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Volume 54, No.3

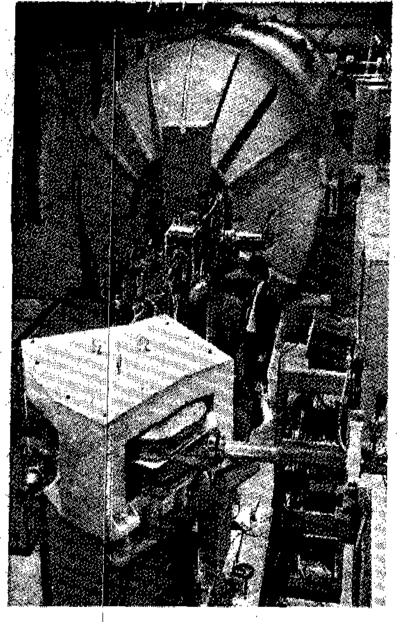
Electronics Australia

WITH ETI

March 1992

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

ANSTO's new Tandem Accelerator



It was being scrapped in the USA, but Australia's Nuclear Science and Technology Organisation bought it, rebuilt and updated it. Now it can be used for ultra-high resolution mass spectroscopy, including radiocarbon dating to much closer accuracy than previously. Peter Murtagh tells the story, beginning on page 10.

'Cheap & cheerful': Rob's new audio oscillator

Kit suppliers tell us there was a very warm response to the low cost 18V/1A power supply that Rob Evans described in the August 1991 issue. Now he's produced a companion audio oscillator, which should be just as popular. Turn to page 58...

On the cover

No, it's not a baby flying saucer, but a multiple beam antenna for cellular radio base stations, being developed at Telecom's Research Labs in Melbourne. Researcher Stan Davies is shown testing one of its lens feeds. (Picture courtesy Telecom Research Labs, taken by Andrew Lucas)

Video and Audio

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Projects and Technical

Professional Electronics

Columns and Comments

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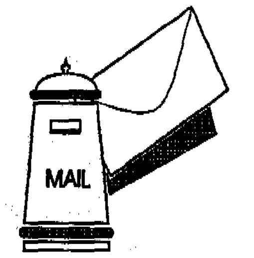
LETTERS TO THE EDITOR



Type II cassettes

I have just finished reading the Challis Report on cassette tapes in the November edition, with considerable interest in the test results. It occurs to me that the comparatively poor high frequency response of the IEC II type tapes could be attributed to using 70us replay characteristic, while using 120us time constant with IEC I tapes.

Derek Williams,
Queens Square, Sydney, NSW

Comment: Louis Challis agrees that the poor response is indeed due to the IEC's choice of a 70us replay characteristic, Derek. With the benefit of hindsight, the IEC made an unfortunate choice.

Editorial response

After reading your editorial in November, I would like to make a couple of points. I don't think that most people think electronics is dull or boring but most people just don't understand it. They want what electronics can give them but are apprehensive of the technological.

This is in part our fault because we talk in terms that are not understood, and also a lot of electronic items come with Japanese English instructions. As for Australian made there is a feeling that if it is worth making, it will be made overseas. Australia has, I believe, a good chance of becoming a force in the electronic field if we are able to use the talents that we have well.

Rather than make people coming up with a new idea struggle to get it to market, fight government, then be told that you need to go to overseas to get it made, we should be putting these ideas into production in Australia.

It should be said that marketing is sometimes more important at this point, what is made must be required if the product is to be successful.

We need to learn what the major companies have learned overseas, that presentation is just as vital to make a product sell. The local market is ready for picking by Australian enterprise, but is our attitude correct?

In most cases the worst offender is the government. For instance I think that quality control is a good idea, but the red tape and cost that government has imposed has made it a burden in most businesses. There is hope but the attitude to make it work is essential if we as a nation are going to become a major force in electronicproduction.

Sam Wallace,
Alexandra Hills, Qld.

Dismayed with review

Electronics Australia is to be commended for excellent technically based product reviews. However, I was totally dismayed with the review of Philips Matchline TV receivers in your December issue. There was no mention of resolution or linearity at all.

With big strides forward in the resolution game being offered by SVHS, separate chrominance and luminance S-connection, Laserdiscs, etc., a statement of resolution becomes a vital statistic in any *meaningful* review of a screen. You appeared more interested in exact weight and dimensions and even dimensions of the remote control — all minor considerations. About the only reference to screen performance stated '...well defined colour areas.' I wonder what that means!

Disappointing in relation to your usual high technical standard.

Don Mantack,
Palm Cove, Qld.

Peak factor

I wonder if you could clear up a slight dilemma for me? I have always thought that to get PEAK voltage from RMS, it was only needed to multiply the RMS by 1.414. I have now been told that it is twice that figure and this is causing a bit of confusion!

If I, my old mentors, Mr Tesla and others are wrong, then why should 2.828 give PEAK? As an electrician, I always thought that 339.3V was PEAK value of 240V and to get the PEAK to RMS was the inverse of root 2? Or are my text books and teachers wrong?

I would like to have an answer from a reputable person such as is on your staff and clear this up for me.

John Smith,
Middelton, SA.

Comment: It sounds as if your confusion is due to a difference in terminology, John. The peak value of a sinewave is indeed 1.414 times, or root-2 times the RMS *value. But the peak-to-peak value, which is twice the peak value, is accordingly 2.828 times the RMS value. So you were right, and whoever told you otherwise was really referring to the peak-to-peak value, not the peak value.*

Valve filaments

I was pleased that 'The Serviceman' found my contribution to be worth publishing in the December 1991 issue. I must round up some more anecdotes.

Comment was made about the use of the term 'filament'. It still is the terminology used by valve makers when referring to directly heated cathodes although, as remarked, in many cases 'wire' would be a more apt description.

By the way, in the case of some modern types, 'mesh' would be more appropriate.

Some readers may not be aware that indirectly heated cathodes cannot be used in valves operating at high anode voltages and/or currents, and that many transmitters are still being produced with valves in their final stages. One reason is that as yet, really high powered, high frequency semiconductors are not readily obtainable. Current practice with solid state transmitters is to have a number of modules working in parallel. Problems of power sharing at VHF can be imagined.

The assumption that the mercury vapour rectifiers in my story were directly heated was correct. In fact, to the best of my knowledge, indirectly heated cathodes were never used in mercury vapour rectifiers, regardless of size. One reason was that to prevent arc backs, it was essential to heat mercury vapour valves throughly to vapourise the mercury before applying HT and obviously quick heating was necessary. No tears were shed when MV rectifiers were replaced about 30 years ago by plug-in solid state rectifier stacks.

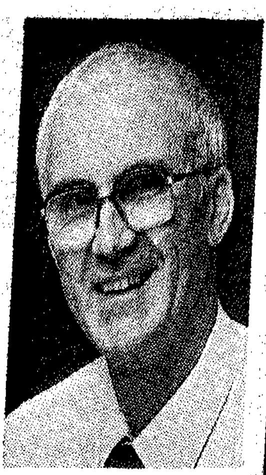
I understand that the term 'filament' goes back beyond early valves and has been attributed to Edison, who applied it to his experimental lamps. As valve manufacture evolved from lamp making, it was almost a foregone conclusion that it would be used for directly heated cathodes. Of course, the most appropriate description 'emitter' came with semiconductors.

Peter Lankshear,
Invercargill, NZ.

DROP US A LINE!

Feel free to send us a letter to the Editor. If it's clearly expressed and on a topic of interest, chances are we'll publish it — but we reserve the right to edit those that are over long or potentially libellous.

EDITORIAL VIEWPOINT



The next big boom in electronics technology?

It's become fairly obvious in the last year or so that the personal computer 'boom' has passed its peak, and is now more like an ongoing rumble. PC's as such have now become established as personal workstations, and are bought like many other appliances at the local discount store. New models keep on appearing, to be sure, but these are largely 'faster and bigger' versions of much the same thing.

So what's going to be the next 'hot' product? This is still a little hard to predict, at least in specific terms. But there are a huge number of developments taking place within the broad area of digital information processing, manipulation and communications. It's looking more and more as if this will be the next major growth area in electronics, both for consumers and professionals.

I'm not just talking here about digital TV and videos, or HDTV and radio via optical fibre cable, or personal satellite phones, or CD-ROM based electronic books, or on-line databases, or video phones, or electronic publishing, or electronic mail, or DAT/DCC/recordable CD/memory chip audio recorders, or interactive computer-controlled audiovisual games and learning packages. I'm really talking about ALL of these, and more — because it's becoming clear that all of these individual developments are now converging and building upon each other.

President Bush has now committed the USA to spending around US$6 billion, over the next four years, to develop a nationwide high speed digital network. This was originally going to be purely for linking research labs and their computers, to allow rapid information exchange and pooling of resources. But now it looks like being expanded to allow things like instant access to health information by hospital workers, remote education via interactive computer video, and instantaneous electronic publishing. In short, a new and vastly strengthened 'information backbone' for the entire country.

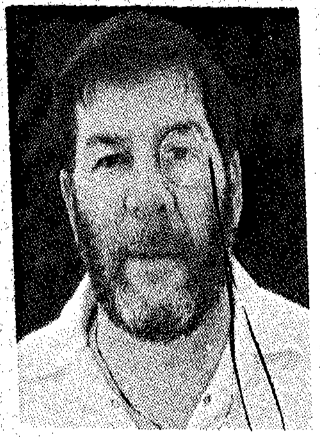
This is just one example of the way things are starting to snowball. There seems to be no doubt now that we're entering a new era, when a common digital technology will be used for work, play, entertainment, learning and communication. The telephone, the pager, the radio, the VCR/TV, the cassette/CD player, the fax machine, the calculator, the pocket organiser and the computer are all beginning to come together, to form a new generation of personal information/entertainment centres — or what Apple Computer's chairman John Sculley has dubbed the 'Personal Digital Assistant'.

Exactly what these new machines are going to look like is still hard to predict. It's also not easy to say just which of the umpteen possible services and facilities will turn out to be the most useful and popular. But one thing's certain — there are going to be some really exciting developments in this area, over the next decade or two!

Jim Rowe

Moffat's Madhouse...

by TOM MOFFAT



Real arcades, and mechanical music

Funny how one thought leads to another, isn't it? I was just reading a column in a computer magazine about 'arcade games'. And it occurred to me — how many computer enthusiasts, especially young ones, have actually SEEN an amusement arcade? I mean, a REAL arcade, not a video games parlour. Like so many things, I guess they're a dying breed.

I mis-spent a good part of my own youth in a proper arcade. My family had a summer cabin up in the mountains, in a little settlement called Cascade, Colorado, in the USA. The nearest town was Manitou Springs, which is nowadays a suburb of Colorado Springs.

You've probably heard of that one; it's the place where the US Air Force has a command post buried deep within a mountain. If there's a nuclear war, and we are all to be annihilated, Cheyenne Mountain is where the big red button will be pressed. But back in the 1950's, Cheyenne Mountain was just an innocent mountain that wouldn't hurt anybody.

Saturday nights during cabin holidays were 'go to Manitou' nights. The first thing you'd come to in Manitou Springs was this big rambling white structure called 'The Arcade'.

It was a covered-over open area you could wander through day or night. The floor was of timber slats, and beneath it ran a mountain stream. If you dropped your money you could kiss it goodbye, and brave boys made it their business to climb up under the arcade, along the rocks in the stream, to prospect for dropped coins. Spooky!

In the very centre of the arcade was a big concrete fountain, that plugged into an underground spring containing the stuff we call mineral water today. Or maybe it was soda water. Anyhow, drinking from it was free, but you had to pay two cents for a paper cup — which you could use as many times as you liked.

Clever kids who wanted to get their two cents' worth would drink cup after cup of this elixir, right up to the bursting point. It was pretty gassy stuff, producing burps measuring at least seven on the Richter Scale.

At one corner of the arcade was a fine old pub with a neon 'Michelob Beer' sign in the window. On arcade nights Dad and all my uncles made a beeline for that pub, and didn't leave until closing time, or until they were dragged out by the women.

Otherwise the women wouldn't set foot in the place. They went off window shopping and later sat in the park next to the arcade, where they would spend the rest of the evening discussing the poor habits of their husbands. From time to time they would also cast scornful glances towards the noises coming from the patrons of the mineral water fountain.

My own companions were two girl cousins, whose main interest was impressing the various young dudes who swaggered about the arcade puffing cigarettes and looking very, *very* tough. So I was left on my own, to wander the infinite joys of the arcade's interior. Several lockable buildings were under the one roof, and each and every one contained the fantastic marvels of the world. Mostly these were pinball machines, to which I suffer an addiction to this very day.

But there were lots of other diversions, like the machine that was a miniature bowling alley. You rolled a small ball and skittled the pins at the other end, and mechanical sensors and relays and logic circuits kept the score for you.

There were also those soccer machines that still exist today, at least in England, where you push rods in and out and twist them to control the actions of little players on a boxed-in field. And those scoop gadgets, now making a most welcome re-appearance. You controlled this big scoop bucket dangling from a chain within a glassed-in box, hopefully to pick up a good prize and drop it into a chute which delivered in into your hands.

Everything went 'ding' and 'dong' and 'clunk', and a whole roomful of them would make a most dreadful — yet somehow satisfying, noise. And then one Saturday night, in an arcade building I hadn't been to for awhile, the clunks and bongs suddenly gave way to the sound of a band playing a Scott Joplin ragtime tune. Where was that coming from? I found out soon enough.

There was a big oak cabinet almost filling one wall. Its front was mostly clear glass panes set into frames, intermixed with coloured glass. The sides of the cabinet were fitted with what looked like leadlight windows. There were bright lights inside, shining out through the coloured glass. Some lights seemed to be pulsing in time with the music.

In the very centre of the cabinet was a paper roll mechanism, much like on a player piano. I guess that's what the thing was, mostly — a pianola, but with a few enhancements.

Above the roll, at about eye level, was this contraption that obviously began life as a violin. But instead of a bow there were four little abrasive 'grinding wheels', that could be moved down to gently touch each string. And on the finger board, no fingers — but pads which could be moved down to squeeze the strings against the finger board at various places. The combination of the correct pad and the correct grinding wheel would produce a single violin note.

To the right side of the cabinet, standing vertically, were the remains of a mandolin, again with pads for the fingers but with things that plucked instead of ground at the strings.

On the left side were a snare drum, a tom-tom, and a cymbal, with mechanical hammers to whack them at the right times. Down in the bottom, among the lowest strings of the piano section, was a big bass drum.

The entirety of this marvelous contraption worked on air pressure. There were little actuator valves everywhere that snapped up and down, and bellows gadgets that puffed in and out, almost in time with the music. One of these had been painted green, with red eyes and white teeth to resemble an alligator, and it sat there chomping away, beating time with Scott Joplin.

As well as selecting the notes to be played on all the instruments and beating the rhythms on the drums, the paper roll seemed to have control over the volume they produced. So when a song started, everything would play full blast through the first chorus. Then the rest of the machine would back off a bit to let the violin have a solo. Next the mandolin would come up, to play in harmony with the violin. Then when the 'middle bit' of the song came along the piano would jump in with some thundering bass notes, accompanied with much thumping from the bass drum.

Since the whole business was co-ordinated by the paper roll, programmed in advance, the band-in-a-box had no choice but to play together. Nobody could get lost, nobody could lose the beat, nobody could start off in the wrong key. So the roll programmers had given the machine some arrangements of exquisite complexity.

The thing would play along for awhile and then begin double-stepping, with part of the machine playing '90° out of phase' with the rest of it, so it sounded like it was going twice as fast. Then it would come back into sync by throwing in little one-beat 'stops', on beat number seven out of eight.

I was hopelessly in love with a big oak box. From then on, on every visit to the arcade, I fed as many coins into that music machine as all the pinball machines put together. In later years I learned to sniff out mechanical music contraptions no matter where they were hidden. An early discovery was a giant museum filled with them in another Colorado town, a wide spot in the road called Nederland, up in the mountains above Boulder. (You've heard of Boulder — that's where the National Bureau of Standards hangs out.)

Still another gold mine of musical gadgets is in Virginia City, Nevada, famous from the US gold rush days. The entire town has been kept as it was in the 1880's, right down to a large cathedral that doesn't have a nail in it — the whole thing is held together with wooden pegs. The place even shunned modern communications, and stuck with the only completely manual telephone exchange left in America. And it used to be my job to keep it going — but that's another story.

I lived in Carson City, just a few kilometres from Virginia City, and it was to be the done thing to mosey right up there for a Saturday afternoon's gambling in Virginia City's small and pleasant casinos. My friends would head for the tables, but I'd head for the music museum, to feed my hard-earned cash into big oak boxes that played thumping, bumping, old-time ragtime.

That's a long way away now, both in time and distance, but it turns out Australia has a fair bit going for it too in the field of musical contraptions. In fact I even have one in my home now, a big noisy wind-powered organ thing that spent its early years entertaining the patrons of a brothel in Bendigo. It almost reaches the ceiling and plays itself from paper rolls. They're much like piano rolls, but the hole spacing is greater and there are fewer of them. The machine can startle guests with a rousing rendition of the *Flying Dutchman Overture*, just like the old spook in the original *Phantom of the Opera* played it down in that cave. Or it can bring tears to the eyes with the old-time waltz sounds of a Luna Park carousel.

But all these things pale into insignificance, as they say, when compared with the most amazing and fantastic musical contraption I've ever had the pleasure of meeting. It's called the Robot Orchestra, and it lives somewhere in Sydney, possibly the Powerhouse Museum. The machine is based on a flatbed truck which acts as a stage. On it are three musicians — a drummer, a saxophone player, and a guy with an accordion. As the music starts, again under the control of holes in a paper roll, the drummer starts tapping, the sax player stands up, and the accordion player rips into it.

The players, of course, are robots — life sized, or maybe a little bigger — and they're made of wood, in sort of a 'blocky' style like robots from science fiction films of the fifties. The drummer twists around on his stool, using one drum and then another.

The sax player stands up for his solos, and then sits down again. The accordion player does a lot of squeezing, but his hands don't really move; his fingers have been replaced with a mechanical actuator for each key on the keyboard. Hidden from view is what appears to be the guts out of an elderly Hammond organ, to provide a kind of bass undercarriage for the overall sound.

When this contraption starts playing it will blow you away. Everything moves at once; the players nod and look around, and if you let your mind drift a bit you'd thing the robots were real players. A bit silly looking, but real. And the music! A lot of it is that double-stepping style that the machine in the Arcade used so many years ago.

In fact I was so taken with the sound that within a week after hearing the Robot Orchestra, I bought an old accordion and introduced it into the jazz band where I was already playing guitar and piano. The rest of the guys grizzled a bit at first about it being an 'old folk's instrument' — but I pointed out that accordions are becoming trendy again. After all, Paul Simon's band uses one. And people sit up and take notice when our own 'Burglar's Dog' band starts thumping out Zydeco and Cajun tunes. When will the Robot Orchestra learn some of that stuff?

The Robot Orchestra was built, I believe, back in the 1950's, in Belgium. And I fear it was among the last mechanical musical makers to be produced. Nowadays things have to be useful to be built, and the Robot Orchestra couldn't spray-paint motorcars or assemble televisions. It didn't have one useful purpose — nothing! — other than to make people happy.

Now televisions and video games are our 'happy machines'. But myself, I'll take an old-time music machine any day. ❖

Mass spectrometer:

New Tandem Accelerator for Lucas Heights

A new tandem accelerator was officially opened last September at the Ansto facility at Lucas Heights in the South of Sydney. The accelerator will be used for both Accelerator Mass Spectrometry (AMS) and Ion Beam Analysis (IBA). AMS will provide a very sensitive mass spectrometer, while IBA will give non-destructive surface analysis of targets. Both techniques will be used in applied research, as well as for environmental, industrial and health studies.

by PETER MURTAGH

Ever since scientists discovered that the atoms of different elements have different masses, and even that the mass of the same element could be different, efforts have been made to measure these masses with ever increasing accuracy.

The machines which measure these minute masses are called *mass spectrometers*. They work on the basic principle that a charged particle (ion) moving through a magnetic field will move in a circular orbit, and that the radius of the orbit depends on the particle's mass, charge and velocity.

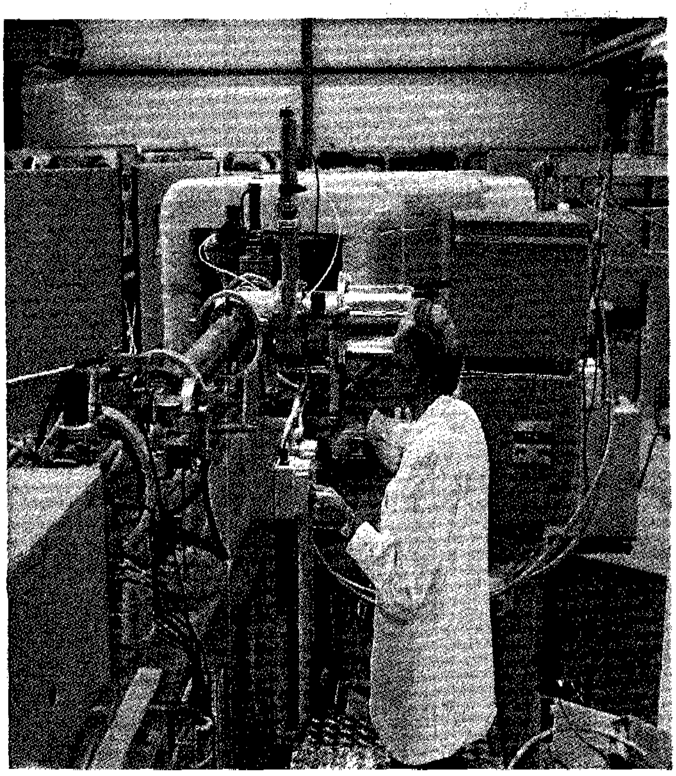
The sensitivity of measurement has been improved by using more intense magnetic fields, as well as by accelerating the ions to higher velocities. The particle accelerators used to achieve these high velocities often use Van De Graaff generators to produce the required high voltage.

With the newly commissioned tandem accelerator at Lucas Heights, scientists at Ansto can achieve AMS (accelerator mass spectrometry) with an accuracy of $1:10^{15}$ — for example, they will be able to detect one atom of radioactive carbon-14 from among one thousand-million-million ordinary carbon-12 atoms!

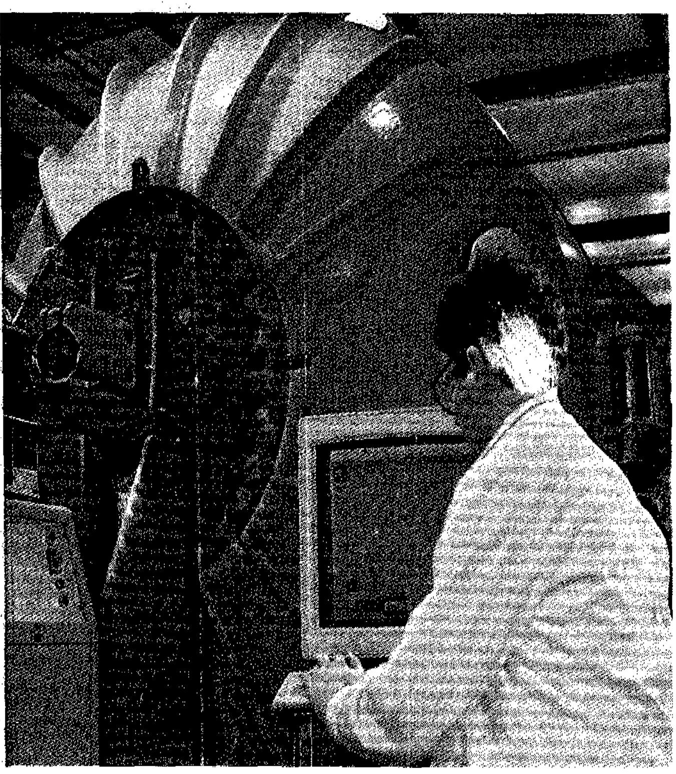
Historical development

J.J. Thomson built what was really the first mass spectrometer back in 1912. In one of his experiments with 'positive rays' (positively charged atoms, now called ions), he fired his rays through an area subjected to parallel electric and magnetic fields, and then onto a photographic plate. Particles with the same charge-to-mass ratio, but with different velocities, fell on a single parabola along the film.

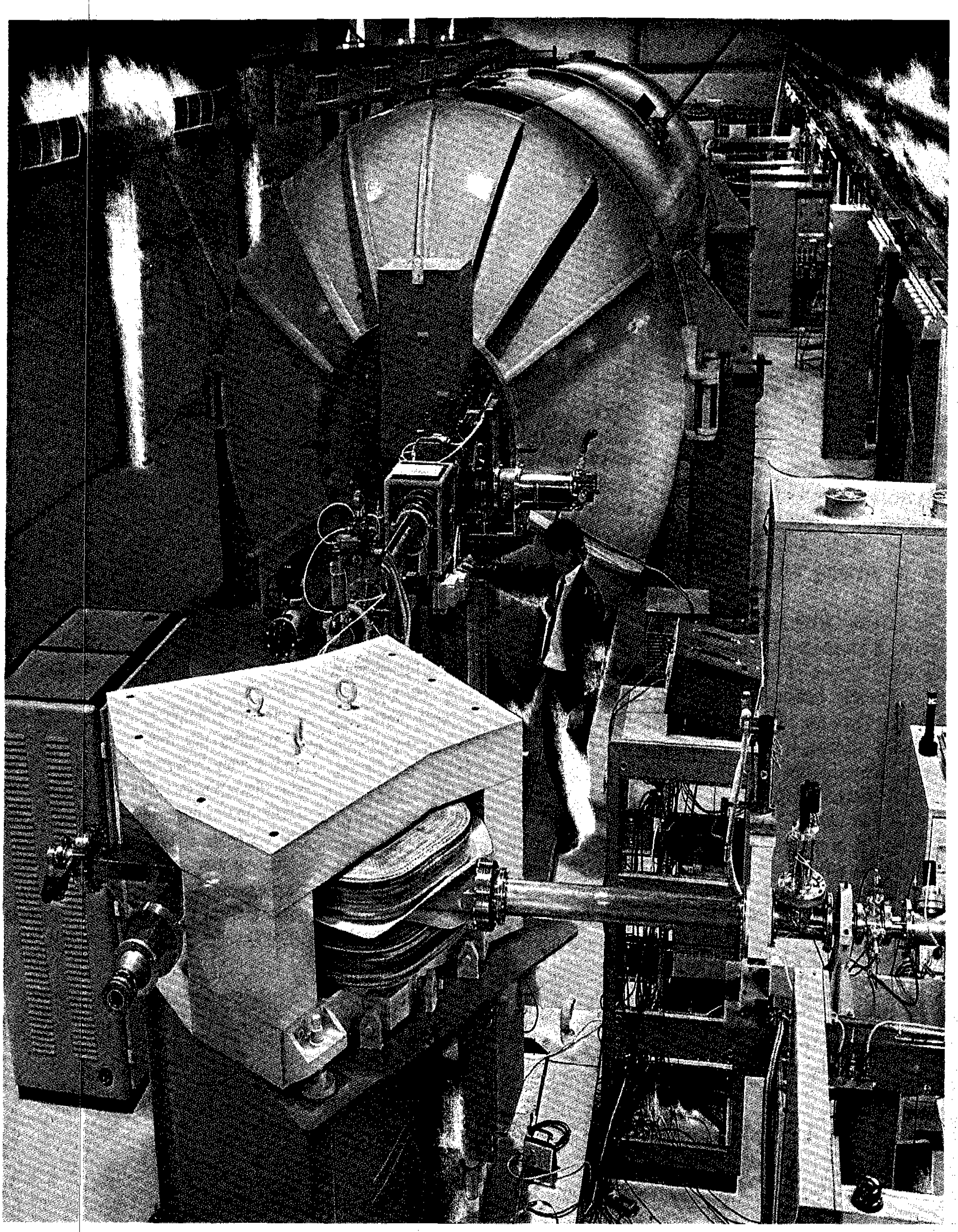
But when experimenting with neon atoms, Thomson was surprised to find not *one*, but *two* parabolas. He was eventually able to explain these two curves when he realised that neon had two separate atomic masses, 20 and 22. He had discovered *isotopes*. But more



The section of the beam line linking the tank to the analysing magnet. At the right, the line enters another room which houses the switching magnet. Note the large cryogenic cooling unit to the front right of the magnet — the current producing the magnetic field can be as large as 300A.



The exit end of the tank. At the far left is the RF source which charges the belt inside the Van de Graaff generator. Beside it is the large spring which applies tension to the internal supporting columns which hold up the entire internal structure.



The beam line emerges from the ion source at the right, passes through the injection magnet, and proceeds to the main accelerator housed in the huge cylinder. Note the corona of discharge wand on the top right of the tank.

on the nature of isotopes and their importance later.

Other scientists like Aston and Dempster improved on Thomson's design, and built more sensitive and accurate mass-measuring devices by using focusing principles to increase the intensity available at the detector.

Box 1 shows one method for measuring mass. The radius of a particle's circular orbit in a magnetic field depends on its mass, charge and velocity. So by first passing the equally-charged particles through a velocity filter, which deflects any without the selected velocity, the radius of orbit now depends only on the remaining particles' mass.

Other methods use the electric and magnetic fields to send particles with the same mass, but different velocities, along different trajectories which meet at the same focus. A.J. Dempster built his mass spectrograph using such a design (see Fig.1).

In 1931, Van de Graaff invented his generator, which was the first machine able to accelerate a particle to energies greater than 1MeV. Scientists use MeV units for the energy imparted by such accelerators — a million electron volts (1MeV) is the energy imparted to a particle with a single electronic charge by a potential of one million volts (1MV).

Van de Graaff used a fabric belt to transfer static charge to a metal dome, where the electric charge accumulated, building up the very high voltages. (See Box 2 for more detail on how it works). Modern versions work on the same principle, but because of various improvements can produce even higher voltages.

For example, the newly-installed tandem accelerator uses sulfur hexafluoride as an insulating gas, and can produce up to 10MV.

Isotopes

The isotopes discovered by Thomson, like all isotopes, were atoms of the same element but with different masses. These different masses are caused by different numbers of neutrons in the nucleus of the atoms. The extra neutrons only affect the mass and not the chemical properties — the atom still remains the same chemical substance.

However, too few or too many neutrons in the nucleus can make the atom unstable (radioactive), and it will eventually 'decay' back into a stable atom by emitting various forms of radiation.

The element carbon provides a good example. It exists in the atmosphere as both stable carbon-12 and carbon-13, and radioactive carbon-14. The '14' means that there are 14 particles in the radioactive nucleus, two more than in normal carbon-12 (the extra two particles are both neutrons).

Radioactive carbon-14 is constantly being formed in the atmosphere when the nitrogen atoms capture thermal neutrons which are formed by the bombardment of the atmosphere by cosmic rays. In the process of gaining a neutron, each atom loses a proton, which means that the nitrogen atom is changed into a carbon atom. But because it still retains 14 particles in its nucleus, it has become carbon-14.

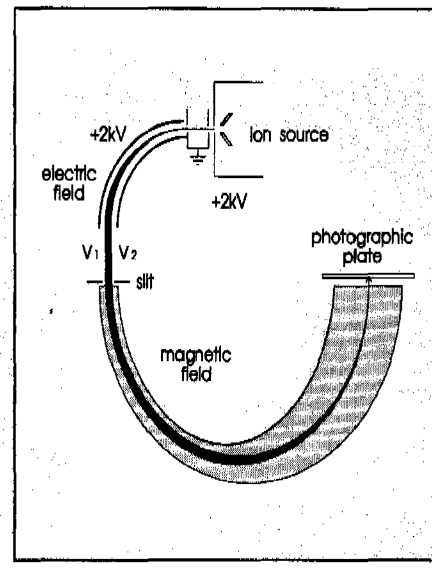


Fig.1: A.J. Dempster's mass spectrometer used an arrangement which focused ions with the same mass, but different velocities, to the same point.

Measurements of carbon-14 are very important for calculating how long ago something was alive. Living things absorb carbon-14 from the carbon dioxide in the atmosphere. Plants absorb the gas directly, and animals eat the plants.

So in all living things, the ratio of carbon-14 to carbon-12 remains constant. But after they die, the carbon-14 slowly decays back to nitrogen by beta emission — every 5730 years the number of radioactive particles halves.

By measuring the ever declining ratio of carbon-14 to carbon-12, the age of a fossil can be calculated. With the $1:10^{15}$ sensitivity of the new Ansto accelerator mass spectrometer, fossil ages up to 60,000 years can be accurately determined.

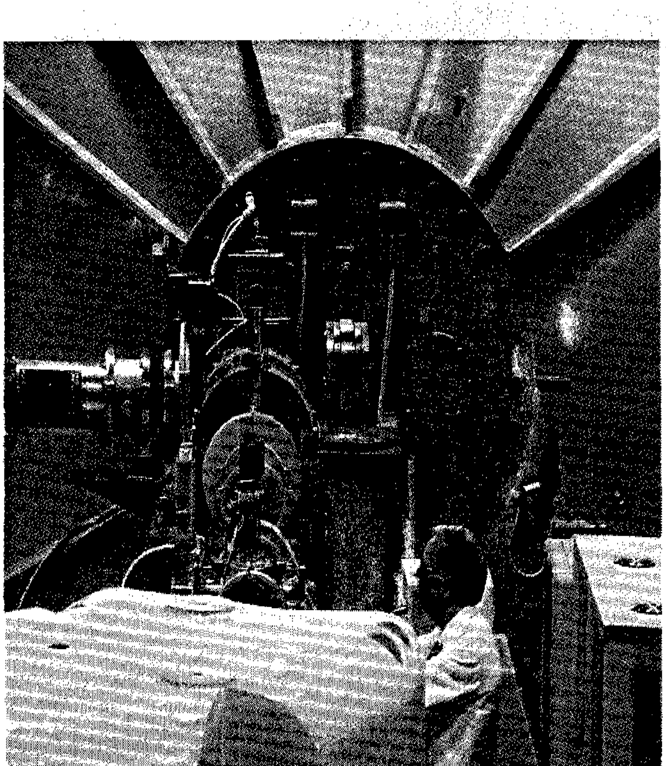
An important application for this carbon-14 dating technique is determining the source of Sydney's air pollution. If the source of the pollution is fossil fuels, like petrol or coal, then there will be practically no carbon-14 present — the fuels formed so long ago that it has all decayed.

But if the source is a bush fire, or backyard burning, then the percentage of carbon-14 will be close to that found in the surrounding atmosphere. The isotopic ratio can thus determine the source of the pollution.

Ten years ago, it would have taken over a week to collect an air sample large enough to be analysed by conventional radioactive decay counting, but today it only takes 10 minutes because of the sensitivity of Ansto's new machine.

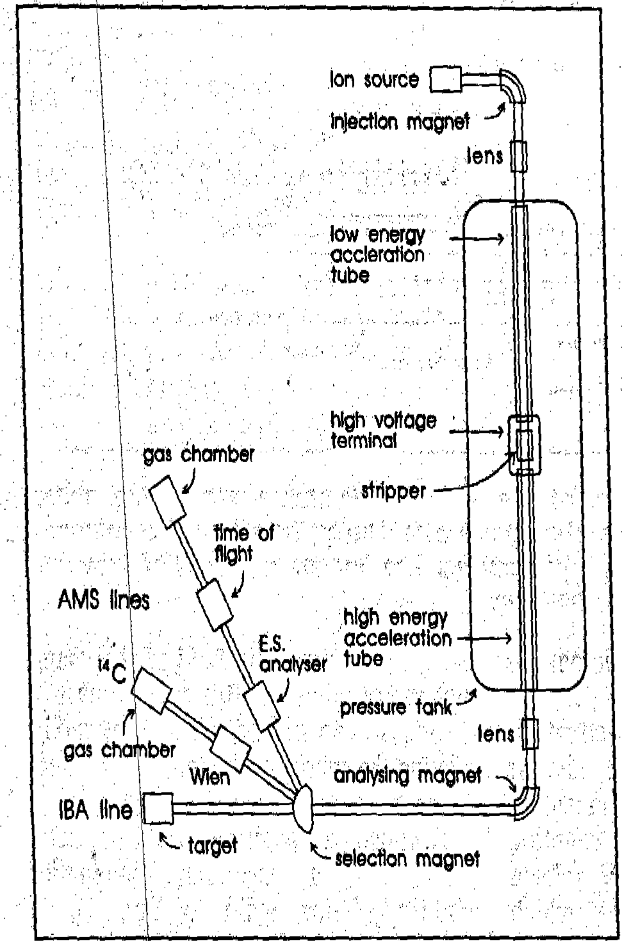
Similar techniques use beryllium-10 to measure the movement of topsoil eroded from farms, and chlorine-36 as a groundwater tracer to determine age and travel time of water moving through the Great Artesian Basin.

These isotopes, along with carbon-14, are also used to date the ice layers in Antarctica. The layers, which date back 100,000 years, contain trapped gas bub-



The beam line emerges beside the tensioner, then enters the analysing magnet which selects the now positively-charged ions with the desired 'magnetic rigidity'. Note the large vacuum pump poking out to the left of the line.

The director of the AMS project, Dr John Bolderman stands beside the third large magnet. This is the switching magnet which directs the ions along the various AMS and IBA lines to the detectors which make the actual measurements.



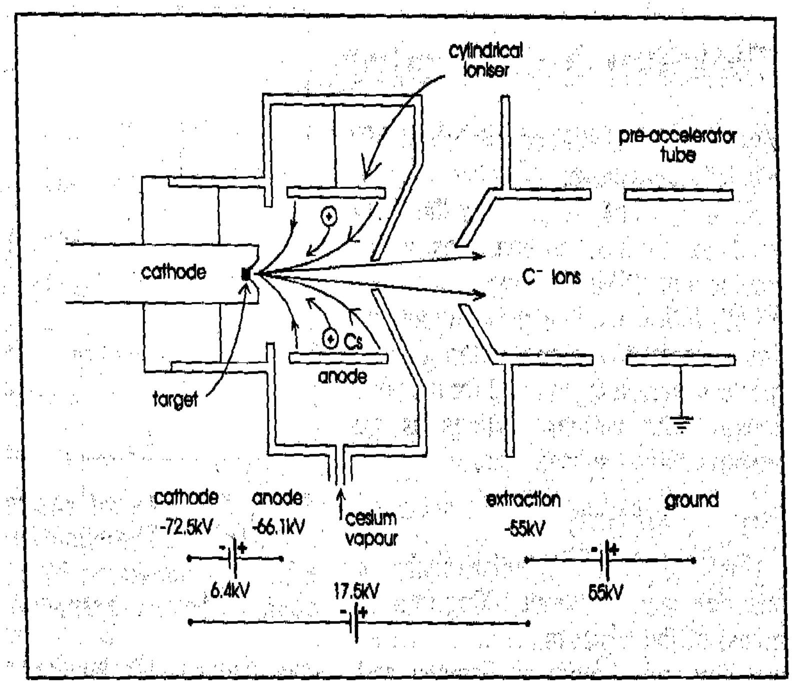


Fig.2 (left) :The various stages of the beam line. The negative ions are attracted to the high voltage terminal where they are converted into positive ions. The ions are then further accelerated through to the detection lines.

Fig.3 (above): In the 'sputter' unit, positive cesium ions dislodge particles from the target material as negative ions. These ions, e.g.,C⁻ ions, are then accelerated on their way to the injection magnet.

bles (a 'fossilised atmosphere'), so they form an important climatic record. For example, they record the variation in cosmic radiation levels over the years.

The Ansto tandem

The 'new' Ansto tandem is actually a recycled accelerator from Rutgers University in the US. Because it was no longer required at Rutgers, it was sold to Ansto for approximately scrap value. But as well as being recycled, the unit has been upgraded and improved since arriving at Lucas Heights in 1989.

But why a tandem?

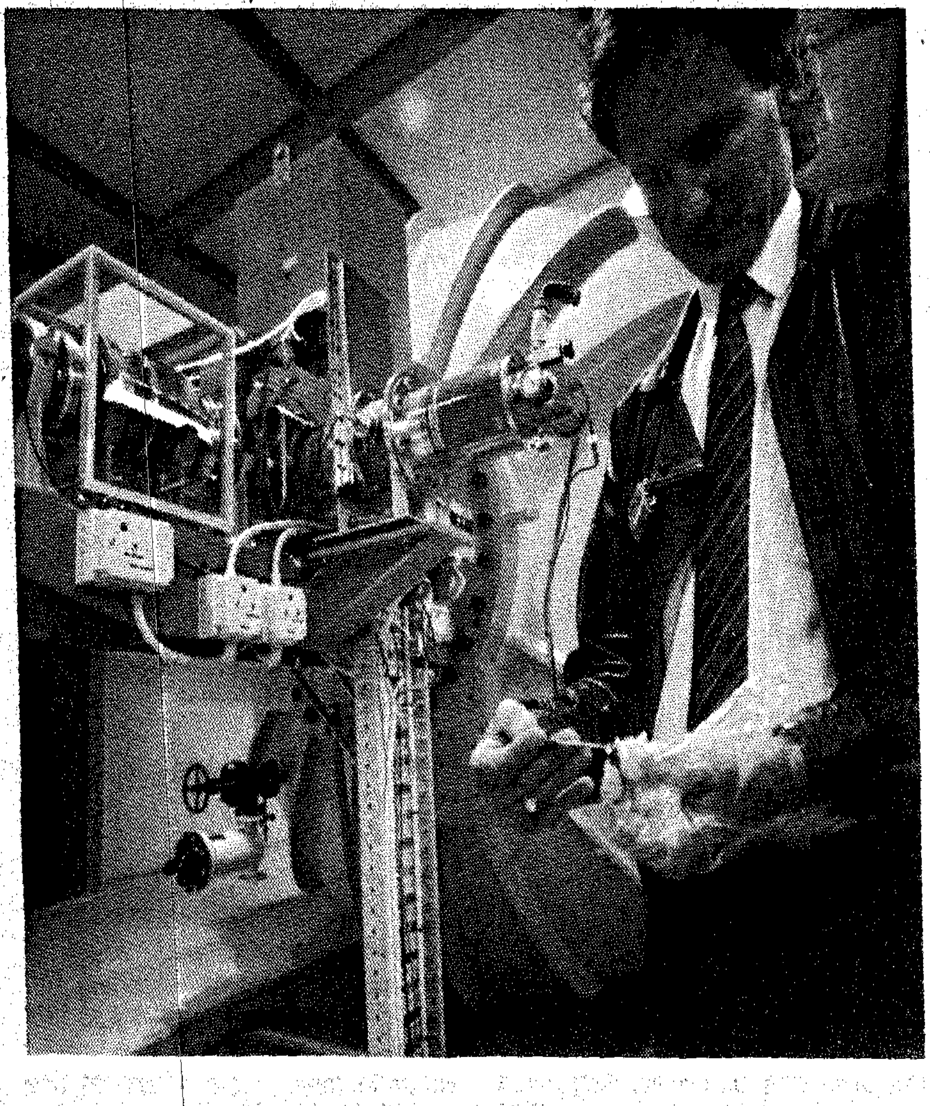
The Van de Graaff accelerator, in its simplest form, creates a high positive voltage which is used to repel positively charged atoms down a tube (refer again to Box 2).

The principle of the tandem accelerator is to use this same high voltage to provide a 'double kick' — to first *attract* negatively charged ions towards the main voltage terminal, and then to *repel* them away from the same terminal.

It is able to do this by stripping off electrons from the beam of charged particles flowing through the high voltage terminal. This converts them from negative to positive ions.

In the case of carbon, the +10MV potential can give the atoms a total energy of 50MeV — 10MeV when attracting the C^- ions, and 40MeV when repelling them again as C^{4+} ions.

The stripper in this case has removed five electrons from each carbon atom. This total energy is five times as great as an ordinary 10MV Van de Graaff accelerator could have given the carbon atoms. However, at any accelerating voltage, there is a distribution of charged states. The C^{4+} state is preferred because it avoids various mass-energy ambiguities when interpreting results, but the greatest yield of C^{4+} interact-



Dr Andrew Smith points to the tiny receptacle which holds the speck (a few 100ug) of source material. He is standing in front of a lens on the beam line at its entry into the tank.

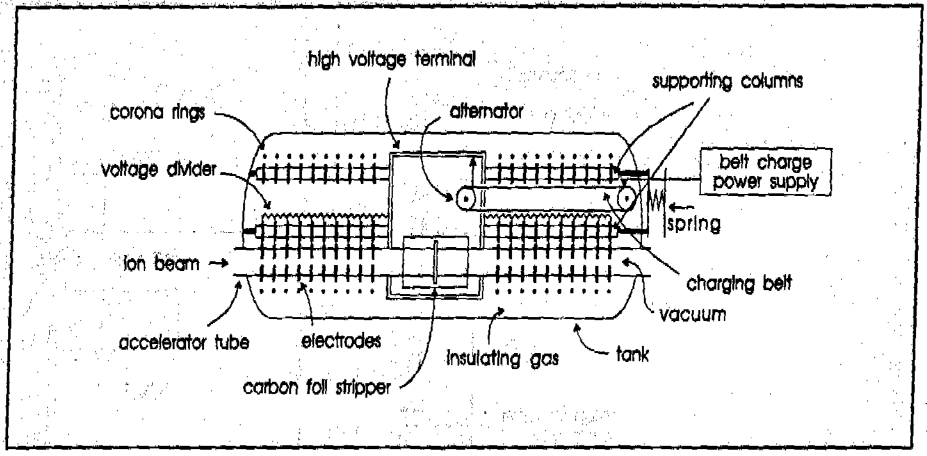


Fig.4: The internal structure of the main accelerator, viewed from above (plan-layout). The whole internal structure is held up by the supporting columns, which are tensioned by a powerful spring. The horizontal layout of tube and columns helps prevent lateral movement.

ing with carbon foil occurs with a 5MV accelerating voltage.

So in practice, Ansto uses the 5MV level to produce carbon ions which emerge with 25MeV energy.

Let's follow the ions through their entire passage along the mass spectrometer. Refer to Fig.2 for the positions of the various sections as we progress down the beam line.

Ion generation

This huge machine is built to analyse a very tiny sample. About 100ug (micrograms) of the target material is inserted in a tiny well 1.5mm in diameter and 2mm deep.

The first stage of the process is to convert the sample to be analysed into negative ions. Unless the particles have an electric charge, they cannot be deflected by the magnetic fields or accelerated by the electric ones along the beam line.

The negative ions are generated by a process called 'sputtering', which involves bombarding the sample with a beam of positive cesium ions. A pool of molten cesium is vapourised and then fed into the sputter unit, where it comes into contact with a cylindrical coil of tantalum, heated to 1000°.

This cylinder forms the anode, where positive cesium ions are first formed by surface ionisation, and then accelerated towards the sputter target (cathode) by a 6.4kV potential difference. (See Fig.3)

Some cesium ions penetrate the target surface and dislodge target atoms. Others ions form a deposit on the target surface, which increases the probability of the target atoms being dislodged as negatively charged ions.

Such negatively charged ions will be accelerated by the same 6.4kV voltage, in the opposite direction — out of the sputter unit. Sputtering only ionises a thin surface layer, but AMS analysis only requires a few hundred micrograms to do its atom counting.

The other alternative, decay-counting, detects the products of the nuclear decay. Since these are random in nature, larger samples and longer counting times are required. A +17.5kV voltage provides an extraction field which propels the ions into the beam line, where a further +55kV pre-accelerator voltage speeds them on their way — towards the selection magnet. The anode of the pre-accelerator is actually at earth potential, which means that the bulk of the sputter unit is a high negative voltage with respect to earth (see Fig.3 again for these voltages).

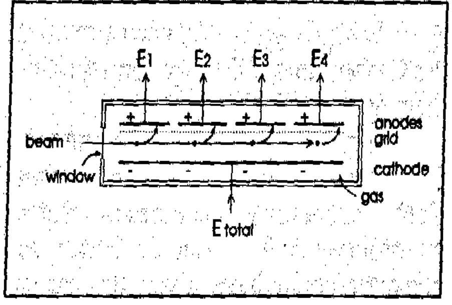


Fig.5: The structure of the gas detector which measures the ions' energy and stopping power. All the previous devices are designed to allow only those ions with the desired mass to reach this final detector.

Lenses

Because the ions emitted from the source have transverse velocity components, as well as the main axial ones, the beam will tend to spread out as it passes down the line.

To overcome this, various 'lenses' are placed along the route, and use both magnetic and electrostatic fields to bend the beam back together. These lenses can also be regarded as devices to 'match' the 'emittance' of the ion beam with the 'acceptance' of the following section of the line.

The magnetic lenses will eventually be replaced with electric ones, as the latter are mass-independent in their focusing. This will simplify the tuning process when changing from one isotope to another.

Injection magnet

The injection magnet is a huge electromagnet using up to 300A of current and producing a field as large as 1.55 tesla. The strength of this field is measured with 0.01% accuracy by a tesla meter, which works on the Hall effect.

Once set up to analyse a particular sample, the magnetic field of this magnet is not adjusted. But nearby masses (isotopes) can still be selected, by modulating the energy of the ions before they enter the magnetic field.

Because a magnetic field detects ions with a particular 'magnetic rigidity' (refer again to Box 1), a smaller mass can be selected by giving it a higher energy. This process is called 'bouncing'.

So, if the injection magnet is set up for carbon-14, then carbon-13 can be obtained with a slight energy increase, or carbon-12 with a greater increase. An electric field accelerates the particles into the magnet chamber to increase their energy, then another field decelerates them as they emerge, to maintain their original energy.

'Bouncing' allows rapid cycling of isotopes for injection into the tandem. The magnetic field can only be changed

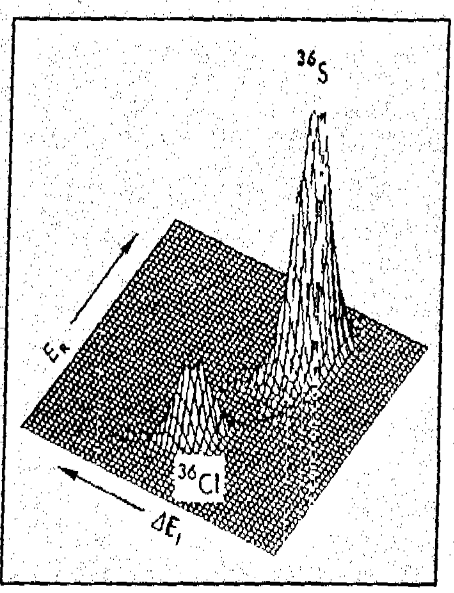


Fig.6: A three dimensional plot produced by the computer when fed with information from the gas detector. Note that some chlorine-36 has still managed to accompany the desired sulfur-36 ions. Ansto scientists use multiple elimination and detection devices to increase the sensitivity of their measurements.

The basic Mass Spectrometer

British scientist J.J. Thomson built the first mass spectrometer. He made use of the principle that charged particles (ions), moving at right angles to a magnetic field, will experience a force at right angles to both their direction of movement and the field. This will act as a centripetal force, bending the stream of ions into a circular path. The radius of the circle will depend directly on the *momentum* of the ion, and inversely on its *charge*.

If the velocity and charge are constant, then it will only depend on the mass: the larger the mass of the ion, the larger the circle.

magnetic force = centripetal force

$qvB = +mv^2/r$

$Br = mv/q$

where m = particle mass
- q = particle charge
- v = particle velocity
- B = magnetic field strength
- r = radius of circle
- and Br = magnetic rigidity

The magnetic rigidity is also referred to as:

(mass x energy / charge^2)

which strictly the square of the term

$(mv/q)^2 = m.mv^2/q^2$

$= 2m.(1/2\ mv^2)/q^2$

$=$ 2.mass.kinetic energy/charge^2

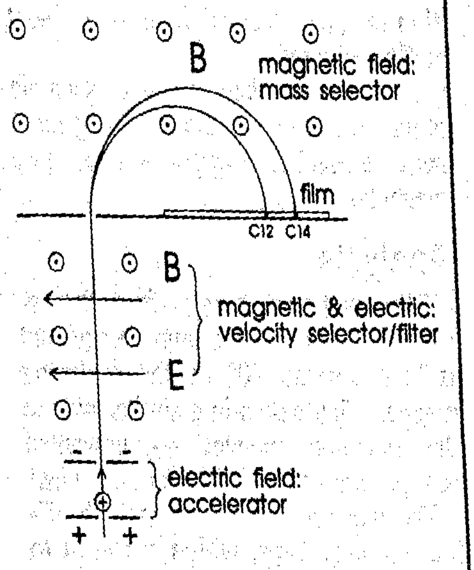
In order to get a constant velocity, the particles can be sent through a velocity filter (selector). A magnetic field acts out of the page, an electric field acts across. The two fields are adjusted until the force acting towards the left caused by the electric field is counterbalanced by the magnetic force acting to the right. When this occurs, only ions with the selected velocity (which equals the ratio of the two fields) will continue in a straight line.

magnetic force = electric force

$qvB = qE$

$v = E/B$

where E = electric field strength



slowly because of its large inductance, whereas the energy can be rapidly modulated. This allows precise measurements with frequent readings made over short time intervals.

The technique is useful for measuring the ratio of the various stable isotopes of an element, which is done by measuring the ion beam currents. Input and output ratios from the main tandem accelerator can also be compared. This measuring can be done at several places along the line by inserting *Faraday cups.*

These are metal 'collection cups' into which the stream of ions can be directed. They are carefully designed so that all the secondary particles which are generated as the ions come to rest are contained within the cup.

Escaping charged particles would constitute a false current. The current flowing to ground from the cup is a measure of the beam current.

The main accelerator

The structure of the 'second half' of the tandem accelerator is typical of a modern Van de Graaff unit (refer to Fig.4). An RF switched power supply provides the charge, which is sprayed onto the belt. The belt then transfers the charge to a large metal surface.

This metal structure forms the high voltage terminal on which the charge accumulates, producing a voltage of up to 10MV.

Very cleverly, this same belt is also used to drive an alternator located inside the terminal, to provide power for the accelerator circuits — it's like a giant 'fan belt'. However, a tandem accelerator also has a low energy as well as a high energy side in its acceleration tube.

The low energy section is a duplicate of the high energy one, but is positioned before the main terminal. So the ion beam passes through two sections of evacuated acceleration tube, one on each side of the main terminal.

If you were to look down either section, you would see about 200 metal plates, aligned at right angles to, and projecting into, the tube. These are the accelerating electrodes, with holes in their centres for the ion beam to pass through.

Outside the tubes, these accelerating segments are joined to column plates, which are connected together in series, via resistors, to the main voltage terminal. These resistors form a voltage divider chain.

Each segment and plate is surrounded by a corona ring. This setup produces an almost constant axial electric field along the entire acceleration tube. The electrodes are designed both to accelerate and focus the ion beam.

The whole internal structure is supported by two columns which are positioned horizontally alongside the acceleration tube. Tension is supplied to these columns by a powerful spring at the far end of the cylinder. The weight of the unit, and the horizontal construction, dampen both vertical and horizontal vibrations.

In order to prevent the 10MV potential from discharging to ground, the complete accelerator is housed in a large cylindrical pressure tank — 13.6m long and 3.7m high. This is filled with an insulating gas, sulfur hexafluoride, at a high 680kPa pressure.

Various controls are provided to maintain the high voltage at the required level. A 'coarse control' operates by adjusting the physical separation between a set of corona needles and the main terminal, allowing excess charge to leak away through corona discharge.

'Fine control' is achieved with a high-power pentode valve arrangement —

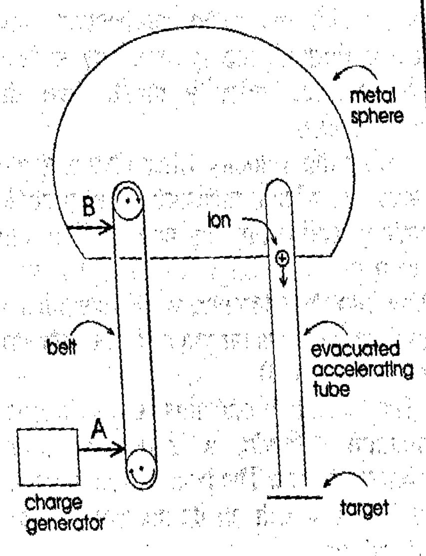
The Van de Graaff Generator

The essential parts of the Van de Graaff accelerator are a hollow metal sphere, an insulated fabric belt stretched over two rollers, and an evacuated accelerating tube.

Charge is 'sprayed' onto the rotating belt as it passes in the vicinity of sharp needle points (A) carrying a high voltage. Positive ions are carried up by the belt into the inside of the metal sphere, where they are transferred through other metal needles onto the outer surface of the sphere (B). The charge continues to build up on the dome until the voltage is high enough to discharge to ground through the surrounding air.

In order to minimise this discharge, the generator is enclosed in a shell containing a gas under very high pressure.

In the traditional way, to use this voltage to accelerate charged particles, positive ions are produced inside the sphere, and at the same potential as the sphere. These ions are then accelerated down an evacuated tube to strike a target at ground potential.



another area where solid state devices have not yet replaced the valve. This provides feedback control of the corona current drawn by the needles.

Note that in order to achieve control, these methods must be balanced against the belt charging current current, as well as the load caused by secondary particle emission within the accelerating tubes, corona discharge (other than at the needles) and the resistive divider current.

In normal operation, the voltage drop across the pentode may rise to as much as 20kV. The maximum voltage available from the belt charging system is 50kV, though it is currently running at a considerably lower level.

In the centre of the high voltage terminal is the 'stripper' unit, whose main function is to remove electrons from the ions in the beam.

Once the electrons have been stripped off, causing the charge on the atoms to be reversed, the same potential which originally attracted the ions now repels them through the second half of the accelerator. The construction of the high energy acceleration tube is identical to the low energy one.

At present, the stripper is a sheet of very thin carbon foil, placed in the ion beam path. Because the foil is quickly 'worn out', hundreds of these foils are attached to a belt, so that they can be placed in turn across the beam path, as needed.

It is obviously very important to minimise the number of times the main cylinder has to be opened up for maintenance. This carbon stripper will eventually be replaced by a model using re-circulating low pressure gas, such as oxygen or argon.

With the carbon foil, stripping happens very rapidly, which can cause defocusing of the beam.

A gas stripper works more slowly, giving greater control, but has the disadvantage that the re-circulating stripper gas has to be removed from the ion tube to maintain the vacuum. The beam line vacuum is maintained at around a few micropascals, so stripper gas molecules must be removed to prevent interference.

The use of a 'stripper' has another benefit — it tends to break up any *molecules* present into their constituent atoms. For example, a carbon hydride molecule which consists of one carbon-12 and two hydrogen-1 atoms has the same mass as a carbon-14 atom, and so can 'cheat' the injection magnet. Because its mass is 14, it will be selected.

But once broken up into separate atoms, it can't cheat the analysing magnet (see Fig.2 for the positions of these magnets).

Analysis

The ion beam emerges from the accelerator with its maximum energy, and is bent through 90° by the analysing magnet. This works in a similar way to the injection magnet — unwanted isotopes are simply bent out of the way.

The magnet is also set up with off-line Faraday cups, which are used to collect other isotopes sent through the system when the selection magnet is 'bounced'. These currents allow the relative numbers of the major isotopes present to be measured.

Yet another magnet is used to switch the selected beam into one of several different detector lines. Different types of detectors are used in each line in order to increase the measurement accuracy. Each detector gives a typical rejection rate of unwanted ions of $1:10^5$. By combining two or three dispersive devices in series, the accuracy improves to $1:10^{10}$ or $1:10^{15}$, depending on the sensitivity needed.

Because of the high demand for carbon-14 dating, one detector line will be permanently set up for this isotope. Fortunately, the most common element with the same atomic mass of 14, nitrogen, does not form a negative ion — so ^{14}N corrections are unnecessary. This line currently has two additional devices added.

The carbon ions first pass through a *Wien velocity filter*. This type of device (explained in Box 1) balances the magnetic and electric forces acting on the ion, allowing only particles with the correct velocity to travel in a straight line.

Other particles will be deflected into the sides of the detector. Because only ions with the same momentum have come through the system, any without the correct velocity must have the wrong mass.

After the velocity filter comes a *gas detector* which measures the particle energy and stopping power. The ion beam passes through a thin mylar window into the chamber, which contains a low pressure gas (argon or isobutane are commonly used).

The chamber contains a continuous common cathode, a grid, and four separate anodes. The penetration of each ion depends both on its nuclear charge and energy.

It loses its energy by colliding with, and ionising, the gas molecules in th[e] detector.

Electrons are collected by the fou[r] anode plates, while the remaining posi[-]tive charge induces on the cathode an[d] grid a signal proportional to the tota[l] energy of the ions (Fig.5).

So, when a beam of ions enters the detector, the cathode measures the total energy, while the four anodes measure the fraction of energy lost under the single plates. This data is fed into a computer, which displays it as a three dimensional plot (see Fig.6) with the peaks in the spectrum displaying the distribution of the ion energies and their stopping power.

The special AMS line which will be used for analysing other ions also uses a gas detector, but preceded by a parallel plate, 22° electrostatic analyser.

'This device has a 22° sector of two co-axial cylinders, with a radial field between them, through which the beam passes (similar to the curved plates in Dempster's design: see Fig.1).

When the ions pass between the plates they experience a deviation depending only on the ratio of their energy-to-charge. If they have the wrong ratio, they will be bent away from the main beam, which alone is bent the exact 22°.

In addition to these two lines, which are used to analyse samples to find out what atoms are present, a third line accelerates a stream of known ions, such as hydrogen. With this line, the tandem is used purely as an ion beam accelerator.

The interaction between the ion 'projectiles' and the target enable scientists to investigate nuclear structure. IBA techniques are highly sensitive and non-destructive. They can be used for the surface analysis of targets drawn from many area such as pollution, archaeology, electronics and medicine.

With AMS analysis the sample is placed in the ion source — with IBA the sample is placed in the detector.

These then are the advantages of the new Lucas Heights tandem accelerator: its AMS is extremely sensitive and ac[-]curate; it can do its analysis b[y] 'sputtering' very small samples, in th[e] order of 100ug; and because it can easil[y] (and automatically) be switched [to] detect different masses, it can be used [to] routinely analyse large numbers of di[f]ferent materials. And it can also be us[ed] for IBA. Industry and science shou[ld] both benefit greatly by its introductio[n].

Acknowledgment is made of the valuable assistance given by [Drs] Claudio Tuniz and Andrew Smith [of] Ansto, in preparing this article.

WINL

Play for these

This month, WINLINES is giving away over 50 deluxe prizes, including top sport and leisure goods, a fully installed Proton car stereo system, and a holiday for two. To play, just select the prizes you would like to win, then phone the Winline numbers next to those prizes. You may call as many times as you like.

When you call, you will be asked to stand by as we spin the wheel. If the prize you selected comes up on the wheel, you're in the draw.

WIRRINA RESORT HOLIDAY – [illegible] will receive a week's holiday [illegible] Wirrina country resort, situated one hour out of Adelaide. This prize includes accommodation, breakfast and use of Wirrina's facilities, including golf course, tennis courts, horse riding, fishing, spa, sauna, solarium and gym.

WIN 00555 1040 LINE

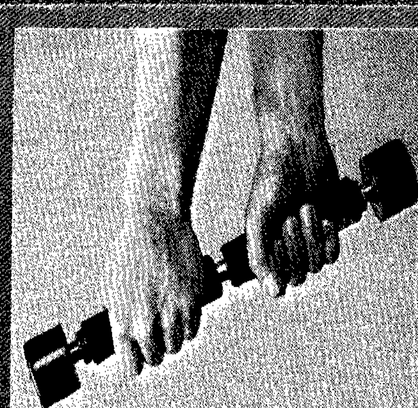
TAKE THE PUB HOME – Ten cases of premium quality Balmain Lager will go to the winner. Five runners up will receive 3 classic pub art beer posters as well as copies of Australasian Beer Guide and Australian Home Brewing magazine.

WIN 00555 1041 LINE

NB: Residents of NSW and NT and under 18's are prohibited by law from winning the first prize.

$700 BARBEQUE – To the winner, a [illegible] barbeque with its own timber wood stand, and complete with gas cylinder and [illegible].

WIN 00555 1045 LINE



EXER-STIK TRAINING AIDS – Ten winners will receive the [illegible] Exer-Stik, the [illegible] training equipment imported from the USA, designed to build strength and enhance flexibility in the fingers, hands, wrists [illegible]. Recommended by golf and tennis professionals, the Exer-Stik can aid any sportsman in attaining that all important edge.

WIN 00555 1046 LINE

CLASSIC ROCK VIDEOS – For the first prize winner, a set of 10 full length rock videos, including The Doors, Eric Clapton, Aerosmith, Cheap Trick, Alice Cooper, Eurythmics, Tesla and more. Plus the winner and 12 runners up will receive the classic Australian Made video featuring INXS, Jimmy Barnes, Divinyls and other top Australian acts.

WIN 00555 1047 LINE

Competition commences 12.02.92 and closes 27.05.92. The competition will be drawn 28.05.92 and announced in the *Sydney Morning Herald* on 03.06.92. Prizes are not transferable and cannot be converted to cash. Description of the

INES

quality prizes

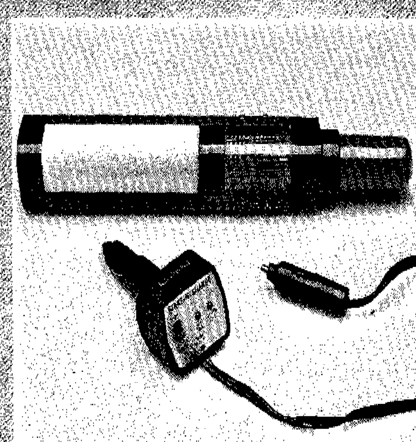
Then you'll be asked to leave your name, address and phone number. If you win, your prize will be forwarded to you directly, and your name will be published in a future issue of this magazine.

You can call the Winlines any time, day or night. They will remain open until five minutes before the prize is drawn, so if you don't get lucky the first time, you can have another go.

InPho, 24 cents/20 secs (Premium)

'WAR IN THE SKIES' REFERENCE LIBRARY – Three winners will receive this collection of five hard cover reference books, including the definitive 'Book of Flight' from the Smithsonian Institute in Washington D.C., 'Aces High' – a truly comprehensive guide to contemporary military aircraft – and exhaustively detailed guides to the F4 Phantom, the F-15 Eagle and the F-16 Fighting Falcon.

WIN 00555 1042 LINE



AUTO EMERGENCY KIT – Ten winners will receive this auto emergency kit – a necessity for long distance night driving. Each kit includes a Leopard Start-N-Change, to recharge dead batteries safely through your car's cigarette lighter, and a Galaxy multi purpose warning light/signal wand for breakdowns.

WIN 00555 1043 LINE

BASEBALL JACKETS – Four winners will receive a baseball jacket from Stagg Leathers of Melbourne. With their combination of leather and pure Australian wool, these warm, stylish and practical jackets can be worn on any occasion. They are valued at $270 each.

WIN 00555 1044 LINE

GOLF CLUBS AND BAG – For the winner, everything the better player wants and the average player needs. A set of golf clubs that needs no introduction, these Tommy Armour Silver Scot 845 irons and 835 woods feature the unique Dynamic Fitting System, and a sweet spot engineered to the precise centre of each club. The bag is also a Tommy Armour original.

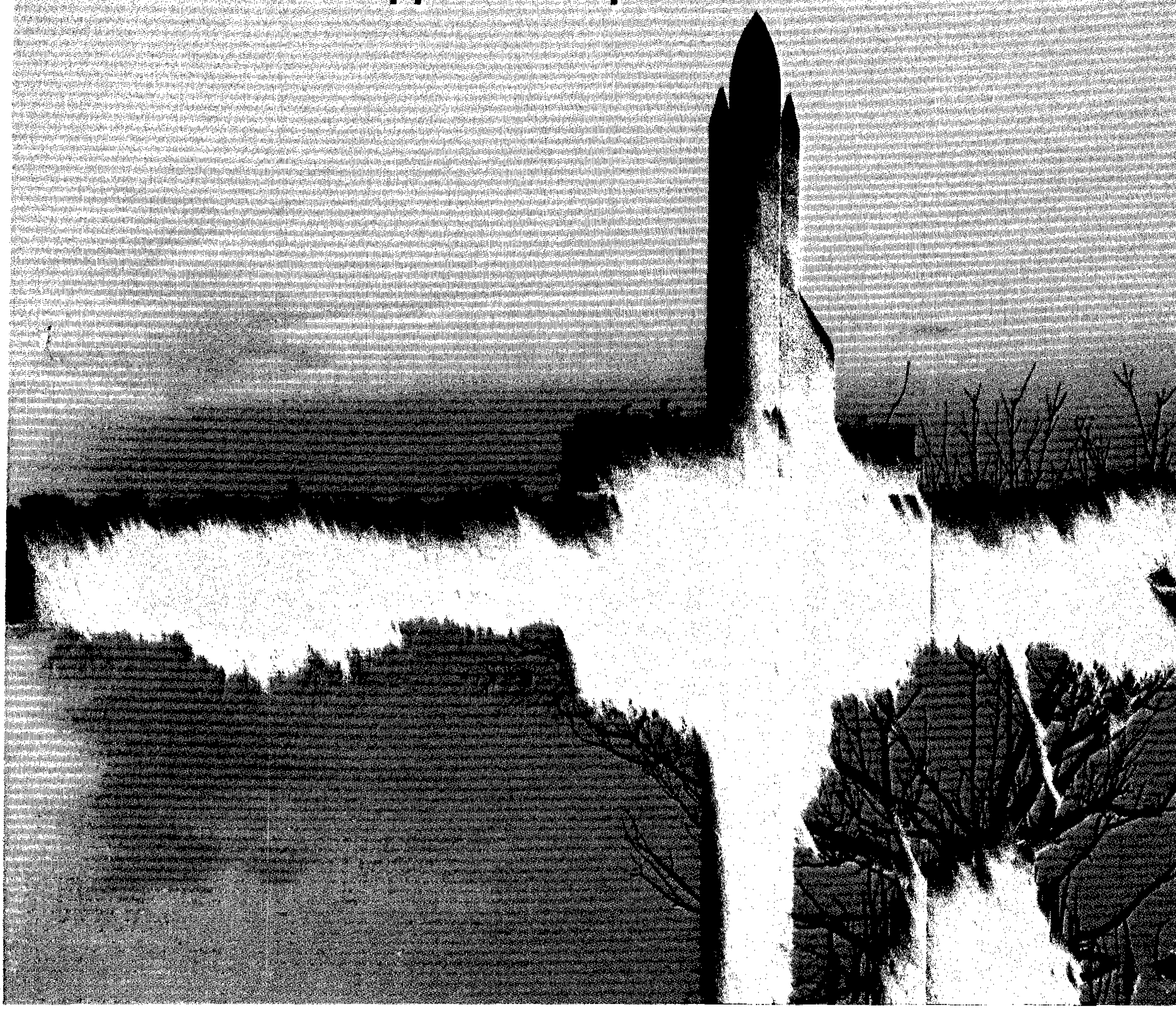
WIN 00555 1048 LINE

CAR STEREO – To the winner, the ultimate combination of excellence in reception, reproduction and style; a fully installed Proton car stereo system, valued at $1,200, with the multitude of special features associated with the Proton name. This precision engineered system comprises a CV-460 Casette/Receiver and a CA260 Stereo Amplifier, with a matched speaker system.

WIN 00555 1049 LINE

competition and instructions of how to enter form part of these conditions. The promoter is The Federal Publishing Company. NSW Permit No. TC92/0000. ACT Permit No. TP91/000. Raffles and Bingo Permit Board 92/0000. NT Permit No. 91/000

NASA's new Upper Atmosphere Research Satellite:



OBSERVING THE EARTH'S OZONE LAYER

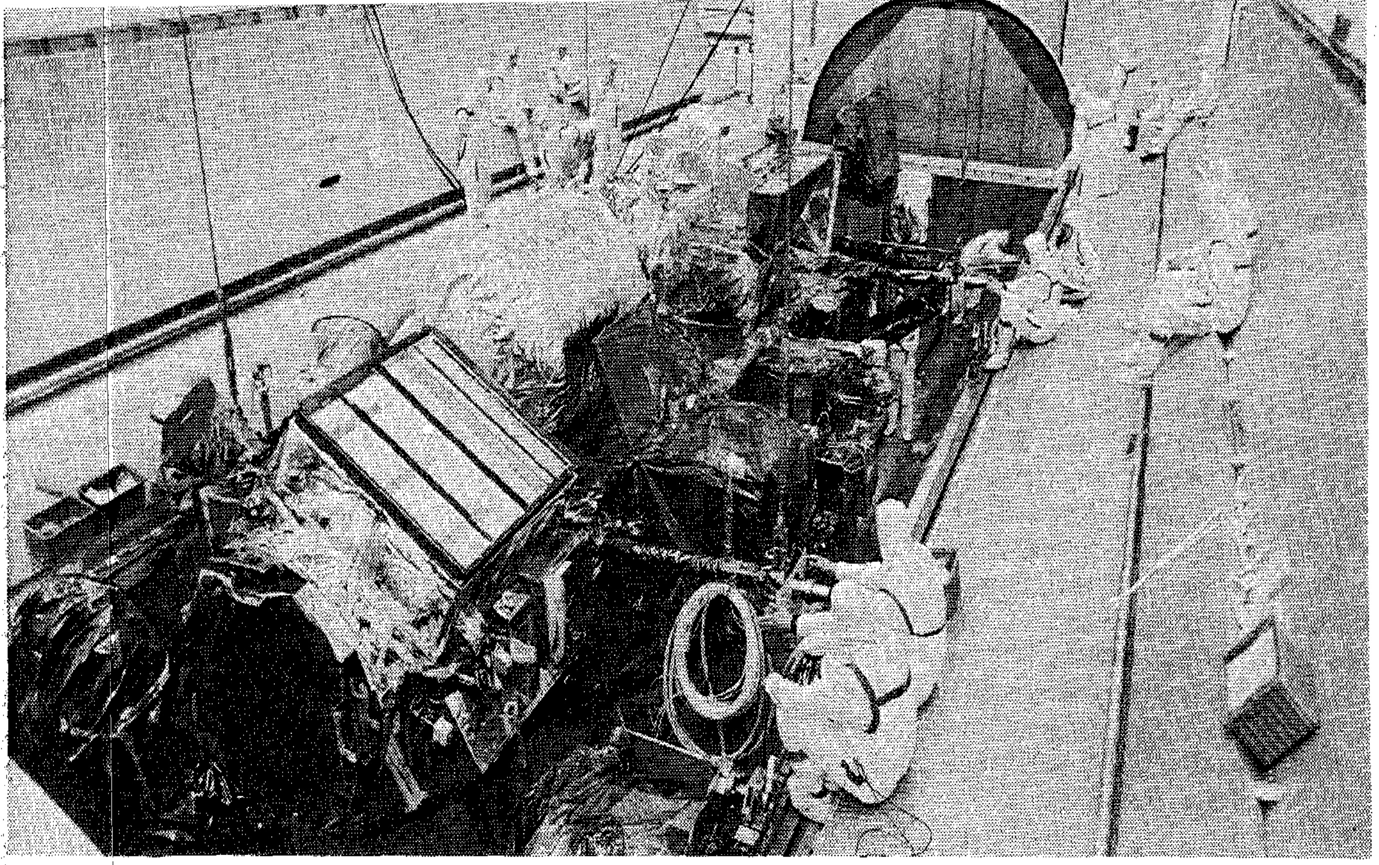
There's still a lot of information needed before scientists will have a really clear picture of the exact mechanisms responsible for the breakdown of the Earth's ozone layer, and the global warming 'greenhouse effect'. NASA's new UARS satellite is expected to provide much of this needed data.

by KATE DOOLAN

We are constantly being warned that our environment is changing, and not for the better. Mounting scientific evidence has indicated that our activities are affecting the composition of the Earth's thin and fragile atmosphere.

