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* to international standard.
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Have you sent in your entry to the Practical Project Competition yet? Don't forget that all entries must be postmarked not later than Monday, September 2nd. There are valuable prizes from Kitsets Australia Pty Ltd, to be won, plus the chance of getting your project published in E-A. So don't delay!

Here it is at last, the stereo cassette tape deck design you've been waiting for. Easy to build, it offers many attractive features, including twin level meters and overload indicators. See page 54.

On the cover
An operator testing colour TV deflection yokes at the Philips Elcoma factory in Hendon, South Australia. Deflection yokes for colour receivers must meet very stringent requirements if accurate convergence and colour purity is to be achieved, and this calls for careful testing. (Picture courtesy Philips Industries Ltd.)

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ELCOMA
Too much red tape may spoil the picture

With the colour TV era just about to dawn in Australia, one of the things I find most disturbing is the situation in the servicing side of the industry. Almost equally worrying is the way in which the likely problems of servicing are apparently being glossed over, minimised and even ignored by many who claim to have the interests of the consumer at heart.

Servicing has always been the Cinderella of the electronics industry, as it has been in many others. I suppose it was only to be expected that it would continue to hold this lamentable position into the colour TV era. Yet when C-day was announced, quite a reasonable notice period was given, and it is disappointing that since then more has not been done by way of technician retraining.

The state-run technical colleges have been doing their bit, but considering the size of the problem, they have made only a modest impression. In a letter recently published in the Sydney Morning Herald, the Director of the NSW Department of Technical Education noted that to date some 200 technicians had completed his department's course in colour TV servicing, while a further 165 were currently enrolled.

In view of these modest numbers it was disppointing to learn that the department apparently restricts enrolment in the course to those who have completed formal radio trades and television receiver servicing courses. The reason given for this is that other applicants would not, in the department's view, be capable of becoming “properly qualified” servicemen.

This attitude is surely quite unrealistic in view of the fact that a majority of the service technicians currently working on monochrome receivers have no formal qualifications in the strict sense. Yet most of them, by virtue of their rich background of practical experience, are probably far more adept and efficient in their job than many who do possess that magical bit of paper.

To bar these people from enrolling in one of the few colour TV servicing courses which do exist seems to me nothing less than sheer bureaucratic conceit. It amounts not only to an insult to the technicians involved, but also to a refusal to provide many consumers with the trained servicing facilities they have a right to expect. And the situation in the servicing side of the industry.

There are already very few young people entering electronics servicing as a vocation; I would estimate that the average age of current technicians would be between 45 and 50. This very serious situation isn't going to be improved by one of the main training bodies adopting a head-in-the-sand posture.

—Jamieson Rowe

PS: I am happy to admit that I was wrong, in the June issue, to suggest that the local manufacture of resistors and capacitors had ceased. Among others, IRH Components are very much alive and well, as Lloyd McCulloch's letter on p.87 testifies.

Printed by Land Printers Pty Ltd, of Lidcombe, NSW, for Sungravure Pty Ltd, of Regent St, Sydney.

* Recommended and maximum price only.

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ELECTRONICS Australia, August, 1974 3
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ELECTRONICS Australia, August, 1974
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BANG & OLUFSEN

It seems quite incredible that the sleekly styled hi-fi units for which B&O are now famous should have grown out of products which were once criticised as "Norman-arched and pot-bellied falsities ..." This is one of the facts which special writer Tim Matthews discovered when he paid a personal visit to the Bang & Olufsen complex in Denmark.

B&O Industrial designer Jakob Jensen.

Bang and Olufsen. The very name of the firm sounds like a hi-fi demonstration; you can almost see the timpanist leaning forward over his drums to muffle that final syllable.

Bang and Olufsen A/S, now internationally known for their high quality sound and vision equipment, was born in Kvistrup Manor, North Jutland, in 1925. The manor belonged to Sven Olufsen's father who regarded his son's enthusiasm for electrical engineering with a certain tolerant amusement.

Peter Bang, a school friend of Sven's, shared the same interest and the two boys were allowed, on sufferance, to potter about together upstairs under the manorial eaves.

After a time activity became so intense up in the attic that they were exiled to the garage. There a photograph of that garage as it was in those days: at the work bench stands Aage Sigh, one of the company's first employees who is still at work with B&O. At that time, he recalls, he was making transformers. "with the utmost economy in materials".

From its earliest days it was the policy of the firm to produce equipment of the highest possible standard, with no short-cuts taken in order to lower prices. With hindsight it may be said that it was a philosophy without which the company would almost certainly have not survived; what was once no more than an instinctive feeling is now the formulated marketing policy of the company.

One of the first contracts which the new company landed was to provide a set of loud-speakers for a new production at Det Kongelige Theater in Copenhagen. Aage Sigh remembers working with Sven Olufsen on the installation.

Finally, after many hours of dusty work, the moment came to switch on the equipment. It was the day before the dress rehearsal; the valves hummed and glowed and Sven Olufsen felt the moment had come to test his loud-speakers at full volume. As he turned up the controls the effect was dramatic. The powerful Bang and Olufsen speakers surpassed all expectations, and as the amplified sound boomed out into the auditorium four metres of the ornate plaster ceiling of the theatre came crashing down into the stalls.

In spite of temporary setbacks people appreciated the new Bang and Olufsen products and the firm began to grow fast. By 1957 it was decided to build the first custom-made Bang and Olufsen factory at Struer, a small village about 15 kms north of the manor house.

Olufsen père still had his say in the conduct of affairs, however, and it was he who dictated that the new building should be built in such a fashion that it could 'if necessary' be easily converted into an agricultural college (Some employees, looking round at the assorted collection of buildings which, today, make up the B&O Struer complex claim that this philosophy has been followed ever since.)

Struer is located in an agricultural area, and although the population of the town is now some 17000 — mainly employed by B&O — the outlook is still rural and the farming locals have still not comprehended the strange new fangled industry which has grown up in their midst.

Over the years Bang and Olufsen prospered, but during the war (as a result, it is said, of having supplied the Danish Resistance Movement with radio sets) the Germans blew up the factory.

After the war the 'agricultural colleges' were re-built and production began once again. B&O was in the forefront of technical development and in 1953 produced one of the first transistor radios in Europe. But as the post-war demand for radio sets and television mushroomed, it has to be confessed that a total confusion of style and outlook began to overwhelm the industry.

In 1954, for the first time, the radio industry was invited to show its wares at the Danish Joiners and Cabinet Makers annual exhibition. Bang and Olufsen's Product Development Manager, W. L. Vindelov, was particularly proud of the company's top model at that exhibition, The Grand Prix, which he had designed with personal pride in the style of the day.

He was delighted, therefore, when he saw that a photograph of his model had been chosen to illustrate an influential review of the exhibition. But his face fell when he began to read the accompanying text. It described the radios, his radios as eye-sores. It was an insult to ask people to buy them, it said. "Norman-arched and pot-bellied falsities with flourishes, hangings and trappings, usually made out of the most repulsive choices of wood, and plastered with plastic and brass. It makes one sick to see so much lack of inspiration gathered into one place."

Engineer Vindelov took a deep breath and read on. "The old-fashioned lavatory-door in its most bovine state has obviously been used as an inspiration for almost all the loud-speaker grilles. Shouting to the sky is going on. "The old-fashioned lavatory-door design. An uneasy alliance between the industrial design of the sixties would be cast.

The first fruit of their labour in 1957 was to be a slim-line radio, later named the Beomaster 900, which both internally and externally created history. It turned out to be a master-mold in which most radio design of the 'sixties would be cast.

The company was still in an uncomfortable position, however, since they had not completely jettisoned the lavatory-door design. An uneasy alliance between the two looks continued to jog along until, in the mid-sixties, Jakob Jensen, a young industrial designer who just returned from studying in the United States, was invited to join B&O.
It is really from that moment that it can be said that B&O realised the vast contribution that design could make as an integral part (not a complete goal in itself) of its production. Today there is always a designer working with every project team, and his contribution is given as much emphasis as his technical colleagues.

"It's taken us years to build up this cooperation," says B&O's international advertising manager Jorgen Palshoj, who certainly does not under-estimate the importance of design. "Design is communication. And communication is the business we're in. It's communication about what the product is — I am a gramophone — and what the product can do."

"It is communication between man and machine." As a small illustration of the last point, Bang and Olufsen insist that all knobs on its products must be designed to respond positively to human touch, to communicate, not merely light up like a modern lift button.

Yet in spite of the high technical quality of their products, B&O insist that they are not producing goods for "hi-fi enthusiasts" — those earnest and knowledgeable men with small screwdrivers, soldering irons and annual subscriptions to a technical hi-fi journal.

Bang and Olufsen are making equipment for the man-in-the-street who appreciates quality but does not want to be involved with the mechanics and maintenance.

One hesitation to repeat the well-known cliche, but B&O are the Rolls-Royce of domestic electronic entertainment. 'Domestic electronic entertainment' may seem a bit of a mouthful, but this, too, is part of the B&O philosophy.

They are not interested in making professional studio equipment, nor — in spite of their initial success at the Royal Theatre in Copenhagen — in supplying public entertainment equipment. "We must do what we are good at — and that is making sound equipment for the home."

Sound equipment, then, is what B&O is really all about, although they do make television sets as well. Somewhat reluctantly, "Since we do not produce or influence the development of the main components in TV products, our possibilities for economical production of independent and original products are much less in the video area than in the audio area," says one of the company's press handouts.

"B&O must, therefore acknowledge that although the product policy for TV is, of course, the same as for the audio area, from an economic point of view and with regard to the product itself, it is not possible to live up to this policy in the area of video to the same degree as it is in the area of audio. However, because of our distribution policy it is highly desirable to market video products too."

Distribution and marketing has an important part to play in B&O's philosophy as design and technical expertise. To maintain its exclusive image B&O is anxious that its products should not find their way into the pages of mail-order catalogues or the shelves of discount stores.

To this end it has built up a strictly-controlled dealer network. Without technically and commercially qualified radio dealers they feel they will have difficulties in getting their products handled with the special attention and care which they demand.

To preserve this network intact B&O has recently made an official request to the various mail-order catalogues and discount stores to cease handling B&O products. It is truly a matter of concern when one considers what the product can do."

Next year, Bang & Olufsen celebrate their 50th year of production of audio equipment — consuming a venture that began in the garret of the olufsen man or house in Jutland.

Today, B&O market a complete range of high-fidelity systems, which are distinguished by their emphasis on styling, quality of workmanship and their emphasis on uncoloured audio reproduction.

Bang & Olufsen are represented in Australia by the GRD Group Pty Ltd — a liaison which is now of 10 years standing. A number of retail stores throughout Australia concentrate exclusively on B&O products, trading under the name Danish Hi-Fi Pty Ltd. There are two such shops in Melbourne: at 698 Burke Rd, Camberwell, 3124 and at Shop 9, Southern Cross Hotel, 95 Bourke St, Melbourne 3000.

In Western Australia, Danish Hi-Fi have opened a store at 308 Walcott St, Mt Lawley 6050. Manager of the WA store is Mr Finn Nielsen, himself a Dane, who has worked with B&O in both Denmark and England.

A store for South Australia is in the advanced planning stage.

A noteworthy feature of all the Danish Hi-Fi stores is their emphasis on clean, strong lines and natural materials, which complement the basic B&O styling.

One of the less obvious features of the showrooms is in the use of a "Beocom-prefix" which is intended to facilitate a more accurate assessment of alternative amplifiers and loudspeakers — particularly the latter.

Simple switching systems are misleading, because they cannot cope with variations in gain and sensitivity between different types of unit.
Bang & Olufsen have constructed a music system for young people of all ages!
The design is untraditional - and why not?
A fully automatic player, an AM - FM tuner amplifier and two compact loudspeakers
Combined they form a system not only matched in technical quality but also in design and colour.

Further information from ... Victoria - Danish Hi Fi (2 shops); N.S.W. - Convoy;
Western Australia - Danish Hi Fi; Queensland - Brisbane Agencies.
BANG & OLUFSEN

EEC for a dispensation (such as that granted for example, to Omega Watches) from the provisions of Article 85 of the EEC Rules of Competition which in a nutshell, provide that all manufacturers must make all their products available to and through all distribution networks which are interested in carrying them.

What are B&O's 'available products'? In short, they are seven, elegant main systems which may be combined in various ways to give complete sound facilities to the home. They range in price from about 40 pounds for a portable radio to around 800 for the new Beo-system 4000 which incorporates ambiphonic data control, a sophisticated gadget which has taken over five years to develop which will 'read' any disc placed underneath it and automatically adjust the machine for speed and record-size. The system is based on wartime bobbin-sights developed by the RAF.

B&O is proud that it produces everything from needle to loudspeaker and is somewhat disdainful of those who assemble their own equipment from various sources. A system, says B&O, "should be considered as a whole in which the individual parts are carefully matched to give the best possible results. For example our SP 15 pick-up is individually calibrated and adjusted to match the associated coil system and is therefore not interchangeable."

B&O has its own needles made (by a firm of diamond polishers in Wales), and its own loudspeaker cabinets (by 16 independent firms of carpenters in Jutland).

Bang and Olufsen resolutely refuse to 'colour' the output of their equipment and insist on producing the most natural sound (and picture) possible. To this end a special listening panel of 20 highly critical music-lovers is often assembled in the factory to pass comment on new speakers hidden behind acoustically-transparent curtains.

Colouration is fatiguing but difficult to perceive straight away. B&O engineers suggest that anyone buying new equipment should take along a couple of records of music that they know well to try out on unfamiliar speakers.

Unlike most radio manufacturers, B&O publishes a complete technical specification of all models. If for any reason one of their items does not come up to these specifications either on delivery or later on, the company will replace it.

In the past ten years B&O has seen its turnover jump from 3.5 million pounds to 27 million and its factory space grow by over 800 per cent. The company — still owned by 23 family stockholders — is determined however that this growth shall now be limited rather than expand at the cost of lowered standards.

These standards have already won the company a number of international design awards, including the French Grand Prix and over 30 other international awards. And, though design by itself is not by any means the goal for B&O, perhaps the honour which is most appreciated by the men at Struer is the fact that recently the Museum of Modern Art in New York chose not merely one, but seven Bang and Olufsen products for inclusion in their Permanent Design Collection.

The Beocentre 1400 illustrated below combines AM tuner, FM / stereo tuner, cassette play and record and a full-scale amplifier with normal phono input facilities. Power output is 20W RMS per channel. Recommended retail price in Australia is $530.00.

The Beomaster 1200 tuner / amplifier dramatises the B&O penchant for slide-rule type controls, which are mated here with matching function selector tabs. The stereo volume controls are at the top left, with the bass and treble tone controls alongside. Radio coverage is LW (long wave), MW (normal AM broadcasting) and FM / stereo which notably covers only to 105MHz. Power output from the unit is 15W RMS per channel. Recommended retail price in Australia is $300.00.

This Beogram 4000 electronic record player is a connoisseur item retailing for $570.00. In-built sensing allows it to adjust automatically to record size and speed, while the turntable, is electronically speed regulated. The actual playing arm (on the right) is designed to achieve accurate tangential relationship to the groove.
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up on the podium level
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ELECTRONICS Australia, August, 1974
Why the colouration in loudspeakers?

Recent visitors to the Australian hi-fi scene were Mr Raymond Cooke and Mr Robert Cox, respectively managing director and sales director of KEF Electronics Ltd, UK. At a luncheon, and at a subsequent lecture in the Recording Hall of the Sydney Opera House, Raymond Cooke talked about the technical research which is behind the production of KEF loudspeaker systems.

Coming from an engineering background, Raymond Cooke is well qualified to talk about loudspeaker systems at the level. Without having been around the hi-fi scene for quite as long as some of the pioneers like Gilbert Briggs, his career and theirs have nevertheless overlapped, and he is able to accept the posture of a pioneer without suffering the limitation of too many passing years. He is, in fact, still in his forties.

Originally, Raymond Cooke had no idea of becoming involved in electronics. By birth a Yorkshireman, he trained as an analytical chemist and pursued this role in the thoroughly traditional and British environment of the London and North-Eastern Railway Company.

With the outbreak of war, having no personal fancy for the infantry, he joined the Fleet Air Arm as a radio and radar mechanic. And it was there that the professional man of chemistry found a new and absorbing interest.

After the war, Raymond Cooke took up electrical engineering in earnest at the London University, gaining a BSc degree with Honours. His first job in the electronics industry was with the Mullard Radio Valve Company, as a production engineer concerned with picture tubes.

But even picture tube technology, with its unique combination of electronics and chemistry, did not provide the right incentives and, in due course, Raymond Cooke moved into the Recording Systems Department of the BBC, and later into Wharfedale Wireless Works Ltd., in association with Gilbert Briggs.

Over lunch, Raymond Cooke explained how this last move came about. As an avid reader of audio articles and textbooks, he gradually reached the conclusion that Gilbert Briggs had arrived at certain acceptable conclusions — for the wrong reasons! Rather differently, he expressed this conviction to the famous GAB and unerringly at the guilty party. The real life detective, who "looks in the ashtray, pauses for a few telling moments, then points unerringly at the guilty party". The real life research worker, like the real life policeman, usually has to sift through a tedious mass of evidence, hoping for some kind of a pattern to emerge.

One line of investigation which KEF Laboratories have been following has to do with the behaviour of a loudspeaker system immediately after having been excited by a signal transient.

The problem is fairly well known in the context of complete enclosures, particularly in the lower register. For a variety of reasons, enclosures add their own resonance "boom" to a transient, in addition to which reflections from the inside faces may issue through the cone, which forms a relatively sound-transparent window in the front baffle.

But over and above the enclosure, subtle effects can be attributed to the loudspeaker itself, which may account for some of the mysterious "Colouration" which is evident to the ear.

When a burst of drive signal is applied to a loudspeaker, the acoustic output does not necessarily have the same "envelope" pattern as the drive signal. There is normally some overshoot or "hang", which produces an acoustic output beyond, and additional to, that during the driven period.

This is integrated by the ear to become part of the total perceived sound and it is reasonable to assume that it can be responsible for some colouration.

Normal frequency runs, which supply and measure a progression of steady tones, produce a "steady-state" response curve, substantially ignoring transient behaviour of the moving system.

Raymond Cooke said that early efforts to isolate, identify and measure the post-drive behaviour of a loudspeaker were extremely tedious, time-consuming and un-precise. More than that, it was not possible to isolate and examine the behaviour and output of the moving system less than 2 milliseconds after the cessation of drive.

"We now have what I look upon as an ideal arrangement — he does all the work and I take most of the credit!"

In 1961, Cooke decided to branch out on his own and founded KEF Electronics in an old Nissen-type hut at Maidstone. The first couple of years were a real struggle but then the tide turned and KEF forged ahead, culminating in the Queen's Award to Industry in 1970, and also the BNEC Export Award for smaller firms.

Now, in 1974, the three letters KEF (which curiously and originally stood for Kent Engineering Foundry) are known around the world, partly because of Raymond Cooke's own globetrotting activities, and partly because of on-the-spot representation — as by Audiocon Pty Ltd. in Australia.

At the lecture in the Recording Hall of Sydney's Opera House, Raymond Cooke indicated that one of the main thrusts in the KEF research program was to try to identify the reason why loudspeaker systems, which exhibit similar response curves, can sound so different on program material.

He remarked that KEF Laboratories are taking the "policeman's approach" to the problem, as distinct from that of a fictional detective, who "looks in the ashtray, pauses for a few telling moments, then points unerringly at the guilty party". The real life research worker, like the real life policeman, usually has to sift through a tedious mass of evidence, hoping for some kind of a pattern to emerge.

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Mr. Raymond Cooke, Managing Director of KEF Electronics Ltd., U.K.
MODEL 1

“GREAT FOR FOUR CHANNEL”
(or any stereo system)

Here’s 4 good reasons:

1. PERFORMANCE — Fabulous! A power handling capacity of 30 watts, and yet an efficient system. A frequency response of 40-18000Hz, an impedance of 8ohms to really suit low cost solid state amplifiers, and a dispersion angle of 120° of the high frequencies.

2. VALUE — Well, you get Jensen’s “Total Energy Response” design concept, and the trademarked “Flexair” suspension, for greater clarity and realistic sound, with a good musical balance, and that’s important.

3. SIZE — Small! Only 14½” high, 10” wide and 8½” deep, so they’ll fit anywhere. They are finished in a neat walnut grained vinyl.

4. PRICE — Would you believe $99 a PAIR! That’s right.

FOR BETTER OR WORSE, COMPARE THEM.

Give your ears a chance to appreciate the fabulous $99 Jensen sound.
All these limitations have recently been overcome by more sophisticated testing procedures and by resource to computer analysis.

The loudspeaker under test is now fed with a train of very narrow rectangular pulses, which are fed into the loudspeaker and repeated — in terms of rise time, duration, amplitude and repetition rate. Theoretically, a rectangular pulse has frequency components extending from zero to infinity and therefore includes all frequencies likely to be fed to the reproducer.

The resulting output from the loudspeaker under test is picked up by a microphone and fed to a recorder for subsequent analysis. The quality of this equipment being such that the true transient, frequency and phase characteristics of the loudspeaker are substantially represented.

The procedure which follows rests on the premise that a great deal can be deduced about the frequency and phase characteristics of a system — any system — by detailed analysis of the way it copes with a rectangular input pulse. Nowadays, such analysis is most obviously performed by computer.

By means of a slide, Raymond Cooke showed a whole family of curves for a typical reproducer, showing its output across the audio spectrum at intervals during the die-away period. Drawn for intervals of a specific number of microseconds apart, all the data fell within the previous minimum limit of 2 milliseconds.

It was very revealing. Coinciding with the end of the drive period, the output across the spectrum was substantially less — the kind of curve one would expect from a high quality unit. And it would almost certainly be the kind of curve one would get from a conventional continuous tone test.

Immediately following cessation of the pulse but with the system still in motion, output across the spectrum in the next curve was noticeably less, with the first hint of peaks and troughs. These were seen to develop in the succeeding curves, so that the output at the end of the measured period had developed very noticeable peaks and troughs. It seemed reasonable to speculate that the presence of this "hang" or "die-away" output, plus its frequency, conscious nature, could colour the total sound as heard by the ear.

But here Raymond Cooke referred again to the "policeman's approach" to a problem. It would be easy to look at the said family of curves and to assert that the culprit had been identified.

More realistically, it will be necessary to examine the post-drive behaviour of many loudspeakers to see whether a relationship can be established between what the curves show and what the ear perceives. If no such relationship can be established, it may be necessary to go back to the scene of the crime and start again!

A point which emerges from all this, and not specifically mentioned by Mr Cooke, is that the "police" of the system are likely to be unaffected by any likely temperature rise, and a fundamental resonance of 25Hz. It operates in what is basically a reflex enclosure but the port space is occupied by a large passive radiator which has in fact been derived from the KEF B139 bass driver. Because of acoustic coupling to the main driver, this passive radiator provides most of the output below 45Hz. The nominal frequency range extends downwards to 30Hz.

The main 200 mm driver handles frequencies up to 3000Hz, beyond which Milinex domed tweeter takes over.

KEF's NEW "REFERENCE" LOUDSPEAKERS

Already doing very well with their existing range of loudspeakers, KEF Electronics Ltd have announced a completely new range which will be known as the "Reference Series". The emphasis, it seems, will be on providing ultimate quality in the home situation, rather than achieving a competitive price level.

The first of the new series to reach Australia is model 104, pictured on the right. Four of them were flown in especially for the Raymond Cooke lectures in Sydney, Melbourne, Adelaide and Perth.

Model 104 has overall dimensions 630 x 330 x 260 mm, or roughly 24 x 12 x 10 inches. As such, it can be used as a free-standing unit, or placed on a reasonably substantial shelf.

It can be regarded as a two-speaker or three-speaker system, depending on the point of view. The main drive unit has a nominal diameter of 200 mm, with Bextrene diaphragm, a drive system which will remain unaffected by any likely temperature rise, and a fundamental resonance of 25Hz.

It operates in what is basically a reflex enclosure but the port space is occupied by a large passive radiator which has in fact been derived from the KEF B139 bass driver. Because of acoustic coupling to the main driver, this passive radiator provides most of the output below 45Hz. The nominal frequency range extends downwards to 30Hz.

The main 200 mm driver handles frequencies up to 3000Hz, beyond which Milinex domed tweeter takes over.

The model 104 is designed to operate in conjunction with amplifiers of RMS rating between 15 and 50 watts per channel into 8 ohms.

Optional finishes are walnut, teak and white, while the grille (not shown) is of black microcellular foam. (Details from Audison International Pty Ltd, P.O. Box 3611, Brookvale NSW 2100; or at 64 Winbourne Rd, Brookvale, NSW.)
'75 Sounds Fantastic... everything with a minimum of mystique!

Following the awareness of the high fidelity industry that technical terms and language scare off a significant percentage of potential customers, the keynote of '75 Sounds Fantastic - a high fidelity exhibition to be held at Centrepoint, Sydney, from August 13 to 17 this year - is the simplicity and beauty of quality high fidelity sound reproduction.

The exhibition is designed to offer the general public a wide range of equipment, advice, and some appreciation of its performance.

Most of the leading manufacturers in the high fidelity field will be displaying their new ranges of equipment and a sound theatre, in which programs encompassing the entire spectrum of musical experience from chamber music to pop will be demonstrated, has been arranged. Visitors to the exhibition will be able to see, hear and compare equipment from all over the world.

Market potential in Australia in this field is enormous for present and future sales and '75 Sounds Fantastic is planned to take hi fi out of its "ivory tower" and into the homes of people who formerly considered it too complex a subject.

However, enthusiasm will find much to interest them at the exhibition, as manufacturers are taking the opportunity to introduce the latest advances in the field also.

Mr Tony Farrington, director of IPC Exhibitions Pty. Ltd, organisers of the exhibition, stated recently that industry support is considerable for '75 Sounds Fantastic and 70% of available space was booked out within two weeks of the exhibition's launching.

Broadcasting Station 2GB will conduct a major promotion in conjunction with the exhibition with planned maximum listener involvement. Jeremy Cordeaux's midday session will be broadcast from Centrepoint daily from Tuesday, August 13 to Friday, August 16.

Arrangements are being completed for the 2GB "live" broadcast booth and also a display of imaginative crystal radio sets constructed by 2GB listeners.

Originally the station's own "brainchild", the crystal set competition came to the notice of "Electronics Australia" when...
Win a Free Passport to PARADISE...

With Sansui

FRENCH AIRLINES

2 UTA Holidays must be Won

To Noumea, The Paris of the Pacific

Here is the opportunity for you to enjoy a free exciting 7 day overseas holiday in charming French Noumea - there is duty free shopping, sparkling white beaches, deep blue lagoons and its French Restaurants are renowned. Yes, it could be YOUR tropical paradise holiday.

Apply your skill to complete the Crossword Entry Form below, and you could be on your way as a guest of Sansui. There are two Noumea Holidays to be won including return economy air fare and Hotel Accommodation.

SANSUI AUTOMATIC RETURN TURNTABLE SR 212
Budget-minded and a winner, this new automatic turntable is not only made of carefully chosen precision components, but it has been designed with particular emphasis on ease of operation, reliability and tonal quality.

SANSUI SPEAKER SYSTEM SP 65
A 2-way wide dispersion, acoustic suspension, 40 Watts. Convenient size, with rich and clear sound, smooth transient response, handsome open pore walnut finish and air tight enclosure distinguish this advanced speaker system.

SANSUI "DOLBY SYSTEM" STEREO CASSETTE DECK SC 737
Real-to-Real quality with cassette convenience. Features include high-density magnet ferrite record/play head, record/play back, record/play back preamplifier tape selection switch and peak level indicator and professional VU Meters.

SIMPLY COMPLETE AND RETURN THIS CROSSWORD ENTRY FORM WITH YOUR COMMENTS - IT COULD BE YOUR FREE PASS TO PARADISE.

CLUES ACROSS:
3. This Hi-Fi Company could send you on a Noumea Holiday.
5. An Amplifier control that accentuates stringed instruments.
6. Abbreviation for an input socket.
7. The Deepest sound.
8. A basic part of tapes or fishing rods.
11. Sansui offer a complete Hi-Fi.

CLUES DOWN:
1. These Sanwa components are both solid state and integrated.
2. A place for your records to revolve (plural).
4. They produce the sound and enhance your room.
9. Sansui amplifiers have this Degree of noise level.
10. The new modulation code which is incorporated in Sansui Stereo Tuners.

Tell us in 25 words or less why you prefer Sansui Hi-Fi Units:
______________________________________________________________
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______________________________________________________________
______________________________________________________________
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NAME

ADDRESS

P/C

Mail to: SANSUI PROMOTION HEADQUARTERS, P.O. Box 73, Hawthorn, Vic., 3122.

SEE SANSUI HI-FI UNITS AT YOUR HI-FI RETAILER NOW ! ! !

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Canberra Office: 25 Molonglo Mkt., Fyshwick, A.C.T. Tel: 52 7332.

Adelaide Office: 2 Bowen St., Kensington. Tel: 52 7332.
Brisbane Office: 14 Prce Street, Fortitude Valley, Qld. Tel: 31 4988.
Perth Office: 27 Oxford St., Leederville, W.A. Tel: 81 4988.

ELECTRONICS Australia, August, 1974
2GB's Frank Vowls rang E.A. Editor-in-chief to compare notes on how such a competition could be run. From this came the idea that "Electronics Australia" might like to publish details of selected entries, with a credit line to 2GB and a publication fee to the competitor. All the station needed now was a sponsor and Reg Hall of Kenwood was ready to admit that a crystal set competition sponsored over the air and exposed in an exhibition, looked like a pretty good novelty promotion. So it became the Kenwood 2GB crystal set competition, with "Electronics Australia" in a back-up role.

The High Fidelity Industry Association, which is sponsoring the exhibition, is composed of suppliers of high fidelity audio equipment in Australia.

The equipment to be displayed ranges from some of the most costly and exotic anywhere in the world to systems which combine economy with an order of performance likely to satisfy a great many initiates to the realm of high fidelity. Some of the budget level systems are made up from items selected from different makers; others, like the new Rondo 3000, are one-brand systems.

Concerning the Rondo 3000, Doug Bell of Pioneer has this to say:

"Rondo 3000 is Pioneer's latest offering to the system buyer. For the person that wants good quality sound, versatility of components and the simplicity of a system purchase, Rondo 3000 is a very attractive 'package'.

"The units that make up the Pioneer Rondo system are a belt drive turntable; tuner amplifier with AM and FM plus two quadraphonic matrix circuits (RM and SQ), a 3-way 3-speaker system and a pair of stereo headphones. Everything to satisfy most needs, and all compatible. The headphones are a particularly interesting feature. More and more people are using headphones as an accessory but, with Rondo 3000, you get them as part of the system.

"Pioneer have an eye on the future with the inclusion of an FM tuner, and the quadraphonic circuits— all the buyer needs is a second pair of speakers to obtain 4-channel sound. Another feature is the matching Rosewood cabinet that is available from Pioneer dealers as an option. It solves that 'where to put the hi-fi' problem for the first-time buyers.

"To anyone with $400 to $500 to spend on hi-fi, the Pioneer Rondo 3000 is a complete, compatible system well worth listening to. Recommended retail price is $459 and the Pioneer 1-2-3 year full warranty applies."

Incidentally, the Sydney branch of Pioneer has moved into a new office warehouse in Brookvale. The building provides over 12,000 square feet of space

75 Sounds Fantastic: The Rondo 3000 system, which has been designed to meet the need for a system combining economy with good performance. See text alongside. (Pioneer Electronics Aust. Pty. Ltd., 256-8 City Rd, South Melbourne 3205.)

75 Sounds Fantastic: Yamaha products will be featured prominently by Rose Music Pty Ltd, of 17-33 Market St, South Melbourne. At the top is the CA600 stereo integrated amplifier, which is rated at 32W RMS per channel at 1kHz into 8 ohms and 40W into 4 ohms, with both channels driven. Power bandwidth over the audio spectrum is very wide and rated harmonic distortion is below 0.1% over all full rated power. Full control facilities are provided, with input facilities for two phono, two auxiliary, radio tuner, microphone and tape system. There is provision also for two sets of loudspeakers. The CR1000, at the bottom, is a complete high-performance stereo receiver/amplifier. In the latter role, it has all the input, output and control facilities that one could possibly need and, for good measure, an RMS power rating of 75W RMS per channel into 8 ohms (100W into 4 ohms) with both channels driven. The radio facility is a high performance FM/stereo tuner but curiously, in a unit which boasts so many other facilities, there is no mention of an AM tuner. Rose Music will also be displaying Yamaha loudspeaker systems which seem to have shed their one-time and rather pointless links with Yamaha organ practice. The latest series have received wide acceptance overseas.
The Acid Test.

"Hey!
Watch out!
The needle's right
over into the red!"

"Relax...
I'm using a
MEMOREX Cassette"

MEMOREX
THE UNDISTORTER!

For the very first time you can forget about overload distortion when you record. Just use 'Memorex' the Undistorter. No hiss, no distortion, no hassle, just beautiful clean clear sound. And Memorex costs only cents more than the cheapies. You'll never know how good your recorder is until you try 'Memorex' tape.

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Patricia Street,
Canberra, A.C.T. 2600.

S.A. HILLS ELECTRONICS P/L
7 Ackland Street,
Edinburgh North, S.A. 5025.

V.I.C. R.J.D. ELECTRONICS
202 Petham Street.
Carlton, Vic. 3053.
HIFI NEWS

and all sales, service and despatch is located at the new address — 20 West Street, Brookvale. The new phone number is 93 0246. A new demonstration centre is planned for the new location for the convenience of customers and dealers.

Rank Industries Australia Pty Ltd will have three complete stands in the main exhibition area. They will be displaying a wide range of products carrying names known worldwide in the context of high fidelity sound reproduction. Included are: Sansui, Wharfedale, Leak, Thorens, Ortofon, Altec, Tandberg, Ampex, Watts, Sileron, Grayson.

In detail, the ranges include:

Sansui — complete range of all products — amplifiers, tuners, turntables, speakers, headphones and tape decks.

Wharfedale — Denton 2, Linton 2, Melton 2, Dovedale 3 (all speaker systems), DC 9 tape deck, DDI headphones.

Leak — 200, 300 and 600 speaker systems and Delta 70 amplifier.

Thorens — TD165, TD160C, TD125 turntables.

Sileron — MK2 and MK4 turntables.

Grayson — TU1 and TU2 turntables.


Tandberg — new 9200X, 3400X and TCD310 professional tape recording equipment.

Altec — complete range of Altec Lansing consumer and professional hi fi speaker systems.

Ortofon — M15E Super, M15 Super, FF15 and FF15E magnetic pickup cartridges.

Ampex — high quality American cassette and reel recording tape and accessories.

Other exhibitors, not mentioned elsewhere in the text, include the following: Arena Distributors A'Asia Pty Ltd, 273 Hay St, Perth, WA, 6000.

Auriema A'Asia Pty Ltd, 15 Orchard St, Brookvale, NSW, 2100.

Australian Musical Industries, 150 Gladstone St, St. Melbourne, Vic, 3205.

R. H. Cunningham Pty Ltd, 493-7 Victoria St, West Melbourne, Vic, 3003.


Haco Distributing Agencies, 57 Anzac Parade, Kensington, NSW, 2033.

Hagemeyer (Aust) N.V., 57 Anzac Parade, Kensington, NSW, 2033.

Jacoby Mitchell Ltd, P.O. Box 2009, North Parramatta, NSW, 2151.

Jervis Australia Pty Ltd, 1 / 111 Old Pittwater Rd, Brookvale, NSW, 2100.

Kitsets Australia, 21 Oaks Avenue, Dee Why, NSW, 2099.

Linear Sound Pty Ltd, 673 / 9 Pacific Highway, Chatswood, NSW, 2067.

Realistic Manufacturing, 541 Princess Highway, Rockdale, NSW, 2216.

Sonab of Sweden, 114 Walker St, North Sydney, NSW, 2060.

Sony Kemtron, 469 Kent St, Sydney, NSW, 2000.


'75 Sounds Fantastic: Whatever other amplifiers there may be at the exhibition, it is unlikely that many of them will have the sheer power of this Bose 1801 unit, intended for use with a separate pre-ampl control unit. With other characteristics which fall well inside limits which the manufacturer considers adequate, the 1801 will deliver 150W RMS per channel into 16-ohm loads, 270W into 8-ohm loads and a whopping 440W into 4-ohm loads! On the left is another item from the Wedderspoon catalog, the AR-LST loudspeaker system by Acoustic Research. Designed for professional or high level domestic use, the AR-LST (Laboratory Standard Transducer) is basically a larger, higher-powered counterpart of the company's popular AR-3 series. (From W. C. Wedderspoon Pty Ltd, 3 Ford St, Greenacre, NSW).

Sonab of Sweden, 114 Walker St, North Sydney, NSW, 2060.

Sony Kemtron, 469 Kent St, Sydney, NSW, 2000.

Sony presents a complete line of new mikes. From a tiny "tie-clip" model to a professional "paired" model for stereo pick-up, over fifteen different models are available to meet a wide variety of sound pick-up needs. Thanks to the successful utilisation of the electret principle which was pioneered by Sony, the professional "condenser" sound is now within the reach of amateur recording buffs. The absence of high peaks and deep valleys in the response of condenser microphones is also very desirable for P.A. (Public Address) use where elimination of acoustic feed-back and good articulation are essential. The moderately priced, maintenance-free dynamic microphones are especially suited for permanent or budget-priced installations.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Frequency Response</th>
<th>Output level</th>
<th>Signal-to-noise ratio (1000 Hz 10 bar)</th>
<th>Wind noise</th>
<th>Maximum sound pressure level</th>
<th>Dynamic range</th>
<th>Weight</th>
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</thead>
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<tr>
<td>250 Ohms</td>
<td>-56.8 dB</td>
<td>Better than 66 dB</td>
<td>Less than 34 dB SPL</td>
<td>92 dB</td>
<td>285 g (10 oz)</td>
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<tr>
<td>300 Ohms</td>
<td>-57.8 dB</td>
<td>Better than 64 dB</td>
<td>Less than 38 dB SPL</td>
<td>98 dB</td>
<td>310 g (1.09 oz)</td>
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<tr>
<td>200 Ohms balanced</td>
<td>-56.0 dB</td>
<td>Better than 66 dB</td>
<td>Less than 38 dB SPL</td>
<td>98 dB</td>
<td>102 dB</td>
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<tr>
<td>200 Ohms unbalanced</td>
<td>-56.0 dB</td>
<td>Better than 66 dB</td>
<td>Less than 38 dB SPL</td>
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Listening to
music in the home

When we listen we become engrossed in the music and, with good equipment, we can often obtain the same satisfaction that we would enjoy in the concert hall. Of course, there are differences between the real and the reproduced. Many of these we recognise as such: we come to terms with them and they do not intrude. More serious perhaps are the distortions which we do not consciously notice but which are nevertheless continuously producing a contradiction between the actual and the imagined. They produce listening fatigue, a condition detrimental to the true objective. These distortions have little to do with the popular conceptions of HI-FI or LO-FI sound; on the other hand they have much to do with good or bad engineering.

Write for free illustrated literature to British Merchandising Pty Ltd, 49-51 York St, Sydney. Or telephone 29-1571.

