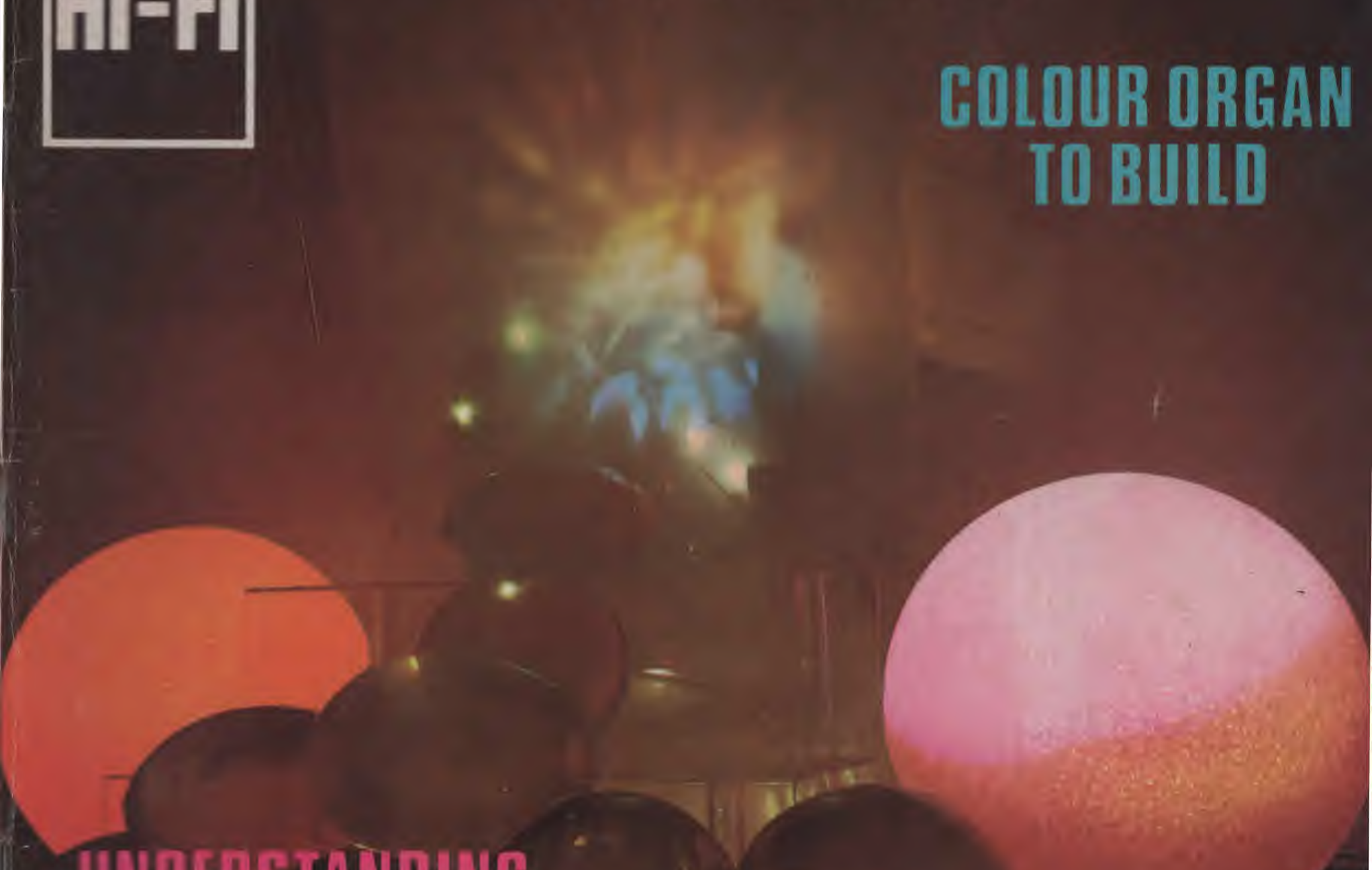
NOVEMBER, 1974
75c

electronics TODAY INTERNATIONAL

HI-FI

COLOUR ORGAN TO BUILD



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Consider these features.

