resistor	1k ohm	1/2watt	5%
R2	"	1k ohm	1/2watt	5%
R3	"	22 ohms	1/2watt	5%
R4	"	22 ohms	1/2watt	5%
R5	"	4.7 ohms	1/2watt	5%
R6	"	4.7 ohms	1/2watt	5%
R14	"	220	1watt	5%
C1	"	0.22 $\mu$ F	polyester	"
C2	"	0.22 $\mu$ F	"	"
C3	"	47 $\mu$ F	25 V electrolytic (PC mounting)	"
C4	"	47 $\mu$ F	electrolytic (PC mounting)	"
C5	"	0.047 $\mu$ F	polyester	"
C6	"	0.047 $\mu$ F	polyester	"
C7	"	47 $\mu$ F	25 V electrolytic (axial leads)	"
C8	"	47 $\mu$ F	"	"
C9	"	0.047 $\mu$ F	polyester	"
C10	"	0.047 $\mu$ F	polyester	"
C11	"	0.27 $\mu$ F	"	"
C12	"	0.27 $\mu$ F	"	"
C13	"	2200 $\mu$ F	35 V electrolytic, (axial leads)	"
C14	"	2200 $\mu$ F	35 V electrolytic, (axial leads)	"
C15	"	2200 $\mu$ F	35 V electrolytic, (axial leads)	"
C16	"	2200 $\mu$ F	35 V electrolytic, (axial leads)	"
D1	diode	A15A	"	"
D2	"	A15A	"	"
D3	"	A15A	"	"
D4	"	A15A	"	"
ZD1	zener diode	BZX 70 C18	"	"
IC1	audio amplifier	TA 25C	"	"
IC2	"	"	"	"
PC board ETO34A TA25C				
2 Fuse holders				
2 1.5 amp fuse.				

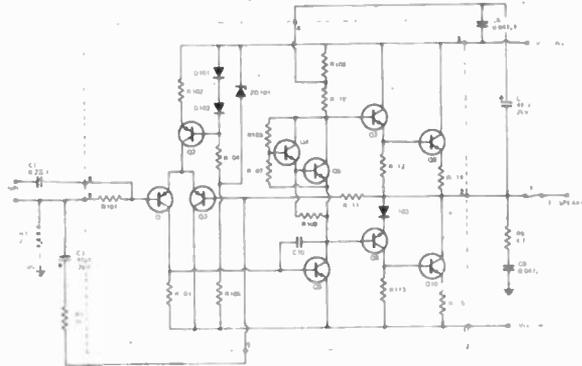
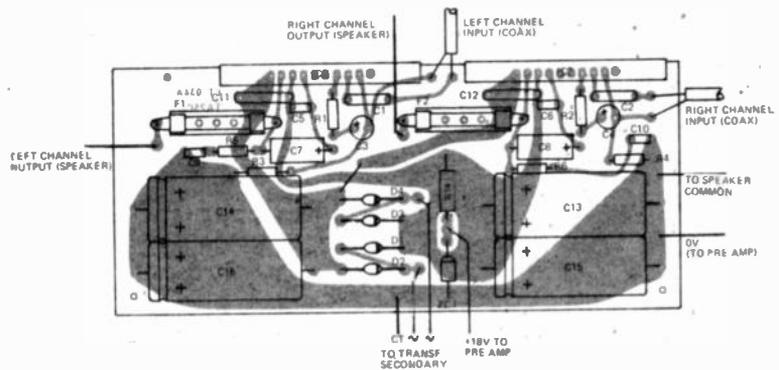


Fig. 2. This circuit shows one channel of the amplifier (less power supplies). All components within the shaded panel are contained within the TA25C module.

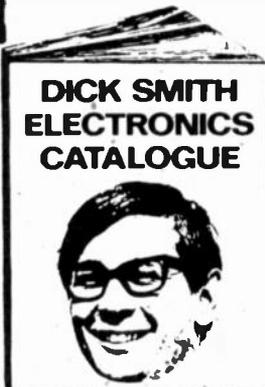
### REVISED SPECIFICATION POWER AMPLIFIER

Frequency Response	50Hz - 20kHz $\pm$ 1dB (-3dB at 20Hz)
Total Harmonic Distortion (25W output, 8 ohm load, one channel)	- less than 0.5% (50Hz to 20kHz)
Input Impedance	typically 27k (minimum 20k)
Sensitivity	470mV for 25W output
Hum and Noise (below 25W)	less than 70 dB
Power Output (before clipping)	26W each channel into 8 ohms 36W each channel into 4 ohms



How the components are mounted on the printed circuit board.

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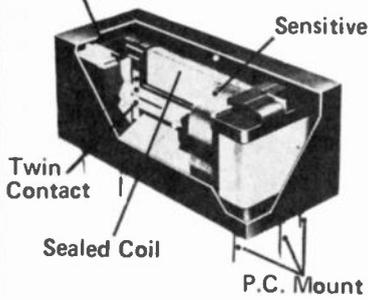
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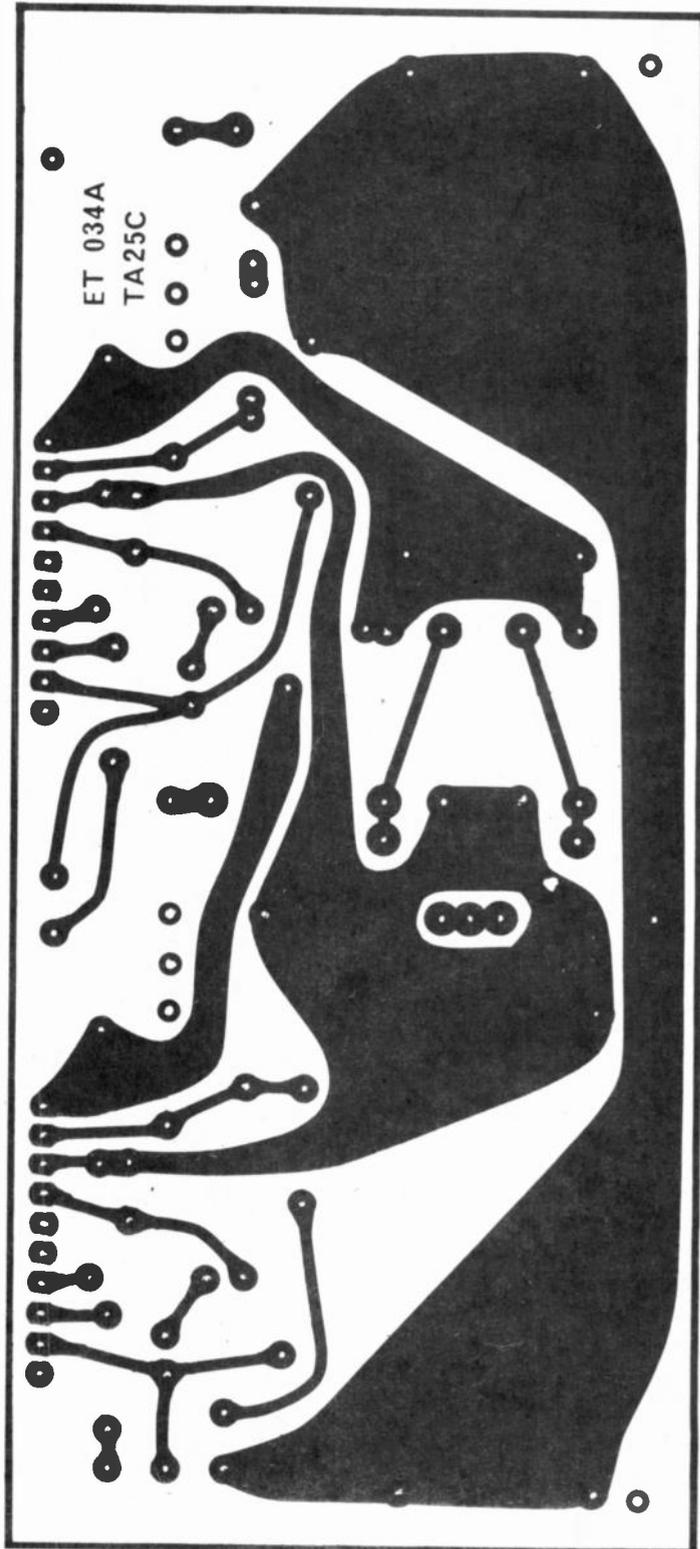
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As before, shields of input cables should be continuous, and connected at both ends. If the amplifier is used with a separate preamplifier which has

its own power supply, the point at which the input cable's shield is connected should also be linked to OV at the point on the printed circuit board marked 'OV to PRE-AMP'.

Note that in the photograph of the new board the modules have a Sanyo parts number. Units sold by STC however will bear the number TA25C.●



Revised version of printed circuit board. Note this board must not be used with the now obsolete TA25B module nor may the TA25C module be used with the earlier board.

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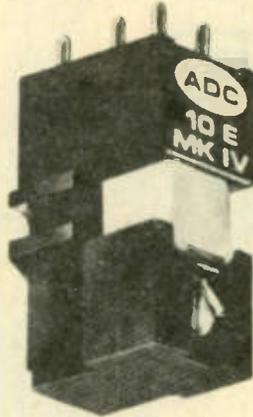
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Type: Induced Magnet\*  
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Tracking Force: .7 gram  
Frequency Response: 10 Hz to 20 kHz ± 2 dB  
Channel Separation: 30 dB from 50 Hz to 12kHz  
Compliance: 35 x 10<sup>-6</sup> cms / dyne  
Elliptical Stylus Tip: Contact radius: .0003"; lateral radius: .0007"  
IM Distortion: Less than ½% — 400 & 4000 Hz at 14.3 cms / sec. recorded velocity  
Vertical Tracking Angle: 15 degrees  
Recommended Load Impedance: 47000 ohms nominal

**ADC 220XE ... \$22.00**

ADC 220XE. Type: Induced Magnet; Output: 6 mV at 5.5 cms / sec. recorded velocity; Tracking Force: 1 to 2½ grams; Frequency Response: 10 Hz to 18 kHz ± 3 dB; Channel Separation: 20 dB from 50 Hz to 10kHz; Compliance: 20 x 10<sup>-6</sup> cms / dyne; Elliptical Stylus Tip Radii: Contact radius .0003". Lateral radius .0007"; Vertical Tracking Angle: 15°

**ADC 550XE ... \$30.00**

ADC 550XE. Type: Induced Magnet; Output: 5 mV at 5.5 cms / sec. recorded velocity; Tracking Force: ¾ to 2 grams; Frequency Response: 10 Hz to 20 kHz ± 2 dB; Channel Separation: 20 dB from 50 Hz to 12 kHz; Compliance: 35 x 10<sup>-6</sup> cms / dyne; Elliptical Stylus Tip Radii: Contact radius .0003". Lateral radius .0007"; Vertical Tracking Angle: 15°.



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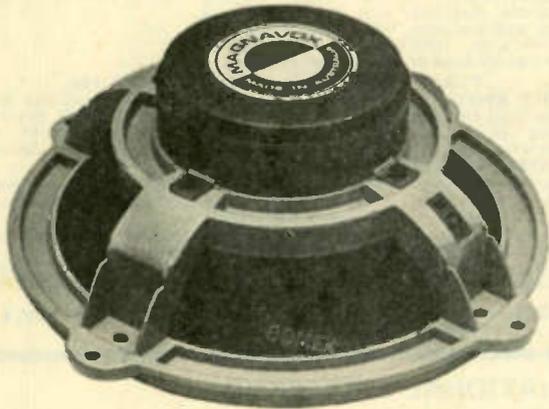
# INSTROL

# SPEAKER SYSTEMS

All the systems below are available in kit form. The cabinet kits come in either unpolished Queensland Maple veneer or unpolished teak veneer. All kits are complete, and include speakers, crossover networks (where applicable), cabinet kits, grille cloth and innerbond.

## MAGNAVOX 8-30 SYSTEM

at reduced prices.



Featured in "Electronics Today". It handles 30 watts RMS, features a new high performance 8" speaker, two 3" tweeters, and is available in cabinet 20 7/8" x 12 7/8" x 8 7/8" (1 cu. ft.) or 23 7/8" x 15 1/2" x 10 7/8" (1.6 cu.ft.). Available in teak or walnut veneer.

### COMPLETE SYSTEM

Kit of Parts \$42.00 (1cu ft), \$52.00 (1.6 cu ft)  
Built and Tested \$55.00 (1 cu ft), \$65.00 (1.6 cu ft)

### SEPARATE COMPONENTS

Enclosure kit (1 cu ft) \$16.50 (maple), \$17.50 (teak)  
Enclosure kit (1.6 cu ft) \$26.00 (maple), \$28.00 (teak)  
Built Enclosure (1 cu ft) \$29.00 (walnut), \$30.00 (teak)  
Built Enclosure (1.6 cu ft) \$38.00 (Walnut), \$40.00 (teak)  
speakers & crossover only \$26.00 (one side only)

## NEW E.T. MAGNAVOX 8-30 DESIGN

A revised version of the popular Magnavox system was featured in July 1972 edition of Electronics Today. It featured a Philips tweeter and improved crossover

### COMPLETE SYSTEM

Kit of Parts \$62.00 (1 cu. ft.) \$72.00 (1.6 cu. ft.)  
Built and Tested \$75.00 (1 cu. ft.) \$85.00 (1.6 cu. ft.)

### SEPARATE COMPONENTS

Speakers and crossover only \$45.00 (one side only)

## WHARFEDALE SPEAKER SYSTEM KITS

The Wharfedale Super Linton, Melton and Dovedale III are now available as build-yourself kits, featuring INSTROL quality cabinet kits in choice of maple or teak veneer.  
The Super Linton kit employs an 8" and 3" speaker, frequency response 40-17,000Hz, cabinet 21" x 11 1/2" x 9 1/2", 15 watts RMS.  
The Melton kit employs a 12" bass and a tweeter, cabinet 22 1/4" x 13" x 10", 25 watts RMS.  
The Dovedale III kit employs a 12" bass, 5" mid-range and 1" tweeter. Cabinet 28" x 15 1/2" x 10", 35 watts RMS.

### COMPLETE SYSTEM

Super Linton kit (Unit 3) \$52.00  
Melton kit (Unit 4) \$93.00  
Dovedale III kit (Unit 5) \$127.00

### SEPARATE COMPONENTS

Unit 3 encl. kit \$15.50 (maple), \$16.00 (teak)  
Unit 4 encl. kit \$26.00 (maple), \$28.00 (teak)  
Unit 5 encl. kit \$35.00 (maple), \$37.00 (teak)

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**BROADWAY 201** — This system features the SEAS wide range 8" speaker, 21TV.GD, in your choice of teak or walnut enclosure. The attractive cabinets, which feature bevelled fronts, measure 16-7/8" x 11" x 9".

**BROADWAY 251** — This system uses the 25 TV.ED, a 10" wide range speaker by SEAS, in teak or walnut cabinets. Featuring bevelled fronts, the enclosures measure 21" x 12" x 11 1/2".

### COMPLETE SYSTEM

Kit of Parts (Broadway 201) \$26.00  
Kit of Parts (Broadway 251) \$33.00  
Built and Tested (Broadway 201) \$36.00  
Built and Tested (Broadway 251) \$46.00

### SEPARATE COMPONENTS

BROADWAY 201 encl. kit only \$14.00 (walnut) \$15.00 (teak)  
Broadway 251 encl. kit only \$19.00 (walnut) \$19.50 (teak)  
8" SEAS (21 TV.GD) speaker only \$12.50  
10" SEAS (25 TV.ED) speaker only \$14.50

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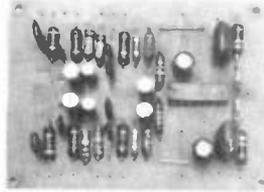
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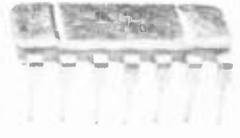


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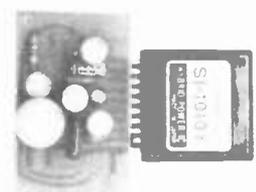
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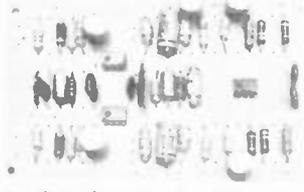


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**Specifications:** Noise level — 92db below 1V on any channel. Distortion — 0.05% or less at 1V rms output. Gain of +6db on the two front channels, controllable from -7 to +6db on the two new channels, and frequency response of +0.5db from 20Hz to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

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The LM380, 2W Audio Amplifier.

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

**Specification:** Voltage gain 34db, Input overload point 100mV rms, Output voltage swing 5V rms, output noise level 70db below 10mV phono input, Voltage range 9-15V DC requires plus and minus power supplies or 18-30V DC single supply. Complete Stereo Kit price — \$6.50., post 25c.

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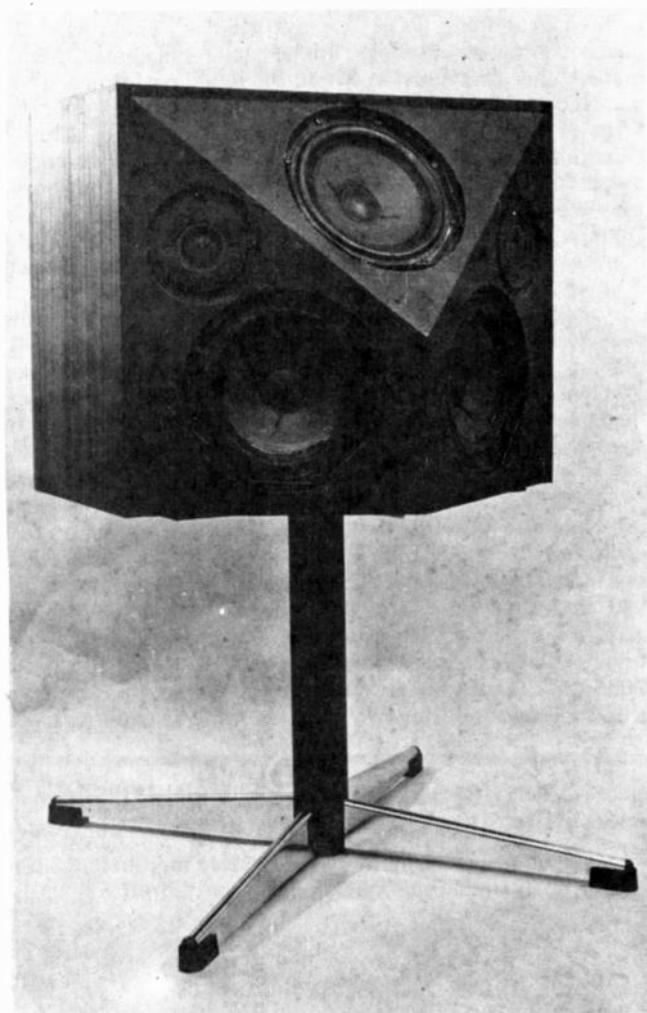
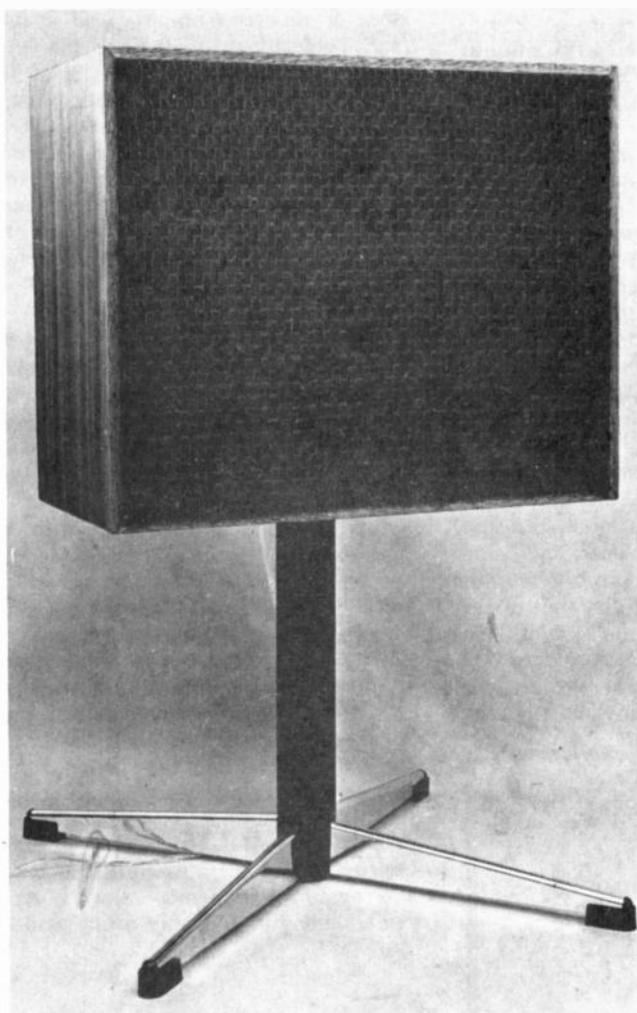
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# Philips Quadreflect Speaker

**electronics**  
TODAY  
INTERNATIONAL  
**product test**

Easily the most exciting speaker we have seen this year' — Louis Challis.



**O**VER the past two decades there has been considerable interest in speaker systems using multiple arrays of drive units, and whilst we have yet to be convinced that this is necessarily either the best or the only way to get good performance, excellent results have none the less been obtained by Dr. Bose and others. These researchers have demonstrated the benefits of multiple arrays when

combined with reflection from the wall behind the speaker system.

In 1953, Philips, in their research centre at Eindhoven, carried out some interesting research work, highlighting the benefits of reduced distortion which result from using this technique. Subsequently, Philips published their results, and this resulted in the company starting a research and design project in Australia.

Their aim was to develop a speaker system with low distortion, good presence, and the ability to handle transients from high powered amplifiers without the risk of overloading which plagues speakers of low power handling capacity.

The project was handed to an engineer who also happens to be a theatre organ enthusiast — practically guaranteeing in advance the ability of

# Philips Quadreflect Speaker

the system to produce high power at almost infra-sonic frequencies!

The engineer's brief was to produce a speaker which would have small physical size, conventional woofers and tweeters, and the ability to handle over a hundred watts of average power. And as Philips' intend to market this unit only in kit form, it had to be fairly simple to build.

The first prototype was the Quadreflect Mark I. This contained seven low frequency drivers (Philips type AD 7065/W8) and four tweeters (Philips type AD0160/-18), with a conventional cross-over operating at 1.5kHz.

In appearance the first unit was vaguely similar to a Bose. It used a 2½ cubic foot enclosure, and the efficiency was higher than other multiple array speaker systems of its size. (Fig. 1).

A small number of these experimental systems were produced, but because of the cost of the enclosure, quite apart from the cost of the multiplicity of speakers, the design had to be reappraised. What resulted was a lower cost version of the original, using four low frequency AD 7065/W8's, and three AD0160/T8's in a one cubic foot enclosure.

The AD 7065/W8 is a 160 mm diameter woofer with a 20 watts power rating and a nominal 28Hz free-air resonant frequency. It has a neoprene roll surround and is designed for front or rear mounting.

The AD 0160/T8 is a 25mm diameter dome tweeter with smooth performance from 1.5kHz to well above the normal upper limit of hearing. This tweeter has unusually high efficiency and is one of the best medium cost tweeters currently available. A special series-connected crossover system ensures that the woofers operate to 1.5kHz and the tweeters then take over and cover the remainder of the spectrum.

The Mark II Quadreflect unit is designed to be mounted on a stand so that the reflection characteristics can be optimized by varying the distance from a wall.

The shape of the Mark II is unusual — at first sight even ungainly. The front is quite conventional, but the rear has three angled faces. Two side angled faces each contain one woofer and one tweeter, whilst the upper angled face contains one woofer. The upward sloping rear face provides one of the best features of the smaller Quadreflect and accounts for most of

the advantages that it offers over the earlier (prototype) 2.5 cubic foot unit. The forward speakers were protected, by grill cloths which, in the units evaluated were not really inspiring. The rear speakers were not protected in any way, we understand however that later units have a grill cloth over these rear speakers.

## HOW THEY WORK

The theory of this system, as with the Bose, is that the majority of the sound is reflected. Only a small portion is heard as direct sound radiation from the front of the enclosure. The concept is limited by the need to optimize the location of the speakers. They must not be too near a corner of the room, nor too close or too far from the wall at the rear. Typically this will be so that the closest part of the enclosure is 18 to 25cm from the wall and approximately 1.25 metres away from the side walls. Under these conditions the one cubic foot Mark II Quadreflect system performs excellently and produces very high sound levels if connected to a fairly powerful amplifier.

## TESTING PROCEDURE

A conventional speaker can be tested under anechoic conditions but as with the Bose, the Quadreflect system relies upon a reflecting wall behind it for it to be able to work correctly. We therefore mounted one speaker in a living room and drove it with a pure-tone signal across the frequency spectrum from 20Hz to 20kHz. Between 100Hz and 200Hz it became necessary to modulate the pure tone with a 10Hz signal in order to reduce the effects of known room resonances.

This test was repeated with the speaker set at various distances from the wall to determine the *extent* of the variations in response which we could hear. It was found that the optimum speaker/wall distance was approximately 25cm. With this spacing the measured frequency response was remarkably flat and only room modes

### MEASURED PERFORMANCE OF PHILIPS QUADREFLECT MK II SPEAKER SYSTEM

Frequency Response	30Hz to 16kHz ± 8dB	
Total Harmonic Distortion	1 watt input	
	100Hz	5 watts input
	1kHz	2%
	6.3kHz	4%
	0.3%	0.5%
Electro-Acoustic Efficiency	0.5%	
Woofer Resonance in Enclosure	70Hz	
Measured Impedance	100Hz	25Ω
	1kHz	10Ω
Enclosure Volume	1 cubic foot	
Dimensions	16¼" Wide x 14" High x 13½" Deep (Without stand)	
Recommended retail price	\$150 Walnut	
	Kit Form (each speaker) \$153 Teak	



Right: AD 7065/W8 woofer.  
Left: AD 0160/T8 tweeter.

at 35Hz and between 100Hz and 200Hz disturbed the relative flatness of the result.

The measured impedance curve showed that a significant enclosure resonance was occurring at approximately 70Hz causing some colouration. This resonance could be reduced by the inclusion of a more suitable damping medium in the enclosure. (Philips tell us that a more suitable material is now being supplied with their constructional kits). The system has more than adequate power handling capacity and each enclosure can absorb 80 watts of continuous (average) power without damage. Efficiency however is rather low and a minimum of 15 watts per channel is

recommended for the average sized living room.

### SUBJECTIVE IMPRESSIONS

The first record that we tried was a New CBS record "Aldemaro Romero and his Onda Nueva" SBP 234147. The Quadreflect immediately demonstrated that its response was good down to 60Hz. There was complete agreement that the response was 'natural' and that the presence was "just right".

We next tried "Carnival", Manuel and the Music of the Mountains, Columbia SOEX 9772/275. The first track of side 2 of this record is 'Guantanamera' and here the guitars

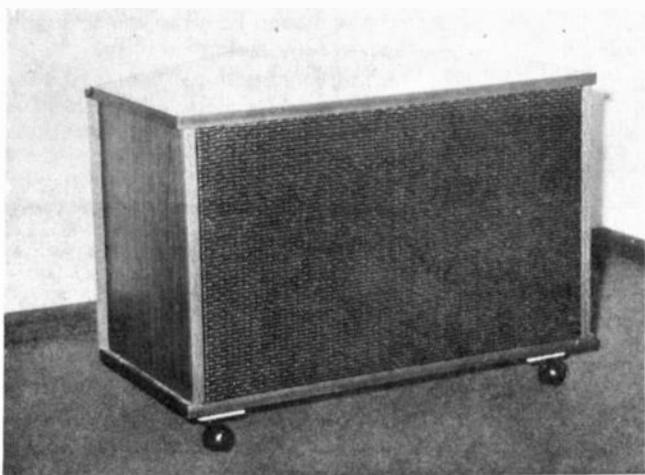
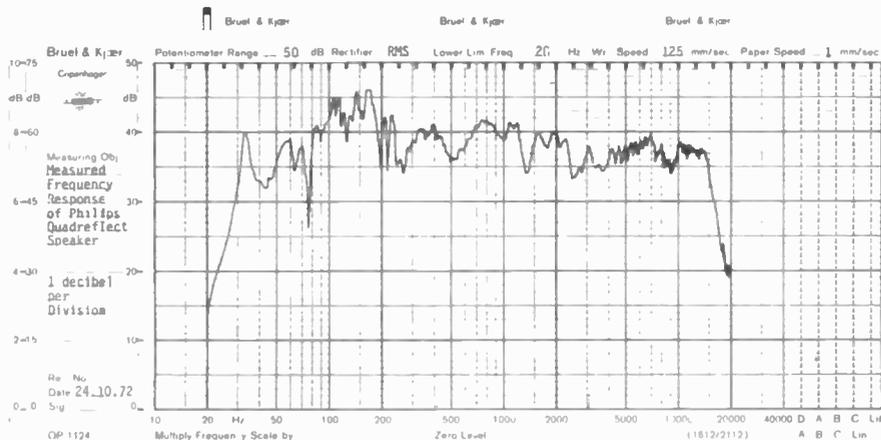


Fig. 1. First MARK I Quadreflect unit.



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	100VW .19	500VW .92
	160VW .20	
	350VW .23	47 uF 6.3VW .18
	450VW .33	10VW .19
	500VW .36	16VW .23
		25VW .27
2.2 uF	25VW .17	50VW .29
	50VW .18	63VW .34
	80VW .18	80VW .42
	100VW .19	100VW .47
	160VW .23	160VW .59
	350VW .29	250VW .60
	450VW .33	315VW .98c
	500VW .37	450VW 1.13c
3.3 uF	25VW .17	100 uF 10VW .23
	50VW .18	16VW .27
	80VW .19	25VW .29
	100VW .23	35VW .34
	160VW .23	50VW .38
	250VW .29	63VW .47
	350VW .31	80VW .68
	450VW .36	100VW .62
	500VW .40	160VW .92
		200VW .76
		350VW 1.15c
4.7 uF	25VW .17	220 uF 10VW .27
	35VW .18	16VW .29
	50VW .19	25VW .36
	80VW .22	35VW .48
	100VW .23	50VW .54
	160VW .29	63VW .69
	250VW .31	80VW .74
	350VW .32	100VW .97
	450VW .38	
	500VW .47	
10 uF	10VW .17	330 uF 10VW .29
	25VW .18	16VW .34
	35VW .19	25VW .48
	50VW .23	35VW .51
	63VW .20	50VW .65
	80VW .27	63VW .85
	100VW .29	80VW 1.41
	160VW .32	100VW 1.27
	250VW .38	
	350VW .40	
	450VW .47	470 uF 6.3VW .29
	500VW .54	10VW .32
		16VW .40
		25VW .52
22 uF	10VW .18	35VW .61
	16VW .19	50VW .69
	25VW .23	63VW 1.02
	35VW .23	
	50VW .28	1000 uF 6.3VW .37
	63VW .25	10VW .43
	80VW .29	16VW .56
	100VW .32	25VW .71
	160VW .42	35VW .92
	250VW .54	50VW 1.18
	350VW .55	
	450VW .69	2200 uF 6.3VW .66
	500VW .69	10VW .61
		16VW .91
33 uF	10VW .18	25VW 1.14
	25VW .22	
	50VW .26	
	63VW .26	3300 uF 6.3VW .68
	80VW .38	10VW .76
	100VW .37	16VW 1.18

# Philips Quadreflect Speaker

sounded more life-like than we had ever heard from a speaker before.

There was a genuine consensus amongst the staff that the Quadreflect

sounded good and offered a more life-like sound than speakers which suffer from colouration somewhere in the spectrum. The Quadreflect

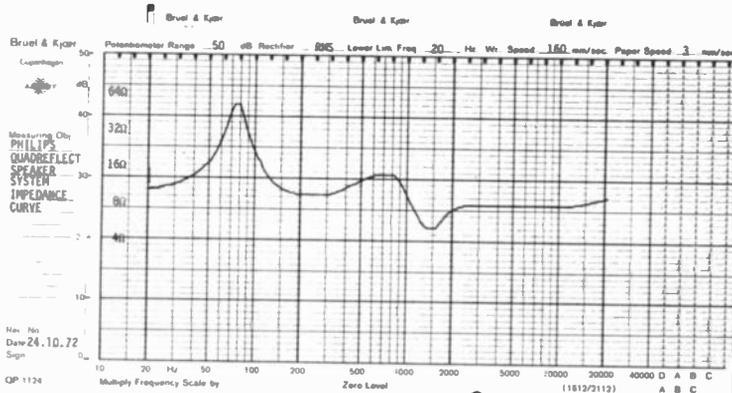


Fig. 1. The polarization selector had four functions:  $45^\circ$  in either direction, or circular to the right or the left.

enclosures produce sound that is both uniform and non-directional. Only the Bose system provides similar dispersion but any further comparison with the Bose without a A-B test would be totally unfair.

We have heard that at least three other manufacturers are currently developing speaker enclosures using this basic concept.

We'll save our A-B testing till these are released, but until then, let it suffice to say that the Philips Quadreflect system is easily the most interesting and exciting speaker we have seen this year. As we have indicated, at present the Quadreflect Units are available only in kit form — but these units are so effective that it is reasonably certain that the hi-fi trade will soon be arranging to supply them in fully assembled form.

A full constructional details of these exciting new speakers will be published in Electronics Today International next month.

**FULL CONSTRUCTIONAL DETAILS OF THESE EXCITING NEW LOUD-SPEAKERS WILL BE PUBLISHED IN ELECTRONICS TODAY INTERNATIONAL NEXT MONTH.**

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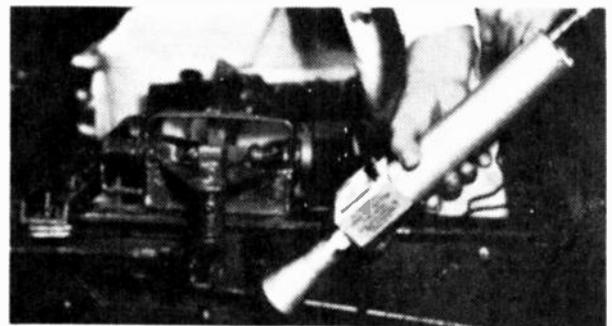
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# Philips has given stereo a lift!

**The Philips Quadreflect Loudspeaker System literally 'lifts' stereo from your living room wall...and brings the music out into your room.**

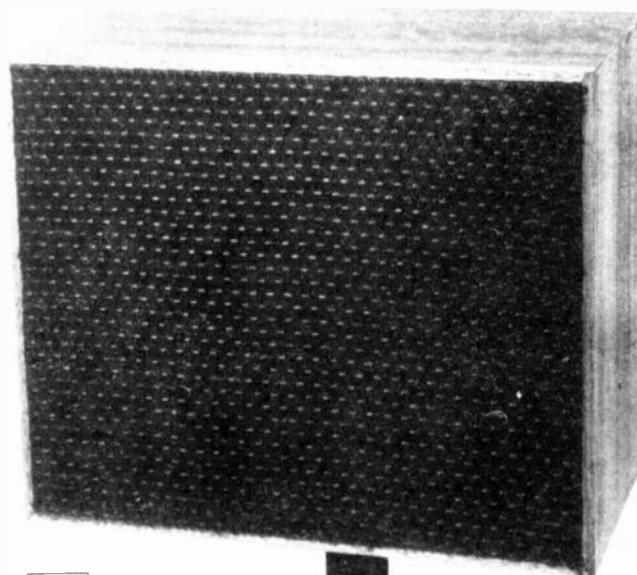
The dynamic realism of this system, which is unmatched by conventional stereo, is achieved by the use of the reflected sound principle.