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for the closest approach to the original sound

QUAD is a Registered Trade Mark.
FREQUENCY MODULATION . . .

Broadcasting in Stereo

While the FM broadcasting system has much to commend it in its original monophonic form, its appeal to listeners interested in high quality reception has been vastly increased by the incorporation of a stereo facility. This article explains how stereo signals are imposed on the one basic FM carrier, and how they are separated out again in the receiver.

by NEVILLE WILLIAMS

In the late 1960's, with the emergence of two-channel stereo tape and disc systems, there was naturally a good deal of speculation about the possibility of stereo broadcasting.

The speculation and interest was worldwide and included suggestions for modulating AM transmitters with nonsymmetrical sidebands, or using pairs of existing transmitters to radiate respectively the left and right stereo signals. In Australia, the latter scheme was taken up by a few stations, usually for late evening stereo music. To reproduce the program in the home, it was necessary to use two receivers suitably placed in the listening room.

While such ventures were interesting enough at the time, they were necessarily short lived. The programs monopolised two stations and doubled the spectrum space required for any given program. There were obvious difficulties, also, in maintaining a suitable phase and amplitude balance between the stereo signals both at the transmitting and the receiving end.

Quite early, an integrated system was required, and far and away the best chance of evolving one related to the then relatively new FM system was to discover, test and promulgate a stereo system that would not render obsolete existing monophonic FM transmitters and receivers. Stereo transmitters should provide a satisfactory mono signal for existing receivers, while mono transmissions should be resolved as such by stereo receivers.

More than that, the stereo signal should conform to the bandwidth limitations already imposed on monophonic FM broadcasting.

No less than seventeen possible methods were submitted for evaluation to the National Stereophonic Radio Committee, an industry group working in association with the FCC. These were narrowed to eight systems, representing six distinct approaches to the problem.

During the latter part of 1960, the methods were air-tested using the facilities of KDKA Pittsburgh and the results wound up as a voluminous report to the FCC described as being "as bulky as two New York City Telephone directories".

After studying these reports, the FCC issued standard specifications for a stereo FM system in April 1961, modelled mainly on proposals originally put forward by the General Electric Company and by Zenith Radio Corporation. With minor variations it has been adopted as a world standard.

This system solves the compatibility problem in the most obvious manner. The left and right signals of the stereo pair are effectively added — e.g., matrixed to form a "sum" signal — and used to modulate the FM transmitter in the usual manner. A conventional mono FM receiver, tuned to the station, produces an apparently normal mono program, with a frequency response to 15kHz.

A listener using such a receiver, whether it be a dated model or a new mono portable, need not be aware that the station is involved in anything technically more ambitious.

The procedure assumes that the program material is itself stereo/mono compatible.

This is usually the case with stereo discs and tapes, which are normally designed to produce an acceptable signal when played in the home on a mono rather than a stereo receiver.

There is one reservation, however. When an FM station is transmitting mono only, the modulation level can be set so that the carrier is deviated to its full permitted limit on signal peaks. Receivers can obviously recover the maximum amount of audio from the transmitted signal, ensuring the best possible signal/noise ratio.

If the station has to transmit information additional to the mono or sum signal, it is reasonable to expect that the mono signal may have to be reduced somewhat, if the station is to stay within the original deviation limits. As a result, the audio recovered by a mono receiver may be proportionately less, with a consequent reduction in the signal/noise ratio.

And this, in fact, is what happens. An FM transmitter handling a stereo signal does have to cope with additional information, of a form yet to be discussed. Presence of this extra information makes it necessary to depress the level of the mono signal so that its peaks under any conditions are not more than what would otherwise represent 90pc modulation. In practice, at the receiving end, it usually ends up in about a 4dB drop in recovered audio. In a strong signal area this would not be noticed but, in a marginal situation, it could represent some degradation in the signal recovered by a mono receiver.

In itself, it is a comparatively small price to pay. Much more to the point is the signal/noise ratio of audio recovered in full stereo mode, and this will emerge later in the discussion.

Having provided all receivers with a...
This superb machine literally speaks for itself. This cunningly designed and engineered unit produces an extremely high quality stereo sound reproduction from an eight track cartridge. One cartridge will provide four separate stereo programmes of up to one hour and twenty minutes in length. The machine will then repeat the programme indefinitely. Track switching is completely automatic or can be selected by a simple push button selector. Each track is indicated as it is being played.

An integral solid state 3-stage pre-amplifier gives a fully corrected frequency response ideal for feeding into the auxiliary input on a suitable power amplifier. Motor temperature is controlled by an integral force-ventilation system. The heart of the machine is a four pole dynamically balanced synchronous motor which delivers an unwavering constancy of speed independent of normal voltage fluctuations.

The TD8S is undoubtedly the highest quality 8 track cartridge player available. But why not hear the superior sound of this brilliant machine for yourself at your nearest retailer of sound equipment, because as we said before, the TD8S literally speaks for itself.

Technical Data
Number of tracks: 8 (4 stereo channels);
Tape Speed: 3 in. per sec. (9.6 cm/sec);
Programme Selector: Automatic and manual; Tape Head: Nortronics 4 track with hyperbolic face; Pre-amp Output: 3 stage 750 mv (nominal) 1 Kc Standard Reference Level Tape; Track Playback Sequence: 1 and 5, 2 and 6, 3 and 7, 4 and 8 and infinite repeat; Wow/Flutter: Less than 0.3% total; Frequency Response: Better than 50-10,000 Hz; Power Supply: 210-250 volts, 50 Cycle AC; Dimensions: Cabinet: 261 mm x 206 mm x 99 mm; Net Weight: 52 lbs.; Cartridge Dimensions: This unit will accept standard 8 track cartridges measuring 139 mm x 101 mm x 22.5 mm.

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**FM-STERO**

mono or L-plus-R or "sum" signal, and having thus achieved compatibility, the system must now provide a second signal for stereo receivers, so that they can reconstruct the original stereo pair. What they require, not surprisingly, is a "difference" or L-minus-R signal.

By ultimately combining the sum and difference signals in a suitable amplitude and phase relationship, the original L and R components can be recovered and made available to the left and right channels of the stereo amplifier.

The algebra, at least, is very simple. To recover the L(left) signal, the sum and difference components can be added directly:

\[ (L + R) + (L - R) = 2L \]

To recover the R(right) signal, the phase of the difference signal is reversed prior to adding it in a second network:

\[ (L + R) - (L - R) = 2R \]

The real problem which faced engineers around 1960 was how to impose the necessary "difference" signal on the FM carrier, in such a way that it could be intercepted and resolved by a suitably designed receiver, without producing any unwanted effects in mono receivers.

In an article presented at this level, it is conventional to suggest that the difference signal is derived by matrixing, then imposed on a supersonic sub-carrier which, in turn, is modulated on to the main FM carrier. The modulation components are ignored by a conventional mono FM receiver, but are resolved and utilised by stereo receiving equipment.

In fact, it can be shown that a quite different concept produces much the same end result. This visualises a time multiplex system which samples the left and right components at a supersonic rate. If this switched sample is filtered to remove all harmonics other than the fundamental (to avoid excessive deviation) and then frequency modulated on to the carrier, the end result becomes virtually equivalent to a sum and difference frequency modulated by the difference signal.

The foregoing paragraph is perhaps more general than precise but it does give the clue to subtleties behind the usual explanation. It also leaves open the way to approaches at the receiving end which relate more to time division techniques than to normal detection.

Fig. 1 is the conventional block diagram of the so-called stereo multiplex system which shows the progress of stereo program signals through to the aerial of an FM transmitter.

The stereo signal pair to be fed to the transmitter are shown entering the block diagram from the left. They first pass through individual pre-emphasis networks, which boost the treble by the customary amount. The bandwidth is at 18kHz for the European standard; 75uS or 15dB at 18kHz for the original US standard.

From the pre-emphasis networks, the stereo pair enter a combining or matrix system. With the levels and phasing under close scrutiny, the signals are added in phase to produce a sum or mono component. This is equivalent to what one would get by playing stereo record with a mono pick-up, or a stereo cassette through a mono player.

In another branch of the matrix circuitry, one channel is reversed in phase by 180 degrees then combined with the other channel to produce what is, in effect a difference component. (You may recall the old axiom: "to subtract a quantity, reverse its sign and proceed as in addition"!)

The mono signal is fed to a delay network and thence to the modulating circuits of what could well be a conventional FM transmitter. Purpose of the delay network is to provide a means whereby the phase of the sum signal can be correctly related to that of the difference signal, the latter being subject to a good deal more processing on its way to the modulating circuits.

This detail aside, the upper portion of the diagram provides the mono FM program, which is the basis for mono/sterro compatibility.

Looking now at the difference signal, this is amplitude modulated on to a supersonic carrier, as previously mentioned. This carrier is at 38kHz, plus or minus a couple of Hz. Assuming that the difference signal will contain frequency components to 15kHz, the output from this modulator will contain a 38kHz carrier, plus sidebands extending from 23kHz to 53kHz.

In fact, the actual 38kHz carrier is suppressed at this point to no more than 1pc of its normal amplitude — and with good reason. If it were retained at normal amplitude and subsequently applied to the main FM carrier, it would add substantially to the deviation, without contributing proportionally to the essential signal information. In fact, the sub-carrier would be at its maximum amplitude during those instants when there was no difference information to convey.

With the 38kHz carrier suppressed, the difference signal assumes the form: double sideband, suppressed carrier, abbreviated frequently — but not very accurately — to the letters DSB. The full abbreviation should be DSB-SC.

This DSB-SC signal also passes through a delay network to permit fine adjustment of the phase, and then on to the main modulator, where it, too, is imposed on the main carrier as a frequency modulation.

Fairly obviously, when the difference signal is at a minimum, so also are the related sidebands; in the absence of the carrier, the difference circuitry adds very little to the modulation swing.

In fact, as far as modulation percentage is concerned, the sum and difference signals tend to be complementary. When the left and right channel information adds to produce the largest sum signal, and therefore the heaviest basic modulation of the FM carrier, at this same instant the difference signal and its contribution is at a minimum. The converse is true.

As a result, inclusion of the difference information has little effect on the amount of sum (or mono) modulation which can be applied.

However, if the difference signal is to be correctly resolved by receivers, they must be able to replace the suppressed sub-carrier with a locally generated signal of precisely the right frequency and phase.

To enable this to be done conveniently, one other component is added to the transmitted signal: a 19kHz reference or " pilot" signal, precisely half the frequency of the suppressed carrier and phase locked to it. This relationship can be established at the transmitter either by generating a precise 38kHz carrier and halving it to produce the reference frequency, or vice versa.

At the receiver, the reference frequency, is separated out and used to phase lock a filter, which effectively regenerating the missing carrier.

But why suppress one carrier from the transmission, only to replace it by another?

The answer lies largely in the fact that the 19kHz reference (or pilot) signal is at a lower frequency than the suppressed carrier and it can also be held to a constant, modest level. In the standards, assume that the reference signal need be responsible for not more than 10pc of the permissible deviation, leaving the remaining 90pc to be shared between the sum and difference signals.

Fig. 2 depicts the frequency spectrum with the essential components present to the carrier of a stereo FM transmitter.

The frequencies 30 to 15,000Hz are the direct audio components obtained by adding the left and right stereo signals — the mono signal.

Just beyond the audio range is the 19kHz reference or pilot tone. The region from 23kHz to just short of 38kHz accommodates the lower sideband of the difference information. At 19kHz is a notch where the difference carrier has been suppressed and, beyond that, out to 53kHz are the upper sidebands of the difference signal.

The vertical scale of Fig. 2 is also significant. It shows the pilot tone at a
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FM-STereo

level of modulation and the sum and difference signals sharing the remaining 45%. As indicated earlier, the relationship between these two is dynamic, the sum or mono signal tending to rise above 45% modulation as the difference signal falls below it.

So much for the transmitted signal, but what does it all mean at the receiving end?

receivers will be the subject later of more detailed discussion but, in essence, they reverse the process outlined for the transmitter and illustrated in Fig. 1.

They receive the incoming carrier and, following normal superheterodyne practice, reduce it to an intermediate frequency usually centred on 10.7MHz. It is then fed to an FM demodulator of one type or another and the modulation extracted.

In the simplest case—a conventional mono pilot tone or tuner—the modulation products encounter a deemphasis filter intended to reduce the level at 10kHz by the appropriate 10 or 15dB. Naturally enough, the deemphasis network heavily attenuates the pilot tone at 19kHz and the “difference” sidebands in the region 23-53kHz, so that not much of this extra information will reach the amplifier. Even if it does, being beyond audibility, it will not be noticed by the listener.

This observation must be qualified in one respect. While to 19kHz pilot tone is normally above audibility, it can cause possible problems if the incoming signal is being tapped through the pilot tone, or one of its harmonics, may happen to beat with the recorder’s bias frequency to produce an audible note, which then appears on the tape. Because of this possibility, it has become virtually standard practice to fit all FM receivers and tuners with a trap circuit intended to keep the pilot tone out of the audio circuit.

But let’s get back to the main theme. In a stereo FM receiver or tuner, every effort is made to preserve the full range of modulation components at the output of the demodulator, the components then being directed and processed as necessary.

First off, the basic audio modulation, or sum signal, is isolated and made available for subsequent merging with the difference signals.

The 19kHz pilot tone is also isolated and made available to phase lock a locally generated 38kHz signal, essential for demodulating the difference sidebands.

These sidebands, in turn, are demodulated to recover the original “difference” information. By matrixing sum and difference components in the appropriate amplitude and phase, it is possible to separate the main sidebands, and recover the original left and right stereo signal information. Suitably de-emphasised, the stereo pair is passed on to the amplifier system.

The stereo signals may be just a stereo pair, or they may contain additional information, in turn, for matrixed quadraphonic presentation. In short, if an SQ pilot tone at 19kHz and the “difference” on the turntable of an FM station, the signal will be processed and transmitted as normal but it will be capable of being decoded at the receiving end, just as if the disc were being played on the system’s own turntable.

A no agreement has yet been reached on the transmission of fully discrete quadraphonic material, as from CD-4 discs. These discs involve their own supersonic modulated carrier which could well cause all manner of problems if it was allowed to reach the modulating circuits of the FM transmitter. Almost certainly, such discs would have to be decoded first into discrete 4-channel audio, before being re-processed like any other 4-channel signal for modulation on to the FM carrier.

In the USA, the Electronic Industries Association has formed a committee to consider the whole problem and they are currently examining about 10 different systems. The objective now is to maintain full compatibility with existing mono and stereo equipment. Curiously, one of the biggest stumbling blocks, for the USA at least, is the presence of the 67kHz background music or “storecasting” sub-carrier, a facility which the FCC seems determined to preserve.

At present, the most favoured of the 4-channel systems is known as the Dorren, after its inventor.

In broad terms, all four signals are applied in sum to the main modulation circuit, to provide the basic mono sound. The normal 38kHz sub-carrier system contains the difference information but it is essentially the difference between the total left and total right. With this, a conventional stereo receiver can recover an acceptable 2-channel version of the program.

However, an additional (suppressed) carrier with sidebands is centred on 76kHz—4 times the pilot tone—and these contain the difference between the respective front and back pairs. A suitably designed quadraphonic receiver can accept these extra sidebands, balance and matrix them with the rest of the signal information to recover the original four discrete signals.

With this scheme, the “storecast” carrier is moved out to 95kHz, five times the pilot tone.

It is conceded that the ultimate station bandwidth will tend to be somewhat greater than with a conventional stereo broadcast but supporters of this and similar schemes are confident that they can maintain the outer sidebands (to a level) acceptable to the FCC, and to a level which will not cause inter-channel interference. The real problem may well be the one faced by receiver manufacturers, who will have to come up with a passband wider and squarer than ever before.

Earlier, reference was made to the matter of signal/noise ratio. It was pointed out that reduction of the “sum” modulation on a stereo program, as compared with full equivalent modulation of a mono transmitter, produced a potential degradation of about 4dB in signal/noise ratio, even when received in mono mode.

Received in full stereo mode, the potential degradation in signal/noise ratio is much greater. In broad terms, this can be accounted for by (1) the reduction of effective deviation for the signal components; (2) the aggregate noise contribution of two channels rather than one and (3) the involvement of an amplitude modulated system with its attendant susceptibility to noise interference.

Because of these factors, the signal/noise ratio for stereo mode reception is likely to be degraded by at least a further 10dB from mono mode reception of the same transmission. Compared with an equivalent mono transmission, the potential signal/noise degradation in a weak signal area adds up to about 15dB; some put it at nearer 20dB.

To some extent, the difference can be countered by the use of higher gain, more directional aerials, perhaps motorised, but the fact remains that stereo reception can pose problems in fringe situations.

Recognising this, modern stereo tuners incorporate provision for manual or automatic reversion to mono mode when the input signal falls below a predetermined level.
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The quest for flawless record reproduction has brought the development of magnetic cartridges and tone arms up to a high stage of precision. At the forefront of this development must be the Shure V15 type III magnetic cartridge and SME model 3009 series 2 improved tone arm, which we review here.

While the majority of high fidelity systems in use today employ an automatic turntable there are still many enthusiasts who prefer to use a manually-operated tone arm. In theory, a tone arm free of the encumbrances of being part of an autochanger mechanism should function more efficiently.

The "SME model 3009 series 2 improved," to give its full title is perhaps the most well-known tone arm for use with a non automatic turntable. (I dislike the term manual; after all, turntables have been motor-driven ever since I can remember). The SME arm has adjustments for static balance in the vertical and lateral planes, as well as antiskating compensation.

In the improved version, the main-counterweight which is mechanically decoupled from the arm, has been made more compact so that it can be moved closer to the pivot and thus reduce the arm inertia. The range of stylus tracking weight available on the outrigger system is 0 to 1.5 grams.

Antiskating compensation is provided by means of a small weight hanging by a nylon thread which runs over a miniature pulley and is attached to a lever on the arm pivot. The lever has graduations on it which coincide with those on the tracking weight outrigger. The pulley is one of the recent improvements; previously, the bias guide as it is called, was just a loop of heavy gauge wire.

A hydraulically-damped lifting and lowering device is incorporated in to the arm, as a matter of course. The m base if fitted in a slide so that it can be precisely adjusted for stylus overhang, or more precisely, for minimum tracking error.

Instead of having the arm rest as a separate fixture, the SME arm rest is cantilevered out from the base. It has a self locking clip which is a change from the previous wire clip.

A commendable feature of the SME arm is the very low bearing friction in both vertical and horizontal planes. It must have the lowest bearing friction of any arm we have tested.

As a further refinement, the SME arm is available with a fixed instead of removable headshell. Some may regard this as a backward step, as it makes cartridge installation and removal more difficult. Nevertheless, SME feel that the elimination of the locking collar and bayonet section from the already lightweight headshell afford a useful reduction in mass. Whether the reduction in mass gives an audible improvement in tracking is a moot point.

We reviewed the version with removable headshell as pictured. Another improvement that will be noticeable to those familiar with the previous model arm is the side-entry socket for the audio leads. This allows a more shallow plinth to be used for the turntable than previously.

The audio leads are terminated in machines phono plugs and are of low capacitance, about 140pF per channel. This means that there is very little attenuation of the cartridge high frequency response.

The cartridge in question was the Shure V15 type III which represents quite a large change over the type II. While the superseded type II was one of the best cartridges available at the time, it did not have a flat frequency response, it had a 3dB depression centred on about 8kHz. While this was curable with appropriate changes to the equalisation circuitry, it still represented a deviation from the ideal.

While the type III appears very similar to the type II, it is electrically quite different and the stylus assemblies are not interchangeable. Shure has reduced the effective tip mass of the elliptical stylus and now used a laminated core and pole-piece structure. Output of the cartridge is unchanged at 3.5mV at 3cm/sec.

We installed the cartridge and arm according to the well written instructions and found no real problems. We linked the facility for rotating the headshell so that the cartridge is correctly oriented with the record surface. Balance and antiskating adjustments and straightforward to make. Tracking weight calibrations on the arm appear to be within at least 50 milligrams of their stated value.

Recommended tracking weight range is from $1/2$ to $1/4$ grams. We found that with the tracking weight set to 1 gram, the V15 would comfortably handle all our difficult records except for the savage plus 18dB 300Hz lateral tracking test on CBS STR110. This required $1^{1/2}$ grams. No apology needs to be made for this.

Frequency response was checked using the CBS STR 100 test disc. As it happens, we need not have bothered — it was ruler straight from go to whoa. Putting it in a more customary way, within plus or minus 1dB from 20Hz to 20kHz. And separation between channels was very good at minus 29dB in both directions, and never less than 20dB over the range from 50Hz to 16kHz.

Viewed on an oscilloscope, the waveform for sine and square waves was always very good. In fact there is very little to criticise with the V15 type III. With the SME arm we did find a few small hassles: the arm rest faces the wrong way (you have to lift the arm out and over it) and it is annoying to have to release the self-locking clip every time to play a record.

So how does the combination sound? That is the hardest question to answer. It does not really "sound" at all. Compared with other cartridge and arm combinations it tracks better, has a flatter frequency response, has greater clarity in the highs and lows. What more can you say, except that its a superb combination.

Further information and recommended retail prices for Shure and SME products can be obtained from the Australian distributors, Audio Engineers Pty Ltd, 342 Kent Street, Sydney, NSW. (L.D.S.)
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The Kenwood KL-7090 is the most complicated loudspeaker system we have ever tested. A 5-way system, it employs no less than 6 driver units — the largest of which is the 380mm woofer. It was submitted for review by Jacoby, Mitchell Pty Ltd.

First impression of the Kenwood KL-7090 is that it is a very well finished loudspeaker system. The front grille is elegantly styled and is removeable. The grille covers a similarly well-finished baffle in walnut veneer, which accommodates a profusion of loudspeakers. One can almost imagine proud owners using the units with the grilles permanently removed so that they could feast their eyes at any time on the impressive array.

Largest of the six loudspeakers in the system is the 380mm (15in nominal) diameter woofer which had determined the width of the enclosure. In spite of its bulk, appeared little different from any other large loudspeaker. We measured its free-air resonance at 30Hz which tends to bear this out.

In the enclosure, we found the resonance of the woofer rose to about 80Hz and although acoustic damping material is used on the insides of the box we would have expected the bass response to taper fairly rapidly below this frequency.

A complex crossover network, comprising three ferrite-cored inductors, five non-polarised electrolytic capacitors and thirteen resistors, splits up the audio spectrum in conjunction with the four-position tone selector switch on the front baffle.

Over the range from 800Hz to 2kHz, signals are handled by the 120mm loudspeaker while from 2kHz to 5kHz signals are handled by a large horn driver. Then from 5kHz to 16kHz the output comes from two multicellular horns in parallel. Above 16kHz signals are handled by a small horn tweeter with what appears to be a defraction grille in front of it.

A complicated approach to loudspeaker design, one must agree. With such small segments of the signal being handled by each transducer, it should minimise Doppler and intermodulation distortion. But it does add another 10kHz crossover over network and with loudspeaker orientation on the baffle, all sorts of frequency and phase irregularities can occur.

Nevertheless, of course, that the designers are aware of these problems but the point is made to highlight the difficulties of this approach to wide-range loudspeaker design.

Before making measurements, the loudspeakers were set up in conjunction with a high quality cartridge, turntable and stereo amplifier and listening tests made with a wide variety of records. This was done both in the home of a staff member and in our laboratory. We found the efficiency to be relatively high compared with most systems on the market and power handling was generous to say the least. In fact, Kenwood rate the KL-7090 for a maximum input of 120 watts. From our experience, the KL-7090 should comfortably handle the program output of amplifiers rated up to 60 watts continuous and more. The result is that they can produce more than enough volume, even for those pop enthusiasts who are out of their mind.

On popular instrumental music, the system gives quite a good account of itself but on classical music, particularly large orchestras it is disappointing because of what appears to be colouration. We cannot state what appears to be the direct cause. Certainly, there is a tendency to peakiness in the 2 to 3kHz region and also in the 8 to 9kHz region but this would not account for the problems we heard. Bass is reasonably strong down to below 80Hz and it tapers off at a rate of about 18dB per octave. Above 10kHz, the response also appears to taper off faster than expected in spite of the horn tweeter covering that range.

Certainly, there are many people who will be satisfied with the Kenwood KL-7090 performance and its elegant styling should appeal to the ladies whether they are interested in music or not. But classical music enthusiasts may have to listen carefully to it before deciding to purchase.

Recommended retail price of the Kenwood KL-7090 loudspeaker system is $399 a pair. Kenwood equipment is available from high fidelity retailers throughout Australia. Further information can be obtained from the Australian distributors, Jacoby Mitchell and Company Ltd, 215 North Rocks Road, North Rocks, NSW. (L.D.S.)
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Low-loss optical fibres from Bell and Corning

Recent advances in fibre manufacturing techniques by two American companies may hasten the time when light pulses will transmit voice, data and video signals throughout a communications network. Communications systems using light will have a much greater signal-carrying capacity, will potentially less cost and less dependence on natural resources, than existing transmission facilities.

Scientists at Bell Laboratories have devised a new manufacturing process for making low-loss light fibres. Light sent through fibres made by the new process loses only about one third of its intensity over a distance of one mile. In ordinary glass of the sort used in window panes, this order of reduction in intensity would occur in a small fraction of an inch. The amount of light loss is directly related to the presence of residual impurities and imperfections in the glass fibre. It is important to have as low a light loss as possible in order to cut down on the number of amplifying stations in long-distance optical communications systems of the future.

Another important feature of optical fibre performance has also been improved in the new Bell Labs process: the dispersion characteristics. Dispersion is caused by the fact that some light within each pulse travels in a zig-zag path during its passage along the fibre, thus travelling slightly faster than the direct light so that the phase of the light from a given pulse will arrive at its destination at the same time.

The new process is derived from a technique widely used in the semiconductor industry and is known as chemical vapour deposition. The glass fibre core, and in some cases its surrounding glass jacket (the "cladding") are formed, layer after layer, from gases passing through a fused quartz tube. The gases are heated sufficiently to react with one another, and are fused on the inner wall of the tube. The chemical composition of the layers is systematically varied by altering the gas flow, thus creating a graded refractive index throughout the layers.

These gases are the same as those used in semiconductor production. and are free of all the impurities which can cause light loss. At the same time, the fabric quartz tube of the Bell Labs deposition. The glass fibre core, and in some cases its surrounding glass jacket (the "cladding") are formed, layer after layer, from gases passing through a fused quartz tube. The gases are heated sufficiently to react with one another, and are fused on the inner wall of the tube. The chemical composition of the layers is systematically varied by altering the gas flow, thus creating a graded refractive index throughout the layers.

These gases are the same as those used in semiconductor production, and are nearly free of all the impurities which can cause light loss. At the same time, the fused quartz tube protects the deposited material from contamination from the ambient environment during the processing.

After sufficient core material has been deposited within the fused quartz tube, the tube is collapsed by further heating and then drawn into the thin fibres that will transmit the light pulses. A ten-inch section of collapsed tube, of less than one half inch diameter, may be drawn into a fibre more than a mile long.

In the Bell Labs experiments the fibre, exhibiting the lowest loss consisted of a pure fused silica core with borosilicate cladding. This transparency occurred at the infrared wavelength of 1.06 micrometres, where a laser light source acceptable for optical communications exists. For some conditions of excitation, losses as low as 1.2 dB km have been observed.

Another company that has made important advances in the field of glass fibre manufacture is the Corning Glass Works, with whom Bell Labs scientists have been comparing results. The company has been successful in producing fibres through a different, though related, process to the Bell Labs technique, with light losses closely approaching those of the Bell Labs fibres. The maximum signal attenuation is specified by Corning as 30 dB/ km at a wavelength of 820 nanometres.

The low-loss glass optical waveguides manufactured by Corning are now available for the construction of prototype systems, and are suitable for use in development programs involving broadband networks, data processing, process control systems and military communications systems.

Britain to export satellite sub-systems

The Electronic and Space Systems Group of the British Aircraft Corporation is to supply satellite sub-systems for the American Telephone and Telegraph Company's domestic communications satellite system. Initial deliveries on the contract will begin in November of this year.

The 24-channel space satellites will be used by the American Telephone and Telegraph Company to relay telephone traffic throughout the United States. BAC will supply satellite spun structure assemblies, spacecraft integration equipment, despin structures, booster adapters, separation sub-systems and power transmission assemblies. The first satellite will be launched from Cape Kennedy in 1976.

With the completion of the contract, BAC will have supplied 14 sets of revenue-earning space satellite equipment. The company is also manufacturing sub-systems for the larger and more powerful Intelsat IVA communications satellites.
Albert Einstein had a hair problem. And a lot of mathematical problems. The hair he could have fixed with a good brush. And with a lot of his other problems, 'Eveready' Gold Alkaline batteries could have helped out. Just think what a man like Einstein could have done with a battery that out-performs all others in high drain electronic equipment. A battery that delivers full and consistent power, even after being left idle for long periods. A battery that isn't bothered by extreme changes in temperature. Albert, we only wish we'd been there to help.

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Albert Einstein had a hair problem. And a lot of mathematical problems. The hair he could have fixed with a good brush. And with a lot of his other problems, 'Eveready' Gold Alkaline batteries could have helped out. Just think what a man like Einstein could have done with a battery that out-performs all others in high drain electronic equipment. A battery that delivers full and consistent power, even after being left idle for long periods. A battery that isn't bothered by extreme changes in temperature. Albert, we only wish we'd been there to help.

'Eveready' & 'Union Carbide' are registered Trade Marks.
New communications satellite in orbit

Shown in the accompanying photograph is a 30-ft diameter flex-rib antenna developed by Lockheed Missiles and Space Company, Sunnyvale, California, and used in the Applications Technology Satellite (ATS-F) launched from the Kennedy Space Center, Florida, on May 30, 1974.

The saucer-shaped antenna is constructed from aluminum ribs and Dacron mesh which is copper plated and coated with silicone. For the ride into space, the antenna ribs and mesh were wrapped around the antenna hub and held in position by a restraining cable. When the spacecraft arrived on station, a signal from the ground caused the cable to sever, allowing the antenna to unfold and begin operation.

US and Soviet space crews are planning to use the ATS-F communications satellite as a main communications link with Earth during their joint orbital flight scheduled for July 1975, provided the necessary tests and verifications are successfully completed over the next few months.

Although previous space communications have been relayed between ground stations using communications satellites, the Apollo-Soyuz Test Project will be the first to use a satellite to relay television and other communications directly from the spacecraft to Earth stations. The previous method of using satellites to relay messages between ground stations proved unwieldy during the recent Skylab missions. Because of Skylab's relatively low orbit of 435km, and the limited number of ground stations available, ground controllers were able to communicate with the crews for only 38pc of the flight time.

For the Apollo-Soyuz flight, communications time would be reduced to only 17pc of the flight time if this method were to be retained. However, by using the ATS-F to link the spacecraft with Earth, communications will be possible for 50pc of the flight time. This will greatly increase the amount of real-time data available to investigators on the ground, as well as increasing the amount of real-time television coverage of the flight.

Lasers may trigger nuclear fusion plants

High energy laser research in progress at three Atomic Energy Commission laboratories in the US may unlock the door to a new source of clean, safe and low-cost electrical energy by the end of the century.

The investigations are directed toward a demonstration that high-energy laser systems can be used to initiate thermonuclear fusion on a scale compatible with a variety of power generating schemes. Laser-induced fusion provides an alternative to the various magnetic confinement techniques that are currently being investigated as avenues toward controlled thermonuclear reactions.

The attractiveness of fusion power is based on the lower radioactivity of the reaction products as compared with fission processes, and on the virtually limitless supply of the fuel element deuterium, or heavy hydrogen, in the world's oceans.

The AEC's laser fusion program has been geared primarily to the US weapons program, for example providing a means of nuclear weapon simulation. However, it has both military and civilian energy production applications, according to Major General Ernest Graves, the commission's laser fusion program manager and assistant general manager for military applications. Some scientists believe that laser fusion could also eventually be used for space propulsion systems.

First-generation laser-fusion power plants probably would be analogous to fission plants, consisting of a reactor, heat exchanger and turbogenerator. Within the reactor, laser pulses in the range 100,000-1,000,000 joules could initiate fusion pulses of 10-100 million joules.

Advanced laser-fusion power plants might employ direct energy conversion techniques such as MHD (magnetohydrodynamical) hot-gas-generator conversion or plasma conversion.

Although laser fusion may not find its way into commercial use for decades, the AEC expects to demonstrate a system that produces more energy than it consumes (net energy gain) by mid-1980. Major milestones along the route to this critical goal include a demonstration of significant thermonuclear burn by mid-1977, and of scientific breakeven — the condition where thermonuclear energy equals the amount of laser energy impinging on the fuel pellet — by mid-1979.

IC replaces IF strip in FM radio tuners

Signetics Corporation of Sunnyvale, California, have developed a new integrated circuit which will eliminate most of the tuned circuits in the IF strip of FM radio tuners. Retailing for just over US$3, it replaces parts worth over US$20 and allows for greater design simplification and ease of construction.

Designated by Signetics as the "NE563", the new 16-pin dual-in-line IC was specifically designed to minimise alignment procedures, and performs all of the standard peripheral functions that high-quality FM receivers derive from the IF section. These functions include AGC (automatic gain control), AFC (automatic frequency control), drive for a signal strength meter, and variable muting.

Technically, the NE563 is an advanced phase-locked loop circuit. It incorporates a double-conversion technique that provides the receiver with a higher frequency response, greater sensitivity, and lower distortion than was previously possible. The incoming IF signal of 10.7MHz from the front of the receiver is amplified and limited in the first section, which has a gain of approximately 66dB. Next, the signal can be routed through an external ceramic bandpass filter to provide the frequency selectivity required.

After passing through the filter, the signal is routed through two mixers and an external low-pass filter. Here the signal is converted to a frequency of about 1MHz and used to drive the phase-locked loop demodulator section. The exact frequency of the local oscillator can be set with a crystal, ceramic, or LC resonator. The output from the NE563 integrated circuit is a low frequency stereo-composite signal and audio.
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NEWS HIGHLIGHTS

Computerised techniques aid land reclamation

Specialists at the Central Asian Research Institute for the Development of Land Irrigation and Reclamation in Uzbekistan (a Soviet republic in Central Asia) are using computerised methods to aid in the design of irrigation projects in arid areas. Electronic technology now solves a range of complex problems from the processing of topographic material to the issuance of blueprints for irrigation projects, together with cost estimates.

Already, more than 50,000 hectares (123,500 acres) of land belonging to the state farms of Uzbekistan have been reclaimed with the help of electronic computers. Overall labour expenditure in this project is now down to 20pc of the total cost.

At present, land reclamation projects in the Soviet Union are served by 40 computer centres set up across the country. In 1973 alone, some 940,000 hectares (2,321,000 acres) of irrigated land were brought into production using computerised planning techniques. (Novosti Press Agency.)

Computer aided electronic circuit design

Techniques used in the design and manufacture of electronic circuits are being transformed by a computer-based design system pioneered and developed over eight years by a British based electronics firm, Redac Software Ltd, Gloucestershire, England.

The computerised design system, which is now being used by some of the world's leading companies, eliminates the lengthy trial-and-error circuit design and manufacturing techniques normally undertaken by circuit designers. The main design applications of the computerised system include: the design of single, double or multilayer printed circuit boards (up to 12 layers); the design of back panel layouts; and the design of micro and thin-film circuits. Conventional techniques, involving the production of layouts on oversized boards using opaque tapes and similar hand methods, are rendered obsolete by the computer design system.

The main machine-interface system consists of an interactive computer graphics terminal, which is linked to standard hardware. Resembling a television screen, the terminal is used to display diagrams and other graphic material stored in the computer's memory. For electronic circuit design, this material includes all the various circuit elements, layout parameters, and general raw material needed by the designer to compose a circuit. The designer can call up any material for instant display, and by the use of a light pen can manipulate, position, change, and interconnect the various circuit elements as he chooses.

When the circuit design is finalised and approved by both the designer and the computer, it is stored with full details in the computer's memory. The design may be retrieved instantly at any time, and may be reproduced at a computer print-out terminal, or recorded on magnetic tape for automated production techniques.

New techniques for HF signal storage

Information storage phenomena, with potential applications in storage and processing of high frequency signals, have been discovered by IBM scientists at the IBM Thomas J. Watson Research Center, New York. Photo-sensitive piezo-electric crystals are able, through the new effect, to store microwave-frequency signals in a very small piece of material.

The most promising immediate application is probably to radar systems where the probe signal could be stored for comparison with reflected signals. At low temperatures, the effect also has promise for computer storage and for high-resolution acoustic holography since it permits high density storage of information for long periods. Information can be erased simply by shining light on the sample.

Storage is accomplished in the piezo-electric crystal by a stable pattern of trapped electrons produced by interference between two input signals. Information is read out by applying a signal at the same frequency as that of one of the original input signals. This causes the sample to radiate a replica of the other input signal as an echo. The storage mechanism is therefore analogous to holography, in that the information stored is an interference pattern produced from an information signal and a reference signal.

Devices based on the new effect can store both phase and amplitude information over a bandwidth of 100MHz to 10GHz. Other possible applications include the storage of an acoustic signal as an acoustic hologram which could be read out optically, processing RF signals by interactions with acoustic signals to perform convolution or correlation of the signals; and integration of thousands of input signals for averaging to eliminate noise.

Remote medical monitor for high-risk patients

Remote medical monitoring techniques developed primarily for manned space flight, and coupled with the technical know-how of a NASA Biomedical Applications Team, have led to the development of a new, portable device able to monitor continuously the condition of high-risk patients.

Now available commercially, the 1.8kg (four-pound) device, called Vitasign Attendant Monitor, is designed to operate from existing patient call systems and conventional electrical outlets. The device makes available, at moderate cost, continuous patient monitoring techniques previously found only in the intensive care units of large hospitals.

To operate the device, three electrodes are placed on the patient's chest. These monitor ECG (electrocardiogram) and respiration rate. A sudden change in the ECG signal, or changes in the normal respiratory cycle, automatically switches on an alarm light on the unit and activates a signal at the central call station to alert medical attendants instantly.

The design Attendant Monitor is expected to be particularly useful in monitoring patients with cardiac diseases, muscular dystrophy, cerebral palsy, tuberculosis, and cystic fibrosis.

ELECTRONICS Australia, August, 1974
MHD Generators may ease the fuel crisis

One of the most pressing problems facing today's highly industrialised nations is the dwindling supply of fossil fuels. Euphemistically termed the "energy crisis," this situation has forced the research and development rate on more efficient methods of producing energy. Among the various alternatives under consideration is magnetohydrodynamic (MHD) power generation.

by EDWARD EDELSON

Standing inconspicuously in the parking lot behind the Avco Everett Research Laboratory near Boston is a trap-covered square tube, about as long as a family car and as wide as a desk, that's worth a second look. It's the heart of the Mark V, a magnetohydrodynamic (MHD) generator whose 32-megawatt output still holds the world's record. The Mark V was dismantled a few years ago, but, says Stanley Perry, an Avco engineer, "I just didn't have the heart to get rid of it."

The Mark V is all too symbolic of the MHD story to date: it's been around for a while, it's achieved tantalizingly promising results — and no one knows what to do with it.

For years, a handful of MHD proponents — most notably Arthur Kantrowitz of Avco — have been saying that their system could increase the efficiency of electric generating plants by 50 percent or more. And for years, MHD research has been limping along on a minimal budget: a few dollars from a corporation here, a small grant from a utility there, a minor effort on the part of the federal government.

