
OCTOBER, 1974
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electronics
TODAY
INTERNATIONAL
GIANT PROJECTS ISSUE
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"But doesn't TEAC make tape decks?"

Yes. We certainly do. We feel we manufacture the finest in the world. So good, in fact, that many popular amplifiers and receivers just don't do them justice. So we created the TEAC line of stereo components.

The AG-6500, pictured above, can handle up to *three tape decks*. It has front panel tape monitor and copy controls that permit you to make two recordings at once—from a master tape, an FM broadcast, or any source. You can easily transfer sound from a reel-to-reel deck to a cassette deck, or vice versa, without unplugging jacks. And you can even make tape transfers while listening to the tuner or a record through your speakers!

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electronics TODAY INTERNATIONAL

OCTOBER 1974 Vol.4. No.7

main features

special projects feature

reviews

news & information

COVER: Win $250-worth components – of your choice! Great new design contest page 42 this issue. (Cover picture by staff photographer John Knight).

ETI now 75 cents
Enormous increases in paper and printing costs has forced us to increase our (recommended) cover price from 60 cents to 75 cents. Concurrently however we have made a few changes to format which we trust will be some partial compensation for our regretted but unavoidable price rise.

NEXT MONTH

UNDERSTANDING COLOUR TV

Complete instructional course in colour TV. Written exclusively for ETI by Caleb Bradley B.Sc. First part begins next month.

THE 555 TIMER

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Latest electronic development enables speech to be varied in speed without affecting pitch!

PROJECTS

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*Apan BFU 121** fully automatic belt-drive turntable features

* 4-pole synchronous motor
* Wow and flutter less than 0.16% wrms
* Signal to noise ratio better than −52dB
* 12" diecast aluminium platter weight 1.3 kg
* Integrated oil damped lifter
* Static balance "S" type tone arm with anti-skate device
* Removeable headshell and revolving counterweight with graduated scale from 1-3 grams
* Complete with magnetic cartridge Frequency response 20-20,000Hz Output 4.5 MV

* Comes complete with "high tension" four-channel leads and is 4-channel ready.

APAN BFU·121 Four·Channel

*Apan BFU 121** fully automatic belt-drive turntable features

* 4-pole synchronous motor
* Wow and flutter less than 0.16% wrms
* Signal to noise ratio better than 52dB
* 12" diecast aluminium platter weight 1.3 kg
* Integrated oil damped lifter
* Static balance "S" type tone arm with anti-skate device
* Removeable headshell and revolving counterweight with graduated scale from 1-3 grams
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news digest

NEW SAFETY RADAR

Despite strong opposition from engineering and medical authorities, the US government still plan to go ahead with air-inflated crash bags for cars.

At present these bags are inflated by inertia sensors located on the vehicle's front bumper. Several electronic companies are researching radar devices that initiate inflation if the vehicle approaches an unavoidable object.

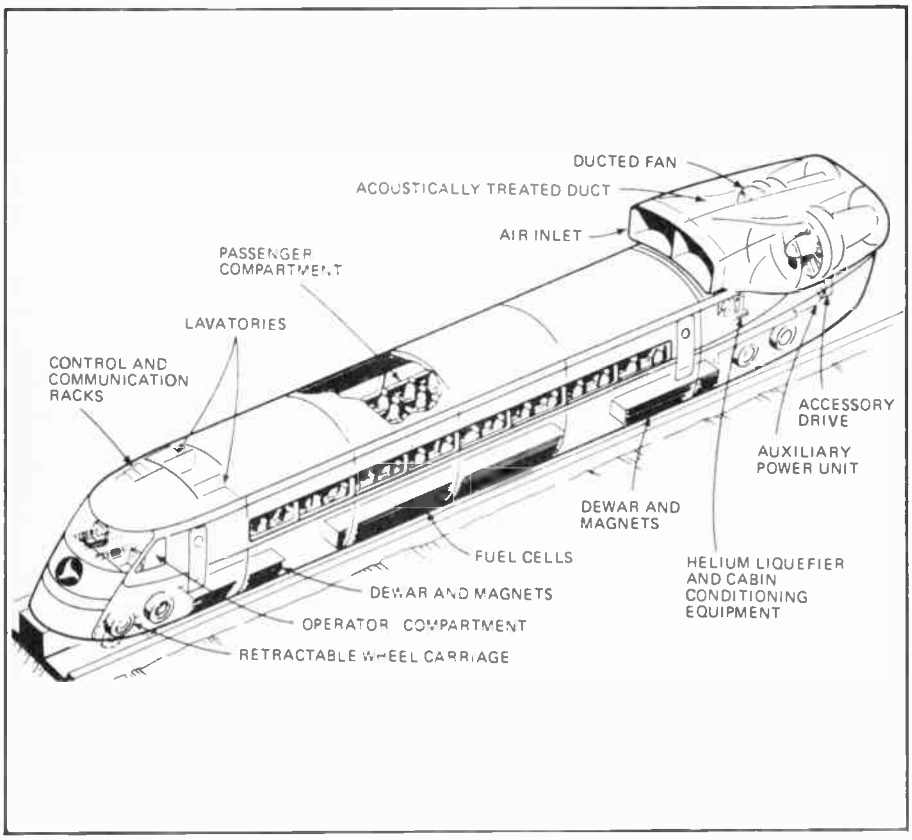
Sperry are currently researching a technique called BARBI (Baseline Radar Bag Initiator) which uses subnano-second pulses of RF energy.

No carrier wave is used. Instead, two hundred volt, 200 pico-second pulses are transmitted forward from a small antenna fixed to one end of the vehicle's bumper (pulse recurrence frequency is about 500 per second). Reflected signals are then filtered and passed to measuring and logic circuits that look for pulses returned from objects 1000mm, 660mm, and then 330mm away. If such pulses occur faster than a pre-determined speed the bag is automatically inflated.

500 KM/H TRAIN

Ford, in the USA, have released details of their proposed 150 passenger, 500 km/h passenger train.

The prototype vehicle, presently being developed for the US Dept. of Transportation is suspended on a magnetic field generated by helium-cooled superconducting magnets. Initially rocket propulsion will be used — presumably to enable the suspension system to be evaluated using just a short length of track. Final propulsion system will be via linear motors apparently powered by an onboard jet powered electric generator.



TRAFFIC ELECTRONICS

Two electronic systems concerned with vehicle movement and control are currently under development.

The first, from Japan's Toyota car company is a multi-purpose system. Four sub-systems are used. Two of these transmit data concerning major traffic congestion, accidents, weather conditions and information of an essentially 'emergency' nature. One channel is used as a radio-telephone link, and the fourth one enables the driver to choose the most traffic-free route to his destination.

All emergency-type data are transmitted from a central office to so-called 'leaky' cables laid alongside all major roads. Special receiving equipment in each vehicle continually monitors the cable and feeds any relevent data automatically into the vehicle's normal car radio.

Also within the car is a visual data panel. This displays all information that is currently indicated by roadside signs — stop signs, speed limits, no entry signs, pedestrian crossing warnings etc. Input data for this service is transmitted via inductive loops buried beneath the road surface.

Optimum route selection is performed by a computer control centre that collects data from many different points. By using a keyboard panel, the driver can check the state of traffic congestion at any road intersection along his route. Thus he can plot the quickest, least congested route to his destination.

The second electronic system is the brainchild of Fred Sterzer, Director of RCA's Microwave Technology Division in Princeton, New Jersey.

Dr. Sterzer's proposal is for an active number plate which if interrogated by a microwave transponder, would transmit a coded signal unique to that vehicle.

The electronic number plate would consist of a printed circuit antenna on which be printed the normal licence number (for visual identification) together with an rf detector, frequency doubler and modulator, and an IC digital generating coder.

The main use of the system, says Dr. Sterzer, is for improving the scheduling and dispatching of vehicles, nevertheless RCA see innumerable other applications in what they rather euphemistically call 'traffic safety'.

These include the identification of stolen and speeding cars, toll collection by a central billing system, automatic entry or restriction to parking areas, tracking down vehicles whose owners have ignored traffic fines etc.

DOLBY FM RADIO

Stereo FM broadcasting has one major drawback over mono FM. That is that the signal/noise ratio is degraded quite considerably — by as much as 20 dB.

In the past the only satisfactory solution has been to increase transmitted power or antenna gain accordingly.

It is also possible to alleviate the problem by using conventional Dolby noise reduction equipment.

This works quite well (achieving a 10 dB improvement), but the technique is obviously only effective for Dolby-equipped receivers, and has the major drawback that non-Dolby receivers will produce an overly 'bright' signal.

Dolby Laboratories have now devised a new technique which is ingeniously simple yet effective.

Due to deficiencies in early microphones, broadcasting stations have always boosted high frequencies by a technique called pre-emphasis. A mirror-image circuit in the receiver then restores the boosted high frequency signals to the correct relative levels.

Reducing the amount of pre-emphasis will thus result in a received signal with insufficient treble content.

Fortuitously, the Dolby noise reduction boosts high frequency signals as well — so that if the transmitted signal is Dolby-encoded but has pre-emphasis reduced the two effects cancel out. Non-Dolby receivers will thus not be affected in any way but Dolby-equipped receivers will now have a far better signal/noise ratio.

The new technique has proved surprisingly effective — to the extent that Dolby have stopped promoting simple Dolby broadcasting.

The FCC in America has given stations the official go-ahead to use the new technique, German radio authorities are currently experimenting with it, and in Australia the technique will be tried out on an experimental basis as soon as FM broadcasting begins.

SUPERB PICTURE FROM EARTH SATELLITE

This superb picture of the Earth was transmitted back to the White Sands Missile Range in New Mexico by a meteorological satellite launched by NASA on May 17 this year. The satellite is 'parked' in a synchronous orbit some 35 900 km above Brazil.

The signals are transmitted to White Sands via a radio link. There, they are digitized and used to modulate a laser that burns the 'picture' onto film.

LIGHT-FIBRE PHONE SYSTEM IN AUSTRALIA

Adding optical fibres to the existing network of conventional cables could revolutionise the telecommunications industry in little more than a decade, according to Austral Standard Cables Pty. Ltd's technical manager Mr. A.H. Hambleton.

Mr. Hambleton recently returned from a seven-week study of cable technology in Britain, Europe, USSR and USA.

Optical fibres could provide an almost infinite number of communication channels," he said.

The significance of their development may be gauged from the fact that a glass or silica fibre less than one millimetre in diameter could carry the same number of channels as co-axial cables similar to the Melbourne-Sydney link.

"The optical fibre concept brings to transmission lines what the transistor brought to electronics," said Mr. Hambleton.

"Fibres will facilitate wide band transmission to every home."

This means, for example, that video telephones may be economically viable and that cable television with 50 or more television channels is practicable.

Mr. Hambleton said the key issue is the availability of band width.

This is expensive to obtain with conventional copper conductor cables which are limited in this regard because of their comparative bulk, cost and an inevitable shortage of the base metal.

Some developments have occurred in Australia with liquid-filled fibres. But overseas technologists have diverted from the Australian method because of the low band width and serious delay distortion limitations of liquid-filled fibres. Instead, they are developing solid fibres with graded optical properties which allow light to be totally and internally reflected along the fibre with minimal loss. Attenuation as low as two decibels per kilometre has been demonstrated in some experiments.

Researchers claim that in about four years, wide band optical fibre transmission could be made available in prototype short-haul, high-density channel systems in large cities such as New York. Mr. Hambleton stressed, however, that the development of optical fibre cables probably will not be required here for at least 10 years.

He said that the British Post Office's successful use of aluminium as a telephone cable conductor is of more immediate interest to the Australian industry.

news digest

PHILIPS NOW MAKING DOLBYIZED CASSETTES

In the same low-key manner that DGG started to produce Dolbyized tape cassettes, Philips are now producing Dolbyized versions of *their* products.

The first Philips Dolbyized cassettes were issued early this year but no official announcement was made – presumably to allow dealers to obtain stocks – or to clear all their old ones!

From now on all Dolby processed cassettes will carry the double B Dolby logo. There is no way of identifying earlier Dolbyized cassettes except by opening the package – the Dolbyized versions are marked accordingly on the inner liner.

Philips Dolbyized cassettes recently released include works by Prokofiev, Beethoven, Rachmaninoff and Richard Strauss.

EMI TO MAKE CD-4 DISCS?

In Britain, EMI have made arrangements with Germany's Sonopress company to cut some experimental discs using the CD-4 discrete process developed by JVC.

EMI are currently emphasizing that this move is purely experimental and should not be seen as an indication that they will quit their current commitment to SQ matrix.

Despite this denial, the US Elektra company (an EMI licencee) is now producing CD-4 discs. There are also very strong rumours that DGG will soon commit themselves to CD-4.

PERSONAL ALARM SYSTEM

All Americans may soon carry a wristwatch-sized personal security alarm!

The US Law Enforcement Assistance Administration has commissioned the Aerospace Corporation to launch a massive field test next year of a prototype system that may eventually become nation-wide.

The system is based on thick-film hybrid UHF transmitters modulated which may eventually be built into standard electronic watches.

To generate an alarm, the wearer presses two buttons simultaneously. This causes an internal shift register to generate a digital code which in turn frequency modulates the transmitter.

The alarm signal is then picked up by the nearest of a vast number of local receivers which retransmits the signal together with data identifying the transmitter's location, to a central processing computer in the local police headquarters.

In the forthcoming field trials, some 5000 alarm units will be used.

BUSINESS CALCULATOR

As we forecast in our July issue, Hewlett-Packard have now introduced a lower-priced simplified versions of the H-P 80 financial calculator.

The new model is a pre-programmed pocket-sized machine which in addition to the usual four functions has 21 of the most commonly used business equations programmed into it. These programmes include, accrued interest, future value of a compound amount, effective rate of mortgage, effective rate of return for compounded amounts, percentage difference, percentage calculations and discounted cash flow.

Included within the unit is a four-memory operational stack and two independent memories for immediate storage and number accumulation.

Firm price was not available at the time of closing for press but we believe that our early estimate of $US 175 is probably about right.

MONOLITHIC QUAD TIMERS

The US Signetics Corporation has just introduced monolithic quad timers – capable of performing four entirely separate timing operations simultaneously. The IC's type numbers NE/SE 553 and 554 can produce accurate delays from microseconds to many hours.

MAGNETIC-ELECTRIC INTERCONVERSION

Philips Research Laboratories in Eindhoven have developed a composite piezo-magnetic/piezo-electric material that inter-converts magnetic and electrical fields.

The actual material is composed of a molten eutectic mixture of barium titanate and cobalt ferrite which is solidified uni-directionally.

Conversion is brought about by mechanical deformation hence optimum efficiency occurs at the mechanical resonant frequency.

There is of course nothing new in magnetic and electrical inter-conversion. It is achieved for instance in a solenoid. What is unique about Philips' new material is that conversion takes place without a flow of current.

POWER LINE MONITOR

Of interest to computer and scientific equipment manufacturers is a power line monitor recently developed by Britain's Data Laboratories (Mitcham, Surrey).

Originally designed for the British Admiralty, the instrument has since been produced in commercial form.

The instrument is connected across the incoming power line and records all phenomena other than the basic mains frequencies.

END TO TYPOGRAPHICAL ERRORS

Typographical errors are the bane of newspaper and magazine editors alike – for no matter how carefully material is proof-read, people tend to read words as they should be, not as they actually are.

A new computer programme just introduced by Bell Laboratories may alleviate at least part of this problem.

In use, the computer stores a list of the most commonly used words and then displays an 'index of peculiarity' if any words are abnormally spelt.

Fortunately ETI does not contain an abnormal number of typographical errors and our editor says that we have no r@$s3&)) for such an exptjpf&@%h?f...

DES TROYER CONTEST

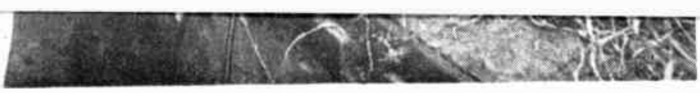
Winners of the Des Troyer Power Supply Contest (ETI August issue) are:–

W. Gowan, Port Pirie SA 5540
I. McAllister, Balga WA 6061
P. Dennis, Auburn NSW 2144
R. Fletcher, Castlemaine Vic. 3450
L.A. Maloney, Nth Mackay Qld. 4740
C.J. Bourke, Pearce ACT 2607
R.T. Burgess, Maryborough Qld 4650
I. Dall, Scarborough WA 6019
K. Jensma, Dundas NSW 2117
P.H. Cox, Carlingford 2118
J.R. Grieg, Lane Cove 2066
J. Kneen, Cheltenham. Vic. 3192

In our judges opinion the best entry was that submitted by Mr. R.T. Burgess of Maryborough, Queensland.

Of the many hundred entries only 30 spotted *all* the faults.

In view of the extraordinary interest that this contest attracted we will publish the winning entry next month. In the meantime, congratulations to the winners – your Adcola soldering irons will be sent off to you



gun synchronises the switch-on of the tube with an externally derived signal.

SEE WHAT YOU SAVE

The accelerating voltage is 2 kV.

Spiral-type scanning is applied (electrostatic deflection plates are used in the tube) for observation of light phenomena. The scanning is produced by two 200 MHz amplitude-modulated sinusoidal voltages. The spot speed is 2 cm/s with a 200V peak-peak sweep voltage.

The time resolution of the tube is 10 ps, and, if a trialkaline photocathode is used, the photon gain is more than 10 000 for a wavelength of 0.5 μm.

VIDEO SYNTHESIZERS NOW

An American company (Electronic Music Studios) is currently developing the video equivalent of the electronic music synthesizer.

The 'electronic pallette' enables the user to generate an almost infinite variety of moving or static coloured shapes or patterns. The system, called Sceptre, is digitally operated. It can generate images in a range of 64 different colours and 16 levels of brightness.

The idea is not unique however, for we know of a woman at Sydney University who is currently adapting our own ETI 4600 music synthesizer for the same purpose.

US COMPANY BIDS FOR UK'S ADVANCE ELECTRONICS

Chicago-based Gould Inc. have made a £4.25 million offer for Britain's Advance Electronics company.

It is believed that Advance have accepted the offer.

OUR AUGUST issue contained an extremely favourable review of the Sennheiser Dummy Head and MKE 2002 Triaxial Stereo Microphone.

To our genuine surprise, Sennheiser have taken exception to our consultant's very carefully considered statement that the system is superb for amateur use but that certain limitations cause it to be less suitable for professional use.

We publish herewith, without further comment, a letter from Sennheiser together with a reply from our consultants.

Dear Sirs,

Our Australian representation, R. H. Cunningham, recently sent us your review about our Dummy Head stereo in general and our Triaxial-Stereo-Microphone MKE 2002 in particular.

Your report contains two frequency plots of the MKE 2002 which are thoroughly discussed. To the discussion of the first frequency plot, showing frequency response of MKE 2002 in free space without dummy head, we have no objection. Discussing the second frequency plot, showing the response of the MKE 2002 mounted on dummy head, we would like to point out that you may possibly have misinterpreted a fundamental design feature. You wrote: "The results, shown in Fig. 2, are not nearly as flat, as the free-air results. In fact there are excursions of the order of ±10 dB — particularly at frequencies above 2000 Hz. This is still quite acceptable for amateur recording purposes — indeed we expect that it is actually necessary in order to provide the frequency discrimination required for the stereo effect. However this non-linear response may be a serious drawback for professional users."

It seems important to us to point out that the frequency response measured at the artificial head must differ considerably from the response measured in free space. If, for instance, a probe microphone is fitted to the input of the auditory canal of a human ear, and this ear is irradiated with a constant sound pressure, the result is a number of totally different non-linear frequency curves.

Prior to the development of the Triaxial-Stereo-Microphone MKE 2002 we have taken numerous measurements at natural human ears. We enclose sound pressure curves measured at the input of the auditory canal of ten different persons in free space at different directions of irradiation. From these curves it can be seen that the non-linearity is not due to a non-linear measurement microphone, which is absolutely linear, but completely due to the non-linearity of the ear itself.

Therefore the criticized non-linearity of the frequency curve of about ±10 dB in the frequency range above 2000 Hz is not a property of the MKE 2002, but solely caused by the anatomical properties of the human ear. **The conclusion that the MKE 2002 is only acceptable for amateurs is, therefore, not correct.**

We would be very grateful if you could clarify this matter in the next possible edition of your magazine.

Sincerely yours,
Sennheiser Electronic
3002 Bissendorf/Hann

LOUIS A. CHALLIS and ASSOCIATES REPLY

Sennheiser Electronics take a line which we are at a loss to understand.

Firstly, in their letter they quote one section of our review, completely ignoring the previous paragraph wherein we adequately explain why there is a difference between the Dummy Headphone's microphone response respectively under free field conditions and when mounted on an artificial or real head.

What does perturb us, though, is not that Sennheiser are dissatisfied with our main review, but rather with our comment that this lack of frequency linearity *may* be a serious drawback for professional users.

Repeating again what we said thereafter *"Sennheiser say that their system is as good as a professional Dummy Head with implanted microphones. We cannot accept this premise and believe that prospective users seeking high precision would be better advised to spend the extra thousand dollars and go for the professional models."*

The reason for this is quite simple. If one moves the Sennheiser Triaxial Microphone System even a millimetre or so with respect to the cavity of the ear, one obtains a different frequency response each time.

Is this the sort of performance that one expects from a professional piece of equipment where reproducibility of performance is one of the primary criteria?

Sennheiser has raised no new evidence to support their claims, but rather present a series of graphs to show the variability in measured frequency response derived with ten different ear positions (ten different subjects).

This variability admitted by Sennheiser is precisely the point we're making. It only goes to confirm that any result measured with the MKE 2002 Triaxial Stereo Microphone and Dummy Head is **not reproducible unless their relative positions are positively and permanently fixed.**

That the microphone and head are two separate units which allow a range of possible mounting positions is of academic value only. It detracts from their use in the professional sphere.

We still believe, as we did at the time of writing the review, that this variability would be obviated with a professional Dummy Head. We leave our readers (especially our professional readers) to draw their own conclusions.

Yours faithfully,
Louis A. Challis
Louis A. Challis & Associates Pty Ltd.

2+2=4

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$66.00

There's a new name for Stereo & Quad Headphones:

Telephonics

A leading designer and manufacturer of quality audio products for 40 years, Telephonics now introduces a complete line of Stereo & Quad Headphones. The same high reliability required for airline entertainment and communications systems is now made available by Telephonics, for home and professional use.

The TEL-111 ELECTRET Headphone, for example, incorporates the latest advances in electrostatic audio reproduction providing flat frequency response from 18 to 24,000 Hz, without the need for the conventional electrostatic power supply. And it reduces distortion to the vanishing point by using a stiff featherlight . diaphragm suspended between two permanently-charged plates. The result is the clean, crisp, Telephonics sound, unobtainable with any but the most expensive speaker systems.

The TEL-26 DYNAMIC Stereo Headphone reproduces sound so faithfully that once you hear it, you'll never be satisfied with anything less. It has a separate tone control and volume control on each earcup to permit precise volume, balance and tone adjustments. And Telephonics mechanical 2-way speaker system gives you the 2-way sound without the cost.

For the breathtaking realism of quadraphonic sound, the TEL-32Q QUAD, 4-CHANNEL Headphone has two 2-way speaker systems (four speakers in each earcup) to let you discover sound you've never heard before. The Telephonics Balance Controller lets you sit in your favorite easy chair, far from your receiver or amplifier, and set the 4-channel balance exactly the way you want it.

The TEL-14 TWO-WAY Headphone contains a full 2-way speaker system, complete with crossover network in each earcup. Deep, smooth bass response from the woofers and the bright treble highlights of the tweeters overlap to make the presence of the music felt, just the way the artist intended.

The TEL-29 LIGHTWEIGHT Headphone, the "Weight Watcher" member of the family is easy on the budget. Constructed of air-light materials for hours of easy listening, the Lightweight never disturbs nor intrudes on the music, but is not completely isolating. A volume control on each earcup allows you to adjust volume and balance without returning to your amplifier.

If you want to hear Sound the way it was recorded, don't let an ordinary Headphone come between you and your music. Demand the exceptional. Ask for Telephonics.

Telephonics

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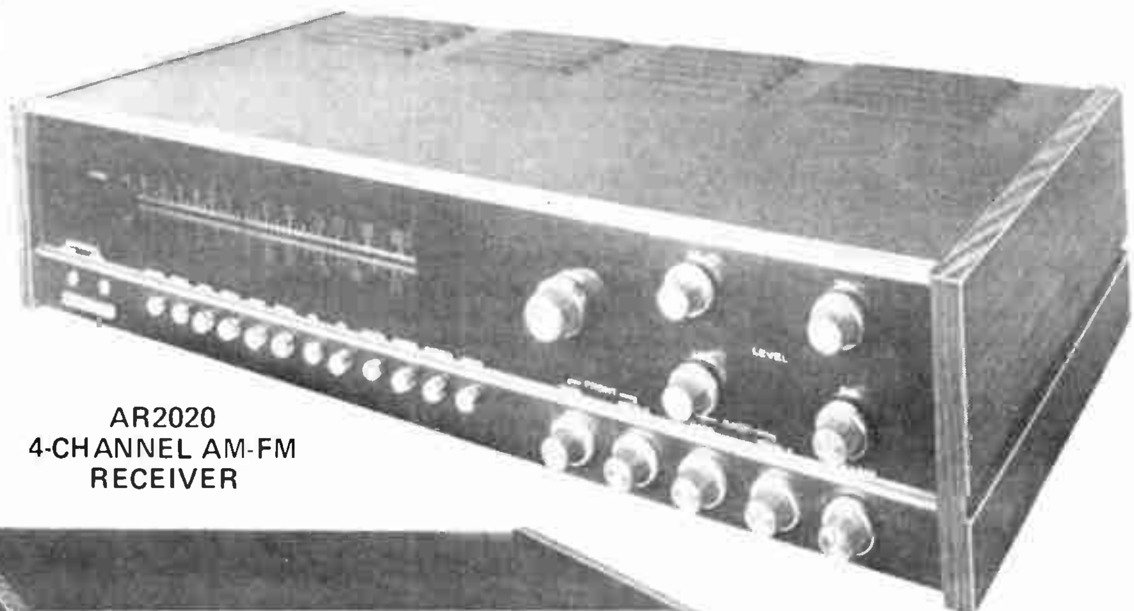

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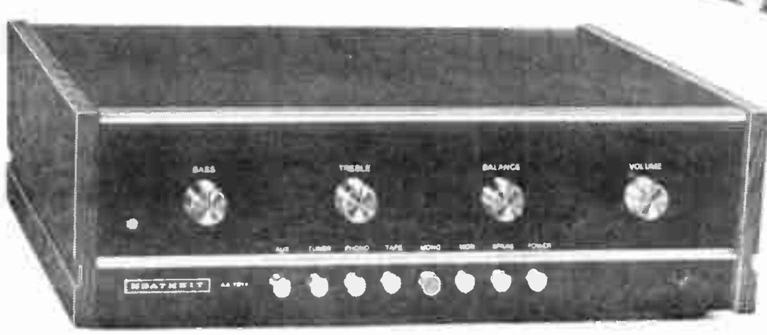

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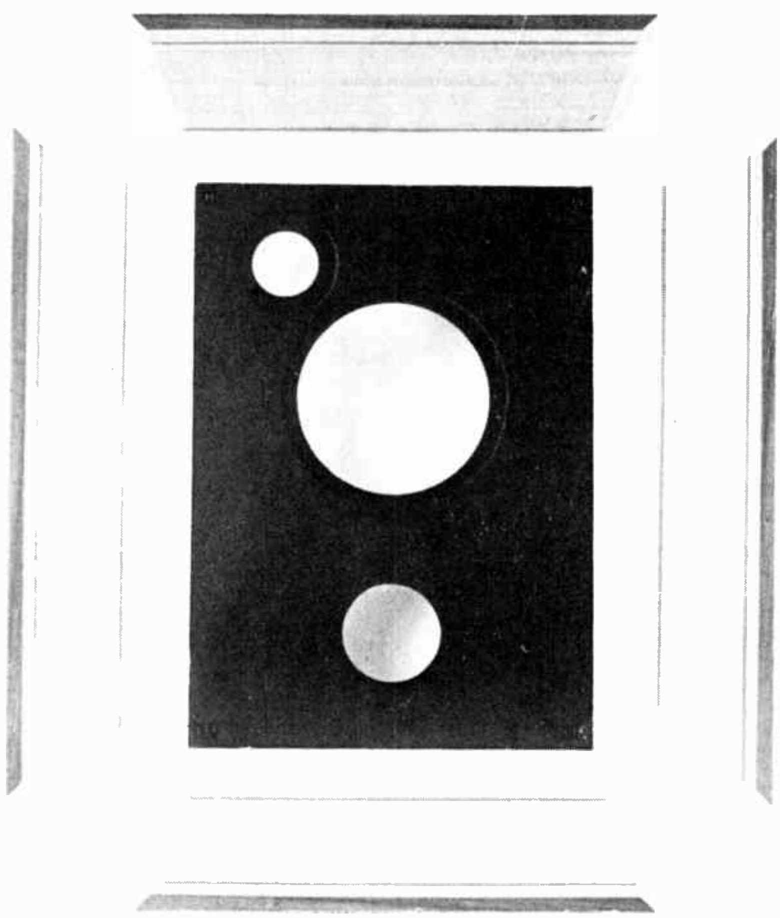

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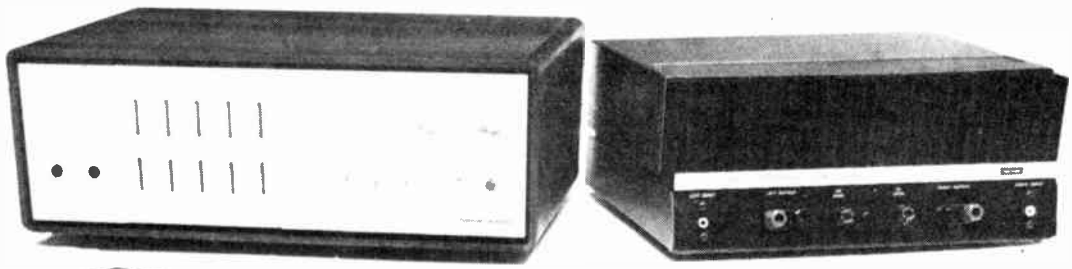

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Audio Magazine, June, 1972

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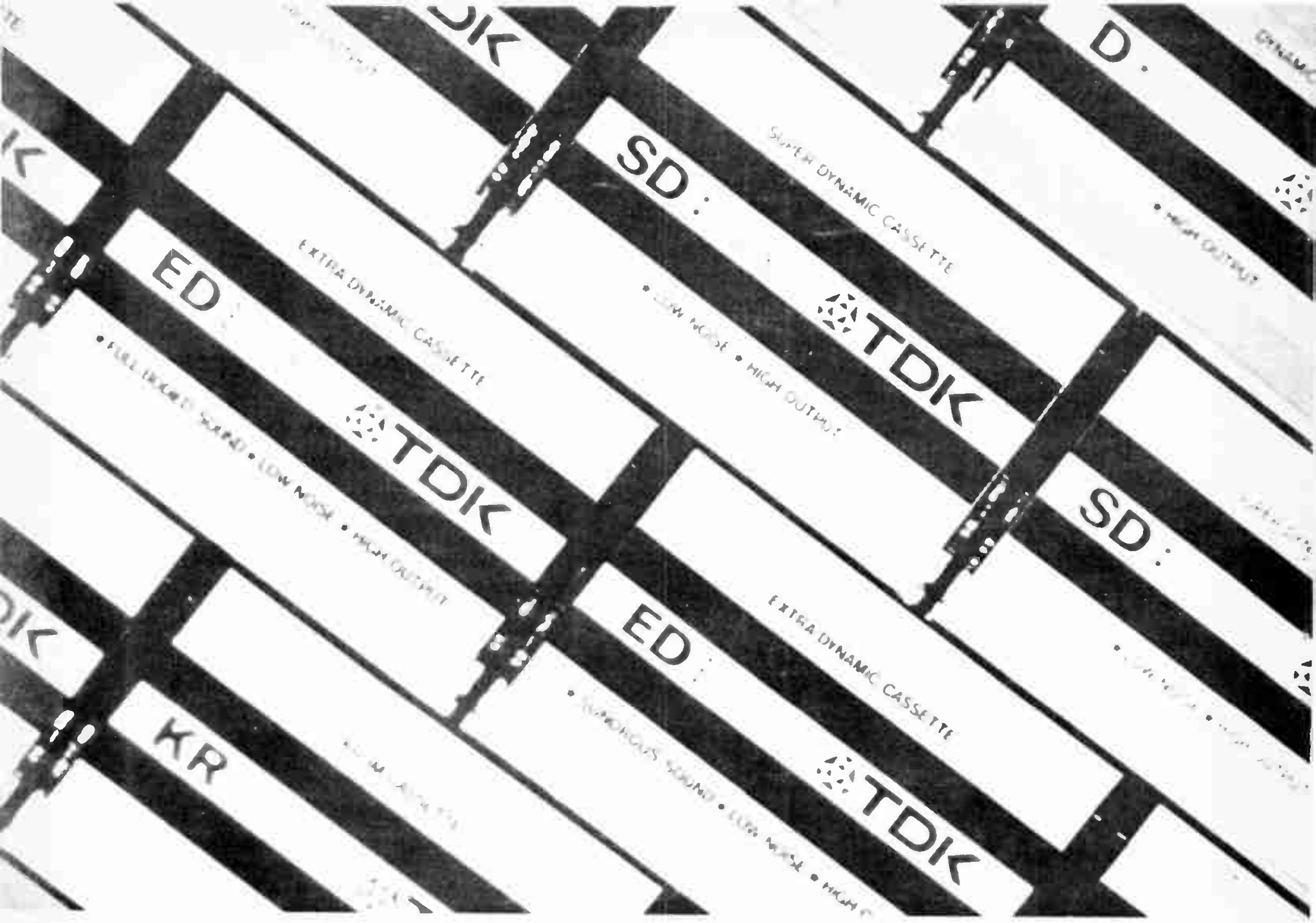

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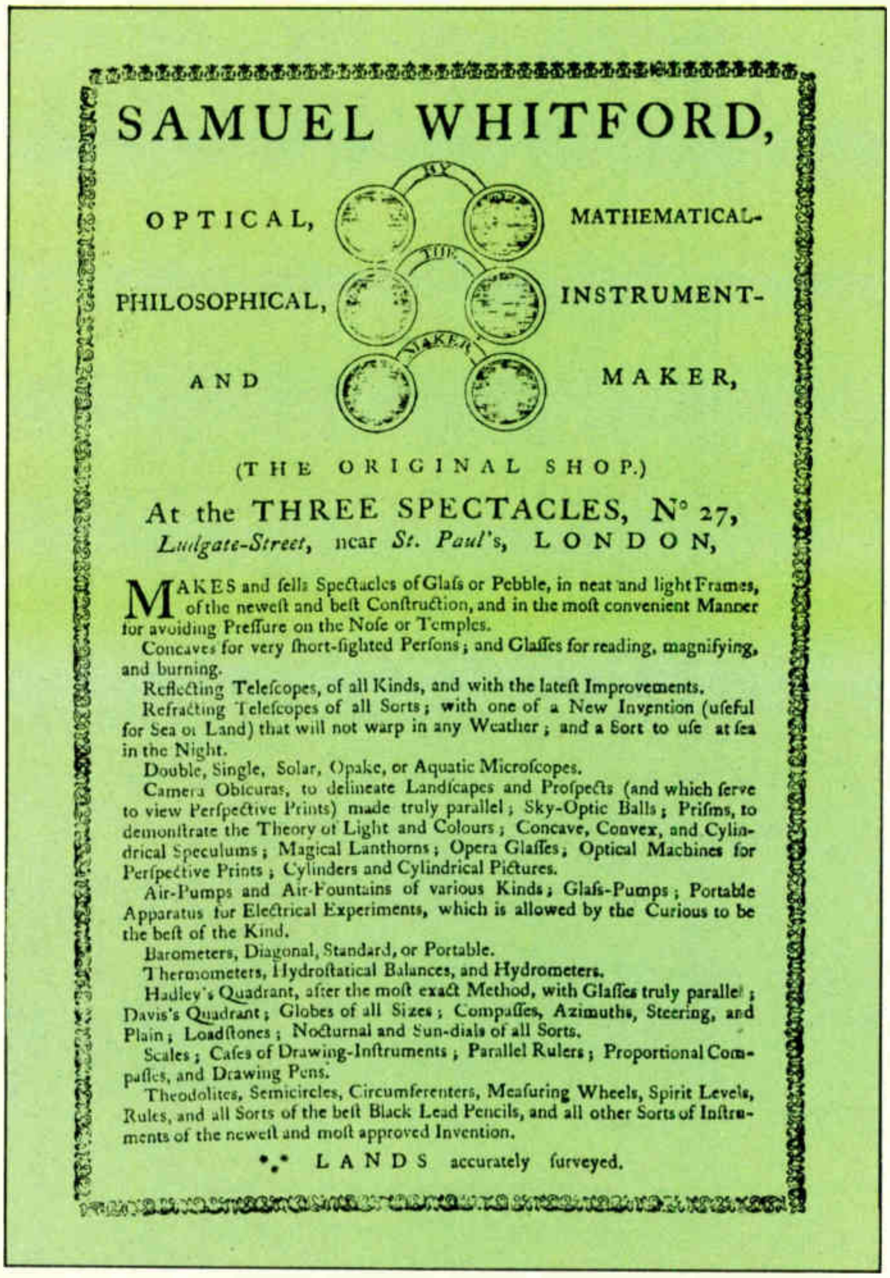
MATRIX TV - a solid-state picture transmission system

by Dr. Sydenham

WHEN MAN learned of ways to produce an optical image – probably when he found that a pin-hole in a screen produced a reduced size picture – he took a great step forward in both understanding and enjoying life.

In 1859 Dionysius Lardner of University College, London wrote in his encyclopaedic "Museum of Science and Art"

"The image of visible objects produced by reflection from smooth or polished surfaces, natural and artificial, and by looking through transparent media, bounded by surfaces having certain curved shapes, play a part so important in the effects of vision, that it must be regarded as highly interesting to explain the optical principles upon which the production of such images depends, so far at least as may be necessary to render intelligible the natural appearances and effects which are familiar to every eye, and innumerable contrivances, from which we derive essential benefit, either in repairing defects of vision, or extending the range of that sense to objects removed beyond its natural limits, either because of their minuteness or remoteness or in fine in producing phenomena affording at once amusement and instruction."



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∴ LANDS accurately ſurveyed.

Fig. 1. Trade card of Samuel Whitford shows evidence of early links between optical and electrical crafts.

All manner of devices were indeed devised. The microscope, the telescope, the camera obscura, the camera lucida and the magic lantern have been handed down to us.

The science of optical imaging was well developed by the start of the 19th century. For many a decade before this, firms had been proudly advertising their optical wares and expertise in handsheets such as that shown in Fig. 1.

Optical instrument-makers excelled at the crafting of mechanical contrivances so it was natural for them also to take on the manufacture of the then emerging electrical machines.

There were very few of these to begin with – Whitford's sheet mentions "portable apparatus for electrical experiments". But by the mid-19th century, the electrical "curiosities" had expanded in number from simple electrostatic devices to include magnetic ones as well. The feeble oil-lamp powered magic lantern gave way to arc-lamp versions – like that of Mr. Dubosc of Paris (illustrated in Fig. 2).

A new science, that of electro-optics, came into being. But it could not advance much in the 19th century, for hardware capable of converting light into electrical signals was not developed until the 1880's. If an experimenter wished to relay or record images before this time then they had to be copied and conveyed by hand. If several people wished to view the same image they had to take turns, use elementary photographs or manage with a multiple instrument such as Nachet's multiple microscope (shown in Fig. 3.

In 1895 Becquerel observed that certain substances used as electrolytes in a primary battery cell generated differing voltages if the two plates

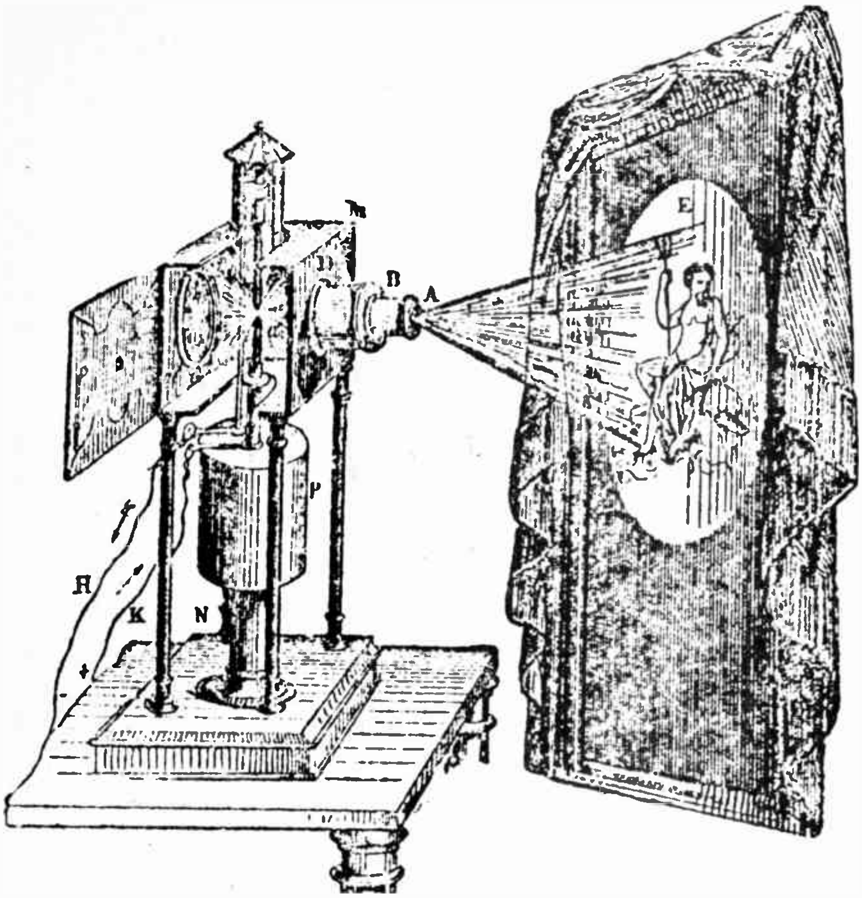


Fig. 2. This magic lantern, made about 1855, uses electrics and optics. In those days electric photo diodes did not exist: opto-electronics was a simple discipline.

were exposed to different light intensities.

A little later, in 1887, Arrherrius found that the resistance of silver halides increases with increasing light level.

In 1905 a photo-electric theory of vision was published and photo-detectors (of cumbersome form) became a more or less routine component available to designers.

By 1920 one could purchase a potassium-hydride photocell complete with a thermionic valve amplifier. Glazebrook, in his 'Dictionary of Applied Physics' (1922) remarked on this package —

> *"Used in this way the photo-electric cell may well prove its usefulness not only in photometry but in signalling without wires and as a means of scientific investigation."*

He was so right*

He also said he was leased to see that such an obscure phenomenon was finding increasing use of technical importance.

Single-cell detectors were continually improved, and far greater sensitivity was achieved by devices such as the photo multiplier. A solid-state photo-diode was eventually developed which was not only small but retained a good measure of detectivity.

Single-cell detectors, however, can only measure and transduce the intensity of radiation occurring in a single-point area. They cannot produce an electrical equivalent signal of two-dimensional images unless some mechanical system is used to enable them to scan an area, or a matrix of such photo cells is used.

The first photo cells were bulky so early inventors of two-dimensional image transducing systems were obliged to use mechanical scanning to effectively move the photo cell across the image.

Nipkow devised his spinning disk method of television in 1884; with it successive elements of the picture were viewed one at a time in a sequential pattern.

His work was further developed by Baird, in the 1920's — who pioneered our present-day television systems.

The Nipkow disk, however, was incapable of producing really acceptable picture definition, it was soon replaced by thermionic camera tubes in which an electron beam is systematically deflected across a photo-sensitive target on which the image is formed.

Zworykin's "Iconoscope", one of the earliest camera tubes, used a photo sensitive area of fine mica flakes — called the mosaic. These minute cells formed small capacitors that became charged to a level decided by the intensity of the radiation falling on them. The many "cells" were interrogated at regular time intervals by an electron beam scanned across them, monitoring the change in beam current occurring at each cell as they discharged.

As the cells were not being read out continuously it was possible to integrate (or average-out) the charge produced over a period of time, thereby increasing the sensitivity to light. This process is now known as charge-integration.

Today's television picture-tubes are still similar to the Iconoscope, the differences being in simplification of

Fig. 3. Before closed-circuit television was invented, multiple viewing had to be undertaken with devices such as Nachet's multiple microscope.

---

*(A future issue of ETI will feature modern electro-optic communication links.)

MATRIX TV

the mica mosaic to give us the relatively inexpensive Vidicon and its derivatives and sometimes to make use of secondary emission which enhances sensitivity in tubes such as the image-orthicon.

Thermionic picture tubes have long provided adequate resolution and linearity for most purposes, and production costs have been reduced to the point where amateur video recording is an increasingly popular hobby.

Nevertheless, thermionic tubes are bulky and thirsty for power compared with the potential capability of the latest solid-state integrated circuit technology. The days of thermionic picture tubes are numbered. Solid-state detection will undoubtedly replace them in the not too distant future — indeed in a few special cases this has already happened.

MATRIX SOLID-STATE DETECTORS

Early photo detectors needed several square centimetres of radiation to produce a useable signal change. Consequently a multiple array used to transduce line or plane optical information was rather large in size. Scanning was much easier to implement in a reasonable space.

Selenium was found to be a photo-electric substance. Willoughby Smith made resistors of it (in 1873) only to find its ohmic value varied with light intensity — thus adding another important transducer effect to the growing list!

The existence of relatively sensitive selenium detectors enabled Ruhmer to study the practicality of matrix array techniques which were connected to a similar array of lights with paralleled wires. In the period 1901-1912 he tried many ways of producing television by such means. He failed miserably. Selenium cells have a quite long time-constant (many milliseconds) so they were unable to follow transients of moving images.

Experimenters tried to reduce wiring connections by scanning the cells using mechanical switches. A scheme was proposed that needed a 32-contact wiper switch rotating at 960 rpm; it was dropped because it would also demand lamps that could be flashed at 640 000 times a second "which was manifestly impossible" says the author of the report.

In 1929, a popular-science technical writer (Ellison Hawks), summed up the situation by these remarks:— "Although there are immense difficulties, however, one would like to suggest that the method should not be finally discarded for it is the only one so far suggested by which the whole of the picture can be transmitted at one time".

When semiconductor technology exploded in the 'fifties and 'sixties it became possible to make highly reliable and inexpensive solid-state photo-diodes that were of only pinhead size. Eventually the problems of placing a large number of these side by side to form a matrix were overcome and we saw the successful development of lines of detector elements using large-scale integrated circuit production methods.

Some of the "immense difficulties" have been overcome, some still remain.

It is now about ten years since satisfactory integrated detector arrays were first made. Line arrays have been used in military optical missile trackers, and in a few industrial applications. Their widespread use was, however, restricted by cost and by the lack of an adequate density of photo-diodes. Today the diodes can be formed 75 μm apart (less than half the size of a full stop on this page) with a 64 by 64 array being comparatively easy to accomplish. IBM recently released details of a "chip" with half a million on a chip size of 1050 x 1600 mm!

Such achievement may well seem surprising but the resolution needed for many purposes is already routinely obtained with the 625 line television system — about 3 000 000 picture elements in the picture area.

The massive IBM array still does not compete on a size basis with a good vidicon tube!

To illustrate the technology used, we now take a look at some manufacturing methods and circuit techniques.

THE MATRIX

Basically light-detecting photo-diodes are paired with semiconducting solid-state switches — shown diagrammatically in Fig. 4a. They are made by sequentially depositing metal conducting and semiconducting films on a supporting insulator substrate. This technique gives the designer a high degree of confidence as the majority of devices made in an array will work as expected. It also enables a variety of components — both active and passive to be produced by the same basic process of depositing films through carefully made screening masks.

The most generally used mode of operation for the photo diode is that of charge-integration.

Using the self-capacitance of the diode, (which is created by the separated metal films), the diode is first charged up with an externally applied voltage source. The associated switch is used firstly to connect the diode to the source — and then to isolate it by effectively opening one connection of the photo diode. Charge in the diode then commences to leak away due to electron leakage within the diode structure and, more dominantly, by electron carriers that are formed by the photons falling on the photo-diode. The charge loss is

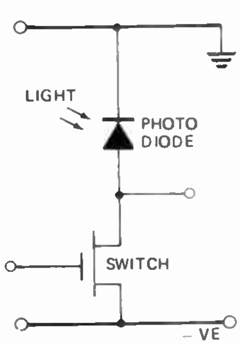
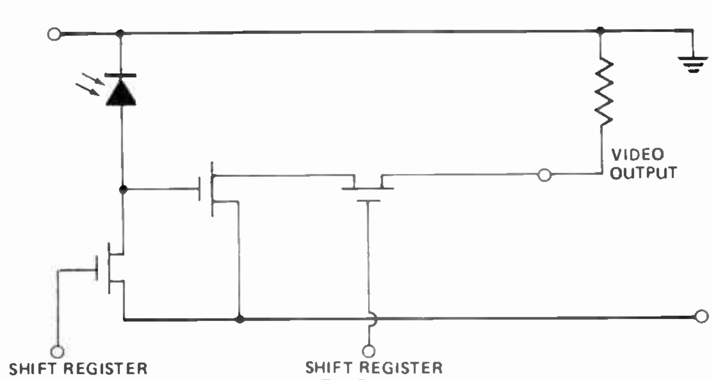


Fig. 4. (a) Basic photo detection element consists of a diode and a switch. (b) The basic system is extended with a buffer and a switch when the voltage sampling method is used.



then measured, as will be explained later.

The amounts of energy involved are minute. The voltage across the diode decays through 2.5 V (that is, the charge is lost and, therefore, so is the voltage) in an integration period of 10 ms when the incident light level falling on the diode is 0.1 W/m^2. This process, due to the tiny area of the diode, involves only 1-10 pC of charge (pC — pico coulombs; the charge of a single electron is roughly 10^7 pC and 1 C flowing per second is a current of one ampere). Direct sunlight provides a radiation intensity of around 100 W/m^2. The energy involved to "drive" the detector through the 2.5 V swing is of the order of 10^{-10} W!

Having devised a scheme to charge the diode and isolate it ready for radiation detection, the next state is to measure the loss of charge. This can be achieved by measuring the voltage across the diode, in which case a second MOS switch is used to connect the external circuit to the diode. A third MOS component is used to buffer the photo-diode from the load imposed by the sampling switches. This is necessary for without it, the sampling switch will present too low a resistance to the diode, leaking charge before the correct voltage level can be decided.

This method of measurement is known as voltage sampling. It is portrayed diagrammatically in Fig. 4b. The sampling rate for this mode of readout is around 200-500 kHz and it suffers from a somewhat large noise level.

An alternative way to interrogate the diode is by what is known as the recharge-sampling mode. In this the criteria of light-level used is that related to the amount of recharge needed to fully re-establish the voltage across the diode, (Fig. 5). This method needs only the first-mentioned charging switch at the diode location, thus reducing the number of elements needed in the full detector component, but it does require more analogue voltages. But having added this extra circuitry, it then becomes possible to read at 5 MHz multiplexing rates — and the noise level is much less than with the above described voltage sampling.

The actual manufacturing method used to make an element of the array is typified by the drawing of one such element that is given in Fig. 6. Simplicity of contacts and junctions is had at the expense of adding more electronic components elsewhere in the data processing. When the array is made as a single line only it is possible to pack the photo-detecting elements at one third of the spacing, that is at only 25 μm centres.

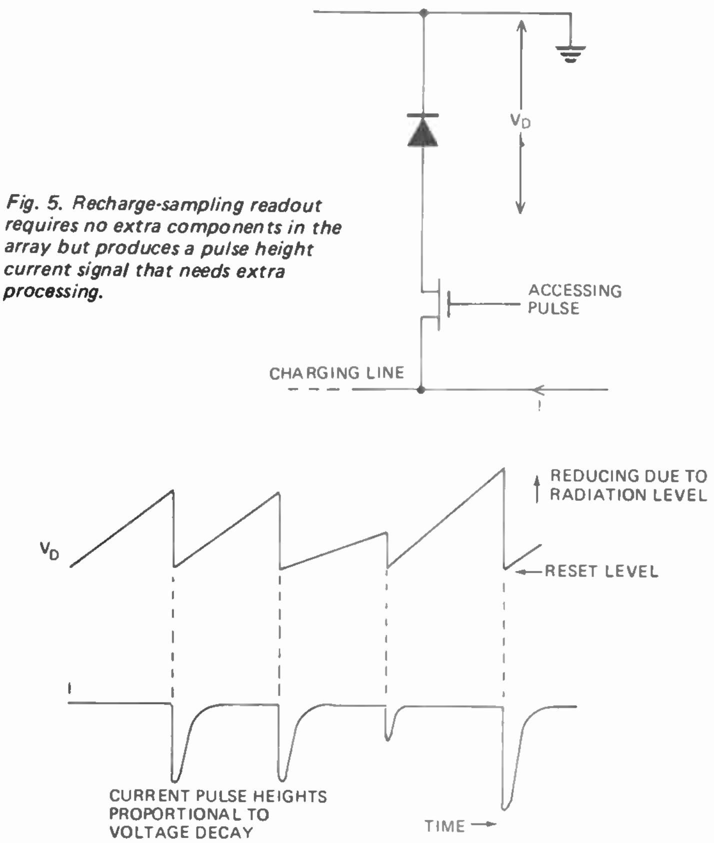


Fig. 5. Recharge-sampling readout requires no extra components in the array but produces a pulse height current signal that needs extra processing.

OBTAINING ACCESS TO THE DIODES OF THE ARRAY

Each element has its input and output "terminals" permanently connected to X and Y conducting lines — made with deposited metal film strips.

The arrangement used for the faster recharge-sampling processing method is shown in Fig. 7. The ends of each X and Y line are connected such that each can be connected to a single common line as needed, this happening sequentially. This is achieved by using a continuously operating pulse generator that 'clocks' a solid-state scanning switch — the register — along in steps. This causes a string of charge pulses to appear on the output line ready for height processing.

Special consideration has to be given to driving these lines, for several effects, such as large line capacitance, tend to limit the useable scan rate unless used in special ways. IPL, for example, have developed a system whereby the flyback time is eliminated thus utilizing the total time more efficiently.

The shift register scanning switches for the X and Y drives, are also formed on the same chip, placing them around the edges. Figure 7 shows an enlarged view of the top of the 64 x 64 IC which includes both the photo-diode array with its recharge switches and the shift registers. (Most users of such a chip would not wish to have to build

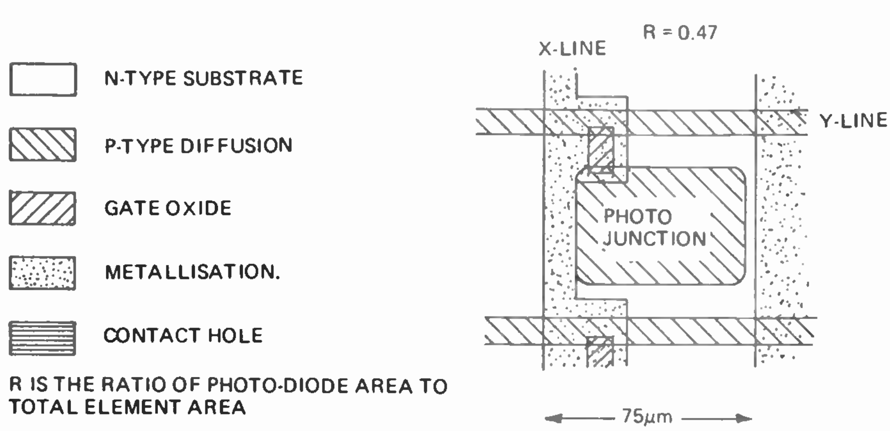


Fig. 6. Photo-diode and switch is manufactured by appropriate diffusion and metallisation on a substrate.

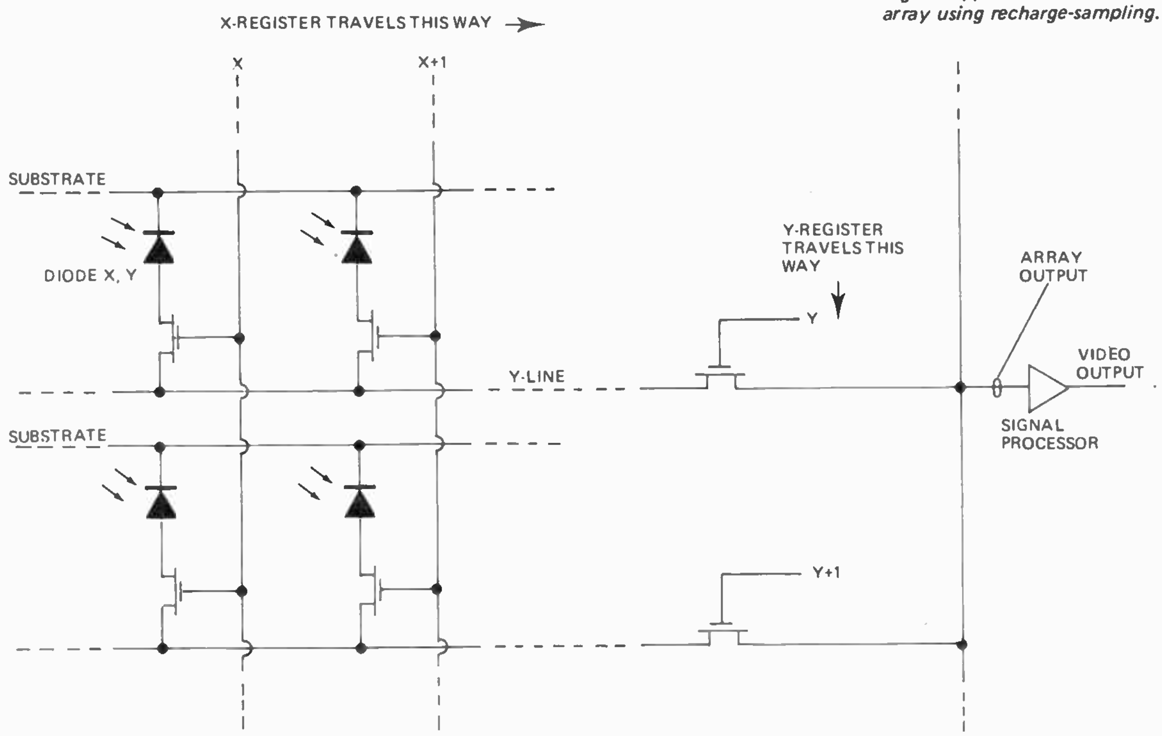


Fig. 7. Typical section of a two-dimensional array using recharge-sampling.

their own processing circuits, so a complete system is offered shown in Fig. 9. In this are housed the clock pulse generator, signal processing circuits and a means to physically mount the appropriate optical element to produce the right size image.)

After preamplification, the recharge pulses appearing on the output line are integrated (rather than peak detected) and applied to a circuit that samples them and holds their level for outputing. as a closely analogue-varying signal.

APPLICATIONS OF MATRIX ARRAYS

Arrays containing only 4096 picture points ("pixels" is a term sometimes used) cannot compete with vidicon television picture tubes on a resolution basis.

Neverthless, there are many applications where an array is superior and/or where the full resolution capability of the thermionic camera tube is not required.

Flaw detection — unwanted pin holes in, say, tape or films can be easily detected using a single photo detector to look for light coming through from a source mounted below. This basic method, however, is limited by non-uniformity of the background

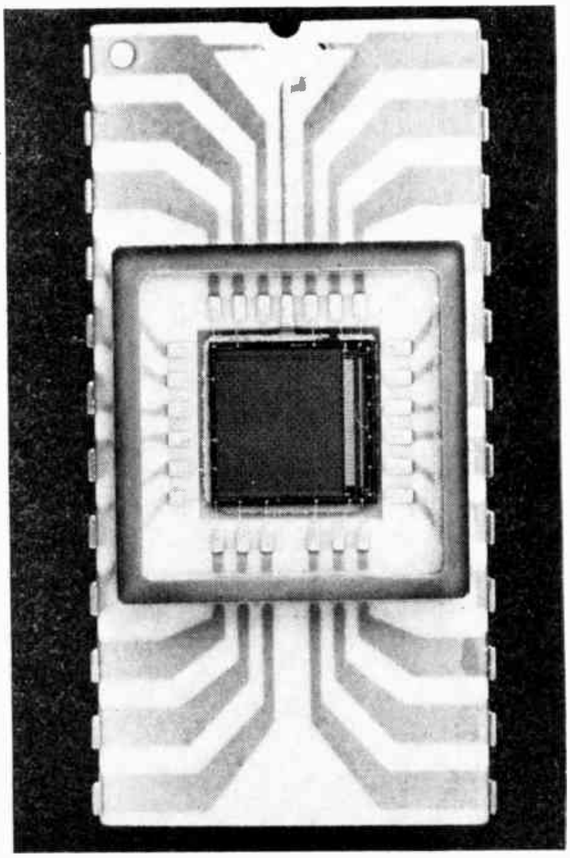
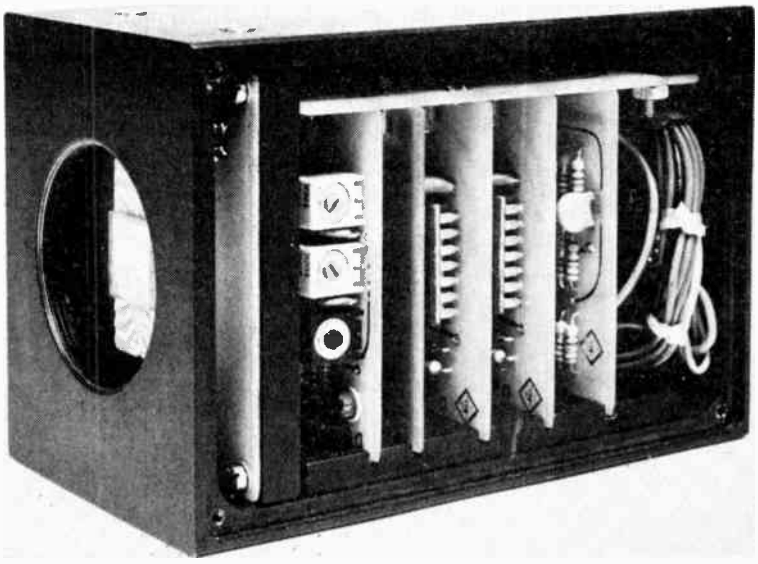


Fig. 8. Integrated Photomatrix Ltd.'s 64 x 64 photo-diode array. The central chip is barely 6 mm square.