Scientific measurements have documented shifts in the chemical composition throughout the lower and upper atmosphere. The latter begins only 10 to 15 kilometres above the Earth's surface, and plays an essential role in the global climate. It contains a protective ozone layer which screens out high energy solar untraviolet radiation, the same UV radiation that may cause skin cancer in humans as well as causing damage to animal and plant life.

Some of the changes that are taking place in the upper atmosphere are out of human control. Variations in the intensity of solar radiation, solar wind and cosmic rays from space influence the dynamics and chemistry of the atmosphere. Vol-



Shown here is the Upper Atmosphere Research Satellite (UARS) being prepared in the Payload Hazardous Servicing Facility at the Kennedy Space Centre, for launch in mid 1991.

canic activity such as the recent eruption of Mount Pinatubo in the Phillipines injected a massive amount of dust, ash and various chemical compounds into the atmosphere. As these events tend to be rare occurrences, their effects pose little threat to the Earth's global atmospheric balance.

Human activities tend to produce long-term trends that can lead to large scale — and possibly irreversible — effects on the Earth's atmosphere, if they are allowed to continue.

The burning of fossil fuels is resulting in world wide increases in atmospheric concentrations of carbon dioxide, which transmits visible light but also reflects infrared radiation back to the Earth's surface — causing the so-called 'Greenhouse Effect'. Based on present rates of atmospheric carbon dioxide increases, the Earth's surface temperature is expected to increase by 2°C by the year 2050.

Other 'greenhouse' gases that may be individually less significant but may collectively produce a similar effect include nitrous oxide, methane and chlorofluorocarbons (CFCs), which are still used in some countries as spray-can propellants. The industralised world uses CFC's in making plastic foams and industrial component cleaners, and as working fluid in refrigerators and air conditioners. Another contributor to altering the upper atmosphere is deforestation, which alters the balance between emission and absorption of carbon dioxide and other gases.

In 1976 the United States Congress, in response to newly identified causes of ozone depletion, directed the National Acronautics and Space Administration (NASA) to expand its research program on the upper atmosphere. Rockets, balloons and high altitude aircraft — along with laboratory and theoretical studies — have confirmed that human-made chemicals are depleting the ozone layer.

Satellite sensing

To study the global scale of upper atmospheric processes, remote sensing from space is necessary and this is the role of the recently launched Upper Atmosphere Research Satellite (UARS).

The Upper Atmospheric Research Satellite is the first major part of NASA's 'Mission to Planet Earth'. This is a long-term research program that will be using ground, airborne and space based instruments to study the Earth as a complete environmental system. UARS will provide scientists with their first complete set of data on the upper atmosphere's chemistry, winds and energy inputs.

To study ozone depletion more completely and to understand other aspects of our fragile atmosphere, scientists need the global perspective available from an Earth orbiting satellite — one that can make simultaneous measurements of all factors of ozone depletion with state of the art instruments.

The UARS science programs have been designed as a single experiment, with nine component instruments that will study the upper atmosphere's chemical, dynamic and energy systems. In addition to the UARS instrument science teams, ten other teams will use the gathered data to improve on the theoretical models of the upper atmosphere. This will enable scientists to predict the effects of change in the atmosphere.

The Upper Atmosphere Research Satellite itself measures nine metres long and 4.5 metres wide. It weighs approximately 31,000 kilograms and is powered by a 9m x 3m solar panel.The UARS observatory comprises of a standard design Multi-mission Modular Spacecraft (MMS), which is coupled to a module that includes the ten scientific instruments. The MMS' Hydrazine Module will power the orbital adjustment manoeuvres for the initial boost to orbit, and also to maintain the spacecraft's required attitude. This system consists of four 11kg thrusters and 12 small attitude thrusters, each weighing 200 grams.

Attitude control

For the UARS spacecraft to make changes in its orientation towards the Earth — which is needed for the long duration measurements of the atmosphere — the spacecraft must know where it is pointed at all times. To do this, UARS uses a system called Modular Attitude Control System (MACS).

The MACS system is a three-axis system made of flight proven NASA components.

The system contains sensors that tell the spacecraft where it is pointed and activators that point the spacecraft as required. The MACS module originally flew on the Solar Maximum Mission which was launched in 1980. Following the spectacular retrieval and repair of the Solar Max by the shuttle crew of STS

Ozone Layer

41C in April 1984, the MACS was returned to Earth and refurbished for use aboard UARS.

The Communications and Data Handling (CADH) system uses software based on modular technology that has previously flown on Landsats 4 and 5, as well as the Solar Maximum Mission. This modular programming allows sections of the software to be repaired or rewritten without needing end-to-end verification of an entire new program. The CADH system consists of a CADH module, a high-gain antenna and two omnidirectional low-gain antennae. Also on the CADH is a transponder for communication between UARS and NASA's Tracking and Data Relay Satellite System (TDRSS).

UARS uses a standard NASA spacecraft computer which provides some autonomous operation of the spacecraft. It will perform some tasks such as command processing, power management and attitude determination computations.

Instructions to the Upper Atmosphere Research Satellite begin with the ground controllers located in the UARS Payload Operations Control Centre (POCC), at the Goddard Space Flight Centre in Greenbelt, Maryland. The POCC is the focal point for all UARS pre-mission preparation and on-orbit operations. For the UARS mission, the POCC is part of the Multi Satellite Operations Control Centre at Goddard — which provides mission scheduling, telemetry data acquisition, tracking, command and processing required for downlinked data.

A Central Data Handling Facility (CDHF), again located at the Goddard Space Flight Centre, will be processing the UARS scientific data. The CDHF is linked to 20 remote analysis computers at the Principal Scientific Investigators' home institutions, via an electronic communications system. This will make all UARS data available to investigators. The CDHF is also designed to encourage frequent interactions between the different investigation groups, and will enable quick responses to unusual events such as volcanic eruptions and solar flares.

Scientific data gathered by the UARS will initially be recorded continously on two onboard tape recorders, at a rate of 32 kilobits per second. On acquiring contact with the Tracking and Data Relay Satellite, the recorded data from UARS will be transmitted through the NASA Communications Network to the Data Capture Facility at Goddard. On arrival there, telemetry preprocessing will be performed; this will include time ordering, merging, editing and sorting of data. The output is then transferred to the Central Data Handling Facility.

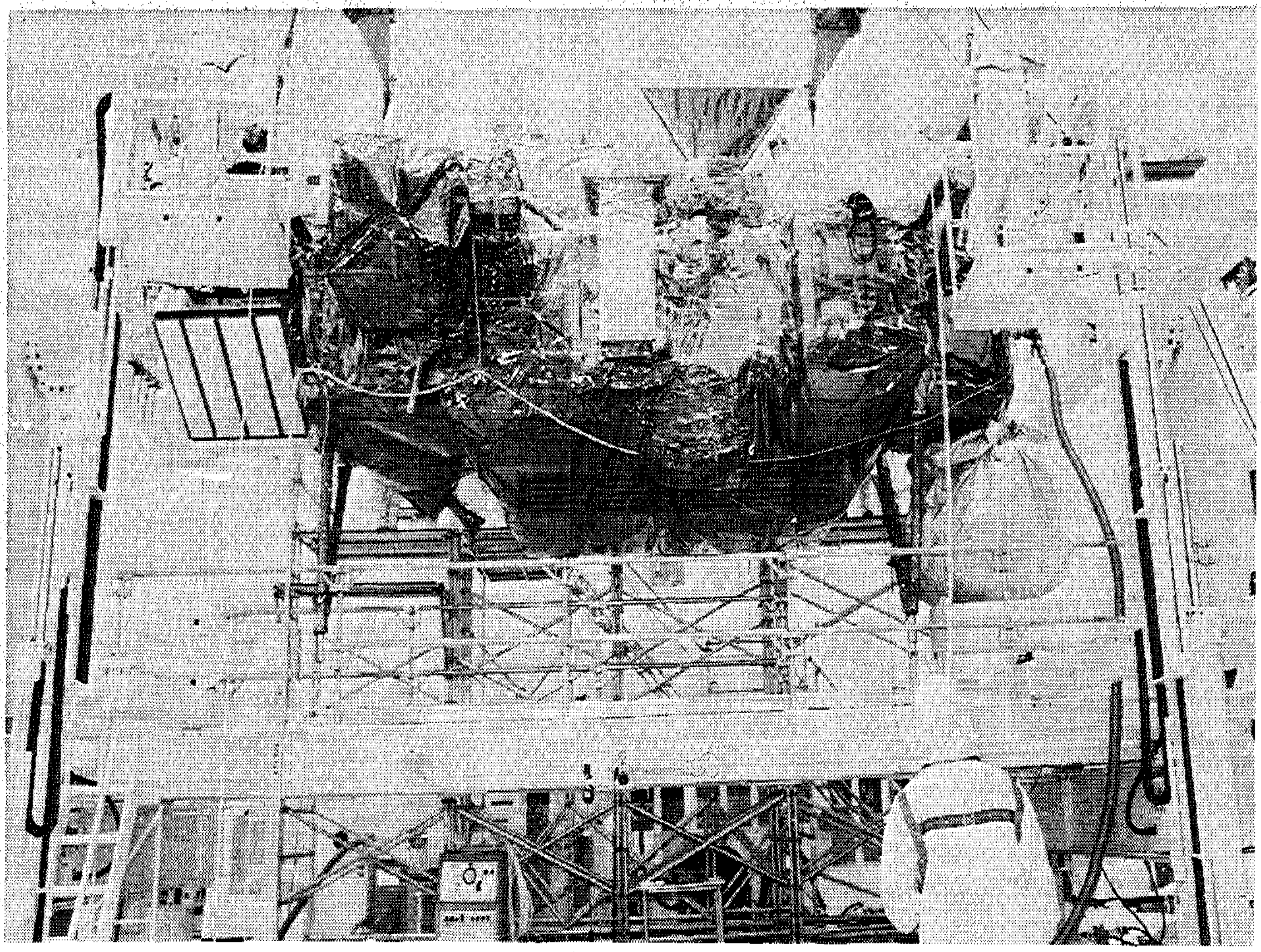
Onboard instruments

The Upper Atmosphere Research Satellite has nine scientific instruments, which will provide critical measurements to gain a more complete understanding of the upper atmosphere.

The instruments will be concentrating their observations on the areas of chemistry, dynamics and energy input. Four of UARS' instruments will be measuring the concentrations and distribution of gases important to ozone depletion and climate change.

The Cryogenic Limb Array Etalon Spectrometer (CLAES) will be determining the concentrations and distribution by altitude of nitrogen, chlorine compounds, methane, water vapour and ozone — all of which take part in the chemistry of ozone depletion.

The Improved Stratospheric and Mesospheric Sounder (ISAMS) will be studing atmospheric water vapour, carbon dioxide, ozone, methane, nitric acid and carbon monoxide. This instrument detects infrared radiation from the



The Upper Atmosphere Research Satellite is hoisted out of the workstand in the Payload Hazardous Servicing Facility during preparation for flight and installation in the payload bay of the Space Shuttle Discovery.

atmosphere and uses it to gain information on atmospheric composition and temperature.

The Microwave Limb Sounder (MLS) will provide a global data set on chlorine monoxide, which is a key intermediate compound in the ozone destruction cycle. Data will also be used to produce three dimensional maps of ozone distribution and to detect water vapour in the microwave spectral range.

The Halogen Occulation Experiment (HALOE) is to observe the vertical distribution of hydrofluoric acid, carbon dioxide, methane and members of the nitrogen family. Every day HALOE will observe 28 occulations of the Sun, to measure the energy absorption of the Sun's rays by the above gases.

The following two instruments, the High Resolution Doppler Imager (HRDI) and the Wind Imaging Interferometer (WINDII), will help scientists obtain a global picture of the horizontal winds that disperse chemicals and aerosals through the upper atmosphere.

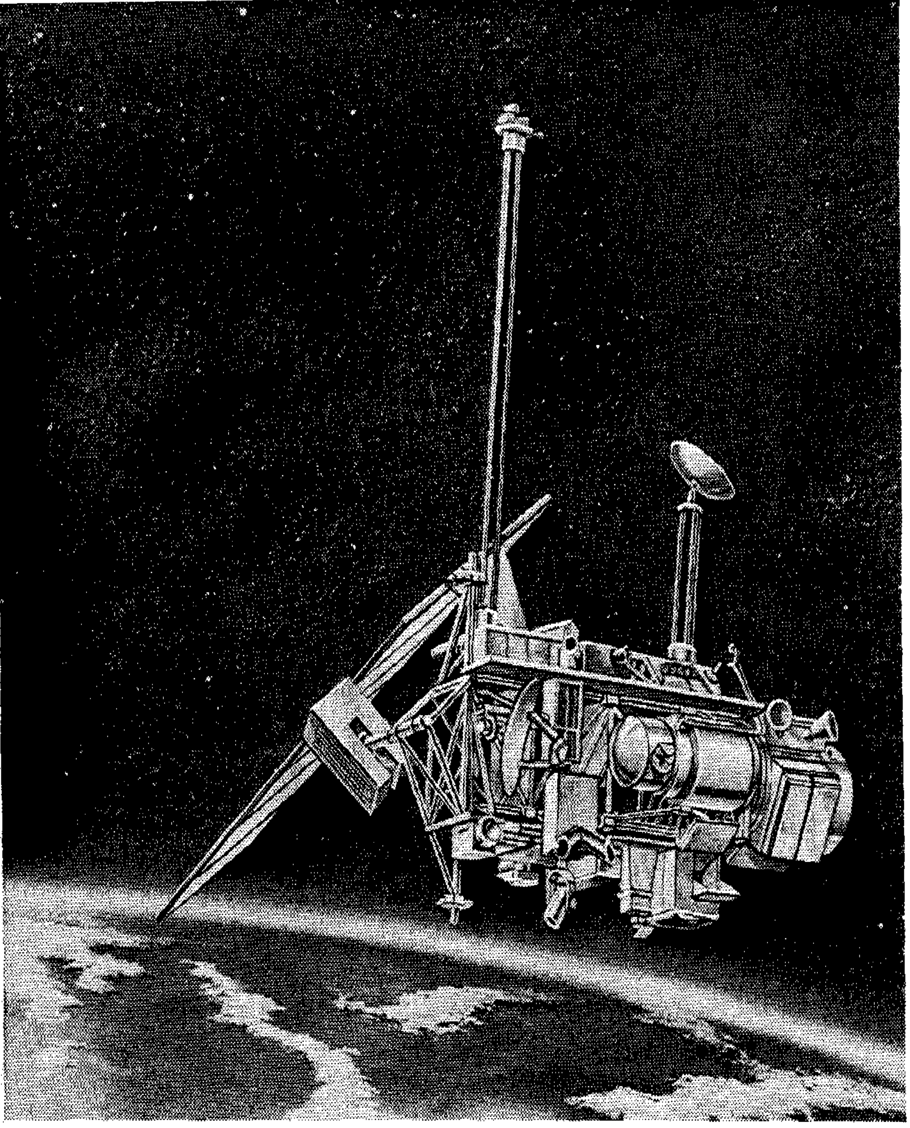
The Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) will be measuring solar ultraviolet activity, which is the most important range in ozone chemistry. Ultraviolet light from the Sun is the driving force of the ozone cycle, dissociating chlorine compounds into reactive chlorine atoms which in turn break up ozone molecules.

The Solar Stellar Irradiance Comparison Experiment (SOLSTICE) will be conducting in-depth ultraviolet studies of the Sun. SUSIM will compare the Sun's ultraviolet energy to the ultraviolet radiation of bright blue stars in other regions of our galaxy.

The Particle Environment Monitor (PEM) will be assisting scientists in answering questions about the effects of energetic particles from the Sun on the upper atmosphere. PEM will use four different primary instrument sub-units, to take detailed particle measurements in different energy ranges.

A tenth instrument, which is not technically part of the UARS, is the Active Cavity Radiometer Irradiance Monitor (ACRIM). ACRIM is an 'instrument of opportunity' which was added to the spacecraft after designers had determined that a tenth instrument could be flown. This experiment will provide monitoring of total solar activity for long-term climate studies, and will be important for other Mission to Planet Earth studies.

Expected to have a life span of three years, the Upper Atmosphere Research Satellite was constructed by General Electric's Aerospace Division and is managed by the Goddard Space Flight Centre for NASA's Office of Space Science and Applications. Surprisingly, in the days of big budget space programs that cost more than intended, UARS came in at US$35 million under budget — for an overall project cost of US$633 million.



An artist's impression of the Upper Atmosphere Research Satellite after being placed in orbit around the Earth by Space Shuttle Discovery.

The launching

The UARS was placed in orbit using the space shuttle *Discovery*, on its 13th flight — which was also NASA's 43rd space shuttle mission. The launching took place from the Kennedy Space Centre in Florida, on 12 September 1991 at 7:11pm. This provided a spectacular night-time launch event, which could be seen from hundreds of kilometres away.

The five-man crew was commanded by astronaut John Creighton, with pilot Ken Reightler and mission specialists Sam Gemar, Jim Buchli and Mark Brown. All were space veterans except for Reightler. Jim Buchli was making his fourth flight into space and became only the second person to make four space shuttle flights — the first being former astronaut and Director of the Kennedy Space centre, Bob Crippen.

On day three of the flight, Mark Brown used the shuttle's remote arm to grab the Upper Atmosphere Research Satellite and deploy it into a 560-kilometre high orbit. Astronauts Gemar and Buchli had made preparation to make a spacewalk to unfurl the antenna of the UARS if necessary, but the deployment was normal and the astronauts stayed inside the shuttle.

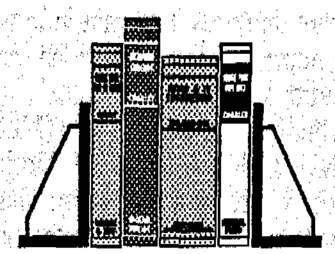
With a flight inclination of 57°, the UARS can cover nearly all the Earth's surface for its observations. During its flight, *Discovery* used the same flight inclination and was visible over most of Australia, being sighted making several early morning passes over Melbourne and Sydney.

Following the deployment of the UARS, the remainder of the shuttle flight was uneventful — except for one occasion when the shuttle had to dodge a spent rocket stage. The astronauts spent most of their time doing medical experiments, which included observation of eight young rats in an experiment on the effect of zero gravity.

Discovery was expected to make the first night landing at the Kennedy Space Centre, but the flight landed at the Edwards Air Force Base in California due to bad weather on 18 September 1991. It had been a six-day flight.

The Upper Atmosphere Research Satellite is now in orbit, working perfectly. In the next several years it will hopefully provide a new insight in the ozone layer and its importance to us. ❖

NEW BOOKS



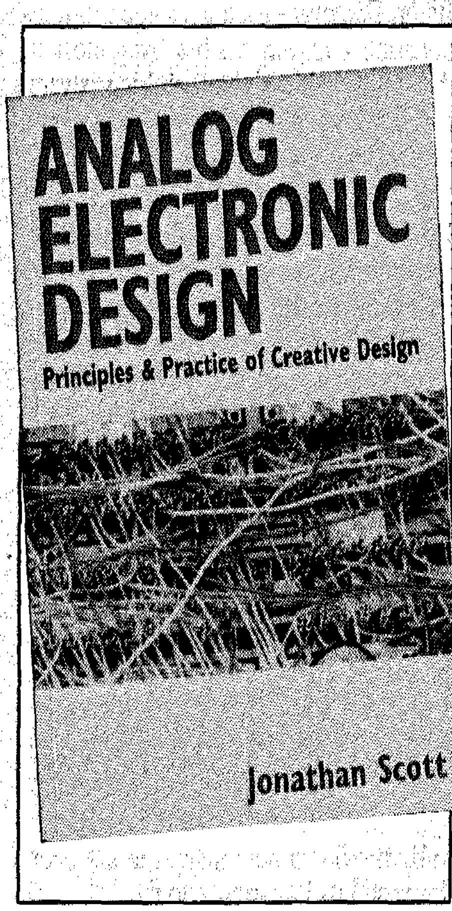
Creative design

ANALOG ELECTRONIC DESIGN, by Jonathan Scott. Published by Prentice Hall, 1992. Soft cover, 235 x 170mm, 554 pages. ISBN 0-13-033192-9. Recommended retail price $46.95.

This book has been written for engineers and students involved in electronic circuit development. It covers the fundamental theory of electronics, as well as the skills of practical application. Electronics is very much a discipline built upon previous knowledge and experience. The book aims to stimulate a creative interest in the topic. Author Jonathan Scott was formerly on the staff of *ETI*, and is now a senior lecturer at Sydney University.

The 20 chapters give a good coverage of electronic circuits. Early chapters (1-6) deal with the various types of components, different methods of building prototypes, active device configurations, some non-linear circuits, and the types of distortion found in amplifiers.

Chapters 7-10 deal with multipliers and mixers, discriminators, phase-locked loops and amplification using opamps. Chapter 11 covers the use of macromodels like SPICE.



Various aspects of amplification are then covered: composite amps, audio and HF amplification (Ch.12-14). The last six chapters (15-20) are devoted to analog filters, oscillators, sampling analog signals, AD conversion, switching power supplies and noise.

Appendix A covers electronic CAD, appendices B-C tutorial problems and solutions, and appendix D laboratory problems.

The book is well written and illustrated, and easy to follow. It actually originates from a final university course for generalist electronic engineers, which explains its comprehensive coverage. As well as being an excellent text for this group, or a very useful reference book for practising engineers, I can recommend it for anyone like myself, anxious to expand their working knowledge of electronics.

The review copy came from Prentice Hall of Australia, PO Box 151, Brookvale 2100. It is available from technical bookshops. (P.M.)

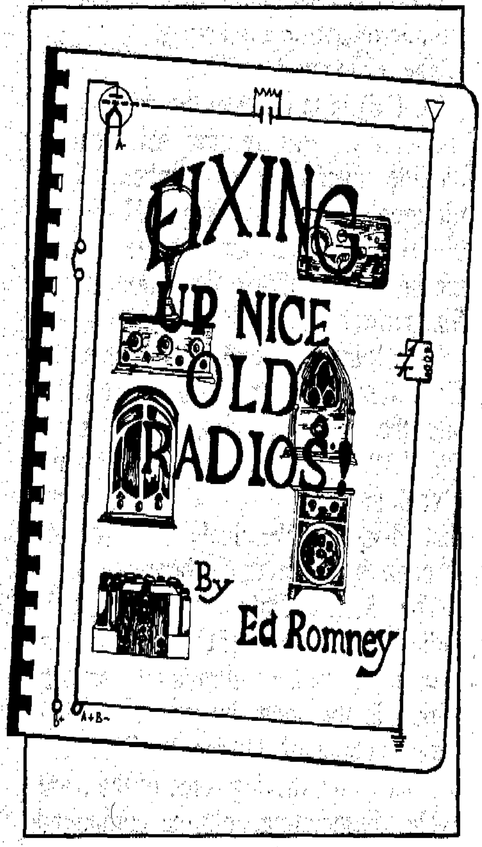
Vintage radio

FIXING UP NICE OLD RADIOS, by Ed Romney. Published by the author, 1990. Plastic ring binding, 217 x 282mm, 186 pages. Price US$25 plus $1.50 shipping.

Here's a book that will no doubt prove irresistible to many of our readers interested in vintage radios — particularly in repairing them and getting them going again. Author Ed Romney not only loves them, as the title of the book reveals, but he has spent many years repairing and refurbishing them. As a long-time instructor in radio and electronics, he also knows how to impart his knowledge in a friendly, easy to follow manner.

He's also apparently quite an expert on both repairing cameras and rebuilding vintage cars, and in recent years has published quite a few books on these topics as well. A man of many talents!

In this volume he works methodically through both the basic operation and repair of 'tube' (valve) type radios, covering virtually every aspect from basic electronic circuit theory to the alignment of the complex sets (including communi-



cations and ham rigs) produced in the late 1930's and 1940's. And along the way he manages to provide a huge amount of information on many sets that were common in the USA, and still available today if you know where to look. There are circuit schematics, wiring diagrams, alignment and component rating data — you name it.

Of course it's inevitably orientated towards US manufacturers and models, but some of these have found their way out here over the years, and in any case a lot of the information given would also apply to other sets available here.

It's all written in an easy, relaxed manner, which should make it of value even to those who currently have little or no knowledge of either radio receivers or valve technology. In fact it would make an excellent introduction to the technical side of vintage radio.

A book that will become quite a classic in vintage radio circles, I expect.

The author is not only happy to accept mail orders, but apparently only sells his books this way. His address is PO Box 96, Emlenton PA 16373, USA, and he will accept payment via Visa or Mastercard. You can even order by phone, if you wish; his number is (412) 867 0314. (J.R.) ❖

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- Data hold & Relative functions
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Adc 4-400mA, 10A
Aac 4-400mA, 10A
Ohms 400Ω, 4kΩ, 40kΩ, 400kΩ, 4MΩ, 40MΩ
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Capacitance 4nF, 40nF, 400nF, 4μF, 40μF

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- ***Data Hold button***
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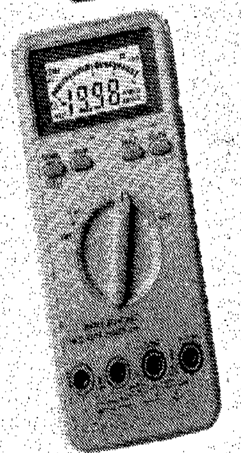

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Vac 200mV, 2V, 20V, 200V, 750V
Adc 200μA, 2mA, 20mA, 200mA, 2A, 20A
Aac 200μA, 2mA, 20mA, 200mA, 2A, 20A
Ohms 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 20MΩ
Frequency 2kHz, 20kHz, 200kHz
Capacitance 2nF, 20nF, 200nF, 2μF, 20μF

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- 3 1/2 digit plus 41 segment analog bar graph
- Autoranging or manual selection
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- Water resistant
- Data hold
- Memory offset

Ranges
Vdc 200mV, 2V, 20V, 200V, 1000V
Vac 200mV, 2V, 20V, 200V, 750V
Adc 200μA, 2mA, 20mA, 200mA, 2A, 20A
Aac 200μA, 2mA, 20mA, 200mA, 2A, 20A
Ohms 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 20MΩ

$166.80
$139.00 ex tax

Model 98

- 3 1/2 digit plus 41 segment analog bar graph
- Autoranging or manual selection
- 8 Functions - Vdc, Vac, Adc, Aac, Ohms, Diode, Frequency, Capacitance
- Data hold
- Memory offset

Ranges
Vdc 200mV, 2V, 20V, 200V, 1000V
Vac 200mV, 2V, 20V, 200V, 750V
Adc 200μA, 2mA, 20mA, 200mA, 2A, 20A
Aac 200μA, 2mA, 20mA, 200mA, 2A, 20A
Ohms 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 20MΩ
Frequency 2kHz, 20kHz, 200kHz
Capacitance 2nF, 20nF, 200nF, 2μF, 20μF

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- ***Eleven functions – Vdc, Vac, Adc, Aac, ohms, diode, logic, continuity, frequency, capacitance and transistor hfe***
- ***Peak hold button***
- ***Automatic power off***
- ***0.5% basic accuracy***
- ***Shock proof from 1.5m drop***

Ranges
Vdc 400mV, 4V, 40V, 400V, 1000V
Vac 400mV, 4V, 40V, 400V, 750V
Adc 400μA, 4mA, 40mA, 400mA, 2A, 20A
Aac 400μA, 4mA, 40mA, 400mA, 2A, 20A
Ohms 400Ω, 4kΩ, 40kΩ, 400kΩ, 4MΩ, 40MΩ
Frequency 0-4MHz autoranging, 40MHz (500mV min)
Capacitance 4nF, 40nF, 400nF, 4μF, 40μF
Transistor hfe 0-1000 pnp/npn
Continuity 2kHz buzzer, <50Ω
Logic to 20MHz
Power Off after 15min

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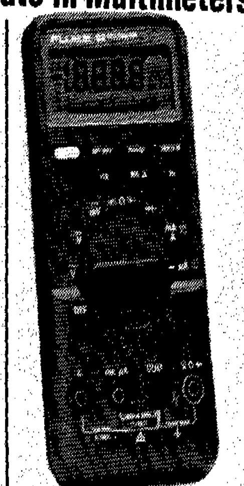

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- 0.3% basic accuracy
- Min/Max average recording
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- Zoom bar graph, x10
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Measures volts, amps, checks continuity and performs diode tests, measures frequency, duty cycle and capacitance. The minimum, maximum and average values can be recorded simultaneously. Analog bar graph updates at 40 times per second and the input Alert™ sounds a constant audible warning of wrong input connections. 3 Year Warranty

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Other Functions
Continuity: threshold <20Ω
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Electrical safety:

Shake hands with the devil - 2

In Part 1 of this article in the December 1991 issue, the author gave graphic details of the fatalities caused by complacency when using electricity. Now, in Part 2, he describes the biological effects of electricity which help explain the causes of electrocution. Details are given of South Africa's 'killer fences' and America's 'electric chair'.

by RICHARD WALDING

The severity of an electric shock depends on the current, duration, frequency, skin moisture, surface area of contact, pressure exerted, temperature and the path through the body. A current passing through vital organs such as the brain or heart is the most dangerous. So the biological effects of electricity result from both the electrical resistance and electrical impedance.

Electrical resistance: Fortunately, the human skin is a fairly good insulator, which provides a protective barrier against injurious electric currents. The effective resistance between two points on opposite sides of the body, when the skin is dry, is in the range of 10,000 to one million ohms. A manual worker with dry, calloused hands could have the highest resistance. However, when the skin is wet, the resistance may be less than 1000 ohms.

Electrical Impedance: Other things being equal, a higher voltage will result in a higher current. But AC voltages and DC voltages need qualification before being compared. Firstly, although 240V AC may have the same average value as 240V DC, the peak AC voltage is somewhat higher — an AC voltage of 240V RMS has a peak value of 340V.

Secondly, the human body acts as having capacitance in parallel with its resistance (Fig.1 shows the total impedance of the body). A DC current can pass through the resistance, but not the capacitance. An AC current can exist also in the capacitive branch. Because of the additional path allowing current to flow, the current for a given AC RMS voltage will be greater than for the same DC voltage. Thus an AC voltage is more dangerous than an equal DC voltage. Alternatively, to produce the same effects, the magnitude of direct current flow of constant strength is two to four times greater than that of alternating current.

Impedance characteristics

As noted above, the human body has both resistive and capacitive components. The internal impedance can be considered as mostly resistive. The outer skin is different. Skin is made up of a semi-insulating layer and small conductive pores, and is thus a network of resistances and capacitances.

Changing impedance: At the moment when a high voltage is touched, capacitors in the skin are not charged and so the impedance of the skin is low. The internal impedance of the body provides the resistance to current flow. If the voltage remains, the capacitors continue to charge, and the impedance rises.

However, if the voltage is over 50V, then the skin starts to break down, making the total impedance of the skin just about zero. The total impedance is then just the impedance of the internal body.

The value of total body impedance for living human beings and a current path hand-to-hand or hand-to-foot for palm or foot size contact areas and dry conditions are given in Table 1.

The impedance from one hand to both feet is 75% of the values in the table, and 50% if from both hands to both feet. For contact areas wetted with tap water the figures can be reduced by 10-25% and for sea water the values are about half.

For about 5% of the population who have a much lower impedance, the figures in Table 1 can be reduced by 50-70%. It is conceivable then that a person who has been swimming in the sea can have an initial impedance of 500 ohms at 240V AC. Using Ohm's Law, it can be shown that 500mA could flow — which is potentially lethal.

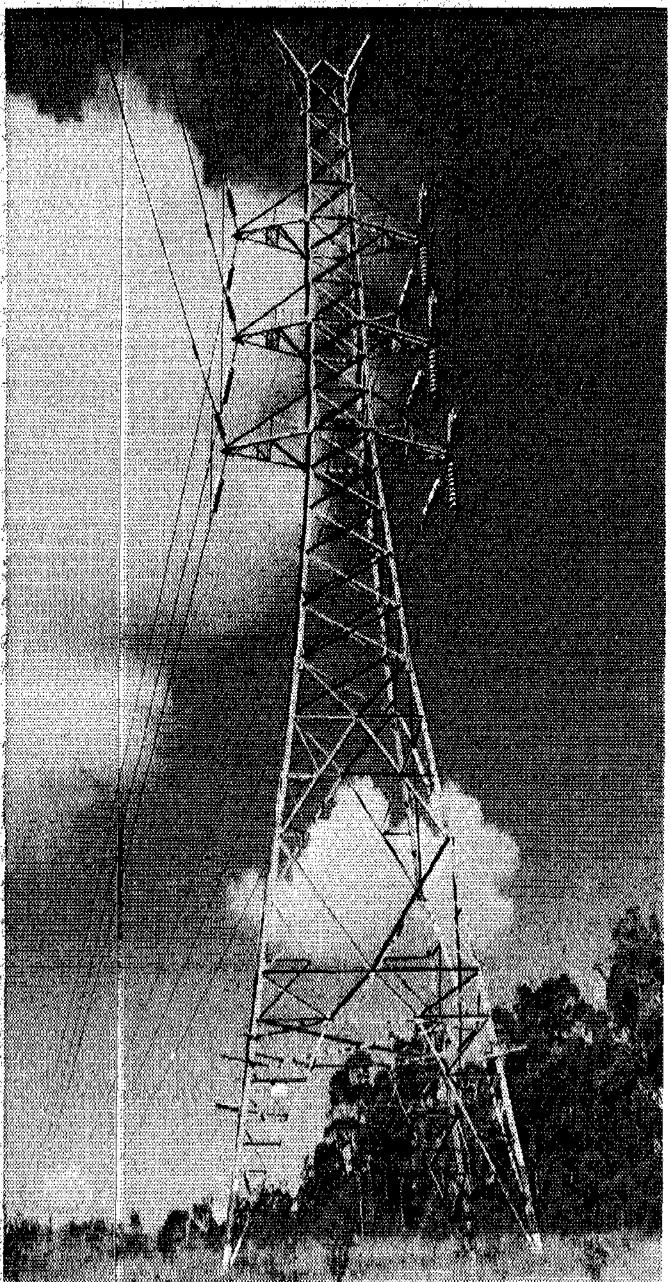
Threshold effects: The following describes the biological effects of a 50Hz or 60Hz current, which are most common in electrical installations. The effects of DC currents are also included but accidents are much less frequent than would be expected from the number of DC applications, and fatal accidents occur only under very unfavourable conditions, for example in mines.

The *threshold of perception* is about 0.5mA. This is the minimum current which causes any sensation. At about 1mA most people can 'feel' a current as a detectable tingling sensation. At 3 or 4mA, pain is felt but rarely causes much damage in a healthy person. The DC threshold is 2mA.

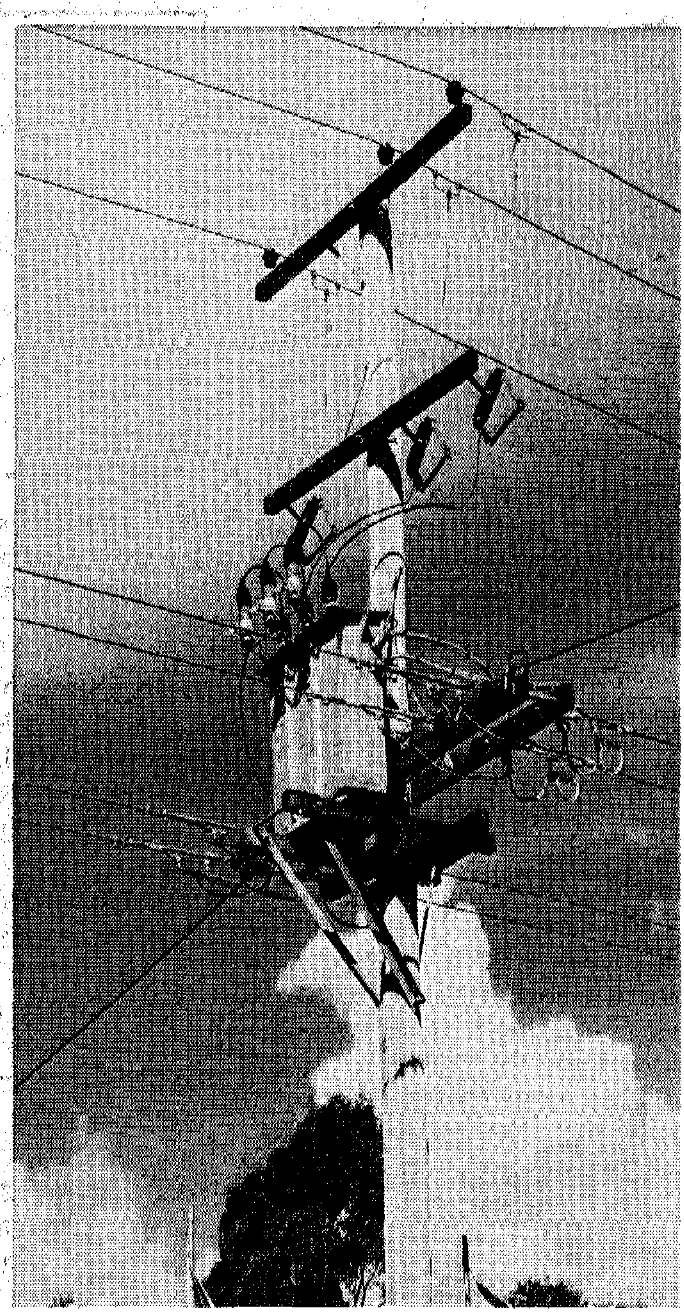
The threshold of let-go is 10mA. For currents approaching 10mA, a person will feel pain and strong muscular contractions, but should be barely able to release the hold on the conductor.

For DC currents there is no definable threshold below 300mA. Only the making and breaking of current causes painful and cramp-like contractions of the muscles. Above 300mA DC, let-go may be impossible or only possible after several seconds or minutes of shock duration.

Respiratory paralysis occurs with about 20mA AC, when the current flowing from the hands to the feet produces a contraction of the chest muscles that halts breathing. This paralysis of the respiratory system will lead to death by asphyxiation if it lasts a few minutes. Artificial respiration can often revive such a victim. The major problem with this current is that within a few seconds, the skin



Voltages are stepped up for long distance transmission. High voltages mean low currents and subsequently the I^2R power losses are minimised.



Street transformers usually step-down 11kV to 415V. Some models used polychlorinated biphenyls (PCB's) as the coolant and now present a disposal problem.

in contact with the conductor will suffer burns and blisters. Such damage drastically reduces the skin's resistance, which can lead to a fatal increase in the current.

Ventricular fibrillation

The threshold of ventricular fibrillation is 50mA. If a current above 50mA passes across the torso for a second or more, the portion passing through the heart causes the heart muscles to begin to contract irregularly.

This cessation of the natural rhythm of the heartbeat prevents proper pumping and oxygenation of the blood. This condition is called 'ventricular fibrillation' and will continue even when the victim is removed from the electric circuit. The consequences are fatal unless medical assistance is available. It is the main cause of death by electric shock.

If the contact time is below 0.1 seconds, current over 450mA may be needed to cause fibrillation — but it can vary, depending on the particular stage of the cardiac cycle when the shock occurs. The most vulnerable part of the cycle corresponds to the first part of the 'T-wave' in the ECG, which is about 10% to 20% of the cardiac cycle (see Fig.2). It occurs about 0.2 seconds after the main peak. Some other times and thresholds are: 3s, 40mA; 0.5s, 100mA; 0.01s, 500mA. It may be seen that there is a considerable increase in the threshold of fibrillation if the current flow is less than one cardiac cycle.

For DC, the threshold for ventricular fibrillation for a falling current is about twice as high as for a rising current. For hand-to-hand passage of current, fibrillation is not likely to occur. The threshold for a 3 second contact is 150mA; for 1 second it is 200mA. For shock durations less than 0.2 seconds, the threshold values are similar to corresponding AC currents (about 500mA). Above 300mA DC, current marks, burns, dizziness and sometimes unconsciousness occur. Strangely enough, if the current is much larger, of the order of 1A, the damage may be much less, and death less likely. Large currents such as these bring the entire heart to a standstill — the nervous system is blocked and respiratory muscles are paralysed. But upon release of the current, the heart often returns to its normal rhythm, and victims can sometimes be saved by prompt artificial respiration. Heavy burns resulting in serious injury are common.

At these high values of current, the effects of AC and DC are not very different. But at lower values, a DC current poses less of a hazard than a comparable AC current, because DC does not trigger the strong muscular contractions of AC.

In the above discussion, we have assumed that the path of the current through the body is from hands to feet. The majority of electrocutions in Australia and the rest of the world are of this type.

If the current path is in one leg and out the other, the threat to life is lessened as no vital organs lie in the path. However, the intense heat tends to kill cells, and surgical excision of large amounts of dead tissue or amputation may be needed.

Defibrillation: Heart fibrillation will occur when a body current of 50mA AC or more passes through the heart. A potential of 220V to 450V generally brings this on. Even though there is muscular activity by the heart, the chaotic motion prevents blood circulation and oxygenation.

In Australia, electricity is distributed from the generating station at a high voltage, say 22kV which is stepped-up to 275kV for statewide distribution. At major towns it is stepped down to 110kV and then sold to the regional distribution authorities at 33kV for their bulk supply. At suburban sub-stations, it is stepped down to 11kV and then to 415V at the street transformers. Here, the three phases are 240V each, with respect to the neutral or earth, with 415V between the phases. One of the 240V phases and a neutral is connected into domestic premises. Some consumers and factories get all three phases and then have a 415V line voltage. The problem is that the final supply voltages are within the 220-450V range that commonly causes fibrillation.

In the USA, street transformers step down a 5.6kV supply to 220V. This means that there is 220V between the phases and 110V between any phase and neutral, although it varies from state to state and even suburb to suburb. Both the 5.6kV, and the 110V usually supplied to domestic premises, are outside the 220-450V AC range, and fibrillation is less common on a per-capita basis.

If fibrillation begins, the treatment — it's called being 'hit with the irons' — involves two steps.

Firstly, the fibrillation (and thus the heart) must be stopped. This is done by

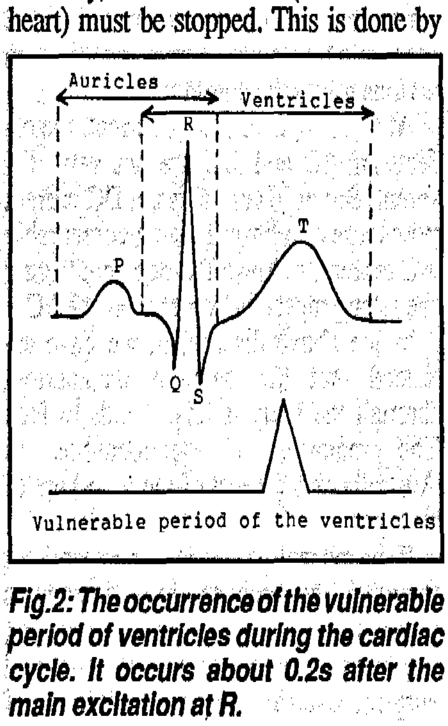


Fig.2: The occurrence of the vulnerable period of ventricles during the cardiac cycle. It occurs about 0.2s after the main excitation at R.

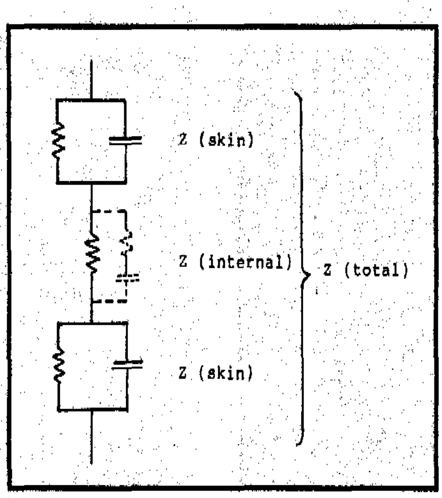


Fig.1: Impedances of the human body. The dashed line indicates that there is a small capacitive component internally.

placing the plates of a defibrillator on the chest on either side of the heart. When the trigger is pulled, a 5kV DC pulse lasting 1 to 50 milliseconds passes through the heart, causing it to stop. The defibrillator has to recover within 5 seconds (typically 2-3 seconds in Australian models) ready to deliver the next pulse.

The second step is to restart the heart, which is usually done with a second pulse, identical to the first. Sometimes the heart may resume its normal 'sinus' rhythm naturally, without this second pulse. If unsuccessful, a third (and final) stronger pulse may be used, but if this fails, then cardiopulmonary resuscitation is continued until the victim reaches hospital.

In American movies, you may have noticed that only one hit is required. In the USA, the 110V and 5.6kV supplies are less likely to cause fibrillation. They just stop the heart. Only one hit with the irons is needed to restart the heart (if it is going to start at all).

The standard procedure in the USA is to give the patient a sharp thump in the chest with your fist. It is called a 'precordial thump' (Latin: cor, cordis, the heart). This can shock the heart into starting. It is not standard practice in Australia — there is no point as it won't stop fibrillation. In fact if a paramedic or doctor uses this as the first treatment, they run the risk of being sued for an inappropriate and time-wasting procedure. US paramedics have to be retrained when they come to Australia.

Doctors often use an electrocardiogram (ECG) in combination with the defibrillation, so they can better monitor the heart's stopping and starting. The ECG has to have a trace recovery-time of less than a few seconds, so it can respond quickly after being blanked out by the defibrillation pulse.

Modern ECGs are also optically decoupled to prevent the 5000V going down their leads. Earlier imported models were not optically decoupled, and sometimes had a common earth with the defibrillator. If and when a fault condition arose, someone holding on to the ECG could die. (It has happened.) In another case in the US, a two-pin ECG plug from the body leads was identical to the 120V mains wall socket. The patient died when the leads were plugged in and turned on. The nurse was touching the bed and was also found dead.

Even without a fault condition, 'leakage current', that is current along an unintended path, can be fatal. Leakage currents are often capacitively coupled; for example, a wire in a lamp forms a capacitor with the metal case — charges moving in one conductor attract or repel charges in the other, so there is a current.

Typical electrical codes limit such leakage current to 1mA, which is generally harmless. But to a patient with implanted electrodes connected to ground through the ECG apparatus, it can be very dangerous. As little as

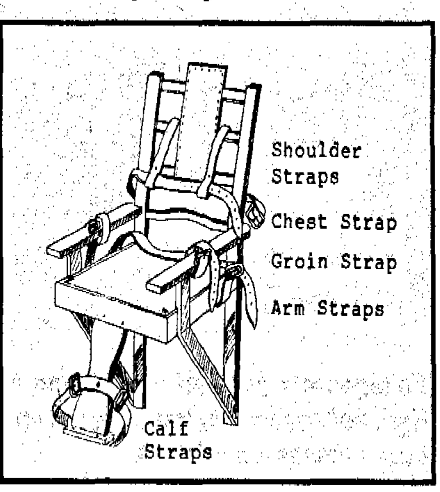


Fig.3: The electric chair. Electrodes are strapped to each calf and a cap with an electrode in it is used to keep the head in place.

0.02mA can cause fibrillation when passed directly into the heart, whereas 50mA is required when entering through the hands. This 'wired' patient is in danger from just touching a light.

In some people, an unusually sensitive response of the nervous system to electricity can lead to death from as little as 12V, although an unusually small skin resistance can be a contributing factor.

Killer fences

A typical electric fence produces 7500V DC pulses, lasting 0.2 milliseconds at intervals of 1 second. These spikes are produced from either 240V AC mains or from a 12V battery. Alternating current units are outlawed. Although special deep-cycle batteries are available from manufacturers, 90% of users make do with a car battery.

Electricity authorities specify a 10,000V maximum for the battery units, but the testing is not as rigorous as for the mains units. A 500-ohm load is placed across live and earth and the units must be able to deliver the specified voltage.

For instance, a 7500V mains unit should supply about 5000V under load. A good unit connected to a clean (unloaded) fence should be able to maintain 7500V over 20km of fencing.

Farmers merely check the fence voltage with a small voltmeter. They get to know what voltages should appear on the fence at different places, usually gate openings, and can tell if the system is operating normally. Animals that get trapped in the fence do die, not so much from the current but from stress.

South Africa's border fence between Mozambique and Zimbabwe is no ordinary electric fence, but is a 'killer fence'. It carries only 3500V DC, but even according to official reports it has killed 89 people in the past three years. Church leaders say the figure is closer to 200 per year. The victims have been women and children fleeing the war with Mozambique. Locals call the fence the 'Snake of Fire'. In contrast, the Berlin Wall only claimed 80 lives in its 28 year history.

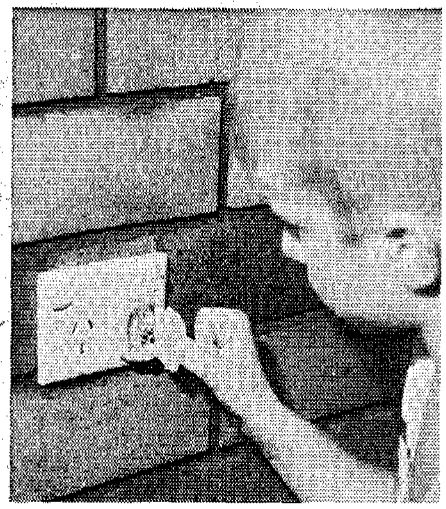
Electrified fencing is common in South Africa but most is like our non-lethal domestic type described above. Voltages up to 10,000V DC are common, and even with pulse durations of 20 milliseconds, 30 joules of energy can be delivered at a current of 300mA.

The problem with this border fence is that it carries a continuous (not pulsing) potential of 3500V DC, and is able to supply 800mA of current. Once the fences are touched, muscle contraction prevents the victim letting go. With ordinary electric fences, there is sufficient time between pulses to let go.

This continuous current level is often fatal. Those who have survived have suffered severe burns and even lost limbs. The fences are installed by a contractor called Eclair, in Johannesburg.

Electric chair

In the late 1880s, in order to challenge the growing success of the Westinghouse Company, then pressing for nationwide electrification with alternating current, the advocates of the Edison Company's direct current staged public demonstrations in New York to show how dangerous their competitor's product really was. If alternating current could kill animals — and awed spectators saw that it could — it could kill human beings as well.



ELCB's will prevent certain accidents. Touch an active while earthed and you'll be safe; touch active and neutral and you won't be.

In no time at all, this sombre warning was turned completely around. In 1888, the New York legislature approved the dismantling of its gallows and the construction of an electric chair. The theory was that in all respects, scientific and humane, executing a man by electrocution was superior to hanging.

In 1890, after his lawyer had unsuccessfully argued that this method was 'cruel and unusual', and thus violating the constitution, William Kemmler became the first criminal in history to be put to death by electrocution. Although eyewitness reports allege that the execution was little short of torture, the fad had started.

The late Robert Elliot, electrocutioner of 387 men and women, assured the public that the condemned person lost consciousness immediately with the first jolt of current. Between 1890 and the end of the 1960s, several hundred people a year have been executed in the US for rape, armed robbery and murder.

The prisoner is securely fastened to a chair (see Fig.3) by his chest, groin, arms and legs, to prevent violent movements and to keep the electrodes in place. These electrodes are moistened copper terminals attached to each calf and a band around the head.

'Jolts' of 4-8 amperes at between 500 and 2000V AC are applied for a half minute at a time. A doctor inspects the condemned man to decide if he is dead, or if another jolt should be administered.

TABLE 1

Touch voltage (V)	Average Total body impedance for 95% of population (ohms).
25	6100
50	4400
75	3500
100	3200
110	3000
240	2100
500	1600
1000	1500

At Sing Sing prison, New York, an initial voltage of 2000 to 2200V at 7-12A is used at half minute intervals over two minutes. Current flow in each leg and the head is monitored. When the switch is first applied, there is a sputtering drone and the body strains against the straps, smoke often appears under the helmet that holds the head electrode, there is the odour of burning flesh, the hands turn red then white, and the cords of the neck stand out like steel bands. Mouths are sometimes taped shut and in some instances, the anus stuffed with cotton. Body temperature rises to 54°C or so, and autopsies have found charred brains in the victims. This may be gruesome, but the physiological effects are inescapable.

In 1982, John Evans was given a half-minute jolt, but the leg electrode broke and was re-attached. A second shock failed to kill him, and smoke came out of his mouth and left leg. He was given a third jolt. Ten minutes later he died. There is no reason to believe that the victim doesn't feel pain. He is so firmly fastened to the chair that he can't move, but the large amount of energy in the shock paralyses the muscles. Presumably it was the failure to move which led to the general belief that the prisoner was not suffering pain. However it has been known for several decades that lack of movement does not mean absence of pain.

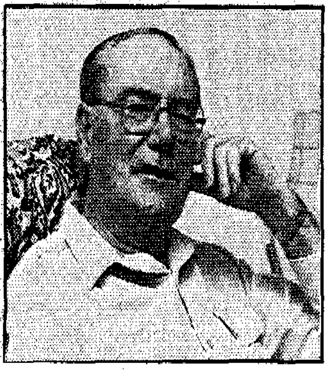
A prisoner being electrocuted is paralysed and asphyxiated, but is almost certainly fully conscious and sentient. Dr Harold Hillman, writing in *New Scientist* (Oct. 27, 1983, p278) said that the victim would feel himself "being burnt to death while he is conscious of his inability to breathe. It must feel very similar to the medieval trial by ordeal of being dropped into boiling oil".

In Britain, it is illegal to operate experimentally on animals which have been paralysed only by curare, and have not been anaesthetised, because it is known they would feel pain.

Shock therapy

In the late 1930s, electro-convulsive therapy was introduced for manic depression. It was soon apparent that patients had to be anaesthetised before the therapeutic shocks were applied, though this is standard practice today.

So, understand the biological effects of electricity on our body, and treat it with the utmost respect. Don't 'shake hands with the devil'. Electricity is far too dangerous for anyone to be complacent about its potential. ❖



When I Think Back...

by Neville Williams

Vintage radio receiver design — 8: The evolution of table and mantel models

The majority of Australian mains powered receivers in the 1930's were 4/5-valve floor model superhets as already discussed, but the 'second set' concept generated a supplementary demand for 3/4-valve 'table' and 'mantel' models. These shared much the same basic technology, but were subject to quite different design objectives.

Before embarking upon this further dimension of receiver design, it may be appropriate to 'clear the decks' by commenting on an aspect of domestic dual-wave sets, large or small, which had to be held over from the last article. I refer to tuning systems of the day, and the frequent difficulty in locating and/or identifying individual short-wave stations.

In place of the humble 0-100 celluloid vernier dials that characterised console receivers in the early 1930's, the models that followed later in that decade were commonly fitted with comparatively large, edge-lit glass dials that offered a more striking and informative display. Blue/green sailing ships seemed to be the preferred motif, surrounded by an array of local and interstate station callsigns.

As well, multiband sets carried shortwave calibrations in metres and kilocycles, plus the odd overseas transmitting centre: London, Paris, Rome, New York, etc.

Unfortunately, and despite the sometimes pretentious graphics, the shortwave calibrations indicated, at best, where overseas stations would most likely be found — and then only by careful and attentive tuning! Virtually all domestic shortwave receivers suffered from this same limitation, for which there was a compelling technical reason:

To take in the broadcast band, multiband receivers had to be fitted with a standard tuning gang of about 415pF maximum, in order to cover from around 550 to 1600kHz — a ratio of about 3:1, embracing a total bandwidth pf about 1000kHz.

On a typical dial scale, a local AM broadcast band station might spread over 6mm or more, making it relatively easy to identify and to tune for the best sound.

When switched for shortwave coverage, the same tuning gang would still span a ratio of 3:1 (e.g., 13.5 - 40.5 metres), which represented a useful segment of the shortwave spectrum. But this was/is equivalent to 22 - 7.4MHz, embracing a total bandwidth of over 14,000kHz — fourteen times that of the broadcast band.

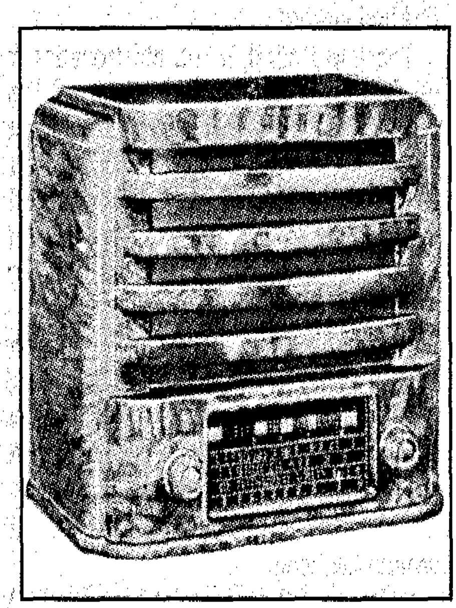


Fig.1: A Kriesler 'compact' D/W receiver, as advertised in our November 1939 issue. In a moulded cabinet, with a choice of five colours, it retailed for around £13 ($26).

Since an AM shortwave station occupies only the same 20kHz-odd of bandwidth as an AM broadcast transmitter, it follows that with such a tuning range it will occupy only about one fourteenth of the dial space — even for a strong signal.

That amounts to only about one-half millimetre, or the thickness of a pointer or calibration mark.

To make matters worse, neither the circuitry nor the mechanics of an ordinary analog (tunable) domestic receiver could/can be held to an accuracy equivalent to the width of a line on a large dial. So a shortwave station of specified frequency will rarely coincide with the dial calibration — and even if one goes searching for a particular signal, it will be less than a millimetre wide, and therefore very easy to overlook.

It helps if the dial mechanism can be made as smooth as possible and free from backlash but, at best, it is difficult to locate and identify shortwave stations relying purely on dial markings. A few models featured double-vernier drive knobs and/or supplementary 'band-spread' pointers, but they could offer only very limited assistance with what remains a fundamental limitation of ordinary tunable domestic multiband receivers.

Now to take up the main theme of this present article:

Smaller, simpler, cheaper?

Scaled-down superhet receivers, using mostly three valves and a rectifier, were an integral part of the world radio scene for so long that, like the proverbial poor, they seemed always to have been with us. However, when I began to reflect on the matter, I realised that such was not the case. They had had a belated marketing timetable in Australia, and a design philosophy all of their own.

With hindsight, it became evident that, when mains-powered 4/5-valve superhets won acceptance in the early 1930's

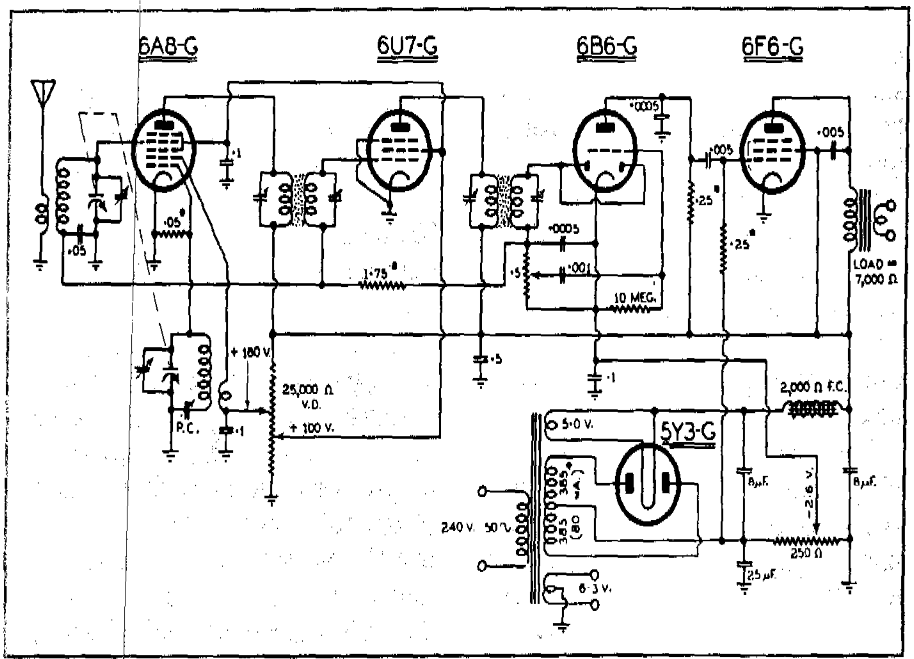


Fig.2: From Radiotronics 99 (July 1939), this circuit suggests the ultimate in simplicity for a 4/5-valve superhet. To that point in time, AWV had not encouraged the idea of dropping the first audio stage, possibly because they lacked a high-gain output valve.

as the optimum design for an average Australian home, polished plywood console cabinets were entrenched along with them, free-standing against the living room wall. Perhaps I should add: with or without in-built record playing facilities, which became increasingly popular from the mid 1930's onwards.

To use a modern 'buzz' phrase, such receivers assumed the role of the 'entertainment centre', around which Australian families would gather each evening to enjoy their favourite serial, quiz show or drama. Anything less pretentious than a full-sized cabinet, bedecked with ornament or family photograph, would have lacked credibility!

That compact models had not been totally overlooked, however, is evidenced by a letter from Ray Brown, an old-timer from North Haven, NSW. Ray remembers having constructed what *Wireless Weekly* presented in the early 1930's as the first so-called 'midget' superhet — a 5-valve design (57 autodyne, 58, 57, 2A5 and 80) in a 'boxy' cabinet measuring a mere 11 x 7 x 6 inches (28 x 18 x 15cm).

This was followed by a 3/4-valve version using a 57, 57, 2A5 and 80 combination — the 58 IF amplifier having been omitted, along with one IF transformer. To compensate for the loss of gain, a reaction winding was added to the remaining IF transformer, so that the second 57 could function as a regenerative detector at 465kHz.

A padder-type compression capacitor served as a semi-fixed reaction control. It was an interesting combination of old and new technology, which Ray Brown says worked well. In its day, the idea of a regenerative superhet, where the reaction could be preset, held a certain fascination for experimenters. But to the best of my knowledge, the circuit found little practical application.

By chance, discussing the same era, a friend from the Blue Mountains area of NSW mentioned that his neighbour had owned an Astor 'Mickey Mouse' receiver. He can't remember much about it, except that the sound level seemed remarkable for the size of the set.

'Table' model sets

Another reader/correspondent, Ted Baker of Bathurst, sent me an historic photostat showing the 'Airmaster' range of broadcast band receivers as marketed in 1935. At the economy end was a 3/4-valve superhet which was offered in two cabinet styles: a slim and presumably inexpensive free-standing console and a lone, relatively bulky table-top model, which I would estimate to have been about 20 inches (51cm) tall.

I worked at Reliance Radio until about 1936. A small company, it could readily have diversified into pint-sized models, but the management presumably felt that the demand for them was limited — or at best patchy.

The only economy model Reliance produced at the time, over and above their normal manufacturer-to-you range, was identified as the 'Series 14-B'. Adapted from their standard 'Series 14' 4/5-valve superhet, it used a more compact chassis, admitted to the odd economy measure and assumed the use of a cheaper cabinet. While available as a table-top model, its main appeal, as I recall, was as an economy domestic console — with much the same valve complement and circuitry as the higher priced model.

After leaving Reliance, I worked for about three months in a factory at Redfern, Sydney, producing receivers for the Emmco/NST/Wilkes organisation(s). Again, the output comprised predominantly console models.

Lest I was being mislead by non-typical examples, I checked through my file of *Radiotronics* promotional bulletins, issued by the AWV Applications Lab. Their job — and my job when I sub-

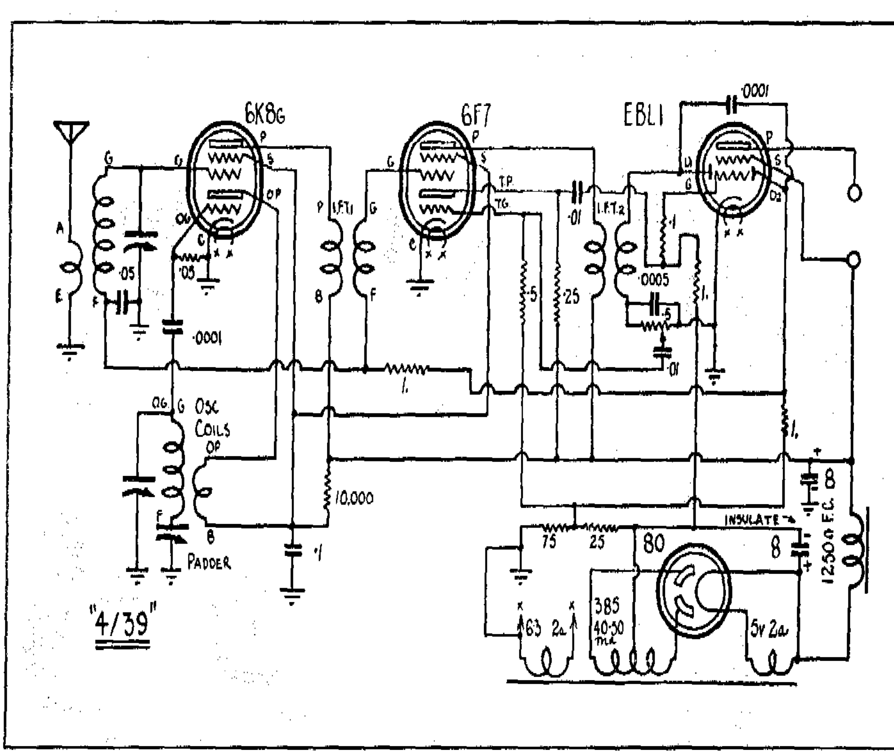


Fig.3: Described for home construction in the August 1939 issue of R&H, the '4/39' was noteworthy because it duplicated the stages of a 4/5-valve superhet using one less valve. It perpetuated the assumption that even small sets should be able to receive interstate and overseas stations.

sequently joined the AWV team — was to identify designers' priorities Australia-wide, and to complement them with technical information about the Company's inventory.

In my *Radiotronics* file, which covers from late 1935 to October 1941, there were several typical circuits for 4/5-valve superhets, circuits for up-market receivers using an RF stage and/or a more elaborate audio system, and a sequence of fairly ambitious battery powered receivers for country listeners.

But there was litle or no mention of physically small receivers or designs with fewer stages. Either the Valve Company Lab team had been remiss, or there was indeed very little local interest in scaled-down domestic receivers.

That they were in production, however, even if in limited numbers, is evidenced by an advertisement in the November 1939 issue of *R & H* for what Kriesler called their 'Dual Wave World Range Compact' receiver. Illustrated in Fig.1, it came in a walnut or black moulded cabinet and retailed in NSW for £12/19/6 ($26), or slightly more in other states and/or in cream, green or marble.

Only just cheaper!

The one deliberately simplified circuit I encountered in *Radiotronics* is shown in Fig.2. Taken from *Radiotronics 99* (July 1939), it minimises the number of components and uses five economically priced valves.

In practice the cost advantage would not have been great and, as in the case of the Reliance series 14-B, any substantial savings in the end price would have had to come from the cabinet, the dial and loudspeaker.

Because of the special nature of the circuit, however, it may be appropriate to interrupt the main theme of the article to comment on the compromises which were deemed acceptable by the Valve Company engineers for an economy broadcast band receiver.

The usual 100pF oscillator grid coupling capacitor was omitted, the circuit being so configured that the normal tuning capacitors blocked any direct path to earth for the grid current. The performance of the 6A8-G was not adversely affected by the omission.

The use of a back-bias resistor with adjustable tapping allowed three of the four cathodes to be directly earthed, and that of the 6B6-G to be bypassed only with an 0.1uF.

Simple AGC was specified, with a 1.75M isolating resistor to minimise loading on the diode detector. Nowadays, 2.2M would be a logical substitute.

The circuit also exploited the novel idea of operating the 6B6-G (or other similar high-mu triode) with a 10M grid resistor and zero nominal bias. In fact, grid current through the unusually high value resistor (accentuated by rectified IF, noise and audio signal components) would generate sufficient bias to allow the high-mu triode to operate normally, presenting a nett input impedance of half that of the 10M resistor. This high figure explains the use of a 0.001uF (1nF) input coupling capacitor.

An 0.25M grid resistor for the 6F6-G was mandatory by reason of the back-bias, the .005uF (5nF) coupling capacitor being admittedly smaller than optimum. A .02uF (20nF) would be a better choice if the bass response was open to question. The 25uF electrolytic across the back-bias resistor could likewise be omitted, if a slight loss of bass and slight increase in hum could be tolerated.

The circuit was deemed unsuitable for the application of negative feedback around the output stage, but the combination of .0005uF (500pF) capacitors on the grid and anode of the 6B6-G and that of 0.005uF (5nF) on the anode of the 6F6-G was sufficient to suppress the residual IF component and smooth out the treble response for routine listening.

As an exercise in cutting corners, circuit No.RD44, which carries my initials, was out of character for the AWV Lab; but it may provide a handy resource for vintage enthusiasts. It would hold good for 1930's-style equivalent valve types as under:

6A8-G/6A7/2A7;
6U7-G/6K7/6D6/58;
6B6-G/6Q7/75/2A6;
6F6-G/42/2A5;
5Y3-G/80.

So back to the original theme:

Early *R & H* issues?

It might be argued that valve manufacturers could scarcely have been expected to promote designs calling for a reduced valve complement. With this in mind, I also thumbed through volume one of this magazine, first published monthly in April 1939 under the title *Radio & Hobbies* ('*R & H*'). It was produced by the experienced *Wireless Weekly* team, who should certainly have been able to identify the dominant interests of prospective readers.

In fact, the initial four issues contained constructional articles on up-market receivers using six or more valves, plus a number of elementary battery sets for beginners. It was not until issue five (August 1939) that they got around to a 'midget' mains operated receiver for everyday use: the dual-wave '4/39', described by (the late) John Moyle.

To my mind, that receiver and the designs which followed over the next 20-odd years epitomised the thinking behind a succession of valve-based Australian 'mantel' radios, as distinct from the earlier and more bulky 'table' models — or scaled-down consoles.

In his introductory remarks about the '4/39', John Moyle explained that 'baby' receivers were already very popular overseas. Some were even mass produced, at prices so low that it was

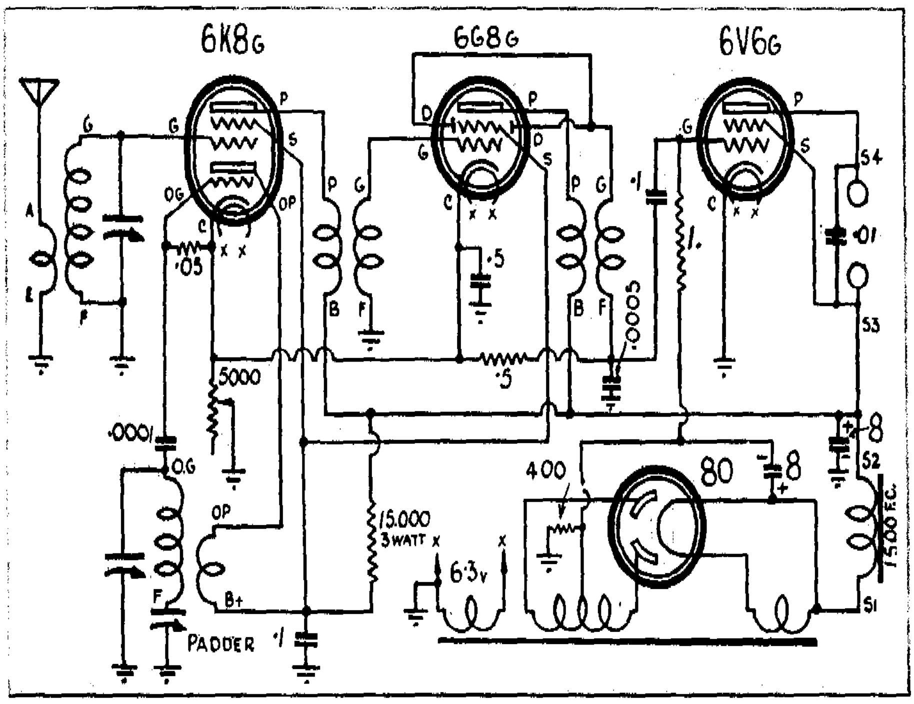


Fig.4: The original 'Little General' circuit from the April 1940 issue of R&H. Thousands of them were built by readers. To assist experimenters, options like fitting a dual-wave bracket or a loop antenna were detailed in subsequent issues.

cheaper to replace them when they failed, than to have them repaired.