There have been some encouraging signs for MHD lately, such as a US-Soviet agreement to cooperate in research, and a slight increase in federal appropriations. However, the energy crisis has created a moment of truth for MHD. As far as people in the field can tell, it's now or never. Either the government comes through with a "quantum-jump" increase over last year's $7.75 million, or the immediate future for MHD development looks dim indeed.

"If the energy crisis can't put MHD over," said one expert I talked to, "then nothing can."

MHD engineers have an offer they think you can't refuse: give them the money and the time — about a half-billion dollars and a decade — and they'll give you a generating station that has no moving parts, is almost pollution-free, and produces perhaps 4,500 kilowatt-hours of electricity for every ton of coal, compared to just 3,000 kilowatt-hours for today's best generating plants.

For a nation that's suddenly fuel-hungry, that offer should be irresistible. But the small band of MHD enthusiasts have said the same thing for a long time without getting anywhere — and you can't blame the jawbreaking name they're stuck with. If one looks at the sort of problems MHD has to overcome, it is easy to understand why its proponents encounter scepticism.

Basically, magnetohydrodynamics consists of passing a high temperature highly ionised gas through a magnetic field and tapping off the electricity generated. A temperature of around some 5,000 degrees F is required to ionise the gas into what physicists call a plasma. This process strips electrons away from many atoms so that the gas becomes a good conductor of
electricity. The plasma is then expanded through a rocket-like nozzle, and sent rotating down an electrode lined channel at about the speed of sound. Additional ionization is achieved by seeding the gas stream with cesium or potassium carbonate.

The walls of the channel, and the electrodes through which electricity is drawn off, must be protected from all sorts of damage — melting due to heat, erosion caused by the sheer speed of the gas, corrosion from the seed metal atoms and, if coal is used as a fuel source, the impact of ash particles. What’s more, the channel must be confined within the poles of a superconducting magnet whose field must be 50,000 gauss or more and whose size approaches that of the family garage.

Downstream, the high-velocity levels of eye-stinging nitrogen oxides produced by the high temperatures of MHD must be dealt with, as well as the sulphur oxides and ash that come out of any plant burning coal or oil fuel. And the extra efficiency promised by MHD plants is lost if corners are cut. Lower gas temperature means less generating capacity, and too much pollution means a visit from an inspector. So meeting the standard for MHD success seems like a tall order — and it seems even taller when one learns just how limited MHD experience has been.

MHD theories have been around since Michael Faraday discovered the principle of the generator. However, the first MHD generator was not constructed until after World War II, and even today operating experience on these generators is not very limited. MHD experience has been done on the open-cycle concept in laboratories. Consider what looks like the world’s current largest plant is the Soviet U-25, designed for an ultimate capacity of 25 MW. Built in a northern suburb of Moscow, it has only a few hours’ total operating time as a megawatt plant. It does, however, have the distinction of being the world’s only MHD generator that is tied into a working power grid. US experts say: the Soviets have made a major achievement in overcoming the engineering problems that accompany putting a promising concept into actual operation. Thus, the experts are impressed with the U-25’s interconnecting equipment, but not with the MHD core. For, one of them said, the Soviets went ahead and built the kind of MHD plant we could have had if research had ended in the mid-1960’s.

Still, MHD people say they can talk realistically about building a plant that could operate at 1,000 MW for hundreds or thousands of hours. Their reasoning: Research has already overcome the critical problems, and the rest is just a matter of tinkering with known principles.

“The problems we face aren’t of a basic physics nature,” says Raymond Janney of Avco. “They’re purely of an engineering nature.”

The best reason for listening to statements like this is the hope that MHD can stretch our precious supplies of fossil fuels. Today’s best coal or oil-burning plants, operating at 1,000 degrees F, turn about 40 percent of the fuel’s energy into electricity. The rest is waste heat. Nuclear plants, running a few hundred degrees cooler, are only about 35 percent efficient. MHD people talk about total efficiency in the area of 60 percent, meaning they’ll get half again as much useable energy out of coal or oil as we do right now.

MHD would get the extra efficiency in two ways — by using its combustion gas directly, eliminating the waste of making steam to turn a generator; and by using a hotter gas — the basic rule of a heat engine says that the hotter you can run it, the more efficient it will be.

There are three MHD concepts aimed at reaching this promised land of high thermal efficiency. Far in the lead is open-cycle MHD, in which gases heated in a combustion chamber are sent directly through the generating channel. Much more work has been done on the open-cycle concept than on the competing closed-cycle proposals, in which the energy is transferred either to a noble gas or to a liquid metal, which then runs through the channel. It’s the open-cycle people, led primarily by Avco engineers, who are talking about building a pilot plant now.

But to believe that open-cycle MHD can make it, one has to look at a lot of small pieces of evidence from several laboratories. Consider what looks like the main technical challenge in MHD preserving the channel from the assault of that powerful blast of hot gas. Even today’s best refractory ceramics, such as zirconia or magnesia, are ripped away too quickly.

The solution to this problem is to feed in a refractory powder with the fuel so that the coating on the channel walls is continuously replaced as it is scoured off. If the rate of coating is just right, the channel gets the protection it needs.

Here, the MHD people think they’ve hit it lucky. Work at Avco and the University of Tennessee Space Institute indicates that ordinary coal slag does just as good a job of channel coating as the most exotic refractory material. “If we had set out to create an ideal material for wall coating, we would have come up with something just like coal slag,” exults Avco’s Richard J. Rosa.

But that rejoicing comes after short-run tests. It has yet to be shown that coal slag will work under continuous plant operation. Avco’s 300kW Mark VI is currently setting up for a 100-hour trial run, possibly later this year. J. B. Dicks and his co-workers at the University of Tennessee are going to run their MHD generator continuously for 100 hours, using coal ash as a fuel source. The idea has looked good in brief runs, but as Dicks points out, “If we run it for a few hundred hours, problems that we can’t see now could become appreciable.”

As for controlling the amount of ash that goes in, the Bureau of Mines Research Center in Pittsburgh is working on a novel three-stage combustion chamber that would do just that. But it isn’t ready yet.

Neither is the superconducting magnet needed for a large-scale generating plant. MHD researchers at Stanford University are about to get an 80,000-gauss superconducting magnet, but that will be used for basic scientific studies. Without a superconducting magnet, the whole MHD project goes up in smoke, because an inordinate amount of energy would be needed for a conventional electromagnet of the necessary size. Yet, as Dicks points out, “No one has ever run an MHD generator with any superconducting magnet, aside from some very small experiments in Europe.”

The MHD advantage is that pollution control is not a tack-on as with today’s systems. But, of course, none of the MHD pollution controls has been proven in prolonged plant testing. Consider the plan for controlling pollution. Nitrogen oxides, a special problem for MHD because they increase directly with combustion temperature, would be handled by a two-stage burning process, using an afterburner to eliminate them. Sulphur oxides and ash would be collected with the seed metal: the seed would be separated out chemically and recycled, while pollutants would be dumped harmlessly.

But if open-cycle MHD has so many questions, the closed-cycle concepts are more like a gleam in someone’s eye.

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The Avco Everett Mark V, which generated 32MW of electricity in brief bursts, holds the world MHD record. The device was dismantled several years ago after the completion of experiments, providing valuable data for future designs.

The above diagram shows how MHD could improve efficiency and lower pollution. After MHD power generation (first stage), exhaust gas heats air to run a steam turbine and to preheat MHD fuel. Fly ash from coal would be recovered with metal seed and recycled, whilst nitrogen oxides and sulphur oxides from exhaust gases could be processed for industrial use.

Laboratory in Valley Forge, Pennsylvania, has something like a monopoly on closed-cycle noble gas MHD. Bert Zauderer, who heads the program, is enthusiastic about the scientific elegance of the idea: instead of heating all the gas to 5,000 degrees F, the idea is to selectively excite only the electrons in the noble gas (in much the same way that electrons in a fluorescent bulb are excited), thus getting the same gas conductivity at a much lower overall gas temperature.

As Zauderer pictures it, a closed-cycle, noble-gas MHD generator would have several columns of ceramic pebbles that would be heated by combustion gases and would transfer that heat to argon or another noble gas, which would then flow through the generating channel.

Zauderer admits that his scheme is five or six years behind the open-cycle concept, that it would need exorciatingably clean fuel to avoid fouling the ceramic pebbles, and that many scientists doubt that selective heating of electrons can be done. "We're the only ones who can get it to work," he said of his concept.

But even though Zauderer measures operating times in milliseconds — all his experiments have been done in shock tubes thus far — he maintains that given $25 million and eight or nine years, his closed-cycle scheme will reach demonstration-plant status. (GE is spending about $500,000 on MHD research this year.)

Still further behind is a closed-cycle MHD concept that would use liquid metal as the generating fluid. Michael Petrick of Argonne National Laboratory, where the closed-cycle liquid-metal work is being done, likes the idea because of its low operating temperatures — in the neighbourhood of 1,500 degrees F — and because the system could be used with the liquid-metal fast-breeder reactor that's now under development and perhaps with fusion plants. The problem with liquid metal — sodium is the leading choice — is that it doesn't flow fast enough, and until recently engineers haven't been able to manage to pump in gas to speed the flow. But just now, Petrick is talking about "something of a breakthrough," a method of injecting gas that has doubled efficiency. "It's beginning to look really attractive," he says.

Petrick has a timetable: run a 100kW generator this year, move to a 1MW generator in three or four years, and have a 20MW pilot plant in operation by 1982. That would cost about $45 million, and would have liquid-metal MHD plant ready by the time the first fast breeder is scheduled to go on line. The open-cycle people have their own timetable, one that was presented to a congressional committee last year.

Open-cycle researchers have put forward two basic proposals in their development timetable: first, that the US support basic MHD research at a level of about $8 million a year; and second, that planning for a 50MW pilot plant, to become operational by 1976, should begin immediately.

It is envisaged that the basic research program would include such efforts as the conversion of a wind tunnel at the USAF Engineering Development Center in Tennessee into a 50kW MHD generator that would operate in 10-second bursts to test new ideas. This program could also include the construction of a 20MW channel by Avco for the Soviet Union. The Soviets say that if the US will build the channel, they'll test it under operating conditions.

The proposed 50MW pilot plant is intended to provide engineers with the necessary data to enable them to begin planning a 1,000MW MHD plant which would go on line by 1982. Present day concepts envisage that the plant would consist of a MHD "topping plant" that would extract perhaps 20 percent of the fuel's energy. Spent gas from the MHD section would then go to a conventional steam generator that would extract 40 percent of the fuel energy. Total operating efficiency would thus be about 55 to 60 percent.

It is estimated that the total cost of the entire MHD development program will be in the region of $500 million — a figure representing the approximate cost of one large conventional generating plant, as MHD experts are quick to point out. If MHD works, the savings in fuel could run into billions of dollars. Just how many billions no one knows as the price of all fuels seems to be going up indefinitely. It only remains for us to put up the research and development money to get the answer.

Reprinted from Popular Science, by arrangement.

ELECTRONICS Australia, August, 1974 39
Squeezing speech aids learning process

Anyone who has ever worked with pre-recorded audio tapes containing oral communications will realise that the fatigue factor in listening to these tapes is high, especially when they contain lecture material. In such circumstances, anything that will heighten listener interest, and at the same time save time and money, will be invaluable. The VOCOM-1 speech compressor/expander described here may be the answer.

Time shortened or time compressed speech has been of academic interest for many years. The principle behind this concept is simple: the average person can understand speech which is much more rapid than can be produced by normal speaking. Because his understanding rate is potentially greater than the delivery rate, a person listening to normal speech will tend to let his mind wander off the topic, thereby missing important parts of the information conveyed. The ideal situation would be, therefore, to introduce some form of speech compression to match the understanding rate of the listener, and at the same time retain the natural voice quality.

These requirements have been fully realised in the design of the VOCOM-1 speech compressor/expander. Developed by PKM Corporation of St Paul, Minnesota, the unit is the result of many years of research by PKM into the problems and techniques of speech compression. In addition, VOCOM-1 is simple to use and costs far less than previous speech compressors.

Earlier speech compressors discarded portions of speech at regular intervals, disregarding completely the contents of the discarded segments. This resulted in chopped speech where intelligibility dropped rapidly as the listening time was reduced. The VOCOM-1 unit functions somewhat differently by employing a technique called selective deletion. Instead of discarding segments of speech, the unit shortens the pauses taken between words in the course of normal conversation.

A person making a conscious effort to speak rapidly not only shortens the pause duration between words, but also tends to shorten vowels. This facility has also been incorporated into the VOCOM-1, and may be used in conjunction with the pause compression facility. The pause compression may be adjusted so that the shortest pause retained on compression is 20 milliseconds (maximum compression) to 1.0 second (minimum compression).

The VOCOM-1 unit is also capable of producing time expanded speech, i.e., speech that is much slower than usual. This is accomplished by automatically sensing when a pause occurs during speech, and inserting an additional pause of controlled duration. The duration of this pause may be adjusted so that each pause in excess of 40 milliseconds on playback expands increased between 100 milliseconds (minimum) to 500 milliseconds (maximum). There is no vowel expansion capability.

Both speech compression and speech expansion are achieved by automatically stopping the cassette transport for short pre-determined periods of time. For speech compression, the machine automatically detects a pause during the recording process and stops the cassette until the next sound is spoken, thereby deleting part of the pause. Vowel compression is also effected during the recording process, and this is achieved by deleting part of the vowel sound. For speech expansion, the machine automatically senses a pause during playback and inserts an additional pause of controlled duration.

There are several advantages to be gained from time compressed speech, especially when the text is compressed to about 60-70% of the original time. The first and most obvious advantage is the time saved (30-40%), resulting in direct money savings. For example, a tape library of 10,000 hours of recorded lecture material can be compressed to some 6,500 hours with a corresponding saving in the cost of tape.

Secondly, time compressed speech attracts greater listener interest and concentration, thus making the unit ideally suited to...
educational institutions using pre-recorded lecture material.

It is also claimed that time compressed speech makes the learning process more efficient, by matching the delivery rate with the listener's ability to absorb information. This obviously has important application in the areas of self-study via pre-recorded audio tapes, sales training programs, and oral communications via tape in general.

While the average listener would find time expanded speech boring, it does have certain specialised applications. For example, the expand facility allows a speaker to slow the word rate of a pre-recorded dictation to match her typing speed. The original dictation may be carried out on a conventional cassette recorder. The recording is then simply inserted into the VOCOM-1, the expand button depressed, and the pause expand control adjusted to the desired rate.

Other specialised applications for the unit when operated in the expand mode include remedial speech training for the mentally retarded and those with speech defects, and the learning of foreign languages. Voice quality, tone, and pitch remain unchanged with both compression and expansion.

Operation of the VOCOM-1 is simplicity itself. Operational modes are controlled by five push on/push off switches centrally grouped and towards the front of the unit. These are the record switch, the pause compress switch, the vowel compress switch, the pause expand switch, and the pause switch. The compression and expansion control knobs are located towards the top of the unit and, as indicated above, allow the amount of compression or expansion to be controlled. A meter, located directly beneath the pause compress control, indicates the amount of expansion or compression in percent. Adjacent to the expansion compression meter is a large VU meter.

Immediately below the compression/expansion meter is the noise reject control. This control is used in the compression mode when recording against background noise, thus setting a threshold on the minimum signal level at which this mode will operate. Other control facilities include those normally found on a conventional cassette recorder, including a volume control, tone control, recording level control, an 8-digit counter, tape transport controls and the headphone and microphone jacks.

One facility not found on a conventional cassette deck is the review control, which is located together with the tape transport controls. When the machine is operated in the playback mode, the review control will backspace the cassette whilst depressed, and return to playback when released. This facility should be particularly valuable to a secretary typing from a speech expanded recording should it be necessary to review a few words that may have been missed. The student listening to pre-recorded lecture material in the speech compression mode will also find this facility useful.

Physically, the VOCOM-1 unit is quite large, the approximate dimensions being 19 x 38 x 49 cm (including the carrying case). The unit is mounted in a sturdy, vinyl covered aluminium carrying case and weighs approximately 7.7 kg (17 lbs).

Our own experiences with the unit showed that 100pc intelligibility could be maintained with the compression set as low as 60pc of the normal time. However, when compression was increased to 40pc (by employing both pause compression and vowel compression) the text became quite difficult to follow, indicating that some listening practice would be required to maintain intelligibility at this level.

Taken overall though, we found the text a great deal more interesting to listen to when compressed to levels of the order of 50-70pc of the normal time. The VOCOM-1 certainly captured the attention of all staff members, and all agreed that one's concentration improved when the unit was operated in the compression mode. A further bonus is, of course, the considerable time saving effected by time compressed speech.

For further information regarding the VOCOM-1 unit contact the Australian distributors, K.C. Electronics Pty Ltd, 239 Scenic Drive, Merewether, NSW 2291. Telephone 63 2411. (G.S.)
An E-A world exclusive project:

Build your own digital computer!

This is the first of a series of articles describing a complete general purpose stored-program digital computer. Designed specifically for home construction, the computer has an instruction repertoire which includes all of the basic instructions available on most modern minicomputers. Despite this the cost has been kept down to a level far lower than any commercial machine, and the construction made very straightforward by having virtually all the wiring on printed boards. These features should make it an ideal project for anyone keen both to learn in detail how a computer works, and to have a small computer with which to gain experience in programming.

by JAMIESON ROWE

A few years ago when I first became interested in digital electronics, one of the things I found was that there were precious few introductory books on the subject — and not many of these were both readable and satisfying. This made the going very tough, and it was because of my own difficulties in getting to grips with the subject that I subsequently wrote the series of articles which became our handbook “Introduction to Digital Electronics.” That book has been very popular, with more than 11,000 copies having been sold to date. It has become widely used as a text and reference in schools and technical colleges, and although it is now in need of updating I believe it has been of some value in helping others to gain an insight into the basic ideas involved in digital circuits and their operation.

There is one section of the book, however, that I am aware is likely to be found less satisfying than the rest that dealing with the digital computer. While I believe this section goes a little further than is found in many basic works on the subject, it is still likely to leave the serious reader with a great many questions about the actual design and operation of a stored-program machine.

Basically I think this shortcoming reflected my own modest understanding of these matters, at the time the book was written. And to this day there are very few, if any, books or other sources from which one can get more than a superficial understanding of the real “nitty gritty” of computers.

Happily in my own case I was lucky enough to have the opportunity to gain first-hand insight into computer operation and programming. Thanks to the generosity of one of our parent companies, John Fairfax and Sons Ltd, and the friendly co-operation of their EDP Managers and staff, I was able to spend many hundreds of lunch-time hours writing programs and running them on their Digital Equipment PDP-8 minicomputers.

It was this extremely valuable experience which allowed me to finally grasp many of the points about computer operation which had never quite emerged from reading books. Truly, there is no real substitute for “hands on” experience, at least as far as the basic operation of computers is concerned!

However there was still one whole area into which even this experience had not provided insight, even though it had laid a very worthwhile foundation: the actual electrical design of a computer. And being an incurably inquisitive person, this naturally became the most intriguing aspect of all.

If, like myself, you’ve ever tried to get hold of the circuits of a minicomputer, with a view to finding out just how they function in fine detail, you’ll probably agree that this is a well-nigh impossible task. I have never found such circuits in any textbook, nor have I been able to find them in any of the voluminous manuals which seem to accompany the machines themselves. I can only assume that the manufacturers prefer to keep the exact details to themselves and their servicing people.

There seemed to be no option, then, but to sit down with some modern digital IC data books, and design my own small computer based purely on a knowledge of general operating principles.

This, then, is the story behind the project itself. It has been a very interesting and challenging one, and I believe that it has taught me a great deal about the general principles of small computer design. I hope that at least some of these rewards may be passed on to readers, as a result of its description. I have spent considerable effort in trying to ensure that construction of the unit itself will present as few problems as possible, and will be doing my best in these articles to help the reader get the most benefit from the overall exercise.

But enough of this preamble. By now, the reader is no doubt wondering if I am ever going to get around to introduce the gadget itself!

Perhaps the best way to start is by describing the computer as a scaled-down version of the Digital Equipment POP-8 machine — at least, in terms of its instruction repertoire and basic console layout. It has the same eight basic types of instruction, and for convenience I have used the same mnemonic names and similar coding.

A view of the “works” of the computer, taken before it was fitted into the case. Virtually all of the wiring is taken care of by the PC boards.

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This has not been done purely because of my own initial experience with the PDP-8 family of machines, nor out of a simple desire to foster the Digital Equipment people — although they have undoubtedly played, and are still playing, a leading role in developing minicomputer technology. While the design no doubt reflects in good measure the experiences of these people, and I am happy to pay tribute to the eminence of DEC, this superficial plagiarism has been done for a far more down-to-earth reason.

The fact is that Digital Equipment has led in the minicomputer field right from the start, and there are many more DEC machines in use than any other. Therefore the chances are great that if the reader builds his or her own computer and gains experience with it, the opportunity to graduate to a commercially available machine, it is likely to be a DEC machine. By making the memory size of my machine similar to that of the PDP-8 as possible, I hope that this transition to bigger and better things will be made easier.

I should perhaps add that most minicomputers have a great deal in common, so the fact that our machine is styled on the PDP-8 should not be seen as making it too specialised. In fact if the reader builds up this machine and uses it to get a solid grounding in the operation of a computer operating on a stored-program basis, he or she should find very little difficulty in making the transition to any modern minicomputer.

Essentially, then, this computer is rather like a PDP-8 and other modern minicomputers, except that it is a good deal smaller. Not so much in terms of physical size, but because the earlier generation of minicomputers are quite small themselves. The contrast is in terms of circuit complexity, which has been scaled down both to reduce the cost and to bring the whole size of the project within the scope of a single individual.

Probablj the most obvious difference is in terms of memory size, and this is because the memory is the most costly part of any computer. In most modern minicomputers there is at least a thousand or so storage locations, the memory of this machine has only a modest throughway.

While this much smaller memory capacity would make the machine of very limited use in practical computing applications, don’t assume from this that it is purely a toy. A memory of 32 locations is entirely adequate for demonstrating virtually all aspects of basic computer operation and programming.

In fact, it is surprising just how complex and powerful a program one can fit into a memory of this size. I have been discovering! And in a very real sense, the small size of the machine’s memory makes programming that much more of a challenge. It is relatively easy to write a program to perform a certain task, as any experienced programmer will tell you — the real trick is to achieve this end as economically as possible. With a memory of only 32 locations, one cannot help being steered automatically in the direction of economic programming!

This is not to say, of course, that a larger memory would not have been desirable. A larger memory certainly broadens the practical scope of the machine, and when the description of the basic machine and its peripheral devices is completed, I plan to look at the possibility of enlarging the machine in this way. But unless memory devices fall dramatically in cost, this will probably involve a significant increase in the overall cost of the machine, so that for the present I must ask the reader to accept my assurance that the present memory size represents an entirely acceptable place to start.

Apart from the memory size, there are two other main ways in which the computer is scaled-down in comparison with a typical commercial minicomputer. One is the word length, or the size of the binary numbers used in the machine to represent both instructions and data numbers. Whereas most commercial minicomputers have a word length of either 16 or 12 binary digits or “bits”, in this case the word length is only 8 bits.

Again, this has been done to reduce both cost and circuit complexity. The main penalty arising from the reduced word length is that the machine can normally deal with only modest numbers — between plus 127 and minus 128, inclusively. The relatively short word length has also made it necessary to reduce the number of augmented operate instructions, as will be explained later. I believe both these limitations are acceptable in view of the savings made possible.

The other main way in which the machine has been scaled down is in terms of the number of input and output devices or “peripherals” which it is designed to communicate with at any one time. Whereas many modern minicomputers are designed to “interface” with up to as many as 32 or 64 input and output devices at any one time, this machine will only interface with up to two of each — four in all.

We have designed the machine, designed mainly as an education tool, I believe, because the need to deal with large
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DIGITAL COMPUTER

numbers of peripheral devices is largely confined to practical data logging applications. Just about all of the basic principles involved in input-output transfer can be demonstrated using two input and output devices, and in fact more devices would probably only confuse the situation.

In any case the machine has been arranged so that the input and output devices simply connect to it via sockets on the case rear. If a total of more than four peripheral devices are plugged up or acquired, it is therefore quite easy to substitute devices as needed. Only four devices may be plugged in at any one time, that is all.

What peripheral devices may be used with the computer? Within reason, almost anything. As part of the basic description, I hope to describe a suitably simple and low cost input keyboard unit, together with one or two appropriate output display units. After this, I hope to give details for interfacing with punched-paper tape readers and punches. It may also be possible to give details of other types of input and output devices, if opportunity permits.

To a large extent, the range of possible input and output devices to which the computer may be connected will be limited mainly by your imagination. There seems no fundamental reason why it could not be hooked up to a variety of equipment, for all sorts of jobs. I myself aim to try out a few interesting possibilities, and I hope that readers will be encouraged to do the same.

The mother board has a modest capacity of the basic machine, it will probably be necessary in some cases to come up with some pretty fancy interfacing circuitry to achieve the desired result. In others, it may be possible to make use of some relatively high-powered “hardware” in the peripherals to make up for the fact that the computer itself can’t accommodate much “software” — ie, much program.

Still, if you are at all adventurous, this should simply add to the challenge. My main aim in these articles will be to help you gain the necessary expertise, so that can go wherever your imagination leads.

At this stage I should perhaps devote a few words to explain the basic electrical and physical construction of the computer.

All of the main circuitry of the machine is designed around TTL digital integrated circuits (ICs). There are a number of medium-scale or MSI devices, used mainly for the various registers, and one large-scale or LSI device — the memory IC. Apart from these, the remaining devices are all low cost “garden variety” 7400 devices. All should be readily available.

No doubt some will wonder why I have not used one of the new “microprocessor” LSI devices as the heart of the machine. This would have reduced the number of ICs used, to be sure; in fact the whole computer would probably have fitted on a single small printed board. However I decided against this approach in quite early in the development of the project, for two reasons which I believe are conclusive.

The first is cost. Microprocessor chips are still quite costly at the time of writing; they sell for about $110 each. By the time one adds a memory device and the additional circuitry required to interface with a control console and input-output devices, this would make the cost of the resulting machine considerably higher than the one presented here. And I don’t know about the reader, but I myself would probably be far too nervous to play around with any single IC costing more than a hundred dollars!

But quite apart from the cost, there is the matter of teaching potential. A microprocessor chip is ideal for manufacturers wanting to build a computer into their systems as an integral part, but by its very nature it is not at all suitable for learning how a computer functions. With virtually all of the computer hidden away inside a 40-pin IC package, all of the real mysteries remain the property of the IC maker.

As it stands, there are a total of 96 ICs in the basic computer, most of these being low cost 7400 series devices. Some 86 are used in the basic processor and memory sections, while the remaining 10 are used in the internal input-output interface circuitry.

If this number seems a bit large, consider that the ICs probably incorporate something like 7,000 “garden variety” 7400 devices. All should be appropriate for commercial manufacture, and the software will be simple enough to demonstrate most aspects of computer operation. For most readers, gaining this very knowledge will be the whole point of the exercise, and if they knew now they wouldn’t be bothering.

The main idea behind giving it here is to show that the computer is quite a capable little machine, despite the fact that it has been scaled down for home construction. It has just about all the basic capabilities found in most modern computers, and is therefore an ideal basis to demonstrate the operation of modern computers, and is therefore an ideal basis to demonstrate the operation of modern computers, and is therefore an ideal basis to demonstrate the operation of modern computers, and is therefore an ideal basis to demonstrate the operation.


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SPECIFICATION OF THE COMPUTER

The machine is a complete stored program general purpose digital computer. Memory storage is provided by means of a bipolar static random-access integrated circuit (RAM), organised to have a capacity of 32 locations.

Both instructions and data words use a format of 8 bits.

Almost all processing is performed serially, with alternative clock rates of approximately 50kHz and 2Hz. Instruction cycle times are constant at either speed, at approximately 120 milliseconds and 24 seconds respectively. Operation may be either continuous or on a single instruction basis, as desired.

There are five main registers, comprising the program counter (PC), the accumulator (AC), the memory address register (MA), the memory buffer register (MB) and the instruction register (IR). The front panel of the machine is also provided with a switch register for manual loading of addresses, instructions and data.

Six types of memory reference instruction are provided, consisting of logical AND (AND), binary addition (TAD), increment and skip if zero (ISZ), deposit and clear accumulator (DCA), unconditional jump (JMP) and jump to subroutine (JMS).

A single address format is used for these instructions, but both direct and indirect addressing are available.

Eight augmented operate (OPR) instructions are provided, comprising increment accumulator (IAC), complement accumulator (CMA), clear accumulator (CLA), rotate accumulator I bit right (RAR), rotate accumulator I bit left (RAL), skip on zero accumulator (SZA), skip on minus accumulator (SMA) and halt (HLT). A number of these instructions may be combined, for programming economy.

Three augmented input-output transfer (IOT) instructions are provided, each of which may be arranged to specify either an input or output device, and of two possible devices in each category. The instructions are skip on device flag (SKF, SDF), transfer data between device buffer and accumulator (KHF, LDS), and reset device flag (RKF, RDF). The second and last of these may be combined for programming economy.

The contents of all registers are displayed on the front of the machine by means of light emitting diodes (LEDs), allowing the operation to be readily followed.

Power consumption of the basic machine is approximately 15 watts, but rises to approximately 60 watts with some combinations of input-output devices.

somewhat transparent pun is that the first part stands for "Educational Digital micro (u) Computer", while the figure 8 represents either the number of basic instruction types, or the word length, or both!

Any one of us I hope we will prove useful as an educational tool. It must have some sort of name, and EDUC-8 is probably as good as any.

Finally, there is the matter of cost. You have probably been wondering if I was ever going to be specific about this, and the truth is that I have deliberately left it until now to give you a chance to put the project in perspective.

It is very difficult to be accurate about cost, because as most readers will be well aware, prices of electronic components are fluctuating all the time. About the best I can do is tell you that as far as we can estimate, the complete basic computer will probably cost you about $300 — maybe a little more, quite possibly a bit less.

Don't forget that because the project is built on a number of boards, you can build it up progressively a module at a time, and distribute the outlay over a period of time.

We will be describing the project with this approach specifically in mind, in fact, as quite apart from the cost angle there are other advantages in tackling the project in stages.

With a project this size there is a lot to be said for building up the key sections one at a time, and checking them out individually before the final assembly as a system.

Well, that's the basic story on this new project of ours. I hope some of my own enthusiasm for it has rubbed off, and that by this stage some of you will be champing at the bit.

Before I close this introduction, I must give grateful thanks to the many people who have helped me very considerably in the development of the project. I am indebted to John Houston and Val Rech of Fairchild Australia, Ron Bell of RCS Radio, Doug Evans of Ferguson Transformers, Peter Carter of A & R Soanar, David Segal of Philips Ecorna, Brian Cleaves of Plessey Australia, Norm Volkman of Wardrope and Carroll Fabrications, and Erle Goodwin of General Electronics Services — to name but a few of the many who generously contributed both advice and samples. I hope that those not named in the foregoing will please assume, rightly, that this is purely because of lack of space.

There are also my fellow staff members at E-A, who have been very tolerant of my involvement with and enthusiasm for the project. I must particularly express thanks to Bob Flynn, who has been of great help in the preparation of the printed board patterns.

And last, but by no means least, I must express my very grateful thanks to my wife Laraine, for putting up with the long lonely nights and weekends when I have been either submerged in the workshop, or present physically but almost constantly preoccupied with a logic problem or printed board pattern. The things we electronics addicts inflict on our loved ones!

STOP PRESS!

Just as this issue was going to press, an advance copy of the July issue of the US magazine "Radio-Electronics" reached us. In it they give details of Mark-8, a minicomputer based around the Intel 8008 microprocessor IC and 1101 memory ICs. Our design is not the first, then, as it transpires — we were beaten by a few weeks!

Addict, such is life. Still, readers will now have a choice of two computer designs, each with rather different emphasis.
Advanced electronics in Polaroid SX-70 camera

A revolutionary new Polaroid camera and film system that produces colour pictures that develop in the light has recently been introduced in Australia. Employing advanced electronic control and sensing circuitry, the new camera features completely automatic operation.

The advanced solid state controls of the Polaroid SX-70 have enabled Polaroid to produce a new, highly accurate, but extremely simple shutter actuated by specially designed solenoids. No cocking is involved. In ambient light, the double-bladed shutter is pre-programmed to select the best combination of aperture and speed. For flash exposures, lens aperture is automatically controlled by focussing. The automatic controls are able to cover a very broad range of lighting conditions, including time exposures for as long as 20 seconds.

The photocell which controls the electronic shutter represents a unique new development. The SX-70 utilises an ultra-sensitive silicon photocell which has a higher degree of precision than the nickel-cadmium cells found on most cameras. The logic circuits built into the camera determine the combination of aperture and shutter speed according to information received by the silicon photocell.

The lens used in the SX-70 required over a year of computer time to design, the result being an extremely compact lens containing four glass elements, each made from a different type of optical glass. Only the front element of the lens moves and the arrangement is so compact that the camera may be folded flat even when the lens is fully extended for close-ups. Despite its compact size, the lens focuses sharply from infinity down to 10 inches.

The double-bladed electronic shutter lies between the third and the fourth element of the lens. Aperture ranges from f.8 to f.90, whilst shutter speed ranges from 100th of a second to 20 seconds. The focal length of the lens is 117mm.

Operation of the SX-70 is quite straightforward. The camera is opened by simply pulling the viewfinder housing upwards, a cartridge containing ten film cards is then inserted in the front of the camera, the protective cardboard film cover being automatically ejected during this procedure. The film pack also contains another completely new development: a 6V battery, so that the camera power source is automatically renewed each time a new film pack is inserted. The battery is used to power the motor, two solenoids and the control circuits. It is only ⅛ inch thick, is slightly smaller than a playing card, and is capable of delivering up to 2.5A at peak load.

After an exposure, the film unit is automatically driven through two small steel rollers which rupture a small pod of reagent, spreading it between the film unit's positive and negative sheets to begin the development process. Simultaneously, a pivoting mirror assembly inside the camera drops down to cover the film pack and return the camera to the viewing mode for the next picture. The exposed film is then automatically ejected from the camera.

Within seconds of leaving the camera, a colour image begins to appear on the film. Migrating dyes from the negative push through from the reagent to form a colour picture on the inner surface of the transparent positive sheet. As the picture continues to develop, the opacifying dyes (originally deposited in the reagent to form a chemical curtain to shield the negative from further exposure) become completely colourless. The brilliant, saturated colour image is then seen against a highly reflective layer of white pigment.

Unlike previous Polaroid camera models, there is no requirement on the user to time the development process, no negative to peel away from the positive print, and nothing to be discarded. Once a photograph has been ejected from the camera, therefore, it may be completely ignored, enabling the photographer to shoot other photographs in rapid sequence if so desired.
The switch is to C & K because switches from C & K Components, Inc. (USA) are superior in every design aspect through engineering know-how and experience. Quality, craftsmanship and care make each of these switches a precision component.

The types illustrated are simply a basic cross section of the range available. The range embraces the widest possible variety of switch combinations to meet every requirement.

Toggles, Rockers, Illuminated Rockers, Paddle Handle, Pushbutton.

Miniature, subminiature and microminiature sizes in many circuit/position configurations are available in one, two, three and four pole models. All switches feature rugged construction and simple mounting. Long-term, trouble free operation is ensured.

Toggle switch contacts are rated 2 amps @ 240 VAC and 5 amps @ 28 VDC resistive load.

A catalogue containing full specifications, options, mounting information, panel layouts, etc., is available on request.
Australia’s radio pioneers

The late 1920s to World War II proved to be the golden era of radio experimentation and home construction in Australia. In this, the final article of our four part series, the author looks at this era, and discusses the audio revolution that took place during this period and the introduction of stereo sound reproduction and experimental television.

by PHILIP GEEVES*

Most Australian families of the 1920s heard their first broadcasts on a crystal set. It was a modest investment and needed no batteries, yet it opened the door to a new wonderland. More affluent, or trendy, people often began with a valve set, perhaps even a multivalue receiver capable of driving a loudspeaker. These sets, with tuned RF stages on breadboard layouts mounted in coffin-like cabinets, enabled their owners to demonstrate the occult art of “tuning” for the benefit of wide-eyed friends. A large outdoor antenna was the distinctive hallmark of a radio home, at least until the first prosecutions of unlicensed listeners, when “there was a rush, not towards the licence counter of the GPO, but to get the backyard aerial down before the postman appeared the next morning.”

One of the chief disabilities of early broadcasting was its poor reproduction of recorded music. Because small synchronous or induction motors and electro-

magnetic pickups had not been perfected, a spring-driven gramophone did duty as a studio record player: The vibrations of the heavy tone-arm were magnified by the gramophone horn and picked up by a carbon microphone. Discs were still made by the original acoustic process, their restricted dynamic range suggesting that all vocalists were singing at the end of a tunnel. The complex tonal patterns of keyboard instruments defied faithful reproduction from acoustic recordings. Consequently, many broadcasters relied on the pianola as a musical reproducer, which anyone with two feet could play like a virtuoso.

The invention of electrical recording changed all that. The vastly improved frequency response of the new discs turned the gramophone into something of a vogue, prompting a noted Australian composer to comment on “the disconcerting popularity of music.” The new process coincided with the introduction of dynamic cone speakers, so it was only a short step to electronic reproduction, with the output of a magnetic pickup feeding into an audio amplifier.

The first pickups used in Australia were heavy devices, with magnets and armatures in full view. To avoid distortion, announcers changed needles after each record. Although this was an exciting period, it meant endless frustrations for professional radio men. Improvements in valve performance and amplifier design caused broadcasters to invest substantial capital in new audio equipment, but listeners with outmoded receivers could not enjoy the enhanced sound, or even notice it.

The new breed of “wireless addicts” preferred to build their own receivers. Radio magazines were largely responsible for the home construction craze, which gained momentum during the 1920s. They printed illustrated articles showing how to build receivers of every genre, explained simplified electrical theory. When technical editors published constructional details of popular models, radio dealers offered kits to home hobbyists. Regular radio exhibitions and amateur displays allowed laymen to study receiver layout and wiring techniques at close quarters. Most sets were battery operated until 1928, but increasing availability of domestic electricity produced the battery eliminator, which freed experimenters from the replacement of expensive B batteries and culminated in the triumph of the “Twenties: the all-electric receiver.

The development of radio owed much to engineers who never lost the lively enthusiasm of their amateur days and, in fact, a number of professionals devoted their spare time to ham radio, thus enjoying the best of both worlds. Ray Allsop, who in 1925 became chief engineer of 2BL, was one of them. He relished the challenge of DX communication and allowed the general public to hear the results. In February 1925 Allsop’s experimental station, 2YG, was heard in Europe on 80 metres. That same month he intercepted a shortwave test transmission from KDKA, Pittsburgh, the world’s first broadcasting station, and relayed the program over 2BL.