Fig. 9. At present the processing circuits of the complete matrix camera require more room than the array (lower centre) but this is largely due to the need to custom build this part of the system.



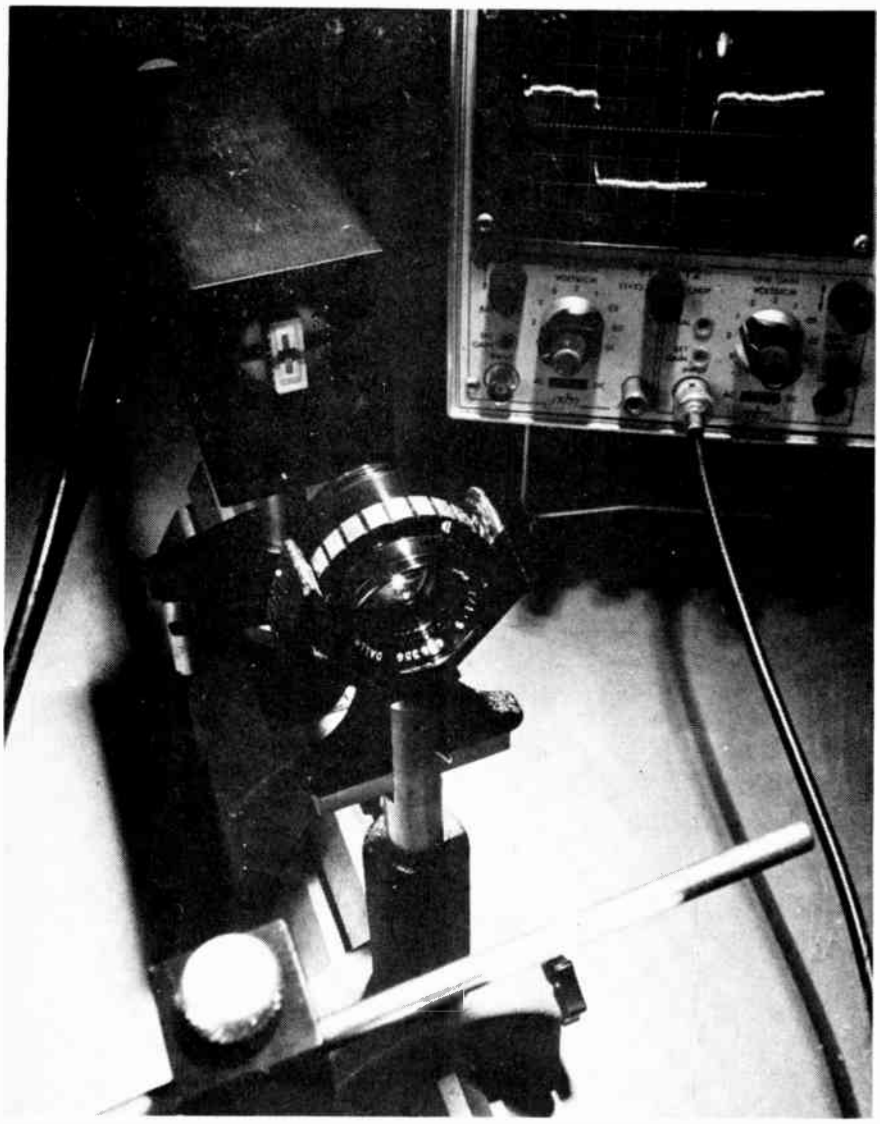


Fig. 10. In this demonstration a linear array is used to produce an electrical signal which has pulse-width proportional to the diameter of the rod seen in the foreground.

illumination coming through the tape or film and cannot provide information about flaw distribution. In looking for small flaws in a wide area the area is actually directed up into smaller fields — that of each element in the array — to increase the signal to background ratio and to define the location of flaws. For this purpose a linear array of 100 photo-diodes is adequate. The actual size of the film and the detector array matter little as the appropriate power lenses will provide the magnification needed. The possibilities for using the data obtained are numerous and depend only on the needs of the taks.

Gauging size — if the width and range to be gauged lies within the full range of a linear array, the array can be used to measure rod size without physical contact and at great speed. Figure 10 demonstrates this principle. Back lighting passing the rod throws a shadow on the linear array. This, in turn, produces the gauging signal seen on the CRO screen. As the diodes resolve measurements in discrete dimensionally stable increments, these arrays can provide greater accuracy and long-term stability than a vidicon method.

If the measurement task is one needing only width change monitoring it is better to use two separate arrays set apart as shown in Fig. 11. This technique increases the relative resolution obtained, and by this method it is possible to monitor the width of sheets, stripes and even railway lines. The block schematic of a hot rod gauging system using two arrays is given in Fig. 12.

Optical character recognition and data digitizing — linear arrays for scanning documents, such as cheques, have been in use for several years. Current developments involve automatic post-code recognition and for the processing of football-pools entry forms.

Linear arrays have been used in an instrument for measuring pipe straightness. This device consists of a flexible tube containing two fixed-end units. Mounted in one fixed unit is a fine light source that radiates across the flexible section to the other side which houses a linear array. The unit is blown by compressed air down the pipe to be tested, bending as the pipe bends. If and when the unit bends, the light scans across the array, thus yielding straightness data.

Television — this is an extension of one-dimensional array methods to two dimensions. Arrays with only 64 x 64 elements, although somewhat limited, are capable of many useful tasks.

Obvious applications include blood count and cell analysis, more complex character recognition situations and area gauging. There is also a large potential market for the arrays as sensors for reading cost and inventory labels in the so-called "point-of-scale" checkout systems recently introduced into some European supermarkets. Here the label on the item is "read" as the checkout girl scans it with a special head. The data is then used to prepare the total cost and to inform the computing storage about the latest stock totals.

To demonstrate the capabilities of their self-scanned matrix array, IPL have developed a complete C.C.T.V. system based on the 64 x 64 array

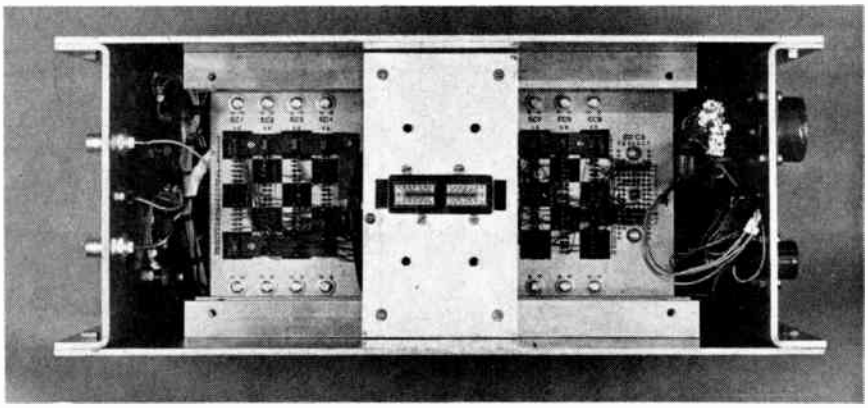


Fig. 11. Width gauging using two linear arrays.

MATRIX TV

element. Figure 13 shows the system using a cathode-ray tube to reconstruct the image.

It is clear that the basic technology exists for designers seriously to consider matrix television techniques.

As integrated circuit manufacture advances toward finer detail and more extensive LSI systems resolution will be improved and price reduced. Currently, it is more difficult to find applications that *need* the fast rate of data obtainable than with its procurement.

We have come a long way since electricity and optics first came together in the instrument makers workshops.

Electronics Today International acknowledges the generous assistance of Peter Fry who directs the technical effort at Integrated Photomatrix Ltd.

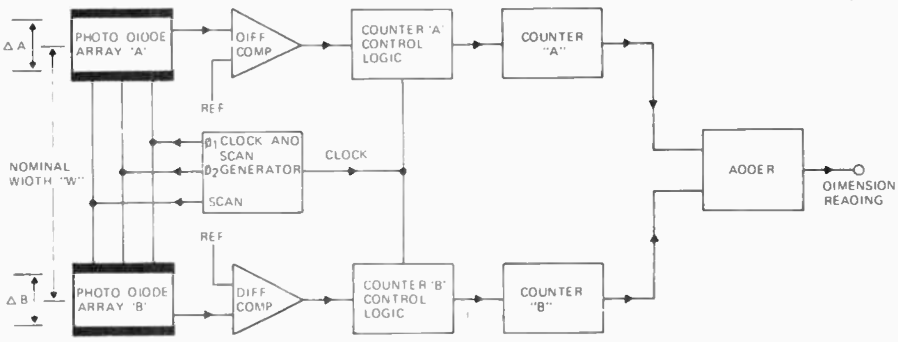
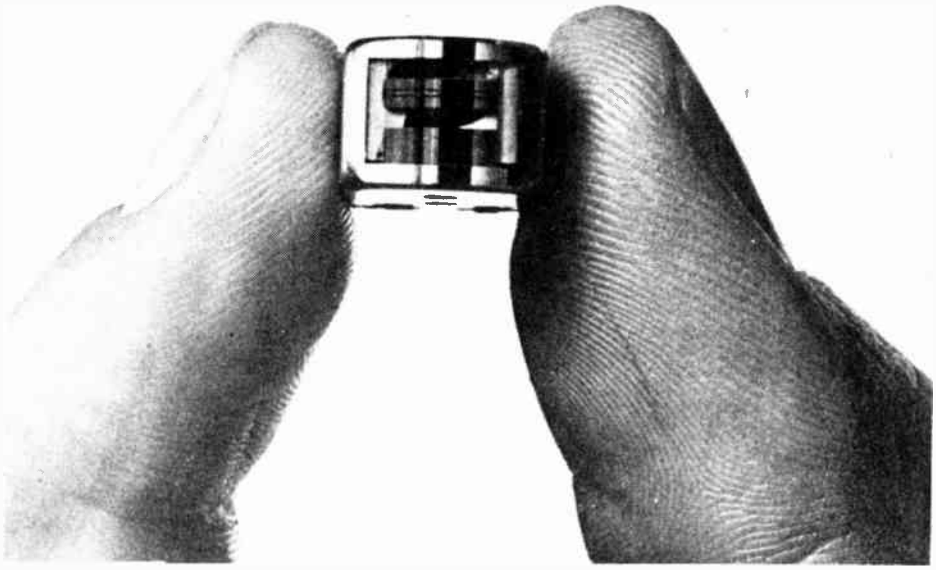


Fig. 12. Block schematic showing how two arrays are combined electronically to provide width variations.

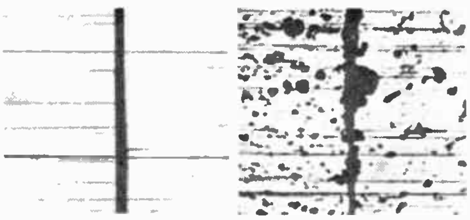
Fig. 13. Although not primarily intended to rival conventional C.C.T.V. (at this stage of development) a useable picture can be formed with a 64 x 64 array. The reconstruction is made on a C.R. Tube.

The Jeweller and the Gem



This is tne extraordinary AKAI GX Head. Its surface is so hard and dust repellent it will always give you new machine performance.

The jeweller and the gem are part of why AKAI Cassette Recorders and Decks deliver such incredibly clear sound. Each AKAI GX Recording and Playback Head is cut by a Jeweller, with such skill and precision that the sound



• After equal use. Enlarged to 800 times

Gap environs of AKAI Single Crystal Ferrite Head — Gap environs of Poly-Ferrite Head

See how AKAI delivers cleaner, clearer sound

reproduced is clearer and cleaner than that obtained from any other type of head.

That's one reason why AKAI Cassette Recorders and Decks are superior. But it is by no means the only one.

For example: The GXC75D (centre) in addition to the GX Head has AKAI's Automatic and Manual Reverse Recording and Playback System (for continuous playback and recording). Plus AKAI's exclusive ADR (Automatic Distortion Reduction) System, which automatically adjusts the recording level signal to prevent high frequency distortion. The combination of this with the Dolby Noise Reduction System, and a special Tape Selector Switch puts the GXC75D in a class by itself.

The GXC46 (left) also boasts the lifetime guarantee GX Head, the ADR System, Dolby Noise Reduction and Special Tape Switch. As well as the OLS (Over Level Suppressor) circuit to eliminate distortion at maximum input.

Likewise the GXC38 (right) is equipped with the GX Head, Dolby Noise Reduction, OLS and a Special Tape Selector Switch for CrO2 (Cromium Dioxide) tape.

AKAI equipment (whether cassette decks or recorders, tape decks or recorders, amplifiers, turntables or speakers) all possess similar advanced technical standards. And all are covered by the AKAI Complete Protection Plan giving 12 months parts and labour warranty, 12 months free insurance and a lifetime warranty on the GX recording heads.

Available from selected hi-fi specialists.

Distributed by AKAI Australia Pty. Ltd.
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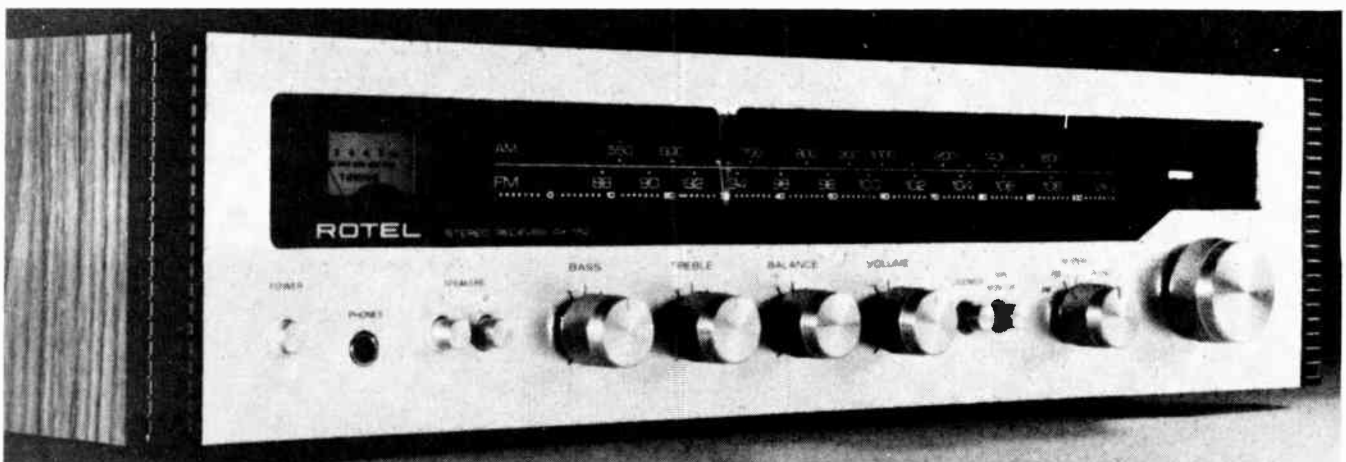
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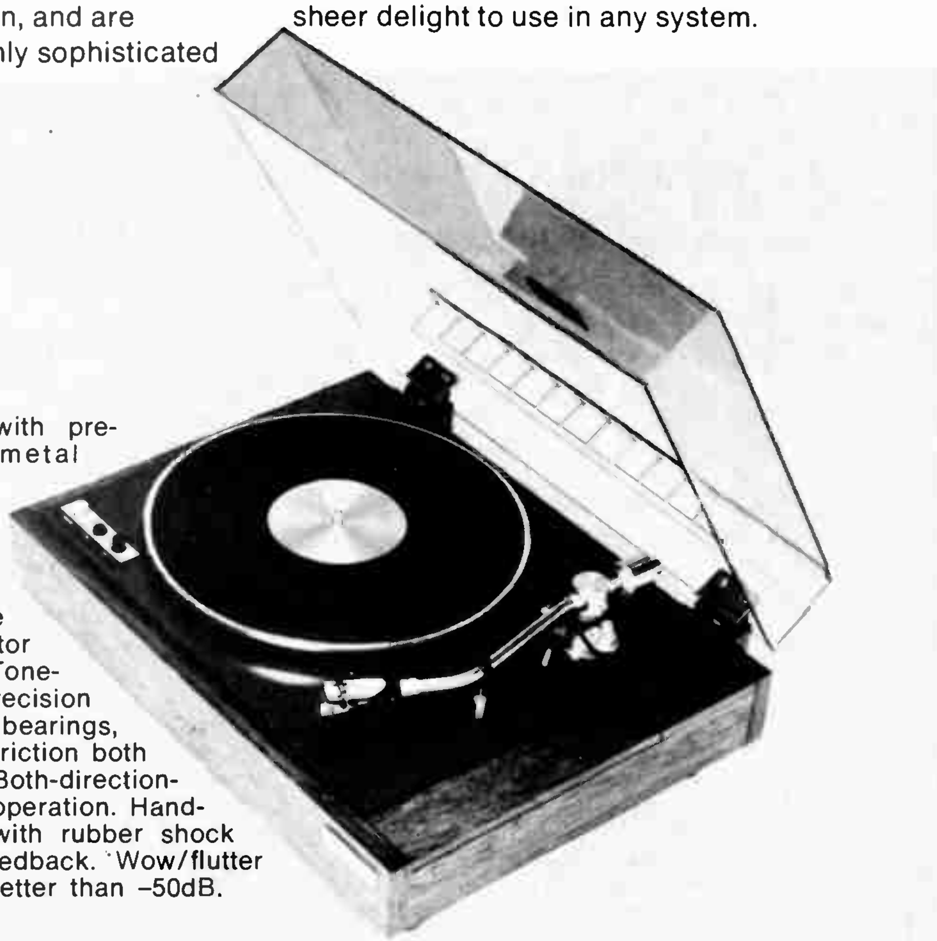
INTERDYN

MICRO-
Built with one aim in mind . . .
superb reproduction.

Micro proudly introduces its new-era range of turntables to discerning audiophiles! The MR 222, MR 322, MR 422 and direct drive models, MR 622 and MR 711, all incorporate the most wanted features in modern turntable design, and are superbly engineered, highly sophisticated stereo transcription units that combine top-rating performance with fine styling. Micro turntables give superb reproduction, represent excellent value for money, offer long service life, and are a sheer delight to use in any system.



MR 422
Superb belt-driven unit with precision-engineered gunmetal main bearing housing and 12 mm dia. stainless steel main shaft for virtual elimination of rumble. Heavy diecast alloy platter is driven by a large 4 pole hysteresis synchronous motor and flat polyurethane belt. Tonearm is fitted with ultra-precision ball bearings and ball pivot bearings, resulting in only 10 mgm friction both vertically and horizontally. Both-direction-damped arm lift for easy operation. Handsome slim walnut base, with rubber shock absorbers to eliminate feedback. Wow/flutter less than 0.06%, rumble better than –50dB.

Available from

- **N.S.W.** M & G Hoskins Pty. Ltd., 37 Castle St., Blakehurst 2221 Telephone: 546 1464
- **Q'LD** Stereo Supplies, 95 Turbot St., Brisbane 4000 Telephone: 21 3623
- **S.A.** Challenge Hi-Fi Stereo, 96 Pirie St., Adelaide 5000 Telephone: 223 3599
- **TAS** Audio Services, 44 Wilson St., Burnie 7320 Telephone: 31 2390
- **VIC** Encel Electronics Pty. Ltd., 431 Bridge Rd., Richmond 3121 Telephone: 42 3762
- **W.A.** Albert TV & Hi-Fi, 282 Hay St., Perth 6000 Telephone: 21 5004

KSV552

eti PRODUCT TEST

LESLIE PLUS TWO SPEAKER SYSTEM

Rotating baffle design is intended to reduce room resonances

IN OCTOBER 1973, two researchers at C.B.S. Laboratories developed a system to overcome what they considered to be a major deficiency in standard speaker systems. Their concept was that if one reduced room standing waves at low frequencies, then the quality of the sound would be enhanced by the removal of dead spots within the room. An exciting concept to say the least.

Many researchers including Harry F. Olson, Richard H. Small, Roy F. Allison, and Ulf Rosenberg, have shown conclusively that the standing wave patterns in a room are a function primarily of the room shape, the distribution of absorption, and the position chosen for locating the speakers in that room.

Altering woofer position will modify the standing wave pattern to some extent, but for this concept to be effective, a movement of the order of greater than $\lambda/10$ is required. At 50 Hz, this requires a movement exceeding 60 cm and presumes that there are no other constricting boundaries to modify the radiation resistance of the room boundaries.

C.B.S. Musical Instruments' dramatic approach is to use a complex rotating drum coupled to the woofer diaphragm. This drum is rotated mechanically to provide continuous 360° phase shifting of the standing wave patterns in the room. Whilst the drum is quite complex its actual effect is a direct function of the positioning of the enclosure with respect to external boundary walls and is modified greatly by the type of cabinet construction chosen by the manufacturers.

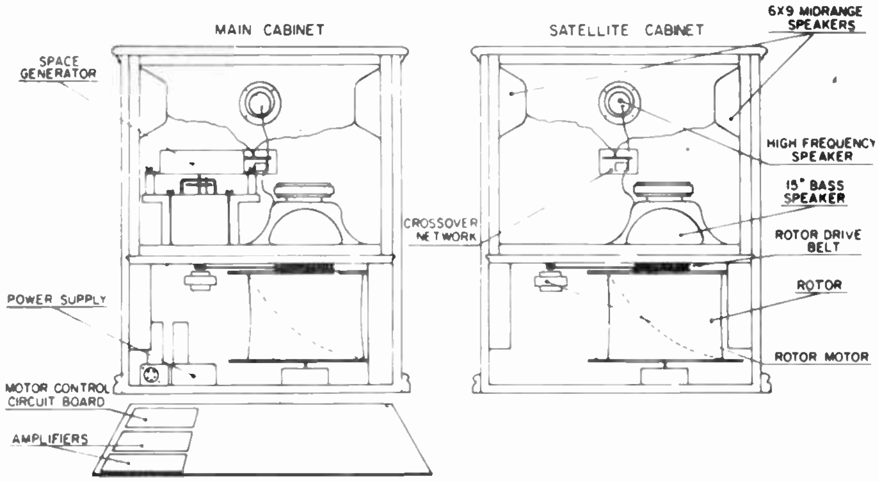
The marketing people at C.B.S. Musical Instruments go to a lot of trouble to explain the need to overcome this problem of standing waves and associated dead spots within the room. They point out very carefully that a test of their system in a typical living room can demonstrate the shortcomings of a laboratory test. In particular they show how a flat laboratory response, when measured in a living room, has much of its flatness transformed into significant peaks and valleys because of the standing wave patterns existing in the normal room, (but it must be pointed out that they ignore the problem of peaks and nulls due to the speakers themselves).

The type 450 enclosures are heavy and large. The 450M, the main unit, contains two 50 watt power amplifiers, as well as the 380 mm diameter low frequency woofer, two mid-range elliptical speakers, and a horn woofer. The mid-range speakers are mounted with one on each side at the top of the cabinet, while the tweeter is mounted on the front face. The 380 mm bass speaker is connected to the unusually shaped scoop rotator. The 450S is a slave unit and contains only the speakers, electrical cross-over network, and mechanical rotator.

On the back of the main speaker unit is a standard tip ring and sleeve input socket, an on-off switch, two separate volume controls for the line input to the main amplifier, and a mode switch which allows the selection or non-selection of the slave unit.

The mechanical drive for the rotating drum uses a small electric motor and an eccentric drive idler system to provide a non-linear speed for the rotating drum.

The cabinet is solidly constructed in



Woofer system of the Leslie Plus 2 enclosures. The driver faces downwards into a revolving baffle that 'sweeps' the room.

walnut veneered timber with an appearance which is most probably better suited to homes with period type furniture, than homes in the modern style.

An alternative model 430 system is more contemporary in design, and would probably be more acceptable in most homes.

Our first test was that of frequency linearity. We measured this in a normal living room instead of only free field conditions because the tweeter only is mounted on the front of the enclosure, and both mid-range and low frequency drivers direct energy from either side.

To carry out this test we set up the speakers in a number of positions which might reasonably be chosen in an ordinary living room or auditorium. We found that the frequency response (as would be expected) was a direct function of the position of the speaker itself and equally important, the position of the measuring microphone, (these measurements were taken with recording chart speeds of 0.1 mm/sec and 0.03 mm/sec). As Ulf Rosenberg of the Stratens Provningsanstalt has previously shown so beautifully, by carefully choosing your speaker position and your microphone position, you can within limits achieve almost any acoustical response at the low frequency end that you choose.

After taking measurements at a number of locations we opted for what is most probably the nearest situation comparable to a real listening room. This was with the two speakers mounted approximately 100 mm from a rear reflecting wall, with the microphone offset at 20° to the main axis, 2.5 metres away. Under these conditions, the low frequency response is particularly good extending right down to 25 Hz and lying within ±6 dB from 28 Hz to 200 Hz. It is significant that the low frequency output of these speakers is substantially higher than the high frequency output and there is some loss of medium and high frequency output because of the manner in which the mid-range speaker's louvres are cut in the cabinet. The tweeter output is lower than normally desirable but in keeping with the mid range speaker's output.

But it must be noted that the Leslie Plus 2's are not *meant* as main speakers but rather to augment the presence and realism of existing speakers — thus in simple terms, overall frequency linearity is not the main criteria.

The main unit has a sloping frequency response, dropping at a rate of approximately 10 dB per decade, and exhibiting a substantially different shape than what we would expect from the graph shown on the manufacturers data sheet.

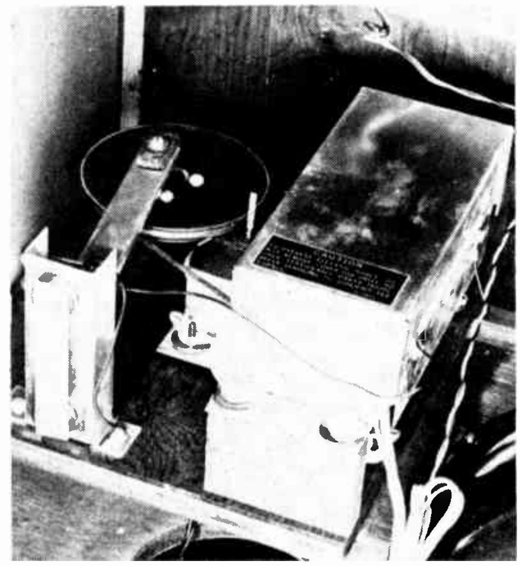
C.B.S. Musical Instruments claims that the frequency response extends through to 20 kHz. This is true, even if it is 20 dB down with respect to the peak at 80 Hz!

Response curves were taken with the speakers and recording microphones in

LESLIE PLUS 2 SPEAKER SYSTEM MODEL NOS: 450M & 450S SERIAL NO: FA12550S

Frequency Response:			
(when measured in a standard test room)			
Main Unit	±15 dB	25 Hz – 20 kHz	
Slave Unit	±15 dB	25 Hz – 20 kHz	
Total Harmonic Distortion:			
(for 90 dB at 2 metres on axis)		Main Unit	Slave Unit
	100 Hz	1.8%	0.7%
	1 kHz	0.4%	0.45%
	6.3 kHz	0.35%	0.9%
Sensitivity:			
(for 90 dB at 2 metres on axis)			
Main Unit	450 mV		
Slave Unit	450 mV		
Maximum Output Power:			
(at 2 metres on axis)			
Main Unit	110 dB		
Slave Unit	110 dB		
Dimensions:	840 mm + 750 mm + 500 mm		
Weight:	56 kg		

BELOW: The rotating baffle in the master enclosure is belt driven via this eccentric mechanism, thus ensuring that master and slave baffles preserve 'random phase relationships.



LESLIE PLUS TWO SPEAKER SYSTEM

many different positions — and quite different results were obtained each time. Thus whilst the rotating baffles may have some minor subjective effects — the basic laws of acoustics seem to remain inviolate!

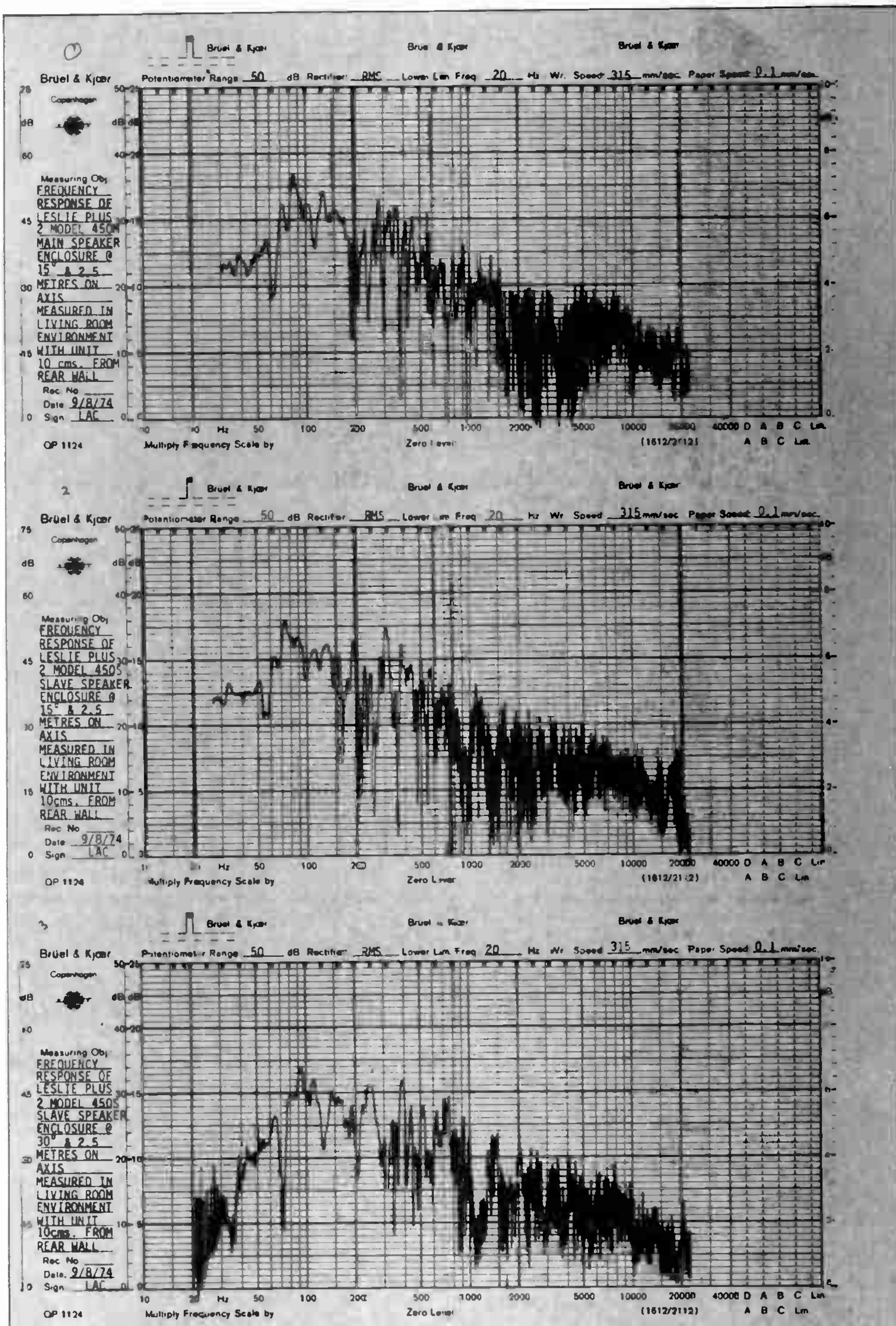
We could not take an impedance curve. Their is no direct access to the speakers themselves, only to the main amplifier's inputs.

Distortion characteristics for the amplifier were quite satisfactory and the peak output a very healthy 110 decibels at most places in the listening room.

HOW THEY SOUNDED

The manufacturers have produced a clever little record with carefully selected passages of organ music, guitar music, piano, and standing wave test bands to highlight the advantages and attributes of the Leslie Plus 2 System. Whilst the record helped to convince us of some of the merits of their speakers, other records in our repertoire, including a little known record produced by Jan Masseus called "Akoetest Opus 45" were far more suitable. The latter record was made using a dummy head stereo recording system and its stereo content is extremely realistic and uncoloured. This record, recorded in the D'oosterpoort Cultural Centre in Gronigen, convinced us more than any other that these speakers have a real value in enhancing some recorded material.

The most outstanding attribute, possibly the only real attribute of the Leslie speakers, is their outstanding low frequency performance and thus their ability to reproduce organ pieces, the beats of drums, orchestral piano playing, and guitar music to recreate what the designers correctly describe as concert hall realism in your own home. It should be clearly pointed out though that only a very small proportion of *orchestral* music contains such content, nevertheless a large proportion of modern day live rock and jazz does. Because of this, the Leslie speakers are best suited for use with electronic organs, for playing live rock, and as an additional pair of speakers for people desiring to reproduce recorded organ music and certain types of orchestral music. They are not suitable as main speakers because their frequency response is not flat enough to provide balanced sound. But it they are placed in a room with a volume of 70 cubic metres or more they will provide a lift at the low frequencies which, as the literature states, provides a realism that you have never experienced before.



TOP: Response of main enclosure. CENTRE BELOW: Response of slave speaker taken at two different points in a typical living room Substantial differences are clearly apparent — clearly illustrating that major standing waves still exist in the room.

Whilst highly sceptical of many of the claims made for them, we accept that they can provide a 'sonic dimension' at low frequencies which we have only experienced with speaker systems costing twice the price.

However this does not seem due to any 'magical' quality of the rotating baffles — rather, the Leslies are very well designed bass speakers.

We would agree completely with the manufacturer's recommendations that these enclosure's should be listened to in your own home before making a positive committment. It is virtually impossible to assess their capabilities (and suitability) in a hi-fi showroom.

The rotating baffle in the slave unit (seen here) is belt driven by a small motor just visible top left of baffle assembly.

MANUFACTURER'S COMMENTS

We welcome the comments in this article. We would like to stress that the L.B.S.-Leslie Plus 2 speakers are designed to add onto a conventional 2-channel stereo system; and not as primary speakers.

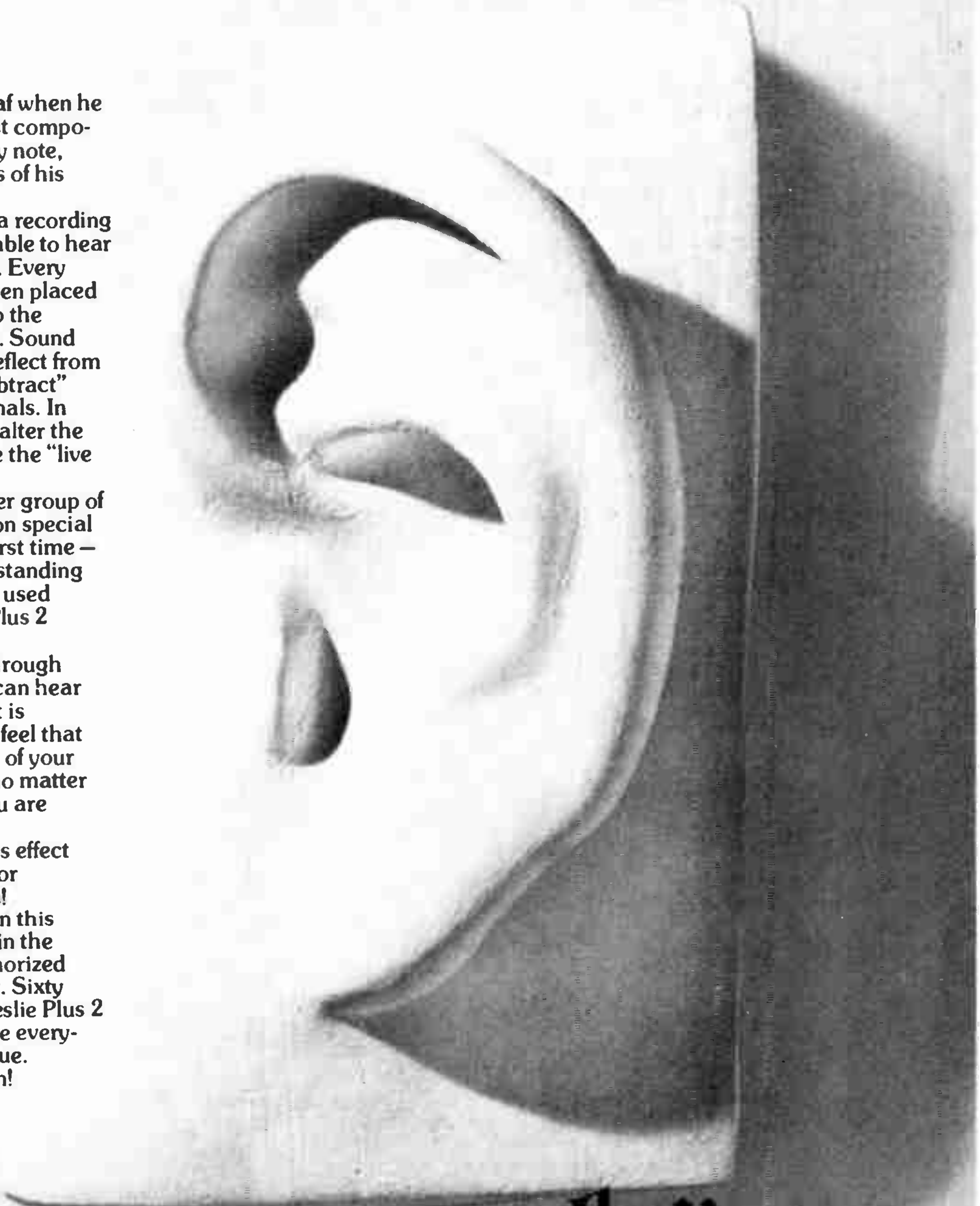
As such, anyone considering the purchase of a quadraphonic system could do well to arrange for a demonstration of these systems.

The only other point we feel which has not been mentioned is that we have found that due to the even sound pressure in the listening room that listening fatigue is very low even after long listening periods at reasonably high output levels.

We would be happy to demonstrate these features to any interested reader.

Nigel Cowan,
Rose Music Pty Ltd.

Beethoven heard his music better than you do.



Beethoven was nearly deaf when he wrote many of his greatest compositions. Yet he heard every note, every phrase in the genius of his mind.

Today, when you listen to a recording of his music, you are not able to hear its full, original dynamics. Every conventional speaker, when placed in your home, falls prey to the "standing wave" problem. Sound waves in a fixed pattern reflect from your walls to "add and subtract" from the true original signals. In this way, standing waves alter the true dynamics and reduce the "live qualities" of the music.

In 1971, the Leslie Speaker group of CBS applied for patents on special designs which — for the first time — effectively dealt with the standing waves. These patents are used exclusively in the Leslie Plus 2 Speaker system.

Here is what this breakthrough means to you. Now, you can hear music with a realism that is unmatched. You literally feel that you're in third row centre of your favourite concert hall — no matter what part of the room you are sitting in.

Also, you can achieve this effect with either stereophonic or quadraphonic recordings!

For further information on this unique system, just send in the coupon, or visit your authorized Rose Music/Leslie dealer. Sixty seconds of hearing the Leslie Plus 2 Speaker system will prove everything we say about it is true.

Hear it for yourself...soon!

Leslie Plus 2 model 430

Leslie Plus 2 model 450

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Leslie

Speakers

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After you don't believe the way the brand new decks sound, you won't believe the way they're priced.

CT-3131A

CT-4141A

CT-5151

The beauty of Pioneer's cassette decks is the way they reproduce high fidelity sound from unbelievably tiny cassettes. In fact, no others on the market with prices comparable to Pioneer's new CT-5151, CT-4141A, and CT-3131A give you so much sound for the money. Take, for instance, CT-5151, the top-notch among the three featured here. With a frequency response range from 30 to 16,000Hz, a built-in Dolby* noise reduction unit, and long-life ferrite solid tape head, you're going to want to compare CT-5151 with most of the expensive reel-to-reel decks. CT-5151 is, indeed, loaded with a lot more features like normal/chromium dioxide tape selector (bias/equalizer independently switchable), full-automatic stop mechanism, tape running pilot light, peak level indicator, over-level limiter, electronically controlled DC motor, and even a memory rewind switch. If you've ever doubted the sound quality of cassette tape, now's the time to hear it all over again. On the CT-5151, CT-4141A, and CT-3131A, just a few of many quality high fidelity products made by Pioneer. To see and listen to them, please contact your nearest Pioneer Dealer.

Dimensions: $15\frac{5}{8}$(W) × $9\frac{1}{2}$(D) × $3\frac{3}{4}$(H) inches.

Weight:	CT-5151	10 lb. 9 oz.
	CT-4141A	10 lb. 6 oz.
	CT-3131A	9 lb. 11 oz.

Pioneer Electronics Australia Pty. Ltd.
256-8 City Road, South Melbourne Victoria 3205,
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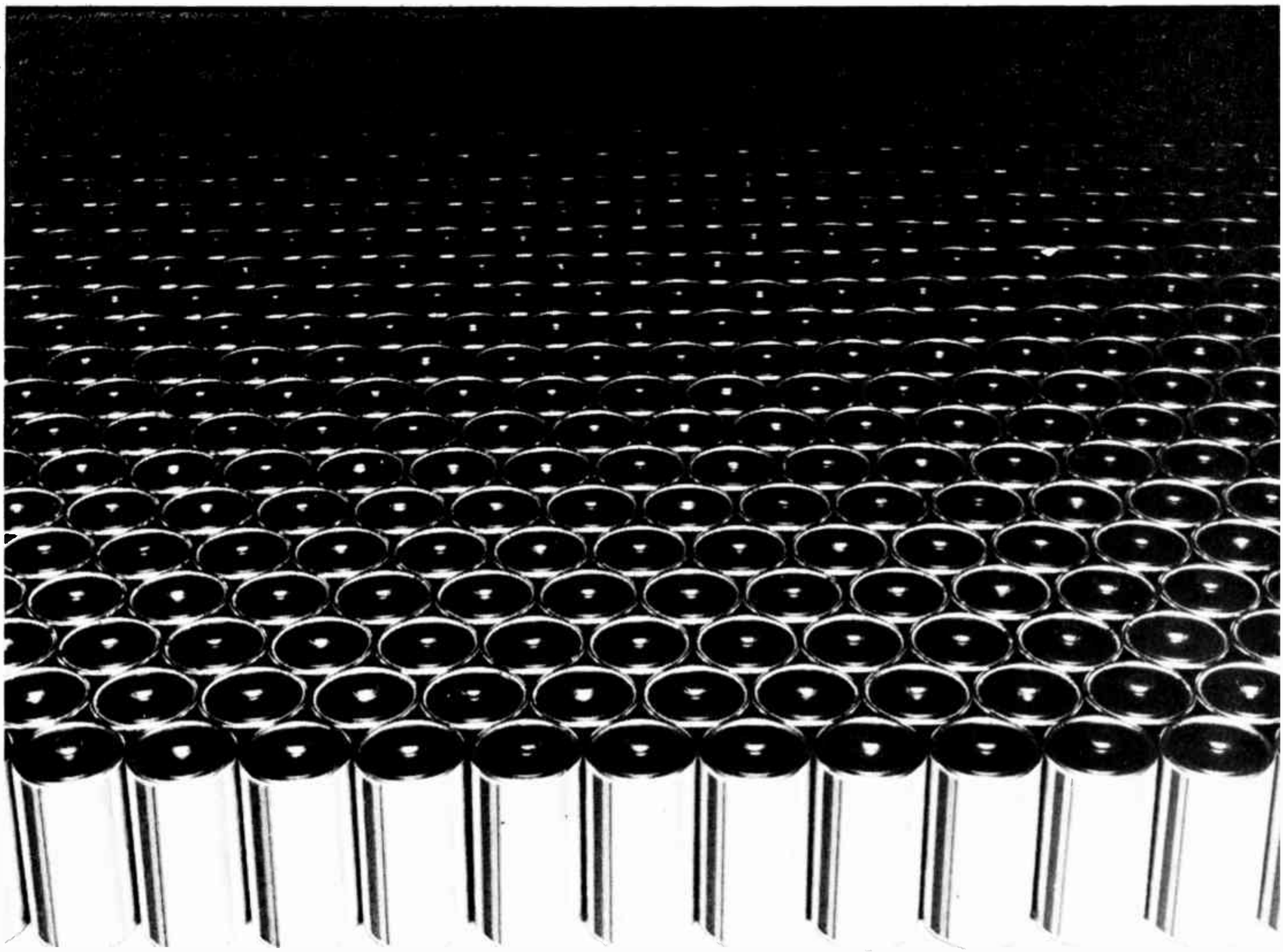
Branches are in all states.

*"Dolby" is a trademark of Dolby Laboratories Inc.

PIONEER

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ELECTRONICS TODAY/DICK SMITH ELECTRONICS
DESIGN
CONTEST

Design a simple, effective, economical device — and win $250 worth of electronic goodies (of your choice)!!

USING any or all of the components listed, readers are invited to design a simple, practical, electrical or electro-mechanical device.

The winning entry will be that device which is the most practical, ingenious, and well-designed, commensurate with the most economical use of components.

The prize kindly donated by Dick Smith Electronics, is $250 worth of his stock — to the winner's choice.

Any type of electronic or electro-mechanical device is eligible providing it has essentially practical value. For example, capacitance sensing alarms, heat detectors, radio control devices etc are acceptable — perpetual motion machines are not!

The restriction placed on input/output devices is to ensure that entries are 'self-contained'. Thus, no matter how ingenious, a read-out mechanism for a $5000 gas chromatograph would not be eligible.

The input/output device/s used must be readily available 'off-the-shelf' items. They must not be 'o'.e-off' circuits specifically intended to interface with the submitted entry.

All entries must be designed to operate from low voltage dc. Voltage chosen is up to the entrant, but must not exceed 32 volts.

Entries must not be of a 'critical' nature. That is, they must not depend for their operation on a totally critical set of component values, rather the devices must work as intended with any component/s having a value within the full tolerance spread specified by the manufacturer/s.

All circuit components must operate within their manufacturers' design ratings.

COMPONENTS

Entrants may use any or all of the components on this list — Item I must be used.

Please note — no components may be used other than those listed — this rule will be rigidly enforced.

Semiconductors — 3 max.
Includes transistors, diodes, simple IC's. No one device to cost more than $3.50 at normal Australian 'one-off' prices.

Resistors — 7 max.
Any values allowed but tolerances to be 5% at best. i.e. use 20%, 10% or 5%.

Capacitors — 5 max.
Any values or types permitted.

Switch — 1 only
Any type permitted.

Potentiometer — 1 only
Any type permitted, may be combined with switch (above) if desired.

Input device — (optional)
Any commercially available devices permitted but should not exceed $20 or so in value. Input devices — if required — may for example be reed switches for burglar alarms; microphones for mixers; photocells for light meters etc.

Output device — (optional)
As above — devices may include loudspeakers, relays, lights, etc.

Unlimited quantities —
Wire, matrix board, Veroboard, metal, screws, nuts etc. i.e. hardware required for construction. This does not include anything that may reasonably be classified as a component — no motors for example!

PLUS

One item chosen from the Dick Smith catalogue included within this issue. The item chosen must be a single entity and must not exceed $3.50 in value. (Note — entrants do not necessarily have to purchase this, or any other components, merely decide which to use).

DO NOT SEND IN COMPLETE WORKING ENTRIES

The entry/s should consist of a clear circuit diagram, full parts list, a full description of the purpose and uses of the entry, a brief technical description explaining how it works — and a brief explanation of why the particular design approach used was chosen. Photographs may be included if required.

Entries will be judged on four main parameters — of differing weight.

Marks will be awarded as shown below. The prize will be awarded to the entrant with the highest cumulative total.

*	Economical use of components	1 – 20
*	Practicality	1 – 20
*	Ingenuity	1 – 20
*	Clarity of presentation	1 – 10
*	Engineering excellence	1 – 20

Entrants may submit any number of entries that they choose, but each entry must be accompanied by the entry coupon on this page. In other words if two entries are submitted, each must be accompanied by a separate coupon.

A large stamped addressed envelope must be enclosed with the entry if the material is to be returned.

Entrants are advised to retain a copy of all material sent, and to send entries by registered post if possible.

PLEASE make sure your name and address is included on *all* major drawings, etc, and that the entry coupon is filled out and included with the entry.

Electronics Today International reserves the right to publish the winning or any other entry — payment will be made, at our normal contributors' rates, for all material published.

Closing date for this contest is November 15th (letters postmarked Nov.15 will be accepted). The winner will be advised by telegram as soon as possible after that date, and full details published in the first possible issue of ETI.

ENTRY COUPON

A separate coupon must accompany each entry — but contestants may submit as many entries as they wish.

NAME (block letters) . . . .

ADDRESS . . . .

. . . .

STATE . . . .

POST CODE . . . . TEL. NO. . . . .

Address entries to:
DESIGN CONTEST
Electronics Today International,
15 Boundary St., Rushcutter's Bay, NSW. 2011

LET'S FACE IT...

. . . the calculator market is flooded with "has beens", maybe's, and "winners" – you just don't know which one to choose.

Although the big guys are spending advertising fortunes, they'll never capture the whole market, because for every customer that is pre-sold on a big brand name, there's one who prefers to comparison-shop and look for real value.

You can't mention value without remembering that value is the whole W.H.K. story – offering the most for your money, so we position ourselves in the market for calculators with brands that make a sale where the so called 'lead' brands haven't got the goods for the right price.

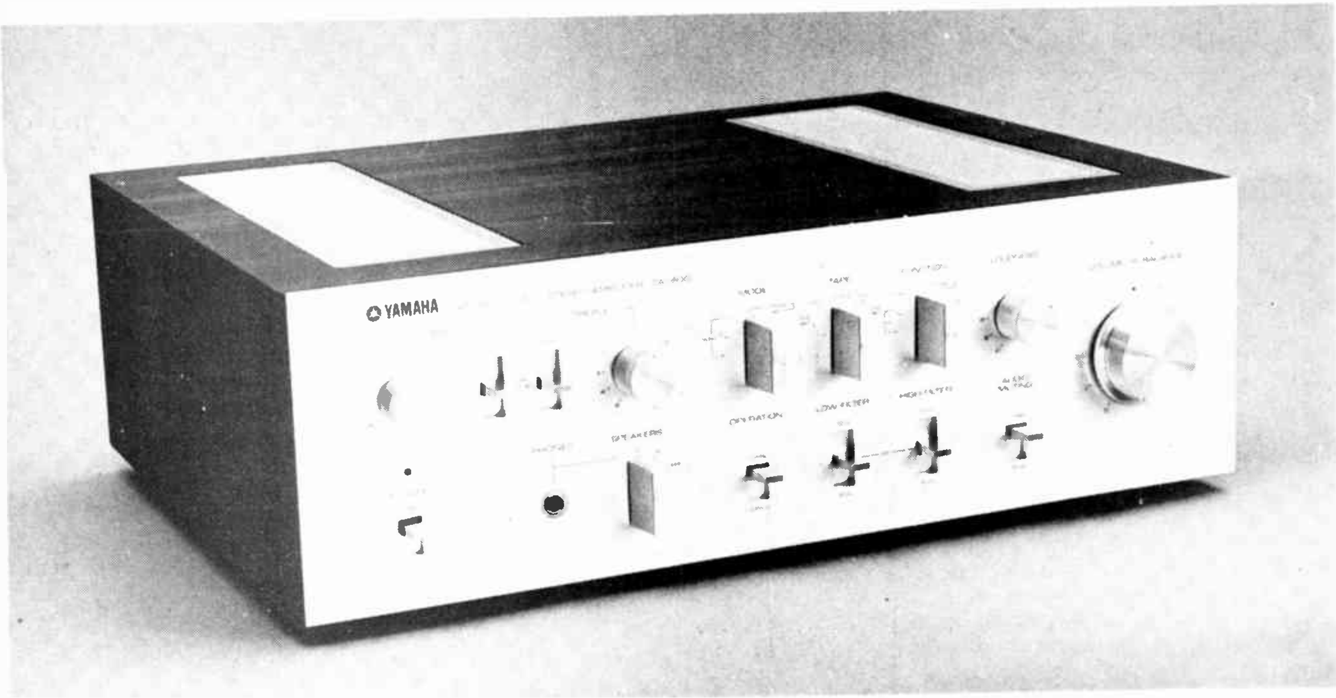
Another thing for you is that W.H.K. have complete servicing facilities for calculators. This is a solid business with plenty of competition, but, we're putting the pressure on our competitors to keep up with us.

THESE ARE A FEW UNITS FROM OUR RANGE OF ADVANCED CALCULATORS

PRODUCT TEST

IS CLASS 'A' WORTHWHILE

Recommended retail price
$439 incl. tax.



Yamaha's CA-800 switchable class A/class B amplifier reviewed.

A SMALL but vocal number of hi-fi enthusiasts insist that for truly distortion-free amplification, nothing but Class A operation will suffice.

Even the best of Class B amplifiers, they insist, is an electronic abomination.

Until now this argument has been difficult to evaluate. Whilst some Class A amplifiers are audibly better than their Class B counterparts, the difference may well be due to things other than the operating mode of the output stages!

Now, Yamaha have produced a high-class amplifier with an output stage that can be switched to either Class A or Class B operation.

The amplifier, Yamaha's CA-800 – has a number of other unusual features as well. Like Leak's old Varislope units, the CA-800 features variable-slope cut-off frequencies for bass and treble filters. It also has a variable loudness control that operates independently of the main volume control.

A very wide range of facilities is provided. There is a bass attenuator with a cut-off frequency selectable at either 500 Hz or 250 Hz – together with a central 'defeat' position; a treble filter with cut-off frequencies of 2.5 kHz and 5 kHz; a low frequency filter (70 Hz and 20 Hz) and a high frequency filter (12 kHz and 6 kHz).

Also provided is a switch for selecting Class A or Class B operation, and the aforementioned loudness control which provides a set of contours for true compensation for the physiological response of the ear.

The rear panel of the amplifier has all necessary inputs together with a preamplifier out and main amplifier input sockets with an electrical coupler switch; two microphone sockets; and a switch for selecting impedances of 100 kΩ, 50 kΩ, or 30 kΩ on phono 1 input.

With one or two minor exceptions, the amplifier is constructed to truly professional standards. For example, each of the audio sockets on the rear panel, with the exception of the speaker outputs, is terminated on a printed circuit card which is itself connected to the preamplifier cards via gold-plated plug-in sockets. The

Most power amplifiers have output stages that operate in what is usually called 'Class B'.

In this mode of operation, two power transistors are connected so that as one 'pushes' the other 'pulls'.

A positive going signal, for example, will cause one transistor to conduct and the other to turn off.

Class B is an efficient mode of operation and quite high power outputs can be achieved econmically, but so-called 'cross-over' distortion will be generated unless the circuit is very carefully designed.

Despite this 'disadvantage', several modern Class B operation amplifiers have very low distortion indeed.

Class A amplifiers have an output stage arranged so that, with normal input levels, the output transistors are never driven into either cut-off or saturation.

In theory, the output waveform is identical to the input waveform. Distortion is very low indeed but the output stage's efficiency is very low. Because of this it is not practicable to build high power output Class A amplifiers.

preamplifier cards themselves are fully shielded from the rest of the unit by well designed steel covers to reduce magnetic and electrostatic induction. The function selectors extend through from the front panel to switches which are incorporated within this shielded cover. All of the circuitry mounted behind the front panel is also shielded in either individual sub-shields or partial shields around individual switches and terminations.

In keeping with the latest technique in amplifier layout, the main amplifier cards and their associated heat sinks are constructed as complete modules with direct connection between the printed circuits and the power transistors.

It was interesting to note that the leads running close to the heat sinks are individually protected with glass insulation spaghetti to preclude the possibility of melting or shorting wires. The printed circuit cards are all individually coated on the rear faces to preclude corrosion, electrolysis and fungus, problems which plagued many earlier and cheaper pieces of Japanese equipment.

One of the few details that precludes this amplifier from being a fully professional unit is the use of phenolic resin based cards in lieu of the more often used epoxy glass cards found in true professional equipment.

The amplifier design incorporates a number of highly desirable features including a relay operated protection circuit to switch off speakers in the event of a substantial dc level appearing at the speaker terminals. There is also a fully-electronic protection circuit to protect the output amplifier and its silicon power transistors against short-circuiting or unusually low speaker load impedances. In addition, each output amplifier card incorporates two fast acting fuses to provide a third stage of protection.

The amplifier is constructed on a strong steel chassis within a very well made and adequately ventilated veneered plywood cabinet. The unit is readily capable of being rack mounted should this be desired although its frontal dimensions are 50 mm short of the standard 482 mm (19") rack mounting.

HOW IT PERFORMED

Evaluating the electrical performance proved to be particularly interesting, for excellent though Yamaha's claimed specifications are — the unit is in most respects even better!

In the Class B mode for example, the amplifier is capable of producing a true 60 watts into both channels at 8Ω impedance with a distortion level lower than the manufacturer claims for 50 watts. Likewise, the performance at 12.5 watts in the Class A mode is better than Yamaha's claim for 10 watts (both channels driven into 8Ω).

It is of course the matter of distortion, its measurement, and its subjective evaluation, which makes this amplifier different from all others, for Yamaha have provided the facility for being able to select Class A or Class B operation at the flick of a switch.

Amplifiers, whether Class A or Class B generally produce more distortion at low power levels than at levels closer to their maximum power output.

A 60 watt Class B amplifier for example may generate four or five times as much distortion at five watts output than at 50 watts output.

YAMAHA CA800 STEREO AMPLIFIER
SERIAL NO. 5761

Power Output (at 1 kHz)

CLASS B	60 watts (rms) into 8Ω both channels driven	
CLASS A	12.5 watts (rms) into 8Ω both channels driven	

Frequency Response

at rated output	20 Hz to 20 kHz	±1 dB
at 10 watts output	20 Hz to 20 kHz	±1 dB
at 1watt output	20 Hz to 20 kHz	±1 dB

Channel Separation at Rated Output

100 Hz	−37.5 dB
1 kHz	−38.0 dB

Hum & Noise re Rated Power

Volume control at maximum gain	−70 dB (Lin.)	−87 dB (A)
Volume control at minimum gain	−68 dB (Lin.)	−87 dB (A)

Input Sensitivity for Rated Output

	CLASS A	CLASS B
Aux. 1	50 mV	100 mV
Aux. 2	50 mV	100 mV
Tuner	50 mV	100 mV
Phono 1		2.8 mV
Phone 2		2.8 mV
Main Amp.	400 mV	900 mV

Total Harmonic Distortion
(at 60 watts output and 12.5 watts output respectively with both channels driven)

	CLASS B (60 W + 60 W)	CLASS A (12.5 W + 12.5 W)
100 Hz	<0.01%	<0.01%
1 kHz	<0.01%	<0.01%
6.3 kHz	0.045%	0.02%

Intermodulation Distortion less than 0.05%

Tone Controls

		Filters	
		250 Hz	500 Hz
Bass	50 Hz	+ 15 dB − 13 dB	+ 17 dB − 14 dB
		5 kHz	2.5 kHz
Treble	10 kHz	+ 6.5 dB − 7.5 dB	+ 10.5 dB − 10.0 dB

Loudness Control
(at constant volume control setting)

Loudness control at 10	50 Hz	+ 13 dB
	10 kHz	+ 5.5 dB

Dimensions 436 mm x 144 mm x 323 mm

Weight 13.5 kg

Class A amplifiers have similar characteristics, but to a lesser extent – so that a 10 watt unit (quite large for Class A operation) will be working closer to its lowest distortion point at the same five watt level.

At least that's what all the text books say – but to some extent Yamaha appear to have hoisted themselves by their own petard, because the CA-800 working in Class B produces so little distortion anyway that further reduction by switching to Class A seems to be of only academic interest. Certainly it can be *measured*, but after many hours of very careful listening at all sound levels we could not *hear* any difference.