These compact 1 cubic foot enclosures feature 3 rear baffles which project the sound onto the adjacent wall. The reflected sound off the wall plus the front radiated sound provides a broad area of low distortion high quality reproduction.

For the Quadreflect System Philips chose the superb ADO160/T8 Dome Tweeter and AD7065/W8 Woofer thus obtaining the maximum results in both the high *and* low frequencies.

Although this system contains 7 loudspeakers per enclosure, it can be used with amplifiers rating from as low as 10 Watts to as high as 80 Watts.

For further information on the Quadreflect Loudspeaker System, which is available in Kit form, contact your nearest Philips Hi-Fi dealer.



\*Stand optional extra

## PHILIPS

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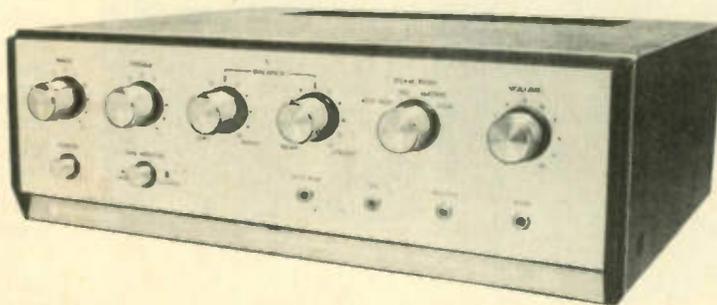
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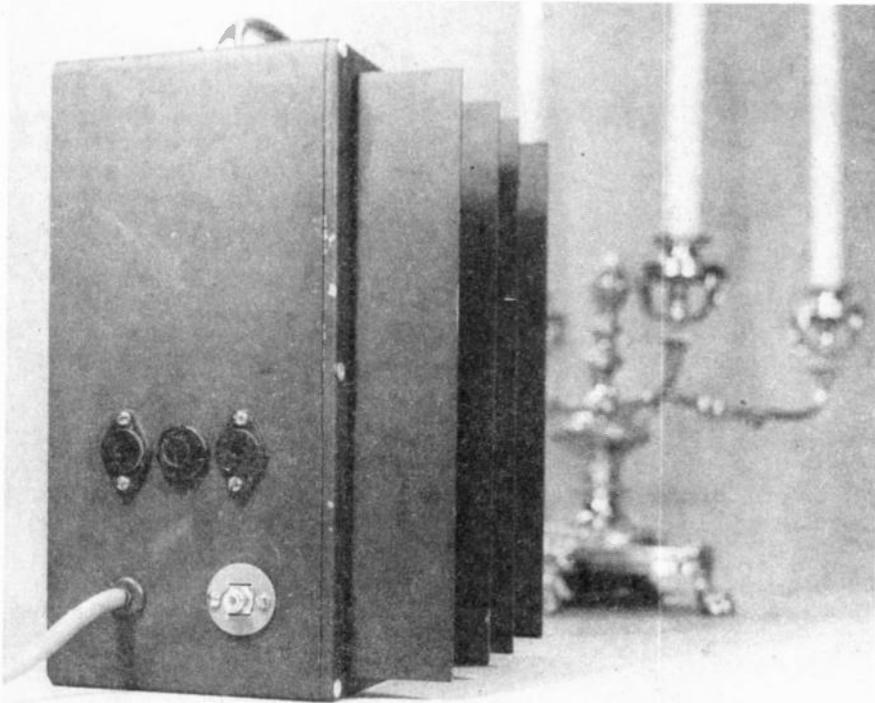
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# 100W GUITAR AMPLIFIER



In the early days of radio one of the standard acceptance tests for shipborne radio apparatus was its ability to withstand a 13 stone radio operator climbing up the equipment rack wearing heavy boots.

Electronic equipment used by pop groups and for public address systems – whilst often built to substantially lower standards – often receives similarly rugged treatment.

For this type of use, the ability to operate reliably despite having spent the previous six hours rolling around in the boot of a car will be of far more importance than a stainless steel fascia with a lot of coloured indicator lights and VU meters.

The amplifier described in this project has been specifically designed for just such applications.

It is intended primarily as a guitar amplifier and for public address systems. In the interests of ruggedness it has been put together entirely without frills. It has no tone or volume controls and must be used with a suitable preamplifier.

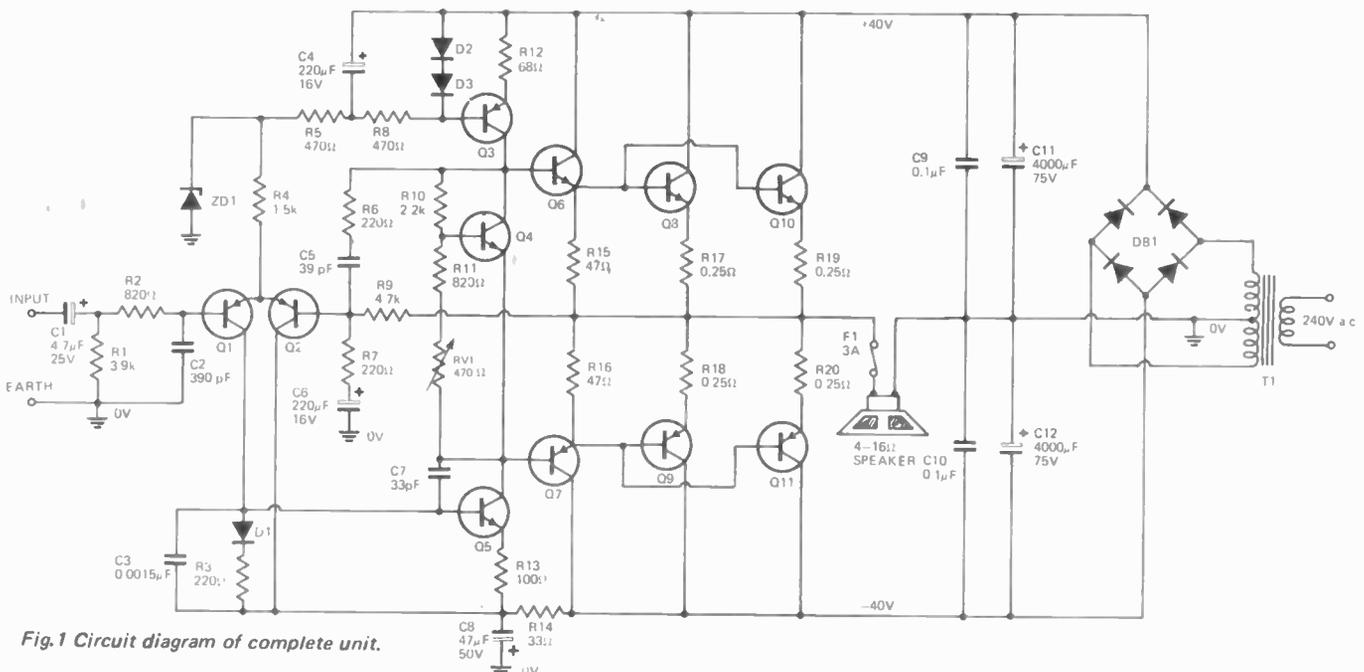


Fig.1 Circuit diagram of complete unit.

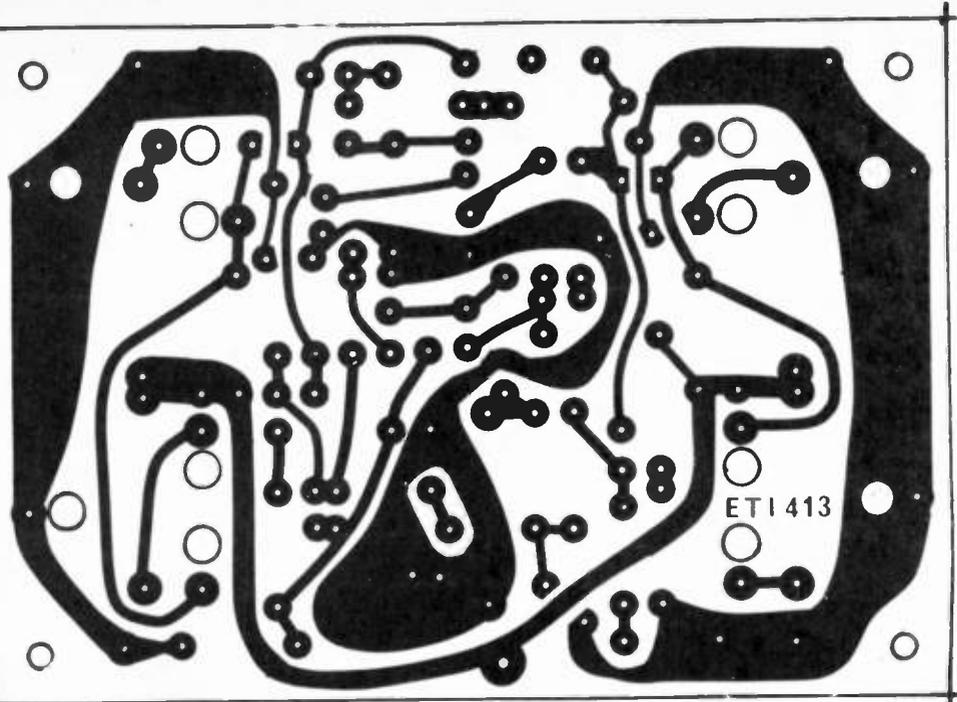


Fig. 2 Foil pattern for printed circuit board (full size).

It is not only rugged mechanically, for it will handle over a hundred watts continuously with a sine-wave input.

Despite the design criteria of ruggedness, the performance specifications put the unit well into the hi-fi area. Frequency response — as the accompanying table shows — is virtually flat from 50 Hz to 20 kHz and total harmonic distortion is less than 0.5% from 0.1W to 80W.

Any number of speakers may be driven from this amplifier providing their combined impedance is equal to or exceeds four ohms.

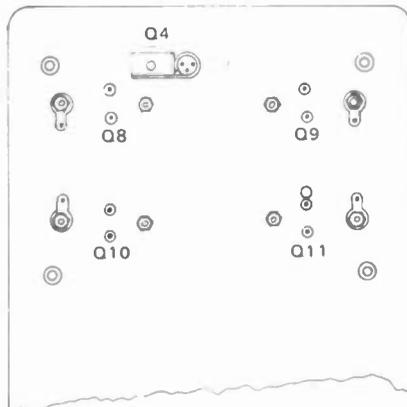
### CONSTRUCTION

Construction is quite straightforward as most components are mounted on the printed circuit board.

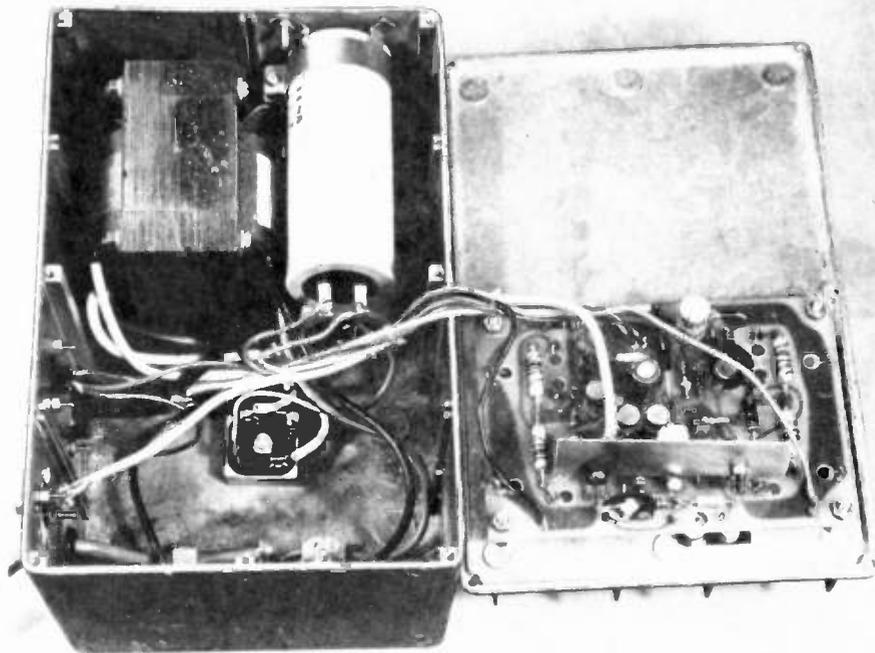
Start by soldering the components on to the printed circuit board according to the layout shown in Fig. 3. Make sure that all capacitors, diodes and transistors are put in the right way round. Metal 'fan' type heatsinks are used on Q3 and Q5. Make sure that these are well away from any other component.

A heatsink is fitted between Q6 and Q7 (Fig. 4) and is insulated by mica washers. Note that the heatsink will be slightly skewed and the transistor slightly twisted so that the heatsink can be bolted on to the 'metal side' of the transistors. Remember that insulating washers must be used.

The printed circuit board will be mounted onto the lid of the die-cast metal box and short connecting leads will be used to connect the board to the output transistors which are mounted on the outside face of this lid.



Inside view of lid showing position of Q4, Q8, Q9, Q10 and Q11 (See also Fig. 6.)



### HOW IT WORKS

The amplifier is of conventional design using a quasi-complementary symmetry, output stage and a differential input stage.

Output transistors are paralleled for greater output capacity — and transistors Q6 and Q7 connected in a Darlington configuration provide current gain.

Q3 is a current regulator supplying approximately 10 mA. This controlled current passes through Q4, thus setting the bias for the output stage, and Q5. The voltage at the collector of Q5 is set by its own base-emitter voltage. Since this transistor is working with an almost constant current in its collector it has a very high voltage gain. This gain is attenuated at high frequencies by C7.

Transistor Q5 is controlled by the differential pair Q1 and Q2. Due to the negative feedback via R7 & R9, the action of Q1 and Q2 is that of an error amplifier. Thus it tries to keep the voltage at its two inputs (the bases of Q1 and Q2) constant. Because of this action, the output voltage is held equal to the input voltage multiplied by  $(R9+R7)/R7$ . This gives the amplifier a voltage gain of approximately 22. This gain may be changed by varying the value of R7. An appropriate change must then also be made to C6 as  $R7/C6$  determine the lower -3dB point. The value of R9 should not be altered.

The output bias current — which is necessary to prevent cross-over distortion — is set by RV1.

## ETI PROJECT 413

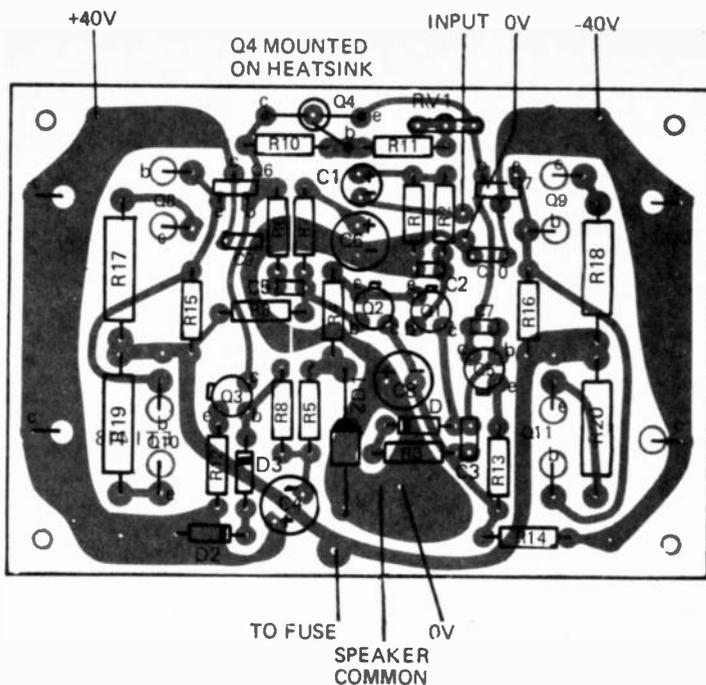


Fig. 3. How the components are mounted on the printed circuit board.

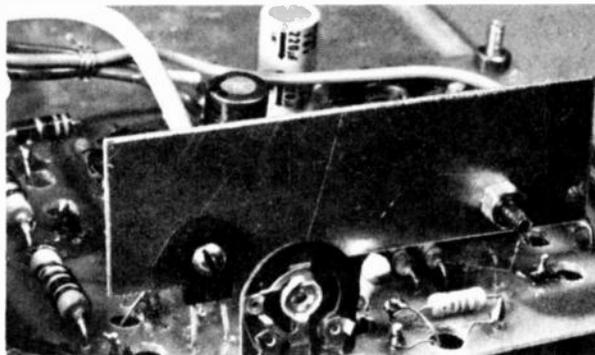


Fig. 4 A heat sink (detailed in Fig. 5) locates Q6 and Q7. In this illustration, Q7 can be seen just to left of the potentiometer.

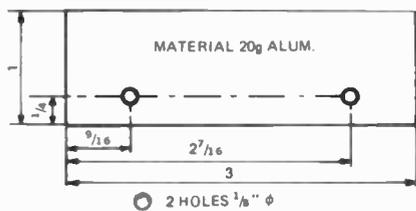
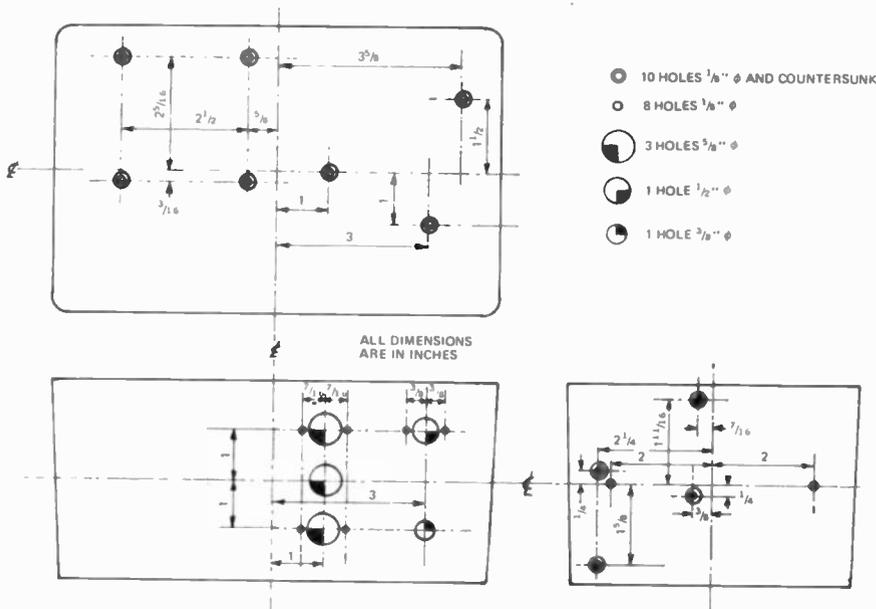


Fig. 5 Details of heat sink for Q6 and Q7.

Drilling details for STC die-cast box 8 3/4" x 5 3/4" x 4"



Countersunk screws and spacers are used to ensure that the printed circuit board stands well clear of inner face of the lid. These should be installed at this stage — but do not yet attach the board itself.

The heatsink for Q4 should be attached to the lid using a countersunk screw and insulating washers. The heatsinks for the output transistors, and the output transistors, should now be installed. Make quite sure that the correct transistors are in the right places. Insulating washers must again be used.

Connect short leads to the emitter, base and collector of the output transistors (the connection to the collectors is made via the transistor mounting screw)

Press transistor Q4 into its heatsink. Install metal connecting pins in the printed circuit board for terminating connections to the output transistors Q8, Q9, Q10, and Q11. Pins are also required for Q4. The pin positions are clearly marked on the printed circuit board overlay.

Now connect all leads from the power supply etc, to the printed circuit board and then fit the board over the leads from the output transistors and screw firmly into place.

Solder the leads from the various external connections to the appropriate pins on the board. Do not wrap the wire around the pins by more than half a turn as it will otherwise be very difficult to remove later (if necessary).

Install and connect all remaining components.

Ensure that the mains earth lead is securely attached to the case as must also be the transformer shield. The input shield should be earthed to the case at the input socket.

(Continued on page 82)

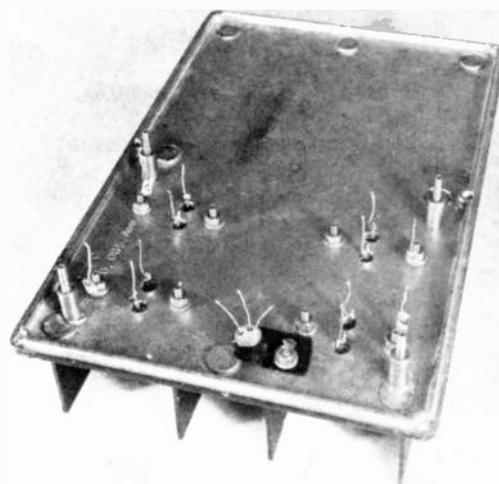
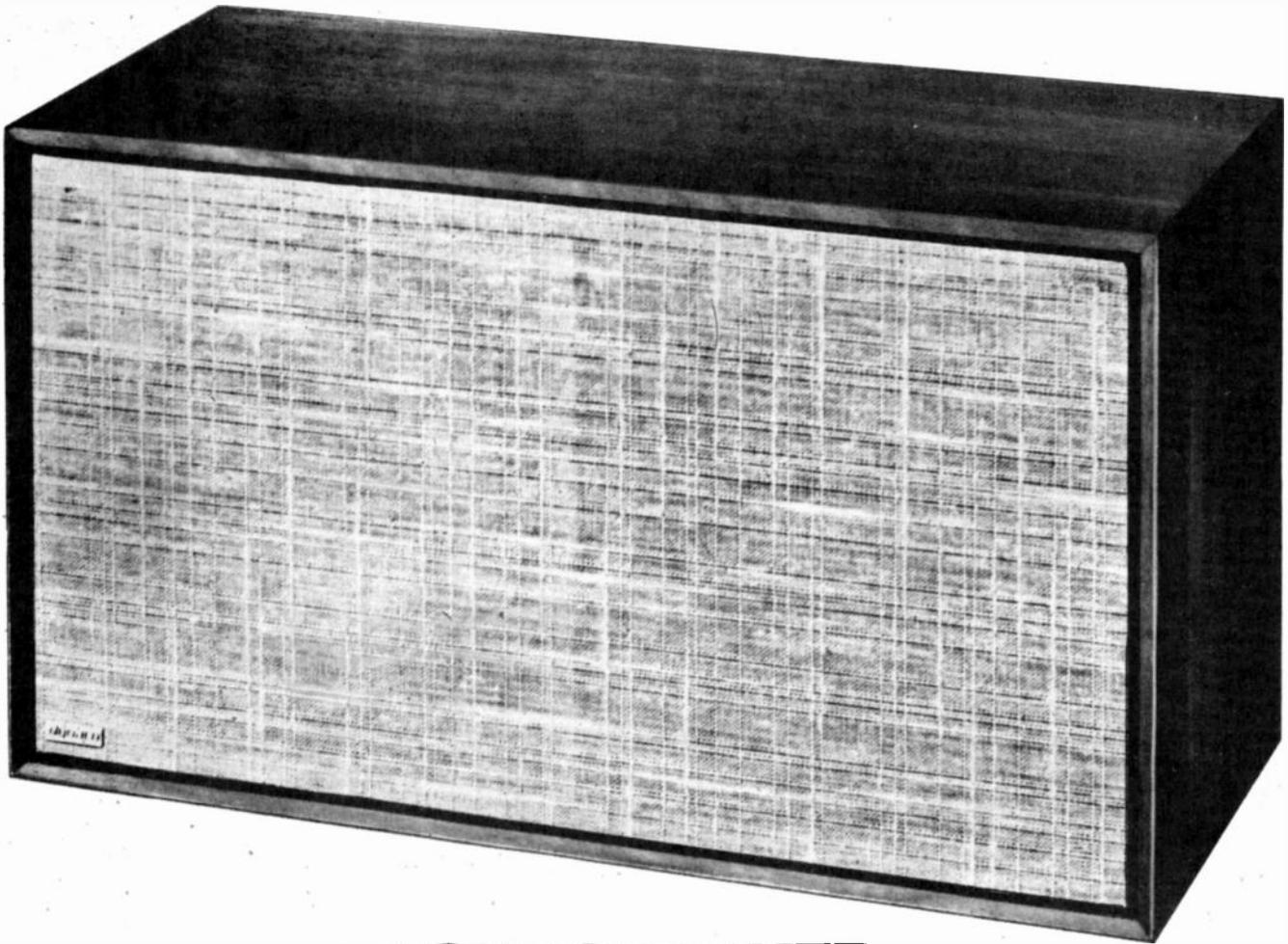


Fig. 6. Lid of the die-cast box showing heat sinks (and output transistor leads). Transistor Q4 and its associated heat sink is clearly visible.

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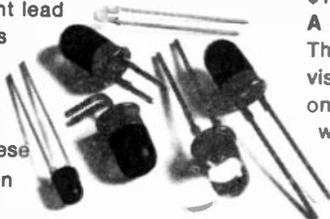
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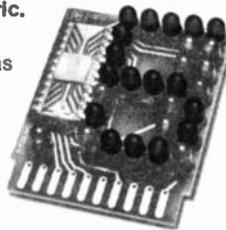
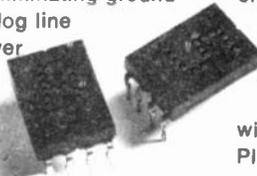
**A complete LED lamp family.** Our LED lamp family offers a complete selection of lens, lead and light output combinations. Our new T-1 Mini-LED is just 0.125" in diameter. This device offers high brightness over a wide viewing angle. And you have a choice of lenses; red diffused, clear or clear diffused. This little gem, known as the 5082-4480, costs just 50c in 100 quantities. The T-1 1/4 long lead wire wrappable 5082-4480 lamps start at 70c each in 100 quantities; the short or bent lead 5082-4440 LEDs start at 60c in 100 quantities. Higher volume prices on all these devices are even more attractive.



**A new low-cost isolator.** At 5 MHz bandwidth, it's 25 times faster than any other isolator on the market. It has a high DC isolation voltage of 2500 volts, and a high common mode rejection of 10 volts at 2 MHz, making the 5082-4350 ideal for eliminating ground loops in digital or analog line receivers, floating power supply and feedback networks. Prices start at \$2.95 each in 100 quantities.

**A low-cost LED display.** Our numeric and hexadecimal displays have simplified your designs with on-board electronics, standard package configuration, and categorized light outputs. Best of all, the 5082-7300 numeric has a new low price of \$12.00 in 100 quantities.

**A new 1.5" LED numeric.** This new LED display, visible from 60 feet, has on-board electronics, wide viewing angle, and is designed for edge mounting in a standard

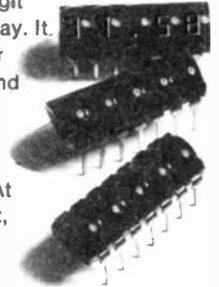


PC board socket. Solid-state reliability makes the 5082-7500 ideal where dependability is important. The price is \$26.00 each in 100 quantities.

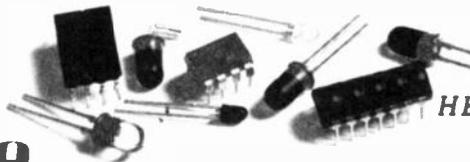
**Small character LED displays.** The 5082-7405 is a 5 digit end stackable display. It

minimizes power consumption and offers ease of implementation with a standard 14 PIN DIP package. At only 7 mW per digit, this display is ideal for calculators, portable instruments and anywhere that low power and high brightness are important. The 5082-7405 is priced at \$3.50 per digit in 100 quantities.

**Easy to get.** Call the distributor nearest you for immediate delivery. Or write us for more information. HEWLETT-PACKARD AUSTRALIA PTY. LTD., 22-26 Weir Street, GLEN IRIS, 3146, Victoria. Telephone: 20 1371 (6 lines). Other offices in Adelaide, Brisbane, Canberra, Perth and Sydney. Also Auckland and Wellington, New Zealand.



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# AUDIO NEWS

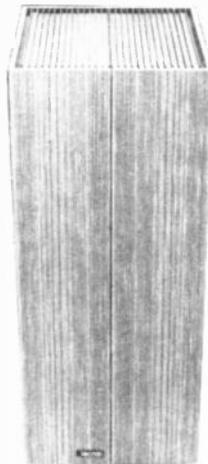
## NEW HORN LOADED SPEAKER

A new British company, Lecson Audio Ltd., are marketing horn-loaded speaker enclosures.

A split path exponential bass horn occupies the lower four fifths of the cabinet and uses two parallel-connected low resonance 13" x 8" drive units for low distortion and high power handling ability. The structure, although light, is heavily cross braced to ensure there is no colouration.

The mid range horn is a short exponential polyurethane foam moulding driven by a 5" paper cone driver. The polyurethane foam is stiff and has a high degree of internal damping. This horn operates in the range 400Hz - 5 kHz. The position of this horn is adjustable to match the stereo sound stage to the listening room.

Further details: Lecson Audio Ltd., Nuffield Road, Industrial Estate, St. Ives, Huntingdon, England.



## DOLBY COMPACT FOR MULTI-TRACK RECORDING

At the recent Audio Engineering Society Convention in New York, Dolby Laboratories introduced the M16, a compact 16-track noise reduction unit only 10½ inches high. Part of the new third generation Dolby M Series, the M16 will reduce the cost of multi-track noise reduction installations by nearly a third of most studios.

The M Series utilizes the standard Dolby A-Type professional noise reduction characteristic. In addition to the standard Dolby Cat. 22 noise reduction modules used in the new series, a new modular all-solid-state interface has been designed, eliminating relays and incorporating switching logic which minimizes operational errors. Also available is an eight-track version and an add-on unit to expand from sixteen to twenty-four tracks, all using the same M Series modular approach. The new units are small enough for mounting on or in many multi-track recorders, thus saving installation time, trouble, and space.

*Continued on page 106*

## PORTABLE CASSETTE RADIO

Released in November, the Sony CF 4-10 combines an FM/MW/SW radio with a portable cassette recorder. It has a four-way power source - ordinary batteries, rechargeable battery, car battery with car battery cord or standard household current. Claimed frequency response for the cassette section is from 50Hz to 10kHz. The radio has an FM/SW telescopic antenna and a MW built-in ferrite bar antenna.

Further details: Jacoby Kempthorne, 469-475 Kent St., Sydney, NSW.

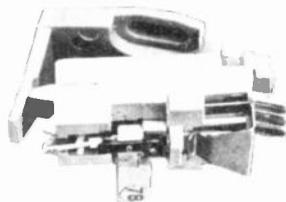


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# RADIO ASTRONOMY FOR AMATEURS

a series - by Roger Harrison VK2ZTB ex-VK3ZRY

## PART X

### Practical aspects of VHF antennae

**O**BSERVATION in the region above 30MHz allows a lot more scope for experimentation and refinement in antenna arrays. The dimensions of antennas having high-gain and consequent good directivity become much more

managable and system sensitivity is greatly improved.

#### THE CORNER REFLECTOR

For VHF use this antenna is simple to construct, provides good gain and bandwidth and is tolerant of

construction inaccuracies. Dimensions for a 140 MHz unit are given in Fig.1. Ordinary fly wire window screens, available from hardware stores, can be used here with excellent results. However, mounting the antenna on a fully steerable mount can present difficulties, and this is its major drawback. But for a drift radiometer or interferometer, it is nearly ideal.

The corner angle can be 90°, 60° or 45°, with maximum gain being obtained for a 60° corner angle. The two reflectors are best joined by several hinges placed along the apex. Gain will be around 12dB.

#### THE COLLINEAR ARRAY

This antenna was mentioned in Part 2 of this series. An illustration is given in Fig.2, with dimensions for 140MHz. The spacing of the reflectors here is 0.3 wavelengths (not 0.25 wavelengths as shown — incorrectly — in Part 2). The spacing of the reflectors can be up to 0.5 wavelengths.

All-metal construction best suits this type of array. Standard TV antenna element-to-boom brackets and components are cheap, readily obtainable and ideally suited.

The array shown in Fig.2 is larger and has a more complex element arrangement than shown in Part 2. It can be mounted such that it is fully steerable if desired. The collinear array can be made fixed for use in a drift radiometer or interferometer and can thus be constructed considerably

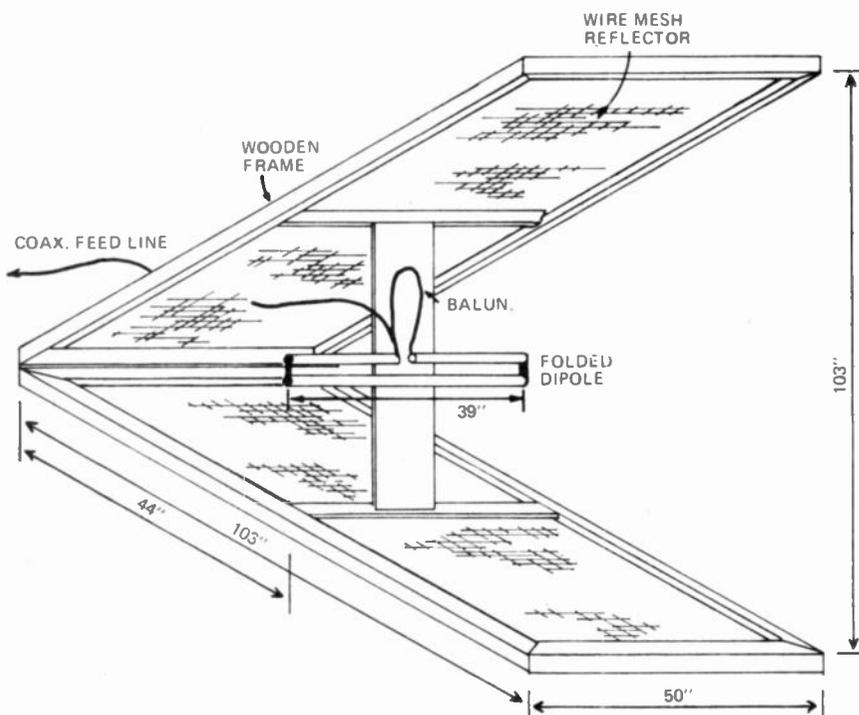
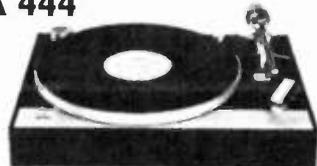


Fig.1 140 MHz corner reflector

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**ERA 444**



**MANUFACTURER'S SPECIFICATIONS**

- Double 48 pole synchronous motor • Heavy die cast 12 inch non-ferrous platter • Belt drive: the belt is made of neoprene and is ground to  $\pm 5\mu$  • Total wow and flutter 33 rpm:  $\leq 0.04\%$  Rumble: 33 rpm  $\leq 73$  dB (DIN) • "Fictitious" horizontal pivot arm • Neoprene "silentblock" suspension • Antiskating • Armlift • Length: 17 inches (41 cm). Width: 12½ inches (31 cm). Height: 5 inches (13 cm) • Speed: 33 and 45 rpm.

This turntable is of French manufacture.

**DRIVE SYSTEM.** The makers say (and they should know) that the motor of the ERA 444 turntable rotates so regularly that it does not need a heavy platter. You see, the ERA motor is synchronous. Its speed is rigorously stable because it is keyed to the frequency of the a.c. current which the Electric Authorities have permanently fixed at 50 or 60 cycles (Hertz) depending upon the country. For this reason it (the motor) does not require speed adjustment.