In 1927 Allsop organised a similar re-broadcast of PCJJ, Hilversum, and the public response to this novelty gave him an even more ambitious idea. The BBC had not yet begun its overseas service so Ray Allsop arranged, through the Netherlands Consul in Sydney, for 2LO, London, to be relayed from Hilversum on 30 metres for rebroadcast over 2BL. This triple transmission proved enormously successful—the first time that Big Ben and the voices of London announcers were heard in Australian homes. It was not until May 1928 that the BBC was heard here somewhat more directly, when the Marconi Company

* Fellow of the Royal Australian Historical Society.
Red-blooded Australians felt an intense involvement with Kingsford Smith's epic trans-Pacific flight from Oakland to Brisbane in 1928 and, because the "Southern Cross" carried radio equipment, it became possible to follow the aircraft's progress. Sydney Newman transmitted continuous Morse hoisting signals from AWA's radio centre, Pennant Hills, while Ray Allop and Tom McNeil shared a long listening vigil, interpreting the cryptic messages from the "Southern Cross" and keeping 2BL's audience aware of every development. An American, Jim Warner, was the plane's radio operator and his gear was built by Heintz and Kaufman of San Francisco. The original transmitter may be seen in the National Library, Canberra.

Looking back, it seems that 1929 was a watershed year for Australian electronics. Overseas, the development of efficient audio amplifiers and loudspeaker systems had hastened the introduction of sound films - "talkies." In Australia, Ray Alsop took up the challenge. As early as 1921 he had succeeded in synchronising a wax cylinder recording with motion picture film: now he perfected his own Rayophone system which, despite bitter opposition from American interests, supplied the sound in almost half Australia's cinemas at a fraction of the cost of imported equipment. 1929 was also the year that AWA introduced its first domestic radiogram, the "Duoforte." Coinciding with the debut of sound films, the radiogram enjoyed widespread popularity as an exciting home entertainment package.

Many improvements in components and circuitry date from that time. One veteran remembers it as a stimulating epoch - "every week the radio papers printed a new circuit, so we would rush home to build it. Screen grid valves and power pentodes gave radio new horizons and, of course, the superheterodyne was a winner." Housed in cabinets, handcrafted units, console receivers of the 1930s were often the most impressive pieces of furniture in average homes and became the focal point of the family circle.

Public fascination with sound films soon generated a belief that television would not be long in coming and it must be admitted, a few local visionaries were not averse to suggesting that television was just around the corner.

An experimental TV station, using Baird's techniques, was built in Brisbane by T.M. Elliott and limited work was done by other experimenters. Three commercial radio stations, 3UZ, 3DB and 2UE, toyed briefly with the novelty of transmitting still pictures, but their enthusiasm outstripped the state of the art and public demand. A Melbourne firm, Television & Radio Laboratories Pty Ltd fostered the idea of Radiovision, which reproduced simple geometric figures on a special receiver. Experimental transmissions over Melbourne stations were soon abandoned. 2UE's interest centred on the Fultograph system, canvassed ardently by its British representative who, however, was realistic enough to concede that "transmissions will be of no value until the Fultograph receivers are distributed." And all this in a time of worldwide depression!

Some unusual hookups were adopted to carry film soundtracks to remote places, but few captured the public imagination so completely as the 1930 transmission from VK2ME which enabled Admiral Byrd's expedition in Antarctica to hear Chevalier's film "The Love Parade" directly from the projection box of Sydney's Prince Edward Theatre. Spectacular achievements of this kind served to remind "John Citizen" that the unfolding science of radio was capable of infinitely more than simply producing agreeable sounds in his living room "wireless." And although Marconi never found time to visit Australia, the very association of his name touched any occasion with magic. It is impossible to convey the feeling of wonderment which engulfed Sydney in March 1930 when, from his yacht "Elettra" in Genoa harbour, Marconi switched on 2,800 lights in the Town Hall to inaugurate that year's radio exhibition.

Dual wave receivers of the 1930s gave Australians a window on the world at a time when European dictators were exploiting the power of radio propaganda. Short wave broadcasts became a commonplace and, through the crackle of atmospherics, that generation listened to history in the making. In Australia, too, short wave techniques were given some imaginative tests, such as the great Southern Seas broadcast on...
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We have just received a limited quantity of auto radio tuners, some complete with dial, pointer and escutcheon. First come - first served!

MODEL PRT15 - Push-button / manual type, 4 coils. A high-grade tuner with dial pointer, push -knobs, tuning spindle and knob and connection wires. 

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MODEL PRT8 - Manual type, 4 coils. Suitable for auto radio work, with insulated handles. Normally packed in 4 per carton but can be supplied in smaller quantities.

MODEL PRT10 - Manual type, 5 coils. As above but finished in satin aluminium. Greatly improves the performance of most Japanese turntables and tone arms. 1/2" mtg holes suit all modern magnetic cartridges - attractively finished in matt black with chrome trim. $4.95. 

Plug-In Headshell - super lightweight model, similar to above but finished in satin aluminium. Greatly improves the appearance of your turntable. $5.35. 

10 Mini Cartridge Lights (20/25) very useful for auto accessoires - suit most car cigarette lighter sockets $1.00. 

12. 2 - Neon indicator Bezo 250 V.A.C. - A very attractive square top red indicator. $1.00. 

13. 2 - 6 Volt indicator Bezo - a beautifully chromed bezel complete with 6 Volt mini-globe. Available in red, green, amber. $1.95. 

14. 10 Earphone Plugs / Socket sets - standard 3.5mm plugs and panel mounting sockets, available in red / black. $1.00.

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105. 3 - Suppressor Condensers 0.05uF, 160VDC for car ignition. $1.00. 

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Empire Day 1933, the first major hookup in this part of the world. One report mentioned...

Nauru transmitted a word picture of natives listening with expressions of awe to the strange voices that came from the air. In New Guinea, miners on the goldfields were sitting around expensive receivers, bought with their newly-acquired wealth, listening to the flashing Empire messages. The minds of many went back to 1914 when intercommunication in the south seas depended on a few strands of cable.

The Wireless Institute of Australia was the sole active national body of its kind until 1932. Each State had a separate Division and the members' prime interest was amateur radio. However, industry leaders, immersed in the rapidly developing science of electronics, felt the need of a more professional organisation. As a result, the Institute's membership began crystallising at two different levels. As early as 1924 Fisk, Mingay and other professionals had the foresight to register the Institution of Radio Engineers, Australia, but the planned organisation remained dormant for eight years when, by common consent, the IRE hived off from the NSW Division of the Wireless Institute.

The new body quickly established an enviable reputation by snaring some of the front runners of electronics as lecturers. In May 1934 Marconi's research manager, H. M. Dowsett, delivered a paper on "Television and its possibilities in Australia" and four years later the IRE had attained the requisite stature to host the first world radio convention ever held in the British Empire.

That prestigious conclave, which was part of Australia's 150th anniversary celebrations, attracted to Sydney many international figures, including General James Harbord, Chairman of RCA, and TV inventor John Logie Baird. More than sixty papers were read, a goodly proportion being contributed by Australian engineers.

One of the most memorable occasions of that 1938 convention was Ray Allsop's stereo demonstration - the first in Australia and only the second in the world. An audience of 2,000 in Sydney's Plaza Theatre listened to an orchestra playing in the nearby Regent Theatre, the stereo components being carried by two equalised PMG landlines to a sophisticated array of loudspeakers backstage at the Plaza (even in those days the terms "woofer" and "tweeter" were in use). In addition, Allsop treated his captive audience to some specially produced short films with stereo soundtracks, including a table tennis match, "the bounce of the ball from side to side was easily followed, both visually and aurally.

It is interesting to recall that this historic demonstration was described as "stereoscopic" sound, because it was thought that the word "stereophonic" had been copyrighted by overseas interests.

The 1938 World Radio Convention provided international recognition that Australian electronics had come of age and, as the stern lessons of history were to show, not a moment too soon. Within a few years Australia would be virtually isolated by the tides of conquest and would become the main strategic base and arsenal of the Allied war effort in the South West Pacific.

When that occurred, the professional capability of the electronics industry would be taxed to the limit in producing the tools of victory on a scale that would have seemed impossible only a few years before.
Complete your sound system with our new

Playmaster stereo Cassette Deck

At long last, we have produced a complete circuit for a stereo cassette deck, to follow the replay preamplifier featured in the November 1973 issue. This first article describes features of the unit and some of the circuitry.

by LEO SIMPSON

After the publication of the cassette playback preamplifier circuit back in November 1973, many of our readers have apparently purchased Vortex cassette transport mechanisms in anticipation of a full cassette deck circuit becoming available. Several of our own staff have done the same but the circuit has been slow in development, for a number of reasons. However it has finally come to fruition.

Basically, the design is for a stereo deck using the Vortex cassette mechanism and with all the recording and replay circuitry necessary to enable it to be connected to a stereo amplifier via the line inputs. It has quite a number of what we feel are interesting features, particularly as some are not available on commercial machines.

To introduce the unit, let us discuss some of the features we have provided and justify why we have omitted other features which may seem equally desirable. We have tried to provide a good all round performance and plenty of operating facilities while keeping the unit simple in concept and low in cost.

Dual level meters are provided for signal monitoring during recording. These are backed up with two LED (light emitting diode) indicators which flash instant warnings of transient overload. Thus peak signals which cannot be "followed" by the meters are detected and indicated.

Normally, the level meters do not operate on playback. However they can be made to indicate the relative level of the playback signal if the deck output is connected to the amplifier Auxiliary inputs rather than the Tape Monitor inputs, with the deck input still connected to the Tape output of the amplifier. In this way, the recording amplifiers may be fed with the playback signal. No instability problems result from this mode of operation.

The level controls are of the rotary type rather than the now popular sliding type. While we agree that they are appropriate for this application as they give ready visual indication of their setting, the need to provide slots and special mounting brackets means that they are considerably more expensive than the conventional potentiometers.

Independent recording level controls are provided. These affect only the signals from microphone or line inputs on recording. They do not affect playback levels. This is as it should be. All playback level control is performed by the amplifier to which the unit is connected.

A stereo headphone socket is provided for listening to playback of tapes without having to connect an amplifier. Normal 8-ohm or high impedance phones may be used. No level control is provided for this output but the level can be easily varied if need be by selecting one resistor in each channel.

3.5mm jack sockets are provided for two low impedance microphones (250 to 600 ohms). These are shorting jacks so that noise from the recording preamplifier is minimised when the microphones are not in use. A five-pin DIN socket provides line inputs and outputs at a level of about 100mV, to suit typical stereo amplifiers. Other sources, such as AM tuner, tape recorder or ceramic cartridge in a record player may also be used for recording. The input impedance for the line inputs is 330k so bass response will be limited when used with ceramic cartridges.
A simple mode selection system has been used for the deck electronics. Normally, the replay preamplifier is always functioning, regardless of the transport position, standing by, in fast forward, reverse or replay. The motor runs continuously. When the play button is depressed, the head is brought into contact with the moving tape and the music begins without any unmuting time for the preamplifier.

Leaving the motor to run continuously means that there are no problems of loud transients in the amplifier when the motor is switched on and off. And the tape comes up to speed faster.

When the record button is depressed, it closes a microswitch which controls the motor and supplies power to the bias and erase oscillator. The relay connects the recording amplifiers to the rec/play head and shorts the input of the replay preamplifiers. If the cassette in the transport has the “knock-outs” removed to prevent recording, then of course the replay button cannot be depressed, blocking the whole operation.

Recording levels can be conveniently set using the level controls without the transport being in motion. If the record button only is depressed. When all settings have been made to the user's satisfaction, just press the replay button while holding the record button down and recording begins.

The deck is housed in a steel case with the same dimensions as for the Playmaster 136 stereo amplifier (as described in December 1972 and January 1973, and soon to be represented in updated form). Besides matching the above amplifier, the standard steel case confers a number of advantages not available in most cassette recorders.

First, it enables the deck to be stacked on top of the amplifier (whether it is the Playmaster 136 or any other) without any problems of hum induction from the amplifier power transformer into the recording head. Most cassette decks have plastic or timber cases which do not provide shielding from external hum fields, and so they cannot be stacked on other equipment.

All controls are on the front panel rather than having them on the top panel. This follows the latest trend in expensive cassette machines. Besides allowing the control and the level meters to be seen easily from across a room, it enables a smaller, more economical dress panel to be used. As an aside, the relatively few controls on our unit would tend to look ugly on a large panel.

Having all the controls on the front panel means that the top cover can be easily removed without disconnecting anything, for easy access to transport and the electronics while everything is working. Adjustments can be made and measurements taken without disturbing any of the circuitry. Cleaning of the capstan spindle and heads is also very easy when the cover is removed.

Another worthwhile advantage of having the controls on the front panel rather than the top panel is that of cleanliness. Any dust accumulating on the top panel is easily removed by a quick wipe with a cloth. On many decks with everything on top, cleaning can be fiddly. And if you put a glass of beer on the deck, the top of the machine is seen and then spilled, there is less chance of the liquid doing any damage to our unit. (Believe me, beer can write off slider controls and switches with sliding contacts. If you throw a lot of parties, your unit is the one to build. And if you damage it, at least you can repair it!)

Separate circuitry is used for recording and playback, rather than having the same circuitry perform both functions. This eliminates complicated switching of inputs, outputs and feedback networks and allows each circuit to be optimised for its function. At the same time, it means that the recording level controls do not affect the playback levels.

Since the circuitry does not use transformers at all, there is no limitation on frequency response for this reason. Relatively high supply volatages are used in the circuitry so that signal overload levels are far above those actually recorded on to the tape. On many machines, low supply voltages can be a serious source of overload distortion.

No special provision has been made for chromium dioxide tape. We have several reasons: The latest high quality ferric tapes give a performance almost equal to or even better than chromium dioxide tape, while the playback head on the Vortex transport is not good enough to allow the ultimate performance from high quality tapes to be realised, anyway. But the most compelling reason is that the extra complexity in circuitry and switching is just not worth the minimal advantage of chromium dioxide tape.

To further explain it, many circuit provisions must be made to get the best performance from chromium dioxide tapes. The signal level to the recording head must be increased and the recording characteristic changed. At the same time, the level meter sensitivity must be reduced by the same amount. Bias and erase levels are increased, and the playback equalisation characteristic also changed. Very few cassette decks perform all of this complex changeover, which should be done automatically when the chromium dioxide cassette is inserted (they have a special recess next to the recording knockouts).

Most cassette decks go halfway towards providing the chromium dioxide tape facility, by having two switches for equalisation and bias changes — and that's it. It is to stand the Playmaster deck, to call it that for the first time, cannot fully erase a chromium dioxide tape but it could be used to make a recording if it was really necessary.

Dolby noise reduction or other noise reduction systems have not been incorporated because we felt that the additional cost and complexity was not justified, particularly with the performance limits set by the transport mechanism and head. That is not to say that apology is required for the potential performance. The present mechanism is used in a number of locally produced cassette machines and they all give credible performance.

We are of the opinion that the Playmaster cassette deck will give comparable performance to commercially available decks priced up to $200 and more.

Other features such as automatic stop and memory function are very expensive. As many imported machines nowadays are not easy to provide with the Vortex mechanism, since it uses an AC motor.

Now let us briefly discuss the transport mechanism and its features. A Vortex unit, made in Japan, it is distributed by Panel Parts, 16 Winbourne Road, Brookvale, NSW 2100. It is supplied complete with pushbuttons, terminal strip and Jf2 250VAC motor. It is sold at around $20 from parts suppliers throughout Australia.

The motor is a capacitor-run, synchronous induction type intended for operation at 110V. In the Playmaster, 110V is supplied from a tap on the transformer, primary winding. Motor power consumption is about 7 watts.

Five pushbuttons are provided for the transport: Record (both directions), Play and Stop — Eject. The Stop and Eject button has a two step operation — push down for Stop and then push down harder for Eject of the cassette.

A 3-digit revolution counter, resettable to zero by pushbutton, is provided. It runs from a belt on the take-up spindle. Tape speed is the normal 4.75cm/sec and wow and flutter is within 0.3%. Fast forward and rewind times for typical C60 cassettes are about 90 to 100 seconds.

Mounting arrangement of the transport mechanism within the chassis will be discussed in a later article. Refer now to Fig. 1. This shows the recording preamplifier which uses two low-noise silicon transistors in a direct-coupled configuration. The main AC negative feedback loop is from the collector to the second transistor to the emitter of the first.

Normal circuit practice in cassette recorders is to provide a recording equaliser with a rising response above 2kHz to allow for the frequency response of the recording. In the circuit under discussion, this rising response is provided by the series resonant circuit in the emitter load of the first transistor. The transistor is an 4milicon choke and a 0.27uF polyester capacitor. The choke is a special unit with ferrite core and a low DC resistance of about 27 ohms. The DC resistance sets the Q of the resonant circuit at a frequency of high frequency boost. After losses elsewhere in the circuit, this amounts to a maximum of about 17dB boost at 10kHz. After this frequency, the response lapses rapidly to curtail noise.

Below 1kHz, gain of the circuit is set by the ratio of the 22k resistor to the 330 ohm emitter resistor of the first transistor. To ensure that the circuit is as insensitive as
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Or from the importers: Panel Parts, 16 Winbourne Rd., Brookvale 2100.

ELECTRONICS Australia, August, 1974
Possible to strong RF signals, there are two 56pF capacitors, one connected between base and collector of the first transistor and the other shunting the 22k feedback resistor. These ensure that response to RF signals is severely curtailed. In addition, there is a 1k "stopper" resistor in series with the microphone input.

Special measures have been taken to ensure that hum is not a problem. The supply to the collector of the first transistor is very heavily filtered by the 39k resistor and 10uF capacitor. The bias current for the input transistor is also heavily filtered from the emitter of the second transistor. The 220uF capacitor at the emitter also sets the low frequency roll-off of the circuit.

The output of the preamplifier is fed to the 10k level control and thence to the recording amplifier. This is shown in Fig. 2. It is a very simple circuit using the ubiquitous 741 operational amplifier.

Besides the fact that it only uses three resistors and one capacitor, the 741 op amp circuit has several advantages over a discrete circuit using two or three transistors. First, it is run from balanced plus and minus 15V supplies which gives it a massive signal handling capability, far more than it really needs. Another advantage is that it has a low output impedance which means that it can drive several circuits without any interaction between them. Finally it is biased from the OV line which means that hum is minimised.

Output from the recording amplifier in Fig. 2 is fed to several parts of the circuit: to the recording head via a 22k resistor, to the metering amplifier, and to the overload indicator drive circuit.

Two separate metering amplifiers are employed to drive the meter movements, one for each channel. The metering amplifiers have a stringent task to perform. Not only must they have a flat frequency response but they must give an accurate indication when reading signals of 100mV rms and less, if the meter calibrations are to mean anything.

Again, we have used 741 op amps as in the circuit in Fig 3. Here the 741 op amp is used as a precision half-wave rectifier with gain. Essentially, the high, open loop gain of the op amp is used to overcome the inherent voltage losses in the diodes. The precision rectifier works as follows: Negative half-cycles applied to the phase-inverting input undergo a different process. They are inverted by the amplifier and tend to be amplified by the full open-loop gain. However the diode connected directly between output and phase-inverting input is forced to conduct very heavily, which chops the gain back to almost zero. Thus for negative half-cycles the op amp amplifies normally with a gain of 10 while for positive input cycles the gain is zero and no output occurs.

Thus the op amp precision rectifier acts like a diode, albeit with very little distortion of the half-cycle and with very low forward voltage losses. It can accurately rectify signals down to below 20mV RMS.

Two overload indicators, one for each channel, are used. The circuit is shown in Fig 4. It consists of a silicon NPN general-purpose transistor operating as a class-B detector and driving a light emitting diode. A LED is used instead of a cheaper incandescent lamp, to obtain a fast response to short-term overloads. The potentiometer is set so that the LED just begins to glimmer when the level meter is reading OdB. The LED achieves full brilliance for recording signals of more than plus 2dB.

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EMI describe it as a Colpitts oscillator tuned with the inductance of the erase head.

Because the erase head is in a series tuned circuit, the voltage applied to the head is considerably more than is available at the junction of the two 33 ohm resistors. Thus the erase head voltage is approximately 17V RMS (48V peak to peak) obtained from a circuit with a supply voltage of only 21V DC. Erase frequency is approximately 70kHz.

Series 10k resistors and a 10k preset potentiometer supply bias to the recording head.

The erase oscillator circuit is of special interest. It is the same as used in a cassette recorder manufactured by EMI (Australia) Ltd under the brand name "His Master's Voice". We used the circuit because of its economy of components and clever elimination of the oscillator transformer.

Because the erase head is in a series tuned circuit, the voltage applied to the head is considerably more than is available at the junction of the two 33 ohm resistors. Thus the erase head voltage is approximately 17V RMS (48V peak to peak) obtained from a circuit with a supply voltage of only 21V DC. Erase frequency is approximately 70kHz.

Series 10k resistors and a 10k preset potentiometer supply bias to the recording head.

The replay preamplifier is the same as featured in the November, 1973, issue, but for one small change.

Next month we shall feature the complete circuit diagram and the constructional details of the cassette deck. First buy your cassette deck!

(To be continued)

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Socketing IC's?

Fig 4, above is the overload indicator.

Fig 5 at left is the circuit of the erase oscillator which is tuned with the inductance of the erase head. Below is a general view of the circuit board which has been slightly modified in the final version.

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ELECTRONICS Australia, August, 1974 59
Tektronix have released this new D61 model in their Telequipment range. It's been specially designed for general purpose laboratory, educational and colour T.V. servicing applications. And its only

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All electronic metronome

For the engineer who is also a music enthusiast, here is a precision electronic metronome that can be adjusted to the desired beat rate, accurate to within one beat per minute and can be assembled from standard parts. The circuit, which can be powered from any 9V transistor radio battery, generates beats even beyond the standard metronome range—from about 15 to 380 times a minute.

A 10-turn potentiometer that has a turns-counting dial is used to set the beat rate. The circuit can be calibrated so that the setting of the potentiometer is accurate to well within one beat per minute over the standard metronome range of 40 to 208 beats per minute. Also, the circuit is relatively insensitive to variations in battery voltage.

A constant-current generator Q1 is used to charge C1. When the voltage across C1 reaches the firing point of the unijunction transistor Q2, the capacitor is discharged and an output pulse is generated. C1 charging current, and hence the operating frequency, is directly proportional to the voltage across the variable resistor R1, a voltage that varies linearly with the setting of potentiometer R2. Diode D1 compensates for the base-emitter drop of transistor Q1.

The circuit is calibrated by adjusting R1 to obtain the upper standard beat-rate limit of 208 beats per minute and then adjusting the stop on the turns counting dial to get the lower standard limit of 40 beats per minute. Plenty of patience and a good stop-watch are needed for good calibration results.

The circuit employs a pulse stretcher, made up of diode D2, capacitor C2, and resistor R3, to increase the available energy from the battery. The volume control may be replaced with a fixed resistor to obtain maximum output, if desired.

For long time delays expensive capacitors with extremely low leakage are required. The practicality of the components involved limits the time between pulses to something in the neighbourhood of ten minutes.

To achieve longer time periods both halves may be connected in tandem with a "divide by" network in between, the first section operating in an oscillatory mode with a period of 1/fo. This signal is then applied to a "divide-by-N" network to give an output with a period of N/fo. This can then be used to trigger the second half of the 556. The total time delay is now a function of N and fo.

Signetics 556 dual timer

Each half of the 556 device behaves like a separate 555 timer and as such all of the applications indicated in the data sheet for the 555 are also applicable to the 556.

In the 556 timer the timing is a function of the charging rate of the external capacitor. For long time delays expensive capacitors with extremely low leakage are required. The practicality of the components involved limits the time between pulses to something in the neighbourhood of ten minutes.

To achieve longer time periods both halves may be connected in tandem with a "divide by" network in between, the first section operating in an oscillatory mode with a period of 1/fo. This signal is then applied to a "divide-by-N" network to give an output with a period of N/fo. This can then be used to trigger the second half of the 556. The total time delay is now a function of N and fo.

Frequency extender for electronic counters

Many amateur stations include 100kHz or 1MHz frequency counters. These counters are quite useful although limited in range. The upper frequency limit of such instruments can be multiplied ten times through the use of an IC prescaler. This device divides the applied frequency by ten and supplies an output suitable for application to the counter. Therefore, the prescaler produces a signal at 1MHz when the input is 10MHz. The unit shown in the circuit can accept signals to about 11.5MHz at levels from 0.4 to 2V peak-to-peak and produces an output of 3.5V peak-to-peak.

If desired, the unit and its power supply can be built on a small piece of Vectorboard and mounted inside the counter. No special precautions need be observed in the construction other than the normal practice of keeping leads neat and short. For those not accustomed to working with integrated circuits, it is recommended that dual in-line packages and sockets be used.

Appropriate substitutions can be made provided that the essential characteristics are maintained. Note that only one of the four gates of the SN7400N is needed. This IC was used because it was available. However, a dual-gate IC could be used instead. The unused input must be connected to -5.5V. When using a substitute IC be certain that the appropriate power supply voltage changes are made, if
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**LM3900 IC as low-cost function generator**

A versatile function generator that minimises hardware as well as cost can be built with one of the newly introduced National Semiconductor LM3900 Norton quad amplifier ICs. The price of the complete generator is just a few dollars and the entire unit can fit on a circuit board as small as 4cm square.

Only a single Norton amplifier is needed to obtain a sine wave generator as shown in (a). When resistor R1 and capacitor C1 are omitted from this circuit, the resulting configuration is the standard one for a Norton-amplifier square-wave generator, with the timing current passing through capacitor C2. The addition of an integrating capacitor C1 to this square-wave generator produces a reasonably accurate sine wave at the output. Resistor R1, which helps to match the circuit's time constants, can be used to adjust the output sine wave for minimum distortion.

A similar circuit can be used to add a sine wave output to the conventional hookup for a square-wave triangular-wave generator built with two Norton amplifiers. As shown in (b), the triangular output acts as the input for the sine-shaper amplifier. For the component values given here, the circuit's operating frequency is around 700Hz. Resistor R1 is the adjustment for minimum sine wave distortion and resistor R2 is the adjustment for the symmetry of the square and triangular waves. The fourth amplifier in the Norton quad package can be connected as an output buffer. (By P. Vleck, in "Electronics")

**Non-polarised electrolytics**

An improvement on the usual "Back-to-back" connection of electrolytic capacitors to form a non-polarised unit can be easily effected by using two diodes to short out automatically the "reversed" capacitor. The capacitors no longer have reverse voltage across them as happen, in the conventional arrangement, and also each provides its full capacitance (instead of only half of this) to the circuit. (From "Electronic Design")

**Note on burglar alarm**

There is an error in my circuit for the Economical Burglar Alarm as presented on page 63 of May, 1974. The supply rail connected to the 40 ohm relay and the door or window contacts is labelled "+6V" and should read "+5V"). Also, may I suggest that a 4k7 resistor be substituted for the 68k resistor as shown in the circuit, if a higher relay current is to be drawn. (By Mr D. A. Scott, 32 Laburnum Street, Blackburn, Victoria 3130.)
SSB transceiver design using Plessey SL600 ICs

Most of our readers will have seen digital equipment using ICs, but many may not even be aware that these devices are now being used in radio communications gear. This article describes a high performance SSB transceiver module developed using the Plessey Semiconductors SL600 series of devices, and should illustrate the advances that have been made in this field.

by JAMES M. BRYANT *

The SL600 series of integrated circuits was developed by Plessey Semiconductors specifically for application in radio communications equipment. Since the devices were released, they have been used in many commercial and military communications equipment designs, including the “Clansman” UK/PRC 320 HF Manpack Transceiver designed and manufactured by Plessey Avionics and Communications. This transceiver covers the frequency range from 2 to 30MHz, using USB, LSB, AM and CW (narrow band) modes. The SL600 device range includes RF/IF amplifiers, a limiting RF amplifier-detector, AGC generators, an AF amplifier, VOGAD and sidetone amplifier, an AM detector, AGC amplifier and SSB demodulator, a microphone/ headphone amplifier, double balanced modulators and a square law device.

In a basic superhet receiver of conventional design the signal from the antenna, having passed through a preselector filter, is amplified and then mixed with a local oscillator to produce an intermediate frequency. This IF signal is filtered to remove signals on adjacent channels, amplified and applied to a detector. An AGC voltage is fed back to the RF and IF amplifiers.

The system has been in use, first with valves and distributed IF amplifiers — later with transistors and/or block crystal filters — since the late 1920s. In many respects it is ideal — it has high gain, low noise and excellent selectivity. Many of the most famous receivers of the past used such a system, but it has one severe drawback — the large gain in the relatively broadband stages prior to the IF filter can lead to large unwanted signals being applied to the mixer, which in turn (and especially with transistor mixers) leads to cross-modulation. Once cross-modulation has occurred no amount of subsequent filtering will cure it. The problem was less severe in the past for two reasons — the valve mixer is far less susceptible to such effects, and, far more important, in the past there were far fewer strong signals liable to cause such troubles than there are on today’s crowded frequencies.

Modern receiver design has moved away from such techniques. The design of HP and

*Linear Applications Manager, Plessey Semiconductors, Swindon, Wiltshire, U.K.

VHF receiver front ends is a difficult task, and the systems used in the highest performance receivers are often not only complex but closely guarded secrets as well. In principle, however, two criteria must be considered. Firstly, a minimum of gain between the antenna and the crystal filter — usually none at HF where antenna noise levels are high, but possibly 10dB at VHF and UHF so that mixer noise does not control system sensitivity. In mobile radios at VHF/UHF, however, sensitivity is often sacrificed for strong-signal performance. Secondly, the use of a mixer having as great a cross-modulation resistance as possible.

Some common mixers are discussed below.

The bipolar transistor is a very poor mixer and suffers badly from cross-modulation. Its common use in television tuners is responsible for the extreme susceptibility to cross-modulation by local transmitters. However, the use of bipolar transistors in the microwave region can give some cost advantages over other systems. Junction FETs, although far better for the purpose than bipolar transistors, do not make ideal mixers when used alone.

Cross-modulation resistance can be greatly improved by employing bipolar transistors in double-balanced modulator circuits such as the SL640 or SL641. The SL640/1 will tolerate up to 30mV RMS of unwanted signal before cross-modulation of a 1µV signal reaches 1pc. This is not a very good performance by the standards of modern HF receivers; nevertheless the SL640/1 may be used in medium performance receivers where its low local oscillator power requirement and extreme ease of use in some degree compensate for its relatively ideal large signal performance. It should be noted that if the SL640/1 is preceded by an SL610 to which no AGC is applied, the signal at the antenna needed to produce cross-modulation is reduced from 30mV to 3mV. This is not satisfactory.

A single balanced modulator using a matched pair of junction FETs can have useful gain, low noise, and high cross-modulation resistance, but has one disadvantage in that quite high local oscillator power is required. Nevertheless, it has been demonstrated that a mixer with 2.5dB gain, working from 50MHz to 300MHz and capable of handling signals in excess of 2V RMS can be made using this technique.

The dual-gate MOSFET is another useful mixer. The fact that it is more often used at VHF than at HF appears to result more from custom than for any real technical reason. It will handle signals of over 150mV, but its biasing is somewhat critical. Local oscillator requirements, however, are modest and it can have both useful gain and low noise figure.

Of all the mixers in use today, however, the diode ring is undoubtedly the best. Using

Fig 1: The circuit schematic for the SSB transceiver module described. Note that ICB is an SL621IC, not an SL612IC as shown.
four matched diodes of any type (most commonly used are silicon Schottky diodes and, in low-cost systems, germanium diodes). This mixer has many advantages. It is bi-directional (so that both transmit and receive) it will suppress very large unwanted signals — although this is also dependent on the local oscillator power inserted — and can be used at frequencies up to several GHz. Disadvantages of the diode ring mixer are its high local oscillator requirement, its conversion loss of about 6dB, and its noise figure of 5dB or more. It requires a mixer capable of handling IV would have to follow it. Using an SL610 with full AGC cross-modulation is encountered at about 250mV RMS input. The mixer must be followed at once by the filter. In modern sets a crystal or ceramic filter is usually employed, so another type will be considered here. The bandwidth of the filter depends on the signal being received — bandwidths commonly used being 300-600Hz for CW, 2.7kHz for SSB, 5.5kHz for AM and between 10 and 25kHz for NBFM.

The filter is followed by a high gain broadband IF amplifier consisting of two or three SL612s followed in turn by a detector. In the gain stage of the SSB transceiver is described here. The bandwidth of the filter depends on the signal being received — bandwidths commonly used being 300-600Hz for CW, 2.7kHz for SSB, 5.5kHz for AM and between 10 and 25kHz for NBFM.

The filter is followed by a high gain broadband IF amplifier consisting of two or three SL612s followed in turn by a detector. The receiver section of the SSB transceiver to be described shortly has been designed along the lines outlined above. It consists of a diode ring mixer fed from the antenna via a preselector followed by a crystal filter (an SEI QC1246X 2kHz bandwidth 0.5MHz filter was used in the prototype) and a 3-stage SL612C IF amplifier. An SL640C acts as product detector and feeds an SL621C AGC generator and an SL630 audio amplifier.

The AGC line is decoupled at LF to prevent supply current surges (which in the SL612C can be induced by step signals) from interfering with other circuits. IF decoupling is unnecessary since the SL612Cs have sufficient internal decoupling, but it is advisable to earth the cans to pin 8. The interstage IF coupling capacitors should be kept as small as possible — at 9MHz 100pF is adequate — to ensure that LF signals at the output of one SL612C (due to noise or AGC action) do not reach the next stage and give rise to low frequency instability as the receiver passes the AGC threshold.

Earlier designs of SSB receivers using SL100 devices had a preset control to adjust the AGC threshold. This is now considered unnecessary provided that AGC to the gain stage is delayed (as described above) until the input reaches at least 3uV. The audio output from the receiver is a maximum of 100mW which, while entirely adequate for headphone and normal domestic or fixed amateur use, may be insufficient for mobile or professional applications (although a listening test may be better to use double-sided board may be mounted off the board. The circuit board for the transceiver uses single-sided copper board. It should be noted that the layout is extremely critical and deviations from it are likely to lead to instability. If a different layout is used it would be better to use double-sided board and make all earth connections to a common point. It is bi-directional (so that both transmit and receive) it will suppress very large unwanted signals — although this is also dependent on the local oscillator power inserted — and can be used at frequencies up to several GHz. Disadvantages of the diode ring mixer are its high local oscillator requirement, its conversion loss of about 6dB, and its noise figure of 5dB or more.

Fig 2: A block diagram showing how the transceiver module is intended to be used to form a complete transceiver. At right is the list of small parts.
SSB TRANSCEIVER

Continuous unetched earth plane on the component side of the board. If a new or different design is attempted on a single-sided board, strict attention must be paid to the instructions on earth connection given in the SL610/11/12 circuit data.

Double superhets can also be designed using SL600 devices but with modern filters such added complexity is rarely necessary except at UHF or where complex tuning systems are used. Inasmuch as the same techniques are used as in single superhets such systems are not described here, but it should be noted that SL600 devices have high gains, therefore too many amplifying stages should be avoided.

Let us now consider the transmitter or exciter section of the design.

Two types of SSB generator are in common use; filter systems and phasing systems. A basic filter system may be built using only two SL640C balanced modulators. The audio and a low radio frequency from an oscillator (the BFO if the system is part of a transceiver) are mixed in one SL640C which, as a result of its good carrier rejection, gives as its output a clean DSB suppressed-carrier signal. This is passed through a narrow bandpass filter to remove one sideband, the remaining sideband is converted to the final frequency by another SL440C and the image is removed by a filter. The output is then applied to the transmitter linear amplifier possibly using a Plessey Semiconductor SL1030 as its first stage.

A more complete filter system would have an SL610C as an internal amplifier which is controlled by an automatic level control signal. This in most cases would be derived from the final linear amplifier — either by a threshold detection system or by grid current detection in the output valve. A phasing system may also be built using two SL640Cs. The audio input, which must normally be of limited bandwidth, is phase shifted so that two audio lines of equal amplitude but separated in phase by 90 degrees are obtained. These audio signals are applied to the signal inputs of two SL640Cs. RF reference and quadrature signals are applied to the carrier inputs, and the two outputs are summed. If the audio reference and carrier reference signals are applied to one modulator and the audio and carrier quadrature signals to the second, the LSB outputs will be out of phase and will cancel. Thus, LSB is obtained. Similarly if audio reference and carrier quadrature are applied to one modulator and audio and carrier reference to the other, USB is obtained.

This method appears attractive in many respects and has the advantages that no expensive filters are used and that the carrier frequency may be varied, so that further conversion may not be necessary. The disadvantage is that to keep the second sideband the required 40dB below the desired sideband the phasing, both audio and RF, must be very accurate — in fact within 2 degrees. In addition, the amplitude of the carrier applied to one modulator must be critically adjusted to minimise second sideband generation, and carrier leak must be minimised on both modulators.

Despite the adjustment problems, this
method of SSB generation is very popular—probably because of the saving of expensive filters.

In the transmitter exciter section of the transceiver design given here, the filter method is used. This makes use of the same FET carrier diode ring (capable of 500 mV output) as the oscillator, simplifying the circuit and significantly reducing costs while keeping the adjustments to a minimum.

As transmitters often contain large RF fields, particular attention must be paid to screening and decoupling. In some cases it may be necessary to decouple individual stages. In areas of high field, device cans should be individually earthed.

The following brief description of a unit which forms the heart of a single sideband transceiver design using SL600 devices should illustrate in a practical way the points discussed in the foregoing. The transceiver could be adapted for use from 10kHz to 500MHz. The basic module as described is constructed on a single printed circuit board and requires only a local oscillator, linear amplifier, preselector, microphone and loudspeaker or headphones to complete the transceiver. The circuit is shown in Fig. 1.

**RECEIVER**

The receiver is a single conversion superheterodyne with a 9 MHz intermediate frequency. In order to improve the cross-modulation characteristics there is no RF amplification, high gain being provided by the IF stages.

The input mixer is an ANZAC MD108 hot carrier diode ring, which is used in order to obtain good large signal performance. The mixer input (pins 3 and 7) is obtained from a pre-selector, which prevents the image frequency being received. The local oscillator signal is applied to pin 8 of the MD108 at a level of about +7 dBm (500 mV). A toroidal transformer is used to match the 500ohm output of the mixer to the crystal filter. IF amplification is provided by three cascaded SL612Cs, which are followed by an SL640C used as a product detector. The carrier insertion oscillator is an FET which delivers 100 mV RMS into the product detector. The audio amplifier, an SL630C, provides 100 mW output into a 400ohm loudspeaker; audio gain control is by means of a DC potential applied to pin 8 of the SL630 by a 5k potentiometer in series with a 5k resistor, as shown in Fig. 1.

Automatic gain control is provided by an SL621C AGC generator, the transistor TR2 being used to buffer the output of the SL621C so that an 'S' meter may be driven from the emitter of TR2 if required. C16, C18 and C20 are kept low (4700pF) in order to retain the linear characteristics there is no RF after modulator is applied to pin 7 of the SL610C. The BFO and crystal filter used in the receiver, the local oscillator to produce the required frequency which afterwards must be removed.

The carrier injection is provided by an FET oscillator, with 2 diode-switched crystals for upper and lower sidebands.

**TRANSMITTER**

The transmitter is also single conversion. It generates SSB at 9 MHz by the filter method using the same crystal filter as the receiver. An SL622C is used as the microphone pre-amplifier; this device has its own AGC which automatically adjusts the output to suit the SL640 balanced modulator.