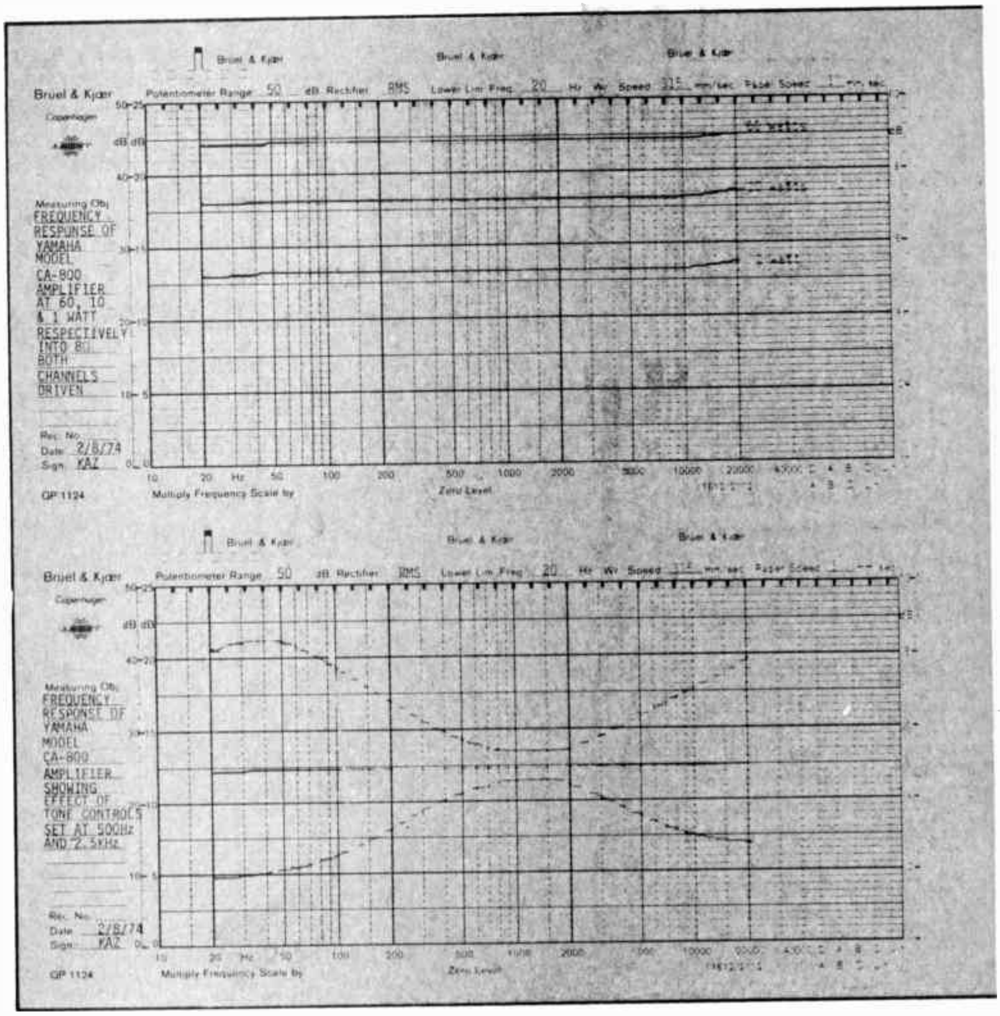
Yamaha claim that the very low level of residual distortion at low listening levels (in Class B) *can* be heard. It could well be, but it must be by perfectionists whose hearing is a great deal more sensitive than ours!

MEASURED PERFORMANCE

The measurable distortion of the amplifier is as low as any we have ever measured. In fact it presented us with a number of interesting problems in electrical measurement to be certain that our measurements were of amplifier distortion itself rather than distortion from our test oscillator.

The distortion products at maximum output were generally in the range –67 dB to –80 dB, re 0 dB at maximum output in the Class B mode, and in the range –74 dB to –80 dB re 0 dB at maximum output in the Class A mode.

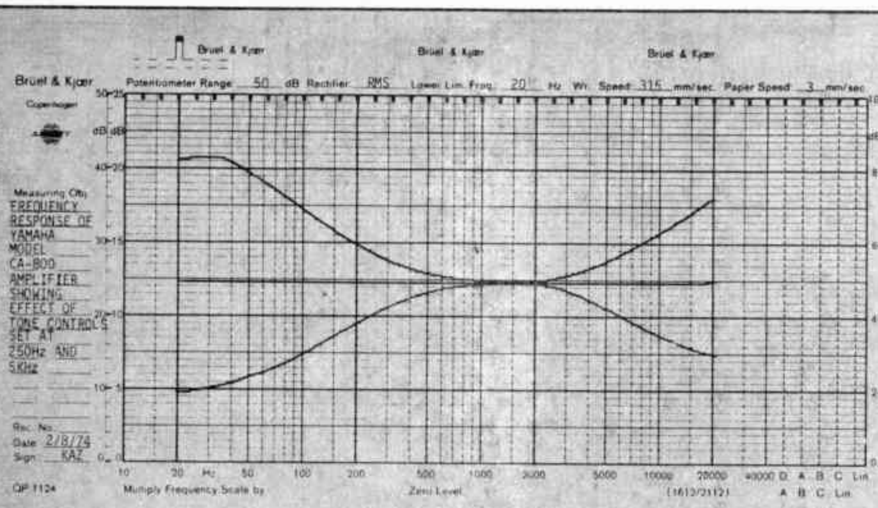
Before embarking upon subjective tests we doubted our ability to be able to discriminate between distortion products 60 dB down on the fundamental component (less than 0.1%). After completing our tests we are *convinced* that we cannot hear such low distortion.

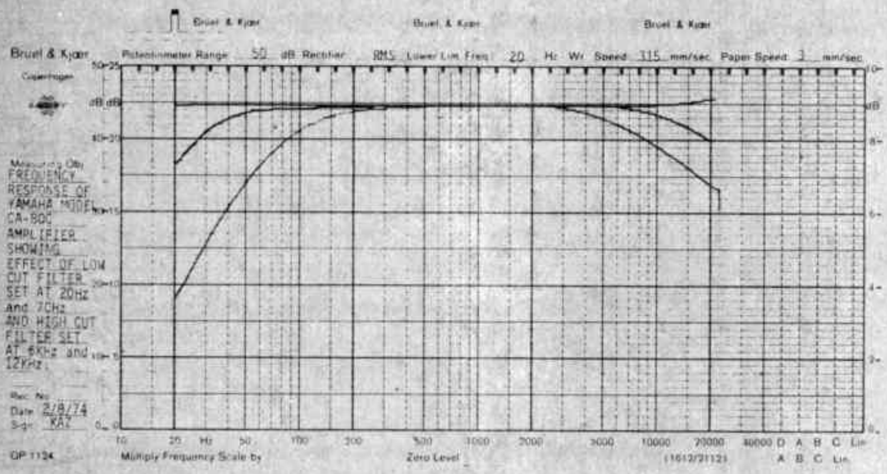


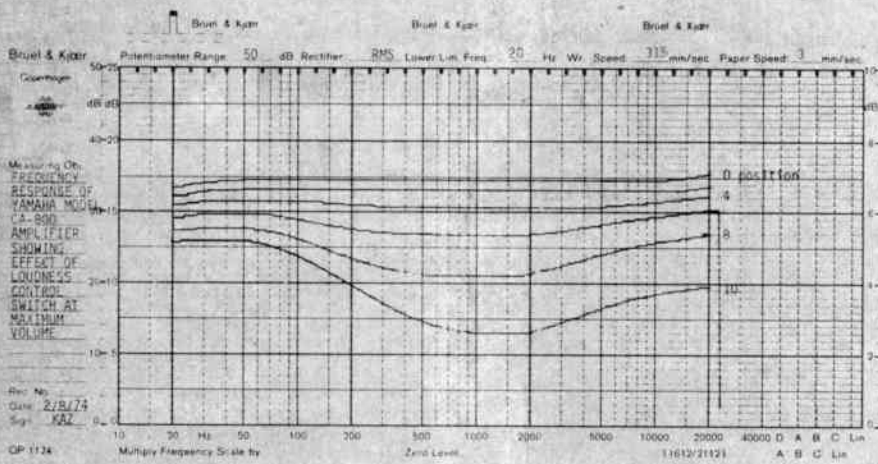
Is then the facility to switch to Class A operation a necessary or desirable feature – or is it just a gimmick?

Certainly its inclusion enables purists to decide for themselves whether or not Class A operation is worthwhile. A further advantage is that if you *can* still detect some distortion when switched to Class A, then you can be virtually certain that it's not coming from the amplifier! But our frank opinion is that for most people, the facility is an interesting gimmick. But, had Yamaha not incorporated such a superb Class B output stage, it would have been a different matter – as we said they've hoisted themselves by their own petard!

One very worthwhile and technically valid feature is the inclusion of a







loudness control which is meant to be used as the preferred means of adjusting listening level. Whilst not unique to Yamaha, this feature is very desirable. Loudness controls are based on the psycho-acoustic fact that as sound levels decrease, high and low frequency components are heard at subjectively lower levels than mid-range sounds. Eventually, at very low sound levels, bass appears to drop out altogether.

Many amplifiers have 'loudness' controls that compensate for this phenomenon to some extent. Yamaha's method, used in the CA-800, is far more complex. The subjective effect is that the overall sound at all levels has the same apparent frequency response as at the higher levels.

The control is used by firstly setting the loudness knob to a 'flat' position. Then the volume control is set to the loudest volume that would normally be used. From then on, volume is adjusted solely with the loudness control — not with the main volume potentiometer.

As there are some hi-fi purists to whom loudness compensation is anathema, the volume control may be used normally — with loudness compensation switched out.

The tone controls and associated switch are well designed and the use of two "break" frequencies follows a growing trend. The choice of frequencies and the resultant response curves are not as different as might be expected, and a lower "break" frequency than 250 Hz and a higher break frequency than 5000 Hz may well have been advantageous.

One fault became apparent during testing. With the amplifier set to maximum treble boost, and with the volume control set to maximum gain for response curve testing, we found it possible to introduce very high frequency (above audibility) instability in the output circuitry, and the amplifier could be induced into oscillation. This worried us, but it may well be that this was an isolated fault in this unit. In every other respect, however, the features of the amplifier were exemplary and it offered a superb performance.

The Yamaha CA800 amplifier offers a performance which is generally better than most other amplifiers regardless of price. It is designed for the purist who is seeking the ultimate, but that the ultimate is "Class A" output operation is something that has yet to be proven! ●

DISTRIBUTOR'S COMMENTS

There has always been controversy about Class A versus Class B operation — and probably always will be.

The inclusion of the Class A facility in the Yamaha CA-800 (and more powerful CA-1000) has once again stirred up this contentious subject.

If perhaps we can quote an analogy given to us recently by one of our clients — he was adamant that he could hear the difference between the two modes of operation. He claimed that the difference could be likened to seeing a pin-point of light in a darkened room once the bright lights that were in that room had been switched off. Initially, says our client, the pin-point is not discernable but once ones' eyes have become accustomed to the change in ambient light the light source is clearly visible.

It is certain that in the case of the CA-800 which as your review says, has excellent performance in Class B, it is difficult to detect any great change when switching quickly between Class A and Class B. One should be prepared to listen for a long period to prove or otherwise the Class A versus Class B argument.

Nigel Cowan
Rose Music Pty Ltd.

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LER 063

FM RADIO
–DRAFT STANDARDS

The Australian Broadcasting Control Board has just released the proposed Draft Standards for the VHF FM Broadcasting Service. These standards are in accordance with recommendations contained in the Independent Inquiry into Frequency Modulation report recently accepted by the Australian Government.

Unless interested parties cause amendments to be made, these Standards will be ratified immediately after November 22, 1974.

EXPLANATORY NOTES

These Standerds ere consistent with international Standards for the pilot-tone stereophonic system, thereby ensuring maximum interchangeability and utilisation of imported equipment end established technical developments. Some of the parameters of VHF-FM services vary from one part of the world to another e.g. U.S.A., Japan, Europe; and in this regard the following quantities ere proposed for use in Australia.

Parameter	Proposals	Comments
Frequency Range	88-108 MHz	As used in U.S.A., Canada and recommended in McLean report. Japanese domestic receivers tune from 70-90 MHz, but most of their export is to U.S. standards 88-108 MHz. European FM receivers generally cover 88-104 MHz (there are relatively few European FM stations above 100 MHz). The dominant use of TV ch5 (101-108 MHz) for Phase 1 of FM development requires receiver coverage up to 108 MHz. The special situation which will obtain in Australia for some, if not many, years is that the 88-108 MHz band will require to be shared between TV and FM transmissions.
Deviation Pre Emphasis	±75 kHz 50 micro-seconds	Applies in both baseband (L + R) and stereo (L – R) channels. Experimental use of noise reduction systems such as Dolby B, accompanied by a reduction in pre-emphasis to 25 micro-seconds, would be permitted. This would be expected to make the difference in monophonic and stereophonic coverage less obvious.
Polarisation	Mixed	Some form of mixed polarisation to improve reception in motor vehicles, and by hand-held and other portable receivers. (Initial transmissions are likely to be horizontally polarised, for speed in transmitting aerial provision.)
Supplementary Monophonic Transmission	Optional	As used in U.S.A., Canada. It is important for designers of FM stereo decoders to take into account the possible presence of supplementary transmissions between 53 kHz and 75 kHz.

Technical Standards for the Australian Frequency Modulation Sound Broadcasting Service

PREFACE

The purpose of this Standard is to specify the system to be used for sound broadcasting in the band 88 MHz to 108 MHz. As far as possible, tolerences have been specified only where these ere appropriate in regard to the system. Separate Standards will specify the performance required of technical equipment at stations, the operation of such equipment, and all other metters the Board considers necessary.

In framing these Standards, it has been assumed that the receiver intermediate frequency is 10.7 MHz, and that the local oscillator frequency is above that of the main carrier.

1. RADIATED SIGNAL CHARACTERISTICS

1.1 CHANNELS
The channel width shall be nominally 200 kHz. The channel spacing shall be 200 kHz, but a carrier off-set of ±100 kHz may be specified where this is appropriate.

1.2 MAIN CARRIER LOCATION AND MODULATION
The main carrier shall be centrally located in the channel and shall be frequency modulated by the baseband signal, the peak frequency deviation being ±75 kHz.

1.3 POLARISATION OF THE RADIATED SIGNALS
The polarisation of the radiated signals shall be specified by the Board.

2. BASEBAND SIGNAL CHARACTERISTICS

2.1 MONOPHONIC TRANSMISSION
The baseband signal shall be the audio signal components within the band 30 Hz to 15 kHz. Pre-emphasis of the audio signal shall be as shown in Drawing 1 of these Standards in accordance with the impedance/frequency characteristic of a series resistance-inductance network having a time constant of 50 microseconds.*

2.2 STEREOPHONIC TRANSMISSION
The pilot-tone system shall be employed for the transmission of stereophonic signals. In this system the baseband signal consists of:–

(i) A compatible signal M, equal to one half the sum of the left-hand signal L, and the right hand signal R, which produces a deviation of the main carrier of not more than ± 67.5 kHz.

(ii) Sidebands of an amplitude modulated suppressed sub-carrier, the modulating signal S of this sub-carrier being equal to one half the difference between the left-hand and right-hand signals. The sum of these sidebands produces a peak deviation of the main carrier equal to that which the signal S would produce if applied to the channel M. The peak deviation is not more than ±67.5 kHz.

(iii) A pilot signal having a frequency equal to one half of that of the sub-carrier, and producing no less than ±6 kHz and no more than ±7.5 kHz deviation of the main carrier.

2.2.1 The frequency of the sub-carrier is 38,000 ±4 Hz.

2.2.2 The residual sub-carrier produces a deviation of the main carrier of not more than ±750 Hz.

2.2.3 The M and S channels shall pass audio signal components in the band 30 Hz to 15 kHz.

2.2.4 Pre-emphasis of the M and S signals shall be the same as that for monophonic transmission.*

2.2.5 The phase relationship between the pilot signal and the sub-carrier is such that when modulating the transmitter with a baseband signal for which L is positive and R equals – L, the resultant subcarrier signal crosses the time axis with a positive slope each time the pilot signal has an instantaneous value of zero. This condition shall be met to within a tolerance of ±3° for the phase of the pilot signal.

2.2.6 A positive value of the baseband signal corresponds to a positive frequency deviation of the main carrier.

3. SUPPLEMENTARY MONOPHONIC TRANSMISSION

3.1 Transmission of a supplementary monophonic programme on a frequency modulated subcarrier may be authorised by the Board.

3.2 The instantaneous frequency of the supplementary sub-carrier shall be confined to within the baseband range 53 kHz to 75 kHz.

3.3 Modulation of the main carrier by the supplementary sub-carrier shall not exceed ±7.5 kHz.

3.4 When transmitting a supplementary monophonic programme, the total frequency deviation of the main carrier by the combined baseband signals shall not exceed ±75 kHz.

Sound Transmitter, Modulating Signal Pre-emphasis
(Time constant 50 Micro Seconds)

* On an experimental basis, the Board may permit processing of the L and R signals of a stereophonic transmission in accordance with the Dolby B-Type noise reduction system. For such transmissions, the pre-emphasis time constant should be reduced to 25 microseconds.

CHANNEL FREQUENCY ALLOCATIONS

Channel Numbers	Freq. MHz
201	88.0—88.2
202	88.2—88.4
203	88.4—88.6
204	88.6—88.8
205	88.8—89.0
206	89.0—89.2
207	89.2—89.4
208	89.4—89.6
209	89.6—89.8
210	89.8—90.0
211	90.0—90.2
212	90.2—90.4
213	90.4—90.6
214	90.6—90.8
215	90.8—91.0
216	91.0—91.2
217	91.2—91.4
218	91.4—91.6
219	91.6—91.8
220	91.8—92.0
221	92.0—92.2
222	92.2—92.4
223	92.4—92.6
224	92.6—92.8
225	92.8—93.0
226	93.0—93.2
227	93.2—93.4
228	93.4—93.6
229	93.6—93.8
230	93.8—94.0
231	94.0—94.2
232	94.2—94.4
233	94.4—94.6
234	94.6—94.8
235	94.8—95.0
236	95.0—95.2
237	95.2—95.4
238	95.4—95.6
239	95.6—95.8
240	95.8—96.0
241	96.0—96.2
242	96.2—96.4
243	96.4—96.6
244	96.6—96.8
245	96.8—97.0
246	97.0—97.2
247	97.2—97.4
248	97.4—97.6
249	97.6—97.8
250	97.8—98.0
251	98.0—98.2
252	98.2—98.4
253	98.4—98.6
254	98.6—98.8
255	98.8—99.0
256	99.0—99.2
257	99.2—99.4
258	99.4—99.6
259	99.6—99.8
260	99.8—100.0
261	100.0—100.2
262	100.2—100.4
263	100.4—100.6
264	100.6—100.8
265	100.8—101.0
266	101.0—101.2
267	101.2—101.4
268	101.4—101.6
269	101.6—101.8
270	101.8—102.0
271	102.0—102.2
272	102.2—102.4
273	102.4—102.6
274	102.6—102.8
275	102.8—103.0
276	103.0—103.2
277	103.2—103.4
278	103.4—103.6
279	103.6—103.8
280	103.8—104.0
281	104.0—104.2
282	104.2—104.4
283	104.4—104.6
284	104.6—104.8
285	104.8—105.0
286	105.0—105.2
287	105.2—105.4
288	105.4—105.6
289	105.6—105.8
290	105.8—106.0
291	106.0—106.2
292	106.2—106.4
293	106.4—106.6
294	106.6—106.8
295	106.8—107.0
296	107.0—107.2
297	107.2—107.4
298	107.4—107.6
299	107.6—107.8
300	107.8—108.0

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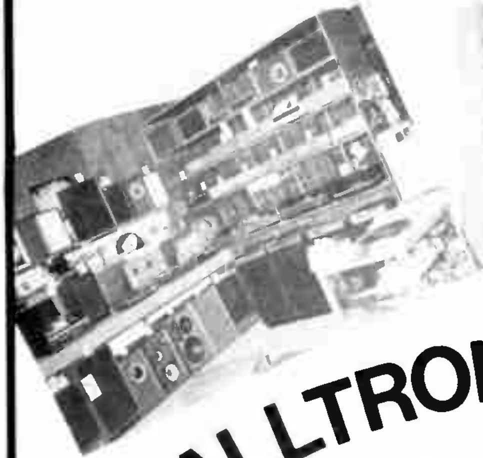

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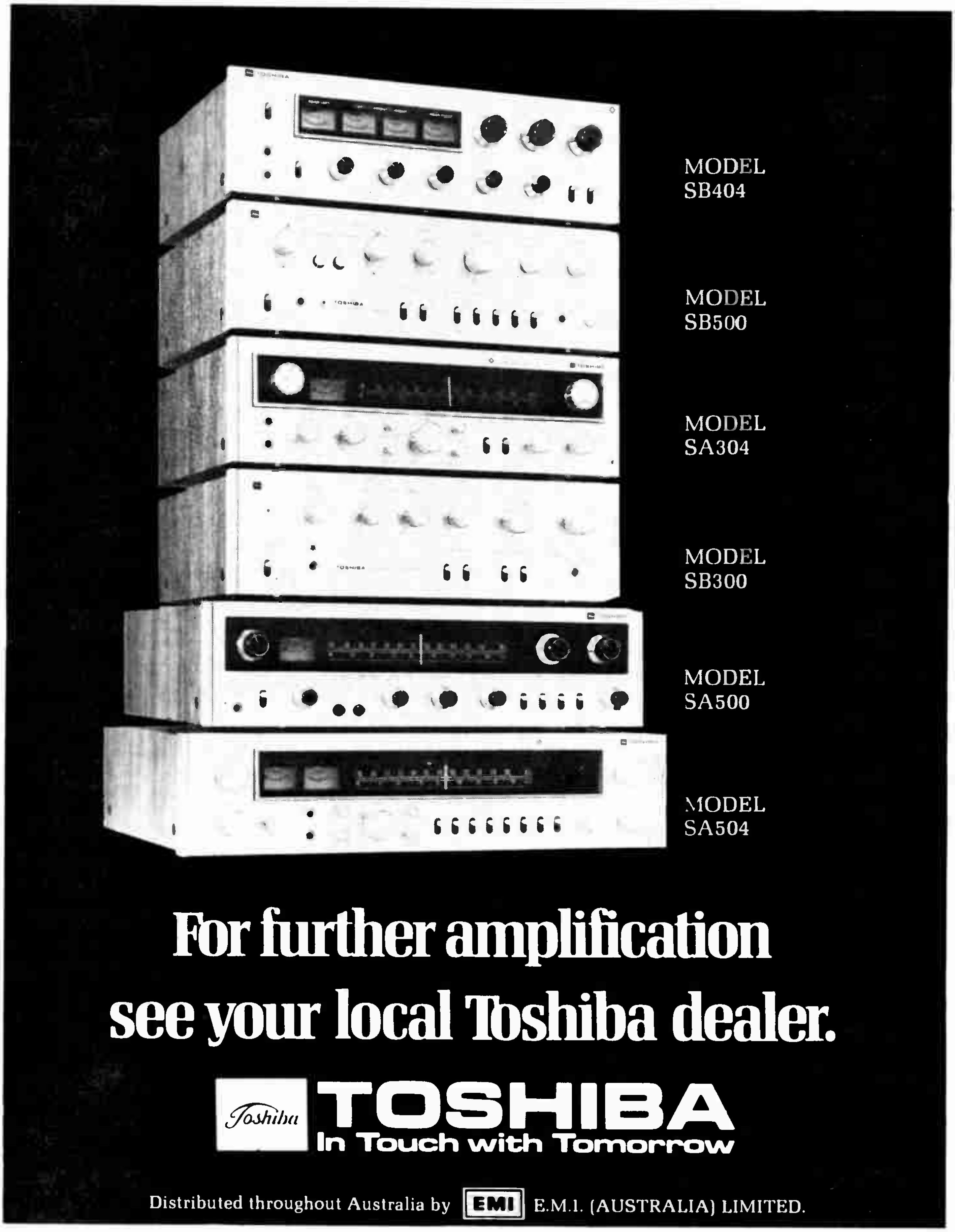
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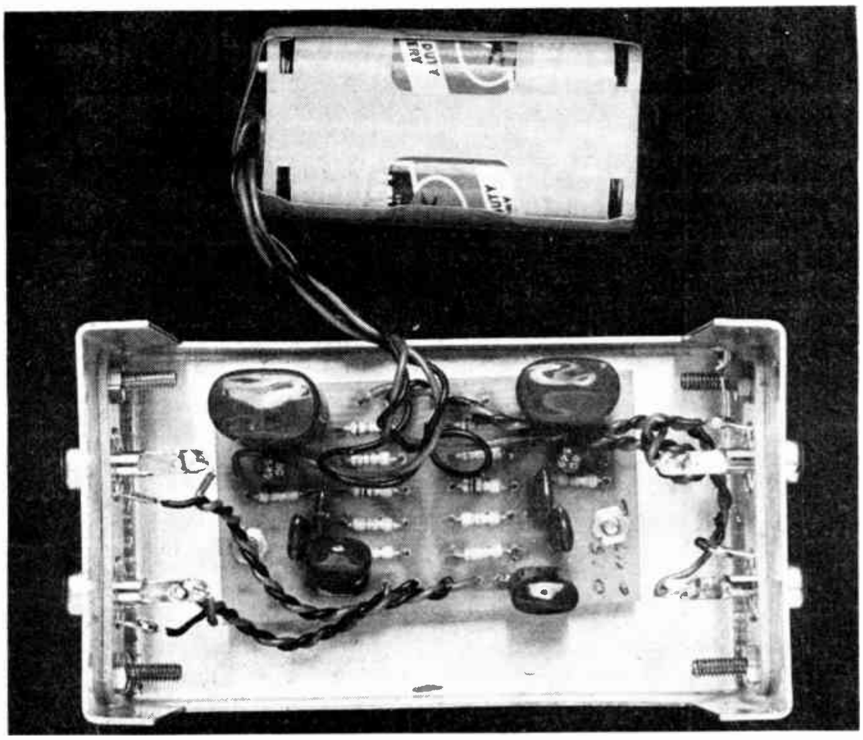
STEREO RUMBLE FILTER

PROJECT 426



This internal view shows how the rumble filter is assembled.

Active filter design improves clarity of bass reproduction.

IN BYGONE DAYS rumble filters were very popular because even the best of turntables, used then, generated considerable vibration due to bearing and motor deficiences. These vibrations, mechanically transmitted to the pickup cartridge, resulted in an audible output. Hence high-pass filters were often incorporated in amplifiers to reduce this objectionable rumbling sound to an acceptable level, and as bass response seldom extended below 50 Hz, a simple RC filter with 6 dB per octave roll-off below 50 Hz was considered adequate.

Modern turntables have far smoother bearing and drive arrangements than their early counterparts – and for this reason many amplifier manufacturers no longer include a rumble filter facility.

Those that do are rarely satisfactory. Their slope is generally inadequate and the main effect of switching them in is to roll off the low-frequency response to the detriment of programme content.

At first sight it would seem better to exclude the rumble filter altogether and just make sure that our turntables do not generate any appreciable rumble.

Surprisingly perhaps, a rumble filter is still very much required and if designed correctly can make an appreciable improvement to reproduction – even when used with turntables that generate no rumble at all!

The reason why will be clearly apparent if you take the front grille

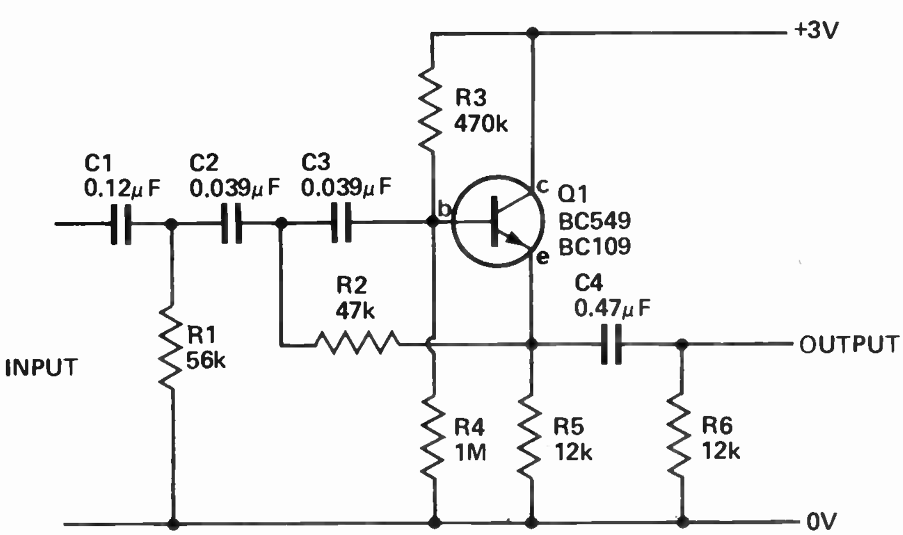


Fig. 1. Circuit diagram of the rumble filter. Two required for stereo.

HOW IT WORKS

The filter consists of three separate sections:–

1. A passive RC filter consisting of R1 and C1.
2. An active filter comprising C2, 3, R2, 3, 4 & 5 and Q1.
3. A passive filter comprising C4 and R6.

The active filter (from input of C2 to output to C4) is a standard design with the exception that values have been selected to give a peak in the response at the cut-off frequency. The maximum lift is about 2 dB and this characteristic, combined with those of the two RC filters, gives a sharp knee to the roll-off. The composite filter has a lift of 0.2 dB before turning over sharply.

Thus low frequency response is maintained substantially flat down to 50 Hz and is only 2 dB down at 40 Hz. Thereafter the response drops very rapidly and is in excess of 30 dB off one of your speakers and — with the phono-cartridge tracing a section of record that has no recorded content (or very low level content) — turn the volume control up fairly high. You will almost certainly find that the cone of the bass driver is making wild excursions to and fro, probably at frequencies between 5 Hz and 15 Hz.

So it's sub-audible — why then does it matter?

Well it really does — and we'll explain just why later in this article — but first let us consider just where this 5 Hz — 15 Hz content comes from.

Firstly, modern turntables and arms have mechanical resonances lying within the 5-15 Hz region. Secondly, stereo cartridges are sensitive in the vertical as well as horizontal planes and will respond to uneveness in record or turntable surfaces. They will also respond to a defect in the record surface known as pressing rumble.

In addition the noise finds its way onto the record during the actual recording process. This recorded noise is due to LF noise and rumble sometimes being induced in the recording lathe by seismic disturbances, and by vibration in drive gears and cutting head carriage rails.

Lastly vibration of a low frequency nature, due to people walking past the turntable or vehicles passing by outside, may well excite the turntable and arm resonances even though the turntable is reasonably well sprung.

WHY SUB-AUDIBLE NOISE MATTERS

This very low-frequency noise is responsible for a remarkable amount of intermodulation distortion which generally makes the bass sound muddy. In extreme cases it may cause the reproduction to sound as if speaker cone break-up is occurring. The reasons for this are as follows.

Preamplifier stages usually have two or three transistors around which large negative feedback is applied for equalization and/or tone control. At sub-audio frequencies these feedback networks are not generally effective. Thus the LF signals may well receive considerably more amplification in the preamplifier than would normally be expected. Secondly although the magnitude of the LF signal may not itself be sufficient to overload the preamplifier, the combined LF and music signals may well cause the preamplifier to clip. Even if clipping does not occur the LF signal will cause intermodulation distortion despite the fact that the LF signal is inaudible!

Most modern power amplifiers are quite capable of amplifying this noise signal, presenting it to the loudspeaker at a surprisingly high power level. The speaker itself has very little acoustic loading at these low frequencies and the cone will thus move considerably and may even be driven beyond its linear excursion region. Even if not actually overdriven, the presence of such large cone excursions will produce a high level of intermodulation distortion.

Whilst elimination of factors causing the noise is by far the best procedure, a lot of these factors are completely beyond the control of the average hi-fi owner. Hence a rumble filter would seem to be the obvious answer. But, we do not want to sacrifice any low frequency response and we want signals in the offending 5-15 Hz region to be attenuated as far as possible — two apparently conflicting requirements. In addition, as LF noise cannot be allowed to enter the equalization stages of the preamplifier,

SPECIFICATION

Input Impedance (rises below 50 Hz)	47k
Output Impedance	< 5k
Input voltage (maximum)	250mV
Cut-off Frequency (−3dB)	36 Hz
Cut-off Slope (maximum)	24dB/octave
Attenuation at 10 Hz	37 dB
Gain at 1 KHz	−0.2 dB.

PARTS LIST
ETI 426

R1	Resistor	56k	¼W	5%
R2	"	47k	"	"
R3	"	470k	"	"
R4	"	.1M	"	"
R5,6	"	12k	"	"
C1	Capacitor	0.12µF	polyester	
C2,3	"	0.039µF	"	
C4	"	0.47µF	"	
Q1	Transistor	BC109,BC549 or similar		

* for stereo 2 off each of the above parts are needed.

PC board ETI426
2 dual RCA sockets (or whatever is on your table)
2 dual AA size battery holders or one 4 way holder.
4 AA size batteries.
2 1/8" x 1/2" bolts and nuts
2 8mm long spaces
1 mini box type AMB7 or similar (58 x 58 x 100mm).

down below 15 Hz where most LF noise occurs.

Current drain of the two filters is only 100 µA and the batteries will last their normal shelf life of about 12 months, thus no power switch is required. Batteries should be replaced annually.

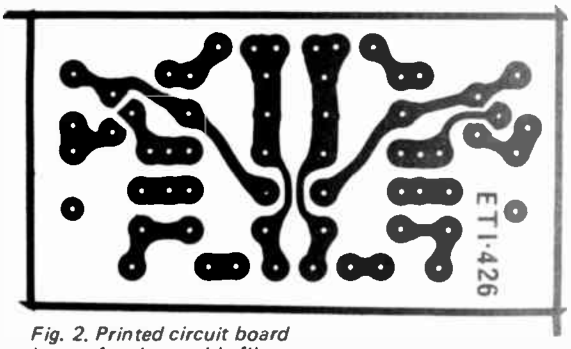
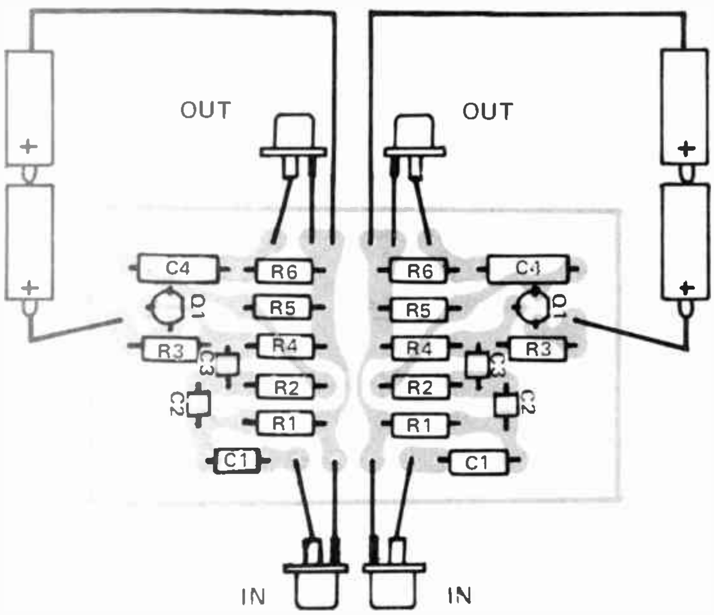


Fig. 2. Printed circuit board layout for the rumble filter 40mm x 70mm.



STEREO RUMBLE FILTER

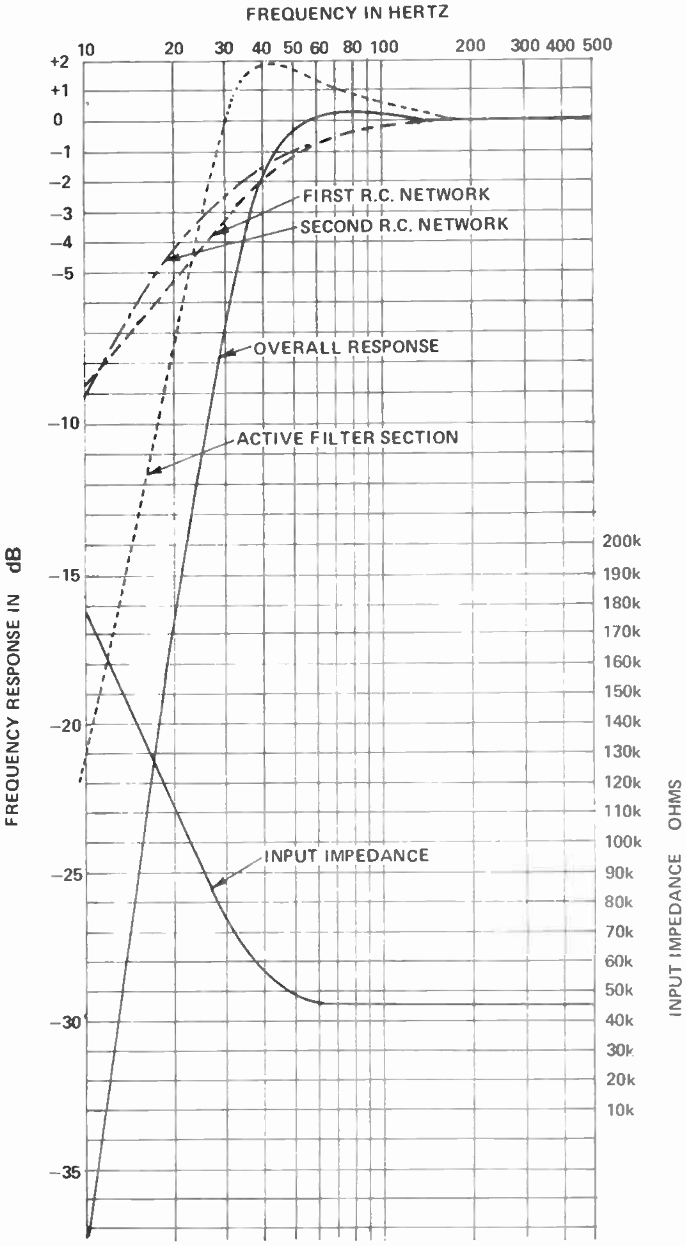
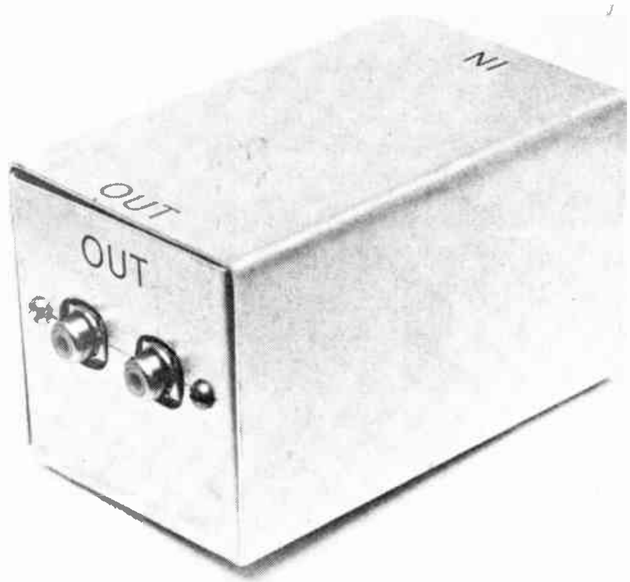


Fig. 4. Characteristics of the rumble filter.



the filter must be situated before the preamplifier. This also poses problems as the signals at this point are very low-level, and there is a danger of introducing hum which would be merely replacing one fault by another.

THE SOLUTION

To maintain response down to at least 50 Hz, whilst obtaining 30 dB or more attenuation to LF noise, we must use a filter which has a sharp knee and an ultimate attenuation slope of 24 dB per octave. The most satisfactory (and cheapest) method of doing this is to use an active high-pass filter — and this is the approach we have used. To obviate the possibility of hum-pickup, the unit uses a battery power supply, one each for left and right channel filters. The use of separate batteries prevents earth loops and ensures that channel separation is maintained. As current drain is very low the batteries may be expected to last their shelf life (12 months or so) and for that reason an on/off switch has not been included.

The unit fits between the turntable and the amplifier, cuts any frequency below 35 Hz and has a total attenuation of 37 dB at 10 Hz increasing at 24 dB/octave below that.

CONSTRUCTION

We built our unit onto a small printed circuit board, but layout is not critical and other alternative methods, such as matrix or Veroboard, may be used successfully. Be careful with the orientation of the transistors especially as there are two different pin configurations in use for the BC549 transistors.

The signal levels involved are extremely small (about 100 μV at 50 Hz) and for this reason a metal box is a must if hum pickup is to be minimized. And, as said before, two separate battery supplies should be used in order to avoid earth loops. We used a conventional four-way, AA battery holder to hold the two sets of batteries. These holders normally connect all four batteries in series. However it is a simple matter to snip the connection between the two sets of two cells.

The RCA sockets for both input and output should be insulated from the metal case. When connecting the unit we found minimum hum was introduced by earthing the turntable to the metal box and then, by taking a separate earth from the metal box to the amplifier. However experimentation in the positioning of earths may well show that some other configuration is best for your particular setup. ●

PROJECT 233

ELECTRONIC COMBINATION LOCK

There's only one chance with this unusual combination lock — any incorrect setting will sound an alarm!

THIS electronic combination lock is a simple device which may be used as a security device, or just for amusement. Very few parts are required and most of them will probably already be in the experimenter's junk box.

A total of 1000 combinations are provided by three, eleven-way switches, only one setting out of the possible 1000 will actuate the output relay (and hence any other device required to be operated). More combinations may be provided by simply wiring further switch banks in series with the existing three.

To prevent people from just rotating switches until the lock eventually opens, "lock" and "unlock" push buttons have been provided. Thus once a switch selection has been made the "unlock" button must be pressed to open the lock. Should *any* incorrect selection be made the alarm will sound. The lock push button must then be pressed to reset the alarm. There is therefore no way in which an intruder can test different combinations, without the alarm sounding, except in the 1 in 1000 chance of selecting the correct combination the first time.

CONSTRUCTION

Construction is very simple. We built our unit into a metal box, but if the unit is meant to prevent access to somewhere, or something, (such as the biscuit tin!) it could well be built directly into the lid or door etc.

Points to watch are the connections to the BC558 transistor, especially as there are two different base connections available, and that the alarm and relays have voltage ratings applicable to the selected supply voltage. The supply voltage may be anything convenient, up to a maximum of 30 volts, this being limited by the rating of the transistor specified. ●

PARTS LIST
ETI 233

R1	Resistor	10 k 20% ½W
Q1	transistor	BC178, BC558 or similar
D1	diode IN914 or similar	
PB1	push button switch (normally closed)	
PB2	push botton switch (normally open)	
RLA, RLB	relay double pole change-over voltage to suit battery supply used.	
SW1 2, 3	Switches single pole 11 position rotary.	
Alarm	— buzzer, sonalert etc. to suit battery supply used.	

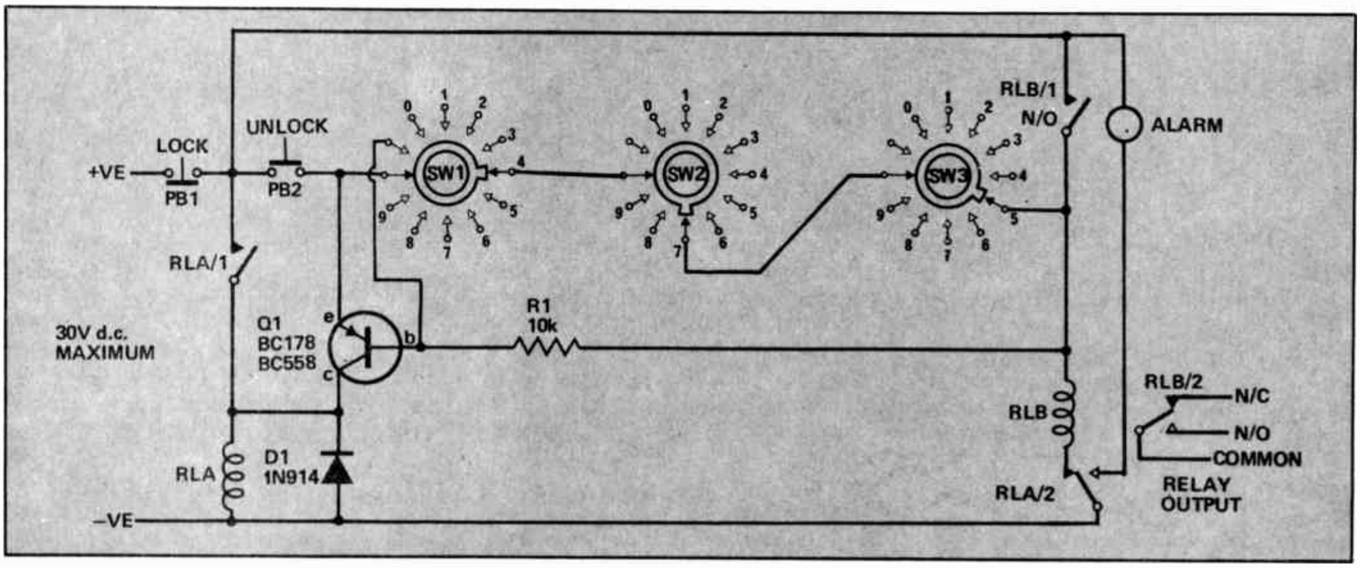
HOW IT WORKS

The three switches (SW1, 2 and 3) are prewired to some specific number. In our circuit diagram the switches are wired to unlock with 475 selected.

When the unlock push button is pressed, power is applied to Q1 and SW1. If the switches are set to the correct "UNLOCK" code, power is also applied to relay B causing it to close. RLB/1 contacts therefore close latching relay B on. The switches can now be altered without relay B opening.

If, however, when the "UNLOCK" pushbutton PB2, is pressed, the switches are not in the correct code position relay RLB is not actuated. Nevertheless, Q1 turns on due to base current flowing through the coil of RLB and R1, and RLA closes. Contacts RLA/1 therefore close, latching on RLA, and contacts RLA/2 change over disconnecting RLB and actuating the alarm. Only by pushing the "LOCK" button can the alarm be de-activated and a new combination tried. If desired the alarm could be connected across the coil of RLA rather than in the position shown.

The switches should normally be left in the number 11 (blank) position. If in this position the unlock button is pressed the alarm will not be actuated. This prevents accidentally raising the alarm.



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Syntron	Surge Stop	SD1544 - -	SD2650 - -	SD2411 - -	SD2452 - -
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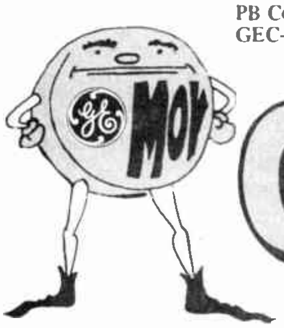

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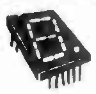

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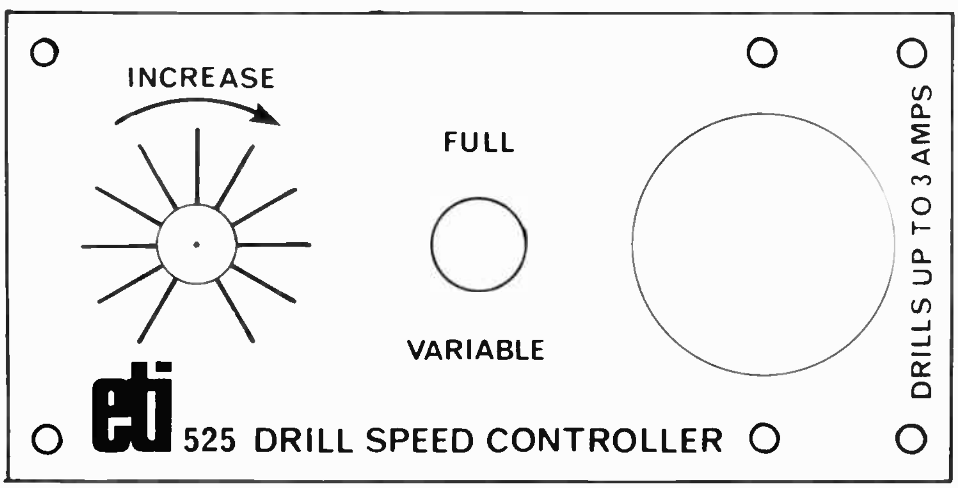
Despite their popularity, many power drills have one major drawback and this is that their speed is often too high for many applications.

This is so even with dual-speed models where even the slow speed, typically 300-750 RPM, is too fast for such jobs as drilling masonry or using fly-cutters on sheet metal etc.

The speed controller described here allows infinite variation of speeds from zero to about 75% of full speed, and is provided with a switch to allow normal full-speed operation without disconnecting the drill from the controller. The controller has built in compensation to maintain substantially constant speed regardless of changes in load.



CONSTRUCTION

It must be emphasized that the controller is connected directly to the mains without the use of an isolating transformer. Care must therefore be taken with the construction to ensure that there is no likelihood of any dangerous conditions arising.

As there are relatively few components used, no supporting tag strip or PC board is necessary. From the photo of our prototype, and from Fig. 2 it can be seen that only two "mid air" joints need to be made, and these should be carefully insulated to prevent any possibility of short circuits.

The SCR used is a stud mounting type and is mounted by using the solder lug, supplied with it, soldered onto the centre lug of the switch. For loads up to 3 amps no other heat-sinking is required. If a plastic-pack SCR is used a hole may be drilled through the switch lug and the SCR bolted directly to it. However in this case it is advisable to insert a piece of aluminium (about 25 mm x 15 mm) between the SCR and switch lug to act as a heatsink.

Remember that, since the unit operates at 240 Vac *all external parts must be earthed.* We used a plastic box with a metal lid. But we also used a cable clamp with a metal screw through the side of the plastic box. This screw *must* be earthed, along with the lid and the earth terminal of the output socket. The earth wire should be continuous That is, it should go from one earth point through to the next and not by separate links. Two earth wires may be soldered to one earth lug. But under no account should two wires be secured under a single screw.

The aluminium lid on the (type UB3) box used is not strong enough for this application, especially when the hole for the output socket is cut. A new lid should therefore be made from 18 gauge steel or 16 gauge aluminium.

To further improve safety it is suggested a small amount of glue, lacquer or even nail polish, be used to secure each screw inside the unit.

With some SCRs it may be found that the trigger current supplied by R1 and R2 is insufficient. If this is the case an additional 10 k resistor should be placed in parallel with each resistor.

PARTS LIST ETI 525

R1,2	Resistor	10k 1W 5%
RV1	Potentiometer	2.5 k lin rotary
D1,2	Diodes	EM404 or similar
SCR1	S.C.R.	2SF28 or similar (400V, 10A, max 20ma gate trigger)
SW1	Switch	McMurdo type 475 or similar.

Box type UB3 or similar.
3 core flex and plug.
cable clamp
3 pin power outlet clipsal 415 or similar.

* Some SCRs used may have a higher than average trigger current and the unit may not operate. If so parallel the two 10 k resistor with additional 10 k resistor to increase the available trigger current.

HOW IT WORKS ETI 525

A universal motor, when running produces a voltage which opposes the supply. This voltage, called the back EMF, is proportional to the speed of the motor. The SCR drill speed controller makes use of this effect to provide a certain amount of speed-versus-load compensation.

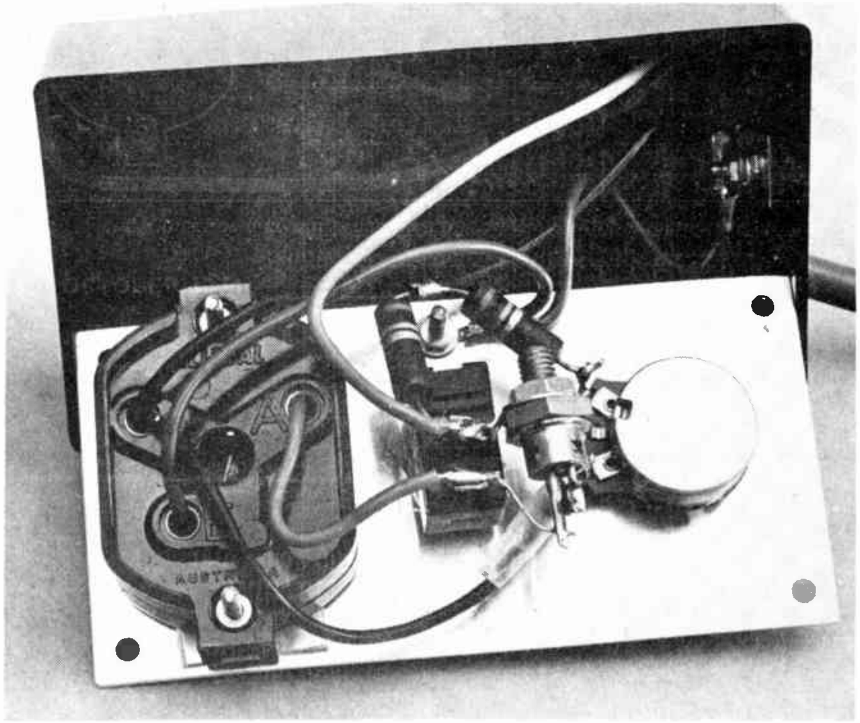
This controller uses an SCR (silicon controlled rectifier) to gate half-wave power to the drill motor. The SCR will conduct only when a anode (terminal A) is positive with respect to the cathode (terminal K), b/ when the gate (terminal G) is at least 0.6 volts positive with respect to the cathode, and, c/ when about 10 mA of current is flowing into the gate terminal. By controlling the level of the voltage waveform to the gate we effectively control the time at which the SCR turns on in each forward half cycle. By this means we effectively control the amount of power delivered to the drill.

Resistor R1, R2 and potentiometer RV1 form a voltage divider which provides a half wave voltage of adjustable amplitude to the gate of the SCR. If the motor is stationary the cathode of the SCR will be at zero volts and the SCR will turn on almost fully. As the drill speed increases, a voltage develops across the drill thus reducing the effective gate-cathode voltage. Thus as the motor speeds up, the power delivered decreases until the motor stabilizes at a speed determined by the setting of RV1.

Should a load be placed on the drill, the drill will tend to slow down, but as the voltage acorss the drill also drops, more power is delivered to the motor since the SCR firing-time is automatically advanced. Hence the speed, once set, is maintained relatively-constant regardless of load.

Diode D2 is used to halve the power dissipated in R1, R2 and RV1 by limiting the current through them to positive half-cycles only. Diode D1 protects the SCR gate against excessive reverse voltage.

In the full speed position the SCR is simply shorted out by SW1. Thus RV1 loses control and full mains supply is applied to the drill.



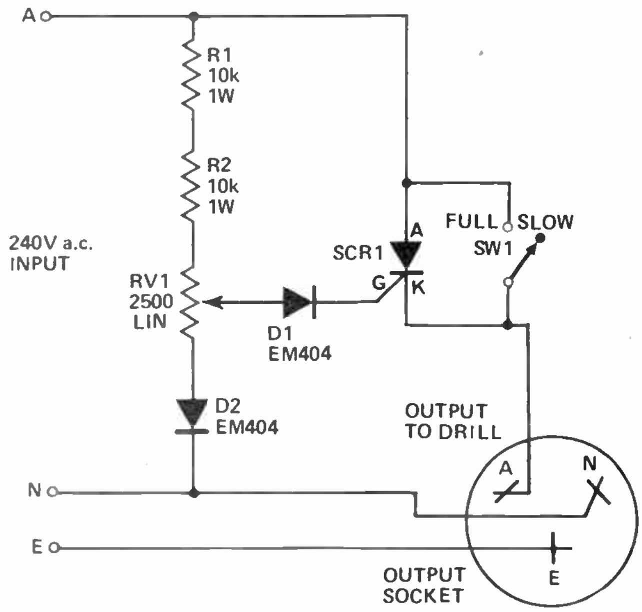


Fig. 1. Circuit diagram of controller.

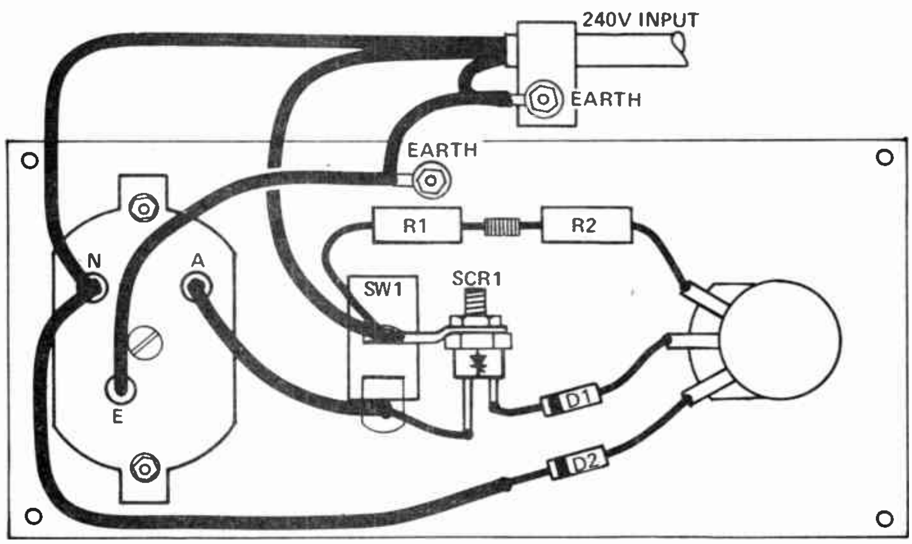


Fig. 2. Component layout — compare this drawing with photograph above.

DRILL SPEED CONTROLLER

USING THE CONTROLLER

Plug the controller into the mains and the drill into the controller. Select either full speed or variable as required. Note that there is no ON/OFF switch provided on the unit and the normal switch on the drill is used for this purpose. When full speed is selected the drill will run normally and the speed control on the controller will have no effect.

When variable speed is selected, the control will adjust the speed anywhere between zero and about 75% of full speed. There may be a dead zone at both low speed and high speed ends of the control. This is entirely normal and is due to different drill characteristics and component tolerances within the controller.

At very low speeds it may be found that drill runs jerkily under no load. However as load is applied the speed will smooth out.

When using the drill at less than full speed the cooling of the motor will be considerably reduced (as the cooling fan is on the armature shaft and also runs slower). Hence the drill will get hotter when used at low speeds, and extended periods of use in this mode should be avoided. ●

PROJECT 307

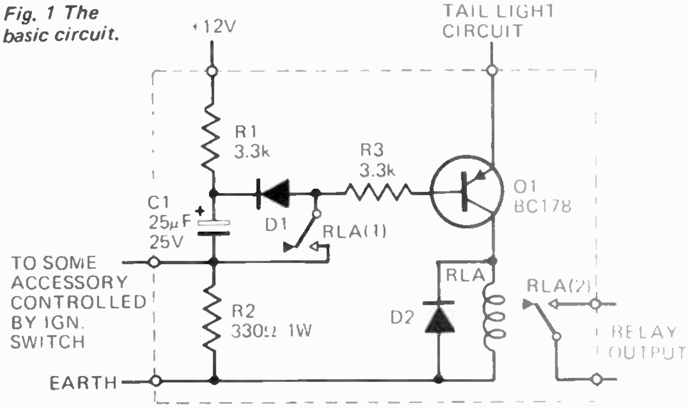
HEADLIGHT REMINDER

Electronic 'reminder' safeguards against flat batteries.

A CAR'S headlights cost approximately one cent an hour whilst in use. Until you forget to turn them off.

Then you are up for recharging the battery, tow starting, apologising to the managing director who has just flown 9000 km to discuss your future with the company, placating uptight parents whose daugher you've returned just after they realised it was now daylight, or whatever

Fig. 1 The basic circuit.



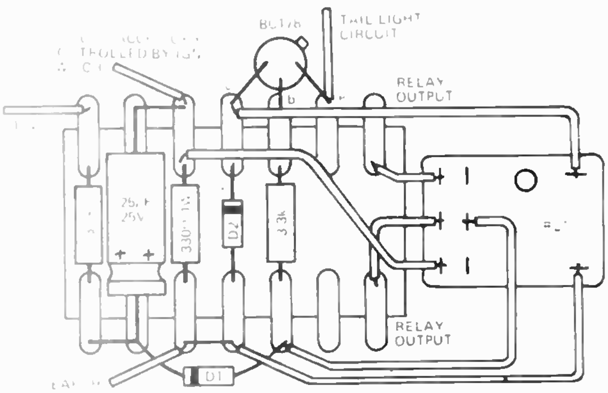


Fig. 2. How the components are connected.

HOW IT WORKS

Normally capacitor C1 is discharged via R1 and the closed switch contacts of an accessory wired via the ignition switch. If the ignition is now switched off, C1 will charge rapidly via R2 thus producing a negative going pulse at the base of transistor Q1.

If the vehicle's headlights (or side and tail lights) were switched on at this time, this pulse will turn on Q1, and close RLA.

The relay contacts RLA(1) and RLA(2) now close and contacts RLA(1) connect the base of Q1 to ground via R2 and R3 thus causing the relay to 'latch on'.

If either front door of the vehicle is opened with the relay in the latched condition an earth will be extended to the audible alarm device via the now closed contacts of RLA(2) and the closed door light switch.

The audible warning will cease immediately the door is reclosed. Q1 will of course be cut off and the relay reset when the lights are turned off (thus removing the positive voltage from the emitter of Q1).

If at any time it is required to disable the alarm circuit all that is necessary is – having first switched off the ignition – to switch the lights off and then on again. The circuit will revert to the status quo next time the ignition is switched on.

PARTS LIST – ETI-307

R1	–	3.3k	5%	½W
R2	–	330 ohms	5%	1W
R3	–	3.3k	5%	½W
D1	–	EM401 – 1N 4005		
D2	–	"	"	
D3	–	"	"	
Q1	–	BC178		
C1	–	25 uf 25V electrolytic cap.		
RL1	–	miniature relay type VP2 185-280 ohm coil two change-over contacts.		
12V	–	alarm, Sonalert, bell, etc. tagstrip etc.		

combination of circumstances are least favourable to your immediate situation.

To avoid such predicaments is relatively simple and a number of circuits have been published that provide an audible warning if the ignition is switched off whilst the headlights or sidelights are still burning.

These circuits are simple and effective but invariably fail to cater for those occasions when one requires lights to be on whilst the ignition is switched off.

Here then is a slightly more complex circuit that provides a 'headlight on – ignition off' warning as the driver opens a door to leave the vehicle. The alarm ceases as soon as the driver closes the door.

The basic circuit is shown in Fig.1. The components may readily be mounted on matrix board or tag strips, and wired as shown in Fig.2.

As shown in Fig.1, the circuit is suitable for vehicles with a negative earth electrical system. To convert the circuit for use with positive earth vehicles replace the BC 178 by a BC 108 (the connections are the same) and reverse the diodes and the 25 μF capacitor.