By contrast, John said, while local demand for small receivers was rising, Australian listeners had become conditioned to conventional receivers in large cabinets — so much so that most would find it both 'amusing and interesting to hear music and speech coming from a small box only a few inches either way'.

Wireless Weekly, he said, had featured the '4/38' mantel receiver during the previous year, reducing the usual 4/5-valve complement by omitting the voltage amplifier and driving the output pentode directly from the detector. As some local manufacturers had found, the resulting gain was sufficient for day-to-day broadcast reception but insufficient for use on the short waves. This time around, *R & H* wanted to do better than that.

In a quest for higher gain, the editorial team had considered resorting to a reflexed IF/audio stage, but were deterred by the difficulties that others had encountered with the idea. (Reflexing was discussed on pages 38-39 of our June 1991 issue).

A little 'big' set!

As it turned out, the *R & H* team came up with an ambitious 3/4-valve circuit, as shown in Fig.3, which provided the same sequence of stages as a normal 4/5-valve superhet. In short, it met what they saw, at the time, as a minimum requirement for any Australian family receiver — be it large or small. The circuit is interesting in its own right.

A 6K8-G served as the frequency changer, with a common feed resistor for the screen and oscillator anode — a configuration which (in the case of the 6K8) was said to counteract the effect of supply voltage variations, minimising oscillator frequency shift and the associated risk of 'motorboating'. Shortwave coverage could be provided by replacing the single coils shown in the circuit with a readily available dual-wave coil bracket.

From the frequency changer, the signal passed to a 6F7, an imported American double valve containing a triode and a variable-mu pentode section, independent except for a common cathode. With pentode characteristics very like those of a 6B7S/6G8-G, the 6F7 could serve as a normal IF amplifier stage, with AGC control.

After IF amplification, the signal passed to twin diodes in a European duo-diode output pentode — a valve with about twice the transconductance — and therefore power gain — of the 6V6. Its intended role was for use in 3/4-valve superhets, operating directly from the detector output.

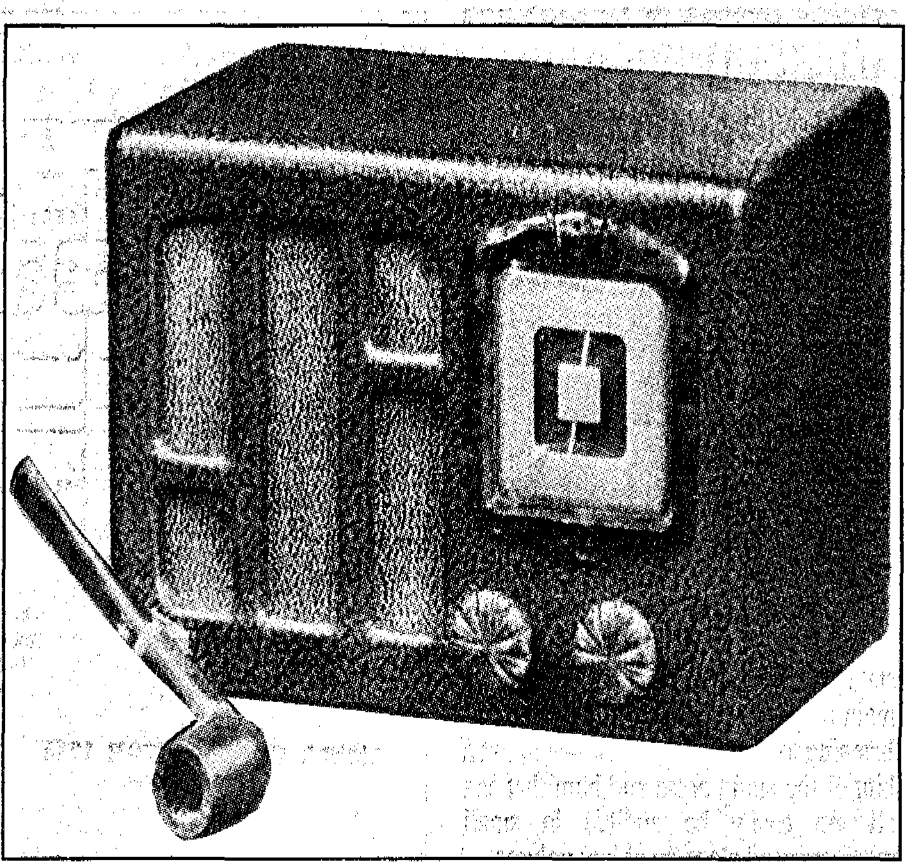


Fig.5: The original 'Little General', in its inexpensive leatherette covered cabinet. The one-piece escutcheon and dial scale pushed in from the front, the 'pointer' being a white line on a drive drum fixed to the shaft of the tuning gang.

In the 4/39, however, the signal was passed back through the 6F7 triode section for prior amplification. With an amplication factor of 8, similar to that of the early type 27 triode, the stage gain was quite low. However, when feeding an EBL1, and in the absence of negative feedback, the overall audio gain would not have seemed all that different to the user from a conventional 4/5-valve superhet.

An interesting aspect of the circuit was that it used back-bias for all stages, including the AGC system. Without going into details, this allowed all cathodes to be grounded, thereby avoiding the complications which might have arisen in providing self-bias for the multi-purpose cathodes in the 6F7 and EBL1. The bias levels were set to keep the current drain within the capabilities of the specified 40mA power transformer.

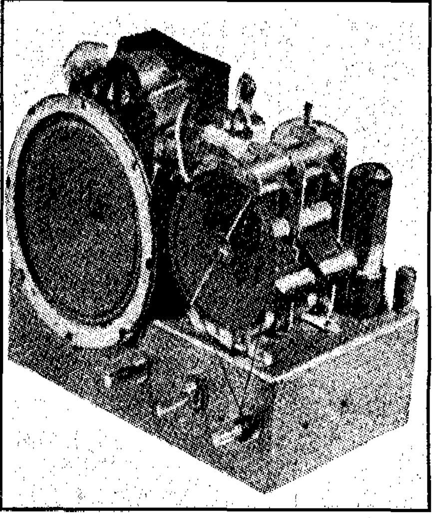


Fig.6: The completed chassis of the 1946 'Little General'. It differed from the original mainly by the inclusion of one of the options, the fitting of a dual-wave bracket, accounting for the extra (central) control shaft.

Superlatives were not spared in describing the appeal and performance of the 4/39: at 10W x 7D x 8H inches (25 x 18 x 20cm), it was 'small enough to take with you on holidays'.

Again: 'on the broadcast band there appears to be nothing that it cannot tune in'. And: 'if there is anything on the shortwave bands worth listening to, you will hear it at excellent strength'.

'A new star arrives'

Despite the apparent enthusiasm, less than a year had passed (April 1940) before John Moyle was waxing equally eloquent about a new midget receiver which the *R & H* staff had developed in the meantime.

It would appear that a few month's experience with 4/39 had confirmed the appeal of a receiver that could be carried at will into the kitchen, the sewing room, the workshop or the kids' bedroom for music, news, race results or whatever. But what had also become abundantly clear was that the set was rarely if ever tuned to interstate or overseas stations. For the role of a personal or 'second' set, the 4/39 had clearly been over-designed.

So the emphasis in the new receiver (Fig.4) was on portability, simplicity and low cost. Gone was the dual-wave bracket and AGC, the 6F7 and the EBL1, to be replaced by ordinary coils, a 6K8-G frequency changer, a conventional 6G8-G IF amplifier and diode detector, and a 6V6-G biased to limit the total drain to 40mA.

Under the banner 'A new star arrives', the simplified design was presented as the 'The Little General Mantel Receiver' — a title that someone has suggested was intended to catch the eye of hobbyists in uniform.

Yes, said John Moyle, the Little General will still receive the main interstate stations at listenable volume, but its main role is to provide intimate personal listening to the local stations — without a hint of the audio noise and hum that can all too easily be audible in small receivers used close-up at low volume.

Fig.5 shows the prototype, photographed for size comparison with John Moyle's perennial pipe. The cabinet was produced at low cost by numerous cabinet makers, but it was well within the capabilities of a handyman.

Assembled from off-cuts of plywood, composition board or softwood, the basic box was first sanded smooth, with rounded corners. After a generous coating of carpenter's glue, it was overlaid with figured 'leatherette', with a scrap of decorative cloth backing the loudspeaker grille.

Phenomenal response

The Little General certainly 'hit the spot' with *R & H* readers. Backnumbers of the April 1940 issue were rapidly exhausted and, thereafter, a constant stream of requests for copies of the circuit arrived through the *R & H* 'Shilling Query Service'.

Before wartime restrictions put a brake on the marketing of new components, it was evident that the sale of key items by the various suppliers had run into five figures. How many of them were absorbed by 'backyard' factories we will never know.

Even without firm statistics, it is difficult to escape the conclusion that the *R & H* 1940 'Little General' played a major role in focusing the attention of the industry and listeners alike on mantel model receivers for personal listening. Even during the war years, the Little General's very simplicity made it an obvious choice for anyone who wanted to 'knock up a set' from oddments.

During this same period, follow-up articles suggested ways in which experimenters could increase the gain (April 1940), or provide a loop antenna (June 1941), or fit a dual-wave bracket into the original chassis (December 1941).

I recall also that someone discovered that a quite healthy sound could be obtained by feeding the signal from a high output standard groove crystal pickup to the grid of the output pentode.

Besides seeing a few Little Generals end up as mini-radiograms, the idea also gave birth to a one-valve phono player — which was novel, to say the least.

Post-war Little General

In January 1946, as Technical Editor, I made my own contribution to the Little General saga with an update of the earlier articles — which had long since gone out

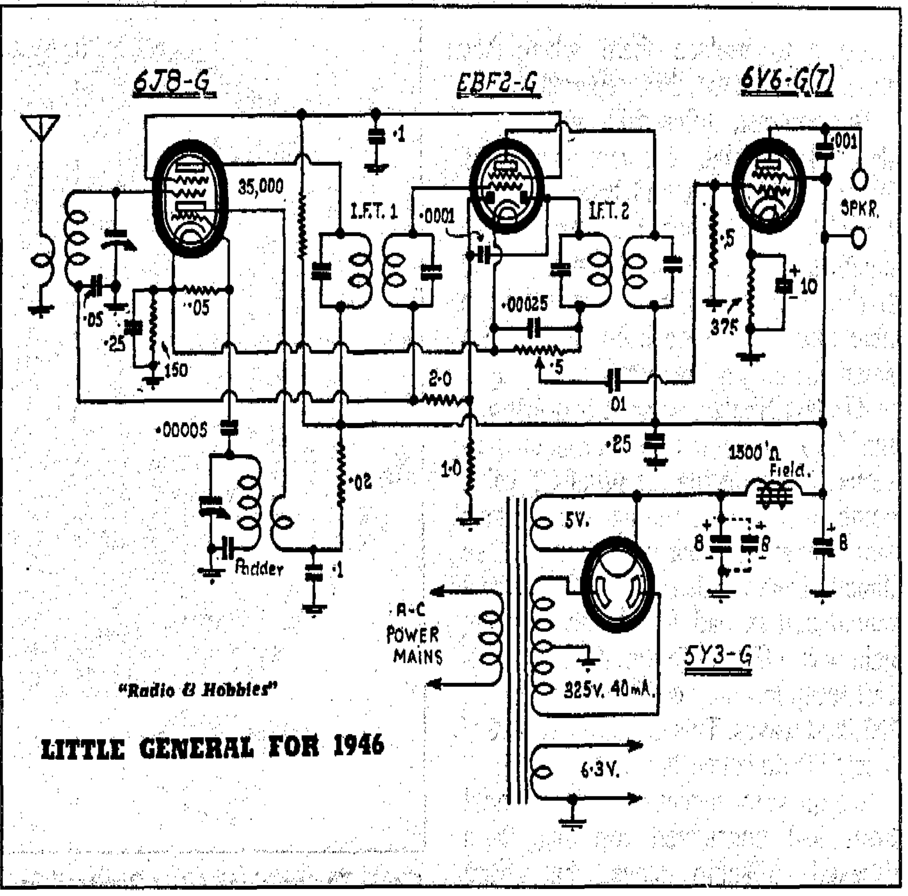


Fig.7: The circuit of the 1946 'Little General', which suggested using the new 6JB-G converter, reverted to automatic gain control and encouraged the use of a lower voltage power transformer.

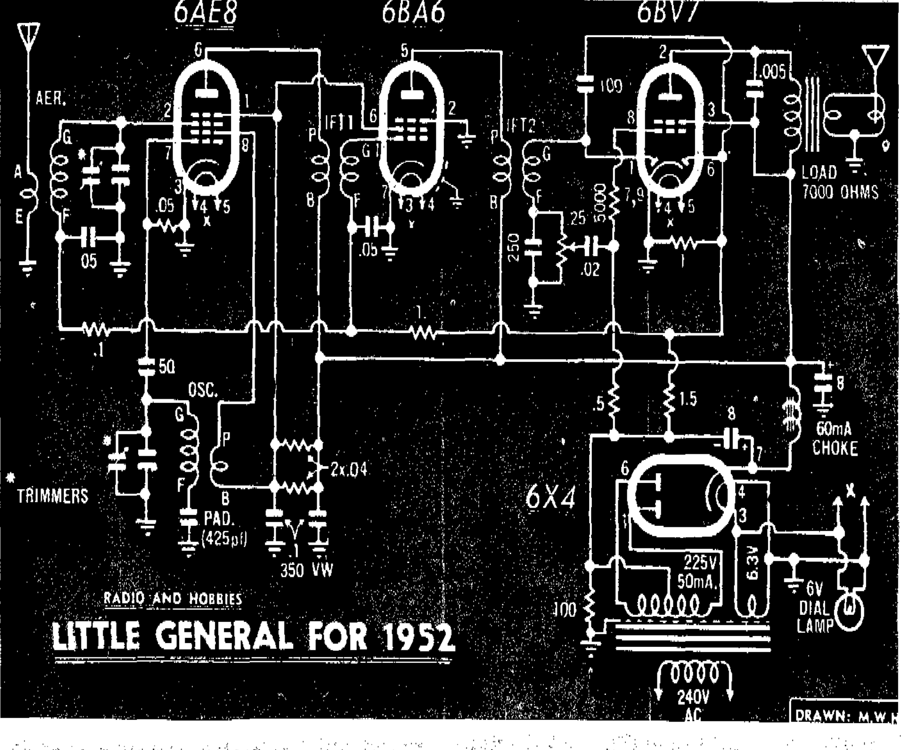


Fig.8: Breaking with tradition, the 1952 'Little General' specified the use of all-glass miniature valves and matching miniature coils and IF transformers. It also saw the adoption of a permag. dynamic loudspeaker and a more energy efficient power supply — all typical of contemporary commercial mantel receivers.

of print. (In those days, office photostat copiers were still 30-odd years down the track).

I explained in the preamble that, while smaller valves and components were on the horizon, the most realistic course as at January 1946 was to retain the chassis, layout and cabinet of the original Little General, adapting the circuit and parts list to accommodate the components most likely to be accessable in this immediate postwar period.

Fig.6 shows the completed chassis, which looked essentially similar to the original version. The dial kit, probably from RCS Radio, involved a moulded drum, which attached to the gang shaft, a knob spindle with a tight-fitting rubber grommet and a length of woven drive cord with tension spring. The matching escutcheon and dial scale fitted through a cutout in the front of the leatherette covered cabinet.

The recommended circuit (Fig.7) showed a 6J8-G as the preferred frequency changer, but other valves such as the 6K8-G, 6A8-G or 6A7, which might be on hand, were suggested as legitimate alternatives.

Following the convention of the magazine at the time, the circuit showed only a single set of coils, and in fact constructors had the option of installing a set of broadcast coils underneath the chassis.

However, the presence of three controls confirms that the prototype carried a dual-wave bracket instead, on the basis that it involved so little extra effort and outlay that we had decided to do it that way, that time around.

An octal-based EBF2-G was nominated as the preferred IF amplifier/detector although, again, there were other options in the way of the P-based version, or the 6G8-G or 6B7S.

My choice at the time was to revert to the use of AGC rather than manual gain control, the detector and delayed AGC circuitry being exactly as might be found in the front end of a full-size 4/5-valve superhet. Output from the detector was fed directly to a 6V6-G or 6V6-GT — valves that by then were so plentiful that alternatives were not even discussed.

In the power supply, a point of note was that a definite effort was being made to discourage the use of a traditional 385/0/385V secondary and to promote a 325/0/325V rating for small receivers, to avoid needlessly high voltages and heat dissipation.

After several years of wartime shortages and uncertainties, the article was very obviously intended to re-position the 'Little General' as an important and on-going feature in the *R & H* repertoire of do-it-yourself projects. To borrow John Moyle's phrase, it was a clear indication that Australians were becoming accustomed to hearing music and speech coming from a small box!

According to *EA*'s old valve receiver master index, which Jim Rowe kindly looked up for me, the Little General popped up again in August 1947 and July 1951, with a totally new version presented by Raymond Howe in September 1952.

'Modern' valves

Climaxing the trend set in the previous year, the 1952 version (Fig.8) discarded once and for all the option of using conventionally based valves and specified a new chassis to accommodate only the new all-glass miniature valves, along with proportionately smaller coils and IF transformers.

Using the same size chassis and cabinet as previously, there was room above the chassis for all the major components and also for a modern edge-lit glass dial, leaving ample space underneath for uncluttered wiring. Noteworthy also was the use of a dynamic loudspeaker with a permanent magnet rather than an electromagnetic field coil — a spin-off from wartime technology.

Despite their much reduced dimensions, the new miniature valves were well ahead of the older types in terms of gain and efficiency. The 6AE8 triode-hexode converter had about twice the conversion gain of the older types, the 6BA6 offered two to three times the transconductance of earlier IF amplifiers, while the 6BV7 was way ahead of the 6V6-G and even more sensitive than the EBL1 — once the pride and joy of the Philips/Mullard range.

With overall back-bias and delayed AGC, the 1952 circuit invites obvious comparison with those discussed earlier. But allowing for a gain advantage of around 2:1 per stage, the overall sensitivity could be expected to be well up on the earlier 3-stage versions. A further point of note is that, with the use of a relatively low-resistance choke in place of the loudspeaker field coil, HT voltage drop in the filter system was less.

In addition, the indirectly heated 6X4 miniature rectifier was much more efficient than the old 5Y3/80, offering the further advantage that it did not call for a separate 5-volt filament winding. It permitted the use of a simpler power transformer delivering much lower voltage, but with a higher current rating.

Since all of the valves shown were Australian-made, along with virtually all the other components, the Little General for 1952 had a lot in common with postwar mantel receivers offered by Australian manufacturers. Some even used leatherette-covered cabinets; but in line with overseas trends, those who could cope with the initial expense came up with a variety of moulded plastic designs.

Occasionally, much to the delight of home constructors, production over-runs of such mouldings turned up later in surplus clearance dealers, giving enthusiasts the chance to accommodate their handiwork in a decidedly 'non-handyman' cabinet.

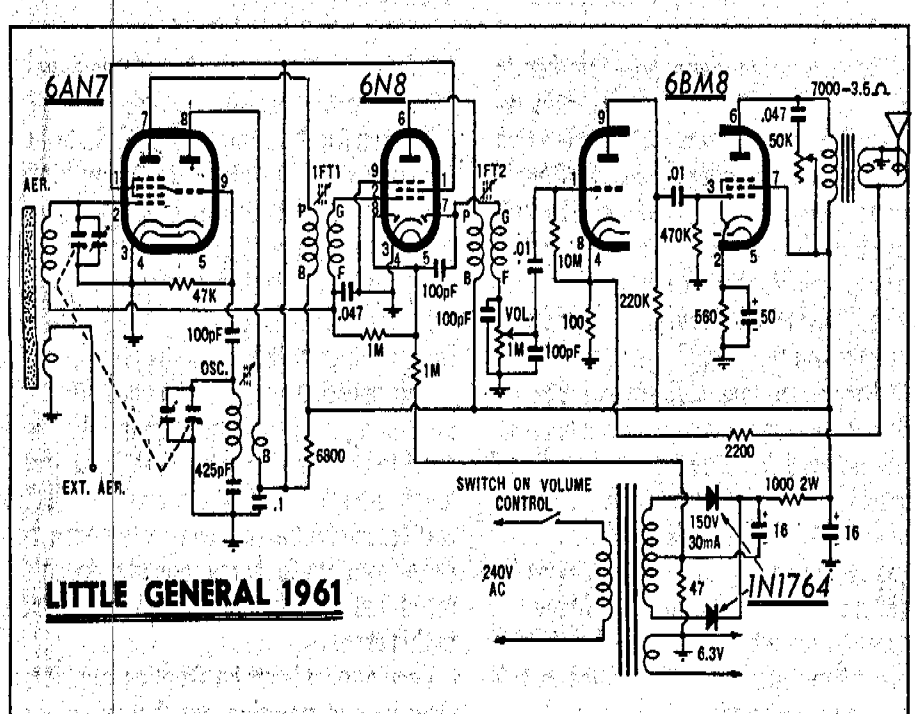
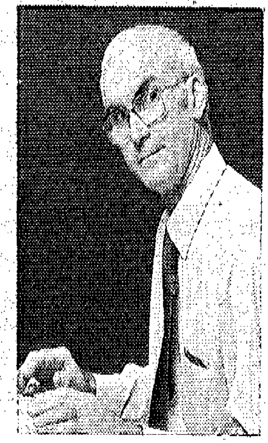


Fig.9: The last of the 'Little General' series, using what was virtually the last generation of mass produced valves. This series also featured widely in Australian monochrome television receivers, before giving place to solid-state devices.

Continued on page 83

FORUM

Conducted by Jim Rowe



Dangerous clocks, blooming tellies and how to get more young experimenters

I have an interesting 'mixed bag' of topics for you this month. A couple of readers have written in with comments about my editorial in last October's issue, about the importance of hobby experimenting, and I'm sure you'll find their comments thought-provoking. There's also a letter from a reader complaining about picture 'blooming' in some of the latest up-market large screen CTV receivers, and another which raises the question of a possible health risk associated with a very common appliance: the humble bedside clock radio.

I imagine many *EA* readers will be aware that over the last couple of years, there's been quite a lot of concern expressed about the possible health risks associated with low-intensity electromagnetic fields — the fields present below high-voltage power distribution lines, or in the vicinity of neighbourhood stepdown transformers, or associated with things like electric blankets (and perhaps even video monitors on computers). From what I've read, it seems that there may well be a statistically significant correlation between the incidence of illnesses like leukemia, and prolonged exposure to some of these fields — particularly in youngsters.

To be fair there's been a good deal of skepticism expressed about this too, and an apparent unwillingness by some people (including some 'experts' employed by power generation/distribution authorities) even to consider the evidence. I'm not sure why this is the case; perhaps it's due to people being concerned about the kind of expensive changes that might turn out to be necessary, if the fields concerned do represent a health risk. Or perhaps they simply can't conceive that such low-intensity fields could be a problem — even on a cumulative basis.

Whatever the reason, it seems to me that this is another of those situations where the prudent approach is to assume that there *may* be a subtle problem, and investigate it carefully, thoroughly and as objectively as possible. Surely it's better to do this than take the complacent approach and assume everything's fine — with the risk that a few years down the track, we might find ghastly and irreversible evidence that we were wrong!

I know that on a personal level, since reading the reports on possible dangers from E-M fields I've made it clear to all of my own family and friends that in my opinion, they should *not* have their electric blankets turned on while they're in bed. They probably think I'm over-reacting, but so far they've humoured me...

With all this in mind, then, I'd like you to consider the following letter. It comes from a reader in Albury, NSW, who has asked to be attributed simply as 'G.S.' even though he has supplied his full name and address as a token of good faith. I think you'll find his letter interesting, because it raises an aspect of the health risk question I for one certainly haven't struck before:

I have been a pretty constant reader of EA since it was Radio & Hobbies, in about 1957. There's a subject I'd like to draw to your attention, which relates to clock radios.

I have a neighbour whose brother in law has recently died from a brain tumour. The doctor mentioned to her that he has had a number of cases of brain tumours, and all cases had a clock radio beside the bed! He now warns patients to remove the clock radio from their bedsides. I wonder if you have heard any comment on this topic?

I happen to have a Tandy clock radio with green fluoro display beside my bed, and indeed I have had a clock radio of some kind beside my bed since I was a teenager, when I bought a Philips valve type one. I later progressed to a radio with a flip-card type clock, and now the present one which is an AM-FM type with phone (although the phone hasn't yet been connected).

As well I recently installed a car radio cassette next to the bed on the side of the bedside table, and it has a green digital display. This was so I could get reasonable audio on FM stereo, and to play tapes at times.

By now I guess you have the general picture. I am now set to wondering about this doctor's theory — does a digital display type of clock radio have any harmful radiations?

I've never even given this possibility any thought, but now I am questioning whether there could be any credence to it. As I have had (like probably many other people) a clock radio next to the bed for many years — to hear the 7am news and gradually surface for the day, am I and others all being exposed to an unwanted radiation which is harmful?

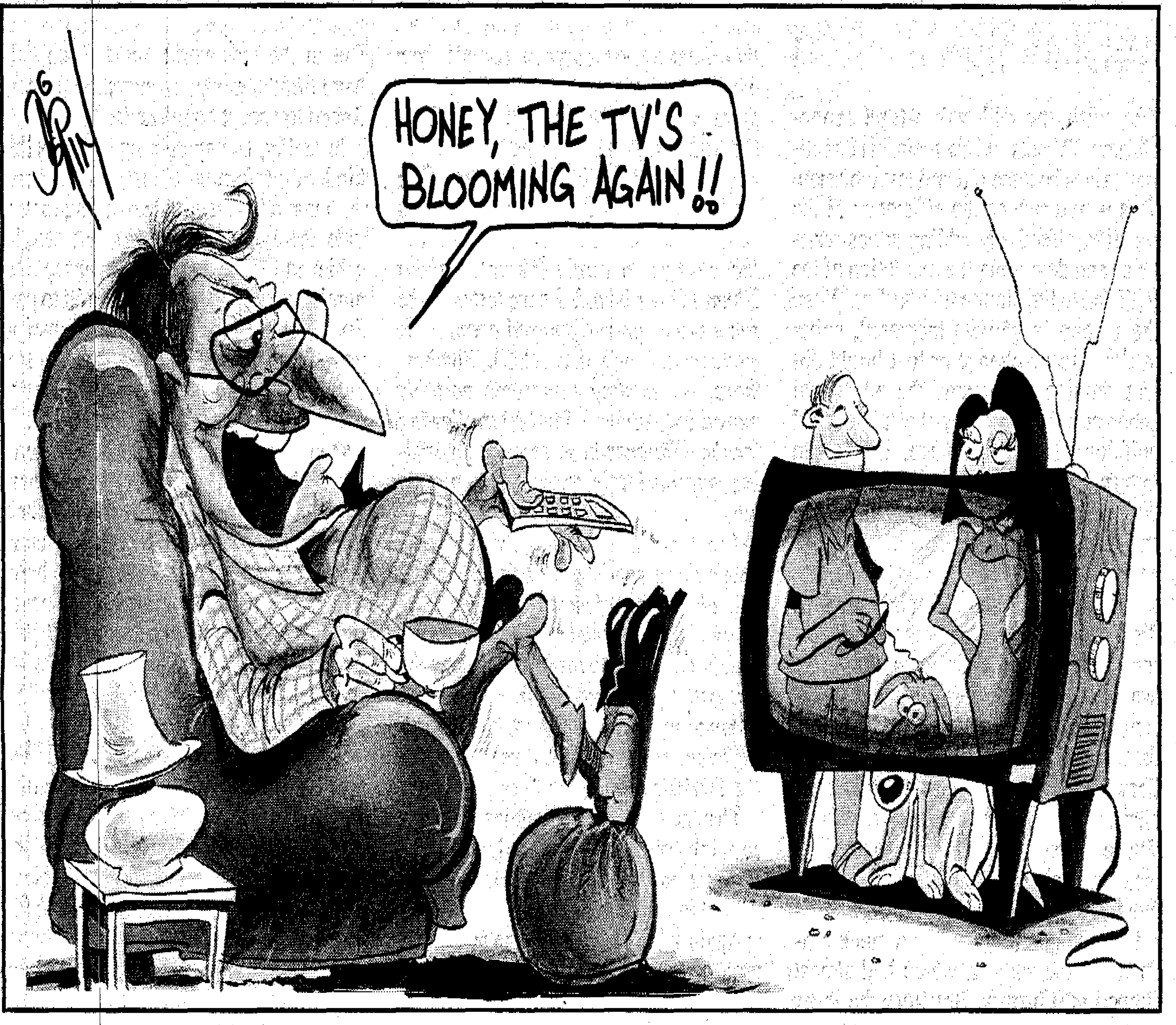
We are in bed on average, let's say at 10pm, then arise at 7am. So we are near this radio for about 9 hours each night — a fairly lengthy exposure.

I must admit I find the doctor's theory hard to swallow, but what do you and other experts think?

Thanks for the compliment, G.S., but I certainly wouldn't claim to be any kind of expert — least of all in this tricky area. But hopefully your letter might prompt a few people who really do know about the subject to write in, and we can all benefit from their knowledge.

The question you raise is certainly an interesting one, and quite possibly related to the broad one of risks from low level E-M fields. As I noted above, I can't recall having read any references to risks from clock radios, but this doesn't mean that there haven't been any studies in this area.

I can almost hear the skeptics laughing already, and pointing out that probably every second person in most of the developed countries has slept with a clock radio of some kind beside their bed, for decades. And of course only a tiny pro-



portion of this enormous number of people will have developed a brain tumour (as yet, at least).

Conversely, those unfortunate people who *have* developed brain tumours may well have a lot of other things in common as well, besides having slept beside a clock radio. No doubt most of them also drank tea or coffee, and ate red meat regularly...

Easy to dismiss

It's easy to heap scorn on any hypothesis like this, and dismiss it out of hand. The problem is that in many situations where this was done in the past, only after many people have died or suffered needlessly has it been realised that there really *was* a significant health risk. Examples that come to mind are birth defects caused by mercury and other heavy metals, emphysema and the many other serious consequences of long-term smoking, and mental problems caused by lead poisoning from paints.

In this case, as G.S. himself points out, most of us do spend quite a high proportion of our lives in bed. So if there *is* a risk from items such as clock radios (and electric blankets), that risk could well be exacerbated by the significant cumulative exposure times involved.

In many cases a bedside clock radio or electric clock is often no more than 30cm or so from our heads, so it seems to me not inconceivable that there *could* be a risk. Not so much from the digital display as such, perhaps, because in many cases this will be a set of LEDs operating from less than 3 volts, and at a few tens of milliamps at most. But in most cases the radio or clock will have a small power transformer, which might well have a significant 'stray' field.

In short, it seems to me that although the story concerned may well stem from largely anecdotal evidence, from a single doctor and a small number of his patients who developed brain tumours, it's probably still worth further investigation. If there *is* a risk from bedside clocks or clock radios, this could cause a huge amount of needless suffering.

I know one thing: just to be safe, after reading the letter from G.S. my wife and I have moved our bedside electronic clock another 40cm or so further away from our heads. Working on the inverse square law, that should reduce the risk of either of us being affected, by a factor of about four times!

I hope that if there's anyone reading this with some objective research data on this subject, they'll write in and share it with us. But don't just write in to heap scorn on the idea, or simply write off G.S., his neighbour's doctor or me as paranoidal half-wits. Things that have sounded just as unlikely when first suggested have turned out to be true...

Pictures that bloom

And now let's turn to our second letter, which raises another new topic: picture 'blooming' or size modulation, in colour TV receivers — especially some of the latest large-screen models.

Before I reproduce the letter, which comes from reader S.S. of Glen Waverley in Victoria, I should perhaps explain what blooming is, for the benefit of newer and/or younger readers. It's essentially an effect where the size of a TV's scanning raster, and hence its picture, varies with the brightness level. Usually the most obvious symptom is that the overall size of the picture grows noticeably as the brightness is turned up. The focus usually deteriorates at the same time.

The relative size of brighter areas of the picture also tends to increase, and these areas become less sharp as well, although this effect is usually less apparent to the untrained eye.

Blooming used to be a common problem with the old valve-type monochrome TV sets, when their EHT rectifier valves became old and lost emission. This would reduce the efficiency of the rectifier, effectively adding series resistance and degrading the regulation of the EHT fed to the picture tube's ultor. When the picture brightness increased, either due to a scene change or to a bright object moving into view, the additional beam current drawn by the tube would pull down the EHT voltage. This would in turn lower the beam acceleration, and the picture would expand or 'bloom' in an annoying fashion, often losing focus as well.

Although colour TV tubes tend to draw roughly three times the beam current, due to their triple guns, the effect has generally been less common in recent years because at about the same time as colour came in, valve EHT rectifiers were replaced by rather more efficient solid state tripler-type rectifiers. While these have breakdown mechanisms of their own, loss of emission isn't one of them.

Hopefully that gives you a quick rundown on the subject, which had almost slipped into history. But from the letter sent by S.S., it would seem that blooming may be re-appearing again, not as a common fault symptom but as a sign of a possible design limitation:

I am considering buying a 68cm colour TV receiver for around $2000, and have been surprised to find that the set of my choice displays an annoying characteristic caused by inadequate EHT regulation. I find it surprising as I had assumed (incorrectly) that for this price, such fundamental parameters in TV design would not be found wanting.

Perhaps you might like to pass comment on my findings, and indicate if I might be applying unreasonable performance standards.

One of the TV sets I am considering is a Panasonic 68cm model named 'The One'. On viewing the unit with normal programme material, it is evident from time to time that when a bright object moves near the edge of the picture, a distortion results that causes other stationary objects to move towards the edge of the picture as the bright object moves nearby. I have tested two receivers at different shops and both behave similarly. A similar effect also occurs when normal programme pictures are faded out to black.

I emphasise that I first noticed this on programme material, although it is also evident when viewing a test pattern, and then altering the contrast control from minimum to maximum on the TV. Under these conditions the top of the circle on the SBS test pattern moved towards the edge of the screen by about 10mm. (The bottom would also have moved about 10mm closer to the bottom edge, making the change in circle diameter about 20mm.) Other brands I have tested in the same price range displayed about 3mm movement (Sony and NEC). Furthermore, my existing Panasonic portable moved only about 3.5mm after allowing for the difference in screen size, by scaling appropriately for a 68cm picture tube.

Just how stable should the image be under these conditions? I find that sets with about 3mm of movement are subjectively OK on normal programme material, but that a set with 10mm shift on the test pattern is annoying on normal programme material, and may indicate insufficient regard to EHT regulation in the TV design.

Thanks for raising this subject, S.S. It's certainly an interesting and important one, yet one that has tended to be overlooked in recent years.

Again I can't say I've come across the problem myself, and I notice that neither Rob Evans nor Louis Challis seem to have noticed any untoward effects of this type when reviewing large screen sets recently for the magazine.

Actually when I first read your letter, I checked the behaviour of my own CTV on a test pattern, out of interest. By sheer coincidence this is also a National Panasonic model, but a set that is now a few years old and with a smaller 63cm tube (Model TC 2656). I've never noticed any blooming evident on programme material, and it turned out to have an image variation of about 2.5-3mm on each side, over the maximum visible range of the contrast control.

This tends to support your hypothesis that this order of image variation is more or less acceptable, on the grounds that it is difficult to detect on normal programme material. But I would agree that if a new 68cm set has a variation of 10mm on each side, or at top and bottom, that would be much more noticeable — and scarcely in keeping with the level of performance one would expect from a set selling for around $2000.

Of course when you ask 'How stable should the image be?', it becomes harder to provide a specific answer. In theory one would like the image to be completely stable, and not vary to any measureable extent — just as we'd all like our hi-fi amplifiers to have no measureable noise or distortion at all. But in the real world, most of us only have limited money to spend, and we're forced to accept compromises.

In reality, all engineering involves this kind of performance/cost compromise, with manufacturers endeavouring to provide the best performance that can be achieved for the price that an acceptable number of customers are prepared to pay. So I guess the only practical answer to your question is something like 'As stable as is necessary for most customers to accept, for the price point concerned'.

Due to the holiday season, I haven't had a chance as yet to seek a comment from the CTV manufacturers about their attitudes to acceptable levels of picture blooming, and the difficulties in achieving these levels. But hopefully one of their engineers will read this, and provide us with an official response — which I'll be happy to publish, needless to say.

I might comment, though, that I suspect EHT regulation becomes more of a problem when CTV screen sizes get larger than about 65cm — due to the higher beam currents required to achieve typical brightness levels. So it's quite possible the problem that S.S. has drawn our attention to is one which has arisen, almost inevitably, with the latest breed of larger screen sets.

Of course it's probably a moot point, whether the CTV set makers started to produce all of those new large screen sets because the public really wanted them, or because the market for traditional 53-63cm sets had slowed down and they wanted to create a new market sector. I don't really know the answer to this one, but if the manufacturers are trying to create a demand for sets with much larger pictures, it could be that they'll have to put more effort into achieving better EHT regulation.

I have to agree with S.S. that 10mm of blooming at top and bottom of a 68cm picture sounds pretty unacceptable. But what do other readers think?

Hobby experimenters

And so to our third topic for this month: the need to encourage hobby experimenting in electronics, as I suggested in my editorial last October. To date two readers have responded to my comments on this, the first letter coming from Mr Jim Longmire of Gosnells, in Western Australia. Here's a somewhat shortened version of what Mr Longmire has to say:

In the October editorial, you lamented the demise of the hobby experimenter, citing this as being partly responsible for *the 'trend away from science and engineering as professions'. I heartily concur. The problem, as I see it, has to do with personal attitudes and the expectations we have of 'technology'.*

Let's have a quick look at both; first the personal attitudes. Our universities and technical colleges give a fair reflection of what's going on, and what is the preference of their students. To a great degree (sorry — couldn't resist it...) they are 'market driven'. I do not think they would persist with 'Industrial Relations in Timbuctoo' if nobody bothered attending. They would, naturally, channel their resources into areas of interest/need. So it comes as no surprise to find the 'Arts' and 'Humanities' well endowed, often to the detriment of the physical sciences.

Why do students choose the 'arts' and 'humanities'? Simple — the in-exactness of these are easier and suited to them more than the discipline of the 'hard sciences'. Not only are they told by 'society' that these are desirable, but they lack the wisdom to discern they're being fed a good dose of bunkum!

Technology — it's a wonderful thing. Give it enough money and you can have anything. A classic example is found in photography today. For only a few hundred dollars, one can have the latest singing and dancing 'point and poke plastic' camera. Auto load, auto focus, auto exposure, auto rewind, auto flash, auto battery check, day and date and time auto back — auto EVERYTHING. Never before have so many photographers had the thinking done for them, and never before have so many photographers produced such rubbish!

You disagree? Spend some time in a one-hour processing shop, and you'll soon understand. And if the battery runs low — or something goes wrong — the cost is often horrendous (assuming parts are still available).

Time does have this habit of moving on, and like it or not we need to adapt. Today the hobbyist is less inclined to go to the lengths of yesteryear for his interest(s). Can you imagine the youth of these days stripping ex-computer boards for parts? It's easier to shop via phone or fax. And herein lies a trap for the unwary; on many occasions I have been caught by faulty components. Without labouring the point, the beginner does not need the hassles of dud parts which cost the proverbial arm and leg, whilst he's struggling with the colour code! It does awful things to their enthusiasm...

Perhaps we should remember one of the chief joys of the electronics of yesteryear: that of doing something few others did. Of being unusual, of breaking new ground, of proving established thinking wrong. Whatever the technical specifications, we derived personal satisfaction from it. And that needs to be nurtured if the hobby experimenter is to survive.

Thanks for those comments, Mr Longmire. As you can see I have taken the liberty of editing it fairly drastically, as you suggested. (Mr Longmire had a further section with suggestions regarding future amplifier project designs, and also a description of problems he had experienced with an amplifier design described in *ETI*, caused largely by faulty components received from an Australian mail-order supplier.)

I can't really argue with anything Mr Longmire says. As he points out, a major factor seems to be the falling interest among young people in the so-called 'hard sciences'. Just how we go about reversing this trend, I don't really know.

New and different

I'm sure Mr Longmire is also right in pointing out that a few decades ago, part of the appeal in experimenting with electronic gear as a hobby was that it was 'new' and 'different'. Nowadays this is somewhat less true, with electronic equipment now being quite commonplace in most homes, offices and schools.

When I started playing around with electronics, building your own gear was often the only way to get many items of equipment — either because it was otherwise too expensive, or simply not available. This generally isn't true nowadays either — a situation which is good in some ways (like cheaper equipment), but not so good in others (like adding to the appeal of 'rolling your own').

For example I remember that some of the first gear I built as a teenager was test equipment: a simple oscilloscope, an RF oscillator, an R-C bridge and a vacuum-tube voltmeter or 'VTVM'. These were all built from *R & H* or *EA* designs, and they gave me great satisfaction because at the time there was no way I could have bought commercial gear.

But moving on again, the second letter to arrive in response to the October editorial came from Mr Clive Davis, of Wynnum West in Queensland. Here's what Mr Davis had to contribute:

I applaud your editorial in the October issue, and maybe you'll publish some of my comments.

I am well aware of how our youngsters show little interest in the sciences in this country. Two of my boys are in the electric and electronic field, and I have channeled dozens this way myself. Personally I am disappointed in how many *of our science teachers know the fundamentals of sciences, but fail to pursue the electronics into building up items from kits of parts. I know it often costs less to buy the finished product made in Japan and brought into Australia.*

My wife and I visited Japan in late September and early October. It was an experience I'll never forget. While there I was able to visit the location called AKIHABARA — literally a street full of buildings, many quite a few floors high, all packed with electronics of every possible type. One shop sold only valves, and boasted that it had every type made. The next had only microprocessors, and made the same claim as the first.

My initial culture shock was not the language or the customs. It was to observe the hundreds of male students gathered, not just looking but buying — and not finished products, but kits and parts. True, it was a public holiday, and some were majoring on handcrafts. But the real culture shock hit when I noticed dozens of teenage girls, also mingling amongst the budding technicians — also with circuit drawings and component lists, and carefully but expertly picking out the components and checking them against their respective PC cards.

In a state of frustration I spoke to my Australian missionary/guide: "What hope have we in Australia? We could never compete against this enthusiasm!"

Many thanks for a great and encouraging publication in EA.

Thanks also to you for your own comments, Mr Davis. I agree that we seem to be well behind the Japanese when it comes to encouraging our young people to explore electronics and other areas of science and technology. And like you, I'm convinced that this has played a major part in the fact that our industry is still lagging well behind theirs as well.

You may also be right in suggesting that the situation is pretty hopeless, but I hope not. I'd like to think that there's *some* way we can rescue ourselves, even though at present I can't see exactly how to start the ball rolling.

I'm convinced that part of the answer lies in changing the attitudes of our teachers, to get them to place more emphasis on the rewards and satisfactions offered by 'hard science and technology' — both as hobbies, and as careers. Then hopefully they will be able to interest more Australian youngsters in getting into activities such as electronics.

Perhaps we'll need to work on our pollies first, though, before we're likely to get far with the teachers. Many of our teachers seem to be overworked and trying to work with very poor and limited resources. Not surprisingly they also seem to have very low morale.

I suspect that many of their problems stem from the fact that our politicians have virtually 'written off' Australia's chances of building a solid technology base — despite the platitudes they mouth at appropriate times. How else can you explain the paltry amounts allocated to upgrading science and technology education? It's an old truism that actions speak louder than words...

So I think we'll probably all have to work on the pollies, to show them that we DON'T want them to let what remains of Australia's modest science and technology slip quietly down the gurgler.

Needless to say, *Electronics Australia* will be continuing to do our bit as well. As ever we'll be trying to come up with as many interesting hobby projects as we can, to attract both the teachers and their young students. All suggestions in this regard will be happily considered, too.

But that's about all we have space for, this month. I hope you'll pay a visit to the Forum again next time. ❖

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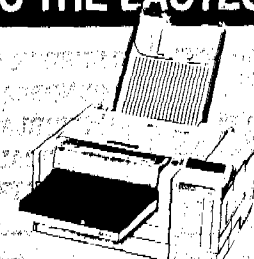

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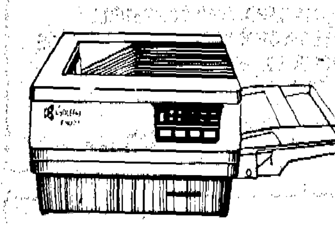

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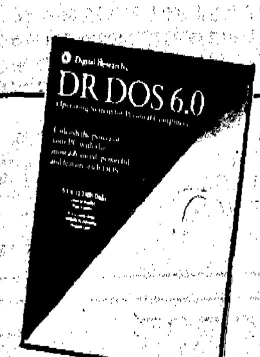

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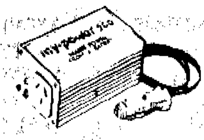

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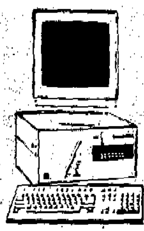

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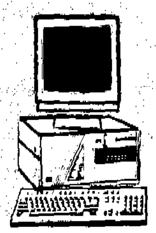

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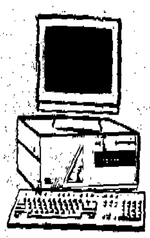

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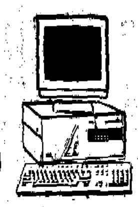

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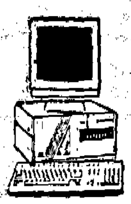

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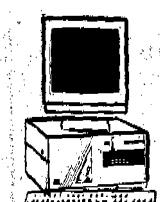

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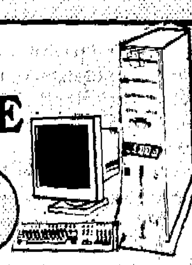

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- Tray 30cm (tilting +/- 15)
- Desk clamp range 3cm -7.5cm
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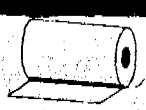

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C20092	$9.95	$9.50
Size: 210 x 11.5 x 30m		
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- MX100, FX100, RX100, LQ1000

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C22003.........$12.95 $11.95

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C22051.........$13.95 $12.50

NATIONAL PANASONIC KXM110 PRINTER RIBBON

C22034............................$19.95

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DELUX PRINTER STAND

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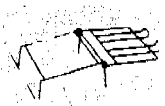

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C21054..80 column......$29.95

C21056..132 Column....$34.95

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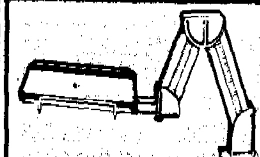

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The CPF provides protection from dangerous electrical spikes that can cause anything from obvious damage (like immediate equipment failure) to less obvious harm that can drastically shorten a system's life.

CPF's superior circuitry design and semi conductor technology responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.

Additionally, CPF's filtering capability helps eliminate troublesome and annoying interference, general hash created by small motors, fluorescent lamps, and the like that threaten the performance and shorten equipment life of unprotected electronic components.

SPECIFICATIONS:
Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
Spike/RFI Protection: 4,500 amps for 20m/second pulses
Maximum clamping voltage: 275V differential mode

Cat.X10088 .... $69.95

RS232 BREAK OUT BOX

A simple way of monitoring RS232 interface lead activity. Interface powered, pocket size for circuit testing, monitoring and patching 10 signal powered LED's and 2 spares. 24 switches enables you to break out circuits or reconfigure and patch any or all the 24 active positions.

SPECIFICATIONS:
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Indicators: Tricolour LED's for TD, RD, RTS, CTS, DSR, CD, TC, RC, DTR, (E)TC
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Power: Interface power
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Dimensions: 85 x 95 x 30mm

X15700 .... $99.95

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NEW TOWER CASE!
Give your computer that professional look.

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Power supply to suit (220W)

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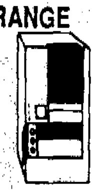
TOP OF THE RANGE MINI TOWER CASE 200 x 415 x 330mm with 200w power supply



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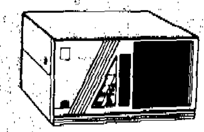

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X11089.

Includes power supply.....$119

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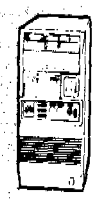

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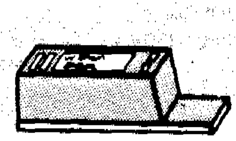

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It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less time for less chips)
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- Mains powered
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Without timer

X14950.....................$99

with Timer........$169

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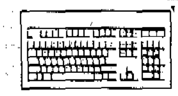

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Keyboard & mouse in one

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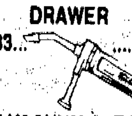

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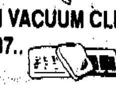
C21087............................$14.95



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C21088 101 KEY.........$5.95

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Change the way you use your computer

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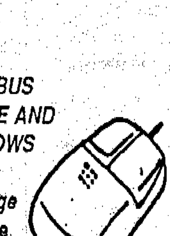

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Supports hunderds of applications.
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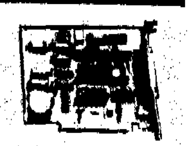

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DB9 M/F 3.0 M.....$19.95
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DB25 M/M 5.0 M....$24.95
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DB25 M/F 1.8 M.....$14.95
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DB25/CN36 M/M 5.0 M...$24.95
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DB25 M/M 3.0 M....$19.95
DB25 M/M 5.0 M....$24.95
DB25 M/M 10 M.....$39.95
DB25 M/F 1.8 M.....$14.95
DB25 M/F 3.0 M.....$19.95
DB25 M/F 5.0 M.....$24.95
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• Six conductor shielded computer interface cable.

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W12672 • CIC9 9 con.	$1.60M	$1.50M	$1.20M
W12674 • CIC12 12 con.	$2.50M	$2.20M	$1.90M
W12676 • CIC16 16 con.	$3.50M	$3.20M	$2.50M
W12678 • CIC25 25 con.	$3.90M	$3.40M	$3.00M

LEDS

QUALITY 3mm LEDS

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Z10141(G)..	$0.20	$0.18	$0.15
Z10143(Y)..	$0.20	$0.18	$0.15
Z10145(O)..	$0.20	$0.18	$0.15

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Z10150(R).	$0.15	$0.12	$0.10
Z10151(G).	$0.25	$0.20	$0.18
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	1-9	10+
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	1-9	10+	100+
RED	20¢	15¢	12¢
GREEN	20¢	15¢	12¢
YELLOW	20¢	15¢	12¢
ORANGE	20¢	15¢	12¢

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LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct Import" low profile IC sockets! PCB mounting solder tail. All tin plated phosphor bronze or berryllium and dual wipe for reliability.

	1-9	10+	100+
P10550 8 pin	15¢	12¢	10¢
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P10565 16pin	20¢	18¢	16¢
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P10568 20pin	35¢	30¢	25¢
P10569 22pin	35¢	30¢	26¢
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P10572 28pin	45¢	35¢	30¢
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WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin plated phosphor bronze.

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P10587 18pin	$1.95	$1.80
P10590 20pin	$2.95	$2.75
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P10596 28pin	$3.95	$3.50
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With pins for easy board insertion. C10170

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$1.20	$1.00	$0.90

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Designed to transmit at 40kHz (L 19990) & recieve at 40kHz (L19991) withup to 20V I/P on the transmitter. These units can't be heard so are ideal for TV remote controls, water level dectectors, burglar alarms, motion dectectors & information carriers as they can be either pulsed or used in a continuous wave mode.

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WOW ! FROM $1.00

D TYPE IDC PLUGS

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• DA15S 15 pin socket P12169	$1.50	$1.20	$1.00
• DB25S 15 pin socket P12171	$4.50	$3.95	$3.50

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7912UC	$0.60	$0.55
7915UC	$0.60	$0.55
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80 x 80 x 25.4mm
12V DC. 1.7 Watt 0.14 Amp
T12469...............$18.95
10+ fans, only $17.95

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Quality fans for use in power amps, computer hotspot cooling etc. Anywhere you need plenty of air.

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We have a great range of panel meters at great prices!

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NEW SWITCH BOXES

9 PIN D SWITCH BOXES

2 WAY..................$59.95
4 WAY..................$69.95

MONITOR & KEYBOARD SWITCH BOXES only $69.50

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Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

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Heatsink compound is applied to the base and mounting studs of transistors & diodes. It maintains a positive heatsink seal that improves heat transfer from the device to the heatsink, thus increasing overall efficiency.

H11800 ..10g...$2.00
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Tuneable:92-104MHz
Freq response: 50-15kHz .
Range: over 300 feet in open field.
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THE SERVICEMAN

Fixing a power supply by proxy, and other stories for newcomers to servicing

This month I have three stories to do with troubleshooting simpler faults, and designed to demonstrate some of the basic techniques needed for any kind of electronics servicing. Hopefully they'll be of interest not only to those who plan to pursue servicing as a career, but also to readers who merely want to fix their own gear when it develops a fault.

The stories related in these pages usually tell of a rather sophisticated approach to complex or difficult jobs. Unfortunately, this treatment leaves behind many of our younger or less experienced readers. The complexity of the stories hasn't stopped them from reading us, but I think it's about time that we gave them a few stories more suited to their 'beginner' status.

The first of the stories comes from a regular contributor, N.W. of Sydney. N.W. is very experienced in servicing, but in this tale he didn't do anything more than show a beginner what to do. His student did all the work, and learned a lot about solid state power supplies in the process.

N.W. calls his story 'Service by proxy', and it not only demonstrates some of the basic principles of faultfinding, but offers a few practical tips as well. He tells it thus:

When a friend who works with photostat copiers won an unexpected reprieve for my own distinctly ancient model, I insisted that he accept payment for his effort. He, on the other hand, flatly refused — suggesting that, if I felt embarrassed, I could return the favour by supervising the repair of a DC power supply which he had been using to run a CB transceiver in his garage/workshop.

Called the 'VK Powermate', he had built it some years ago from a design published in the May 1978 issue of this very magazine. He still had the issue on hand, and was happy to do whatever was necessary in the way of benchwork and legwork.

What he needed was a bit of guidance, as to how to go about identifying and correcting a fault which had developed a few days previously. I normally steer clear of this kind of situation, but felt obliged, in this case, to be as helpful as he had been. So I said okay — but that I'd need a copy of the circuit and descriptive article, so I'd know what it was all about. This posed no problem and he turned up with a photostat copy next morning.

The equipment had been operating quite normally, he said, when the transceiver suddenly went dead. So too did the panel light on the power supply. He had checked the mains fuse on the rear panel of the supply, but it was okay.

Remembering that there was another fuse on the wiring board inside, he had also removed the top of the case to gain access.

It had blown but, alas, that apparently wasn't the problem. When he replaced the blown fuse, the new one lasted for about as long as it took to operate the 'on' switch! What should he do next?

Looking at the circuit, I noted that it provided for a 16-volt zener diode across the DC output terminals. The stated intention was that, if the output voltage rose sufficiently high to endanger the equipment it was supplying, the zener would go into reverse breakdown and hopefully take out the DC fuse.

In the process, the zener might itself be destroyed, but the designer had reasoned that it would be easier and cheaper to replace a fuse and a zener than repair the possible damage to a transceiver caused by over-voltage.

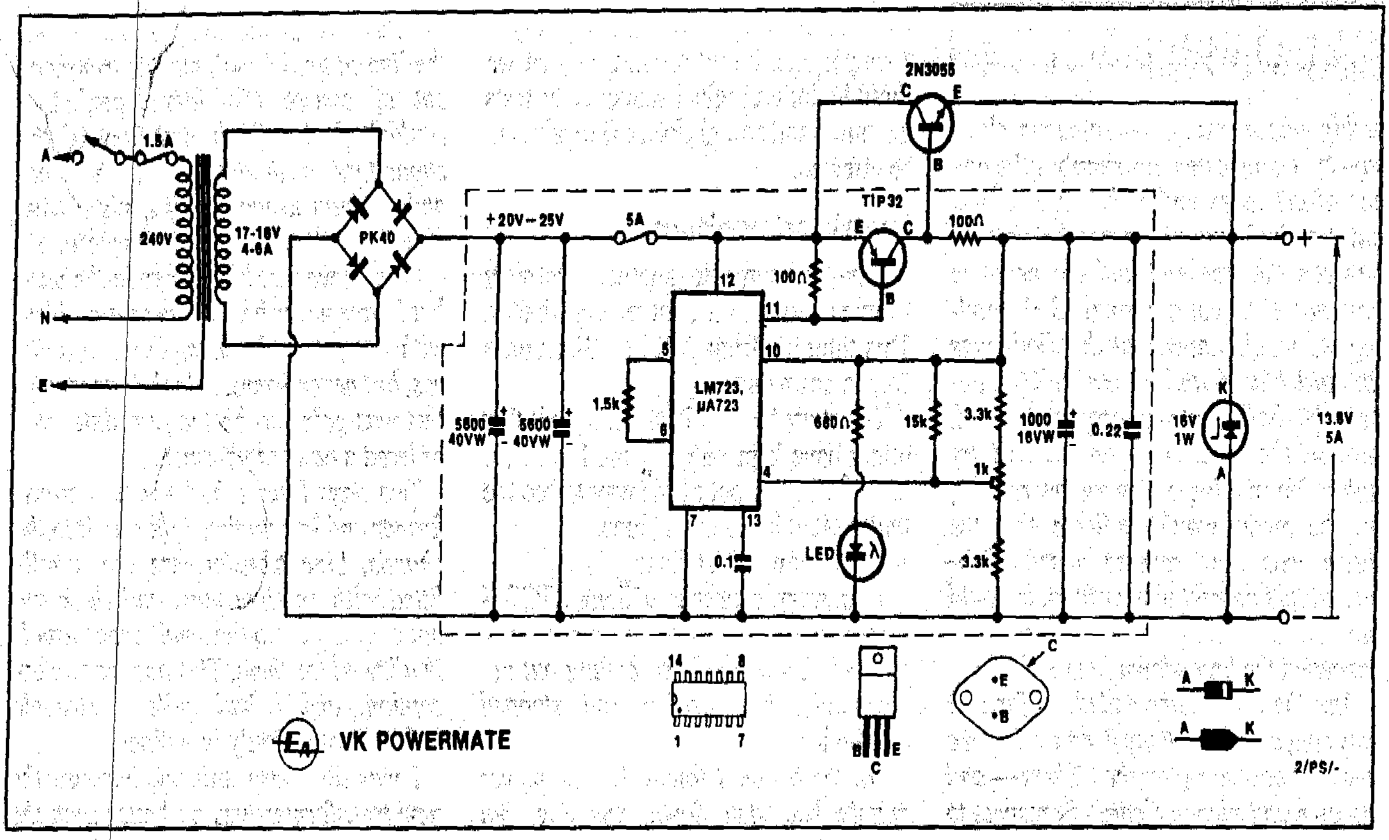
My tip was that my friend would find the zener diode to be a dead short. I suggested that he go home and measure the resistance across the output terminals.

To do this he would need to set the ohmmeter in turn to the various resistance ranges, and observe if the readings differed when he reversed the polarity of the test leads. What he would be looking for was evidence that the meter was looking back into one or more semiconductor junctions — either that, or a dead short.

He was on the phone shortly after doing this test, to report that there was no ambiguity in the readings. Irrespective of the range or polarity, the meter showed a dead short. And, yes, he had long since disconnected the supply leads to the transceiver.

It was a safe bet, I told him, that the zener diode was 'kaput'. Although at this stage, there was nothing to show whether the diode had broken down spontaneously or had been the victim of another fault. All he could do was to snip it out of circuit, clip the voltmeter (set to the 50-volt DC scale) across the output terminals and switch the supply on again briefly.

If the meter showed 13.8V, fine! If it read higher than that, switch off again immediately. "That shouldn't take more



The circuit for the original 'VK Powermate' supply of May 1978, which forms the subject of this month's first story. Our correspondent had to guide the supply's owner through its repair, via a series of phone calls...

than a minute", he said. "Hang on and I'll do it now."

He was back on the phone in next to no time, with the news that the supply was alive again — but the voltmeter had swung to about half-scale, indicating around 25 volts.

Looking at the circuit, I noted that the output from the rectifier was marked '20-25V', suggesting that either or both the TIP32 or 2N3055 transistors had broken down. "My bet", I said, "is that you'll find a short between the collector and emitter of the 2N3055 power transistor. It wouldn't be the first I've come across such a thing and it probably won't be the last."

"It should be easy enough to get at; I suggest you disconnect it and check it out. If it's faulty, replace it with a new one, taking care to give the insulating washers a fresh smear of heatsink compound."

"By the way!" I added, "Don't install a new zener as yet. You can install one before you reconnect the transceiver. But in the meantime, there's no point in risking another fuse and another zener for no good purpose."

He rang me next evening to say that he had picked up new 2N3055 from a nearby Tandy store, but he couldn't get a new zener there because they didn't stock one.

He'd installed the new transistor and it had certainly made a difference: the DC output voltage was down to about two volts!

Checking the respective pins of the 2N3055, he had verified 25 volts on the collector — but there were only a couple of volts on the base and emitter.

"That suggests to me", I said, "that the new 2N3055 is operating correctly in emitter-follower mode, but that it's getting only 2V on the base — whereas the figure should be up around 14."

"That means that the board has to come out and, if I were doing the job, I'd probably replace both the IC and the TIP32. They're less than $2 each, and for that price I'd rather replace them both at one go than risk having to remove and refit the PC board twice."

"Fair enough", he replied, "I'll have to trek to one of the places that sell bits for kits, anyway, and I'd rather make one trip than two. By the way, how do you go about unsoldering an IC? I don't have one of those solder-sucker things."

On the subject of de-soldering, I suggested to my friend that he invest in a spool of de-soldering braid rather than a solder sucker — which in my experience work best only for those who've developed the necessary facility in using them.

For beginners, de-soldering braid is quicker and cleaner. You hold the end of the braid over the joint, press it down with the iron tip and — zip! The solder melts and disappears into the braid by capillary action. Snip 4 or 5mm off the end of the braid, and you're ready for the next joint.

(Another advantage of de-soldering braid is that it acts as a heat sink, limiting the amount of heat that can reach the copper track and/or sensitive semiconductors — Ed.)

Before actually removing the original IC, I warned him to check on how it was installed: whether the replacement has an identical dimple to distinguish one end from the other, and how it cross-checks with the diagram.

That done, I told him, you should prise the IC gently free from the board. Then with it out of the way you can check the exposed copper pattern under a magnifying glass for whiskers of solder, breaks in the track or any other irregularity. Clean up the area with a squirt of CRC-226 or Electrolube, and a small paintbrush or toothbrush. Then insert the new IC and solder in place, as per the original.

I suggested that he again not solder the new zener into place until he had reinstalled the board and checked the supply, to ensure that it was finally delivering the requisite 13.8V.

When next he rang, a couple of days later, it was to say that he had followed the instructions to the letter and that the supply now appeared to be back in normal working order.

He had noted a break in the copper track adjacent to one of the pins, but felt sure that it would have originally been bridged by the solder. To make sure, he had fashioned a tiny hook on end of a single strand of hook-up wire, looped it around the pin in question, laid it along the suspect track and soldered it in position. The one thing that remained to be done was to install the new zener, and he wasn't absolutely sure from the markings which way round it should go.

Rather than try to interpret apparently *ambiguous markings on someone else's say-so, I suggested he simply clip one end of the zener under the positive output terminal and measure the voltage between the free end and the negative terminal. If he got a normal 13.8V reading, he would know that the diode was forward biased and he must NOT connect the diode that way around. Instead, reverse the diode end-for-end and try again. No reading or a very low reading on the meter would indicate that the diode was now reverse-biased. Connected this correct way around, it would pass current only if the voltage across it exceeded the breakdown figure of 16.*

And there the story ended, as far as I was concerned, with my friend able once again to eavesdrop on the CB'ers — and my own conscience cleared in respect to my own refurbished photocopier. As to what caused the power supply to fail in the first place, and if so how, I'm content to leave that in the too-hard basket!

Thank you, N.W. That story not only taught the youngsters about how to go about servicing a power supply, it also had a lesson for us 'wrinklies' about how to get our photocopiers fixed free!

Seriously though, although the story is a simple one, it still reminds us that we should adopt a logical sequence of tests if a quick and straightforward repair is to be effected.

Overload problem

Now we come to another relatively simple story, from another contributor. This time it's from A.K., of Blackmans Bay in Tasmania.

The story he tells is about a fault that might have kept on recurring forever, if he hadn't gone out of his way to see the faulty set at its owner's home.

Here's how A.K. tells it:

This story concerns a Sony KV2764 stereo colour TV. The customer complained that it had been cutting out occasionally, but now it had stopped altogether.

On the bench, I found that the power supply had shut down, meaning that either the power supply itself was faulty or else there was something that was loading it down.

My first test was to disconnect the line output transistor, whereupon the power supply started up and could be made to work well into a 75-watt dummy load. This seemed to place the problem firmly in the line output stage.

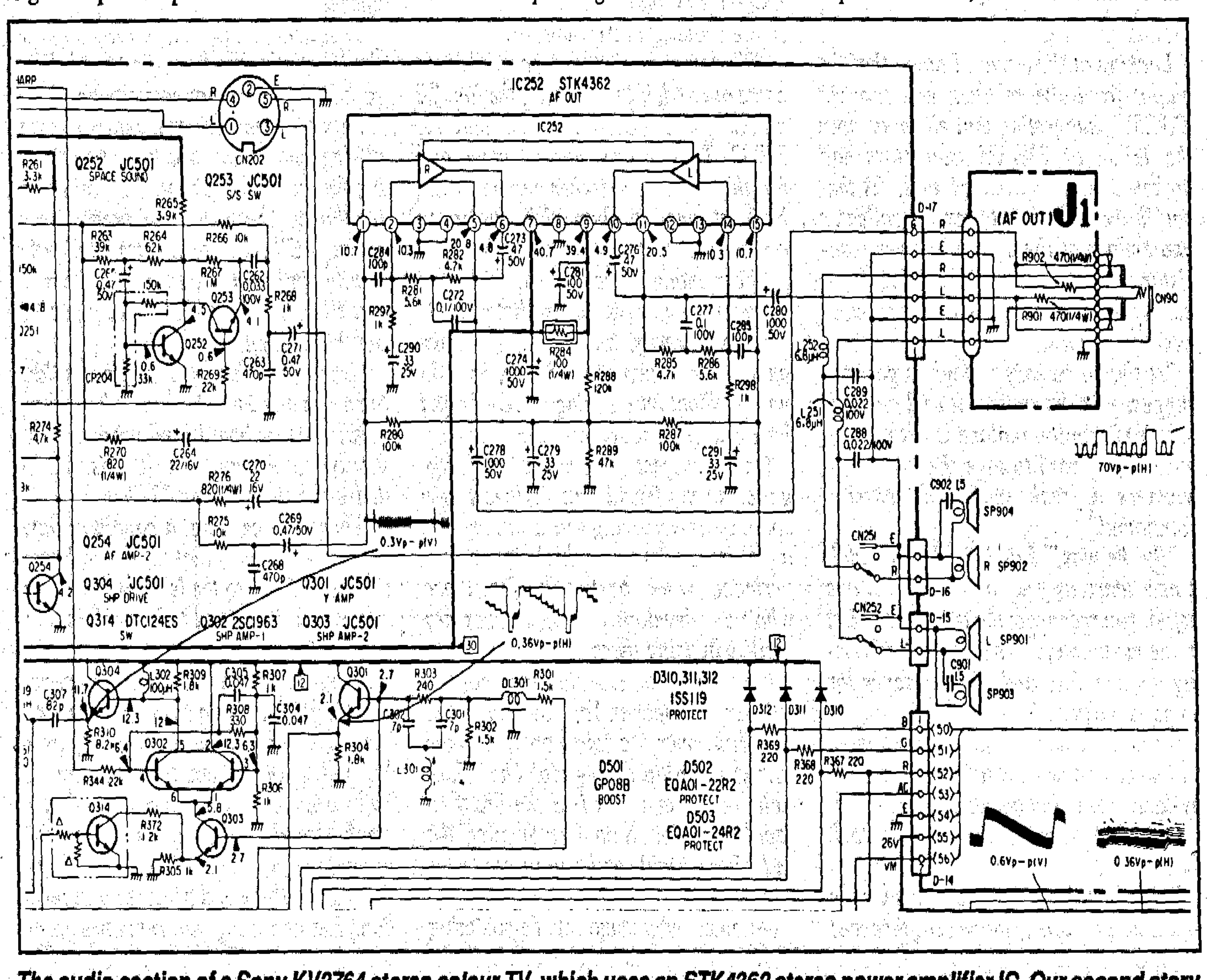
I checked all the components around the line output. I took out the transistor but of course this tested perfect. I couldn't find a fault with any of the capacitors or diodes around the area, and I began to wonder if I might have struck a faulty line output transformer.

I may have just been lucky in the past, but I have never before struck a problem with Sony transformers. Other brands, yes, but never Sonys. It looked as though this was going to be the first time, so I ordered a new transformer.

Two days later I had the new transformer and lost no time in fitting it to the chassis. Line transformers are usually fitted with multiple pins, and these are not easy to fit into the small space usually allowed for them. This one was no exception, and I had quite a struggle before I got it firmly into place.

I was also very unlucky, because the new transformer was no better than the old one. After stamping my foot and saying a few rude words, I did what I should have done earlier. I looked again at the circuit diagram. This time I realised that there was more than one rail from the power supply. I hadn't noticed the 30V rail before.

Once again I disconnected the line output transistor, to remove that load



The audio section of a Sony KV2764 stereo colour TV, which uses an STK4362 stereo power amplifier IC. Our second story this month concerns one of these sets that 'cut out' from time to time — but the cause of the trouble turned out to be quite simple and straightfoward.

from the power supply. Then I checked the 30V rail, only to find that it was down to 8.5V.

This explained why the power supply shut down. It couldn't manage the line output load, plus the shorted 30V rail, although it could supply either alone. Now I was beginning to get somewhere.

I checked diode D654 which supplies the 30V, but it was OK. Then tracing out the rail, I found that it supplies only the sound output chip IC252, an STK4362. I pulled out the chip and tried the supply again. It was back to the full 30V. I reconnected the line output stage and the set came good, with a first class picture — but of course no sound.

I ordered a new STK4362 and when it arrived, a couple of days later, I wasted no time in getting it into the set. Sound and picture came good, and a soak test showed no sign of trouble. Certainly there was no hint of 'cutting out', as the owner had originally complained.

The set went home two days later, and I heaved a sigh of relief. After all, a new line output transformer for no reason is an expensive way not to find a fault!

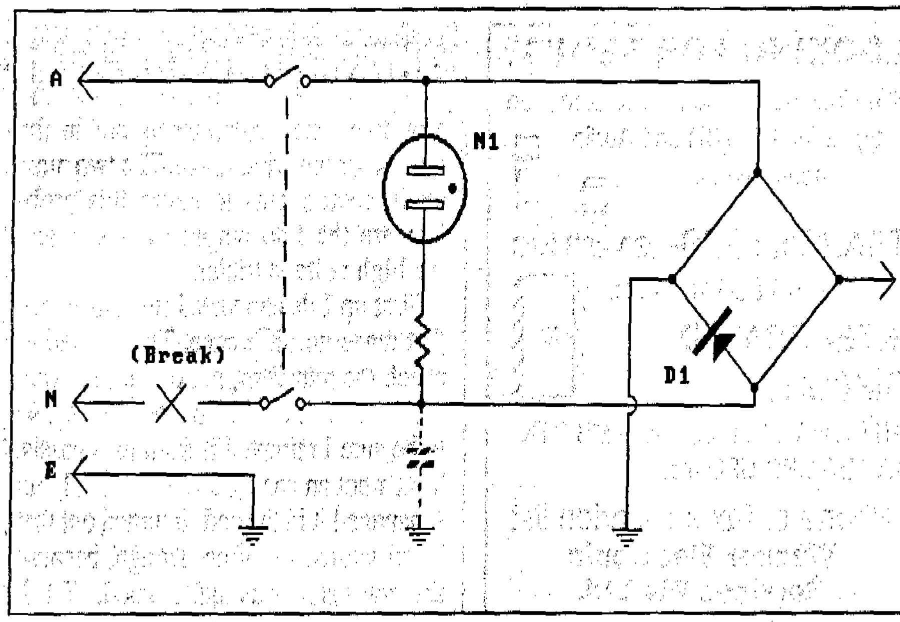
But that wasn't the end of the story. Two days later (what is it about 'two days' with me?) the owner called to say that the set was cutting out again. With the prospect of another shorted sound chip, I told him not to use the set again but to bring it back to the workshop.

In the shop, I couldn't find a thing wrong with it. There was certainly no sign of it cutting out, even when I dropped the mains supply to 200V. Two days later I was convinced that there was nothing wrong with the set, so I loaded it into the van and took it back to the owner personally. I had begun to suspect that there was something about his house that was causing the trouble.

I put the set back where it belonged, attached the antenna and plugged it in to the power. Of course, it worked perfectly. But then the owner came over and plugged in a lead to two large high fidelity speakers.

He explained that his wife was hard of hearing and that she needed the extra speakers to be able to hear clearly. Somebody had shorted out the load resistors on the headphone socket so that the internal speakers were replaced by the big extension units. So that explained everything — at least to me. It was harder to explain to the owner, but I did my best.

The STK4362 sound chip was never designed to supply this kind of load, and even if it had been, the attached heatsink was far too small to effectively cool the chip.



Here's a simplified version of the mains input circuitry of the elderly Graetz CTV which forms the subject of our third story. This one had stopped altogether, but proved to be a little deceptive when our Serviceman tried to find the cause...