The SL640C is followed by an SL610C amplifier which has ALC (derived from later stages of the transmitter) or a DC RF gain control applied to pin 7 of the SL610C. Resistor R1 and R3 provide the correct match to the filter.

The diode ring mixes the 9 MHz SSB with the local oscillator to produce the required output frequency (and of course the image frequency which afterwards must be removed).

The carrier injection is provided by an FET oscillator, with 2 diode-switched crystals for upper and lower sidebands.

**CONSTRUCTION**

The circuit board is single-sided, with two wire links on the top— one in the receive HT line and the other in the transmit HT line. The layout of this transceiver is critical; change of printed circuit design is not recommended as this could lead to instability.

Transformer T1 is made from four 2-inch lengths of 26SWG wire twisted together; the twisted wire is then used to wind two turns on a CR071-8A core (ITT). Any linear ferrite or iron dust toroid with an inside diameter from ½ to 1½cm should be satisfactory. The ends are then separated and three windings connected in series for form the secondary, the primary being the remaining winding.

The board may be used as a receiver by omitting the following components: R1 to R5 inclusive, C1 to C13 inclusive and the three integrated circuits used in the transmitter. A 500 ohm resistor should be connected between the crystal filter output and earth.

The 100 mW audio output has been found adequate for most purposes but if extra power is required it could be obtained from a Plessey SL414 audio amplifier external to the board. In practice the sensitivity of the receiver is satisfactory up to 30 MHz but above this frequency an RF amplifier is useful to take advantage of the lower atmospheric noise.

**ACKNOWLEDGEMENT**

This article has been adapted from applications literature on the SL600 series of communications IC devices, published by Plessey Semiconductors, by arrangement with Plessey Australia Pty Ltd, Components Division, Professional Products Department.
Bookworms Corner

Chew your way through some of these (most are in paperback form so are excellent value).
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(see E A March 1973)

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"Seedy eye" on capacitor discharge ignition

CDI — capacitor discharge ignition — continues to be a subject of debate amongst electronic enthusiasts. To some, it is the key to economy and performance, the best thing that's happened to motoring since electric headlamps. To others, the whole idea is a load of unmitigated codswallop, whatever that may be!

As a contribution to the argument, we have to hand a letter from a reader in Padstow, NSW. From a background of instrumented tests, he has this to say:

Dear Sir,

It has been amusing to read the variety of articles and comments on electronic ignition in both this and other publications. Most are pro CDI but all lack concrete documented evidence. Surely the most effective way to evaluate ignition systems is by using an analysing instrument and an engine dynamometer to measure engine performance.

Evaluation along these lines was carried out by the writer using:
1. A Ford Falcon 6-cylinder engine coupled to an engine dynamometer, and
2. A Holden 6-cylinder engine coupled to a Vare Tunescope Analyser, model 3090.

The dynamometer measures torque in foot-pounds with relation to rpm. Horsepower may be calculated from this by dividing torque times rpm by 5250.

The Tunescope Analyser enables primary and secondary voltage waveforms to be observed on a large-screen CRO, and has provision to monitor the air-fuel ratio.

The CDI used for these tests used a 1 uF oil-filled capacitor supplied with 400 volts from the DC converter at an engine speed of 2000 rpm. The SCR trigger signal is delayed from the DC converter at an engine speed of 2000 rpm.

Incidentally, I do not use CDI on my car, as it does not give a noticeable improvement over the original ignition system. After all, how does one improve the starting ability of a car which starts first time every time?

B.F. (Padstow, NSW)

That last sentence is very eloquent. B.F. is obviously in a position to have CDI in his car if he wanted it but he hasn't bothered.

A plot of torque against engine speed for a Ford Falcon 6-cylinder engine, with conventional and also capacitor discharge ignition.

Primary waveforms (top) and secondary waveforms (below) observed on a Holden 6-cylinder engine with conventional and CD ignition.
with it because he doesn't have an urgent problem that needs to be solved. Nor, apparently, does he believe that he might accrue from using CDI are sufficient to overcome objections of cost, complexity, and the rendering of a vehicle "non-standard" from the servicing viewpoint.

Of course, we recall the decision making of a tech college teacher, with access to similar testing facilities, who did install CDI in his car.

But he had a problem to solve. The car was one which did not take kindly to wet conditions and to driving rain in particular. The risk of electronic breakdown was far lower than that due to moisture on the ignition system as fitted and the extra kV which a 031 gave system made all the difference in his particular case.

Component Supply

To change the subject, here's a letter from a serviceman who has generated some strong feeling about the component supply position. He says:

Dear Sir,

I refer to your recent observations about parts shortages and I must agree with your sentiments about the diversity of available components.

Surely the hobbyists can get by with a standardised "point one" capacitor. Surely such things as resistors and capacitors can be standardised. How many projects in the past couple of years have you described where metal film or metal glazed resistors were needed. Yet some hobbyists, with more money than sense, insist on getting these bits and create a scene when they cannot get them!

I personally work in the TV servicing industry and I find it frustrating in the extreme when I cannot get the necessary spare, but I've got the same problem.

If I want to build a "state-of-the-art whatnots", and I find that some of the bits are out of stock then, while I may be crook, I can at least understand the situation. And I'm the only one concerned.

But you try to tell Joe Customer that you can't get valves, changeover tuners, EHT transformers, knobs, certain capacitors or resistors and he goes through the roof! One particular manufacturer has been making solid state TV sets for a year now. But you try to get the horizontal output transistor. No go, and even if you could, it costs the best part of six bucks. This is a much vaunted transistorised set, supposedly ultra reliable!

In my experience, transistorists are okay for small signal stuff, perfect for IF, tuner, AEC and sound. But try to put them in the power stages, Hos and Vert output and all Hell breaks loose!

And take the humble switchback pot. Millions of them are made per year and they're almost a standard item in every set. But the news has just filtered through that they won't be made any more. Instead of just replacing the switch back we have to change the entire pot. Some of these pots cost us seven grand each! Good business, of course, but the sort of thing to make the blood of any decent technician boil.

It's hard enough now to satisfy a customer, considering labour costs, and this will make the customer even surer that we are a pack of thieves.

6CM5's? Can't get 'em! I checked back through my call records and there are thirty-one sets attended to by me which are still not repaired, because they need 6CM5's and I can't get them. Some of these sets have been like this for four months. What do I do? Lose the customer? Most likely!

And who do I blame for this shortage? Myself? The supplier? No. He's just as much worried about it as I am. It must come squarely back to the manufacturer. Now I don't expect them to react to a shortage within a week. They've got to set up a production line for each valve and I can hardly expect them to halt one line already set up and change over to another valve. But four months? Surely it doesn't take that long!

Ask "The Serviceman" if he's had any trouble. His troubles may not be the same as mine but he most certainly has had a lot of calls wasted by a lack of spares.

Just what do we do about it? Complain to the suppliers? I don't think that will solve anything, for he's just as likely to jack up at us. What is needed is direct agitation to the manufacturers by all sections of the trade, including your magazine.

If this goes on any longer, I'll become a blacksmith.

R.M. (St Albans, Vic)

A blacksmith! What's a blacksmith?

Fairly obviously R.M. doesn't really spend too much of his time building "state-of-the-art whatnots", otherwise he would not be so quite convinced about the practicability of using non-state-of-the-art components.

One could find plenty of examples but one that comes to mind is the little SQ decoder that was included in the Playmaster 140 quadraphonic amplifier. With an IC and miniature peripheral components, the whole thing could fit comfortably in the palm of the hand. More importantly, it fitted comfortably into a convenient space in the standard chassis. Try to build that same gadget without the IC, or even just using large size components, and it would have become a real headache.

One might even go on to suggest two definitions for misery (from the hobbyists viewpoint).

"Misery is trying to fit conventional point ones on to a board designed for miniature polyesters" or "Misery is having to make a complex gadget several times larger than necessary because you can't get the right parts."

But, of course, R.M. is right enough when he points out that a serviceman's lot is not a happy one. (Where have I heard that before?) His misery extends to his customer and, in the ultimate perhaps, to his banker.

Whether R.M. should blame the manufacturer for his problems is another matter. In some cases it may be justified, but those cases are being overshadowed by much more momentous circumstances.

All around Australia, component manufacturing lines are phasing down as the result of lowered tariffs. If we can't mass produce components cheaply enough to compete with imports, we certainly won't be able to produce economical spares a few at a time.

Maybe we should raise the sights to the politicians who re-shaped the tariff levels! In the meantime, we'll leave the subject open, to see what you think.

FOOTNOTE: I happened to encounter an executive from IRH who said that his company, at least, had no immediate intention of cutting off the supply of switch backs. Maybe that will make R.M. feel just a little less miserable.

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by DAVID EDWARDS

Primarily, the aim of the present project is to simplify the problem which faces enthusiasts and musicians of tuning their instruments in a precise and uniform manner. Perhaps a little background would be helpful:

Before the era of electronic instruments, tuning pianos and organs in particular was regarded as something of an art, understood and practised by relatively few people. It involved setting the frequency of a single note with the aid of a tuning fork or pitch pipe, then setting up one complete basic octave, by playing pairs of notes in a particular sequence and reacting to the beats between them.

The basic adjustment would then be extended over the whole keyboard, till the necessarily noisy job was finished.

However, over the past 25 years or so, the realm of music making has been invaded by scientists and engineers—short on mystique but strong on mathematics! They pinned down the formerly errant musical pitch to a precise A = 440Hz. Then, by dividing the octave of the tempered scale into its 12 precise intervals, they nominated the frequency of each semitone correct to several decimal places.

Against this background, the job of tuning electronic instruments at least should have become merely a matter of turning a knob or reading a meter but, at a practical level, it hasn't been as easy as this:

The technology behind audio generators, frequency meters and such like, while more than adequate for amplifier testing, has lacked the precision necessary to set the intervals of the musical scale. Even those instruments especially designed as electronic tuning aids have tended to rely on extrapolation from a single reference somewhere within their range. They have lacked the assurance that every single interval was individually and permanently locked to a reliable standard.

One possibility that was considered some years ago was to have a set of precision crystals, in a semitone relationship, with a divider chain capable of reducing the selected crystal frequency to the corresponding musical pitch. But, for most enthusiasts, it was fated never to be more than a possibility, because of the cost of the crystals required.

With the evolution of more sophisticated divider circuits, it became feasible to envisage a single, stable high frequency oscillator and divider chains set up for selected whole numbers, which would divide the one source frequency to audio tones closely approximating semitone intervals.

Calculation showed that a very convenient frequency for a master oscillator would be 1.999360MHz—a frequency for which good quality crystals can be ground relatively cheaply. This can be divided down to frequencies suitable for the top octave of a typical instrument by a series of whole numbers, as follows: C, 239; B, 253; A sharp, 268; A, 284; G sharp, 301; G, 319; F sharp, 338; F, 358; E, 379; D sharp, 402; D, 426; C sharp, 451.

While an intriguing possibility, it posed the very practical problem, initially, of requiring far too many discrete components to be the basis of a "handy" tuning aid.

Faced with this, we looked at the alternative, several years ago, of using a single divider chain, but switching the logic circuitry to produce one semitone at a time, as required. But the problem then became one of wiring complexity, along with the cost of the necessary switch.

In consequence, it stayed in the "too hard" basket. At least, until we received the article by S. H. Dolding, which we published in the May issue. The design presented in that article used seven ICs, and a diode matrix to simplify switching.

More recently, the designers of integrated circuits have addressed themselves to the problem, prompted in particular by the demands of electronic organ manufac-
The device which actually triggered the development of the instrument is the AY-1-0212, made by General Instrument Microelectronics Ltd, and available from General Electronics Services. This is a MOS large-scale IC which comprises twelve separate divider chains, one for each note, on a chip mounted in a normal 16-pin dual in-line package. The device will operate from input frequencies anywhere between 100kHz and 2.5MHz, and can thus be arranged to produce its twelve output frequencies at a variety of pitches, if required.

As soon as we learned of the availability of this device, we obtained samples and literature and immediately set about the development of the basic tone generator module which forms the heart of the present instrument. However just as we were finalising the module design, we learned that another IC of this type had also become available.

The second device is from the Mostek Corporation, of Texas, and is designated the MK50242. It is imported by Namco Electronics (Aust.) Ltd, and available from Total Electronics, who distribute their product lines.

Needless to say, we obtained samples and literature for this device just as soon as we could, and compared it with the AY-1-0212 device around which we had designed the module. Happily, we found that although the two are not quite identical, they are so nearly so that the MK50242 may be used in the module with only minor changes. Hence we are recommending the two devices as equally suitable alternatives. Primarily this means that readers should have twice the chance of being able to buy the key tone generator IC, than if only one of the devices were available.

Before we look at the circuit, it should perhaps be explained that there is a certain amount of flexibility about choosing the crystal frequency.

As we noted earlier, the division ratios used to produce the twelve notes are whole numbers in the range 239 to 451. As one might expect, these are a practical compromise; they must be made no larger than is necessary to produce acceptable accuracy within the octave, in order to keep the complexity of the IC pattern within reasonable bounds. Naturally because of this compromise the actual note frequencies produced are not separated by the
The largest actual error is something like 0.11pc. In practical terms the only significance this has is that if one chooses the crystal frequency to make say "A" exactly correct at 440Hz and its multiples, than all of the other notes — including "C" — will have a slight error in terms of absolute pitch. On the other hand it is possible to choose a different crystal frequency such that "C" and its multiples have exactly their correct absolute pitch, although this will obviously make "A" and the other notes slightly out.

Thus the crystal frequency which is strictly needed to make "A" exactly right turns out to be 1.999960MHz, the figure noted earlier, while that needed to make "C" exactly right is slightly higher at 2.000911MHz.

As you can see, these frequencies are very close together. One is only 0.032pc lower than 2MHz, while the other is only 0.045pc higher than 2MHz. These errors are half an order of magnitude smaller than the errors in the basic scale, so that from a practical point of view we are really splitting hairs.

Our recommendation, therefore, is that the most realistic crystal frequency to use is the round figure of 2MHz. This also has the advantage that we have used crystals of this frequency in previous projects, such as the Digital Frequency Counter of December 1973. Suitable crystals may therefore be available ex stock from many suppliers.

If you have a particular reason for wanting absolute pitch accuracy, then this compromise crystal frequency may not be good enough. In that case you will merely have to obtain a crystal to order on one of the suppliers.

We have combined this basic circuitry with a simple power supply, to produce a complete self-contained music generator module which may ultimately be used for other projects — like the present tuning instrument. The module is based on a printed wiring board which measures 125 by 109mm and coded 74/99.

To form the tuning instrument, all that is needed apart from the board module is a small stepdown transformer, two rotary switches to select the note and the pitch required, and a simple loudspeaker driver circuit.

The board is basically designed to be used with a standard 0.150 inch printed circuit board edge connector having 32 contacts.

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This wiring diagram should make construction a relatively simple and straightforward process. Take care when mounting the AY-1-0212 IC, as it is easily damaged by static electricity. Note that the printed wiring diagram is shown smaller than actual size.
This interior view of the completed prototype clearly shows the disposition of all the major components, the tagstrip, and the printed wiring board.

However, we have made provision for the use of circuit board pins and directly soldered on leads. We made our prototype using the edge connector, as this made frequent removal and replacement quite easy.

The AY-10212 device requires supply voltages of +12V plus or minus 1V to pin 1, 0V to pin 10 and -15.5V plus or minus 1.5V to pin 9. Pin 2 is the input connection, and the twelve outputs are available from the remaining pins.

The printed circuit board was designed to supply these voltages to the AY-10212, using three separate zener diode referenced supplies working from a transformer with two 12V secondaries.

The MK50242 only requires a single supply rail. The recommended supply voltage ranges from +11V to +16V, with a typical value being +15V. It is thus possible to use the same +12V supply as required by the AY-10212. The components required for the -15.5V supply can be left off the board as they are not needed, giving a small saving in cost. This is partially offset by the increased price of the MK50242 as compared with the AY-10212.

The crystal oscillator circuit is basically the same as in the 200MHz counter. This consists of a 7400 quad gate wired in the manner recommended by Foster and Rankin in their article of November 1972. We have used the fourth gate to provide a buffered auxiliary output, so that if required the 2MHz output would be available for use with any other equipment.

 Provision has been made on the printed board for a trimmer capacitor to adjust the frequency of the crystal oscillator. However, this will not normally be required in the present application. In place of the trimmer and its shunt capacitor, the circuit should normally be wired with a single 33pF NPO ceramic capacitor in series with the crystal, as shown in the circuit.

The connection between the crystal oscillator output and the input circuitry of the tone generator IC is made via a small copper link, both ends of which are brought out. If an alternative 2MHz signal is available, then this link can be broken, and the signal fed in through the relevant connection. If, after breaking this link, it is required intact once more, then provision has been made to use a wire strap to bridge the gap.

The input circuitry to the tone generator IC consists of an impedance and voltage matching stage consisting of a single transistor, working in the common emitter mode. The main function of this stage is to increase the signal level to that required by the MOS device.

Each of the twelve outputs of the IC need to be converted back down to a suitable level for inputing to the TTL dividers. Because of the risk of damage to the IC, it was decided to use twelve separate buffer stages followed by the selector switch, rather than using one stage after the switch. However, since only one output is required at any one time, we were able to use a common collector resistor.

As all these stages are working at less than 10kHz, no special transistors are required. Almost any general purpose audio or switching transistor will be satisfactory, provided that the gain is high enough. The twelve base resistors required need only be 1/4 watt types.

A twelve position single pole rotary
switch is used to select which note is to be played. It is more critical than the -15V line.) The diode should be a 12V type. (This supply is decoupled from the +5V supply using a 400mW zener diode in conjunction with a capacitor. The +12V supply consists of a 1000uF, 25V electrolytic, printed circuit board type (AY-1-0212 only).)

To protect the devices during shipment, a word of warning is perhaps in order concerning MOS devices. MOS devices are susceptible to damage caused by static electrostatic charges, so that unless reasonable handling precautions are observed, the devices may be rendered inoperative.

To protect the devices during shipment, they are packed in conductive foam. Do not remove your device from its packaging until you are ready to install it in its socket. We will give details of the procedure to be followed in actually installing the device further on in the article.

Construction of the tuner is relatively simple, as most of the components are mounted on the circuit board. Before any components are placed on the board, it should be carefully inspected for any breaks in any of the copper tracks or bridges between them.

Once this has been done, the wire strap can be fitted, followed by the resistors and capacitors. All 1/4 watt resistors will fit to the board in the normal horizontal position, but the 1 watt types need to be stand on end. If 1/4 watt resistors cannot be obtained, then larger types may be used standing up. Take care when mounting the electrolytic capacitors that their polarity is correct, as shown on the printed board overlay.

The power supply components can now be fitted. Ensure that the zener diodes are fitted with the correct orientation, as shown on the overlay. The fourteen transistors are best fitted next. Do not apply excessive heat as this may damage them.

The socket for the tone generator IC is the next component to be fitted. When fitting the three TTL IC's, take particular care that they are fitted with correct orientation, and in the correct place. Use a

**LIST OF COMPONENT PARTS**

1. Case, 230 x 215 x 90mm, with matching front panel
2. Power transformer, 240V to 12V and 12V at 0.8A. (Ferguson type PF5359 or similar)
3. Printed wiring board, 74 / 09 (125 x 167mm)
4. Rotary switches, 12 position single pole
5. 12MH quartz crystal, AT-cut fundamental
6. 70 mm dia, 15 ohm speaker. (Rola 2C or similar)
7. 16 pin DIL integrated circuit socket
8. 320 ohm, 0.050 inch pitch edge connect (McMurdo Redline or similar)
9. 6V Pilot light
10. 3 pin DIN socket
11. 1k linear potentiometer
12. Miniature tag board, 5 pcs, tag Mains cord, plug, rubber grommet and clamp
13. 1A fuse and m-line fuse holder
14. 3 knobs
15. 3 terminal block

**SEMICONDUCTORS**

1. Tone generator IC, AY-1-0212 or MK52042 (see text)
2. 7400 quad nand gate
3. 7493 4 bit binary counters
4. 2P100 watt transistors, T801, 2N3053, BFY50 or similar
5. 300 miliwatt transistors, BC108, BC548, or similar
6. 12V, 400mW zener diode, BZ879 / C12 or similar
7. 1.5V, 400mW zener diode, BZ879 / C15 or similar
8. 15V, 400mW zener diode, BZ879 / C15 or similar (AY-1-0212 only, see text).
9. 3 Silicon diodes, EM401 or similar
10. 2 Silicon diodes, EM401 or similar (AY-1-0212 only)
11. RESISTORS (all 1/4 watt unless specified otherwise)
   - 12 ohm, 1 watt
   - 22 ohm
   - 27 ohm, 1 watt
   - 100 ohm, 1 watt
   - 150 ohm
   - 180 ohm, 1/2 watt
   - 390 ohm (AY-1-0212 only)
   - 680 ohm
   - 1k
   - 3.3k
   - 2.2k
   - 1.0k
   - 13.3k
   - 120k

**CAPACITORS**

1. 1000uF, 25V electrolytic, printed circuit board type
2. 1000uF, 25V electrolytic, printed circuit board type
3. 1000uF, 12V electrolytic, printed circuit board type
4. 1.0uF polyester
5. 33pF NPO ceramic
6. 47pF NPO ceramic

**MISCELLANEOUS**

1. Rubber feet for case, multicoloured hook-up wire, insulated spacers, machine screws and nuts, washers, self tapping screws.

**NOTE:** Resistor wattage ratings and capacitor voltage ratings are those used in our prototype. Components with higher ratings may generally be used if physically compatible. Components with lower ratings may be used in some cases, if ratings are not exceeded.

**TONE GENERATOR**

We have connected both inputs to the gates, this connection must be broken. Provision will have been made to remake the connection to ground so that the reset function may be used if required.

A small copper link on the pattern is used to connect the reset function controlled by a dual input nand gate. The inputs to this gate must be connected to a low logic level before the counter will operate. When they are connected to a high logic level, the counter is reset.

We have connected both inputs to the nand gate in parallel together, and joined them to a spare output connection, so that the reset function may be used if required. A wire link is required to connect the output of the first divider to the input of the second. Both dividers have been arranged so that they may be used independently of each other, if this is required. Provision has also been made for the collector load resistor of the tone generator buffer stages to be used with either divider.

These provisions are not particularly relevant in connection with the present project, but are designed with future applications in mind.

As detailed earlier, for the AY-1-0212 we require supply voltages of +12V and -15V. A +5V, 150mA supply is also required to drive the TTL logic, and also to drive the output device. We have used a power transformer having two 12V secondaries connected to form a 24V centre-tapped winding, in conjunction with two back-to-back full wave rectifiers to supply voltages of plus and minus 17V, after filtering by two 1000uF electrolytic capacitors.

The +15V supply is obtained using a 400mW zener diode in conjunction with a series resistor. It is possible to use either a 14, 15 or 16V diode, since the actual voltage is not critical.

To prevent possible interaction between the MOS and TTL logic, the +12V supply is decoupled from the +5V supply using a diode and another 1000uF electrolytic capacitor. The +12V supply consists of a 400mW zener diode and a series resistor, and is similar to the +15V supply, except that the diode should be a 12V type. (This result is more critical than the -15V line.)

The +5V supply for the TTL logic uses a 5.6V 400mW zener diode in conjunction with a 1 watt general purpose transistor. A 100uF electrolytic is placed in conjunction with the zener diode to improve the ripple rejection.

This supply has been brought out to one of the output connectors on the board, so that it can be used to drive the output devices. Alternatively, if another +5V supply is available, then the relevant components may be left off the board, and the +5V applied to the connection.

Note that the selector switch MK52042 is being used then the -15V supply is not required. The relevant components may simply be left out.

We have provided two distinct output facilities for the tuning instrument. A small speaker serves to give an audible output, so that instruments may be tuned by listening for beat notes. This is driven by a Darlington pair, acting as a switch. This arrangement is very efficient, giving a quite reasonable amount of sound while only drawing 30mA from the +5V supply. It does have the disadvantage that the speaker is being activated by a square wave, but we have not found that this causes any great difficulty.

The second output facility is a 3-pin DIN socket on the rear of the chassis. The output signal is filtered and attenuated before being supplied to it, so that the level is suitable for feeding into the auxiliary input of a stereo amplifier, or into the input circuitry of a CRO or similar device.

Before you proceed to deal with the construction, a word of warning is perhaps in order concerning MOS devices. MOS devices are susceptible to damage caused by static electrostatic charges, so that unless reasonable handling precautions are observed, the devices may be rendered inoperative.

To protect the devices during shipment, they are packed in conductive foam. Do not

**CONTINUATION PAGE**

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Designing a quartz crystal controlled clock

Using a quartz crystal oscillator as the basis for timekeeping gives a considerable improvement in reliability over that obtainable when using the mains frequency as reference. It also provides the opportunity to make the clock independent of mains power. There are problems associated with minimising power consumption, but if these are solved as discussed here, the result can be a very attractive timepiece.

by IAN POGSON

In June and July, 1969, we described a Crystal Drive Unit for Clocks. This was done in response to many requests for a crystal clock, and although we realised that there were many problems associated with such a venture at the time, we "had a go." Although it worked reasonably well the resultant circuit had a number of shortcomings and fell short of what we would have liked.

Ever since then, I have been looking for ways out of problems which were manifested in the unit originally described. One major problem was that there seemed to be no immediate answer to an economical readout device. It may be remembered that we originally used an ordinary 50Hz synchronous clock movement. This required between one and two watts of power to drive it and necessitated an audio amplifier with consequent relatively high power consumption. This was of the order of 250mA at 12 volts - hardly a proposition where battery operation is envisaged.

The overall approach to frequency division was reviewed also. In order to get maximum reliability, flip-flops should be used, but as they each only divide by two, it means that a large number of stages would be needed to divide from say 100kHz, or thereabouts. And the more stages used, the higher climbs the current consumption.

Before proceeding further with discussion on design philosophy, perhaps it would be a good idea to set out what sort of specifications I had in mind and so endeavoured to achieve. The unit shall be battery operated, from one or two dry cells (1.5 to 3V) and at a current consumption of about one milliamp or so. Under these conditions, one or two dry cells would last around one year. Although this seemed an idealistic approach, I felt that it could be done. I had already developed a crystal oscillator and divider chain which could be operated at 3.6V and a couple of milliamps. Perhaps this could be reduced still further, but the big problem was the readout.

Between eighteen months and two years ago, I was studying some technical information given for battery operated, transistor switched, clock movements. Clocks with these movements are very common and use a balance wheel oscillating at a standard rate of five beats per second; but instead of the usual mechanical escapement, an electro-magnetic, transistor switched system is used. This results in a very reliable system and requires one dry cell with a current consumption of about 200 microamps.

One table in the technical information just referred to, showed the variation in rate with applied battery voltage. By changing the supply voltage between say 1.7V and 1.3V, the rate of the movement would change by several seconds per day. One example indicated that with 1.7V, the rate was -8 seconds per day, through to -5 seconds per day with 1.3V. This seemed to be a clue to the solution of the readout problem which I had been looking for. The next problem was how could this characteristic be exploited?

A preliminary check which I made, varying the supply voltage to a typical movement bore out the figures set out in the table referred to earlier. It therefore seemed likely that some sort of servo system making use of this voltage versus rate characteristic might be the answer to the readout problem, thus making it possible to use one of these clock movements as the readout.

After much thought and work with a scratch-pad, the idea of superimposing a square wave at 5Hz on the nominal 1.5V DC supply was considered worth trying. The square wave could have a peak-to-peak value of about one volt. This would mean that the supply to the movement would be varying between one volt and two volts, at a 5Hz rate.

When applied to the clock, the theory was that if the movement was being effectively fed with one volt, according to the table, the clock would lose. As the square wave being fed to the clock was controlled precisely by a crystal, the movement would slide with respect to the supply rate and so it would then find itself looking at the high voltage part of the waveform. This would cause the clock to gain, and so the movement would hunt between the two supply voltages. Provided the movement was regulated within the control range, the clock would
keep time under the control of the crystal.

The idea was tried and it was found that the clock movement was in fact under the control of the crystal. This account is perhaps an oversimplification of the facts but suffice to say that at this point, the results were most encouraging and well worth being pursued further.

It was reasoned that the synchronising phenomenon should be observable on a CRO. This proved to be so, but after some investigation, it was found that the hunting theory was not correct — although it was obvious that the two frequency components remained synchronised. The clock movement takes its energy from the battery in the form of five pulses per second, each pulse being about 15mS in duration. This pulse straddles one or other of the edges of the 5Hz square wave from the supply, system and the phase relationship remains in this mode.

Having observed this effect, the question arises as to just by what mechanism does synchronising take place? I can only offer a suggestion, which is that the clock pulse straddles the edge of the supply square wave in such a fashion that a proportion of the normal pulse fed to the movement varies with rate, thus keeping the clock movement precisely in lock with the supply frequency.

Regardless of the correctness or otherwise of this theory, it would seem that we have a case of two frequencies close to each other, coming into lock. As one frequency is fixed, the other (the clock) is the one which moves and locks in.

The basic system just described has proved to be successful and units have been operated under these conditions for months at a time. However, 5Hz is a very low frequency and when a 5Hz square wave had to be considered, it became doubly difficult to handle. As the pulse taken by the clock is only about 15mS wide, as mentioned earlier, the thought came to mind that a 1Hz supply was not essential. Instead, multiples of 5Hz could be used just as effectively, provided we did not use a frequency with a half-period of less than 15mS. A square wave at 25Hz has a half width of 20mS, so that theoretically the clock pulse could lock on any one of the edges just as effectively.

This setup was easy to arrange and it was soon established that the theory was correct. The movement in any way. Two leads are required and less current drain as well. This is therefore the arrangement which we have adopted.

Before proceeding further, there is one point which should be brought out. Due to the rather sluggish mechanical nature of the five beat per second balance movement which we have been able to synchronise successfully, there is the matter of portability. If the movement is shifted about in a portable situation, it may be that the oscilations of the balance wheel may be interfered with slightly and synchronisation may be lost temporarily, with a consequent loss of accurate readout.

This is only a theory on my part and hopefully it may be wrong, as I have not put it to the test. If the unit is picked up more or less gently and moved from one place to another, there seem to be no ill effects. The idea that vigorous movement may upset it is just a word of caution.

Initial development of the foregoing system was done with two 6kHz crystals which happened to be on hand. The low frequency made division that much easier but other crystal frequencies could be used and adapted to our purpose. More will be said later on about crystals. Apart from the work associated with the technique of synchronising the clock movement, a considerable amount of work has also been necessary to establish suitable crystal oscillators, astable multivibrators and flip-flops as dividers, and a suitable method of driving the clock movement.

In the early stages, it was considered satisfactory to operate the whole system from a 3V supply and with a current drain of about 1mA or so. In some respects, 3V allowed circuits which were somewhat more economical with respect to components, when compared with some changes which had to be made so that 1.5V operation would be possible. Both aspects will be dealt with and readers may adopt whichever approach they feel suits their particular purpose.

In this first article, it is proposed to deal with basic circuits so that the experienced reader may tailor his own design. In a later article, we will describe a complete crystal clock unit, with full constructional details.

In order to put the synchronising system into effect, we must meet two requirements with respect to feeding the clock movement. A DC supply nominally at 1.5V is needed to meet the basic supply need of the movement and to synchronise it the 25Hz square wave signal must also be fed to the movement.

This is achieved in the 3V version with a Darlington pair, the clock movement being connected between the second emitter and the negative terminal of the battery. This supplies DC at 3V minus 1.2V, resulting in about 1.8V available for the movement, when new batteries are fitted.

The 25Hz synchronising signal from the crystal source and divider chain, is fed into the first base of the Darlington pair and so this signal is impressed on the DC component just mentioned. Both therefore appear across the clock terminals.

As may be seen this simple arrangement for synchronising of the readout movement is achieved without interfering with the movement in any way. Two leads are
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Figs 7 and 8 show suitable circuitry for 6kHz crystals, while Fig 9 shows the circuitry employed for 12.8kHz crystals.

merely connected to the lugs intended for the single dry cell. This is shown in Fig 1. With only a 1.5V supply, the theoretical voltage drop of 1.2V across the transistors in the circuit would leave only 0.3V with a new dry cell. For the 1.5V version this problem is solved by introducing a transformer of about 11 ratio and parallel feeding the DC and signal components, a system of modulation, if you like. This is shown in Fig 2.

With the quite low frequencies likely to be involved in this circuit, the demand on a small transformer to pass say, a 25Hz square wave, is asking a lot of it. A small transistor audio driver transformer was tried, and although the frequency response as checked on a CRO was anything but good, it functioned very well.

We have been interested in the moment and look at crystal oscillators suitable for this particular application. As the subject is rather a vast one, we cannot hope to cover it in great detail but will touch on points which are likely to be of most interest to readers.

Possibly the most economical crystal frequency to use would be 1MHz. This frequency is getting into the lower price bracket. To offset this somewhat, more dividers are needed, with consequent expenditure in terms of money, space and battery consumption. Another theoretical advantage with the 1MHz crystal is that they are usually supplied in the “AT” cut, which, under its best conditions, has a very low temperature coefficient. A suitable circuit for 1MHz crystals for our purpose is shown in Fig 3.

The frequency which I am inclined to favour is 100kHz. The advantages are that less dividers are required, resulting in a saving of battery consumption, and there are no doubt many readers who have a crystal of this frequency salted away in the junk box. If one has to buy a new one outright, then the price may be somewhat more than that for 1MHz. However, this should not be excessive. The temperature coefficient is not as good as 100kHz crystals are normally ground from a “DT” cut or “+5degX” cut.

At a glance both temperature characteristics are similar. However, the DT cut usually has a lower temperature coefficient and it is possible to grind a specific crystal with a certain turnover point (within a tolerance of about plus and minus 10degC). The +5degX cut generally has a higher temperature coefficient and the turnover point is fixed at about 45degC. No doubt, economics will play an important part when ordering the crystal of your choice.

Two simple circuits for 100kHz crystals and suited to our purpose are shown in Figs 4 and 5, as implemented for 3V and 1.5V respectively. However, we have a preference for the somewhat more elaborate circuit shown in Fig 6.

As mentioned earlier, I have carried out a large proportion of my investigations using 6kHz “NT” cut crystals. These crystals are in the form of a quartz bar, mounted in an evacuated glass envelope and fitted with a standard BTG type of valve base. Those which I have are four-terminal devices, although I understand that some low frequency crystals are also available as two-terminal devices. This is a minor point and can be readily accommodated with modifications to the circuit. Low frequency crystals are delicate devices and care must be taken in physically handling them. More importantly, they should only be used in a circuit which is not likely to shatter them. Due to their delicate nature they should only be used in circuits as recommended by the manufacturers. We have used the 6kHz crystals mentioned earlier in the circuit shown in Fig 7, when operating from a 3V supply.

Very low frequency crystals can be made to operate satisfactorily from a 1.5V supply but rather more has to be done to meet this requirement. The oscillator of Fig 7, if modified as shown in Fig 8, will perform well with 6kHz crystals. It may be seen that the resistive collector load has been replaced with an iron cored inductor. The optimum value of inductance has not been determined but something around 1 to 2H appears to be all right. The higher the inductance, the greater is the output, within limits. Under these circuit conditions, it is wise to insert a 33k resistor in series with the crystal, to avoid overdriving, with possible damage to the crystal.

Readers who are interested in this circuit could easily do some investigations on the best type of inductor to use. The current requirement is so low as to be negligible. Therefore, a small iron cored inductor, with a value of 1μH would be ideal. Short of this, we have found one winding of a valve output speaker transformer to do the job. Filter chokes, transistor driver transformers, etc are some others which can often be used. The objection to most of these is that they are too large, but this may not always be a problem.

The circuit given in Fig 9 is one taken from a commercial unit using a 12,000Hz crystal. It allows the use of an iron cored inductor for the collector load and in the original units is a specially wound and very small component. The circuit is specifically for 1.5V operation and we have not tried it on 3V. Readers wishing to operate the circuit from 3V would be advised to guard against possible damage to a valuable crystal.

As you may well imagine, very low frequency crystals are rather expensive. The kind of price to be expected is about $25 each plus sales tax. However, as a measure of compensation for the price, the frequency division is considerably reduced, offering the advantages of less cost for this part, lower battery consumption and slightly improved reliability. The temperature characteristics is rather similar to that for 100kHz crystals.

So far, we have only mentioned crystal frequencies in well rounded figures. They may well be suited to division down to say, 50Hz, 25Hz, etc. However, if you wish to avoid dividing by odd factors involving synchronised bistable devices, you should envisage using a crystal frequency of 6kHz. This is the case for the circuit conditions described above. The crystal frequency required is most likely to be a rather odd figure. This should present no problem, assuming you have a crystal ground to order. Suitable frequencies just above or below 100kHz, or at a low frequency of say, 64kHz may be obtained quite readily.

The subject of division has only been touched on so far. We have used both astable and bistable multivibrators quite successfully. For readers not very familiar with the use of these circuits for frequency division, it is worth noting that there are some important differences between them. The bistable multivibrator in ordinary circumstances, will divide only by two, or not function at all. This feature makes this

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**This Vedette unit from Timatic, as supplied by Australian Time Equipment, is typical of the movements suitable for crystal control.**

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Photodiodes
OKI photodiodes are of diffused planar silicon construction, feature high performance and reliability and are suitable for application in computer peripheral equipment, process control, industrial control, photo-meters or any other design requiring light sensitivity.

A 9-bit silicon photodiode array is available which finds application in punched paper tape readers of input machines for computer and NC equipment.

Phototransistors
OKI phototransistors are of planar silicon construction and are highly sensitive devices. They are particularly suitable for use in optical measuring equipment, control devices and other electronic applications.

Solid-state Numeric and Alphanumeric Displays
OKI numeric displays are of GaAsP monolithic or hybrid, 7-segment composition. They are suitable for application in a wide variety of display apparatus. Features include high brightness with small current, numerals 0-9 and decimal point and rugged, vibration-resistant construction.

The alphanumeric display (not illustrated) is a 5 x 7 dot matrix of 36 GaAsP red L.E.D.s.

Light Emitting Diodes
OKI L.E.D.s are available in INFRARED, RED or GREEN versions. A wide range of body styles is available to suit a multitude of applications including solid-state indicators and displays, photocouplers, photo switches . . . e.g. punch tape readers, conveyor control, rotation counters, automatic weighing machines, position control and opto-isolators.

Light Emitting Diodes
OKI L.E.D.s are available in INFRARED, RED or GREEN versions. A wide range of body styles is available to suit a multitude of applications including solid-state indicators and displays, photocouplers, photo switches . . . e.g. punch tape readers, conveyor control, rotation counters, automatic weighing machines, position control and opto-isolators.

Photocouplers
The OKI photocoupler employs GaAs L.E.D.s and Si photo transistors. Its light source and sensor are optically coupled with no electrical connection. Typical applications include pulse transformers, photoswitches, photorelays, power separation circuits (for analog and digital) and level converting circuits (for potential and impedance).

Optical Mark Sensor
(*not illustrated)
OKI manufacture an optical mark sensor which senses by the reflection method, 12-unit signal marks and a timing mark recorded on the paper for OCR use and converts the data into electrical signals.

It is composed of GaAsP L.E.D.s as the light source, planar silicon photodiodes as the sensor and IC preamplifier.

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AC79/R2
type of divider a very reliable device. On the other hand, as it will only divide by two, quite a large number of dividers are normally required to divide down from a high frequency.