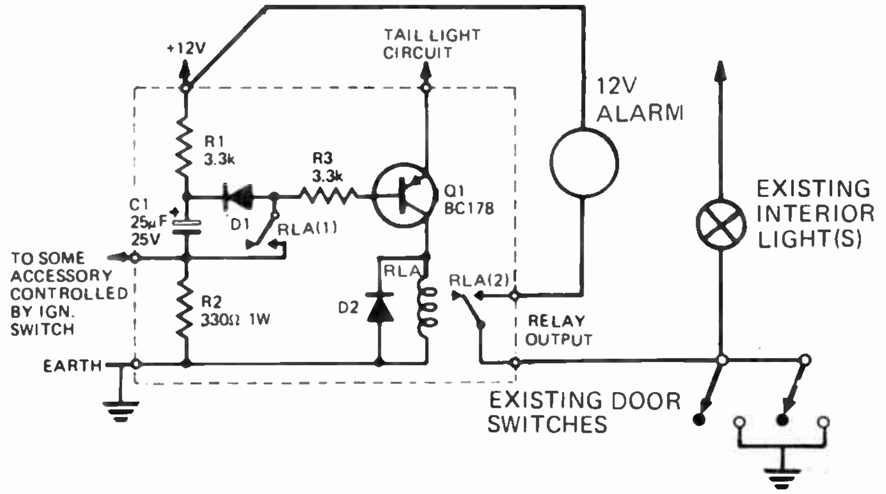


Fig. 3. How the warning circuit is wired into the vehicle's electrical system.

Figure 3 shows how the basic circuit is wired into the car's electrical system. The alarm unit may be a Sonalert, a buzzer, bell or even a flashing light. The existing door-operated interior light is used to extend an earth to the relay thus obviating the necessity to install any additional switches.

The lead marked 'tail light circuit' should be connected to the live side of the tail light wiring. (If a headlight only warning is required, this lead should be connected to the live side of one of the headlights). Further leads connect the unit to earth, the 12V vehicle supply and to the live side of any accessory that is wired through the ignition switch. ●

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A full set of parts, assembled and tested with detailed instructions for the do-it-yourself man to install in any 12 volt car is available for **$29.50** including post and packaging.
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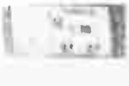

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Cabinet assembly Kit No: HBS 4-50	**$39.95 each Post $3.00**
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TYPE	SECONDARY	RATINGS	PRICE
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PF3598	2 x 9V each at 10VA	ditto	$ 6.00
PF3599	2 x 12V each at 10VA	ditto	$ 6.00
PF3600	2 x 15V each at 10VA	ditto	$ 6.00
PF3601	2 x 20V each at 10VA	ditto	$ 6.00
PF3602	2 x 25V each at 10VA	ditto	$ 6.00
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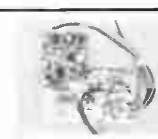

(From discontinued prod. model) Consumption: 18-20 mA Total (no signal) Amplifier: 8-12W. Power Output: Exceeds 1.2W RMS per channel. Speaker imp: 15 ohms at 400 Hz. 8 transistors. Complete with Volume, Treble & Bass controls. COMPLETELY UNUSED & Supplied with full data and schematic diagram. ONLY $11.95 + $1.00 p & p.

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PROJECT 232

COURTESY LIGHT EXTENDER

Car interior light stays on briefly after the door is closed

ALL MODERN CARS are fitted with door-switch operated courtesy lights. Useful devices, but not *quite* as useful as they might be because they are so arranged that the light is extinguished as soon as you close the door — just when you need light to find the ignition switch, do up your seat belt etc. How much better if the internal light stayed on for a few seconds *after* the door is closed.

This little project does just that. It provides a four-second delay (approx) after which the interior light slowly dims — being finally extinguished after 10 or 12 seconds.

The unit is very simple to construct and once tested and properly insulated it may be wired across one of the car door switches. In operation, after a short delay the lights will gradually dim until they are completely extinguished. There is no battery drain in the off-state as the unit only operates during the delay period after the door is closed.

HOW IT WORKS

Most car door switches are simply single-pole switches, with one side earthed. When the door is opened the switch earths the other line thus completing the light circuit.

In a car where the negative terminal of the battery is connected to the chassis the negative wire of the unit (emitter of Q2) is connected to chassis and the positive wire (case of 2N3055) is connected to the wire going to the switch. In a car having a positive earth system this connection sequence is reversed.

When the switch closes (door open) C1 is discharged via D1 to zero volts and when the switch opens C1 charges up via R1 and R2. Transistors Q1 and Q2 are connected as an emitter follower (Q2 just buffers Q1) therefore the voltage across Q2 increases slowly as C1 charges. Hence Q2 acts like a low resistance in parallel with the switch — keeping the lights on.

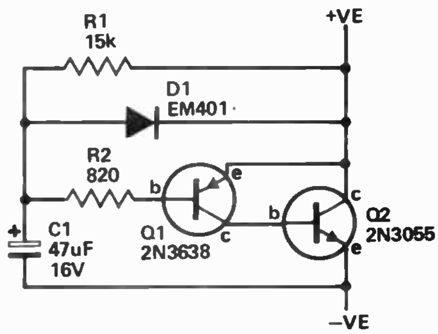
The value of C1 is chosen such that a useful light level is obtained for about four seconds, thereafter the light decreases until in about 10 seconds it is out completely With different transistor gains and with variation in current drain due to a particular type of car the timing may vary, but may be simply adjusted by selecting C1.

CONSTRUCTION

In our prototype, as shown in the photograph, all the components are assembled directly onto the 2N3055 transistor. This only requires two "mid-air" joints to be made.

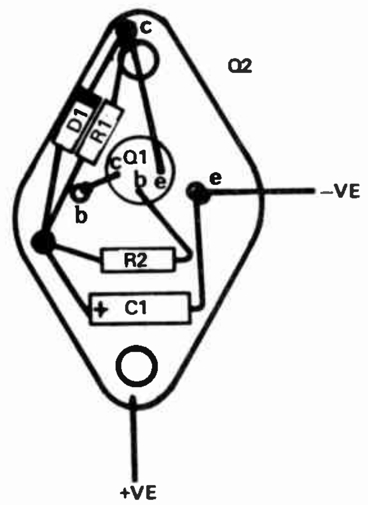
After checking that the unit works correctly the assembly may be placed in a small plastic pill box which is then filled with epoxy. Alternatively merely wrapping the unit in insulation tape will be sufficient.

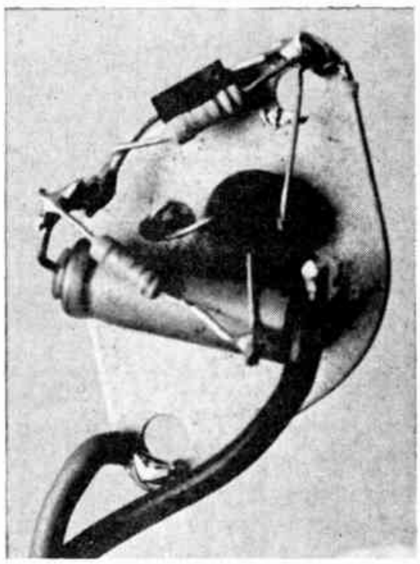
Due to the fact that the 2N3055 only conducts for a few seconds every so often, a heatsink is not required for cars fitted with a single lamp courtesy light. If your car has *more* than the usual amount of interior lighting operate the unit a number of times in fairly quick succession. Then, if the 2N3055 gets too hot to touch, use a small piece of aluminium as a heatsink. This need should however be rare. ●



PARTS LIST
ETI 232

R1	resistor	15 k ½ watt 5%
R2	"	820 ½ watt 5%
C1	capacitor	47μF 16 volt electrolytic
D1	diode	EM401 or similar
Q1	transistor	2N3638 or similar
Q2	"	2N3055





FANE

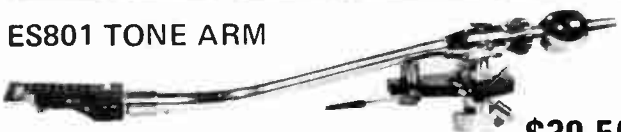
HI-FI BASS LOUDSPEAKERS FROM ENGLAND

12" The model B122/10LR is a 12" bass speaker featuring a rubber suspension which allows a fundamental resonance of 17Hz in free air. This low-resonance, combined with a 2" voice coil working within a carefully selected magnet structure makes the speaker ideal for a sealed cabinet of about 2 cu.ft. capacity. Efficiency of the B122/10LR is surprisingly high for this type of loading and the speaker is ideal for amplifiers with an output of 20-25watts r.m.s. per channel at 8ohms. **$39.50**

12" The model B122/12LR, like the B122/10LR described above, is also suitable for sealed cabinets but because of its more powerful magnet structure a volume of about 3 cu.ft. is required to ensure the speaker gives its optimum performance. **$49.50**

15" The Fane model B152/12LR is a 15" bass driver with a fundamental resonance of 15Hz in free-air. Once again a sealed cabinet provides ideal loading for this unit and the volume can be varied from 3 to 5 cu.ft. The performance in 5 cu.ft. is particularly outstanding as the resonance is kept in the region of 30Hz. This results in firm, non-resonant bass without any of the "boxiness" often associated with conventional speakers. Efficiency is reasonably high and power-handling is up to 30watts r.m.s. at 8ohms. **$59**

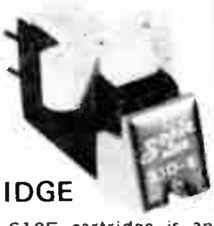
ES801 TONE ARM



$39.50

The ES801 Tone Arm is a high-quality product of excellent performance. All facilities are provided and include removable headshell, adjustable anti-skate, lateral balance, stylus pressure scale, oil-dampened cueing lift and plug-in connecting cable. The acoustic performance is characterised by lack of arm resonance and consistently low bearing friction. All in all a very reliable unit which fills the requirements of most domestic hi-fi systems. The ES801 is the best buy currently on the market at only **$39.50**

STAR SONIC S10E CARTRIDGE



The Sonic S10E cartridge is an outstanding value as it is a magnetic cartridge employing an elliptical diamond stylus. The unit has a compliance of 15 x 10-6 cm/dyne at 100Hz which makes it suitable for using with most tone arms. Fitting the cartridge is extremely simple, because the standard 1/2" mounting system is employed Frequency. Response is 10 to 25,000Hz and recommended tracking weight is 1 to 2 grams. A fantastic buy for only **$15.00**

EC-004 RECORD CLEANER

The EC-004 is most effective for removing dust from the path of the stylus whilst the record is being played. The super-fine brush effectively sweeps the grooves clean but does not damage the delicate record surfaces. At the same time a soft, plush covered cylinder treated with anti-static chemicals ensures that static build-up is eliminated and also collects any spurious dust swept aside by the brush. An adjustable counter balance weight is standard equipment and the stand is a heavy casting which can be placed in various positions to control the tracking performance of the arm. A must for record care at only **$3.90**

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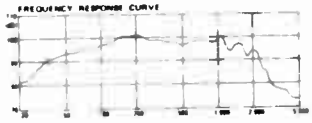
The new ERC-724 tuner is a carefully designed unit which will become a welcome addition to your existing stereo system. The AM section features an internal ferrite rod aerial which provides interference-free reception, for local stations, and allows good interstate reception for evening listening. The FM stereo section covers the range 88-108MHz. The ERC-724, is a compact unit (23.5cm x 15cm x 8.5cm) attractively presented in a walnut cabinet. Guarantee is 12 months, including parts and labour. An excellent buy for only **$64.50**

NEW MODEL CHALLENGE LOUDSPEAKERS

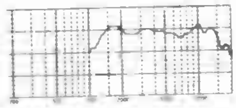
10" 10L-24 WOOFER



This robust unit features a 4 layer wound 1½" voice coil which allows it to handle 30watts r.m.s. comfortably. The combination of extremely rigid cone and low-fundamental resonance of 35Hz in free air ensures deep, positive bass when used in the recommended enclosure sizes. Outstanding value **$16.90**

FREQUENCY RESPONSE CURVE

1" H-22 DOME TWEETER



The development of dome tweeters has been a major project of most loudspeaker manufacturers of recent years. The H-22 dome is one of the latest designs. The 1" diaphragm is made of carefully selected metallized mylar material which is free from resonances or rattles, and is of very small mass to allow maximum efficiency. Undeniable value for **$8.50**

NEW RELEASE MOKUTONE LOUDSPEAKERS

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HM-24 2" DOME MIDRANGE $16.50

An advanced unit of super high efficiency which operates effectively from 900Hz to 8,000Hz. The low-mass 2" diaphragm allows improved transient response over conventional mid-range loudspeakers. The HM-24 is extremely well made and handles high power provided it is used with a suitable crossover network.

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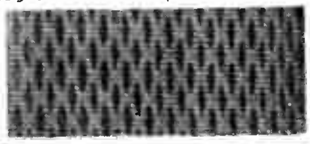

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Challenge

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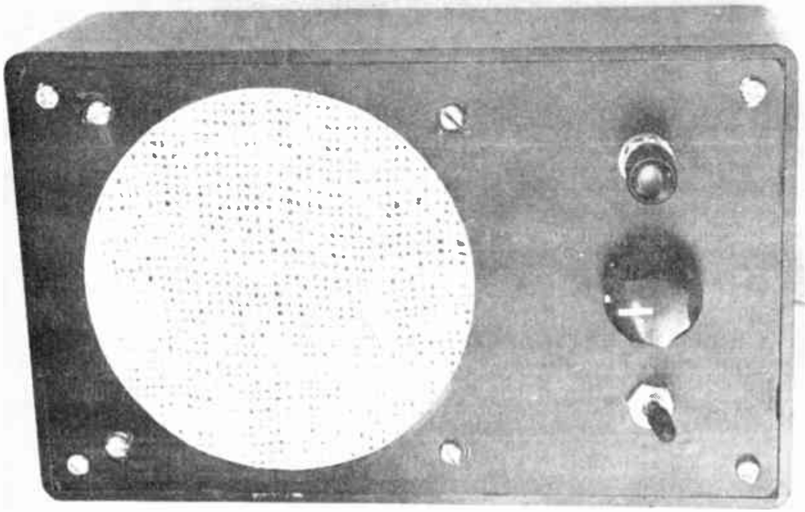
PROJECT 234

SIMPLE INTERCOMS



Three intercom systems using the LM380 audio IC.

AN INTERCOM SYSTEM is not only one of the most useful projects that one can build, it is also one of the easiest.

Commercial intercoms are of course readily available – often at prices even lower than one could build the units for oneself. Nevertheless a project of this nature is still more than justifiable for not only does it provide valuable experience but the system can also be built to suit one's exact needs.

In the ETI unit, as with most simple intercoms, a speaker doubles as both microphone and loudspeaker, its role being changed from one to the other by a pushbutton 'talk/listen' switch.

As a loudspeaker is not particularly efficient when used as a microphone, we have used a step-up transformer and LM 380 integrated circuit amplifier.

The transformer chosen is a 240 V/12.6 V centre-tapped device (of which only one half of the primary winding is used). The specification of this transformer is not at all critical and virtually any device having roughly the specified characteristics will do.

Whilst the circuit of a suitable power supply is shown (Fig. 4) current drain is low and battery operation may be used if the unit is not used very much.

CONSTRUCTION

Construction is very simple indeed and, as there are very few components, we suggest that the amplifier be built onto matrix board or similar. A heatsink is not required for the LM380, when working into a 15 ohm, be sure to obtain speakers having this impedance. Higher impedances will result in much lower power output, and lower impedance speakers (eg 8 ohms) will require the use of a heatsink.

The internal layout of the prototype unit is shown in Fig. 5. Note that we used the system connections shown in Fig. 2. This system requires (easily obtainable) single-pole push buttons but requires three interconnecting wires between station 1 and station 2. It also has the advantage that an

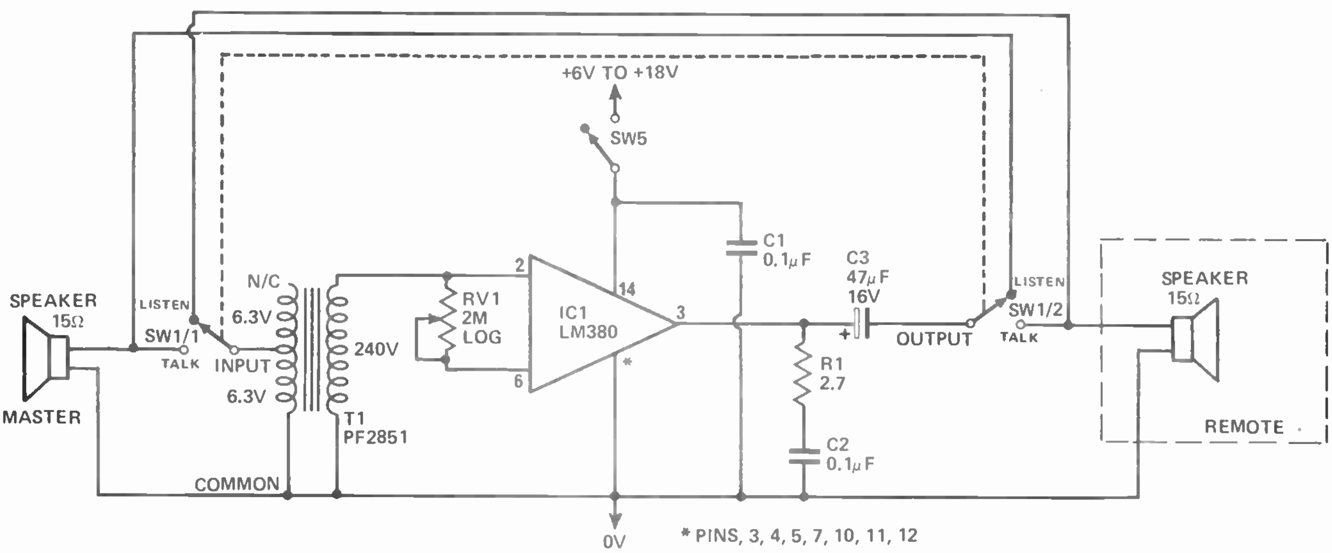


Fig. 1. About the simplest possible intercom, in this arrangement the master station listens to remote station at all times until TALK button is pressed.

output is heard only when the TALK button at either station is pressed.

The system shown in Fig. 1 only requires two wires to the remote station but has the disadvantage that station 1 is always listening to station 2 except when the talk button is pressed.

If two remote stations are required the system illustrated in Fig. 3 should be used. Again this requires three wires to each of the remote stations. Switch SW1 is the push-to-talk button and SW2 selects the required remote station.

We used a small 9 volt battery to power our unit but, if continuous use is expected, it would be wiser to use a larger battery. For example, the standby current is about 3 mA which would result in only about 150 hours operation from a small battery. The best battery system would probably be two 6 volt lantern batteries connected in series. Alternatively a simple power supply such as shown in Fig. 4 could be used.

Electronics Today, in the near future, will publish more circuits using the versatile LM380 audio amplifier.

HOW IT WORKS ETI 234

The (approximately) 1 millivolt output from the speaker is stepped up by transformer T1. The transformer is a standard 240/12.6 CT type used in reverse, only half of the 12.6 volt winding is used. Alternatively either of the A&R audio transformers, as specified in the parts list could be used.

The output of T1 is connected directly to the non-inverting (+) input of the LM380 (pin 2) and also, via potentiometer RV1, to the (–) input. Since the input resistance of the IC is about 150 k, the signal level at the negative input is dependant upon the setting of RV1.

The IC, as with all differential amplifiers, amplifiers the *difference* in signal level between its two inputs, pins 2 and 3. Thus RV1 effectively acts as a volume control.

With the connections shown on Fig. 1, the remote station speaker acts as a microphone, applying its output to T1. The output of T1 is amplified by the IC and applied to the MASTER speaker. Thus the master station is listening to the remote station at all times other than when SW1 is pressed.

When SW1 is pressed the master speaker becomes the microphone and the remote speaker receives the amplified signal from the IC.

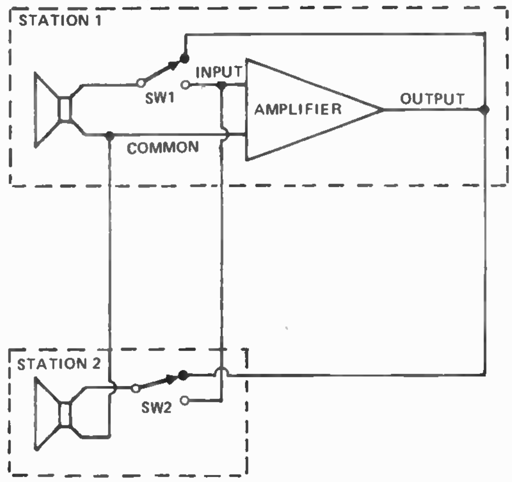


Fig. 2. This system gives privacy to station 2 but requires three wires between stations. The amplifier circuit is identical to that in Fig. 1.

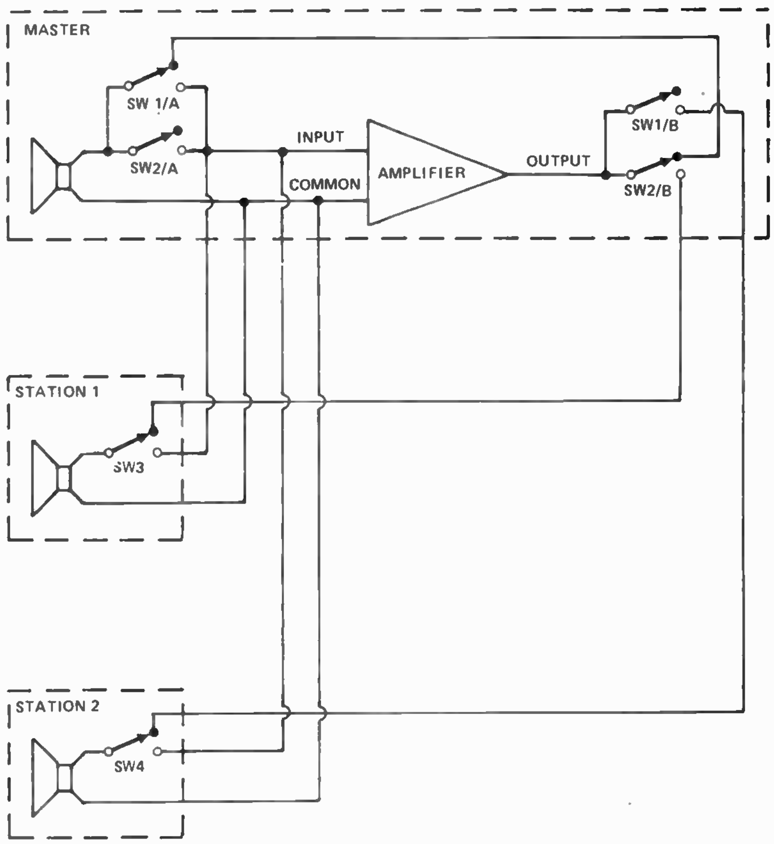


Fig.3. An extension of the previous system to a master and two slaves requires three wires from the master to each slave, and a more complex switching arrangement.

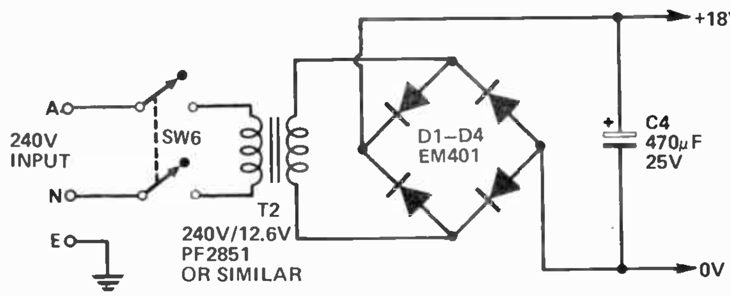


Fig. 4. A simple power supply for use with the intercom.

SIMPLE INTERCOMS

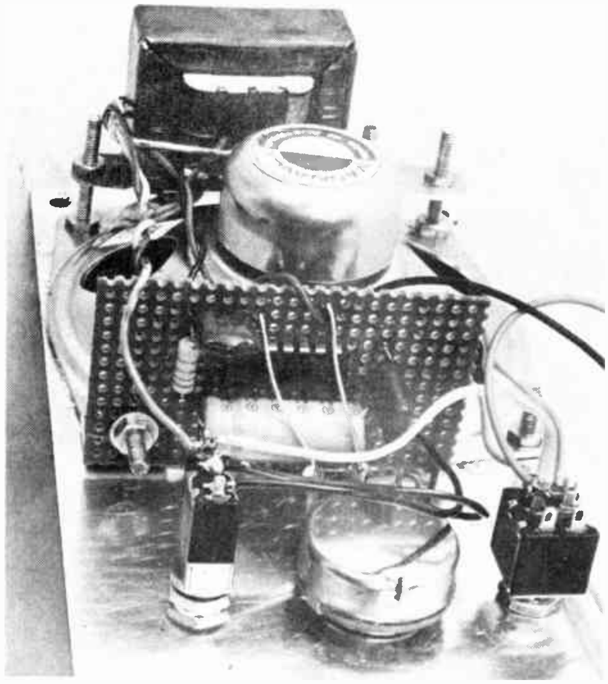


Fig.5. The method of assembly may readily be seen from this internal view.

TO REMOVE CATALOGUE

HOLD COMPLETE CATALOGUE IN RIGHT HAND AND, WITH MAGAZINE OPEN AND HELD FLAT ON TABLE, PULL CATALOGUE AWAY. THEN RECLOSE MAGAZINE STAPLES.

Parts List
ETI 234

R1	Resistor	2.7 ohm ½ watt 5%
C1, C2,	Capacitor	0.1µF polyester
C3		47µF 16 volt-electrolytic
IC1	Integrated circuit	LM380
T1	Transformer	240/12.6 volt centre tapped Ferguson type 2851 A & R type 6474 A & R E7/3.5 or E5/3.5 (or any 240/6.3 volt transformer you may have)
RV1	Potentiometer	2M log rotary

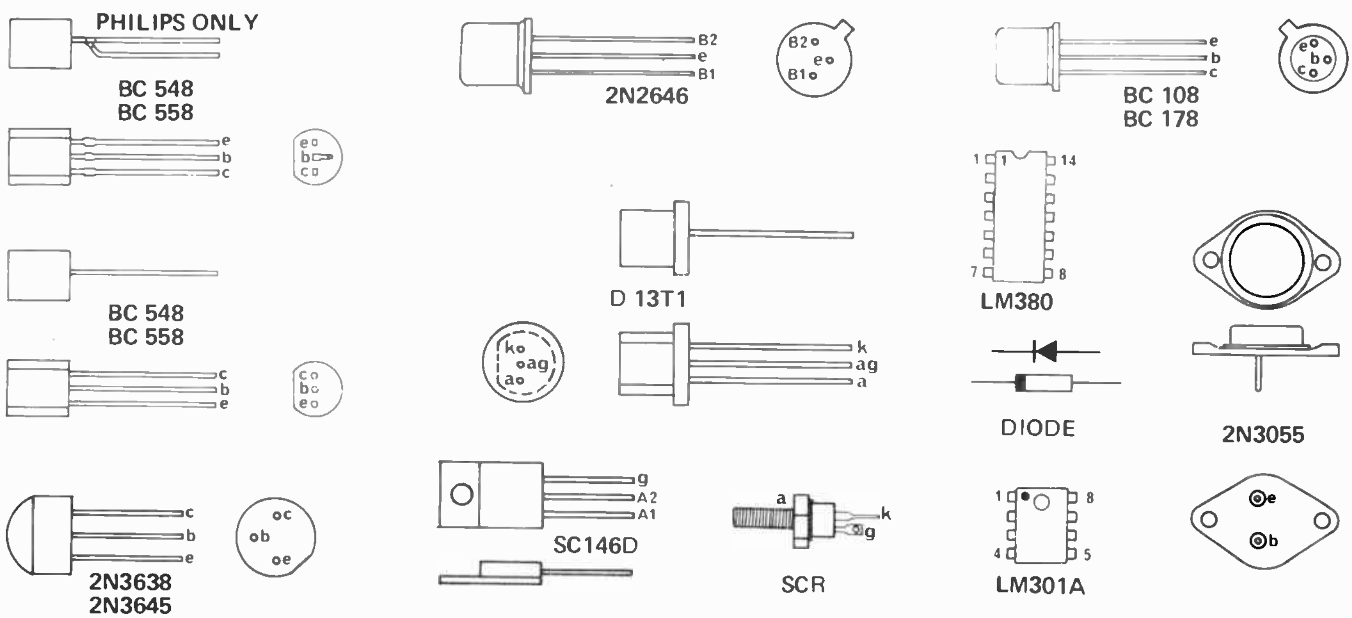
	System 1	System 2	System 3
SW1	DPDT pushbutton	SPDT pushbutton	DPDT pushbutton
SW2	—	SPDT pushbutton	DPDT pushbutton
SW3	—	—	SPDT pushbutton
SW4	—	—	SPDT pushbutton
SW5*	SPDT toggle	SPST toggle	SPST toggle

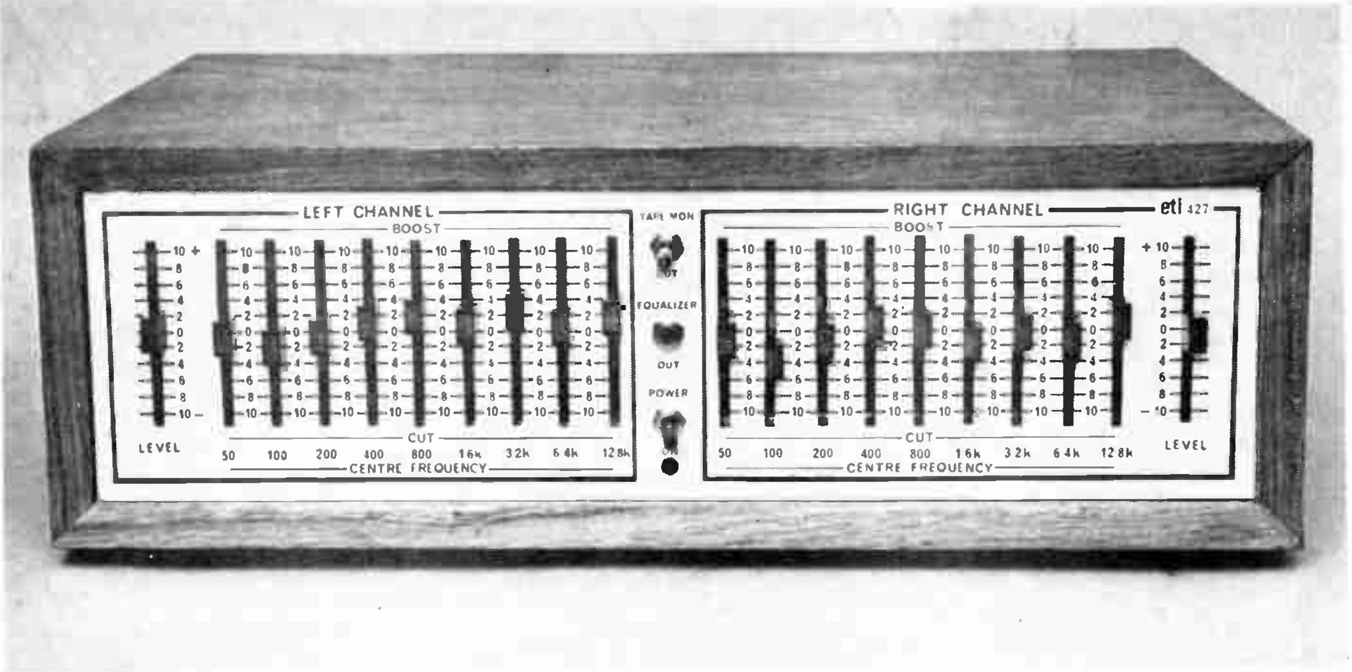
Loudspeakers 15 ohm 3" diameter Magnavox 3T or similar.
Six to 12 volt battery. *
Plastic or metal box, piece of matrix board, bolts and nuts etc.
* required for battery versions only.

Power Supply

D1-D4	Diode	EM401 or similar
C4	Capacitor	470µF 25 volt electrolytic
C5	Capacitor	25µF 25 volt electrolytic
T2	Transformer	240/12.6 volt CT Ferguson PF 2851, A & R 6474 or similar
SW6	Switch	DPST toggle 240 volt ac 1 amp.

BASE CONNECTIONS FOR TRANSISTORS USED IN THIS PROJECT SECTION.





PROJECT 427 GRAPHIC EQUALIZER

Inexpensive unit compensates for speaker and room deficiencies.

MANY audophiles are discovering the advantages of graphic equalizers in domestic as well as professional sound systems. Unfortunately the costs of such units have prevented them becoming as popular as warranted by the many advantages they offer.

The advantages of an equalizer are not generally well known but are as follows.

Firstly an equalizer allows the listener to correct deficiencies in the linearity of either his speaker system alone, or the combination of his speaker system and his living room.

As we have pointed out many times in the past, even the best speakers available cannot give correct reproduction in an inadequate room. It is a sad fact that very few rooms are ideal, and most of us put up with resonances and dips, sadly convinced that this is something we have to live with.

Whilst the octave equalizer will not completely overcome such problems, it is possible to minimize some non-linearities of the combined speaker/room system.

In a concert hall it is also possible to use the unit to put a notch at the frequency where microphone feedback occurs, thus allowing higher power levels to be used.

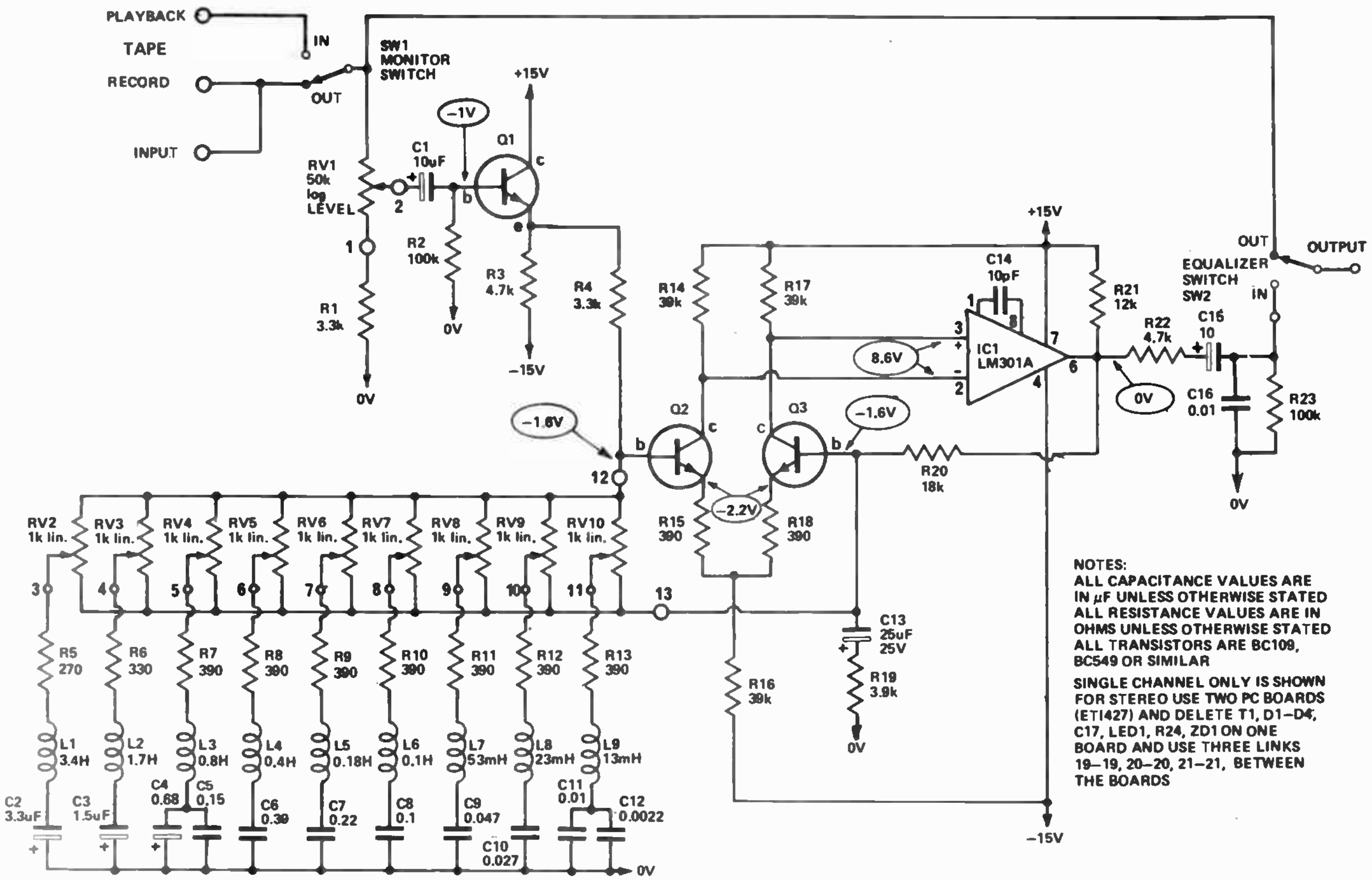
Thirdly, for the serious audiophile, an equalizer is an exceedingly-valuable tool in evaluating the deficiences in a particular system. One adjusts the equalizer to provide a uniform response, the settings of the potentiometer knobs then graphically display the areas where the speaker etc is deficient.

There is a snag, however, one must have an educated ear in order to properly equalize a system to a flat response. It is not much use equalizing to your own preference of peaky bass etc in order to evaluate a speaker.

Ideally, a graphic equalizer should

MEASURED PERFORMANCE (of Prototype)

Frequency Response			
Equalizer out		Flat	
Equalizer in	10 Hz – 10 kHz	±½ dB	
and all controls at zero	1.5 Hz – 30 kHz	+ ½ – 3 dB	
Range Of Control			
Individual filters		±13 dB	
Level control		+ 14 – 9 dB	
Maximum Output Signal at < 1% distortion		> 6 volts	
Maximum Input Voltage		3 volts	
Distortion at 2 volts out, controls flat	100 Hz <0.1%	1 kHz <0.1%	6.3 kHz <0.1%
Signal to Noise Ratio at 2 volts out (unweighted)		69 dB	
Input Impedance		50 k	
Output Impedance		4.7 k	



▲ *Fig. 1. Circuit diagram of one channel of the equalizer.*

GRAPHIC EQUALIZER

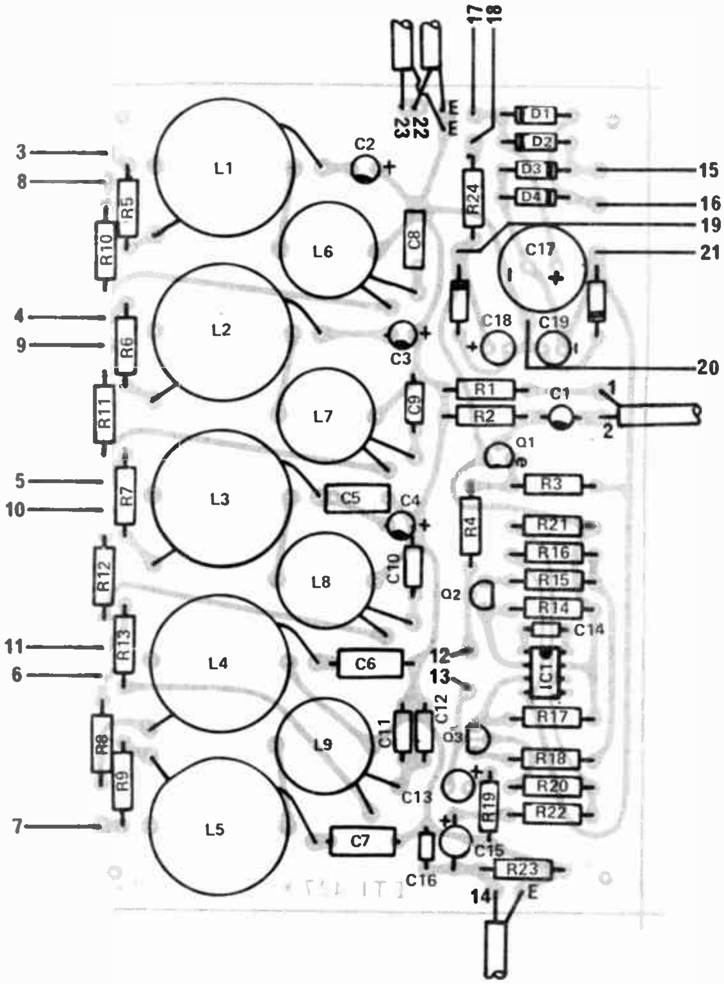
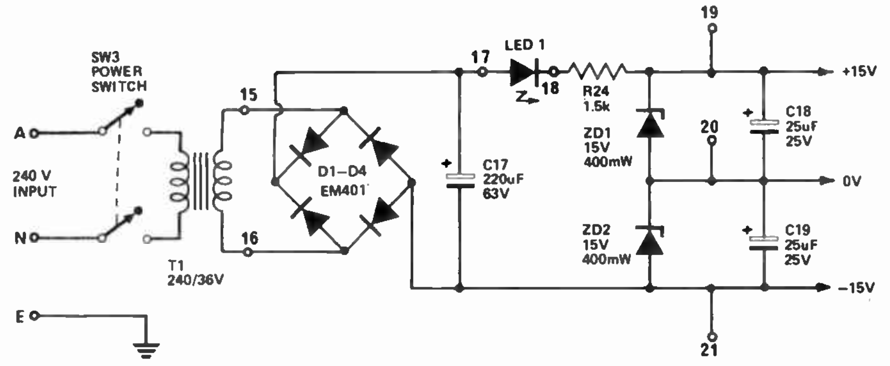


Fig. 2. Component overlay of the equalizer (one channel only)

have filter at 1/3 octave intervals, but except for sound studios and wealthy pop groups, the expense and size of such units are too much for most people.

Recently some excellent commercial units have become available with filters spaced at octave intervals. These are relatively inexpensive and cater for the needs of most professionals and domestic users. Such a unit is the Soundcraftsmen 2012 reviewed in the July 74 edition of Electronics Today International.

The Electronics Today Equalizer has been designed to provide nine filters spaced at octave intervals in each of two channels. It is simple to construct and should be available inexpensively in kit form.



Circuit diagram of the equalizer power supply.

HOW IT WORKS ETI 427

This equalizer is basically similar to those used in the ETI Synthesizer and master mixer projects with the exception that it has nine filter sections per channel.

The equalizer stage is a little unusual in that the filter networks are arranged to vary the negative feedback path around the amplifier. If we consider one filter section alone, with all others disconnected, the impedance of the LCR network will be 390 ohms at the resonant frequency of the network. At either side of resonance the impedance will rise (with a slope dependant on the Q of the network which is 2.5) due to the uncancelled reactance. This will be inductive above resonance and capacitive below resonance. We can therefore represent the equalizer stage by the equivalent circuit below.

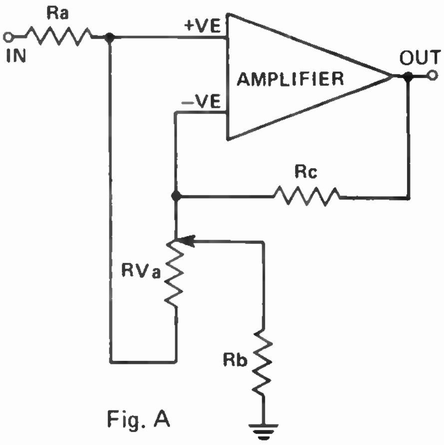


Fig. A

It must be emphasized that this equivalent circuit represents the condition with one filter only, at its resonant frequency.

Additionally letters have been used to designate resistors to avoid confusion with components in the actual circuit.

With the slider of the potentiometer at the top end (Fig. A) we have 390 ohms to the OV line from the negative input of the amplifier, and 1 k between the two inputs of the amplifier. The amplifier, due to the feedback applied, will keep the potential between the two inputs at zero. Thus there is no current through RVA. The voltage on the positive input to the amplifier is therefore the same as the input voltage since there is no current through, or voltage drop across resistor RA.

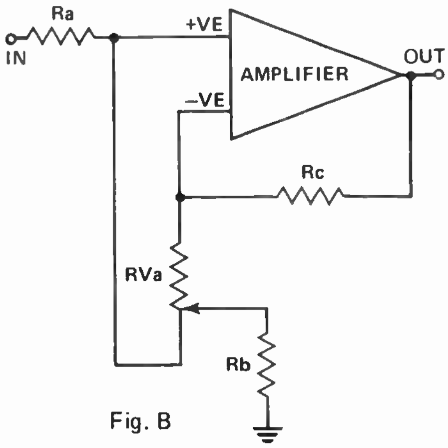


Fig. B

The output of the amplifier in this case is approximately the input signal times (3300 + 390)/390 giving a gain of 19 dB. If the slider is at the other end of the potentiometer, (Fig. B), the signal appearing at the positive input, and thus also the negative input, is about 0.11 (390/(3300 + 390) of the input. There will still be no current in the potentiometer and in RC, thus the output will be 0.11 of the input. That is, the gain will be -19 dB.

If the wiper is midway, both the input signal and the feedback signal are attenuated equally, and the stage will have unity gain.

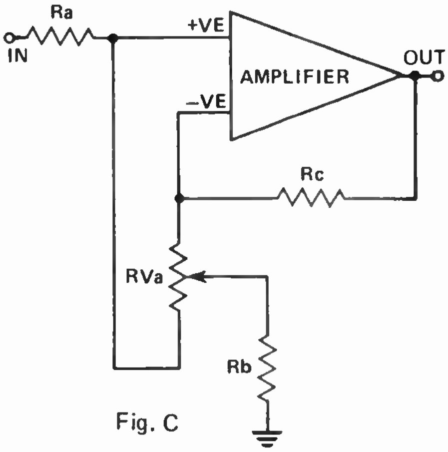


Fig. C

With all filter sections in circuit the maximum cut and boost available is reduced, but ±14 dB is still available.

Reverting back now to the actual circuit, the amplifier consists of IC1, Q2 and Q3. The transistors help to reduce the effect of the noise in the IC and add gain at the high-frequency end. This additional gain is required because the negative feedback, due to the potentiometer between the two inputs, causes high-frequency roll off. This does not affect operation of the unit provided the open-loop gain is above 60 dB over the entire audio range. An overall closed-loop gain of about 15 dB is maintained by R20/R19 with the filter potentiometer at mid position.

The output of the amplifier is decoupled to the output of the unit via C15, and C16/R22 provide a cutoff above 30 kHz.

The input signal is buffered by Q1 because the equalizer stage requires a low impedance signal source for correct operation. Potentiometer RV1 provides level control with 0 to -23 dB range which, combined with the equalizer characteristic, results in an overall level range of + 14 to -9 dB.

The power supply used is a simple, full-wave bridge filtered by C17. Plus and minus supplies are derived by means of two 15 volt zeners in series fed via R24. The front-panel power indicator is an LED connected in series with the dropping resistor R24.

CONSTRUCTION

All components, with the exception of the transformer and the slide potentiometers, are mounted on two printed circuit boards — one for each channel. Whilst the layout is not critical, any alternative construction method could be used, we strongly recommend the use of printed-circuit boards to ease construction and eliminate a possible source of faults.

The components should be assembled to the boards with the aid of the overlay Fig. 2 Carefully check polarities of ICs, capacitors and transistors, etc, before soldering in place. Check particularly the BC549 transistor as there are two lead configurations manufactured for the same type number. The Philips type is the one shown on the overlay. Attach lengths of wire and Coax of adequate length to the board before mounting in position by means of 13 mm spacers.

Due to the close spacing used for the slide potentiometers it is necessary to mount the 9.6 mm spacers, to the potentiometer support-bars, before mounting the potentiometers. Use 6.4 mm long countersunk screws for this purpose.

The potentiometer assembly, and all other external components, (switches etc) can now be assembled to the chassis and the unit wired as shown in the interconnection diagram.

The circuits used have very high gains and it is necessary to take precautions

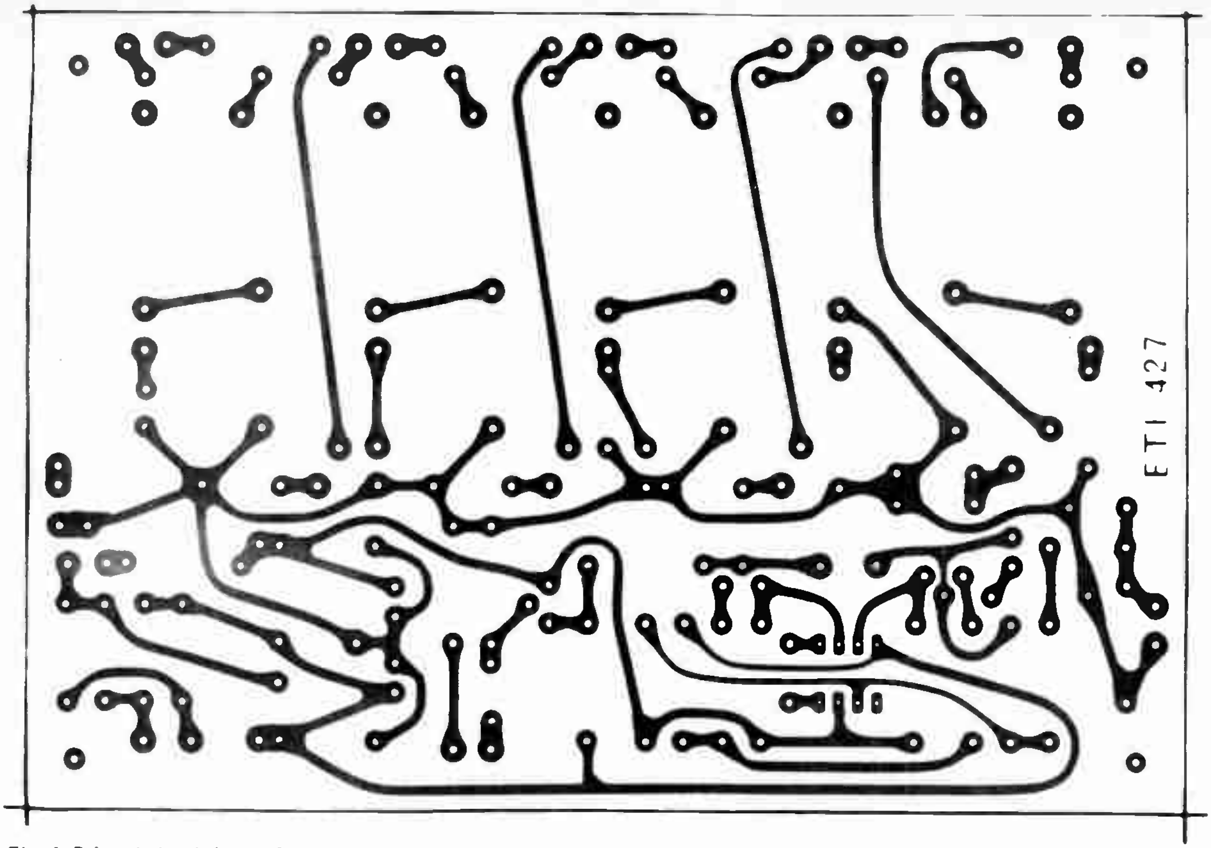


Fig. 4. Printed circuit board for the equalizer. Full size 152 x 103 mm.

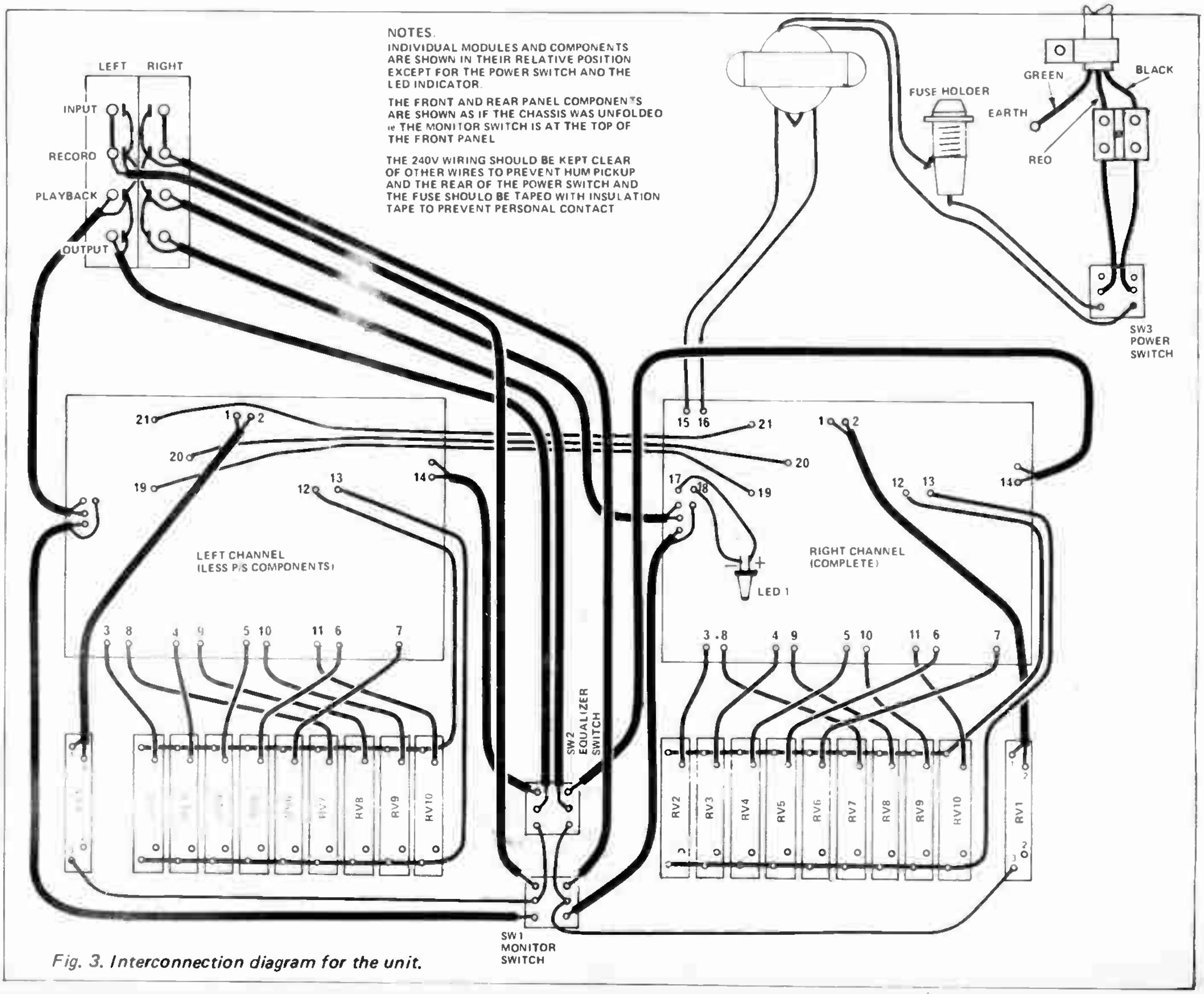


Fig. 3. Interconnection diagram for the unit.

against mains hum-pickup. The transformer should be mounted in the position shown, and the 240 volt wiring, to the front power switch, should be run down the right-hand side of the chassis and along the front, in front of the potentiometer support brackets. If a different transformer is used, or if hum pickup does occur, it may be necessary to mount the transformer inside a metal box to shield it.

Due to tolerances of resistors variations in V_{be} of Q2 and Q3 etc, the steady-state output of IC11 may be anywhere within plus or minus one volt of zero.

Hence it is desirable to determine the polarity of the steady state voltage at pin 6 of IC1 in order to determine which way round C15 should be inserted. If the output is positive insert as shown in Fig. 1. Alternatively C15 should be a non-polarized type such as the Sonar RBP series.

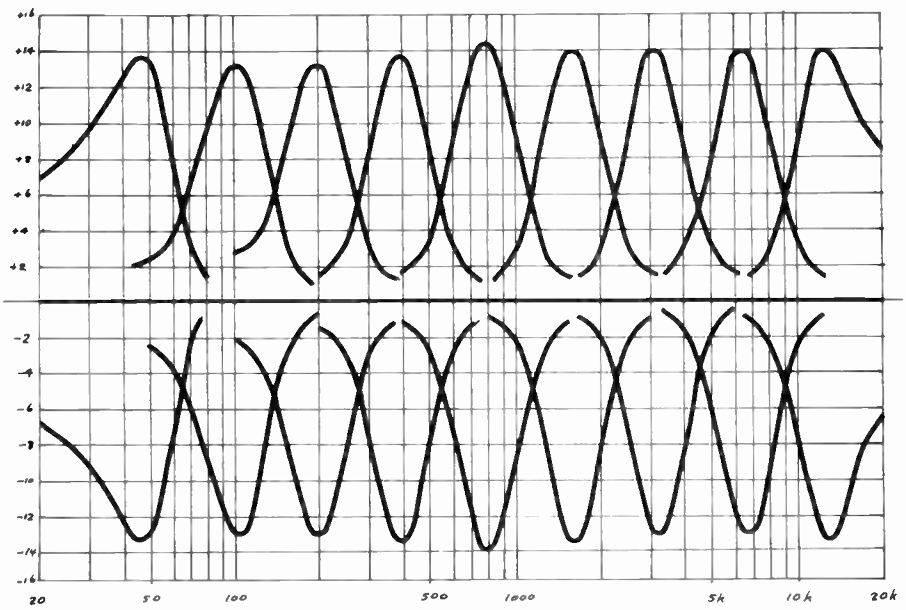


Fig. 5. Individual filter responses for the unit. Boost at top and cut at bottom.

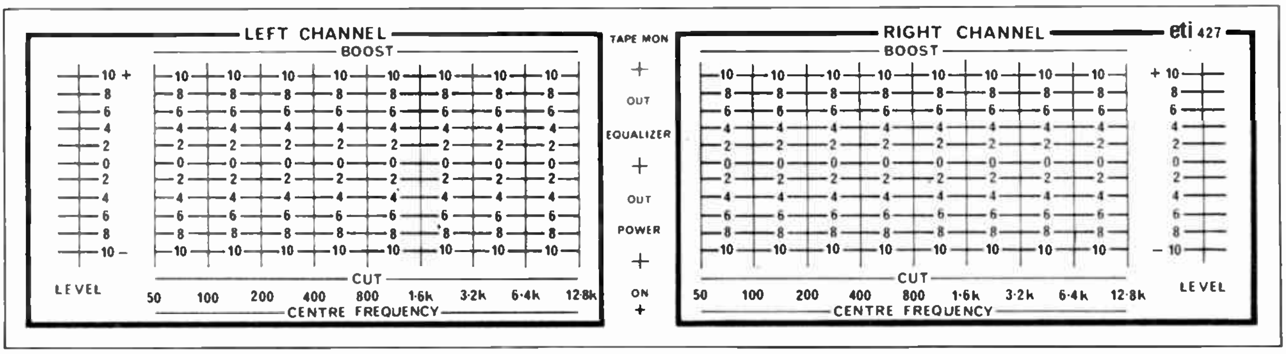
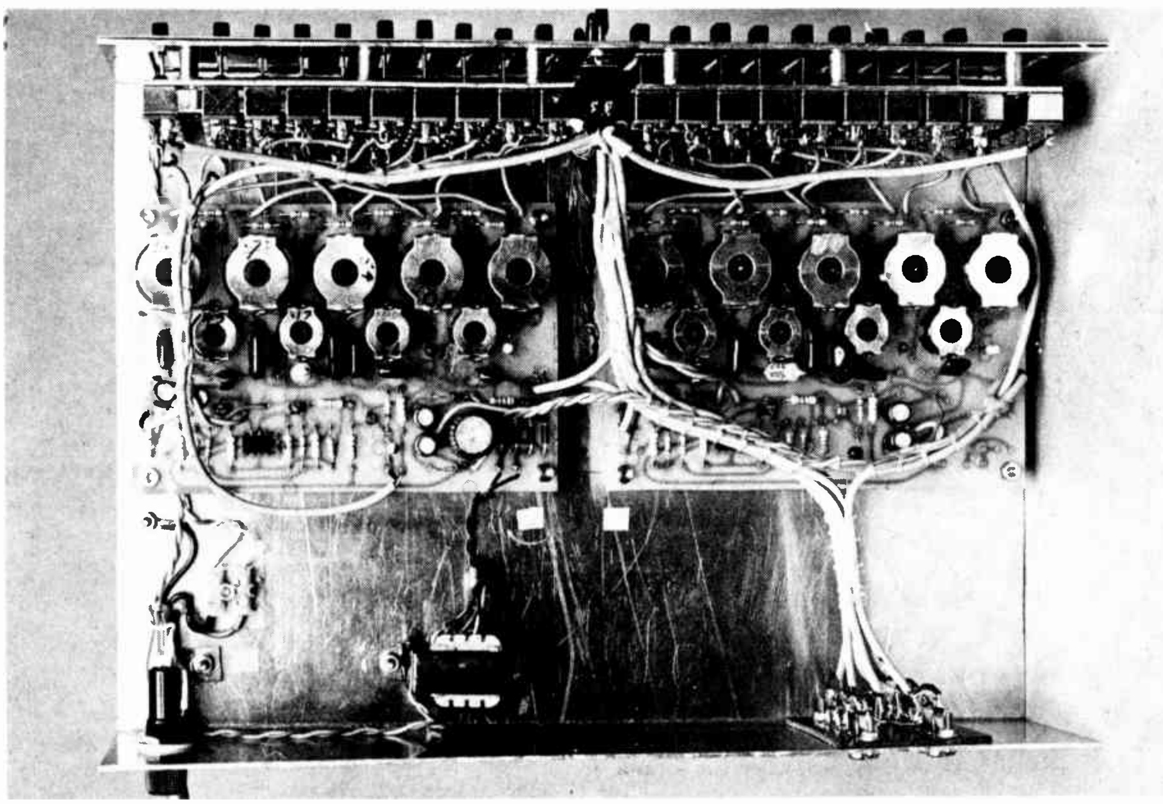


Fig. 6. Front panel artwork for the equalizer. Full size 336 x 88 mm.



Internal layout of the equalizer.

GRAPHIC EQUALIZER

TABLE I. CHOKE WINDING DATA

The types of potcore available at any given time is variable. We have therefore provided winding details for several different cores.