The small internal speakers would have been fully driven with about 1 watt of power, and this is what the chip would normally supply. The big extension speakers would not have been overdriven by a 50-watt amp, so the chip was really working out of its class. I might have been able to effect some improvement by fitting a larger heatsink, but that wasn't the right solution.

The owner had a reasonably good hi-fi set in the same room as the television, so I suggested that he run the TV sound through that. He confessed that he hadn't thought that to be possible, but he was prepared to try, if I would tell him how.

It was easy. I quickly rigged a lead with a 5-pin DIN plug at one end and two RCA plugs at the other. I plugged them into the AUX inputs on the hi-fi and the audio outlet on the television.

Mrs Customer declared the new setup to be far better than the old one, so everybody was happy. There has been no further sign of cutting out, and the sound chip runs far cooler now than it ever did while trying to feed the big external speakers. It should last forever.

Thanks for that story, A.K. It just goes to show that for some people, a little knowledge is a dangerous thing. The owner of that set was also lucky that it wasn't a live chassis model. I've sometimes found earphone sockets fitted to live chassis sets, and the owners wonder why they get a tingle now and then.

They were just lucky they didn't touch something that was earthed, at the same time as they were wearing their headphones. Half mains voltage straight into your left ear wouldn't be very nice!

Deceiving glow

To finish off this collection of simple stories for beginners, here's one from my own workshop. In fact, I should be too ashamed to tell this one, but there's a lesson in it for all of us, not just the beginners. So here goes.

The set was an old Graetz, a German set dating from 1975 when colour first started. I had maintained it for years for its first owner, then reconditioned it and sold it for her.

I gave the new buyer a three-month warranty, but I didn't see him for a year and a half. So I must have done a reasonable job on it.

Anyway, it came back last week with the complaint that it just wouldn't go. It had been cutting out occasionally, but now it was quite dead. The only sign of life was the lamp inside the power switch — that still lit up, suggesting that power was getting into the set at least.

The way the owner mentioned 'cutting out' suggested to me that the set had been hiccupping, a not-unusual

Fault of the Month

Sony KV1400AS CTV

SYMPTOM: Intermittent channel changing (a) persistently to programme position 1, and (b) persistently to another particular channel.

CURE: (a) Any interruption to mains power, no matter how briefly, will reset to programme 1 position — i.e., reset mode. Check the power leads, plugs etc. for looseness. (b) Any contamination of touch buttons, from dust or sticky fingers, will make one position more sensitive than others. Atmospheric moisture will make the problem position even more touchy. Clean the touch panel with a rag barely dampened with metho.

This information is supplied by courtesy of the Tasmanian Branch of The Electronics Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

THE SERVICEMAN

symptom when components are in the process of breaking down. The two most likely components to cause this problem are the line output transistor and the high voltage tripler.

First up I disconnected the tripler, but that made no difference. Then I tried to check the transistor, but the results were ambiguous. It could have been leaky, so to be sure I removed it from the chassis. That's not an easy job in this model, but I managed it in the end. It turned out that I had wasted my time, though, because the transistor was quite good. Yet it seemed that something had failed, and was shutting down the power supply. Or was it?

It was quite possible that the power supply itself was faulty. I had assumed that the panel lamp proved that the power supply was running, but in reality it proved nothing of the sort. The lamp could be powered in any number of ways that didn't involve the supply.

So next I looked at the chopper transistor and some of the parts associated with it. There was nothing that I could find wrong with anything on the power board. It was beginning to look as though the fault was even earlier than the power supply.

That only left the bridge rectifier across the mains, and the relay switch in the ultrasonic remote control (URC) box.

I was hoping that I'd find a problem with the rectifier, because I had no wish to get involved with the complex circuitry inside the control box.

At this point I pulled out the service manual, to remind myself about the circuit arrangements. From away back I remembered something about plugs and sockets, and about it being rather complicated. In fact, it wasn't anywhere near as bad as I had feared. The URC leads terminate in a small PCB, with a plug on one side and a socket on the other. It simply sits between the plug on the switch panel and a flying socket on the power lead to the set. I unplugged the URC lead and reconnected the power wiring. Then switched on.

There was still nothing. The panel lamp glowed invitingly, but nothing was reaching the power supply.

The circuit diagram showed that there was a small resistor in series with one lead to the bridge rectifier. It was probably a surge protection resistor, and if it was open, then I'd get just the result I was seeing. So I set about finding the resistor, to test it.

One thing I've always found with European sets is that nothing is where you'd expect it to be. This resistor is shown as though it were on the switch panel, but it's not — it's on the rectifier panel. And it was as good as gold.

So where did that leave me?

With the URC receiver out of circuit, and no breaks between the switch and the rectifier board, there simply had to be power getting through. But there wasn't.

The panel lamp showed that power was getting to the switch, but it wasn't getting to the rectifier. I couldn't work out what was going on.

I went over everything again, checking the switch contacts and testing for continuity right up to the rectifier.

Everything was perfect. Yet when I tested for power at the rectifier, there was nothing.

Then I tried testing for power at the switch terminals, and it was here that I found the clue that allowed me to solve the problem. There was no power at the switch either. That left only the power lead, but it seemed there could be no fault with that, because the panel lamp came on every time the switch was operated.

Still, it had to be something, so I tested the power cord for continuity. And found none!

At least, I found no continuity in the neutral (black) lead. It was broken, at the plug end. So that explained why there was no power at the switch or at the rectifier. But it didn't explain how the lamp could light up, when there was no power available to light it.

The answer was that the lamp was not the usual type of panel lamp — a miniature incandescent bulb. It was a neon lamp, fitted directly across the switch contacts, in series with a multi-megohm resistor. What had happened was that the neon was connected between the mains active and the chassis metalwork, when the switch was on. The capacitive reactance between the metalwork and ground was enough to pass the tiny current needed to light the lamp.

It's interesting to consider what would have happened if the active lead in the power cord had broken. There would have been insufficient capacitance between the broken active lead and ground to light the lamp.

So I had wasted an hour or more, looking for the simplest possible fault. All because I didn't appreciate the neon lamp for what it was.

That's all for this month. Back next month with more stories, from my bench and yours. ❖

Phase-locked loop FM demodulators

The Phase Locked Loop is the modern state-of-the-art demodulator for frequency modulated signals. It is a very old idea, made economically feasible by todays large scale integrated circuits.

by BRYAN MAHER

The desirable properties of a demodulator for frequency modulated signals you would probably list as:

(1) Linearity in response.
(2) Rejection of AM and noise interference.
(3) Sufficient audio bandwidth.
(4) Economy in mass production.
(5) Easy to set up and align.
(6) Drift free.
(7) Self locking onto received carrier.
(8) Ability to work on small signals.
(9) Ability to follow drifting transmitter carrier (for applications such as cheap walkie-talkies).
(10) Built-in de-emphasis.
(11) New or old idea immaterial.
(12) Stereo output possible.

The three previously described FM demodulators all depended on critically tuned circuits for their operation. Though they did work very well, they really only satisfied the first three of the above requisites.

They required accurate tuning alignment, using a crystal controlled test generator, and needed a fair sized IF signal input. Their dependence on tuned LC circuits also required some detailed assembly work in production.

Sixty years ago a radically different FM demodulator called the *phase-locked loop* or 'PLL' was invented, of course using valve technology.

Because many discrete components were involved it was cumbersome and expensive. Only one large receiver manufacturer used this circuit around 1932, calling it the Bradley Locked Oscillator detector.

By 1934 it had more or less disappeared from commercial production. The idea was good but the implementation in those days was clumsy.

Enter LSI

The modern production of large scale integrated circuits (LSI) from 1970 onwards breathed new life into this old demodulator concept. Today we can purchase over the counter a complete FM demodulator in a single IC package for a modest sum. First came Signetics with the whole demodulator on a single silicon chip. This PLL integrated circuit revolutionised radio receiver design. No longer were fussy LC tuned circuits needed in the FM demodulator, so mass production manufacturers and home hobbyists alike loved it. Motorola and Fairchild then produced the PLL on a few separate building blocks.

Today we use the National Semiconductor LM565N at about $3.60, the Signetics or Motorola NE565N or the Signetics NE560B, all complete PLLs. Also you may consider the National Semiconductor types LM1310 or the second generation LM1800 at about $10.

Alternately we could use the Motorola CMOS family MC14046B or MC145*** series components. Many of the above have a wider range of uses than just demodulation (but more of that later).

PLL demodulator

The essential block diagram of the PLL demodulator is shown in Fig.1. From the figure it is immediately apparent that the PLL is a closed loop feedback circuit.

The phase comparator has two inputs: the frequency modulated signal output from the final intermediate frequency amplifier, which we call f(in), and the signal output from the voltage controlled oscillator, f(vco). The phase comparator looks at both inputs f(in) and f(vco) simultaneously and senses the relative phase timing of each. The comparator then produces an output at G, proportional to the difference in phase of the two inputs. (Recall that word 'phase' essentially means a division of time).

This difference signal G is amplified and passed through a low-pass filter to point 7. Here it also becomes the feedback signal to control the frequency of the voltage controlled oscillator (VCO).

The effect of this feedback signal is

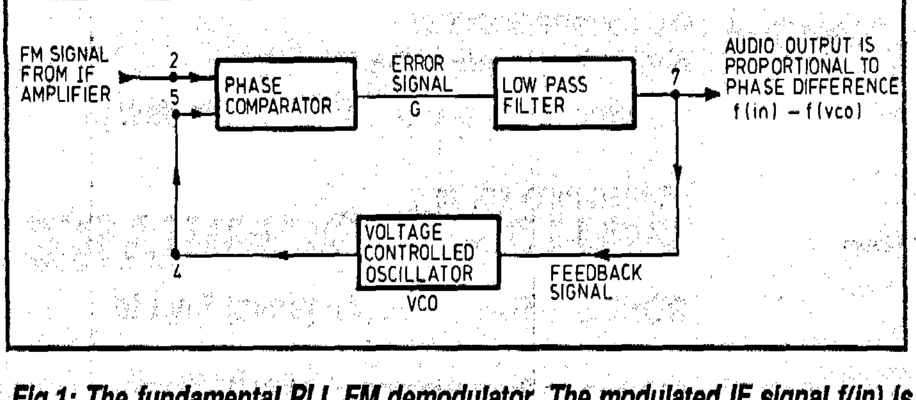


Fig.1: The fundamental PLL FM demodulator. The modulated IF signal f(in) is compared with f(vco), the output from the voltage controlled oscillator or VCO. Any difference in phase is the error signal at G, which is low-pass filtered to become the control voltage for the VCO. This signal becomes a copy of the original audio modulation at the radio station.

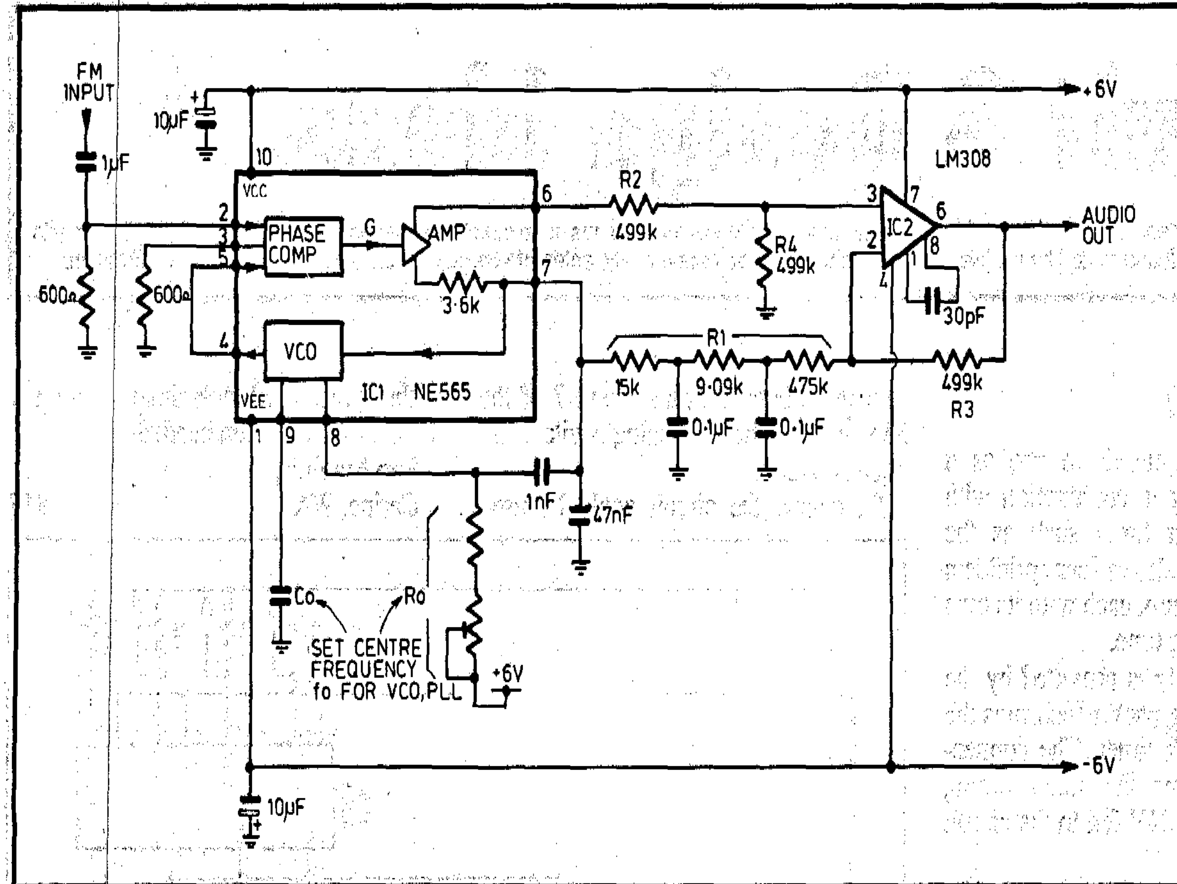


Fig.2: Circuit details for one application of the Motorola NE565N PLL IC as an FM modulator. Co and Ro form the time constant setting the free running frequency of the VCO when there is no signal input.

such that it tries to change the frequency generated by the VCO until f(vco) matches f(in) in frequency. Even further, it attempts to make them exactly in phase with each other.

That means voltages rising and falling exactly in unison. While the system is searching for a perfect match we say it is in the capture state.

No modulation

If f(in) is for the moment unmodulated — say the fast-talking disk jockey has paused for a breath — then f(in) is a pure steady sinewave at the centre frequency of the receiver's IF amplifier.

Within a very short time the feedback will adjust f(vco) to exactly match f(in), in both frequency and phase. We call this the locked state. There is now zero phase difference between f(in) and f(vco), so the feedback signal at 7 is a constant DC value, holding f(vco) exactly in sync.

FM modulation

Now the FM radio station plays music or speech, i.e., the RF carrier is frequency modulated. The positive audio half cycle increases the carrier frequency. Frequency change implies phase change.

The PLL phase comparator finds a phase difference between f(in) and f(vco), so immediately the feedback loop control signal works fast, rising to force a matching increase in f(vco), to restore equilibrium.

No sooner is that done than the audio negative half cycle comes along, and decreases the carrier frequency. The PLL comparator now senses this change, and the feedback signal falls to adjust f(vco) quickly downward.

Hopefully a startled gasp can be heard as most readers of this series (we do have readers, don't we?) immediately wake up to what is happening. (If not, try reading that last few lines again!)

Yes, of course! When the radio station audio signal rises in the positive direction, increasing carrier frequency, our PLL feedback signal at point 7 will also rise positively.

Similarly the onset of the station audio negative half cycle causes our PLL feedback signal to go down also in a negative direction. In short, our little PLL feedback control signal is simply recreating the radio station audio signal...

All we need to do now is take a sample of that feedback control signal, suitably filter and/or adjust its DC level. We thus end up with a near-perfect audio signal, a replica of the broadcast music or the disk jockey's voice.

Fig.2 shows a more detailed circuit for a PLL FM demodulator using an NE565 chip IC1 and an LM308 op-amp IC2. The PLL feedback signal appears at pin 7 of IC1, and a DC reference signal at pin 6. These are used to drive the input of op-amp IC2, in differential fashion. Four equal 499k ohm resistors R1, R2, R3 and R4 give IC2 a closed loop gain of unity.

Because IC2 is fed differentially, the final output carries only the audio signal content, ignoring the 4 volts or so DC level in the feedback signal. (If you've forgotten how an op-amp operates in differential-input mode, the second edition of my book *Op Amps Explained* is now on sale at a newsagent near you — sorry for the commercial!).

Free running

Probably by now you are bubbling over with questions, such as what happens to f(vco) when our radio receiver is not tuned to any station? And does it run at zero frequency, or perhaps go berserk? Well, it would go a bit silly if we neglected that possibility.

Remember the PLL is driven by the intermediate frequency (IF) section of our receiver. And you may recall that essentially only one frequency is passed by the tuned IF amplifiers. So the final stage IF is nearly a constant, except for the changes caused by the FM modulation itself.

But when you're not receiving a station, there is no IF signal (except noise of course), so no sensible feedback signal exists. So all we do is insert two little components Co and Ro into the VCO circuit.

This external time constant (CoRo) keeps the VCO happily running at *close* to the IF centre frequency when no station is received. This condition is called the 'free running' state.

Easy adjustment

To ensure reliable circuit operation, good quality components should be used for Co and Ro. Both should have good temperature stability. An NPO capacitor for Co and a metal film resistor plus a

Continued on page 90

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

Sprinkler timer

I designed this circuit to use as a sprinkler controller in conjunction with a plug-in 24 hour timer such as the Kambrook type. It allows four sprinklers to be activated in turn, each with its own adjustable watering time.

The power supply is provided by the same 24V AC plug pack which runs the 24 hour Kambrook timer. The connection is made *after* the main timing switch, so that the 24V fed to the circuit is switched.

When the Kambrook switches on, IC2 and IC4 are reset from the pulse produced by R1 and C1, IC4 is a quad D flipflop, set up as a shift register. In IC4's reset state, Q1-bar will turn on the first solenoid valve SL1, via relay 1, while the other valves will remain off as they are connected to outputs Q2 - Q4.

The 555 chip IC1 is set up as a pulse generator, with the pulse width being adjustable by RV1, RV2, RV3 or RV4.

These pulses are fed into IC2 which is a 12-stage binary counter. After 4080, pulses, the output of IC3 goes low, is inverted by IC5a, and clocks pin 9 of IC4.

This pulse turns on both Q1 and Q2, and this turns off relay 1 (connected to Q1 bar) and turns on relay 2 (connected to Q2).

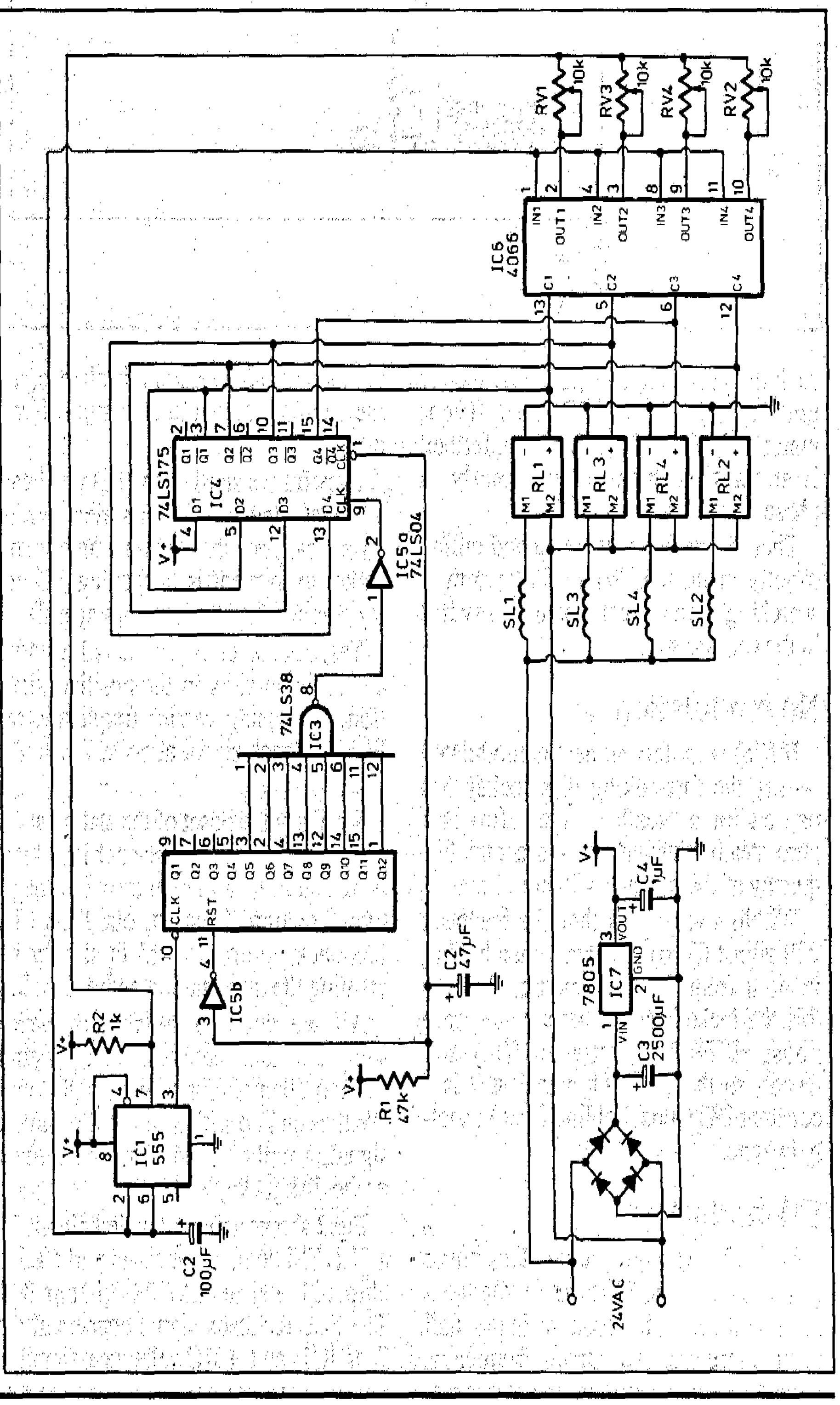
Subsequent pulses to pin 9 will turn on relay 3 and relay 4 in turn. After the last valve is switched off, no valve will switch back on until the circuit has been reset — when the main 24 hour timer next turns on.

I used solid state relays (RL1 - RL4) to drive the 24V valve solenoids, but it would probably be cheaper to use ordinary relays or triacs. The ontime for each valve can be adjusted via the appropriate potentiometer (RV1 - RV4).

These resistances are connected, one at a time, between pins 6 and 7 of the 555 by whichever analog switch has been activated.

Of course the circuit could be used without the Kambrook timer — by just switching it on when needed.

Leo Aravidis,
Carine, WA. **$45**



DREAMED UP A GREAT IDEA?

If you have developed an interesting circuit or design idea, like those we publish in this column, why not send us in the details? As you can see, we pay for those we publish — not a fortune, but surely enough to pay for the effort of drawing out your circuit, jotting down some brief notes and popping the lot in the post (together with your name and address) and send them to Jim Rowe at -

Electronics Australia,
PO Box 199,
Alexandria, NSW 2015

Capacitor leakage tester

With the increased interest in restoring old valve radios, one of the most common problems is leaky capacitors. In one radio which I fixed recently, every bypass and coupling capacitor was leaky and had to be replaced.

Using a multimeter on the high-resistance range won't give a good indication of leakage, as the multimeter only puts a low voltage across the capacitor. In normal use, it could have a couple of hundred volts across it.

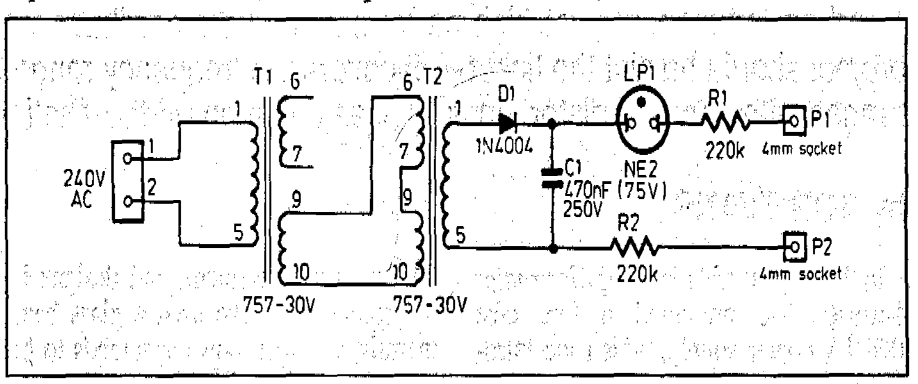
A simple qualitative indication of leakage can be made by placing the capacitor, a neon lamp and a resistor in series across a high DC voltage.

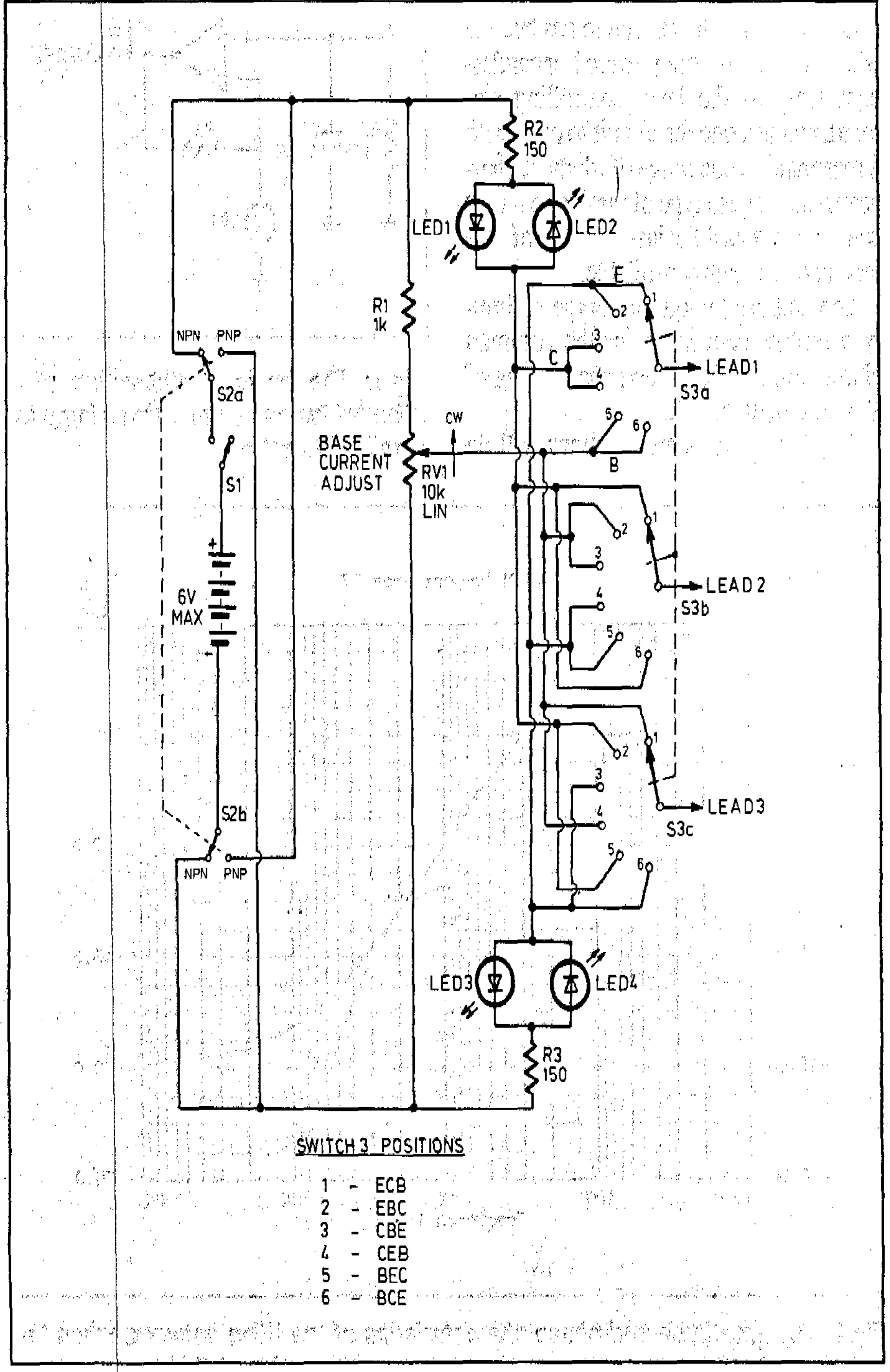
The capacitor to be tested is connected to the two 4mm sockets, P1 and P2. A DC voltage of about 180V is fed to it, via a 75 - 90V neon bulb such as the NE2, and a resistor of, say, 470k. (In the actual circuit, this approximate 470k is provided by two 220k resistors.) An economical way of obtaining the 180V DC supply is to use two small transformers with tapped secondaries, connected back-to-back, to give 120V AC, which is then rectified and filtered. I used a pair of the Arlec 7VA series transformers, connecting their secondaries as shown.

If a good capacitor is placed across the terminals, the neon lamp will light as the capacitor charges up. A point will be reached where the lamp will extinguish — this time is proportional to the value of the capacitor. When a slightly leaky capacitor is connected, the lamp will light and then extinguish as before — but because of the leakage, the capacitor will discharge to the point where the lamp will light up again as the capacitor charges up again. The frequency of the blinking will be related to the amount of leakage and the capacitance value. The greater the leakage, or the smaller the capacitor, the faster the lamp will blink.

If the capacitor is very leaky, or shorted, the voltage across the capacitor cannot reach the point where the lamp extinguishes.

Ian Johns,
Dickson, ACT $35





Transistor leads identifier

This design is based on a circuit published in *Elektor* in March 1985, which allows the identification of the leads on unmarked transistors.

It has been improved by adding a switching arrangement, rather than moving the component leads around, to try all combinations.

Very few components are needed — three resistors, a pot, four LEDs, three switches and a battery. The only hard to obtain item is the three-pole, six-position switch.

To operate the device, the transistor is connected to the leads, and then the 'base current and adjust' potentiometer is cranked up and down in each of the six switch positions of S3.

If turning the potentiometer clockwise increases the brilliance of two LEDs simultaneously, then the base lead has been identified and whether the transistor is NPN or PNP.

If the two LEDs decrease in brilliance, rather than increase, then the wrong NPN/PNP switch position has been selected. If two or more switch positions light up LEDs, then the brightest is the correct position.

All other indications, such as LEDs getting brighter individually, are invalid. Leads 1, 2 and 3 are then identified from the 'switch position' table.

Len Ahearn,
Curtin, ACT. $30

Construction project:

Low cost sine/square wave oscillator

Need an inexpensive yet high-performance audio oscillator for your workbench? If so, our new project should be just the ticket — it covers the frequency range from around 6Hz to 70kHz in four ranges with very low distortion, and uses common off-the-shelf parts.

by ROB EVANS

In the August 1991 issue of *Electronics Australia* we presented a low cost 18V/1A power supply, which we introduced as 'mean, lean and recession-compatible' — an expression that in many ways described the design philosophy behind the project, rather than the unit itself.

As it happens, this has proven to be a very popular project, indicating that many readers share our views on what is really needed from low cost workshop instruments.

So here we are again, taking a hard-nosed, tight-fisted view of another very useful piece of test equipment: the benchtop audio oscillator. Needless to say, we've taken the same approach as with the abovementioned power supply by taking a careful look at what performance and features are *really* needed from an oscillator, based upon how it is generally used.

The final result bears many similarities to that earlier power supply, in that it uses the same small (and inexpensive) plastic instrument case, has no power switch, and delivers the same realistic and above all, practical level of performance.

In this case, the sine wave output produces less than 0.1% distortion over a 20Hz to 50kHz range (typically 0.07%), and the square wave offers rise and fall times of less than 50ns — more than adequate for most uses...

At the very outset we decided to use a Wien bridge style of sine wave oscillator, due to its low cost, high performance and predictable characteristics. The very nature of the Wien bridge circuit means that some form of automatic level control circuit is needed, as with most other low distortion oscillator circuits.

This is generally based around a non-linear resistive element, and designs in the recent past have used a glass bead thermistor, which nowadays tends to be rather expensive and (often) difficult to track down.

Our answer to this problem has been to use a common low-powered incandescent lamp as the level controlling element, and arrange the circuit to cope with a reasonably wide range of filament characteristics. These type of miniature lamps can be purchased for just a couple of dollars, and are readily available.

The unit used in our prototype is simply a replacement lamp for the common alarm warning lights, and has a rating of 12V at around 50mA.

Any lamp with similar ratings will do

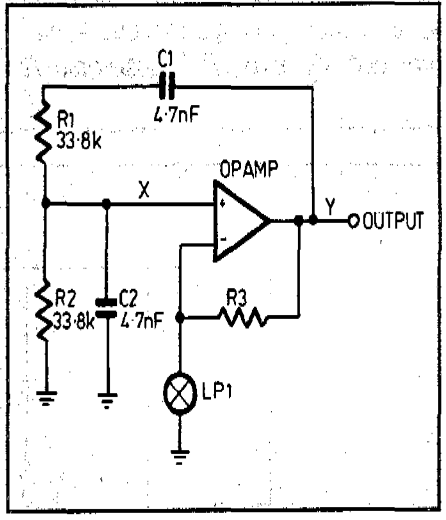


Fig.1: The basic configuration of a Wien bridge oscillator using a lamp for amplitude control.

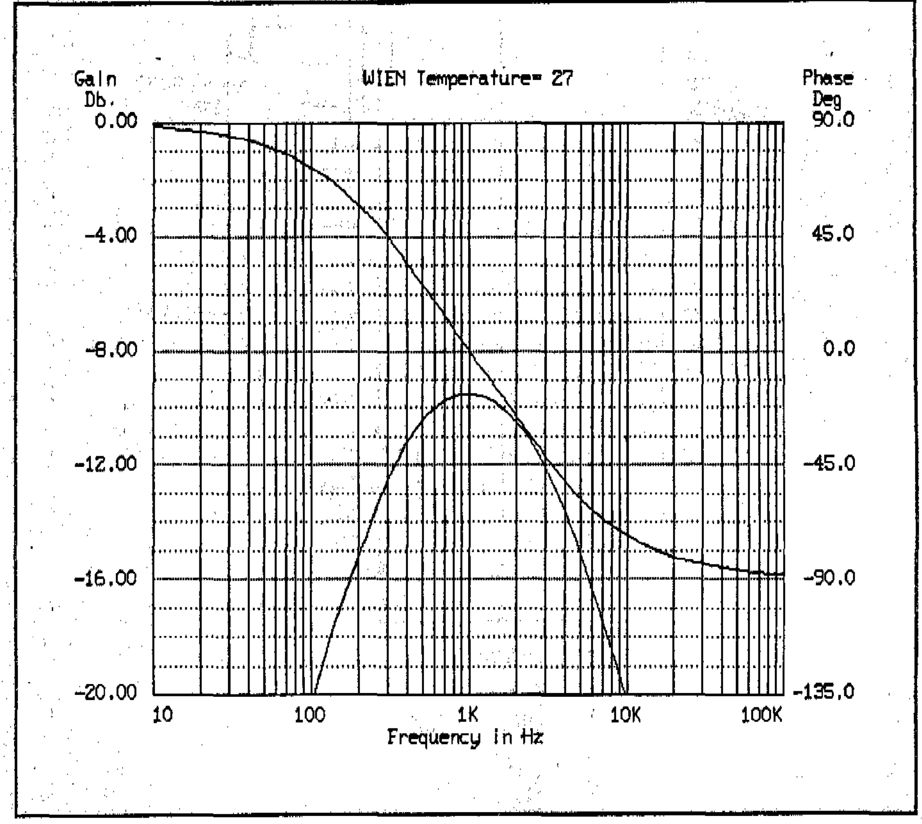
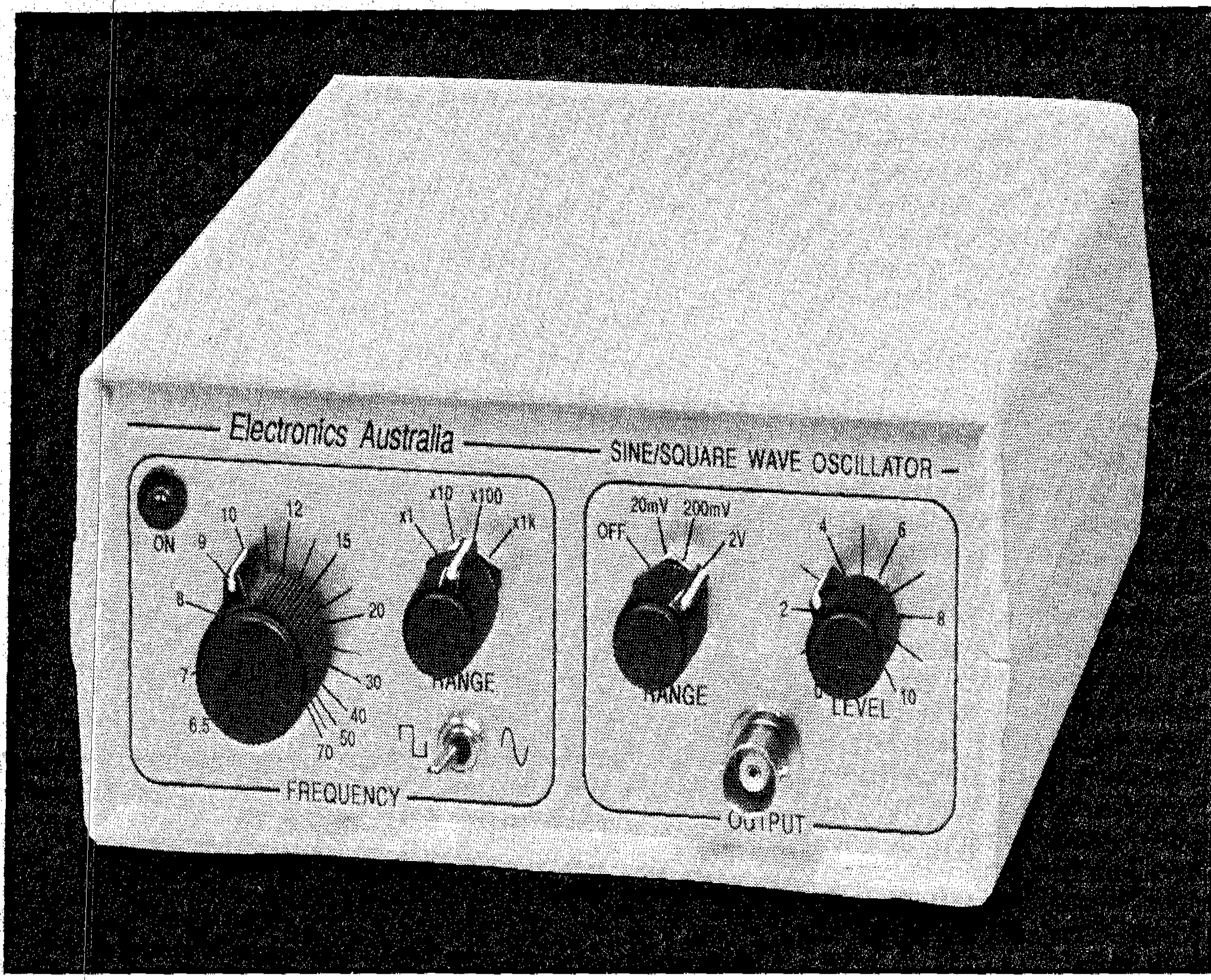


Fig.2: The amplitude and phase characteristics of the Wien network, when the component values are set to provide minimum attenuation at 1kHz.



the job, although bulbs with a power rating less than 0.5W are preferable.

Other than a few changes to the standard Wien bridge oscillator circuit to accommodate the lamp as a level control element, the overall design is really quite conventional and uses time-proven circuit techniques.

We have elected not to use any specialised close tolerance components, although some constructors may wish to follow this option.

The Wien bridge

The basic configuration of this circuit is shown in Fig 1. It consists of a high-gain differential amplifier (generally an op-amp) with two separate feedback circuits; the actual Wien network (R1, R2, C1 and C2) which provides positive feedback, and a resistive network (R3 and LP1) to control the level of negative feedback.

If we consider for the moment that the Wien network's 'input' is at point Y and its output is at point X, the transfer characteristic will be as shown in Fig.2.

As you can see from the diagram, with the component values shown its response peaks at 1kHz and the phase shift passes through zero at the same frequency.

Since these characteristics represent the op-amp's positive feedback condition, the circuit will oscillate at 1kHz if the *overall* gain is greater than unity. For this to occur, the op-amp must be set for a gain of at least +9.5dB (or 3) to overcome the reciprocal loss (-9.5dB or 0.333) in the Wien network.

Now, since the op-amp's gain is determined by the level of negative feedback, which is in turn set by the resistive ratio of R3 and LP1, we can expect oscillations to begin when R3 is *twice* the value of the lamp's resistance:

i.e., $1 + (R3/LP1) = 3$.

To keep the overall gain at unity and the oscillations at a constant amplitude, the circuit exploits the positive temperature coefficient (PTC) characteristic of the lamp's filament — which exhibits a higher resistance as its temperature increases. In turn, the filament temperature will depend upon its power dissipation, which is determined by the output signal level (since LP1 and R3 are effectively the op-amp's load).

So in the circuit as shown in Fig.1, as the output oscillations grow, the filament will dissipate more power and increase its resistance, which then increases the level of negative feedback and consequently reduces the op-amp's gain. This will tend to reduce the output signal level, and thus stabilise the circuit's output amplitude.

If R1 and R2 are equal in value, and C1 and C2 also have the same value, the frequency of oscillation will be equal to the reciprocal of $2\pi RC$. With the values shown in Fig.1, this calculates to 1kHz.

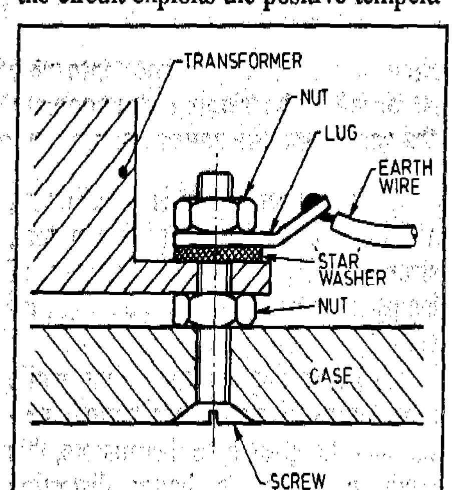


Fig.3: Use this diagram as a guide when you're mounting the power transformer. Note the additional nut, to ensure reliable earthing even if the transformer should overheat.

Circuit description

In our final circuit as shown in the main schematic diagram, the oscillator is formed around op-amp IC1, with the negative feedback controlled by RV2, R3 and LP1. The capacitive sections of the Wien bridge are formed by C1 to C4, depending upon the position of the range switch SW1a, and C5 to C8 as selected by SW1b.

The resistive elements of the bridge are made up of R1 and RV1a, and R2 and RV1b, where RV1 acts as the 'fine' frequency control to adjust between the 'coarse' settings of SW1. To adjust for a wide variety of lamp characteristics (that is, the nominal resistance of each type), RV2 has been included in the negative feedback leg of IC1.

Also included in this path is the pair of back-to-back zener diodes, ZD1 and ZD2, which help to reduce the degree of amplitude 'bounce' as the oscillator's frequency setting is changed. To understand the beneficial effect of the zeners, this bouncing effect may need some explanation.

Amplitude bouncing occurs in all oscillators which use a thermistor or lamp as a level control element, due to the thermal inertia of the device itself. As the lamp is (say) heating up in response to a high signal level, it will take a moment for its resistance to increase and consequently lower the op-amp gain. The signal will therefore continue to increase in amplitude until the lamp resistance effectively 'catches up', and the gain is finally reduced.

Since the output amplitude was far too high, the stabilising circuit will tend to overcompensate, the level will then fall too low, and the cycle continues.

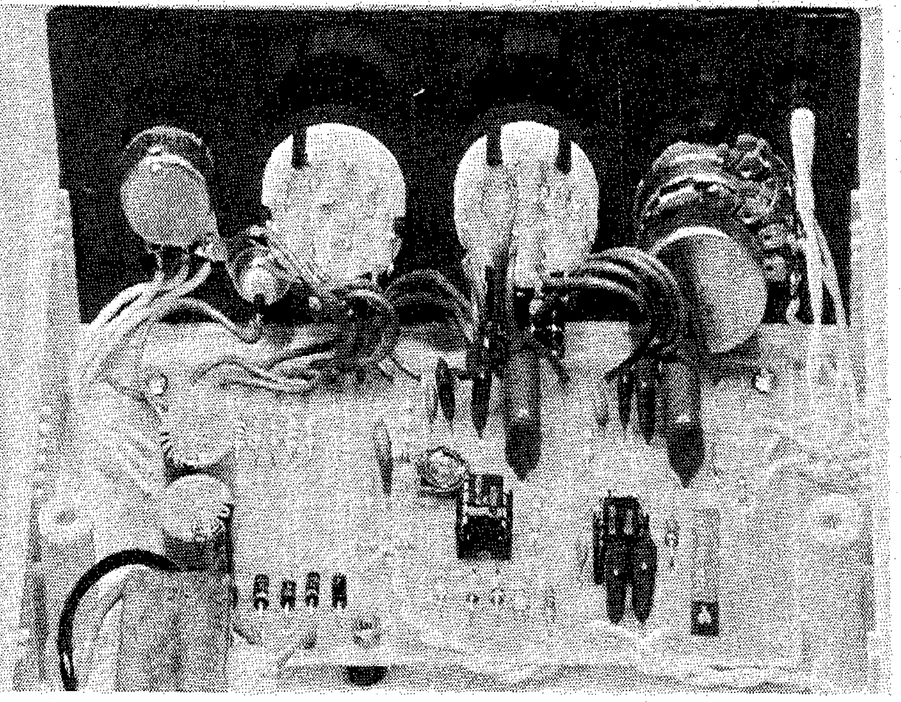
However, these errors will be smaller with each overshoot, and the level will finally stabilise — how long this actually takes will largely depend upon the thermal characteristics of the lamp (or thermistor). In extreme cases, the circuit may even lapse into 'motorboating' or 'squegging', where the output signal becomes amplitude modulated at some lower frequency.

In our circuit, if IC1's output signal rises to a high level the zener diodes will begin to conduct, thereby increasing the negative feedback and momentarily dropping the op-amp's gain.

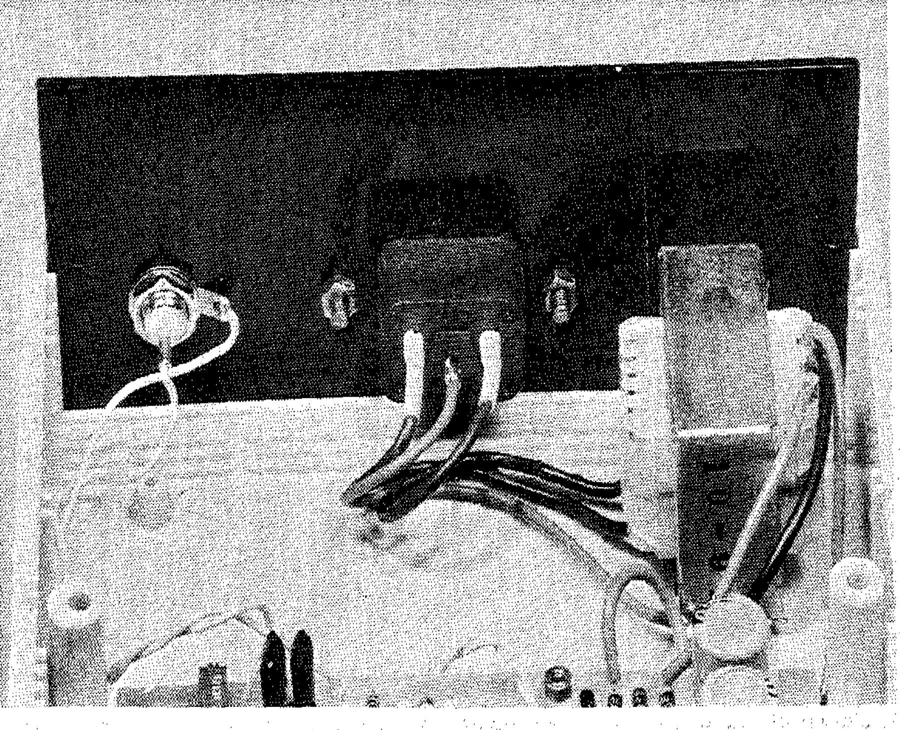
This limiting action of the circuit will tend to break the bounce cycle by vastly reducing the degree of positive overshoot, and forcing the output amplitude to quickly settle at its nominal level.

When the output is at this steady level, the circuit values are arranged so that the zeners are not conducting and don't influence the quality of the sine wave output.

In practice, there will simply be an increase in distortion as the output amplitude overshoots in a positive direction, which is generally preferable to a large positive overshoot — particularly when testing audio amplifiers and loudspeakers.



This inside photograph shows most of the internal circuitry, mounted on a small PC board just behind the front panel. The small lamp used for amplitude control is visible at the right hand end of the board.

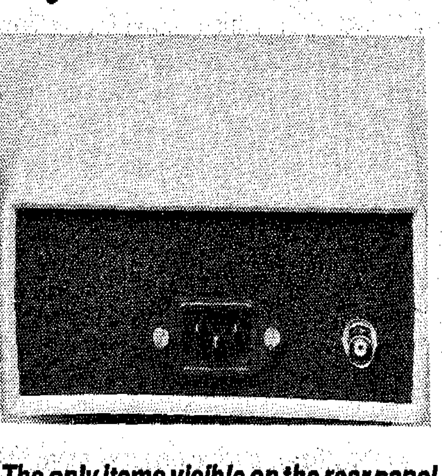


Here's a view of the components which are near the rear panel of the oscillator. At far left is the trigger output connector, with the IEC mains input connector in the centre and the power transformer on the right.

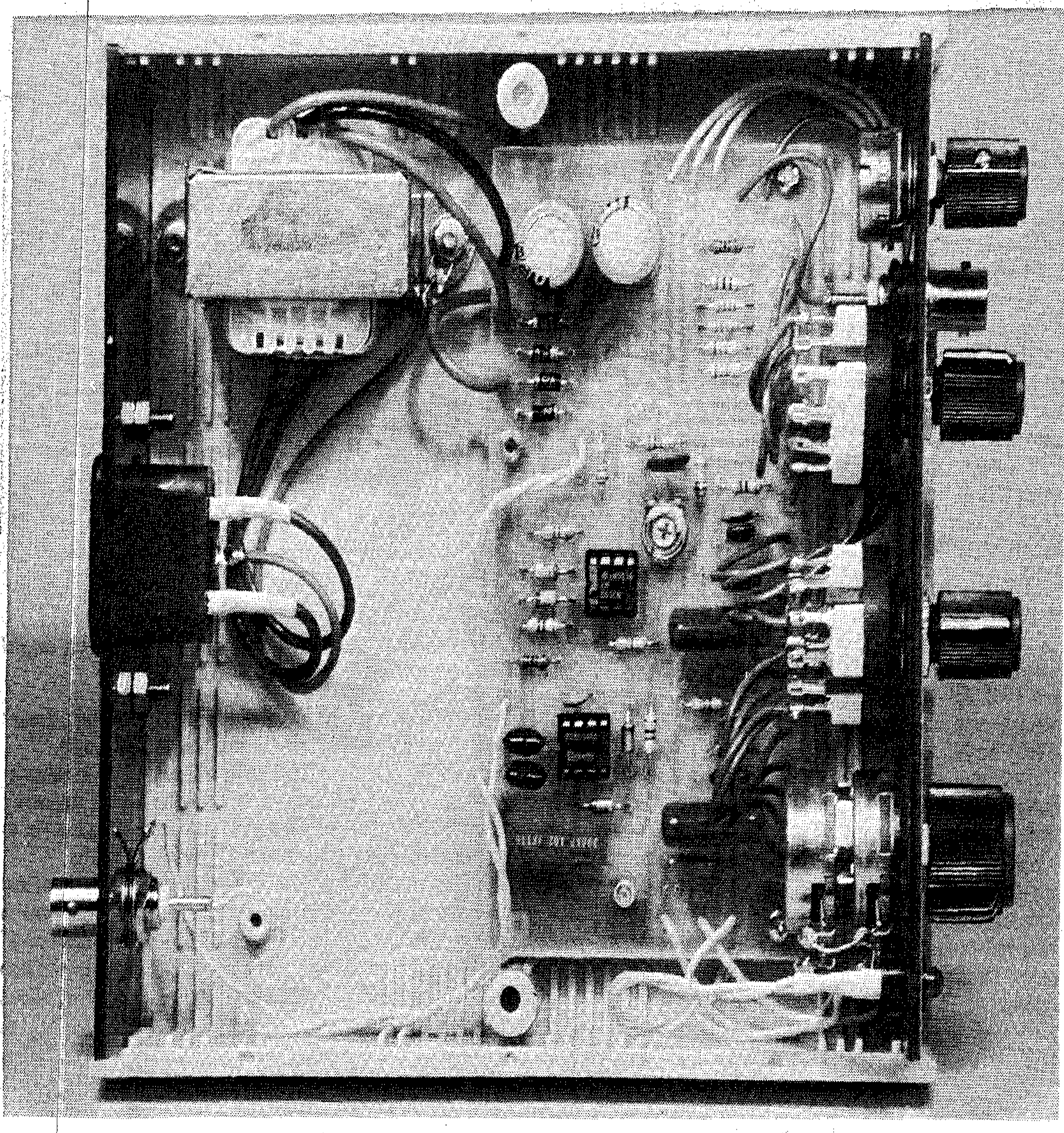
As it happens there is a secondary, and more subtle benefit of this system, since it allows a wider variety of lamps to be used without the risk of instability or squegging.

It's interesting to note that while most lamps have a greater thermal inertia than the glass type thermistors, this tends to result in better distortion figures at very low frequencies.

With a relatively fast-responding thermistor, the device tends to heat and cool with the waveform peaks at these frequencies, which in turn modulates the op-amp's gain and increases the output



The only items visible on the rear panel are the IEC mains input connector and the trigger output connector.



This overall view of the interior of the oscillator shows virtually everything, apart from the sine/square wave selector switch — which is hidden underneath the frequency range switch. Note that the active and neutral mains connections to the IEC plug terminals should be either protected with heat shrink sleeves, as shown here, or via one of the proprietary 'boots'.

distortion. As you would imagine, the slow-responding lamp is less susceptible to this effect.

The final sine wave output from IC1 is applied to the 'sync' output (used for an oscilloscope trigger) via R5, and the sine/square wave switch (SW2a) via R4.

When in the sine wave position, SW2a passes the signal directly to SW2b and the output level control RV4. This in turn feeds the output voltage divider composed of R11 to R15, which provides voltage divisions of 1, 10 and 100 or attenuations of 0dB, 20dB and 40dB respectively.

These various levels are selected as required by the output range control SW3, and passed to the main signal output via isolating resistor R16. Note that a grounding tap is also supplied to SW3, for the 'off' position.

When the square wave option is selected on SW2, the sine wave signal from IC1 is disconnected from the main output and passed directly to IC2 via SW2a and R7. The 555 timer IC2 is arranged as a simple Schmitt trigger, where both the trigger *and* threshold inputs (pins 2 and 6, respectively) sense the incoming signal.

In this circuit the power supply rails have been restricted to about +/-4.7V by the action of ZD3 and ZD4 and their associated limiting resistors R8 and R9.

This effectively increases the sensitivity of the trigger and threshold inputs to around -1.5V and +1.5V respectively, since their respective changeover points are defined as 1/3Vcc and 2/3Vcc.

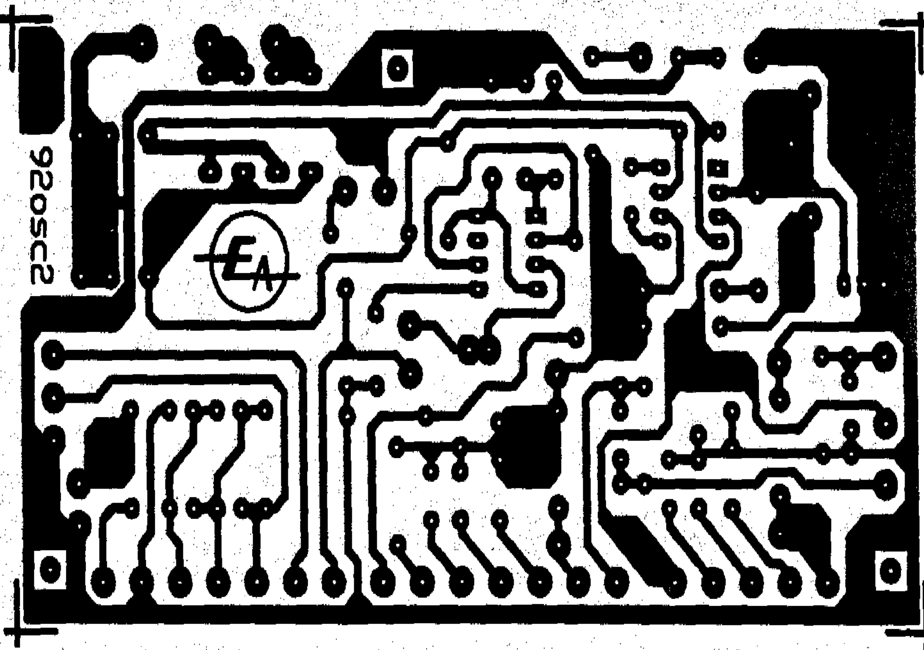
So when the input sine waveform swings below -1.5V the 555's output (pin 3) will swing high, and will then drive low when the input passes above +1.5V.

The resulting square wave (which swings between about +/-4V) is then applied to the level calibrating attenuator composed of RV3 and its load components (R10 and so on), and is passed to the output circuitry via SW2b.

When the square wave mode is not selected, the input signal is removed by SW2a, and R6 holds the 555's inputs at a level which is between the two changeover points (0V). This both isolates the 555 and inhibits its action, so as to prevent any interference with the unit's sine wave mode.

The remaining section of the schematic diagram shows the unit's power supply. This is quite a basic affair, based around a common 2851-type transformer (with a 6.3-0-6.3 volt secondary winding) and a full-wave rectifier composed of D1 to D4. The resulting split supply rail then is filtered by capacitors C13 and C14, producing an output of around +/-9V.

A more complex (and expensive) fully regulated supply was found to be unnecessary, due to the excellent power supply rejection capabilities of the 5534 op-amp.The final minor parts include the power indicating LED (LED1) and its associated current limiting resistor R17, IC1's compensation and bypass capacitors C9 to C11, and the 555's control voltage input (pin 5) bypass capacitor C12.



If we tried to tell you this was not the PCB pattern, you wouldn't believe us, would you? So we won't. As usual, it's reproduced here actual size.

Construction

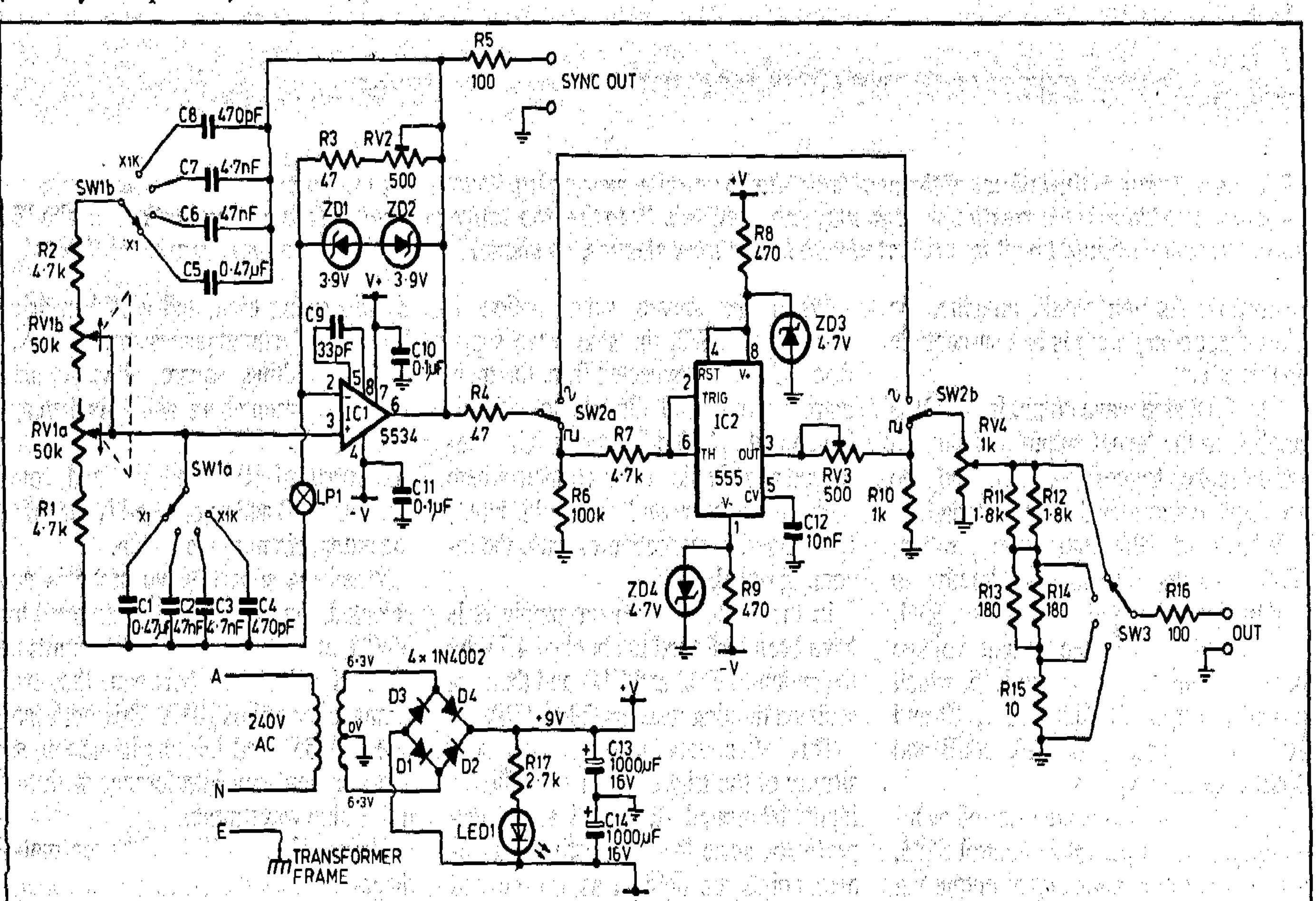
Building the oscillator is quite a straightforward process, with the only (slightly) awkward task being the wiring of the two selector switches SW1 and SW3. All of the smaller components are held on a single printed circuit board (PCB) coded 92osc2, which measures 120 x 63mm and is mounted into the bottom of the case just behind the front panel.

Begin the construction by fitting the components to the PCB as shown in the component overlay diagram, working your way from the smaller devices (resistors) through to the larger parts (electrolytic capacitors). As usual, take particular care with the orientation of any polarised components such as the diodes, ICs and the power supply filter capacitors C13 and C14.

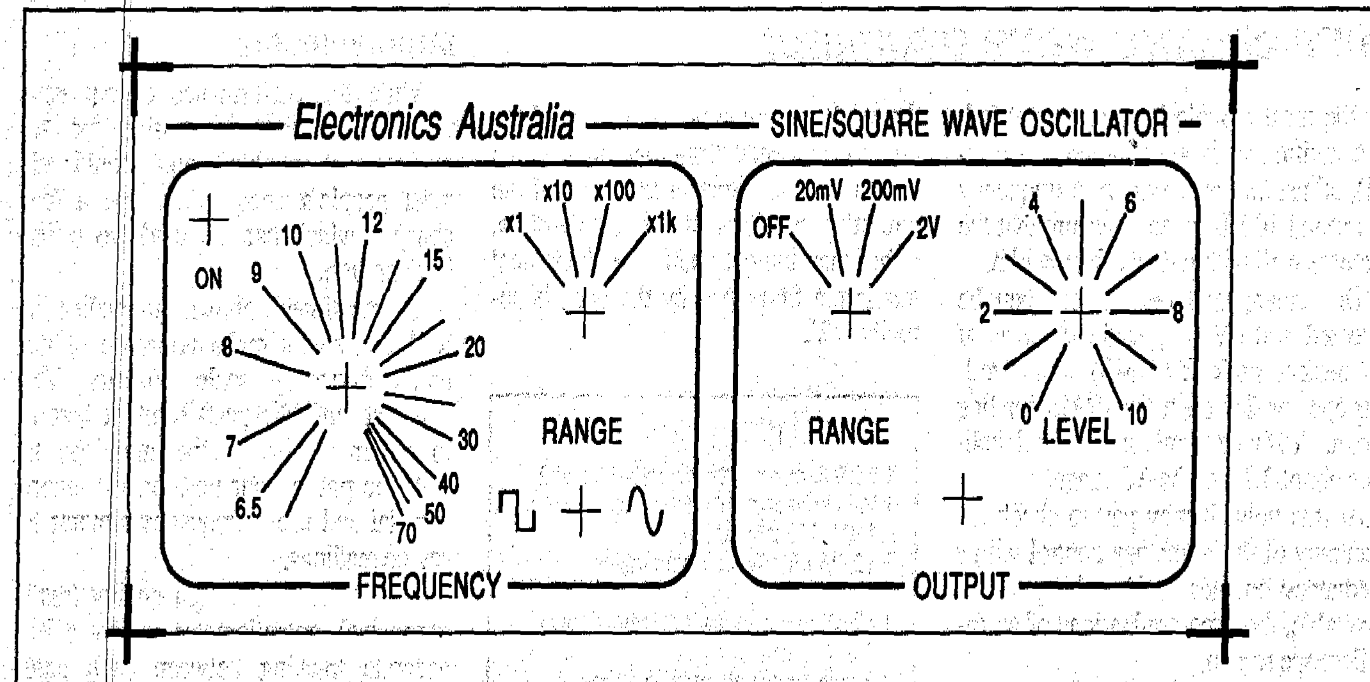
Once the circuit board assembly is completed, attach appropriate lengths of hookup wire to each of the external connection pads, as shown in the overlay diagram. While 'rainbow' wire could be used to make a much neater connection between the PCB and SW1, it should be avoided due to the resulting increase in cap-acitance between each wire.

This in turn will tend to cause substantial scale errors on the highest frequency range, as the stray capacitance adds to the value of C8 and C4 (470pF).

Next fit the larger parts to the front and rear panels, and mount the transformer to the bottom of the case. Note that one of the transformer's mounting legs will also serve as the mains earthing point, and is



As you can see from the schematic, there's really very little in our new oscillator. Just two low cost ICs and a handful of supporting components. Yet it provides virtually all of the facilities needed by most people...



And this, believe it or not, is the front panel artwork — also actual size.

directly connected to the earth pin of the IEC mains socket.

In this case, a nut should be fitted to the mounting bolt *before* the transformer is installed, then a lock washer, the earth lug, and another nut fitted respectively (as shown in Fig.3). The idea here is that if the transformer overheats (due to a fault condition) and begins to melt the plastic case, the two nuts will maintain the earth connection between the frame and the lug.

The other essential safety procedure is to fully cover any exposed mains wiring, such as the IEC connector pins. The easiest method here is to fit a matching plastic boot to the rear of the IEC socket, however if this is not available the active and neutral pins should be carefully covered with heatshrink tubing.

Also, if the transformer at hand is fitted with solder lugs for the primary winding connections (240VAC) rather than the preferred type with flying leads, both connecting lugs should be thoroughly insulated with heatshrink tubing.

The transformer secondary leads can now be connected to the PCB as shown in the overlay diagram, and the board screwed to the bottom of the case.

Note that the transformer's centre tap lead connects to the PCB pad which is *closest* to the side of the box, and a screw, nut and spacer is used to locate the rear of the circuit board assembly. After that, the lengths of hookup wire can be trimmed and soldered to the appropriate pins of the pots and switches; methodically follow the component overlay here, as wiring mistakes are difficult to trace at a later date.

Once you are satisfied with the neatness and accuracy of the final result, it's time to give the unit a test run.

Commissioning

With IC1 and IC2 removed from their matching sockets, apply power to the unit and measure the power supply voltage at the appropriate ends of the rectifier diodes — this should read around +/-10V while not loaded by the ICs.

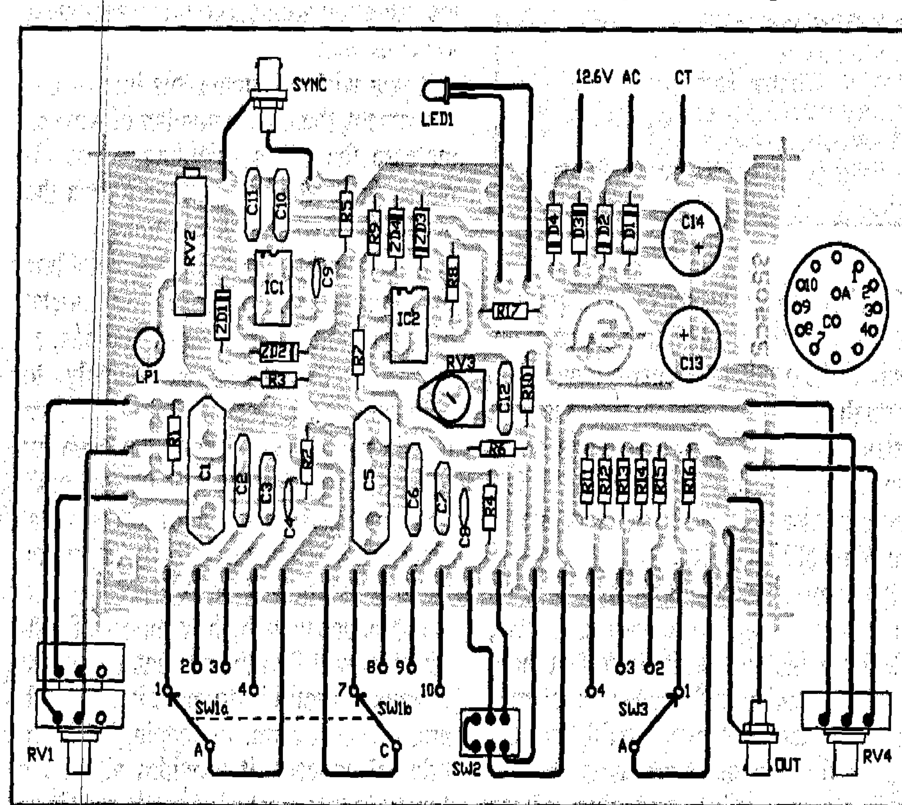
Then check that the voltage across both ZD3 and ZD4 is around 4.7V, and the power LED (LED1) is illuminated. If the LED is not active, or a zener is only dropping about 0.7V, the most likely cause in both cases is that they have been installed with a reversed polarity.

If all is well, switch the unit off and fit IC1 and IC2 with the orientation as shown in the component overlay (pin 1 towards the rear of the case). Then select the sine wave mode (SW2), a frequency setting of around 1kHz, a reasonably high output level, and reapply power while monitoring the output signal with an amplifier or oscilloscope.

Since RV2 has not yet been set to match the lamp characteristics, the output will be either a severely distorted sine wave if the trimpot is set too high, or devoid of signal if the setting is too low.

RV2 can now be adjusted to correct the above situation, where a clockwise rotation will increase the gain.

The sine wave output level should finally be set to 2V RMS with SW3 and RV4 at their maximum positions, as read



Using this wiring diagram in conjunction with the interior photographs, should allow you to wire up the oscillator with a minimum of hassle.

by the most reliable instrument at hand. If a multimeter is used (preferably digital), adjust the oscillator for a frequency of around 100Hz so as to ensure that the meter is well within its AC bandwidth.

The squarewave output can then be selected, and RV3 adjusted for a level of 4V peak-to-peak (2V RMS) on an oscilloscope, or 2V on a true-RMS reading meter. A standard multimeter will indicate about 2.2V on its AC range.

At this point it may pay to check the accuracy of the frequency control with a frequency counter or if nothing else is available, the time graduations of an oscilloscope screen.

If you have used a standard off-the-shelf potentiometer for RV1, be prepared for the actual oscillating frequency to disagree with the front panel scale at several points. This is mostly due to the general non- linearity and mistracking between the two sections of a typical dual-ganged pot, and is quite unavoidable.

By the way, the actual front panel scale that we have used was theoretically derived and will match an ideal potentiometer. This is about all that can really be done, since the scale markings will then be at the mean of the errors produced by a range of pots, rather than positioned to match the vagaries of the device in our actual prototype. And clearly, a perfect pot is not available.

If the mistracking in your unit is only minor, you should be able to move RV1's knob around so as to minimise the errors across the scale, or even adjust a commonly used marking (say '10') to be as accurate as possible at the expense of the other positions.

On the other hand, a particularly poor pot could cause the readings to be radically out of kilter, making the scale almost unusable.

In this case, double check that the components which form the Wien bridge in fact have the correct values, and RV1's total resistance is close to its 50k rating. As you would expect from the way the circuit works, if the pot has a maximum resistance of only say 45k (which is quite possible), the low-frequency section of the dial will be incorrect.

With this pot, the (say) 7Hz calibration mark would need to be moved by about 30° in a counter-clockwise direction to correct for the error.

On the other hand, when RV1 is adjusted to the top end of the frequency band (fully clockwise) the bridge resistance is set entirely by R1 and R2, and the results are quite predictable. So if the highest frequency is not close to '70', the error is due to errors in the value of the circuit's capacitors and fixed resistors, rather than the pot itself. The theoretical maximum frequency by the way, is actually '72'.