As in all professional turntables, the drive is through a belt made of a special neoprene and ground to its specifications within 0.002". The simplicity of this one-step drive eliminates wow and flutter.

**SUSPENSION.** The makers say that the ERA suspension uses an inner suspended frame on which the arm and the platter are rigidly mounted. In this fashion the arm and platter are radically isolated from the chassis and external vibrations. Thus rumble is non-existent.

The suspension of the inner frame is by means of springs. The springs are damped by polyurethane foam so that the resonant frequency of the suspended mass is 2 cycles (Hertz) which eliminates all vibrations above that figure, i.e., all the audible frequencies.

**THE ARM.** The makers say (and they should know)—"Put a 45 r.p.m. record off centre on the platter. In addition slide a cigarette underneath: the music is horribly distorted (yes, horribly distorted) yet the arm tracks."

By principle its (the tone arm) pivot eliminates all frictions. The pivot is in fact the inter-section of four counter-balanced spring blades. They form two X's which do not touch each other. Being fictitious (an apt word) the pivot cannot wear out. It can work a billion times.

**VERDICT.** Go by what the makers say—and they should know. And the styling is great. A pity that better instructions are not supplied—the ERA certainly deserves better and more comprehensive information than that given.

**ERA 555**



- Double 48 pole synchronous motor • Heavy die cast 12 inch non-ferrous platter • Belt drive: the belt is made of neoprene and is ground to  $\pm 5\mu$  • Total wow and flutter 33 rpm:  $\leq 0.04\%$  • Rumble: 33 rpm  $\leq 73$  dB (DIN) • "Fictitious" horizontal pivot arm • Fictitious "silentblock" suspension • Antiskating • Armlift • Length: 17 inches (41 cm). Width: 12½ inches (31 cm). Height: 5 inches (13 cm) • Speeds: 33 and 45 rpm.

**ERA 666**



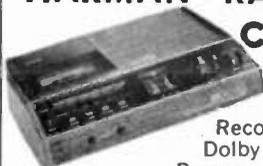
- Double 48 pole synchronous motor • Heavy die cast 12 inch non-ferrous platter • Belt drive: the belt is made of neoprene and is ground to  $\pm 5\mu$  • Total wow and flutter 33 rpm:  $\leq 0.04\%$  • Rumble: 33 rpm  $\leq 73$  dB (DIN) • Fictitious "silentblock" suspension • Antiskating • Armlift • Length: 17½ inches (42 cm). Width: 13 inches (33 cm). Height: 5 inches (13 cm) • Speed: 33 and 45 rpm.

**ERA AMPLIFIER ST 50**

- Original power: 2 x 24 watt • Power band-width: 30-30 000 Hz. • Tone control: degree of bass: + 18 dB at 70 Hz. Degree of treble: + 14 dB at 10 kHz • Coefficient of distortion: 0.5% • Signal-to-noise ratio: 50 dB • Input. Phono magn.: 4 mV at 1000 Hz. Tuner: 55 mV. Tape: 450 mV at recording, 340 mV. • Output: loudspeaker boxes contacts for DIN- and RCA-norm.



**HARMAN - KARDON CAD5**

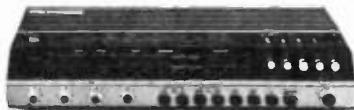


Professional Tape Cassette Recorder with Built-in Dolby Noise Reduction Processor.

**330A.** 100 watt AM/FM/Stereo FM solid state receiver.

**CITATION ELEVEN CITATION TWELVE**

**SCHAUB - LORENZ Stereo 3001 Electronic**



Power output: 2 x 10 watts (continuous sine wave), 2 x 15 watts music power.

Frequency range: 40-20,000 Hz.

**MODELS: 4000L, 5000, 6000 Stereo Hi-Fi**

Power output: 2 x 30 watts output (continuous sine wave), harmonic distortion  $\leq 0.2\%$  (1 kHz), 2 x 40 watts music power. Power bandwidth: 15-40 000 Hz.

**STEREO RECORDER 80 HI-FI**



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\*Empire's trademark for miniature laser beams that pulse and throb in rhythm with the music.

**9500 M11 RMS Power Ratings**

20-450Hz	200 watts RMS
450-5,000Hz	100 watts RMS
5,000-20,000Hz	40 watts RMS



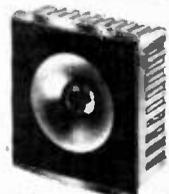
**ARMSTRONG**

**SERIES 500: Amplifier and Control Unit Sections, 521, 526, 523.**

Power output, continuous sine wave 25 watts per channel, 8 ohms  
Power bandwidth 20-25,000 Hz  $\pm 1$  dB  
Frequency response 20-20,000 Hz  $\pm 1$  dB  
Harmonic distortion Less than 0.5% at 1 kHz measured at 25 watts output  $\pm 1$  dB

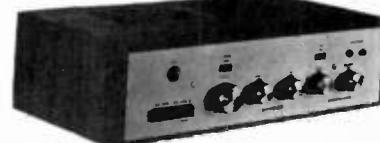
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**TECHNICAL SPECIFICATION:**

Impedance Matching: 8 ohms.  
Power Handling Capacity: 20 watts, continuous on speech and music.  
System Bass Resonance: 68 Hz.  
Frequency Range: 40 Hz-20 kHz. (Useful output down to 32 Hz. with corner mounting).

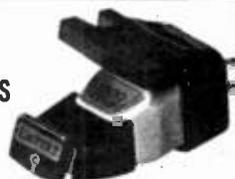
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8 OHMS: Music power 70 watts total—

Equivalent music power  $\pm 1$ dB 85 watts  
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# RADIO ASTRONOMY FOR AMATEURS

larger than shown here — with a consequent increase in gain and directivity.

The gain of the 24 element collinear as shown should be in the vicinity of 15dB.

The collinear is very tolerant of construction inaccuracies and has a bandwidth of about 1.5 to 2% of centre frequency — much broader than parasitic arrays of similar size.

A single long-collinear antenna can be constructed from a coaxial cable by interchanging inner and outer conductors at half-wavelength intervals. This type of collinear is very simple to construct and, if sufficient elements are used together with a reflector, can have enormous gain. A 26 element antenna mounted 0.3 to 0.5 wavelengths above a screen reflector can have a gain approaching 28dB! It is not usually practicable for most amateurs to construct a steerable array of the necessary size at 140MHz. A fixed array though, is quite practicable. At 140MHz it will be 60ft long and hence such an antenna can be fitted in the average suburban backyard.

Details of the construction of this type of collinear are given in Fig.3. Each element will be 27½ in. long (for 140 MHz) i.e. the distance between inner and outer conductor transpositions.

Strangely enough, low-loss coax should not be used for the antenna itself. Were this to be used, sidelobes would be reduced but beamwidth somewhat increased. Reduction of sidelobes is the important consideration here.

Coaxial cable type RG58/u (¼ in. dia) is well suited to this antenna. The cable used to feed it should be of a low-loss type such as ET13M or UR67. A balun must be used. Details will be given later in the section on baluns.

A mesh reflector, one wavelength (83 in.) wide, can be laid on the ground underneath the antenna which is 0.3 to 0.5 wavelengths above it (24 in. to 41½ in.).

The coax cable elements can be supported by a nylon or hemp line. Curtain rings, taped to the coax antenna elements would do the job nicely.

The interconnections between adjacent elements must be waterproofed. A good cloth insulating tape (such as used for cars) can be used to seal the joints — or one of the

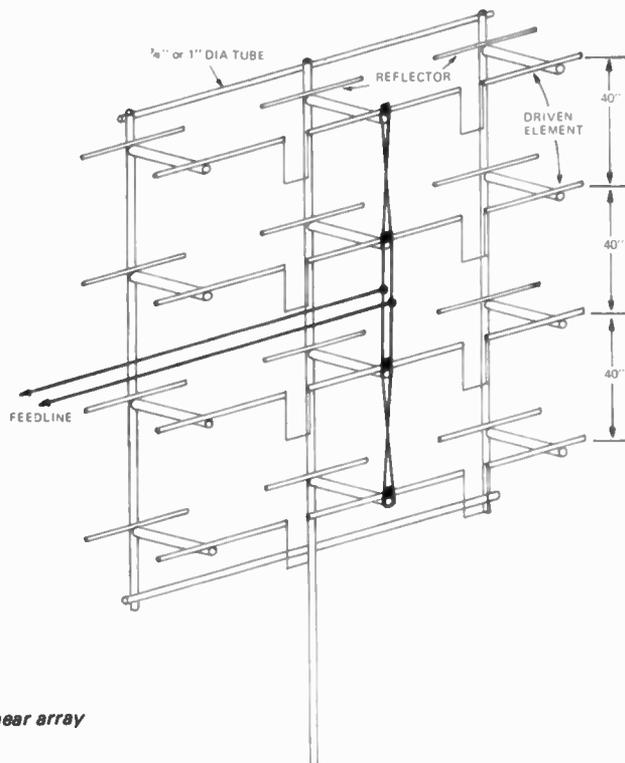


Fig.2 Collinear array

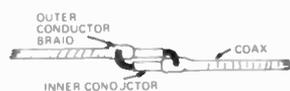
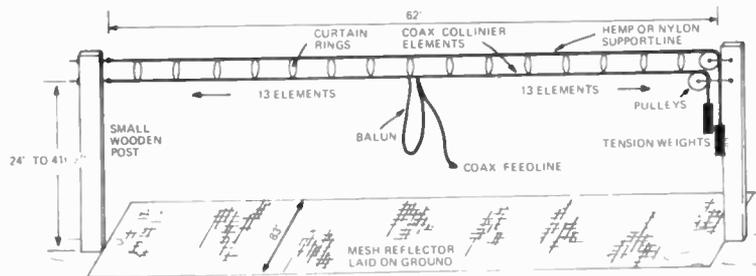
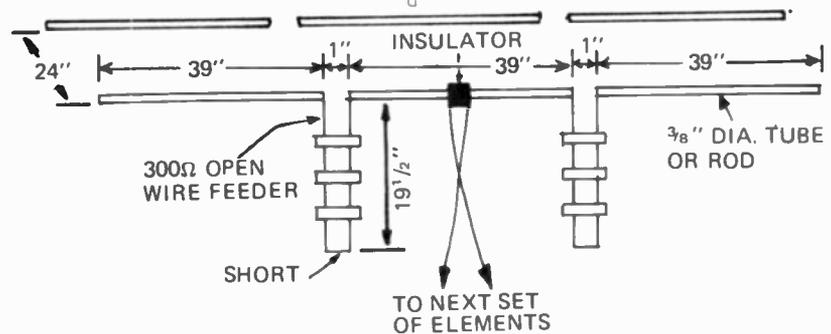


Fig.3 Co-axial collinear antenna

plastic sealant goo's found on handyman bars in hardware stores.

Bandwidth of this antenna will be between 3.5 and 4 MHz at 140 MHz.

This type of collinear array has been described (for other uses) by H.A. Wheeler in 1956 IRE Conv. Rec Volume 4, Pt 1, by Grochs in Nationa Bureau of Standards Report No. 8772 March 5, 1965, IEEE Transactions or Antennas and Propagation, August 1972, and 6UP, The Newsletter of the N.S.W. VHF and TV Group September, 1972.

## THE KOOMAN ARRAY

This is very similar to the collinear array. The element spacing is different and a screen reflector is used.

Construction is shown in Fig.4. The wire-mesh reflector can be made from copper or brass fly-wire gauze (as for window screens) or 1 in. or ½ in. chicken wire mesh. The latter will have less wind resistance if this is a problem. Gain for the 12 element array shown is in the order of 11dB to 13dB.

The two sets of dipole arrays can be

# RADIO ASTRONOMY FOR AMATEURS

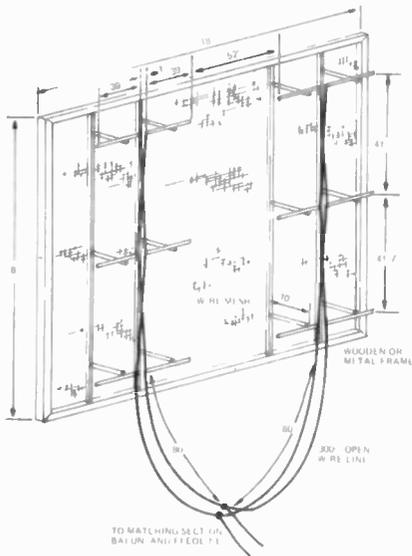


Fig. 4 Kooiman array

mounted closer together with a consequent reduction in gain and size of the array.

Bandwidth of this antenna is somewhat broader than a collinear array. It also is very tolerant of construction inaccuracies.

The Kooiman array lends itself to all-metal construction using standard TV antenna construction components. Alternatively it can have a light wooden frame with joints glued and screwed for strength. A coat of varnish or paint will ensure a longer life for the structure.

At any place where the wire-mesh screen comes in contact with metal, make sure the two are well bonded electrically and mechanically as noise is generated when two metals rub together.

The feedline is connected as shown in Fig. 4. The impedance at the feed point will probably be between 250 to 400 ohms. A closer-spaced structure will have lower impedance. If possible, the impedance at this point should be measured prior to constructing a balun and matching section. But more or, this later.

## THE SIMPLE YAGI

At VHF, a yagi is of quite small dimensions, and readily handled. Yagis up to 10 elements are easily constructed, provide the highest gain for weight/size/cost ratio when compared to many other antennas.

However, if large gain and directivity are wanted, then a large array must necessarily be used. A long yagi (i.e. one having a beam greater than say two wavelengths), is quite an unwieldy device and can have an enormous moment about its balance point. Many people prefer an array of small yagis to a long yagi.

A five element yagi has a gain (over a dipole) of about 8dB to 9dB, is easy to handle and is readily stacked in an array of arrays. A bay of four, five-element yagis should have a gain in the vicinity of 15dB which compares favourably with the collinear and corner reflector and can be made lighter in weight than either. Therein lies its advantage.

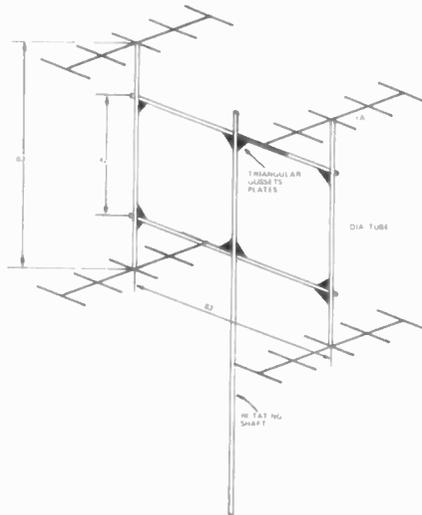


Fig. 6 Four Yagi array

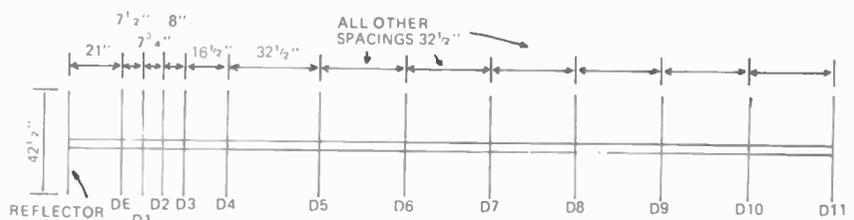


Fig. 7 Long Yagi design for 140MHz

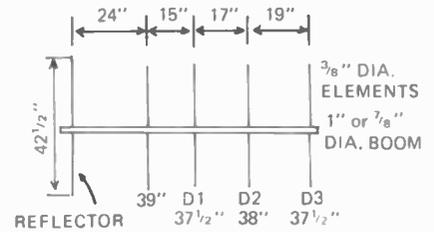
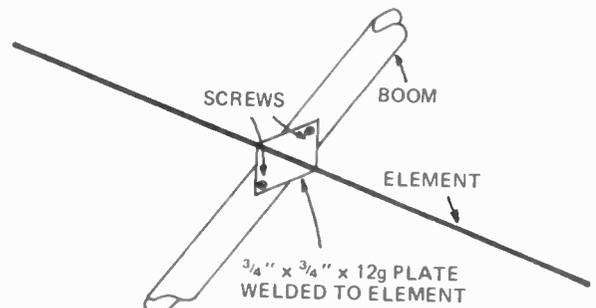


Fig. 5 Five element Yagi for 140MHz

Dimensions for a 140 MHz design are given in Fig. 5. Again, all metal construction can be used employing standard TV antenna components. Matching a feedline to the driven element can be achieved in a variety of ways. I have devoted a section to this problem later in this article.

Design information for small yagis is given in Part 2 of this series if you wish to use a frequency other than 140 MHz.

A bay of four stacked five element yagis is shown in Fig. 6. The H-frame shown is the most practical for this application. The bay of four yagis is suitable for a polar mount or fully steerable mounting system. The same arrangement can be used for longer yagis. If yagis having boom lengths larger than 10 ft. are used, the H-frame will need heavy gauge aluminium tube or larger diameter. The addition of diagonal stays to brace the structure would also be worthwhile.

## LONG YAGI

The design of a long yagi is given in Fig. 7. This is based on data published in "QST", January 1956 in an article of W6QKI and W2NLY. The performance of these designs has been proved over many years.

The elements should be 1/8 in. or 3/32 in. dia. rod mounted on top of the boom. They can be soldered or welded to a 3/4 in x 3/4 in. x 12g diamond shaped plate which can be

A comprehensive range of **Moririca photoconductive cells and devices** designed for a multitude of applications are readily available. The range includes cadmium sulphide and cadmium selenide types together with a variety of photocell lamp modules and sophisticated resistive and sensing devices as outlined below. These cells feature high sensitivity, fidelity and power dissipation coupled with fast spectral response inclined more towards infra-red than visibility. Contactless, non-mechanical construction of photocell lamp modules completely eliminates noise and mechanical wear so that a lengthy, silent operating life is ensured.

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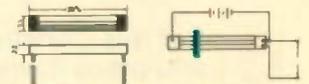
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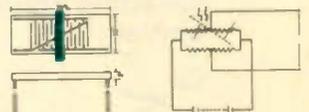
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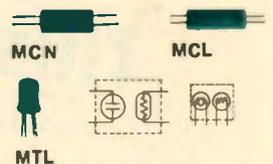
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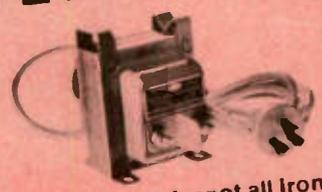
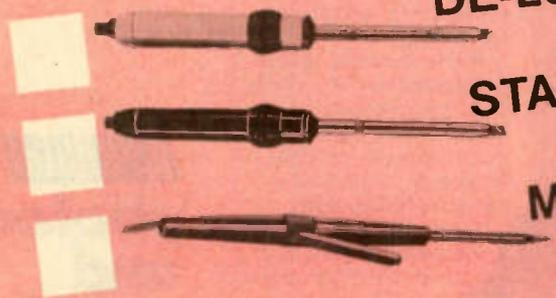


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# RADIO ASTRONOMY FOR AMATEURS

From page 90.

screwed to the boom as shown in Fig.7(b).

Gain of this antenna should be between 16dB and 17dB over a dipole. Boom length is about 25 ft.

If this antenna is for use on a steerable mount, stable well-braced construction should be used. Accurate construction is essential to realise the full performance of this antenna.

## THE LONG QUAD-YAGI

A yagi array having square elements ("quad") is referred to as a quad-yagi.

Ian Berwick, VK3ALZ, has done quite a bit of work on these antennas and has produced a design having a gain of 19dB with a boom length of 31 ft.

His design appeared first in 'The Victorian VHFer' for May 1972 and subsequently in 'GUP' for June and September, 1972.

A design for 140 MHz is shown in Table 1. Matching is best done by a gamma match as shown in Fig. 8. The

elements can be made from 1/8 in. soft drawn aluminium rod or 3/16 in. to 1/4 in. dia. brass tube. The loop must

manner to Fig.7(b) should be satisfactory.

The quad yagi is much more tolerant of construction inaccuracies than the conventional yagi. Bandwidth is greater (about 1.5 MHz for this model) than an equivalent yagi.

Further antennas and some practical construction hints will be given in the next article in this series. ●

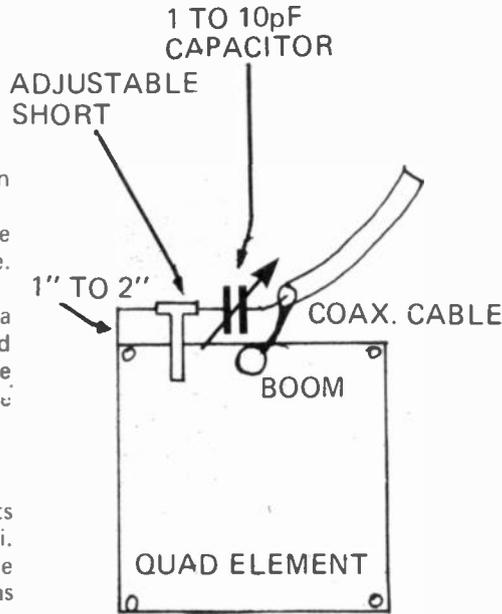


Fig. 8 Gamma match for quad-Yagi

be electrically continuous. Mounting the elements on the boom can be a problem. Attaching one side of the element to the boom in a similar

TABLE 1

ELEMENT	LENGTH	SPACING
Reflector	89"	
Driven Element	85"	21"
D1	81"	7½"
D2	81"	7¾"
D3	81"	26"
D4	81"	32"
D5	81"	
D6	81"	
D7	81"	
D8	81"	
D9	81"	
D10	81"	
D11	81"	
D12	81"	
D13	81"	

140 MHz long-quad dimensions. Lengths refer to total loop length.

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# TRANSDUCERS IN MEASUREMENT AND CONTROL

## PART 8

The eighth article of a series by Peter Sydenham, M.E. Ph.D., M.Inst. M.C., Non-contact and many lesser known methods of determining temperature are discussed.

The two previous articles in this series were concerned with scales, standards and the transfer of heat, all of which are common to every temperature sensing procedure. The introduction led to discussion of thermometers using the expansion principle and then to the direct electrical methods, namely, resistance, thermocouple, thermistor and semiconductor thermometry.

Another significant group of devices operate without need for mechanical contact with the medium to be measured — they make use of the radiated energy of substances.

### THE RADIATION PHENOMENA

All physical objects radiate energy, the quantity depending upon their temperature and emissivity (the degree to which surfaces come close to ideal radiators). The presence of radiation must have been realised since antiquity, but only as visual experiences or feelings of warmth which were accepted without satisfactory explanation. Once it had been shown, in the late 18th century, that heat was in fact, energy, it was only a matter of time before quantitative explanation was evolved.

The relationship between the radiation from a surface and its temperature was first proposed by Stefan in 1879. His work, coupled with that of Boltzmann in 1884 led to the Stefan-Boltzmann law that states that the energy radiated from a unit area of surface in a given time is proportional to the fourth power of its absolute temperature. The law only applies for sources that are known as black body or full radiators. Such sources absorb all energy falling upon them and thus appear black to the eye. The law, however, only provides part of the picture for no information is available to explain where the broadband blackbody source-radiation peaks. A family of several curves, (Fig.1), shows the relationship between energy, temperature and wavelength for an ideal black body radiator.

It was a scientist called Wien who, in

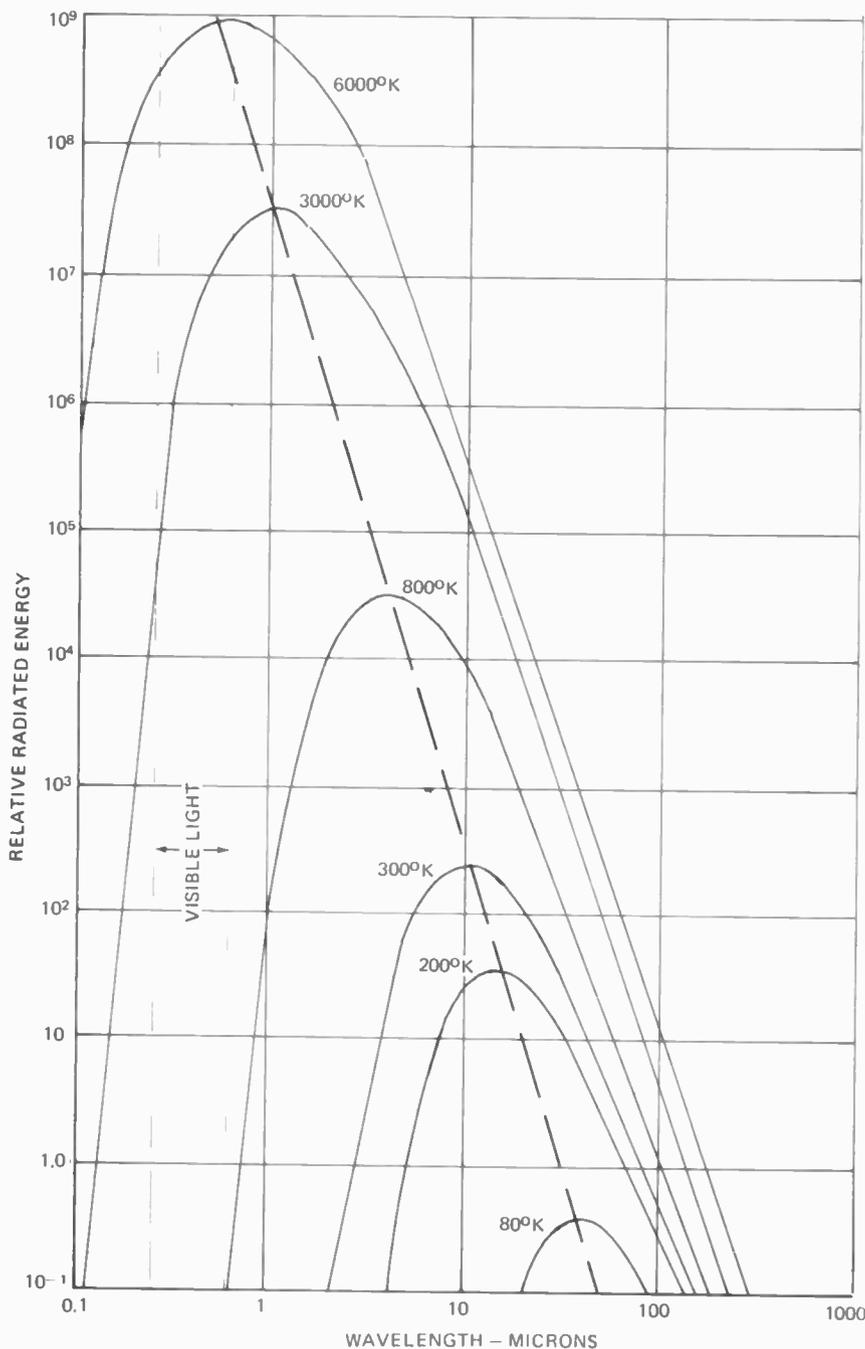


Fig. 1. Distribution of black body radiation as temperature varies. The total energy radiated at a particular temperature is represented as the area under the curve for each.

1896, provided science with the law that describes how the peak shifts wavelength with temperature and how the energy is distributed across the spectrum at each value of temperature. A little later, in 1900, Max Planck suggested a modified expression that gave closer agreement with observed values over a wider range of wavelengths and temperature. However, for most purposes, Wein's law is adequate. As black body radiation enters into numerous scientific and industrial endeavours, tables have been computed for the many possible combinations and special slide rules made for calculating the total power, peak emission and distribution. For much of the need, however, simple graphs like Figure 1, suffice to estimate the energy within a given bandwidth. The actual energy received at the detector is found by subtracting the losses of the optical system (airpath attenuation, reflection and absorption losses in elements and detector efficiency) from the total known to be received at the entrance aperture of the instrument. If working over a long atmospheric path, the original radiation will no doubt be filtered by the transmission windows of the path. Finally, the detector output will be the transduced energy received through the instrument but modified by the spectral response of the detector. In other words, a detector should optimally be matched to have a significantly overlapping spectral response.

If an enclosure is uniformly heated, radiation issuing from a small hole will be very close to that from a perfect black-body. The actual substance from which the enclosure is made and the shape of the cavity matter little. An early source, used by Summer and Pringsheim in 1897 was a hollow sphere of copper, blackened on the inside. This was heated in a molten salt bath. It served for the study of radiation from 200 to 600°C. For higher temperatures they used a blackened iron cylinder heated by gas combustion. A modern source, used to establish the gold point of the IPTS scale (1063°C) has molten gold inside a cavity. Several manufacturers supply temperature-controlled cavities for standardising detectors in infrared work.

In practice some sources to be measured are close enough to the ideal black body for the laws to be used without modification. Looking into an industrial furnace is a good example, a hole bored to a depth of at least five times its diameter into the surface of an incandescent body is another near-perfect arrangement, for all energy entering such a cavity is internally reflected and absorbed at

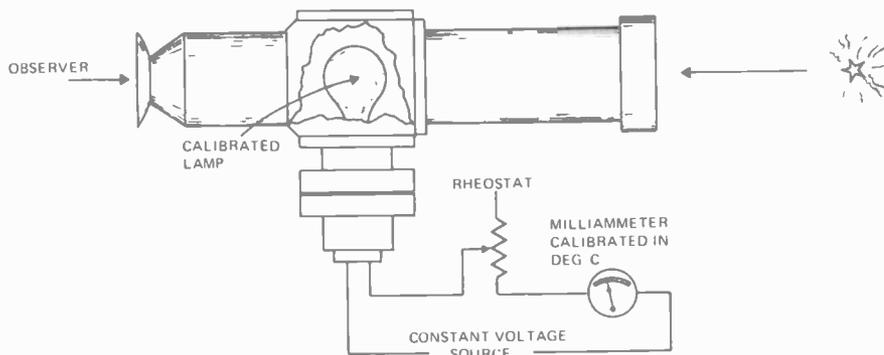


Fig. 2. The basic disappearing-filament optical pyrometer — the rheostat is adjusted until the light filament just disappears. Temperature is read from the dial.

each reflection so that virtually none escapes.

There are, however, many instances (surfaces for example), where the appearance is not black and the emissivity is not unity but something less. A gray body is one similar in performance to a black body but where the emissivity is less than unity. Tables of emissivity of surfaces are available. By way of example, carbon can absorb as much as 94% of incident energy whereas unoxidised silver only 7%. This might lead one to think visual experience is a good measure of emissivity but that is not true for the eye has response over a narrow band of the black body radiation spectrum only. In fact, at infrared wavelengths the reverse situation applies. An object can never be brighter than the black body of the same temperature. Not all are black or even gray — some have an emissivity that follows no obvious law, perhaps peaking at various wavelengths, with zero at others. These are known as non-gray bodies. Gases do not radiate as black body radiation but rather at specific wavelengths. The temperature measurement of gases requires a different approach.

### RADIATION PYROMETRY

There are two basic groups of devices by which temperature can be measured using radiation. These either determine the total radiation emitted or just the radiation in a narrow band of wavelengths. It is necessary in both cases to know something of their emissive behaviour, for all surfaces fall short of being perfect black body radiators. Temperatures calculated from the observed valued will always be low to some extent; corrections will be necessary if precision is needed.

### THE DISAPPEARING FILAMENT PYROMETER

Instruments used to determine the temperature of a source from its apparent brightness were formally called pyrometers as they were

developed mainly for furnace work. A more recently introduced term is radiometer but this term is also used for instruments used for measuring other forms of radiation than visible and infra-red.

Early pyrometers made use of the human eye as the detector of radiation. This biological photocell system is capable of only low grade accuracy when determining absolute radiation level but has quite high acuity when comparing two sources in the same field of view. In the disappearing pyrometer, (Fig.2), the eye sees the source (often through a calibrated filter to reduce the brightness to an acceptable level) and a heated filament in a common focal position. The filament current is adjusted until it just disappears into the background. In simple instruments, the current rheostat is calibrated directly in degrees, but in more precise cases the current is carefully determined with a standard resistor and a voltage measuring potentiometer. The value is then referred back to standardization curves obtained when the instrument was calibrated against sub-standard black body sources. Special tungsten amps, usually with a strip filament, have been evolved for this purpose in order to retain their luminous efficiency over as long a period of calibration as possible. Such pyrometers can be intercompared by simultaneously viewing a common source — which need not be a black body.

Many processes need continuous operation and for these the balancing-out procedure has been automated. The cost of the instrument is naturally higher than for a manual device but often the total system application demands greater precision, faster response, improved reliability or continuous operation for measurement records and control, and all of these require the manual element to be eliminated. One technique alternately scans from a standard source to the surface of interest using a rotating or

## TRANSDUCERS IN MEASUREMENT AND CONTROL

nodding mirror. A photo-cell determines if the brightnesses are equal and if not, the error signal is used to alter the source heater power accordingly. In recent years, a number of these instruments have been reported in the technical literature. A schematic of an early I.C.I. unit Figure 3 (used for monitoring fast moving synthetic fibre threads as they are made) illustrates the concept. A small heated aluminium plate provides a reference background temperature that, in this case, can be varied from 45° to 280°C. The nylon line moves between this source and the detector. After collimation by a calcium-fluoride lens assembly (special materials are need for optimal operation at the infra wavelengths generated — there is little to be seen by eye at these temperatures) the image falls onto a infra-red photo-conductive cell. At the rear of the detector head is an eccentric cam that causes the unit to oscillate from the background to the background plus nylon-thread. The signals obtained are low level and noisy so synchronous detection is incorporated. The chopper wheel produces a higher fixed frequency signal from the cell. This is synchronously rectified in a unit called a phase-sensitive detector which produces the error signal which

is used to control the heat of the source until balance is achieved. The temperature is measured as the power level to the background source.

One difficulty in pyrometry is that the emissivity may be an uncertain quantity and results subsequently imprecise. An approach to overcoming this, uses two measurements made at two different wavelengths within the broadband radiation. The principle, (hopefully invoked), is that the energy radiated at one wavelength increases with temperature at a rate different to that at another. Opinion differs on the effectiveness of this method. Benedict (in his book 'Fundamentals of Temperature, Pressure and Flow Measurements — see bibliography in last month's article) suggests it is rarely helpful, but research workers of the Central Electricity Generating Board in Britain have made use of it in a system for monitoring the surface temperature of a captive pulverized coal particle (of 0.25mm diameter). Their application was to observe the events leading up to combustion as the coal is heated using the heat from focussed lamps. This difference in outlook illustrates how instrumental methods can be condemned by a personal experience which may not have been adequate. The design of instruments is so incredibly fraught with unknowns and compromises that reasons for the lack of success can often only be found by extensive and perhaps prohibitive extra research.

Until quite recently, pyrometry was useful only for measuring high temperatures for, as can be seen in Figure 1, the total power radiated falls off as the fourth power as the temperature decreases. Traditionally, the pyrometer served as a means to measure visibly hot objects. A white-hot tungsten lamp peaks at 3000°K but, by reference to Figure 1 again, it can be seen that very little of the energy is actually radiated at visible wavelengths. Visual experience of radiation virtually disappears at around 800°K but there is still energy in the infra-red regions and this can be sensed as warmth. At absolute zero, no radiation occurs but as virtually nothing can be maintained at zero temperature, all objects emit radiation. The lower the temperature the longer the wavelength and the smaller the power level.

### INFRA-RED RADIOMETERS

The infra-red portion of black body radiation has been the subject of scientific interest since it was discovered but little practical use was made of it until the 1940's when military scientists developed heat-seeking devices during the Second World War. Since then IR technology has improved enormously, especially in the area of detectors.