Note that R5 and R6 may alter with certain cores. Part numbers quoted are for Elcoma Ferrite potcores.

Part Nos listed are Philips

Core 4322.022.29120 or 4322.022.29320 (AL = 1600)
Bobbin 4322.021.30330. Clip 4302.021.20020

	Inductance	Turns	Wire Size	Resistance	Notes
L1	3.4 H	1450	0.125 mm	104 ohms	R5 = 270 ohms
L2	1.7 H	1030	0.125 mm	70 ohms	R6 = 330 ohms
L3	0.8 H	700	0.16 mm	30 ohms	
L4	0.4 H	500	0.16 mm	20 ohms	
L5	0.18 H	340	0.16 mm	13 ohms	

Core 4322.022.28090 or 4322.022.28290 (μe = 330)
Core 4322.022.29110 or 4322.022.29310 (AL = 1000)
Bobbin 4322.021.30330 Clip 4302.021.20020

	Inductance	Turns	Wire Size	Resistance	Notes
L1	3.4 H	1800	0.10 mm	180 ohms	R5 = 180 ohms
L2	1.7 H	1280	0.125 mm	90 ohms	R6 = 300 ohms
L3	0.8 H	860	0.16 mm	40 ohms	
L4	0.4 H	630	0.16 mm	28 ohms	
L5	0.18 H	420	0.16 mm	16 ohms	

Core 4322.022.24080 or 4322.022.24280 (μe = 220)
Bobbin 4322.021.30270 Clip 4307.021.20000

	Inductance	Turns	Wire Size	Resistance
L6	100 mH	465	0.125 mm	23 ohms
L7	53 mH	340	0.16 mm	10 ohms
L8	23 mH	225	0.16 mm	6.2 ohms
L9	13 mH	170	0.16 mm	4.5 ohms

Core 4322.022.25100 or 4322.022.25300 (AL = 630)
Bobbin 4322.021.30270 Clip 4307.021.20000

	Inductance	Turns	Wire Size	Resistance
L6	100 mH	400	0.16 mm	12 ohms
L7	53 mH	290	0.16 mm	8 ohms
L8	23 mH	190	0.16 mm	5 ohms
L9	13 mH	145	0.25 mm	1.6 ohms

PARTS LIST – ETI 427

R5	Resistor	270	½W	5%
R6	"	330	½W	5%
R7,8,9	"	390	½W	5%
R10,11,12	"	390	½W	5%
R13,15,18	"	390	½W	5%
R24	"	1.5 k	½W	5%
R1,R4	"	3.3 k	½W	5%
R19	"	3.9 k	½W	5%
R3,22	"	4.7 k	½W	5%
R21	"	12 k	½W	5%
R20	"	27 k	½W	5%
R14,16,17	"	39 k	½W	5%
R2,23	"	100 k	½W	5%

RV1 Potentiometer 50k log 45 mm slide
RV2-10 Potentiometer 1 k lin 45 mm slide
C17 Capacitor 220 μF 63V electrolytic
C13,18,19 Capacitor 25 μF 25V electrolytic
C1,15 Capacitor 10 μF 16V electrolytic
C2 " 3.3 μF 10V tag tant.
C3 " 1.5 μF 25V " "
C4 " 0.68 μF 25V tag tantalum
C6 " 0.39 μF polyester
C7 " 0.22 μF "
C5 " 0.15 μF "
C8 " 0.1 μF "
C9 " 0.047 μF "
C10 " 0.027 μF "
C11 " 0.01 μF "
C12 " 0.0022 μF "
C16 " 0.001 μF "
C14 " 10 pF ceramic
L1-L9 Chokes See table I
Q1,2,3 Transistor BC109, BC549 or similar
D1,2,3,4 Diodes EM401 or similar
ZD1,2 Zener Diode BZX70C15
LED 1 light emitting Diode
IC1 Integrated Circuit LM301A
PC Board ETI 427
For stereo operation double the above components except R24, C17, LED 1, ZD1, ZD2, D1-D4 where only one is required.
Transformer 240V — 36V @ 30 mA PF3787 or similar
SW1,2,3 switch DPDT miniature toggle
4-way RCA socket, 2 off
Chassis to Fig. 6.
Front panel to Fig. 7 and 8.
20 off knobs for slide pots McMurdo D/N 4093 — Black (Isostat)
4 pot support rails (Fig. 9)
12 threaded spacers 9.6 mm long
8 plain spacers 12.7 mm long
24 screws, countersunk head, 6.5 mm long to suit spacers
3 core flex & plug
Cable clamp, grommet, terminal block

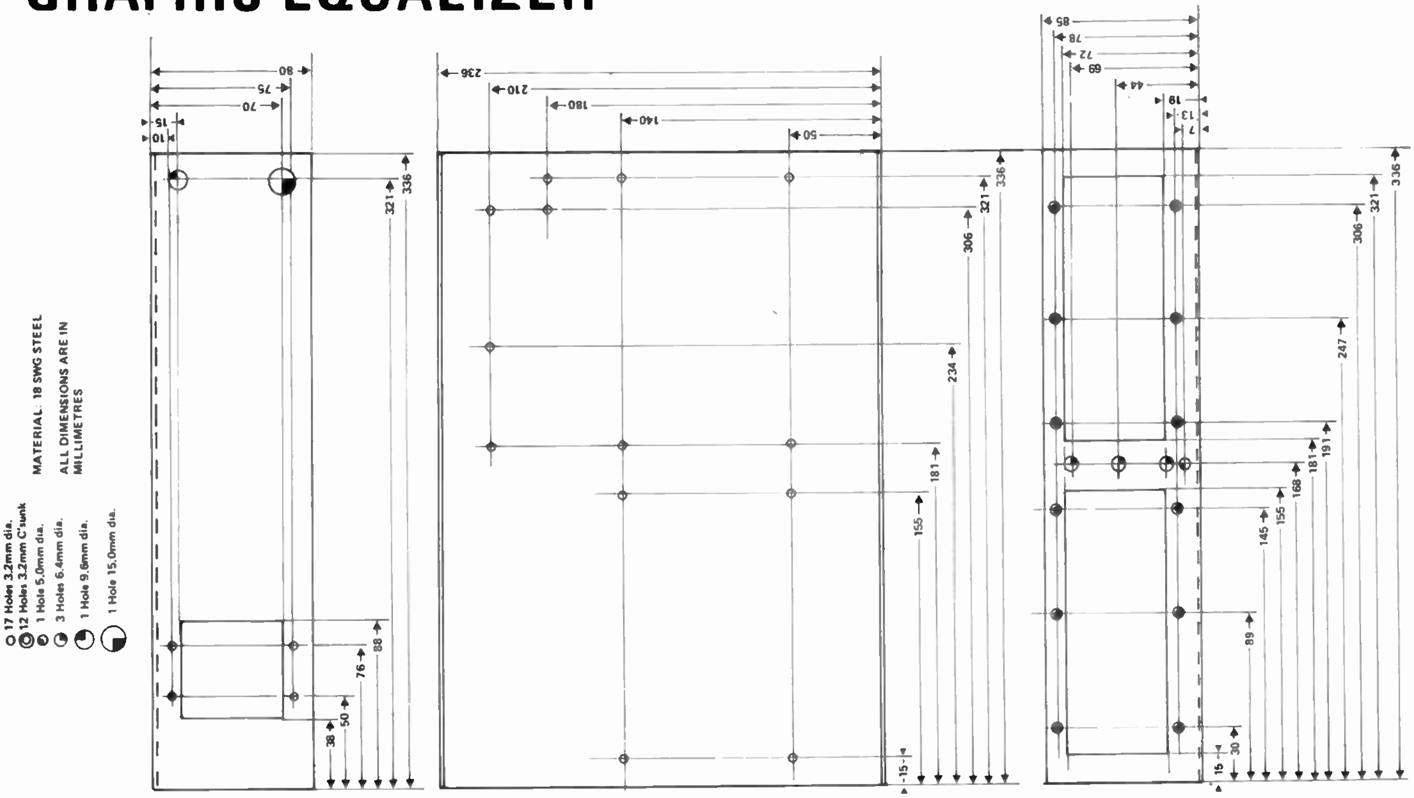


Fig. 7 Detail of the chassis.

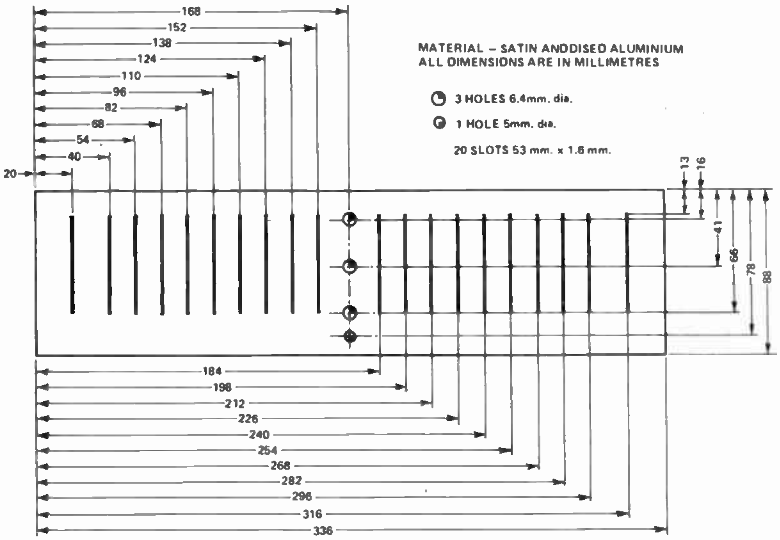


Fig. 8 Metalwork details of the front panel.

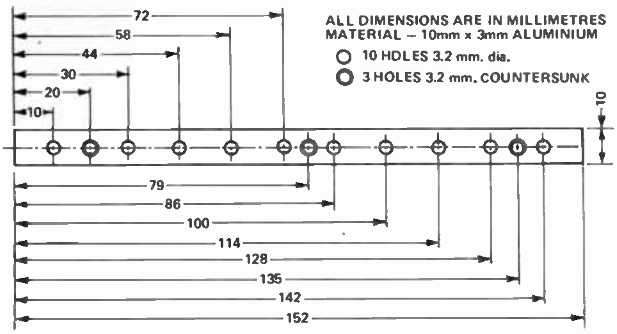


Fig. 9 Drilling details for potentiometer support brackets.

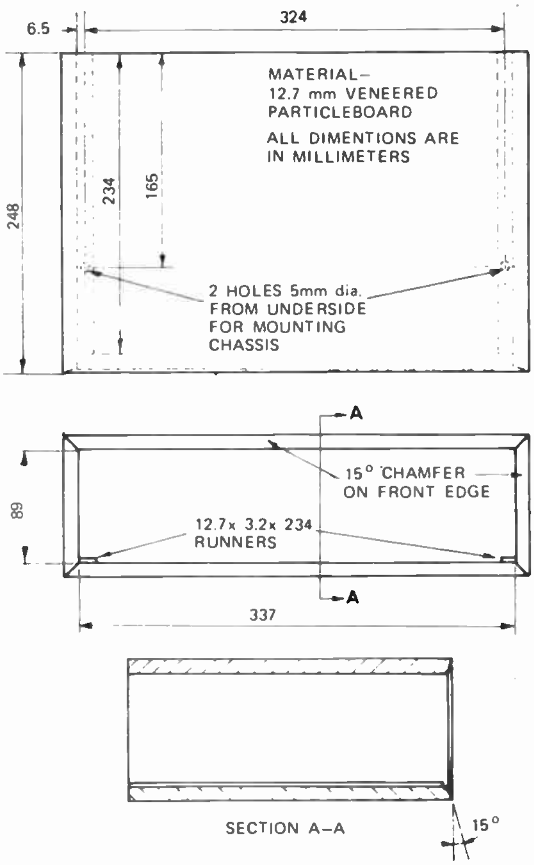
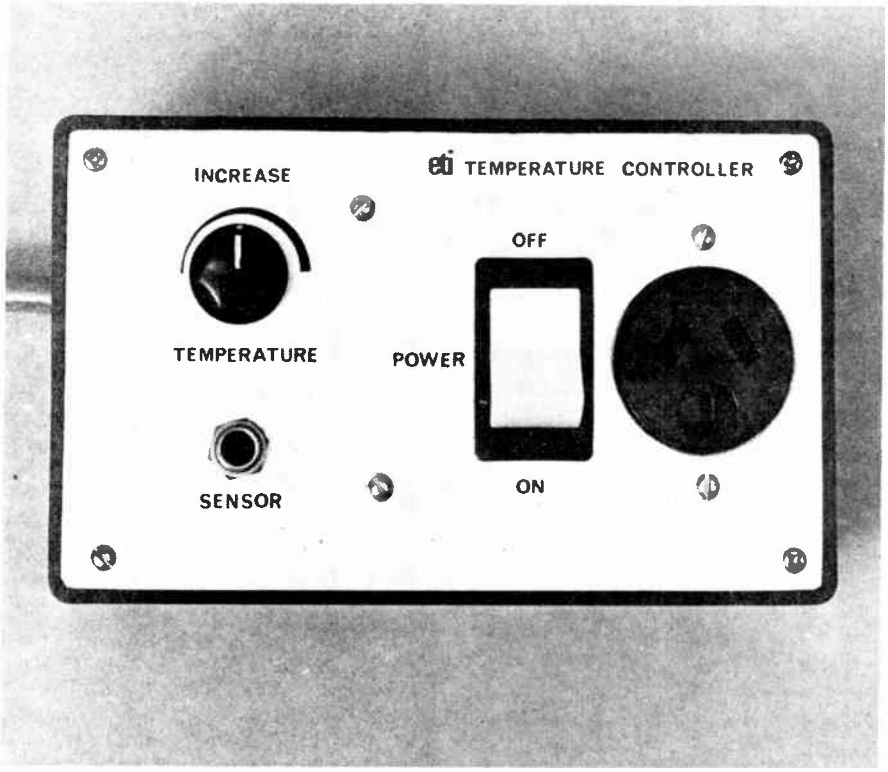


Fig. 10. Constructional details of the cabinet.

TEMPERATURE CONTROLLERS

PROJECT 530



Three temperature controls – phase control, zero crossing (on/off), zero crossing proportional.

MANY scientific experiments depend upon the maintenance of a stable temperature – often, as with pathological specimens, over long periods of time.

Even the cheapest of useable laboratory ovens and water baths must therefore incorporate a controller capable of maintaining temperatures constant to better than 1°C – in fact many will better this by a factor of at least two.

Other applications of temperature controllers include processing of colour film on an industrial scale where large quantities of water must be held to close temperature limits, maintaining air temperature constant in chicken hatching or even just controlling a room heater in the home.

The accuracy required and the heating power necessary will depend very much on the application, and thus there is no such thing as a universal temperature controller. In this article we describe three different temperature controllers which will cover the majority of applications. They are all designed primarily for use with a thermistor as the sensor and all may be constructed on the one basic printed circuit board. They have been specifically designed to operate with an isolated thermistor thus simplifying installation and minimizing risk of shock.

CONTROL METHODS

Temperature controllers may be of two basic types, simple ON/OFF control and proportional control. In the simple ON/OFF controller the heater is ON when the temperature is below the set point, and OFF when the temperature is above the set point.

Unlike the ON/OFF system where full power is applied until the set temperature is reached, proportional control continuously varies the power applied to the heating element (over a small range known as the proportional band see Fig. 1) by an amount depending upon the deviation of the actual temperature from the required temperature.

Solid state controllers – apart from having either ON/OFF or proportional control – may be categorized as using either phase control, or zero-voltage switching techniques.

PHASE CONTROL

Phase control is a technique used to control the average power input to a load by varying the time during which current is allowed to flow in each half cycle of mains supply. This is possible by using a triac (or back to back SCRs) between the load and the mains supply. A triac may be triggered into conduction by a pulse on its gate at any time during the half cycle, and then remains conducting for the remainder of the half cycle. Thus by controlling the time at which the trigger pulse occurs, with respect to the commencement of the half cycle, we may set the power input to the load at any desired level. This is illustrated in Fig. 2.

This type of control, although inherently suitable for proportional control applications, generates large amounts of radio interference, primarily at low and medium frequencies (up to 3 MHz). It seriously affects long and medium wave radio transmissions and may also interfere with audio equipment.

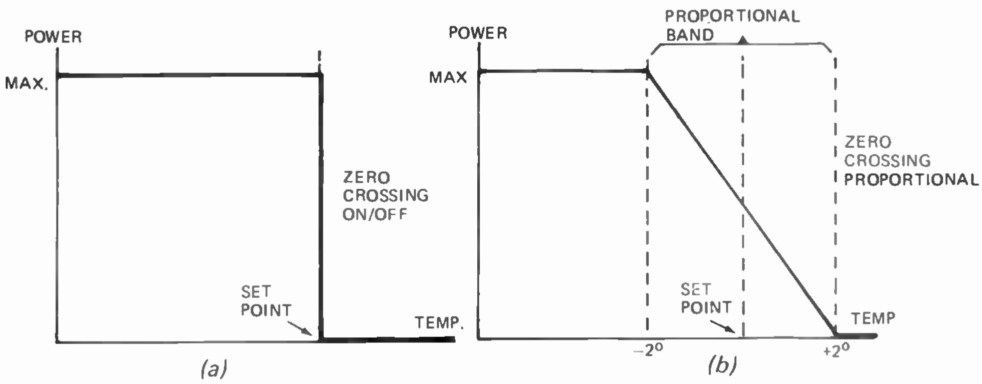
Whilst the extent of RFI may be reduced by filtering, the size of chokes required for large loads – such as heating systems – becomes excessive.

Phase control also introduces another problem – that of bad power factor. This is difficult to compensate for as the power factor changes with control setting. Some supply authorities object to this quite strongly, and others ban phase control completely.

The use of phase control should therefore be restricted to light-load applications requiring only a few hundred watts, even though potentially it is the best control system of all.

ZERO VOLTAGE SWITCHING

Zero voltage switching overcomes most of the problems inherent in phase control systems. The technique differs from phase control in that the supply is switched to the load *only* as the ac waveform passes through zero, eliminating RFI.



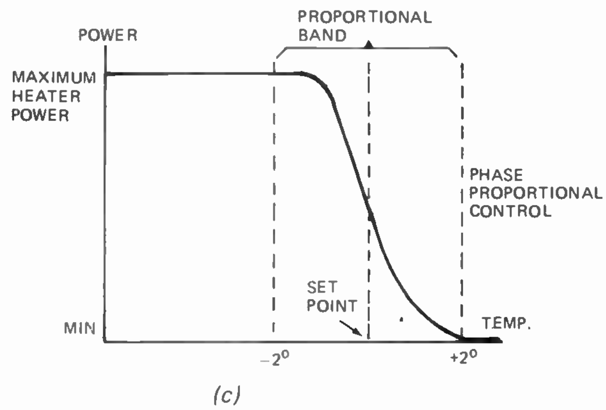


Fig. 1a. In straight on/off control the heater is ON when the load is below the set point temperature and OFF when it is above.
1b. In zero-crossing proportional control the heater power is varied linearly over a small temperature range known as the proportional band.
1c. In phase-proportional control the same proportional band is used but the control curve follows a cosine law. (Power proportional to phase angle of firing point).

In straight ON/OFF zero crossing control the power is switched "ON" when the temperature is below the desired set point and "OFF" when the temperature reaches the set point. Whilst very accurate control is possible with this method, the size of heater must be carefully selected to suit the thermal inertia of the system. Too large a heater will produce large overshoots hence this system should be used only where the load has large thermal inertia, or where the heater is selected to provide only 25% or so more heat (at full output) than is dissipated by the system through losses. In such a system the heater will switch on and off at a fairly rapid rate allowing bursts of complete half cycles to flow. The ON/OFF switching always occurs at the zero crossing point.

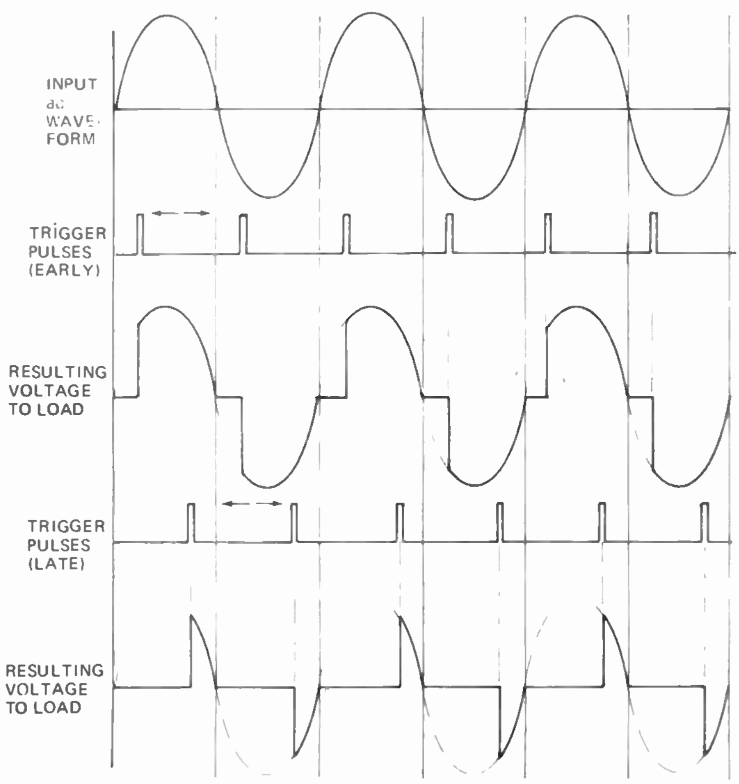


Fig. 2. In phase control the time relationship of the trigger pulse is varied to control the amount of power delivered in each half cycle.

In zero-crossing proportional control the control system varies the amount of power delivered within a set time period, eg 1 or 10 seconds, by sweeping the control voltage over a small range. Using this method the average power delivered by the heater is smoothly varied within the proportional band.

Again the zero-crossing mode ensures that little RFI is generated. The method relaxes the requirement for selection of the heater to a considerable extent but accuracy is not necessarily as good as with straight ON-OFF control.

CONSTRUCTION

Construction of the controllers will vary considerably depending on the application. We built a phase control unit into a box as shown in the photograph. However it may be more practical, where a particular device (oven etc) is to be controlled, to build the electronics into the controlled system.

Most, if not all, of the ICs manufactured for phase or zero-crossing control have the thermistor at mains potential and the thermistor must therefore be insulated in some manner for most applications, this is often quite difficult to do – especially for home constructors, consequently the ETI controller circuits have been designed such that the thermistor is completely isolated from the mains. It is only necessary to protect it with a sheath etc, when used for monitoring such things as liquids.

The triac itself should be mounted on a heatsink. In our prototype we mounted the triac on the front panel. Remember however that the triac must be carefully insulated electrically from the heatsink, and the heatsink triac assembly should be mounted in a cool place.

Pulse transformer T2 may be constructed as per the winding details in Table 4. It is essential that adequate insulation be provided over the ferrite rod (some ferrites are conductive) and between the primary and secondary windings.

Choke L1 is only required in the phase-control circuit and this too must be carefully insulated.

Where a box is used to house the assembly care must be taken to earth all exposed metal surfaces including screws. The mains earth should be secured under a single screw provided for this specific purpose. In our case the mains earth was made direct to the front panel.

Finally take care with the polarization of components on the printed circuit board. Also ensure that reference is made to the *correct* overlay for the type of controller used.

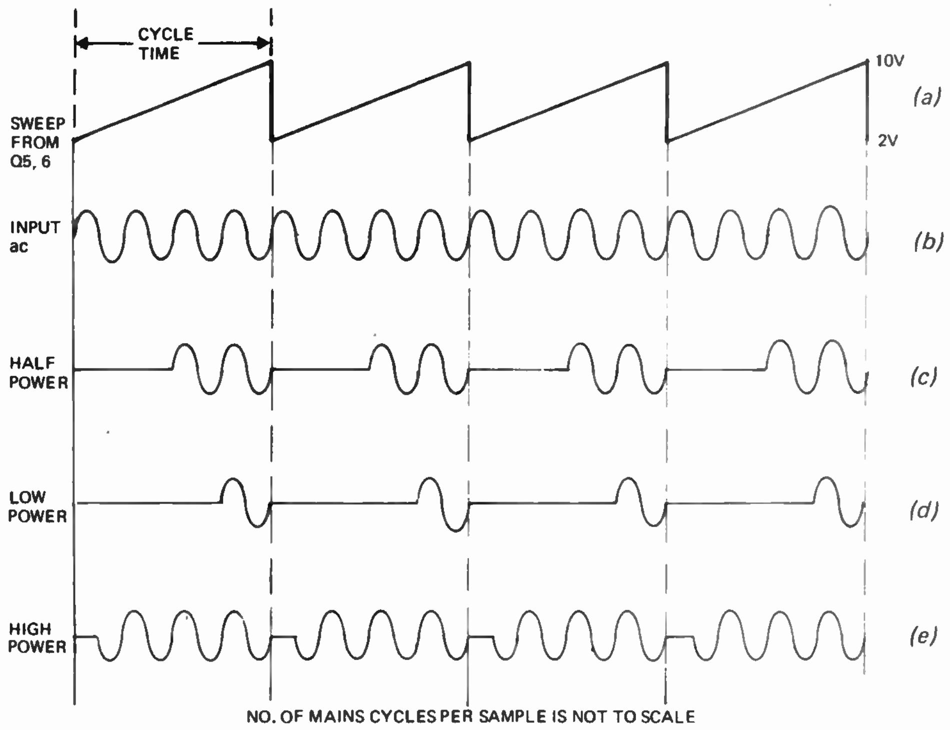


Fig. 3. The sweep voltage (a) is used to obtain a fixed cycle time. When the load has reached a temperature within the proportional band, the controller will vary the number of complete, half cycles within the time period in order to maintain the correct temperature. Note that in a typical system the cycle time may contain 50-500 cycles of mains, not four as shown.

TEMPERATURE CONTROLLERS

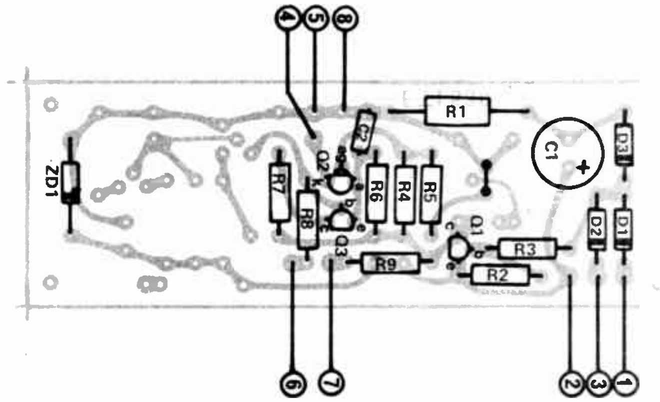


Fig. 5. Component overlay for the zero-crossing controllers. Note that for ON/OFF control some components are not fitted (refer Fig. 4).

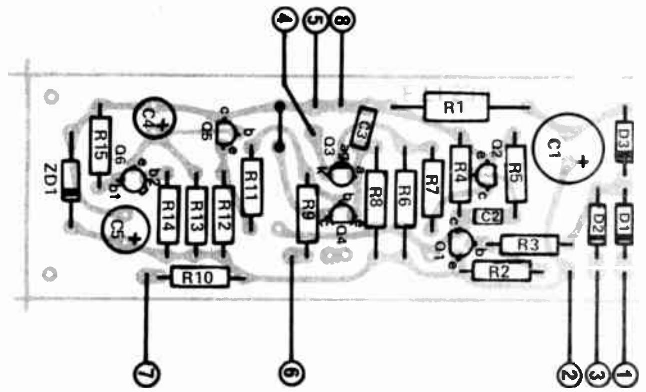


Fig. 6. Component overlay for the phase-proportional controller.

HOW IT WORKS

THERE are three different methods of control.

(a) Zero crossing control.

(b) Zero crossing proportional control.

(c) Phase control.

All three methods use the same power supply and synchronization method, that is the circuitry to the left of Q1. Up to this point only, component numbers are identical for all circuits.

Transformer T1, together with diodes D1 and D2 provide a full-wave rectified 100 Hz that is negative going with respect to terminal 2 of the transformer. This charges C1 via isolating diode D3 to about 21 volts peak (typically 20 volts when loaded). From this supply resistor R1 together with zener diode ZD1 generate a stabilized 15 volts supply for the triggering circuit.

The negative going 100 Hz waveform at the junction of D2 and D3 is applied to divider network R3 and R2. Thus Q1 will be turned on whilst ever its base is 0.6 volts negative with respect to its emitter. Hence at the collector of Q1 a narrow negative going pulse will be generated every 10 milliseconds that is centred around the zero-crossing point of the mains waveform.

ZERO CROSSING CONTROL

The synchronization pulse from Q1 is passed via C1 to the base of Q2. The positive going edge of the pulse turns Q2 on producing a negative going pulse at the collector of Q2. Thus at the junction of R6 and R7 there will be a pulse which drops from 15 to 7.5 volts just after each zero crossing. This pulse is passed to the gate of the programmable unijunction transistor Q3 (PUT). The PUT has the characteristic that it will fire only when the anode is more positive than the gate. Thus the anode must be higher than 7.5 volts if the PUT is to fire. Capacitor C3 is charged via R8 but transistor Q4 does not allow C3 to charge beyond the voltage at the base of Q4 plus 0.6 volts. If C3 does not reach 7.5 volts, therefore, the PUT cannot fire and the heater will be off.

Thermistor TH1 is chosen such that, at the working temperature, its resistance is equal to the combined value of R10 plus RV1 (set at mid point). If the temperature falls the resistance of TH1 will rise and the voltage at Q4 base will rise, and, if the temperature increases the resistance of TH1 drops and the voltage at Q4 base drops. That is the thermistor has a negative temperature coefficient.

Thus the voltage to which C3 is allowed to charge (as clamped by Q4) is dependant on temperature. When the temperature falls below the set more and this voltage at the anode of the PUT will allow the pulse at the gate of the PUT to fire it discharging C3 through the pulse transformer T2 thus in turn firing the triac. The triac continues to fire on each half cycle until the temperature rises above the set point.

Thus the heater will be on when the temperature is below the set point and off when the temperature is above the set point. Additionally switching occurs very close to the zero crossing point of the mains ensuring that little RFI is generated.

ZERO CROSSING PROPORTIONAL CONTROL

In the zero-crossing proportional mode unijunction transistor Q6 produces a sawtooth waveform with a period depending on the value of C4. With 100μF this period will be approximately 10 seconds and with 10μF approximately 1 second. This waveform is buffered by Q5 and then passed via R11 to the base of Q4. The effect of this voltage is to sweep the voltage to which C3 is clamped over a time period selected by C4 and over an amplitude (proportional band) determined by R11. Thus the temperature of TH1 will determine at what point in each sweep the triac turns on. Hence the triac turns on for a number of half cycles in each sweep, that is, for a *time* in each sweep inversely proportional to the temperature sensed by TH1. Switching still occurs at the zero-crossing point and RFI is therefore minimal.

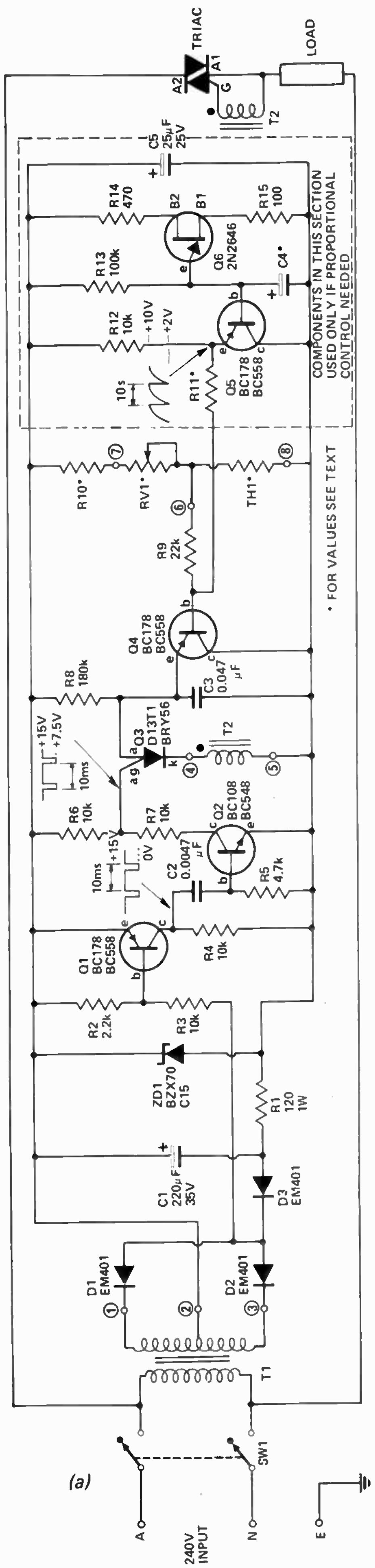
PHASE CONTROL

In the phase control circuit Q1 will turn off for a short period centred around the zero crossing point of the input ac waveform. Thus the voltage at the junction of R4 and R5 will fall to zero at the crossing point and then rise to 7.5 volts for the remainder of the half cycle. Additionally the pulse at the collector of Q1 is fed to the entire timing circuit (including the thermistor) and synchronises firing to the mains.

Capacitor C2 will charge rapidly via Q3 and R7 until the voltage at Q3 emitter reaches 0.6 volts less than that at its base. Capacitor C2 will continue to charge thereafter at a slower rate determined now by R6 (1 to 10 megohm) until such time as the voltage at the anode of the PUT exceeds that on the gate. When this occurs the PUT will fire discharging C2 through the pulse transformer and gating the triac on as before.

Thus the triac will be switched on for a period within each half cycle and this period will be inversely proportional to the temperature sensed by TH1.

This last mode of operation generates radio interference and capacitors C3, C4 and C5 and choke L1 are 'incorporated in the circuit to minimize this'.



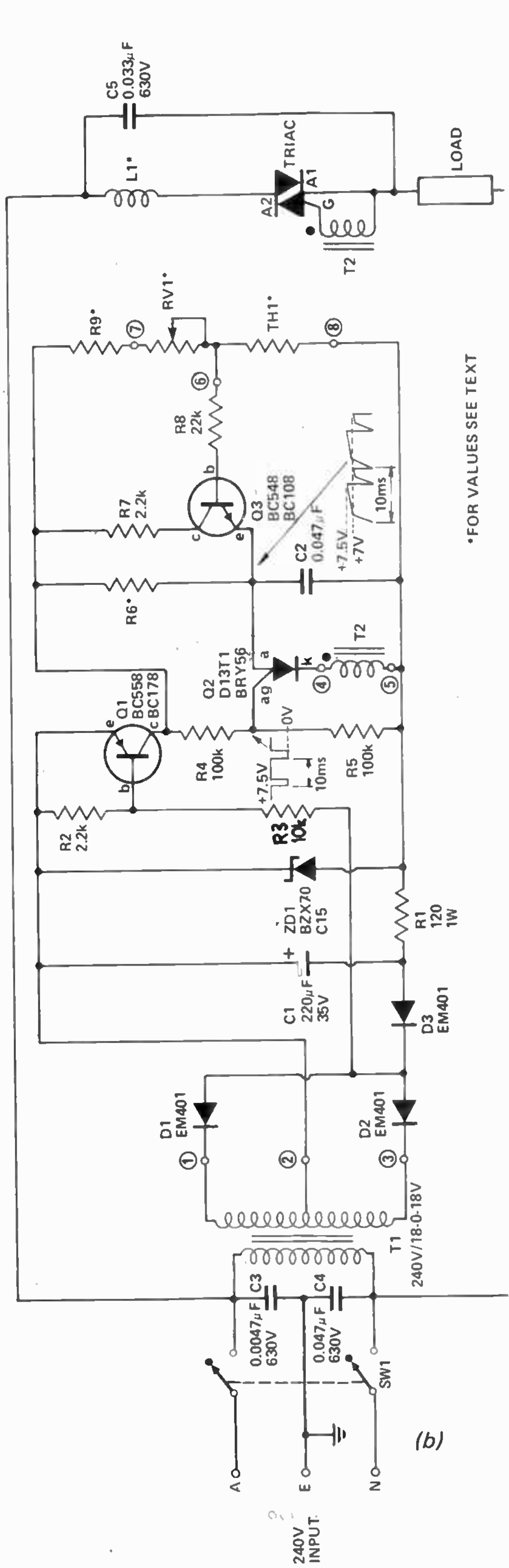


Fig. 4a. Circuit diagram of the zero crossing controllers. Those components within the dotted box are fitted if proportional control is wanted.
4b. Circuit diagram of the phase-proportional controller.

TEMPERATURE CONTROLLER

THE RESISTANCE of a thermistor at any temperature may be calculated from the formula

$$R = Ae^{\beta/T} \quad \ldots\ldots\ldots \quad 1$$

where A = a constant
e = base of Napierian logs (2.718)
β = slope factor
T = temperature deg K.

and from the above resistance versus temperature change.

$$\Delta R = A\,(e^{\beta/T_1} - e^{\beta/T_2}) \quad \ldots\ldots\ldots \quad 2$$

The values of R6 (phase control circuit) and R11 (zero crossing proportional) must be selected to obtain the desired proportional band. These values will depend upon the characteristics of the thermistor used and may be calculated as follows.

Firstly the thermistor should be selected to have a value between 4.7 k and 100 k at the desired working temperature. This value may be found by use of the graphs, if available as shown in Fig. 8, or calculated using equation 1 and the data provided for the particular thermistor. As for example that given in tables 1 to 3.

Resistor R9 (or R10) should be chosen to equal 0.9 of the resistance of the thermistor at the maximum working temperature and R9 + RV1 should equal 1.1 times the resistance of the thermistor at the minimum working temperature.

Having selected a thermistor it is then necessary to determine the resistance change over the desired proportional band.

For example assume we select the 330 k 0.6 watt standard rod type to operate at a working temperature of 70°C and a proportional band of ±2°C.

Then from equation 2.

$$\Delta R_{TH} = 0.25\,(2.718^{\frac{4200}{341}} - 2.718^{\frac{4200}{345}})$$

$$= 7432$$

From equation 1

$$R_{TH} = 0.25\,(2.718^{\frac{4200}{343}})$$

$$= 51979 \text{ ohms}$$

Now we must determine the voltage change at point 6 as follows.

$$\Delta V = \frac{\Delta R_{TH}}{R_{TH}} \times 7.5$$

$$= \frac{7432}{51979} \times 7.5$$

$$= 1.07 \text{ volts}$$

For the phase control circuit we may now calculate R6 from:–

$$R6 = \frac{1.5 \times 10^6}{\Delta V}$$

$$= \frac{1.5 \times 10^6}{1.07}$$

$$= 1.4 \text{ M say } 1.5 \text{ Meg}$$

For the zero crossing circuit we may calculate R11 from:–

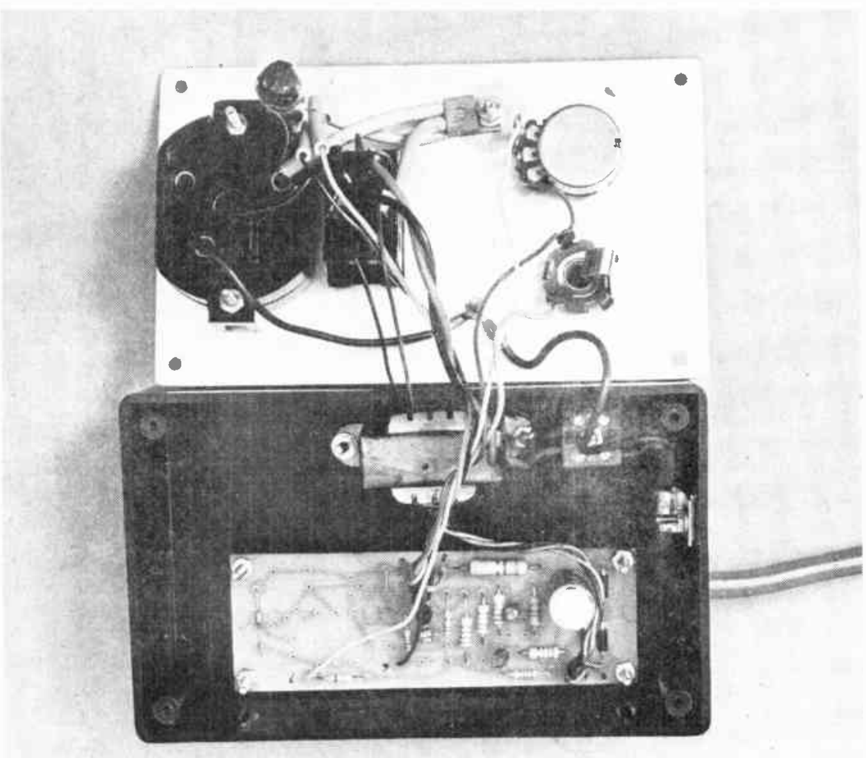
$$R11 = \frac{8 \times (\frac{R_{TH}}{2} + 22\text{ k})}{\Delta V}$$

where R_{TH} and ΔV are as determined above.

$$\text{Thus } R11 = \frac{8\,(25989 + 22{,}000)}{1.07}$$

$$= 358{,}800 \text{ ohms}$$

say 330 k



Internal construction of a typical controller. Note that board is assembled as phase-control version, triac is insulated by mica washer and mounting bush from front panel. Note also pulse transformer is epoxied to front panel at top left.

THERMISTOR SUPPLIERS

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WINDING DETAILS TABLE 4
Pulse Transformer

Former 25mm of 7.0mm or 9.6mm diameter ferrite rod.

Primary 30 turns, single layer close wound of 0.25mm enamelled copper.

Secondary 30 turns, single layer close wound of 0.25mm enamelled copper.

Insulation between primary and secondary and over core – 4 layers of cellulose tape.

Bring out leads for primary and secondary at opposite ends of transformer.

Choke L1

Former 50mm of 8.0mm or 9.6mm diameter ferrite rod.

60 turns single layer close wound of 0.63mm enamelled copper.

Insulate former and over winding with plastic insulation tape.

PARTS LIST – ETI 530 A

Zero Crossing (ON/OFF)

R1	Resistor	120	1 watt	5%
R2	"	2.2k	½ watt	5%
R3,4,6,7	"	10k	½ watt	5%
R5	"	4.7k	½ watt	5%
R8	"	180k	½ watt	5%
R9	"	22k	½ watt	5%

C1 Capacitor 220 μF 35 volt electrolytic
C2 Capacitor 0.0047μF polyester
C3 Capacitor 0.047 μF polyester

D1,2,3 Diode EM401 or similar

ZD1 Zener Diode BZX70C15 or similar.

Q1,4 Transistor BC178, BC558 or similar
Q2 " BC108, BC548 or similar
Q3 " D13T1, BRY56 (PUT)
TRIAC SC146D or similar

T1 Transformer 240/18-0-18 volt PF 3787 or similar

T2 Pulse transformer see text.

SW1 Switch DPST 240 volt ac 10 amp.

R10,RV1, TH1 are selected as detailed in text. Suitable box, heat sink for triacs, outlet socket, nuts, bolts, power cord and plug. Printed circuit board ETI 530 and 4 off 8 mm spacers.

PARTS LIST – ETI 530 B

Zero Crossing (proportional)

All parts for ETI 530 A plus the following.

R11 selected as per text.

R12	Resistor	10 k	½ watt	5%
R13	"	100 k	½ watt	5%
R14	"	470	½ watt	5%
R15	"	100	½ watt	5%

C4 Capacitor selected as per text.
C5 " 25 μF 25 volt electrolytic

Q5 Transistor BC178, BC558 or similar
Q6 Transistor 2N2646 (unijunction)

PARTS LIST ETI 530 C

Phase Control

R1	Resistor	120	1 watt	5%
R2,7	"	2.2k	½ watt	5%
R3	"	10k	½ watt	5%
R4,5	"	100k	½ watt	5%
R8	"	22k	½ watt	5%

C1 Capacitor 220μF 35 volt electrolytic
C2 " 0.047μF polyester
C3,4 " 0.0047μF 630 volt polyester
C5 " 0.033μF 630 volt polyester

D1,2,3 Diode EM401 or similar
ZD1 Zener Diode BZX70C15 or similar
Q1 Transistor BC178, BC558 or similar
Q3 " BC108, BC548
Q2 " D13T1, BRY56 (PUT)
TRIAC SC146D or similar

T1 Transformer 240/18-0-18 volt PF 3787 or similar
T2 Pulse Transformer see text.

L1 Choke (see text)
SW1 Switch DPST 240 volt 2 amp

R6, R9, TH1 and RV1 selected as detailed in text. Suitable box, heat sink for triac outlet socket, nuts, bolts, power cord and plug. Printed circuit board ET1530 and 4 off 8mm spacers.

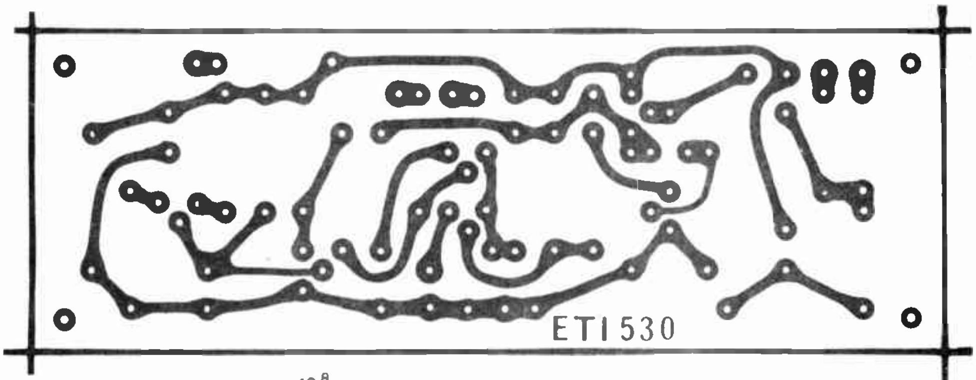

Fig. 7. (Above) Printed circuit board, common to all controllers described, has full size dimensions of 120 x 41 mm.

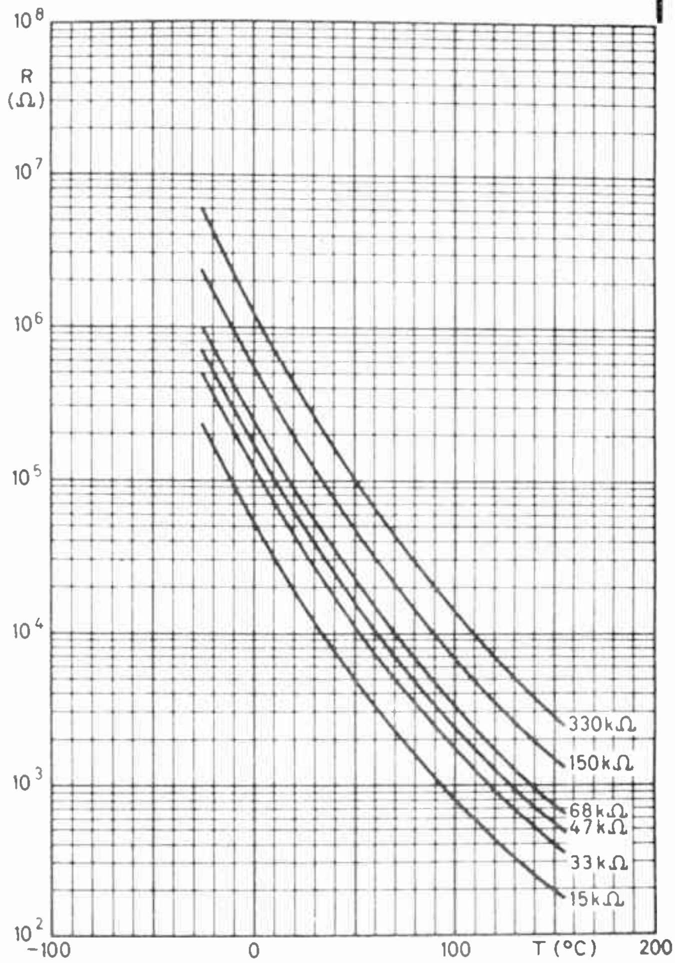

Fig. 8. These graphs show the resistance versus temperature characteristics for the standard disc type of thermistor detailed in Table 3.

THERMISTORS

TABLE I

STANDARD ROD TYPE (0.6 watt)
Operating temp – –25°C to +150°C

R(25°C)	β	A
15 k	3550	0.1
47 k	3925	0.089
150 k	4075	0.173
330 k	4200	0.25

TABLE II

STANDARD ROD TYPE (1.5 watt)
Operating temp –25° to +150°C

R(25°C)	β	A
15 k	3550	0.1
47 k	4000	0.7
150 k	4150	0.134

TABLE III

STANDARD DISC (0.5 watt)
Operating temp –25° to +125°C

R(25°C)	β	A
15 k	4375	0.0063
22 k	4200	0.017
33 k	4250	0.021
47 k	4325	0.023
68 k	4375	0.029
100 k	4400	0.039
150 k	4600	0.030
220 k	4650	0.037
330 k	4700	0.047

Above are most commonly available types from Philips suitable for operation up to +150°C. For some applications small glass types, are available, not detailed here, which work at temperatures up to 300°C. These may be more suitable for some applications but are difficult to obtain.

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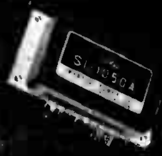

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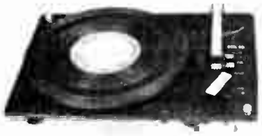

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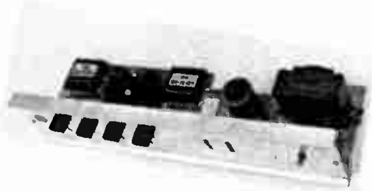

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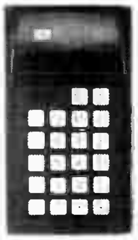

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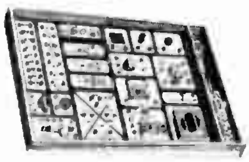

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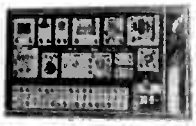

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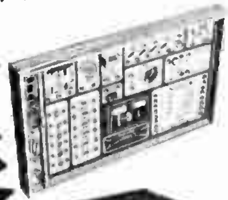

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STEREO FM

Music Broadcasting Society transmit stereo FM — Trevor Jarvie reports.

VISITORS to the High Fidelity Industry Association's audio show '75 SOUNDS FANTASTIC, in Sydney last month, heard stereophonic FM radio for the first time in Australia.

Beginning on August 13th and continuing for five days, the Music Broadcasting Society of NSW transmitted programmes of classical and popular music within the Centrepoint complex in the city, using transmitters designed and constructed by its Technical Committee.

The Society plans to establish an independent, non-profitmaking stereo FM radio station specialising in classical music in Sydney before the end of this year: the transmitters used for the demonstration broadcasts will be the heart of this radio station.

Since 1961, after the Radio Frequency Allocations Review Committee (the Huxley Committee) recommended that the VHF radio bands be used for the expansion of the Australian television service, the international FM band (88-108 MHz) has been unavailable for radio purposes in this country. Earlier this year, however, an independent commission of inquiry chaired by Sir Francis McLean recommended that the band be freed progressively so that an FM radio service could be developed. The McLean Commission also recommended that a limited service begin as soon as possible in those areas where there would be no likelihood of interference with the present television service.

In Sydney, the only part of the 88-108 MHz band which is currently available for FM is 92-94 MHz, since television channels 3, 4 and 5 (85-92 MHz, 94-101 MHz and 101-108 MHz respectively) are in use in the adjacent areas of Newcastle and Wollongong. The exhibition broadcasts were therefore transmitted at 93.0 and 93.8 MHz (the 0.8 MHz between the transmissions being the internationally accepted minimum at the present time). With an effective radiated power of 250 milliwatts, each out of two quarter-wave ground-plane aerials, the transmissions were received with good strength throughout the Exhibition area, and in some instances could be detected more than a block from the Centrepoint building.

Permission for this historic demonstration of the capabilities of stereo FM was obtained from the Australian Post Office, which presently administers 92-94 MHz, and the Australian Broadcasting Control Board. The development and control of the FM bands has in recent months become the subject of some controversy, and the question of the ultimate authority over the

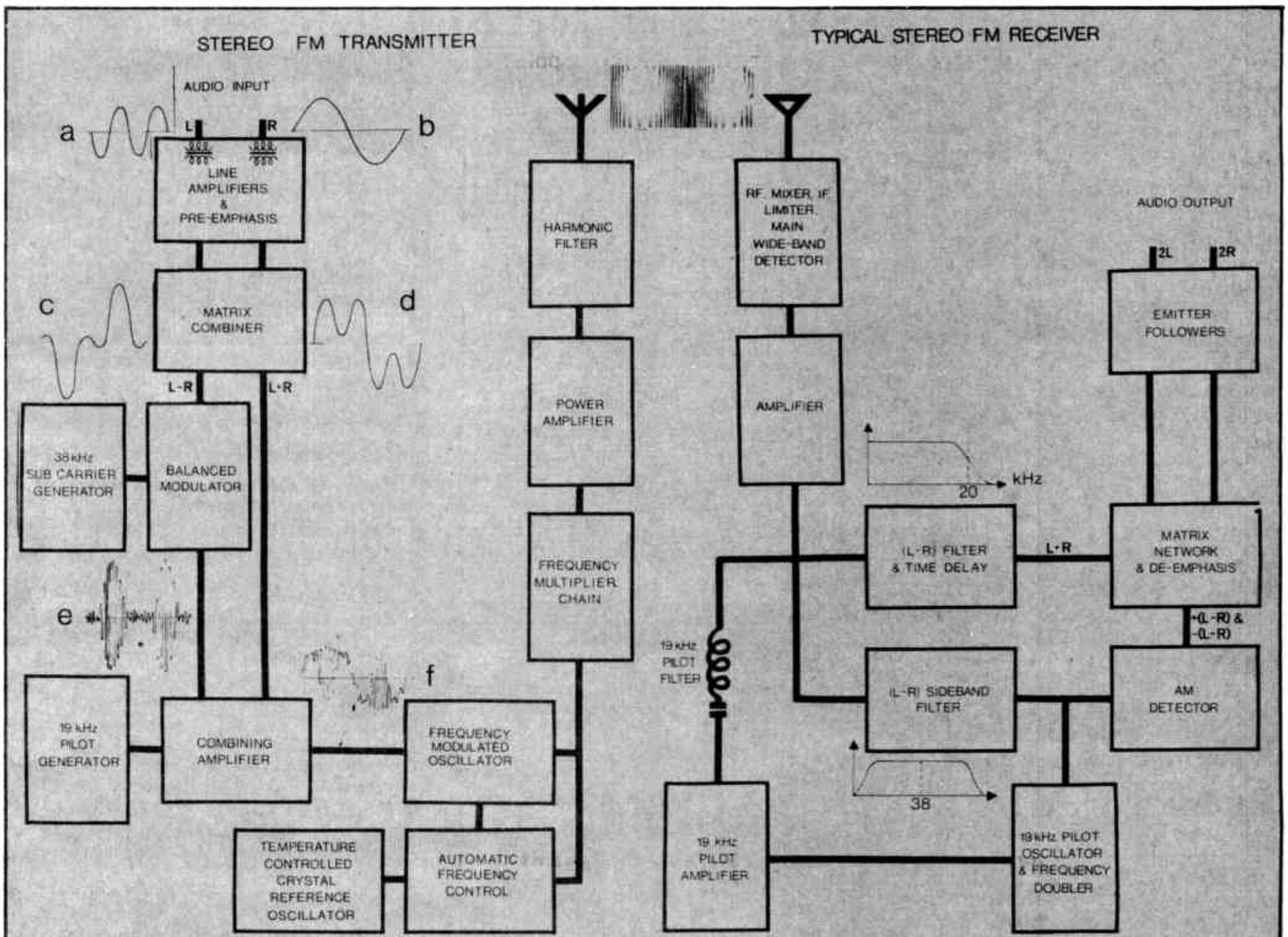

Fig. 1. Block schematic of the society's FM transmitter — and a typical FM stereo receiver.

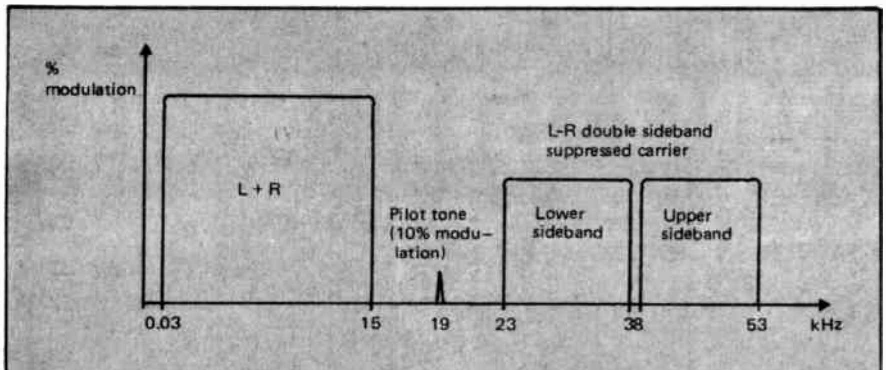

Fig. 2. The encoded stereo signal frequency modulated and ready for transmission.

introduction of FM has yet to be resolved. In a study recently completed by the Australian Government's Priorities Review Staff, wide-ranging proposals for the reconstitution of the Broadcasting Control Board and the shift of ministerial responsibility for broadcasting to a committee of ministers under a "central, non-specialist minister" were made. The Music Broadcasting Societies of NSW and Victoria and some other independent groups are seeking to establish FM radio services on an *experimental* basis until the bureaucratic and political structures are sorted out.

TRANSMITTING STEREO FM

For stereophonic broadcasting from a single transmitter, a means must be found of encoding two channels of information at the transmitter, and broadcasting them in such a way that they can be recovered at the receiver. In addition, the transmission system should provide a compatible monophonic signal for reception by radios that do not have stereophonic capability. The G.E./Zenith "pilot tone" system, developed in the late 'Fifties and now internationally accepted, fulfils both these requirements for FM radio and is the system chosen for Australia.

With the pilot tone system, the two audio-frequency stereo signals (L and R), after amplification and *pre-emphasis* (boosting the transmitted high frequencies to improve treble signal-to-noise ratio), are fed into a *matrix combiner*. Here, the stereo L and R signals are combined to produce a *sum signal* (L + R) and a *difference signal* (L − R) (Fig. 1 a-d). The difference signal is then applied to a *balanced modulator*, which creates a double sideband, suppressed carrier, amplitude modulated signal with a centre frequency of 38 kHz (Fig. 1e). In the Society's prototype transmitters, this function was performed using a switching method with a balanced modulator IC (UA 796) in preference to a diode bridge.

The audio-frequency (L + R) signal, the amplitude modulated (L − R) sidebands, and a 19 kHz "pilot tone" (derived, like the 38 kHz balanced modulator frequency, from a 1.9 MHz crystal oscillator) are combined to form the encoded stereo signal which is then frequency modulated for transmission (Figs. 1f and 2). Frequency modulation was achieved in the 93.0 MHz transmitter by modulating the frequency of a 10.333 MHz (93 ÷ 9) LC oscillator, and subsequently multiplying the frequency using two tripler stages. At the lower frequency it was judged easier to achieve good natural frequency stability. A temperature-controlled crystal reference oscillator was also used in this stage. The signal after multiplication was amplified and passed through a harmonic filter before transmission.

AT THE RECEIVER

A monophonic receiver "sees" only the frequency modulated *sum* component of the stero encoded transmission (which corresponds to a mono signal), detects and broadcasts it.

A stereo receiver, after the detection stage, separates out the three components of the encoded signal (L + R audio, 19 kHz pilot tone and L − R sidebands). The pilot tone is then doubled in frequency in the receiver and added to the (L − R) sidebands. The resulting double sideband AM signal, its carrier component (which was removed in the balanced modulator of the transmitter) restored, can now be detected, and difference signals (positive and negative) at audio frequencies obtained. These are fed into a matrix together with the sum signal, and the original L and R audio information is regenerated:

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

De-emphasis is also achieved at this stage.

WHAT NEXT?

The success of these first demonstration broadcasts by the Music Broadcasting Society of NSW may be gauged by the fact that every exhibitor at the audio show with tuners on display had a constant stream of listeners tuning in to stereo FM. The total design and execution of the transmitters was achieved within the three months' period projected by the Society's Technical Committee in evidence to the McLean Commission: in fact, the second transmitter was constructed in a matter of days! In the next three months, the Society's attention will be turned to the construction of a fully operational 1 kW e.r.p. stereo FM radio station giving Sydney-wide coverage of serious music programmes, owned and financed by interested listeners themselves. ●

SPECIFICATIONS OF MUSIC BROADCASTING SOCIETY'S STEREO FM TRANSMITTER

TRANSMITTER SPECIFICATIONS

Operating frequencies: 93.00 and 93.80 MHz ±0.001%
Peak frequency deviation: ± 75 kHz
Frequency response: 30 Hz to 15 kHz ± 1 dB
Pre-emphasis time constant: 50 microseconds
FM noise: −65 dB
AM noise: > 50 dB
Harmonic distortion: < 0.25% at peak deviation
Channel separation and crosstalk conforming to C.C.I.R. standards
Output power: 250 milliwatts
Aerial: $\frac{\lambda}{4}$ ground plane

HAM RADIO SUPPLIES

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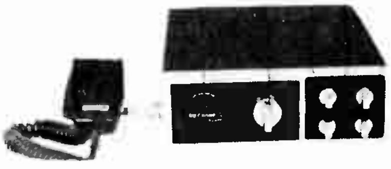
The words "PMG approved type" in our advertisements do not mean that this equipment is covered by a PMG licence. But the equipment is of a type approved for licence application. Individual purchases of radio receiving and transmitting equipment must obtain a licence to operate from the PMG radio branch in their particular state.
Some equipment sold by us cannot be licensed and therefore can only be operated by licenced amateurs.