PARTS LIST

1 PCB 63mm x 120mm, coded 92osc2
1 Plastic instrument case, 160 x 150 x 65mm
1 12.6V/150mA 2851-type mains transformer
1 Miniature incandescent lamp, approx 0.5W or less
2 2-pole 4-position rotary switches
1 DPDT miniature toggle switch
4 Plastic knobs, one large and three small
2 BNC sockets, panel mounting
1 IEC-type mains plug, panel mounting
Solder lug, small spacer for PCB, nuts, bolts, hookup wire, heatshrink tubing, etc

Resistors

All 0.25W 5%: 1 x 100k, 3 x 4.7k, 2 x 1.8k, 1 x 2.7k, 1 x 1k, 2 x 470, 2 x 180, 2 x 100, 2 x 47, 1 x 10 ohm
1 50k dual-ganged linear pot
1 1k single-ganged linear pot
1 500 ohm horizontal-mounting trimpot
1 500 ohm PCB-mount multiturn trimpot

Capacitors

2 1000uF 16V PCB-mount electrolytics
2 0.47uF metallised polyester
2 0.1uF metallised polyester
2 47nF metallised polyester
1 10nF metallised polyester
2 4.7nF metallised polyester
2 470pF ceramic
1 33pF ceramic

Semiconductors

1 NE5534 op-amp IC
1 555 timer IC
2 4.7V 1W zener diodes
2 3.9V 1W zener diodes
4 1N4002 power diodes
1 5mm red LED, plus mounting flange

To check the influence of the capacitor values, note the maximum frequency on each of the oscillator's coarse ranges (x1 through to x1k). If the main figure is *consistently* multiplied by the range scale (say 75Hz, 750Hz, 7.5kHz and 75kHz), you can assume that the error is due to the value of R1 and R2.

Alternatively, the multiples could be quite uneven (say 70Hz, 680Hz, 7.2kHz, 70kHz), which would indicate that there is some variation in the capacitor tolerances. In general however, you'll find that the fixed components are quite close to their required value, and most of the oscillator's scale errors are likely to be due to variations in RV1.

Improvements

While the performance of our new oscillator is quite impressive for the modest cost involved, and should suit most people's needs, there are a few changes which can be made to refine its operation.

As mentioned above, anomalies in RV1 can easily make nonsense of the unit's frequency scale linearity. The simplest (and cheapest) solution here is to either recalibrate the markings to suit the pot in your unit, or just ignore the dial and use a frequency counter to set the readings.

Other than that, a high quality (read: expensive) potentiometer which offers accurate tracking between each gang could be used for RV1, in place of the garden variety unit. However, some constructors may feel that the cost of such a component is difficult to justify in such a low-cost test instrument.

The same line of thinking can probably be applied to the idea of installing close-tolerance components in the Wien bridge circuit, which would improve its accuracy to some degree. Nevertheless, these superior components are still quite reasonably priced and would be of some advantage if a high-quality pot is used for RV1.

In its standard form, the oscillator offers quite respectable distortion figures (generally less than 0.1%), which should suit most applications. After some research however, we found that this figure could be reduced to around 0.03% by adding shielding around the PCB and RV1, indicating that a substantial amount of the distortion artifacts could be attributed to mains hum.

If you wish to pursue this line of improvement, there are a number of ways to increase the unit's shielding — as always, the method will depend upon the resilience of your bank account.

The choices include using a metal box for the complete unit, installing a metal front panel in the existing plastic box, or using an external power supply to eliminate the effect of the unit's own transformer. The cheapest improvement however, is to simply earth the pot's body and install a square of foil or metal plate (which is also earthed) under the oscillator section of the PCB.

In practice though, the majority of constructors will find the oscillator to be an extremely useful instrument in its standard, low-cost form. In keeping with our original concept, it provides all of the functions that most of us *really* need in an inexpensive benchtop sine/square wave oscillator. ❖

The Best Passive Infra-Red Detector We've Ever Seen

We have made yet another scoop purchase of an extremely high quality 'National' (Panasonic) Japanese PIR. Quite frankly we have never seen a PIR built as well. To give you an example, the first amplifier stage from the Pyroelectric element is actually built right behind the element and housed in a shielded box. This maximises the signal to noise ratio and helps reduce false triggering.

Three lens configurations are offered:

1) Ceiling mount, 360° coverage. This is the only unit that we know that can do this.

Cat LA-5028 **$149.50**

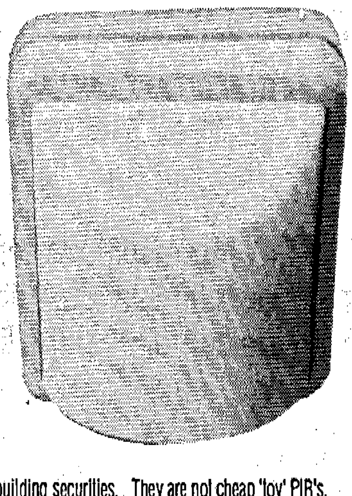
2) Wall/ceiling mount long range. Will detect intruders up to 30 meters away, with a narrow beam angle. Ideal for hallways, looking down rows of shelving, etc.

Cat LA-5030 **$99**

3) Wall/ceiling mount, wide angle (80°) up to 16 metre range. Ideal corner mount unit, covers an enormous area.

Cat LA-5032 **$99**

Each unit comes with comprehensive instructions, NC Tamper Circuit, N.O./N.C. alarm output. Power requirement 6-18V DC or AC. Range sensitivity is adjustable which is in keeping with the professionalism of the unit. These units were used by professional installers for major building securities. They are not cheap 'toy' PIR's.



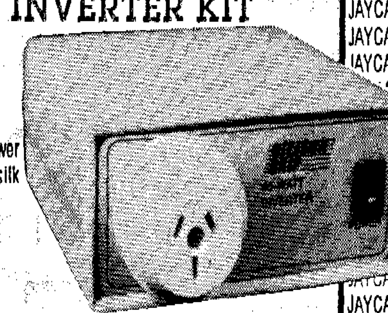
NEW KIT - 40 WATT INVERTER KIT

Ref SC Feb 1992

This compact 40W Inverter can drive low power appliances such as shavers from a 12V battery. It is ideal for use when camping in areas where 240V AC supply is unavailable, or as part of a small solar power installation. Kit comes complete with punched and silk screened front panel and all specified components.

The Jaycar version will in actual fact deliver around 60 watts.

Cat KC-5108 **$99**

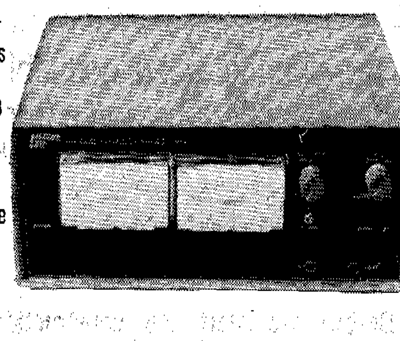


NEW KIT - Adjustable 0-45V at 8 Amp Power Supply Kit

Ref SC Jan/Feb 1992

Do you need a really big power supply? One that's big enough to do away with car batteries on your workbench? Well, this is for you! It's output is adjustable from 0-45V DC and it can deliver currents up to 8 amps. Features current limiting, current overload indicator, separate voltage and current metering, 13.8V output switch setting and utilising the latest switch mode design. Kit comes complete with instrument case, toroidal transformer, punched and screened front and rear panels and all specified components.

Cat KC-5109 **$399**

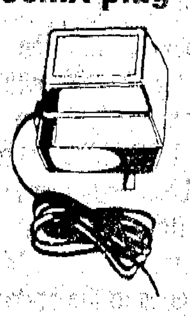


SCOOP PURCHASE on quality Ferguson 9V DC 300mA plug pack.

Supplied with 1.5 meters of cable and terminates to bare ends. We only have a small quantity of these and at this price they won't last long. Be quick!

Cat MP-3005

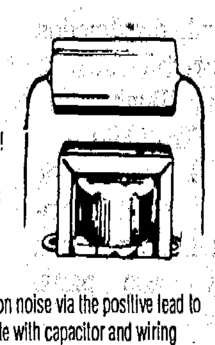
$10.95 / 10+ $9.85



HEAVY DUTY HOT LINE FILTER

Huge 20 Amp current capacity!! Ideal for high power amplifiers in car audio systems. Virtually eliminates ignition noise via the positive lead to battery. Complete with capacitor and wiring instructions. Inductance 0.5MH.

Cat AA-3075 **$14.95**



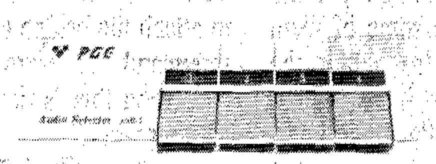
AUDIO SWITCH BOX

If your amplifier has not got enough inputs, then this switch will solve your problems. There are many components available now for HiFi systems including tuner, cassette deck or 2, VCR, CD player Stereo TV, DAT, laser disk etc.. Most amplifiers don't have enough inputs.

This audio switch box has 3 sets of RCA sockets on the rear for any three of the above, and one set for the output to the amp. This output lead is supplied with the switch (2 RCA to 2RCA plugs). There is more input on the switch and its for a walkman. So, now you can play your walkman through your Hi Fi stereo with a minimum of fuss. The connection lead for this is also supplied (3.5m plug to 3.5m plug - stereo). The selector switch has push buttons and once the unit is wired up, all components can be left connected. Requires no power.

Size 138(L) x 29(H) x 39 (D)mm.

Cat AC-1660



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Batteries Why not keep a 2nd battery charged up for your cellular phone. You just don't know when you may need it.

NEC P300 SERIES

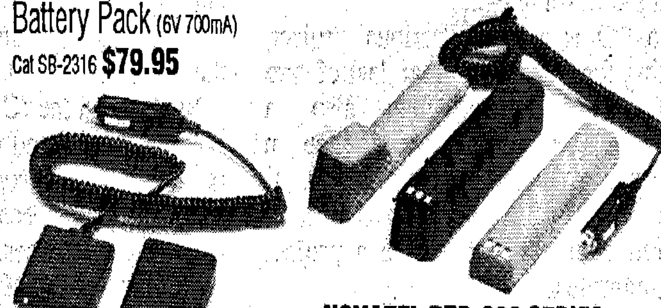
Battery Eliminator Cat MP-3116 **$59.95**

Battery Pack (6V 700mA) Cat SB-2316 **$79.95**

MOTOROLA 9800/9500 XL

Battery Eliminator Cat MP-3114 **$59.95**

Battery Pack Cat SB-2314 **$89.95**



MOTOROLA MICRO TAC PT 500 FLIP

Battery Eliminator Cat MP-3110 **$59.95**

Battery Pack (6V 200mA) Cat SB-2310 **$79.95**

NOVATEL PTR-800 SERIES

Battery Eliminator Cat MP-3112 **$59.95**

Battery Pack Cat SB-2312 **$99.95**

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Construction Project:

POWERHOUSE 1200: TWICE THE POWER! - 2

In this second article describing his design for a 12V (or 24V) to 240V inverter capable of handling 1200W continuous and surges of 2400W, the author explains how to assemble the unit and get it going. We provide full assembly diagrams, together with the complete parts list.

by PETER HARRIS

Before we start the construction, another warning: Because of the extremely high currents involved (up to 700 amps!) with this project, extreme care and attention to detail are required to construct this project if it's to work correctly and without damage to the components.

Also it can't be stressed too much that this project produces mains voltage that is potentially LETHAL — again, please read the warning box.

So this is a really 'serious' project, calling for not only a great deal of care and commonsense, but also a reasonable amount of experience in electronic kit/project construction. If you don't have this experience, it would be unwise to tackle a project this complex.

However Altronics, who will be providing a kit of parts for the inverter, are prepared to assist builders with any aspects of its construction that may be of concern.

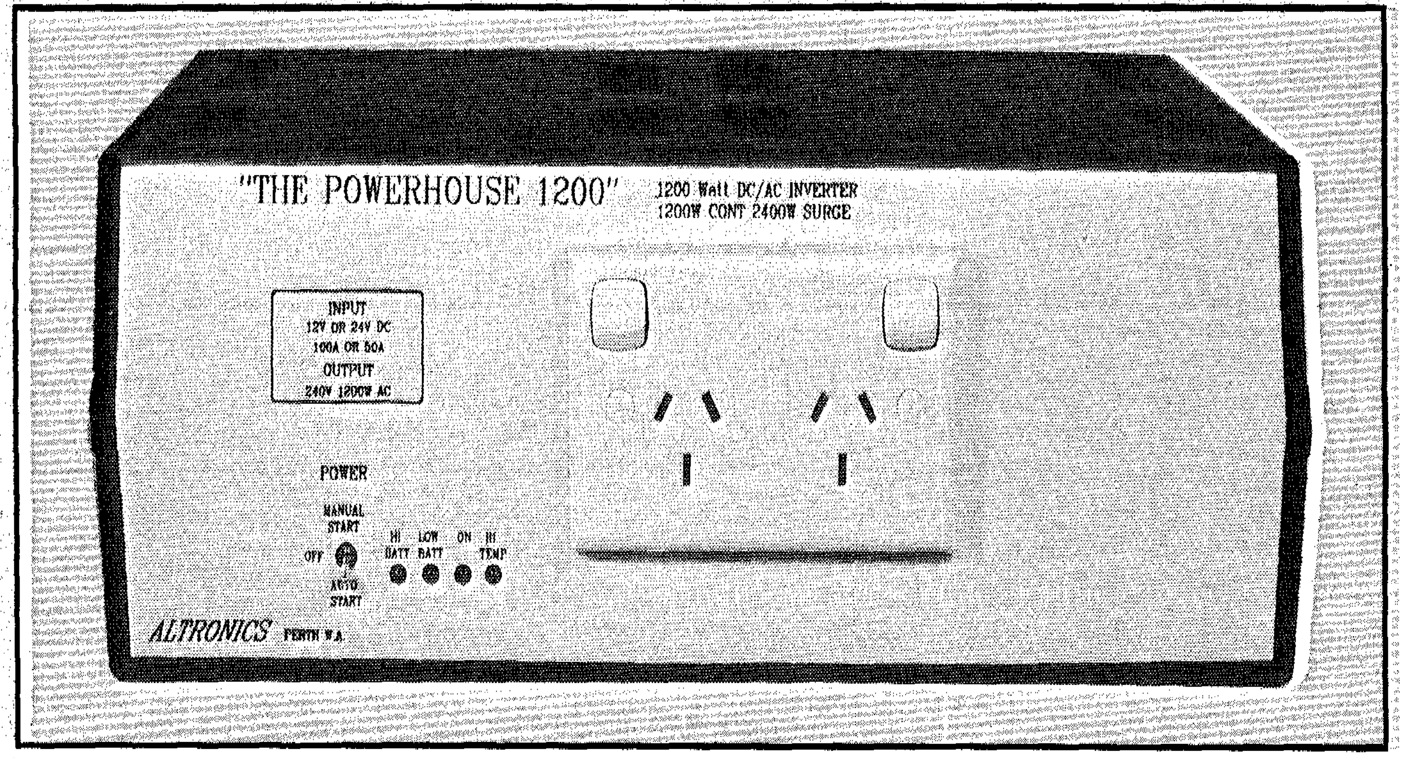
With all that in mind, construction should start with the control circuitry. This is virtually all on a PCB measuring 154 x 85mm, and coded K6780/90.

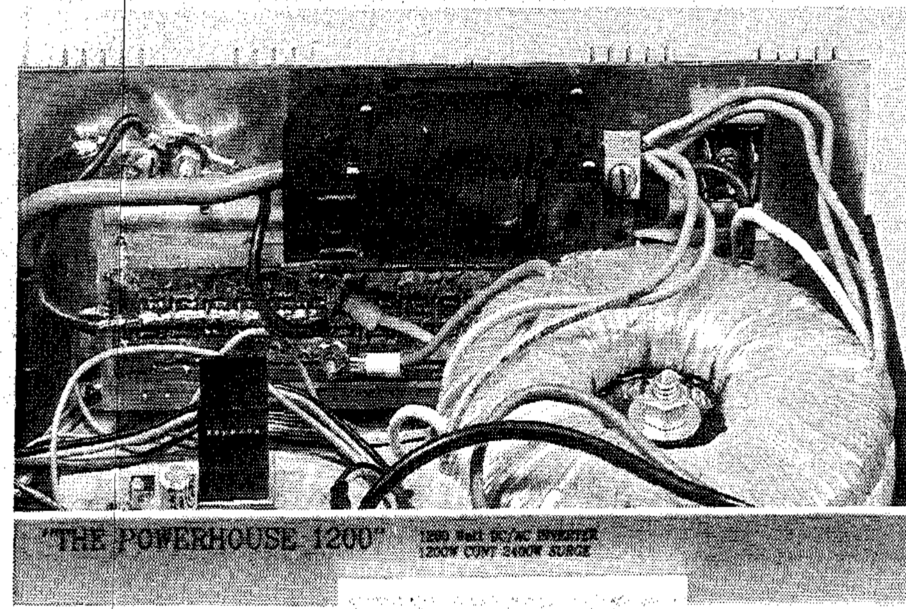
Assembly of this PCB is quite easy. Start with all the low profile components, resistors, diodes, links and trimpots. Install all these parts, making sure that they are all in the correct position, and the diodes are the right way round.

Next install the ICs, making sure that you are earthed and your soldering iron is earthed before you handle them and solder them in, because some of them are CMOS devices. Also solder the power pins on IC3 (pins 7 and 14) and IC2 (pins 8 and 16), to allow their internal protection diodes to operate while you're soldering the remaining pins. Inspect the PCB for solder shorts as you go. Next install the capacitors, transistors, crystal, regulator (metal part to the outer edge of the PCB), switches and terminal block. Install the LEDs by bending the legs at 90° with a pair of pliers, approximately 6mm from the body of the LED. Make sure that the flat on each LED body faces away from the switches (towards R23).

Finally install the 35A bridge. The positive lug goes to the bottom right of the PCB, with the negative lug nearest C14. The bridge has a 'U' heatsink mounted against its upper surface, and attached by the same central screw used to attach the bridge to the PCB. Fit this screw and nut before soldering the legs, and when this is done carefully check all your work.

With the control PCB complete you





Looking inside the case towards the rear, with the cover off. The circuit breaker is mounted at top centre of the rear panel, with the power switching PCB and power FET mounting bracket below it.

can now turn to the power PCB. This measures 208 x 57.5mm, and is coded K6790B. On it are mounted all of the power FETs and their associated protection components.

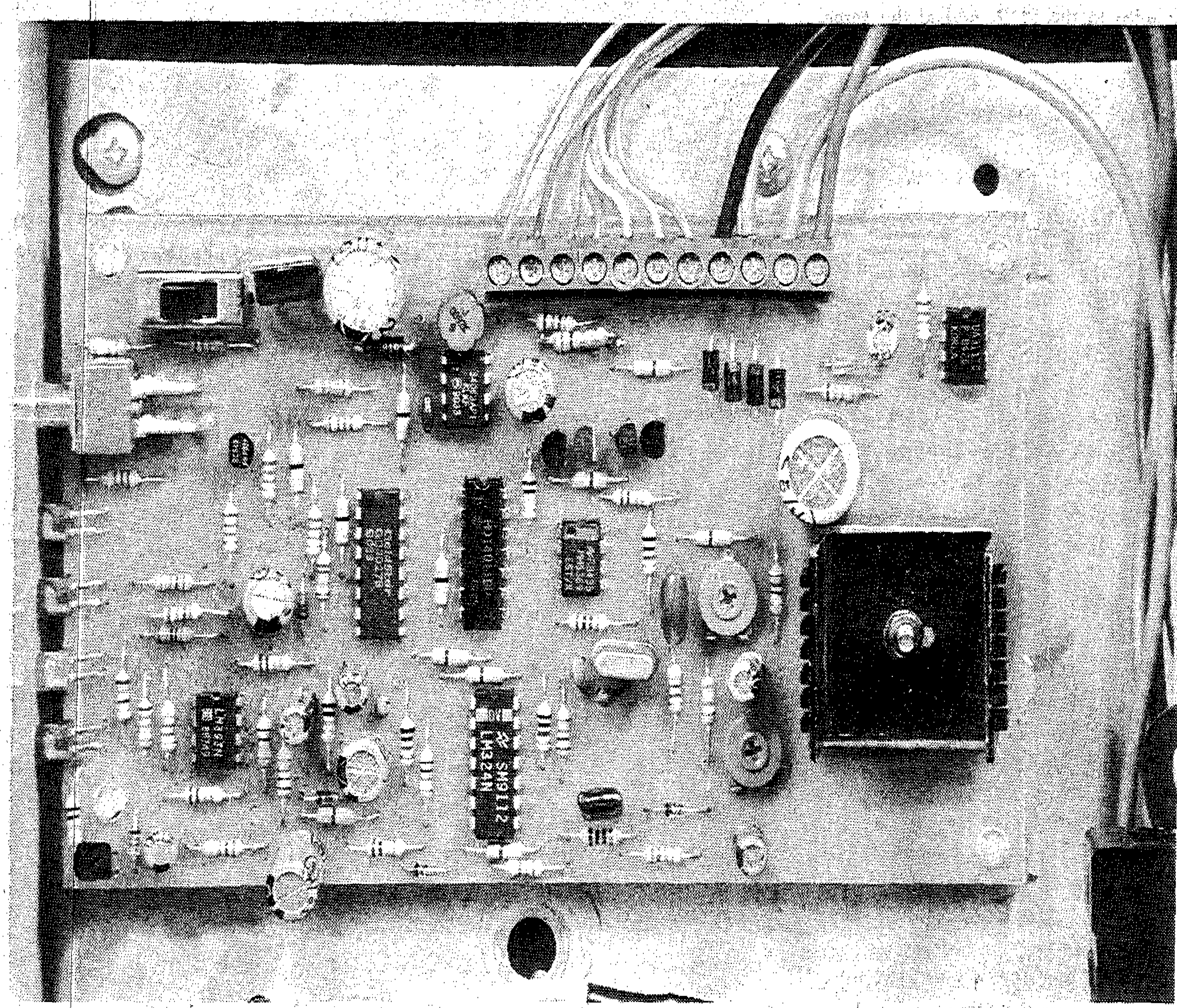
Although this board is not particularly difficult to assemble, it is a little trickier than the control board. And as this board and its devices must handle very high currents, care MUST be taken — any mistakes can be not only expensive, but dangerous.

The first thing to do is install all the resistors, diodes, bipolar transistors and the LM334Z — leaving the power FETs out at this stage. Then inspect all connections, making sure there is nothing shorting.

Next install the 4mm bolts for the high current connections. There are five bolts, two for each bank of FET drains and one for the positive battery input. Screw each bolt through the PCB into one nut — no washers are needed. Make sure they are TIGHT. Now solder the nut to the PCB track. You will need a lot of heat; make sure that the solder 'takes' properly to the nut and PCB, to ensure a good electrical and mechanical bond.

Now you should be ready for the installation of the power FETs. To do this first push all of the FETs into the PCB, with the flat heatsink surfaces of the two rows facing each other. Do not bend the legs just yet. Position the main heatsink bracket between the FETs, using the heatsink assembly diagram to check the correct positioning.

Now place the strips of insulation material on each side, between the FETs and the heatsink bracket. Next place the clamping brackets on each side of the assembly, as per the diagram. Tighten the screws to just hold everything in position, adjusting the assembly if



Here's a closeup of the control PCB, showing where everything goes. The indicator LEDs and main function switch are at left, poking through holes in the front panel. All connections to this PCB are via the terminal block at upper centre.

necessary, and then tighten the clamping screws up TIGHT.

Next comes the soldering of the FET leads. Bend the centre legs (the drain leads) of the FETs outwards and hard down against the PCB track, to give maximum contact area, before soldering. The gate legs (connecting to the 47Ω resistors) can be soldered and cut as normal. Finally the source legs are bent inwards, and in the case of Q7-Q34 down over the earth wires.

The earth wires are used to augment the current-carrying ability of the long earthed centre track of the PCB, as well as to make the main earth connections. Each is prepared from a 180mm length of heavy duty multi-strand wire, with a 90mm section of insulation stripped off one end. The bared sections are laid along the board track, with the first wire bonded to the track between FETs Q7-Q13 and Q21-Q27, and the other between FETs Q14-Q20 and Q28-Q34. See the main wiring diagram for more detail.

Bend the FET source legs over each wire to hold it in place while you solder the wire to the PCB, and at the same time solder the source legs to the two. Note that this may take some time if you have a low wattage soldering iron — but **do not use a gas flame to melt the solder**, as the heat may destroy the FETs.

Next solder a 200mm length of 7-way rainbow cable to the seven pads on the power PCB, to connect back to the control PCB.

Now that all that is complete, double check to make sure that all diodes are the right way around, and there are no shorts between the pins of the FETs. Use a multimeter on the ohms range to make sure that there are also no shorts between the FETs and the heatsink bracket.

The power PCB assembly can be tested at this stage if you have a current-limited power supply. Connect the positive (12V) to the transformer bolts and the negative to the earth wire. Set the current limit to 0.5A (or similar), and switch on. Nothing should happen — i.e., no current should flow.

Short the G1 or G2 pin (pin 5 or 6) to the positive side of the supply. The FETs should turn on, shorting the supply. Note that the voltage will not go to zero, but sit at a couple of volts. This is because the gates are not above 10V any more. Check to make sure each side works.

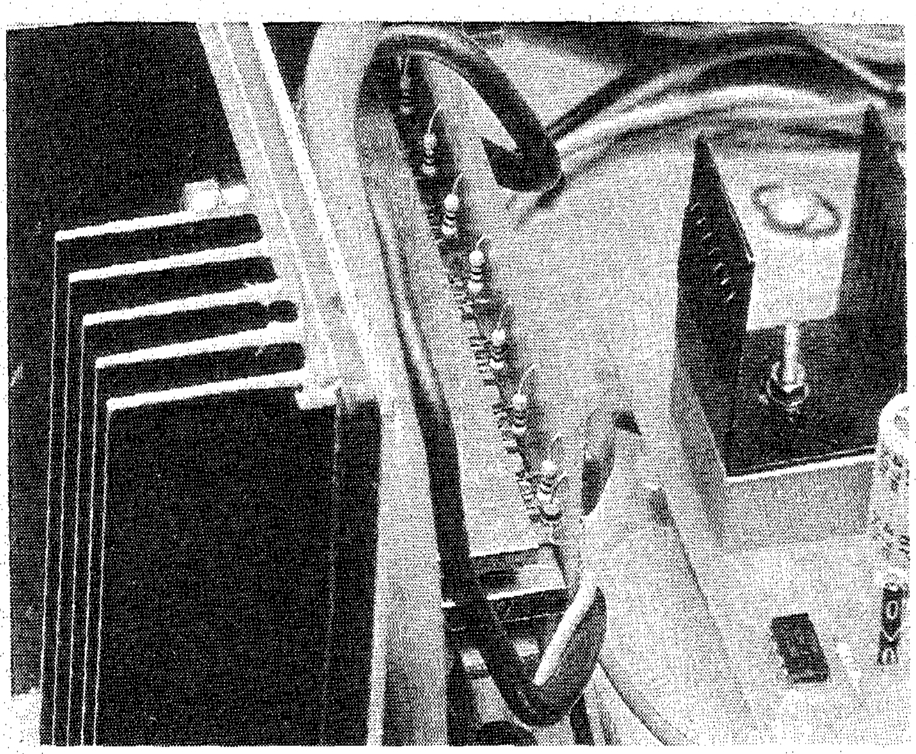
WARNING!

The output voltage and current capability of this inverter are such that accidental contact with both output lines — or the active output line and the battery terminals — could easily prove FATAL. It is important therefore to take just as much care, when using the inverter, as you would when using any appliance or equipment connected to the 240V AC power mains.

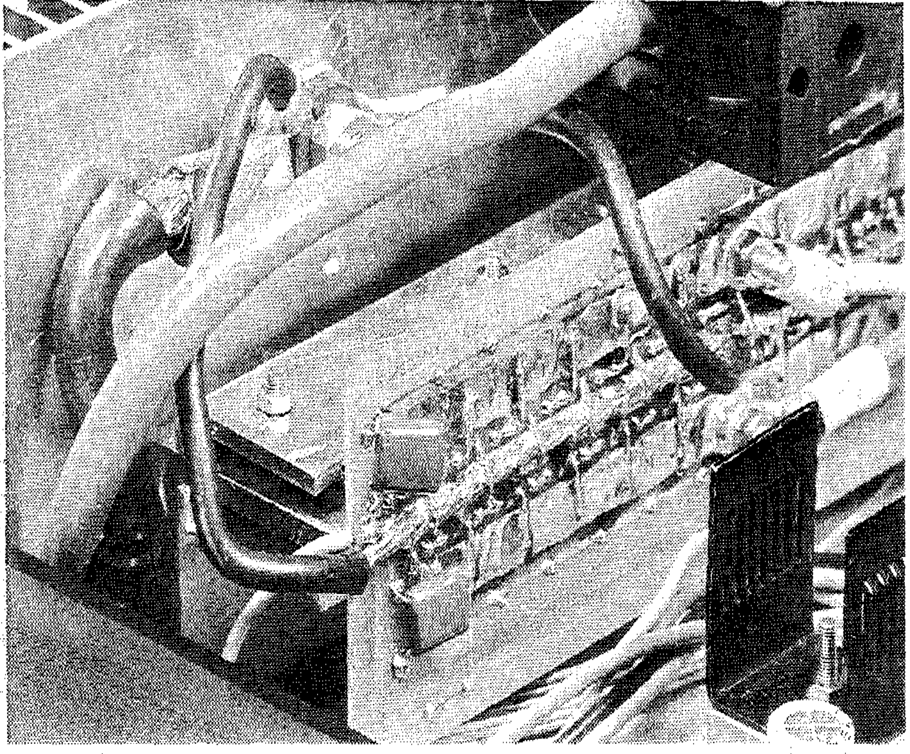
Equipment to be operated from the inverter should also be in a safe condition. Frayed cords, exposed but unearthed metal parts (unless double insulated) and broken or wet unsulators should be repaired before the equipment is used.

It is also important to keep the electrolyte level of the battery above its plates. This not only prolongs battery life, but also reduces the risk of explosion. When charging the battery, do so in a well ventilated area — the hydrogen given off from a charging battery is highly explosive.

When connecting or disconnecting the inverter to the battery, make sure that the appliance is not plugged in and the inverter's control switch is in the 'Off' position. This will prevent sparks as the battery connections are made or broken, and again minimise the risk of explosion.

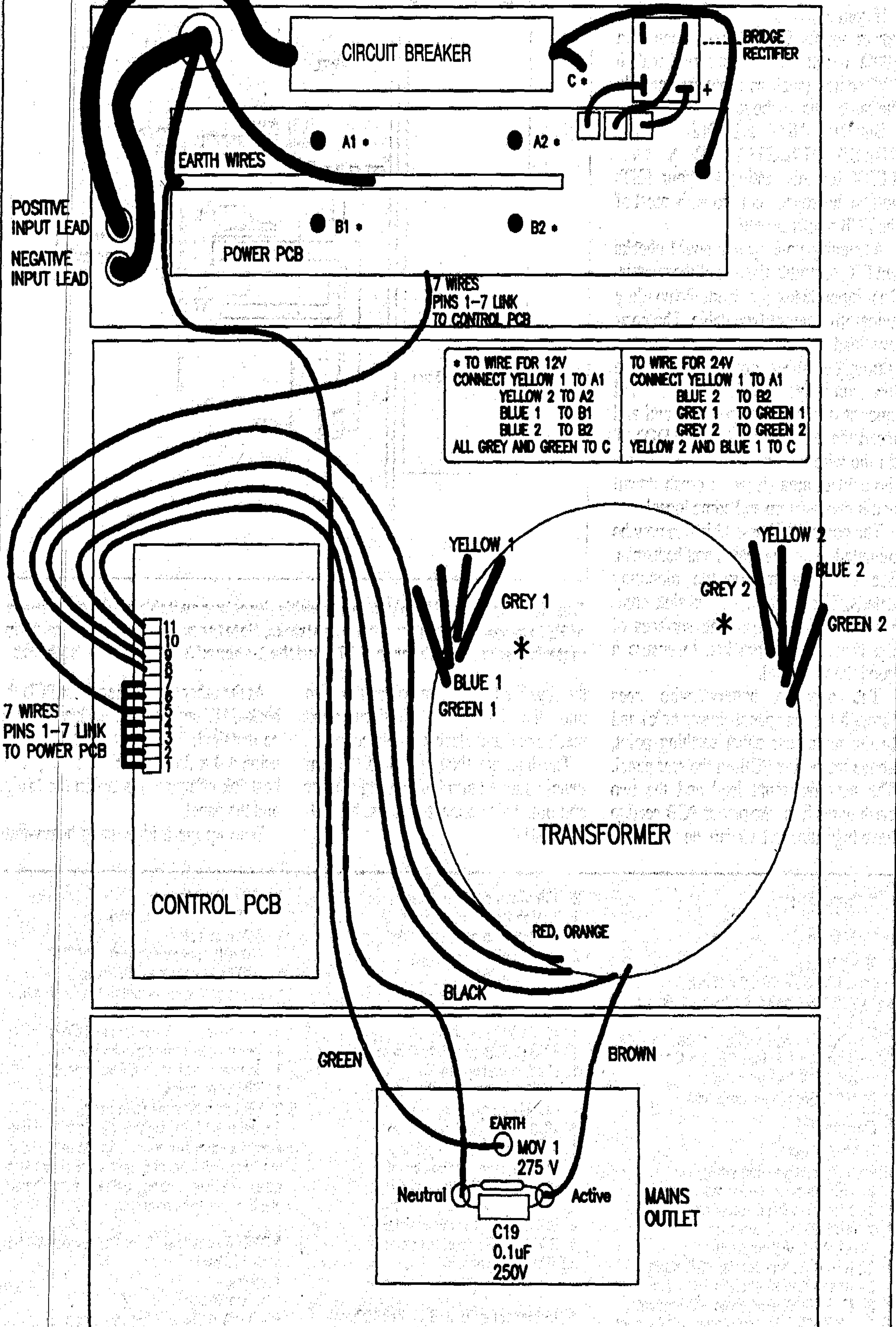


A closeup shot showing a glimpse of the component side of the switching PCB (centre). The power FETs are hidden underneath the metal strip which clamps them to the heatsink coupling bracket.



The same board as viewed from a different angle, showing mainly the copper side with the heavy-duty earthing wires soldered along the centre track. Also visible at right are the leads to the transformer primary, attaching to the terminal bolts.

GENERAL WIRING DIAGRAM



Here is the main wiring diagram for the inverter, showing how the main sub-assemblies and major items are wired together. Note that the wiring between the transformer primary and the power PCB, which varies between the 12V and 24V versions, is specified in the table at upper right.

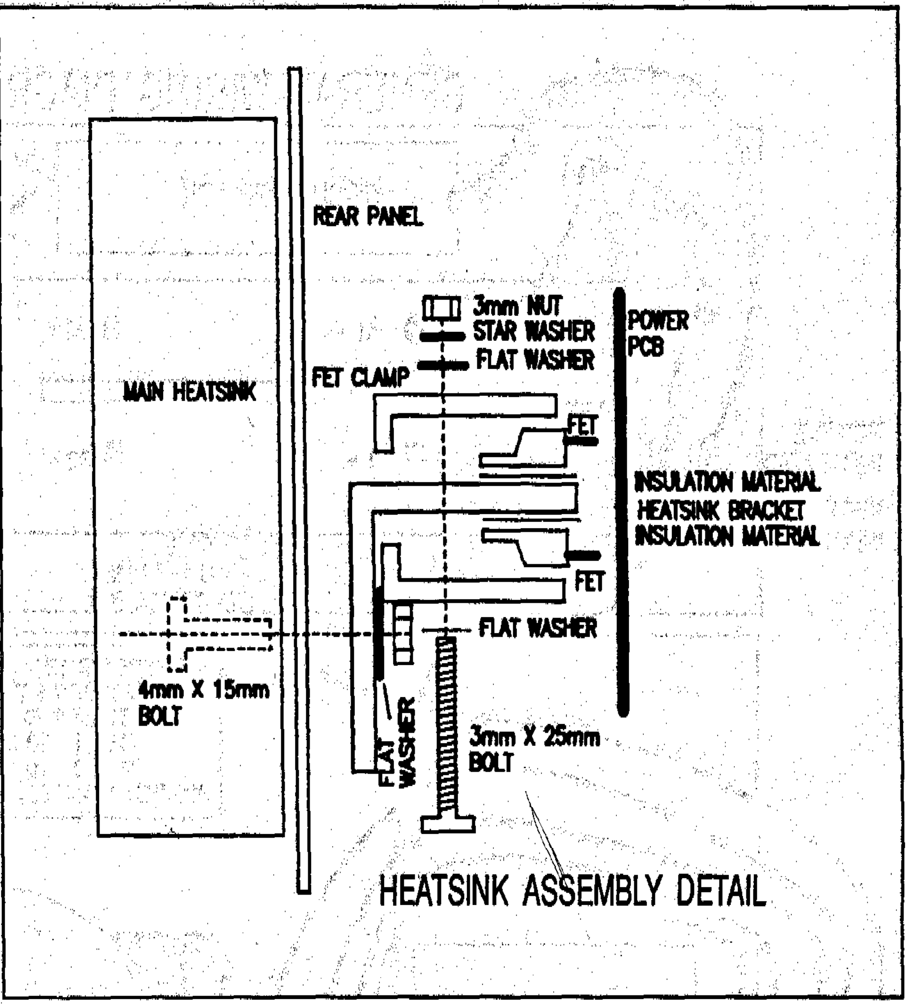
Powerhouse 1200

If you don't have a current-limited power supply for this test, connect a 100Ω 1-watt resistor in series with a 12V source (such as a battery) and do the same tests as above.

But **DO NOT CONNECT THE BOARD DIRECTLY TO A BATTERY** for this testing — your FETs will be destroyed, and probably most of the PCB tracks as well!

Assuming your power board checks out OK, assemble the rest of the chassis. The input leads are from heavy-duty automotive starter type cable. The positive lead goes through the back panel (through a rubber grommet) directly to the circuit breaker. Remove a small amount of insulation from the end and insert the lead into the breaker. **DON'T** tin the wire with solder, as this reduces the contact area (it won't crush down) and it may heat up and come loose!

The power PCB assembly can now be mounted to the rear panel and heatsinks. See the diagram for the mounting details. Use a smear of heatsink compound between all mating surfaces of the heatsink and bracket, to ensure a good thermal bond.



This diagram should help you to assemble the power switching PCB and its array of FETs to the rear panel and main heatsinks. Note the need for strips of insulating material between each row of FETs and the L-shaped heatsink coupling bracket.

The negative battery wire goes through the rear panel (lower hole) and to the main rear panel earthing point, above the power PCB on the rear panel. The negative input lead and the two earth wires from the power PCB need to have lugs attached. Crimp the wires into the lugs first, and then solder the wire into the lug. This provides good mechanical and electrical connections.

The lugs are then bolted to the rear panel using a 6mm bolt, spring washer and nut. This connection must be really TIGHT.

At the other end of the power PCB the back-EMF suppression bridge needs to be installed. Bolt this to the rear panel using a 4 x 25mm bolt, smearing some heatsink compound between the bridge and the panel.

Wire up the bridge using heavy-duty

PARTS LIST

Resistors

All 1/4W 5%:
1 x 0.47Ω; 32 x 47Ω; 3 x 100Ω; 1 x 180Ω; 1 x 220Ω; 3 x 680Ω; 6 x 1k; 1 x 1.2k; 4 x 2.2k; 2 x 4.7k; 8 x 10k; 2 x 18k; 2 x 22k; 2 x 27k; 1 x 33k; 2 x 39k; 1 x 47k; 1 x 56k; 2 x 100k; 1 x 470k; 2 x 1M; 1 x 4.7M; 2 x 10M
1 20k 1/4W 1% metal film
2 10k trimpots, min. horiz type

Capacitors

2 22pF ceramic
1 1nF metallised polyester
1 47nF metallised polyester
4 0.1uF metallised polyester
1 0.1uF 250V AC mains rated type
1 0.22uF 16VW tantalum
2 1uF 63VW electrolytic, PCB mount
2 10uF 63VW electrolytic, PCB mount
2 47uF 16VW electrolytic, PCB mount
1 47uF 50VW bipolar electro, PCB mount
4 100uF 35VW electrolytic, PCB mount
1 220uF 63VW electrolytic, PCB mount

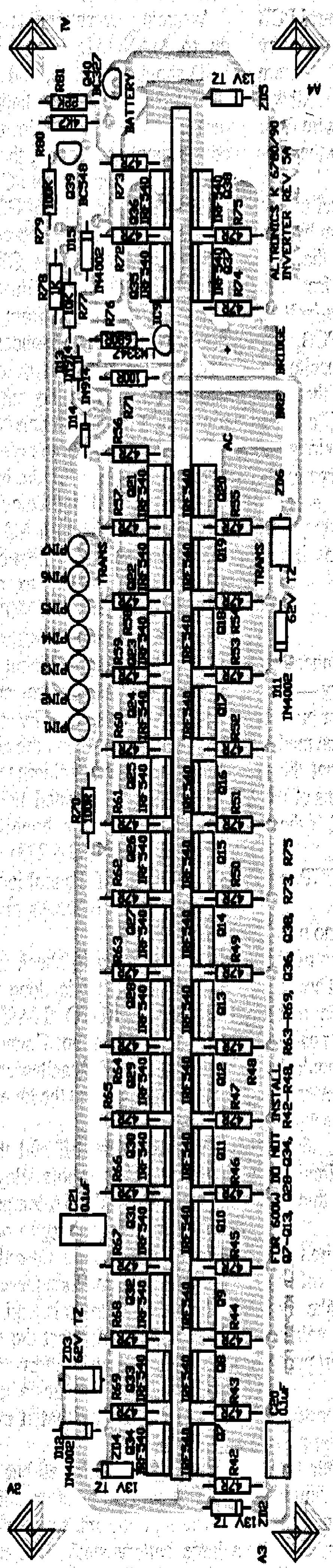
Semiconductors

6 1N914 silicon signal diodes
7 1N4002 silicon 1A/100V diodes
1 OA91 germanium signal diode
1 1N5819 1A Schottky diode
2 35A silicon bridge rectifier
1 5.1V zener diode, 400mW
3 13V transorb or zener diode
2 62V transorb
3 Red LEDs, 5mm
1 Green LED, 5mm
1 MM5369-EST clock oscillator/divider
1 4027 CMOS dual flip-flop
1 4093 CMOS quad NAND gate
1 LM324 quad op-amp
1 LM393 dual comparator
1 LM311 comparator
1 MC34063 switching regulator
1 7812 TO-220 12V regulator
1 LM334Z temperature sensor
1 BC640 PNP silicon transistor
2 BC548 NPN silicon transistor
2 BC337 NPN silicon transistor
3 BC327 PNP silicon transistor
32 IRF540 power FET

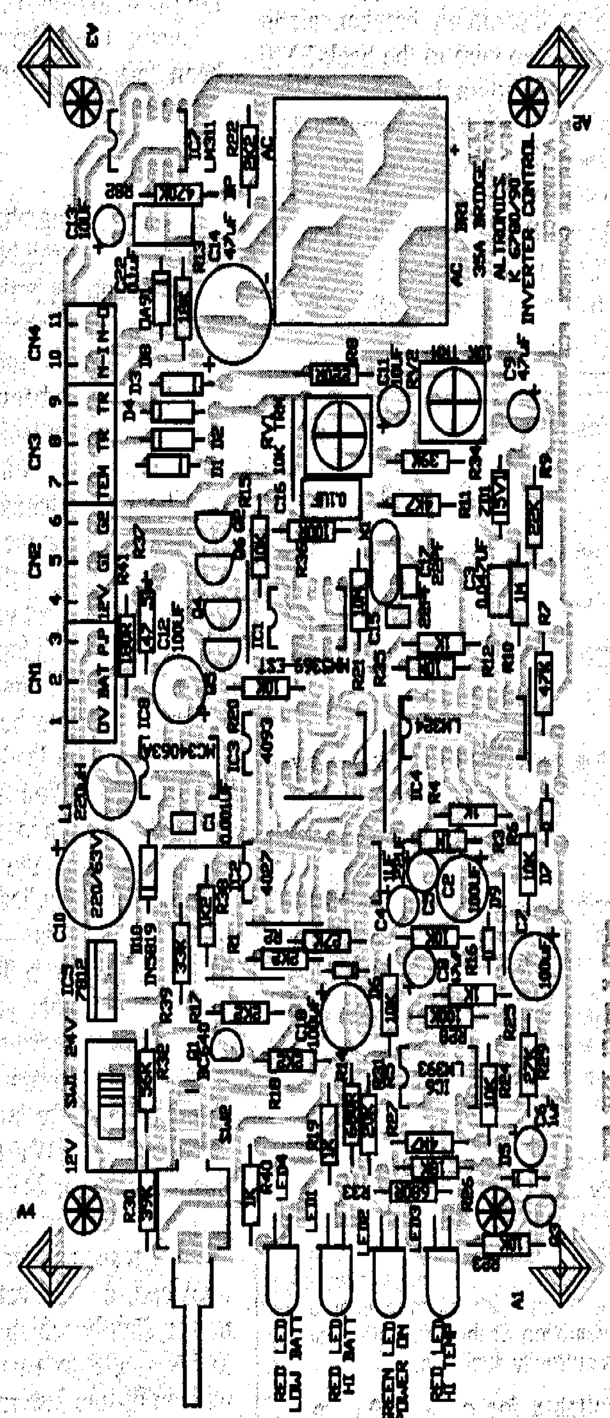
Miscellaneous

1 Instrument case, 355 x 250 x 122mm
1 Toroidal transformer, 1200W rated
1 PC board, 154 x 85mm, code K6790A
1 PC board, 272 x 95mm, code K6790B
1 Set punched metal panels
2 Heatsink extrusion, 100 x 110 x 33mm
1 Heatsink extrusion, 72 x 110 x 33mm
1 Heatsink angle bracket, 255 x 40 x 40mm
2 FET mounting clamps, 255 x 32 x 5mm
1 100A circuit breaker
1 3.5796MHz quartz crystal
1 220uH inductor
1 250VW metal oxide varistor (MOV)
1 SPDT slider switch, PCB mount
1 DPDT centre off miniature toggle switch, 90° PCB mount
3 Three-way PCB mini terminal block
1 Two-way PCB mini terminal block
1 2-outlet mains socket, flush mount
1 Mini 'U' heatsink
2 Silicone rubber insulating strip
2 x earth lead ring lugs; 3 x battery lead ring lugs; 5 x 4mm solder lugs; 1 x 6mm x 25mm machine bolt and nut; heavy- duty hookup wire; rainbow ribbon cable; nuts, bolts, washers, lock washers, etc.

NOTE: A complete kit for this project will be available from
Altronics,
174 Roe Street,
Perth WA 6000.
The catalog number for the kit is K-6790, and it costs $799. We understand that Altronics will also have fully assembled and tested versions available, for $999 (12V version K-6792, 24V version K-6793).
For further information contact Altronics at PO Box 8350, Stirling Street, Perth 6849 or by phone via (008) 999 007.



Here are the wiring overlay diagrams for both the power switching and control PCBs of the Inverter, to guide you in fitting the components. As usual, take care with the orientation of polarity-sensitive components such as IC's, transistors, diodes and electrolytic capacitors.



hookup wire, to the three large PCB pads nearby. The positive lug connects to the pad nearest the end of the PCB, connecting to the drains of power FETs Q35-Q38, while the two AC terminals wire to the other two pads which connect to the drains of the two main FET banks. The negative is not connected (see wiring diagram).

The next thing is to mount the power transformer and wire this in place. Before wiring it, you must determine what voltage the inverter is to run from, 12V or 24V.

For a 12V system, attach lugs to the **yellow** and **blue** primary wires. Position the transformer so that all the wires reach to correct points. Bolt the primary wire lugs in position on the power PCB. The other primary wires (green and grey) go to the circuit breaker, along with the positive wire to the back-EMF suppression circuit on the power PCB.

If the inverter is to run from a 24V battery, then the **green** and **grey** wires are connected together at each side. The **yellow 1** wire connects to bolt A1 on the power PCB, with the **blue 2** wire connecting to bolt B2. The **yellow 2** and **blue 1** wires connect to the circuit breaker — again see the wiring diagram for detail.

Finally screw the connecting wires from the power PCB to the control PCB terminal blocks, making sure that they all go to the correct place and are secure. Wire the transformer feedback winding and the black neutral wire from the 240V secondary winding to the control PCB as well, as shown.

Mount the mains outlet socket on the case front panel and wire the **brown** (active) 240V secondary wire, the **blue** or **black** (neutral) return wire from the control PCB, the **green** or **green/yellow** earth wire from the power PCB, the MOV device and the 0.1uF capacitor to the socket as shown. Note that the **brown** wire goes to 'Active' on the mains outlet, the **black (blue)** wire goes to 'Neutral' and the **green (green/yellow)** wire to 'Earth'.

Check to make sure nothing has been left out. That about does it for the assembly.

Testing

Before rushing ahead and connecting your inverter straight to a battery — and possibly hurting both it and your pocket — a few simple checks should be made:

1. Check with a multimeter that there are no shorts between any pins of the FETs. This is IMPORTANT! If there is a problem, fix it now.
2. Check that the cases of all FETs are insulated from the heatsink.
3. Visually inspect that there is no metal swarf down between the legs of the FETs. Blow all loose material away.
4. Using a multimeter on the ohms range measure between the positive and negative leads. There should be no shorts. You should measure a diode junction in one direction and an open circuit the other. (A digital meter may indicate open circuit in both directions — the main thing is that there are no shorts.)

Also check that you have wired the transformer according to the voltage that you need to run it from. Make sure too that you have switched the voltage select switch SW1 to the appropriate position: 12V or 24V.

Before applying full power, connect a 1Ω 5W resistor in series with the positive lead, or connect the inverter to a power supply which is current limited to 5A — OR to a battery, but in series with an in-line fuse rated at 5 amps.

Connect the power (the front panel power switch should be OFF at this stage). Nothing should happen; no current should flow. If something does happen, then there is a problem with the power PCB. Disconnect power and check again — make sure that the polarity is correct!

Assuming everything is OK, switch on to MANUAL START. The 'ON' LED should come on, and the inverter should run. If all that happens is the fuse blows, or the current limit on the power supply comes on, then there is a problem with the control PCB.

Disconnect the G1 and G2 wires (terminals 5 and 6) from the control PCB and try again. If all is OK, then the problem is definitely in the control PCB. Check all tracks from IC2a to the terminals, and all components along the way. Use the circuit as a guide. Check also that there are no shorts on the power PCB from terminals 5 and 6.

Once the inverter runs correctly, then set-up can begin. With the inverter running and no load connected, connect a multimeter (on the high AC volt range) to the output. The voltage can now be adjusted, using RV2, to read 230V. (This is close enough to 240V RMS, for the inverter's output waveform).

The only other adjustment to be made is the over-temperature cutout. The easiest way to set this is by adjusting the voltage at pin 7 to read the correct voltage for the current ambient temperature. The voltage is adjusted using trimpot RV1, and the reading should be:

Vtemp = (Tamb°C + 273) x 0.0148

For example if the ambient temperature is 25°C, this works out at 4.41V at terminal 7.

The next thing to check is the auto-start section. This is done simply by switching to AUTO START. The inverter should not run. Connect a small load (say a 25W incandescent lamp) to the 240V output, and the inverter should fire up.

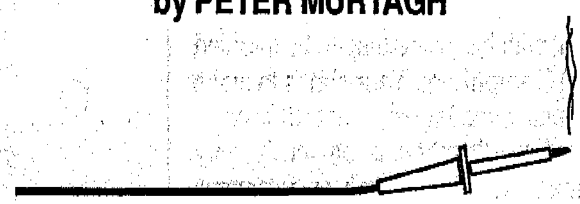
Switch the load off and the inverter should stop after a short delay. You may have to remove the 5A temporary fuse, and/or connect a battery to run the load properly. But this should only be done after passing all previous tests.

The last thing to do is load test the inverter. Securely connect the input leads to a high-capacity battery (read *truck* battery!). Then connect a load to the inverter and check that it can deliver the goods!

Note, however, that all but the largest batteries will 'die' after only a short time at high powers, so unless you have a large battery stack, you will flatten your battery very quickly.

Your Powerhouse 1200 should now be complete and ready for use — congratulations! ❖

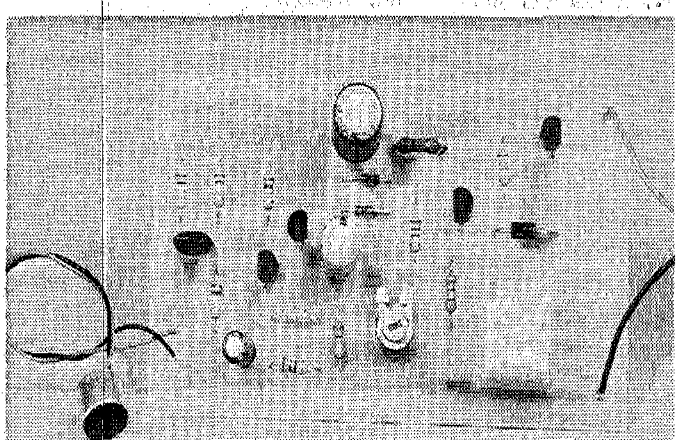
Experimenting with Electronics

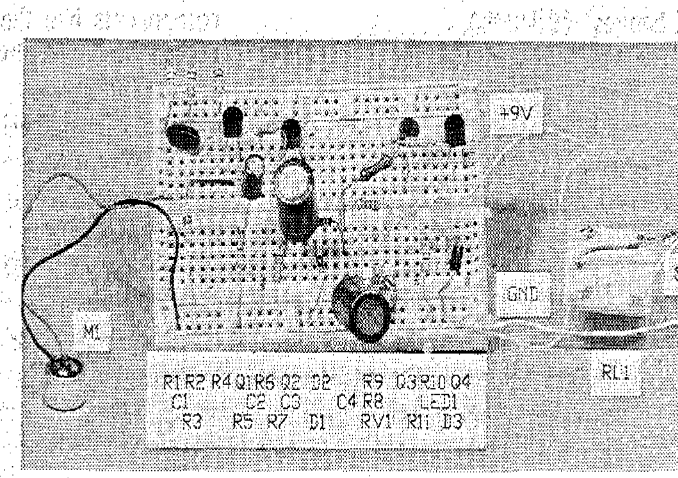


by PETER MURTAGH

Sound switch

This month we are presenting the last of our different methods of switching a circuit on or off — in response to sound. Because a microphone converts sound into an alternating current (AC) waveform, a sound switch cannot use the same amplifier circuits of our previous projects. Modification is needed so that such amplifiers can magnify the full AC signal. Once amplified, this signal can be rectified and used to switch a relay.





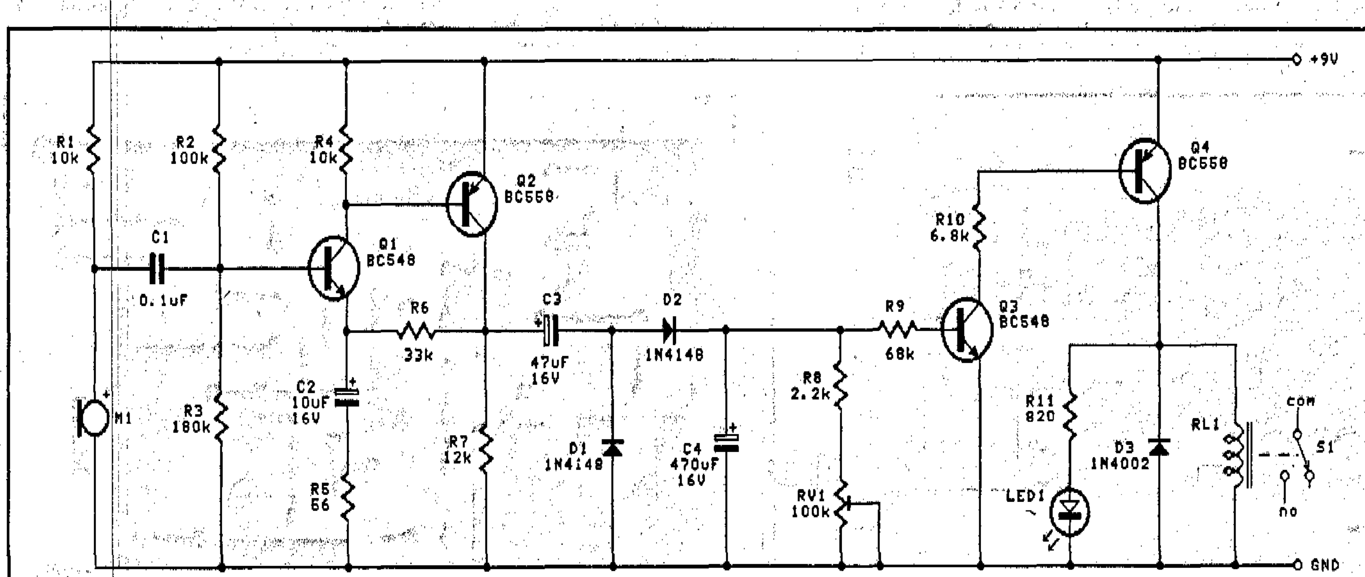
The photos show the PCB layout (on the left) and the breadboard construction (on the right). The components on the breadboard are labelled, as per the schematic diagram, so it can be used to clarify any connections that are not clearly shown in the photograph.

A sound-activated circuit can be used in a variety of ways. The phone rings in the house — you use the relay to activate a bell or flashing light in the garage. Or someone rings the front door bell — and on comes a courtesy light.

As usual, for safety reasons, we don't suggest that you use the relay to switch 240V mains power — this project is definitely designed for low voltage use.

The new feature in this month's circuit is the AC amplifier. Two transistors (Q1 and Q2) form an amplifier which is biased on, so that it is in the middle of its operating range. When the alternating sound wave is detected by our microphone, the amplifier can react to both the positive and negative cycles of the signal.

With the types of amplifier in our previous projects, only half the microphone signal would be detected. And the shape of that half signal would also be altered. These changes to the signal are called *dis-*



The schematic diagram shows how the usual two-lead microphone insert is wired. If your mic has a third wire, then connect C1 direct to its 'signal' wire, not to a junction between the power lead and R1, as shown. With shielded cable, the outside layer connects to 'ground'.

tortion, which is something to be avoided with AC amplifiers. Your aim is to make the sound wave larger — not different.

Avoiding distortion is obviously very important in circuits such as intercoms and hifi amplifiers.

But, because our sound switch only activates a relay, it will still work even with a distorted signal. However, we still want to amplify both halves of the microphone signal in order to get a larger output.

Our circuit is designed either to switch on only while the microphone is picking up a signal, or to remain on with a variable time delay of up to about 25 seconds. The trimpot RV1 varies the length of this delay. If you wish to alter the delay time, it is easy to do so (see the section on 'Changes' for details).

For example, consider the circuit being used for an extension phone bell. With the shortest delay, you will still get the standard ring-ring of the phone; but with the extended delay there will be one continuous ring which will last until the phone is answered.

You probably wouldn't want a continuous phone ring, but you could easily want a light to stay on continuously while ever an intermittent sound is being detected. Different delay times will suit different applications for the project.

And once again, (as in previous circuits), we have used a relay to control the circuit's output. This isolates the switched load from the sensor, as well as making it easy to switch on and off whatever you like: a light, a flashing indicator, a buzzer or a siren...

As in last month's circuit, we have included a LED to indicate whether the relay is switched on or off.

If you don't plan to actually switch another circuit with your sound-switch, then you may wish to save the cost of the relay. Just omit it, along with its protection diode D1 — the circuit will work fine without them.

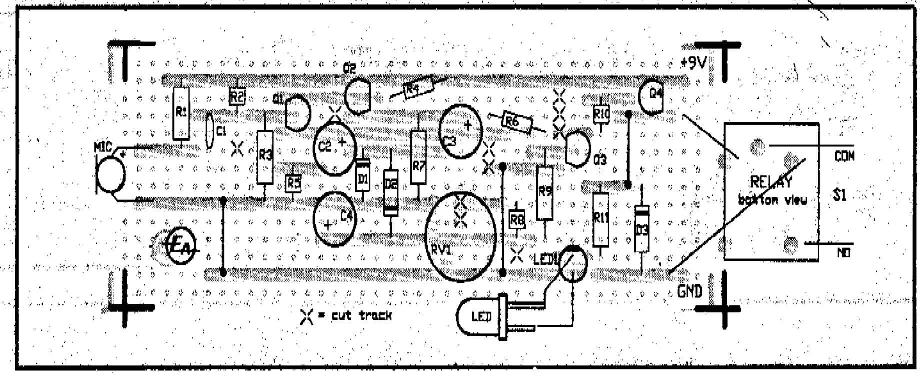


Fig.1: Strip-board construction. Wherever the space for mounting resistors is less than 10mm, mount the components vertically.

Construction

Construction of this circuit is straightforward. First solder the more rugged components like the relay, resistors and trimpot, followed by the more sensitive components.

If you are not using the PCB design, solder wires to the relay contacts to make it easier to connect it to your stripboard or breadboard.

Take care with the orientation of the electrolytic capacitors, the diodes, LED and transistors. Check with Fig.3 to see which pin is which for these components. Also note that Q1 and Q3 are NPN transistors (BC548), while Q2 and Q4 are PNP transistors (BC558). It is quite easy to accidentally interchange the two types, especially as their E-B-C layout is the same.

Changes

As mentioned above, trimpot RV1 has been included to vary the delay time. It supplies the path for capacitor C4 to discharge. So, to further lengthen the delay time, C4 could be increased to say 1000uF, and RV1 could be increased to 470k.

Doubling the size of the capacitor roughly doubles the delay time, and combining this with a trimpot five times its original value, gives an far longer overall delay. It won't be the full ten times bigger since the resistance of R8 and RV1 is in parallel with that of R9 and Q3. (With these new values, our circuit stayed on for 3 min. 40 sec.)

Of course, you could also reduce the values to achieve a smaller maximum delay time, but shorter times can easily be obtained by varying RV1.

It is also possible to alter the gain by varying the ratio of R6: R5. If the switch is too sensitive and turns on with background noise, then you can decrease the gain by decreasing the value of R6 and/or increasing R5. Similarly, if the switch is not sensitive enough and won't respond to your signal, then increase the gain.

How it works

Resistor R1 provides a steady DC current through the condenser microphone. This current is altered whenever the microphone picks up sound, producing an AC signal.

Resistors R2 and R3 form a potential divider to provide a constant DC voltage across the base-emitter junction of Q1. This voltage provides a steady base current, which is amplified by Q1 plus Q2, which together form a complementary 'Darlington pair' amplifier.

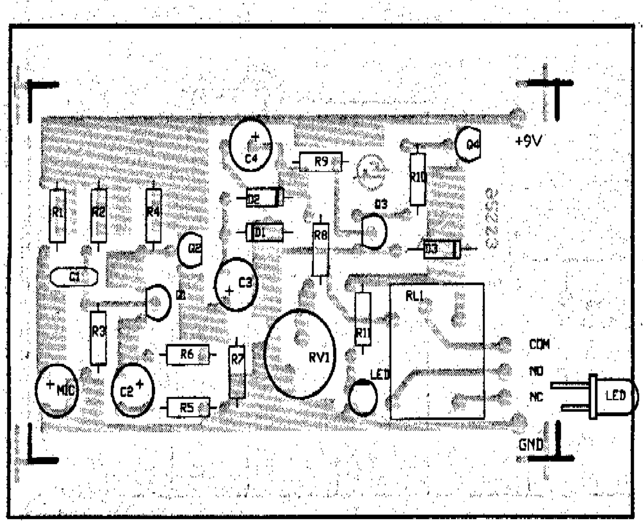
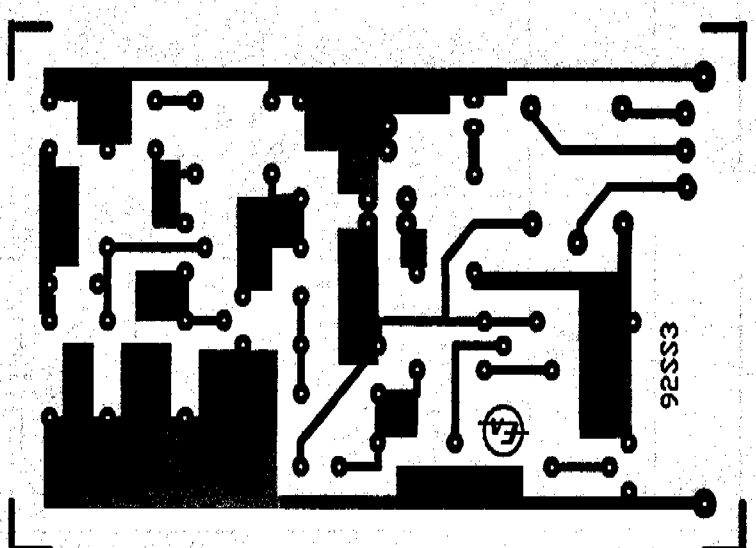


Fig.2: The component layout on the printed circuit board. The relay and protecting diode D3 can be omitted if external switching is not required.



This is a full size reproduction of the PCB artwork which can be used to etch your own board.

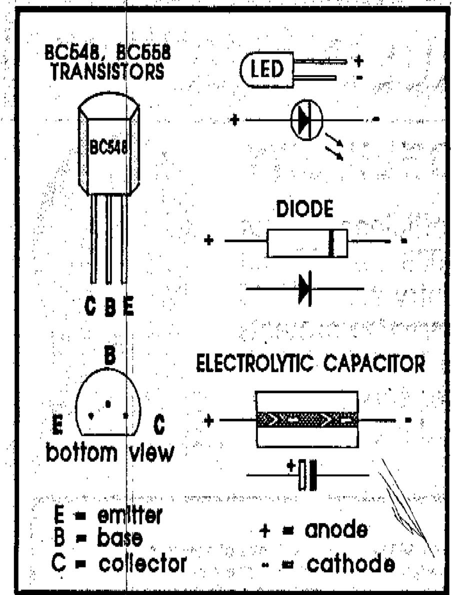


Fig.3: Component leads identification.

Let's look at the purpose of resistor R6. This provides negative DC feedback, which means that any change in the amplifier's output voltage is fed back to its input, but out-of-phase.

So, any increase in the output voltage produces a decrease in the input voltage, which cancels the original increase. Such a system gives a very stable amplifier, because any variations caused by transistor heating or aging etc., are automatically corrected.

For example, suppose that the collector current (Ic) of Q2 increases. This causes an increased voltage across R7, which in turn produces a *decrease* in the voltage across R6.

The decrease arises because the voltage divider R2 and R3 provides a constant voltage at the left end of R6 and the voltage at its right end has just increased. So the actual voltage drop across the resistor is less, and hence the current through it (Q1's Ic) is less. This smaller current also flows through R4, so the voltage across R4 also decreases.

With the base voltage of Q2 (a PNP transistor) going more positive, its base current, and hence its collector current in turn, will decrease. This decrease in Q2's Ic cancels the original increase. This is how negative feedback works.

But it is a different story with an AC signal. The input from the microphone is first amplified by Q1, then, as before, is fed to the base of Q2 for further amplification. But transistors Q1 and Q2 provide different paths to ground for their AC signals — via C2 and R5 for Q1, and through C3 on to C4 via diodes D1 and D2 respectively.

Whereas R6 provides the DC amplifier with 100% negative feedback (resulting in a gain of only 1), R6 and R5 now form a voltage divider, resulting in only a small fraction of Q2's AC output being fed back out-of-phase to Q1. So the AC gain of the amplifier is quite high, about 600 (the ratio of R6 to R5).

Let's have a look at a few numbers to see the effect of this AC gain and the original DC biasing. With a gain of 600, a ±5mV output from the microphone will be amplified to a ±3V signal applied to the left side of C3.

But the DC biasing (via R2 and R3) means there is a steady current of about 0.3mA, which produces a DC voltage of about 3.5V at the same location.

So the AC signal can make its complete ±3V swing, varying from 0.5-7.5V. Without the biasing, it would 'crash' into the ground rail when going negative. The AC signal passes across C3 and is rectified by diodes D1 and D2, and then applied to C4.

Such a setup is called *voltage doubling*, because its net effect is to add together the positive and negative pulses.

During the negative halves of the AC signal, current flows through R7 and D1, making the negative side of C3 more positive than normal. This voltage, which is stored in C3, is then added to the positive halves of the signal, 'doubling' the effective voltage. This higher positive voltage causes a current to flow through D2 and charge up C4.

Capacitor C4 can now provide the current to switch on Q3, and Q4. These two transistors form the same type of complementary Darlington pair amplifier as Q1 and Q2, but without the feedback. Because the amplifier has a high input impedance, and a high gain, a very tiny Q3 base current of less than 1uA (microamp) is sufficient to switch on the relay and its LED. (Diode D3 provides the usual protection for Q4 when the relay turns off and its field collapses).

Transparencies

A high contrast, actual size transparency (negative) is available for only $2 for anyone wishing to make their own printed circuit board. This special price applies for transparencies for projects in this series only. Write to *EA*'s reader services division.

Happy experimenting — please send us your comments on the circuits we have published as well as ideas for future projects. ❖

PARTS LIST

Miscellaneous

PCB 97x55mm, coded 92SS03
1 9V battery
1 PCB mount, SPDT 12V Mini Relay
1 LED, any colour
1 electret microphone insert

Resistors

All 1/4W, 5%:

2 10k	R4	brown-black-orange
1 100k	R2	brown-black-yellow
1 180k	R3	brown-grey-yellow
2 56 ohms	R5	green-blue-black
1 33k	R6	orange-orange-orange
1 12k	R7	brown-red-orange
1 2.2k	R8	red-red-red
1 68k	R9	blue-grey-orange
1 6.8k	R10	blue-grey-red
1 820 ohms	R11	grey-red-brown
1 100k trimpot		horizontal-mount

Capacitors

1 0.1uF	C1	polyester 'greencap'
1 10uF,16V	C2	PC-mount electrolytic
1 47uF,16V	C3	PC-mount electrolytic
1 470uF,160V	C4	PC-mount electrolytic

Semiconductors

2 1N4148 signal diodes D1,D2
1 1N4002 power diode D3
2 BC548 NPN transistors Q1,Q3
2 BC558 PNP transistors Q2,Q4

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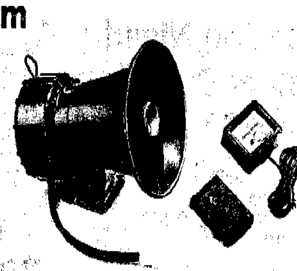
ALTRONIC COMPONENTS

High Power Car Alarm

With Wireless Remote Control

125dB siren. Visible warning by flashing headlights when the alarm system is triggered.

The alarm system will be triggered by unauthorised entrance through the car doors, booth, bonnet (negative trigger inputs) or removal of the car sound unit (normally closed input to earth). Automatically resets after 60 seconds.



S 5220 **$99.00**

Strobe Signal Lamps

Uses Xenon Strobe tube for high energy flash output at a rate approx 1 per second. 12V DC. 320ma. **Dimensions:** 97 diam 50H.

S 5455 Blue Normally $27.95

This Month **$20.00**

S 5450 Red Normally $27.95

This Month **$20.00**

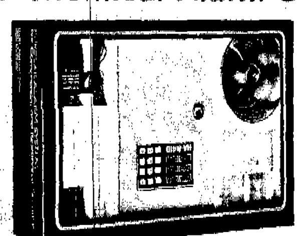
High Energy Siren

Absolutely ear splitting SPL 120dB. Handy brack for wall mounting etc. 12V 300mA. Ideal for industrial applications or alarm systems. **Dimensions:** 100mm Diam. 125mm L.

S 5177 Normally $29.95

This Month **$22.00**

Economical Alarm System Kit



The kit comes complete with the following components: • One Alarm Panel • One Passive Infrared Detector (P.I.R.) • One AC Power Pack • One 8 Ohm Horn Speaker • Three pairs of Magnetic Reed Switches • One 12V/1.2AH Rechargeable Back Up Battery • Emergency Panic Button

Alarm Panel Features: • 5 Protection Circuit Loops • Independent Connections for N.C. and N.O. Sensor Switches • Arm - Disarm by Digital Access Key-Pad • Multi-Station Remote Control • Warble Tone — Steady Tone Siren Driver • Adjustable Timers for Entry Delay and Siren Duration • "Latch" and "Timing" Output Relays • Remote and Local Alarm Status Indication

This system is easily installed by the Home Handyman. No special tools or equipment are required. Comprehensive installation instructions supplied.

S 5470 Normally $349.00 **This Month Only $299.00** **Save $50.00**

Door Strike

Ideal for security access areas, this high quality lock will fit most door jambs. Operates off either 12V AC or DC making it ideal for any type of system.

S 4390 $39.95

Alarm Stickers

For the House 200mm x 75mm

S 5400 Normally $1.95

This Month **$1.00**

For your Car 70mm x 25mm

S 5410 Normally $3.95

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Battery Operated Portable Passive Infra-Red Intrusion Alarm

Ward off thieves and intruders at home or when travelling

This is a portable, battery operated passive infrared intrusion alarm. It employs the most advanced circuitry offering fully automatic operation and superb performance. The alarm gives over 100 squre metre protection.

Features: • A ready to use system, no installation • Fully automatic operation, very user friendly • Large coverage, over 100 square metres • Portable wall mounted • Long life 9V battery operation • Battery low warning • Lightweight, compact and attractive • Recommended for home, shop, caravan or when travelling

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Weatherproof Horn Speaker

10 Watt 8 Ohm

C 2015 Normally $15.95

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Pressure Mats

Ultra thin switch mat for under carpet or mat etc.