Visibly responsive photo-detectors such as the common silicon photocell

(Turn to page 99)

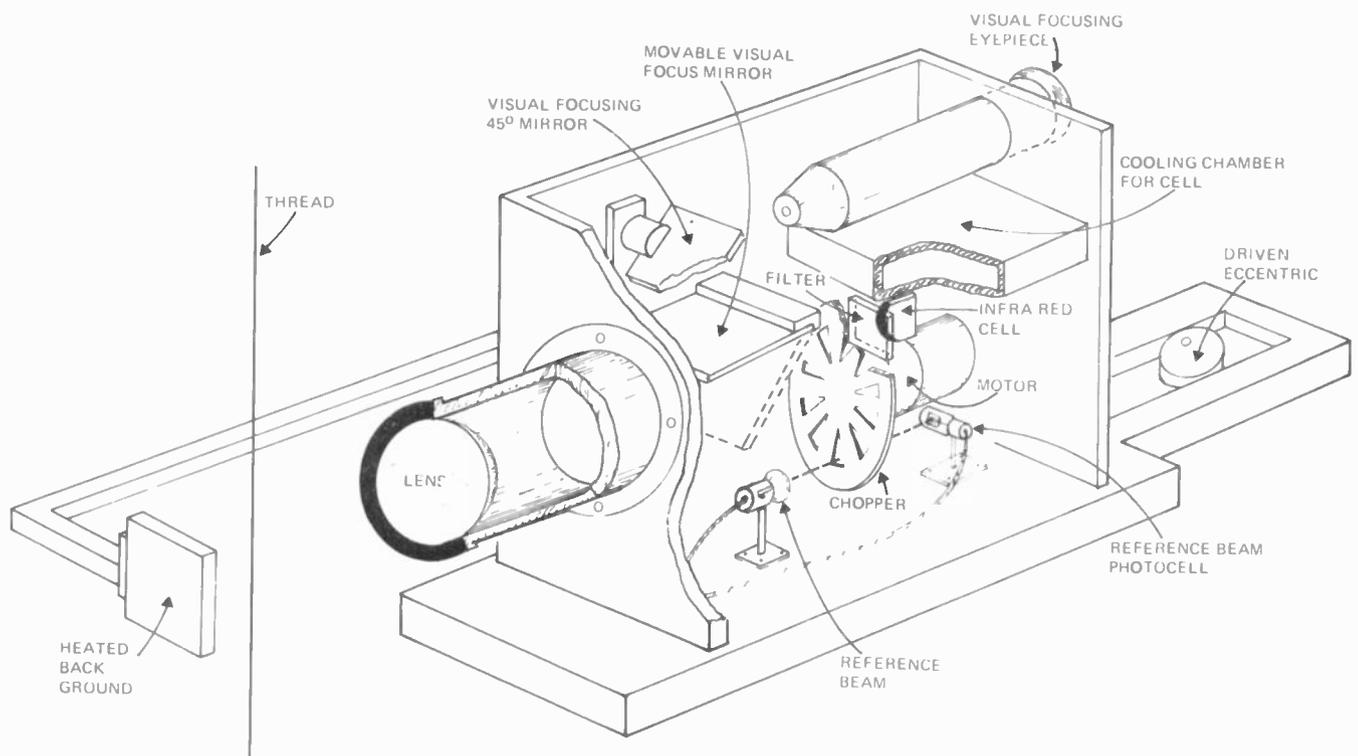


Fig. 3. Schematic of the I.C.I. nylon thread non-contact thermometer.

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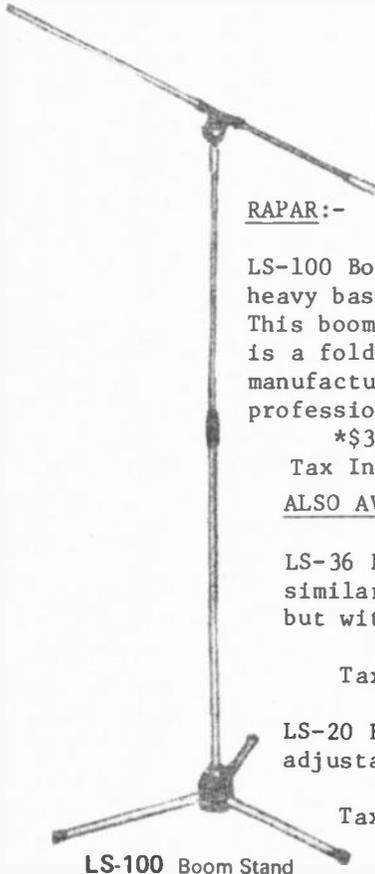


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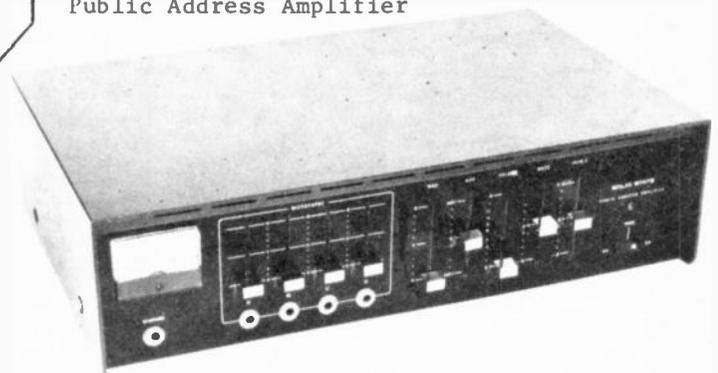
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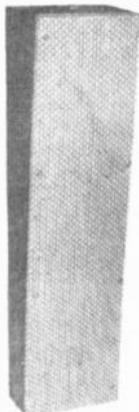
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# TRANSDUCERS IN MEASUREMENT AND CONTROL

have some response in the near-infrared region but little as the wavelength increases. Early IR cells used the impinging heat to alter the resistance of a fine wire or, later, deposited films — these are known as bolometers. They are characterized by broadband response but lower sensitivity.

A chart of detectors is given in Figure 4; and as can be seen, apart from bolometers, no device covers the spectrum. Because of this detectors must be chosen to suit the wavelength of interest.

Detectors with peak response at  $35\mu\text{m}$  wavelength are available, so it can be seen that temperatures down to a few degrees absolute can be detected provided the noise level is controlled. Much of the noise seen by a detector is generated as emission from its own components and adjacent mounts. Furthermore, at room temperature the electrical resistance noise of the element can swamp the signal. For sensitive IR radiation detection, the detector is usually cooled by operating it on the bottom of a specially designed dewar flask filled with liquid nitrogen or helium or, for continuous operation, on the end of a miniature cryostat. One important parameter of the design of IR radiometers is the cost of the detector — for they can be as high as \$5000.

The sensitivity of IR detectors is now universally quoted as the specific detectivity ( $D^*$ ). This is a normalized value of sensitivity that makes allowances for different active element areas, electrical bandwidth of operation and the measured noise equivalent power (NEP is the rms infra-red signal incident upon the detector that produces a unity signal-to-noise ratio). All detectors can be intercompared on this common basis. Without becoming involved with actual  $D^*$  figures, it suffices to say one reported modern IR system can sense the detail of a television tower through 70 km of thick fog.

Fig. 5. Basic block diagram of a radiometer used in the infrared regions.

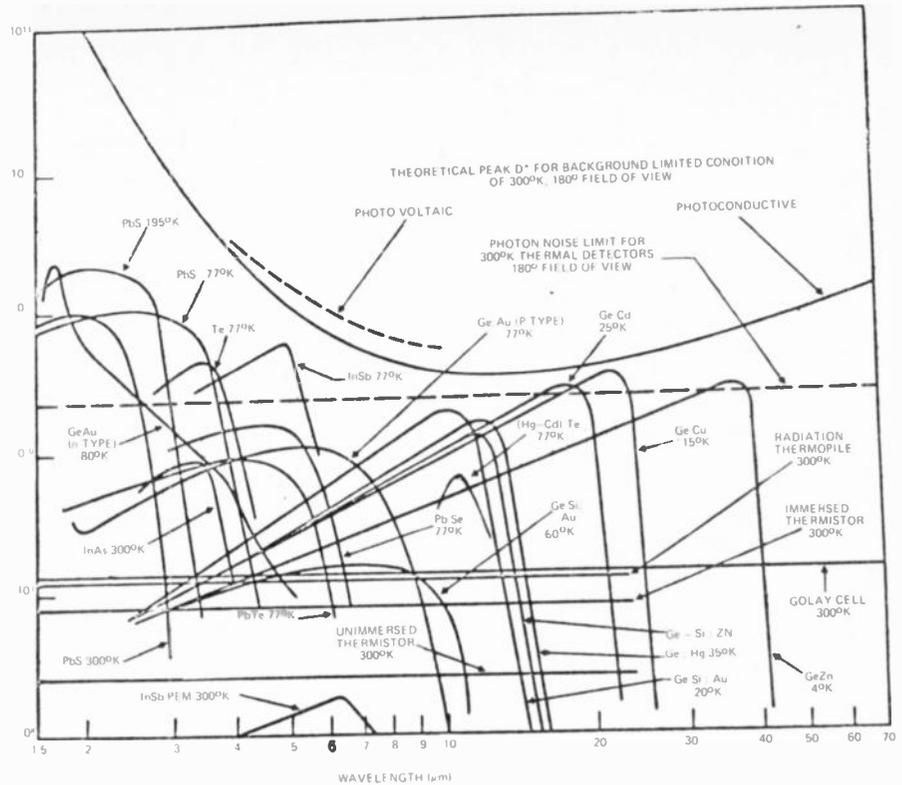
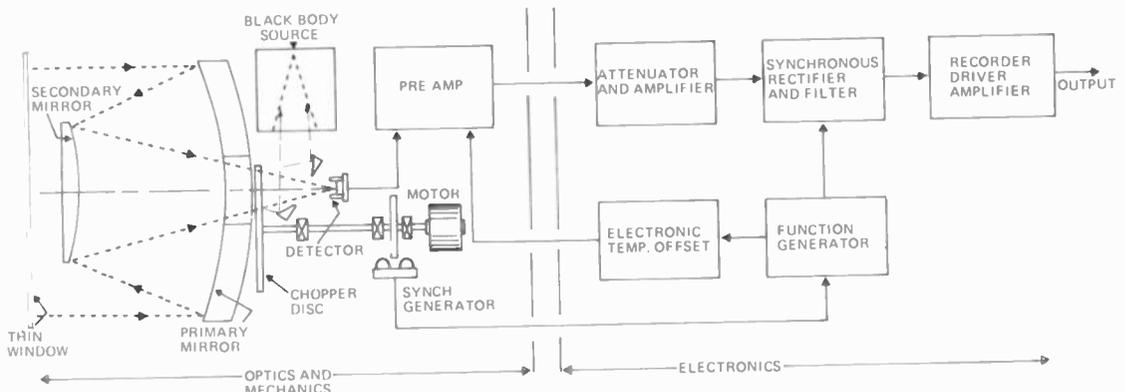


Fig. 4. Relative response of photodetectors operating over the visible to far infrared spectrum.

The basic IR radiometer is very similar in principle to the thread temperature measuring pyrometer already described, the main difference being that the temperature reference is not placed behind the object, for that is usually not possible. Instead, a small black body source is built-in so that it and the scene are viewed alternately.

The relatively low power levels involved with low temperatures means that the IR radiometer must have a high gain telescope to gather as much energy as is practicable. In the unit shown in Fig. 5, a folded reflector telescope is used. Refracting elements are to be avoided in IR work (unless small) for the cost of the exotic materials needed rises rapidly with size. Reflectors, on the other hand, require only low-cost reflective coatings. The entrance aperture to the telescope, however, needs a transmitting cover but some simple expedients, such as using thin plastic

sheet helps — in this case the focussing properties are of no importance.

A chopper system (perhaps a rotating wheel or vibrating slit) is incorporated to enable synchronous detection to be used. This can allow signals as small as 100dB below the noise level to be recovered. In the system illustrated, the chopper also serves to switch the detector to the scene and reference source alternately. Many rocket probes have carried radiometer devices like this into space to determine the emission and transmission losses of the sky and atmosphere. Narrow bandpass optical filters (only nanometre bandwidths at times) are usually employed to select the wavelengths of interest along with multiple detectors with different peak responses.

## THERMAL IMAGING

Initial interest in IR was for the detection of the hot exhaust plumes and engine covers of aircraft, the

## TRANSDUCERS IN MEASUREMENT AND CONTROL

virtue of heat sensing being that the enemy cannot detect when they have been detected — as is the case with radar. The prime purpose was simply to detect the presence of the source but the trend moved to establishing thermal pictures of objects so that they might be identified, especially at night or in fog.

Thermal pictures are produced by scanning the detector across the scene in a systematic manner, as is done in television. It is necessary to scan the detector, for matrices of detectors are not yet available with sufficient detectivity and spatial resolution. Infra-red television camera tubes exist and they are used occasionally. One use is to plot a thermal map of a tool-bit whilst it is cutting in a lathe operation. Currently attempts are made to develop adequate arrays of detectors but in general, thermal imaging instruments still use mechanical scanning arrangements to sweep a single detector across a scene.

The scanning arrangement generally consists of a motor which drives a scanning optical element. This may be a rotating square, prism or flat with mirrored surfaces or it might be an oscillating mirror. This method — in effect — scans the detector across the scene, (Fig.6), for it is desirable to have the detector stationary especially when cooled. Synchronized to the drive, by electrical or mechanical means, is a moving light source which exposes a film or appears as a moving spot on a CRO screen. The brightness of the spot is controlled by the output of the detector which is decided in turn by the temperature of the element of scene being viewed. A line is thus reproduced on the film or screen which has temperature transformed into visible luminance level. In airborne units the second axis of the picture is provided by the flight movement — as the aircraft flies it produces a continuous strip thermal map of surface features below. In Figure 7 are scenes produced in this way. The power lines are quite clear: even their thermal shadows are to be seen.

Stationary thermal imaging devices have a second scanner, usually a large nodding mirror, that provides the frame fillup. As the frame rate is considerably slower than the line rate, the mirrors can be large. Their frequency of oscillation is low.

Military thermal scanners were the first to be developed and they are at least as sensitive as being able to detect the heat wakes where a ship passed many hours before, or where planes or vehicles stood on the ground. As the

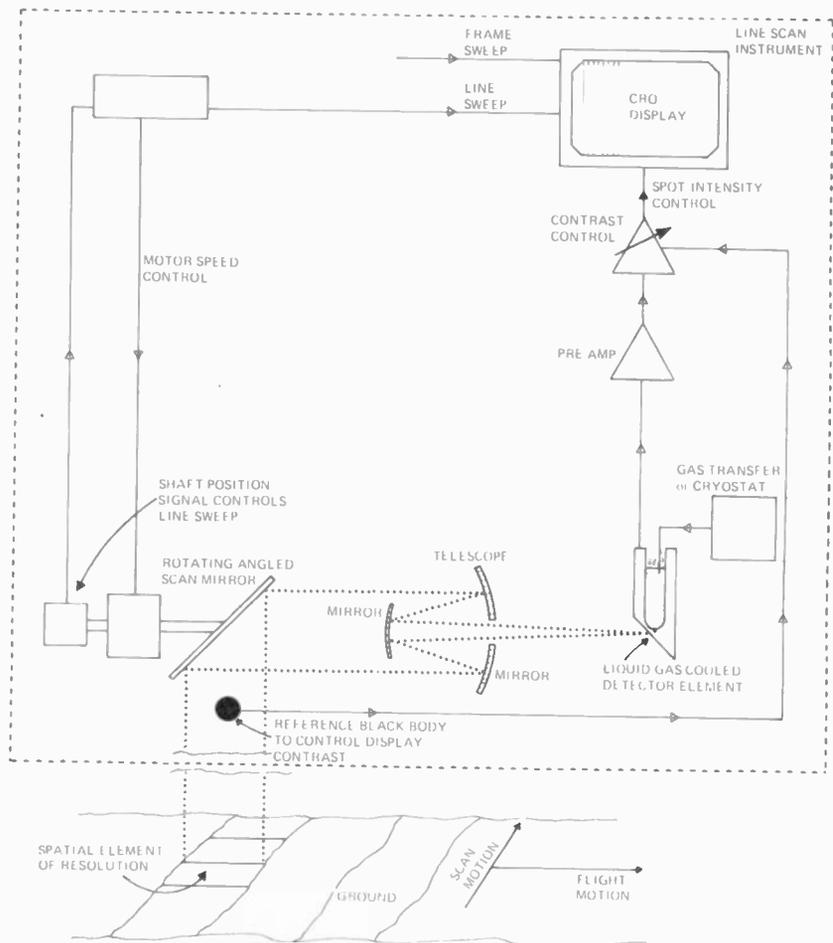


Fig. 6. Schematic of airborne thermal scanning apparatus used in remote sensing for civil and military purposes.

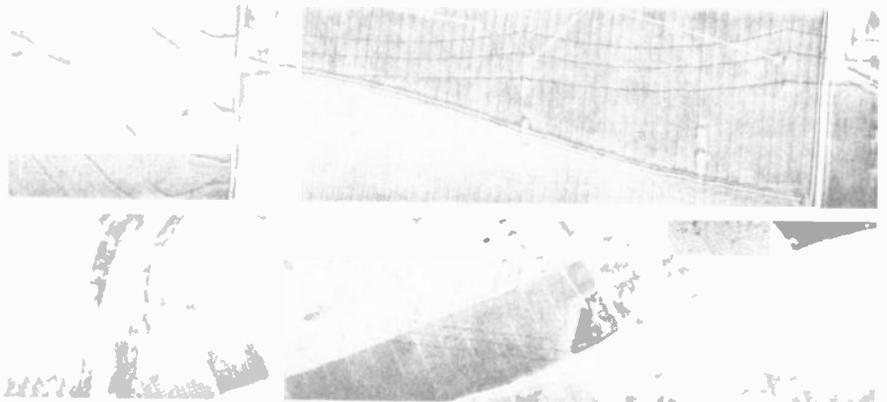


Fig. 7. Thermal maps of countryside in California made with a Daedalus thermal scanner. Note especially the wind shadows and what could be thermal shadows of the power lines.

details were released from official secrecy, civil interests blossomed. Now under the name of remote sensing, (which also includes other radiation methods as well as IR and visible) countries are observing, to name just a few uses, the cloud formation from satellites, the mineral potential of previously poorly prospected areas, the movement of ground water, effluent discharges at sea, and thermal currents around power station cooler discharge channels. Recent publicity has been given to the Earth Resources Technology Satellite (ERTS). This was launched by NASA this year, and

participating countries will receive data on the thermal emission of the land as seen as the satellite sweeps across, from 900 km up. The satellite's salient features are shown in Fig. 8. Differences over short and long periods will assist geological exploration, agricultural problems such as pest infestation and the control of pollution.

### ACOUSTIC THERMOMETRY

There are some applications where the more generally accepted methods described so far are not appropriate  
(Turn to page 102)

# THE INNOVATORS

Most of JVC NIVICO Stereo and discrete 4 channel components incorporate exclusive inventions.

For example the CD4 - 4 channel discrete record system which guarantees the only complete separation of sound.

This revolutionary achievement and many others has set JVC NIVICO apart from the ordinary.

JVC NIVICO line of Hi Fi components, the world's most advanced, include amplifiers, reel to reel/cartridge/cassette decks, turntables, speaker systems and pre-recorded 4 channel material.



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# TRANSDUCERS IN MEASUREMENT AND CONTROL

for one reason or another. Acoustic thermometers may fill the need, especially at the extremes of the temperature scale, for example, in gas plasmas (15,000°C) or in cryogenic systems near absolute zero.

The speed of sound propagation usually travels slower as the temperature of solids and liquids rises — and conversely in gases. The velocities of sound propagation in various media are given in Fig. 9. The method then, is to determine the speed of sound and compute the temperature of the medium from this, knowing the velocity at a known temperature.

Two ways of doing this have been developed. The first way is where the sound wave is launched in the medium itself; the alternative is where the waves travel in a secondary material which is in thermal equilibrium with the medium. In either case there are two choices. A pulse can be transmitted, and the flight time measured; alternatively, the resonant frequency may be determined. Again, both methods require a sending transmitter and receiver although one may double for each if reflections occur. One pulse technique, known as the sing-around method, emits a send-pulse as one is received. The system then resonates giving a frequency-variable output with temperature change. Piezo-electric crystals are sometimes employed to couple to the cavity of interest. Magnetostriction is also used. Quartz crystals have already been mentioned in their role as temperature sensors in the previous article in this series — their operation is also acoustic. Thin wires have been used to sense temperatures in nuclear reactors (gas-filled cavities, discussed below, could be grouped as acoustic).

Other methods using sound that could be useful are to monitor the echo returned between dissimilar metals, for the reflection alters with temperature; to look for wave bending due to thermal gradients, and to sense when a solid surface becomes liquid and starts to reflect.

## MISCELLANEOUS TEMPERATURE DETECTORS

### Fluidic Sensors

A cavity filled with a gas oscillates at a frequency dependant upon the gas temperature. The upper limit of operation is currently decided by the sensor material. Hypersonic X15 aircraft used fluidic sensors to measure temperatures from 0° to 2500°C. Gas flows in, past the cavity, shown in

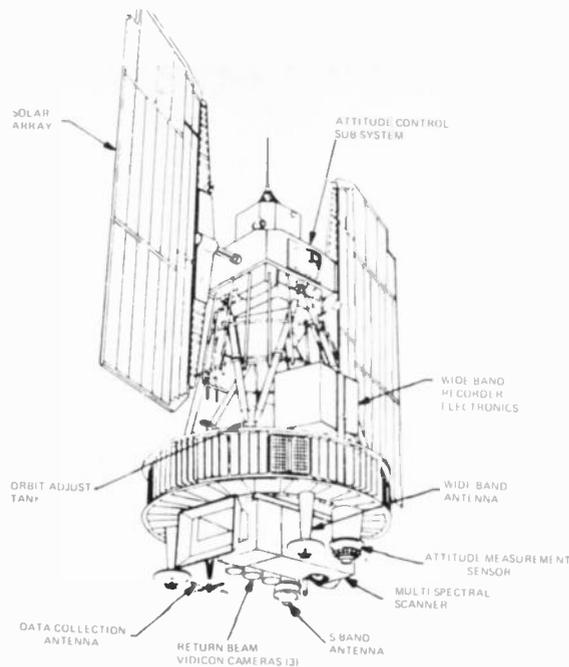


Fig. 8. The ERTS satellite currently orbiting the Earth to provide thermal emission data over long periods.

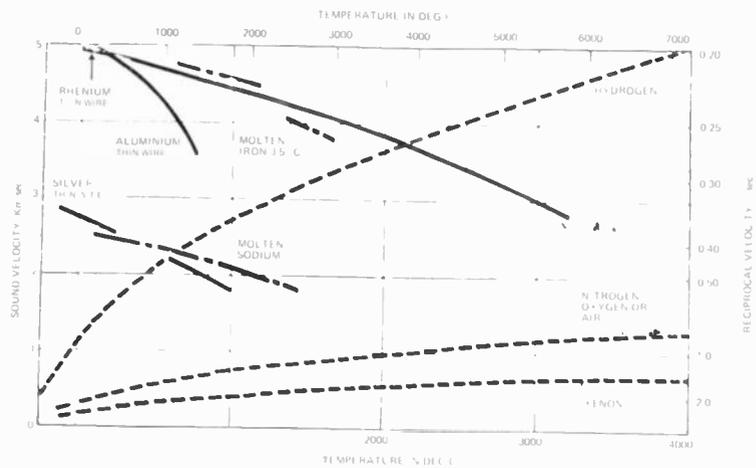


Fig. 9. Propagation velocities of sound in various selected media.

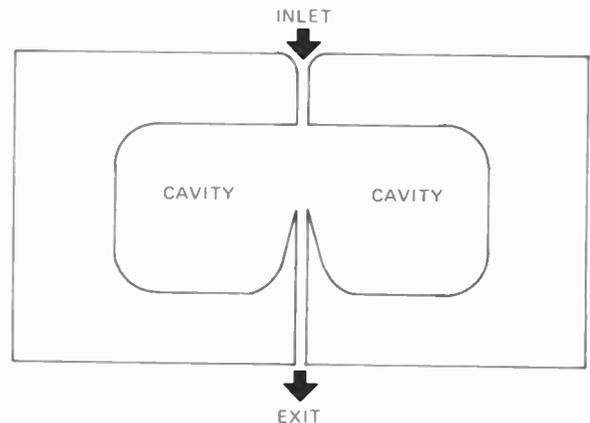


Fig. 10. Cross-section through a resonant fluidic temperature sensing cavity.

Fig. 10, and is exhausted. The frequency of oscillation within the cavity depends upon the velocity of sound in the gas. For a given gas and size, the frequency varies as the square root of the Kelvin temperature of the gas. Typical output frequencies lie in the range 5 to 40kHz. Response time is limited partially by the time taken to cycle the gas, and more so by the time for the complete cavity volume

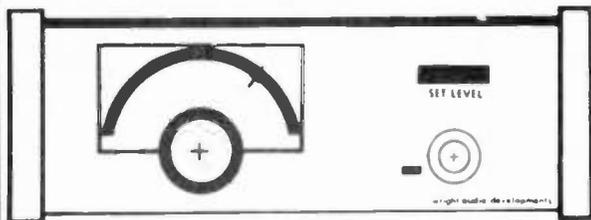
to change. Even so, rapid response is possible.

### Eddy Currents

Temperature changes alter the conductivity of electrical conductors. By placing a sensing inductor coil near the test specimen it is possible to monitor temperature using the changes in impedance of the coil. This method is subject to many unwanted

(Turn to page 105)

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**TEAC 2060 STEREO TAPE RECORDER** offers reverse and playback in both directions by automatic reverse. Built-in hi-fidelity amplifiers and speaker systems. 20 watts total music power 8 hours continuous recording or playback without tape change. 3 speeds. Frequency response 30 to 20,000 Hz at 7½ i.p.s. List price \$463. **ENCEL CHRISTMAS PRICE \$289.**

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# 100W GUITAR AMPLIFIER

(Continued from page 82)

Electronics Today International is currently developing a matching preamplifier specifically for use with this unit and suitable for all P.A. and pop group use.

The ETI preamplifier has multiple inputs — up to eight are normally provided but this may be extended if required.

Each input has its own individual tone controls. Other features of the unit include:

- Mixing facilities.
- Echo facility on all inputs.
- Simulated stereo output to two channels (switchable)
- Master room equalizer.

Full constructional details of this preamplifier will commence in our February issue.

## ERRATA

### PROJECT — WIDE RANGE VOLTMETER ETI 107

Integrated circuit IC1 as originally specified was an LM308H. This can be advantageously be replaced by an LH0042C.

The LH0042C has much lower input current (typically 15 pA at 25°C resulting in lower zero errors on the low ranges. The IC is also slightly cheaper than the LM308H. It is supplied by National Semiconductor Corporation.

No changes are required to the circuitry and pin connections remain the same.

### PROJECT — FLUORESCENT INVERTER ETI 516

A line was omitted in TABLE II (choke winding details). Add to the text: "Winding consists of 250 turns 26 gauge B & S".

In the parts list resistor R1 should be 1k, ½W, 5%; R2 should be 33 ohms, 5W, 5%. The values and positions of these resistors are shown correctly both in the circuit diagram (Fig. 1) — and the component drawing (Fig. 3).

## SATELLITE SOLAR CELL



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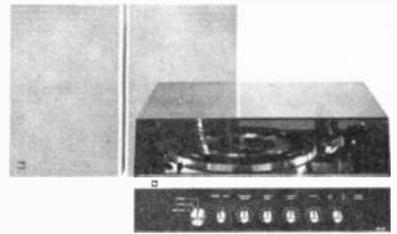
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## TRANSDUCERS IN MEASUREMENT AND CONTROL

(Continued from page 102)

systematic errors, for example, changes in coil resistance with temperature and because of such errors the desired effect is very small. For example, only 0.05% change will occur in the coil for a degree change in an adjacent aluminium plate.

### NON-ELECTRICAL TRANSDUCERS

A number of non-electrical output devices also exist to sense temperature. If a component, irradiated with the isotope Krypton 85, is raised in temperature, some of the isotope is initially released but then stops. To determine the temperature rise the part is heated until release just occurs again—and that is the temperature to which it was subjected in service.

Paints, pellets, crayons and liquid crystals (the cholesteric form) are available that change colour with temperature some remaining, others returning when cooled.

### FURTHER READING

Several of the references given in Part 7 are relevant to the radiation methods discussed in this part. Acoustic methods, however, are not described in general texts as yet.

"Infrared Systems Engineering", R.D. Hudson, Wiley, 1969.

"Infrared Radiometry", J.R. Collins, Electronics World, Oct. 1967, pages 23-27 and 69.

"Using Infrared Thermometers effectively", H.L. Berman and M.R. Wank, Optical Spectra, July, 1969, 77-80.

"The Selection of a Biothermal Radiometer", D. Mitchell, C.H. Wyndham and T. Hodgson, J. Sci. Instrum., 1967, 44, 847-851.

"An Infrared Pyrometer for the Measurement of Nylon Thread Line Temperatures", H. Bevan and R.E. Ricketts, J. Sci. Instrum, 1967, 44, 1048-1050.

"Temperature Measurement of Particulate Surfaces", J.H. Bach, P.J. Street and C.S. Twamley, Jnl. Phys. E: Sci. Instrum. 1970, 3, 281-286.

"C.S.I.R.O. and the Australian Programme for the Earth Resources Technology Satellite (ERTS)", M.J. Duggin, C.S.I.R.O. Mineral Research Laboratories Investigation Report 95, July, 1972.

"Sound Ways to Measure Temperature", L.C. Lynnworth, Instrum. Technology, April, 1969, 17, 4.

"Ultrasonic Thermometry", S.S. Fain, L.C. Lynnworth and E.H. Carnevale, Inst. & Cont. System, Oct. 1969, 42, 107-110.



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# AUDIO NEWS

## AUDIOSON TO DISTRIBUTE GARRARD

Audioson International Pty. Ltd. has been appointed national distributor for the Plessey Garrard range of quality Hi-Fi turntables. Announcing this appointment, Plessey Ducon Pty. Ltd., the Garrard agent for Australia, advised that where previously British Merchandising Pty. Ltd. had been the distributor for New South Wales, and Audioson for the remainder of Australia, it had been mutually agreed that the distributorship for N.S.W. would be transferred to Audioson International Pty. Ltd.

Audioson will supply the Garrard equipment complete with power and audio leads. A full range of bases and covers manufactured by Audioson is also available.

Service centres have already been established in all capital cities to cover the 12 month warranty period. It is intended to expand the number of service centres to include all major populated areas. Extended servicing from the centres will also be available after expiry of the 12 month warranty period.

Audioson International is a specialist in hi-fi audio equipment and maintains a modern factory at Brookvale, N.S.W., for woodworking and assembly.

The company also holds the national distributorship for the "Corinth" range of loudspeakers, from another of the Plessey companies in Australia, Plessey Rola Pty. Ltd. of Victoria.

## TEAC 4-CHANNEL STEREO TAPE PLAYER

The TEAC A-2420 four-channel stereo tape player is a four-track, four-channel discrete system with four-track, two-channel stereo or mono playback facilities. It has automatic shut-off, with a silicon damped tension arm, automatic equalization coupled to the speed control, automatic reverse/repeat operation and a 'dupli-sync' outlet for automatic bi-directional tape duplication. Claimed frequency response is 30Hz - 22kHz at 7½ ips and 30Hz - 16 kHz at 3¾ ips.

Further details: Australian Musical Industries Pty. Ltd., 619 Pacific Highway, St. Leonards, NSW.

## KOSS HEADPHONES

Dynasound Pty. Ltd., announce that they have been appointed Australian National Distributors for the KOSS Corporation of America, manufacturers of "KOSS" Professional Dynamic and Electrostatic Headphones and Accessories. Further information and prices are available from Dynasound Pty. Ltd., 329 Princes Highway, St. Peters, N.S.W. 2044.

## WRIGHT TO MAKE MONITOR RECEIVERS

Following the success of the high quality Broadcast Tuner reviewed in the September issue of Electronics Today International, and interest shown by representatives of the national and commercial broadcasting service, Wright Audio Developments are now finalising modifications to allow their LDT-3A tuner to be single channel crystal-locked and rack mountable for use as an off-air monitor receiver.

In addition to AM tuners, Wright Audio Developments have ready for release a series of high quality public address amplifiers and associated equipment. The amplifiers are in the sizes 25 Watt, 50 Watt, and 100 Watts output into a 70 volt line. All are fully protected against short and open circuit speaker lines and other abnormal load conditions. Each is also available in either rack or mounting or free-standing versions, and either as a base amplifier with a single one volt input, or complete with two microphone and two phono inputs.

Supplementary to these amplifiers is a range of plug-in modules which may be used to provide additional facilities in the amplifiers, used individually, or used collectively to construct complex audio control mixers and similar systems. A range of speaker systems will be available also, with power handling ability to match the range of amplifiers, so that complete systems may be assembled to suit

auditoriums, shopping centres and outdoor arenas, as well as schools, churches and other similar installations.

Further details: Wright Audio Developments, 23 Avenbo Rd., Berowra, NSW.



## SONY TC-570 FOUR-TRACK STEREO TAPE RECORDER

The Sony TC-570 four-track stereo tape recorder was introduced onto the Australian market this month. The unit incorporates two speakers in the lid, and the music control centre can be used as an independent power amplifier or tape deck. The unit has four pairs of stereo inputs - phonograph, tuner, microphone and line. Output is a claimed 20 watts per channel.

Further details: Jacoby Kempthorne Pty. Ltd., 469-475 Kent Street, Sydney, NSW.

## KLIPSCH SPEAKERS IN AUSTRALIA

Auriema (Australasia) Pty. Ltd. have announced their appointment as Australian Distributors for Klipsch loudspeakers.

Paul W. Klipsch, President of Klipsch and Associates Inc. is recognised as the world's leading authority of the design and construction of folded horn type loudspeaker enclosures and horns for mid range and treble applications.

The full range of Klipsch loudspeaker models will be launched in Australia in January, 1973 and will be available through a select network of dealers in each capital city.

Prices will start at \$450.00 each and range to near \$2,000 for the top of the line Klipschorn. All basic models of the Klipsch loudspeakers will be available from around \$1,100 each.

## PLESSEY TWEETER

Plessey Rola is aiming at a share of the international high fidelity market with its newly released Model X30 Dome Tweeter. These new tweeters have been designed and attractively packaged to appeal strongly to the audio enthusiast.

Claimed to be capable of significantly upgrading the high frequency performance of any speaker system, the Model X30 tweeters are available in pairs. Detailed application notes, together with information for building a self-contained tweeter array which can be used in conjunction with an existing enclosure, are supplied with the tweeters.

Conversions and adaptations to existing speaker systems are made easy. Both 8 ohm and 15 ohm units are available to match the impedance requirements of various systems.

The dome shape of the tweeter is claimed to provide 180° dispersion of high frequencies. A non-metallic loading plate

(Continued on page 108)

# THE CHAMPIONS

The major features of these amplifiers were put there for one reason.  
Your ears.

Like the sophisticated ITL . OTL . OCL circuitry that has eliminated noise and distortion, and improved the damping factor so the low frequencies come out pure and clean.

The contemporary, yet unique design front panel houses the most -up-to-date controls needed for tailoring sound.