SIGNED
K.J. MILLBOURN



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High-gain single sideband or A.M. 23 channel. Transceiver, 5 watts A.M., 15 watts P.E.P. sideband, all channel crystals included. ANL, noise blanker, PTT. mike, 12volt D.C. operation, R.F. output and "S" meter with provision for external receiver VFO control.

KEN KP-202 2W, 144 MHz band. FM. Hand held transceiver with crystals for 4 channels provision for 6 channels.

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KCP/2 NICAD battery charger & batteries.

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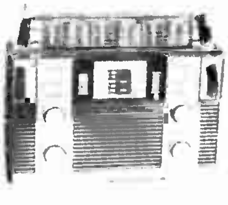

a truly portable communications receiver, based on the WADLEY LOOP principle, the same principle as applied in the DELTAHET and RACAL receivers. A truly crystal-controlled highly sensitive multiple-heterodyne portable receiver of exceptional stability with continuous, uninterrupted coverage from 500 kHz to 31MHz.
BARLOW-WADLEY XCR-30 features include: Selectable USB/LSB, CW & AM reception, frequency read-out 10kHz throughout the entire range, calibration accuracy within 5kHz, antenna resonator, tuning signal-strength meter, zero-set control, clarifier-vernier tuning, MHz & kHz tuning controls, telescopic antenna. Power source: 6 type D dry cells: provision for external DC power supply. Weight 9 lbs; size 11½ x 7½ x 4in.

All for $225.00

KENWOOD/TRIO TS 520 5 BAND SSB TRANSCEIVER

SP520 — TS520 — VFO520

Specifications
Frequency Range: 80 meter band — 3.50 to 4.00 MHz; 40 meter band — 7.00 to 7.30 MHz; 20 meter band — 14.00 to 14.35 MHz; 15 meter band — 21.00 to 21.45 MHz; 10 meter band — 28.00 to 28.50 MHz, 28.50 to 29.10 MHz, 29.10 to 29.70 MHz; WWV — 10.00 MHz.
Mode (Receive only) USB, LSB, CW.
Input Power: 160 watts on 80 to 15 meter band, 140 watts on 10 meter band.
Antenna Impedance: 50 to 75 ohms, unbalanced.
Carrier Suppression: 40 dB.
Unwanted Sideband Suppression: 40 dB.
Harmonic Radiation — 40 dB.
AF Response: 400 to 2,600 Hz (−6 dB).
Audio Input Sensitivity: High impedance (50kΩ) 0.5 μV for 10 dB (S+N)/N on 80 to 15 meter band. 1.0 μV for 10 dB (S+N)/N on 10 meter band.
Selectivity: SSB: 2.4 kHz (−6 dB), 4.4 kHz (−60 dB), CW: 0.5 kHz (−6 dB), 1.5 kHz (−60 dB), (with optional CW filter).
Frequency Stability: 100 Hz per 30 minutes after warm-up.
Image Ratio: 50 dB.
IF Rejection: 50 dB.
AF Output Power: 1 watt (with 8 ohms load and 10% H.D.)
AF Output Impedance: 4 to 16 ohms (Speaker or Headphone).
Tube and Semiconductor Complement: 3 tubes (2 x S2001, 12BY7A), 1 IC, 18 FET's, 44 transistors, 84 Diodes.
Power Requirements: 120/220VAC, 50/60 Hz; Transmit: 280 watts; Receive: 26 watts (with heater-off) or 13.8 VDC; Transmit: 15 Amp; Receive: 0.6 Amp.
Dimensions: 333 (13.11) wide x 150 (5.91) high x 335 (13.19) deep mm (inch).
Weight: 16 kg (35.2 lbs).

Nett. amateur prices

TS 520 $543.00, VFO 520 $91.00, SP 520 $22.40.

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Trio QR666 general coverage communications receiver solid state 550 kHz — 30 MHz 6 bands.

Price $296

Trio TR72009 144 MHz band car transceiver 12volt. **$217.00.** Please send S.A.E. for information on above items.

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Trio Model 9R59DE, four bands covering 540 kHz to 30 MHz., two mechanical filters for maximum selectivity, product detector for SSB reception, large tuning and bandspread dials for accurate tuning, automatic noise limiter, calibrated electrical bandspread. S meter and BFO, 2 microvolts sensitivity for 10 dB. S—N ratio.

AT NEW REDUCED PRICES **$145**
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SOLID STATE 19 TRANSISTOR MULTI-BAND RADIO — 9 RANGES

$79

AM, SW, FM, VHF, AIR, PB BATTERY/ELECTRIC COLOUR CODED 9 BAND DIAL

1. AM 535 to 1600 kHz, 2. Marine 1-5 to 4 MHz, 3 & 4. combined SW 4 to 12 MHz, 5. 30 to 50 MHz, 6. 88 to 108 MHz, 7, 8 & 9 combined VHF Aircraft 145 MHz-174 MHz incorporating weather band.
Slider controls, Dial light, Fine tuning control, Flip-up Time Zone map, Telescope antennas complete with batteries and AC cord.
$79.00 p.p. $1.40

AM/FM/AIR-PB-WB SOLID STATE RADIO

VHF MONITOR

battery electric

$37.50

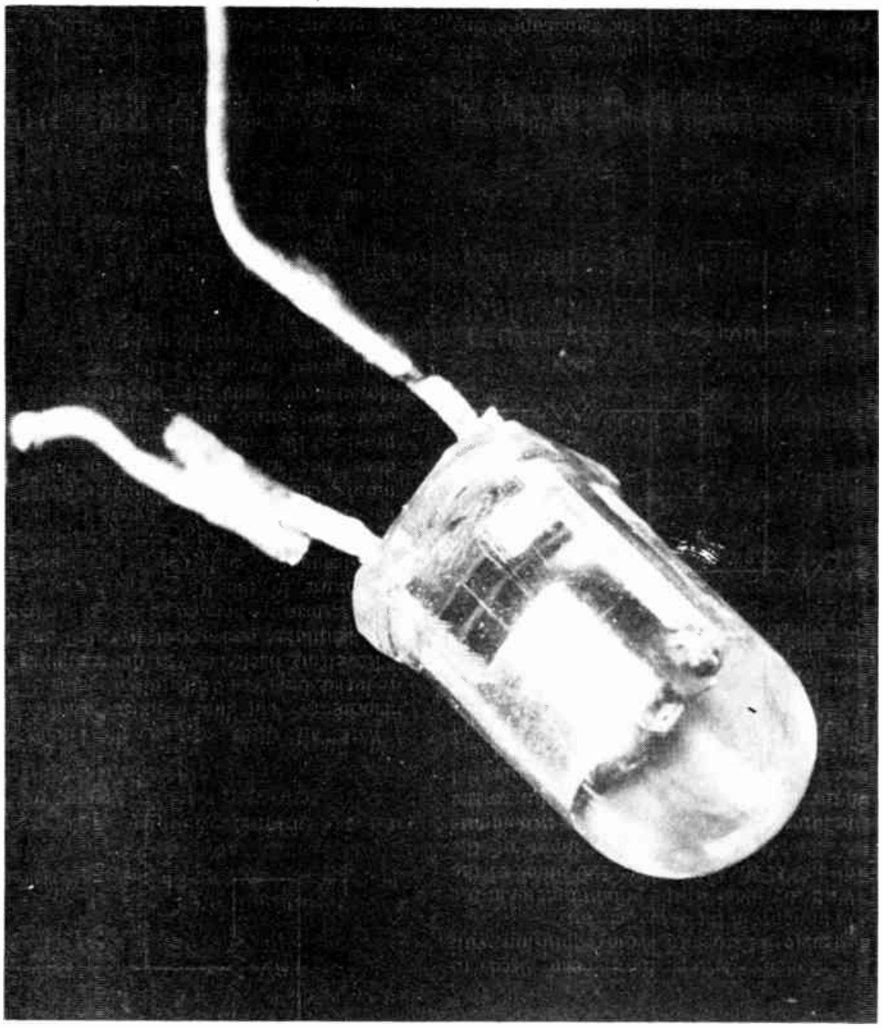
SPECIFICATIONS

Transistor: 12 Transistor, & 8 Diode; Frequency: FM 88-108 MHz, AM 540-1600 kHz, AIR-PB108-174 MHz; Power Output: Maximum 500 mW, Undistorted 280 mW; Speaker: 3" 8 ohms; Earphone: Magnetic 8 ohms; Power Source: DC 6V UM-2 x 4 pcs. or AC 230 Volt; Antenna: Ferrite bar for AM, Rod antenna for FM/AIR-PB-WB; Controls: Volume (w/on-off switch); Selector (AM/FM/AIR-PB-WB); Accessories: Earphone & batteries; Dimensions: 3 3/8" x 6¾" x 9¾"; Weight: Approx. 3 lb.

MODEL NC-310 DE LUXE 1 WATT 3 CHANNEL C.B. TRANSCEIVER

- WITH CALL SYSTEM
- EXTERNAL AERIAL CONNECTION

SPECIFICATIONS, NC-310
Transistors: 13
Channel Number: 3, 27.24 OMHz Citz. Band
Transmitter Frequency Tolerance: ±0.005%
RF Input Power: 1 Watt
Tone Call Frequency: 2000 Hz
Receiver type: Superheterodyne
Receiver Sensitivity: 0.7μV at 10 dB S/N
Selectivity: 45 dB at ±10 kHz
IF Frequency: 455 kHz
Audio Output: 500 mW to External Speaker Jack
Power Supply: 8 UM-3 (penlite battery)
Current Drain: Transmitter: 120-220mA
Receiver: 20-130mA.
Price $49.50 per unit or $99.00 pair



One lead is positive – the other negative – here's how to tell which is which.

LED CONNECTIONS

LIGHT emitting diodes (LEDs) are extensively used in electronics as replacements for incandescent indicator lamps. They have much longer life, are smaller and have relatively high efficiency. However, unlike their incandescent counterparts, they only light with the correct polarity of drive voltage. In fact, they may be damaged by connecting them the wrong way around because their reverse – breakdown voltage is typically only 3 volts.

Thus it is essential to identify the leads of the device (cathode and anode). But this is difficult, as each manufacturer has a wide range of LEDs having different shapes and sizes, and there are even more different methods of marking the leads than there are manufacturers.

To assist the constructor we have made a survey of the currently available red indicator LEDs. The various shapes and methods of lead identification are detailed in Fig.1.

IDENTIFYING TERMINALS

To identify the terminals of an LED that is not shown in Fig. 1 it is necessary to apply a voltage and see if the lamp lights.

When positive voltage is applied to the anode (with respect to the cathode) the lamp will light. However it is essential to use a method which will not damage a lamp connected in reverse. Hence the applied voltage must be limited to 3 volts and the forward current limited to 50 mA. The following three methods will test LEDs and determine lead polarity without risk of damage.

The simplest method is to use a multimeter, on its lowest ohm range, as a voltage source. Do remember that the black or negative lead of the multimeter is in fact at the most positive voltage. Thus, when the polarity of lead connection which causes the LED to light dimly is found, the anode of the LED is that lead to which the black lead of the multimeter is connected.

The circuit of Fig.2a may also be used, where two 1.5 volt batteries and a 33 ohm resistor (all in series) are used to drive the lamp. Again the LED will light when the most positive voltage is connected to the anode.

In the last mentioned method, the applied voltage is not high enough to damage the LED when the leads are reversed. If higher test voltages must be used the circuit of Fig. 2b will be found suitable. The four series diodes across the LED, will be forward biased and, will limit the applied voltage to 2.8 volts, (0.7 volts per diode) thus preventing damage under reversal.

Any of the above methods may be used to determine LED lead connections and to detect faulty devices.

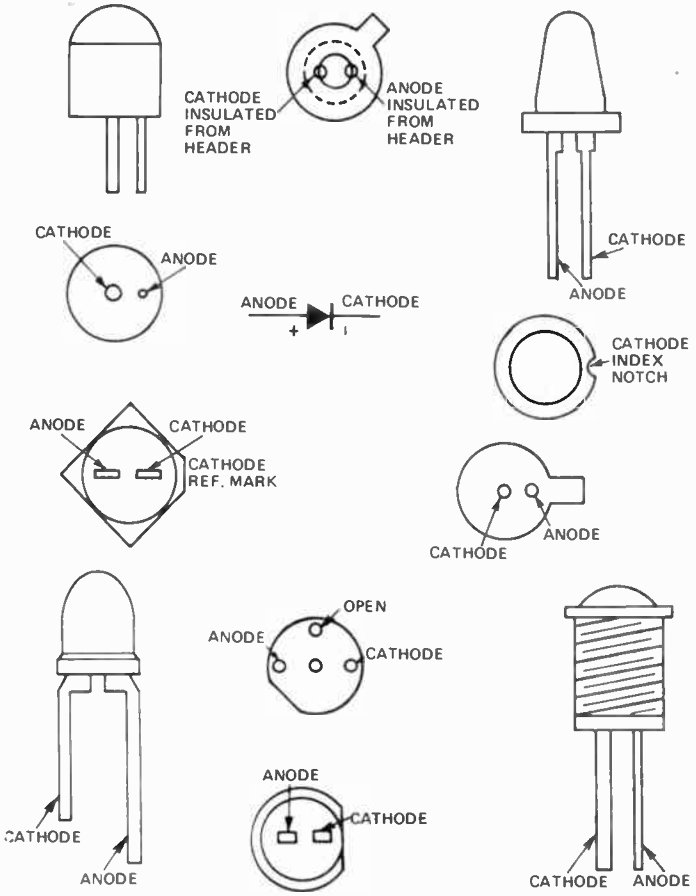


Fig. 1. Common lead connections for LED indicator lamps.

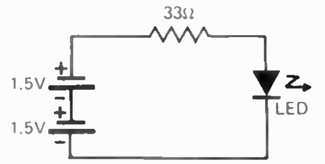


Fig.2a. Method of determing LED connections using two torch cells and a resistor.

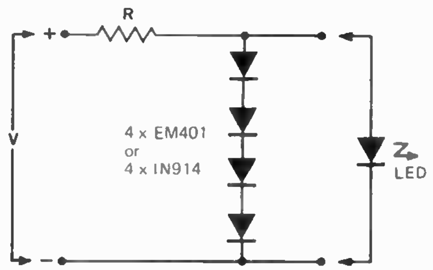


Fig.2b. Higher test voltages may be used providing that diodes are used, as shown, to limit the voltage applied to the LED. The resistor R should be selected as shown below.

V = 5 volts	*R = 82Ω*	*¼ watt.*
V = 6 volts	*R = 100Ω*	*¼ watt*
V = 12 volts	*R = 220Ω*	*½ watt*

TYPICAL LED CHARACTERISTICS

Power dissipation	200 mW
Continuous current	50 mA
Peak current	3-5 A
Forward volts drop	1.6 V
Reverse breakdown	3.0 V

Typical characteristics of red LEDs, does not apply to yellow or green LEDs nor to lamps designed for TTL or MOS drivers.

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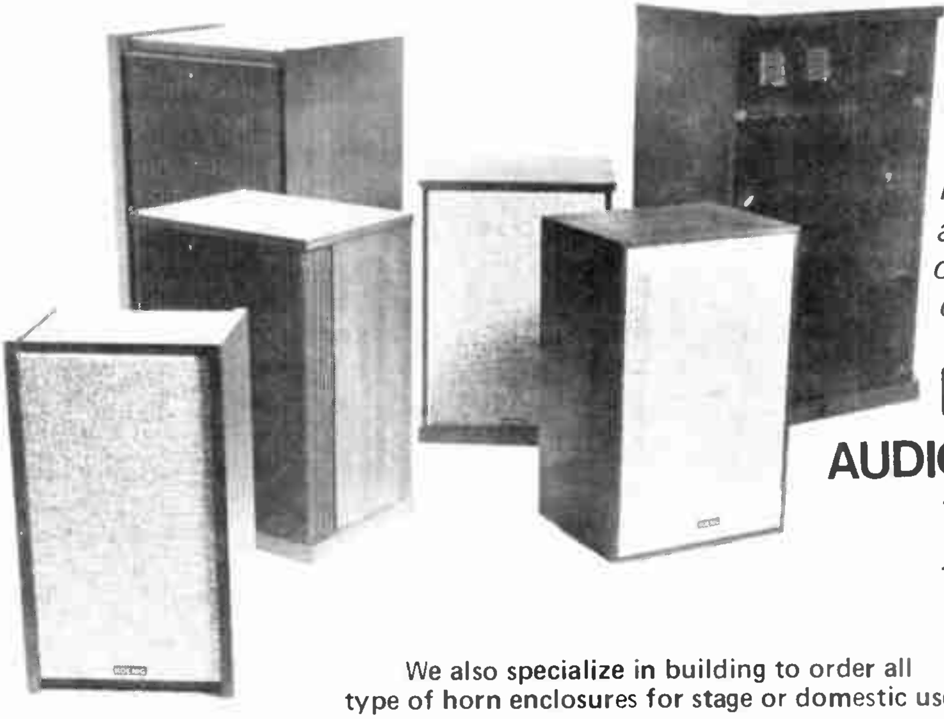

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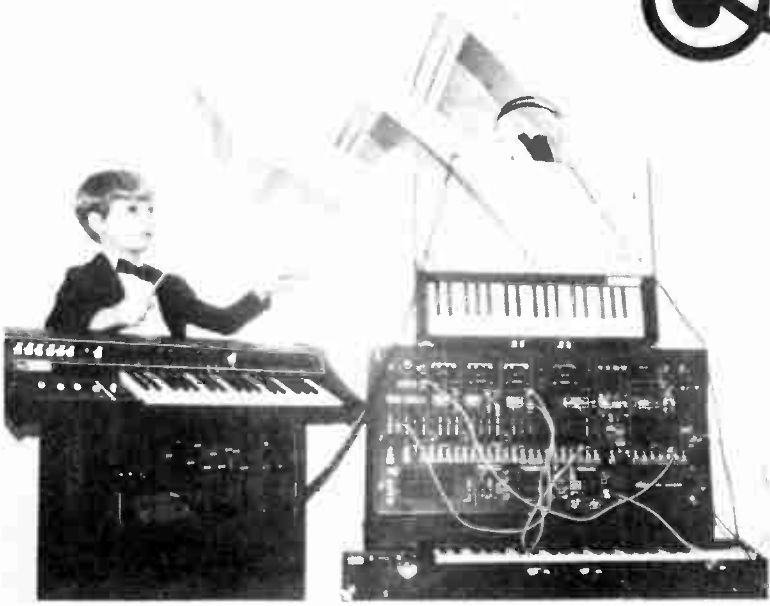

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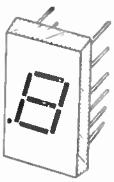

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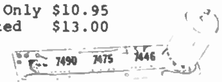

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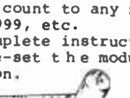

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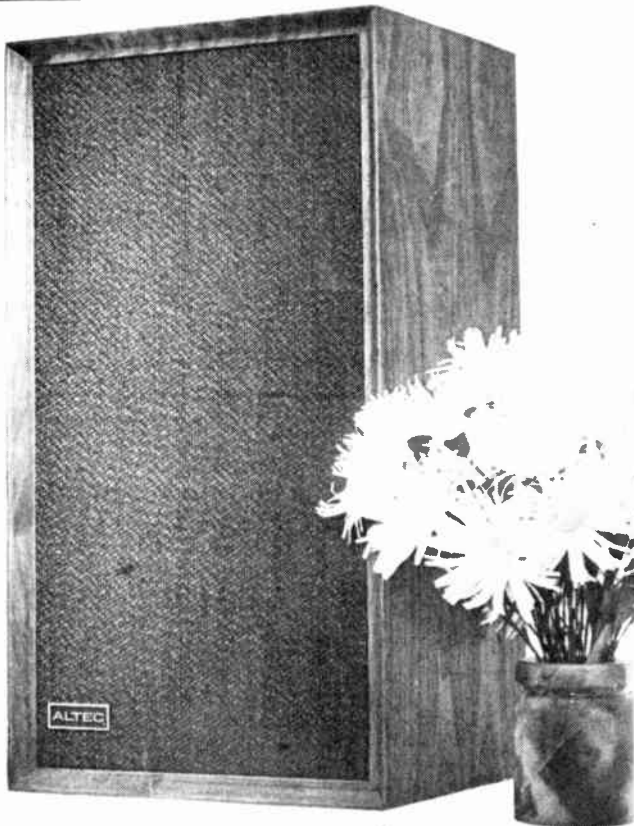

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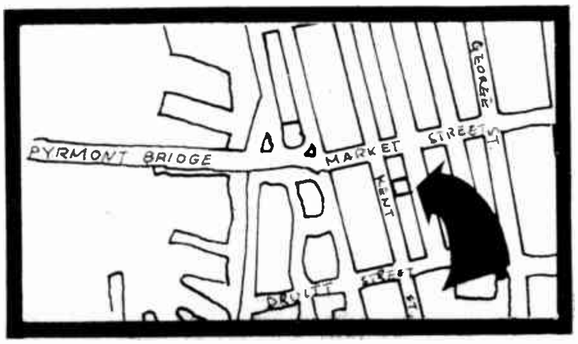


ELECTRONICS -it's easy! PART 11

Introducing emitter followers and dc amplifiers.

IN OUR GENERAL discussion of the ac amplifier we have shown how this common system component can be used to increase the amplitude of ac signals. The frequency range of a typical ac amplifier may extend from a few hertz to many megahertz, the upper limit being limited mainly by the performance of the active device (transistor etc) used.

The type of amplifier illustrated, in Fig.15 of the previous section, is only one of several different basic design concepts that we may use. Each different approach has particular advantages and disadvantages that suit it more to one application than another. For example a different approach must be used where the amplifier is to be loaded by a low impedance or where dc signals must be amplified.

We will now discuss the three basic amplifier configurations, their fundamental properties and their typical uses. This will then equip us with the information needed to understand basic dc amplifiers and, in addition, modern integrated-circuit amplifiers.

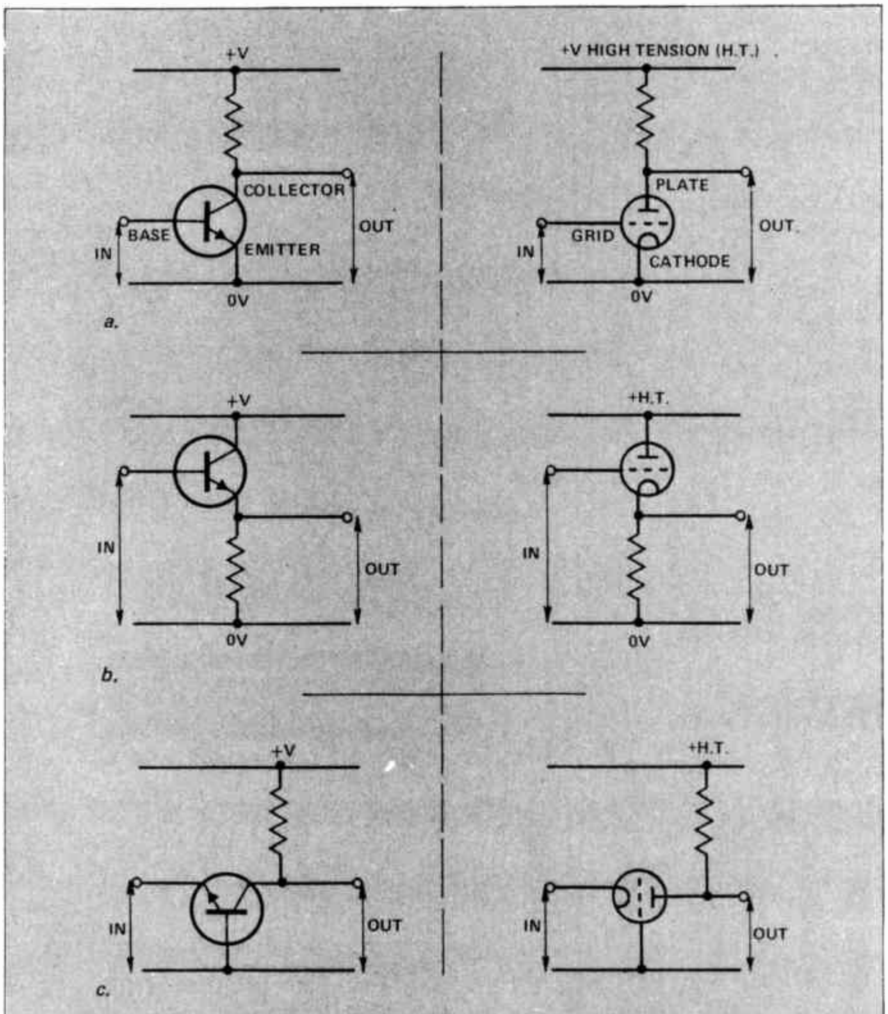


Fig. 1. Basic configurations of transistor (left) and valve (right) amplifiers. (a) Grounded emitter, grounded grid. (b) Grounded collector more commonly called emitter follower, and grounded plate more commonly called cathode followers. (c) Grounded base and grounded grid.

In our previously-described amplifier you will remember that we developed the circuit from a basic configuration of the transistor where the emitter is connected to the negative rail. This method of connection, naturally enough, is known as "grounded-emitter" and is illustrated in Fig.1a (together with the equivalent valve circuit). This, and the other methods of connection were first devised for use with valve circuitry and then conveniently passed on to transistor technology. There is one major distinction between the two amplifier elements – valves operate as voltage devices, transistors as current devices. In the 50's and early 60's, transistor technique was taught by using analogues with the then established and widely known valve practices. Today, valves play only a limited part in electronics, but we have included valve counterparts alongside the transistor circuits to assist those previously trained in valve technology and the newcomer too will be acquainted with components that are still used in some special applications.

THE EMITTER FOLLOWER

Another valuable configuration is that given in Fig. 1b – the grounded collector circuit which is more commonly called an emitter-follower.

In this case it is the collector that is connected directly to the supply rail, not the emitter. The term 'grounded' may appear incorrect but, when it is remembered that a perfect voltage supply has zero resistance, it can be seen that the collector is effectively connected directly to the ground line. As it is much a case of where the essential load resistor is placed it might be easier to remember that this configuration places the load resistor in the emitter lead, *not* the collector lead. The transistor is wired into the circuit with the same polarities at each connection as for the grounded emitter.

In the development of a satisfactory grounded-emitter circuit we saw how the addition of an emitter resistor provided thermal stability. We also saw how this resistor reduced the dc gain of the circuit. This is because the collector current through the resistor produces a voltage drop which opposes the original drive voltage applied to the base-emitter circuit.

The emitter follower uses this effect to provide impedance buffering between two stages. The output voltage developed across the resistor is closely equal to (but not quite the same because of the voltage drop across the base-emitter junction) that applied to the input.

This may seem a futile process for the voltage level of the signal cannot be amplified. In fact, however, it is the signal current that is amplified. The emitter-follower, therefore complements the operation of the grounded-emitter circuit. It is invaluable as a means to raise the current level of signals without altering the voltage level.

Although current gain is very important in some applications (discussed later), in small signal situations we usually regard the emitter follower as an impedance — conversion stage. This will become more obvious after we examine emitter-follower characteristics.

The voltage drop across the forward biased base-emitter junction is a constant (almost) 600 mV for a silicon transistor (400 mV for germanium). Thus the voltage at the emitter closely follows the signal at the base, but with a 600 mV lower mean dc level.

Hence the voltage gain of the emitter follower is always slightly less than unity.

$$\text{gain } A \simeq \frac{Ze}{Ze + (\frac{1}{gm} + \frac{Zs}{\beta})}$$

Where

Ze = impedance in emitter

$\frac{1}{gm}$ = a factor dependant on resistances within the transistor but typically 50 ohms at 1 mA for small transistors (falls with increasing current).

Z_s = source impedance

β = transistor current gain.

Thus if an emitter resistor of 1k is used with a transistor having a β of 100 and the impedance of the source is 2k.

Voltage gain A =

$$\frac{1000}{1000 + (50 + \frac{2000}{100})} = \frac{1000}{1070} = 0.93$$

Input Impedance

$$Zin \simeq \beta\,(Ze + \frac{1}{gm})$$

Thus for our example

$$Zin = 100\,(1000 + 50)$$

$$= 105\text{ k}$$

Output Impedance

$$Zout \simeq \frac{Zs}{\beta} + \frac{1}{gm}$$

$$= \frac{2000}{100} + 50$$

$$= 70\text{ ohms}$$

The actual output impedance is the value as calculated above in parallel with the emitter resistor. That is, in our case —

70//1000 = 65 ohms

Thus we can see that the input impedance of 105 k will not appreciably load the 2 k source and the full signal voltage (0.93 gain) appears at the emitter across an impedance of 65 ohms. Thus we see how the impedance conversion has taken place. By choosing the correct values this impedance may be adjusted to a desired value, eg 50 ohms.

The emitter follower, therefore, can be used to connect a low input impedance stage to a preceding high-output impedance stage without introducing serious attenuation due to loading.

For example, if a stage with an output impedance of, say 10 k is to drive a stage with 1 k input as shown in Fig.2 a direct connection would load the first stage so much that its signal voltage output level would be reduced to roughly one tenth of its original magnitude. A single emitter-follower stage can be designed to have 100 k input and 50 ohm output which will enable the original two stages to be joined with little attenuation of the signal level. Figure 3 shows a typical circuit in which voltage gain is obtained by a grounded-emitter stage followed by buffering with an emitter follower.

The amount of impedance reduction

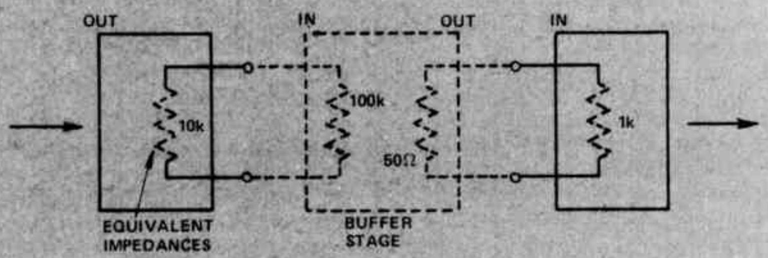
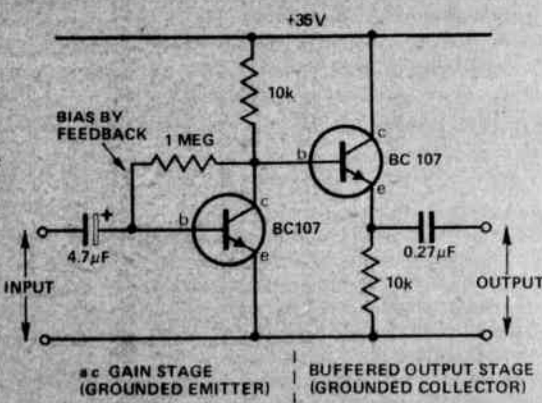


Fig. 2. The emitter follower, used as a buffer stage, allows two stages to be coupled without introducing loading effects.

Fig. 3. A typical grounded emitter stage buffered by an emitter follower. Note the bias arrangement for the first stage and that base of the emitter follower is directly coupled.



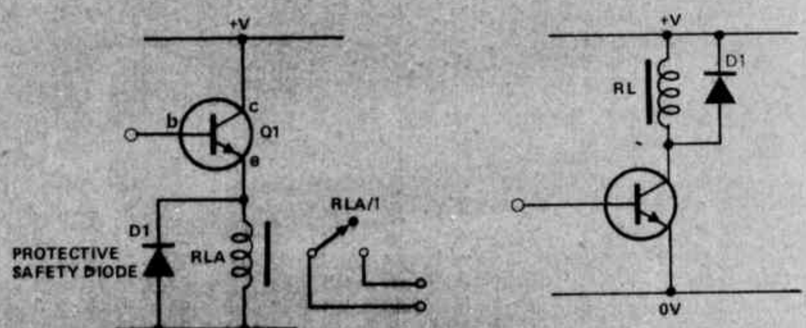


Fig. 4 (a). In output stages the load becomes the resistance in the emitter of the follower circuit. (b). The alternative grounded emitter circuit note that diode D1 absorbs high voltages induced in the relay coil when the transistor turns off.

ELECTRONICS –it's easy!

	GROUNDED BASE	GROUNDED EMITTER	GROUNDED COLLECTOR
Current Gain	<1(.98)	High (200)	High (200)
Voltage Gain	High	High	<1
Input Impedance	Low (40)	Medium (2 k)	High (100 k)
Output Impedance	High (1 Megohm)	Medium (30 k)	Low (1 k)
Power Gain	Medium (30 dB)	High (40 dB)	Low (16 dB)
Cut-off Frequency	High	Low	depends on R_L
Voltage Phase Shift (L.F.)	Zero	180°	Zero

Fig. 5. Comparison table of characteristics for alternative connection modes. Note that these are typical values only.

attainable depends largely upon the β value of the transistor. Where greater than tenfold reduction is needed the designer can resort to cascading two or more emitter-follower stages or use can be made of special semi-conducting active devices (eg the field-effect transistor) that have high input impedances.

When the buffer stage is also the final output stage, and is required to drive an actuator such as a loudspeaker or relay coil, the actuator itself may be used as the emitter resistor, being wired into circuit as shown in Fig.4. In this case there is no need to provide a separate resistor.

The emitter follower does not change the phase of the signal. This contrasts with the grounded emitter amplifier where a positive-going signal becomes a negative going output. That is, ac signals are phase shifted by 180° or one half-cycle.

The emitter-follower is a robust stage and is less likely to be damaged than the grounded-emitter circuit. The main point to watch is that the emitter load impedance (the resistance value added in parallel with the input resistance value of the next stage) is not so small that the collector current I_C exceeds the manufacturer's stated safe maximum value.

The input base connection of the emitter-follower stage is usually coupled directly to the output (collector) connection of the preceding stage. There is no need for thermal runaway compensation or for a bias network. The emitter-follower is a very simple stage but nevertheless a very important one.

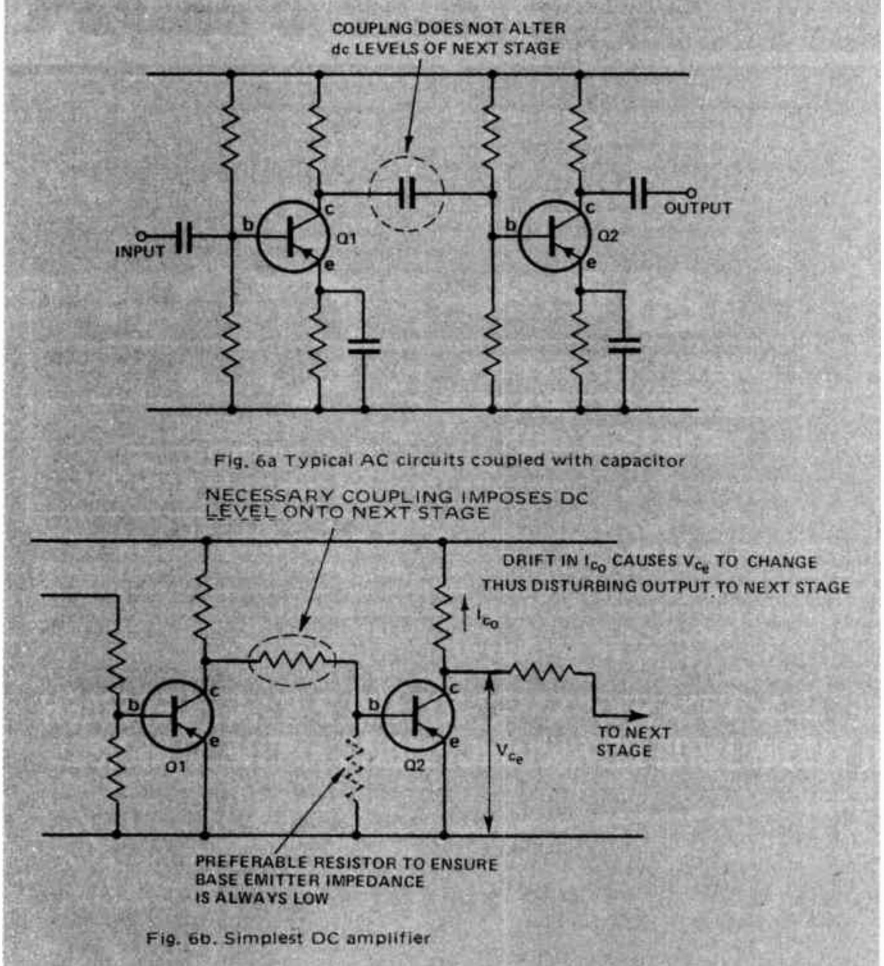


Fig. 6 (a) Coupling between ac stages by a capacitor does not affect levels of either stage. (b) Direct coupling between dc stages creates problems because of imposed dc levels.

GROUNDED BASE CONFIGURATION

Having grounded, firstly, the emitter then, secondly, the collector the next obvious stage design is to ground the base.

The schematic of a grounded-base stage is given in Fig.lc. This design is seldom used but there are circumstances where its peculiar characteristics render it useful. It can provide voltage gain roughly equivalent to the β of the transistor but it cannot provide more than unit current gain. Its usefulness arises from its ability to couple low-impedance input transducers – microphone transformers for example – to normal grounded emitter gain stages with optimum power transfer. The input impedance of the grounded-base stage is in the region of tens of ohms and the output impedance is near a megohm.

The characteristics of the three configuations for a transistor are tabulated in Fig.5. Such a table can only be used as a guide, for the actual values of each circuit depend largely upon the β of the device and upon the passive components wired in to form the practical working stage – all remarks made apply to both p-n-p and n-p-n transistors alike; only the polarity of the supply needs to be changed.

THE COMPLIMENTARY TRANSISTOR

The foregoing explanations implicitly suggest that the emitter of a p-n-p device must always be connected to the positive polarity and that of a n-p-n to a negative polarity. This is usually the case in practice — but not an absolute rule.

Remembering that the transistor is a three-layer device we can see that it is, in principle, symmetrical. The p's of a p-n-p device could, in principle, be either the emitter or the collector, implying that it could be connected either way into a circuit. In practice, the junctions are made in such a way that operation is optimized for the connections stated by the manufacturer. It is, however, possible to procure special transistors that are made to exhibit similar characteristics for both possible connections of the collector and emitter, but one seldom meets the need for this in electronic circuits.

DC AMPLIFIERS

We have seen how it is necessary to add passive components to a basic active element to construct a practical ac amplifier. The same applies to constructing a practical dc amplifier.

To better understand what is required let us examine the different requirements of ac and dc amplifiers.

In the ac amplifier two different design conditions exist together, the bias and other steady state conditions and, the ac coupling which allows the signal to cause variations around these steady state conditions. This is necessary so that both polarities of the ac waveform may be amplified. Thus each stage in a chain of ac amplifiers is self-contained that is, the dc levels of one stage are not imposed on the next. This is illustrated in Fig. 6a.

If the signal to be amplified is a dc level (including also signals below 5 Hz) it is not possible to isolate the steady-state conditions of successive stages and some means of direct connection must be used.

Figure 6b illustrates a basic method of interconnecting dc amplifiers by means of a resistor. It is obvious that the dc level at the collector of Q1 will cause current flow into the base of Q2 and a corresponding collector current in Q2. This implies that with no signal to the base of Q1 the output voltage from Q2 will not be zero, and its level will depend on the conditions in the previous stage.

From this we see that the first important requirement is to *carefully* select resistor values such that the following stage is not driven into saturation. The series coupling resistor is thus chosen to limit base current into Q2. It must not be too high, however, because the dc signal will be attenuated by the ratio of this resistor to the base-emitter resistance of the following transistor.

A further problem is that when the input to the base is zero, the collector output is not zero but at the supply voltage. So that even with no input to the first stage, the second may well be saturated.

Thus this particular approach, whilst capable of providing some dc amplification, is not very practical. Resistors must be chosen to suit actual betas of the transistors used as a change in gain means a change in output current and in bias to the next stage.

Assuming we managed to establish a workable set of values the next problem is that the values of the components and the gains of the transistors may (and do!) change with age and, more spectacularly, with temperature. Thus if the output (dc) voltage is somehow set so that it is zero with zero level input, it subsequently will drift in time and with temperature. If the overall gain is 100 000 (typical value) it does not require much drift at the first stage to fully saturate the last stage! (A 10 V swing is produced by a tenth of a millivolt change).

Finally, to add to the problems to be faced by the designer we have not overcome the problem of amplifying both positive and negative polarity signals; the schematic arrangement of Fig. 6b can only handle negative signals. Positive signals merely bias the input stage into a totally non-conducting stage. An n-p-n equivalent (of Fig. 6b) handles positive signals but not negative.

TURNING THE TRANSISTOR ELEMENT INTO A WORKING DC AMPLIFIER

A decade ago the electronic system builder had to design and build his own dc amplifiers Commercial units were available but were very expensive. The dc amplifier was regarded as a system block best avoided if possible! Numerous designs were investigated in an attempt to overcome the problems in a satisfactory way but it was not until 1936 that the first successful high-gain dc amplifier was built (in Sweden) by Buchtal and Nielson. Since then many

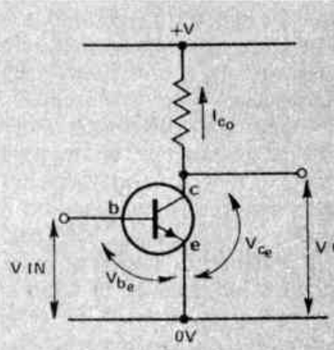


Fig. 7. Basic grounded-emitter stage of a dc amplifier is rarely satisfactory due to drift in V_{out} due to changes in leakage current I_{co}.

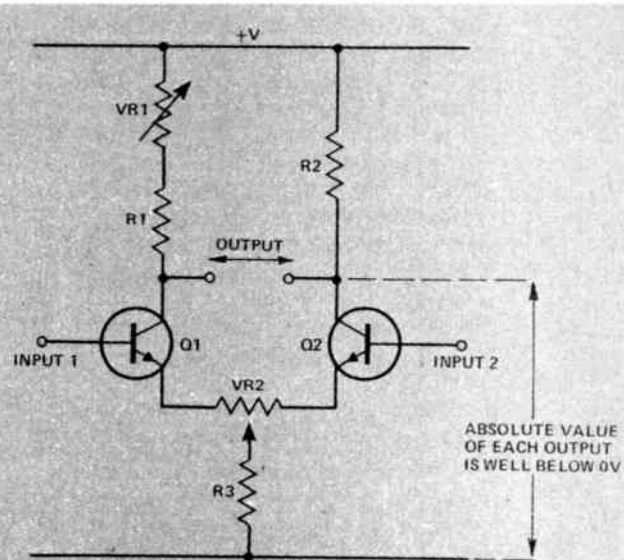


Fig. 8. Schematic of the differential pair arrangement which is used to reduce effects of thermal drift.

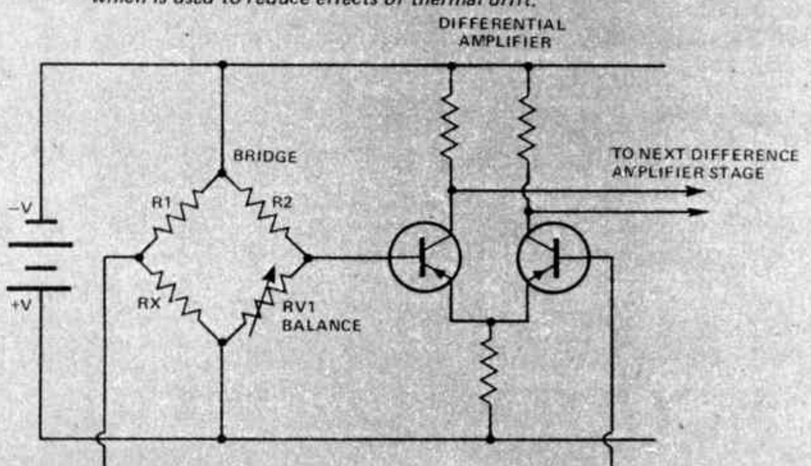


Fig. 9. Differential dc amplifiers are ideal for use with Wheatstone bridge arrangements and sensors of various kinds. The circuit provides high common-mode rejection. That it is rejects noise hum etc. and only amplifies the difference signal.

intriguing circuit 'tricks' have been devised to overcome the drift problem that is still encountered with this and subsequent designs.

Today the situation has, quite suddenly, been reversed and we more often than not use a dc amplifier to provide the relatively simple ac amplification than build a special-purpose ac amplifier.

This revolution has come about with the use of integrated circuit manufacturing methods whereby numerous elements — (typically, 20 transistors, half as many resistors and a capacitor or two) are formed into a dc amplifier that, now markets for $1.00 or less and, may be mounted in a space about 5 mm square.

The circuit requirements of a dc amplifier stage have not been eased; in fact a modern amplifier in integrated form contains more elements than its earlier discrete predecessor. Now, a few highly specialised designers devise the IC circuit which, after extremely thorough testing, is made as a one piece package that the electronic-system designer then uses as a basic building block.

The low price of such amplifiers means that, despite their internal complexity they can be used as freely as transistors were a few years ago.

Before we discuss how to use these amplifiers, let us consider some basic circuit techniques that are used to create the general purpose dc amplifier.

THE DIFFERENTIAL PAIR

In the basic grounded emitter circuit shown in Fig.7 V out will be roughly β times V in. However an unwanted leakage current, termed I_{co}, also flows through the device and resistor and, produces voltage drops across them. Thus the V_{out} value may alter even though V_{in} remains the same. When several stages are cascaded, to provide a gain approaching a million, the temperature dependency of I_{co} is large enough to produce a considerable swing in output voltage. Obviously such a system is unworkable, more a thermometer than a useable dc amplifier!

One remedy is to control the temperature of the element and this was standard practice in early units. Today internal electronic compensation will overcome this problem except in the most stringent cases.

There is, however, a more powerful method of eliminating the temperature effect. It uses two transistors to form what is known as a *differential pair* — as shown in Fig. 8.

When used as a single input dc amplifier, input 1 (or 2) is connected to the bottom rail with the signal to be amplified being fed into the other input. (The emitter resistor provides further temperature compensation). When the working input is also connected to the bottom rail both transistors are connected in an identical manner. Thus the two collector resistances are equal, and if the two transistors have similar leakage currents, the voltages developed at each collector will be closely identical and will 'track' each other with temperature changes.

The output is taken to be that between the two collector voltages, not from one of the collectors to ground. When the two inputs are identical (no difference input signal) the output will be zero. (If not, VR1 is trimmed to make it so.) If one input rises above the other in magnitude, the output between the collectors will swing accordingly, but with the opposite sense and larger amplitude.

In this way the differential pair handles bi-polar (positive or negative going) signal swings, and provides significant temperature compensation.

A further advantage of the differential method is that any noise (such as mains interference or hum) is common to both transistors and, therefore, does not appear at the output. This is called common-mode rejection.

A similar differential circuit can be constructed using a pair of emitter-followers. In this case current gain is obtained instead of voltage gain.

To obtain more gain such a stage can be connected to the two inputs of a following differential pair. Note particularly that the output has no connection with the common lower rail and any attempt to make such a connection prevents correct operation of this compensating method.

In many cases where dc amplification is needed, the input already exists as two leads which cannot be connected to earth — Fig.9 shows the commonly encountered Wheatstone bridge used in measurement. A small change in RX causes the bridge to go out of balance providing either a negative or positive output signal to the differential amplifier. In practice RX might be a temperature-sensitive resistor (thermistor) a strain-sensitive resistance grid (strain/gauge) or a light dependent resistor (LDR), to name just a few uses of the bridge.

Thus it can be seen that the differential pair concept is invaluable in the creation of a workable dc amplifier. In discrete designs the transistors must be carefully matched for best results. In IC designs however this close matching of both characteristics, and the temperature of the devices is almost automatically achieved.

THE COMPLEMENTARY PAIR

The differential pair can handle a bi-polar signal swing but has two major disadvantages. Both output leads must be isolated from ground and the method is wasteful of both power and transistors. For these reasons dc or ac power output stages (where power lost as heat is expensive)often use what is called a *complementary-pair* circuit — shown schematically in Fig.10.

Here the load is connected between the two joined emitters of p-n-p and n-p-n transistors and the 0 volts rail, and the two bases connected together. If the input signal swings positive the upper transistor begins to conduct, increasing the positive voltage applied to the load, and the other transistor is

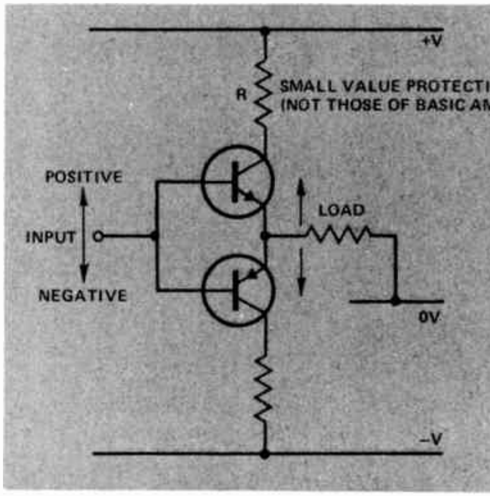


Fig. 10. The complementary pair provides bipolar operation in a very efficient way.

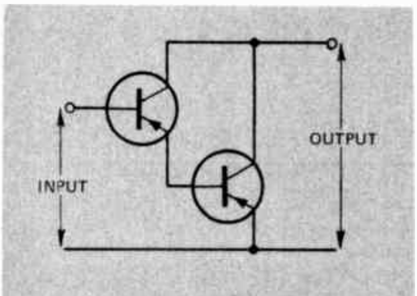


Fig. 11. Two transistors connected as a "Darlington pair" provide a super Transistor and perform better than two emitter followers caseaded.

biased into a safe 'off' state. In the reverse direction the opposite applies. As the complementary pair uses emitter followers it is inherently stable. However transients or other effects could possibly switch the off-state transistor to an on-state in which case the transistors would rapidly be destroyed. Addition of small value resistors in each collector helps to reduce this risk.

THE DARLINGTON PAIR

When the need arises for an amplifier with high input impedance the initial stage could be an emitter follower. If still higher input impedance is needed it is better to use the *Darlington-pair* circuit shown in Fig.11 than to cascade emitter followers. Although not immediately obvious, this circuit does consist of two cascaded emitter followers in which the emitter load for the first transistor is the base-emitter junction of the second. With the Darlington pair it is relatively easy to obtain input impedances of greater than 1 megohm. For still higher values the designer would normally use the field-effect transistor (FET). This will be explained later in the series. Darlington pairs are, in effect, a super-transistor for the combined unit still has three terminals, has far greater input impedance and a typical combined gain of 30 000. The pair is available as a single packaged unit.

THE INTEGRATED CIRCUIT LINEAR AMPLIFIER

Having covered the main (but by no means all) circuit concepts used to build high performance dc amplifiers, we are better able to look a little closer at the IC operational amplifier. This circuit block is now used as the general purpose amplifier for both dc and ac analogue signals.

The ideal amplifier should be extremely stable to temperature changes, should not drift over long periods of time, should have relatively high input impedance, very low output impedance, wide tolerance to voltage supply variations, not be damaged by accidental short circuits of the output and be standardised in mounting methods and supply voltage.

Before IC devices were made, numerous manufacturers provided dc amplifiers in even more numerous packages and forms. This did not lead to the drastic price reductions realized by IC manufacturing, additionally their high cost did not guarantee that the units were as good as their makers claimed.

Today there are many makers of integrated circuit components. All offer dc amplifiers that provide a performance so good that we rarely even remember that dc amplifier design is very difficult. We just wire them in and forget them.

Figure 12 shows the basic circuit schematic of the very commonly used µA 709 operational amplifier. This unit requires the addition of several components but is now a standard IC offered by numerous manufacturers. A later design that is commonly available, and inexpensive, is the µA 741 shown in Fig. 13. This unit needs fewer components to complete the amplifier circuit.

Integrated circuit amplifiers are marketed in single units mounted in round cans and flat packs. One form is also sold with *four* dc amplifiers on a normal dual-in-line flat pack. Figure 14 is a useful reference chart of the

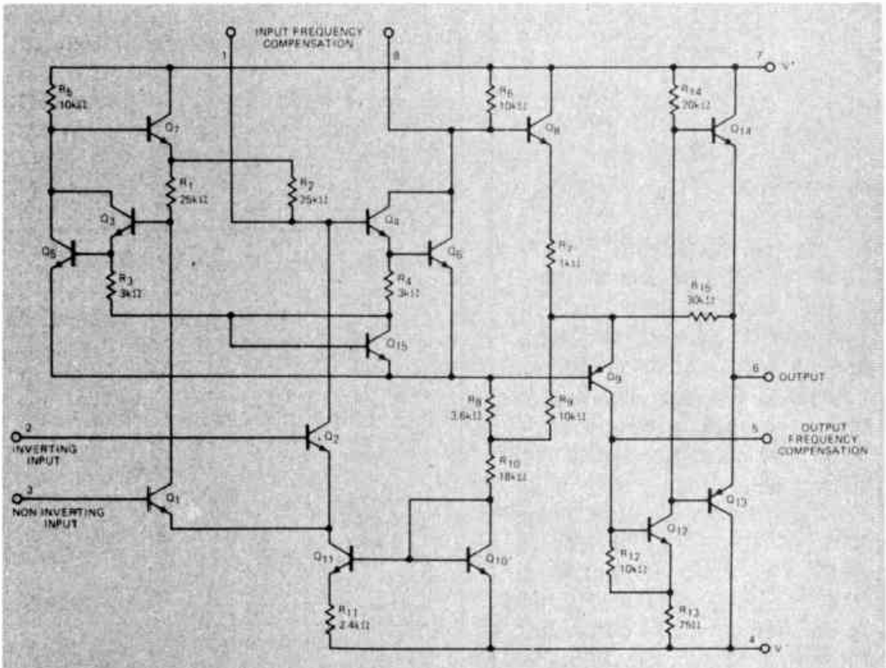


Fig. 12. Schematic diagram of the µA709 high performance, integrated circuit operational – amplifier as marketed by Fairchild. Can you pick the Darlington pair, a complementary pair and a differential pair?

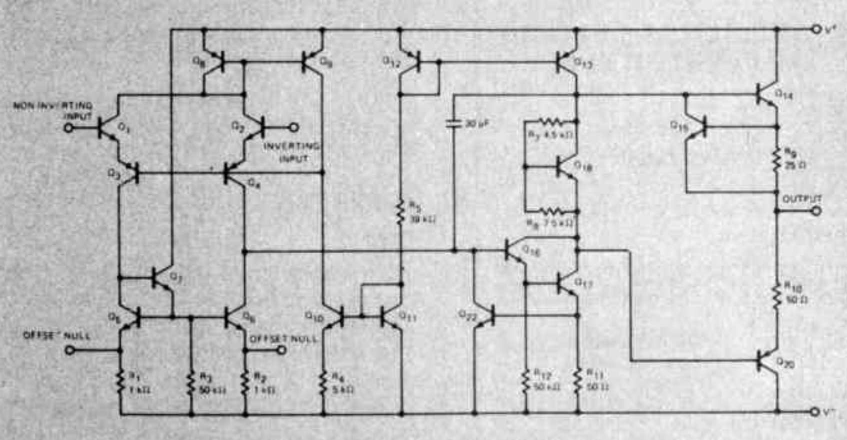


Fig. 13. The µA741 IC amplifier fills a similar role to the 709 but, as this schematic shows has a more complex circuit and includes the frequency compensation capacitor on the chip. This IC is therefore simpler to use and gives superior performance.

ELECTRONICS -it's easy!

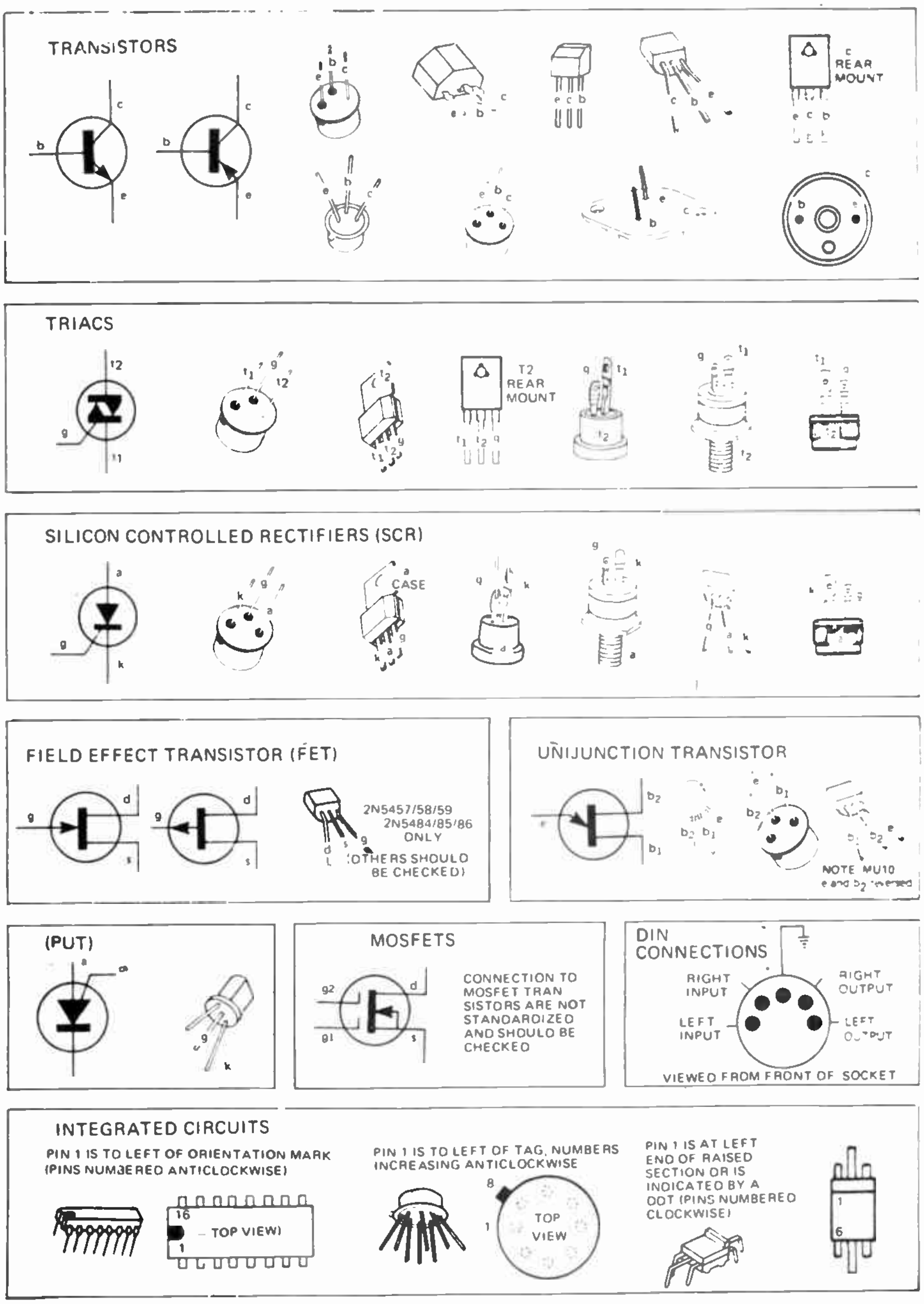


Fig. 14. Symbols, case outlines and connections for the commonly encountered active devices.

main semi-conductor packages (including some yet to be discussed) and their connections.

REFERENCES

Data

Semiconductor manufacturers are pleased to provide data sheets and application notes for their products. The electronic engineer uses these for design data and basic system ideas. Well known companies are:–

National Semiconductor, Fairchild, General Electric, Motorola, Philips, RCA, STC, Plessey, Sinclair, Texas Instruments, Hewlett Packard, Sprague, A.W.A.

Data is provided in several forms.

(a) Books and binder catalogues that are expanded with time (not always a free service).

(b) Application notes which often run to 100 page unbound books.

(c) Individual data sheets giving vastly more data and detail than normal user needs (these may tend to confuse when first encountered).

For those who have a mathematical bent, and an urge to know the intricate whys and wherefores of amplifier design, an inexpensive useful text is the:–

"Transistor Manual" by General Electric, this is now in its 7th edition. It gives the theory of operation of transistors and plenty of generalised practice.

ELECTRONICS – in practice

OFTEN THE NEED arises to drive an output device, such as a relay, with a smaller input signal. The gain needed can easily be obtained with a single dc connected transistor stage which switches the power to the relay. This requires the transistor to operate in what is called switching mode (rather than linear amplification). Although switching circuits have not yet been covered this exercise is useful, helps to build more confidence in the use of transistor devices and illustrates more problems of dc circuitry.

The basic circuit is given in Fig.15. With the switch in the off position the transistor base current is at minimum and V_{ce} rises to nearly 12 V (the transistor 'resistance' changes to be very much greater than the resistance of the coil of the relay). The coil is then de-energised. (The switch, in practice, could be replaced by any other device which provides sufficient voltage change to switch the transistor, eg another transistor or LDR etc).

When the switch is put to the on position, base current flows and is limited by R_b. This is chosen to ensure that the transistor is fully conducting and, therefore, providing a very low resistance compared with the relay coil. The coil is then virtually connected across the supply and the relay operates.

A diode is connected across the relay to absorb the large voltage spikes that are induced across the relay as the current through it collapes when the transistor is turned off. Without it the transistor would be pulsed and probably destroyed.

The design steps are as follows:

(a) To fully energise the relay 12 V/185 Ω of current (65 mA) must flow through the transistor.

(b) From data charts we select BC108 (or BC107, 109) as being capable of withstanding the 12 V supply and the 65 mA needed. The actual limits of the BC107 n-p-n series are shown in Table 1.

(c) The minimum gain (β) of a BC 108 is around 100, so the base current of the on-state must be at least 65/100 = 0.65 mA. To be on the safe side double this, for it is essential that the transistor be properly saturated. A base current of, say, 2 mA is, therefore, needed. Further delving into the data sheet values and curves establishes that this value of I_b is well within safe limits.

(d) Choose R_b to give 2 mA from a 12 V supply which leads to a value of 6 k for which the nearest preferred value is 5.6 k.