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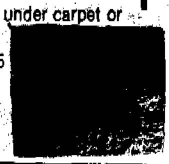
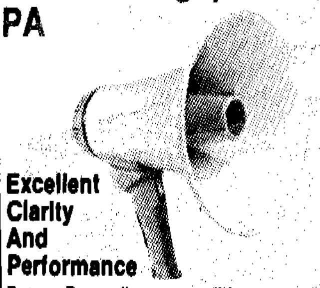


10 Watt Megaphone PA



Excellent Clarity And Performance

Range: Depending on conditions approx. 300M Requires 8 x AA batteries.

A 1980 Normally $147.00

This Month **$99.00**

12" Guitar Speaker

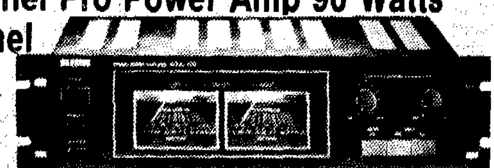
100W Max

Attention all guitarists and keyboard musicians. This fine USA designed speaker is supplied as standard equipment to the world famous brand name series of Guitar Amps.

Impedance (300Hz) 8 Ohm, **Sensitivity** 94dB/W (0.5m) **Voice Coil** 50mm **Nett Weight** 4000gm **Magnet** 1420gm/50oz

C 3102 **$99.00**

Two Channel Pro Power Amp 90 Watts Per Channel



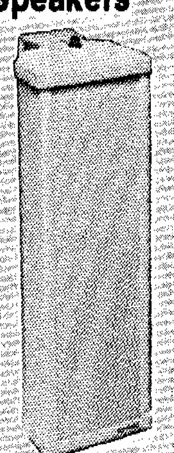
This stereo is ideal for background/foreground applications. Fantastic for restaurants, shops, disco's, aerobics, PA sound systems and home.

• 90 watts RMS per channel minimum into 8 Ohms from 20 to 20,000Hz with less than 0.05% THD • 2 large power meter indicators • EIA Panel with handle device • XLR socket for speaker terminal • Output relay to eliminate turn-on and off transients • Dimensions: (W x H x D) 482 x 92 x 295mm • Weight: 10.5kgs • Ideally suited to A 2210 stereo tuner.

A 2040 $625 **This Month $599.00**

PA Sound Column and Hi Fi Extension Speakers

Massive 100 Watt input rating make these models simply brilliant as extension speakers for home, club, hotels etc.



The new versions of these models include a natty little built-in protector allowing around 100 watt input without damage to the drivers.

Rugged Extruded Construction

These vibration free enclosures are constructed from die extruded heavy guage aluminium and finished with incredibly durable industrial powder coat enamel. The speaker ends are sealed via gaskets and tough moulded "LURAN S" UV resistant end caps. The end result is "Good Looks" together with assured rugged durability for the Australian environment.

Excellent Reproduction

The drivers have been chosen for wide range, low distortion, mid range "presence" (essential for high grade vocal work) and high efficiency in general. Weather proof Construction and use of "Doped Cones". Foam plastic and cloth is sandwiched between baffle and front grill to prevent water ingress.

Installation Hardware

Each speaker system is supplied with wall mounting brackets.

C 0944 White

Normally $149.00 ea. or $280.00 pair This Month **$100.00 ea**

Standard CB Type Microphone

Low Impedance Dynamic mic with curly cord (incl switch pair). Suitable for CB's, radio transcievers etc. Does not include plug. **Frequency Response** 300-8KHz **Impedance** 500 Ohm **Sensitivity** -70dB

C 0332 Normally $17.95

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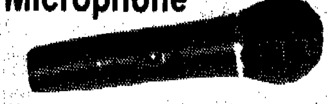
High Performance ALC Wireless Microphone



(Automatic Level Compressor)
For high grade vocal entertainment

• Cardioid-uni directional pick-up pattern • **Carrier frequency:** 88-108MHz adjustable • **Field strength of carrier:** With 50uV/m at a distance of 15M from the mic • **Battery compliment:** 1 x 9V

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This Month **$99.00**

Altronics Aviation Headset

• High performance noise attenuating earphones • Noise cancelling microphone • Cushioned head pad • Super sturdy • Great performance • Superb, professional pilot's headset will last a lifetime with reasonable treatment • Includes standard aircraft jacks.

C 9070 $189.00

PHONE ORDER TOLL FREE 008 999 007

SHORTWAVE LISTENING

by Arthur Cushen, MBE

World Conference to look at Frequency Plans

The World Administrative Radio Conference (WARC) is to meet again this year, to consider its frequency plans. Already there is good news for radio listeners, with better consultative discussions between East and West European countries.

One of the basic subjects which affects radio listeners is the mediumwave band expansion from 531-1602kHz up to 1805kHz. Already the Federal Communications Commission in the United States has increased the band to 1705kHz, allowing stations to operate in that section since few domestic receivers cover that part of the spectrum. Listeners with complete coverage communication receivers will have no problem in finding those frequencies, but those with the usual AM/FM domestic radios will find that the frequency range ends at 1602kHz.

In Australia and New Zealand some stations will have to move out of this new band. Here in New Zealand, there are two navigational beacons on 1602 and 1629kHz, while in Australia 4AVA Gold Coast 1656kHz with 20W has announced a planned move to the FM band.

A second interesting proposal covers the 41-metre band, which is shared by radio amateurs and international broadcasters. In fact, in region three, North and South America, there is no provision for international stations to use this band.

The suggestion put forward is that the band should be split in two, 7000-7300kHz for use by radio amateurs and 7300-7500kHz by international broadcasters. Already this upper part of the band is being rapidly filled by shortwave services.

The third item of interest is the most radical of all. The suggestion here is that all international broadcasters, by 2015, should operate on single sideband (SSB). The reluctance of stations to even test in this mode has been noted, with the main drawback being the loss of audience in third world countries, where most re-ceivers are not equipped for SSB reception.

Close cooperation

For the first time ever, countries of Western and Eastern Europe met in Prague recently to work out better frequency usage and to attempt to avoid interference. A practical demonstration of cooperation was announced in the November frequency change, when Radio Nederland, after consulting with the Soviet Radio Services, moved some of its channels to avoid interference with Radio Moscow.

The Prague meeting held last year looked at interference, and in this context, interference means broadcasting on the same frequency into the same target area. This first meeting gave broadcasters in Western Europe the first chance to make contact with their colleagues in Eastern Europe.

Deutsche Welle in Cologne played a special role, because it had taken over the former Radio Berlin International transmitters in East Germany, which it is now using in its worldwide services.

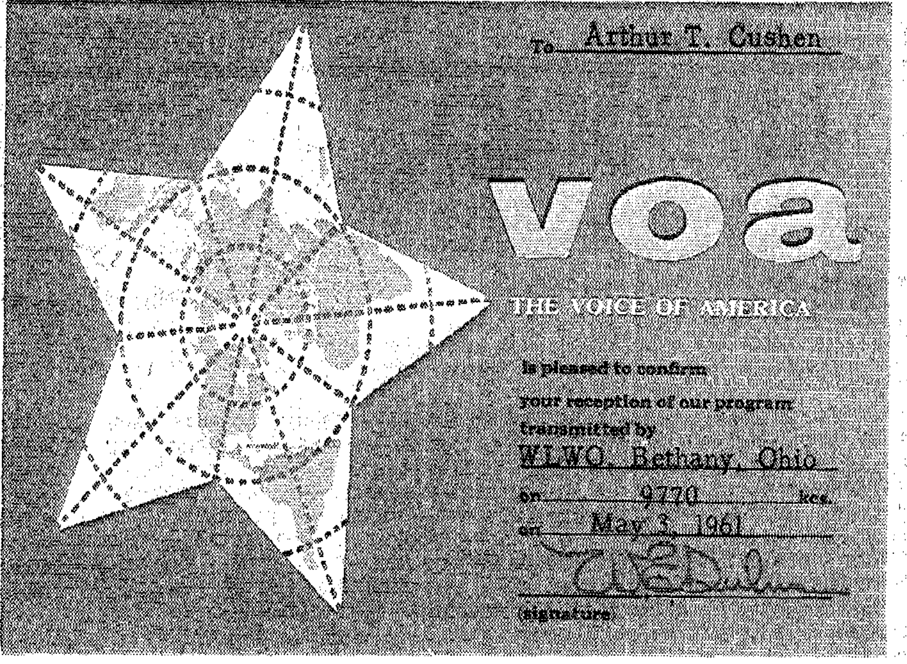
The success of the first meeting was such that conferences are now being held twice a year. European broadcasters can put forward their frequency plans for the future, and endeavour to make sure that mutual interferences does not occur to one another's transmissions when beamed to the same target area. For the shortwave listener, this is most exciting news, as we can look forward to the day when we can tune to international broadcasters and every time, find them on a good clear channel. This can be accomplished by using and sharing existing radio frequencies.

Bethany celebrates 50 years

The Voice of America relay station at Bethany, Ohio is celebrating 50 years of broadcasting with the installation of three new 250kW transmitters and the issuing of its own verification card.

My records on broadcasting in Bethany go back much further, when in 1937 the site which is near Mason Ohio, was used by the Crosley Broadcasting Corporation with studios in Cincinnati.

During the wartime years from 1941, it was taken over by the Voice of America, but previous to that it was assigned callsign W8XAL. In 1939, when ex-



A typical verification from WLWO, Bethany Ohio issued by the Voice of America to confirm reception of the shortwave service at a site which has just celebrated 50 years of broadcasting.

perimental calls were dropped, it became WLWO.

At the height of the VOI activity, 1943-45, the following call signs were verified from Bethany — WLWR, WLWS, WLWO, WLWK, WLWL. On some occasions, a figure was added to the callsign to give even more transmitter facilities to be identified from the Bethany site. Reception reports should be addressed to Bethany Relay Station, Voice of America, PO Box 227, Mason, Ohio 45040 USA, for the attention of John Vodenik. The new card shows a coloured photo of the Bethany Relay station with the VOA logo, and a comment 'half a century of broadcasting to the world 1940-1992'.

Deutsche Welle uses jamming transmitters

Several years ago, at the height of the Cold War, jamming transmitters throughout the USSR attempted to block broadcasts from Western Europe. This continued for many years. The end of the Cold War meant that the USSR had a tremendous number of transmitters which were not being used, and many international broadcasters looked on these transmitters as potential relay points to improve their service into the USSR. At the same time the USSR used many transmitters to carry in the Moscow area all the programme services from the Soviet Republics.

Last year, the first definite move to use these surplus Soviet jamming transmitters was taken by the Deutsche Welle — a rather ironic twist of fate, as instead of jamming transmitters they are now carrying the broadcasts which they were once intended to block out. In July last year an agreement was signed in Cologne between Deutsche Welle and the Soviet Telecommunications Ministry. This opened the way for the initial renting of 19-1/2 hours a day, using shortwave transmitters with a capacity of between 200 and 1000kW. Three transmitting sites are involved in the Soviet Union for tranmissions to Asia, and this has already resulted in an improvement in reception quality in the Asian target areas.

A wide variety of languages are being carried by the Soviet transmitters, including German, English, Indonesian, Chinese, Bengali, Hindi, Urdu, Pashtu, Dari and Persian. The use of the Soviet transmitters gives a wide variety of frequencies for listeners in Asia, and this is backed up by the transmitters of Deutsche Welle from Germany, as well as from its relay stations.

Deutsche Welle transmissions to Australia in English are heard twice daily at 0900-0950 on 6160, 11915, 17780 and 17820kHz, as well as three frequencies in the 13-metre band. The second transmission at 2100-2150 is on 6185, 9670, 9765, 11785 and 15350kHz. Transmissions are direct from transmitters in Germany, both in the West and East German areas, as well as from the relay station at Trincomalee, Sri Lanka.

Later information indicates that transmissions carrying the DW programme from the USSR are being received and English has been noted at 0200-0250 on 17620kHz. There is no station identification, but the usual tone signal common to all Russian transmitters is heard before the programme originates from the Cologne studio in Germany.

This item was contributed by Arthur Cushen, 212 Earn St. Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 10 hours behind Australian Eastern Standard Time.

AROUND THE WORLD

FRANCE: Radio France International, Paris broadcasts in English to the Far East at 1230-1300 on 11670, 15195kHz; 1400-1500 on 11910, 21770kHz; 1600-1700 on 17620, 17800kHz; and 1800-2000 on 15300 and 17845kHz.

INDIA: All India Radio Delhi in English to Australia at 1000-1100 has made a frequency change and is now using 15050kHz, replacing 15335kHz.

JAPAN: Radio Japan's 'DX Corner', which contains interesting news for shortwave listeners on reception, equipment and propagation information, broadcasts on Sunday at 0930-0950 on 11840 and 21610kHz. In recent programmes Ian McFarland, well known as the host of 'Shortwave Listeners Digest' on Radio Canada until the programme ceased last year, is heard on occasions with his excellent assessment of the hobby in the DX Corner feature. Ian is now owrking for Radio Japan's English Department.

PAPUA NEW GUINEA: Port Moresby with its National Programme has been heard on a new frequency of 6080kHz. Broadcasts originate on 4890kHz and this new channel has been noted from 2000 sign on. The 6080 frequency is actually allocated to Daru, Western Province, but this station has not been observed on the frequency. Daru also uses 3305 for the period 0700-1400. (Leslie Low of Queensland supplied this information).

PERU: The well known Lima station, Radio Cora del Peru, is heard on 4914kHz opening at 1000. After a march sign on, full identification is given. At times this is followed by a hymn, and then normal programmes are heard. Signals are good at the moment because there is no co-channel interference from Radio Gran Columbia in Quito, Ecuador, which generally uses 4911kHz but has been silent for several weeks.. ❖

WHEN I THINK BACK

Continued from page 37

The final chapter

A detailed sequence of articles in the issues June-September described the construction of the 1956 version, with the 1957 version appearing in April of that year. By that time, the situation had changed. TV broadcasting had commenced in Australia, and it was obvious that radio would no longer dominate family entertainment. A TV set would in future take the place that had been occupied for so long by the radio console.

For sure, radio would still have a place for casual listening — provided the set didn't take up too much room and could be moved around, as required. Quite suddenly, from being a second set, the 'Little General' type of radio had become the only one that most families needed.

The final chapter in the 'Little General' saga came in a series of articles by Alan Nutt (March-June 1961), culminating in the design shown in Fig.9. Ironically, it reverted to the basic design which had set the ball rolling in 1939: a four-stage circuit using three valves — this time Philips all-glass 9-pin miniatures, manufactured in Australia and equally popular with commercial manufacturers.

A 6AN7 triode-hexode converter was fed from a ferrite-rod loopstick, in lieu of an antenna and antenna coil. This was followed by a 6N8 duo-diode pentode, doing the job of a 6G8-G/6B7S, but much more efficiently. Last but not least, the 6BM8 provided a high-gain triode audio stage and a high-gain output pentode, expressly intended for that role.

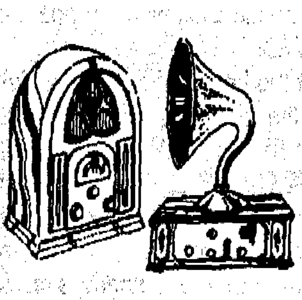
The valve rectifier had disappeared, to be replaced by a pair of semiconductor power diodes — the first step to what was soon to follow, with all valves being replaced by solid-state devices.

In the meantime, what happened to the negative feedback, which was featured in the later 4/5-valve and larger receivers? In brief, negative feedback was/is fine if: (1) There is gain to spare; (2) The circuit is amenable to its use; and (3) The loudspeaker and baffle system is of sufficient quality to justify it. Faced with these prerequisites, most small-set designers said: 'Forget it!'

Within a few years, anyway, Australian valve/mantel sets would be rendered obsolete by imported transistor portables featuring optional mains/battery operation and multiband reception — not in response to Australian demands, but because they were universal designs intended for world markets! ❖

Vintage Radio

by PETER LANKSHEAR



Understanding automatic gain control — 1

For many vintage radio enthusiasts, much of the pleasure from their hobby comes from restoring their receivers to full working order. The functions of Automatic Gain or Volume Control, incorporated in the majority of receivers made after the mid-1930's, are important, and an understanding of what goes on can be of considerable help in fault finding.

First of all, we need to clarify a long-standing confusion — should we talk of automatic *gain* control, 'AGC', or of automatic *volume* control — 'AVC'? Over the years the two terms have often been used synonymously, but strictly speaking the latter term (AVC) is not accurate. 'Volume' refers to the sound level from the audio amplifier and speaker, which is normally controlled manually, whereas it is the receiver's *gain* that has automatic control.

By the late 1920's, the gain of large receivers was nearing the usable limit, and mains operation had made plenty of audio power available — with the result was that careless use of the volume control when tuning across strong signals could produce some very distressing noises. Another problem for listeners remote from transmitters was night-time fading. Some automatic control of receiver gain to compensate for varying signal strengths was needed.

Virtually all AGC systems encountered in valve radios vary control grid bias proportionally to the strength of the received signal. Several methods of generating a negative control voltage were developed, and some of the earliest were the most complex.

As there is no way that all the systems and variations that have evolved can be covered in two articles, we will concentrate on those most widely used, and therefore more likely to be encountered.

The first example of AGC seems to have been used in the RCA model 64, one of the '60-series' all-triode superheterodyne receivers which were very advanced at the time of their introduction in 1928. It used a separate AGC valve biased to cutoff, but with its anode connected to earth via a resistor and the cathode connected to a negative supply of 100 volts. Signals applied to the grid caused a current flow in the valve, producing a negative voltage at the anode proportional to the strength of the signal. This negative voltage was used to control the gain of the RF and IF amplifier valves.

RCA's AGC system was very effective, and various versions were used for several years. Meanwhile, a simpler system was devised by H.A. Wheeler of the Hazeltine Corporation, and released in 1929, to be taken up by some of their licensees — primarily Philco.

Wheeler's AGC system resurrected the valve diode, which had been largely neglected since the advent of the De Forest triode in 1906. After all, as valves were very costly, there had been little demand for a function that provided no amplification. However, diode detection has the great advantages of simplicity with low distortion — and as a bonus, can provide 'free' AGC from the negative voltage developed across the load resistor. Diode AGC became universal within a few years and, adapted for solid state electronics, is still in use.

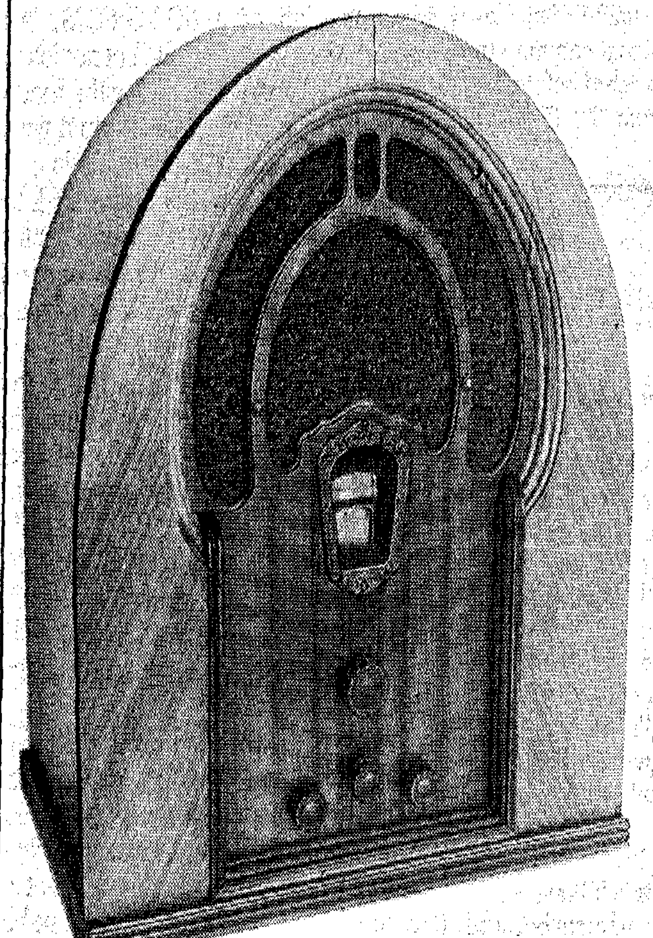


Fig.1: The 1932 model 71 was one of Philco's most popular series of 'Baby Grand' receivers. Advanced for its time, it used RF pentodes as well as a diode for both detection and AGC — a system Philco first used in its 1930 models. This simple and reliable arrangement remained a favourite for many years.

A typical example

Philco's model 71 is a typical example of Wheeler's AGC system. Referring to Fig.2, the 'detector rectifier' is a type 37 triode, with its cathode earthed and its grid acting as a diode anode (anodes do

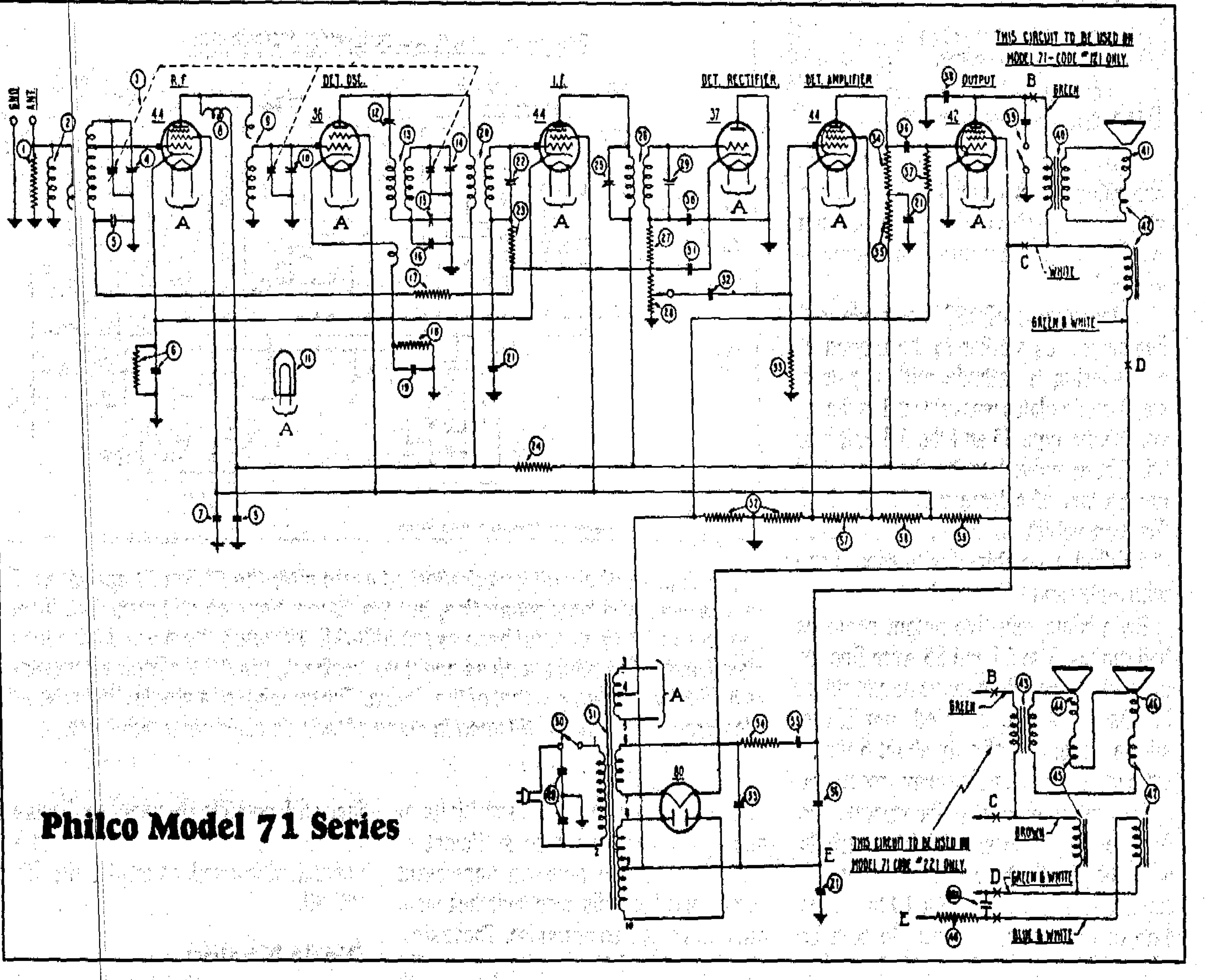


Fig.2: The Philco 71 used the type 39/44, the first variable-mu RF pentode, which had just been released. The autodyne mixer used a type 36 sharp cutoff tetrode, with a 37 triode connected as a diode for detection and AGC. The 42 output valve was also very new, and was to become a standard for many years.

not have to be solid metal). The normal anode is also earthed, and serves as a shield. Rectification of a received signal (in IF form) by the diode causes a direct current, with demodulated audio superimposed, to flow through resistor 27 and the volume control 28, producing a negative voltage proportional to the strength of the received signal.

Capacitor 30 is the 'reservoir' capacitor charged by the rectification of the IF signal, and capacitor 31 filters any IF from the audio. The audio signal is coupled out to the audio amplifier through capacitor 32.

The junction of the filter resistor and the volume control is the source of the AGC voltage, which is connected to the grid circuits of the RF and IF amplifiers. Resistors 17 and 23, together with bypass capacitors 5 and 21, have a long time constant and filter out any audio component — leaving a negative DC voltage to control the gain of the RF and IF amplifiers.

The first receivers using diode AGC were TRF's with sharp cutoff type 24 tetrodes as RF amplifiers, but gain control of these by bias variation was not very satisfactory as only a small increase would cut the anode currents right off. This was a problem even with manually controlled receivers, and it was finally solved by the 'variable mu' or 'super control' RF type 35 and 51 tetrodes, introduced in 1931.

These two valves had been developed independently and were so similar that they were combined in the 35/51, essentially a 24 with the control grid wound with a variable pitch. Whereas an increase in bias to 8.0 volts was sufficient to cut off the anode current of a 24 completely, the new valves took about 40 volts to achieve a smooth reduction to cutoff. This simple modification was very successful and thereafter became standard for RF amplifying valves.

The RF pentode

The next improvement was the addition of a suppressor grid to the tetrode to produce the first RF pentodes, the types 39 and 44. As with the 35/51 these had variable-mu characteristics, and again the two were very similar and were replaced by the 39/44.

Although these pentodes had 6.3 volt heaters and were originally intended for car radios, Philco anticipated the eventual changeover to 6.3 volt from 2.5 volt filament valves for domestic receivers and used them for their 1932 models, including their model 71. By now all of their sets were superheterodynes.

For manufacturers who still preferred the 2.5 volt filament series of valves, the type 58 variable-mu RF valve was in production by the end of 1932 and was one of the first group of valves made by Australia's AWV Co.

Using diodes

Other radio manufacturers were adopting the simple and very satisfactory diode AGC, but using triodes was uneconomic and inevitably diode valves were produced. The first American valves made for detector and AGC service were the G-2-S and G-4-S double diodes, made by Grigsby Grunow and first used in their Majestic radios in 1932.

These were used for full wave detection and AGC, as used by Stewart Warner in 1935 in their model 136 — as described in this column for June 1991. However, as will be described in the next of these articles, the extra diode also made *delayed* AGC practical.

Duo-diode triodes

If two combined diodes were more economic, why not include a triode as well — and provide a diode detector, AGC and audio amplifier all in one envelope?

In the middle of 1932, a triode with characteristics similar to the proven 27 and sharing a cathode with a pair of small diode plates was released as the 2.5 volt heater type 55 and the 6.3 volt type 85. These proved to be the successful progenitors of a large number of dual-function valves with one, two and even three diodes, combined with triodes and with audio and RF pentodes.

Even some sensitive output pentodes had diodes. The 55 and 85 were fine for transformer coupling to the output stage, but as resistance coupled amplifiers, with a stage gain of only about 6 times, were inadequate for shortwave receivers.

The solution was to incorporate the first really successful high-mu triode with the diodes to create the type 75, capable of providing about 10 times the gain of the low-mu valves. So popular was the 75 that variations and close relatives were used as long as valve receivers were made. Some of the better known derivatives were the 2A6, 6B6G, 6SQ7 and 6AV6.

British and European valve makers compromised with triodes with a mu in the region of 30 to 50, popular examples being the EBC3 and EBC33.

With the availability of dual valves, diode generated AGC became increasingly popular and eventually only very inexpensive and some reflexed receivers did not have some form of AGC.

One application where AGC is essential is of course car radios. Not only must they have very good sensitivity, but also the wide variations in signal strength encountered, often at short intervals, demand an effective AGC system. Car radio development, especially in America where they could be afforded, increased rapidly with the introduction of 6.3 volt heater valves and AGC.

Problems for listeners

Although it make receivers more docile, AGC was not initially always an unqualified success. For one thing, it made accurate tuning more difficult for some users, by appearing to flatten the response curve. Consequently, several different types of tuning indicators were developed.

In some locations, such as cities with high electrical activity, the sensitivity of many receivers could be sufficient to raise inter-station noise to unpleasant levels, and local/distance switches were often fitted as a compromise. These simply desensitised the receiver, generally by adding extra bias to the RF or IF amplifiers, and were satisfactory in strong signal locations.

More sophisticated methods were muting, quiet automatic gain control, or squelch circuits which set receiver sensitivity to a predetermined level by applying a large biasing voltage to the detector diode, audio amplifier or IF stage. When the threshold was reached, the bias was overcome and the receiver operated normally. Most of these systems caused distortion, especially around the threshold level, and eventually were to be confined to communication systems and radio telephones.

Probably the most successful method of coping with difficult tuning and between station noise was pushbutton tuning, still popular in some applications. Last month's column described an advanced motorised example, the Ekco PB289.

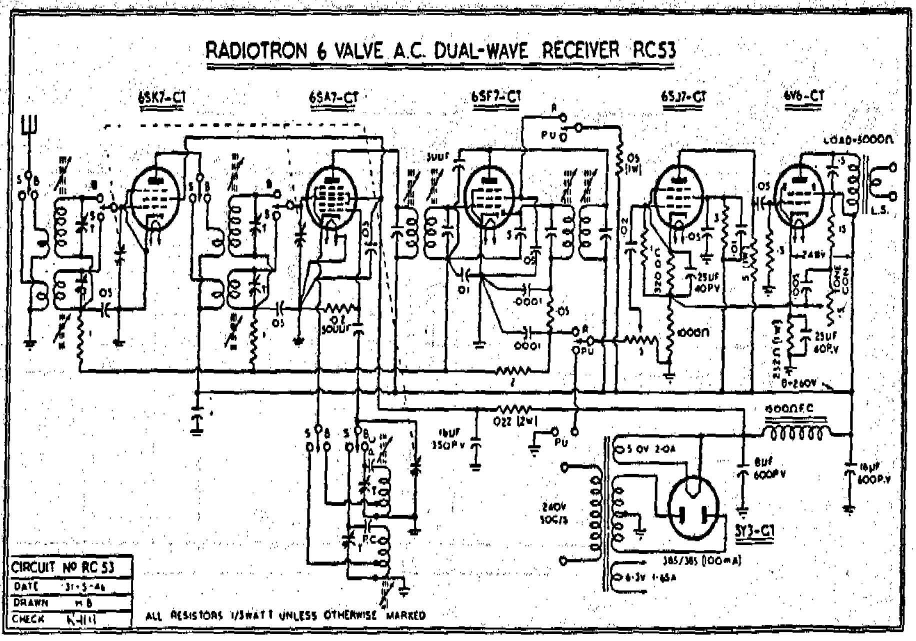


Fig.3: This AWV circuit was drafted 14 years after the Philco 71 appeared. The valves were of a later generation, but the 80 rectifier was still standard, by now repackaged with an octal base as the 5Y3-GT. Although there are differences in detail and refinements such as negative feedback, the AWV circuit arrangement is basically the same as that of the Philco. The concept of a single diode detector also providing AGC is still used in many of today's solid state receivers.

Diode biasing

Diode biasing of the first audio stage made use of the negative voltage that is developed across the detector diode load resistor, and was used in some instances by direct coupling to the grid of a low-mu resistance coupled triode. Usually the diode load resistor was the volume control, so that the bias at the grid was dependent on both signal strength and control setting.

By simplifying loading on the diode, direct coupling is beneficial in minimising detector distortion and with low-mu resistance coupled triodes, especially the types 55 and 85, was a reasonably satisfactory system. However, volume control noise could be a problem, the low-mu triodes often did not have sufficient gain, and diode biasing was not suitable for the high- mu triodes that replaced them.

A variation of diode biasing was tried for a while, by using the resistance coupled semi-remote-cutoff pentodes 2B7 and 6B7. Plenty of audio gain was available and with the variable-mu characteristics of the valve there was an element of audio AGC, but noise caused by the action of moving the slider of the volume control was a problem.

In the next article we will look at delayed and amplified AGC, and the problems — some which can be unsuspected — that AGC faults can create. ❖

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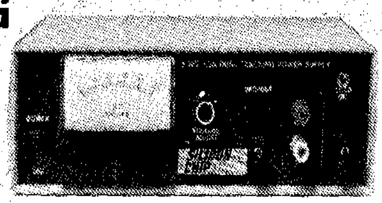

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B1293/PB

Construction Project:

'El Cheapo' Car Voltmeter

This simple voltmeter gives a visual indication of the voltage of a 12V car battery. It uses three LEDs and is packaged in a film container so you can mount it under your car's dash, or slip it into your pocket. It couldn't be much simpler...

by NORM BUSH and PETER PHILLIPS

This project has been around before, and was first published in *ETI* some years ago. So why is it being presented again?

There are several reasons, including a modification to the circuit. But the main reason is to present an interesting packaging method. A new printed circuit board has been developed, small enough to allow the whole unit to be built into a 35mm film container.

The lead photo shows the idea, in which the LED indicators that show the battery voltage are now fitted to the lid of the film container. The PCB tucks away inside and the leads to the battery exit from the back of the case. To mount the unit, a bracket such as that shown in the photo can be used.

The original design had the LEDs mounted on the PCB, and was therefore larger than it needed to be if the LEDs were removed. As well, an extra diode has been added in series with one of the LEDs to give a better differentiation of the battery voltages.

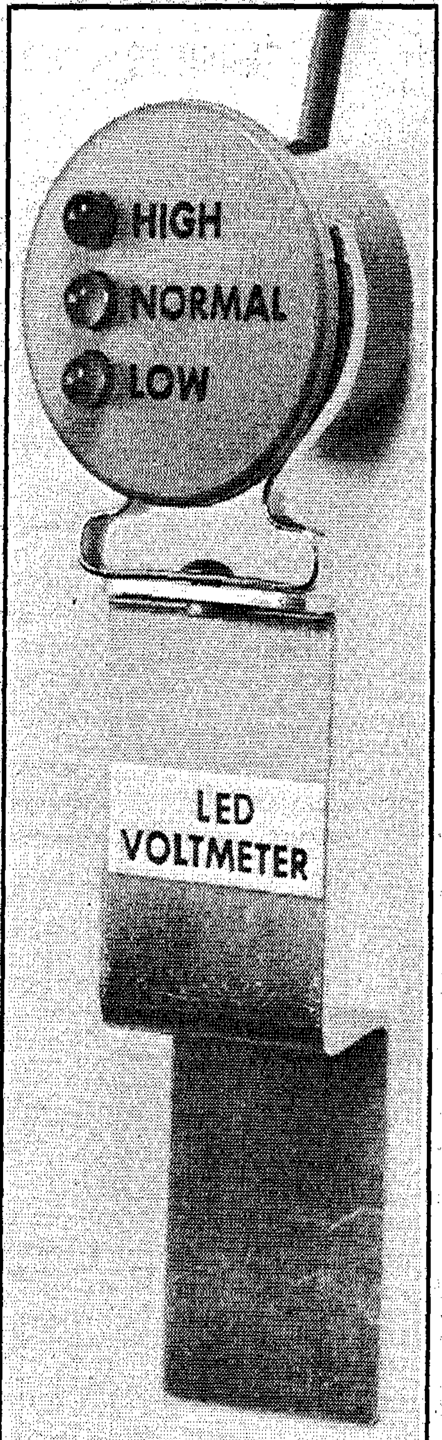
The basic principle is that the LEDs indicate if the battery voltage is low, correct or high. We'll have more to say about that later in the article, but the idea of such a voltmeter is probably attractive to quite a few readers. After all, it could save you money by indicating that the charging system is overcharging the battery, or that the battery voltage is dropping significantly when the headlights are on. In short, a simple monitor of the charging system in any 12V vehicle.

How it works

The circuit seems simple enough, but as the designer points out in the original article, it took a bit of doing. The principle of operation relies on the fact that different coloured LEDs have different voltage drops across them.

When a current of 20mA is flowing, a red LED has a forward voltage drop of 1.7V, a yellow LED has 3.0V and a green LED has 2.3V.

The whole circuit connects to a 12V battery and when the battery voltage falls below 11.4V, zener diodes ZD1/ZD2 (13.6V) and ZD3 (11V) are off. Therefore, both Q1 and Q2 are off, as are LED1 (red) and LED3 (green). However, LED2 (yellow) will light via R1. The voltage drop across LED2 in series with D1 will be about 3.7V.



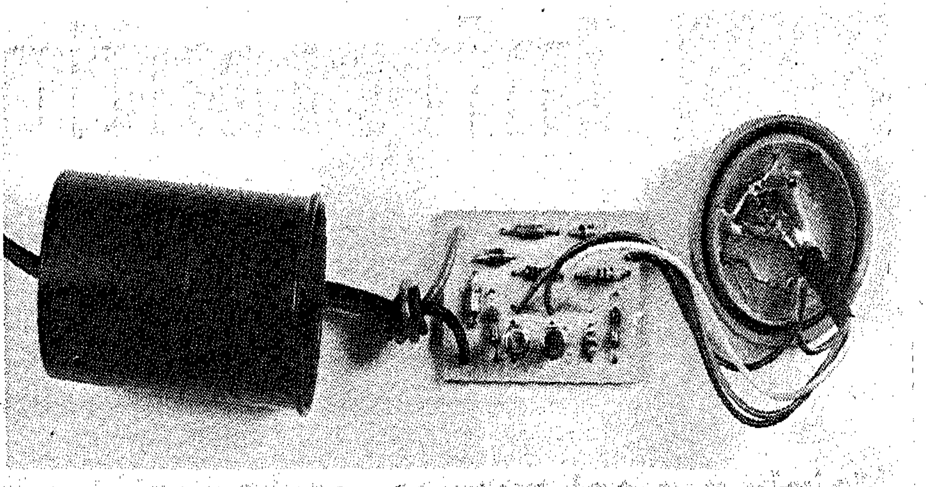
When the battery voltage rises above 11.4V (zener voltage + base-emitter voltage of Q2), ZD3 will conduct, turning on Q2. This will light LED3 and drop the voltage across LED2 and D1 to about 2.3V. This reduces the current in LED2 and it will start to turn off. In practice, LED2 doesn't go out completely as even 1mA of current in a LED is sufficient to cause it to light. At this voltage, both the green (normal) and the yellow (low) LEDs are on at much the same brightness level. As the input voltage rises, the green LED will glow more brightly and at 12V the green LED will be fully on and the yellow LED only partly on.

When the battery voltage rises above 13.7V, the series-connected zener diodes ZD1 and ZD2 conduct, turning on Q1. This causes LED1 (red) to light, dropping the voltage across LED2 and D1. However, because the red LED is only partly on, all three LEDs will be on at around the same brilliance.

Finally, when the battery voltage exceeds 13.85V, the red LED turns on harder, turning off both LED2 and LED3 as there is insufficient voltage to cause these LEDs to conduct. Thus the red LED is the only LED on, indicating that the battery voltage is too high.

In the original design, diode D2 was not included. By adding it, we found that while the green and yellow LEDs are both on together at voltages around 12V, only the red LED is on for voltages over 14.2V. Without D2, the green and red LEDs are both on when the voltage exceeds 14.2V. This might lead you to believe that the voltage is only slightly higher than normal, when in fact both the green and red LEDs will remain on for all voltages higher than 14.2V. Also, because the brightness of the green LED varies as the voltage rises above 11.4V, a better indication is given for a 'normal' battery voltage of 12V. At this voltage the green LED is fully on, and the yellow LED is partly turned on. Without D2, the green LED is fully on at 11.6V and the yellow LED is off. As most auto-electricians know, 11.6V is *not* a normal battery voltage.

Table 1 shows the indications for various input voltages, as measured on the prototype. As you can see, there are five distinct indications of battery voltage, compared to three in the original design.



This photo shows how everything fits inside the film container. The LEDs and D2 are glued in place and connect with hook-up wire to the PCB.

Construction

Construction is very simple, and involves stocking the PCB, fitting the LEDs to the lid of the case then connecting the LEDs to the PCB with hook-up wire.

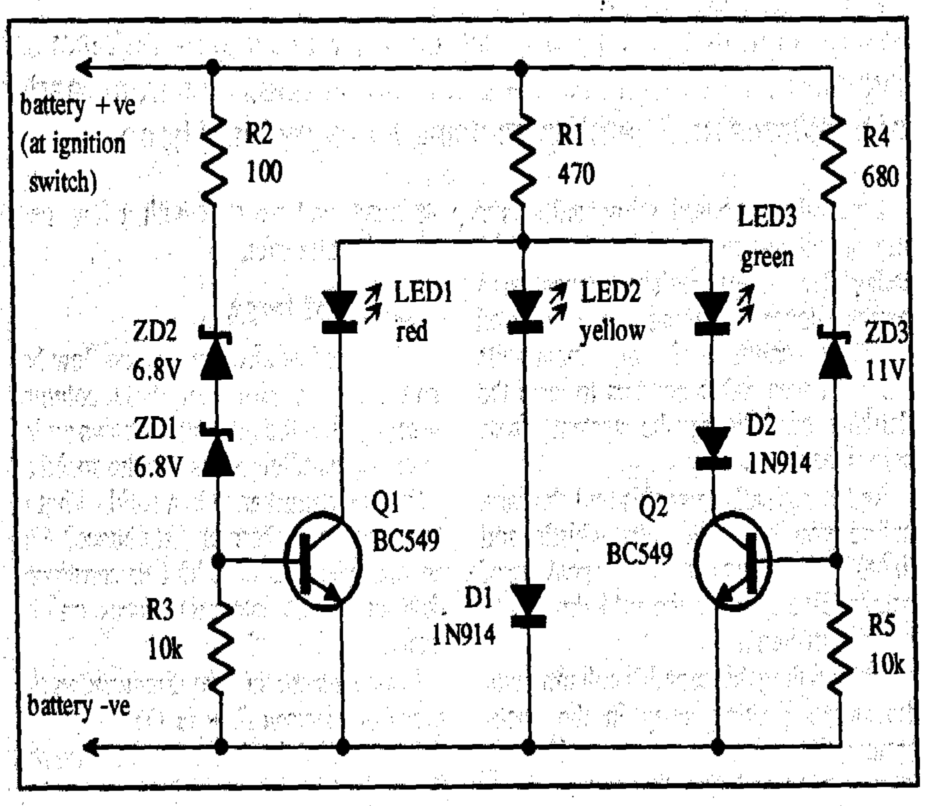
The PCB is purposely small so it can fit in a 35mm film container, and the space between pads for the diodes is less than usual. Be careful forming the leads, to prevent undue stress on the diode element. Also, solder them quickly to minimise heat dissipation. Naturally, make sure they are mounted the correct way round before soldering.

The plastic used to make film containers is rather difficult to drill, and we suggest you cut the holes for the LEDs with a wad punch. If you mount the LEDs to one side of the lid, there will be sufficient space to attach rub-on lettering. We used 5mm LEDs in the prototype, although smaller LEDs will probably work.

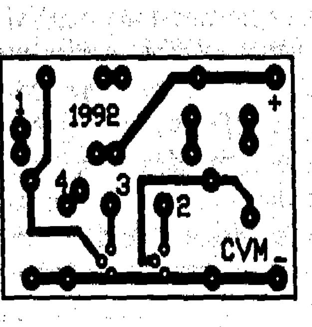
The anodes of the three LEDs are connected together and a single lead (lead 1) from this point goes to the PCB. The diagram of Fig.1 shows the physical arrangement for the components mounted on the lid of the container. Note particularly the orientation of diode D2.

Keep the lead lengths of the LEDs short (3 or 4mm) and solder hook-up wire to the cathodes of the red and yellow LEDs. Another lead comes from the cathode of D2 and these leads, numbered 2, 3 and 4 connect to the PCB. A lead length of about 90mm is suitable, perhaps held together with a piece of plastic tubing. Use 5-minute epoxy glue to hold the LEDs and D2 in place. All connections should be completed before gluing.

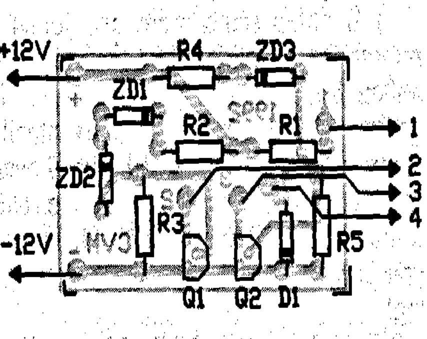
The only other connections are the leads that connect to the battery, and these exit from a hole in the back of the case. Although not ideal practice, you can tie a knot in these leads to prevent external stress disconnecting them from the PCB.



The circuit lights the three LEDs to give a display that allows five levels of interpretation of the battery voltage. LED2 is on when the voltage is less than 11.4V. LED1 lights for voltages higher than 13.85V. For voltages between these limits, LED2 lights in combination with the other LEDs.



The PCB artwork is shown here full size so that you can make your own board.



The layout for the PCB. The numbered leads connect to the LEDs and D2 shown in Fig.1. Be careful mounting the diodes as their pad spacing is relatively short.

Installation

The method used to fit the case to a dashboard will depend on the vehicle. Perhaps the easiest way is to use a metal tool clip with the outer parts of the clip cut away and the sharp edges filed off. With a bit of bending it will securely hold the container without crushing it. The clip can either be mounted directly to the dashboard or fixed to a suitable metal bracket. We used a piece of 18G (or thereabouts) aluminium, bent to give a bracket able to hold the unit above the top of the dashboard. Another method is to use double-sided adhesive tape. You might be able to locate the unit on the steering column, or somewhere convenient. Obviously it should be visible from the driving position and out of direct light, as otherwise a high ambient light might make the LEDs difficult to see.

Of course, there is no reason why the LEDs cannot be mounted separately. You

Continued on page 95

Information centre

Conducted by Peter Phillips

Mainly project queries, and a 'hot' topic

We're a bit more traditional this month, with most of the discussion concentrating on projects. But I've also thrown in a few ideas and some questions from readers — including one on the subject of heat transfer. There's something for everyone, I hope...

I recently purchased a few additions to my sound system, and consistent with today's technology, each component has a remote control. Having never enjoyed armchair control of this magnitude before, I was rather anxious to taste the delights of 'driving the system' from across the room.

And it's great! Press this and that and before you know it, bells whistle and lights flash — metaphorically speaking of course. But there *is* the odd drawback, I've discovered...

While typing this month's column, with the stereo blasting away in the background, the phone rang. It seemed wrong to race over and turn the system down manually, so I grappled around for the remote control for the amplifier.

Unfortunately I picked up my calculator by mistake. (Phone still ringing...)

I fumbled some more and found a remote for something. Not the right one, although it looked the part. (Phone really getting on my nerves, now). Eventually commonsense prevailed and I raced over, turning the volume down in the old-fashioned way. Then I raced back and — you guessed it, the phone stopped ringing!

So what's my point? Like black wallets that are always getting lost, I want to suggest that remote controls should be colour coded. Bright yellow, green, red, blue, luminescent, whatever... so long as they are easily located in an emergency. Good idea? Well, its all I can think of to save the confusion I am now experiencing.

OK, I thought I'd get that off my chest first, and where better than in this column. After all, this is a column for ideas and perhaps someone in the hifi industry will agree with me. Fortunately not all the ideas expressed this month are as offbeat as mine, and we start with a few ideas about heat transfer.

Speed of heat

The speed of electron and ion flow has had quite an airing in these columns recently, and the next letter draws an interesting parallel to this and the speed of a thermal disturbance in a solid. What is the speed of a thermal disturbance? Has anyone ever measured it? Our correspondent has some interesting ideas on the topic...

I was interested in the discourse on the speed of electron flow in the December '91 issue, and the distinction between the flow of electrons and the propagation velocity of a disturbance (or signal). Back in the '60s I was involved in the development of a continuous metal casting process which featured the introduction of molten metal into a water-cooled mould. The partly solidified casting was then withdrawn downward, at a speed dictated by the rate of solidification of the metal.

For small round castings, it was desired to run two such moulds in parallel. The mould construction (laminated materials were used) was such that the conduction of heat through the wall was not always the same from mould to mould and the matching of moulds in pairs having similar thermal conduction characteristics became necessary. I needed to get some relative idea of the thermal conduction of a solid.

The first experiment involved using a 1000W quartz-iodine lamp, placed in the interior of a mould and measuring (with a stop watch) the time from switch-on to the first appearance of a temperature rise on the outside. A thermocouple was mounted on the outside of the mould and connected to a sensitive galvanometer.

Another (heat-shielded) thermocouple was used as a reference and the outfit could detect changes less than 0.001°C. The time was found to be too short to measure.

The heat source was then changed to a flashbulb with an estimated power input of about 100kW, but again the same result. Eventually an indirect method was devised that actually worked. The findings showed that the interval between the application of heat to one side of a solid and the first rise in temperature on the other face a few centimetres away was virtually instantaneous; too fast to measure with a stop-watch.

So what is the velocity of a thermal disturbance in a solid? How fast does a temperature 'front' travel? Another question might be, 'how fast does heat flow in a solid?' This of course refers to the steady-state condition and is perhaps analogous to the speed of electron flow.

I conclude that if heat can be regarded as a molecular agitation, its velocity of propagation corresponds to the velocity of sound in the material, sound being another form of molecular movement. I have not noticed any reference to this in the literature, but no doubt it has been established by someone, somewhere. Any ideas? (R.V., St Georges Basin NSW).

Thanks for these interesting thoughts R.V. I recall an experiment at school (many years ago) where it was demonstrated that heat travelled more quickly in copper than in aluminium. The method used was to fix two objects with wax to the metal rods, at an equal distance from the point of heat application. The object attached to the copper rod was always the first to fall off.

However the time taken could be measured in minutes, and the concept of heat travelling at the speed of sound was certainly not demonstrated. But when you think about it, a thermal *disturbance* is different to heating the object sufficiently to melt wax. And that's the interesting question. What is the speed of the disturbance?

I'm prompted to ask a few more: does a thermal disturbance travel at the same speed in all heat conducting materials, or even in any material, taking into account heat attenuation?

After all, the speed of an electric current is much the same in a 10M ohm resistor as it is in a 1 ohm resistor. If anyone can help us, I'd be pleased to hear from you.

IR remote control

I've had an enquiry on where the ICs used in the Infrared Remote Control published in July 1987 can be purchased. One source I've found is Farnell Electronic Components, who can be contacted on (02) 645 8888. They are located at 72 Ferndell Street, Chester Hill, Sydney.

Laser engine

In September 1991, a laser beam project developed by Oatley Electronics with a do-it-yourself 'laser engine' was published. The aim was to put laser experiments within reach of mere mortals. Apparently this project has been very popular, and the next letter offers a suggestion on how to improve the laser engine.

After messing about for months with variable frequency scanning circuits to make a pattern generator for my 5mW laser, I must confess that the design published in the September '91 issue is much simpler, much cheaper and more reliable.

However a feature I added to my 'laser engine' that is not in your design is a motorised shutter. To do this, I fixed a Mechano wheel to a motor, and placed the wheel in the path of the laser beam after it has passed through the laser engine. The wheel has eight 6mm holes equally spaced around the perimeter and makes an ideal shutter.

The speed of the motor driving the shutter is controlled in the same way as the motors driving the deflection mirrors in the laser engine. The shutter has the effect of breaking the pattern into dots or curves which chase each other, loop in and out or form spirals, depending on the pattern and the speed of the shutter.

Obviously, experimenting with different hole patterns in the wheel used as the shutter would give other effects. I also wonder what sort of patterns would be produced if another spinning mirror was added after the other two. (J.P., Temuka NZ).

I grew up with a Mechano set, and it's good to hear that this technology is alive and well. It's also good to hear that the 'laser engine' idea has proven successful. Thanks for this idea J.P., it has all the hallmarks I look for — simplicity, ingenuity and low cost. I'm sure other experimenters will be interested.

Why 240V?

There are quite a number of things that we take for granted, as we generally assume the reasons are all part of history. The next letter asks a few questions that when you think about it are perfectly reasonable:

I have a couple of historical questions that have intrigued me for a number of years and I wonder if you or any of your readers can shed some light on them.

How were the values of the mains voltages used in Australia arrived at? Why an odd figure like 240V, or 260V in WA? Why not a round figure like 200V or 300V? The same applies in the USA. Why 110/115V, and not 100V?

On another topic, why were 78rpm and 33.33rpm chosen as the speeds of gramophone records. (D.B., Dandenong Vic).

Why indeed? Interesting questions D.B., and no doubt the reason lies in the early development of both technologies. Usually these things are not arbitrarily chosen by a committee, they just seem to happen and before we know it, they have become standards.

However, there is no doubt an interesting story attached to all these questions and if anyone can provide some information, I'd be pleased to publish it.

Power amplifier

Although magazine space problems have prevented my Basic Electronics series from appearing regularly, I generally get a few letters seeking further information when each part is presented. And it's nice to know that most readers seem to like the series.

The next letter asks for a bit more information about the amplifier module that I described in the November '91 issue.

I must express my appreciation for your Basic Electronics series. I wonder if you could give a bit more explanation about the power amplifier described in the November '91 edition.

My first question concerns the collector voltage of Q2. Why is it only 0.64V? It would seem to me that Q2 is therefore saturated (or very close to it) and so would seem incapable of performing much in the way of an amplifier. It it were able to pass signals, wouldn't it be with considerable distortion?

Also, what is the purpose of R12? Is it a protective device to limit current? If so, as it presently stands it also adds to the resistance of the power supply and has the potential to cause instability problems, as well as limiting the power available on peak signals. I would have expected either C7 or an additional capacitor to be located after, rather than before this resistor.

I'd appreciate your comments. (J.H., Nathan Qld).

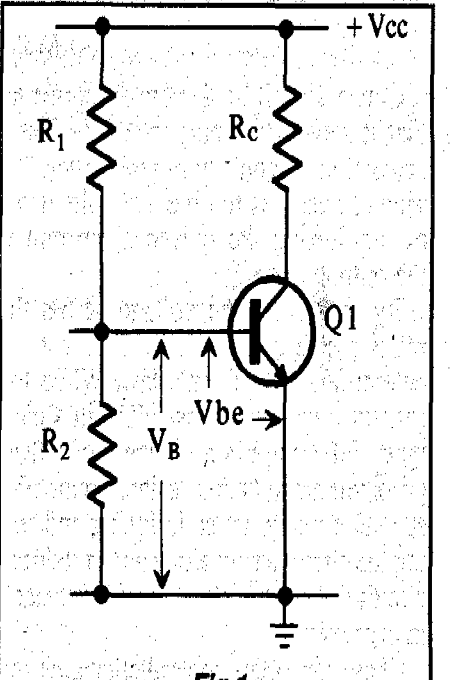


Fig.1

Glad you like the series J.H., and thanks for your comments. Dealing with your first question, the answer lies in the principle of operation of a transistor. Unlike a FET (or a valve), a transistor is a *current* operated device and voltages don't always tell the story. The circuit of Fig.1 might illustrate the idea.

In this circuit there is no emitter resistor, so the base-emitter voltage (Vbe) will always be around 0.6V — as this is the voltage across a forward-biased PN junction. Therefore the base voltage (Vb) will also be 0.6V.

If an input voltage of say 2V peak to peak is applied to the input, the conundrum arises of how can the base voltage remain at 0.6V. In this case, the input signal will either be clamped at 0.6V, or a series resistor between the signal source and the amplifier will be required.

However, while the base voltage remains relatively constant, the base *current* will increase and decrease. Because the collector current is controlled by the base current, the collector current will also increase and decrease, and the output voltage of the circuit will be developed across Rc.

This is exactly what is happening in the power amplifier, and although the collector voltage of Q2 is relatively constant at 0.6V, because it is connected to the base of a transistor similar to that of Fig.1, the current still varies and therefore amplification occurs.

INFORMATION CENTRE

Concerning R12, I seem to remember that it served two purposes. The first is protection as you say in your letter. The second reason is to give a simple means of monitoring the quiescent current in the output stage.

By measuring the voltage across this resistor, the quiescent current can be determined with Ohm's law. While this resistor might cause instability in a more powerful amplifier, none of these problems arose in this design. I remember spending many hours designing and testing the circuit as my aim was to produce a circuit that was fairly standard, yet stable in operation.

These are often contradictions, as text book circuits rarely perform as they are described. Ideally, another filter capacitor after R12 should be included, but it didn't seem to be necessary. However, providing you can measure the quiescent current with a milliammeter, I can see no reason why R12 can't be omitted.

CC amplifier

The topic of power amplifiers relates somewhat to the next letter, which again seeks further information as a result of the Basic Electronics series.

I'm writing seeking information about common collector amplifiers as a result of your very informative Basic Electronics series which discussed this topic in part 12. Some time ago I tried using a CC amplifier as a video stage. I wanted to be able to take a video input and expand it to feed up to six outputs. However, I couldn't get it to work. The normal level for a video output is (I believe) 1Vp-p at 75 ohms and I wanted to be able to supply this level of video to a number of outputs.

I set out by using a common emitter amplifier connected to a number of CC amplifiers as I thought this might make up for lost gain. However I was unable to get 1V out, as the CC amplifier loaded the preceding CE amplifier too much. Any help would be appreciated and thanks for the series. (B.P., Hastings NZ).

An interesting situation B.P., as the theory tells us that a CC amplifier (or emitter follower amplifier as they are often called) has a high input impedance.

While this is true, it is only in comparison to other amplifiers and given an output load of 75 ohms, a typical input impedance will probably be less than 10k. When several CC amplifiers are connected to one CE amplifier, the load resistance seen by the CE stage is quite low.

This is further compounded by the fact that you are dealing with frequencies that extend from DC to several MHz. Therefore the circuit needs to be DC coupled and transistors such as a BF115 or similar will be required.

As a suggestion, you might try connecting a single CC amp-lifier as a buffer stage to the CE amplifier. The extra CC amplifier can then be used to drive the output CC amplifiers. This is rather similar to a conventional power amplifier which has an input amplifier stage, a driver then the output stage.

In your case however, there are several output stages. From this you can see that the design is relatively complex, as you've already found. This might be a suitable project and is one I'll try and look into as time permits.

RF preamp

There are times when components from the past are a better alternative than those of today. The Antenna Tuner and RF Preamp present by Jim Rowe in the November 1991 issue is an example.

In this circuit, Jim had to resort to using a dual varicap diode and all the associated circuitry because suitable tuning capacitors are no longer available as stock items. But what if you *do* have suitable tuning capacitors?

I've been a short wave listener for many years and a reader of EA since 1976. I've been waiting for a long time for a project like your Antenna Tuner and RF Preamp described in the November issue, and although it looks great, I would rather use air-dielectric tuning capacitors in place of the BB212 varicap diode. I have a number of tuning capacitors from old receivers and if I could use them, it would save the cost of buying a kit. (J.N., Mt Warrigal NSW).

As it turns out J.N., this is quite easy to do and if you have suitable variable capacitors, then why not. You'll need two air-dielectric tuning capacitors with a capacitance range of 20pF to probably around 500pF. As I recall, most air dielectric tuning capacitors range up to around 330pF, which may still be suitable. If not, you could try using the two sections of a two-gang capacitor connected in parallel. You then delete all components associated with the BB212. These are the BB212 itself, resistors R16, R17 and R18, capacitors C11 and C12 and the variable resistors VR1 and VR2.

The tuning capacitors are then connected with one connected in parallel with D1 and D2 and the other from the rotor of S2b to ground.

Note that in both cases, the rotor/frame of the tuning capacitor should be connected to the 'earthy' side of the circuit to prevent hand capacitance detuning effects.

Also, because the power supply requirements will no longer be so stringent, it's possible that a simpler regulator could be used. For example a simple zener diode and a series resistor might suffice.

What??

This question comes from Don Law (Tumblong NSW) who has posed questions for us before. This one is rather mathematical, and might prove a bit of a challenge. The question is:

An experimenter has two resistors connected in parallel and is calculating the resulting value. He is using the time honoured method of the product (xy) divided by the sum (x + y) on his calculator. However, while performing the calculation he presses the add button rather than the divide button, so that instead of dividing the sum into the product he *adds* the sum to the product. That is, he ends up with (xy) + (x + y) rather than (xy)/(x + y). The display shows 90. What are the values of the two resistors? Incidentally, the resistor values are whole numbers, not decimal values.

Answer to February's What?

If you didn't know that the VA rating of transformer in a centre-tapped rectifier needed to be higher than that for a bridge rectifier, here's why.

In Fig.2, let's assume the turns ratio is 1:1 and the input RMS voltage is 10V. Because the load resistor is 10 ohms, assuming no losses, the RMS current in the load will be 1A, the same as the primary current. Therefore, because VA equals the RMS current times the RMS voltage, the VA rating of the primary is 10VA. You'd expect the VA rating of each half of the secondary to therefore be 5VA. Not so!

In this circuit, each half of the transformer operates separately, and the waveform shows the current flowing in D1. The RMS value of this waveform equals half the peak value (this is easily

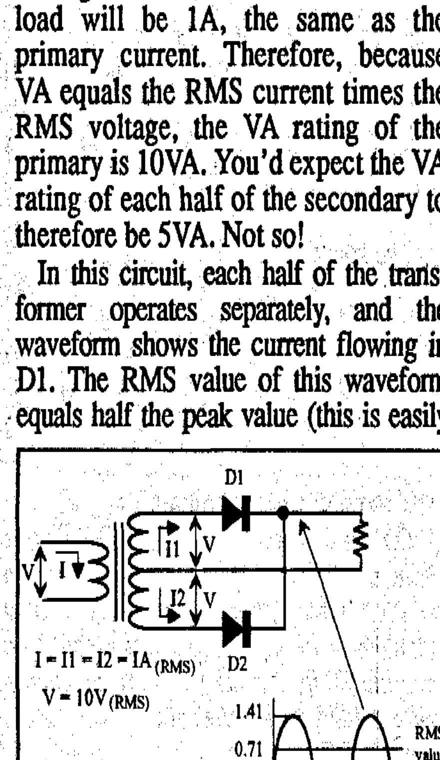


Fig.2

proven, but I'll leave the proof out of this explanation). Using the equation already explained, the VA rating of the top half of the secondary is therefore 0.71 x 10V, giving 7.1VA. The lower half needs to be the same, giving a total of 14.2VA. A bridge rectifier has AC in the secondary of the transformer, and for the example circuit, the secondary current will be 1A RMS, giving a VA for the secondary of 10VA. ❖

NOTES AND ERRATA

Automotive Engine Control - 2 (January 1992): On page 49, the range of typical opening times given for injector needle valves was in error by a factor of 10 times. The range of opening times should be from approximately one to five milliseconds.

240V Power relay (January 1992): As explained on p.94, resistor R2 is used to decrease the sensitivity of the triac. For those requiring a further decrease in that sensitivity, e.g., to stop the clock on your video from turning the relay on, when the video itself is off, try decreasing the value of the resistor. Start at around 1k and, if necessary, continue with decreasing values, until R2 shunts sufficient current around the diodes to give correct operation.

Also the schematic diagram on p.93 shows the top of the current-limiting resistor for neon2 (R4) connected to the active wire of the master socket. It should, of course, be attached to the active of the slave socket. ❖

NEW KITS FOR EA PROJECTS

Jaycar Electronics has advised that it has released the following kits for *EA* projects:

DOLBY SURROUND SOUND DECODER (January 1992): The Jaycar kit is a short-form version, which includes main and switch PCB's, all on-board components, rotary switch and pot. The catalog number is KA1741, and the kit is priced at $39.95.

LOW VOLTAGE CUTOUT (January 1992): This kit is complete with all specified components, and includes jiffy box and Scotchcal front panel label. The catalog number is KA1739, and the kit is priced at $22.95.

240V POWER RELAY (January 1992): The Jaycar kit again includes all specified components, including jiffy box and Scotchcal label. It carries the catalog number KA1740, and is priced at $49.50.

NOTE: This information is published in good faith, from information supplied by the firm or firms concerned and as a service to readers. Electronics Australia cannot accept responsibility for errors or omissions.

'El Cheapo' Car Voltmeter

Continued from page 91

Battery voltage	Yellow LED	Green LED	Red LED	Condition
less than 11.4V	fully on	off	off	Battery voltage too low. Check battery and/or charging system.
11.4V - 12V	partly on	partly on	off	Battery OK, but check charging system as output could be low.
12V - 13.7V	partly on	fully on	off	Normal operation
13.7V - 13.85V	partly on	partly on	partly on	Battery OK, but check charging system as output could be high.
more than 13.85V	off	off	fully on	Definitely a problem. Check charging system

Table 1

could use a fancier case, such as the case of an old watch or similar. With a bit of imagination and rustling through the junk box a suitable case might be found that can fit directly to the dashboard.

The PCB can then be fixed behind the dashboard, protected by the film container. The method of connection to the battery is also a matter of choice. The unit takes around 20mA, so it could be permanently connected to the battery. Otherwise, connect it so the ignition switch isolates the supply to the volt-meter when the ignition is turned off. For vehicles with a negative earth (most vehicles), the negative lead connects directly to the vehicle chassis, and the positive lead goes to the positive terminal of the battery. Reverse these leads for positive earth vehicles.

Ideally, the active lead (positive lead for negative earth vehicles) should be fused. This protects against the possibility of an accidental short between the active lead and the metal chassis. You might be able to connect the voltmeter at the fuse box, perhaps to a fused accessory such as the radio. Also, the leads from the voltmeter should have thick insulation in case vibration causes the insulation to chafe against the metalwork of the vehicle.

Of course the voltmeter doesn't have to be built into your car. You can use it as a pocket battery test instrument, if you wish.

PARTS LIST

Resistors

All 1/4W, 5%:

R1	470 ohm
R2	100 ohm
R3,5	10k
R4	680 ohm

Semiconductors

D1,2	1N914 or similar diode
ZD1,2	6.8V, 400mW zener (1N4736 or equiv)
ZD3	11V, 400mW zener (1N4741 or equiv)
Q1,2	BC547 NPN transistor (or equiv)
LEDs1-3	5mm LEDs: red, green, yellow

Miscellaneous

PCB coded CVM, 25mm x 39mm;
35mm film container;
mounting hardware for container;
hook-up wire;
automotive quality hook-up wire.

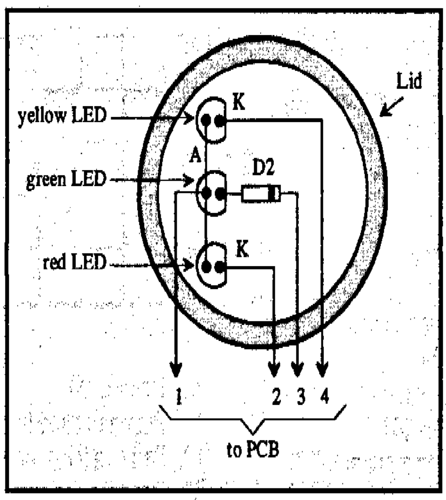


Fig.1 shows the underside of the lid and how the LEDs and D2 are fitted. When all leads have been soldered, hold everything in place with epoxy glue.

Display interpretation

As noted earlier, Table 1 shows the voltages obtained from the prototype for the various LED indications. These may vary a little, depending on the components and we suggest you bench test the unit before installing it.

The conditions shown in Table 1 are generalisations, and driving conditions should be taken into account. For example, if you're using high power driving lights, the battery voltage could drop below 12V. The battery voltage should recover under normal driving conditions, where a normal battery voltage is usually somewhere between 12-14V. And this little voltmeter will keep you informed. ❖

50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

March 1942

Corrosion resistance: An invaluable invention is the increasing of corrosion resistance in metals by impregnation with silicon.

The silicon alloy forming the case has valuable physical properties, and does not part from the core. It is virtually free from the tendency to split or flake.

The silicon impregnation is no more expensive than ordinary case-carburising. Thousands of transport vehicle parts have been used to replace expensive alloy steel parts when treated in this way.

Private warplane: Red-haired Squadron-Leader Keith Truscott, commanding officer of Australia's most famous fighter squadron, will in future fly his own Spitfire against the Germans.

It has been presented to him as a gift from the 'Red Heads of Britain', who have contributed 5000 pounds for its purchase.

March 1967

Ultraviolet laser: A tiny, transparent platelet of zinc oxide — the phosphor material with properties similar to those used on the face of a television tube — has made possible the development of the first solid-state laser to produce ultraviolet light.

The discovery is of both scientific and practical importance, since lasers of this kind might be used to produce novel types of TV pictures and radar displays as well as high speed computer printout devices.

Atomic power station: The State Electricity Commission of Victoria has started preliminary planning for a possible nuclear power station in the State by the mid-1970's.

The SEC has appointed a study group to examine the economic feasibility of nuclear power as a means of generating electricity, and is discussing the project with the Commonwealth Atomic Energy Commission.

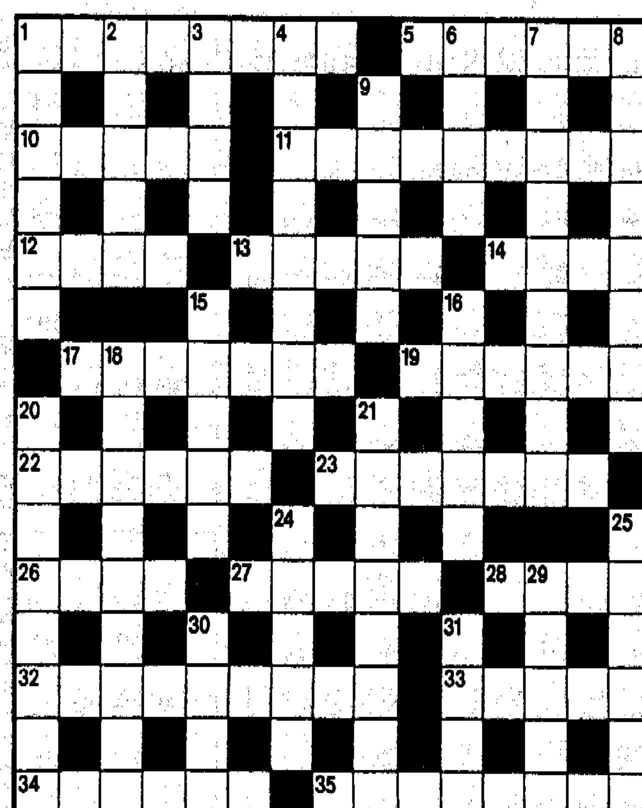
The Commission has made it clear for some time that nuclear power would be considered, along with brown coal and natural gas, as a possible power source for development after the present brown coal base-load program, which is definitely planned ahead until the mid-1970's.

High-speed teleprinter: A teleprinter with a print-out speed of 250 characters per second has been produced by Motorola in USA.

Said to be a considerable advance on existing equipment, it achieves its fast printout time by using electronic pulses to form characters on electrically sensitive paper.

The unit can accept a variety of input codes, including those used in digital computers and data processing systems. There are no impacting keys and the equipment is virtually noiseless. ❖

EA CROSSWORD



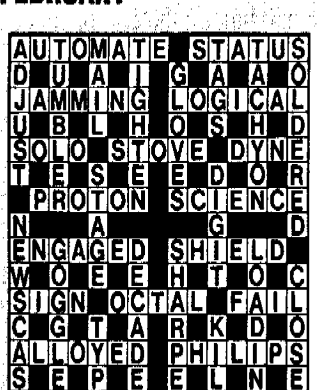
ACROSS

1. Small instruction manual. (8)
5. Word indicating a number. (6)
10. Charged layers, the Van ---- belts. (5)
11. Twelve-sided figure. (9)
12. Miniaturised. (4)
13. Electronic musical instrument. (abbr) (5)
14. Form surface pattern. (4)
17. Frequency band. (7)
19. Region of a ferromagnetic substance. (6)
22. Special yearly magazine. (6)
23. Components in chains. (7)
26. A magnetic compass does this. (4)
27. Non-trunk telephony, the —— call. (5)
28. Blue-green colour. (4)
32. The study of memory improvement. (9)
33. Symbol used with resistance. (5)
34. Compass component. (6)
35. Portable. (4-4)

DOWN

1. What's protected by a dosimeter? (6)
2. Tough thermoplastic polyamide. (5)
3. Big ——, a cosmological explosion. (4)
4. One using a gnomon? (3-5)
6. Hold at fixed settings. (4)
7. Such is a Fleming rule. (5-4)
8. It's written extensively. (8)
9. Summed. (5)
15. Unlock. (5)
16. Put one's hand in contact. (5)
18. Part of a telephone set. (9)
20. One who does small repairs. (8)
21. Country rich in element 50. (8)
24. Pertaining to sound waves (5)
25. A device of course! (6)
29. Waitlist. (5)
30. Instrument facilitating assembly, etc. (4)
31. Group of characters. (4)

SOLUTION FOR FEBRUARY



EA with ETI marketplace

ADVERTISING RATES FOR THIS PAGE

SMALL ADS: The minimum acceptable size of 2 centimetres x one column costs only $50. Other sizes up to a maximum of 10 centimetres are rated at $30 a centimetre. **CLASSIFIEDS:** $4 for 40 letters. Just count the letters divide by 40 and multiply by $4, ROUND UP TO THE NEAREST WHOLE NUMBER. **CLOSING DATE:** Ads may be accepted up to the tenth of the month two months prior to issue date. **PAYMENT:** Please enclose payment with your advertisement. Adress your letter to: **THE ADVERTISING PRODUCTION MANAGER, ELECTRONICS AUSTRALIA, P.O. BOX 199, ALEXANDRIA NSW 2015 FAX: (02) 693 9997**

FOR SALE

CHIPSPEED KITS AND PARTS: All night hi-light kit (EA Nov 90) $67 plus $10 P&P or $5 Sydney. Extended Pulse Burn electronic ignition kit (AEM Feb, Apr 87) $70, fully built and tested $99, includes P&P.6,9,12V 300mA plugpack $17, includes P & P. Metal film resistors, 0.6W, 1RO to 1MO, $5.50 per 100 (can be mixed) plus $2 P&P/1000.220nF 630vdc polycarbonate $1.BUX80 $7.60. Send SAE for resistor sample/prices of gates 2.5,5 and 12,5 A/H sealed lead acid cells. Chipspeed Electronics PO Box 38 Casula Mall 2170.