The astable multivibrator is rather different from the bistable circuit in terms of its behaviour as a divider. The astable circuit can be made to divide by any integer, from two upwards. We have had them dividing by as much as a factor of 20. Because of the switching time of the bistable multivibrators, it is not completely reliable as in the case of the bistable circuit. Because the astable circuit can be made to divide by any number, in some circumstances, it is possible for the dividing factor to jump to the adjacent number either above or below the chosen one.

This problem can be almost eliminated by careful design and adjustment, and avoiding divisions above five or so, at least no greater than ten. The lower the dividing factor, the greater the percentage of change required to jump to the next adjacent number. Assuming these precautions, we have found it expedient to use a combination of astable and bistable multivibrators for our dividing circuits.

The principle which we have adopted is to use bistable divisions by two wherever possible and then use the astable circuit to divide by three, four, or five. To divide by ten, we use the factors two and five - i.e., one bistable and one astable.

The basic circuit of the bistable divider described used is shown in Fig 10. It must be pointed out that the circuit as shown is only suitable for dividing frequencies above 2kHz or even lower. When dividing from higher frequencies, the two 180k resistors should be shunted with small capacitors, 220pF or less, as the frequency increases. Also, the 68k and 1M resistors have to be reduced in value as the frequency of operation is increased.

The basic circuit of the bistable multivibrators used is shown in Fig 11. Values for capacitors are not shown, as these will depend upon the frequency and general operating conditions. The two time constant capacitors should be of equal value to suit the frequency, while the input coupling capacitor value will be determined by the amount of drive required, to lock the circuit to the required frequency. One or both of the 100k resistors may be varied to adjust the circuit to the wanted operating frequency.

The dividers, both bistable and astable, should function satisfactorily from 3V or 1.5V, with little if any changes from those given in Figs 10 and 11 apart from those required for operation at different frequencies.

From the information given thus far, the experienced reader should be able to tailor his own clock system. By way of an example, suppose that a 100kHz crystal is to be used with a readout movement of the type which is switched on and off with the usual 5 beats per second. The drive frequency for this type of movement may be 25Hz, as discussed earlier, and this will require a division of 400. This may be achieved with three astable type dividers each dividing by 5.

In addition, a suitable oscillator circuit may be chosen from Figs 4, 5 and 6. At the other end, a driver circuit from either Fig 1 or 2 will be needed and the type will depend upon the supply voltage chosen.

Even after having decided upon the design and having made it up, there are a number of points which can help in getting the unit functioning properly. This sort of discussion is outside the scope of this present article, but in the unit which we hope to describe very soon, these points will be covered.

Some readers may be asking the question as to why we have used discrete components throughout, rather than go to the use of ICs. The answer is a simple one in that, as far as we know, there are no suitable ICs on the market which will suit our purpose. Many commercially available crystal clocks now use the IC technique, with a consequent major saving of space, but they are almost certain to be custom made types and not available to home builders.

Philips Elcoma have produced a very attractive IC specifically for a battery operated crystal clock. It is intended to operate with a 32,768Hz crystal and when divided by 2 to the power of 15, gives an output of one second pulses. It will operate over a supply range of 0.9 to 3 volts and the typical current consumption is 24uA. The type Nos are SAJ250A and B, according to the package and other minor details.

This IC has been investigated but the main problem lies in the lack of a suitable movement to use in conjunction with it. Of course, a special crystal on 32,768Hz must be used, but these are obtainable. The only devices which will respond to one second pulses, are units which are quite specialised and consume somewhat more current than would be permissible for strictly battery operation. Philips suggest the use of a stepping motor but this falls into the same current category.

The idea of increasing the crystal frequency by a factor of five, resulting in an output of 5Hz pulses seemed to be worth investigating. Unfortunately, the investigation was able to make along these lines proved to be unsuccessful. In spite of this, some readers may be interested in this IC and may be able to accommodate the problems associated with the higher current consumption. Further inquiries may be directed to Elcoma but we understand that stocks were not readily available a short time ago at least.

Another question which readers may be asked is, how small can the crystal clock be expected from the type of clock under discussion. This is not an easy one to answer, as this factor is very much tied up with the crystal oscillator and more particularly with the characteristics of the oscillator being used. As I see it, the main problem lies with the temperature versus frequency characteristics of the crystal which you are using and this may vary over quite a wide range.

A study of crystal manufacturers' curves and figures would indicate that if the oscillator is adjusted precisely for the average ambient temperature, a sharp change in temperature could cause a change in time-keeping by about one second per day. This is still well within the needs and requirements of many users and would be acceptable for many navigational purposes.

A further question arises from this latter discussion. Is it possible to have a battery operated crystal clock and provide some form of temperature compensation, to improve its time-keeping qualities? Before we answer this one, it is worth bearing in mind that the results obtainable from an uncompensated crystal clock are so superior to other types of clock systems that in most cases an improvement will not be sought. Work is proceeding however on this aspect of crystal clocks and although I am not able to make any definite statement at the time of writing, suffice it to say that the indications are encouraging.

Another point of interest is that during the past few weeks, the new developments which have come forward are quite exciting. Apart from the search for temperature compensation, I have succeeded in synchronising the newer type of tuning fork battery operated clock. This can have some advantages over the system just described, in the form of a fork having a constant frequency, 100Hz, 300Hz, to quote two of them, with consequent less division. It should also make for a more reliable unit under temperature compensation. Work pointed earlier. Also, the second hand runs smoothly, rather than jumping at a rate of five per second, which has some aesthetic appeal.

Work is already proceeding on a clock which is at least partly temperature compensated and one which uses a tuning fork movement for the readout. It is hoped to describe such a clock in the future, providing a satisfactory design can be achieved. However we would like to emphasise that such a unit would not render obsolete the one which we propose to describe shortly.

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Typical routine jobs

One risk in writing these notes is that of giving the budding serviceman a wrong impression; that servicing is all intermittent faults and similar curly problems. It isn't. You'll get your share, of course, but the great bulk of the jobs will be routine and — let's face it — relatively dull.

As I have mentioned on previous occasions, the kind of service job I usually write about is not the kind of job that pays the shop rent. More often than not one is battling to keep the bill down to a reasonable figure and still break even on the deal.

And since we cannot pick and choose our jobs, what we lose on the swings we have to make up on the roundabouts: in this case the routine jobs that seldom find their way into print.

Several months ago, a colleague employed in one of our larger service companies contributed his experiences of service calls over a period of several days on the road. Although most of these were routine, they nevertheless created a lot of interest. This was mentioned to me by another colleague the other day, when he enquired about the possibility of a similar article appearing again.

"Well, what about you?" I said.

"Yes, I'll be in it," he replied.

So, for the next few days, he took a pad and pen with him on his rounds, and came up with the following.

(1) An Astor TV set. The customer complained that the picture had dropped to a height of about two inches. A new 6G6V valve restored the height to normal, and the job was done.

(2) An HMV V1 TV set. This set had a raster but no picture or sound. I hinged the chassis down, checked voltages and found no HT on the video IF stages. As I had a raster, I knew that the main HT was present, thus ruling out the transformer, rectifiers, etc. I checked the 300 ohm 5 watt decoupling resistor which feeds HT to the video IF, and found it O/C. Replacing this restored the set to normal operation. Just why the resistor failed, I don't know. I checked the set's performance and found all voltages, etc, to be normal. However I have found these resistors open in the past without any apparent reason.

(3) An Astor TV set. This one had horizontal pulling — particularly on heavy contrast. Experience has taught me that an open power supply filter capacitor would be the most likely offender. A new 100 +200uF electro cured the trouble.

(4) A Philips 1100 series TV set. Poor contrast. Replacing the 6U9 brought contrast back to normal. Another happy customer.

(5) A Philips tape recorder. My next call was to a tape recorder in one of our local government institutions. The recorder would only record sometimes, but more often would not. It played back OK. I removed the covers and sprayed the contacts of the various push buttons with "Serviceman's Friend" and manipulated them several times, after which the machine recorded each time. A phone call a week later confirmed that the recorder was still working OK.

(6) A Sanyo record player. This also involved a cleaning job — the turntable would not rotate. I removed the turntable and found that the motor spindle was stiff to turn with the fingers. A squirt of "Serviceman's Friend" on the bearing and the motor was again running perfectly.

(7) An Astor TV set. Picture pulling on heavy contrast. Again I replaced an electro in the power supply and another cranky set was back in business.

(8) An AWA tape recorder. The customer stated that it would not record and was very weak on playback. He explained that it was used a lot at parties, and as the family were going to another one that night he would like it fixed — if possible. A quick look at the heads and rollers soon showed why it wouldn't record or play back satisfactorily. A good clean up with a soft rag moistened with methylated spirit and the recorder was again working normally.

(9) A Pye I26 solid state TV set. Complain — wedges in picture — hum in sound. Sounded like an electrolytic — but it wasn't. In fact when I removed the cover, I was greeted by the tell-tale smell of something cooking. A quick check with the multimeter showed one of the power diodes in the bridge rectifier was shorted, and another open. To be certain, I replaced all four. The set then worked perfectly. A phone call to the customer a week later confirmed that it was still OK.

(10) A Healing TV set. Picture took about five minutes to come on — and then was narrow. A new 6CMS cured the trouble.

(11) The same customer had a portable radio (HMV Sprite) which lost sound intermittently. As the fault was frequent in repetition, and particularly at low volume. I took a punt on the speaker — and sure enough it was. When the set cut out, I could restore it to normal by pressing lightly on the speaker cone. Not having a suitable speaker with me, I took the set back to the workshop, and fitted a new speaker.

(12) Another 12 inch solid state portable TV set — HMV Z2 this time — with similar symptoms to No 9 — except that there was no smell. Again I went for the diodes in the power supply, and found one O/C.

(13) A Healing TV set. No raster and a faint hum and squeal in the sound. Again experience saved a lot of time and a replacement electrolytic in the power supply restored raster and cleaned up the sound.

(14) A Philips 074 TV set. Raster, but no picture or sound. A quick glance at the chassis showed that the 22 ohm cathode resistor and the "white level" pre-set tab pot associated with the 6Y9 video amplifier were both well and truly cooked. After replacing these and the 6Y9, and resetting the 6Y9 plate voltage to 70V without signal, the set returned to normal. What happens is that the 6Y9 apparently shorts intermittently, and takes the other components with it. Before leaving the set, I fitted a modification suggested by the manufacturer to minimise this trouble. This consists of a 1500 ohm 5 watt resistor in series with the screen (pin 9) of the video amp section of the 6Y9. Should the tube flash over again or shorten, this resistor limits the current which can pass through the cathode resistor, and thus prevent the other components from burning out.

(15) A Philips 1100 series TV set. An easy one. No raster. 6CMS not alight and white around the top cap. I carefully removed it and fitted a new one. Another one working.

(16) HMV VI TV set. Raster but no picture or sound. Replaced 6Y9 and produced a weak picture and quite good sound. Replaced 6X9 — good picture and sound. Adjusted the contrast range preset, and the job was done.

(17) Kriesler TV set. Another easy one — no raster. Replaced the 6AL3 and moved on to the next job.

(18) A Healing 800 series TV set. A dim, narrow raster — this was the owner's description. On examining the raster more closely, it appeared to have a trapezoidal effect. This is usually caused by a faulty yoke. When I looked at the yoke I could see why. It had almost decomposed, the epoxy base had just about disintegrated with either excessive heat, old age or both. As I did not have a suitable yoke with me, I had to call back later that afternoon. Fitting a new yoke restored the set to normal.

(19) The same owner asked me to look at an old mantel set (HMV) which squealed whenever it was tuned. Fitting a new 6BE6 cured it, although it still had an intermittent rushing noise. Replacing the 6BE6 cured this fault and the old set gave a very good performance.

(20) A Kriesler TV set — 79-23 chassis. Raster took about five minutes to appear, and when it did, the horizontal hold control required frequent resetting for the following few minutes. Again experience shortened the task, and a new 6X9 horizontal oscillator valve fixed it. I also replaced the 6U9 and the 6G6 in the video IF stage, as these were weak also, causing problems.

Well, that's my friend's list, and it is as about as representative of routine day to day jobs as one could get. Note that most of the jobs were completed on the spot, and
that many took only a few minutes.

Note also how often he used the phrase "previous experience". If you are a budding serviceman, take particular note, for experience is the name of the game. The service manual, the text book, and the slide rule are fine when you're stuck with a curly one — but curly ones don't make money.

Finally from a serviceman apprentice in Victoria comes a letter expressing his appreciation of these notes, and relating how a story from several years ago helped him in a recent unusual job.

The issue which prompts this letter is October 1964. And what connection has this 10-year-old issue with this letter, you may well be asking.

In this article the serviceman mentioned some baffling results he had when he replaced a known faulty 6M5 valve with a brand new one and found that it, too, refused to work.

The solution was that the set was wired with the cathode bypass capacitor connected to pin 3, the true cathode, and the cathode resistor to pin 8, marked N/C but in the valve actually in the set connected internally to pin 3.

With a current series 6M5 the set did not work, due to the valve design being slightly modified and the internal connection being deleted.

Such was the set which I encountered this very week. The set had been brought in minus the cabinet and speaker by the handyman owner and sported a brand new 6M5. I immediately tried another new 6M5 on the theory that the other might have been a faulty new one, something which has happened in the past, but this one, too, refused to work. So I upturned the chassis, commenced measuring voltages, and encountered the puzzling wiring described earlier. There was no sign that a resistor had ever been connected to pin 3 and so I consulted the valve manual to make absolutely sure that the cathode was pin 3.

Then from within the dim recesses of my mind came this story and I immediately checked pin 8 and found a resistor attached to it. I shortened pin 2 and 8 together with two screwdrivers and the set burst into life. I lifted the resistor from pin 8, transferred it to pin 3, and the set worked like the proverbial "beaut".

But think how puzzled I would have been if I had not remembered the article. The owner was hopping mad when he heard the story. While cleaning the dust and fluff out of the back of the set he had been working on the theory that the other might have been a faulty new one, something which has happened in the past, but this one, too, refused to work.

Another common fault I have found is also mentioned in an old Serviceman article and which again concerns the 6M5 is silver migration between pins 1 and 2. This fault is all but dead now but still crops up in some of the very early Kriesler sets and some old radiograms still fitted with their original 6M5. My usual cure is to turf the old valve out and fit a new one, since they are at least ten years old anyway and about due for replacement.

Yours faithfully,
R.M., St Albans, Vic.

Well, thank you, R. M., and it is gratifying to know that these stories help readers, even after many years.
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The views expressed by correspondents are their own and are not necessarily endorsed by the editor of 'Electronics Australia'. The Editor reserves the right to select letters on the basis of their potential interest to readers and to abbreviate their contents where this appears to be appropriate.

**Australian industry**

May I compliment you on your "Editorial Viewpoint" in the June issue of your excellent journal. It painted a clear picture of the effects so far of the November Tariff decision and nobody could argue that, in general, your estimate of the impending problems of the Australian Electronics Industry is correct.

When every other country in the world protects and fosters its electronics industry, it is almost unbelievable that our Government could take such action that leaves the Australian electronic equipment and component manufacturers at the mercy of imports.

In the Tariff decision there was no built in automatic adjustment of Tariffs to cater for rapidly rising costs of labour and materials; no attempt to restrict the level of imports from countries with a low standard of living and where employees are paid little more than subsistence wages; not even any incentive to the Australian industry to produce finished equipment in Australia from the low priced imported components. The sole reason, it seems, was to provide cheap imported Radios and Mono TV now and, more particularly, low priced Colour TV in due course.

It is apparently a case of "Oh well! We have full employment and anybody put out of work in the electronics industry can go and get a job somewhere else."

That may be true, but what happens to the technical skills that have taken years to develop? The special technologies involved in the electronics industry cannot be re-learned overnight. Once the various segments are shattered and scattered, it will take many years to restore them and restore them we must if Australia is to grow as an independent nation.

Having said all that in support of your editorial, I must now say that we believe the Australian electronics industry will survive. In spite of the great difficulties which at present loom ahead, it will continue to give Australian Engineers and Technicians the opportunity of showing they are the equal of or better than any in the world; to develop advanced technologies in spite of the immediate small demand; to provide quality components and equipment at reasonable prices consistent with the high standard of living enjoyed by the average Australian.

In your editorial you have made the statement "there is now virtually no resistor or capacitor manufacturer in Australia".

Perhaps the word "virtually" lets you off the hook, but the fact is that IRH Components (formerly International Resistance Company (Australia) Pty. Limited) was established over 40 years ago, is fighting fit, and is here to stay. We are still the largest manufacturer of resistive products in the Southern Hemisphere, and proud to be an Australian Company.

We believe there is a future for the Australian Electronics Industry and have demonstrated our confidence by investing several hundred thousand dollars in equipment over the past few months to give us a modern thick film "metal glaze" resistor production plant. That is, of course, in addition to our existing plant for the production of five deposited carbon, carbon composition, wire wound resistors, variable carbon and wire wound resistors and ceramic capacitors.

In future issues of Electronics Australia, it will give us great pleasure to prove to your readers that there is definitely a major resistive products manufacturer alive and well in Australia.

Lloyd H. McCulloch, Sales Manager, IRH Components Division, Natronics Pty Ltd.
The Crescent, Kingsgrove NSW.

**Metric dimensions**

I have been a regular reader of your publication since before the "Radio and Hobbies" days, a fact which in itself is my recommendation of its value as a popular publication.

I notice it is becoming the practice to quote dimensions of products and projects in metric units. However I view with concern the use of "centimetres" in E-A, not milimetres or metres. The May issue quoted the size of a ferrite rod and a circuit board in centimetres, and although the advertiser of the calculator offered to readers in the June issue gave its size in millimetres, your accompanying article used centimetres.

The conversion to metric is going to be difficult enough without the use of unofficial or non-standard units. It is hoped your editorial policy with regard to the use of metric units will be as precise as it was with the use of Hertz to replace cycles per second, a few years ago.

R. N. Simpson,
(West Pennant Hills, NSW).

**COMMENT:** While we value your opinion, we find it hard to become as worried as you appear to be. Despite the fact that the Metric Conversion Board has decided to frown on the centimetre, our observation of what is happening here and elsewhere is that people are continuing to use the unit. We suspect that his is because it represents a size which is more convenient, for many purposes, and more readily visualised than either the metre or the millimetre. One way or another, we think it likely that the unit will continue to be used. Surely the real test of a unit is that it meets the needs of people in measuring, not that it has bureaucratic approval.

**Transistors — when?**

I am writing this letter in the hope you or a reader may be able to enlighten me on an interesting anomaly I have come across. I feel it is very interesting matter. In all the literature I have ever read, the date for the discovery of the transistor is given as 1948, it still only being a lab. curiosity.

Yet in two books I have read recently I came across reference to the use of transistors as early as 1941. The first book "A strange Kind of War" by Admiral M. Mikes, says that in 1941 he received some 'transistors' from Bell Labs. for him to evaluate in his capacity in a sort of inspection and evaluation of new inventions.

The second reference occurred in 'Day of Trinty" by Lansing Lamont where among other things he mentions that some transistors arrived. This was in 1945.

I would be very pleased to hear any information anyone may have on this matter as it seems strange to hush up a 7 year discrepancy this many years ago.

Russel Costin, (48 Real Avenue, Norman Park, Qld 4170).
Three channel stereo mixer

For a change, this month, we are presenting a contributed article. It describes a three channel stereo mixer which should appeal to many readers by reason of both its simplicity and its low cost. It should also provide an interesting constructional exercise for the beginner.

by BRIAN WOODWARD*

Mixer circuits appearing in the last few years have, generally, been complex, filling the requirements of pop-groups using very elaborate recording equipment. The cost of building a mixer using complex matching techniques is high in relation to the use such a mixer would have if it is being used only with domestic equipment; record players and cassette recorders.

The author’s requirements were simple, a low-cost, stereo mixer capable of handling three channels, with matching facilities for most portable equipment. It was to provide music and spoken accompaniment to a slide show, with the third channel to add a tone signal for the projectionist, indicating a change of slide. For club use, or for sending slides and a cassette to relatives abroad, a mixer adds a touch of professionalism difficult to obtain by any other means.

Before construction began it became obvious that potentiometers were the largest single cost, followed closely by sockets and matching circuitry. An enormous saving was made with the former by using disposals trimpots joined by shafts made from No 4 knitting needles.

(EDITORIAL NOTE: The use of trimpots in this role may not have the approval of the manufacturers. Trimpots are not necessarily designed to withstand the same number of operations as a conventional pot, and the constructor must be prepared to accept some risk of premature failure.)

Sockets were limited to RCA and 3.5mm jacks although DIN could also be added. Matching circuitry was limited to resistors switched in or out to give approximately the correct matching value.

It is possible to construct a passive mixer using potentiometers alone but two problems arise. Firstly, there is considerable interaction between the wipers of the potentiometers. This was overcome by adding a 22k resistor in series with the potentiometer wiper but introduced the second problem — significant signal loss. This was overcome by adding a very basic amplifier with a gain of about 20.

The amplifier uses the new edition of the BC109, the plastic encapsulated BC549 which is presently available for as little as 25 cents. Whilst the circuit is not “hi-fi” the amount of distortion added is minimal and is unlikely to be greater than the inherent distortion in most cassette recorders.

The output could be taken directly from the 4 uF capacitor at the collector but, in the prototype, a 10k output level control was added to function as a master control and give increased versatility to the unit.

There are three chassis on the prototype; one each for the input sockets, the circuit board, and the output sockets. These were made from scrap aluminium, although the entire unit could be mounted in an aluminium box. But if the layout for the circuit board illustrated is used, the measurements given, particularly those for the potentiometer shafts, must be strictly adhered to.

Cut and drill the chassis as indicated, drilling small pilot holes before drilling the 6mm (1/4in) holes for the shafts. Score the line where the chassis is to be folded several times with a tungsten carbide tipped marking pen or a sharp awl, then fold the chassis. When shaping the chassis fold a section through only a very small angle at any one time as aluminium stretches very easily and may become distorted.

Before drilling the circuit board mark the holes that are used by the trimpots and drill a slightly larger hole. The correct size is 1mm. Although a one-off circuit board was made for the prototype, Veroboard is also suitable as the hole size is usually correct for trimpots. If using Veroboard construct the mixer with the copper strips running in the direction of the holes that are used by the trimpots.

The original unit was housed in a small wooden box but the final choice is a matter for the individual. The master volume control knob is on the left and the mixing knobs on the right marked “1”, “2”, and “3”.

The circuit is comparatively simple, consisting of three passive mixers for each channel, added to function as a master control and give increased versatility to the unit.
the same direction as the trimpot shafts and use links for the "earthy" side. This will greatly reduce the number of copper strips that have to be cut.

When assembling components, mount all of the trimpots first. Do not fold the mounting lugs on the copper side of the board but trim them very short so that they stand no more than 1mm above the copper. At a later stage the wiper arm has to be eased slightly away from the resistance strip and, if a wiper is moved too far and goes open circuit, the trimpot will have to be replaced. So it should be as easy as possible to remove from a completely assembled board.

After the circuit board has been assembled fit the input and output sockets and switches to their respective chassis and wire up the matching resistors. Connect the sockets to the board with the thinnest available shielded cable, and be aware that the cable must be long enough to rise above the shafts when assembled and also allow room to manoeuvre the small interconnecting shafts into place.

Temporarily fit the circuit board to the chassis to determine the correct length for the power supply leads and the mono/stereo switch leads. After these have been soldered into place, the mixer can be tested.

With a small screwdriver, set all the trimpots to mid-position. Connect the batteries, and connect the output to an amplifier. Inject a known mono signal into each of the inputs in turn to ensure that a variation in component values has not cut a signal excessively in any channel. Switch the matching resistors in and out of circuit during the test as they too should be balanced.

With the circuitry operating satisfactorily the board and switches can be mounted on the chassis. Connect an ohm meter to one side of a trimpot and to the wiper. Very gently prise the wiper away from the resistance strip taking great care not to damage the carbon surface. Continually check the operation of the trimpot with a small screwdriver until a noticeable lowering of the friction has taken place but do not cut a signal excessively in any channel. Switch the matching resistors in and out of circuit during the test as they too should be balanced.

The length to be trimmed is 3mm on the short shaft and 7mm on the longer one. Clamp the end of the shaft that is not to be trimmed between two pieces of wood and cut the 1 x 2mm rectangular section with a metal file or with the flat face of a fine solvent based pen.

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MORSE PRACTICE OSCILLATOR (speaker version). A 2 transistor device with a small speaker that permits you to practise morse code. Runs off a 6 or 9 volt battery. All parts except morse key provided. Cost $4.90.

COMPRESSOR/PEAK LIMITER. A simple design which really works well. Runs off 6v DC or off your 6.3v AC heater chain. This kit includes a built in rectifier for operation off the heater chain (ideal for your Hi-Fi rig). PA system, tape recorder, guitar amp (specially suited to bass guitar to give that rich 'chunky' sound) incorporates fast action and slow decay. Can be adjusted for peak limiting or compression. Can be fitted simply to any audio amp. Kit contains all the components plus circuit and explanation of function. Cost $8.40.


METAL LOCATOR. Detects metal to a depth of 18". Can be fed into a pair of headphones, or to a small amplifier. Full pictorial details for building the search coil. Also diagram for recommended layout. Gives rather outstanding performance for such a simple device. Entirely portable with up weight of only 2 lb. Great for finding metal objects under the sand at beaches. Cost $7.95.

COLPITT'S TAIL OSCILLATOR. For testing xtal. Handy to have around. Kit contains xtal socket, xstr, components and diagram. Cost $2.70.

TRANSMITTER FOR RECORD PLAYER OR GUITAR. Transmits at top of broadcast band, with adjustable tuning. Plug in a guitar or record player and transmit to your nearest radio. Only a foot or so of aerial wire is required to cover 20m. Kit contains 2 xstras, prewound coil, variable capacitor, all necessary components and diagram. NB. It is illegal to connect a microphone to this unit for the purpose of emitting voice. Really simple to build. Cost $4.80.

ELECTRONIC SIREN. Exceptionally realistic - can be hooked onto a large amplifier if required. Contains 2 transistors, small speaker. Ideal for junior to mount on his bike. Contains 2 transistors, speaker, push switch, components and circuit. Cost $4.90.

VHF RECEIVER. One of our best sellers. Suitable for covering from 27.130 mcs with different coils. Uses one transistor and operates on the super regenerative principle. Little external radiation. Can be used in conjunction with a standard transistor broadcast receiver by merely standing the VHF receiver against the transistor radio, and tuning the transistor radio to a clear point on the dial. Also fitted with an audio output for connection to a hi-im- pedance earphone or external amplifier. All pieces including metal front provided. Step by step pictorial assembly instructions included. Easy to build. Listen to police, taxis, aircraft fire brigade, etc. Fascinating night time entertainment. No external aerial needed — only 3 ft of stiff wire. Cost $15.40.

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STROBE FLASHER. Produces incredible stroboscopic flashing light effects — used by dance bands for stage lighting effects. Our circuit uses ordinary light bulbs rather than expensive 'strobe' bulbs — easy to build and get up. Will drive 6 standard 100 watt light bulbs — adjustable flash from "Sunburst" (one flash in 5 seconds) to 30 flashes per second. Incredible effects. Cost $8.40.

BAXANDELL TONE CONTROL. A 2 transistor tone control circuit — ideal for adding in front of our 5 watt amp (kit No. 49) or any amplifier circuit. Max input level 200mV. Input impedance 20kohms. Output 50k ohms. Operates off 5-18 volts with a slight gain of up to 6db. Treble and bass response approx 16db cut and lift at 40cps and 20,000cps. Uses 2 low noise silicon transistors. Complete with bass and treble potentiometers and all components. Cost $3.90.

5 WATT AMP. A very popular kit — can be assembled in under 2 hours with only a basic knowledge of electronics. Step by step pictorial instructions. Only 4 xstras, 10 resistors, and 5 condensers to solder in place. Operates off 5-18 volts. Runs off battery or power supply — power supply circuit provided. Input impedance 20k ohms. Input sensitivity 20mV. Output load 3.15 ohms. Everything, including tag-board, provided (not metal base). Cost $16.00.

5 WATT AMP WITH TONE CONTROL. This is a combination of our 54.90 transistor and our baxandell tone control (kit 48) mounted together on a silk screened printed circuit board. Can be used in conjunction with a ceramic or xtal cartridge. Two of these units make a high quality stereo amplifier. Input impedance is 200,000 ohms which can be raised by adding a series resistor. Input sensitivity is better than 20mV. Can be run off a battery for low power. Kit includes PC board. Cost $19.90.

HHE HAW SIREN. A highly realistic European style siren which operates a loudspeaker (supplied with kit) when turned on. Runs off 9 volts. Ideal for children's trikes, pedal cars, etc. A real attention getter. Tag board and complete step by step pictorial instructions included. About 3 hours of work required to construct this unit. Cost $16.00.

250 MW AMP. A simple 3 transistor amp which comes with a 3" high impedance speaker. Input impedance is 30,000 ohms and sensitivity is 20mV. Tag board provided, along with pictorial layout and constructive details. Assembly time is about 2 hours. A handy little general purpose amp — runs off 9 volts — can be used with either negative or positive earth. Handy for amplifying the output of a xtal set or other small signal output devices. Cost $16.50.

HOMODYNE TUNER. From Electronics Australia Nov. 1973. This is the discrete component version of this kit which has proven to be one of our most popular sellers. This kit is complete to the last nut and bolt and includes an attractive anodised cabinet and silk screened front. The heart of the kit is a pre-aligned permeability tuner and a handful of components with PC board. Only a voltmeter is required to align the tuner. Performance is superb and clean. Operates off 12 volts. Feeds any amp with its power supply circuit provided. Input impedance is 200,000 ohms which can be raised by adding a series resistor. Input sensitivity is better than 20mV. Can be run off a battery for low power. Kit includes PC board. Cost $16.50.

MONEY BACK IF NOT COMPLETELY SATISFIED
Drawing for the main chassis and panel. Panel holes must line up with the pot shafts.

Wiring details of the impedance switch.

Dimensions and details of the pot shafts.

hole and rest it in the slot of the front trimpot. The second shaft can now be fitted, preferably with both trimpots at minimum level setting, and held in place with tweezers as the front one is pushed in and slotted into the recess on the rear shaft. Slip a 10-15mm length of wire through the small hole drilled in the shaft to prevent it from being pulled out of the mixer.

After the operation of the shaft has been checked a small dab of fast-setting resin cement can be applied to the joint at the rear of the front trimpot. If the mixer is to receive a great deal of use, and after the operation of the mixer has again been checked, more glue can be applied to the shafts where they butt on to the trimpots. Take care not to allow glue on any moving surface.

Once completed the mixer will invariably find uses for itself. The author makes cassettes for parties or cars using two turntables. This eliminates the pause between tracks on a record and offers the possibility of some variation in music rather than twenty minutes of the one composer.

Although two batteries have been used, a battery drain rarely exceeds 2.5mA so their life should be quite long.

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**Classical Recordings**

Reviewed by Julian Russell

**Mahler: Symphonies 5-10 — highly recommended**

MAHLER — Symphony No. 5 in C Sharp Minor. Symphony No. 6 in A Minor. Symphony No. 7 in E Flat. Symphony No. 8 in E Flat, with Ileana Cotrubas, Heather Harper, Hanneke van Bork, Birgit Finnila, Marianne Olevan, William Cochran, Hermann Prey, and Hans Heinrich. Four choirs and organ. Symphony No. 9 in D Symphony No. 10 (unfinished) In F Sharp. All played by the Concertgebouw Orchestra of Amsterdam conducted by Bernard Haitink. Philips Stereo No. 6761 001 (Ten discs in box.)

I recently wrote about a Philips box containing Mahler's first four symphonies played by Haitink and the Concertgebouw Orchestra and, in doing so, admitted that despite much formidable competition from other established Mahler interpreters Haitink was, to me, the most satisfying. Should you have missed that issue or skipped reading my review I will repeat here the salient points, the combination of which I find unique in Haitink's performances.

In the first place there is Haitink's unwavering concentration throughout any symphony he is playing. Despite the alluring byways scattered by the composer, Haitink always keeps to the main road, so to speak. He examines these byways, appreciates their charm, and often their beauty, before he allows them to go up into highways. His progress never deviates. Does this make his Mahler sound stark and totally lacking in irrelevant, if beautiful, aside? By no means. Haitink offers Mahler's music with all the many directions of the composer respectfully observed, though admittedly these often leave plenty of choice to the conductor.

In reviewing Philips' new box which contains Mahler's other six symphonies, including the unfinished 10th to save space I use Haitink's performance of the Ninth as fairly typical of the others. So that I can now add that my conditions set out above were all that is needed to bring off Haitink's great performance of the Ninth, even a concertmaster by slavishly observing the same markings could produce something just as great.

Nothing could be further from the truth. In addition to noting Haitink's smallest guide, Haitink shows that he appreciates just why the composer put it there. This understanding results in the succession of profound truths that make his performances so wonderful to listen to time after time. Mahler's meaning is never in doubt and it is Haitink who speaks, not some deputy seeking self-glorification in a personalised statement.

Then we come to Haitink's choice of tempos. How completely right they always sound, how significant their contrasts and how they never fail to keep the music moving at exactly the right rate of progress from the first bar to the last. In current terminology the form is the message. There is no self-indulgence, no leaping, gesticulating Bernstein between the music and its audience. There is not even the always tempting sweetness of Kubelik to woo us. If anything, Haitink is of sterner temperament than his competitors. And among these I include the formidable Klemperer.

If you seek agreement — or disagreement — with these superlatives of mine, play the Scherzo of the Ninth which has three distinctly different tempos and hear how truly — — to my way of thinking — Haitink deals with them. And if you remain still uncertain go on to the Rondo Burlesque finale and compare it with that of any other conductor's. I don't care whose.

Of course, in an integral recording of 10 symphonies by the same orchestra and conductor there are bound to be bars, even movements, that you might prefer in other hands. But over the whole opera — and there are five discs in the first box and 10 in the second — my own personal reaction is one of deep satisfaction, a feeling that nothing can ever go wrong, and vast enjoyment of a style which, while always consistent, is never mannered or monotonous.

I admit that the engineering doesn't always offer the same sheer beauty of sound as do some of Philips' competitors. But none, and I repeat none, of the others has captured such clarity of recording, a clarity that makes even the most complex polyphony and polytonality as easy to follow as a simple two-part canon. I feel absolutely safe in asserting that even the most inquisitive student of Mahler's music will hear in this magnificent set. things they have never heard before.

In his treatment of the 6th Symphony I am grateful that Haitink doesn't seek to pursue the composer's own needs for filigree searching. He gives us impudence instead. He doesn't become hysterical in the climaxes. Instead you have controlled passion — and drama — which is never allowed to get out of hand. On no occasion does he miss the point of an ironic Mahler aside. And he just as skilfully avoids pumped up grandeur and orundity.

For him, physics is out. Haitink's cosmos never terrifies humanity. Man may be small in comparison to the rest of the universe but he can still fight with enormous resource things outside his true self. Certainly. And that I think, is Haitink's message in this truly great undertaking by conductor and orchestra. Emotion is unexaggerated, excitement never superficial. When excitement comes it is for Haitink's own mannered and personal interpretation. This is scored, as you probably know, for solo voices and many choruses and in this Solti's vast experience in conducting opera gives him a slight edge over Haitink. But I could quite comfortably live with the Haitink reading, and indeed, intend to do so. A highly recommended set.

**Violin Concerto No 2 — warm, easily appreciated**

ZYMNANOWSKI — Violin Concerto No. 2.

WIENIAWSKI — Violin Concerto No. 2.

Henryk Szeryng with the Bamberg Symphony Orchestra conducted by Jan Krenz. Philips Stereo No. 6500 421.

Back in the 1930s Szymonowske had quite a vogue among the more adventurous record buyers. The Fountain of Arethusa was a great favourite, played, I seem to remember, by either Heifetz or Szijetgi on a 78. It was a picturesque piece, as was the short piano item that Schnabel often included in his concerts. However he seemed to lose favour around the middle 1940s and the concerto, which I have never come across before, was recorded for the first time in 1967. Szymonowski died in 1937 and this second violin concerto was his last major work.

To the ears of his life he paid constant but never plagiaristic homage to Chopin and Debussy and you find these influences persisting in the concerto under review. It is to Chopin that the work owes its strong Polish nationalistic flavour. As Denby Richards' sleeve notes point out much of the material was taken from folk songs that the composer jotted down in the Tatra Mountains.

The result is a work at once warm, easily appreciated at first hearing, grateful to its performer and based on a secure formal structure. Its performance here by first class and Henryk Szeryng's beautifully shaped and intoned performance is very well matched by the support he receives from the Bamberg Symphony conducted by Jan Krenz. One hears too little recorded music by this fine orchestra which I once heard live in Bamberg and was very impressed, afterwards going to supper at a place where, among other things they sold "smoked" beer.

I should have thought that the coupling, the Wieniawski Second Concerto, would by now have outlived its usefulness. Yet it obstinately remains in the repertoire, is recorded by some of the world's finest violinists, and is still a favourite among amateurs, especially the less difficult Romantic movement. It is man's main interest lies in the virtuoso material it provides for a player who likes that kind of thing. But Szeryng's reading happily plays down this aspect of the concerto which, to me, I much prefer to a flashier approach. But in doing so Szeryng leaves the listener in no doubt that, if he liked, he could make it all sound as showy as any other violinist playing
today. In this concerto also the Bamberg supply an impeccable accompaniment. The engineering is first class.

MOZART — Symphonies Nos. 29 in E Flat (K543) and No. 40 in G Minor (K550). Concertgebouw Orchestra conducted by Josef Krips. Philips Stereo No. 6500 430.

It is interesting to compare the Concertgebouw’s playing for its resident conductor Haitink and compare it with what the orchestra is doing under conductor Joseph Krips. The playing under both conductors has all the Concertgebouw’s customary excellence. But where, one suspects with good reason, under Haitink they could produce a dark urgent sound in the first movement of the G Minor you have, under Krips, a much too lethargic, easy-going mood. Going on to the two inside movements things improve considerably, only to relapse again in the Finale which, although marked allegro assai, is taken at a much slower tempo.

By the way, Krips uses a largish orchestra which includes the clarinets that although marked allegro assai, is taken at a much slower tempo.

The F Flat I found much more enjoyable. Although Krips seems never to be in a hurry, this leisurely attitude suits the music admirably. Indeed his whole performance has true elegance, even if an occasional dramatic point is dropped here and there, admirably. Indeed his whole performance has true elegance, even if an occasional dramatic point is dropped here and there.

The playing under both conductors has all the Concertgebouw’s customary excellence. But where, one suspects with good reason, under Haitink they could produce a dark urgent sound in the first movement of the G Minor you have, under Krips, a much too lethargic, easy-going mood. Going on to the two inside movements things improve considerably, only to relapse again in the Finale which, although marked allegro assai, is taken at a much slower tempo.

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If you’re a long-time devotee of classical music, you’ll almost certainly have many of the items, assembled in this set, scattered throughout your record library. If so, you may not want to buy them again, unless it is because the new set makes so many familiar items readily accessible.

On the other hand, if your record collection is of a lighter or more specialised kind this quite extensive collection of classical excerpts may prove to be an excellent investment by way of variety and for the guest who prefers something different from your own specialty.