These simple steps can be greatly elaborated upon by the trained expert but for general usage they are adequate.

TABLE I

	BC 107	BC 108	BC 109
V_{ce} max. (Volts) (base shunted to emitter)	50	30	30
V_{ce} max. (Volts) (base lead open)	45	20	20
I_{cm} (mA)	200	200	200
P total max (mW) (maximum dissipated power)	300	300	300
hfe (β)	125-500	125-900	240-900
ft (max. useful frequency)	300 MHz	300 MHz	300 MHz

The circuit, therefore, operates the 65 mA reply coil with a control current of only 2 mA – a considerable reduction. For further sensitivity another stage can be added as shown in Fig.16.

Now the design criteria is that the extra transistor provides 2 mA when switched off – which also means it must pass about 4 mA when on, for the collector resistor decides the flow into the following stage as well as into the transistor. The base current of Q1 is, therefore, now 50μA or less. Note also that the phase is now changed – with the switch up the relay is 'off' instead of 'on' as in Fig.15.

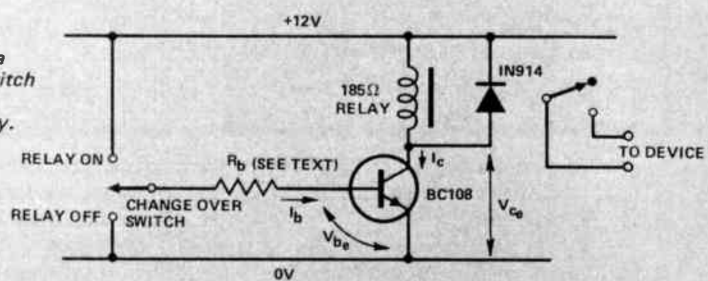
Switching circuits are the easiest dc circuits to design, for thermal effects are not so rampant. This is because the currents needed can be over-driven to ensure that changes in leakage and gain do not bring the transistor out of the 'off' or 'on' state.

It is good practice to clamp the base to earth when the transistor is in the off state. Should the base be left open-circuit, thermal runaway may occur. This is because the leakage current, dependant on temperature, causes V_{be} to rise, collector current to increase and further temperature rise to occur – thermal runaway.

In the two-stage switch V_{ce} of the first transistor never quite goes to zero so a small base current is injected into the next stage. Thus it is by no means certain that the second transistor will turn off.

This can be overcome by using a small resistor or a forward-biased diode (which produces a 600 mV voltage drop) in the emitter of the relay driver transistor. This raises the turn-off voltage at the base of Q2 well above the saturation-voltage at the collector of the preceding transistor ensuring reliable turn-off of Q2, and little chance of spurious turn-on due to transients. ●

Fig. 15. The use of a transistor as a dc switch provides greater sensitivity for a relay.



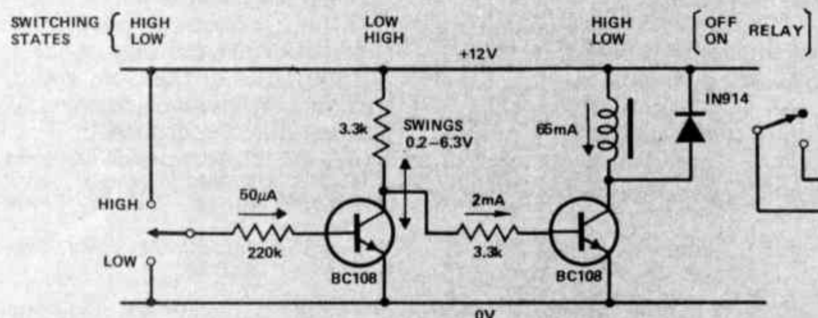


Fig. 16. Two stages of dc amplification further increase the sensitivity, but, are more difficult to design. (see text).

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LER 051

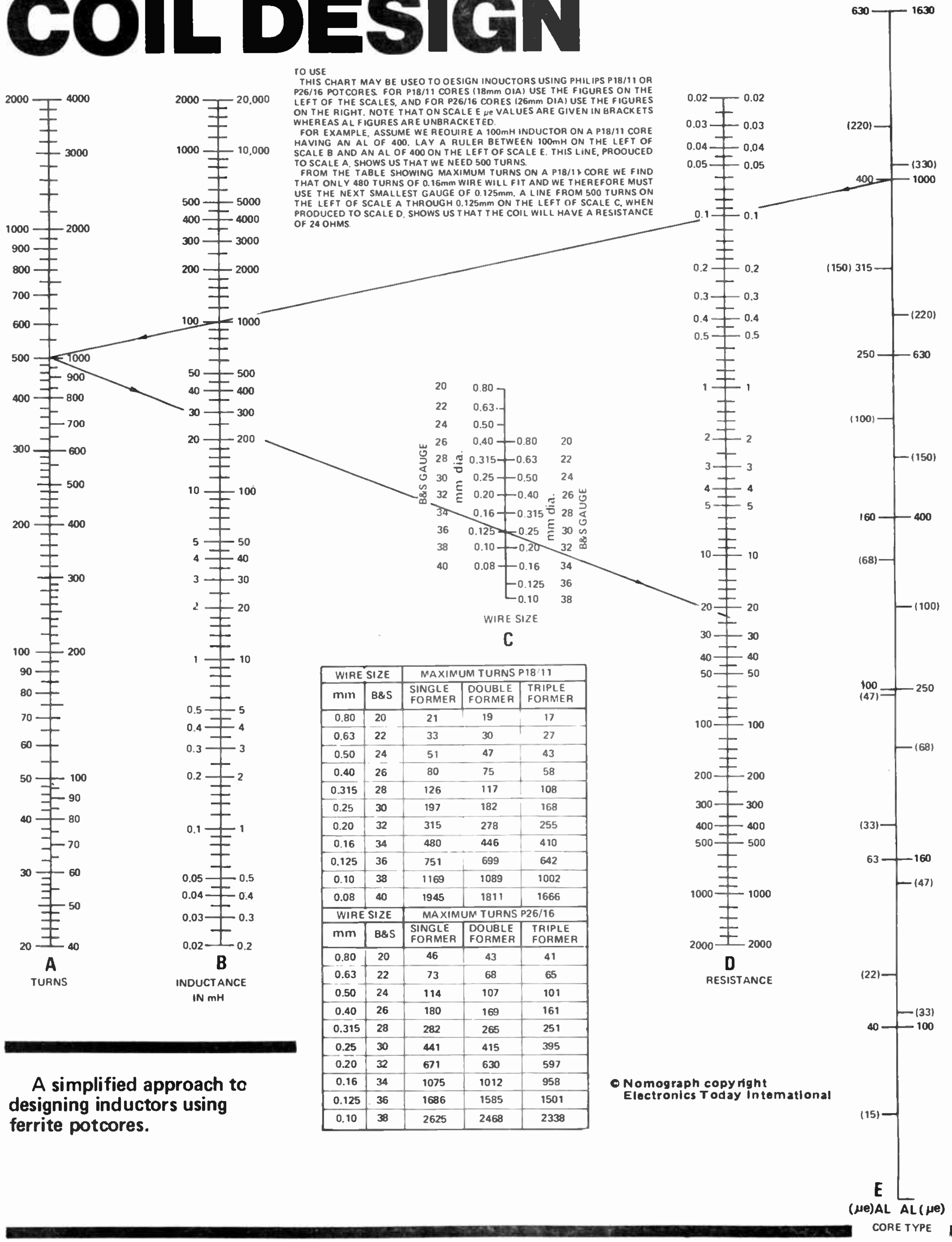
POT CORE COIL DESIGN

TO USE

THIS CHART MAY BE USEO TO OESIGN INOUCTORS USING PHILIPS P18/11 OR P26/16 POTCORES. FOR P18/11 CORES (18mm OIA) USE THE FIGURES ON THE LEFT OF THE SCALES, AND FOR P26/16 CORES (26mm DIA) USE THE FIGURES ON THE RIGHT. NOTE THAT ON SCALE E µe VALUES ARE GIVEN IN BRACKETS WHEREAS AL FIGURES ARE UNBRACKETED.

FOR EXAMPLE, ASSUME WE REOUIRE A 100mH INDUCTOR ON A P18/11 CORE HAVING AN AL OF 400. LAY A RULER BETWEEN 100mH ON THE LEFT OF SCALE B AND AN AL OF 400 ON THE LEFT OF SCALE E. THIS LINE, PROOUCED TO SCALE A, SHOWS US THAT WE NEED 500 TURNS.

FROM THE TABLE SHOWING MAXIMUM TURNS ON A P18/11 CORE WE FIND THAT ONLY 480 TURNS OF 0.16mm WIRE WILL FIT AND WE THEREFORE MUST USE THE NEXT SMALLEST GAUGE OF 0.125mm. A LINE FROM 500 TURNS ON THE LEFT OF SCALE A THROUGH 0.125mm ON THE LEFT OF SCALE C, WHEN PRODUCED TO SCALE D, SHOWS US THAT THE COIL WILL HAVE A RESISTANCE OF 24 OHMS.



WIRE SIZE		MAXIMUM TURNS P18/11		
mm	B&S	SINGLE FORMER	DOUBLE FORMER	TRIPLE FORMER
0.80	20	21	19	17
0.63	22	33	30	27
0.50	24	51	47	43
0.40	26	80	75	58
0.315	28	126	117	108
0.25	30	197	182	168
0.20	32	315	278	255
0.16	34	480	446	410
0.125	36	751	699	642
0.10	38	1169	1089	1002
0.08	40	1945	1811	1666

WIRE SIZE		MAXIMUM TURNS P26/16		
mm	B&S	SINGLE FORMER	DOUBLE FORMER	TRIPLE FORMER
0.80	20	46	43	41
0.63	22	73	68	65
0.50	24	114	107	101
0.40	26	180	169	161
0.315	28	282	265	251
0.25	30	441	415	395
0.20	32	671	630	597
0.16	34	1075	1012	958
0.125	36	1686	1585	1501
0.10	38	2625	2468	2338

A simplified approach to designing inductors using ferrite potcores.

DESIGNING POTCORE FILTER COILS

FERRITE potcores are widely used in the construction of small inductors and transformers. However very few amateurs know how to choose a core appropriate to their needs, or how to wind a coil of specific inductance.

This article describes a simple method of designing chokes for low frequency applications. The design of coils for high frequency applications, and of transformers, is beyond the scope of this article. Design details given apply only to the Philips 'P' series of pot cores and more particularly to the 18 mm (P18/11) and 26 mm (P26/16) diameter cores which are the most commonly available.

Each core size is available in four different ferrite materials (3H1, 3B7, 3D3, 4C6) to cover the frequency range from audio to about 20 MHz. Additionally each material, in each size, is available with a number of permeabilities to cover different inductance, stability and Q factor requirements.

There are two factors commonly used to classify ferrite cores. These are effective permeability (μe) and AL factor.

The μe factor is primarily determined by the permeability of the material used and its cross sectional area, and secondly by the air gap left between the centres of the two core halves. For example an 18 mm 3B7 core without any air gap (type 0 4000) has a μe of 1750 and a tolerance on inductance of ±25%. The use of increasingly larger air gaps in the same core size and material lowers the μe but increases the stability and reduces the tolerance on inductance.

A second factor in common usage is AL. This factor gives, in nanohenries, the inductance of ONE turn on the core. The inductance of N turns on the core is

$L = N^2 \, AL \times 10^{-3}$ millihenries

The selection of a core size, a core material, a permeability value, a wire size and the number of turns depends on all the following factors:–

– inductance, stability of inductance
– frequency range
– Q factor
– unbalanced dc coil current
– level of ac coil current

Choosing the correct core taking *all* these factors into account is a difficult task indeed. However a large number of core types are eliminated by first selecting in accordance with frequency range and stability.

TABLE 1

FREQUENCY RANGE	CORE TYPE
0.1 – 200 kHz	3B7, 3H1
200 kHz – 2 MHz	3D3
2 MHz – 20 MHz	4C6

FREQUENCY RANGE

Firstly select the core material from Table 1 in accordance with the desired frequency range. To choose between 3H1 and 3B7 it is necessary to consider temperature stability.

If the tuning capacitors associated with the coil have small or varying, temperature coefficients, a 3B7 core should be used as they have the lowest temperature coefficient in the range 0° – 70°C. Alternatively, if using polystyrene capacitors (temp coeff –150 PPM/°C) a 3H1 core having an effective permeability μe) around 150 will give excellent temperature compensation for the temperature coefficient of these capacitors.

INDUCTANCE STABILITY

Since the inductance of a coil is proportional to core permeability, the change of effective permeability (μe) with temperature determines the stability of inductance.

The percentage change of inductance with temperature is linearly proportional to μe and hence low μe cores should be used for greatest stability. Stability is therefore obtained at the expense of inductance obtainable with a given core size.

The temperature effect is not large enough to affect any but the most critical of applications and the tolerance on inductance as stated in tables 2 and 3 will be obtained over the temperature range +15° to +35°C.

DIRECT CURRENT

A direct current in the winding will change the inductance value of the core and if large enough, could cause saturation. In general large air gaps, and hence lower permeability (μe), cores should be used where large dc currents are flowing.

Q FACTOR

The Q of a coil is influenced by different factors at different frequencies.

At frequencies below 10kHz it is almost completely determined by the dc resistance of the winding. The Q factor of any given coil increases linearly with frequency, and the larger the core, the larger the Q. The highest Q factors are obtainable by using gapless cores of 3H1 or 3B7 material (providing that tolerance and stability are acceptable) eg. 04000 series (P18/11) and 08000 series (P26/16).

Throughout the ultrasonic range core and winding loses affect Q, but Q factors of several hundred may still be obtained by optimum choice of wire and core, such that core and winding losses are equal. For further information, on optimum design, reference should be made to Philips Data Handbook – Components and Materials, Vol. 4.

At higher ultrasonic, and lower radio frequencies, additional factors of dielectric and skin-effect losses and parallel winding capacitance, all affect Q making exact design difficult. Use of Litz wires, split section formers and small cores with low μe values will assist.

INDUCTANCE

The tolerance given on inductance, in Tables 2 and 3 is obtained when using the specified core, and a wire size that will completely fill the former close layer wound. Due to slight changes in wire diameter and different methods of winding, the exact number of turns accommodated may vary by ± 10%. Hence it is safer, when winding experimental coils, to only try and fit 90% of the turns indicated in the maximum number of turns tables.

If the former is only partly filled, errors up to 4% may occur with the lower μe cores. However the use of an adjustor will allow a + 10% adjustment range which is generally sufficient to cope with tolerances found in practical circuits.

When optimum stability is required the type of adjustor that matches a certain core should be used. If it is desired to widen the adjustable range, at the possible expense of stability, an adjustor indicated for a potcore with a high μe value may be used with a potcore of low μe value.

Design data for this article has been derived from the Elcoma publication – "Ferroxcube Potcores" 1972.
Nomograph copyright – Electronics Today International.

Table 2 P18/11 Potcores

A. PRE-ADJUSTED PAIRS WITH STANDARD μ_e VALUES						
catalogue number 4322.022 . . .	grade of ferroxcube	effective permeability (μ_e)	number of turns for 1 mH α	tolerance on inductance %	adjustor type 4322.021	adjustor colour
28030	3B7	33	98.2	±1	30780	green
28040	3B7	47	82.3	±1	30800	red
28050	3B7	68	68.4	±1	30980	white
28060	3B7	100	56.4	±1.5	30980	white
28070	3B7	150	46.1	±2	30810	brown
28080	3B7	220	38.1	±3	30810	brown
28090	3B7	330	31.0	±3	31090	grey
28230	3H1	33	98.2	±1	30780	green
28240	3H1	47	82.3	±1	30800	red
28250	3H1	68	68.4	±1	30980	white
28260	3H1	100	56.4	±1.5	30980	white
28270	3H1	150	46.1	±2	30810	brown
28280	3H1	220	38.1	±3	30810	brown
28290	3H1	330	31.0	±3	31090	grey
28430	3D3	33	98.2	±1	30780	green
28440	3D3	47	82.3	±1	30800	red
28450	3D3	68	68.4	±1	30980	white
28810	4C6	15	146	±1	30780	green
28830	4C6	33	98.2	±1	30790	yellow
08000	3B7	1910.0	12.9	±25	–	–
08200	3H1	1910.0	12.9	±25	–	–
08400	3D3	730.0	20.8	±25	–	–

$N = \alpha \sqrt{L}$ (L in 10^{-3} H)

B. PRE-ADJUSTED PAIRS WITH STANDARD AL FACTORS						
catalogue number 4322.022 . . .	grade of ferroxcube	AL factor	corres-ponding μ_e value	tolerance on inductance %	adjustor type 4322.021	adjustor colour
29030	3B7	63	20	±1	30780	green
29040	3B6	100	31.8	±1	30780	green
29050	3B7	160	51	±1	30800	red
29060	3B7	250	79.5	±1	30980	white
29070	3B7	315	100.2	±1.5	30980	white
29080	3B7	400	127	±2	30810	brown
29100	3B7	630	200	±3	30810	brown
29110	3B7	1000	318	±3	31090	grey
29120	3B7	1600	510	±3	31090	grey
29230	3H1	63	20	±1	30780	green
29240	3H1	100	31.8	±1	30780	green
29280	3H1	160	51	±1	30800	red
29260	3H1	250	79.5	±1	30980	white
29270	3H1	315	100.2	±1.5	30980	white
29280	3H1	400	127	±2	30810	brown
29300	3H1	630	200	±3	30810	brown
29310	3H1	1000	318	±3	31090	grey
29320	3H1	1600	510	±3	31090	grey
29430	3D3	63	20	±1	30780	green
29440	3D3	100	31.8	±1	30780	green
29450	3D3	160	51	±1	30800	red
29460	3D3	250	79.5	±1	30980	white
29830	4C6	63	20	±1	30780	green
29840	4C6	100	31.8	±1	30790	yellow

$L = N^2$ AL (10^{-9} H)

C. COILFORMERS	
catalogue number	number of sections
4322.021.30330	1
4322.021.30340	2
4322.021.30350	3
4322.021.30130	1 with pins
4302.021.20030	1 with pins

D. MOUNTING PARTS	
catalogue number	description
4322.021.30550	container
4322.021.30660	spring
4322.021.30470	tag plate
4322.021.30710	nut
4322.021.30720	bush
4302.021.20020	clip

Table 3 P26/16 Potcores

A. PRE-ADJUSTED PAIRS WITH STANDARD μ_e VALUES						
catalogue number 4322.022	grade of ferroxcube	effective permeability (μ_e)	number of turns α	tolerance on inductance %	adjustor type number 4322,021 . . .	adjustor colour
24030	387	33	120	±1	30760	green
24040	387	47	100.5	±1	30770	red
24050	387	68	83.6	±1	30960	yellow
24060	387	100	68.9	±1.5	30970	white
24070	387	150	56.3	±2	30730	brown
24080	387	220	46.5	±3	31080	grey
24230	3H1	33	120	±1	30760	green
24240	3H1	100.5	100.5	±1	30770	red
24250	3H1	68	83.6	±1	30960	yellow
24260	3H1	100	68.9	±1.5	30970	white
24270	3H1	150	56.3	±2	30730	brown
24280	3H1	220	46.5	±3	31080	grey
24430	3D3	33	120	±1	30760	green
24440	3D3	47	100.5	±1	30770	red
24450	3D3	68	83.6	±3	30960	yellow
24810	4C6	15	178	±1	30760	green
24820	4C6	22	147	±1	30770	red
24830	4C6	33	120	±1	30970	white
04000	3B7	1750	16.5	±25	–	–
04200	3H1	1750	16.5	±25		
04000	3D3	705	25.9	±25		

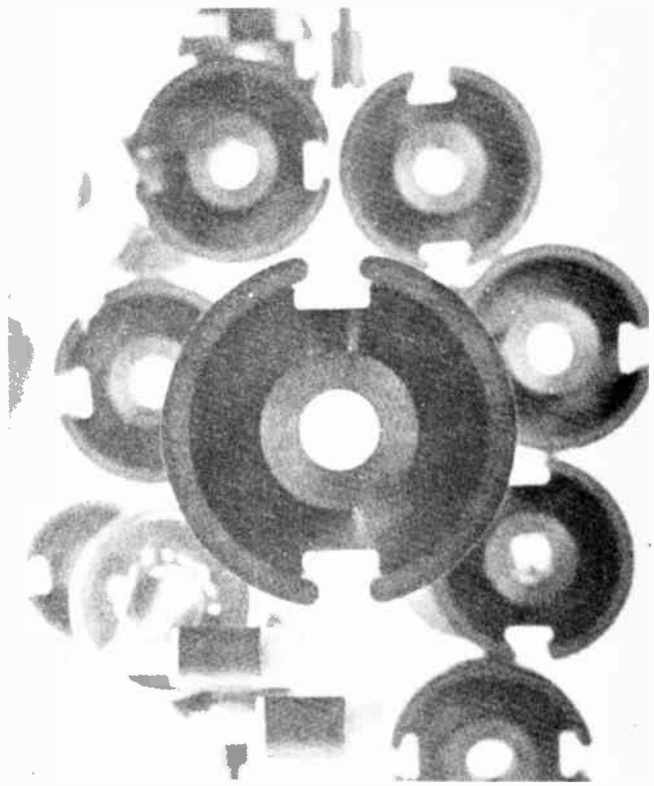
$N = \alpha \sqrt{L}$ (L ir 10^{-3} H)

B. PRE-ADJUSTED PAIRS WITH STANDARD AL FACTORS						
catalogue number 4322.022	grade of ferroxcube	AL factor	corres-ponding μ_e value	tolerance on inductance α	adjustor type 4322.021 . . .	adjustor colour
25030	3B7	63	30	±1	30760	green
25040	3B7	100	47.5	±1	30770	red
25050	3B7	160	76	±1	30960	yellow
25050	3B7	250	119	±1.5	30970	white
25070	3B7	315	149	±2	30730	brown
25080	3B7	400	190	±2	31080	grey
25100	3B7	630	298	±3	31080	grey
25230	3H1	63	30	±1	30760	green
25240	3H1	100	47.5	±1	30770	red
25250	3H1	160	76	±1	30960	yellow
25260	3H1	250	119	±1.5	30970	white
25270	3H1	315	149	±2	30730	brown
25280	3H1	400	190	±2	31080	grey
25300	3H1	630	298	±3	31080	grey
25420	3D3	40	19.0	±1	30760	green
25430	3D3	63	30	±1	30760	green
25440	3D3	100	47.5	±1	30770	red
25450	3D3	160	76	±1	30960	yellow
25810	4C6	25	11.9	±1	30760	green
25820	4C6	40	19.0	±1	30770	red
25830	4C6	63	30	±1	30970	white

C. COIL FORMERS	
catalogue number	number of sections
4322.02130270	1
4322.021.30280	2
4322.021.30290	3
4322.021.30090	1 with pins
4302.021.20010	1 with pins

C. MOUNTING PARTS	
catalogue number	description
4322.021.30530	container
4322.021.30640	spring
4322.021.30450	tag plate
4322.021.30710	nut
4322.021.30720	bush
4302.021.20000	clip

Potcores not pot luck



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Now we have 308 different types of potcores. We've called them the Philips "P" Series. They're all listed in a handy ready reference for easy selection.
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ELCOMA, P.O. Box 50,
LANE COVE, N.S.W. 2066

* Pack quantities in sets of 10 pairs or 20 halves.

PREFERRED RANGE

P18/11 POTCORES—PRE-ADJUSTED PAIRS

Catalogue Number 4322.022	Grade of Ferroxcube	AL Factor	Corresponding μ e Value	Tolerance on Inductance %	Adjustor Type 4322.021	Adjustor Colour
25040	3B7	100	47.5	±1	30770	Red
25050	3B7	160	76	±1	30960	Yellow
25060	3B7	250	119	±1 5	30970	White
25070	3B7	315	149	±2	30730	Brown
25230	3H1	63	30	±1	30760	Green
25250	3H1	160	76	±1	30960	Yellow
25260	3H1	250	119	±1 5	30970	White
25270	3H1	315	149	±2	30730	Brown
25280	3H1	400	190	±2	31080	Grey
25300	3H1	630	298	±3	31080	Grey
04000	3B7	3673	1750	±25	—	—
04200	3H1	3673	1750	±25	—	—
SEPARATE POTCORE HALVES						
4322 020 21500	3B7	≥2770	≥1310	—	—	—
4322 020 21510	3H1	≥2770	≥1310	—	—	—

P26/16 POTCORES—PRE-ADJUSTED PAIRS

Catalogue Number 4322.022	Grade of Ferroxcube	AL Factor	Corresponding μ e Value	Tolerance on Inductance %	Adjustor Type 4322.021	Adjustor Colour
·29080	3B7	400	127	±2	30810	Brown
·29260	3H1	250	79.5	±1	30980	White
·29270	3H1	315	100 2	±1 5	30980	White
·29280	3H1	400	127	±2	30810	Brown
·29300	3H1	630	200	±3	30810	Brown
·29310	3H1	1000	318	±3	31090	Grey
08000	3B7	6009.3	1910	±25	—	—
08200	3H1	6009.3	1910	±25	—	—
SEPARATE POTCORE HALVES					L = N· AL (10 H)	
4322 020 22000	3B7	≥4504.3	≥1430	—	—	—
4322 020 22010	3H1	≥4504.3	≥1430	—	—	—

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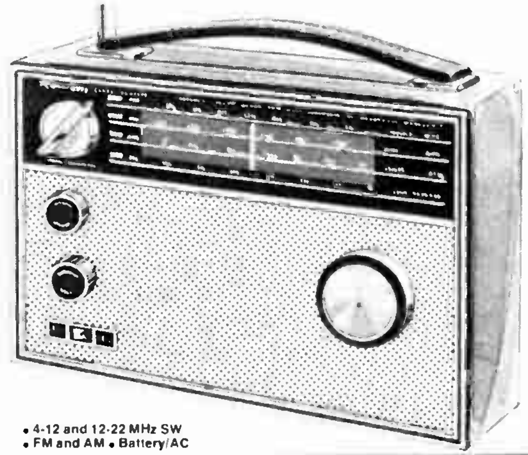

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• SEVEN HILLS	Shop [illegible]0B Regional Centre	Phone: 622-7507
• GOSFORD	Imperial Centre Mann Street	Phone: 043 24-3392
• CAMPBELLTOWN	[illegible] Dumaresq Street	Phone: 046-23524
• MERRYLANDS	20[illegible] Merrylands Rd	Phone: 637-4448
• HORNSBY	[illegible]b Burdett Street	Phone: 47-1673
• MIRANDA FAIR	Fountain Court Level	Phone: 525-3350
• EMERTON	Shop 17 Emerton Village Jersey Road,	Phone: 625-5870
• MAROUBRA	181 Maroubra Rd	Phone: 34-5683
• NEWCASTLE	788 Hunter Street West	Phone: 69-2207

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EQUIPMENT NEWS

HEATHKIT MODEL 1B-1103 FREQUENCY COUNTER

Recently released by the Schlumberger Group is the Heathkit model IB-1103 frequency counter. This is an eight digit instrument designed for radiotelephone service applications.

Frequency range is 180 MHz with a resolution of 1 Hz higher resolution at audio frequencies such as is required in selective tone calling. A phase lock multiplier has been incorporated, this gives a resolution of 0.0001 Hz on low frequency signals with a gate time of 1 second.

A temperature compensated crystal oscillator is used giving an aging rate of 1 part per million per year. The oscillator may also be externally synchronised.

Further details: Schlumberger Instrumentation Australia Pty Ltd, 112 High Street, Kew 3101 P.O. Box 138, Kew Vic.

INDUSTRIAL RADIO LINK

The SILVERSTONE IRL-5 is a modern radio control link, designed specifically for simultaneous control of both switched or proportional control functions. Designed on the modular principle the IRL-5 may be tailored to customers' requirements swiftly and economically, hence fulfilling the role of an almost off the shelf, customised remote control system.

Capable of handling up to 40 or more separate command functions, all of which may be used simultaneously, the SILVERSTONE IRL-5 will go a long way towards satisfying the need for an economical and versatile radio control link.

The SILVERSTONE IRL-5 is basically a digital system utilising pulse position modulation. The command information is directly proportional to the time interval between adjacent pulses. This time interval is decoded and fed into a reference generator (one per channel) which rejects all pulses below a predetermined width. Depending on each customers requirements, these decoded pulses are then used to control, either closed-loop servos or to energise relays. In the case of a customer requiring a high noise immunity or elaborate security, several pulses may be fed into a "NAND" gate, thus ensuring the required security level. The greater number of pulses fed into the "NAND" gate, the greater the security.

The standard transmitter section is a one watt unit available on either the 27 MHz or 40 MHz industrial frequencies. The bandwidth of the system is such that two units only 15 kHz apart may be operated in close proximity without interference. This allows up to 22 units to operate in close proximity on the available frequencies.

Further details: Silvertone Electronics, 6/2 Schofield St., Riverwood, NSW.

CLOSED LOOP AC CONTROLLER

A closed loop ac controller with a range of from 25 V to 250 Vrms is being produced by Westinghouse Ltd. It is suitable for a wide range of medium power applications including control of loads on motors, infra-red heaters, and incandescent lamps using tacho generators, thermistors or optoelectric devices as sensing elements.

The module includes all the triggering circuitry, a comparator circuit and operational amplifier. These are fed from an internal power supply which is derived from the external mains dropping resistor. As a result, it is claimed, very few external components are required to make up a flexible closed loop control using the internal operational amplifier.

Using thick film circuitry with chip and discrete components bonded onto a ceramic substrate the device offers optimum thermal transfer to an electrically isolated baseplate. The circuits are fully encapsulated to provide reliability with protection against a wide range of environmental conditions.

Modules can be supplied fitted to heatsinks.

Further details: Westinghouse Brake & Signal Co. (Aust) Pty Ltd, 49-51 Wellington Street, Windsor, N.S.W. 3181.

DIGITAL SIGNAL GENERATOR

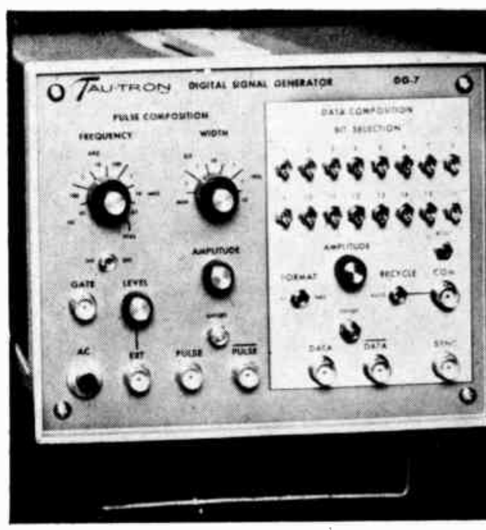
Tau-Tron's Model DG7 Digital Signal Generator is an inexpensive dual purpose pulse/data generator for device and IC testing, printed circuit logic board checkout, exercise of memory systems and testing communication links.

Particular features that make it versatile include: individual pulse and data output, capable of driving up to 10 volts with ±4 volts offset; sixteen bits/word, both true and compliment; variable frequency DC – 35 MHz plus amplitude; offset and width variability on the pulse generator.

Rise and fall times are less than 7nS with RZ and MRZ availability.

Both serial and parallel combinations of DG7 units are possible, a typical serial example being two DG7 connected in a series ring to provide a 32 bit data stream.

For further details contact: Arlunya Pty. Ltd., P.O. Box 113, Balwyn, Victoria 3103. Tel: 836-6533.



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NEW AC CARRIER PREAMPLIFIER FOR HP OSCILLOGRAPHIC RECORDER

Physical variables such as strain, pressure, force, velocity and flow can be measured in noisy electrical environments with this new Model 17403A AC Carrier Plug-in Preamplifier for Hewlett-Packard's 7402A 2-Channel Oscillographic Recorder. The 17403A is a signal conditioning interface between passive transducers (AC or DC) and the Model 7402A recorder.

The 17403A has a true differential floating input with common mode rejection of 120 dB at 60 Hz. Almost any passive transducer (requiring excitation) can be used with the Model 17403A, including LVDT's, RVDT's and strain gages. Transducers with full scale sensitivities from as low as 0.1 mV/V to 5V/V can be used.

Calibrated zero suppression is standard. It is used in analysing small signals when large static loads are present on the transducer. Overload indication is also standard.

Uses for the 7402A with the 17403A include measuring physical variables in industrial or medical research and development, product line testing of components, or trouble-shooting.

Further details: Hewlett-Packard Australia Pty Ltd, 31-41 Joseph St, Blackburn, Vic. 3130.

LOW COST SIGNAL CONDITIONING SYSTEM

A new series of inexpensive galvanometer conditioning modules for use with oscillographs has been developed by SE Labs (EMI) Ltd., of Great Britain.

The first unit commercially available, known as the "Mini-System", is designated the SE 993. Drive for medium and high current galvanometers is provided by a six-channel amplifier and attenuator.

Inputs from 0.5 to 500 volts drive full scale output currents of 75 mA. The SE 993 is a three terminal network with a common

EQUIPMENT NEWS

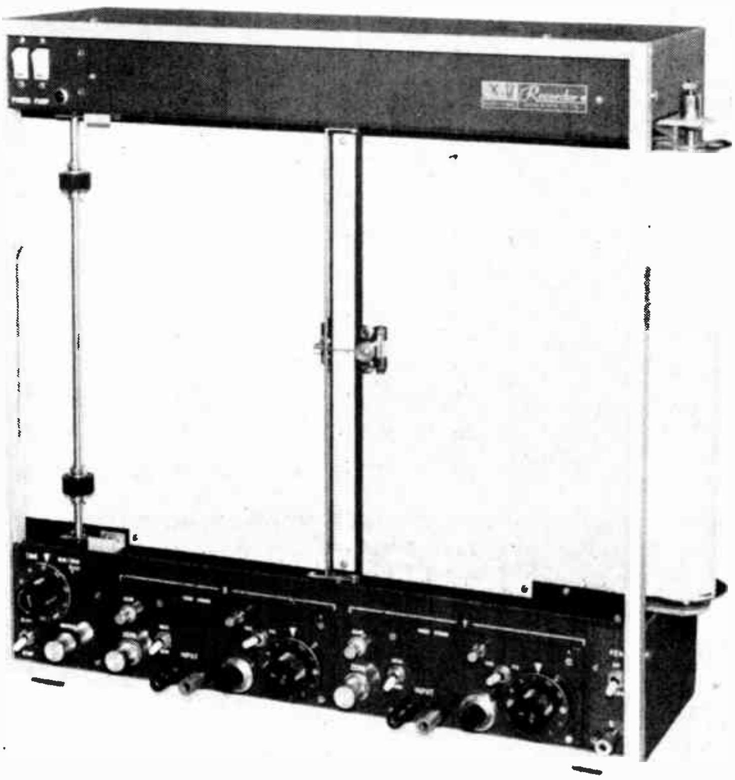
line between input and output. Common mode signals are rejected since each amplifier, in a six-channel bank, has its own isolated power supply.

A standard 19" rack mounting can be used for the SE 993 six-channel unit. For table use, the SE 990 cabinet, which can accommodate 12 channels (two banks), may be more convenient.

The sole Australian distributor for SE Labs, Watson Victor Limited, advise that customers' own suggestions for new "Mini-System" modules will always be welcomed.

Further details: Mr. Carl Toovey, Watson Victor Ltd.

HIGHLY SENSITIVE X-Y RECORDER



The RIKEN DENSHI Model F-24C is a multi-purpose X-Y recorder designed for versatile research applications. The recorder operates as a normal 250 mm x 250 mm X-Y plotter, but it can also be operated as a 250 mm strip chart recorder, resulting in a plotter with an almost unlimited time base, which is accurate to better than 1%, even for the slowest rates.

Measuring voltage can be set at any desired value, by the built-in vernier. Ten different chart speeds from 75 mm/hr to 480 mm/min. for strip chart recording. High common mode rejection of ac and dc signals ensures stable recording of any input signal.

Even at the maximum sensitivity of 2 mV full scale, accuracy and stability is ensured by the built-in two-step clamping circuitry.

Other salient features include 0.4 sec. full scale both axes, ±0.2% linearity; ±0.3% accuracy and vacuum hold down.

Further details: John Morris Pty Ltd, 63 Victoria Avenue, Chatswood, N.S.W. 2067.

RF POWER AMPLIFIERS

A new range of power amplifiers from Marconi Instruments together cover the frequency range 50 kHz to 500 MHz with gain up to 47 dB and maximum power output 10W.

Models TF2167 and TF2175 are broadband amplifiers whilst TF2172 is tunable in six bands and has sufficiently wide selectivity to allow use with most forms of modulation, but narrow enough to provide excellent harmonic rejection. A typical application for the TF2172 is to amplify the harmonic output from a signal generator thus enabling it to be used over a wider frequency range.

With the exception of a single tube in the output stage of the TF2172 the amplifiers are all solid state.

Further details: C/- Amalgamated Wireless (Australasia) Limited, 422 Lane Cove Road, North Ryde, N.S.W. 2113.

DIGITAL CARTRIDGE RECORDERS

Penny & Giles Data Recorders Limited of the U.K. have released a new series of digital cartridge recorders incorporating the 3MDC300A data cartridge. Designated the PG200 series, the new cartridge recorder is designed as a modular system available in four stages of sophistication from the basic tape transport with its servos, right through to a fully fitted 4-track system with integral control logic, read/write electronics and ac power supply.

The series of units have been specifically developed to satisfy the requirements of the OEM manufacturer who will have the advantage of only purchasing hardware which is outside his capability. This concept results in considerable cost savings, making the PG200 a cost effective unit for any data processing system.

Several design innovations have been achieved. For instance, a comprehensive phase lock data recovery system which compensates for speed variations and data rate writing errors, or an ac powered unit eliminating the need for dc power supplies.

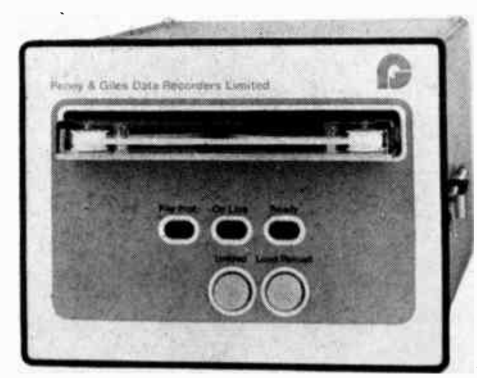
The units operate with read/write speeds of 30 ips and rewind and search speeds of 90 ips whilst maintaining start and stop times of less than 15 and 25 milliseconds. The cassette, operating with a density of 1600 bpi, phase encoded, has a capacity greater than 20 x 10^6 unformatted bits.

The control system permits manual or remote operation with status indication linked to a fully locked interface system which is comprehensive and foolproof.

The DC300A data cartridge used in the PG200 is designed around an elegantly simple drive system consisting of a capstan, two tension rollers and a unique continuous drive band partially wrapped around the periphery of the tape on both the supply and take up hubs. Compliance inherent in the band provides consistent tape tension at all times. External power is applied to the drive through the single capstan, making tape control extremely simple whilst providing for search speeds up to 90 ips. Because tape handling is a function of the tape cartridge and not the motor, the tape cannot spill, stretch or break under any conditions.

Tape handling is fast, accurate and precise and physical distortion of tape is insignificant.

Further details: British Merchandising Pty Limited, 49 York Street, Sydney, GPO Box 3456, Sydney, 2001.



PRECISION DIGITAL THERMOMETERS

Two digital thermometers, claimed by the manufacturers to be the most accurate in the world, are now available from Kenelec Systems Pty. Ltd.

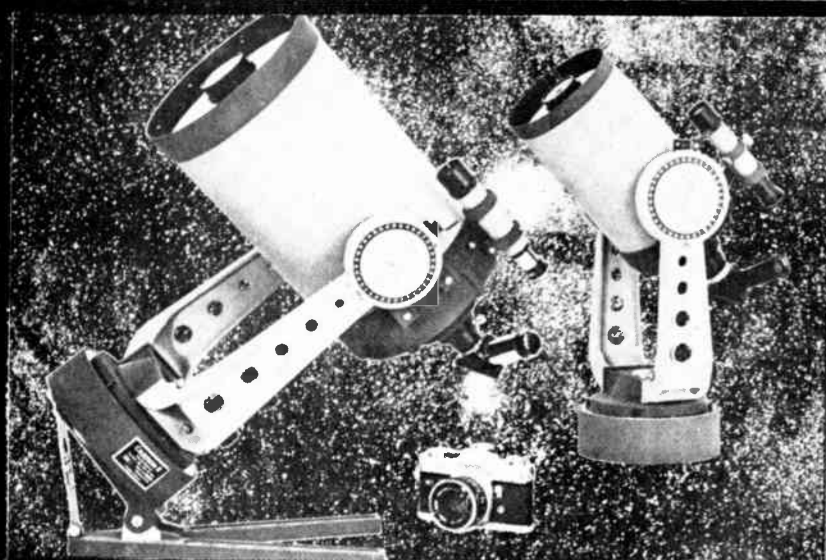
Features of the most popular model, the Doric DS-100-T5, include 1 microvolt sensitivity, which virtually eliminates self-heating errors, digital linearization technique which allows use from 10°K to 1063°C, and compatability with any resistance type element – platinum Ro's from .25 ohms to 5000 ohms. More than 50 ranges are available to optimise accuracy exactly where it is needed, with stability and repeatability to .01°. Multichannel capability is available at low cost, with no sacrifice in accuracy. Some special capabilities have been built in to the other model, the DS-100-T1. These include the measurement of both absolute and differential temperatures, high speed capability up to 20 readings per second, and DVM plug-in facilities for laboratory versatility. Perfect zero stability is claimed, with accuracies as fine as 0.03°C depending on the temperature range chosen.

Further details: Kenelec Systems Pty Ltd, 142 Highbury Road, Burwood, Vic. 3125.

ECONOMICALLY-PRICED L.F. GENERATOR

An economically priced low-frequency generator, combining low output distortion with a very flat frequency response, has been announced by Philips. Designated the PM 5106, this 10 Hz to 100 kHz instrument is an important addition to the company's range of low frequency equipment. The unit meets particular needs for a simple sine/square-wave generator with a powerful output – such as in the educational market.

With 0-10 V rms no-load sine-wave and 0-20 V_{p-p} square-wave, outputs the PM 5106 has a typical signal distortion of less than 0.8% to 100 kHz, and a frequency response that is better than 0.2 dB referred to 1 kHz for sine-wave and 0.05 dB for square-wave signals. Rise-time on square-wave signals is less than 0.3 us.



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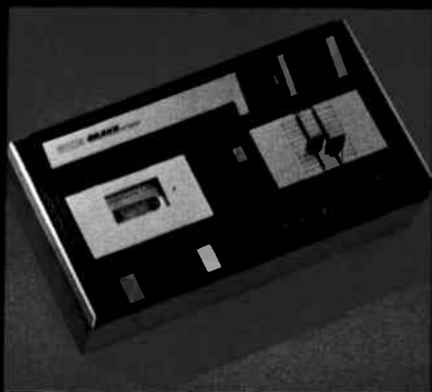
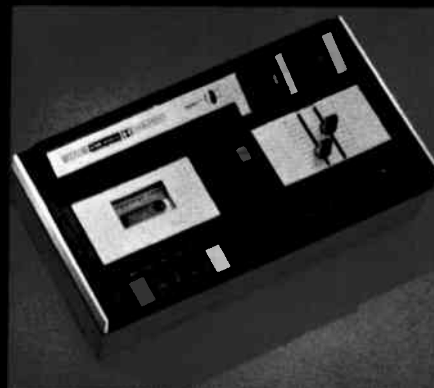


AKAI CS30 D
Top quality deck **$149**



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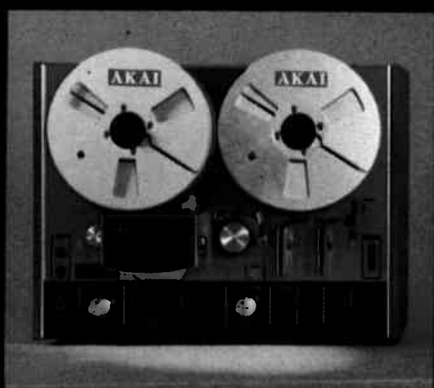
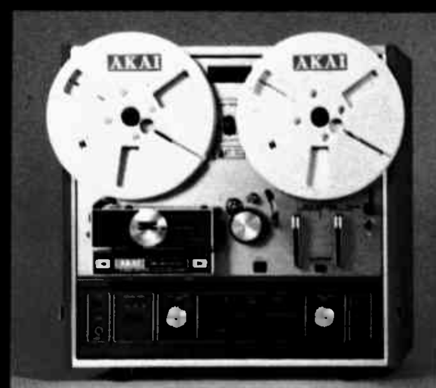
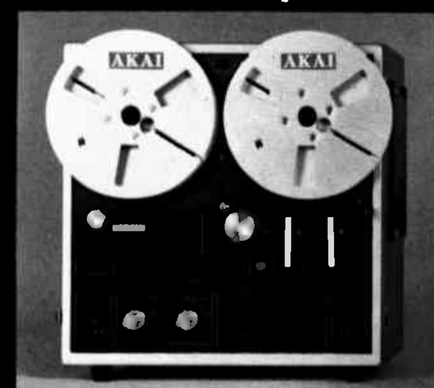
Worlds best value, life time warranty heads **$255**



AKAI 4000DS HI FI DECK
3 heads super value **$219**



AKAI 201D
3 motor deck cross field heads
$299



AKAI 1721
full recorder, complete **$269**

Plus these LINEAR DESIGN Hi-Fi Amplifiers all with 2 YEAR warranty

A107	20 watts rms	$89
8000	100 watts rms	$199
169-B	32 watts rms	$95
2500	50 watts rms	$149

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Complete range of fabulous Memorex tapes and Jensen Hi-Fi speakers

No matter what you want in a speaker, hear it is.

Whatever you want in a speaker—we've got the lot. Whether you want to build a new system or upgrade an already existing one, Plessey have a complete range of loudspeakers, midrange and tweeters—everything you could ask for in high quality high fidelity sound. Plessey offer not only the best results but also the best sound value.

WOOFER & WIDE RANGE

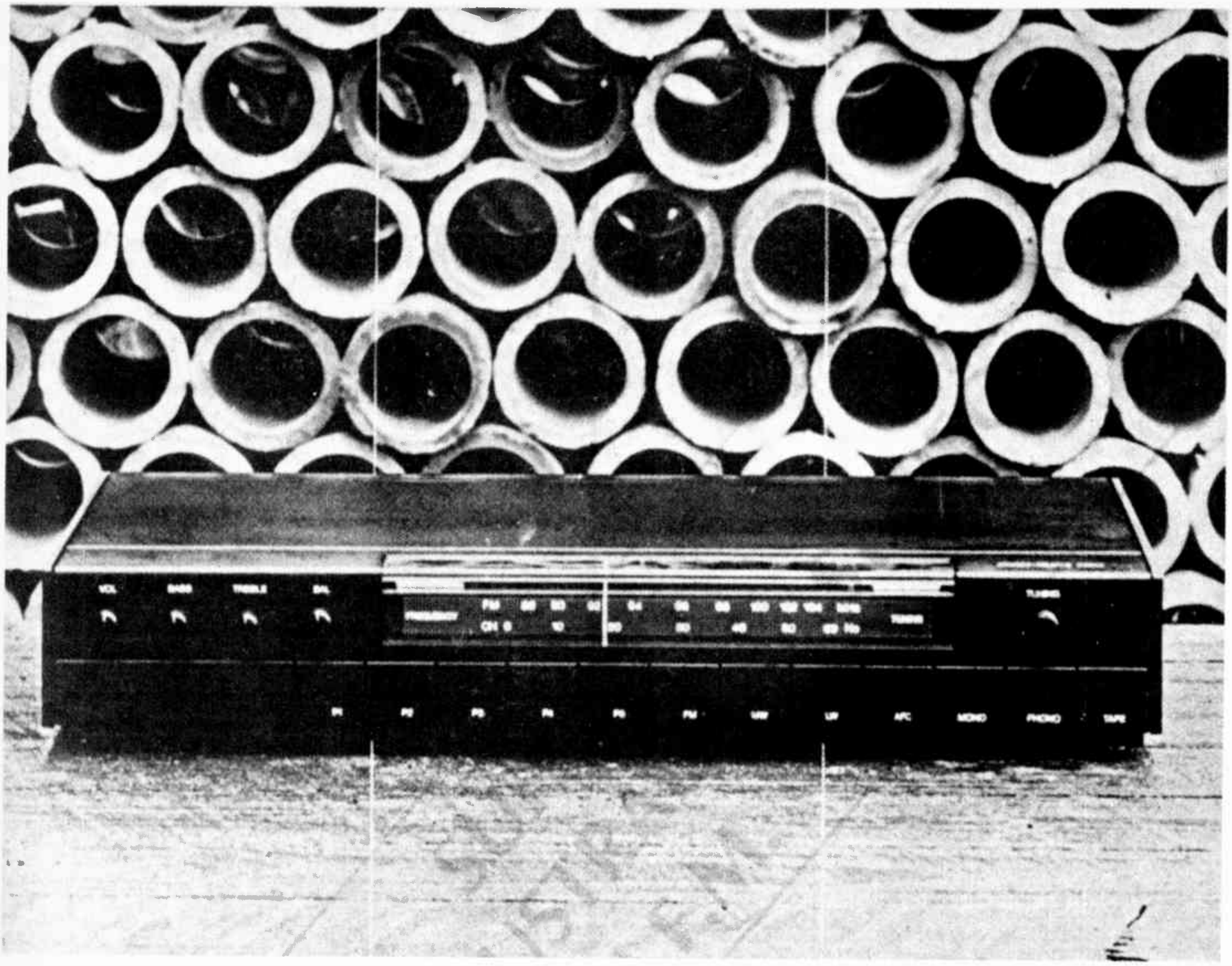
LOUDSPEAKER	POWER HANDLING	FREQUENCY RESPONSE
KC6M	8W RMS	50Hz-11kHz
KC6MX	8W RMS	50Hz-20kHz
C60	10W RMS	35Hz-7500Hz
C60X	10W RMS	30Hz-17kHz
C80	20W RMS	35Hz-8kHz
C80X	20W RMS	35Hz-20kHz
C100	20W RMS	40Hz-11kHz
C100X	20W RMS	40Hz-20kHz
C12P guitar	30W RMS	55Hz-10kHz
C12P woofer	30W RMS	35Hz-10kHz
C12PX wide range	30W RMS	35Hz-13kHz
C12PX guitar	30W RMS	55Hz-13kHz
12U50	50W RMS	25Hz-11kHz
12UX50	50W RMS	40Hz-13.5kHz
MIDRANGE		
C6MR	20W RMS	450Hz-6600Hz
KC5MR	15W RMS	700Hz-14kHz
TWEETERS		
X20 horn	—	3kHz-30kHz
X30 dome	—	3kHz-30kHz
KC 3G X cone	—	1.5kHz-19kHz
5FX cone	—	4kHz-20kHz

PLESSEY

Plessey Australia Pty. Limited,
Components Division,
The Boulevard, Richmond, Vic. 3121

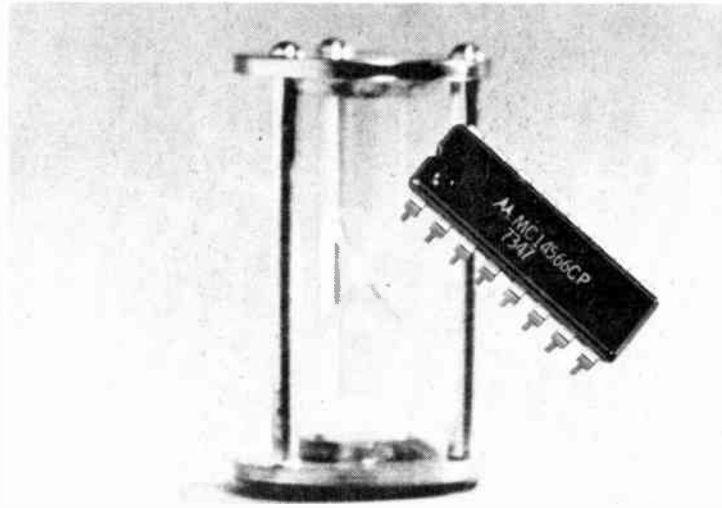
Distributors & Stockists: N.S.W. Lawrence & Hanson Pty. Ltd., Martin De Launay Pty. Ltd., Dick Smith Wholesale Pty. Ltd. VIC. Lawrence & Hanson Pty. Ltd., Radio Parts Pty. Ltd. W.A. Atkins Carlyle Ltd. QLD. The Lawrence & Hanson Electrical Co. (Qld.) Ltd. S.A. Gerard & Goodman Pty. Ltd. TAS. Harts Wholesale, W. & G. Genders Pty. Ltd. N.Z. Plessey (N.Z.) Limited, Rata Street, Henderson, Auckland. In all states, Kits-Sets (Aust.) Pty. Ltd.

AR68



COMPONENT NEWS

TIME BASE GENERATOR PROVIDES MINUTE AND SECOND INTERVALS



Accurate time outputs can be generated from either a 60 or 50 Hz line frequency using a new Motorola complementary MOS IC designated the MC14566. Capable of dividing by, 5, 6,10,50 or 60 the time base generator (TBG) can convert the incoming power line frequency to a binarily coded decimal output.

The McMOS circuit consists of a monostable multivibrator and two ripple counters. One ripple counter is a ÷ by 10, and the other counter is ÷ 5 or ÷ by 6, selectable by external pin control. By cascading as ÷ by 60 counters, seconds and minutes can be counted and are available in BCD format at the circuit outputs. The internal monostable multivibrator output can be used as a reset or clock pulse generator to provide added frequency flexibility.

The divide-by-5 counting has been included for generating 1.0 Hz from a 50 Hz power source. This function is controlled by a separate pin on the device. All inputs are diode protected to prevent circuit damage.

Full details: Motorola Semiconductor Products, Suite 204, Regent House 37-43 Alexander Street, Crows Nest. 2065.

MODEL 5528 PRESSURE SWITCH FEATURES 1% SET POINT ACCURACY

Bourns Model 5528 Industrial Pressure Switch designed and produced by the Instrument Division of Bourns, Inc. operates in areas where space is at a premium.

All mechanical linkages, bearings and multiplications have been eliminated and a diaphragm-actuated microswitch is available in single or dual configuration to provide either a double redundant system or separate circuits.

Standard Specifications:

Pressure Ranges – 0-10 to 0-250 psig; Wiring – single pole, double throw; Switch Rating – 3 amperes resistive at 28 Vdc; 2 amperes inductive at 28 Vdc; Sensor – single diaphragm Ni-Span-C material; Contact Resistance – 1.0 ohm maximum at 5 ±2 milliamperes dc.

In addition, the Model 5528 Industrial Pressure Switch has a stainless steel case to withstand high overload pressures and extreme shock environments while providing a high degree of accuracy. No calibration shift has been detected after a pressure of 150% of the rated ranges.

Further details: Tecnico Electronics, Premier St., Marrickville, N.S.W. 2204. Technico Electronics, 2 High St., Northcote, Vic. 3070.

SAFE SPRAY CLEANER

A combination of high solvency and spray force are claimed to provide a superior cleaning action for electrical equipment, according to Redic Australia Pty. Ltd.

The aerosol packed cleaner, identified as Redisol, is also claimed to be the safest known replacement for poisonous carbon tetrachloride and other extremely toxic chlorinated solvents.

For use principally as a cleaner and degreaser for electrical equipment, it is safe on all metals including aluminium, electrical insulation and most plastics. As a useful bonus, it is also safe and effective for fabrics.

Non-inflammable, fast drying, and leaving no residue, its applications also include sensitive mechanical equipment such as recorders, computers and vending machines.

Further details: Radio Australia Pty. Ltd., Sydney Road, Bayswater, Vic., 3153.

HOW TO USE LOW-CURRENT OPTO-ISOLATORS

A number of low-power applications for low-current, high gain optically-coupled isolators are detailed in a new four-page application note from Hewlett-Packard. It shows how HP's new 5082-4370 series isolators can be used where large common-mode signals are encountered along with low power requirments. The high current transfer ratio (CTR) of these devices enables them to be used in applications where there is insufficient input current for other isolators.

Applications described in the note include uses as RS232C line receivers, 1 to 5000-foot line receivers, a telephone ring detector, high-voltage status indicator and a party-line line receiver.

Application Note 951-1, 'Applications for Low Input Current High Gain Optically Coupled Isolators' is available free of charge by writing to MARCOM Department, Hewlett-Packard Australia Pty Ltd, P.O. Box 36, Doncaster East, Victoria, 3109.

ANALOGUE CIRCUIT FUNCTIONS

A comprehensive range of analogue circuit function packages is now available from Kenelec Systems Pty. Ltd.

Designed by Burr-Brown, the modules are claimed to improve both the speed and the cost of circuit and systems design, either simple or complex. By selecting the required functions and connecting them into the configuration, a working system can be produced.

The range includes multipliers, dividers, square root generators, sine/cos function generators, logarithmic amplifiers, comparators etc. Produced by the latest thin film, thick film and monolithic techniques in Burr-Brown's own production facility, the packages cover DIP's, flat packs, TO cans and specials such as transfer moulds and epoxy castings.

Units can be selected to handle specific application conditions and environments, such as high stability requirement, high noise environment, wide temperature range etc. Literature and application notes are available from Kenelec Systems Pty. Ltd., Melbourne 288 7100.

COLOUR C.R.T. FOR DATA DISPLAYS

Thomas Electronics of Australia Pty. Limited, under a Department of Supply contract, have developed a 4-colour cathode ray tube for high density data display applications which greatly increases the readability of such displays.

The C.R.T. operates on the voltage penetration principle, and four distinct colours are obtainable by switching the anode voltage on the tube. At 8 kilovolts the display is red, and it changes through

orange and yellow to green at 16 kilovolts. The switching of EHT voltage can be achieved at speeds of up to 25 microseconds.

A high resolution magnetic focus gun is provided with a spot size of 0.3 mm, giving over 1,000 resolution elements per diagonal. Thus the voltage penetration system has the advantage of providing a degree of resolution not obtainable with shadow mask tubes.

Because of the colour range limitation and cost, these tubes are not at this stage suitable for colour T.V. applications. Thomas Electronics can provide this screen in a complete range of bulb types.

Further details: Thomas Electronics of Australia Pty Ltd., 12 Larkin St., Riverwood, NSW, 2210.

HERMETIC-PACKAGED MICROWAVE STRIPLINE SCHOTTKY DIODES

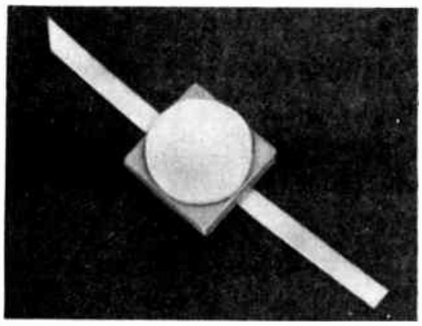
Two new microwave mixer Schottky diodes in hermetic packages are designed to operate in the 1 to 12 GHz range. The Hewlett-Packard Model 5082-2200 has a maximum noise figure of 6.0 dB and a VSWR of 1.5:1. A lower cost Model 5802-2202 has a maximum noise figure of 6.5 dB and a VSWR of 2.0:1.

Matched pairs of each model are also available. Model 5082-2201 is a pair of matched 5082-2200's; Model 5082-2203 is a pair of matched 5082-2202's.

The miniature hermetic package is designed for either microstrip or stripline, with flat leads that are easily soldered and provide good continuity of transmission line impedance to the diode. Hermetic sealing assures high stability in hostile environments.

These HP diodes are assembled using passivated silicon Schottky barrier beam lead diodes. Uniformity of RF characteristics is tightly controlled so that components can be replaced in the field without circuit adjustments. Typical equipment applications include telecommunications receivers, microwave synthesizers, ECM and radar front ends where high burnout rating and high sensitivity are required.

Further details: Hewlett-Packard Australia Pty Ltd., 31-41 Joseph St., Blackburn, Vic. 3130.



COMPONENT NEWS

ECONOMY THUMB-WHEEL SWITCH

The Digitran company of California, have now released a new addition to their 29000 Series economy thumb-wheel switch range.

Illustrated is the "New Message Unit" especially designed for use in digital clocks, alarm systems and timers.

This series is claimed by the manufacturers to be an ideal replacement for old-fashioned space consuming rotary switches.

The switches offer error-proof positive setting action, easily read in-line character display and maximum accuracy and reliability, as well as a far more attractive control panel.

The Series 29000 finds optimum use in test and measurement instruments, numerical machine control settings of variable operations, process control systems, data terminals or any other applications where visual monitoring of variable data input will help eliminate operator error.

Standard case material is ABS thermoplastic in black. Printed circuit boards are laminated fibreglass. As a result of new design, tooling and fabrication techniques, the Digitran company can now offer this highly economical miniature switch with a quality level and operational specifications which compare favourably with other Digitran thumb-wheel switches.

Further details: British Merchandising Pty. Ltd., 49 York Street, Sydney, G.P.O. Box 3456, Sydney, 2001.

ELECTROPNEUMATIC THICKNESS SENSOR

Schaevitz Engineering have produced a thickness measuring sensor that does not need to touch the object being measured.

Using the new device, delicate and deformable materials can be monitored for thickness variations with a precision of 2.5 thousandths of a millimetre.

The device, a null sensing pneumatic servo, maintains a constant gap from the working material which may be paper, plastic or coated metal while an electronic sensing device monitors the profile. The electronic section is basically the Schaevitz LVDT, which has a very accurate electrical output proportional to displacement.

Further information available from: Ronald J.T. Payne Pty. Ltd., 385 Bridge Road, Richmond 3121. Tel: 42-1416.

BOURNS ANNOUNCES NEW ECONOMY SINGLE-TURN PRECISION POTENTIOMETERS

A ball bearing supported shaft, and long-life conductive plastic elements are incorporated in Bourns two new economy priced precision potentiometers. The new 7/8" diameter units are the Model 6538 (servo mount) and 6638 (bushing mount).