WEATHER FAX PROGRAMS: For IBM XT/AT's *** "RADFAX2" $35, is a high resolution, shortwave weather fax, morse & RTTY receiving program. Needs CGA, SSBhf radio & RADFAX decoder. Also "RF2HERC", "RF2EGA", & "RF2VGA", same as RADFAX2 but suitable for Hercules, EGA & VGA cards respectively. *** "SATFAX" $45, is a NOAA, Meteor & GMS weather satellite picture receiving program. Uses EGA or VGA modes. Needs EGA or VGA color monitor and card, + "WEATHER FAX" PC card. *** All programs are on 5.25" OR 3.5" disks (state which) + documentation, add $3 postage. ONLY from M.Delhunty, 42 Villiers St, New Farm 4005, QLD. Ph: (07) 358 2785.

TELONIC HD-1A: sweep generator 1-1000 Mhz,Cintel square wave generator 1Hz-1Mhz, Airmac modulation meter AM & FM, A.W.A distortion & noise meter A51932, Hewlett Packard 524C frequency counter all attachements. Older type instruments in perfect operating condition, $50.00 each, ph (02) 688 1936.

XT/AT HANDBOOK BY CHOISSER & FOSTER: Pocket size 92 pages . For Engineers & Programmers, & other serious PC/XT & PC/AT users. A collection of hardware & software facts and data on the PC compatible family and its operating system. Latest edition. This is the one advertised by Annabooks in U.S. mags Byte, Dr. Dobb's Journal, etc. $20 icluding postage. 5 or more $15 each. Don Mckenzie 29 Ellesmere Cres Tullamarine 3043.

AMIDON FERROMAGNETIC CORES: For LF/HF/VHF/UHF applications. Send DL size SASE for data/price to RJ & US IMPORTS, BOX 431 KIAMA NSW 2533. Agencies at Geoff Wood Electronics, Albury. Assoc TV Service, Hobbart: Electronics Components, ACT: Truscott Electronics, Melbourne T.V.

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SECURITY ALARM COMPONENTS: Commercial quality alarm panels, detectors, cable, everything for complete alarm system. Discounted prices. 4 Core alarm cable $35 per 100m. 2 core alarm cable fig.8 $15 per 100m P.I.R. Detectors pulse count $59 ea, Horn Speakers $12.50 ea. Alarm control modules $69.50 ea. Mail Order Service Send S.A.E. for free price list to Security Distributors 141 Todds rd Lawton QLD 4501. Ph: (07) 882 0002

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BARGAIN PRICED LASER!: A BIGGER LASER! This SPECIAL priced kit includes a brand new large 3-5 mW HE-NE laser tube, and high quality potted 12V laser power supply to suit. Use them for effects, surveying, holography, healing, etc. Definetly not for kids!: LASER LIGHT AND HIGH VOLTAGEDANGERS! The price is an incredible $199 for the tube and a supply. Certified P + P: Australia $5...N.Z.(air-mail): $10 Major cards accepted with phone and fax orders. Oatley Electronics, P.O. Box 89 Oatley NSW 2223 Phone: (02) 579 4985 Fax: (02) 5707910.

Basics of radio

Continued from page 55

conductive ceramic 10-turn pot for Ro would be nice. Notice that we split Ro into fixed and variable parts in series, for two reasons. Firstly this way the resistance adjustment is smoother. Secondly we never want Ro to go to zero. The potentiometer part of Ro should be soundly manufactured and mechanically stable. None of those cheap miniature types, please!

When no station is being received the NE565N runs at a VCO centre frequency fo given by:

fo = 1/3.7 RoCo

where: fo is in Hertz

Ro is in ohms

Co is in Farads

and the VCC supply is +/-6V.

Assuming stable values for Ro and Co, this centre frequency may drift due to temperature change, typically 200ppm/°C (i.e., 200 parts per million per degree C).

The supply voltage should also be stabilised by simple zener diodes. Otherwise the centre frequency may change by 200ppm for each 1% change in supply voltage. Fig.2 shows the NE565 working on +/-6V supply, drawing from 8 to 13mA. With suitable changes to the circuit, you could use supply voltages up to +/-12V. This unit works well for input signals f(in) greater than 10mV RMS. The audio output at pin 7 will be in the low hundreds of millivolts range (p-p).

More questions?

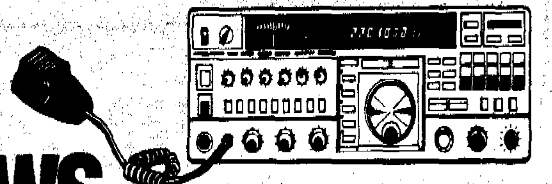
You may well have more questions about the PLL demodulator, such as:

(1) Do we have to set the centre frequency with extreme precision?
(2) What if our receiver's local oscillator drifts?
(3) Or if the carrier of a cheap walkie-talkie transmitter wanders?
(4) How does the PLL reject AM?
(5) How sensitive is the phase detector?
(6) What about stereo?
(6) How about noise?
(7) Can we select the audio bandwidth?

But for the moment, we'll leave it there until next time. Then we will delve deeper into the fascinating PLL, for it is truly one of the most versatile electronic building blocks, whose uses are limited only by your imagination.

Thanks to Signetics, Motorola, National and other manufacturers for data and specs on the chips mentioned in this chapter. ❖

Amateur Radio News



Pirates caught, fined

A recent weekly broadcast from VK2WI reported that the DoTC has prosecuted two users of CB transceivers that had been modified for 'out of band' use.

One such 'pirate' in Perth was fined $3500, while the other on the Gold Coast was fined $6000 — plus court costs in both cases. The Gold Coast user also had all of his radio equipment and test instruments confiscated.

The VK2WI broadcast commented that the prosecutions are part of a DoTC campaign to 'toughen up' on people who use equipment, including illegally modified equipment, to operate out of their designated bands.

Antenna for WICEN use

Also from a recent VK2WI broadcast comes news that a dual-band 2m/70cm antenna has been installed on the State Emergency Service building in Hornsby, Northern Sydney, for use by WICEN (Wireless Institute Civil Emergency Network).

The antenna was installed by Barry White VK2AAB and Dave Horsfall VK2KFU, and tests showed that it allowed contact with both Newcastle and Wollongong — giving a good idea of its coverage.

The long-term plan is to install WICEN antennas on all SES buildings, as funds allow.

Interesting book on RAAF radar

Colin MacKinnon, VK2DYM has sent brief information on a new limited-edition book called *Radar Yarns*, the first in a series being published by a committee of ex-RAAF personnel to document the history of RAAF ground radar during WW2.

Edited by Ed Simmonds and Norm Smith, *Radar Yarns* is in the A4 format and runs to 230 pages. It gives an introduction to RAAF radar, followed by a most interesting compilation of the experiences of operators and technicians while serving on radar stations.

The book includes the most complete known listing of RAAF ground radar stations around Australia and in the Islands, plus photos of installations.

Very little has yet been published on the introduction of radar to the Australian armed forces, which should make the book of considerable interest. VK2DYM describes the stories it presents as 'enthralling', and says it really makes one appreciate the trials and tribulations endured by those involved in pioneering this highly technical and then secret development.

Copies of *Radar Yarns* are available for $24 posted, from Colin MacKinnon, 52 Mills Road, Glenhaven 2156.

New VK2 6m record

A new VK2 record for contacts on 50MHz has apparently been set by Mike Farrell VK2FLR, according to the NSW Division's resident VHF advisor Roger Harrison VK2ZTB.

In late November VK2FLR used 50MHz to make contact with the Azores, a distance of around 20,000km — breaking his own record of a week or so before, wherein he had worked GI4JCD, on the island of Jersey in the English Channel.

Apparently VK2FLR then went on to work US amateur W5UN via 2m EME ('moon bounce') on November 23, with VK2DVZ in Northern NSW also making contact with W5UN on the same day. Congratulations to all, and especially VK2FLR.

Mobile phone users fined

No doubt most radio amateurs will be aware that operating a mobile transceiver wile driving is not only very dangerous, but is also illegal.

Operating a mobile cellular telephone while driving is also illegal, at least in NSW, unless it is operating in 'hands free' mode (which all mobile cellular phones are required to provide). Despite this, it's surprising how often one sees motorists driving along with a phone handset in one hand.

The NSW authorities are apparently putting increasing effort into enforcing the law, however. According to a report in the *Sydney Morning Herald*, some 1057 NSW motorists were fined during the first eight months of 1991 for using a hand-held telephone whiledriving.

Another 99 were fined for either answering, or attempting to answer a call while driving. either answering, or attempting to answer a call while driving. These offences carry a fine of $85 each. ❖

Electronics Australia's

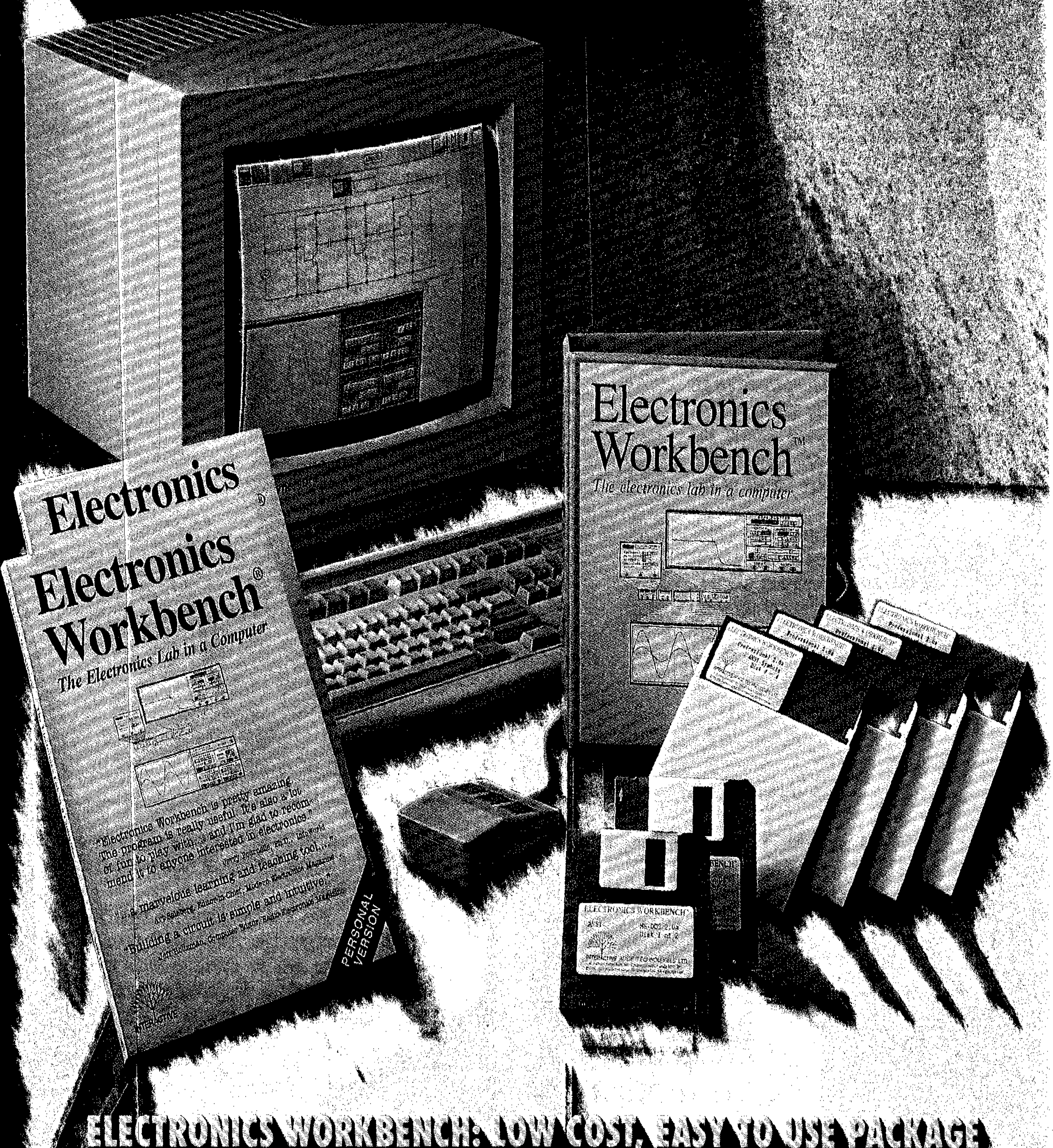
Professional Electronics

S • U • P • P • L • E • M • E • N • T

APPLE TO DEVELOP CONSUMER PRODUCTS

FEATURES ON PC ENHANCEMENTS:

FRIEN... TEACHES SIMULATION; ...ONTROLLER ENHANCES, ...EEDS LASER PRINTING; ...COST DMM HAS RS232



ELECTRONICS WORKBENCH: LOW COST, EASY TO USE PACKAGE THAT TEACHES THE BASICS OF ANALOG & DIGITAL SIMULATION

NEWS HIGHLIGHTS

FCC BACKS MOTOROLA'S IRIDIUM

The US Federal Communications Commission (FCC) has made a formal submission to the International Frequency Registration Board (IFRB), requesting an international frequency reservation for low earth orbit (LEO) satellite systems.

The FCC action reinforces the US position at this year's World Administrative Radio Conference (WARC-92), and is seen as strong evidence that the FCC intends to implement a LEO-type system — probably Motorola's Iridium system.

This is the first announcement by any country of its intention to implement this innovative technology for radiodetermination and mobile satellite services.

Leo Mondale, vice president of Motorola affiliate company Iridium Inc., said "We applaud the FCC's foresight. By submitting low earth orbit satellite frequencies for use within five years, near-term implementation of an Iridium type LEO system can be a reality."

"Motorola has developed the Iridium system to be owned and operated by an international partnership, uniting carriers and equipment companies around the world to deliver universal, truly portable communications to every corner of the globe."

The Iridium system is a proposed global personal communications system, to permit users of hand-held phones to communicate with any other user at any time, and from anywhere in the world. Licensing authority for the system is currently being considered by the FCC.

PC'S CONTROL SA GRAIN TERMINAL

One of the world's most advanced grain handling systems has been installed at Wallaroo in the north west of South Australia, in time to handle over half a million tonnes in the latest coming harvest.

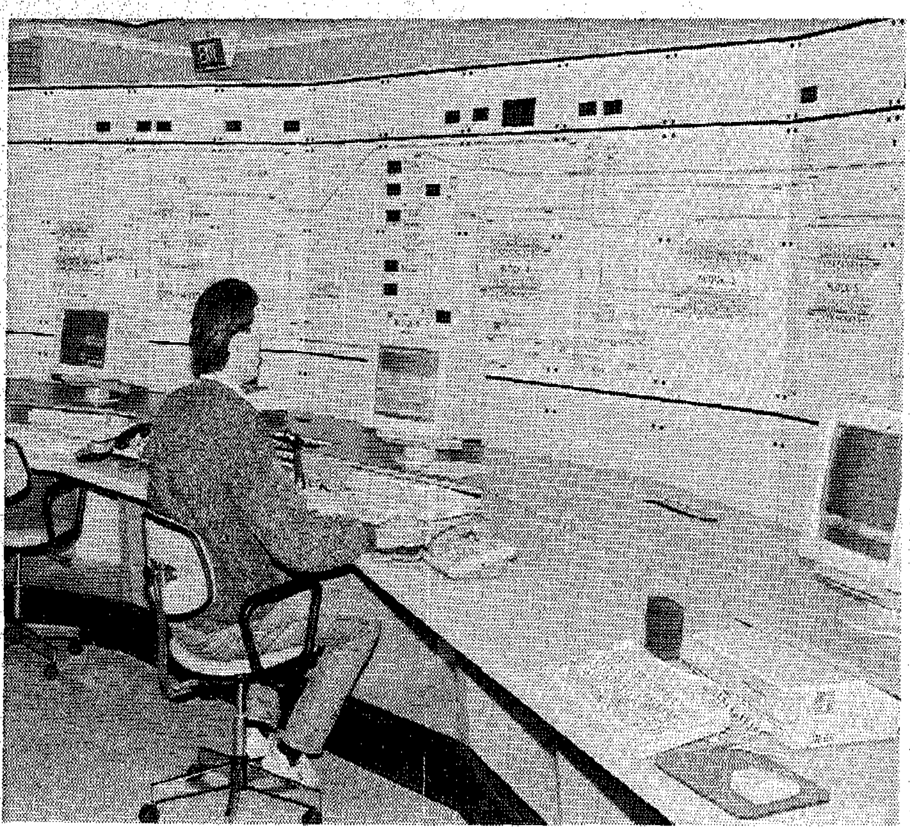
One of the most remarkable features of the Australian developed system is that it relies totally on computer hardware available to most Australian schools.

Intertech won the contract to automate the grain handling terminal's control process, based on earlier systems the company had installed in Port Lincoln and Port Giles terminals for South Australian Co-operative Bulk Handling Limited.

"Each of the solutions has been with microcomputers at the core — starting with Acorn BBC Model B's seven years ago — as they proved more flexible to program and more user friendly to the operator," said Earle Rowan, Intertech MD.

The Wallaroo system is based on 10 Acorn Archimedes RISC systems. One is located in each storage block, one in the central control room and one in the Manager's office and Assistant Manager's office. The system is linked via a two-tier local area network so that any controller can control the total plant is required.

The systems are connected to more than 5000 discrete signals, switches and analog sensing devices via 25 kilometres of signal wire, and the display shows the exact status of each block, or the complete system in real time.



AWA-RTA LAND BIG HK TRAFFIC CONTROL CONTRACT

Australia's AWA has entered into a contract with the Hong Kong Government to implement an Advanced Traffic Management System (ATMS) for the Kowloon and Tsuen Wan areas. The contract, which has a total value in excess of A$27 million is believed to be the largest contract for such a system ever let.

AWA chairman and chief executive Mr John Iliffe attributed this success in the main to the close cooperation between AWA and the NSW Roads & Traffic Authority, which is supplying the SCATS traffic management software.

"Not only will the NSW Government receive over A$4 million from AWA for software licences and support, but the contract also provides a significant export boost for Australian manufactured products," he said.

All of the equipment to be supplied under the contract is to be manufactured by AWA at its Homebush, NSW factory.

The contract provides for the installation of the SCATS traffic signal system at 512 intersections in Kowloon and Tsuen Wan.

The SCATS system has been installed in every major Australian city except Brisbane and in countries including New Zealand, Singapore, Philippines, Malaysia and Ireland. It now controls 5,300 sets of traffic lights in 29 cities around the world.

A recent AWA contract for its installation in Oakland County, Michigan, is regarded as a significant breakthrough into the United States market.

The contract, announced in mid-October of last year, represents the first high-tech traffic control system of its type ever installed in the US.

FIRST LAB SAMPLES OF 64MB DRAMS

Siemens AG and IBM Corp have announced that, as part of their joint development of the 64-megabit memory chip, the 'first silicon' laboratory samples have been produced.

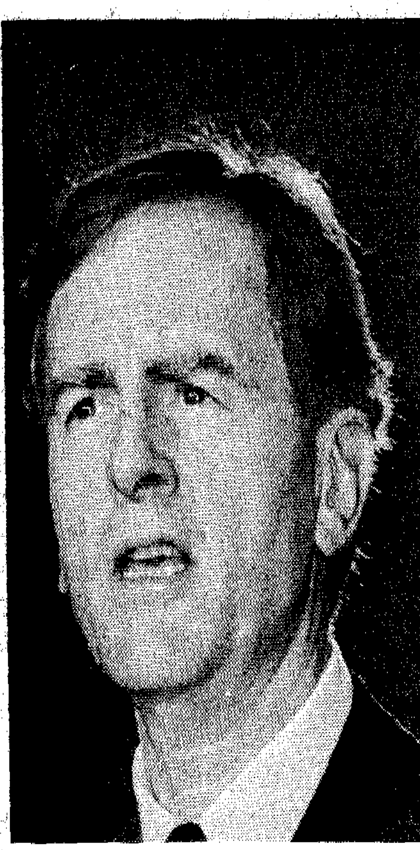
With this coup, both companies have underlined their technological leadership. Their January 1990 agreement for joint development of the 64-megabit DRAM has now reached its first critical milestone on time.

The 67,108,864 bits on the surface of the 64-megabit DRAM enables the storage of the data equivalent of nearly 4000 pages of typing. A time plan for the market launch of the new memory chip was not announced, but generally mass production is expected about the middle of the 1990's.

The newly built 'Advanced Semiconductor Technology Centre' of IBM in East Fishkill, New York will be used as the pilot line for the 64Mb DRAM. The joint work on design, test technology and packaging of the chip is based in Essex Junction, Vermont. The development team, half from Siemens and half from IBM, has based its work on preliminary designs by Siemens in Munich and by IBM in Essex Junction.

The world market for semiconductor components has currently reached around US$55 billion (A$71 billion), with more than a quarter of this market in DRAM memories — of which 4-megabit and 1-megabit versions are the current top sellers. The 16-megabit chip developed by Siemens and IBM is expected to be mass produced in the next year or so.

APPLE PLANNING CONSUMER PRODUCTS



In a speech given at the US Consumer Electronics Show in Las Vegas, Nevada in January, Apple Computer's chairman and CEO John Sculley unveiled plans for his company to expand into the consumer electronics market. But not merely as another maker or supplier of today's familiar products — rather as a developer of innovative 'personal digital assistant' or PDA products, which Apple sees as the next big growth area.

Mr Sculley noted that conventional consumer electronics is in the process of converging with personal computing, and that these are both converging with entertainment, communications, education and publishing — to create a new and potentially enormous digital consumer information market.

Apple see its reputation for innovative development of computer products, combined with its expertise in integrating hardware and software components to achieve products that are both 'friendly' and easy to use products, as placing it in an ideal position to play a key role in the new market.

During the second half of 1992, he explained, Apple will be introducing consumer-specific versions of low-end Macintosh computers, in the USA. These products will interface with and control devices like VCR's and laserdisk players, to form the basis for multimedia systems.

The next stage will be to develop and release a range of PDA-type consumer products, including such devices as electronic books, electronic organisers, multimedia players, electronic note takers, display telephones and personal communicators.

These products are likely to begin appearing in 1993, and will be released both under the Apple brand and under other brand names, as Apple is currently in the process of setting up strategic relationships with existing major consumer electronics firms.

Referring specifically to digital telecommunications, Mr Sculley noted that Apple has been actively working in this area for several years — working on both wired and wireless systems:

"We are interested in playing an important role in creating easy-to-use devices for digital-based services. We expect that the advent of digital television and digital telephony will create a logical follow-on of opportunities to the first wave of standalone PDA's."

In his summary, Mr Sculley warned that "The digitals are coming! So is pervasive networking that will dramatically increase the range of home-delivered services. And Apple intends to be there as a leader in this segment of the consumer electronics industry, through constant innovation and the best possible ease-of-use technology. We are choosing a path which builds on our strengths and at the same time shares some of our best technologies with some of the world's best consumer electronics companies."

INMARSAT DEVELOPING GLOBAL PAGING

Business executives and professionals on the move are likely to have access to a global satellite paging service using pocket-sized receivers, as early as 1994.

Designed to operate via the Inmarsat satellite system, the pagers will enable mobile users on land to receive messages no matter where they are in the world. This will enable travelling executives, journalists, and couriers to be contacted by their offices.

Although wide area terrestrial paging services are available in many countries, including some that involve use of satellites for inter-system connections, the Inmarsat satellite paging service will be the first global, direct paging service via satellite, operating to a single worldwide standard. It is designed to provide a higher degree of penetration into urban areas than would normally be achieved by purely line-of-sight mobile satellite services.

Inmarsat, a 64-nation cooperative, operates a system of geostationary satellites to provide global mobile telephone, telex, facsimile and data services to maritime, aeronautical and land mobile users all over the world. The decision to include paging in Inmarsat's portfolio of services was taken by Inmarsat's governing Council at its 41st session that concluded in London late last year.

The decision on paging follows a series of technical and commercial studies and experiments over the last couple of years. This new service is designed to complement existing and planned terrestrial paging systems by providing a very wide area of coverage at affordable prices through the Inmarsat global satellite network.

NEWS HIGHLIGHTS

The system will provide for conventional tone paging, as well as alphanumeric messages and various forms of data, to be displayed on a small LCD screen.

A variety of receiver models are expected to be available — from pocket-sized stand alone units, to those integrated into briefcase-sized Inmarsat-C/M satcoms terminals, and receivers designed for installation on commercial vehicles.

With satellite pagers integrated into their Inmarsat briefcase satcoms terminals, subscribers can be paged and advised to call their offices, even if their terminals are turned-off.

WEEKLY CMOS IC PROTOTYPING

Orbit Semiconductor is now offering a weekly prototyping service for CMOS integrated circuits, available to Australian and New Zealand IC designers via Integrated Silicon Design Pty Ltd in Adelaide, South Australia.

Custom IC designs can now be fabricated much faster than previously, in any of Orbit's 22 standard CMOS processes.

The new Orbit Foresight program is similar to the well-known MOSIS program. A full custom design 2.4 x 2.4mm can be fabricated, and twelve 40-pin DIP packaged parts delivered for as little as A$2600.

Designs as large as 9.6 x 9.6mm can be accepted, as well as other packaging (including PGA), at additional costs. Process options available include 1.2, 1.5 and 2.0 micron double metal and/or double poly, Pwell or Nwell CMOS, and BiCMOS.

Further details are available from ISD at PO Box 99, Rundle Mall, Adelaide 5000; phone (08) 223 5802.

NASA READIES U-V ASTRONOMY SATELLITE

NASA's Extreme Ultraviolet Explorer (EUVE) satellite has been scheduled for launch on May 28, 1992, from the Cape Canaveral Air Force station in Florida.

Originally set for launch on January 16, the launch was rescheduled because EUVE had to accomplish two critical milestones at the Goddard Space Flight Centre, Greenbelt, Md, before it was shipped to Kennedy Space Centre, Fla. The two milestones were Modular Antenna Pointing System (MAPS) acceptance testing and software/hardware verification.

These milestones were scheduled to be completed earlier, but there were problems with the printed circuit boards and electric motors in the MAPS.

The EUVE will map the entire sky to determine the existence, direction, brightness and temperature of thousands of objects that are sources of extreme ultraviolet radiation.

The scientific mission of EUVE will consist of a six month all-sky survey, which will be followed by a spectroscopy phase of at least one year.

In the spectroscopy phase, individual targets, whether discovered in the all-sky survey or identified from other information, will be analysed in detail through individual observations made with an onboard extreme ultraviolet spectrometer.

US FIRMS LINK FOR HDTV R&D

Three leading US companies — Zenith Electronics Corporation, AT&T Microelectronics and Scientific-Atlanta, Inc — have joined forces in the worldwide race on advanced television technologies. The companies are working together on all digital technologies to deliver noise-free HDTV images in terrestrial, satellite and cable television systems.

In Europe and Japan, advanced TV efforts have focused on analog transmission systems via satellite. In addition to digital HDTV, Scientific-Atlanta and Zenith are taking a lead role in innovative digital technologies for compressing and transmitting standard TV signals via satellite and cable television systems.

Scientific-Atlanta will develop the necessary transmission system and equipment to allow secure satellite transmission of the Zenith/AT&T DSC-HDTV signal to make HDTV programming available to all markets and to support a timely market introduction.

Under a separate agreement Zenith Advanced Television and Scientific-Atlanta have developed a common transmission structure for carrying the Zenith/AT&T digital HDTV signal and Scientific-Atlanta's digitally compressed standard TV signal from the television studio over satellite and through cable television systems to the home.

The new digital program delivery system will include delivery over both satellite and cable and would allow two HDTV signals or four to ten digitally compressed standard television signals in one satellite transponder and one HDTV and from two to five digitally compressed signals down a cable to a television subscriber's home.

The system will combine the powerful Vector Quantisation (VQ) compression system for standard TV signals, with Zenith's rugged four level vestigial sideband (VSB) modulation technology.

TAI/OLEX COMPLETE PAKISTAN F-O LINK IN RECORD TIME

Telecom Australia International (TAI) and Olex Ltd have completed a 2000km optical fibre system in Pakistan in record time.

After winning the contract to lay an optical fibre trunk route from Islamabad to Karachi, the joint venture partners took just 10 months to complete construction of the project, which was ready for ac-

NEWS BRIEFS

- ***PC92*** and ***Communications & Office Technology 92*** will both be held at Darling Harbour, Sydney on 10-13th March 1992. The PC show is Australia's longest running personal computer show, and is held concurrently with a display of the latest in communication technology and office equipment.
- The computer cable manufacturer ***Kooka Connections*** and the data communications products wholesaler ***Data Accessories Australia*** have merged. Their new business premises are located at 117 North Road, Denistone East 2112; phone (02) 878 5344.
- The National Secretariat of the ***Australian Electric Vehicle Association*** (AEVA), and its publication EV news, have a new address: State Electricity Commission of Victoria, Energy Services Department, Monash House, 15 William Street, Melbourne; GPO Box 4622SS, Melbourne 3001; phone (03) 691 4094.
- Sydney-based communications equipment supplier ***Sam Technology*** has been appointed as Australian distributor of the Finnish Teleste antenna range of TV communications equipment, components and systems.
- The Association for Information and Image Management will hold its inaugural Conference and Exhibition at the Darling Harbour Convention Centre from 3-5 March, 1992. The theme of ***AIIM'92*** will be 'Optical & Image Processing'. Phone (02) 954 5844.

ceptance testing by the Pakistan PTT in late January.

Commissioning and handover is expected to take place by the end of March.

TAI's Managing Director Mr Ken Loughnan said the project was one of the most prestigious in the region and had been an outstanding success.

Mr Loughnan said the efficient planning and installation of the optical fibre route had set the foundation for further offshore expansion by the merged Telecom/OTC.

"One of the strengths of TAI is that it provides a platform for other local industries to launch themselves overseas," Mr Loughnan added.

"As such, TAI's activities form a solid foundation for increasing export income and job creation in Australia. Because of TAI's involvement in Pakistan, more than 35 other Australian companies have had opportunities to export their products and services to this part of the world," Mr Loughnan said.

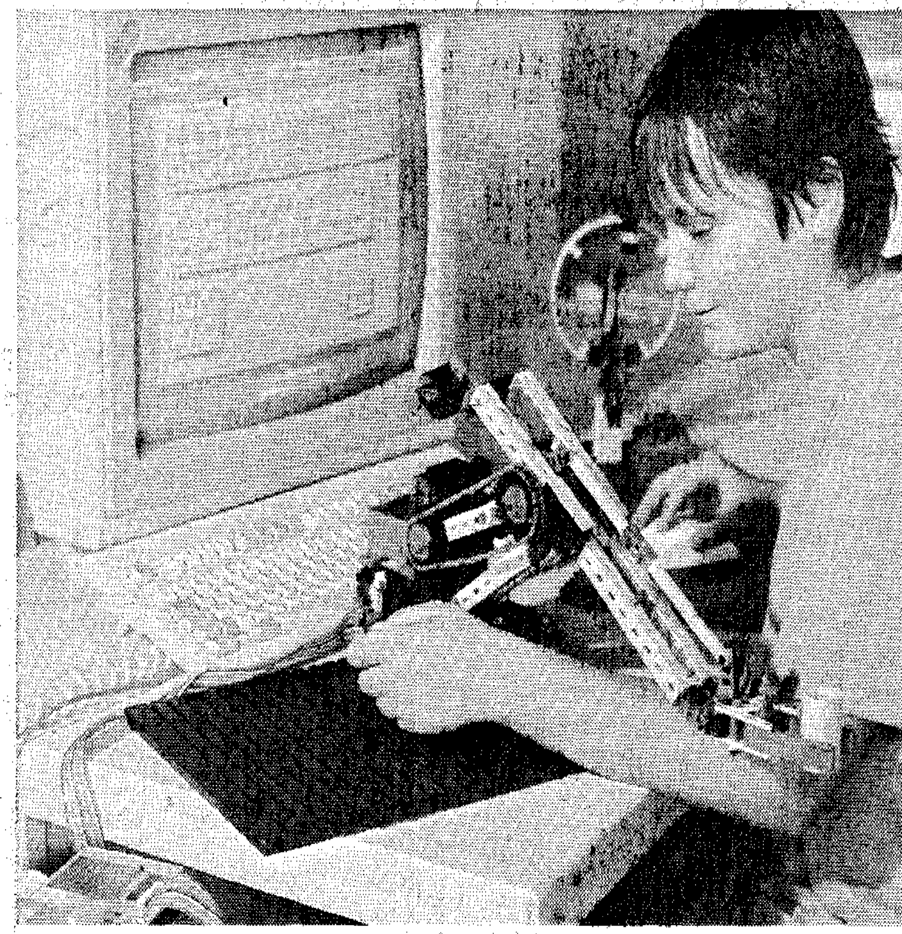
NEW EXECUTIVE DIRECTOR FOR AEEMA

Mr Alex Gosman has been appointed to the position of Executive Director of The Australian Electrical and Electronic Manufacturers' Association following the retirement of Mr Dick Brett from full-time duties with AEEMA at the end of 1991.

Mr Gosman has been the Deputy Director of AEEMA since September 1989 and has had primary responsibility for telecommunications and broader industry policy issues.

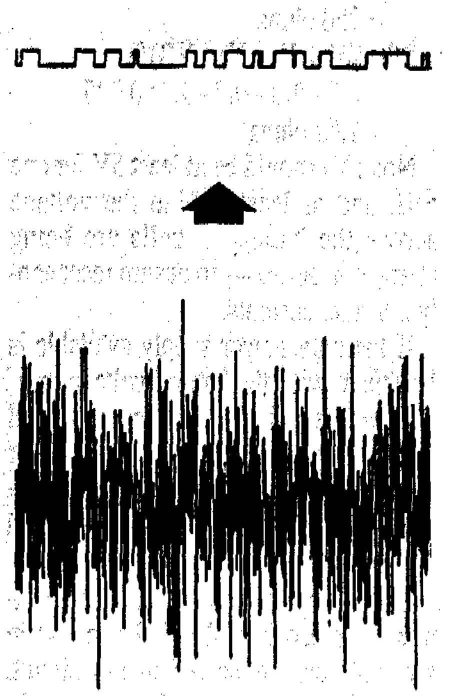
Prior to joining AEEMA, Mr Gosman was a Senior Industry Analyst with the Commonwealth Department of Industry, Technology and Commerce, where he worked in the anti-dumping and information technology areas. He has a B.Ec from the ANU.

Under Mr Gosman's direction AEEMA will further develop its profile and position as the 'advocate' in Canberra for the electrical and electronic industries — industries that are essential to Australia having a developed manufacturing capability.



German educational product maker Fischertechnik has developed a professional level training system called 'Computing', shown here being used by a rather young professional. The system is used for training in the operation of process controllers, guidance systems and robots. Although described as 'a professional level construction set', it is also described as 'an interesting gift for young people'.

ANU DEVELOPS IMPROVED DSP



A team of researchers at the Australian National University has developed an improved technique of using adaptive digital signal processing to extract wanted signals that are buried in noise.

The software involved runs on a desktop computer, and has been used in the ANU John Curtin School of Medical Research to extract low-level neurological signals from noise and 50Hz hum — almost inevitable when measuring extremely small signals, even with the best available instruments.

Led by Professor John Moore, of the Department of Systems Engineering in ANU's Research School of Physical Sciences and Engineering, the team developed special ADSP algorithms which are said to offer a tenfold improvement in the ability to extract signals from surrounding noise and hum.

THIRD INMARSAT-2 SATELLITE LAUNCHED

The third of the Inmarsat-2 mobile communications satellites has been successfully launched from Kourou, French Guiana. The satellite, the third of a new generation of four spacecraft, will provide a wide range of global mobile communications for ships at sea, aircraft and mobile users on land, including telephone, telex, electronic mail, facsimile, data and position reporting, fleet management and safety and distress communications.

The satellites have been built by a consortium headed by British Aerospace for Inmarsat, the 64-member country international cooperative. Inmarsat already operates a global satellite system of nine spacecraft.

The new Inmarsat-2 F3 spacecraft will be deployed over the Pacific Ocean coverage region at 179° East longitude, and was scheduled to enter commercial service on 19 January, 1992. ❖

LONGER LIFE FOR NICADS - 2

In the first of these articles we discussed the reasons why NiCad batteries fail, and gave some practical hints on how to prolong their life. This month we look at several circuits which will achieve this result...

by JAMES MOXHAM

The rate at which NiCads are recharged is a compromise between too small a trickle charge, which favours the formation of cadmium dendrites, and too large a charge which produces too much gas and so causes the loss of electrolyte.

A NiCad cell is characterised by a rated capacity C, which represents the number of ampere-hours (Ah) which it can deliver under nominal conditions of charge, discharge rate and ambient temperature. Fig.1 gives the rated capacity C for various sized cells. It also gives the current to recharge them at 0.1C over a 14 hour period.

Fig.2 shows a simple circuit used in some commercial chargers. It is repeated for each cell to be charged. So, to charge three cells, build the circuit three times. Some commercial chargers only charge even numbers of cells, but this circuit is flexible.

To calculate the values for R1 and R2, use Ohm's law. I.e., resistance is given by voltage/current.

For example, to charge an AA cell at 0.1C (45mA) from a 12V supply with the LED current = 5mA:

Fig.2

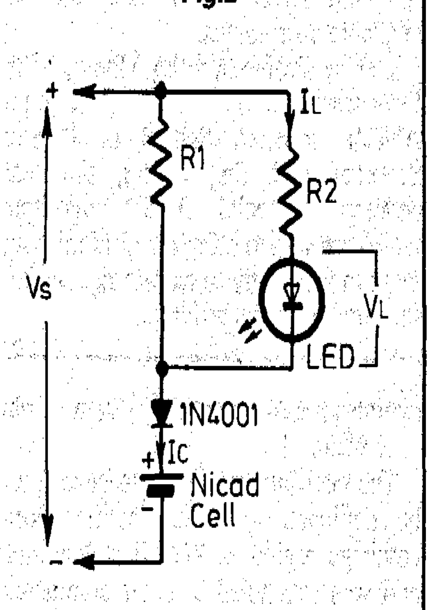


Fig.1

Capacity & Charging Current for NiCad Cells

Size	Capacity	Charging Current
N	150mAh	15mA
AAA	180mAh	18mA
AA	459mAh	45mA
C	1.2Ah	120mA
D	1.2Ah	120mA
C (high capacity)	2.0Ah	200mA
D (high capacity)	4.0Ah	400mA
9V	110mAh	11mA

$R1 = (V_S - V_D - V_B)/(I_C - I_L)$
$= (12 - 0.7 - 1.3)/(0.045 - 0.005)$
$= 250$ ohms
$R2 = (V_S - V_L - V_D - V_B)/I_L$
$= (12 - 1.8 - 0.7 - 1.3)/0.005$
$= 1.6$k ohms

Note: V_S should be at least 5V for one cell, and at least double the voltage across the battery if cells are being charged in series — to ensure reasonably constant currents.

If the only power supply available is less than twice the battery voltage, or if the number of cells to be recharged varies, then a constant current generator circuit is required. Fig.3 shows a charger of this type which can be used for currents up to 100mA.

The LED provides the constant voltage reference and also indicates when the cells are connected in the circuit. For a 12V supply, typical values for R1 would be 47 ohms (AAA cell, 18mA); 15 ohms (AA cell, 45mA); and 8.2 ohms (C or D cells, 100mA). With a 12V supply, up to six cells can be charged in series.

Fig.4 is an alternative circuit for charging higher capacity C and D cells. The 22k pot can be replaced with a switched resistor chain if charging is required at different rates; for example if you wished to charge 2Ah C cells at 200mA and 4Ah D cells at 400mA.

Although the best way to prevent overcharging is to fit a timeout mechanism, such circuits are more complex and expensive. I have found it more convenient to build a series of less costly chargers, even though this requires me to remember to turn them off after 14 hours.

Dendrites

If you are having persistent trouble with dendrites, then it is worth trying the circuits in Figs.5 and 6.

Dendrites are threads of cadmium deposited on the electrode during trickle charging, which can easily short out the cell and so lose charging capacity.

Dendrite suppression is widely used in the electroplating industry for metals such as copper, zinc, silver and cadmium. The idea is to use biased AC rather than DC current. This alternately charges and discharges, but the charging current is greater than the discharging one.

Fig.3

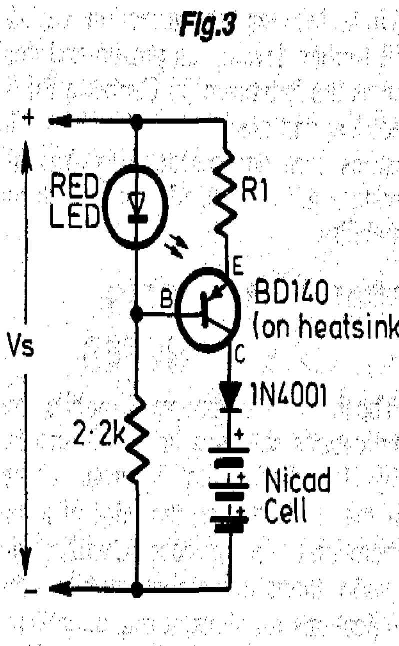


Fig.4

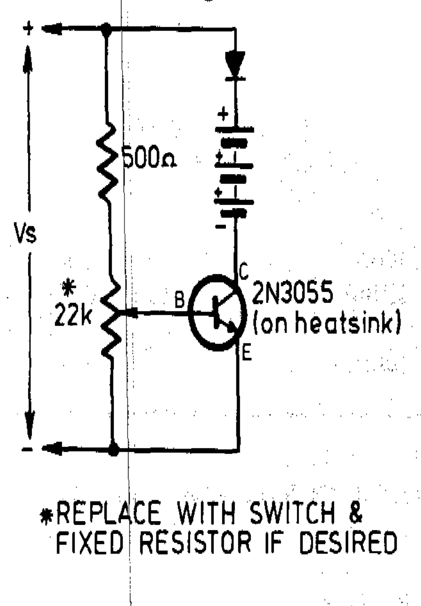
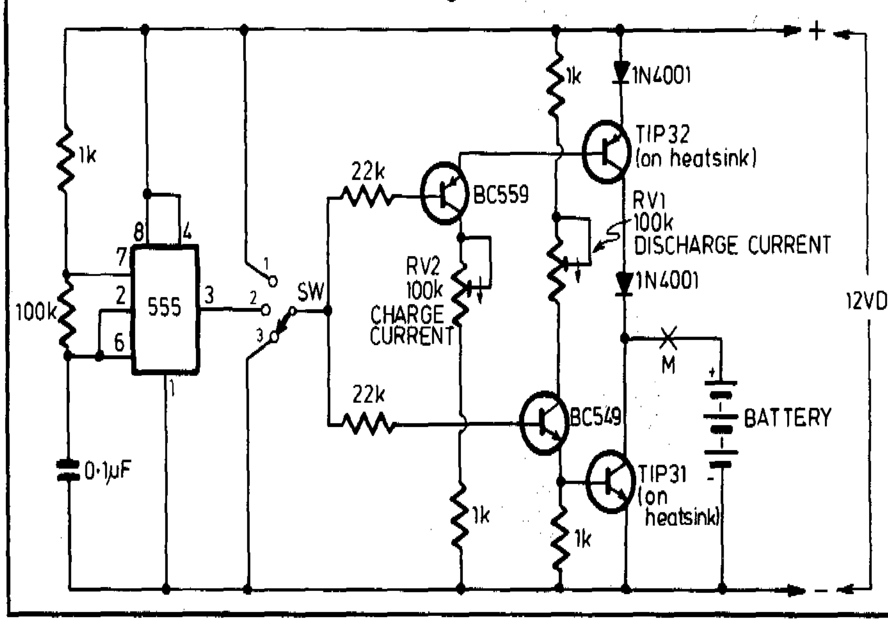


Fig.6



In Fig.5, each cell charges through R2 and discharges through (R1+R2) on each alternate AC cycle. The ratio of R1 to R2 should be between about 4:1 and 5:1.

Fig.6 shows a constant current, periodically reversing charger. Switch S allows the battery to be discharged (position 1), DC charged (position 3) and AC charged and discharged (position 2). The 555 timer circuit provides a series of square pulses at pin 3 to control the reversal. The circuit shown gives a frequency of 100Hz, although this is not critical.

The first stage in using this charger requires the discharge and charge currents to be set. To measure these currents, insert a meter at point M, in series with the NiCad cells.

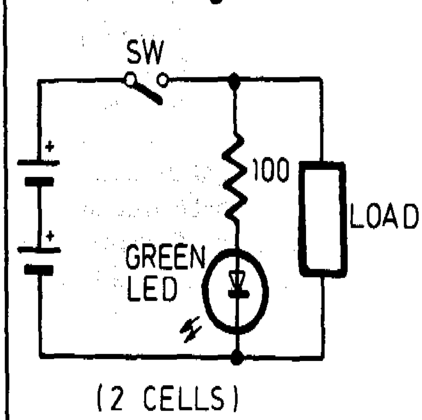
Firstly, set the switch to discharge (position 1). Adjust the 100k trimpot VR1 to discharge at 0.025C (about 12mA for an AA cell).

Note that this circuit should NEVER be used to discharge fully a multi-cell NiCad battery, as it will almost certainly result in the reverse charging of some cells.

Secondly, set the switch to charge (position 3). Now adjust 100k trimpot VR2 to charge at 0.1C. Finally, remove the meter and set the switch to position 2, which will supply the AC charging pulses.

Voltage monitoring

Fig.7



When using NiCads, it is important to know when the first cell of a stack has discharged — to prevent damage through reverse charging. The best way to do this is to monitor the voltage of the complete stack and display an alarm. Figs.7-9 show circuits designed for an end-point voltage of 1.1V per cell, as voltages tend to drop off sharply after this point. Diodes and LEDs are used for the voltage reference.

Unfortunately, the concept of low voltage LEDs only works up to four cells. But a solution for up to eight cells is possible by effectively splitting the battery into two and monitoring each half block.

Fig.10 shows a monitor for a five-cell combination. It uses the op-amp LM324 as a comparator. Green LED D1 provides the reference voltage for the bottom two cells, while red LED D2 and the two 1N914's are the reference for the top three cells.

(This circuit can be modified for up to eight cells.) D3 is another LED which indicates that the battery is alright to use. If the positive and negative connections to the inputs of IC1c are reversed, then the LED will glow when a low battery condition occurs.

Fig.11 lists the voltages across typical diodes at various currents. Figs.7-10 make use of this data to determine the reference voltages.

Fig.5

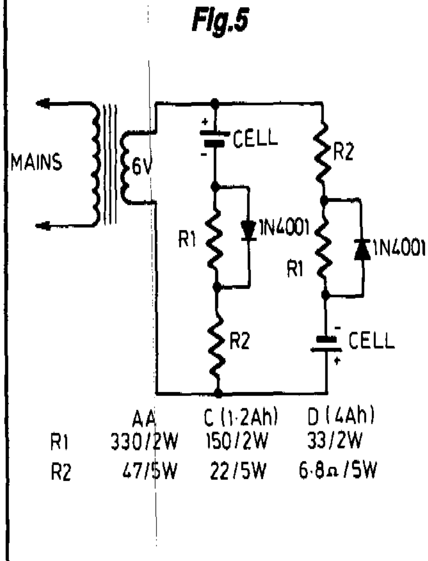


Fig.8

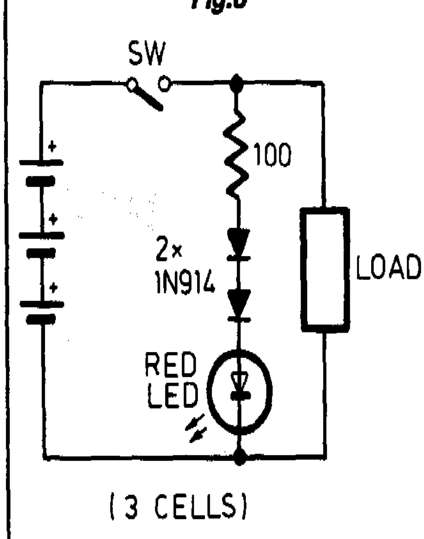
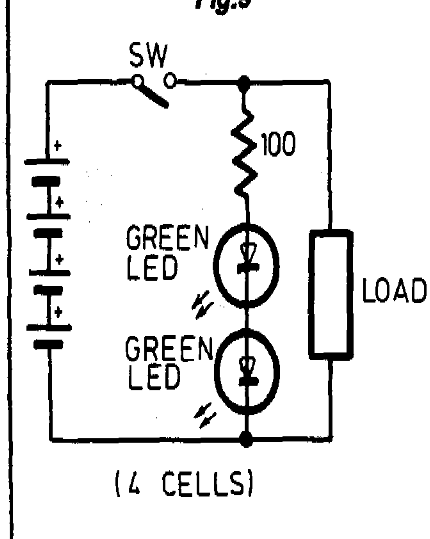


Fig.9



Longer life for NiCads - 2

Fig.10

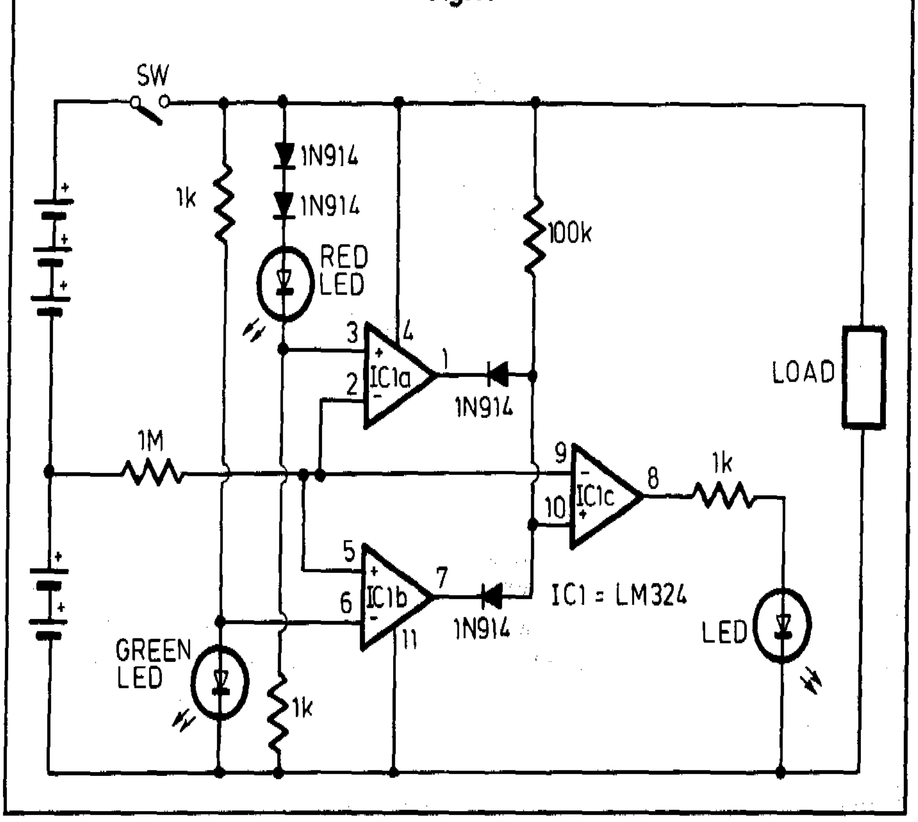


Fig.11

Typical LED and diode voltage drops

Current	Red LED	Yellow LED	Green LED	1N914
10uA	1.50V	1.72V	1.82V	0.50V
100uA	1.61V	1.81V	1.92V	0.61V
1mA	1.69V	1.91V	2.00V	0.70V
10mA	1.82V	2.10V	2.21V	0.82V

All of the above circuits suffer from the drawback that they require modification to the original equipment in order to insert them in series after the on/off switch. Fig.12 shows a solution to this problem.

It is a stand-alone monitor with low quiescent current drain, which sounds an alarm when the load is connected AND the battery is low. It is suitable for six NiCad cells and was developed for use in a radio-controlled car.

IC1 (4011B) pulses the main circuit for approximately 1ms every second until feedback through D1 latches IC1a, if the low battery condition occurs.

R1 is a resistance of approximately 0.02 ohms, which is provided by using 20cm of telephone cable. This value is suitable for loads greater than 200mA. The resistance should be increased for lower loads.

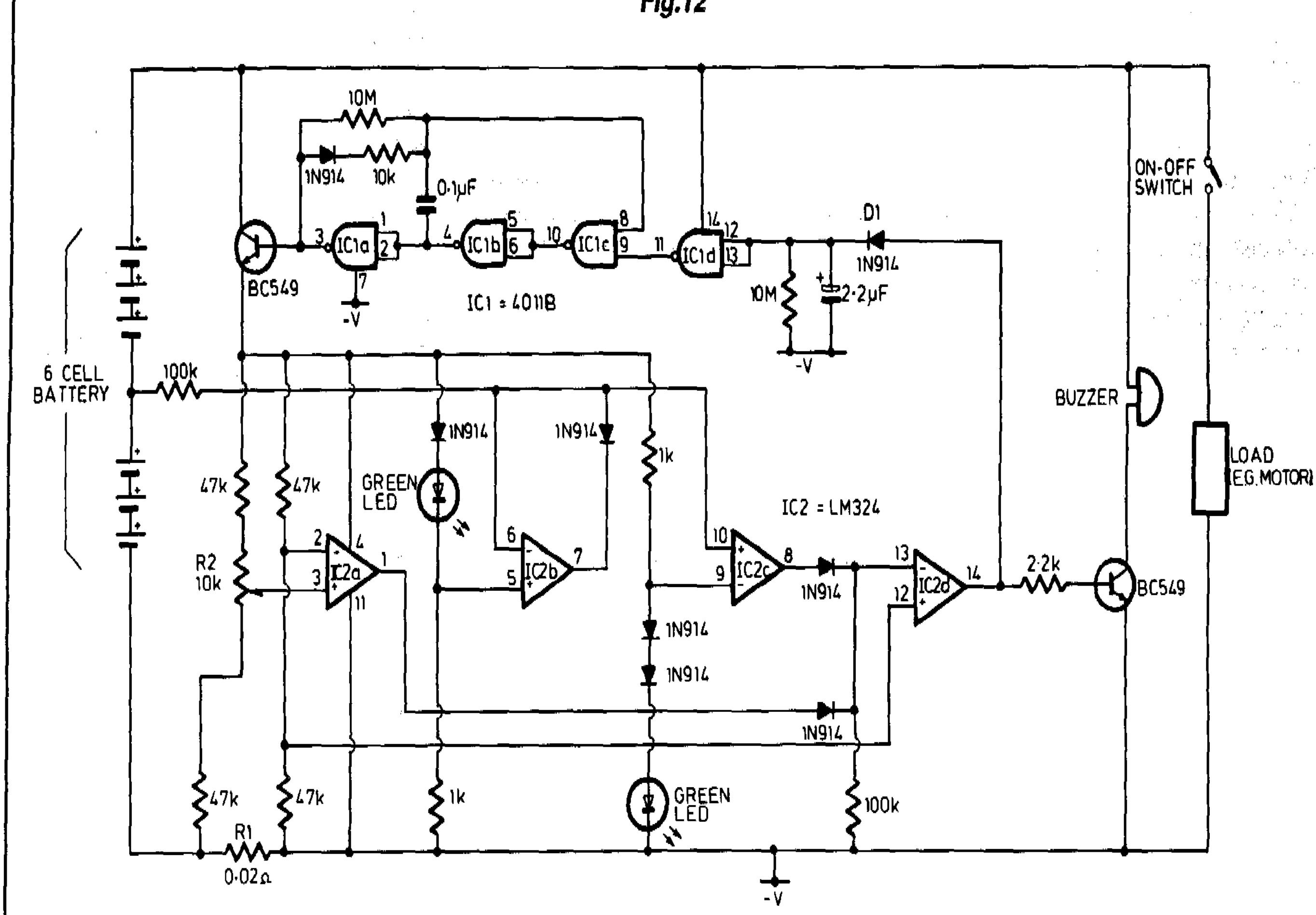
R2 is adjusted so that the output of IC2a (pin 1) goes low when a load is applied. Pin 7 of IC2b goes low if cell 1, 2 or 3 goes flat and this pulls the output of IC2c low also. Pin 9 of IC2c monitors the voltage of cells 4-6, so pin 8 goes low if any of these fail.

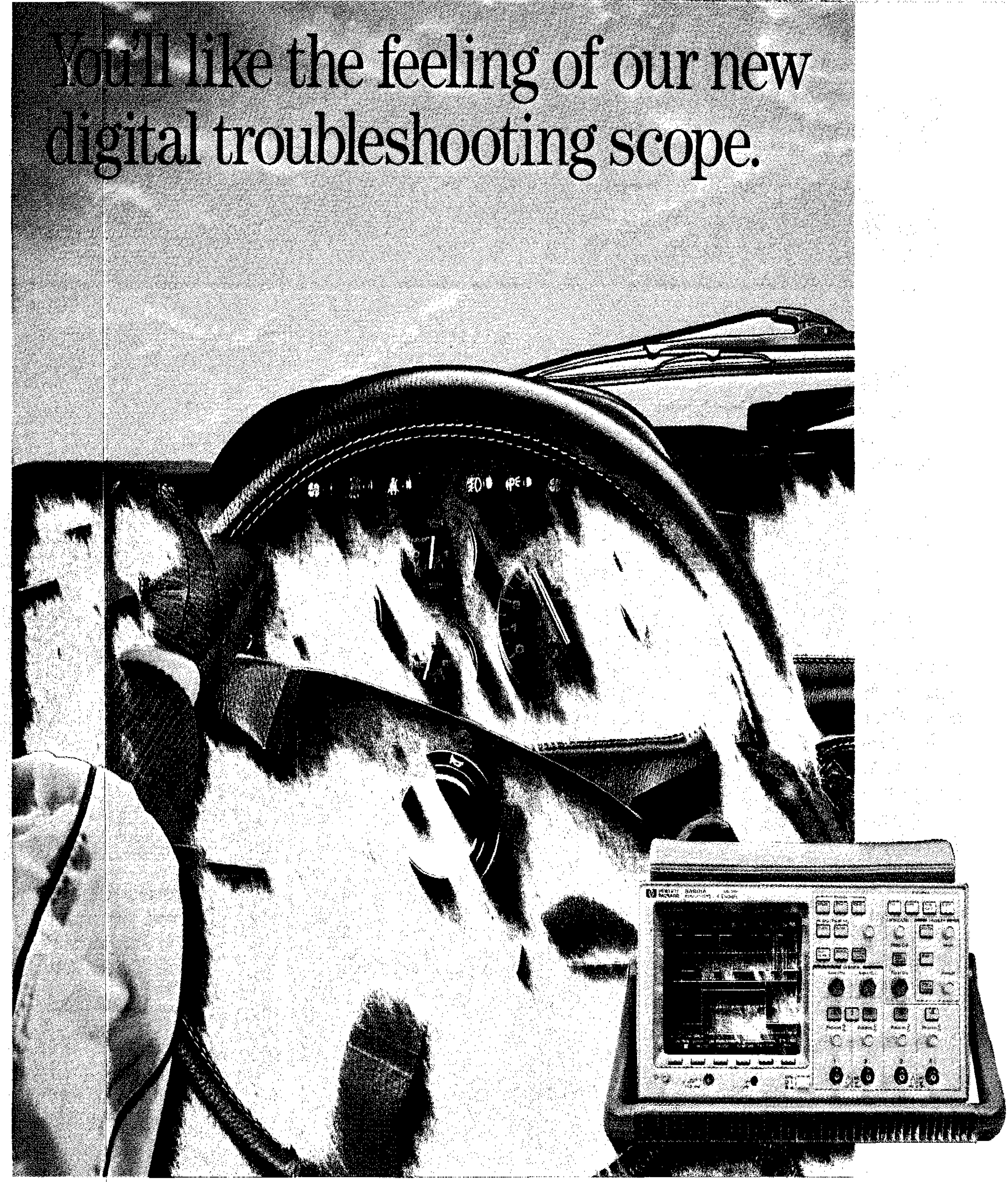
The output of IC2d (pin 14) goes high if both pins 12 and 13 go low. This occurs when the load if connected and any cell fails. Pin 14 both turns on the warning buzzer and supplies the feedback to latch IC1a.

Finally, following is a list of references which I have consulted when writing this article. Most of them can be found in university libraries. Generally, they cannot be borrowed, but are available for photocopying.

Continued on page 119

Fig.12





Now there's a 100 MHz digital scope that handles just like analog.

Digital oscilloscopes have certain advantages that are hard to overlook. But for troubleshooting, many engineers still prefer analog scopes. Simply because they like the way they handle.

The HP 54600 changes that. It *looks* like a 100 MHz analog scope. All primary functions are controlled directly with dedicated knobs. And it *feels* like one. The display responds instantly to the slightest control change.

But when it comes to troubleshooting, the HP 54600's digital performance leaves analog and hybrid scopes far behind. At millisecond sweep speeds, the display doesn't even flicker. Low-rep-rate signals are easy to see without a hood.

It has all the advantages that only a true digital scope can provide. Like storage, high accuracy, pretrigger viewing, hard copy output, and programming. And since it's one of HP's basic instruments the HP 54600 gives you all this performance at a very affordable price.

So if you like the feel of analog control, you'll like the way our new digital scope handles troubleshooting. To find out more call the Customer Information Centre on 008 033 821 or Melbourne 272 2555.

HEWLETT PACKARD

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Silicon Valley NEWSLETTER

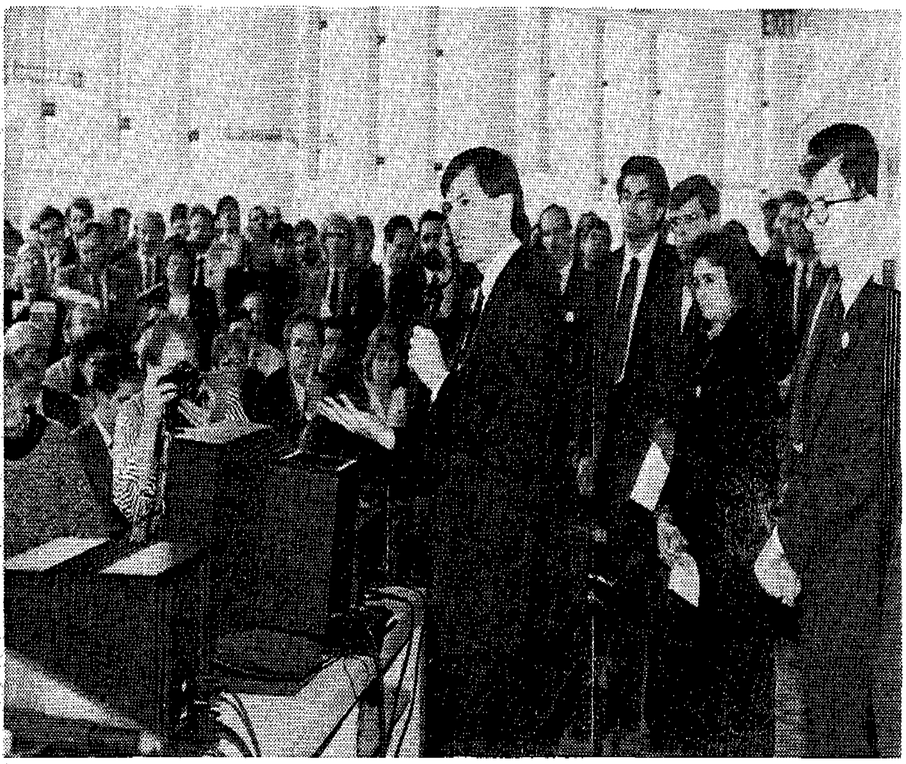
US software firms sue UK publisher

A group of seven US software companies announced the filing of a copyright infringement lawsuit against the British newspaper publishing house of Mirror Group Newspapers & European Ltd.

The seven are represented by the Business Software Alliance, a US software industry group formed to combat software counterfeiting and piracy. The group bases the suit on a recent search of the Mirror offices, during which some 670 copies of illegally copied personal computer software programs were discovered.

The seven plaintiffs include Lotus, Autodesk, Aldus, Microsoft, WordPerfect and Symantec.

A spokesman for Mirror has so far declined to comment on the suit. But representatives for the Business Software Alliance said the company has indicated to them it would fight the charges.



When NeXT Computer launched its innovative new machines a couple of years ago, company founder Steve Jobs personally presented the product in a marathon 2-1/2 hour press show at Davis Symphony Hall in San Francisco. Now the firm has an order for 100 workstations, to be used with Comnetix pictorial database software by the Toronto Police Department in Canada.

US catching up says Corrigan

There are strong indications the US electronics industry is on a course towards catching up with US Japanese competitors, according to LSI Logic chairman, Wilf Corrigan. Mr Corrigan gave the keynote address at the opening of the 40th anniversary of the Wescon Trade Show, held in San Francisco a few weeks ago.

This year's show displayed many signs of the recession plaguing the industry, including an attendance of less than 40,000 (compared to 56,000 in the early 1980's), fewer exhibitor booths and few new product announcements.

Corrigan said his hopes for a recovery of the US high-tech industry is based on the fact that the Japanese have lost several of the key advantages they enjoyed while building up their high-tech industries — including the cost of capital, labour and real estate, and availability of plenty of skilled engineers.

While Japan is beginning to experience a shortage of engineers, the US commercial industry is being flooded with a new wave of engineering talent, both from abroad and from the redeployment of a substantial portion of the defence and aerospace engineering workforce in the face of cutbacks.

Corrigan also forecast that by the end of this decade, chip companies will be putting 100 million transistors onto a single chip, an achievement that will introduce the age of 'Mega-integration' — where entire computer systems will be built onto a single chip and supported only by memory chips.

US leapfrogs Japan in HDTV technology

Signs continue that the US has leapfrogged the Japanese in the development of the next generation of high definition television. Almost a decade earlier than expected, General Instrument and its Videocipher Division gave the first demonstration of its all-digital HDTV technology, which it hopes will be chosen by the US Federal Communications Commission as the basis for a US HDTV standard.

During the first demonstration, General Instruments engineers showed how television pictures were converted into full digital signals, transmitted (over cable) using an advanced data compression technology, and deciphered and shown on a digital television screen.

While the prototype system has not yet transmitted digital signals over the air, the initial demonstration of the system represents a huge boost for the US efforts and a major blow to the Japanese, who have proposed an analog HDTV system.

Until one year ago, it was thought inconceivable that the US would be able to develop an all-digital HDTV standard in time for the 1993 FCC field tests. But in 1990, General Instrument announced that it had been able to develop just such a capability, as a spin-off from its military communications business. Since then, Zenith and AT&T have also announced plans to offer an all-digital HDTV standard, and Thomson Consumer Electronics in cooperation with Philips, NBC and the David Sarnoff Research Centre are also expected to enter the HDTV contest, with an all-digital system.

The General Instrument demonstration was seen on a rectangular, movie screen-like television set. Pictures shown were extremely clear and free from any jagged edges, 'snow', or other distractions.

With competition from four all-digital systems, most industry experts now agree that it is very unlikely that the analog Japanese system will be chosen by the FCC. Digital systems offer vastly greater advantages, including the ability for viewers to freeze, store, edit and even combine, television pictures with other data files on an attached or built-in computer.

TI, Hitachi to share 64Mb DRAM costs

Strengthening their already close ties in the area of memory chip development, Texas Instruments and Hitachi have signed a 10 year joint technology development pact aimed at bringing a new generation of 64-megabit DRAM chips to the market. The agreement is an extension of the 1988 agreement in which the two firms agreed to jointly develop a 16-megabit memory chip.

The TI-Hitachi deal is likely to be followed by similar deals between other US chip makers and Japanese or European competitors. Earlier, IBM joined with Siemens in an effort to develop next generation memory chips, and Toshiba and Motorola also have a 16-megabit DRAM development pact.

The key factor behind the increasingly complex network of joint development deals between US and foreign competitors is the sharing of R&D costs. Few if any, semiconductor manufacturers are in a position to single-handedly develop a 64-megabit chip — a product that will require several billion dollars in investments in R&D and new production facilities. Also the agreement will assure that at least two or three US companies will be playing a role in the memory markets of the future. It also assures the US access to advanced semiconductor manufacturing technology.

According to a TI spokesman, the 64-MB chip will contain no less than 143 million transistors, and linewidths will be down to 0.35 microns.

NeXT finds niche in fighting crime

Stephen Job's NeXT Computer may have discovered a particularly suitable niche for its NeXT workstations: fighting crime!

Recently, the Metropolitan Toronto Police Department in Canada acquired a criminal 'mug shot' identification system built around the NeXT Computer. The system, developed by Comnetix Computer Systems, has allowed the Toronto police departments to scan some 130,000 mug shots into a database program on the NeXT computer. After scanning the image into the computer, operators detail many facial features. Besides the colour of eyes, hair, skin etc., specific features such as 'two front teeth missing,' and 'prominent Adam's apple,' are added to each file.

When victims or witnesses describe facial features of criminals, detectives can search the database on any number of specific facial features mentioned. Almost instantly, the computer will display the digitised mug shots of criminals who fit the description. Toronto detectives are said to be impressed with the ease of operating the NeXT machines, and the vast amount of time saved from letting people browse through huge volumes of mug shot books in search of a possible criminal.

The NeXT system is particularly well suited for the task, as its optical disk drive with 256 Megabytes of storage per disk is capable of storing thousands of digitised photos onto a single disk.

The Toronto Department has ordered 100 of the Comnextix systems, which come with a colour camera that automatically stores digital colour images of a booked criminal into the computer's database. A scanner also allows for older file photos to be digitised and stored along with new entries.

Nolan Bushnell sees big changes

Nolan Bushnell, father of the videogame industry, has predicted that VCR movie rental stores will go out of business — soon after consumers will begin taking of new services that will transmit any movie they wish to see directly into their homes via satellite.

Bushnell was the keynote speaker of the annual Multimedia Expo in San Jose. The man who invented the original 'Pong' video game and founded Atari, also said that IBM and Nintendo will lose their position as industry standard setters in personal computers and home video games. "The only time standards work is when things are standing still. And right now, everything in PCs, video games and home entertainment is on the move."

Also, Bushnell believes that practical, low-cost video telephones will be entering the market for the first time in 1992. Market penetration, however, will be very slow at first, limited only to small groups of people who benefit from the videophone experience — such as family members and companies with remote offices, or with employees working at home. "The most useless thing a person can own is the only picturephone in the world."

Computer chiefs lobby Bush for data highway

A group of some of the most influential computer industry executives have called on President Bush to dramatically expand plans aimed at covering the United States with a network of interstate high speed data 'highways', planned to allow scientists working with supercomputers in different locations to exchange data at the rate of at least one billion bits per second — thousands of times faster than any existing network.

The Computer Systems Policy Project, formed two years ago by the top executives of 12 of America's largest computer companies, said they want the network to be in place and operational before the end of this decade. They emphasised that the program is critical to ensuring the US will play a major role in leading edge technological developments in the coming decades.

The call to the White House came just days after the US House of Representatives followed the US Senate in approving a Bill calling for the development of such a network, a project that could cost nearly US$3 billion.

The White House is expected to sign the Bill, although Bush has favoured a somewhat less ambitious version of the program. However, funding for the project remains a question as the Bill does not ask for specific funding commitments.

"This is really the building of the foundation for the economy of the future," said Apple chief John Sculley, one of the founding members of the CSPP.

To be sure, the commitment to build the data highway network will tie the US government closely to the sponsoring of a number of research projects, across a broad spectrum of technologies. Special communications and signal processor semiconductors will need to be developed, years ahead of their anticipated delivery through normal industrial evolution. And while the hardware aspects will have to be of breakthrough level, the software to operate the system will be a massive undertaking.

Sculley said that a commitment from the government to both the funding of the research and the implementation of the network is required, to generate the interest and commitment from companies that will participate in the development. ❖

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Opto couples for logic

Quality Technologies has taken the guesswork out of 'logic in' to 'logic out' compatibility over temperature minimising the effects of LED degradation, and obtaining high speed operation. Typically this problem was approached by selecting input/output resistors, often by trial and error.

The new Optologic family of logic-to-logic compatible, optically coupled isolators offer LSTTL-in to TTL-out or LSTTL-in to CMOS-out. The device eliminates resistor selection, and features guaranteed DC parameters over temperature.

As well as its isolated logic-to-logic interface function, the input amplifier offers solutions for high speed data communications and precise DC level sensing.

For more information circle 272 on the reader service coupon or contact KC Electronics, PO Box 307, Greenborough 3088; phone (03) 467 4666.