Turnover switches allow you to control highs and lows. Filters eliminate scratch and rumble, the loudness control maintains rich sound at low volume.

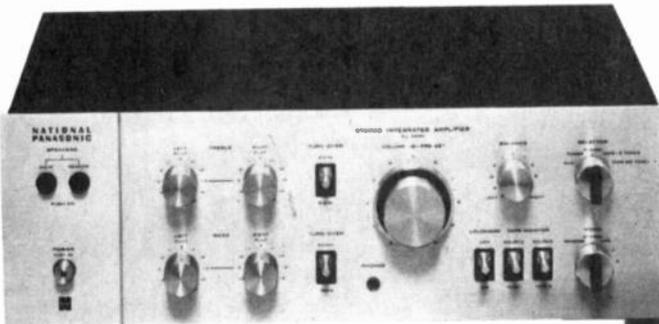
On the rear panel there is a full range of inputs and outputs.

But you'll never know how good our champions really are until you put them to the ultimate test. After all, hearing is believing.

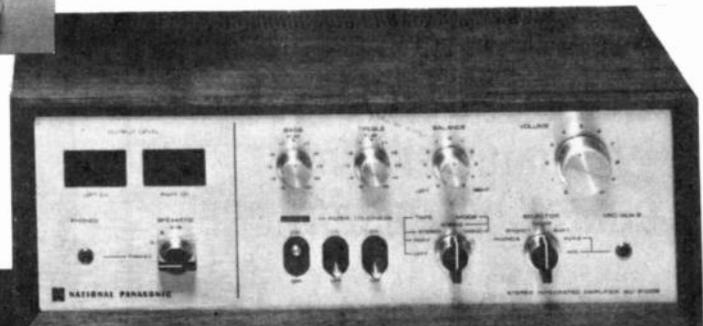
SU 3600. RMS Power 120, Harmonic Distortion less than 0.2%,  
Frequency Response 5Hz-100KHz - 3 dB.

SU 3400. RMS Power 84, Harmonic Distortion less than 0.2%.  
Frequency Response 5Hz-100KHz - 3dB.

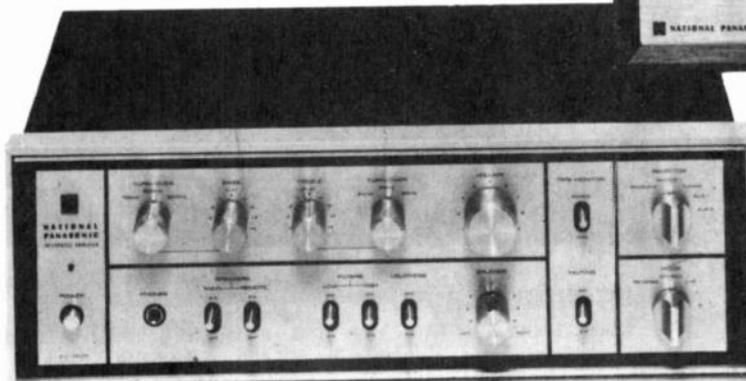
SU 3100. RMS Power 36, Harmonic Distortion 0.08%.  
Frequency Response 10Hz-100KHz - 3dB.



SU 3400



SU 3100



SU 3600

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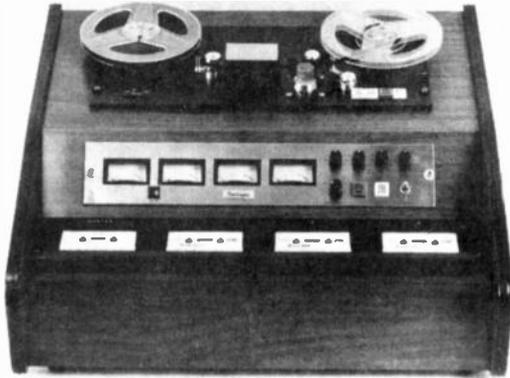
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# AUDIO NEWS

(Continued from page 106)

eliminates flux leakage, and is designed to boost performance – with a horn loading effect – in particular sections of the response curve.

Further details: Plessey Rola Pty. Ltd., The Boulevard, Richmond, Vic. 3121.



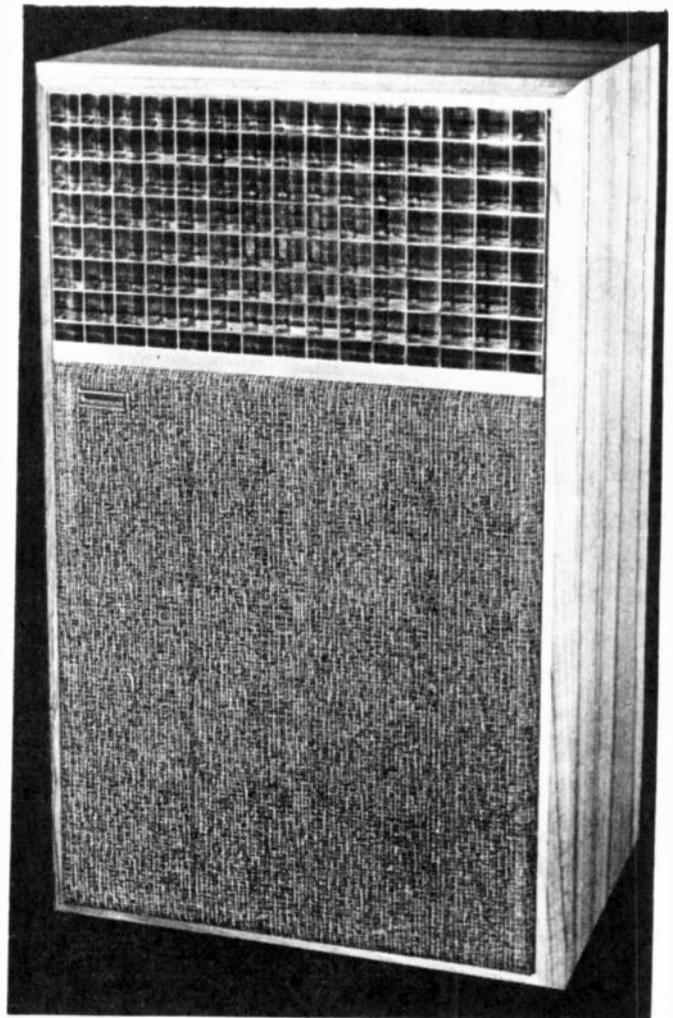
## TAPE DUPLICATORS

Leroya Industries Pty. Ltd., have announced their appointment as sole Australian Distributors for Pentagon Industries Inc. of Chicago, USA, makers of High Speed Tape Duplicators.

A single unit duplicator can produce up to 90 C60 cassettes per hour and, with an add-on unit, 270 cassettes per hour can be duplicated.

A time saving device automatically rewinds and cues the master reel tape on open reel to cassette versions.

Users of Pentagon Duplicators include Ampex Corporation, N.B.C., R.C.A., Bell & Howell, Kodak as well as many universities and educational authorities throughout the USA. (Latest models accommodate 10½" reels rather than the 7" reels shown in photograph).



## METROSOUND AGENCY

Magna-Techtronics (Aust.) Pty. Ltd. announce their appointment as distributing agent, in Australia, for Metrosound Hi-Fi amplifiers and speakers from the U.K.

The current range of Metrosound Hi-Fi audio equipment comprises a 30 watts per channel amplifier, the ST.60 and two models of speakers, the Duplex 25 and Duplex 15.

The speakers feature a cone unit for the lowest frequencies allied to an electrostatic unit for the middle and high frequencies. The basic advantages of such a system is that by using a cone unit, one can obtain a particularly large movement in operation, and so obtain a linear response comparatively easily.

The electrostatic unit is shaped to avoid the beaming effect common with conventional cone loudspeakers when used at high frequencies, and is claimed to provide full dispersion over a conventional living room.

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# TEAC brings you the consummate in stereo cassette decks.

Here are three that sum up the best of TEAC technology.

Common to them all is a transport and hysteresis-synchronous drive motor so precise and fool-proof that they can hold their own with some of the best open-reel types. Beyond this, the differences begin. Each model has a package of add-ons for your particular needs.



Model A-210

If all you need is a basic superior deck that can economically record and playback on conventional tape within a frequency response range of 30-12,500Hz, you'll want to look into the A-210. It's outer rotor drive motor holds wow and flutter down to a negligible 0.15%. Separate stop and eject buttons. Low-noise solid-state electronics. Contoured fingertip-control pushbuttons for all operational modes. Large VU meters. Sliding scale record-playback level controls. Standard phone jacks for professional-style 600-ohm mikes and 8-ohm headsets. Strobe-type running light.

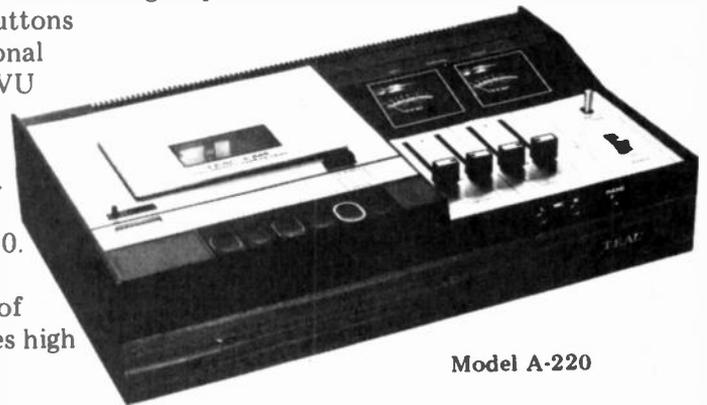
If you're looking for a deck that can handle the new chromium dioxide tapes, you should look into the TEAC A-220. It has the add-on feature of a tape selector switch in the CrO2 position, provides recording and playback frequency response of 30-16,000Hz. As an added convenience, the A-220 incorporates high density ferrite heads and separate record and output level controls.

But if you're looking for the definitive Dolby deck with everything you need for near-professional operation, only the A-250 will do. It has TEAC's high-density ferrite heads. These "brown jewels" are so extraordinarily durable that we warranty them for the original owner's lifetime. Add to these a Type B Dolby System that improves the basic signal-to-noise ratio of the A-250 by an additional 10 dB.

You can count on superior performance from conventional, high-density/high energy, and chromium dioxide tapes.

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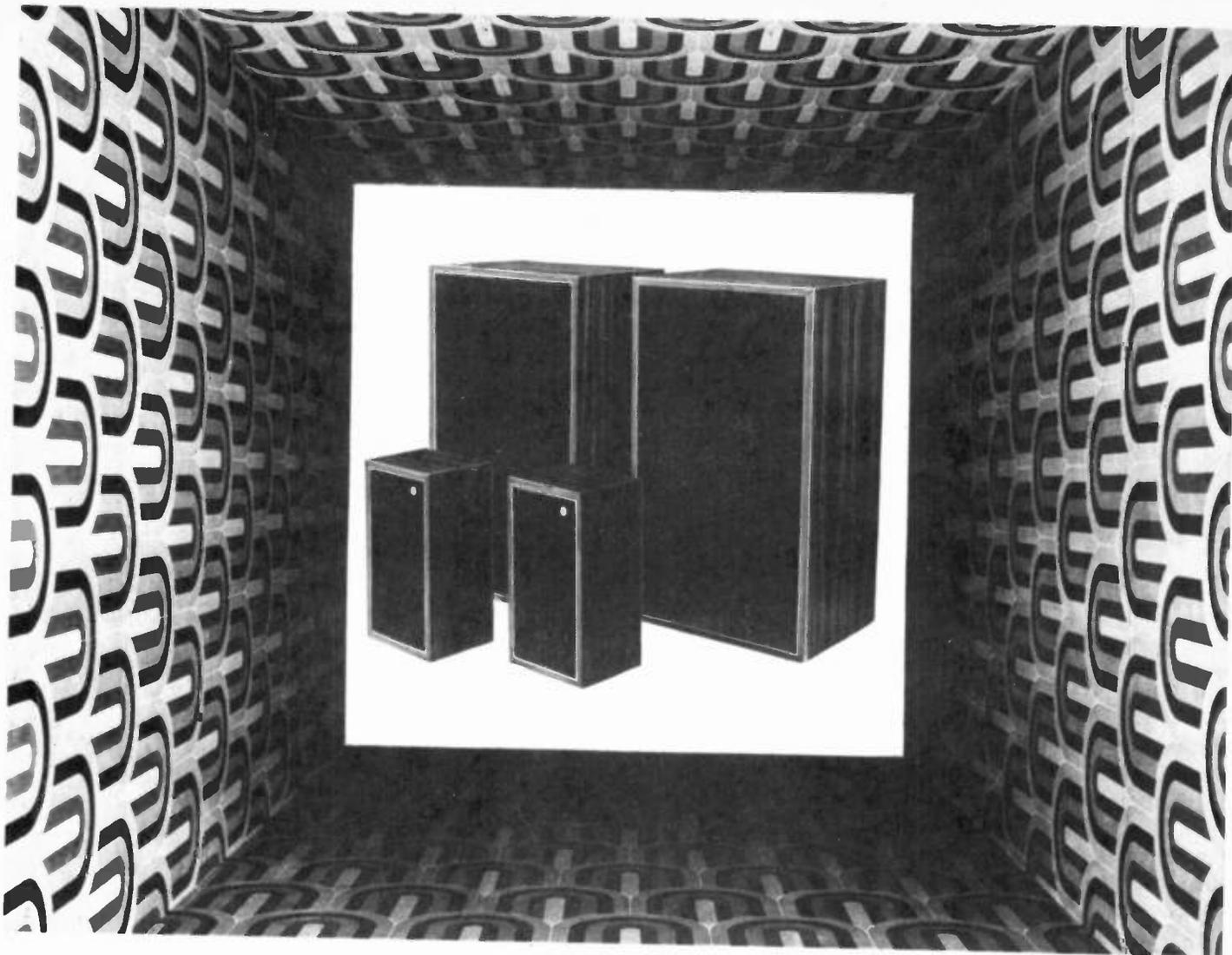
Model A-220



Model A-250

If you'd like to know more write to us for the TEAC Catalogue, price list and franchised dealer list.

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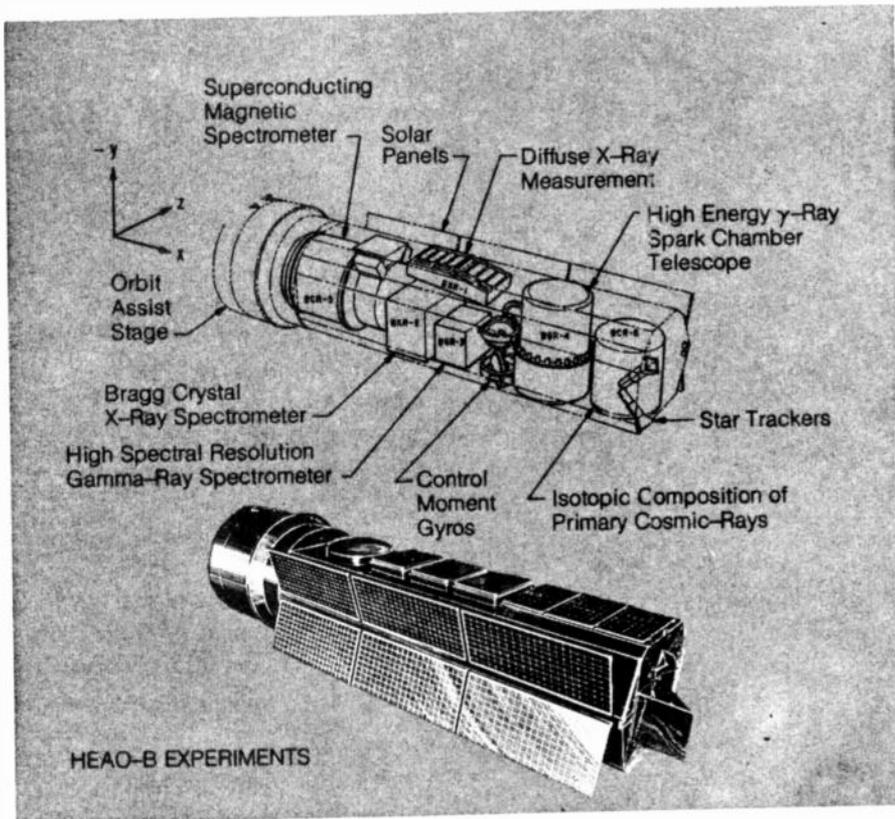
For more than 50 years AWA has been supplying high-quality sound reproducing equipment for your enjoyment. Now we give you the correct sound that is clear and crisp without the usual additions or subtractions commonly called distortion. This is one of the reasons why AWA is acknowledged a leader in the field and our audio systems are some of the world's finest.

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**AWA** ...leaders in audio

# Searching for the Antiworld



(Continued from page 35)

charge passes through the three chambers, the electronics read out the position data and make a preliminary analysis. If the event appears to be an antimatter candidate, the accurate coordinates and other information are recorded on magnetic tape for more careful analysis elsewhere."

These experiments may not be able to determine which, if any, of the proposed antimatter theories is correct; random interstellar magnetic fields mix cosmic rays from many sources over a period of millions of years before they reach the Earth. Unlike optical astronomy, high energy astronomy cannot identify a given particle with a specific galactic or extragalactic source. However, the mix of particles carries sufficient information about the general nature of the sources and galactic structure to test the existence of galactic antimatter with assurance.

## BACKWARD IN TIME

If HEAO discovers significant antimatter events in cosmic rays, it will support a charge-symmetric cosmology; if not, the findings will strengthen the arguments of many physicists, perhaps a majority, for an

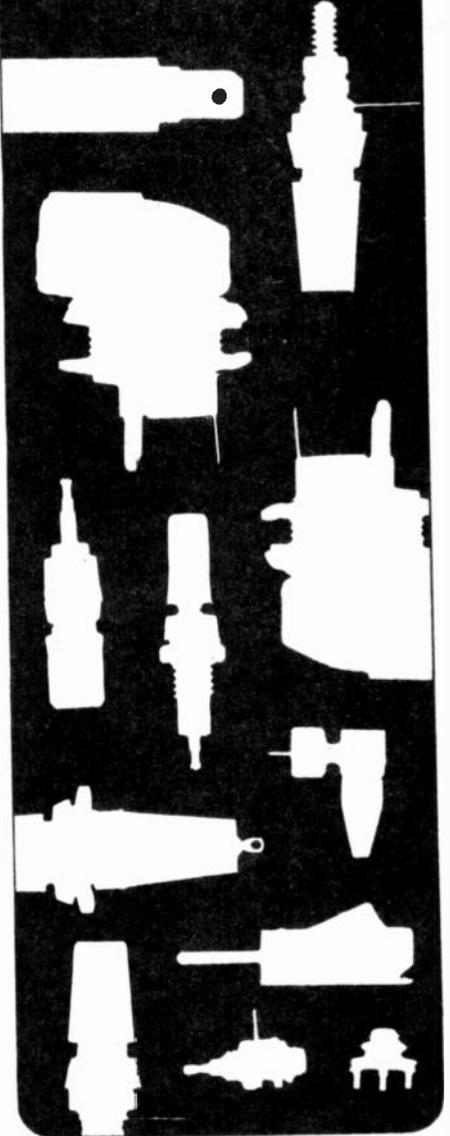
asymmetrically-charged, matter-dominated Universe.

In 1949, Nobelist, R.P. Feynmann proposed that, mathematically, antiparticles could be regarded either as oppositely charged particles or as objects moving backwards in time while particles move forward. Some researchers relate the uniform expansion of the Universe — an object moving in one direction in time — with a corresponding time asymmetry of particle motion. Because symmetrical arrangements are not always the most beautiful, a Universe made predominantly of matter need not be rejected on æsthetic grounds, they say.

But whether the day is won by the matter-dominant camp or by those who believe in the equality of matter and antimatter, scientists have always accepted the equivalence of truth and beauty. ●

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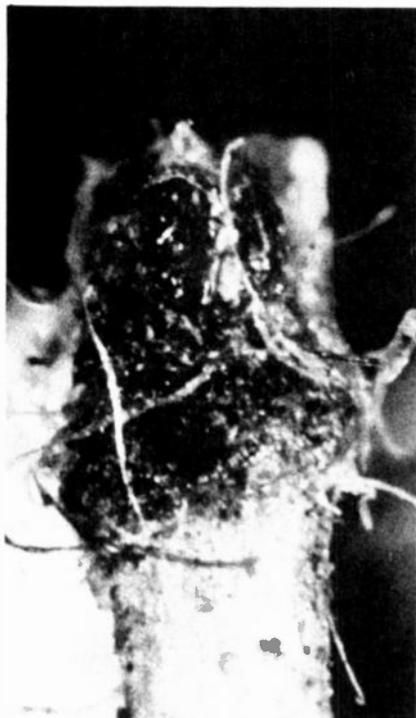
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# RECORD WEAR

Do records lose their brilliance after a few playings?  
Louis Challis reports



Unretouched micro-photograph of stylus after playing just one dirty record!



Elac automatic and record player was used continuously for several hundred hours.

**A**UDIO folklore has long held that the high frequency content of gramophone records is partially destroyed the first time that they are played.

But as folklore is notorious for wrong conclusions — or at best — the right conclusions for the wrong reasons — the record wear story is one about which we have always had reservations.

Reservations mind you, not disbelief, for we knew for a fact that the most difficult passages of rest records such as the Shure TTR101 are effectively ruined by as little as three to five playings due to the high stylus velocities involved in tracking the high energy high frequency content.

Most records are ruined by poor styli and excessively high tracking weights — but what happens to records played

with new styli and low to medium tracking weights?

Would you believe that the high frequency content increases!

For our experiments we chose a number of brand new pressings. These were:— JUST THE BEGINNING, Cherry Pie CPS1000. MOZART KLAVIERKONZERTE, (F MAJOR KV37), Deutsche Grammophon 139 447 SLPM. JOY — THE GREAT COMPOSERS HITS FOR THE '70s, CBS SBR 235509.

The equipment we used for our evaluation consisted of two high quality automatic changers fitted with removable head shells, and capable of being programmed so that they automatically played a 7" band of the records over and over again.

The electrical output from each record player was then fed to the input of a 60dB amplifier, with 47k input impedance, and thence to an

audio frequency analyzer which provided one-third octave band analysis on a high speed level recorder. The frequencies analyzed were those falling within the 8kHz and the 16kHz third-octave bandwidth filters.

We started our tests with a 12 micron conical stylus installed in a high quality cartridge tracking at one gram.

According to the folklore the high frequency content should have decreased with repeated playing.

But it didn't! As the record was played repeatedly, the measured output from 8kHz to 16kHz increased!

Actually the explanation is quite simple. The increase in output is caused by distortion of the fundamental program content at lower frequencies and the consequent generation of 'apparent output' at the higher frequencies.

Our second test was run using a medium quality magnetic cartridge fitted with a 12 micron conical stylus tracking at three grams.

The resultant analysis showed after 10 playings the high frequency distortion of the highest level passages had increased by 10% (1dB). In the same time there was only a 5% increase in distortion for program components 10dB below the peak level.

After a further 40 playings the peak level distortion had only increased by another 5%, and by 2% for signals 10dB below the peak levels.

Subjectively however, it was readily possible to hear the difference between the record used in our second test (after it had been played 50 times), and a brand new record even without making immediate A-B comparisons. And while the low frequency content was hardly affected, the high frequencies exhibited a roughness and lack of clarity that was most pronounced.

Finally we switched to a crystal cartridge fitted with a diamond stylus and tracking at three grams.

The results were much as we could have deduced from our previous tests. Firstly, the rate of increase of distortion was even more marked than with the magnetic cartridge tracking at three grams, but now two other factors became clearly evident.

After the first 12 playings there was an attenuation of approximately 3dB in some of the low level high frequency program material, but this was soon masked by an increase in surface noise which rose almost linearly — typically at the rate of 0.08dB per playing.

It was interesting to note that, although recorded material with high sound levels and fundamental content in the 4kHz to 8kHz range exhibited a significant colouration after many playings, piano music with little fundamental content above 4kHz exhibited only a loss of highs after as many as 120 playings.

The other factor that was noticeable was the increase in surface noise which rose by typically 10dB in the one-third octave band centred on 16kHz.

So separating the facts from the folklore — what are we left with?

1) Cartridges which track properly in the vicinity of one gram (and fitted with a good and clean stylus) cause no significant deterioration of records until at least 10 playings. This deterioration then occurs at the high frequencies above six to eight kHz and is usually inaudible even to the trained ear. But after some 40 playings, this deterioration

is apparent, particularly if an A-B test is performed with a new record of the same pressing.

- 2) If one uses a cartridge tracking at approximately three grams, then the deterioration is more pronounced after ten playings, and there are typical increases of two dB in high frequency distortion.
- 3) Cartridges tracking at three grams also exhibit a more rapid increase

in the level of surface noise.

- 4) Good bi-radial styli seem to generate far less distortion than do conical styli for a given class of cartridge.

The message seems quite clear.

Provided you keep your records clean, then money spent on good quality cartridges will result not only in better playing now, but also continuing enjoyment for years to come. ●

## THE EARLY YEARS

The first Edison cylinder records used a tin foil platten which was clamped onto a mandrel and had an exceedingly short life — of some 6 to 10 playings.

Because of the production problems involved with tin foil, Edison experimented with various waxes for the outer surface of his cylinder recordings. But these were short lived as they gave only 20 to 30 playings with a "low volume" horn, or as few as 10 playings using a large horn to provide the greater acoustic output required for a large room.

Edison even tried metallic soaps for the recording surface, but when in 1902 another company developed celluloid as a viable recording material, Edison developed the famous Edison cylinder which used a celluloid outer sheath on a plaster of paris base. These were technically very advanced for they could provide a frequency response of 150 to 6000 Hz and used a diamond or sapphire stylus with a radius tip to provide long life.

When Columbia Records produced three minute records to counter Edison's two minute records, Edison increased the rotational speed from 120 r.p.m. to 160 r.p.m. and the groove density inch from 200 to 500 per inch. This improved the fidelity and provided a frequency response of 150 to 7000 Hz but the cylinders did not last as long. These cylinders were produced right up to 1929 until superceded by the disc recordings first introduced in the early 1920's.

The best of these early discs were designed to have a "silent surface" and were made from shellac. The material was rather abrasive and caused the styli to wear very rapidly. These laterally cut records originally

were designed to rotate at 80 r.p.m. and had a frequency response of approximately 150 to 6000 Hz. The steel stylus which was almost invariably used, lasted for just one playing and then had to be replaced. If it was not replaced then the high frequencies, which were already deficient, were even further attenuated.

The Edison and French Pathe discs and disc reproducers used a "hill and dale" system of recording. The Edison discs used a rotating sapphire stylus system not unlike a ballpoint pen to track from outside to in as on present day recordings. The Pathe system tracked from inside to out to make use of the lower velocities at the centre of the record when played with a steel stylus. This system was used on studio transcription records up to 10 years ago. By this means, when the stylus reached the outside of the record, the higher velocities compensated in part for the loss of high frequencies resulting from the blunting of the stylus.

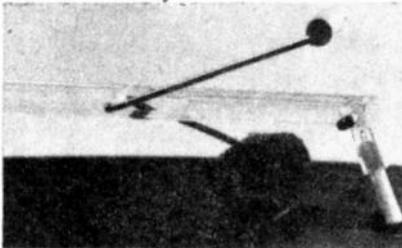
The Edison discs were very well made and because of the use of a fully profiled stylus were almost indestructible. The earliest examples were 3/8" thick and were made as a multi-layer construction with a bakelite surface and a fibrous filler between a shellac binder at the centre.

These records played at 80 r.p.m. and had no great loss of high frequency right up to about 8 kHz.

Edison used condenser microphones, electronic amplification and electro-magnetic cutting heads to produce what were remarkable examples of recorded material — even by the standards of to-day.

# WATTS to give for Xmas?

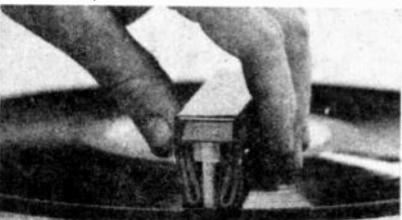
What do you give the hi-fi enthusiast for Xmas? This is always a problem . . . but, at last, a highly satisfactory solution has been found. *Watts record cleaning equipment*. Now you can give a present that offers immediate and lasting pleasure without involving excessive outlay!



The most popular Watts record cleaner is the remarkable "Dust-Bug" which automatically cleans the record as it plays. Static charges are removed simultaneously . . . the "Dust-Bug" costs only \$5.60.\*



New records are kept like new with the Watts "Disc Preener". All dust is collected from the record surface simply by holding the Preener as the record revolves. This effective unit costs only \$2.10.\*

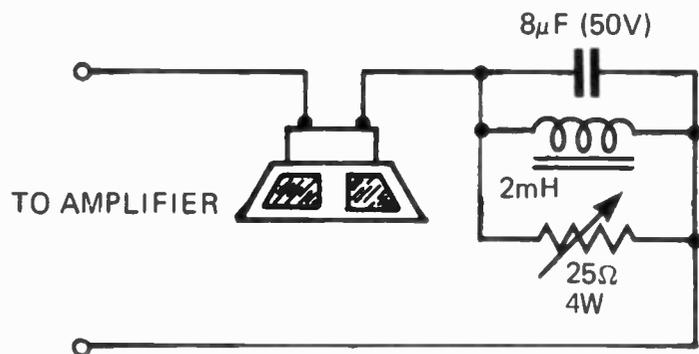


Keeping new records as-new and restoring fidelity to older discs is a job for the Watts "Manual Parastat Mk. IIA". Where pick-up pressure is less than  $1\frac{1}{2}$  grams the "Manual Parastat" is essential, for even the most minute particle of dust or dirt will adversely affect performance. Price of the Watts "Manual Parastat" is \$13.80.\*

Watts record maintenance products are available at all franchised Bleakley Gray dealers.

\*Prices quoted are suggested consumer prices only.

SG-WX3



## BETTER SOUND FOR \$5

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**E**conomy loudspeaker enclosures often contain just one wide range drive unit — usually of five inches or more in diameter.

Such speakers often sound 'peaky' due to the drive unit's characteristic of having too much output around 1000Hz.

A really dramatic improvement can be effected simply by wiring a choke/capacitor combination in series with the speaker.

This removes a lot of the energy around 1000Hz. The choke/capacitor combination is then bridged with a 25ohm potentiometer to bring some of the response back up.

The net result is a 6dB to 10dB decrease in that region, and what was previously a closed-in honky little sound now becomes a big spread-out spacious sound.

Losses in the network will decrease the speaker's efficiency — meaning that you will have to turn the volume control up a bit, but most amplifiers can easily provide the extra power required.

Figure 1 shows how the components are connected into circuit. The various bits may be built into the speaker enclosure — or even located alongside the amplifier. Once set, the potentiometer will not require subsequent adjustment.

The potentiometer is set merely by listening to some of your favourite

music and choosing the setting you prefer best.

This simple modification can be used to advantage with any single drive unit speaker enclosure. It is perhaps the simplest and cheapest way to improve response that you can ever make. ●

This extraordinarily simple, yet effective modification, was recently suggested by Henry Kloss, now President of the Advent Corporation.

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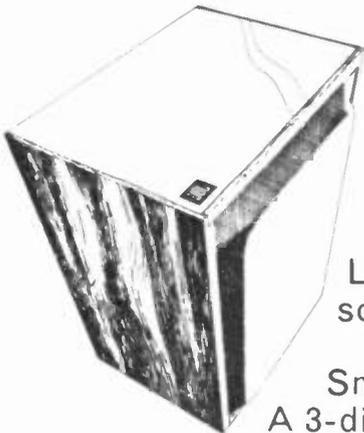
SPECIAL TAPE RECORDER ADJUSTMENT, OUR TECHNICIANS CAN ADJUST YOUR TAPE RECORDER SO THAT IT GIVES SUPER PERFORMANCE ON THE BRAND OF TAPE YOU USE. YOU WILL BE AMAZED AT THE IMPROVEMENT IN PERFORMANCE FOR SUCH A SMALL CHARGE.

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- Can be used as a deck — removable hand grip for home decor
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- Tape mode indicated by tape pilot lights — Red on REC, Green on PB, FF, REW, STOP
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- Magnetic cartridge input
- ... for enjoying a record player
- Speaker switch; on/off on PB, monitor level on REC
- Two record level meters, input select switch, stereo/mono switch
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115 W	AY9149	PNP	TO3	-60	1.1 V @ 4 Amp	20-150 @ 4 Amp/4 V
115 W	AY8150	NPN	TO3	40	1.1 V @ 4 Amp	20-150 @ 4 Amp/4 V
115 W	AY9150	PNP	TO3	-40	1.1 V @ 4 Amp	20-150 @ 4 Amp/4 V
35 W	AY8170	NPN	TO66	40	1.5 V @ 3 Amp	Typ. 30 @ 3 Amp/4 V
35 W	AY9170	PNP	TO66	-40	1.5 V @ 3 Amp	Typ. 20 @ 3 Amp/4 V
35 W	AY8171	NPN	TO66	60	1.5 V @ 3 Amp	Typ. 30 @ 3 Amp/4 V
35 W	AY9171	PNP	TO66	-60	1.5 V @ 3 Amp	Typ. 20 @ 3 Amp/4 V
25 W	2N3054	NPN	TO66	55	1 V @ ½ Amp	25-100 @ 2 Amp/4 V
10 W	AY8139	NPN	TO5	40	6 V @ 1 Amp	Typ 45 @ 1 Amp/2 V
10 W	AY9139	PNP	TO5	-40	6 V @ 1 Amp	Typ 35 @ 1 Amp/2 V
10 W	AY8140	NPN	TO5	60	6 V @ 1 Amp	Typ 45 @ 1 Amp/2 V
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## AMATEUR RADIO

Quality of pictures received are surprisingly good. Figure 2 shows photograph received from the Itos-1 satellite at the end of March 1971.

### STUDY OF PROPAGATION

A number of amateurs are at present studying a variety of propagation phenomena. Bob Grummitt, VK4ZRG of Townsville has been studying transequatorial propagation on VHF for some six years. His observations have mostly been confined to the region 45 to 54 MHz. He is now intending to explore above 100 MHz, particularly on the 144 MHz amateur band.

Brian Young VK3BBB/T of Traralgon is studying tropospheric propagation on 144 MHz and continuously monitors FM repeaters located at Mt. Barron (Tasmania), Melbourne and Geelong.

Mike, VK2AM (Sydney) has been conducting tropospheric scatter propagation experiments on 144 MHz with Reg, VK1MP in Canberra. The success obtained with quite modest equipment illustrates what can be done. Mike runs 25 watts input (about 8 watts at the antenna) to a five element Yagi and has a homemade MOSFET converter. Reg runs 120 watts (about 50 watts at the antenna) to a 14 element Yagi and a homebuilt valve converter. Both use morse-CW modulation. The path is about 140 miles long.

Rod VK2ZQJ (Sydney) will be conducting schedules with VK2ZAY at Boggabri using SSB on 144 MHz by the time you read this. Both stations can run 400 watts PEP output. The path length approaches 300 miles. ●

## WOULD YOU LIKE TO BE A RADIO AMATEUR?

The Wireless Institute of Australia, established in 1910 to further the interest of Amateur Radio, can help you to attain the knowledge necessary for the P.M.G. Amateur Operators' Certificate of Proficiency examination. Correspondence Courses may be commenced at any time. Personal Classes commence in February each year.