To be sure, a similar purpose might be served by a handful of somebody’s “favourites from the classics” but the single set does avoid duplication and it does offer convenience in handling.

There are something like 58 separate items on the 18 sides here and it is obviously not possible to list more than a few of them. Record 1 starts with “Cappuccio Italiano” and ends with “Ride Of The Valkyries”; in between are six other items, including “Thunder and Lightning Polka.”

Among the six items on record 2 are “Rosamunde: Entr’acts No 2” and “Hungarian Rhapsody No 2.” The “Goodies” continue on record 3 with “Sleeping Beauty Ballet Waltz,” “March Slave,” “Zampa Overture,” “Kerkes: Large” and “Dance Of The Hours.”

Record 4 is devoted mainly to two longer items: Ravel’s “Bolero” and “Carmen Suite.”

Here are some of the titles on the remaining five records, picked at random: Poet and Peasant Overture — Invitation To The Dance — 1812 Overture — Figaro Overture — Prince Igor Overture — Socerer’s Apprentice — A Night On Bare Mountain — Light Cavalry Overture — Marche Militaire — Artist’s Life Waltz — William Tell Overture — La Traviata — Siegfried’s Rhine Journey.

Orchestras include the New Symphony of London, Vienna State Opera — Filamoni di Roma, and Orchestre de la Societe Des Concerts Symphoniques. Of the conductors, Sir Adrian Boult is the best known.

All the items are listed on the labels and on the jackets but there are no notes about the music as such. Instead, an accompanying booklet discusses each of the 37 conductors represented.

In the time available I had no chance of listening right through the 18 sides and there were domestic reasons why I could not thunder them out at symphonic volume. Allowing for these limitations, I heard nothing in any of the tracks sampled to cause the slightest apprehension about either the technical or the musical quality.

To be sure, the specialist could debate the relative merits of these and other performances but for us humble mortals, Reader’s Digest have assembled a very acceptable set of recordings. (W.N.W.)

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THE BOONE FAMILY (The Family Who Prays) and the First Nashville Jesus Band. Stereo, Lamb & Lion LL-1006. (From Sacred Productions Aust, 181 Clarence St, Sydney and other capitals.)

The First Nashville Jesus Band gives the clue to the nature of this album - a gently rhythmic C & W sound that should have a wide family acceptance. There's a wide range of Gospel sentiment but, by and large, it's a happy sound with a message woven through. The songs may be unfamiliar but excellent direction avoids any problem on that account: Gloryland March - How Can You Refuse Him Now? - Dust On The Bible - Old Fashioned Singing - Bubbling In My Soul - The Family Who Prays - Help Me Understand - The Lord Is Counting On You - I'll Meet You In The Morning - Thank God - Old Country Church - He Will Set Your Fields On Fire.

An imported album, the packaging and sound quality are excellent, matching the performance itself. For happy family listening - recommended. (W.N.W.)

EXCITING SONGS ON THE WAY
Presented by Cliff Barrows; Arranged and conducted by Ralph Carmichael. Stereo, Light LS-5621. (From Sacred Productions Aust, 181 Clarence St, Sydney, and other capitals.)

There are 22 tracks on the two sides of this new album but it is obviously not intended to be played a track at a time. The choruses and songs are all relatively short but they are bridged one into the other so that there is no break in the sound. It's a happy, predominantly vocal performance and I enjoyed it. Here are just a few of the track titles: Tell It Like It Is - A Living Circle - Cleanse Me - Every Time I Feel The Spirit - In Christ There Is No East Or West - Someone Loved Me First - Go Tell It On The Mountain - When I Think Of The Cross - Were You There? - My Master - We Are More Than Conquerors - Amazing Grace.

An imported album, the quality is good and the youth choir is as good as you'd expect having in mind the two well-known Gospel musicians who are supporting them. Another one I can recommend for family Gospel listening. (W.N.W.)

Instrumental, Vocal and Humour


There are many versions of the "1812 Overture" which are frequently teamed with "Marche Slave" or "Romeo and Juliet" but this is the only version that I know with all three pieces together. And it's an SQ version. And I suppose if any classical music is going to be benefited by SQ recording this should be it. However, I did not listen to it on a four-channel system. I was able to compare this version with one made in 1964 by the LSO conducted by Massimo Freccia. By comparison, the ten-year-old disc was far superior in sound quality, even though it now has its share of clicks and pops. The recording made by Previn in 1973 suffers badly from tape hiss which will tend to be emphasised in the four-channel mode. In addition, the disc seems to suffer from "inner groove distortion" throughout much of its length.

In interpretation, Andre Previn seems to have little advantage over the many other versions I have heard. In any case, if you only listen to the "1812" occasionally the differences seem to come down to "more thunderous cannon" and "more clangorous bells." Such the same can be said of the other two pieces.

Unless you are particularly keen to obtain this selection of Tchaikowsky pieces on an SQ disc, you are recommended to shop around before deciding on this album. (L.D.S.)


This medium-priced set provides a cheaper alternative to the full price Decca set reviewed in these columns a few months ago. While the Decca recording, with the London Symphony conducted by Andre Previn, must be considered superior musically as well as technically, it is around $4 dearer. This performance cannot be discounted, as it is certainly a very acceptable one. There is no break in the sound. It's a happy, well-balanced and clearly defined stereo spread. My recommendation would be to go for the Decca set if you can afford the extra few dollars, but if price is a serious consideration, regard this set as a suitable alternative. (H.A.T.)

A CLASSIC MOOG EXPERIENCE. The Sound of the Criss Cross. Stereo, Barclay L-35962 (Festival).

If you're wondering about the significance of "Criss Cross," there are no notes whatever on this jacket to enlighten you. What I can tell you is that the sound on this album is a mixture of Moog, organ and human voice. They alternate, they substitute, they blend, phrase to phrase, in short, they criss cross! And I'm delighted to report that the whole thing is very well-executed and a tribute to the skill of a whole array of musicians, vocalists and panel operators!

As indicated by the title, the themes are borrowed from the classics: L'Arlesienne Suite No 1 - The Toccata And Fugue Of Seville (Figaro) - Norwegian Dance No 2 - William Tell Overture - Patahétique Sonata - Turkish March - Habanera (Carmen) - The Fifth Season - Mozart Symphony No 40.

You don't like fractured classics? Fair enough, but if you suffer no such inhibitions, my tip is that you'll like this Moog/ orchestral criss cross. The quality is very good indeed and it spreads nicely in simulated quadraphonic. Recommended. (W.N.W.)


Recorded in 1964 by Decca this very pleasant album is now re-released on the economy label Ace of Diamonds at the favourable price of $4.50. Recording quality is very good and surface noise is low.

Playing by the highly reputed Janacek Quartet is exemplary - while the playing is highly disciplined, it has not been to the detriment of feeling. Whether you are collecting records on a budget or not, we can highly recommend this disc. (L.D.S.)
ENCYCLOPAEDIA OF THE ORGAN. VOLUME 7


This is a further volume in the massive 18-LP Erato "Encyclopaedia of the Organ" collection being released in Australia by WRC. It is of especial interest to this reviewer, both because of the music and because of the organist.

There are not that many recordings of Buxtehude's music, considering that he was a composer (and performer) who had a very profound influence on J. S. Bach. It is therefore very welcome that his complete organ works were included in this collection; it will broaden the available readings very significantly.

In this case lovers of 17th century organ music are particularly fortunate, because the performer is Marie-Claire Alain, the erudite and extremely gifted French woman organist. In my opinion, she is without doubt in the very top eschelon of living classical organists. Her playing of Bach is incredibly satisfying in its blend of clarity, appropriateness of registration and sheer poetry; it comes as no surprise that she brings these same talents to the music of Buxtehude on this disc.

Volume 7 includes the Preludes, Fugue and Chaconne in C. the Chaconne in E minor, the Toccata in F major, and the Preludes and Fugues in A major, F sharp minor, E minor, A minor and C. And Mme Alain's readings of these pieces are very satisfying indeed. Full details of the sources and the registration are given in the accompanying notes, which also include comments by Mme Alain on registration and ornamentation. The organ is very suitable for this sort of music, having been built in 1960 by Marcussen to a neo-classical specification.

For baroque organ lovers, an outstanding recording in every way. (J.R.)

NOW WE ARE SIX. Steeleye Span. Chrysalis stereo L.35100.

A most unusual record. His. In some ways, it follows on from the album entitled "Gypsy" which I reviewed in these columns in May. It, too, is a mad mixture. It starts off with a lively Irish jig then moves to a plaintive lament, "Drink Down the Moon," with bass drum accompaniment that feels like a kick in the chest when it is played at a good level.

Side 2 has the following tracks in its mad mixture: "Two Magicians, " a bawdy tune if ever there was one, with clever lyrics, "Edwin," a tune such as the Beatles might have originally composed, and "Twinkle Twinkle Little Star," yes, the original number you learnt in kindergarten without any twist.

Six people make up the group: Maddy Prior, Robert Johnson, Peter Knight, Tim Hart, Rick Kemp, Nigel Pegrum and David Bowie who appears on one track playing the guitar.

One very interesting part of the opening is the discourse between two American motorcycle police and the sound of one of them starting his Harley Davidson and riding off across the lounge and disappearing under the television set - acoustically that is! The marvels of stereo. The quality is good and the stereo image put to good use. (N.J.M.)


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**VARIETY FARE**

BY YOUR SIDE. Peters and Lee. Philips stereo SP 1192.

Anyone who has seen this very attractive singing duo on television will be interested in this record. In spite of Norma Peters’ blindness, he and Dianne Lee seem to have a special rapport which is very charming to watch. On record they perhaps don’t come across in such a special way but they are still very pleasant. On some tracks they tend to be drowned out by the orchestra.

Recording quality is good and surface noise low.

Twelve tracks are featured: The Old Fashioned Way — If — All I Ever Need Is You — Stars Fell On Alabama — Raining In My Heart — Everybody Needs A Rainbow — United We Stand — Until It’s Time For You To Go — Nevertheless — She’s About A Mover — Loving Baby — By Your Side.

(L.D.S.)

★ ★ ★

NON-STOP CAROLE KING. The Sunset Festival Orchestra, Harlequin L5110 Festival release, £3.39.

Carole King’s song writing efforts are certainly well represented on the hit charts and this largely orchestral version demonstrates the reason for her popularity, with fifteen hits such as: You’ve Got A Friend — Goin’ Back — It Might As Well Rain Until September — Where You Lead — Hi-de-Ho — So Far Away — Go Away Little Girl — A Natural Woman. The quality suffers a little from an edginess on the orchestral version, clever lyrics and Cat Stevens’ unique vocal style. Those who want to sing along can do so with the words printed on the record sleeve.

Recording quality is good, though it struck me that it was not as good as his last album “Catch Bull At Four.” Sibilants tended to be overemphasised and stringed instruments a little edgy. Surface noise was low.

Songs presented are: Music — Oh Very Young — Sun C79 — Ghost Town — Ready — King Of Trees — A Bad Penny — Jesus — Home In The Sky. (L.D.S.)

★ ★ ★

YALE CONCERT. Duke Ellington and his orchestra, Fantasy Records L 35667 Festival release.

My first playing of this enjoyable record coincided with the sad news of the Duke’s passing in a New York hospital after a serious illness. The world of music has lost one of its all-time greats. Recorded in one of the older halls at Yale university, this session has the ambiance typical of a live performance before an appreciative audience in 1968.

The titles are: The Little Purple Flower — Put-Tin — A Chromatic Love Affair — Boola Boola — Warm Valley — Drag...


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GOOD TIME CHARLIE. Charlie McCoy. Monument stereo L-34970. Distributed by Festival Records Pty Ltd.

Charlie McCoy's harmonica and a bunch of other enthusiastic musicians are teamed up here to produce the best Charlie McCoy album I've heard. Lively arrangements and "foot-tappin'" rhythm all the way through. Recording quality is good apart from some inner groove distortion. Surface noise is low.

Eleven tracks are featured: Good Time Charlie — Is Anybody Goin' To San Antone — Soul Song — Something — Minor Miner — Don't Touch Me — John Henry — Till I Get It Right — Louisiana Man — Shenandoah — Orange Blossom Special. (L.D.S.)

GLEN CAMPBELL'S GREATEST HITS. Glen Campbell. World Record Club stereo S 5536.

For those wanting the best of Glen Campbell's hits sung by Glen Campbell and not played by some anonymous orchestra, here is the record. Quality is good.

Twelve tracks are featured: Galveston — The Dock Of The Bay — Wichita Lineman — Gentle On My Mind — Honey Come Back If You Go Away — Bridge Over Troubled Water — Folk Singer — Until It's Time For You To Go — You'll Never Walk Alone — Rose Garden — It's Only Make Believe. (L.D.S.)

IT'S HAPPENING NOW. Ronnie Aldrich, his two pianos and the London Festival Orchestra. Stereo, World Record Club WRC S 5575. (665 Camberwell Rd, Hartwell, Vic. 3124.)

Most of the duo-piano work I seem to have heard lately has been done by Ferrante and Teicher, but this WRC album comes as a reminder that Ronnie Aldrich can rightly claim some of the limelight. Yet, oddly enough, some of the sound here, with the London Festival Orchestra, reminds one quite strongly of Liberace.

Anyway, Ronnie Aldrich is in that league as he plays: Hey Jude — Ride My See-Saw — Concerto De Aranjuez — Light My Fire — Scarborough Fair — Both Sides Now — Theme From Mozart Piano Concerto No. 21 — Soulful Strut — The Nature Of Love — I've Gotta Be Me — Little Green Apples — For Once In My Life.

The piano tone is hard and clean and the twelve tracks add up to good value for prospective purchasers. (W.N.W.)

MANUEL AND THE MUSIC OF THE MOVIES. Stereo World Record Club S. 5534. (665 Camberwell Rd, Hartwell, Vic. 3124.)

It should hardly be necessary to observe that the strings, guitars and voices of the Manuel orchestra specialise in smooth, melodic sound and that's what you get on the twelve tracks of this album. Without being in any way dull, it's very, very easy on the ear.


A Columbia recording, released through W.R.C, the quality is right up to standard. Recommended.
This compact, low cost stereo amplifier was described in the June Electronics Australia. Simple to build (based on 2 integrated circuits) it should be within the scope of anyone with basic soldering knowledge.

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None of the tracks have been on LP before, although they exist on 78's in collections. Berigan came from the same background as Beiderbecke. They shared the same heavy drinking habit. Berigan also had a lyrical trumpet style and it was this which caused him to be compared with Beiderbecke. The five Beiderbecke compositions were arranged for small orchestra by Joe Lipman. They are "In A Mist", "Davenport Blues", "Flashies", "Candlelighters" and "In The Dark", being important examples of jazz impressionism. It surprises me that they have not been used in the repertoire of classical orchestras which claim to be "with it!"

Solos are sparse in the performances, which were written to display Beiderbecke's unusual harmonies. The other big band performances on the disc are good workmanlike examples of thirties swing, featuring tenor player Georgie Auld (then a teenager) with Berigan. Berigan died of cirrhosis of the liver in 1942. (G.W.)

THE WORLD'S MOST GLORIOUS MELODIES. Reginald Kilbey and his stringers. World Record Club 5576.

The world's most glorious World Record Club sides are 5576. The world's most glorious melodies are: Melody in F - Songs My Mother Taught Me - Panis Angelicus - Cavatina - Barcarolle from "The Tales Of Hoffmann" - Chanson Triste - Plaisir D'Amour - Trauern - Che Faro from "Orpheus" - Poeme - Pantomime from "Zemire Et Azor" - Waltz In C Sharp Minor

Recording quality is good but instrumental arrangements are a little lacklustre. (I.D.S.)

Jazz and Rock


That most delicious of all improvised music styles, ragtime, is superbly demonstrated for us on this two-LP set. Volume One of the two was honored with a Record of the Year award by the American Stereo Review.

The ragtime form derives from a 16-bar pattern, the themes being played in four groups of four bars each.

"The Entertainer", played here by Rifkin, displays this to perfection. This is the theme of the movie "The Sting".

The particular charm of Joplin was the melancholy which was never very far away. The rags on the album were composed between 1899 ("Maple Leaf Rag") and 1914 ("Magnetic Rag").

They are acting to play, each a masterpiece. Joplin stopped writing rags to concentrate on the second of two operas. Rifkin's performance follows Joplin's dictum that rags shouldn't be played too fast. He captures the rhetoric of "Bethania - a concert Waltz" written by Joplin to show that ragtime was a vehicle for themes of some depth. (G.W.)

BUNNY BERIGAN, HIS TRUMPET AND ORCHESTRA. Mono. RCA LPV-381-G.

Five tracks recorded by Berigan as a tribute to Bix Beiderbecke form the centrepiece of this outstanding historic release.

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SPECIFICATIONS


ELECTRONICS Australia, August, 1974
Low cost Data Precision DVM

A recent addition to the ranks of low-cost digital multimeters is the Data Precision model 124, available from Kennelec Systems. Using a 3 ½-digit seven-segment gas discharge readout with large, easily read numerals, it offers five functions and 22 ranges at a very attractive price.

The model 134 is produced by Data Precision Corporation, of Wakefield, Massachusetts, a well-established US manufacturer in the field of digital instruments. It represents their bottom-of-the-line instrument, intended as a modern replacement for the traditional VOM in servicing and similar applications.

The instrument measures about 14 x 10 x 21 cms overall (W x H x D). Its case is of steel with moulded plastic ends, and is fitted with a combined handle and tilting ball. The front panel is finished in metallic satin, with lettering silk-screened in black and blue.

The readout uses Sperry-type gas discharge tubes, with seven-segment characters about 13mm high. These are very bright, and this together with the size makes them easily readable even at a distance of many metres in a brightly lit room. The display has three full digits together with an over-range 1 and polarity indication.

The five measuring functions provided on the model 134 are DC and AC voltage, DC and AC current (yes, I know these terms are redundant), and resistance. There are four ranges for each of the voltage and current functions, with nominal FSD values of 1, 10, 100 and 1000 volts and milliamps respectively. The resistance function has six ranges, spanning from 100 ohms to 10M — again in terms of nominal FSD.

All ranges have a 100pc over-range factor, so that in practice they have an FSD of 1999 and resistance. There are four ranges for the uppermost ranges. The rated frequency response of the AC ranges is from 50Hz to 1kHz, for full rated accuracy.

When we opened the sample instrument pictured, we found the construction very sturdy. Fairly obviously the model 134 has been designed down to an attractive price, but this has been done with care and forethought. The complete circuit is wired on a single large printed board mounted vertically, except for the readout devices and their special driver ICs. These are on a small plug-in vertical board.

The board appears to be well laid out, with just about all parts readily accessible. And it is a pleasure to note that it sports a complete part identification legend, with just about all parts readily accessible. And it is a pleasure to note that it sports a complete part identification legend, with just about all parts readily accessible.

Only for AC voltage the accuracy is specified as a percentage of full scale deflection, as is the case with almost all VOMs. The overall accuracy is thus expressed as 0.1pc; 0.5pc; and for resistance, 0.8pc and 0.5pc, and for the lower ranges, 0.6pc, for DC, 0.6pc and 0.5pc, and 1.8pc and 0.5pc. In each case the figures represent bipolar tolerances, and the second sets of figures are for the uppermost ranges. The rated frequency response of the AC ranges is from 50Hz to 1kHz, for full rated accuracy.

When we opened the sample instrument pictured, we found the construction very sturdy. Fairly obviously the model 134 has been designed down to an attractive price, but this has been done with care and forethought. The complete circuit is wired on a small single printed board mounted horizontally, except for the readout devices and their special driver ICs. These are on a small plug-in vertical board.

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The basic accuracy of the instrument is still likely to be around 1pc, which is at least three times better than all but the most expensive analog VOMs. In use the model 134 is very easy to drive, and its big display numerals give all the expected advantages of digital readout. It seems quite good in terms of zero stability, and its accuracy quite adequate for all likely servicing and general measuring situations.

At the quoted price of $150 it would appear to be a very good value for money. Enquiries regarding the model 134 and other instruments in the Data Precision range may be directed to Kennelec Systems, at 142 Highbury Toad, Burwood, Victoria, 48 Oxford St, Paddington, NSW, or representative in other states. (J.R.)

SCR-Transistor array on one chip

A new addition to the range of special consumer integrated circuits manufactured by RCA is the CA397E. This device consists of five independent and completely isolated elements on one chip.

1. Uncommitted NPN Transistor.
2. Sensitive-Gate Silicon Controlled Rectifier (SCR).
3. Programmable Unijunction Transistor (PUT).
4. PNP - NPN Transistor pair.
5. Zener Diode.

Applications for the device include timers, light dimmers, oscillators, comparators, SCR triggering and pulse circuits.

For further information please contact Amalgamated Wireless Valve Company Pty Ltd, 554 Parramatta Road, Ashfield, NSW 2131. Phone (02) 797-5757. Telex 24530.
New battery charger from A & R Soanar

Many attractive features are offered by this new battery charger from A & R Soanar, including two charging rates and both 6V and 12V operation.

The A & R Soanar Electronics group has just released an all purpose battery charger designed to meet the varied charging requirements of the lead-acid batteries used in cars, trucks, caravans, boats, motor-cycles, etc.

Designated Battery Charger 4, the new unit has modern styling and is compact, robust and very portable. It weighs 2kg and measures 14 x 8 x 13 cm.

Suitable for charging both 6V and 12V batteries, Charger 4 has several unique features. It incorporates two distinct charging circuits, nominated HI and LO, which are selected by a switch on the front panel of the unit.

The HI position provides a high current boost charge, peaking at 6 amps, for quickly energising completely discharged batteries. On this setting it is possible to obtain sufficient charge in a dead flat battery to start a car within 2-3 hours. Naturally the actual time depends upon the age and condition of the battery concerned. Full charging takes approximately 12 hours.

Many chargers on the market provide a single charging rate, usually in the vicinity of 4A. However Charger 4 also incorporates a trickle charge facility, designed specifically for continuous charging. (Prolonged charging in excess of 1A is not advisable, as battery cells commence to deteriorate with high current once the battery has become fully charged).

The LO position on Charger 4 provides a 1A charging rate, and batteries may be left on continuous charge at this rate for periods of at least a week without causing damage to either battery or charger.

Continuous trickle charging has the advantage of maintaining a battery in peak condition and making it immediately available, fully charged, when required. This is particularly important for batteries which are only used intermittently, such as those fitted to power boats, caravans, emergency lighting systems or the second car.

Charger 4 also features an internal safety cutout switch, to protect the unit from damage in the event of an overload, short circuit, incorrect selection of battery voltage or the inadvertent reversal of lead polarity. The action of the cutout is automatic, and self-restoring when the fault is corrected.

The casing of the unit is coloured bright orange to make it stand out from its surroundings, and serve as a visual reminder of any charging programme. An ammeter with large scale and reading from 0 to 8A allows monitoring of the charging rate and gauging of the charge level reached.

Low cost desoldering

Desoldering can be achieved using an ordinary soldering tool and at low cost using a specially treated absorbent braid called SODER-WICK. Almost any size of solder joint can be completely desoldered in a second, by placing the end of the Soder-Wick on the joint, applying the flat face of the iron tip to it, and removing both when the solder melts.

No flux is needed, so flux spatter is eliminated. Residue, if any, is pure non-corrosive and non-conductive resin. Holes are clean, and the entire joint surface is ready for re-soldering without further cleaning. The thirsty wicking action leaves even plated-through PCB holes clean.

Soder-Wick also prevents thermal damage to components by acting like a heatsink. Distributors of Soder-Wick are Royston Electronics Pty Ltd, of 22 Firth Street, Doncaster, Victoria.

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As an aid to the "do-it-yourself" types, Dick Smith Electronics is now offering the Tele-fix-calculator, a diagnostic chart which pinpoints the valve, or valves, most likely to be the cause of TV receiver faults. All one simply does is rotate the circular dials to display the relevant picture and sound symptoms and read off the resultant code number. The suspected valve types are then read from a table on the back of the Tele-fix.

BSR latest 202 top model of BSR range of record players $52 including Magnetic Cartridge. Pack and post $1, interstate $2.

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50 / Ohm pots ideal for ext. speakers etc 50c.

Suit Homodyne Tuner

Car Radio Push Button Tuner

$4.50

Pack & Post 55c. Interstate 85c.
New range of small encoded keyboards

Mechanical Enterprises have released a new family of 15 small encoded keyboards for use in data communications, control devices, and other applications requiring boards with 10, 12, or 16 keys. Each keyboard is encoded with the Harris HD-1065 keyboard encoder, which features a 4-bit parallel output and 2-key rollover. All keyboard outputs are bounce-free and TTL compatible. The keyboards are factory coded in BCD, but can be altered in the field to make coding changes.

The new keyboards are available with one of three basic Mechanical Enterprises' switches, as follows:

- LM Gold V-Bar Switches — low profile switches with close mounting centres for hand-held keyboards.
- LFW Gold V-Bar Switches — full-stroke, mechanical spring-on-spring switches available in a pushbutton version or with double-shot moulded keytops (as illustrated in the photograph).
- Mercuron Switches — full-stroke, mercury-filled tube switches, featuring sealed contacts.

For further information, contact General Electronic Services Pty Ltd, 114 Alexander St., Crows Nest, N.S.W. 2065.

Coaxial plugs & sockets from McMurdo

McMurdo (Aust) Pty Ltd has recently released a new range of coaxial plugs and sockets for TV, radio, electronic and instrument applications. Included in the new range are in-line, chassis mounting and printed wiring board sockets to suit a wide range of applications. Both polished aluminium and insulated free plugs are available for 1/4-inch and 5/32-inch cable entry.

A reinforcing circlip on the socket provides both strength and resilience, with excellent plug to socket contact. All inline plugs and sockets are equipped with an insulation clamp to ensure reliability of cable to socket connections.

Specifications of the new range are as follows: impedance — 65-75 ohms; VSWR — greater than 1.2:1 up to 250 MHz; capacitance — less than 5pF; current rating — 2A; insulation resistance — greater than 30,000 Megohms; contact resistance — less than 2 milliohms, breakdown voltage — greater than 4kV.

An extensive range of attenuators is also available, and these have attenuation characteristics ranging from 3dB to 36dB.

For further information, contact McMurdo (Australia) Pty Ltd, 17-21 Carnish Road, Clayton, Victoria 3168. Also at 219 Blaxland Road, Ryde, N.S.W. 2112.

Electronic equipment stolen from Aegis

Aegis Pty Ltd advises that their factory premises in Thornbury were entered by thieves on the night of Thursday, May 30, and the following items of equipment were stolen:

- Hewlett Packard HP35 Calculator, Serial No. 1302S4038
- Tektronix Model 422 Double Beam Oscilloscope, Serial No. 140
- Sugden Distortion Measuring Unit Type SC453, Serial No. 2128
- Sugden Audio Oscillator Type Si453, Serial No. 2059
- Odhner Adding & Calculating Machine, Model MX11C/9, Serial No. 21489

Aegis Pty Ltd kindly advise Aegis Pty Ltd, or Calculating Machine, Model MX11C/9, Serial No. 21489.

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For the amateur


RSGB publications have an excellent reputation, and this new book by H. L. Gibson would certainly appear to uphold the tradition. While some of the designs have presumably been published earlier, much of the material has not, so that the book becomes a very desirable reference manual for the amateur who wants to build up his test resources — in terms both of understanding and equipment.

The opening chapter on indicating instruments is at a quite elementary level and is presumably intended for study by prospective recruits to the amateur ranks. Chapter 2 on "Electronics Instruments" gets progressively deeper, beginning with a simple valve voltmeter, then its solid state counterpart, and on to a complete electronic multimeter and its peripherals. The text and circuits could be treated as study material or as the basis for a whole series of constructional projects. Dip oscillators enjoy quite extensive treatment, as does also the subject of frequency measurement, which begins with simple crystal markers and ends up with a digital frequency meter.

There are chapters on the measurement of RF power, noise, and aerials and transmitters. There are sections on diode rectifiers and on transistors, and a section on linear instruments. A chapter on the design and construction of oscilloscopes is followed by a section on diode rectifiers and on transistors, and a section on linear instruments. A chapter on the design and construction of oscilloscopes is followed by a section on diode rectifiers and on transistors, and a section on linear instruments. A chapter on the design and construction of oscilloscopes is followed by a section on diode rectifiers and on transistors, and a section on linear instruments.

Mainly for boffins


A rather specialised book, presenting a theory embracing transit-time effects in unipolar one-dimensional semiconductor devices such as FET's, space-charge limited current devices, and Gunn devices. It is written primarily for engineers and applied physicists with interests in the solid state and semiconductors. The author is a researcher currently working in the Department of Electronics and Telecommunications at the Polytechnical Institute of Bucharest, Romania, and the book is based on this research. It is divided into 14 chapters, grouped into three sections. Those in the first section...
introduce the mechanisms of carrier injection and transport in crystalline solids and the metal-oxide semiconductor system. Those in the second section discuss linear theory, small signal operation, stability and noise. Finally in the third section non-linear theory is treated, together with transient noise. Finally in the third section non-linear theory, small signal operation, stability and transport in crystalline solids introduce the mechanisms of carrier injection and transport in crystalline solids and the metal-oxide semiconductor system.

The treatment is highly mathematical, and far too deep for this reviewer. However it would appear to be very well written, and should be of considerable interest to anyone involved or intending to become involved in research into unipolar devices.

The review copy came from the publisher direct, and no information was given regarding local price or availability. (J.R.)

**Biggest yet...**


Retailing for around $73.00, this book ranks as the most expensive we have ever reviewed. However, before reaching for the "hip pocket nerve" tranquillisers, it may be as well to point out that it is intended mainly for libraries of large institutions and the like, and that the contents are rather specialised in that it attempts to list all the major works in electronics literature during the period 1965 - 1968.

This enormous growth in recorded information in recent years has added greatly to the difficulties of the scientist in keeping abreast of the work being done in his own and related fields, and also to the problems of literature searching. Nowhere are these problems more pronounced than in the field of electronics, and it is as a contribution to easing the problems of literature searching, which is both time consuming and costly, that this volume is intended.

The book begins by giving a list of all periodicals cited in the text, together with a list of the abbreviations used. This is followed by some seventy sections, each devoted to a specialised field of electronics, in which a list of all the major works in that field between 1965 and 1968 is presented. Information pertaining to each entry is presented in three columns: column 1 lists the bibliographical details of the work cited, column 2 lists the total number of references cited, and column 3 gives a brief summary of the contents.

The concluding chapters contain comprehensive author and subject indices. These not only contain information relevant to this volume, but also to the two previous volumes, Volumes 1 & 2, which cover the periods from 1945 - 1959 and 1959 - 1964 respectively.

In summary, this book should be invaluable to companies, research institutions, and student libraries where a great deal of information research is required. The time saved in searching out the relevant subject titles would justify its undeniably high price within a very short period of time. The book does, however, have one serious shortcoming in that, apart from the author and subject indices, it only covers the period from 1965 to 1968. For the individual, it is too expensive, and on a valued for money basis would be hard to justify.

The review copy came from Novalit Pty Ltd, Royal Place, off 210 Swan Street, Richmond, Victoria 3121. (G.S.).

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WE OFFER A FURTHER CHOICE OF TWO COMPACT SLIM-LINE "INCREDIBLE" AMPLIFIERS

No. 1. An economical amplifier chassis with specially extruded satin finished aluminium front panel with an elegantly simple appearance. Includes "Incredible 25" module with slider controls and knobs, power supply and mains lead, ON/OFF switch, headphone socket, chassis, front panel and input output plugs and sockets — including 5 pin din socket for tape record playback. Easily fits under most record player plinths, $39.95., post and packing $2.00.

No. 2. Our de luxe amplifier chassis with every facility — but still with a low price tag. Includes "Incredible 25" module with modern slider controls and knobs, power supply and mains lead, ON/OFF rocker action switch and bezel, headphone socket, speakers ON/OFF switch, rumble and scratch filters, mono/stereo switch, phono auxiliary selector switch, chassis, front panel and input output plugs and sockets including 5 pin din socket for tape record playback. Easily fits under most record player plinths $44.50., pack and post $2.00.

RECORD CHANGERS AND SPEAKERS

While it is possible to use almost any combination, we recommend one of the following:
- 8" Twin Tone Hi-Fi Speaker, each $4.00
- 3" Tweeter and Cross-Over to match, each $4.20

As above, complete in a modern factory made walnut speaker cabinet. Size 11" x 7" x 15\(\frac{1}{2}\)" high — pair $39.00.

BSR Auto Record Changer with base, cover and ceramic cartridge, ready to play $59.00. GARRARD Stereo Auto Changer with base, cover and ceramic cartridge ready to play $49.00.

PRE-PAK electronics and agencies
HEAD OFFICE: 718 PARRAMATTA ROAD, CROYDON 2132.
PHONE: 797 6144

ELECTRONICS Australia, August, 1974
Commonly referred to as the Remembrance Day Contest, this amateur radio event is a competition for young people sponsored by the International Telephone Union (ITU). It is the most popular amateur radio contest among Australian operators. The contest was inaugurated on the 1st January, 1974, and is hosted by the Wireless Institute of Australia. The contest is open to active transmitting stations in Australia, New Guinea, and the Falkland Islands. The competition is aimed at promoting the development of radio amateurs and the importance of technological advancements in the field of telecommunications. The contest encourages participants to demonstrate their skills in amateur radio operations and to engage in friendly competition.

**Sponsors and Participants:**
- **ITU**: The primary sponsor, an international organization that promotes the development of telecommunications infrastructure worldwide.
- **Wireless Institute of Australia**: The local organizer and host of the contest, providing technical support and regulations.
- **Australian operators**: The participants who are actively involved in the contest, celebrating their dedication to the field of amateur radio.

**Rules and Regulations:**
- **Amateur Bands**: All amateur bands may be used, including cross-mode operation. Transmissions are permitted on both phone and CW during the contest, with various frequency bands and modes specified for different regions.
- **Scoring**: Contacts are scored based on specific criteria, such as the number of stations contacted and the type of transmission used.
- **Technical Requirements**: Participants must adhere to technical requirements, such as power limits and frequency bands, to ensure fair competition.

**Purpose:**
- **Youth in the Electronic Age**: The contest promotes the education and development of youth in the electronic age, encouraging them to engage with technology and pursue careers in the field of telecommunications.
- **Educational Value**: It fosters a deeper understanding of the historical significance of telecommunications and its impact on social development.

**Conclusion:**
The Remembrance Day Contest is an essential event that celebrates the passion and dedication of amateur radio operators worldwide. It serves as a platform for technological innovation and educational development, highlighting the importance of telecommunications in a rapidly evolving digital landscape.

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**Table 1: VK SCORING TABLE**

<table>
<thead>
<tr>
<th>VK1</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9/2</th>
<th>PZL 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VK1</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9/2</td>
<td>PZL 1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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**Table 2: ZL SCORING TABLE**

<table>
<thead>
<tr>
<th>ZL1</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9/2</th>
<th>PZL 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

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Radio clubs and other organizations, as well as individual amateur operators, are cordially invited to submit news and notes of their activities for inclusion in these columns. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent direct to Pierce Healy, VK2APQ.
Complete kit $198.00 P & P $3
Mixer equaliser kit $19.50 P & P 40c
Preamp & tone control for 2 channels $21.00 P & P 40c.
Power supply $28.25 P & P 40c.
Metalwork $15.90 P & P $1.00.
Front panels $2.90 ea. P & P 40c.
Timber case $7.25 ea. P & P $1.00.
All coils prewound.

ETI 413 100 WATT
GUITAR AMPLIFIER

ETI 420 4-CHANNEL
AMPLIFIER

ETI 423 ADD ON
DECODER AMP

SYNTHEISER

Please enquire for price details.
For details write to the correspondence section secretary W. T. Treveton, 34 Flower Street, Fern Tree Gully, Victoria 3156.

**RADIO CLUB NEWS**

**Central Coast Amateur Radio Club**

The June, 1974, issue of the CCARC News Sheet contained a brief report on WICEN activity during the bad weather that struck the Central Coast, NSW area. Ray Wells, VK2ZAF, and Don Crofts, VK2ZUX, had a net operating on Channels 1 and B with the base at Wyong Shire offices.

There were many offers of assistance from amateurs in these trials - VHF, VK2PA, VK2ZRN, VK2ZQG, VK2QX and VK2ZV to list a few. All were on standby. Fortunately the storms abated and full assistance was not needed. However, the work done and the offers of assistance were appreciated and show that club members are willing to assist in an emergency.

The need for a permanent VHF antenna at the emergency control centre so that WICEN operators need only take along a transceiver, controller and coax from the antenna, and power, to start operating.

Sunday, 23rd February, 1975, has been chosen for the popular Gosford Day.

The CCARC AOCP classes are making good progress. These are held each Saturday afternoon at the clubrooms.

Club meetings are held on the first and third Friday nights of each month at the clubrooms, Dandelalo Street, Gosford. All information from the secretary, Barry Gibbons, VK2ZUX, PO Box 238, Gosford 2250.

**Westlakes Radio Club**

Elementary, Junior and Intermediate VYRS classes are being run for the first time at the Westlakes Radio Club by Jamie Campbell, VK2YCT, and David Crofts, VK7YBH. The classes are held between 1300 hours and 1600 hours on Saturday afternoons.

In spite of bad weather during May and June, progress has been made on the building work at the club. The major delay to occupation of the new premises is completion of the sewerage installation. In this case the problem is finance. The committee and members are making every effort to raise the $500.00 which is estimated it will cost. The ladies' auxiliary is also assisting with the fund raising.

Details of club activities write to Secretary, Eric Brockbank, V2ZOP, PO Box 1, Teralba, NSW 2384.

**Gold Coast Radio Club**

The committee of the T. S. Tyalgum has given the Gold Coast Radio Club permission to erect permanent HF and VHF aeralis on the premises. Meetings of the club are held on the second Friday of each month. In lieu of meeting an occasional social evening is held at one of the popular rendezvous in the area.

Although hampered by bad weather, work is progressing on the VHF FM repeater installation which will operate on the new channel 1 (input 146.100MHz output 146.700MHz). The VHF FM simplex calling frequency 146.5015MHz is being used in the Gold Coast area. For information on GCR or when holidaying on the Gold Coast contact the secretary, Mike Adams, VK2ZUX, PO Box 238, Gosford 2250.

**Mount Isa Radio Club**

The Mount Isa Amateur Radio Club are endeavouring to raise money for a club house in their area. Raffles and the sale of surplus equipment are among the methods used. Details may be obtained from the secretary, Graham Algic, PO Box 101, Mount Isa, Qld, 4825.

**Moorabbin & District Radio Club**

The committee of The Moorabbin & District Radio Club has decided that the club should have an emblem depicting amateur radio. This emblem would be produced as a badge and would be the basis of a new club letterhead and QSL card.

A prize of a new club badge is offered to the member who most suits the design which is selected as most appropriate.

In addition to meetings held on the first and third Fridays of each month, when interesting and instructive lectures are arranged, social evenings are also conducted. The ladies' auxiliary group also holds its own transmitter hunts on the fourth Friday of the month.

Social evenings include barbecues, film nights and dancing. The annual social evening is a Valentine Dance on Saturday, 24th August, in the Moorabbin area.