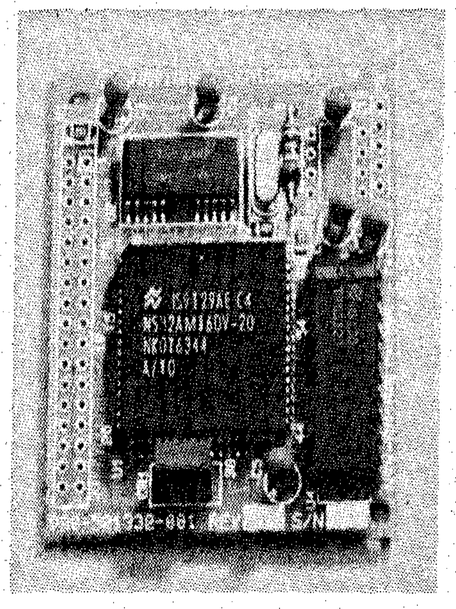
Dedicated voice processor chip

National Semiconductor has entered the single chip voice processing market with a 32-bit voice processor.

With built-in digital signal processing, the NS32AM160 is specifically designed as a single-chip voice solution for such applications as digital answering machines, fax/voice phones, intelligent voice response systems and speech recognition systems, and can also add voice functions to any electronic product.

The design of the AM160 was optimised for digital answering machines, from inexpensive consumer models to full sized combination fax/digital voice systems. With the AM160, a complete digital answering machine system is possible with just three chips. This not only means a package smaller than a deck of cards, but also, because National Semiconductor provides full software and development tool support, a fast time to market.

Beyond answering machines, the NS32AM160 is expected to play an important role in a number of other emerging voice markets, including intelligent voice response systems, voice dictation



machines, voice annunciators and annotators, and speech recognition.

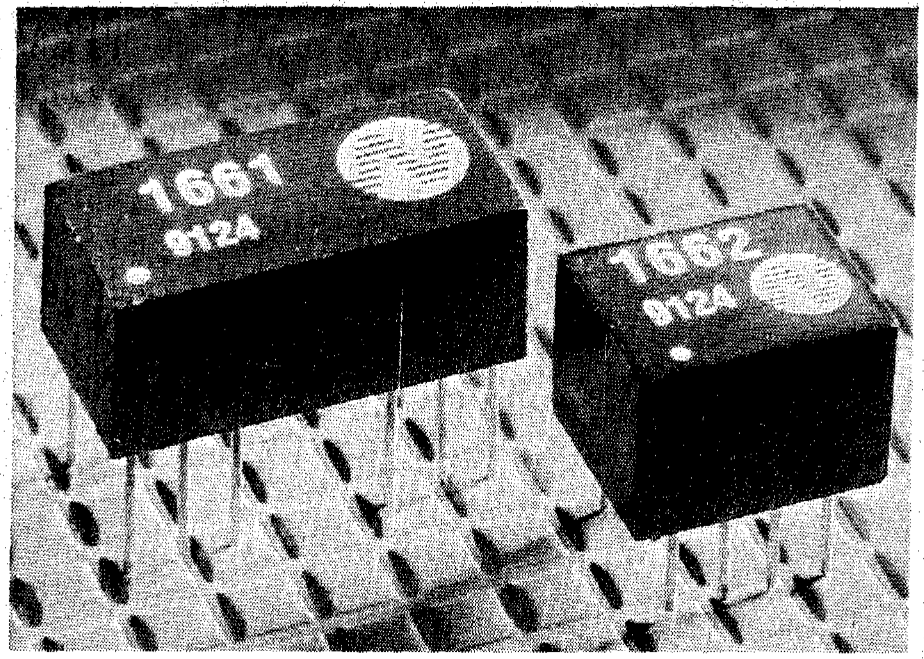
For more information circle 271 on the reader services coupon or contact National Semiconductor Australia, 16 Business Park Drive, Monash Business Park, Nottinghill 3168; phone (03) 558 9999.

10BaseT filters and chokes

Newport Components has launched its 1661 filter/isolators and 1662 common-mode chokes networks products, which are compatible with IEEE 802.3 10BaseT systems and are highly effective. The 1661 filter/isolator provides 17MHz low pass filtering and 2000V isolation for both transmit and receive lines in a single 16-pin, 0.3" pitch, dual-in-line packages. To complement the 1661, the 1662 common-mode chokes provide 20dB reduction in common mode noise with negligible differential loss.

These four winding devices are offered in 8-pin, 0.3" pitch, DIL packages. Both devices comply with the industry standard specifications.

For more information circle 273 on the reader service coupon or contact Alpha Kilo Services, PO Box 180, Lane Cove 2066; phone (02) 428 3122.



Compact 12-bit DAC

The new Maxim MAX526 is a quad multiplying 12-bit voltage output, digital-to-analog converter (DAC). The new device replaces four DACs and four output amps with a single CMOS monolithic IC, saving board space and simplifying design. It delivers the performance expected from expensive hybrid or module quad DACs: guaranteed monotonic 12-bit performance with 1/2LSB relative accuracy over temperature for all four outputs, and 1LSB total unadjusted error with no zero or full scale adjustments at 25°C.

Built-in, buffered voltage-output amplifiers minimise part count by removing the need for external output amps, and provide the speed and drive needed for most applications. The output amps are optimised for low power consumption (175mW type), and offer low noise (50uV RMS) and fast settling time (3us to 1/2LSB). The total harmonic distortion plus noise is less than 0.012% for 10V reference signals up to 35kHz. The 3dB bandwidth is 700kHz.

The MAX526's fast settling time is ideal for multiple positioning applications such as robotics. Other applications include minimum component count analog systems, digital offset/gain adjustment, arbitrary waveform generators, industrial process controls and automatic test equipment.

For more information circle 274 on the reader services coupon or contact Veltek, 22 Harker Street, Burwood 3125; phone (03) 808 7511.

200MHz analog multiplier

Elantec has released a new IC analog multiplier, the EL2082. It has a two quadrant, current-mode multiplier architecture, which extends the bandwidth while maintaining accuracy.

Costing around US$6 (100+), the chip offers a full power bandwidth of 150MHz. Most current analog multipliers are based on the Gilbert cell, which is a voltage-mode, four quadrant circuit. It sacrifices some of its high accuracy at wider bandwidths.

The EL2082 uses current steering to achieve its wide signal bandwidth. In fact, its front end resembles that of a current-feedback amplifier.

An input current of +/-1mA produces a linearly related output current of +/-12mA, +/-4%. Just one resistor, connected between the voltage signal and current input, converts the voltage signal to a current.

The EL2082 is a low cost device that brings all but the most precise multiplier applications to video-bandwidth signals.

For more information circle 276 on the reader service coupon or contact Reptechnic, 3/36 Bydown Street, Neutral Bay 2089; phone (02) 953 9844.

Eight digit LED driver

The MAX7219 eight digit, seven segment LED display driver is designed to easily interface to any microprocessor. It has a user friendly three wire serial interface that allows multiple MAX7219's to be cascaded for larger arrays. Also, the serial interface has a fast 100ns access time that allows data to be directly loaded. Data is sent in 16-bit packets.

The MAX7219 has a power-saving shutdown mode in which the supply current is only 150uA.

The device powers up in this mode (display off) and enters normal operation within 250us. It provides six levels of digital brightness control. Maximum display current can be set with an external resistor or potentiometer.

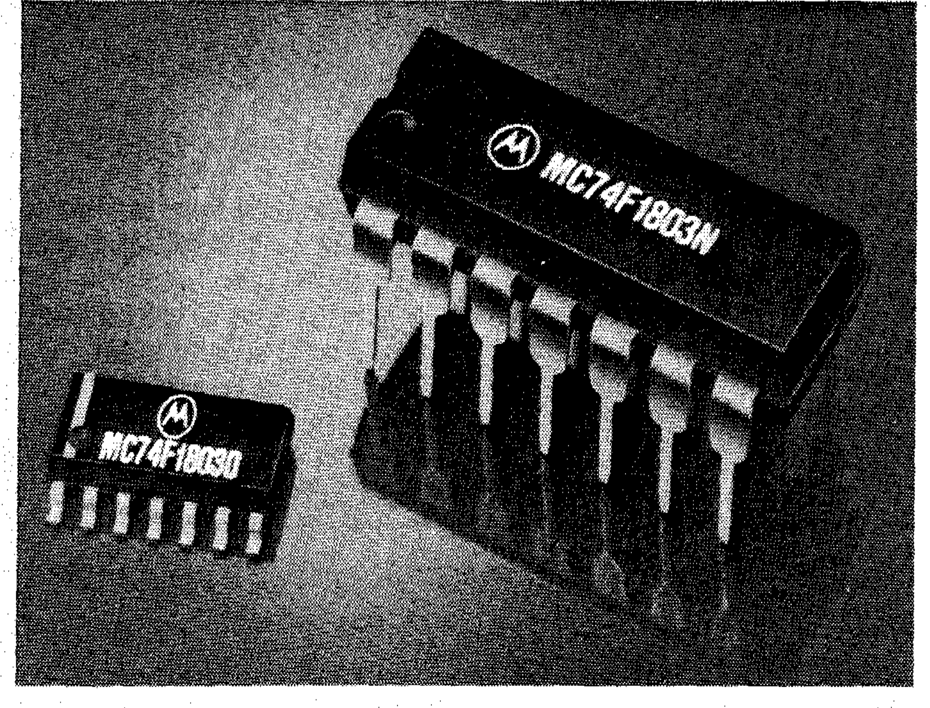
High speed clock driver

Motorola has introduced the MC74F1803 clock driver, a high speed, low power, quad D-type flipflop featuring separate D-type inputs and inverting outputs with closely matched propagation delays. With a buffered clock input that is common to all flipflops, the MC74F1803 is useful in high frequency systems as a clock driver, providing multiple outputs that are synchronous.

The MC74F1803 is designed for general purpose system applications, with operating frequencies up to 35MHz and skew requirements of 2.0 nanoseconds or more. The device is compatible with a variety of microprocessor types and is available in both a standard 14-pin DIP and an SOIC package for surface mount applications.

Because of the matched propagation delays, the duty cycles of the output waveforms are symmetrical within 2.0 nanoseconds. The MC74F1803 clock driver is extremely user friendly because any combination of 'Q or Q-bar' outputs can be used without compromising the skew guarantee.

For more information circle 275 on the reader service coupon or contact Motorola Australia, 673 Boronia Road, Wantirna 3152; phone (03) 887 0711.



Seven segment or no-decode mode is individually selectable for each digit for more flexibility. Plus, the MAX7219 can be programmed to scan between one and eight digits with a typical scan rate of 1300Hz for eight digits.

For more information circle 277 on the reader services coupon or contact Veltek, 22 Harker Street, Burwood 3125; phone (03) 808 7511.

Very fast SRAM

Toshiba Corporation is introducing three families of 1-megabit SRAMs, including versions claimed to have the world's fastest access time of 12 nanoseconds — 20% faster than the current models.

Based on 0.7-micron microlithographic technology, the new SRAMs have a BiCMOS structure. BiCMOS combines two types of widely used silicon technologies on a single silicon substrate: CMOS and bipolar. CMOS devices feature lower power consumption, less heat dissipation and higher integration density than bipolar devices.

On the other hand, bipolar devices generally operate faster than CMOS devices, and also have superior output drive capability.

By blending the merits of both structures, the new BiCMOS SRAM achieves faster access time than CMOS SRAMs, and higher integration and lower power consumption than bipolar SRAMs. The new devices adopt a bipolar structure for peripheral circuits, such as sense amplifier and word-line drive circuits.

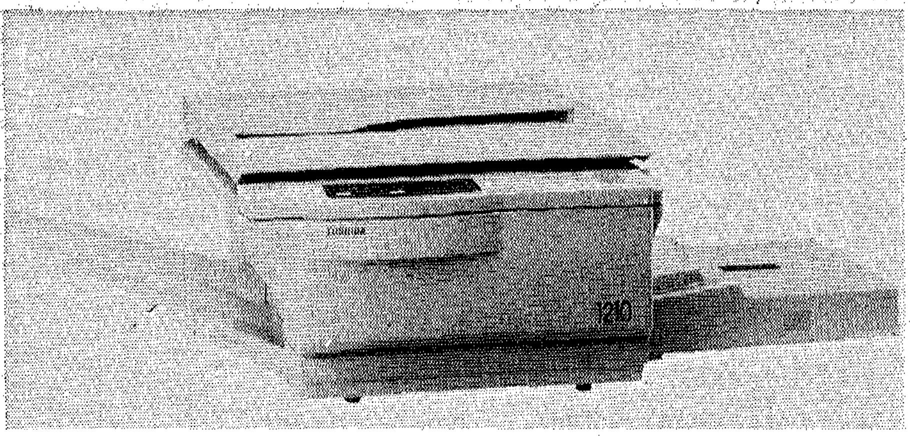
In addition to using the BiCMOS structure, Toshiba has adopted a new pin layout to reduce noise generated by the ground pins and voltage supply pins.

This noise is one of the major causes of limited access speed. The new layout allocates these pins to the centre of the pin rows, instead of positioning them at the corner.

This layout reduces wiring lengths between the chip and these pins, thereby cutting noise and is expected to enter the mainstream of SRAM design.

The sample price of 12ns access time models is US$320. ❖

NEW PRODUCTS



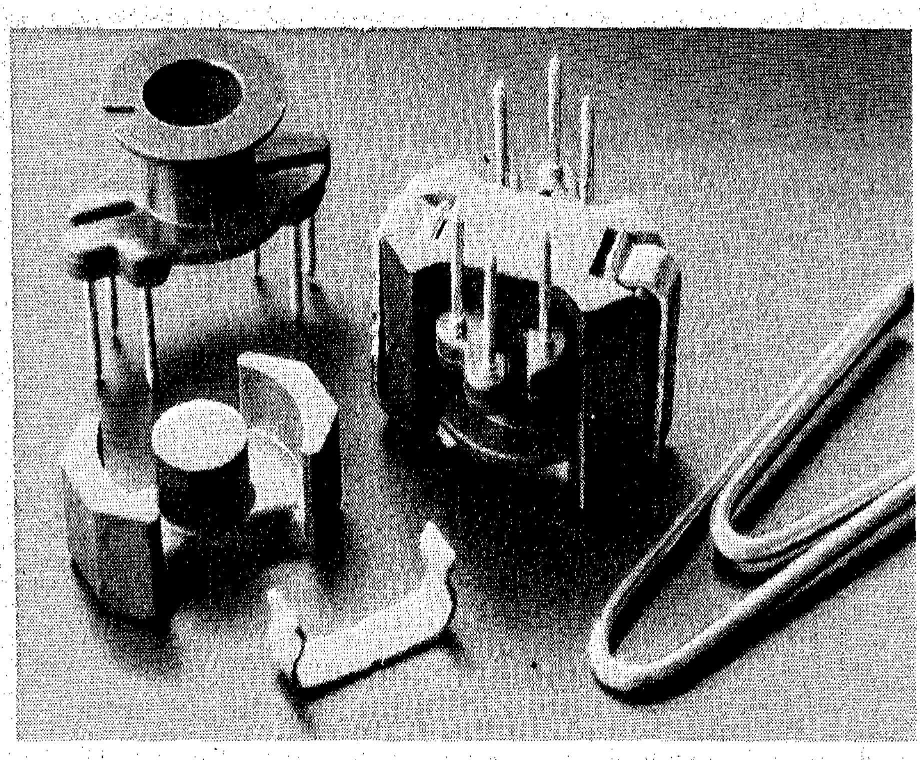
Compact copier

Toshiba has released a new compact business photocopier, the 1210, which can print 12 copies per minute providing edge-to-edge copying and assuring a 100% copy of the original, with a multiple copy function of up to 99 copies.

It is fitted with an Automatic Toner Density Control, which uses an advanced microprocessor monitor, and adjusts toner density for every copy.

Toshiba also offers an optional colour developer unit of either red or blue.

For more information circle 241 on the reader service coupon or contact Toshiba Australia, PO Box 350, North Ryde 2113; phone (02) 887 3322.



Compact ferrite core

The new 'RM4 Low Profile' ferrite core from Siemens makes it possible to produce even smaller transformers.

It is particularly suitable for DC/DC converters, but can also be used for transformers in Telecom interfaces.

The new core has been developed for applications with small space requirements, whose dimensions respond to the grid on printed circuits.

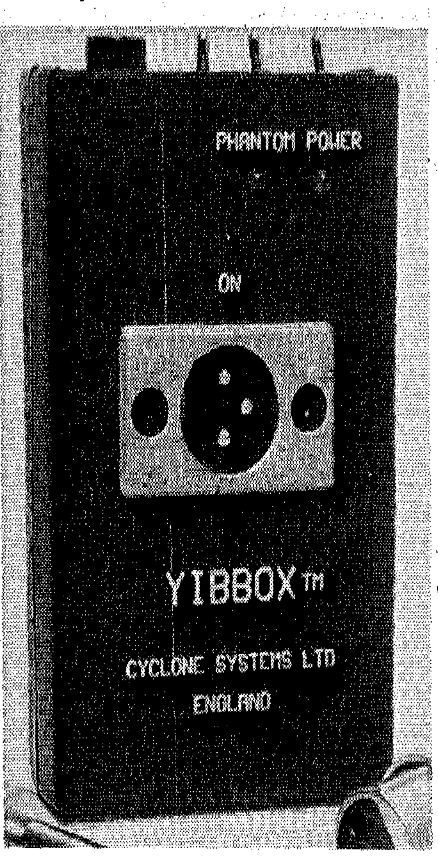
It occupies a surface area of about $100mm^2$ and has a height of 7.8mm; it is available in two materials for power electronics applications (N47 and N67) and also in the material T38 which is suitable for Telecom applications. A surface mounting version is currently in preparation.

For more information circle 242 on the reader service coupon or contact Siemens Components, 544 Church Street, Richmond 3121; phone (03) 420 7716.

Audio faults locator

Faults in audio equipment can be located quickly and in almost any location using a new instrument from Britain. Yibbox, from Cyclone Systems, is a 9V battery powered 400Hz oscillator which provides a test signal for injection into the equipment under examination.

Since the instrument provides balanced and unbalanced outputs at 0, -20, -30, and -50dBm, it can be used to check micro-

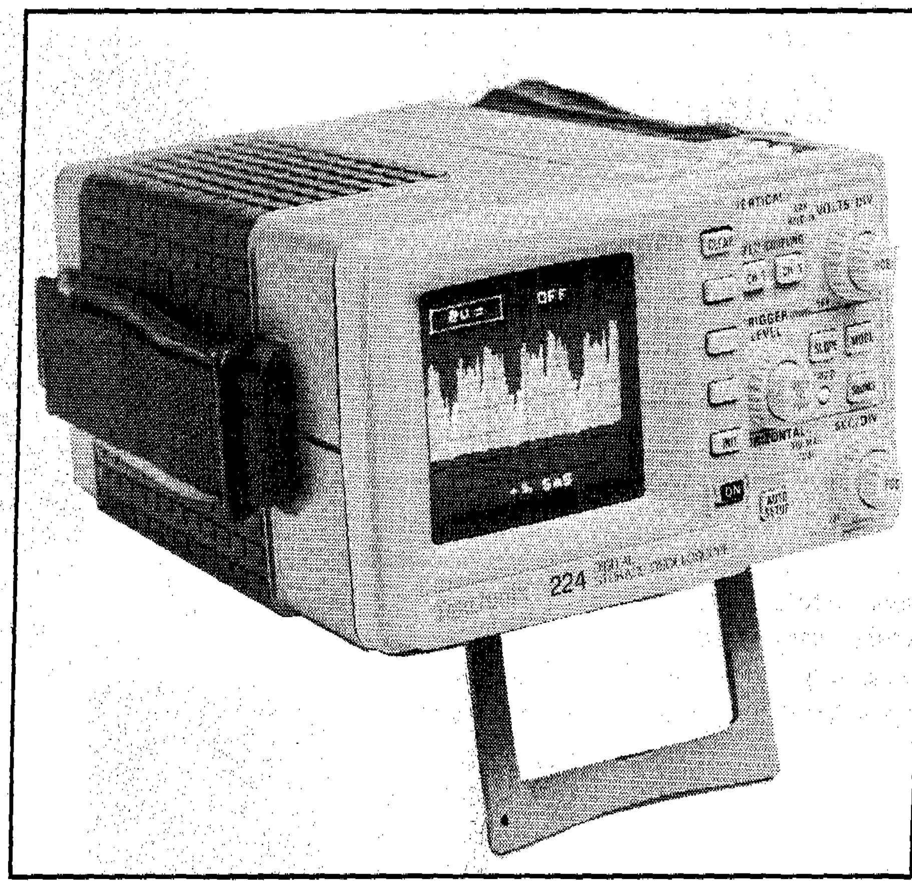


phone feeds, keyboard feeds, broadcasters' earpieces and musicians' headsets. It can even test a standard 8 ohms loudspeaker.

Two light emitting diode indicators show the presence of 'phantom power' — the voltage supply required by certain microphones. The instrument itself incorporates an electret microphone which allows the engineer to talk into the audio system for test or communications purposes. Yibbox is conveniently portable, measuring only 100 x 63 x 36mm and weighing just 200g. It runs from an internal 9V battery with a life of up to 24 hours in continuous operation.

The company is seeking an Australian agent for its product. For more information, phone the British Consulate-General in Sydney on (02) 246 7521; or Cyclone Systems in the UK, (0011) 44 727 830479.

Fast handheld digitising scope



Tektronix has introduced a very fast 60MHz handheld digitising oscilloscope claiming it to be the fastest in the industry. The new 224 extends the capabilities of the popular 222 family of ultra portable digitising scopes into high speed electronics testing applications.

It combines the benefits of handheld portability with battery powered operation for troubleshooting high speed TTL circuits.

The 224, with its TV field trigger and compact design, makes servicing such equipment easy. It weighs only 2kg and two inbuilt rechargeable batteries provide three hours of reliable operation. Its dual channel design allows input-to-input comparisons.

Each channel of the dual-channel 224 is isolated from the other channel, and from earth ground. True isolation of channels and separation from each ground removes the risk of the operator receiving serious shock or electrocution.

It also removes the risk of small voltage spikes or accidental grounding causing damage to sensitive electronic parts.

True floating measurements can be made up to 400 volts per channel, or 800 volts peak to peak, in complete safety.

For more information circle 245 on the reader service coupon, or contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113; phone (02) 888 7066.

Dual action PLCC extractor

A new J-lead IC remover has a dual action to protect fragile PLCC packages when being extracted from carriers.

Firstly its two steel fingers are inserted at diagonal corners of the package. Then as hand pressure is applied, the steel fingers lock under the PLCC body. Finally, as hand pressure is applied, the fingers apply a balanced upward pull to remove the package without damage.

For more information circle 244 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566. ❖

Handheld DMM has RS-232C port

Digital multimeters capable of being linked to a computer for making automated measurements are generally 'bench type' instruments, carrying a fairly high price tag. However Dick Smith Electronics is now offering a low cost 3-1/2 digit handheld model which offers this very facility — along with capacitance measurement, bipolar transistor checking and frequency counting to 200kHz.

Time is money, according to the old saying, and even though we electronics people may not be paid as much as many other professions, even *our* time is becoming more and more expensive.

So much so that where a lot of repetitive measurements have to be made, it's becoming increasingly more attractive to have them carried out using a computer-driven automatic setup, rather than manually by a technician or engineer.

The only catch, until now, has been that measuring instruments designed to interface with a computer for this kind of automated testing have generally been too expensive for use by small labs, workshops and factories. But that's now rapidly changing, with the latest generation of test instruments — many of which offer built-in computer interfaces, for a price little more than that of their 'manual use only' predecessors.

A very good example of the trend is the new Q-1570 handheld digital multimeter from Dick Smith Electronics. Superficially this may look very similar to many other 3-1/2 digit instruments, but along with a full complement of all the usual measuring facilities it also incorporates a bidirectional, optically isolated RS-232C serial port — capable of allowing the instrument to be readily interfaced with a computer for automated testing and data logging.

And it comes complete with test leads, user manual, both serial interface cable and sample driver software for a standard IBM-compatible PC, all for a retail price of only $215.

Many features

Even judged as a standard handheld DMM, the Q-1570 has many attractive features. It has a high contrast LCD display, with clearly read 16mm-high primary digits supplemented by a 41-segment bar graph, and many smaller secondary annunciators. The maximum count is 1999, with auto ranging and auto polarity.

A large rotary function switch is used to select one of the instrument's 30 different measuring ranges. These include five each for DC voltage (200mV/2V/20V/200V/1000V) and AC voltage (200mV/2V/20V/200V/750V); three each for DC and AC current (2mA/200mA/20A); six for resistance (200Ω/2k/20k/200k/2M/20M); three for capacitance (2000pF/200nF/20uF); two for frequency (20kHz and 200kHz); one for diode testing (0-2V V_F, at 1mA) and continuity (beep for less than 30Ω); one for measuring the h_{FE} of a bipolar transistor (0-1000, at I_B=10uA/V_{CE}=2.8V); and finally logic level testing (Hi/—/Lo). The last of these makes use of the meter's relative measurement facility, to allow it to 'remember' the positive supply rail voltage of a circuit under test, in order to make its decisions about logic levels. Logic 'Hi' is indicated for voltage levels equal to 70% of the memorised supply rail, and 'Lo' for levels less than 30%; levels in between these two are regarded as undefined ('—').

Along with this full set of basic measuring ranges, it also offers such niceties as data hold, maximum/minimum hold, and relative offset nulling. The latter can be used to make measurements of voltage and current changes, to null out lead resistance for low resistance measurements, and for cancelling stray capacitance for low-value capa-citance measurements.

Another nice feature is the ability to store up to five measurement readings, for later recall. Incidentally most readings are made at the rate of about 2-3 per second.

But of course the main drawcard of the Q-1570 is its built-in RS-232C serial interface, which lets the meter communicate with a computer.

The interface is bidirectional, and incorporates optical isolation in both directions, to allow the DMM to be 'floated' at up to 500V above or below ground during measurements, without risk of damage to either itself or the computer to which it's connected. The interface circuitry is completely inside the meter's plastic case, with only five small pin-jacks evident on the outside (on the right-hand side, near the transistor testing socket).

The serial data cable supplied with the meter has a special matching five-pin plug on one end, and a standard DB25 socket on the other to mate with the serial port of an IBM-compatible PC.

The interface is essentially of the simple three-wire type, with no hardware handshaking. However because of the opto-couplers used at the meter end, the computer port's DTR and RTS lines are needed in order to provide power for the receive data line.

The software used in the computer must therefore set the DTR line positive, and the RTS line negative. Luckily this is quite easy to do with most MS-DOS machines, even from a BASIC program. The serial interface operates at a fixed data rate of 1200bps, with a format of seven data bits, two stop bits and no parity.

Two comms modes

The Q-1570 actually provides two different ways to communicate with the computer: it can either send measurement data back continuously, without being requested, or only in response to a command from the PC.

Which of these two modes is in use is selected via a front-panel button marked 'COMM', and when the meter is in the 'automatic' mode the word 'COM' is displayed on the LCD.

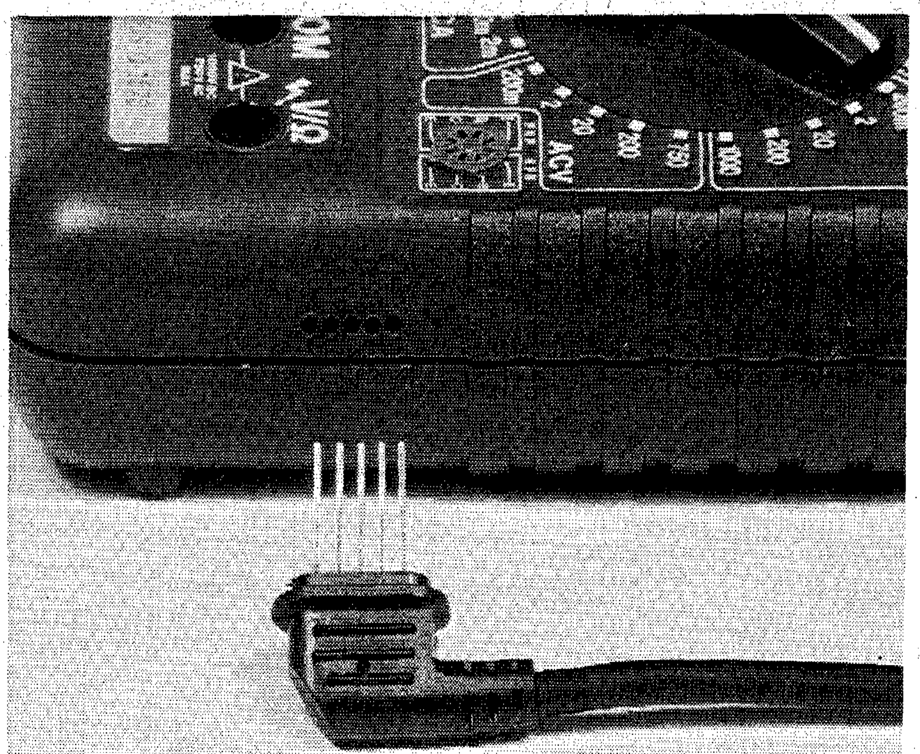
By the way the computer cannot control the measurement mode or range setting of the Q-1570; it can essentially only request measurement data. All range and mode selection must be done via the manual controls.

In both the 'auto' and 'polled' modes, the meter sends back the measurement data in the form of a 14-byte sequence.

Six bytes are used for the reading itself (four digits plus sign and decimal point), preceded by a two-character code for the measurement mode (DC/AC), and followed by four characters representing the measurement unit and multiplier. The 14th byte is always a terminating carriage return character (hex 0D).

To assist users in getting the meter going with a computer, the accompanying 5-1/4" floppy disk contains a sample measurement/data logging program called *METDEMO*. This is actually supplied in two forms: one as a GWBASIC source file, able to be listed and examined as well as being run, while the other as a directly executable .EXE file (probably compiled BASIC).

The disk also provides a helpful *READ.ME* file, explaining the basic hardware and software operation of the meter's interfacing, and another BASIC



A close up of the side of the Q-1570 multimeter, showing the row of five small pin jacks used for the serial interface — along with the mating five pin connector on the end the interface cable. As you can see it's not polarised.

source listing giving useful fragments of GWBASIC source code — both to illustrate the concepts, and to allow incorporation into the user's own programs.

In practice

We tried the sample Q-1570 meter out with a variety of common PC's, from an elderly IBM/XT to a HiCom 33MHz 486 model, and making a range of different measurements.

As a basic 3-1/2 digit handheld DMM it generally gave a good account of itself, producing stable readings that were comfortably within its stated specs (DC volts accuracy is 0.3% of reading, + 1 digit). And when used with a PC for simple data logging and similar low-level auto-mated testing, it also performed well — although we did find that for some reason the '.EXE' version of the *METDEMO* program wouldn't run on about half of our machines (both the IBM XT and a President XT, and also an Epson AT running at 12MHz). This may be due to some kind of incompatibility between the compiler used to produce this program and the BIOS of these machines. The BASIC source code version *would* run on the same machines, however, using their own BASICA or GW-BASIC interpreters as appropriate.

Our only other small gripe is that we're not too impressed with the five-pin connector system used for the meter's serial port. This seems to us a bit flimsy, and lacks any way to latch or secure the connection. It also isn't polarised — so it's all too easy for the plug to be inserted accidentally the wrong way around. A small shrouded connector of the standard DB9 type would be preferable, we'd suggest.

Overall, though, our basic reaction is that the Q-1570 is a very attractive and potentially very useful little meter. As well as being a well-made and flexible 3-1/2 handheld DMM, the inbuilt serial interface and communications 'intelligence' gives it the added ability to be used in a variety of simple data logging and automatic testing applications. And all for a price that is very little higher than many existing standard handhelds!

The Q-1570 is available from all Dick Smith Electronics stores, and many DSE dealers. It's also available via the firm's 'DS Express' mail order service, from PO Box 321, North Ryde 2113; phone (008) 22 6610, or in Sydney 888 2105. (J.R.) ❖

Longer Life for NiCads - 2

Continued from page 106

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PC Enhancements Feature:

Electronics Workbench

If you think you need an engineering degree to operate a circuit simulator, or that simulators are only for professionals, perhaps our review of *Electronics Workbench* will change your mind. As the name suggests, it's like having a complete experimental workbench built into your PC — complete with power supplies and test instruments.

by PETER PHILLIPS

My first foray into circuit simulators was published in *EA* in February 1989. This package was a simplified, low-cost version of *PSPICE*, produced for the educational market by Microsim and sold by Prentice-Hall.

Since then, *EA*'s editor Jim Rowe has reviewed a range of more sophisticated circuit simulators, and these have been published over the last 12 months. In fact, a one-shot booklet covering these reviews has since been produced, and is probably still available at newsagents. It makes excellent reading if you're in the market for such a product.

In what seems to be a growing market, Emona Instruments has recently entered the field with a product from Canada. Although aimed at the educational market, *Electronics Workbench* (EWB) really has something for everyone interested in electronics.

There are several versions of EWB, and the one I'm reviewing here is the top-of-the-line version. The package is available for both Apple Macintosh and IBM-compatible computers, and I'm reviewing the IBM version.

An overview

A circuit simulator is a computer program that allows a circuit to be either drawn or entered in some form into a computer. By pressing the appropriate 'buttons', the operation of the circuit can be simulated and the results displayed.

The quality of such a program can be measured in various ways, including ease of use, facilities provided, the size of the component library, speed of computation and so on.

The requirements depend heavily on the application, and a design engineer will need more facilities than a hobbyist. In fact, a program suited to an engineer may well be too complex for the general user, while a simplified program might only be of use to learners.

Electronics Workbench fits between these limits. It is certainly easy to use, it has a reasonable range of circuit symbols and it can perform analysis of analog and digital circuits.

The program requires a hard disk drive and is best suited to a VGA screen. It has full colour, drop-down menus, is mouse driven and an interactive help screen is available. In short, it is intuitive and not unlike a Windows application to operate.

A palette of circuit symbols (called the 'parts bin') is displayed on the left of the screen, and a circuit schematic is drawn by 'dragging' the required symbol into the workspace.

These are then connected by linking the ends of the components. This task is simplified in that you point to the component lead and drag a 'rubber-band' to the next. The program automatically routes the connection to give a neat layout.

The 'bench-top' has a array of instruments, such as a digital multimeter, oscilloscope, function generator and so on. To connect an instrument, it is dragged into the workspace and connected much as you would in practice.

An 'on-off' switch is positioned in the menu bar, and by pointing to the switch the circuit is then energised. The instruments will then display the readings obtained by the simulation and include waveforms, voltage readings and so on.

The program is in two modules: the analog and digital modules. They both have a different component library and different instruments. The screen layout is the same for both modules, but apart from the operating procedures, the modules are vastly different.

This is much as you would expect in the real world, although the program doesn't allow a digital circuit to be interfaced to an analog circuit. But I did say this package falls between the limits of having everything and being merely a learner's program.

We'll look at the analog module first, as this is the section most readers will be interested in.

Analog module

To be honest, the analog module is the more difficult of the two modules to work with. Drawing circuits is easy, but getting them to work requires a degree of patience. The algorithms for an analog circuit are always more complex than a digital circuit, as there are lot more variables. Obviously, the more complicated the circuit the longer the computation time, with an increased likelihood of your getting the message 'check circuit configuration'.

I tried a number of circuits, including the examples provided with the package. I found that op-amp circuits were generally the easiest to get going, and the circuit I'm describing is a simple op-amp integrator.

The screen layout of EWB is shown in Fig.1. The component library is on the right of the screen, and those not shown are accessed by scrolling with the icon at the top right. The instruments shown on the screen are the function generator and the oscilloscope.

Those left on the workbench at the top of the screen are the multimeter and the Bode plotter. This latter instrument can be used to view the frequency response of a circuit and frequency measurements can be read from the display.

The circuit of the integrator is shown, as is the resulting output as displayed on the oscilloscope. Note the first cycle of operation, in which things need to stabilise before settling down to give the

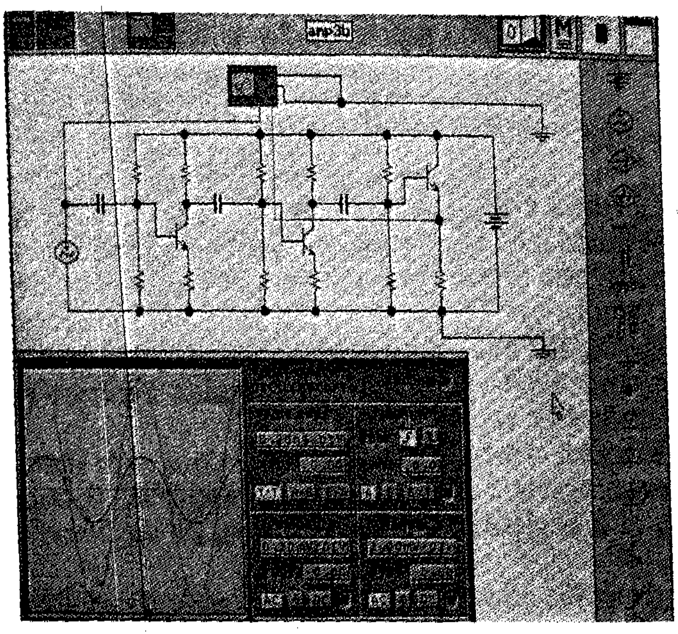


Fig.1: The Electronics Workbench screen display. The display is in full colour and this image is from a VGA screen. An EGA screen gives larger symbols, and a circuit requires more screen space. The 'scope display shows the first two and a bit cycles of circuit operation.

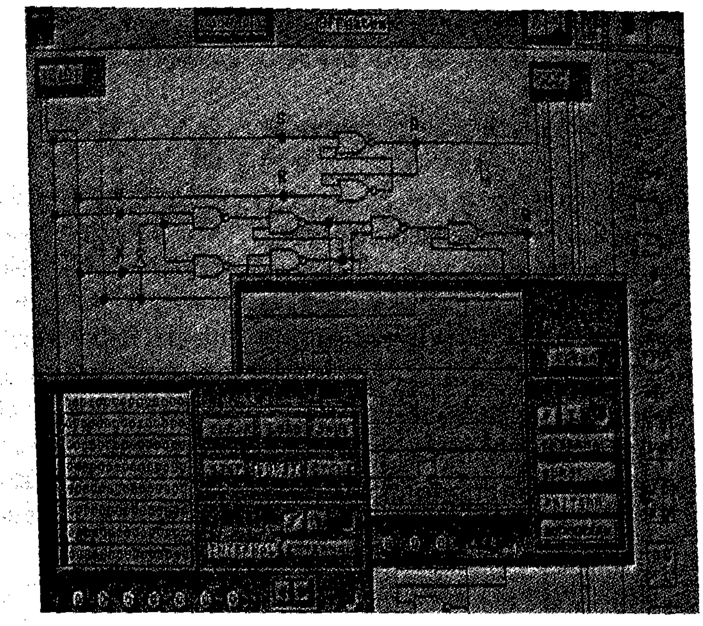


Fig.2: The digital module is shown in operation here. The circuits were produced directly from the truth table. The word generator provides the input sequence and the logic analyser can display up to eight signals.

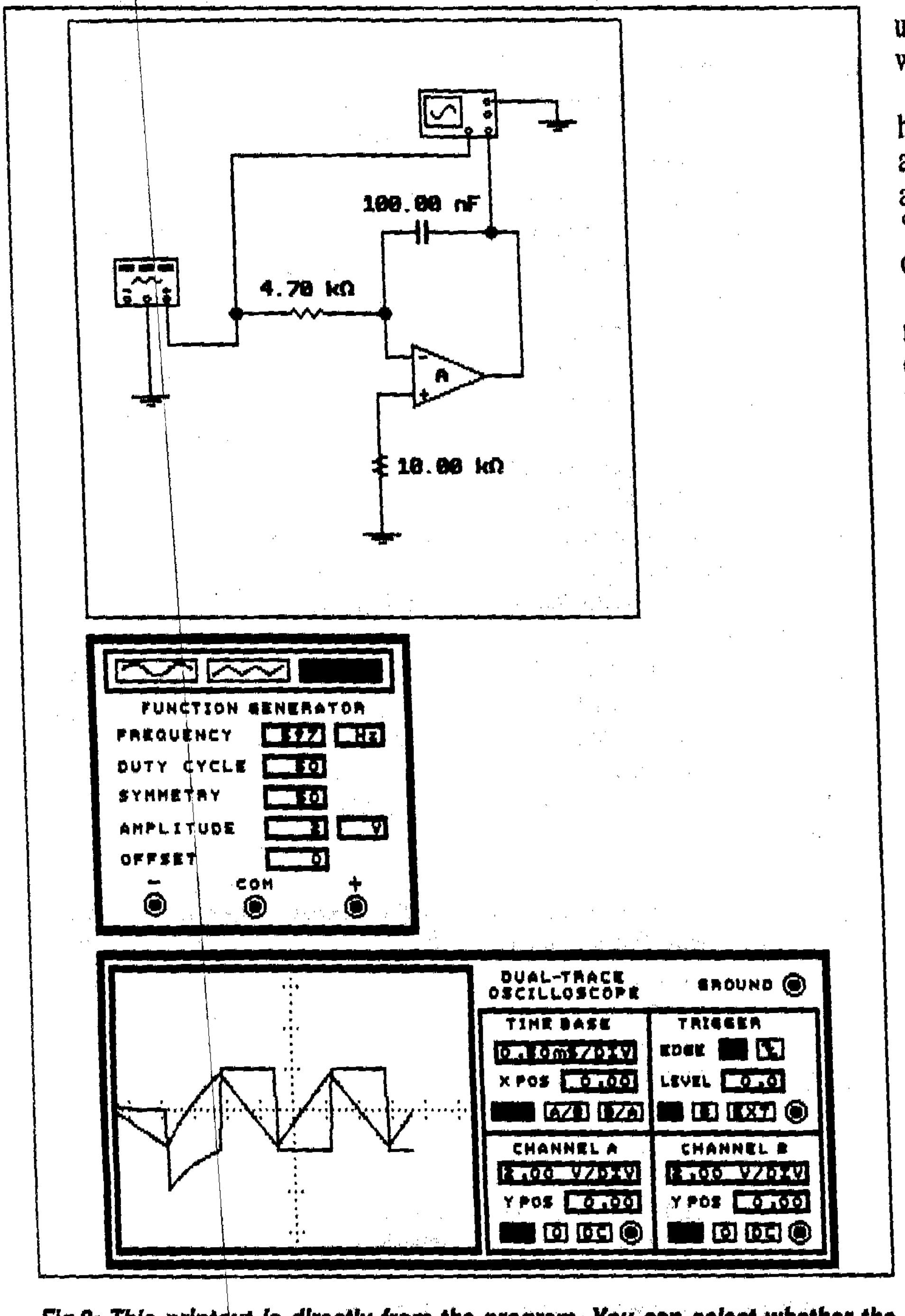


Fig.3: This printout is directly from the program. You can select whether the instruments are included in the printout. A parts list of the circuit can also be printed if you wish.

usual triangular wave output for a square wave input.

The 'scope and the function generator have all the usual 'controls', and these are adjusted by pointing to the control and moving the mouse. Referred to as 'spin selectors', this operation takes a bit of getting used to, but is quite effective.

Each component is represented by a model, and various parameters can be changed. For example, the op-amp has numerous parameters such as the supply voltage, input and output resistance, offset current and voltage, slew rate, unity gain frequency and so on. All of these can be set to suit.

Values must be entered for each resistor and capacitor, as the initial value is assumed to be zero.

Incidentally, the rectangular symbols shown at the bottom of the component library are a voltmeter and an ammeter. Like all components in the library, you have an unlimited number, so voltmeters can be connected to virtually any point in the circuit to help when troubleshooting.

I tried a range of circuits, including various transistor amplifiers, oscillators and so on. While I got them all to work, I have to admit that in some cases it may have been quicker to construct them on the bench rather than use the simulator.

The manual points out that even the order of component placement can upset the operation of the circuit, so little wonder I had a few problems. But to be fair, I suspect part of the problem was my inexperience and after a few hours, I learnt how to avoid some of the problems.

Electronics Workbench

The computation time is reasonably quick, and once a simulation has been run, voltage readings can be obtained immediately. The program supports a maths co-processor, and if one is present in the computer this is detected during installation and is automatically selected.

The program can produce a printout of the circuit, the instruments, a list of the components used in the circuit (parts list) and so on. A vast range of printers are supported, including my HP DeskJet. The diagram of Fig.3 shows the printout of the circuit, as well as the 'scope display and the function generator settings for the circuit.

The component library includes most of the usual analog components, although there are no thyristors or FETs. The components not shown in Fig.1 are a fuse (partly hidden at the bottom), a relay, a positive output power supply and a negative output power supply.

As already mentioned, each active component has a model to represent it, and the parameters of each component can be changed quite easily. This is fully described in the manual.

Digital simulation

The digital module in *Electronics Workbench* has some incredible features, and would suit anyone involved in combinational logic circuit design. It has a *limited* array of devices, although ICs can be designed and saved as a macro.

For example, a counter is not available in the parts bin, but one has been used in an example circuit supplied with the package.

This component can then be borrowed for use at will. Unfortunately, the manual only gives brief details on how to design an IC, although I'm sure that given time with the program, this will become clear.

To explain some of the features of the digital module, look at Fig.2, which shows two gate circuits connected to the 'word generator' and their outputs connected to an 8-channel logic analyser. A truth table is also shown in this diagram, along with the Boolean expression for the circuit.

There are a number of options available to design a logic circuit, and I chose to enter a truth table in the 'truth table converter'. As shown, I wanted a logic 1 for the binary inputs of 000, 100 and 111. Pressing the appropriate selector then gave the simplified Boolean expression as shown at the bottom of the 'converter'. The apostrophe represents the bar usually found in a Boolean expression.

But it doesn't stop there. The next thing was to get a circuit. Again by pressing the appropriate selector (convert Boolean to logic circuit), EWB almost immediately produced the top group of gates. I then asked it to produce the same thing in NAND gates, shown as the lower group of gates in Fig.2.

To prove their equivalence, I connected the first three outputs of the word generator to both circuits, and connected the logic analyser so the output of both circuits could be viewed.

Pressing the GO icon (switch on top of the screen display) gave the waveforms shown, which are as they should be — the same. The word generator is set to give inputs to the circuit that sequentially count in binary from 000 to 111.

The only other instrument available in the digital module is a voltmeter, which acts like a logic probe. The parts bin contains the usual gates, an R-S flipflop, a D flipflop, a J-K flipflop and a half-adder. There is also a seven-segment display which will show a numerical display as the circuit is operating. As for the analog module, there is an unlimited supply of each component. Incidentally, for those into the DIN standard logic symbols, Emona have advised me that these are available on request.

Summary

Compared to any other simulator, *Electronics Workbench* is certainly the easiest I've ever used. This is a program that can not only be a design tool, but also an excellent learning aid. For example, a circuit can be entered and modified at will without all the expense and mess.

As I've already said, the analog module sometimes makes hard work of what should be a simple task, but this is also true of actually constructing the circuit. And how many people have access to the range of instruments supported by this program? Even using the instruments is instructive, as the controls perform exactly as they would on the real thing.

This program is aimed at the educational market, and in these tight times, a computer simulation is quite possibly a cost-effective way of providing the 'equipment' required for practical sessions. However, to prevent lost time, the circuits being studied would need to be designed, proved and saved as a file before being used in a teaching environment.

But given this, students could change component values and do all the usual experiments without the need for lots of equipment.

Site licences are available, and those interested should contact Emona Instruments. (See address at the end of this review).

On the topic of equipment, a word about the computing system required is probably in order. There are three versions of the program, referred to as the Personal version ($149), the Personal Plus version ($299) and the Professional version ($429).

The first two versions are basically in monochrome and can only operate with either a CGA or a monochrome screen. The Personal version is limited to circuits with no more than 20 components, while the Personal Plus version has an unlimited number of components per circuit. Neither of these versions use a maths co-processor, although both can work directly from a floppy disk.

The Professional version (the one reviewed here) uses either an EGA or a VGA screen and is in colour. A hard disk drive is required, and the program requires around 2M of disk space and 640K of memory.

A Microsoft-compatible mouse is also required. The computer is specified as PC or AT compatible. The computer used in this review is a '386DX compatible and obviously the faster the system the better.

Summing up, *Electronics Workbench* is an attractive package with a good quality manual and many nice features. It is also well priced when compared to programs like *PSPICE* at $1200 (or $3000 for the full suite) and $1850 for *Micro-Cap*.

These programs offer more facilities, but *Electronics Workbench* doesn't have too much that's missing.

The review copy was supplied by Emona Instruments, and my thanks go to John South for his assistance in preparing this review.

For further information contact Emona on (02) 519 3933 or at 86 Parramatta Road, Camperdown 2050. ❖

PC Enhancements Feature:

Higher speed, resolution from laser printers

Laser printers have been around for some years now, but for many people they remain a somewhat expensive replacement for a typewriter or dot-matrix printer. An Australian company has pioneered laser printer enhancement via standard PC's — advancing the laser printer so that it now competes directly with professional typesetting systems, for a fraction of the cost.

by BILL HALLIWELL

Laser printers are here to stay. In communications, commercial and media applications they have replaced the ubiquitous typewriter or the humble dot-matrix printer that once happily rasped away next to everyone's PC.

Like most new computer technology, laser printers were costly when introduced. Although the price of a standard laser printer has dropped, they still don't come in much under $3,000.

The early laser printers were also fairly noisy and slow. So slow it prompted a US technology company to produce a PC-based controller card (the LC-2), which beefed up their output speed. That company, LaserMaster, is clawing its way to the top of the laser printing world by continually improving on good ideas and making them work better.

Just after the introduction of the LC-2 controller card from LaserMaster, an Australian company was formed to import and distribute LaserMaster products. That company, Precision Images was founded by Melbourne businessman John Blackett-Smith, in 1988.

John Blackett-Smith, having a background in film production and the electronic media, was one of the first 'computer buffs' of the late 1970's to turn his hobby into a profitable business.

"With the constant improvement in desktop publishing (DTP) programs I could see, as LaserMaster did, an enormous potential for the future development of the laser printer and its applications."

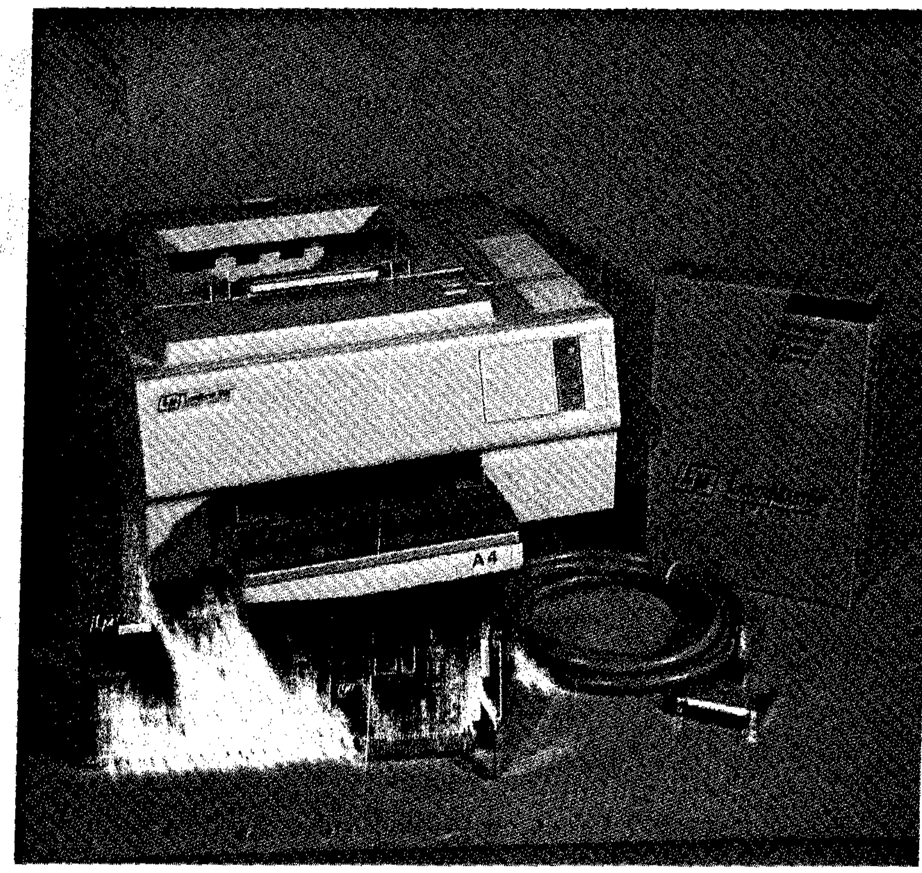
"But laser printers were still too slow. The more complex DTP programs became, the slower and more inadequate laser printers appeared in everyday use", he said.

For a long time laser printers were confined to an output resolution of 300 dots per inch (dpi), which made for great looking office correspondence but 300dpi fell far short of true typesetting quality.

LaserMaster then developed their LX-6 Controller Card, which improved the resolution of any laser printer with a Canon engine from 300 to 800dpi — while again increasing output speed. It was a major leap, and one which began to put LaserMaster, and Precision Images, on the map.

But it was still impractical for their laser printers to compete with typesetters and fully exploit the ever-advancing DTP programs such as *Ventura*, *PageMaker* and the like.

Then, in 1989, LaserMaster introduced their first stand-alone laser printer which came with its own controller card. The LX1000 used a system, patented by LaserMaster, called TurboRes which took the laser beam and placed toner more accurately and with



LaserMaster's TX1000 AFM Personal Typesetter, which offers 1000 x 1000dpi resolution at a speed of eight A4 pages per minute. As you can seen it comes complete with its own custom controller card.

more flexibility onto the page — emulating a resolution of 1000 x 1000dpi.

Now, for the first time, output from the LaserMaster could be taken to a printer who could make a plate directly from the laser-printed page.

This advance meant that expensive bromides and other types of sensitised paper were no longer required in every pre-press process.

Given that bromides can cost anywhere between $3 to $12 per sheet and that most conventional typesetting systems can have a six-figure purchase price, LaserMaster was set to turn the publishing industry around in a radical way.

But according to John Blackett-Smith, there was still some, understandable, industry resistance which hindered the growth of his aptly named company, Precision Images.

"We would talk to printers and commercial firms which did their own publishing and as soon as we said 'laser printer' they would smile, scoff and dismiss us as if we were trying to sell them some kind of high-tech toy."

"Our first move to overcome this market resistance was to begin a campaign to convince the computer and printing industry media that there was a workable alternative to the conventional typesetter, and that not every laser printer was doomed to the unsatisfactory resolution of 300 or 400dpi."

"We hired a journalist to get our message across to computer journalists, writers for printing industry magazines and the general press."

"This was easier said than done, because even these industry specialists were under the impression — initially — that the best a laser printer could ever do was 300, 400 or maybe as much as 600dpi."

"Our initial press releases were often seen as 'just another story about boring old laser printers', as one top computer writer once quipped. It wasn't until 1991 that the computer, communications and printing industries began to take LaserMaster seriously", he said.

Meanwhile, during 1991, LaserMaster, never a company to rest on its laurels, developed and released the first true laser-based typesetter: the LX 1200. This provided output on A3 or A4 sized sheets at 1200 x 800dpi. Now there was even more reason for the printing and publishing industries to sit up and take notice.

Midway through 1991, after a co-operative deal with the US software giant, Microsoft, LaserMaster's entire range of laser printers and typesetters went fully PostScript compatible — offering 135 Type 1 fonts absolutely free with each of its units. This represents a saving of around $5,000 over 135 fonts purchased individually.

John Blackett-Smith says LaserMaster is destined to reach number one in the laser printing world, because they are always looking for and finding ways to improve their technology.

"Late in 1991 we were able to release details of LaserMaster's Automatic Font Management (AFM) system. LaserMaster also released SmartSense to automatically switch between PostScript and PCL printing modes.

Like all LaserMaster products, this relies on the power of the customer's PC to enhance and improve the performance of their printers."

"AFM means LaserMaster units are faster than ever before, because this system allows the printer to treat all the fonts on the host PC's hard drive as if they were already resident in the printer controller ROM.

This eliminates the need to pre-select fonts or to pre-configure the printer driver, and because AFM stores fonts temporarily in the controller RAM the virtual memory is cleared of all font data as soon as the document has finished printing", he said.

So now LaserMaster typesetters and laser printers are all fully PostScript compatible with the highest resolutions, and offer the ability to handle the highest number of fully manageable fonts of any machine on the market today. But John Blackett-Smith says there are even more surprises from LaserMaster due in the early months of 1992.

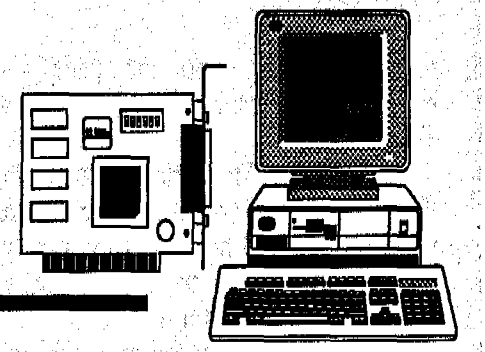
"When Precision Images opens its new Sydney headquarters in late February we will release details of a new range of LaserMaster imaging products which will use the PC to speed up and enhance the functions of scanning devices.

This opens up a gigantic field of potential in the areas of high speed data communications and document storage and retrieval", he said.

Precision Images offers the LaserMaster range of typesetter and laser printers beginning with the TX True-Tech Controller Card for HPII/III (800 x 800dpi) at $4,990 (ex-tax); the TX800 AFM laser printer (800 x 800dpi at eight pages per minute) at $9,990 (ex-tax); the TX1000 AFM Personal Typesetter (1000 x 1000dpi at eight pages per minute) at $15,250 (ex-tax); and the top of the line TX1200 AFM A3 Typesetter (1200 x 800dpi at 20 pages per minute) for $37,990 (ex-tax).

Precision Images has a nation-wide network of authorised dealers, which can be contacted on Melbourne (03) 811 9934 or at their new Sydney headquarters on (02) 954 0040. ❖

The LaserMaster Controller Card is also available separately, to operate with standard HP LaserJet II/III printers. It comes complete with software for automatic font management, including PostScript/PCL switching.



Single channel data logger

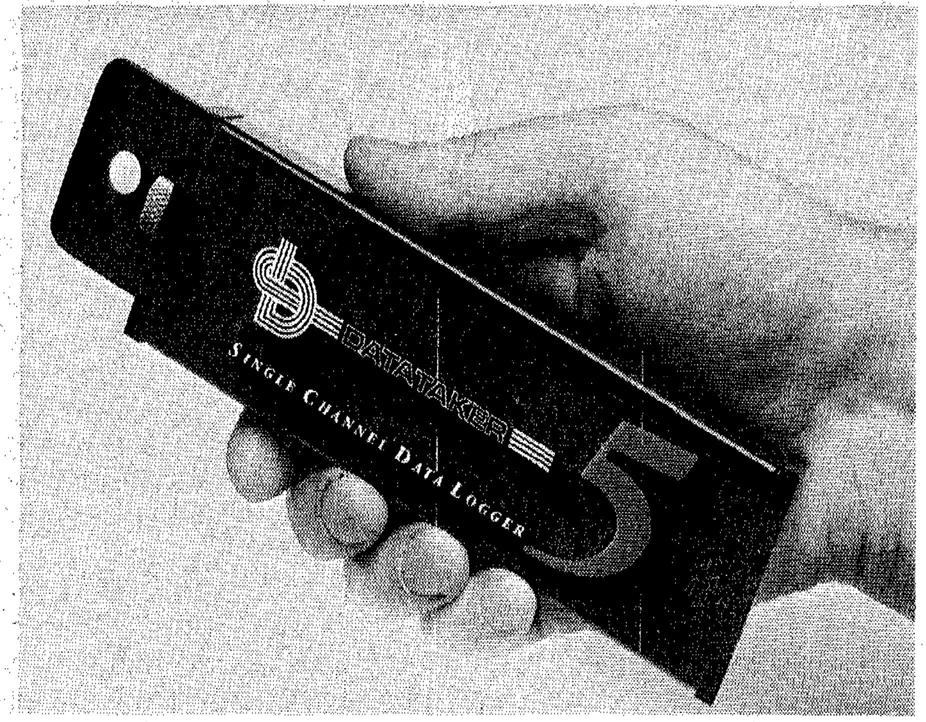
Designed and manufactured in Australia, the Datataker 5 is a single channel data logger for recording temperatures, events or voltages. The logger has a stainless steel housing and a memory capacity of 2000 readings.

Records are held in non-volatile memory, which can maintain data for 100 years without power.

Battery life is one year with an alkaline battery, or up to five years with a lithium battery. The unit is 210mm in length and 50mm wide by 25mm deep.

The Datataker 5 is programmed using menu driven software which runs on an IBM computer. The recording interval can be from one second to 18 hours. Recorded data can be time and date stamped.

The software provides graphing of data, production of reports and production of Lotus 123 compatible files. Models are available for event logging or voltage logging with custom versions available for specific sensors.



Applications include food transport logging, energy monitoring, production counting, machine monitoring, electricity and gas consumption monitoring. For more information circle 161 on the reader service coupon or contact Data Electronics, 7 Seismic Court, Rowville 3178; phone (03) 764 8600.

Frame grabber for Macs

The MR Grab1 from Display Research Laboratory is an extremely low cost, 8-bit, real time black and white frame grabber for Apple Macintosh computers.

It is implemented as a short NuBus card, and because it is so fast, it can be used in place of an overlay card to create single monitor presentation or courseware, with real time video and computer graphics.

Externals for HyperCard 2.0 and sample HyperCard stacks provide ready-made buttons for copying to applications. One sample allows control settings such as brightness and contrast to be adjusted interactively, while a VCR-like control panel permits video images to be captured and saved. Another sample demonstrates various special effects and transitions commonly found in TV programs.

Also released for use with MR Grab1 is MR 8C, an extender card that plugs into its tail and converts it into a colour frame grabber.

MR 8C accepts Y/C separated video or analog RGB for high quality colour. Its TV quality, while using only eight bits per pixel, comes as a result of a proprietary digital two dimensional and time-domain error compensation circuit.

Additional to the frame grabber family is the MR Split. This is required when the MR Grab1 and MR 8C are to be used with a composite video source. It is a Y/C separator that separates the brightness and colour component of a composite video signal to give S-video format output.

For more information, circle 162 on the reader services coupon or contact Anitech, 52/2 Railway Parade, Lidcombe 2141; phone (02) 749 1244.

24-pin printer has inbuilt feeder

A new 24-pin dot matrix printer, featuring a built-in automatic sheet feeder (ASF) has been released by Siemens. According to the company, it is the only printer in its class to offer an integral ASF at no extra cost.

The machine is priced at $695. Called the MT82, it is targeted at small to medium sized businesses and education and government departments.

Continuous paper handling is featured, as push tractors come as standard. The printer also offers users a paper parking facility which requires just a single button manoeuvre. In draft mode, the MT82 prints at 192cps and in letter quality at 64cps. It offers an 80 column width, and a selection of resident fonts including draft and LQ Sans Serif and Roman (LQ). A range of plug-in fonts is also available.

Compatible with most PCs and software, the printer provides IBM Proprinter X.24 and Epson LQ850 emulations as standard. A parallel Centronics interface comes as standard, while an optional RS232 interface is available at $69.

For more information, circle 163 on the reader service card or contact Siemens, 544 Church Street, Richmond 3121; phone (03) 420 7254.

386SX built into keyboard

CCI of Melbourne has designed and manufactured the 'Joey' — a 386SX computer built in a keyboard. In the base of a 101-key Trackball Keyboard is a 386SX motherboard with 1 - 8MB RAM, onboard VGA, I/O and hard and floppy disk controller, an 80MB hard disk drive and a 1.44Mb floppy disk drive.

The unit incorporates CCI's own 386SX motherboard, using the VLSI 'Scamp' chipset, and will take the full range of Intel and AMD SX CPUs. With room inside to take a full-sized card, the Joey can be configured as both a stand alone machine or network terminal (with or without disks). At the end of a day's work, it can be disconnected from the monitor and taken home to be used on another monitor.

Also, with the addition of a battery pack and a transmitter, the Joey becomes a remote PC able to broadcast to a TV screen or a VGA monitor. With a nine metre range, and the ability to broadcast to more than one TV screen at once, this is claimed as the 'ultimate' in flexible, portable computing.

Connected to an external power pack and a VGA monitor, it serves as a normal desktop computer. Then, disconnected, it can be used in a classroom, boardroom, on site or, indeed anywhere there is a TV or monitor.

For more information circle 164 on the reader service coupon or contact CCI, 26 Fulton Street, Oakleigh South 3167; phone (03) 562 9900.

COMPUTER PRODUCTS

Mightier 'Mights'

Continually releasing newer and better products within the computer industry is hard at the best of times, let alone during a time of quiet economic activities.

Yet international UPS manufacturer Lumen Electronics claims to have done just that, with the release of three new, more powerful Upsonic UPS systems — 800VA, 1400VA and 2000VA — into its existing range of PC Mights.

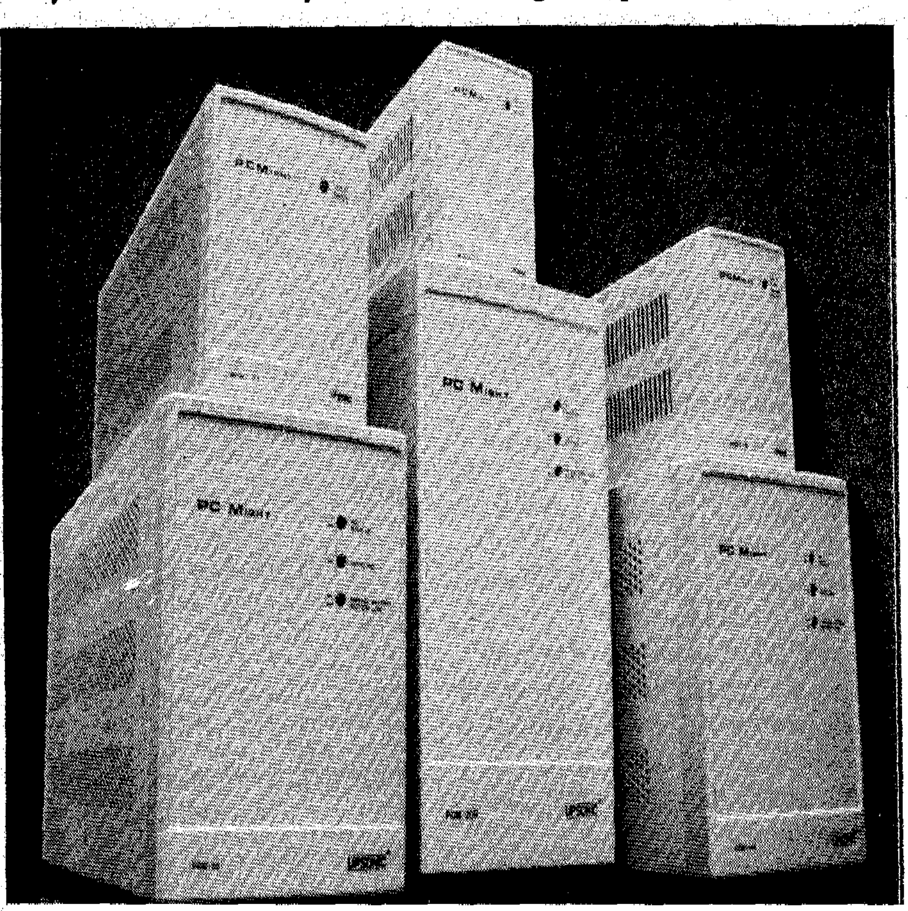
With six units — 250, 350, 550, 800, 1400 and 2000Va — in the range and more to come, literally every computer from the desktop 286 through to the most powerful mini system is now catered for.

More users can now afford the added safety and assurance that only a UPS can give. The Upsonic PC Might formulas of equality and reliability are also well proven, with well over 100,000 units sold worldwide in the last 18 months.

Every Upsonic PC Might is built to exacting international standards, and in Australia comes complete with either a 12 month or 36 month warranty.

Locally, Lumen International Electronics (Australia) is changing its name to Upsonic, to retain corporate international marketing uniformity. There are no changes at all to existing product, personnel, location or phone numbers.

For further information circle 180 on the reader service card, or contact Upsonic, 18 Amberley Crescent, Dandenong 3175; phone (03) 706 9090.



New IBM 386SX processor

IBM Australia has introduced a new custom, high speed 386SX microprocessor as an upgrade to its popular mid-range Personal System/2 Model 57 SX.

The new upgrade option uses the powerful new IBM 386SLC processor. The new optional upgrade boosts performance of the model 57 SX by up to 88% without requiring a new system.

Customers can run popular programs, such as Lotus 123 or AutoCAD for OS/2, faster than many 386DX systems. The 386SLC has the same 32-bit internal, 16-bit external design as the Intel 386SX, and is fully compatible with Intel 386 architecture.

It is priced at $1320 (ex tax), and installs easily in the math coprocessor socket on the Model 57 SX system board.

IBM designed the 386SLC with eight kilobytes (KB) of internal cache and an internal cache controller, which improves performance by accessing data from high speed cache memory rather than system memory, whenever possible.

Performance has been further enhanced by optimising commonly used instructions.

For more information circle 171 on the reader service coupon or contact IBM Australia, PO Box 400, Pennant Hills 2120; phone (02) 634 9111.

VGA image to TV/video

Business World has released a new PC enhancement product for outputing a VGA image to TV or video.

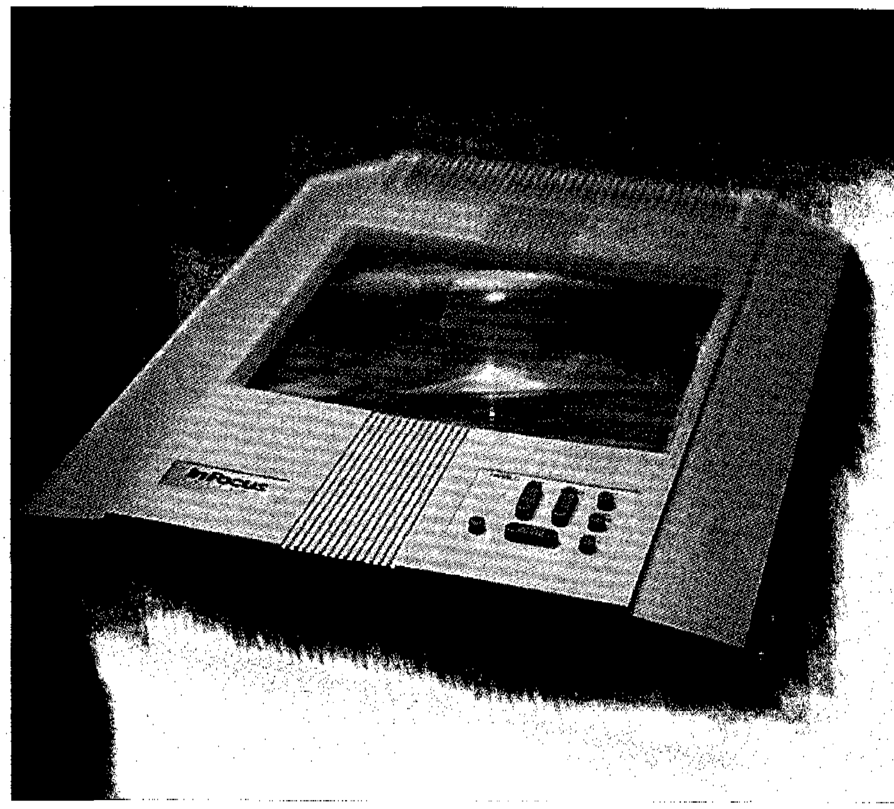
The PC-Video Adaptor converts the RGB signal from the VGA output into a composite PAL signal, but presents the graphics onto a TV, VCR projection TV, or large screen TV.

READER INFO NO. 25

PC-Video is a box type unit. It connects your existing VGA card through a cable provided. The unit designed for Laptop or Notebook computers as well as desktops.

For more information circle 168 on the reader service coupon or contact Business World, 1352 Ferntree Gully Road, Scoresby 3179; phone (03) 764 2222.

Colour LCD panel for OHP's



In Focus Systems' new 1600LC PC Viewer, projects 16 true VGA colours using a revolutionary new LCD technology. The unit sits directly on an overhead projector and connects to the PC graphics card.

It displays computer generated screen images directly from a personal computer onto a screen or wall, via a standard overhead projector.

The breakthrough colour technology uses a recently discovered LCD phenomenon called 'birefringence'.

It also transmits up to 50% more of the overhead projector's light than comparable colour panels, allowing far brighter colour images to be presented on standard overheads projectors.

The 1600 PC Viewer operates with IBM and compatible desktop, laptop or notebook computers with VGA, EGA and CGA graphics, as well as Apple II, Macintosh, Macintosh II and Macintosh LC computers.

The 1600LC has 640 x 480 resolution and 'loop through' that allows a monitor to be connected with no additional components or wiring.

The 1600LC can also be combined with Electroboard's LiteShow II to become a remote controlled, fully portable, presentation management system. The Viewer PC costs under $5000.

For more information, circle 170 on the reader service coupon or contact Electroboard, 275 Alfred Street, North Sydney 2060; phone (02) 957 5842.

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PCB PATTERNS: High contrast, actual size transparencies for printed circuit boards and front panels are available. Price is $5 for boards up to 100sq.cm, $10 for larger boards. Please specify negatives or positives.

PROJECT QUERIES: Advice on projects is limited to postal correspondence only and to projects less than five years old. Price $5. Please note that we cannot undertake special research or advise on project modifications. Members of our technical staff are not available to discuss technical problems by telephone.

OTHER QUERIES: Technical queries outside the scope of 'Replies by Post', or submitted without fee, may be answered in the 'Information Centre' pages at the discretion of the Editor.

PAYMENT: Must be negotiable in Australia and payable to 'Electronics Australia'. Send cheque, money order or credit card number (American Express, Bankcard, Mastercard or Visa card), name and address (see form). All prices include postage within Australia and New Zealand.

ADDRESS: Send all correspondence to: The Secretary, Electronics Australia, P.O. Box 199, Alexandria, NSW 2015.

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