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*Micro's 611 is an integrated unit with acoustically correct shock absorbers to prevent feedback and mechanical jarring. 0.05% wow/flutter, rumble less than -52 dB. On/off lamp to check speed and visual inspection of record surface and stylus, separate compartment for spare head shells, cartridges, screwdriver, stylus cleansing brush.*

The MR 611 incorporates the new Micro 101 arm, a highly sophisticated new concept, with super precision radial bearings which enable the playing of 4 channel records because of the negligible bearing friction. Correctly designed anti-skating evenly distributes the bias force over the entire record surface ensuring superb tracking, stereo imaging and quadraphonic channel balance.

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# HI-FI

(Continued from page 23)

efficiency, the lower the power required to drive them, and as the amplifier cost is directly related to power output, less money need be spent on the amplifier if high efficiency speakers are used.

Having apportioned the money, check Fig 1 that your various allocations will enable you to buy sufficient power for your needs.

If you are buying a tuner amplifier, calculate as if it were a straightforward amplifier, and then add somewhere between \$60 and \$80 to the price. Much the same applies if one has a cassette player in mind, in this case add between \$50 and \$100 to the amount which would otherwise have been spent on the record player — but spend it all on the cassette unit instead.

As one goes up in price, it may be necessary to vary the percentages slightly, spending just a little more on speakers and amplifier, and a shade less on the record player. In this league the record player will probably be offered with a choice of cartridges. Here one should spend just over two-thirds (of the record player's allocation) or the player itself, and the remaining one third or so on the cartridge.

We must emphasize that the allocation we have suggested is just a rough guide. There may well be combinations of units, falling outside these guide lines, that will still be well matched. But if you do allocate your money as indicated you are very unlikely to go wrong.

Here are a few examples to illustrate the general principle.

## EXAMPLE A

You have allocated \$400 — therefore you have about \$100 to spend on each of the four items (you need two speakers remember!)

Minimum price for a reasonable amplifier is about \$5 a Watt — thus for your money you can afford a 20W amplifier.

You have an average sized listening room and Fig 1 shows that 20W is about the right amount of power.

All is well — and you should have no difficulty in assembling a well balanced outfit.

## EXAMPLE B

Here you have the same amount to spend as in example A, but you have a very large listening room.

Figure 1 indicates that you need at least 40W if you are intending to use low efficiency speakers.

Here it is necessary either to just spend more money — or to settle for a 20W amplifier and restrict one's choice of speaker enclosures to the more efficient bass reflex type.

## EXAMPLE C

You can afford \$500 but would prefer to use a cassette player instead of records.

Deduct between \$50 and \$100 from your total allocation of \$500. This leaves \$400 which you should apportion in the ratio described above. To the amount that you would normally have used for the record player add the \$50 — \$100, so that you now have between \$150 and \$200 to spend on the cassette player, \$100 for the amplifier, and \$100 for each of the two speakers.

## WHERE TO BUY IT

We very strongly advise you to buy your gear from an established hi-fi dealer unless you know exactly what you need and can service the equipment yourself.

Good hi-fi dealers can be recognised by the quality of the agencies that they hold. If these include several top names then it is a safe bet that they are reputable businesses prepared to back up their sales with service.

Occasionally the identical goods can be bought at a lower price from a discount store — but the price difference is usually not very great, and whilst you have no absolute guarantee that a hi-fi dealer's service will be any better than that from a discount store, our experience is that it nearly always is.

## INSTALLING HI-FI

With present day equipment, installation is a straightforward procedure and can be completed by practically anyone within an hour or two. Nearly all manufacturers provide detailed explanatory literature — others leave rather more to be explained by the dealer.

But the procedure is not difficult and you can almost certainly rely on your dealer for assistance if you run into any problems. Many dealers will even install the complete equipment if required.

All the interconnecting leads will be supplied and it is simply a matter of plugging these leads into the right places.

It is probable that the speaker leads supplied will not be long enough. These may be replaced by standard two-core lighting flex.

Speaker 'phasing' is important. This will almost certainly be explained in the instructions supplied with the speaker enclosures. If it is not, then ask the dealer to tell you how to do it — or even to come along and check it for you.

The record player should be level in both planes. Check that it is, with a spirit level.

An adjustment will probably be provided for setting the tracking weight of the record player tone arm. Again, instructions will be provided with the unit and adjusting to the correct weight is a simple matter.

Transistor amplifiers do not generate much heat and as long as you do not actually cover them up, it is only necessary seriously to consider

(Turn to page 122)

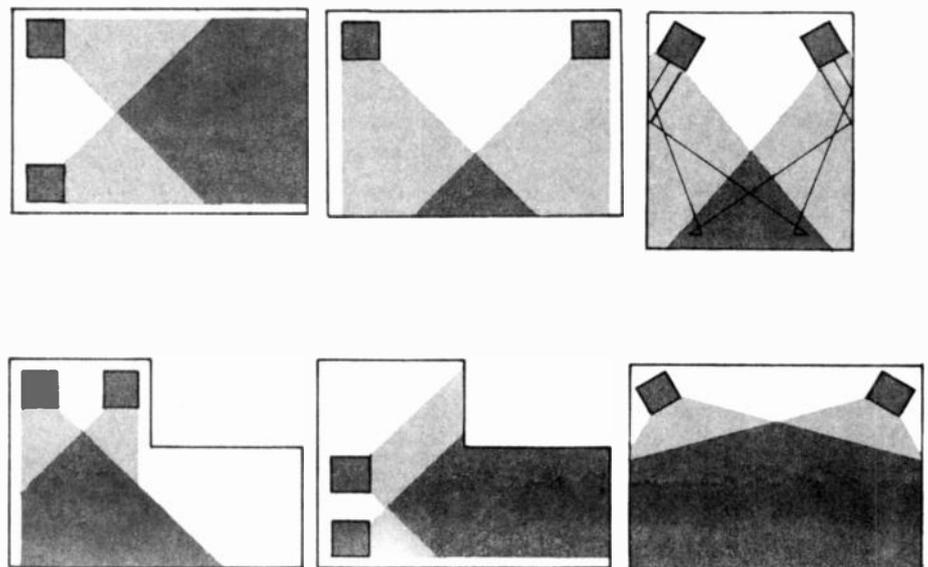


Fig. 2 Suggested speaker placings

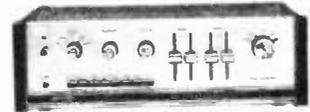
# LUX AMPLIFIERS



507X 505X 503X 708 202 700  
25 WATTS TO 80 WATTS RMS

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210 310 610  
8 WATTS TO 32  
WATTS RMS



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# GRACE 840 ARMS GRACE CARTRIDGES



G840

<b>GELESTION DITTON</b>	<b>10</b>
" "	<b>120</b>
" "	<b>15</b>
" "	<b>25</b>
" "	<b>44</b>

# LUSTRE ST 510D ARMS MICRO CARTRIDGES

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SPEAKER  
KITS**

Here's help for the budget-minded! Quality acoustic-suspension, neoprene surround speaker kits which you can fit into your own readily-made enclosures.

Ranging from the two-unit Type 10 with power rating of 40W to the Type 60 with 4 drive units and power rating of 120W, these speakers have the smooth response, superb performance, long throw woofers and matched dispersion characteristics for which Seas are world famous.

To fit cabinet sizes 10 litres (1/3 c.ft) to 60 litres (2 c.ft)

**TYPE 10.** Two drive units, 6½" woofer, 1½" dome tweeter. Frequency range, 45-20,000 Hz. Power rating 40W (Typical cabinet 14" x 8" x 7"). Suggested Retail \$44.50 ea.

**TYPE 18.** Two drive units, 8½" woofer, 1½" dome tweeter. Frequency range, 35-20,000 Hz. Power rating 60W. (Typical cabinet 17" x 10" x 9"). Suggested retail \$44.50 ea.

**TYPE 30.** Three drive units, 10" woofer, 1½" dome tweeter. Frequency range, 30-20,000 Hz. Power rating 70W. (Typical cabinet 20" x 11" x 10"). Suggested retail \$49.50 ea.

**TYPE 35.** Three drive units, 2 x 8½" woofers, 1½" dome tweeter. Frequency range 30-20,000 Hz. Power rating 120W. (Typical cabinet 22" x 12" x 9"). Suggested retail \$69.50 ea.

**TYPE 60.** (Kit illustrated.) Four drive units, 2 x 10" woofers, 1 x 6" mid-range, 1½" dome tweeter. Frequency range 25-20,000 Hz. Power rating 120W, crossover frequency 600 Hz and 3000 Hz. (Typical cabinet 25" x 17" x 11"). Suggested retail \$99.50 ea.



Specialist Interdyn agents

NSW: Encel Electronics Pty. Ltd., 260 Elizabeth St., Sydney, Tel. 212 7322.  
Q'LD: Stereo Supplies, 100 Turbot St., Brisbane 4000. SA: Challenge Hi-Fi Stereo, 6 Gays Arcade, Adelaide, 5000. TAS.: Audio Services, 72 Wilson St., Burnie, 7320. VIC.: Encel Electronics Pty. Ltd., 431 Bridge Road, Richmond, 3121. Tel 42 3762. WA: Albert TV and Hi-Fi, 282 Hay Street, Perth, 6000. Tel 2 5993.

For information write to:

sole Australian distributors:  
**INTERNATIONAL DYNAMICS (Agencies) P/L**  
P. O. Box 205, Cheltenham, Vic. 3192

# HI-FI

(Continued from page 120)

ventilation on bigger units (of 30W and over).

The length of the signal leads between the record player and the amplifier is fairly critical and affects high frequency response. If the leads are too long don't cut them — just coil them up. If too short, then move the amplifier closer to the turntable.

The two speakers should be placed about eight to ten feet apart, and for most types, raised so that the tweeters are between 3'6" and 4'6" above floor level. Figure 2 shows a number of suggested speaker placings.

Locating the speakers in the corners of the room will increase the bass output — moving them away from the corners will reduce it. Try several different speaker placings before making a final decision.

Hi-fi equipment specifically named or shown in this article has been included solely to illustrate certain points. The inclusion of any item should not be taken as an endorsement of quality, nor as any recommendation to purchase. Nor should it be assumed that other equipment — that has not been included — is in any way inferior.

## LEISTER HOT AIR TOOLS



Shrink soldering with the LEISTER KOMBI Hot Air Gun which provides hot air up to 600°C. Variety of attachments, countless applications. Ask for brochure B1 from the Australian agents.

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MELBOURNE: 163 St. George's Rd.,  
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# harman/kardon

## HK 1000

When stereo cassette decks were first introduced, "convenience & versatility" was the obvious advantage over reel to reel recorders. It was not however, until Harman/Kardon introduced its instruments, that cassette decks became worthy of the

name "High-Fidelity". Now ... Harman/Kardon introduces the HK1000 Stereo Cassette Deck: We invite comparison with ANY TAPE CASSETTE DECK IN THE WORLD, regardless of size, features or price. Your own ears will tell you that the

specifications of the HK1000 — wow & flutter, signal to noise ratio, frequency response, distortion, phase linearity, etc — are equal to many of the finest reel to reel recorders available today.

**THE HK1000 IS TRULY A WORTHY ADDITION TO THE QUALITY COMPONENTS OF YOUR PRESENT HIGH FIDELITY STEREO SYSTEM**



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**the music company**

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# EQUIPMENT NEWS

## AUTO-RANGING NANOVOLTMETER

A new auto ranging digital nanovoltmeter from Keithley features a 4½ digit display in which the last digit shows tens of nanovolts on the lowest range.

This model 180 digital nanovoltmeter provides a wide range measuring capability (from below 30 nanovolts to 2 volts) with automatic ranging. The instrument is claimed to have 0.01% resolution and an accuracy of  $\pm 0.03\%$  of reading  $\pm 0.02\%$  of full scale.

A single range control selects automatic, remote or manual ranging. Wide range measurements can be quickly performed over five decades in the automatic mode. Remote programming of ranges can be quickly accomplished by grounding built-in BCD lines. A separate line permits remote selection of either automatic or remote ranging.

Complete systems capability is provided with the addition of the optional Model 1802 digital output. The field - installable model 1802 utilizes fully isolated, open collector, BCD outputs and controls. In

addition the 1802 provides a complete set of timing outputs including clock pulse, clock interval, and flag. Multiple strobe lines enable the user to monitor specific data lines in 4 - bit sets for use with any computer or printer.

Complete input to output isolation - claimed to be greater than  $10^9$  ohms - enables floating measurement up to 500V, yet the output can be near ground potential. Output can be isolated from chassis.

The unit is protected to overloads of 50 volts instantaneous or 30 volts rms. No ambiguous reading is displayed as the 180 blanks out when a particular range is overloaded.

High normal mode rejection (greater than 90 dB) eliminates many of the problems encountered with line frequency interference. The 180's common mode rejection ratio is claimed to be better than 120 dB.

Built-in zero suppression compensates for thermal offsets generated in the external circuitry. Zero stability is said to be better than 30nV/°C.

Further details from: Warburton Franki, Box 182, Chatswood, NSW 2067.

## ANALYSER/RECEIVER

This new radio interference analyser receiver has automatic frequency control.

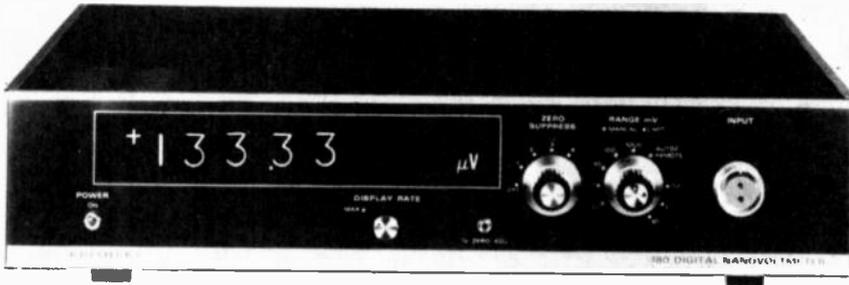
The Singer Model NM-65T analyser features single and multiple band X output, mercury switch impulse calibrator to facilitate calibration, 21.4 MHz IF output, "X" and "Y" outputs for external recording of a single band or of all bands for remote indications, and four simultaneous video outputs - log IF, linear IF FM detected and stretched linear.

Typical uses include field strength measurements of radars or microwave transmitters at varying azimuth positions, microwave scatter propagation studies and general laboratory application as a two-terminal microvolt-meter.

The instrument offers increased output indication with the output meter providing a 60dB range on a five inch scale which permits voltage measurements over a large range without changing attenuator steps.

The NM 65T can measure electromagnetic interference and field strength. It has a frequency coverage of 1-10 GHz using three selectable band widths with exceptional frequency stability with IF and four simultaneous video outputs - log IF, linear IF, FM detected and stretched linear.

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



## VARI-SPEED DRIVE CONTROLLER

A new controller primarily intended for electro-magnetically coupled variable speed machinery drives has just been announced by Western Australian company, Southerly Electronic Engineering.

Feedback ratio is set independently of speed setting, allowing system response to be optimised. The manufacturers claim that system response may be simply and precisely set in a few minutes for dead beat or overshoot (minimum response time) characteristics, as required. Basic integral time constant is 100 msec, derivative time

constant is continuously adjustable 0-500 msec.

Output voltage of the controller is continuously variable between 0-100 volts.

The claimed ease of installation and setting up, together with low power losses (no ballast resistor is required to damp the coupling coil) makes this controller an attractive unit for OEM manufacturers or as a replacement for existing thyatron controllers.

Further details from: Southerly Electronic Engineering, 34 East Parade, Mount Lawley, Western Australia 6050.

## ELECTRO-MECHANICAL VIBRATOR

Advanced Dynamic Instruments, a division of Electrodyne Inc., of the U.S.A., now has available a 50 force lb vibrator model AV-50 LS, claimed to be ideally suited for modal studies or flutter testing of structure. The AV-50 LS thruster has virtually zero axial spring stiffness, and, therefore, is suited for precision resonant frequency and damping experiments. The thruster utilizes a hardened shaft for connection to the test specimen and dual linear bushings for alignment and maximum radial stiffness. Stroke of the AV-50 LS thruster is 1.0" peak to peak.

Further details from: British Merchandising Pty. Limited, GPO Box 3456, Sydney 2001.



## DATAVISION CHARACTER GENERATOR

The Datavision range of character generators provides a flexible and inexpensive means of generating supplementary character information for display on television screens.

Large, 32 scan-line high characters can be displayed in up to eight rows with 16 characters in each row, or alternatively, as a one line horizontal crawl across the screen.

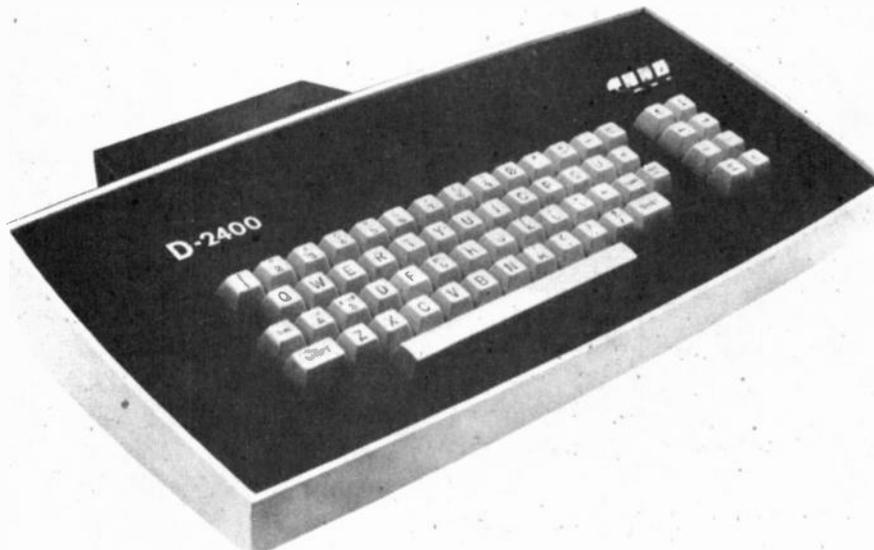
The D-2400 is an entirely self contained portable unit. Information can be produced from a keyboard input for immediate imposition on any video picture. Alternatively, information can be stored for up to a four page capacity for subsequent presentation when required. This could mean, for example, having up to 32 one row

titles in store. Furthermore, a two channel capability allows for any one of the four stored pages to be displayed via the programme video output channel, while another and different page is being composed or revised on the preview channel.

Additional storage capacity is available through a relatively inexpensive option facility, which allows a model D-2400 operator to store information "off-line" on any audio magnetic tape recorder. This facility is extremely useful for frequently used repeat material.

The equipment is colour compatible, and is claimed to feature all the facilities required by TV stations and users of closed circuit television systems.

Further details from: Plessey Electronics.



## SELF CHECKING MULTIMETER

It isn't necessary to remove this new Hewlett-Packard digital multimeter from a system to check its readiness to make measurements. A built-in microprogrammed subroutine lets the user quickly check calibration - or isolate trouble from the front panel.

Sixteen front-panel tests are designed to save time in calibration and locating malfunctions. Several tests, individually and in combination, show the user the operation condition of the instrument. Each test interrogates an internal parameter and displays the results on the front panel. Results are compared with proper values given on a pull-out instruction card. Among the tests are a series of logic tests, measurement of ratio amplifier offset and measurement of the reference voltage.

This new Hewlett-Packard Model 3490A Multimeter measures dc from 0.1 to 1000 volts in five ranges, and ohms from 100

ohms to 10 megohms in six ranges. Ac is measured from 1.0 to 1000 volts in four ranges. Results appear on HP 5½ digit solid-state numeric readout.

Input impedance on dc is greater than 10<sup>10</sup> ohms on the three lower ranges for accurate measurements of high impedance sources.

All ohms ranges provide true 4-wire measurement capability. Maximum current through the unknown is about 1mA and overvoltage protection guards against high voltage inadvertently applied to the ohms terminals.

### Systems Options

Several options give the Model 3490A the necessary versatility to become a low-cost instrumentation system. Both an ASCII character serial interface and a BCD character parallel interface are available.

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



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10 PROJECT ELECTRONIC KIT, NO.28202, 10 working projects, SOLAR BATTERY, builds radios, oscillators, signal generators, all solid state. \$7.50 p.p. .75c

15 PROJECT ELECTRONIC KIT No.1544, learn electronics with each project. Build these, morse code oscillator, radios, alarms, sirens etc. \$9.90 p.p. .85c

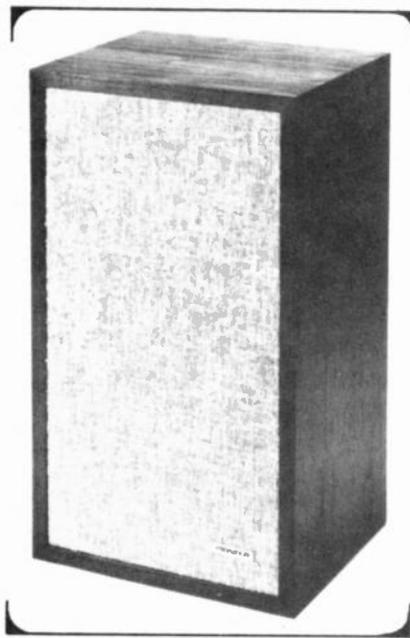
IC-20 20 PROJECT ELECTRONIC KIT, learn about integrated circuits with this educational kit, 20 working projects including integrated circuit. \$11.90 p.p. .95c

50 PROJECT KIT No.28201 DELUXE MODEL, 50 working projects, educational entertaining, all solid state, includes everything, nothing to buy, constructed in hardwood case, panel meter, radios, amplifiers, burglar alarms, tachometer, test equipment, good value - \$19.50 p.p. \$1.20

DELUXE 150 ELECTRONIC PROJECT KIT using integrated circuits. Contains all parts for 150 different working projects including I.C. diode & transistor radio, electronic switches, relays, alarms, test equipment, etc. etc. Very good value, Prices \$30.95, p.p. .95c.

# guts

## CS-E450



A new speaker from Pioneer with the gutsy 'English sound'. This year's 'star' of the Hi Fi Audio Show. CS-E450. 10" air-suspended cone woofer, finned dome tweeter, hermetically sealed enclosure. A speaker with crisp smooth bass and a constant even response through 30-20,000 KHz. See the CS-E450 at your Pioneer dealer.

**\$135** suggested retail price.

#### SPECIFICATIONS.

*Speakers:* 10 inch (25 cm) cone type woofer, 1 inch (2.5 cm) 2 way system finned dome type tweeter.

*Frequency range:* 30 to 20,000 KHz.

*Maximum input power:* 50 watts (RMS 25 watts).

*Impedance:* 8 ohms.

*Sensitivity:* 87 DB/W (at 1 m distance).

*Crossover frequency:* 2,000 Hz.



# PIONEER

High fidelity stereo — that's how perfection sounds.

AS-178-V

## EQUIPMENT NEWS

### LOW COST COMPUTER HARD COPY PRINTER

Now available from DC Datagraphix is a low cost printer for video terminal and minicomputer users with hard copy requirements.

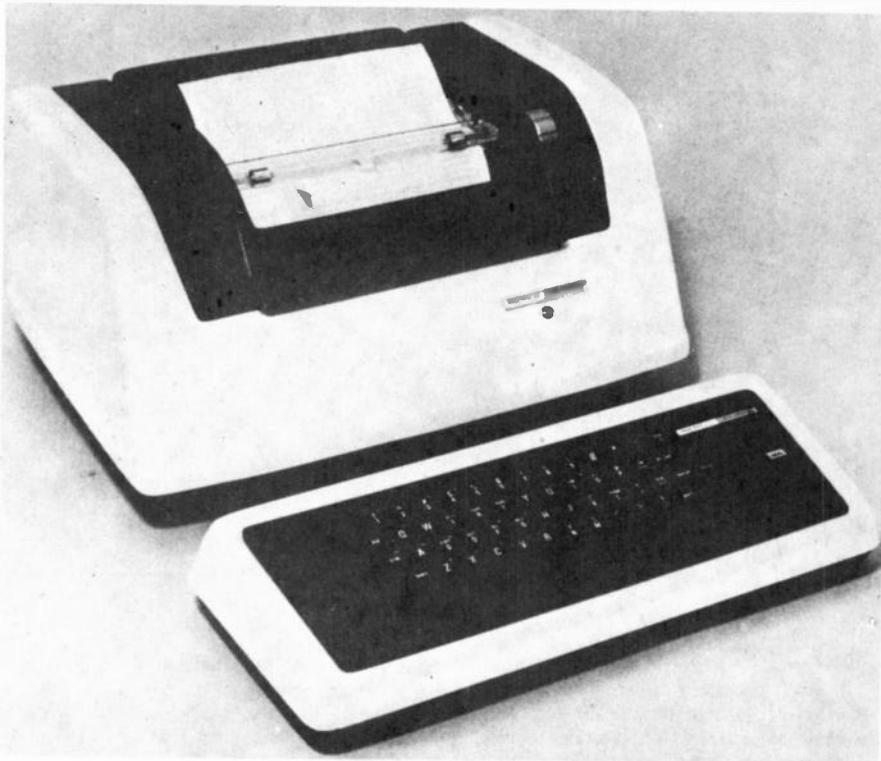
The Repco 120 is a low cost, impactless printer designed to interface with CRT terminals, minicomputers or other remote data terminals. The printer operates at up to 120 characters per second with 80 characters per line, six lines per inch vertically.

Other features include quiet operation through impactless printing on electrosensitive paper, long life assured by integrated circuits, low cost and attractive design.

The unit when interfaced with a modem can be used as an input/output terminal over telephone or private wire communication lines.

It has been designed to handle serial (RS 232B) data, or parallel (TTL levels) data of 64 character standard ASCII code.

Further details from: DC Datagraphix, 32 Smith St., Collingwood Vic. 3066.



### NEW DVM RANGE

Schlumberger announces a completely new range of 12 digital voltmeters using modular construction and designed to allow the user to optimise the instrument for the application.

Named the 'Master Series', the voltmeters in the range use dual slope integration to achieve a high degree of noise immunity. All models operate at a sampling rate of 10 sample/s, but on certain models a remote programming facility allows faster rates, of 25 and 100 sample/s.

The main features in the design of these instruments claimed to ensure high accuracy and long-term stability are:

1. A stabilised reference source using a carefully selected Zener diode to give a stability of better than 20 parts in  $10^6$  over a period of one year;

2. Dual ramp integration to minimize system errors. The internal circuits are drift-corrected between each reading on a time-sharing basis;

3. A fully chopper-stabilised input

amplifier to give low drift rates and long-term stability.

4. Options of programmable and remote-control operation;

5. To cater for systems applications the front-panel controls are easily inhibited.

Typical instruments in the range are the models A200 and A203 meters. The A200 has input sensitivities from 1  $\mu$ V to 100 mV, giving a nominal measuring range of 0-10 mV up to 0-1 kV in six ranges. The input impedance is 1 G $\Omega$  on the low range and 10 G $\Omega$  on the intermediate ranges and 10 M $\Omega$  on the high-voltage ranges. Auto-ranging is provided on this d.c. meter, and the input stage is fully floating and guarded.

The model Z203 has the additional capability of five a.c. mean sensing and five resistance ranges from 0-1 k $\Omega$  to 0-10 M.

Some of the additional units available include fanout units, printers, online calculator for linearising etc., recorder drive unit, a ten-input programmer and a current adapter for d.c. and a.c. measurements.

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

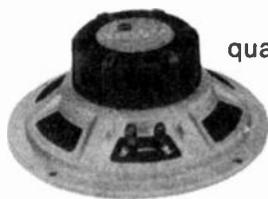
# When uncompromising fidelity is essential

## Plessey products are specified.



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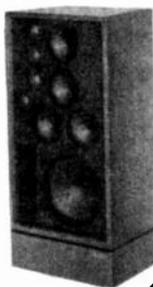
Plessey professional recording machines have become standard equipment in broadcasting and sound studios throughout the world.



Hi Fi enthusiasts have learned that Plessey loudspeakers, kits and enclosures meet their demands for perfection without injuring their wallets. Plessey has a long standing reputation for

In the field of sound reproduction, Plessey has but one aim: **to produce the best in high fidelity**

Manufacturers of high quality radios and record playing equipment choose Plessey components as a matter of course.



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

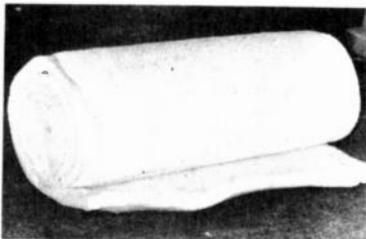


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# EQUIPMENT NEWS

## WIRE PREPARATION UNIT

A new wire preparation unit has been announced by the Electronic Products Division of Gardner-Denver.

This numerically controlled unit, Model 14YA, provides precision wire cutting and stripping of solid wire for high or low volume production.

The new 14YA wire preparation unit is designed for use as an on-line system with terminal locator (semi-automatic) wiring equipment. The 14YA may also be used as a bench mounted unit to provide cut-and-strip wire in bulk quantity.

Further details from: Gardner-Denver (Aust.) Pty. Ltd., 185 Briens Road, Northmead, NSW 2152.



## SWITCHING POWER SUPPLIES REDUCED IN SIZE

By eliminating the conventional mains transformer and heat sinks and incorporating novel design features, the size of a direct off-line switching power supply has been greatly reduced.

Another feature of the new Advance unit is its increased efficiency compared with conventional series-regulated power supplies.

Direct rectification of the mains supply at the incoming voltage makes the usual 50 MHz mains transformer unnecessary. The rectified voltage drives a pair of inverter transistors operating at a frequency of approximately 30 kHz. The latter, in turn, drive a high-frequency step-down transformer whose output is rectified by barrier diodes to provide a 5-V output to a choke. This integrates the modulated waveform which is of rectified pulse width.

Output is stabilised by varying the conduction time of the inverter transistors, thus rendering unnecessary the series elements carrying output current found in conventional equipment.

These special design features enable the manufacturer to produce a complete switching power supply of a smaller size than the mains transformer alone which forms but part of a comparable linear unit. Weight of the new unit is only 7½ lb (3.4kg) compared with 45lb (20.4kg) for

conventional equipment of similar switching capacity.

Output efficiency of the units is claimed to be 75 to 80 percent so that heat dissipation is low and a fan cooling system is not needed.

Further details from: Jacoby Mitchell Pty. Ltd., 215 North Rocks Road, North Rocks, NSW 2151.

## FREQUENCY DIFFERENCE TO 1 IN 10<sup>11</sup>

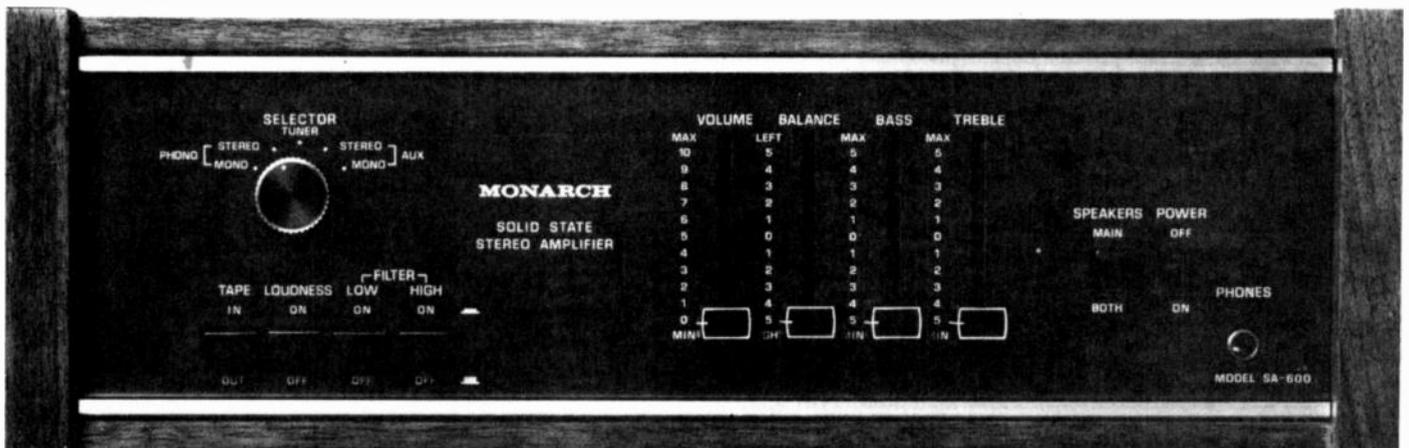
The new Tracor Model 527A Frequency Difference Meter is designed for instant determination of the fractional frequency difference between two stable oscillators instantaneously, to an accuracy claimed to one part in 10<sup>11</sup> or better.

The fractional frequency difference is displayed on a front-panel, centre-zero meter, with a front panel oscilloscope indicating the phase relationship of the two input signals. By observation of the oscilloscope over a period of a few minutes, and using time averaging techniques, the 527A's accuracy can be extended to one part in 10<sup>12</sup>.

An external recorder output provides a dc voltage proportional to the frequency difference for presentation on a chart recorder. Thus the frequency change rate and long term stability between two

*(Continued on page 131)*

# Mighty music maker Monarch



## THE PROFESSIONAL AMPLIFIER FOR PERFECTIONISTS WITH A LIMITED BUDGET

Like all Monarch amplifiers SA600 gives you savings of up to \$100 over other amplifiers of similar performance. 22 watts per channel of clean undistorted power — enough power for any speaker system. All silicon transistor circuitry means low noise. Harmonic distortion of 0.8% for transparent sound. Four slide controls for bass, treble, balance and volume. Main and remote speaker connections. High and low filter. See and test the SA600 at your Monarch dealer — you'll agree, for your dollar, the most flexible comprehensive amplifier available.

GUARANTEED FOR TWO YEARS!

**MONARCH SA 600** **\$139**

Recommended retail price:

AUSTRALIAN DISTRIBUTORS

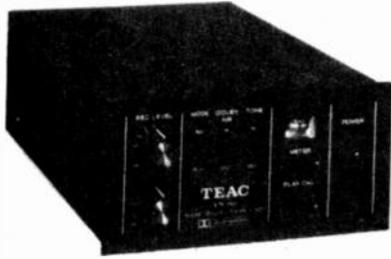
**WEDDERSPOON**

W. C. WEDDERSPOON PTY LTD

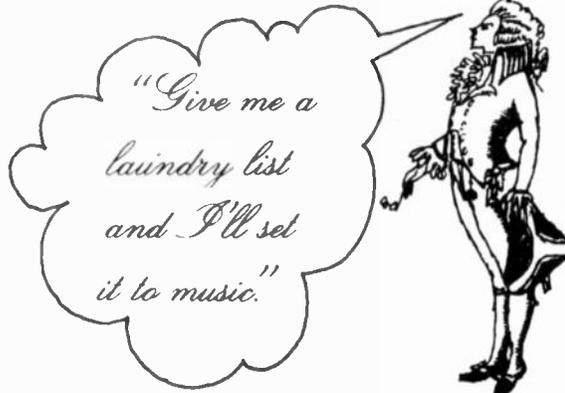
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# TEAC's AN-60, AN-80 and AN-180 Noise-Reduction Units.



TEAC AN-60



**If Rossini were alive today, he would set their specs to music.**

Rossini once made this boast and could probably have delivered. But a recording of the music on the best of today's cassette or reel-to-reel machines with their inherent noise and hiss could never capture the clean, crisp sound of the Rossini laundry list.

With the introduction of TEAC's AN-180 Dolby\* Noise-Reduction Unit, Rossini's Laundry Largo and just about anything else you record will have the same brilliance and luster as the original.