Both models are designed for extensive customizing, and are available with a long list of options. Standard models feature moulded-in rear terminals, independent linearity of 1.0% output smoothness of 0.1%, front and rear ball-bearing shaft support, and an extended temperature range of -65^{o} to $+125^{o}$C.

Significant specifications (standard models)

- Resistance range, lK ohm to 100K ohm
- Resistance tolerance, ±10%
- Resolution, Infinite
- Power rating – watt at 70°C
- Rotational Life, 20 million shaft revolutions.

Further details: Tecnico Electronics, Premier St., Marrickville, 2204. N.S.W. Tecnico Electronics, 2 High St., Northcote, 3070. Vic.

SMOKE & GAS DETECTOR

Appropriately called the COSMOKE GASALARM, a sensitive smoke and gas detector is now available in Australia from Kimpex Pty. Ltd.

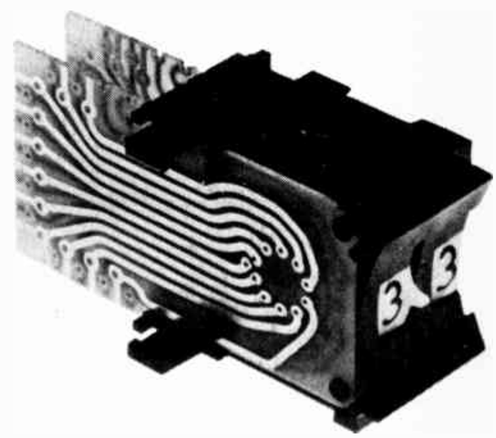
Developed in Sweden, the measuring element is a new type of catalytic semiconductor which uses a heating element to obtain variable sensitivity in its bridge coupling. It is designed to detect small quantities of carbon monoxide, hydrocarbons, chlorine gas, sulphur dioxide, ammonia and hydrogen sulphide, as well as explosive gases such as gasoline, propane and solvent gases.

Typical instrument indicating or alarm ranges are 0 – 5000 rpm CO in air; 0 – 0.5 or 0 – 0.05% LP Gas; and 0 – 10 mg/m^3 Cl_2 gas. For extreme sensitivity requirements, a 0 – 100 ppm range can be provided. When it is considered that cigarette smoke exceeds 500 ppm and car exhausts run from 10 000 to 100 000 ppm, this sensitivity can be readily appreciated.

As for exposure times, CO at 2000 ppm can kill in an hour or so. The COSMOKE provides for multiple detection points with appropriate instrumentation for indication or alarm systems.

Further details: Kimpex Pty. Ltd., 142 Highbury Road, Burwood, Vic., 3125.

INTERNALLY ILLUMINATED ROTOR MINIATURE THUMB-WHEEL SWITCHES



Philips' ELCOMA division have released an internally illuminated rotor thumb-wheel switch. This much sought after variety adds to an extensive range of miniature thumb-wheel switches carried by ELCOMA.

The switch comprises a white, translucent rotor, black lettering and a built-in lamp. The nominal rating of the lamp is 60/m A, 5 V. In total darkness the lamp voltage may be reduced to as low as 2 V. Specially designed, the lamp has a minimum life of 50 000 hours (5-7 years), with a corresponding extension for reduced voltage operations.

The switch is available ex-stock with the following functions:

Type LM 10 P1C –
10 position, 1 pole switch

Type LM 10 P2C –
10 position, 2 pole switch

Type LM 1248C –
Binary coding switch.

45 WATT UHF TRANSISTOR

Motorola have introduced a new UHF power transistor (MRF621). Designed for 12.5 Vdc operation in the 406 MHz to 512 MHz region, the MRF621 forms an ideal basis for power amplifier designs in commercial/industrial UHF mobile radio applications. This advanced technology device is rated 45 W P out @ 470 MHz, 12.5 Vdc collector supply. Minimum power gain is 4.8 dB and collector efficiency, 55% minimum. No degradation in output power occurs when working into a 20:1 VSWR at any phase angle.

Motorola Semiconductor Products, Suite 204, Regent House, 37-43 Alexander Street, Crows Nest 2065.

DATA TRANSMISSION APPLICATIONS NOTES

Monolithic integrated circuits designed specifically to transmit and receive digital data via differential cables and data buses have been available for several years. But important changes in transmission concepts and IC design have recently been made.

A new applications note from National Semiconductor called AN-73, Data Bus and Differential Line Drivers and Receivers, brings the designer up to date.

The applications note covers bus circuits which offer the advantages of: receivers; lower input currents, permitting more driver/receiver pairs per line; higher noise immunity and speed; and the elimination of the terminating pull-up resistors by employing a Tri-State output.

Further details: Electronics Pty. Ltd., Cnr. Stud Road & Mountain Highway, Bayswater. 3153. Tel: 729 6333.

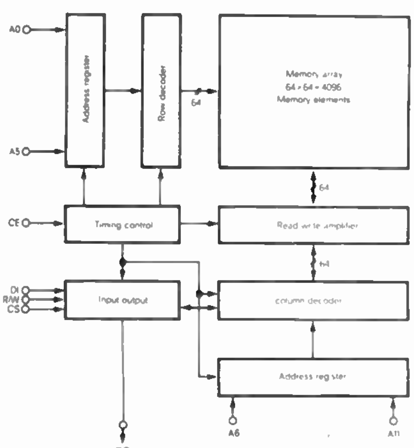
SIEMENS OFFERS 4096-BIT RAM, 15,160 TRANSISTORS ON 18 MM^3 CHIP

A dynamic read-write memory (RAM) with a capacity of 4096 words/one bit per word is now being introduced by Siemens. Samples of this module will be available this year from about the end of August.

The new semiconductor memory uses n-channel silicon-gate technology. A total of 15,160 transistors are integrated on a chip with the dimensions 4.4 mm x 4.1 mm = 18 mm^3. These transistors are used for the address and timing control circuits and for the sense amplifiers as well as for the memory elements.

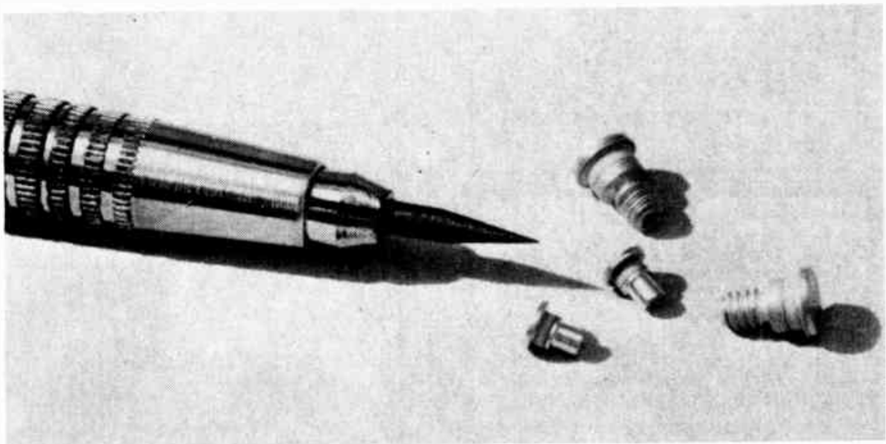
The S 142 operates with 12-V timing, from which the jointly integrated timing control circuit derives all other necessary timing pulses. The remaining inputs and the data output are TTL-compatible. The semiconductor memory requires powers of 12 V, 5 V and –5V.

Further details: All Siemen's offices, or Siemens Aktiengesellschaft, ZI/Presseabteilung Technik Joachim Ullmann, D-8520 Erlangen, Postfach 3240. Federal Republic of Germany.



COMPONENT NEWS

SILICON DIODE ACHIEVES OVER 1.5 WATTS AT 5.5 GHZ



Rated at 1.5 watts minimum power output at 5.5 GHz, this new Hewlett-Packard 5082-0423 silicon IMPATT diode typically provides 1.5 watts of output power over the band 4 – 6.4 GHz.

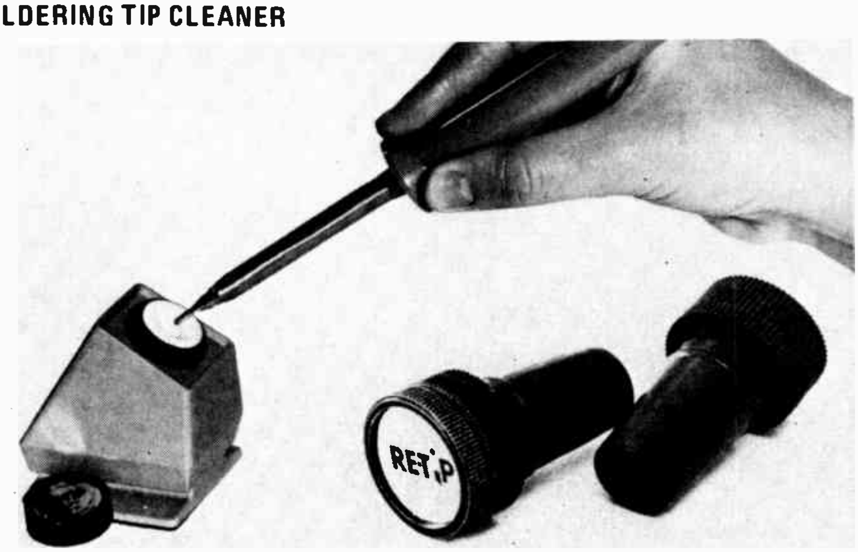
It is suited for use as the active element in microwave oscillators and amplifiers. It extends the frequency range of HP's 5082-0420 line down from 5.3 GHz to 4.0 GHz.

An IMPATT oscillator circuit, when properly designed, has noise performance comparable to reflex kylstron or Gunn oscillators.

The AM noise spec for the 5082-0423 is typically -140 dB in 100 Hz bandwidth, 1 kHz from the carrier; FM noise is typically less than 4 Hz (RMS) in 100 Hz bandwidth, 100 Hz from the carrier. Efficiency of the 5082-0423 is typically greater than 5.5%.

Further details: Hewlett-Packard Australia Pty Ltd, P.O. Box 36, Doncaster East, Vic. 3109.

SOLDERING TIP CLEANER



The oxides and contaminants which accumulate on the tip of a soldering tool can now be quickly removed with the aid of a device called the RETIP, available from Royston Electronics Pty. Ltd.

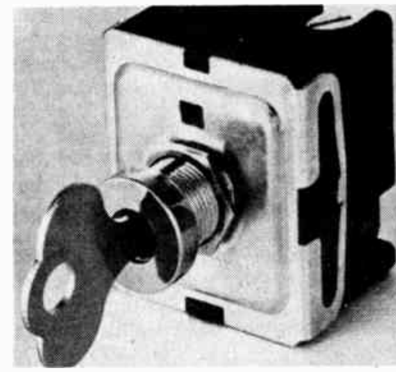
Simple insertion and withdrawal is all that is required. Normally an operating tip is uniformly tinned with a coating of solder, which soon oxidises. Retip assures the integrity of this protective coat by removing only the oxides and contaminants, and not the solder. Oxide scale is also removed from tips which need retinning.

The modern plated tip depends for its service life on preservation of the original plating, which means that abrasive cleaning methods must be avoided. There are no abrasives whatever in Retip. Another advantage is the fact that Retip absorbs a minimum of heat, so tip temperature is not significantly lowered during cleaning.

Retip is available in cartridge form for the toolbox, or in a non-skid base for bench application.

Further details: Royston Electronics Pty. Ltd., 22 Firth Street, Doncaster, Vic., 3108.

KEY-OPERATED SWITCHES



A series of key-operated switches with a wide range of applications are being marketed by AWA through Manufacturers Special Products.

These 240 Vac switches, made by Oak Industries Inc., USA, are for use in security systems, point-of-sale equipment, petrol pumps, elevators, garage doors and mini computers, as well as in other industrial equipment and appliances.

Both series have power input rating ranging from 7.5 up to 38 amps, including motor ratings up to 2 hp 240 Vac. They offer either single or double-pole switching, with indexing from 2 to 12 positions in steps of 30°, 45°, 51.42°, 60°, 72°, 90° or 180°.

Series KS-1 is also designed for applications that require "tamper-proof" control. This type of lock cannot be operated by a screwdriver or similar device.

These key-operated switches are also obtainable with low-power switch sections rated at 0.5 amp. 28 Vdc.

Further details: Manufacturers Special Products, Amalgamated Wireless (Australasia) Ltd., 554 Parramatta Road, Ashfield. N.S.W. 2131.

NOISE GENERATION DEVICES

Kenelec Systems Pty. Ltd. can now provide a comprehensive range of electronic noise generation devices, from small encapsulated noise source modules to full scale instruments.

As an example, their 1600 Series have dimensions of 45 x 40 x 18mm. These modules provide low level wide band output, with a portion of this wide band specified to a certain flatness. Frequency range is 10 Hz to 5 MHz. Frequency band of individual modules varies from 10 Hz/20 kHz or 10 Hz/500 kHz through to 5 kHz/5 MHz. There are 72 different frequency bands to choose from. Another series, the 1800, provides frequencies from 10 kHz to 100 MHz.

Complete solid state instruments, either cabinet or rack mounting, can also be supplied. The Model 602A, for example, has a rectifier type output meter circuit which reads proportional to average value, calibrated to read RMS value of Gaussian noise, 0-5 volts RMS scale.

Further details: Kenelec Systems Pty Ltd., 142 Highbury Rd., Burwood, Vic. 3125.

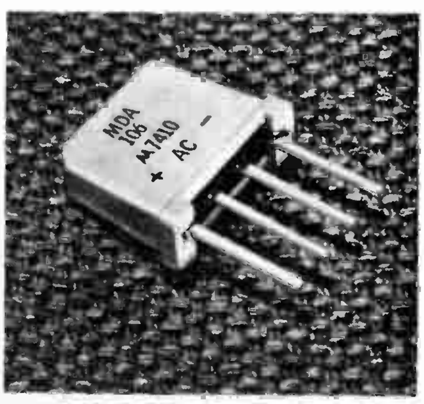
FULL WAVE BRIDGE RECTIFIERS DELIVER 1.5 AMPERES AT 55°C

The MDA100 series of full wave bridge rectifiers are encapsulated in miniature plastic cases.

These rectifiers utilize the same chips as the popular and time tested IN4000 rectifier series. Rated realistically at 55°C ambient for full output of 1.5 Amperes.

Peak repetitive reverse voltages are:— MDA100 – 50; MDA101 – 100; MDA102 – 200; MDA104 – 400; MDA106 – 600; MDA108 – 800; MDA110 – 1000.

Further details: Motorola Semiconductor Products, Suite 204, Regent House, 37-43 Alexander Street, Crows Nest 2065.



BUYING BY MAIL

Sometimes things go wrong — but it's not always the supplier's fault!

EVERY WEEK, literally thousands of people buy electronic components and constructional kits by mail order.

It's big business. One company alone — Dick Smith Electronics — receives over 200 orders a day, and Dick's just one of many other companies in this rapidly expanding field.

Considering the enormous turnover it's surprising how rarely things go wrong. "The vast majority of our business is quite straightforward", one supplier told us, "but that doesn't mean that mistakes don't occur.

Of course we make mistakes from time to time — but quite honestly not all the errors are ours".

Having leafed through some of the 'problem' letters, that seems the understatement of the year! Consider this beauty — and how one would answer it.

Dear Mr. . . . . .

I'm sick and tired of kitset suppliers who can't even supply simple components. I hope your much vaunted service is better — please send me the following parts:—

1/ Transformer with five wires
2/ Three inch by three inch meter
3/ Seven wire relay
4/ Six resistors type R1
5/ Half-inch diameter capacitor acitor (yellow)

Yours etc.

An extreme example certainly, but kitsets supplier's files are full of orders for R1's and C15's — fine if you know the project concerned, but nine times out of ten the customer is probably trying to buy bits for an obscure project printed in an overseas publication — who knows, they rarely say!

Other causes of problems seem so ridiculously obvious — but they happen time and again.

People forget to give their names and addresses — or write them so badly that they're unreadable. At one supplier I saw a totally blank coupon from Electronics Today together with an equally blank postal order — no other clues at all, apart from the Post Office stamp.

Then there are furious anonymous letters about equally anonymous orders — they have come together in the files because someone has noticed the handwriting is similar.

Other correctly addressed envelopes contain orders made out to other companies or ask for special items obtainable only from competitors.

Yet others ask technical questions about projects or ask for photostat copies of projects (generally impossible to supply without infringing copyright).

Many send cash or uncrossed postal notes in unregistered envelopes — a slightly risky procedure. Quite recently the Post Office were able to catch some of their staff stealing orders — but this still didn't stop the unlucky customers blaming the supplier!

In many suburbs, postal deliveries are so delayed that parcels may take at least a week to be delivered (A week! — you must be joking. In our local Post Office it's 12 weeks at present — Ed) but customers will often start abusing the supplier after only a few days.

So when you are ordering by mail do follow this procedure:—

1/ Use an order form if available.
2/ Place your order using the parts numbers quoted in the kitset supplier's catalogue or advt (if possible).
3/ Write — preferably print — clearly.
4/ Check the order before you send it.
5/ Check again to make quite sure you have included your name and address.
6/ Enclose crossed postal order or cheque. If you must send cash make sure the envelope is registered.
7/ Include a return address on the outside of the envelope. ●

KITSETS* piggy

KIT'S KOLUMN

Hum. There I am in the stock room and HE comes out of the Presidential suite and sez I have to write part of his ad for him because I know more about Kitsets stock then anyone. Lesee now . . . . .

Dimmit Dammit

A Trend light dimmer is just the thing for sexy mood lighting, NOT a kit. Comes ready to install with everything, including wall-plate and architrave fitting. Switch on and adjust globes or tubes from glimmer to glare. Easy — only 2 wires to connect. Usual white colour. Knob is golden.
P & P 50c **$9.90**

Petrol Stretcher

The way petrol is going, we'll soon be offering a pedalling kit. In the meantime, the big deal is electronic ignition. Our kit is the famous Electronics Australia 12 volt capacitor discharge unit (Aug 70). You'll pay over $40 for commercial boltons and we reckon this is still the best. Gets you better fuel economy, longer plug and points life, easier starting, zippier performance. Kit comes with secondary winding of transformer pre-wound. Complete with STC diecast box. Should pay for itself in 6 months. Tell us whether your car is positive or negative earth. P & P $1. **$20.50**

Keep your iron hot,

Kit

U-BUILD STEREO AMP. HUGE 50 WATT PER CHANNEL

Hang on to your house when you build this beauty. Superb ET circuit gives genuine 50W RMS per channel with both channels driven into 8 ohms at typically less than 2% distortion. Ideal for nerve-shattering jokes on your mother-in-law. If you can whack a crystal set together, this should be a snack for you. Complete with real teak cabinet.
P & P $2.

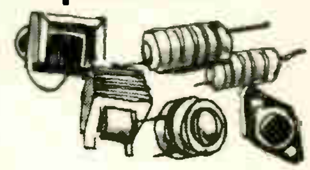
$115

PLAYMASTER 136 AMP. A LITTLE LESS IS A LITTLE LESS

$70

Maybe our 50W giant scares you. OK — go for this. It's undoubtedly the best medium powered amplifier kit on the market. 13 watts RMS per channel. Performs better than ready-made units at over 3 times the price. Has provision for simulated quad. Complete, including cabinet.
P & P $2.
(Less $8.25 if Fairchild transistor pack not required)

Component Specials



If these were our only lines, we'd be out of business at these low prices. Check us out then stock up. Prices go back up at end of October.

SEMI CONDUCTORS —
SN7400: 45c SN7442M: $1.21
SN744N: 99c SN7470N: 66c
SN7473N: 55c SN7490N: 98c

TRANSISTORS —
BC107: 10 for $1.80 BC108: 10 for $1.80 BC109: 10 for $1.80 BC177: 10 for $2.20 BC178: 10 for $2.20 BC179: 10 for $2.20

DIODES —
A15A: 70c IN914: 10 for $1.20 IN4004: 10 for $1.40 A14A: .22c

POLYESTER AND TAG TANTALUM CAPACITORS
All 10% off our 1974-75 catalogue prices. Pack/post .50c

Abracadabra Screen Wipers

12V Variwiper kit is something you can knock together in a night. A lifesaver in light rain or mist — operates wipers at selected intervals instead of continuously. Terrifies parking police. Commercial units selling in auto accessory shops for around $14. Our kit price: (P & P 50c) is only

$8·00

Multimeters & Test Equipment

University Graham Multimeters:
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NEW REGULAR ETI FEATURE!

As the name of this section implies, these pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory.

Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we provide constructional details.

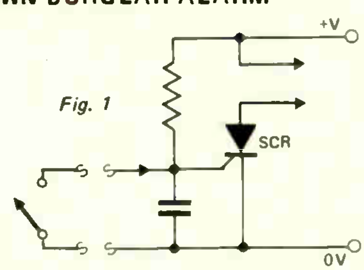
Electronics Today is always seeking material for these pages. All *published* material is paid for — generally at a rate of $5 to $7 per item.

IDEAS FOR EXPERIMENTERS

A potpourri of circuits, ideas, hints and tips.

HOW NOT TO DESIGN YOUR OWN BURGLAR ALARM

Fig. 1



Innumerable designs have been published for simple burglar alarms based on variations of the circuit shown in Fig. 1. In these circuits an SCR is normally prevented from triggering by the external guard circuit — which is supposed to short the SCR gate to cathode.

These circuits are fine if the external leads are only a few inches long — but completely hopeless for most alarm applications where the external circuit may extend to hundreds of feet.

Never ever hang an 'aerial' onto the gate of an SCR. If you do, that SCR will be triggered by every electrical disturbance for miles. Thunderstorms, arc welders, contactors, fluorescent light starters, power drills — everything and anything is liable to trigger the SCR into conduction — and thus cause false alarms.

Many of these circuits show a capacitor or resistor connected from cathode to gate — this the project explains — is to prevent false triggering.

It doesn't.

The problem may be completely overcome by adding a capacitor, a unijunction and a few resistors as shown in Fig. 2. This circuit is virtually false-alarm proof. As long as the external loop is closed, the capacitor is shorted out. There is no way in the world that the UJT can oscillate — and until it does, that SCR is firmly held off.

Another advantage of the revised circuit is that, by suitably selecting C1/R1, a time delay may be built into the triggering circuit. This delay should preferably be half a second to one second. It is very worthwhile incorporating as it will prevent false alarms due to an external alarm switch momentarily vibrating open due perhaps to sudden wind gusts physically disturbing a structure.

A further problem with the circuit (Fig. 1) is that the SCR may also be tirggered by signals picked up in the SCR anode leads to the alarm bell.

This can be overcome by using the SCR to trigger a relay. If a second pair of contacts are available then these should be used to self-latch the relay thus further ensuring that the alarm will stay latched on (the SCR is of course self-latching).

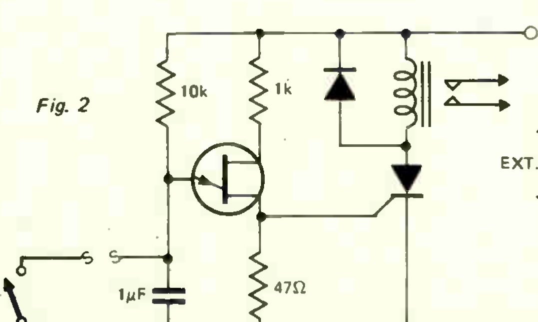
With transistor alarm circuits, another problem may arise if a circuit such as that shown in Fig. 3 is used.

Here the external triggering circuit is part of the bias circuit for Q1. Normally the closed external circuit will cause Q1 to be biased on via R1.

This circuit works well if fairly low value resistors are used for R1 and R2. However if R1 exceeds 75 k or so, problems may arise. What happens is that moisture across the external switches or leads can create a high resistance 'short' across the alarm circuit. This 'short' will appear to the alarm input as a closed switch and will prevent the alarm functioning if external triggering switches are opened.

So keep the values of those bias resistors down low. About 47 k for R1 and 4.7 k for R2 is about right.

Fig. 2



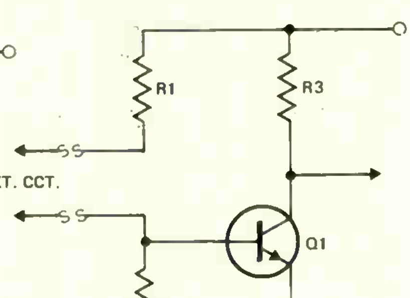


Fig. 3

FINISHING FRONT PANELS

The finish on aluminium panels can be improved by etching them in a caustic soda solution. To get the best effect:

1) Do all marking out on the back of the panel.

2) Drill holes two ways — small pilot hole from front to back. This minimises the problem of getting rid of the 'flash' which arises round the holes while drilling. Removing flash often leaves scratches, and it is better that these be on the back of the panel than the front.

3) Rub the front of the panel with medium grade emery cloth to rid it of all unwanted marks and scratches. The emery should be rubbed only in one direction for the final rubbing. This leaves the aluminium with a bright matt finish. From this point on, avoid touching the front of the panel.

4) Attach a length of thin plastic string or tubing to the panel by tying it through one of the panel holes.

5) Prepare a caustic etching solution. Put about 30 grams of caustic soda in

a glass or plastic dish. (The plastic throw-away food containers are ideal.) Carefully pour on about 300 ml of hot water. (1 oz. of caustic soda in half a pint of water, if that's any easier for you.) The strength of the solution is in no way critical. Now, by means of the plastic string, lower the panel into the solution, leaving one end of the string hanging out of the dish. It will fizz fiercely and the solution will get hotter – but all is well.

6) About 3 minutes later remove the panel, rinse it under a cold water tap, and wipe it clean. Rinse it again thoroughly, and if it looks O.K. – dull matt all over, it's finished. Hang it to dry.

A panel finished this way has a satin chrome look to it, and does not retain finger marks the way untreated aluminium does.

TOY SIREN

This circuit can be built small enough to be fitted inside a toy.

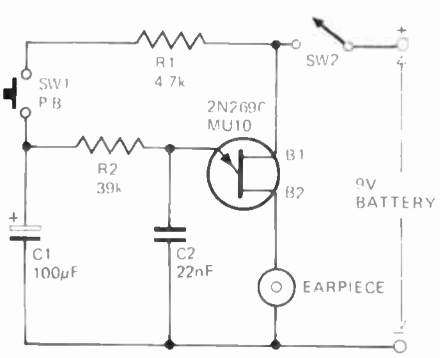
With a little manual skill on the part of the operator it can be made to sound like the sirens on such vehicles as fire-trucks, ambulances etc.

The transducer used is an earpiece which will give a scaled down sound in the proximity of the toy, without being annoyingly loud.

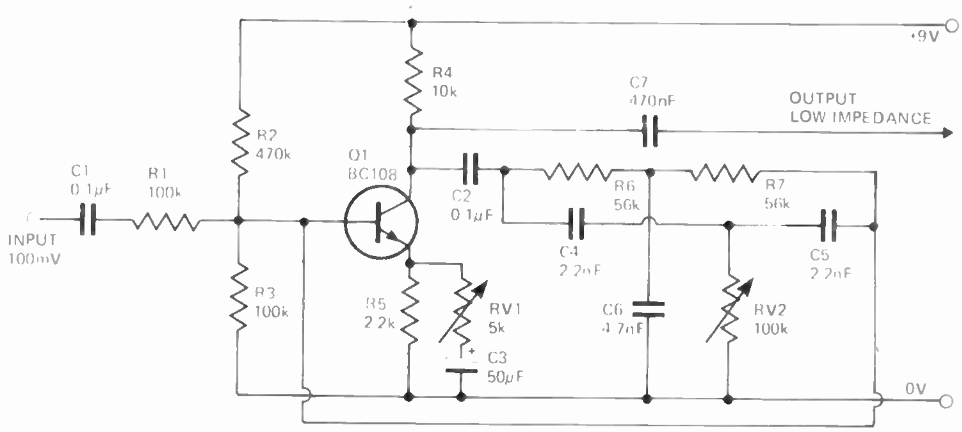
The circuit consists of a relaxation oscillator utilising one unijunction transistor. (2N2646, MU10, TIS43) R2 and C2 determine the frequency of the tone.

On pushing the button SW1 the capacitor C1 charges up and the potential at the junction of R2 and C2 rises thus causing an upswing in the frequency of oscillation; if one now releases the pushbutton the charge on C2 will drop slowly with a proportional reduction in the frequency of oscillation.

Manual operation of the button at intervals of approximately 2 sec will give a siren sound.



SIMPLE WAA-WAA CIRCUIT



This circuit can be incorporated in guitar amplifiers or electronic organs.

A phase shift RC oscillator makes up the basic circuit. C4, C5, C6 and R6, R7, RV2 make up the components of the bridge that determine the operating frequency. Negative feedback is obtained by feeding part of the signal back to the base via C2.

The waa-waa effect is achieved as certain frequencies are amplified more than others.

The transistor used is not critical however it should have a gain of more than 150. An NPN type such as the BC108 or BC109 is suitable.

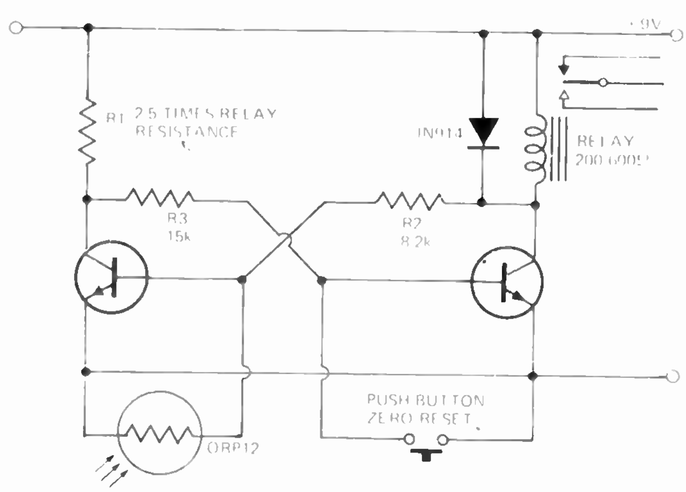
The values of C4, C5, C6 are chosen so as to emphasise waa-waa effect on the higher audio frequencies. This gives the sound its brilliance. These values can be changed quite freely till the specific desired effect is achieved.

When adjusting the unit initially, RV1 is turned to its minimum value. RV2 is now adjusted to and fro till a point is found at which an audible whistle appears indicating oscillation.

RV1 is then adjusted till the oscillation just disappears. RV2 is turned over its whole range and if at any point oscillation occurs again, RV1 is again advanced till it ceases.

It should be possible to set RV2 to any value over its range of adjustment without any oscillation being apparent, this should also be achieved with the minimum possible value of RV1. The unit is now ready for operation.

PHOTO ELECTRIC RELAY



There are many applications where photoelectric detection is used to switch a circuit on or off.

This simple circuit is a bistable multivibrator. The base resistor of Q1 is a photoresistor type ORP12. When not illuminated resistance is high, Q1 conducts and Q2 is off.

As the illumination on the OPR12 is increased the resistance drops till Q1 cuts off and Q2 turns hard on energising the relay coil.

The system is reset by the pushbutton. The diode across the relay coil can be any low power silicon type. It is for protecting Q2 from any spikes generated across the coil when de-energised.

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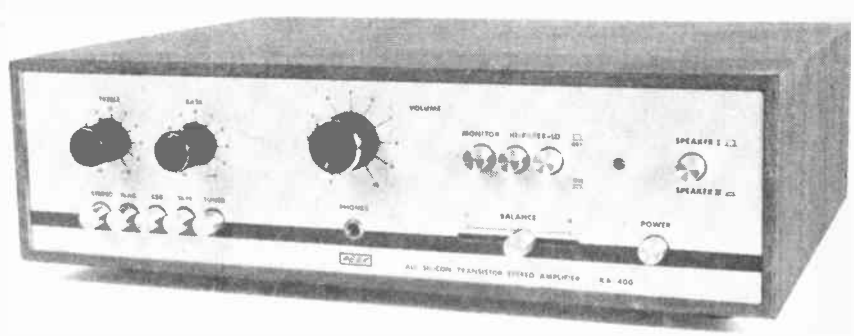
The **PEAK BD-2000U** stereo record player is equipped with a heavy cast aluminium turntable, 30 cm dia, which is belt driven and dynamically balanced for utmost resilience and lowest wow and flutter levels. Both 45 and $33^1/3$ RPM speeds are readily obtained by operating a switch on the top panel.
Normally fitted with the PEAK MC-7 magnetic cartridge for widest frequency response and fidelity.
Available with or without the matching base/cover set illustrated.



The **PEAK KA-400** Stereo Amplifier has a full 20/20 Watt RMS power rating and frequency response 20 to 20k Hz. All wanted controls are incorporated with ultra-modern push button switching on main parameters. Spring loaded speaker switches enable quick connection of the two pairs of speakers which can be connected to this amplifier. Jet black facia with oiled walnut cabinet give this unit a most attractive appearance to complement its fine performance.

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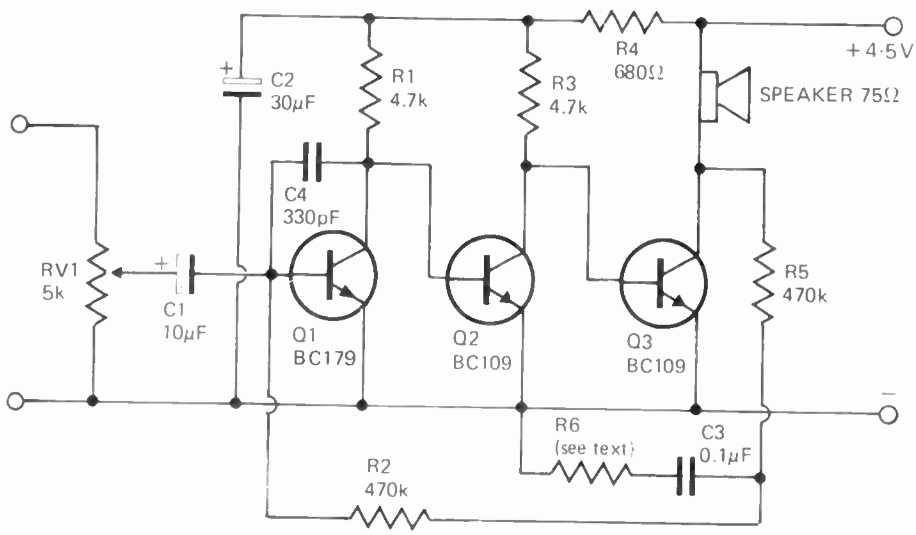
IDEAS FOR EXPERIMENTERS

ECONOMY AMPLIFIER



When power output, harmonic distortion, frequency response are not the absolute parameters for an amplifier, such as in the case of small personal portable radios, operation of an amplifier in class 'A' does have a number of advantages.

The circuit shown uses only three transistors, does not require an output transformer, and gives an output of between 100 – 200 mW for a battery supply of only 4.5V.

RV1 provides volume control and couples into the amplifier through C1. The following three stages are directly coupled.

Q1 base bias is established by resistors R2 and R5. R1 – Q1 act as a bias potential divider for Q2 base and similarly R3 – Q2 bias base of Q3.

R2 and R5 also form part of an overall negative feedback loop improving frequency response and reducing distortion.

A compromise between gain and quality results in a choice of values for R6 and C3. C3 is a decoupling capacitor and R6 is adjusted by trial and error. (Minimum value should be 22 k.)

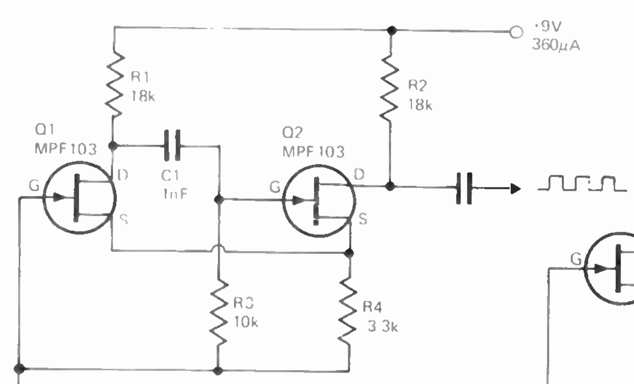
FET SQUARE WAVE GENERATOR

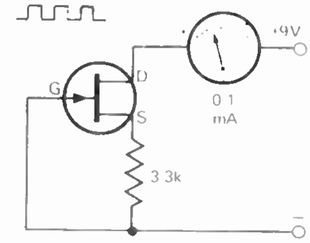
Field effect transistors lend themselves readily for use in astable multivibrator circuits.

The output square wave yields an amplitude close to the power supply voltage, and battery drain is low.

In this circuit the battery supply is 9 V. Drain is a minimal 360 µA. The waveform shows very good symmetry and this is achieved by matching the FETs by means of the circuit (b); transistors are matched up for equal drain currents.

Frequency of operation is set by R3 and C1. The values in the circuit give a frequency in the region of 15 kHz.

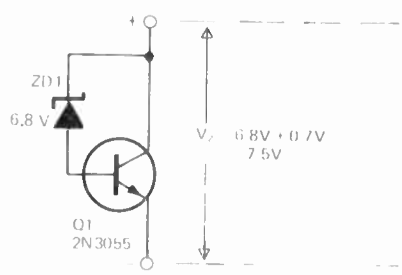




FET SQUARE WAVE GENERATOR

INCREASING POWER RATING OF ZENER DIODES

ZENER DIODE POWER BOOSTER



There are occasions when a higher power Zener diode is required and one is not readily available. Here is a circuit which with the aid of a power transistor can increase the power rating of any Zener diode.

By simply shunting the base-collector junction of the transistor by a low power Zener and if the gain of the transistor at the operating current exceeds 30, then across the collector-emitter terminals the device will behave as a Zener diode.

If the original diode is a 250 mW device then the power dissipation of the system will be 30 x 250 mW = 7.5 watts. It should be noted that the Zener voltage thus obtained will be 0.7 V higher than the diode rating.

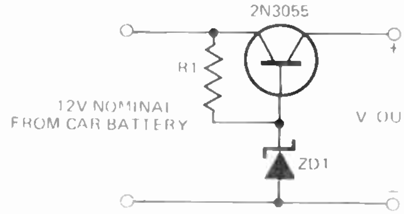
Thus if originally a 6.8 V diode was used then the new voltage will be 6.8 V + 0.7 V = 7.5 V. Thus for a power of 7.5 W, the maximum permissible current will be 7.5 W/7.5 V = 1A.

12V – 9, 7.5, or 6V CONVERTER (automobile)

Many transistorised items such as radio, cassettes and other electrical items operate on batteries. Usually these are in the 6–12 volt range and sockets are provided for external power supply.

This circuit enables these devices to be operated from a car's electrical supply.

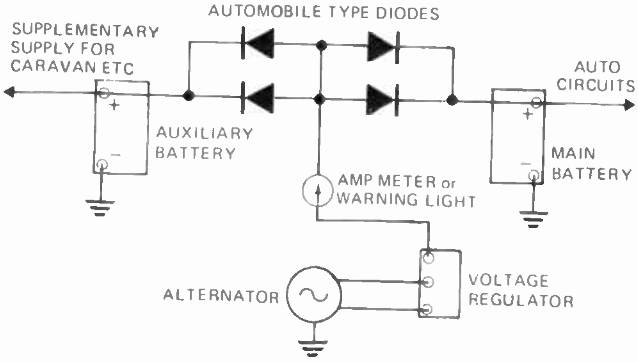
The table gives values for resistors and specifies diode types for different voltages. Should more than one voltage be required a switching arrangement could be incorporated. For high currents the transistor should be mounted on a heatsink.



OUTPUT VOLTAGE	9	7.5	6
R1 (½ WATT)	180Ω	270Ω	330Ω
ZENER DIODE (250 mW)	10V	8V1	[illegible]

IDEAS FOR EXPERIMENTERS

AUXILIARY BATTERY ADAPTOR



AUXILIARY BATTERY ADAPTER FOR NEG EARTH AUTO SYSTEM

When towing a caravan or using the automobile battery supply for other heavier duty purposes the drain on the battery may be excessive.

Here is a method of hooking up an auxiliary battery to the auto's charging circuit without upsetting the existing battery, and limiting discharge to external circuitry, to the auxiliary unit only.

The four isolating diodes are of the automobile type as used in alternators, being capable of carrying up to 25 A they should be mounted on heatsinks.

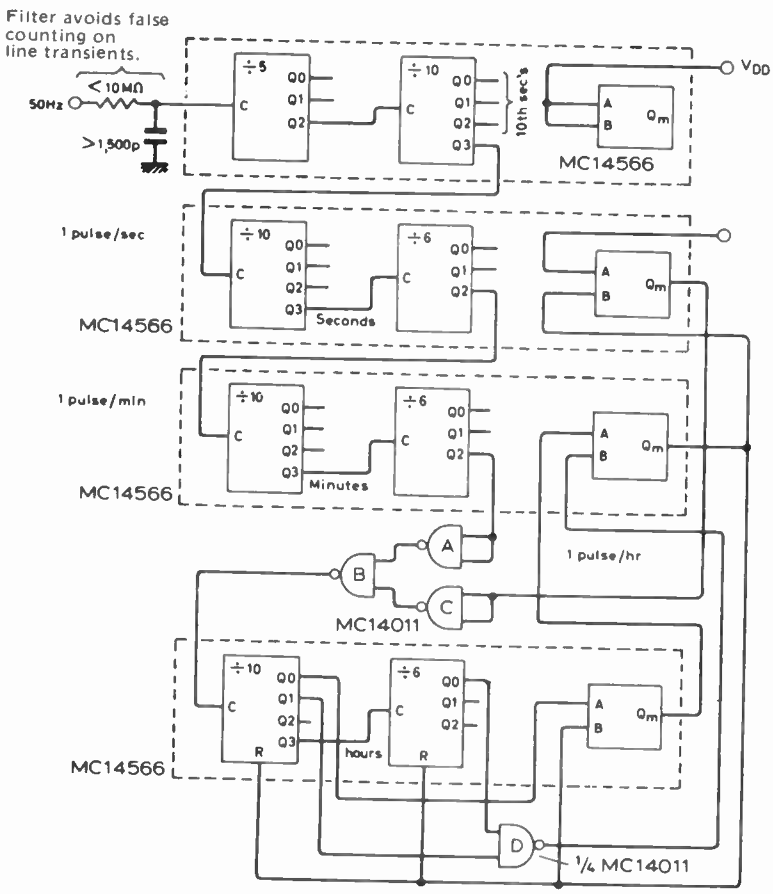
CMOS CLOCK

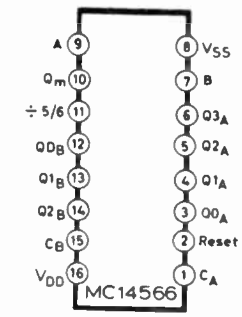
A new, and unique, addition has been made to Motorola's rapidly expanding family of CMOS logic circuits. It is the MC14566 time base generator which consists of two pulse shapers, a divide-by-ten ripple counter, a divide-by-5 (or 6) ripple counter and a monostable multivibrator on a single chip. A single MC14566 can be connected to divide by 50 or 60 (÷ 5 and ÷ 10 or ÷ 6 and ÷ 10) to produce one output pulse per second when fed with a 50 or 60 Hz input. In addition, a binary coded decimal output indicating tenths-of-seconds is available.

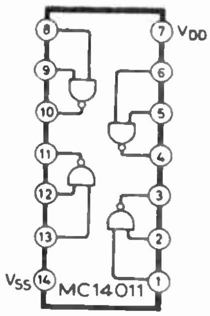
A second MC14566 can be connected in cascade with the first (arranged to divide-by-ten and then by six) to provide one output pulse per minute and a BCD output of up to 59 seconds. A third cascaded MC14566 will then provide a minute's BCD output and one pulse per hour.

Although the devices can be used to construct electronic digital clocks – as shown in the circuit diagram – their main application will be to provide timing signals in industrial process control, data-logging and computing equipment from 50 or 60 Hz line supplies.

Available in a plastic package (suffix P) or a ceramic package (suffix L), the MC14566 has Zener diode protection fitted to all inputs and is available for operation over the extended industrial temperature range (−40 to 85°C) or the full military temperature range (−55 to 125°C). As with all members of the Motorola CMOS family the power supply voltage can be from 3 to 18 V, the noise immunity is typically 45% of V_{DD} and an input capacity of 5 pF is standard for all inputs. Quiescent power dissipation at 5 V supply voltage is 25 nW, rising to about 1.5 mW at a clock frequency of 1 MHz when working into a 15 pF load. Normally, when used as a timer, power consumption would be less than this since the clock frequency would be either 50 or 60 Hz. Maximum operating frequency is typically 4.2 MHz at V_{DD} = 15 V. ●







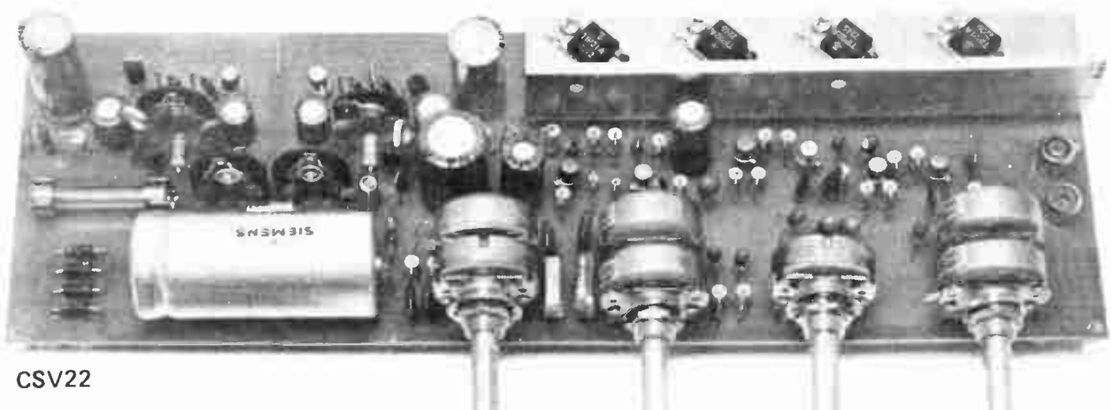
Quad two-input NAND gate

V_{DD} = +3V to +18V
V_{SS} = 0V
Connect pin 11 to V_{SS} to divide by six and to V_{DD} to divide by five
All unused reset pins must be connected to V_{SS}

DOMINION CSV22 COMPLETE PREASSEMBLED & TESTED 12W RMS PER CHANNEL STEREO AMPLIFIER

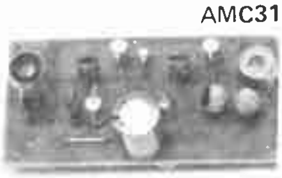
SPECIFICATIONS:

Power Output:	24 watts (12 watts per channel R.M.S.)
Frequency Response:	20-25,000 Hz ±1db
Harmonic Distortion:	Less than 0.4% @ 20 watts total
Output Impedance:	4-16 ohms
Sensitivity:	(a) Tape Input 250mV (b) Magnetic Input 2.5mV
Controls:	Volume, Balance, Bass ± 10db at 100 Hz, Treble ± 10db at 10 KHz
S/N Ratio:	Better than 60db (Mag.), 65db (Tape)
Sockets:	RCA sockets for magnetic cartridge input
Semi-Conductor Complement:	16 silicon transistors, 4 silicon diodes
Power Supply:	240V – 31V AC transformer (not supplied)



CSV22

AMC318



MP200

SMP9

MP47

DOMINION MINIATURE IN-LINE MODULES USING ALL SILICONE LOW-NOISE TRANSISTORS

SPECIFICATIONS: (Common)

Frequency Response:	20 – 20K Hz
Distortion:	0.5% Max. at 2.5V Output
Signal to Noise Ratio:	80 db below 2.5V Output
Operating Voltage:	9V D.C. – Negative earth
Input & Output:	RCA type sockets on the board

• SMP9 Stereo Pre-amp Module • MP47 Hi-impedance Microphone Pre-amp • MP9 Mono Pre-amp Module • MP200 Low impedance Microphone Pre-amp • AMC 318 Audio Multicoupler . . . A splitter giving three completely independent outputs from one input. e.g. One output can be shorted, loaded etc., without affecting the other two outputs.

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7402	.19	7450	.24	74150	1.09
7403	.19	7451	.27	74151	.89
7404	.22	7453	.27	74153	1.29
7405	.22	7454	.39	74154	1.59
7406	.39	7460	.19	74155	1.19
7407	.39	7464	.39	74156	1.29
7408	.25	7465	.39	74157	1.29
7409	.25	7472	.36	74161	1.39
7410	.19	7473	.43	74163	1.59
7411	.29	7474	.43	74164	1.89
7413	.79	7475	.75	74165	1.89
7415	.39	7476	.47	74166	1.65
7416	.39	7483	1.11	74173	1.65
7417	.39	7485	1.39	74176	1.09
7420	.19	7486	.44	74177	.99
7422	.29	7489	2.75	74180	1.09
7423	.35	7490	.76	74181	3.65
7425	.39	7491	1.29	74182	.89
7426	.29	7492	.79	74184	2.69
7427	.35	7493	.79	74185	2.19
7430	.22	7494	.89	74190	1.59
7432	.29	7495	.89	74191	1.59
7437	.45	7496	.89	74192	1.49
7438	.39	74100	1.65	74193	1.39
7440	.19	74105	.49	74194	1.39
7441	1.09	74107	.49	74195	.99
7442	.99	74121	.57	74196	1.09
7443	.99	74122	.53	74197	.99
7444	1.10	74123	.99	74198	2.19
7445	1.10	74125	.69	74199	2.19
7446	1.15	74126	.79	74200	7.95

LOW POWER TTL

74L00	.33	74L51	.33	74L90	1.69
74L02	.33	74L55	.33	74L91	1.45
74L03	.33	74L71	.33	74L93	1.69
74L04	.33	74L72	.49	74L95	1.69
74L06	.33	74L73	.69	74L98	2.79
74L10	.33	74L74	.69	74L164	2.79
74L20	.33	74L78	.79	74L165	2.79
74L30	.33	74L85	1.25		
74L42	1.69	74L86	.69		

HIGH SPEED TTL

74H00	.33	74H21	.33	74H55	.39
74H01	.33	74H22	.33	74H60	.39
74H04	.33	74H30	.33	74H61	.39
74H08	.33	74H40	.33	74H62	.39
74H10	.33	74H50	.33	74H72	.49
74H11	.33	74H52	.33	74H74	.59
74H20	.33	74H53	.39	74H76	.59

8000 SERIES TTL

8091	.59	8214	1.69	8811	.69
8092	.59	8220	1.69	8812	1.10
8095	1.39	8230	2.59	8822	2.59
8121	.89	8520	1.29	8830	2.59
8123	1.59	8551	1.65	8831	2.59
8130	2.19	8552	2.49	8836	.49
8200	2.59	8554	2.19	8880	1.33
8210	3.49	8810	.79		

9000 SERIES TTL

9002	.39	9309	.89	9601	.99
9301	1.14	9312	.89	9602	.89

Please specify data sheets required with order. Add $.50 per data sheet for items priced less than $1.00 each.

CMOS

74C00	.39	74C74	1.15	74C162	3.25
74C02	.55	74C76	1.70	74C163	3.25
74C04	.75	74C107	1.50	74C164	3.50
74C08	.75	74C151	2.90	74C173	2.90
74C10	.65	74C154	3.50	74C195	3.00
74C20	.65	74C157	2.19	80C95	1.50
74C42	2.15	74C160	3.25	80C97	1.50
74C73	1.55	74C161	3.25		

4000 SERIES RCA EQUIVALENT

CD4001	.55	CD4013	1.20	CD4023	.55
CD4009	.85	CD4016	1.25	CD4025	.55
CD4010	.85	CD4017	2.95	CD4027	1.35
CD4011	.55	CD4019	1.35	CD4030	.95
CD4012	.55	CD4022	2.75	CD4035	2.85

MEMORIES

1101	256 bit RAM MOS	1.75
1103	1024 bit RAM MOS	4.95
5260	1024 bit RAM Low Power	3.95
7489	64 bit RAM TTL	2.75
8223	Programmable ROM	4.95

LOGIC PROBE KIT

- Ten nano sec capability
- Checks TTL & DTL logic
- Dual slope memory
- Internally or externally powered
- Internal 5V regulator

Kit is complete with all necessary components, case, probe, complete instructions and logic chart [illegible]

POWER SUPPLY SPLITTER

- Ground reference for positive & negative output from single supply — any DC source to 20V
- Balanced output adjustment
- 1 amp current capability with sink
- Increase usefulness of your power supply

Complete with all components & instructions $4.95

PHONO AMP (for ceramic xtal cartridge)

- 2 watt RMS at 8 ohms
- Build into turntable for self contained amp with tone control
- Power supply not included — can use battery supply

Complete with components & instructions — Mono [illegible] — Stereo [illegible]

Hi Voltage Power Transistors — Prime Quality

[illegible] TO-3

NPN	[illegible] VOLT	[illegible] ea	With combined
NPN	[illegible] VOLT	[illegible] ea	[illegible]
NPN	[illegible] VOLT	[illegible] ea	[illegible]

CALCULATOR CHIPS

5001	LSI (40-Pin) Add, subtr, mult & div 12 dig. Data supplied with chip	$3.95 ea
	Data only — Refundable with purchase	1.00
5002	LSI similar to 5001 exc des for battery operated - Data supplied with chip	7.95 ea
	Data only — Refundable with purchase	1.00
5005	LSI (28 pin) Full 4 funct mem 12 dig displ & calc 7 seg mltplx outp Data suppl w chip	8.45 ea
	Data only — Refundable with purchase	1.00
MM5736	18 Pin, 6-dig add subtr mult div	3.95 ea

DIGITAL CLOCK CHIPS

MM 5311	28-pin any readout 6-dig BCD mux with spec sheet	9.95 ea
MM 5312	24-pin any readout 4 digit 1pps output BCD mux with spec sheet	6.95 ea
MM 5313	28-pin any readout 6 digit 1pps BCD mux with spec sheet	7.95 ea
MM 5314	24 pin LED-Incandescent readout mux 6 digit with spec sheet	8.95 ea
MM 5316	40-pin norm alarm set snooze alarm-timer 12 or 24-hr operat with spec sheet	12.95 ea

LED's

MV10B	Visible red TO 18		25 ea.
MV50	Axial leads microminι dome	25 ea.	5/1.00
MV5020	Jumbo clear dome visible red	35 ea	3/1.00
ME4	Infra red (invisible) diff dome		60 ea

DISPLAYS

MAN1	Red, 7 seg, 270"	$2.50 ea
MAN2	Red alpha numeric, 32"	4.95 ea
MAN3A	Red, 7 seg 127" in line leads	79 ea
MAN3M	Red, 7 seg 127" staggered leads	1.15 ea
MAN4	Red, 7 seg, 190"	2.15 ea
MAN5	Green, 7 seg, 270"	2.95 ea
MAN7	Red, 7 seg 270"	1.50 ea
MAN8	Yellow 7 seg, 270"	3.95 ea
MAN66	75" high direct viewing LED	4.65 ea
DL707	Red, 7 seg., 3"	2.15 ea

OPTO ISOLATORS

MCD2	Diodes	$1.00 ea
MCT2	Transistor	[illegible] ea

LINEAR INTEGRATED CIRCUITS

300	Pos V Reg super 723	TO-5	$ .79 ea
301	Hi performance AMP	MINI-DIP, TO-5	.32 ea.
302	Voltage Follower	TO-5	.79 ea
304	Negative Voltage Regul	TO-5	.89 ea
305	Positive Voltage Regul	TO-5	.95 ea
307	Op AMP super 741	MINI DIP, TO-5	.35 ea
308	Micro Power Op Amp	MINI DIP	1.10 ea
309H	5V Regulator 200 ma	TO-5	1.10 ea
309K	5V 1A Regulator	TO-3	1.65 ea
310	Voltage Follower Op Amp	TO-5	1.19 ea
311	Hi perf Volt Comparat	MINI DIP, TO-5	1.05 ea
319	Hi speed Dual Comparat	DIP	1.29 ea
320	Neg Reg [illegible]	TO-3	1.35 ea
324	Quad Op Amp	DIP	1.95 ea
339	Quad Comparator	DIP	1.69 ea
340T	Pos Volt Reg 6V, 8V, 12V, 15V, 18V, 24V	TO-220	1.95 ea
370	AGC Squelch AMPL	TO-5 or DIP	1.15 ea
372	AF IF Strip detector	DIP	.79 ea
373	AM FM SSB strip	DIP	3.25 ea
376	Pos Volt Regulator	MINI DIP	.59 ea
377	2W Stereo amp	DIP	2.69 ea
380	2 Watt Audio Amp	DIP	1.49 ea
380-8	.6W Audio amp	MINI-DIP	1.25 ea
381	Low Noise Dual Pre Amp	DIP	1.79 ea
382	Low Noise Dual Pre-Amp	DIP	1.79 ea
550	Prec Voltage Regulator	DIP	.79 ea
555	Timer	MINI DIP	.99 ea
560	PLL AMP	MINI DIP	.45 ea
709	Operational AMPL	TO-5 or DIP	.29 ea
711	Dual Different Compar	DIP	.29 ea
723	Voltage Regulator	DIP	.59 ea
739	Dual Hi Perf Op AMP	DIP	1.19 ea
741	Comp Op AMP	MINI DIP, TO-5	.35 ea
747	Dual 741 Op Amp	TO-5 or DIP	.79 ea
748	Freq Adj 741	MINI-DIP	.39 ea
1303	Stereo Pre Amp	DIP	.89 ea
1304	FM Mulpx Stereo Demod	DIP	1.19 ea
1307	FM Mulpx Stereo Demod	DIP	.82 ea
1458	Dual Comp Op Amp	MINI DIP	.69 ea
LM2111	Dual LM 211 Volt Comp	DIP	1.95 ea
3065	TV FM Sound System	DIP	.69 ea
3075	FM Det LMTR & Audio Pre Amp	DIP	.79 ea
3900	Quad Amplifier	DIP	.59 ea.
4005	Precision Timer	DIP	.65 ea
7524	Core Mem Sense AMPL	DIP	1.89 ea
7525	Core Mem Sense AMPL	DIP	.89 ea
7534	Core Mem Sense Amp	DIP	2.59 ea
7535	Core Mem Sense Amp	DIP	1.15 ea
8038	Function Generator	DIP	4.95 ea
75451	Dual Peripheral Driver	MINI DIP	.39 ea
75452	Dual Peripheral Driver	MINI DIP	.39 ea
75453	351 Dual Periph Driver	MINI DIP	.39 ea
75491	Quad seg driver for LED readout	DIP	1.55 ea.
75492	Hex digit driver	DIP	1.69 ea

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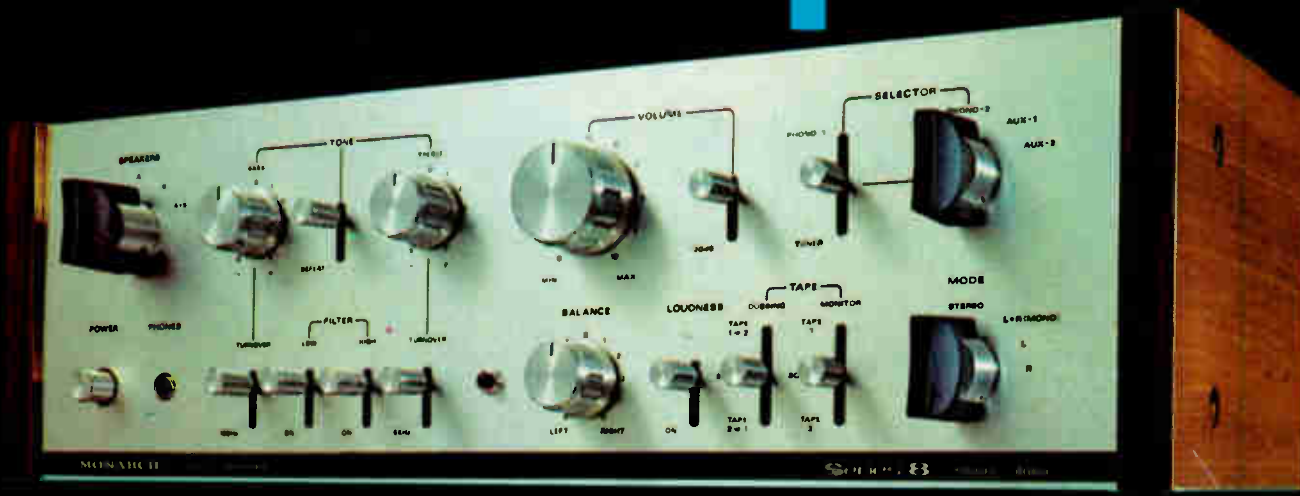
The compliment we like best about the new Monarch Series 8:

"It's no surprise!"



When people already think of one name as the best value for money, they naturally expect every new model to maintain the same high standards — or improve on them. So, Monarch's brilliant new Series 8 amplifiers will come as no great surprise.

No surprise — even though we've created a superb new amplifier, top-of-the-range Monarch 8000 to bring you continuous RMS power of 55 watts per channel at 8 ohms, with distortion of less than 0.1%; even though we've included tape dubbing and turnover controls; even though we've produced a frequency response of 10 Hz to 60,000 Hz; even though we're presenting three other new Monarch amplifiers — the 80, 88 and 800, which feature dramatic improvements in power and efficiency. It's no great surprise — because you *expect* Monarch to be the best . . . And it is, so all Monarch amplifiers remain "kings" on a power-to-performance-to-cost rating.

Try any of them. The prices are as undistorted as the sounds. All with the same beauty of design you expect of top performers. And all have the Monarch two-year guarantee on parts and labour. You know you're getting Monarch quality. Without paying more.

Monarch 8000	—	110 watts RMS
Monarch 800	—	80 watts RMS
Monarch 88	—	48 watts RMS
Monarch 80	—	24 watts RMS

MONARCH

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