**Illawarra Branch**

For details contact the secretary, Michael Park, VK4ASJ; Flat 2, 6 Melbourne Street, Murrumbeena 3175. Branch meetings are held in the Moorabbin Baseball Clubrooms, Summit Avenue, Moorabbin, commencing at 8.00 pm. Visiters welcome.

**Ilawarra Branch**

For further information write to:

**IONOSPHERIC PREDICTIONS FOR AUGUST**

Reproduced below are radio propagation graphs based on information supplied by the Ionospheric Prediction Service Division of the Department of Science. The graphs are based on the limits set by the MUF (Maximum Usable Frequency) and the ALF (Absorption Limiting Frequency). Block bands indicate periods when circuit is open.

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>MUF (MHz)</th>
<th>ALF (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>2.5</td>
<td>0.8</td>
</tr>
<tr>
<td>14</td>
<td>4.5</td>
<td>2.0</td>
</tr>
<tr>
<td>21</td>
<td>7.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**SO YOU WANT TO BE A RADIO AMATEUR?**

To achieve this aim, why not undertake one of the Courses conducted by the Wireless Institute of Australia? Established in 1910 to further the interests of Amateur Radio, the Institute is well qualified to assist you to your goal. Correspondence Courses are available at any time. Personal classes commence in February each year.

For further information write to:

**THE COURSE SUPERVISOR, W.I.A.**

14 ATCHISON STREET, CROWS NEST. N.S.W. 2065
Radio Canada International has recently announced a new tentative operating schedule. Due to come into operation next month, the new schedule includes the use of the three new relay stations located at Moosbrunn, Malta, and Kigali.

In recent months, programs from Radio Canada have been relayed to Europe over the BBC transmitters at Daventry and over the Trans-Europe transmitters at Sinel, Portugal. From September, Radio Canada programs will be carried by additional relay stations in order to provide better reception in Europe and Africa, and plans are under way for the programs to be re-broadcast by Moosbrunn, Australia, Deutsche Welle, Malta, and from the Deutsche Welle relay base at Kigali, Rwanda.

The relays from Malta are scheduled on 610kHz, 1800-1900GMT; 7240, 0530-0730; 9505, 1800-1900; 9710, 0530-0730.

The relays from Kigali are scheduled for later announcement as are the programs to be relayed from Moosbrunn.

LATIN AMERICAN NEWS

BOLIVIA: Radio Nacional Huancuni, located at Huancuni, province of Oruro, has been heard on 5965kHz with good signals during the afternoons. Reception in New Zealand has been possible from around 0900GMT and the station gives frequent identification announcements. At 1045GMT, the BBC service in Russian opens on the frequency and blocks out further reception.

ECUADOR: Many listeners have been puzzled by the Ecuadorian station which has been operating all night on 4780kHz, and is best heard around 0000GMT. Jack Buckley of Coogee, NSW, has been hearing this signal, which has also been observed in New Zealand. The station is Radio Popular Independencia, Quito. In New Zealand, Bryan Clark of Wellington and Chris Davis of Featherston have heard this station on a second receiver, on 11560kHz.

PERU: Radio Chinchachoya has made a frequency change, and we have been hearing this station closing on 0545GMT, on 4860kHz. The call sign B2ZJZ has been received.

ARGENTINA: Two good signals have been heard at 0930GMT, and these are Radio Nacional Buenos Aires on 6060kHz and Radio Nacional Mendosa on 6100kHz.

BRAZIL: One of the low frequency Brazilians, ZYES, on 334kHz, has been heard by Chris Davis of Featherston, NZ, around 0845GMT. This station has the slogan “Radio Alvorada de Londrina” and has been providing good reception, considering that transmitter power is only 1kW.

NEW ECUADORIAN SIGNAL

A new station in Quito, Ecuador, has been heard on 5064kHz, between 0100 and 0300GMT. The station uses the slogan “Radio Nacional Progreso,” and has popular Latin American music with station announcements every ten minutes. During the closing announcement, reference is made to the broadcast only being available on short wave, and a full address is given during this announcement in Spanish. Radio Nacional Progreso uses the march “Anchors Away” as its

Further details on other stations, and information on what is being heard by readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT, add eight hours for WAST, ten hours for EAST and twelve hours for NZT.

MEDIUM WAVE NEWS

HAWAII: Station KPUA at Hilo is to make a frequency change to 670kHz according to “Broadcasting.” Previously, it had been suggested that the frequency would be 632kHz, but KPUA has now applied for a construction permit to operate on 670kHz with 5kW.

GUAM: Guam Broadcasting Company has applied for a license to operate on 481kHz with 5kW.

SOUTH AFRICA: The Springbok Radio has been heard on a new frequency of 481kHz. By several New Zealand listeners, according to the NZ DX Times. The reception has been heard around 0200GMT, and the station has been broadcast. There is some interference on the frequency before this time from the Voice of America, which is now using 480kHz and a radiated power of 5kW.

LISTENING BRIEFS

AFRICA

EGYPT: The Voice of Africa, Cairo, has been heard during test transmissions on 152kHz. According to the DX Club of India, the station broadcast from 1900-2200GMT and requested reports to: Voice of Africa, PO Box 566, Cairo, Arab Republic, Egypt.

LATIN AMERICA: The Springbok Radio has been heard on a new frequency of 481kHz. By several New Zealand listeners, according to the NZ DX Times. The reception has been heard around 0200GMT, and the station has been broadcast. There is some interference on the frequency before this time from the Voice of America, which is now using 480kHz and a radiated power of 5kW.

SEYCHELLES: The Far East Broadcasting Corporation has been heard on 6075kHz, with an interval signal on 1527kHz. At 0600 the sign-on announcement indicates that the transmission is beamed to India and Pakistan. The program includes popular music to 0630GMT, followed by a program for children.

JOHANNESBURG: The BBC World News is relayed from 0100-0300GMT.

TANZANIA: According to the DX Club of the Shortwave Club, Radio Tanzania has extended its schedule to 1950-2105GMT. Portuguese has been noted at 0900GMT and English at 1900GMT. No sign-off of the schedule does not seem to follow the same pattern daily. Early reception of the signed at 1800GMT also included a news bulletin in English at 1335kHz.

ASIA

SRI LANKA: According to the DX Club of India, Radio Sri Lanka is now operating, English with the All Asia Service of the Sri Lanka Broadcasting Corporation, from 0800-1200GMT on 1250, 1530, 6075kHz. Reception in South America is from 1230-1730 on 11250kHz, 17125kHz, 17185kHz. Reception in Malaysia is at 0200-0300GMT and English at 0300GMT. No sign-off of the schedule does not seem to follow the same pattern daily. Early reception of the signed at 1800GMT also included a news bulletin in English at 1335kHz.

LAOS: A new station is reported in “DX Corner” as being transmitted on 738 and 88kHz. The station is, however, operating only in Laos.

INDONESIA: Radio Republic Indonesia at Jayapura has also been heard opening the frequency on 152kHz, followed by full announcements at 0900GMT, and carries the same program as on 6075kHz. Radio Republic Indonesia at Jayapura has also been heard by Craig Tyson and Wembley, WA, on 718kHz. This station is now operating a new frequency of 88kHz on 0900-1200GMT, with a sign-off of a long signal, followed by full announcements at 0900GMT, and carries the same program as on 6075kHz. Radio Republic Indonesia at Jayapura has also been heard by Craig Tyson and Wembley, WA, on 718kHz. This station is now operating a new frequency of 88kHz on 0900-1200GMT, with a sign-off of a long

Further details on other stations, and information on what is being heard by readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT, add eight hours for WAST, ten hours for EAST and twelve hours for NZT.

The report should be accurate and written in a courteous manner, and should provide information that applies only to that station.

Avoid using terms which the radio station may be unfamiliar with.

Make every effort to include a report on between 15 and 20 minutes of the program.

Give a good summary of signal strength and conditions.

Include the return postage with the report.
MODEL RH-20 $20.00
Packaging & Postage $1.00.

20,000 Ohms per Volt DC
10,000 Ohms per Volt AC
Specifications:
DC Volts: 0.25, 2.5, 10, 50, 250, 1000.
AC Volts: 10, 50, 250, 500, 1000.
DC Current: 50µA, 25mA, 250mA.
Decibels: -10, +22 (at AC /10V) +20, +36 (at AC / 50V). Upper frequency limit 7KHZ.
Batteries: Two 1.5V dry cells.
Complete with test leads.

MODEL RH-80 $22.00
Packaging & Postage $1.00.

20,000 Ohms per Volt DC
10,000 Ohms per Volt AC.
Specifications:
DC Volts: 0.25, 2.5, 10, 50, 250, 1000, 100.
AC Volts: 10, 50, 250, 500, 1000.
DC Current: 50µA, 25mA, 250mA.
Decibels: -10, +22 (at AC /10V) +20, +36 (at AC / 50V). Upper frequency limit 7KHZ.
Batteries: Two 1.5V dry cells.

NEW RH (Radio House)
RANGE OF MULTIMETERS

MODEL RH-60 $29.00 Packing & Postage $1.00

50,000 Ohms per Volt DC.
10,000 Ohms per Volt AC.
Specifications:
DC Volts: 0.25, 2.5, 10, 50, 250, 500, 1000.
AC Volts: 10, 50, 250, 500, 1000.
DC Current: 25µA, 5mA, 25mA, 250mA.
Decibels: -10, 100K, 1M, 10M.
Decibels: -10 +62dB.
Accuracy: DC ±3 p.c., AC ±4 p.c. (of full scale).
Batteries: Two 1.5V dry cells.

"HANDYMAN" RH-150 $14.75
CHECKED PACKED & POSTED $15.50

Pocket-size 3 1/2" x 4 1/4" x 1 1/4".
Instruction sheet and circuit.

SPECIFICATIONS:
DC Volts: 2.5, 10, 50, 250, 1000.
10,000 ohms per volt.
AC Volts: 10, 50, 250, 500, 1000.
DC Current: 1.25, 25mA.
Resistance: 20K and 2M.
Decibels: -20dB, +62dB, 70KHz.
Capacitance: .0001, .01, .0025, 25µF.

4-SPEED RECORD UNIT

"Ambassador" 4 speed 16, 33, 45 & 78 rpm stereo phono unit, complete with Ronette pickup. Stereo ceramic cartridge and stylus for LP and 78 records.
Packed ready to mount with screws and template for installation.
Instructions for connecting to amplifier or radiogram. 240V AC mains operated.
Posted NSW $16.50.
Posted Interstate $17.00.
Reduced from $25.00.
Special Offer.
Order now, limited stocks.

WORLD RANGE RADIO

10 Bands, Solid State, Battery and 240 Mains Operation

Specifications: 14 Transistors, 6 Diodes, 1 Thermistor.
1. Tuning Range and Intermediate Frequency
Amplitude Modulation (AM) 535-1600KHz 455KHz
Marine Band (MB) 1.5-4.0MHz 455KHz
2. Wave International Short
Wave - 1 (SW1) 6-12MHz 455KHz
Wave - 2 (SW2) 12-16MHz 455KHz
Wave - 3 (SW3) 16-24MHz 455KHz
Wave - 4 (SW4) 24-28MHz 455KHz
Frequency Modulation (FM) 88-108MHz 10.7MHz
Aircraft (VHF1) 108-140MHz 10.7MHz
Police Band (VHF2) 140-170MHz 10.7MHz
Weather Band (VHF3) 170-200MHz 10.7MHz
3. Antenna
Built-in Ferrite bar antenna for AM, MB.
Built-in Telescopic antenna for SW1, SW2, SW3, SW4, FM, VHF1, VHF2, WB (swivel-type telescopic directional antenna).
4. Output Power
Undistorted Power 600mW.
5. Power Supply
DC6V: UM -1 ("D") size flashlight battery x4, or 240 Volts.
6. Speaker
3.5" Round PM dynamic
7. Earphone
8 ohm Magnetic earphone
8. Dimension
11" (H) x 13" (W) x 5" (D)
9. Weight
Approximately 8 lbs. (Without batteries)
$135.00 Packing & Postage $1.50.

MODEL SE400 MINILAB
TEN-IN-ONE TESTER
PRICE $49.75, P&P $1.00

FEATURES
1. ACV (AC Voltmeter)
Four ranges: 0-15, 0-50, 0-150
2. DCV (DC Voltmeter)
Four ranges: 0-15, 0-50, 0-150
3. OHM (Ohm meter)
0-10k, 0-100k, 0-1M ohms, ± 3pc.
4. RESISTANCE (Resistance substitution)
5. CAPACITANCE (Capacitance substitution)
Five values: .002uF, .005uF, .02µF, 0.1uF, .1uF
6. RF FIELD (RF Field strength meter)
Frequency range 1 – 140MHz
7. DC 500mA (DC Ammeter)
8. BATT OUT (Battery supply)
9. GENERATOR (RF Signal generator)
Frequency fixed at 455KHz, up to 700KHz adjustable.
10. GENERATOR (AF Signal Generator)
Frequency 400Hz (approx).

RADIO HOUSE PTY. LTD.
306-308 Pitt Street 61-3832 26-2817
760 George Street Sydney. 211-0171

ELECTRONICS, Australia, August, 1974
Thank you for the compliment. As you can see your April 1, 001. JOKE: I could hardly believe the ad fractures. Note, however that a subscription to EA wish has been complied with. At the time of writing classical I mean stuff like Mozart, Bacharach, etc. In

ELECTRONICS Australia, August, 1974

113

240
### National Radio Supplies

**332 Parramatta Rd, Stanmore, NSW 2040. Ph. 56-7398.**

<table>
<thead>
<tr>
<th><strong>Valve Special</strong></th>
<th><strong>Double Gang Pots</strong></th>
<th><strong>7 Valve Radio Chassis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>807 6S7 New</td>
<td>with switch. 50k &amp; 25k car radio type. 3 for $1.50 + post</td>
<td>BC &amp; SW new with dial. Like Admiral Tampa, no valves but complete. $5.00 + post</td>
</tr>
<tr>
<td>6U7 6SA7</td>
<td>Cheaper than switch backs!</td>
<td></td>
</tr>
<tr>
<td>6K7 6SJ7 cartons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6H6 7C7</td>
<td></td>
<td></td>
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<tr>
<td>All this mixed.</td>
<td></td>
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<td>5 for $3 + post</td>
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<thead>
<tr>
<th><strong>Alligator Clips</strong></th>
<th><strong>Mixed Knobs</strong></th>
<th><strong>Valve Sockets</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium size, insulated. 10 for $2 + post</td>
<td>TV Channel selector, fine tuning for all TV. 10 for $4.50</td>
<td>Includes pix tube sockets, old &amp; new types. 10 for $1.80 + post</td>
</tr>
</tbody>
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<thead>
<tr>
<th><strong>Small 350mA Transf.</strong></th>
<th><strong>Perspex Covers</strong></th>
<th><strong>Princess</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitable cass. recorder</td>
<td>for stereo. From $3.50 + post</td>
<td>Radio-cassette. $115 + post</td>
</tr>
<tr>
<td>240V to 6.3V CT $3 + post</td>
<td></td>
<td></td>
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<tr>
<td>Bridge rectifier to suit 50c</td>
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<td></td>
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<table>
<thead>
<tr>
<th><strong>Transformer Special</strong></th>
<th><strong>Walkie Talkie</strong></th>
<th><strong>Turntables</strong></th>
</tr>
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<tbody>
<tr>
<td>240V to 6.3V 3A $2.50 + post</td>
<td>1 watt Stratocorn, 2 channels. Very powerful. $45.20 inc post</td>
<td>Imported with ceramic cartridge 3 speed, high qual. sterep $22.00 + post</td>
</tr>
<tr>
<td>240V to 5V 3A $2.50 + post</td>
<td></td>
<td>Smaller type, Jap, sterep with arm 7.90 w / cartridge</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Speaker Boxes</strong></th>
<th><strong>Plugs</strong></th>
<th><strong>Stereo Cabinets (PyE)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>With front, complete. 8 x 6, ideal extension or small stereo. Nice looker $2.20 + post</td>
<td>RCA, 3.5 mm &amp; 2.5 mm types</td>
<td>Portable type, vinyl cover $2.50 + post</td>
</tr>
<tr>
<td></td>
<td>Mixed 10 for $2.20 + post</td>
<td></td>
</tr>
</tbody>
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<thead>
<tr>
<th><strong>Philips Miniwatt</strong></th>
<th><strong>Speaker Transformers</strong></th>
<th><strong>Signal Injector</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve &amp; picture tube handbook</td>
<td>7k / 15, 5k / 3.5 etc</td>
<td>Sim. 3TC. 2 for $3.00 + post</td>
</tr>
<tr>
<td>Now only $1.50</td>
<td>$1.00 each or 7 for $5.00</td>
<td></td>
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<tr>
<th><strong>Power Transformers</strong></th>
<th><strong>TV Valves</strong></th>
<th><strong>Pioneer Phones</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>240V to 285V CT 6.3V / 3A 5V / 2A</td>
<td>6AU4 6BM8 6BL8 6GV8 6GV8 152 12AU7 6J6</td>
<td>Stereo, to clear. $5.00 + post</td>
</tr>
<tr>
<td>240V to 385V CT 6.3V / 2A 6.3V / 2A 5V / 2A</td>
<td>All $1.50 + post</td>
<td></td>
</tr>
<tr>
<td>240V to 385V CT 6.3V / 100mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each $4.00 + post</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Fuses Mixed</strong></th>
<th><strong>EHT Transformers</strong></th>
<th><strong>Resistor Pack</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>30 fuses for $2.50</td>
<td>Philips NT3102 $7.20</td>
<td>100 mixed for $1.50</td>
</tr>
<tr>
<td></td>
<td>Philips NT3101 $7.00 inc. post</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>20 Mixed Electros</strong></th>
<th><strong>Assorted Pots</strong></th>
<th><strong>12 Mixed Pots</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(pigtailed) inc. small types for transistor repair</td>
<td>Preset types, mixed values 10 for $3.00 + post</td>
<td>or 12 Oak Switches $1.80</td>
</tr>
<tr>
<td>$4.00 + post</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Speaker Special</strong></th>
<th><strong>Small Power Transf.</strong></th>
<th><strong>New Garrard Player</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>7 x 5 3 ohms</td>
<td>Radio / valve. 240V to 6.3V 40mA $2.80 + post</td>
<td>SPR22 STEREO</td>
</tr>
<tr>
<td>5 x 3 15 ohms</td>
<td></td>
<td>3 speed with ceramic cartridge $14.80 + post</td>
</tr>
<tr>
<td>6&quot; round Hi-flux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 ohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6WR 15 ohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3TC 15 ohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 x 9 3 ohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6x9 Tesla high qual. 8 ohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.50</td>
<td></td>
<td>$4.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Speaker Transformers</strong></th>
<th><strong>Bezel Special</strong></th>
<th><strong>Meter Leads</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Marked fig. 8</td>
<td>Mixed – 10 for $2.00 + post</td>
<td>Pin type, 2 plugs, 2 probes 40c</td>
</tr>
<tr>
<td>7k / 15, 5k / 3.5 etc</td>
<td>Different colours – a very good save.</td>
<td></td>
</tr>
<tr>
<td>$1.00 each or 7 for $5.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Electronics Australia, August, 19/4**

114
Tone Generator from p77

hot iron with a small tip, and only solder in those pins which are connected into the circuit.

We have left room on the board for the use of a socket for the crystal, but this is not essential. We did not use one, but soldered the crystal directly to the board with a small amount of solder.

Carefully check the completed board for any errors, particularly with regard to polarity and position.

The only remaining component to be fitted is the tone generator IC. Particular care is required, as this can be damaged by stray electrostatic charges. Hold the IC by the top, and do not touch the pins. Insert it into the socket by pushing firmly, taking care that none of the pins are bent, and that each one enters its correct socket clip.

The board is now complete, and can be put aside until the remaining construction has been finished.

The amplifier for the speaker and the filter and attenuator for the output socket may now be assembled on the tag strip, according to the layout. Also included on this tag strip is the dropping resistor for the pilot light.

Cut the shafts of the switches and the variable control potentiometer to a suitable length, and fit them to the front of the chassis. If desired, the note selection switch can be carefully disassembled and the stop filed off. This will enable the shaft to rotate through 360 degrees completely, making use of the pilot slightly easier.

The remaining components, including the insulated spacers used to mount the board, can now be fitted, using the wiring diagram and photographs as a guide.

The speaker is held behind its cutout by four machine screws countersunk into the panel in conjunction with washers and nuts. Details can be seen in the photograph. The screws must be countersunk so that the front panel can be fitted.

The amplifier for the speaker and the switches be done using multicoloured wires, as this makes the job much easier and less prone to mistakes. Connect them by crossing all the necessary wires to the edge connector.

Once this has been done, position the connector in the approximate position that it will occupy when connected to the printed board, and commence the wiring to the switches. This will have to be done as shown on the wiring diagram. It will be found that the wires from the connector can be grouped in two major bundles, one to each side of the board.

After completion, check thoroughly that no mistakes have been made. When this has been done, the remaining wiring can be completed.

The printed board can now be screwed to its mounting spacers, and the edge connector pushed firmly home. The tuner is now ready for testing. Plug the mains cord into a suitable receptacle, and switch on.

The pilot light should immediately glow. Advance the volume control and listen for a note.

If no sound can be heard, rotate the octave switch to the right hand switch. Check the switches and the potentiometer, as well as the pilot light. When fitting the knobs to the switches, ensure that their relative position is correct. The octave switch knob is fitted so that the pointer is vertical when the switch is set to the lowest position.

The note selection switch should be positioned so that A = 440 Hz can be heard when the pointer is vertically upward. If you are unable to tell this note by ear, set the knob to the change-over between C and C sharp occurs at the correct place. (These notes are nearly an octave apart, and occupy adjacent switch positions.)

The instrument should now be ready for use.

As a result of current expansion, a progressive and wholly Australian owned company manufacturing high quality electronic instruments for local and export markets offers excellent opportunities in the following position.

SENIOR ELECTRONICS TECHNICIAN

Experienced in solid state techniques to join our final test and alignment team. Formal technical training is essential, as is a logical approach to fault finding. An appreciation of oscilloscopes, their circuitry and uses is to be preferred as current models have up to 60MHz bandwidth, 2uV / cm sensitivity and dual time bases to 10ns/Div. Technicians with the qualifications who see the challenge which this position (and the rapidly advancing state of the art) has to offer should contact

Michael Greenall
B.V.D. ELECTRONICS PTY LTD,
329-333 Burke Road,
Gardiner, 3146.
Tel. 25 4425.
All current models, fully guaranteed. Now available at our new low prices. Standard Model, 4 speed Ceramic cartridge, sapphire stylus $37.50 As above with cueing device $39.00 Deluxe model with 13m turhautable, cueing device, stylus pressure and adjustment also player spindle, ceramic cartridge, diamond stylus $39.00. Deluxe C142, 4 pole shielded motor, heavy duty turhatable. Fully adjustable cueing device, bias compensator, changer / player spindle. Magnetic cartridge, diamond stylus Pack and post NSW $49.50 Interstate $51.50 Beautiful teak or walnut P.C boards. $113.90 ea. Tinted, fully moulded perspex cover $12.50 ea.

BSR STEREO RECORD CHANGERS

SONATA NS-1600D

All silicon solid state Hi-Fi stereo Amplifier. 16 watts RMS per channel. Each channel has separate Bass Treble controls. Inputs for magnetic or ceramic cartridge. Crystal mic, radio, tape - tape out, stereo headphones. 8 16 ohms Instruction booklet, circuit supplied. Timber cabinet. Dimensions 4½" x 8½" x 6" 50 watts RMS. Solid state guitar amplifier. PM125 4 inputs, 7 channel with separate variable, bass and treble controls. Speed and intensity control for vibrato. Remote foot switch with plug and lead. Black vinyl carry cabinet. Fully constructed and ready for operation off 240VAC 115V-60Hz.

GUITAR AND ORGAN SPEAKERS

Pioneer 15" 20,7500 Hz Res 45 Hz 30 WATTS RMS $23.00 Fully constructed. Plays 17" 125X20 20,7500 Hz Res 45 Hz 50 WATTS RMS $23.00 Role 12" 120X20 13500 Hz Res 45 Hz 50 WATTS RMS $40.00 Goodman audiom 18 P 18" 100 watts=8 OHM American C.T. S. 15" 100 watts R.M.S. 8 OHM $55.00 Indicate imp. required with order, 8 or 15 ohms.

MAGNAVOX WIDE RANGE TWIN-CONE SPEAKERS

8 16 OHMS 30 16,000Hz 6WKR MKS129W RMS $9.90 6WR MKS16W RMS $10.75 10WR MKS16W RMS $11.50 12WR MKS16WRMS $13.50 Pack and Post $6.50

PHILIPS

Model AD 0100 TB 1 1 Dome Tweeter. $8.95 P&P 35c.

DIMMER SWITCH

240V AC 500 Watts $11.75

SOLDERING IRON

240V AC 30 watts, lightweight 2½oz, heating time 1½ mins. $7.25

BRAND NEW GTE TRANSISTORS

AT464 10 for $2.95
AT414 10 for $1.95
2N2448 10 for $1.35
2N3638 10 for $1.35
2N4413 4 for $3.00
2N3770 4 for $3.00
M4820 4 for $2.60

COMMUNICATION RECEIVERS

MULLARD MAGNAVOX BOOK SHELF SYSTEM TEAK OR WALNUT

6WR MKS 3TC 8 or 16 ohms 15½" x 8½ x 8½ Complete $32.50 Cabinet only $17.70 ea.

VOLT-OMH-MILLIAMMETER

Price $34.75

Speaker 8 16 OHMS. Suitable for radio cassette or cartridge $5.75 each, $32.50 pair. P&P 35c.

PLAYMASTER 136 STEREO AMPLIFIER

As per Dec 72 E A Full kit including Fairchild transistor sections $62.50 Metal work only $75.45 P.C. boards $6.00 Wired and tested $82.50

KAISE

VOLT-OMH-MILLIAMMETER

HIGH SENSITIVITY
100,000 Ohms per Volt DC
10,000 Ohms per Volt AC

SPECIFICATIONS
- DC Volts 0.6, 1.2, 60, 200, 600, 1200
- AC Volts 0, 10, 20, 300, 600, 1200
- DC Current 12V, 300mA, 6mA, 60mA, 600mA, 12A
- AC Current 12A
- Resistance 70k ohms, 300k ohms, 2M ohms, 20M ohms
- Decibels. +10 to minus 50, +10 to minus 500, +10 to minus 5000
- Accuracy DC plus minus 5% AC plus minus 4% (or full scale)
- Overload Protected by dual silicon-diodes
- Double jewelled plus minus 3pc Nut
- Plus minus 5% 10 dege Centigrade stabilised trim resistors
- Polarity changeover switch
- Scale with mirror

Price $34.75

Send SAE for full tech. Details.

TELE 51-7008

116 ELECTRONICS Australia, August, 1974
COMMUNICATIONS RECIEVER Trip 993DS in box. With manual. No further use. $90. Johnson (03) 64204.

WE SELL construction plans TELEVISION 3 D Converter, 253 camera, kinescoping recorder. VTR COLOUR CONVERTER HOBBYIST: Electronic microscope, mains or battery power, voice typewriter, Morse code to voice typewriter, Morse code to typewriter copier, transistorised television. ANSWERING MACHINE pushbutton dialler, phoneline, auto dialler, telephone extension in your automobile, legal connector. SECURITY Microphone Jammer, voice recorder, microphone photography. Plans $5.00, air shipped from our USA research labs. COURSES: Telephone engineering $29.50, security electronics $32.70. Investigative electronics $22.50. Super hobby catalogue air mailed $1.00. Payment accepted in dollars (Australian, New Zealand or UK). Mail to: Don Rees Radio, 90 The Entrance Rd, The Entrance, NSW. Phone Gosford 3341.

FOR SALE

COMMUNICATIONS RECIEVER Trip 993DS in box. With manual. No further use. $90. Johnson (03) 64204.

WE SELL construction plans TELEVISION 3 D Converter, 253 camera, kinescoping recorder. VTR COLOUR CONVERTER HOBBYIST: Electronic microscope, mains or battery power, voice typewriter, Morse code to voice typewriter, Morse code to typewriter copier, transistorised television. ANSWERING MACHINE pushbutton dialler, phoneline, auto dialler, telephone extension in your automobile, legal connector. SECURITY Microphone Jammer, voice recorder, microphone photography. Plans $5.00, air shipped from our USA research labs. COURSES: Telephone engineering $29.50, security electronics $32.70. Investigative electronics $22.50. Super hobby catalogue air mailed $1.00. Payment accepted in dollars (Australian, New Zealand or UK). Mail to: Don Rees Radio, 90 The Entrance Rd, The Entrance, NSW. Phone Gosford 3341.

LANTHAN ELECTRONICS

69 Buchanan Ave, North Balwyn, Vic 3104. P.O. Box 162. Ph. 85 4061

BASIC BATTERY SAVER KITS

Consist of tapped transformer, bridge rectifier, filter cap & circuit. Will supply DC voltages from 6 to 15. Suitable for use with radios, tape recorders, record players, toys, instruments etc.

One amp size $7.50

Two amp size $11.50

Plus pack & post Vic 0.55. Other 0.95.

BASIC BATTERY CHANGER KITS

Consists of transformer, bridge rectifier, ballast resistor, parallel or series capacitor & diode.

Two amp model charges 12 volt batteries only.

Four amp model charges both 6 & 12 volt batteries.

$8.25

Plus pack & post Vic 0.65. Other 0.95.

BASIC MOTOR SPEED CONTROLLER

For reducing speed down to stop, without loss of torque. Suitable for all ac / dc or brush type motors. 2 amp, 500 watt - 2 amp size

$6.95

Plus pack & post 0.30.

BASIC LAMP DIMMER KIT

For controlling incandescent lamps from full to out at up to 1400 watts. Consists of triac, diac, pot. wire, knob, ferrite rod inductor, capacitors, resistors - circuit.

$11.35

Plus pack & post 0.20

PLASTIC CABINETS

Suitable for above speed controller & lamp dimmer kits. Approx size - 117x6x235 mm. $1.35

Including postage.

HAND TOOL SPEED CONTROLLERS

Complete ready to use kit. Requires speed down to stop with no loss of torque. Suitable for all ac / dc or brush type motors.

500 watt-2 amp size $14.90

2500 watt-10 amp size $22.90

Plus cert. post. Vic 0.75. Other 1.51.

BARGAIN PACK SEMI-CONDUCTORS

16 assorted including EM304, PN3569, 3638, 3645, BC547(107), S48(108), 548(109). All new standard stock.

$5.00

Including postage.

DIODES - EM404

One amp 400 PIV $5 for $1.00

Other 10 for $10.00

Including postage.
MARKETPLACE — Cont.

PHILIPS TYPE video recorder monochrome. Type EL3402 Helical scan one inch. & T.V. monitor 23 inch screen. as new $700. Ph. Sydney 90 7346.


WANTED

BOOMERANG TAPE RECORDING CLUB calling all tape recorder owners. Full details, PO Box 18, Wellington, N.Z. 2920.

PLUG IN AMPLIFIER for EM1 WAT, or WM1 oscilloscope. J. Rosemann 107 Victor Rd. 5m Oakleigh. Vic 3167. Phone 579 1205.

ELECTROMAGNET SPEAKER for early 30V Philco. SCALE FOR AWA 523 Radioi. Mr N. Mattick, Margraves 2950.

UNUSUAL UNITS, state condition and price airmail to J. Anderson, 81 West Belt, Rangiora, New Zealand.

BOOMERANG TAPE RECORDING CLUB calling all tape recorder owners. Full details, PO Box 18, Wellington, N.Z. 2920.

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UNUSUAL UNITS, state condition and price airmail to J. Anderson, 81 West Belt, Rangiora, New Zealand.
### POSTAGE KEY:

<table>
<thead>
<tr>
<th>Area</th>
<th>Rate</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: NSW</td>
<td>F &amp; P</td>
<td>$1.15</td>
</tr>
<tr>
<td>B: NT, NTN, New Guinea</td>
<td>F &amp; P</td>
<td>$1.60</td>
</tr>
<tr>
<td>C: SA, NT, Tas, New Guinea</td>
<td>F &amp; P</td>
<td>$1.95, D: $2.75</td>
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### VALVES BRAND NEW IN CARTONS

<table>
<thead>
<tr>
<th>Material</th>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>807</td>
<td></td>
<td>$1.50</td>
</tr>
<tr>
<td>8545T</td>
<td></td>
<td>$1.50</td>
</tr>
<tr>
<td>95c</td>
<td></td>
<td>$3.75</td>
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<td>7X7</td>
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<td>$1.00</td>
</tr>
<tr>
<td>7X7</td>
<td></td>
<td>$1.00</td>
</tr>
</tbody>
</table>

### PARABOLIC REFLECTORS

- **Pyrex Mirror**
  - 36" dia. ideal solar radio optical ex-perimenting also decorative purposes.
  - $27.50. Sorry shop sales only.

### TELEPHONE SETS

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single line number can be connected together on standard batteries at each phone</td>
<td>Any</td>
</tr>
<tr>
<td>Standard desk type with magneto belt</td>
<td>$35.00</td>
</tr>
<tr>
<td>with On-Off Switch and indicator</td>
<td></td>
</tr>
<tr>
<td>cartridge</td>
<td></td>
</tr>
<tr>
<td>lamps</td>
<td></td>
</tr>
<tr>
<td>for model machines</td>
<td></td>
</tr>
<tr>
<td>with continuous tuning</td>
<td></td>
</tr>
<tr>
<td>and harmonics</td>
<td>Ideal for Sig Tracing in trains. radio etc</td>
</tr>
<tr>
<td>with On-Off Switch and indicator</td>
<td></td>
</tr>
<tr>
<td>cartridge</td>
<td></td>
</tr>
<tr>
<td>lamps</td>
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</tr>
<tr>
<td>and harmonics</td>
<td>Ideal for Sig Tracing in trains. radio etc</td>
</tr>
</tbody>
</table>

### ELECTRONIC FREQUENCY Meters

- **I.F. and R.F. circuits.**
- **Powered by a Penlight Batteries with On-Off Switch and indicator.**
- **Lamp Size 1½" Diam.**
- **Long Only $6.50.**
- **Payable at nearest attended railway station.**

### RECORDING TAPES TOP BRANDS

<table>
<thead>
<tr>
<th>Size</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; x 150'</td>
<td>Top Quality Brand New</td>
<td>$7.50</td>
</tr>
<tr>
<td>3&quot; x 400'</td>
<td>Top Quality Brand New</td>
<td>$15.00</td>
</tr>
<tr>
<td>5&quot; x 1000'</td>
<td>Top Quality Brand New</td>
<td>$25.00</td>
</tr>
<tr>
<td>7&quot; x 2000'</td>
<td>Top Quality Brand New</td>
<td>$35.00</td>
</tr>
</tbody>
</table>

### COMMUNICATIONS RECEIVER

- **TCA R5223 Communications Receivers.**
- **Receive direct sound as much as a R390 A or a RACAL but gives the opportunity of having a unit with a similar performance at a fraction of the cost.**
- **Coverage from 1.5 to 30.5 Mhz. bands.**
- **First conversion is crystal locked into a 2.5 to 3 Mhz tunable second IF.**
- **UV sensitivity.**
- **Suit pocketed pocket units less than 1 Ibf.**
- **Accepts coastal 50 or 75 ohm antennas. Diversity operation possible.**
- **Complete with leads.**
- **Headset and headphones a bargain at $25.00.**
- **Cable to rail available at nearest attended railway station.**

### BATTERY CHARGERS BRAND NEW WITH METER

- **Plugs into 240v power and gives both 6v and 12v DC output.**
- **With ammeter and voltmeter.**
- **Dimensions. 9" x 5½" x 3" $35.00 value only.**

### SOCKET SPANNER SET

- **32 piece metric brand new.**

### CIRCULAR SLIDE RULE

- **3½" in diameter.**
- **Will do the same work as the conventional slide rule.**
- **Intruction book included.**
- **$26.00.**
- **(2 TELEPHONE SETS) $42.00.**

### AERIAL CLOCKS

- **Genuine Smiths Eight Day Jewelled movement, sweep second hand and start of trip indicator.**
- **Dial mould tings. Ideal for car rallies.**
- **$17.50.**

### TELEPHONE WIRE

- **1 mile twin (2 miles) genuine ex Army.**
- **$1.25 per 100' or 25.00 per 1000'.**

### BATTERY CHARGERS

- **BRAND NEW WITH METER.**
- **Plugs into 240v power and gives both 6v and 12v DC output.**
- **With ammeter and voltmeter.**
- **Dimensions. 9" x 5½" x 3" $35.00 value only.**

### SOLENOIDS

- **Plunger Type 12V 3000MA Suits electric camera control, miniature trams, radio etc.**
- **$2.50 P & P 20c.**

### FOCUSING MICROSCOPE

- **Battery and mirror illuminated 900X magnification Complete with dissecting kit slides etc.**
- **P & P A. $1.45, B. $1.60, C. $1.75, D. $1.85.**

### BATTERY HAILER

- **Battery operated, transistorised, in good used condition $27.50.**
- **Post A 70c, B 85c, C 1 1/2, D 2.10.**

### Deitch Bros.

**70 Oxford Street, Sydney 2010**

**SORRY NO C.O.D.**

**ELECTRONICS Australia, August, 1974**

**119**
AMPHIPRIAN TRADING CO.

6000 2N3918 Transistor min 100 at 20c ea.
6000 40498 Transistor min .100 at 40c ea.

800 yards 4 core T.R.S. 40 / .0076 (15 amp) min 100 yards at $50.

600 pwr. supply Transformers 240 V. prim. 4 / 4 V. at 6.5 Amp. & 100 V. at 250 mA. 68 ea.

150 pwr. supply Transformers 240 V. prim. 550 & 200 V. at 150 mA. 28V at 500mA. & 12 / 12 V. at 500mA. $12 ea.

500 R/T mikes Hi Imp. $8.50 ea. OR $6.00 / .12.

Also edge connectors, trimpots, trim caps. IF coils, transformer wire, pot cores, duel pots. Valve shields WRITE FOR INFO.

Send cheque of money order to:
P/0 Box 24, Waverley, N.S.W. 2024.
How to graduate to 4-channel sound. Study the TEAC A-2340R.

It’s TEAC’s breathtaking 4-channel A-2340R. A dynamite open-reel tape deck that gives you “surrounding” sound. Puts you right in the middle of the band.

Here’s what it can do.
First, the A-2340R records and plays in four-channel, two-channel or monaural. It can handle any kind of recording and playback you demand of it.
Then there’s the Automatic Reverse playback for two-channel play. Stereo tapes get a complete run through. When side 1 finishes, side 2 begins. Automatically.
And the built-in mic-line mixing capability allows you to mix, record and be as creative as you like in making tapes.
And to assure stable and constant tape run, the A-2340R has three motors.
All in all, it’s one of the easiest to operate tape decks on the market.
All at a price you’d pay for a top quality stereo deck.
Now, go study the A-2340R at your next opportunity.
If you're planning a first rate stereo or four channel system then the JVC turntables become a 'must' component.

These precision built units not only offer the best features of stereo turntables costing twice as much, but have a very special added advantage—they all have 4 channel (CD4) ready status. In fact all that is required is a 4 channel stylus.

With JVC you not only have 4 channel but also a choice. Three turntables specially designed to suit your particular need.

So if you want the best in stereo or four channel, choose JVC.

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