Our Dolby circuit removes machine and tape noise with such thoroughness that there is a signal-to-noise ratio improvement of 3 dB at 600Hz, rising to 5 dB at 1000Hz and 10 dB at 4K Hz and above.

Because we manufacture the ICs used in our Dolby circuit to extremely tight tolerances, ours operates at distortion levels of less than .3% — lower than many competitive units. So you see there is no question that you should have a TEAC Dolby Noise Reduction Unit.

We designed the deluxe AN-180 not only to Dolbyize fine decks, but to afford them features they might be missing.

It's actually a simultaneous record-playback control center with its own record and playback amps. It has built-in mike and line preamps that maintain mixing capability, or add this capability to recorders not so endowed.

TEAC AN-80



TEAC AN-180

It has large professional-type VU meters for Dolby level setting as well as record/playback level indicators. AN-180 also incorporates such features as an internal 400 Hz, 100 Mv oscillator level controls, source/tape monitoring and a multiplex interference filter.

Even without Rossini to write a setting for the AN-180 specs, they make such beautiful music.

- Frequency Response, 20-15,000Hz  $\pm$  5 dB • Increased SN Ratio, 10 dB at 10,000Hz • Harmonic Distortion, below 0.3%
- Signal to Noise Ratio, better than 65 dB • Channel Separation, better than 55 dB

If you just need the best no-nonsense Dolby with none of the frills, ask your dealer about the TEAC AN-80 and AN-60

\*Dolby is a trade mark of Dolby Laboratories, Inc.

**TEAC** A Sound Idea If you'd like to know more write to us for the TEAC Catalogue, price list and franchised dealer.

Sole Australian Distributors: Australian Musical Industries Pty Ltd., 155 Gladstone St., South Melbourne Vic. 3205 Ph. 69-7281  
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AMI 113

# EQUIPMENT NEWS

oscillators can be determined by recording the dc output against time.

The Frequency Difference Meter has many applications including the adjustment of oscillators to the same frequency, frequency difference measurement, offsetting of one oscillator from another by a specified amount, add the analysis and measurement of short and long term oscillator stability.

The 527A accepts any combination of inputs, with nominal frequencies of 100kHz, 1MHz, 2.5MHz and 5MHz. No switching is required when input frequencies are changed. A switchable inbuilt crystal filter also enables operation with relatively noisy signals inputs.

The bench model is 16.875 inches wide, 3.5 inches high and 12.75 inches deep. Rack mounting is achieved by the use of detachable mounting plates.

Further details from: Instrumentation Division, Racal Electronics Pty. Ltd., 47 Talavera Road, North Ryde, 2113.

## PORTABLE EIGHT-CHANNEL COMMUNICATIONS RECORDER



As an extension to their XMN-range of portable 1, 2 and 4-channel communications recorders, the audio systems department of Philips Industries have now announced an 8-channel version designated XMN-8. Designed for continuous use and fitted with a fail-safe fault detection and alarm indication system, the new XMN-8 is claimed to provide an economic way to ensure a word-for-word record of all incoming and outgoing messages at air traffic control units and other communications centres. The recorder is specially recommended for the smaller type of airport where budgetary reasons prohibit the use of more expensive rack-mounted machines. It will also come in conveniently on large airports where a limited extension of the number of communication channels requires a little extra recording capacity.

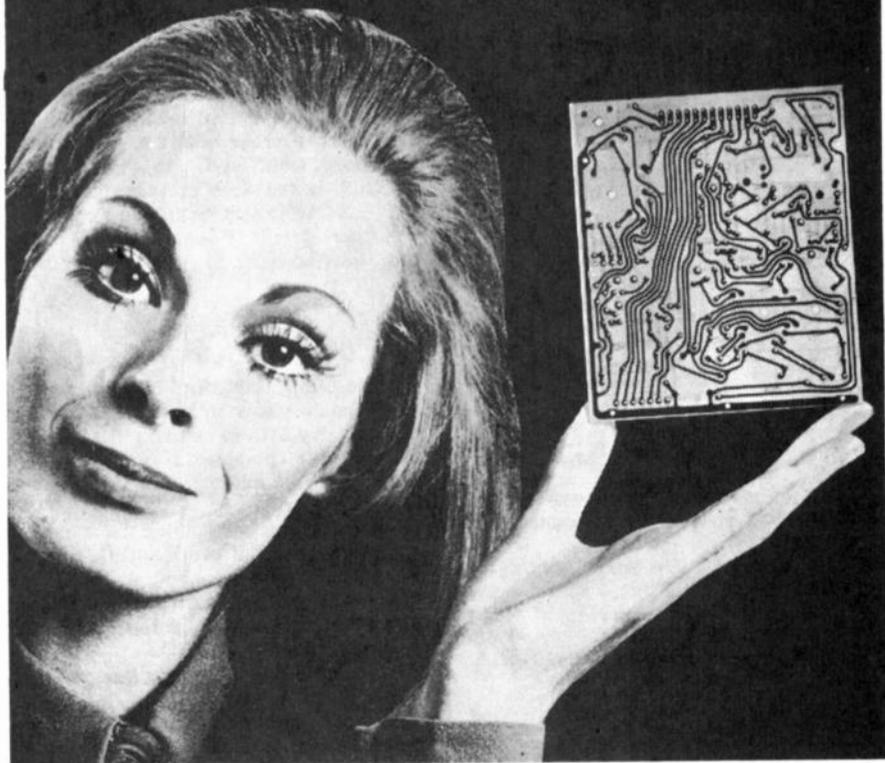
# Adcola solves printed circuit soldering problems

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Output power 4.5W RMS.  
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# COMPONENT NEWS

## IC INSTRUMENTATION AMPLIFIER

Analog Device's AD520 is claimed by the manufacturers to be the first instrumentation amplifier to be manufactured in integrated circuit form. It is a closed loop gain block with differential inputs and an accurately predictable input-to-output gain relationship. The AD520's performance is unlike that of conventional IC operation amplifiers because of an internal feedback design which permits gain adjustment from 1 to 1000 by varying the value of a single resistor. Further, high input impedance is achieved at both inputs and both input impedance and CMRR remain high at all gain settings.

The AD520 performs like a modular instrumentation amplifier. Because of its monolithic construction, however, its cost is below that of modules. The device features low bias and offset currents, high gain linearity, excellent frequency response, and is short circuit protected and offset voltage nullable. Thus it is suited for all general purpose, high accuracy amplifier requirements. Its small size, complete-on-a-chip ease of application offer the circuit designer an attractive alternative to both modular instrumentation amplifier packages, and user-wired collections of IC op amps and high-precision external components.

Both the AD520J and AD520K are supplied in a 14-lead hermetically-sealed dual-in-line package, and are specified for operation from 0°C to +70°C. The AD520S, in the same package, is specified for -55°C to +125°C operation.

Further details from: Parameters Pty. Ltd., 68 Alexander St., Crows Nest, 2065

## REPCO CONTROLS

Repco Controls Pty Ltd has been formed in Melbourne as a subsidiary of Lorimier Contacts Pty Ltd, to combine the activities of electronic components distributor W.G. Booth Pty Ltd, and the industrial products division of Lorimier.

Repco Controls will develop the marketing of a wide range of professional electronic components including Bourns, RCL, AB Electronics, Sprague Semiconductors, and Mallory capacitors through the W.G. Booth division.

The manufacture and marketing of relays, solenoids, solid state timers and other electronic control devices will be carried out through the industrial products division of Lorimier Contacts.

In Sydney and Adelaide, the branch offices of Lorimier and W.G. Booth will now trade under the new name. Lorimier Contacts Pty Ltd, a division of Repco Ltd, will concentrate its own manufacturing and marketing activities on its well established position in automotive electrical products.

Mr Geoff. S. Drury has been appointed general manager of Repco Controls Pty Ltd.

He was formerly general manager Victorian operations Jacoby Mitchell Pty Ltd, and before that Victorian manager Racal Electronics Pty Ltd.

## PRINTED CIRCUIT BOARD BROCHURE

New literature available from Plessey Rola Pty. Ltd., details the company's product range available in printed circuit boards, and describes the advanced techniques and exacting quality control procedures used in its Melbourne manufacturing plant.

Both the photo print and screen printing methods of manufacture are employed.

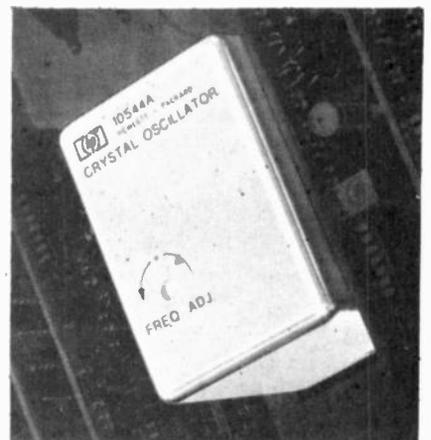
Tolerances on the printed image can be held within .005" of the artwork, while less than .010" in line widths can be achieved with photo print techniques.

Boards can be produced in finished sizes up to 18" x 18", or larger in one dimension. Profile tolerances can be maintained within .002" as required.

Materials for the boards may include epoxy paper or gloss, phenolic paper, polyester glass, and others, such as for flexible type boards.

Plessey is a major supplier of electronic components and equipment in Australia, and is itself a big user of printed circuit boards.

## PRECISION CRYSTAL OSCILLATORS



New miniature quartz oscillators from Hewlett-Packard have specifications like those of laboratory secondary standard instruments. Yet they are small enough to mount readily in typical PC configurations for use in instruments, communications and navigation equipment - fixed, mobile, portable or airborne.

Aging rate is claimed to be five parts in 10<sup>10</sup> per day (that's less than 5/100 of a second in a year) - reached within 24 hours after being off for 24 hours. The crystal warms up quickly reaching stable frequency within less than 5 parts of 10<sup>9</sup> after only 15 minutes.

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

# There's nothing new about ADVENT LOUDSPEAKERS ... just something better

Advent loudspeakers have acoustic suspension systems, the basic design concept of which was developed twenty years ago. And literally millions of acoustic suspension systems have been built since. As a matter of fact Henry Kloss, the President of Advent Corporation has been responsible for building most of them. He built them at Acoustic Research, he built them at K.L.H., (he was co-founder of both) and with this experience behind him, he now builds them at Advent. Only experience has taught him how to build them better.

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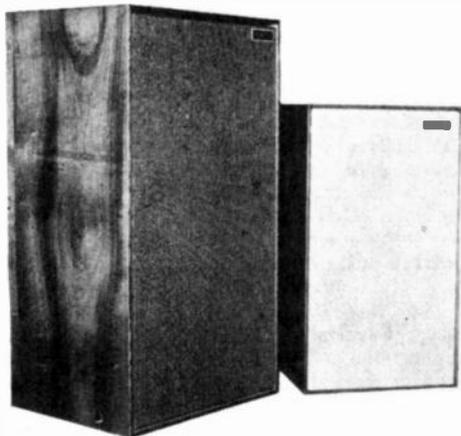
## The Advent Loudspeaker.

This loudspeaker can be positioned on a shelf or on the floor. It's perfect for the average-sized lounge, filling it with sounds of remarkable clarity range and depth.  
Price \$169 each.

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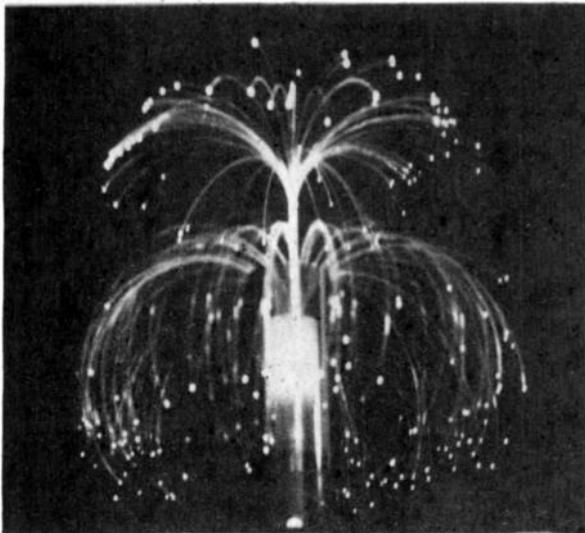
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OP3006	30 mil	mono-fiber	36 feet	\$ 5.75
OP4503	45 mil	mono-fiber	18 feet	\$ 4.31
OP4506	45 mil	mono-fiber	36 feet	\$ 8.27
OP7076	.087 mil	light guide	6 feet	\$ 2.75
		7 x .017		
OP7193	.120 mil	light guide	3 feet	\$ 2.75
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OP7196	.120 mil	light guide	6 feet	\$ 4.67
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OP7373	.152 mil	light guide	3 feet	\$ 3.35
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OP7376	.152 mil	light guide	6 feet	\$ 5.87
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# BOOK REVIEWS

REVIEWERS: Brian Chapman,  
Jan Vernon.



MODEL CAR RACING BY RADIO CONTROL by George Siposs. Published 1972 by TAB Books. Soft covers 224 pages 8½" x 5½". Review copy supplied by Grenville Publishing Company Pty. Ltd., Australian price, soft covers \$4.95, hard covers \$8.70.

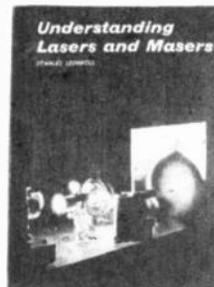
Model car racing is big business in the USA but has not really caught on in Australia, perhaps mainly because of the requirement for a well laid out "scale" race track which needs to have dimensions of between 100ft by 50ft and preferably 200ft by 100ft.

Mr. Siposs' first book (published 1970) "Car Racing by Radio Control" was written in answer to letters from hundreds of hobbyists all over the world requesting information on this new sport which was established in California by a small group of enthusiasts. The book sold out almost immediately. A slightly revised second edition was published in 1971, and this new volume which is completely revised and includes much new material, in 1972.

The book is not concerned with the internal workings of radio control gear, merely what you can do with it. The main accent of the book is on principles and construction of the model cars themselves, and the technique, etiquette and organisation of model-car racing.

Sections are included on engines, power trains, suspension systems, chassis, building a car, driving technique and remote control gear. Additionally there are sections on trouble-shooting and the organization of race club activities. At the end of the book an excellent section provides reference sources for those who want to pursue the subject further.

An excellent book for anyone interested in this new sport. — B.C.



UNDERSTANDING LASERS AND MASERS by Stanley Leinwoll. Published by Iliffe Books London 1965. Soft covers, 87 pages 8½" x 5½". Review copy supplied by Butterworth Pty. Ltd., Australian price \$3.10

In 1960 the first laser was built, this followed on the development of the maser in 1954, and a paper by A.L. Schawlow and C.H. Townes in 1958 proposing that an optical maser was possible. Maser is an acronym for Microwave Amplification by the Stimulated Emission of Radiation, and is a method of utilizing the energy states within atoms to produce electromagnetic radiation.

Similarly the word laser has the same meaning with respect to radiation within the visible spectrum, that is, light.

When first introduced the laser was more of a scientific curiosity than a useful device, as no-one really knew how to put the thing to work. Since that time however, laser usage has increased at an astounding rate and one is continually amazed at the places where lasers are finding application.

The laser has in fact created an enthusiasm amongst scientists, engineers and laymen which has rarely been equalled. One potential application however is a little disquieting — that of laser weaponry.

This book will fill the need of those in electronics and other technologies to know what lasers and masers are, how they work, what the applications are, and likely future developments. It is a most readable and worthwhile book. — B.C.

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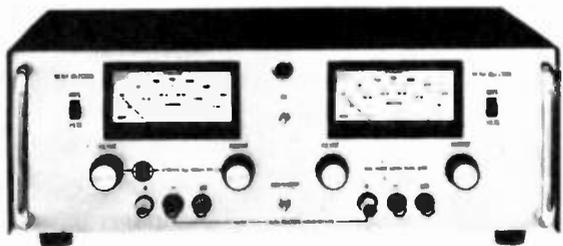


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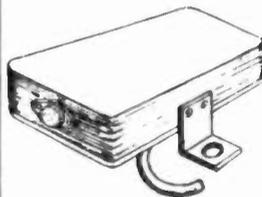
## NEW KITS

- Logic I.C. Power Supply as described in November '72 E.T.I. Complete Kit: \$18.90 Post 75c.
- Digital Frequency Meter. See September E.T.I. for all details. Kit Price: \$74.50 plus the readouts.
- Fluorescent Light Inverter for 12V operation. See November 1972 E.T.I. Kit complete including diecast box and connectors, not fluorescent tube. Kit Price: \$14.50.

**THANK YOU...** For another successful trading year. This has been perhaps our most satisfying trading year since our operation commenced some 7 years ago. We have made many new friends and extended our services to many thousands of new clients throughout Australia.

As the year closes, we trust that 1972 was a successful year for you too... now the management and staff of the Kit-Sets Aust. group extends to all Readers our best wishes for the coming Christmas and New Year.

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**BRISBANE SALES DEPT:** 293 St. Pauls Terrace, Fortitude Valley. Phone 52-8391.

**Canberra Distributor:** Electro Pak, 5 Garama Arcade.

**Newcastle Distributor:** Varcoe-Bennett, 2 Third Avenue, Lambton North.

# BOOK REVIEWS

**WORLDS – ANTIWORLDS – ANTIMATTER IN COSMOLOGY**  
 by Hannes Alfvén, (translated from Swedish by Rudy Feichtner),  
 103 pages – W.H. Freeman and Company, San Francisco &  
 London 1966.

Hannes Alfvén (winner of the 1970 Nobel Prize in Physics) divides his time between the Royal Institute of Technology, Stockholm and the University of California, San Diego. He writes in Swedish. The original Swedish title of this book is *Varlden – spegelvarlden: Kosmologi och antimateria*. The English title means the same but its Wagnerian splendour loses a little in translation. But this does not apply to the book itself. It is readable, fascinating and thought provoking.

It presents a theory of the development of the galaxies which is not as well known as the most quoted theories but will no doubt attract more interest as further discoveries are made about anti-matter.

The theory originated with Doctor O. Klein, former Professor of Theoretical Physics at the University of Stockholm. Klein's model of the development of the metagalaxy assumes that there is symmetry between matter and antimatter and that the primordial state was a thin ambiplasma (a mixture of plasma and antiplasma) contracting under the influence of gravitation. Before this stage, space consisted of radiant energy. This radiation generated the proton-antiproton pairs, the primordial ambiplasma.

The present metagalaxy, says Klein, developed from a process of contraction due to gravitational attraction, annihilation as proton-antiproton, radiation of gamma rays and radio waves as a result of annihilation, and expansion as the pressure of radiation stopped contraction.

This expansion is occurring at the present time as manifested in the red shift of galaxies. At the same time condensation occurring within the metagalaxy (by virtue of gravitational irregularities) forms the galaxies which, consisting of ambiplasma, produce intense

radiation as they contract and it is the intensity of this radiation which brings about the separation of matter and antimatter eventuating in galaxies in their present state.

Separation without complete annihilation would seem a flaw in the theory but Alfvén draws a parallel with the Leidenfrost phenomenon in which a drop of water on a hot plate at a sufficiently high temperature does not instantly evaporate because it is insulated by a thin layer of water vapour. Lower the temperature and the drop vanishes in a small explosion.

When matter and antimatter meet, some will be annihilated but the intense radiation will keep the main masses separate.

Alfvén's book is a careful and imaginative description of Klein's theory showing why the theory is possible.

His purpose is "to see how far we might go in cosmological speculation without having to introduce new natural laws".

There are chapters on cosmology and natural science, present and past theories of the creation of the metagalaxies, plasma physics and a chapter on matter and antimatter.

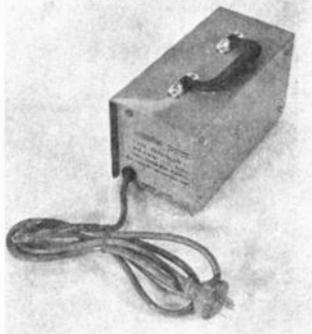
This latter chapter describes the structure of matter and the discovery of the positron and the antiproton. If matter and antimatter exist in the separate amounts, how are they distributed? As possible answers, the author says that every second star may be antimatter, or every second galaxy, or even half of our own solar system. With our present technology we cannot tell.

There is something very attractive about any discussion of this subject. Perhaps the thought that within our own solar system there may be planets which we can never land upon – we would be instantly annihilated. Or it is perhaps the symmetry that appeals to us?

Alfvén writes very convincingly – he gives antimatter more status in his book by always referring to matter as *Koinomatter* (from the greek "Koinos" common or well known), therefore he implies antimatter exists in the metagalaxy.

But whether it does is at present not known. Arguments for the existence of antimatter (apart from laboratory experiments) include radio stars, quasars and other celestial objects with enormous energy outputs. Still he points out that it is beyond our powers at present to demonstrate that antimatter does or does not exist in the universe.

So what we are left with is our accumulation of observations, natural laws and fascinating theories. – Jan Vernon



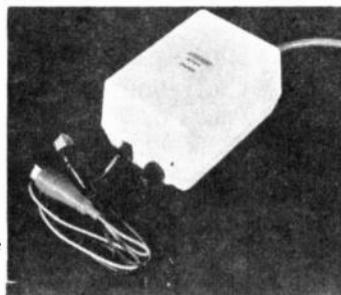
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Ferguson products are available from electrical and radio wholesalers and  
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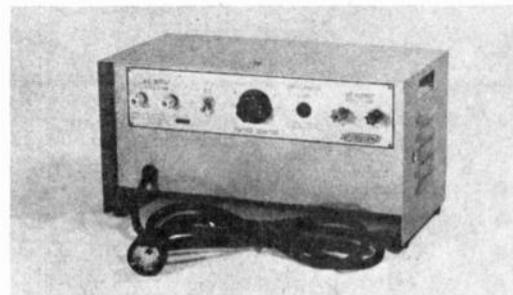
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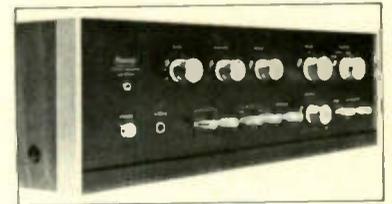
When you're considering the purchase of a complete new stereo system, the control amplifier is the key to the whole program. So it's worthy of detailed analysis.

There are six audibly superior control amplifiers in the Sansui range . . . from 30 watts RMS to 100 watts RMS. All feature *all-silicon* transistor design — and distortion is considerably *less* with Sansui control amplifiers, as output stages are semi-complementary Darlington designs without *input* or *output* transformers. Transformers have always caused some distortion problems in amplifier design — but not with Sansui!

The startling difference you will notice with any Sansui stereo amplifier is the *tonal*

*quality* and the obvious *dynamic range*. In every price bracket your new Sansui amplifier sounds like a much more expensive unit. These are not idle words. In the review of the least expensive Sansui amplifier, the AU-101, a leading Australian journal said . . . "*... few amplifiers, regardless of price, give an overall test result as good as this*". Another review said . . . "*... better than most other amplifiers at twice the price*". With those comments made about the AU-101 (recommended price \$149) can you imagine how effective the other models in the Sansui range are? With more power and, let's face it, higher price tags?

*Let's look at the complete Sansui stereo amplifier range:*



MODEL	POWER RATING at 8 ohms.	FREQUENCY RESPONSE	REC. PRICE
AU-101	30 watts RMS	20-60,000 Hz. $\pm 2$ dB.	\$149
AU-505	50 watts RMS	20-60,000 Hz. $\pm 2$ dB.	\$199
AU-555A	50 watts RMS	20-40,000 Hz. $\pm 1$ dB.	\$237
AU-666	70 watts RMS	10-40,000 Hz. $\pm 1$ dB.	\$325
AU-888	90 watts RMS	10-70,000 Hz. $\pm 1$ dB.	\$403
AU-999	100 watts RMS	5-100,000 Hz. $\pm 1$ dB.	\$460

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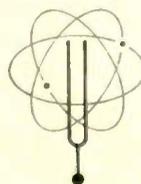
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AR49

REVIEWER: John Araneta

**TCHAIKOVSKY** – Symphony No. 4 in F minor – George Szell, London Symphony DECCA SPA 206.

There are at least twenty-two recordings of this symphony available. It may sound perverse to say it, but I rather think it a testimony of how difficult this symphony is to bring across that most of these recordings range from the mannered to the larger majority favouring safe, straight and generally indifferent readings. None of these recordings can wholly efface my memory of a live performance at the end of which the audience got up spontaneously to cheer Seiji Ozawa. One reads of such things after a Tchaikovsky concert by Kussevitzy, Furtwangler, Mengelberg, among others. I am hardly suggesting the revival of scoopy playing, excessive rubato, or vibrato these conductors were often capable of. Tastes change after all. But how many conductors today perform romantic works with true *accelerandi* and how many such works fail to make any effect because they must make do with sudden interchanges of dynamics or rhythm. I may not ordinarily take to the Schumann Fourth but Furtwangler's recording does make me feel there are few conductors around for this music. If mannered readings of the Tchaikovsky Fourth no longer present a solution for us, neither are straight readings the complete answer. Most straight readings of this work seem to fall back with the realization that difficult enough as it is to present a coherent idea of the structure behind say, the first movement, it also seems safer not to accept that heroic intensity called for by content, thus not lapsing into vulgarity or mannerism. But I feel this separation between "playing" and "feeling" accounts for many dull or straight readings of romantic literature. Feeling is in the proper comprehension of how certain characteristics of romantic works should be treated: like *accelerandi*, transition passages (it seems easier to give attention to these in earlier music), the intensifying of sound gradually but surely – a demand in short that a conductor be creative as well.

Until the present recording came along, I was quite prepared never to hear on records a performance of the Tchaikovsky Fourth that would try to combine creativity with our present desire for fidelity to the printed score. Is this much heralded Szell release the Fourth we have been waiting for. Yes, almost. Almost, because there are times when Szell shows a Toscanini-like unwillingness to linger and intensify. (What a baleful influence has Toscanini been to modern conductors. Which does not mean he was incapable of creative conducting.) But there are far too many moments in this performance which must put this version at the very top of the list. Listening to the first movement I was first of all glad the initial statement of the motto theme was arresting enough and (thankfully) unmannered, the playing of clarinet and bassoon before the exposition beautifully piano then pianissimo. The exposition moves forward

as it seldom does. No divorced sections, transitions treated with value, so that I was soon wondering what sort of performance this might be. But at the entrance of the timpani at 70, one knew this performance would be different from any other. Perhaps even after a fourth playing I feel Szell a bit unbending but one cannot help but wonder at the care and drive of this first movement. This is certainly the best structured and controlled first movement I have heard.

I think the second movement rather reserved and while Szell's fast treatment of the principal theme is unusual it is also effective and gives a strong feel of drive and character. The playing from 170-80 is true expressive playing, beautiful. The Scherzo is light, built up steadily and never vulgar. The virtuoso playing up to this point leads one to wonder what the finale will be like. But one hardly expects the unnerving series of true *accelerandi*. The speed of the playing must be heard to be believed, and more important the panache and accuracy. Every section follows into place unerringly and yet there seems no rush. The return of the subordinate theme is eloquently energetic and at 220 the rit. is unforgettable. As the movement draws to a close I doubt if anybody can suppress astonishment at the steady but intense control as everyone gives their all.

This record was made in the early sixties but the sound is quite good if not as startlingly clear as those of more recent vintage. At \$2.99 you cannot not have this record. Even if you are tired of Tchaikovsky. – J.A.A.

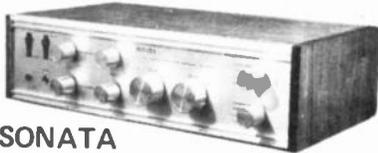
**CHOPIN** – 4 Ballades. Ivan Moravec (piano). CONNOISSEUR CS-1266

Now and then one comes across a performance which precludes any written statement on it. The difficulty is two-fold. How to convey the character of the performance – in such a case it seems to make no sense writing of how this or that series of bars are played. Beautiful is a useless word. And what has writing to do with such playing? One is forced to say simply, "Here it is. YOU have to hear it." At such times I feel the sole and only possible use of such a report must be limited to bringing such an event to notice. Here is Chopin playing as one seldom hears in a lifetime. What cliché! But so I feel here indeed is such a performance. (A friend who heard Hoffmann in his youth assures me the playing here is very reminiscent of the great pianist's style. But op.47 was done better!) How sure can I be that a recording can be called a performance? No myriad splices can bring together what we have here. After an initial playing, my reaction was to wonder at the audacity of the readings here. What liberties! Yet I cannot remember ever once thinking of the word "liberties" while actually listening. Creativeness rather. But this word has the sense of wilfulness somewhat defeating the spontaneity and

intuition here. Have no doubt, Moravec can only have exerted the strongest will to achieve what he does here. One hears of player and instrument disappearing and of hearing only the music. Shall I tell you of every return of Tempo I on op.38? For once here is refrain as only the most ideal singer can give us, no longer mere refrain but a device stimulating the memory, not just the reminder of structure, but a recall. I have said nothing at all. Chopin here sounds like no salon composer one knows. Moravec brings out all the voices and the very complex structure of these pieces, and I am convinced of their structure after this. At times I just wonder, "How does he do it? How decide which, what, how?" Follow the score and you can decide for yourself how Moravec effects that opening transition from largo to moderato in the op.23. Just seven bars. One can talk about the superb legato, pedalling. Pauses? One hears them. One thinks of Huneker's "noiseless suspensions" and if you think that is out of date reaction – here it is. You have to hear it. Recording? If it were playable with a grit surface I would have this disc. – J.A.A.

**ELGAR** – DREAM OF GERONTIUS – Soloists, King's College Choir, London Sym. Orch. & Chorus, Benjamin Britten (cond.) DECCA SET 525-6.

I must confess I cannot stomach the Roman Catholic sweetness of this work. "It stinks of incense," Stanford said and I often feel I must agree. But it puzzles me that my more reformation-minded friends are with it. Having infuriated every Elgarian in reading distance I must now say there are times, and listening to these records after not having heard the score for over ten years, when I myself can be seduced. There are undoubted beauties in Elgar's score and I can feel for those solos from the Angel. One must also admit that in a fine performance, the intensity of "Take me away" can strike a justifying chord in me. I only wish that Elgar could not have spoiled his finale with that rhythm, and harp, and those ultimate chords. Feeling myself at last in some way admitted to that closed company of Elgarians, I find to my distress they do not like this recording. "It's not intense enough. It does not give." What shall I say? I do like Britten's detachment and his non-saccharine treatment of this score. I will say there are times when more intensity would not have gone amiss. Minton's Angel is ravishing, so that both available recordings do have superb Angels. Shirley Quirk's Priest and Angel of Agony are as fine as any. Much as I like this recording, I am afraid I cannot wholly accept Pears' Gerontius. There is as always with Peter Pears a moving projection of the text, but there is far too much vibrato in the voice to be pleasing. The choirs are almost always well controlled and it goes without saying that the sound of King's is just right for those choruses. Fine sound but I do wish import Decca pressings would not have those ever so occasional ticks and shush. – J.A.A.



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REVIEWER:  
Michael Delaney.



"The Slider" — T. Rex. E.M.I. Stereo. BLN.5001. Telegram Sam — Rabbit Fighter — Baby Strange — Ballrooms Of Mars — Chariot Choogole — Main Man — Metal Guru — Mystic Lady — Rock On — The Slider — Baby Boomerang — Spaceball Ricochet — Buick Mackane.

Bolan is his own main man with the universe supposedly reclining in his hair and T. Rex is the silver-studded sabre-tooth dream machine monopolizing top 40 charts right the way across Europe. Fine. This we know.

There's T. Rex, Slade and the Faces — all three make the little girls scream with Bolan being the only one who can turn it into full scale hysteria. He's the high camp demi-god of British rock — the other two don't appeal much outside the working class: Slade is huge in aggro-bovver land with the kiddies too young to suss Steve Marriott and the Faces hold down the industrial areas like Birmingham and Manchester.

Both bands owe most of their flash to the singers: Rod Stewart is the perennial underdog — a born loser who wins; Noddy Holder struts around like something out of "A Clockwork Orange" complete with cockney nadsat — "Look Wot U Dun". They've got success with no magic: an illusion without charisma excepting Stewart who does have magic but not fantasy-type magic. And that's the reason he's not as big as Bolan. Rod can't crap on and make the children believe it — Bolan can and does.

Then you get the facts: "Electric Warrior" stayed in the album lists for over 14 months; "Bolan Boogie" was gold three weeks before it reached the stores; "Hot Love", "Jeepster" and "Get It On" made a million each as did "Telegram Sam" and

"Metal Guru"; "My People Were Fair"/"The Angels Of The Ages" — a double set comprising the first two Tyrannosaurus albums — was reactivated and went straight to numero uno along with the maxi revival "Debra". All told — T. Rex has done 13,000,000 records in less than a year. Which ever way you look at it — they've cleaned up.

"The Slider" — the first new Rex album released for just on 12 months — will probably go down as Bolan's definitive. It comes closest to being the most integrated disc he's cut since "Unicorn" concentrating on detail rather than energy output. It lacks the monotony of "Electric Warrior" in both range and presentation and the major influences seem to have moved slightly away from the Berry/Nelson riff while retaining the same eclectic simplicity. Bolan's genius for persona is still there — a little more subdued this time around but still there and going strong. He's always had this maddeningly idiosyncratic approach swapping back and forth between prose and poetry somehow squeezing in the music where it was best suited — hoping to God that it'd fit.

This was the way he used to write in Tyrannosaurus Rex by exaggerating the possibilities of the lyric and melody taken as two distinct forms. It was like an experiment trying to find the balance between Yin and Yang. Most of the time it worked. There was "One Inch Rock" where he spun open verse, binding it together with a chord backing. "Happy Gumbo" and "The Wizard" were much the same on a more complicated level, incorporating his voice as an instrument in its own right.

Now — however — instead of angling both of them separately he's extended his words to fit the music. This is possibly the biggest difference between "The Slider" and its predecessors. Bolan has started to write total songs — "Warrior" had some good ideas but it was largely either prose set to music or music written around his poetry. And that does have its limitations.

It's an entirely new feeling for Bolan to muck about with one in which he has the freedom to write rock 'n' roll in a more advanced form thereby making the melodies a little less rigid. And that's the thing; up until "The Slider", his style wasn't fully equipped to handle much outside a basic blues frame. He'd write nice riff-rhythms and then restrict their potential by sticking fervently to the 12-bar — no surprises. "Warrior" was very much like that mainly

because he was still getting used to the electric medium — a process of playing what he could with the means available. He had the potency and imagination but not the knowledge.

"The Slider" isn't so much a change in priorities as it is an improvement on what went down in his "Hot Love"/"Get It On" stage substituting his love for parody with a more home grown technique. Bolan has always been a master at parodying old rock 'n' roll — something that few people seem to realize. "Ride A White Swan" was a revamped Rick Nelson tune and "Jeepster"/"Get It On" came straight out of the Eddie Cochran archives. Then there was "Woodland Rock" a melody ripped off from Chuck's "Too Much Monkey Business". But the thing is that he doesn't need to do that anymore because his own style has developed to the point where it's strong enough to stand alone — all plagiarism aside.

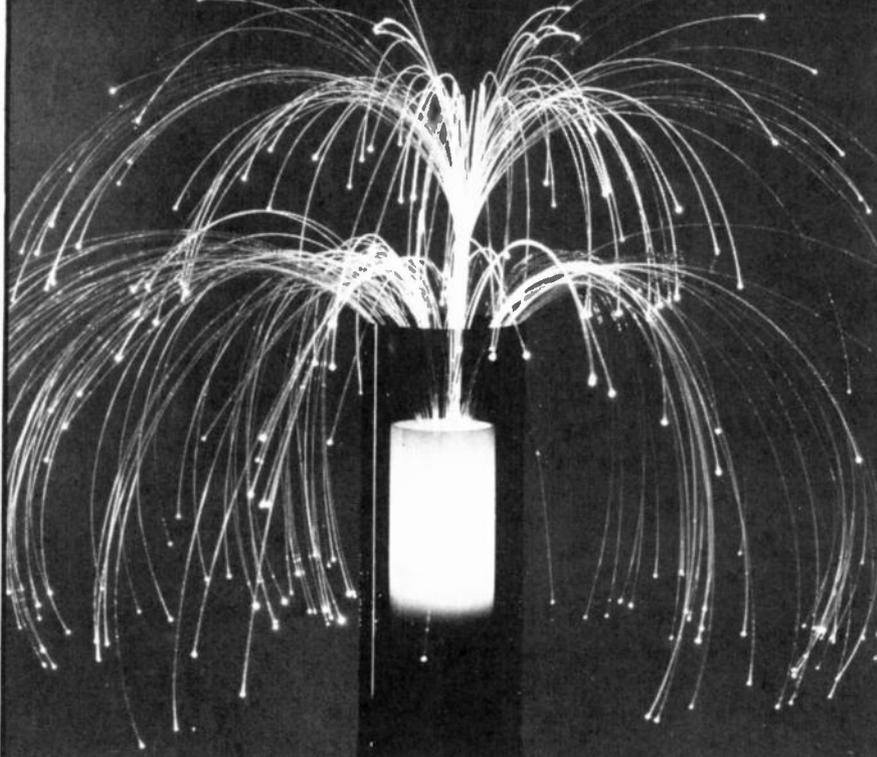
"Metal Guru" is one of his best songs simply because it tries to break new ground. "Telegram Sam" was the ultimate parody and once that had been done he was forced to look elsewhere. He'd been using every trick in the book to keep on playing the same chord sequence but it was starting to lose its novelty. And Bolan has always based a whole lot of his impact on novelty little changes in time and emphasis instead of rearranging direction.

One of the nicest bits about the new album is its feel for movement. Bolan's ideas have become more cohesive and uniform in delivery and as a result — his entire approach has diversified: the up-tempo cuts are softer wielding extra muscle without increasing volume; the ballads seem to be more relaxed and the overall performance is much less sporadic.

Generally, the songs have gained an edge missing from "Electric Warrior". They're more compact and incisive, centralizing the action on riffs instead of diluting it out over a rhythm. "Chariot Choogole" is one of the best tracks because it's different — softer and harder. Things like "Planet Queen" or "Mambo Sun" should have been treated the same — both demanded hard rocking but only got it off peak and devious. And sinister music isn't really what T. Rex is about now that they've decided to get dirty.

"The Slider" is Bolan's first electric album to fully exercise its grip. There seems to be an added drive and clarity in what he's doing which in turn has helped him to take further liberties with his style. Most of

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his earlier works had trouble trying not to sound repetitive: "Warrior" had little definition between tempo and "T. Rex"/"A Beard Of Stars" were both built essentially on the same phrases. All three were good but they could've been much better with a bit more passion and a lot less plumage. There's been a couple of minor changes in the imagery as well. When Bolan first started to write his sex songs he'd drag the ladies up with hub cap diamond star haloes and luggage eyes and buckskin dresses made by elves. Cute. But things must have got pretty tiresome after a while as no doubt they did. You can't be orgasmic and rude by knocking off quotes from Tolkien a la "My People Were Fair And Had Sky In Their Hair".

The changes are very subtle but nevertheless thorough. Bolan has simplified his form to relate specifically to lyrics. He no longer writes open verse the way it used to be circa "One Inch Rock" preferring to hit the kids with a series of one liners - classic pop garbage. As a result, the melodies are free to develop unhindered by the thought of conveying poetry. And that's the reason why "The Slider" is so much more viable than "Electric Warrior". Bolan's aim is to be a musician. He did the poet thing with Tyrannosaurus Rex - the "T. Rex" album was the culmination of that period bringing into effect the initial move to phase out the complex material.

The new album is crammed with beauties designed to boot you up the crotch. There's "Rabbit Fighter", "Telegram Sam" and "Baby Strange". And then there's the title track - possibly his most emotive song. Bolan S-L-I-D-E-S:

*'Slim lined sheik faced  
Angel of the night  
Riding like a cowboy  
in the graveyard of the night.  
New York witch in the dungeon  
of the day  
I'm trying to write my novel  
but all you do is play.'*

His women aren't madonnas and he no longer writes stuff like "She Was Born To Be My Unicorn" simply because the kids want something raw to scream about. He uses innuendo just as skillfully as Jagger.

Bolan may not be "Jumpin' Jack Flash" but then Mick's not "King of the highway and queen of the hop". Cock-rock is here. Buy some. M.D.



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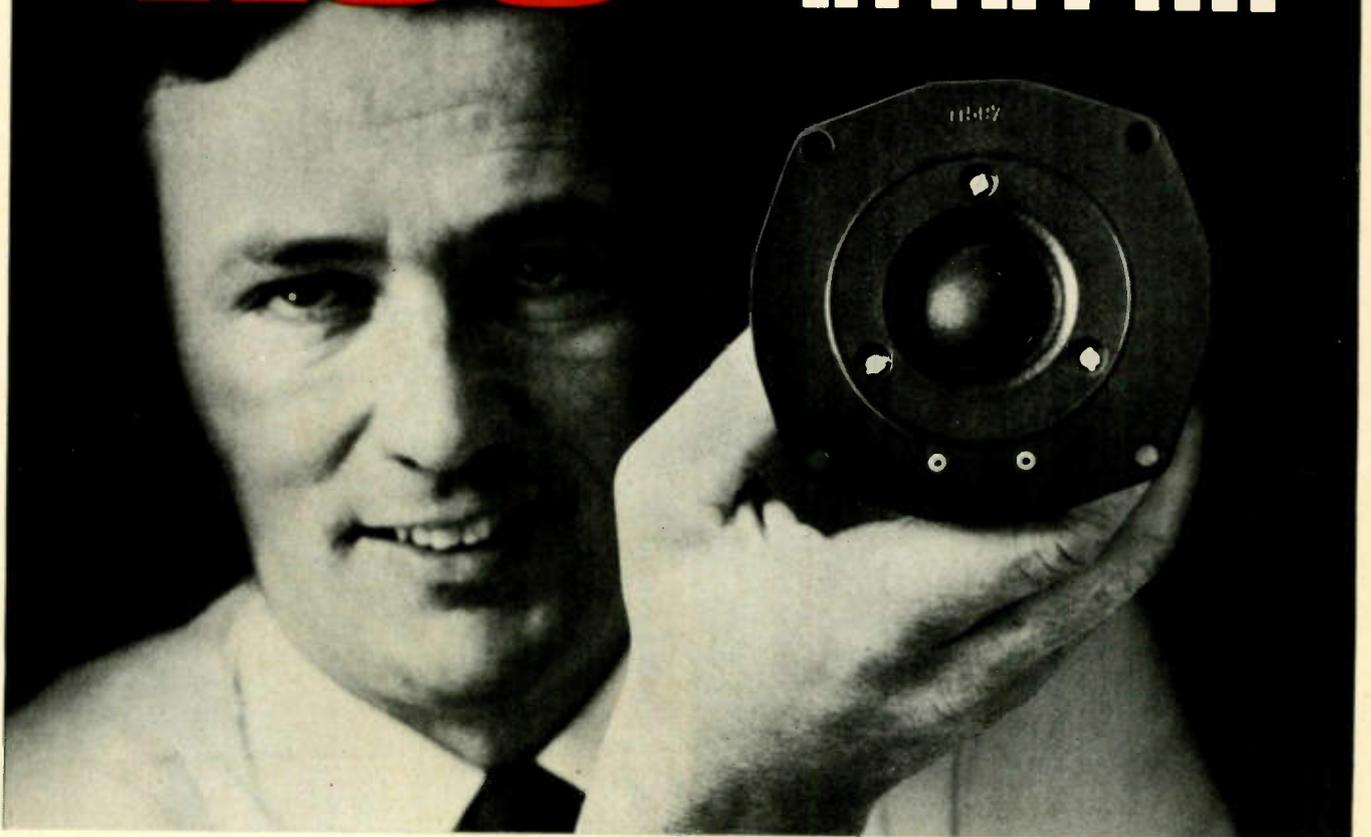


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AR48

# INPUT GATE

LETTERS  
FROM  
OUR READERS

## IT'S TIME?

Along with the score or so of like publications I read along the way every trip, I have just been perusing your number for July 1972. Generally, I should say it is fairly acceptable, but I take exception to a couple of items.

Before repeating the TDK panel on p. 94, you might just look up the dictionary meanings of 'exclusive', 'unique' and other extravagant claims, and then examine what is inside a BASF cassette and note its bevelled rollers, steel pins and the keypiece that holds the leader in a corresponding slot in the bobbin. Whether other makes feature these items as well, I do not know, but even one other make is sufficient to give the lie to their present claim.

The other matter I regard far more seriously. I could hardly believe my eyes as I read 'Large-scale Integration' on p. 13, shoved in with items of bona-fide interest and the tit-stuff from which escape is as impossible as from the subjects of your rather sententious editorial on p. 5. I am not a South African, although when passing that way in the course of my business trips I find those with whom I deal courteous and frequently hospitable.

While not giving myself over to anger, I am filled with disgust by an editor who would allow this kind of cheap, irresponsible lavatory-wall twaddle to be printed in an electronics magazine: can you imagine seeing it in

'Wireless World', 'Practical Electronics', or nearer home to you, in 'Electronics Australia'? Dr. Hastings Banda has said that it does nobody in Africa the slightest bit of good to blackguard the South Africans in England, picket sports fixtures and so on, and I am sure this would have included snide-pushing of the kind referred to. I had been somewhat dismayed to note that since I last saw an issue you had adopted the tag 'international'. The word has long been a rather unattractively-pink luggage-label for fellow-travellers, another of whose characteristics is that they can't give you the time of day without dragging politics into it. I got the right answer to your sum, but am glad I had not sent it in, as a year's subscription to a magazine like yours would have been an embarrassment.

A.E.M.  
Madras,  
India.

\* The TDK panel on page 94 of the Australian edition of the July 1972 issue was a paid-for advertisement. I am sure you are aware of the accepted conventions, general practices and regulations governing a publisher's responsibility for advertisements in his publications. Claims for uniqueness or exclusiveness in design or other features, on the part of the advertiser, are outside the realm of censorable material; and an editor or publisher has no right to reject or ask for

amendments to, such advertisements. If the advertiser's claims are suspect in such matters, he alone should be approached and is answerable.

The LSI item on page 13 of the same issue, you will notice, is separated from the main text by two thick lines. May we congratulate you on being the first (and, so far, the only) reader to have taken exception to this item? Both in Australia and in the UK this item has been received, noticed and appreciated for what it is, viz., a bit of humour with undertones of rejection of bigotry.

We are not trying to compete with or emulate the journals which, you say, will not publish similar items. The white-black issue is not a political but a humanistic one, and it becomes political only when the governing body of a country makes it so. — Ed.

## SOLID-STATE HIGH

The idea for this anecdote came during a recent solid state physics lecture in the form of a clue issuing from the instructor's peculiar choice of words:—

QUESTION: "Why is a drug addict like a tunnel diode?"

ANSWER: "Both are doped to degeneracy."

Never let it be said that University physics lectures are not the spawning grounds of ideas!

K. J. M., Canley Heights, N.S.W.

## New Product

### 50 MHz Counter Kit

**Decade Counting Module for Frequency Counting, time measurement, event counting etc.**

1. 50MHz or 20MHz counting capability
2. Module kit consists of 8290 or 7490, 7475, 7447 & Minitron 3015—F
3. Single Plane 7seg. Readout
4. Lamp Test, Selectable Ripple Blanking
5. Decimal Point
6. PC — Glass Epoxy Plug in Board
7. Well documented application note with step-by-step assembly and hook-up instruction.

#### Gate Module F

1. Module consists of 7440, 7400, 7476 & 74500
2. Adj. Reset Generator
3. Reset & Strobe outputs
4. Gate uses Schottky TTL
5. PC — Glass Epoxy Board
6. Application note & assembly instruction

#### Input Amplifier & Pulse Shaper Module

1. 1 meg. ohm inp. impedance
  2. 20mV sensitivity at 50MHz
  3. Diode protected FET input
  4. Frequ. Response 10Hz to 70MHz ± 2db
  5. Glass Epoxy PC — Board
  6. Application note & assembly instruction
- ALL Modules operate off +5 V. rail.

#### 50 MHz Counter Kit Price List

50MHz Decade Module	.....	\$22.50 ea.
20MHz Decade Module	.....	\$19.50 ea.
Gate Module F	.....	\$15.75 ea.
Input Ampl. Module	.....	\$16.20 ea.
P/P	.....	\$0.25

Frequency Standard & Clock Divider to be announced

#### Integrated Circuits

SN 7490N	.....	\$2.20 ea.
SN 7441AN	.....	\$2.75 ea.
SN 7475N	.....	\$2.20 ea.
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SN 7430N	.....	\$1.00 ea.
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SN 7472N	.....	\$1.85 ea.
SN 7473N	.....	\$2.00 ea.
SN 7447N	.....	\$3.20 ea.
LM 709 OP-Amp	.....	\$1.50 ea.
LM 305 Pos. Reg.	.....	\$3.80 ea.
LM 304 Neg. Reg.	.....	\$4.80 ea.
TTL 209 LED	.....	\$1.50 ea.
LM 380 2 Watt Audio IC, 12218V rail, 50Kohm input Imp, Voltage gain of 50, short circuit & overload protection	.....	\$2.85 ea.

Postage on IC 10c ea.

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RF — Power Transistor BLY89, 25 Watts out at 175 MHz, Rail 13.6V, Balanced Emitter. Only \$9.00 ea. P/P 20c

Transistor DC-DC convertor, Transformer Ideal for CD Ignition, 12 Volts inp, 320 Volts at 150mA output. P/P 20c \$3.00 ea.

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2N 3866	.....	\$1.50 ea.
2N 3819	.....	FET 85c ea.
MPF 121	.....	\$1.50 ea.
TIS 88	.....	\$1.20 ea.

P/P 10c ea.

#### Capacitors Electrolytic

1000µF — 100 Volts \$1.50 ea. P/P 25c  
4000µF — 10 Volts \$2.00 ea. P/P 25c

## YUNKER ELECTRONICS PTY LTD

(formerly Wayne Communication Electronics),

757 Glenferrie Road, Hawthorn, VICTORIA 3122 — Telephone: 81-2818

# THE JAM SESSION IS DEAD.

The compact tape cassette has always had its obvious advantages.

Unfortunately, it's always had one not-so-very-obvious disadvantage.

Jamming.

After all, what good is a super sensitive tape, and super faithful reproduction, if it's going to get stuck on you when you need it most!

We introduce the BASF jam proof cassette.

The first cassette actually guaranteed against jamming or

we'll replace it at any time, free of charge.

Every BASF Cassette is fitted with a special kind of tape transport system that guides the tape through the cassette without it ever snagging or sticking. It's called "Special Mechanics" and only BASF Cassettes have it.

Variable tension is practically non-existent—which means you can also forget about things like wow and flutter.

Special Mechanics tape transport makes the super sensitivity and super faithful

reproduction of our tapes all worthwhile. Choose BASF LH (Low Noise, High Output)—the finest ferric oxide cassette tape on the market. Or pay a little more for the ultimate—BASF Chromium Dioxide—its extended dynamic range, highest output and lowest noise level, plus the additional reward of minimal headwear are the qualities you'll appreciate.

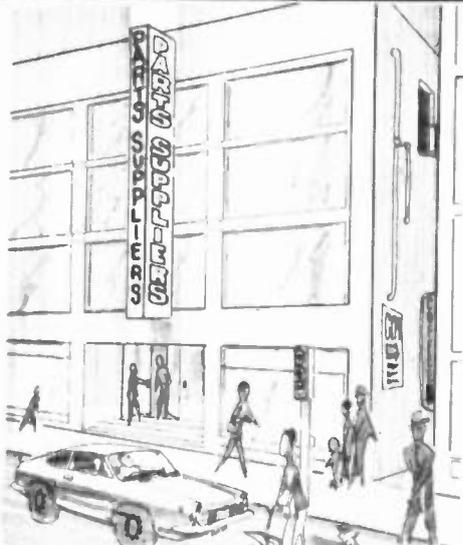
Hearing is believing!

Buy BASF jam proof cassettes. And record a jam session without missing a single mind blowing never-to-be-repeated improvisation.



Distributors: Sydney (Head Office): Maurice Chapman & Co. Pty. Ltd., 276 Castlereagh St., 2000. Newcastle: W. L. Redman Agencies, 11 Hall St., N.S.W., 2300. Canberra: Sonny Cohen & Sons, 20 Isa St., A.C.T., 2600. Melbourne: Maurice Chapman & Co. Pty. Ltd., 146-150 Burwood Rd., Hawthorn, Vic., 3122. Brisbane: Chandlers Pty. Ltd., 399 Montague Rd., West End, Qld., 4101. Adelaide: Neil Muller Pty. Ltd., 8 Arthur St., Unley, S.A., 5061. Perth: Anderson-Tedco, 11-13B Belmont Ave., Belmont, W.A., 6104. Launceston: P. & M. Distributors, 87A Brisbane St., Tas., 7250. Darwin: Pflitzners Music House, 2 Darwin Arcade, Smith St., N.T., 5790.

BA2275



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## NEW SOUTH WALES

**A.C.E. RADIO:** 136 Victoria Road, Marrickville, 2204. Telephone 51-7008

**EDGE ELECTRIX:** 25a Burwood Road, Burwood, 2134. Telephone 747-2931

**DICK SMITH (WHOLE-SALE) PTY. LTD.:** 10, Atchison St., St. Leonards, 2065. Telephone 439-5344.

**KITSETS AUSTRALIA:** Suite 2, 21 Oakes Avenue, Dee Why, 2099. Telephone 982-5571

**NATIONAL RADIO SUPPLIES:** 332 Parramatta Road, Stanmore, 2048. Telephone 56-7398

**RADIO DESPATCH SERVICE:** 869 George Street, Sydney, 2000. Telephone 211-0191

PRINTED CIRCUIT BOARDS FOR ALL ETI PROJECTS CAN BE OBTAINED FROM R.C.S. RADIO PTY. LTD., 651 FOREST RD. BEXLEY, NSW. 2207. TELEPHONE: 587-3491.

## VICTORIA

**E.D. & E:** 232 Flinders Lane, Melbourne, 3000. Telephone 63-3596

**J.H. MAGRATH & CO:** 208 Little Lonsdale Street, Melbourne, 3000. Telephone 663-3731

**S.T.A. ELECTRONICS:** 392 Centre Road, Bentleigh, 3204. Telephone 97-4832

## QUEENSLAND

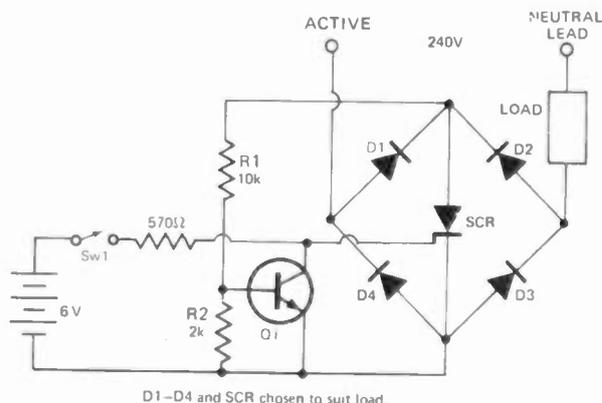
**KITSETS AUSTRALIA:** 2/673 Ann Street, Fortitude Valley, 4006. 52-8391

## SOUTH AUSTRALIA

**GERARD & GOODMAN:** 192-196 Rundle Street, Adelaide, 5000. Telephone 23-2222

**TRUSCOTT ELECTRONICS:** 62-64 Hindmarsh square, Adelaide, 5000. Telephone 23-3024.

# TECH-TIPS

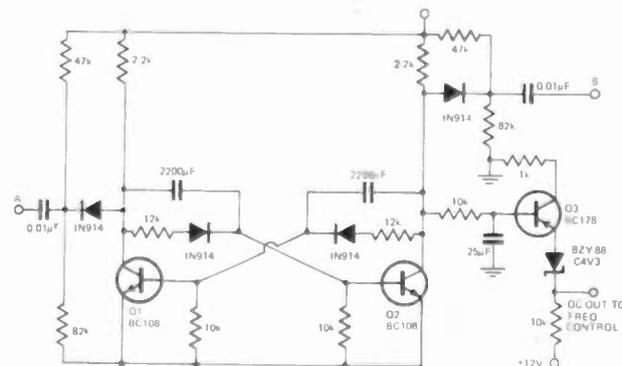


## SIMPLE ZERO CROSSING SWITCH

In many control applications power control by zero point switching is preferable to phase control because minimum RFI is generated this way.

A simple circuit is shown which provides a solid-state zero point switch with a minimum of components. The values of R1 and R2 are chosen to provide the correct width trigger pulse for the SCR being used.

The unit will find many uses as a solid-state relay where large powers are required to be switched by reed or micro-switches.



## PHASE LOCK CONTROL CIRCUIT

The circuit shown was used to phase lock a UJT oscillator at 10 times the frequency of a 16Hz oscillator which was varying  $\pm 25\%$ .

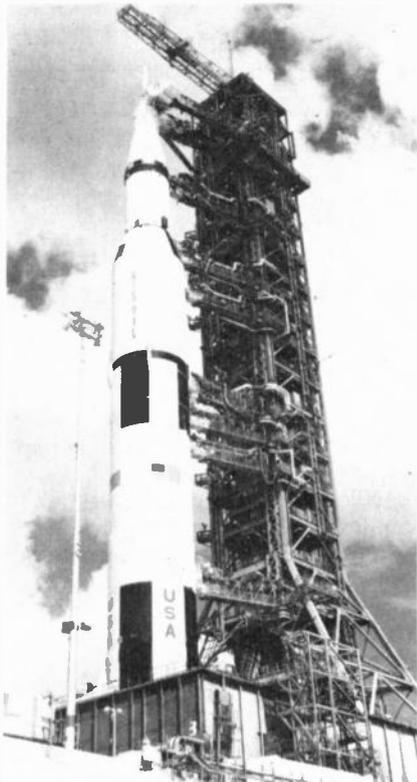
The reference frequency is coupled in at B, and a trigger from the phase locked frequency enters at A. The resultant multivibrator pulse train at Q2 collector is filtered and then dc shifted by Q3 and a Zener diode. The resultant dc error signal may be used to correct the frequency of a voltage tuned multivibrator or UJT oscillator. The sync signal may be generated by counting down the B signal by the ratio of the two signals.

## TECH TIPPING

We are sure that many experimenters have original circuit ideas which would be of interest to other readers.

Electronics Today International will pay \$3 for each original item selected for inclusion in Tech Tips.

## APOLLO 17



Apollo 17 Launch Vehicle was transported from the Vehicle Assembly Building Aug. 28, 1972. The final mission in the Apollo Program will be manned by Commander Gene Cernan; Lunar Module Pilot Harrison Schmitt and Command Module Pilot Ron Evans. Lift-off is scheduled for Dec. 6, 1972.

## PUSH BUTTON FACTS

BBC engineers have invented a new system to give television viewers the choice of extra push-button information on their screens. The system, patented under the name of Ceefax, is expected to undergo its first trials next summer. It could be in production two or three years later.

A Ceefax unit, attached to a normal television set, will probably take the form of a small box with a number of push-button keys. Viewers would be able to choose from 30 'pages' which could be displayed on the screen at the press of a button. Each page would resemble a teletyped message. It could cover things like weather forecasts, news summaries, sports results and stock market prices.

The Ceefax unit would store the information and all 30 'pages' could be continuously up-dated every minute. The invention stems from studies in the BBC research departments on improved ways of displaying informa-

tion on television screens, including facilities for the deaf.

There are several ways in which the Ceefax data which is transmitted could be 'tucked into' the television signal. For instance, in every second a viewer is watching television, there are 50 'gaps' which occur so quickly that they are never seen. In these fractions of seconds the Ceefax data can be transmitted, stored and up-dated. A full page of news could be completely up-dated in seconds.

Next year's trials will probably use equipment manufactured by the BBC as prototypes. But industry would have the opportunity of producing Ceefax units — as an adaptor to television receivers — for public service operation.

## NEW RADIO TELESCOPE



The 5km radio telescope at Cambridge was inaugurated by the President of the Royal Society Professor Sir Alan Hodgkin on Oct. 17th. The ceremony marked the completion of the most powerful instrument of its kind, built for the Science Research Council at a cost of £2 million. The telescope will be operated under an agreement between the Council and Cambridge University, as part of the Mullard Radio Astronomy Observatory under the direction of the astronomer Royal, Sir Martin Ryle, FRS, Professor of Radio Astronomy in the Cavendish Laboratory.

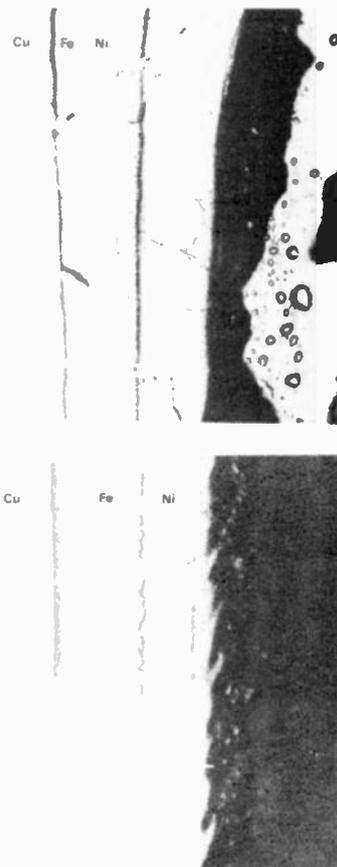
## LONGER LIFE FOR SOLDERING IRON TIPS

Research by the CSIRO Division of Tribophysics has significantly improved the quality of soldering iron tips.

The Division of Tribophysics was asked to ascertain the normal cause of failure of plated long-life tips and to recommend methods of extending their service life.

Major mode of failure was found to be the formation of microcracks in the iron layers. Liquid solder rapidly penetrates into these cracks, alloys with the copper core, and causes the coating to lift and peel. The cracks in the iron layer may be due either to embrittlement during electro-deposition or to fatigue cracking caused by continual heating and cooling.

The Division studied the characteristics of the plating baths used in the



The layer of metal on a failed tip (TOP) show, at a magnification of 430, a number of small cracks through which molten solder has penetrated. A correctly plated section is shown (BELOW) at the same magnification.

manufacturing process. The control limits necessary to produce a more ductile deposit of iron and more effective cohesion between the electro-plated layers were established.

Following this research, Adcola Products Pty. Ltd., has installed a new specially designed plating line to produce multi-layer plated tips which are expected to last more than 50,000 operations each. Soldering irons made by Adcola have electronic feedback controls built into the body of the tool and are available in about 180 different tip sizes and shapes. They are used extensively in the aerospace industry and for the assembly of mass-produced goods in several countries.

Turn to page 150

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# news digest

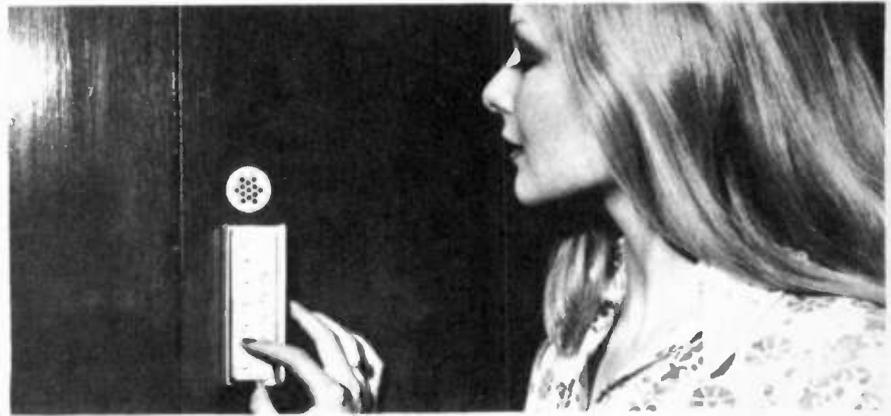
## DRAFT STANDARD FOR TRANSUCERS

The Standards Association is seeking comment on a draft Australian standard for transducers for electrical measurements, issued as DR 72166. The draft applies to transducers which convert an electrical quantity, such as voltage, power, frequency, impedance into a related electrical output. A main feature of the draft standard is the classification of transducers in terms of their permissible error. The draft covers reference standards and definitions, classification, the influence of factors which may affect accuracy, mechanical and electrical requirements, marking and tests. Copies of DR 72166 may be obtained without charge from the various offices of the Standards Association in all capital cities and Newcastle. Comment on the provisions of the draft is invited from interested persons or organizations and should reach the head office of the Association, 80 Arthur Street, North Sydney, N.S.W. 2060, or any branch office not later than 31 December 1972.

## KEYLESS LOCKS

A new range of electronic combination locks that eliminate the use of keys or plastic cards was put on display at a British company's stand at the recent International Security Exhibition and Conference held in London. The Data-lock 2000 (seen here) is part of this range which is ideally suited to areas where access is restricted and where keys may not be carried on the person, such as banks, stores, code rooms, operations and control rooms. The Data-lock code box is in the secure area, while outside there is just a waterproof finger-plate with press button figures. Operation of the correct combination, which has been pre-set inside, will activate an electric

lock allowing access to the secure area. If there is any error in touching the figures an alarm sounds, and this alarm can only be switched off internally or by pressing the correct four-figure combination. The code box has an in-built battery that is constantly float-charged from the mains so that should the main supply at any time be cut off the battery will take over the operation of the whole system. Also, as an additional security, if anybody tampers with the finger-plate by trying to cut the wire an alarm will sound. A special high security electric lock completes the system. Manufacturers are J. Donne Holdings Ltd., Canberra House, 312-319 Regent Street, London W1R 57B.



# BOOKS

**COLOUR TELEVISION THEORY** — By Geoffrey H. Hutson — PAL-System Principles and Receiver Circuitry. — \$10.80. CONTENTS: Light, Colour Signals, Basic PAL Coder, Transmitter, and Receiver Arrangements, Display Devices, Convergence: Convergence and Raster-shape Correction Circuitry, Chrominance Signals.

**DICTIONARY OF TELECOMMUNICATIONS** — R.A. Bones. \$7.50. — 208 pages. The wide range of definitions, including many reproduced from or based on, British Standards recommendations, is supplemented by appendices including units and abbreviations, wavelengths and frequency bands and signal reporting codes.

**PRINCIPLES OF PAL COLOUR TELEVISION AND RELATED SYSTEMS** — By: H.V. Sims, C. Eng., M.I.E.E., R.I.E.R.C. — \$3.80. CONTENTS: Development of Colour Television; The NTSC System; Phase Distortion; The PAL System; Some Inherent Deficiencies; PAL Decoders; The SECAM System; etc.

**110 SEMICONDUCTOR PROJECTS FOR THE HOME CONSTRUCTOR** — R.M. Marston — \$6.10. 124 pages, including 110 illustrations. This book introduces the reader to such outstandingly useful new devices as the field-effect transistor, unijunction transistors, silicon controlled-rectifiers, silicon planar transistors etc.

**PRACTICAL THINKING** — Edward DeBono — \$5.95 — 198 pages. This book looks at practical everyday thinking which allows us to use something effectively without knowing all the details. Thinking may seem to be too complex a process to be understood but the two basic steps are quite simple. Etc.

**THE HI-FI AND TAPE RECORDER HANDBOOK** — Gordon J. King. — \$6.80. Hi-Fi fundamentals, Voltage Amplifiers, Feedback and Control Circuits, Power Amplifier, Faults in Valve Amplifiers, Transistor Amplifiers, Loudspeakers and Enclosures, Disc Recording, Pick-ups and Record Playing Equipment, etc.

**A.B.C.'s OF INFRARED** — B. Vernard — \$4.75 — 144 pages. Numerous illustrations are included to clarify the explanations of the various instruments and methods. Many examples are given to illustrate novel and unfamiliar concepts, and questions for self-testing are provided at the end of each chapter.

**BEGINNERS GUIDE TO TRANSISTORS** — J.A. Reddihough — 160 pages. — \$3.55. Describes what transistors are, how they work, the many types available and their many applications. This will be useful to the layman wishing to understand the fundamentals or the apprentice technician.

**A.B.C.'s OF INTEGRATED CIRCUITS** — R.P. Turner — 96 pages — \$4.25. This book is intended to serve as an elementary introduction to the IC, its construction behaviour, and uses. The theory and mathematics have been purposely kept at a minimum; instead, the approach is descriptive and practical. Etc.

**BASIC ELECTRONICS OF NAVY PERSONNEL**. 9 1/2" x 6" 538 pp \$4.55. This covers every important aspect of applied electronics using no more advanced material than principles of applied electricity and elementary maths. This course is as valuable to hobbyists as to beginning students.

**SEMICONDUCTOR DEVICES AND CIRCUITS** — ALLEY AND ATWOOD. 490 pages. \$8.50. Semiconductors, Junction Diodes, Junction Transistors, Common-Emitter Amplifiers, Device with High Input Impedance, RC-Coupled Amplifiers, Transformer-Coupled Amplifiers, Small-Signal Tuned Amplifiers, etc.

**DICTIONARY OF ELECTRONICS** — HARLEY CARTER. 410 pages, many illustrations. \$5.95. Contains concise but explanatory definitions from many branches of Electronics, including radio, television, communication, radar, electronics instrumentation and industrial electronics.

Prices are current at time of publishing but are subject to change.

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Add postage N.S.W. 60c. Other states 80c.

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**Bi-directional record and playback tape deck Model A-4070**

- 4 Ferrite heads (6 head function) ● Reel size 7"
- Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .06% at 7½ ips ● F/R 25 to 24,000 Hz at 7½ ips
- S/N ratio 58dB

**Make music - not noise**

You may not realise it, but until now, even the best tape decks allowed a degree of noise during recording and playback. This may have been all right for conventional tapes, since they were far from perfect.

But with the recent introduction of the low noise/high output tapes, it's no longer permissible.

Which brings us to a new generation of decks by TEAC. And TEAC calls them Superior Sound/Low Noise decks: decks designed to get the most out of the low noise tapes as well as the conventional types.

Five of these new generation decks are described here. If you'd like to know more, write to us and we'll send you further information (catalogue, dealer list and price list) on the unit(s) that interests you.

**TEAC**  
A Sound Idea



**Stereo Tape Deck Model A-3300**

- Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .06% at 7½ ips
- F/R 25 to 24,000 Hz
- S/N Ratio 55dB



**Stereo Tape Deck Model A-1230**

- 3 heads-4-head function
- Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips
- F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB



**Automatic Reverse Stereo Tape Deck Model A-1250**

- 3 heads-4-head function
- Reel size 7" ● Tape speed 3¾ ips and 7½ ips
- Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB



**Combination Head Stereo Tape Deck Model A-1030**

- Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● One motor mechanism ● Wow and flutter .05% at 7½ ips
- F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB
- Auto. Shut-off

**LET INSTROL PUT A LITTLE SWEDEN  
INTO YOUR CHRISTMAS...**



**...WITH SONAB**

Write in for fully descriptive literature on SONAB

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