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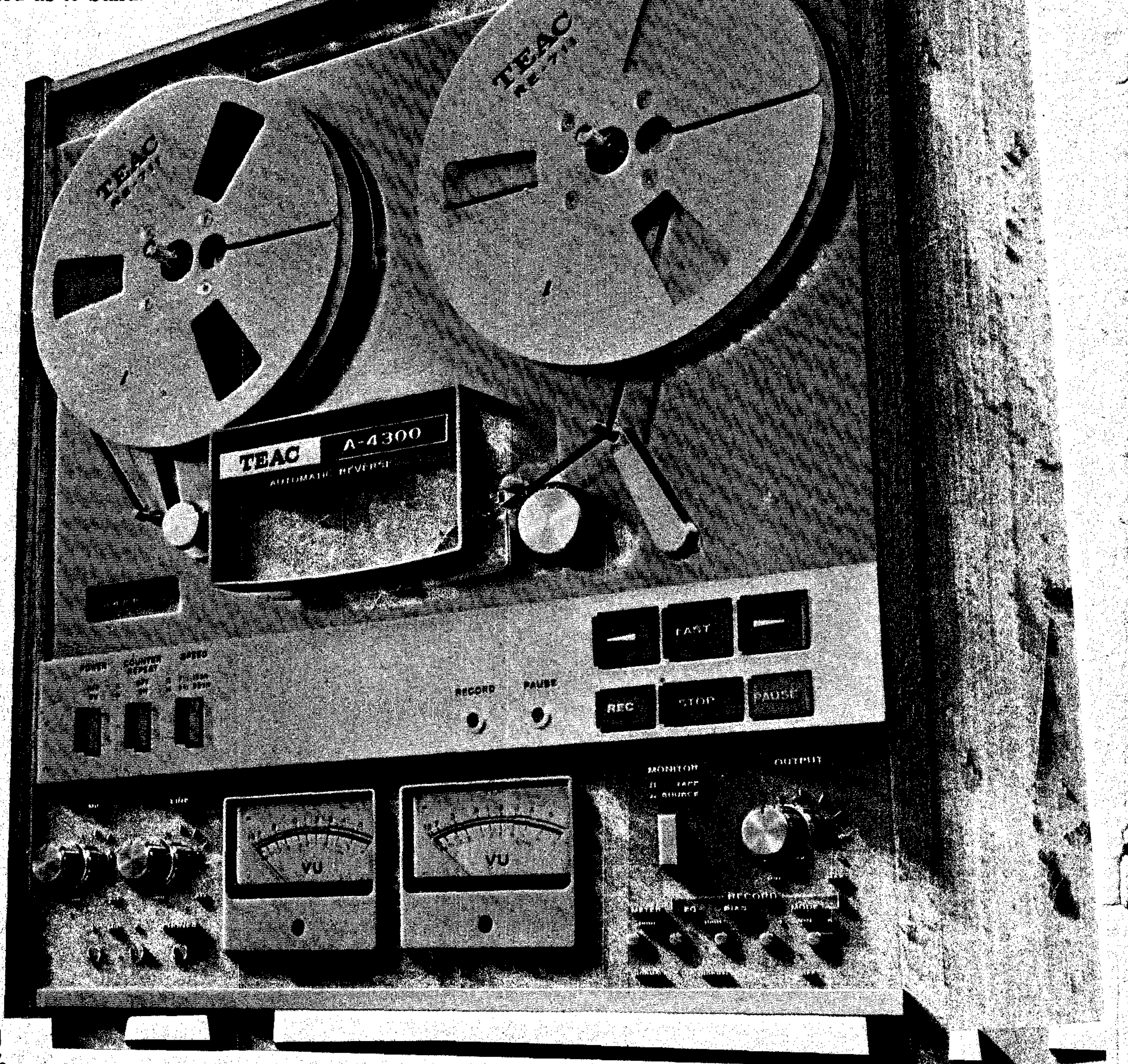
Investigate the A-4300 soon. After all, it's the deck you asked us to build.



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NOVEMBER, 1974 Vol. 4. No. 8.

main features

projects

reviews

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COVER: This dramatically effective picture of ETI's great new colour organ was arranged by Kim Ryrie.

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news digest

CABLE TV IN AUSTRALIA NOW

Our article on Cable TV (pages 90 – 93 this issue) mostly concerns development overseas — where most of the development and design originated.

Nevertheless some installations have been made in Australia. In Queensland for example, Community Broadcasting Services have completed a number of CATV projects.

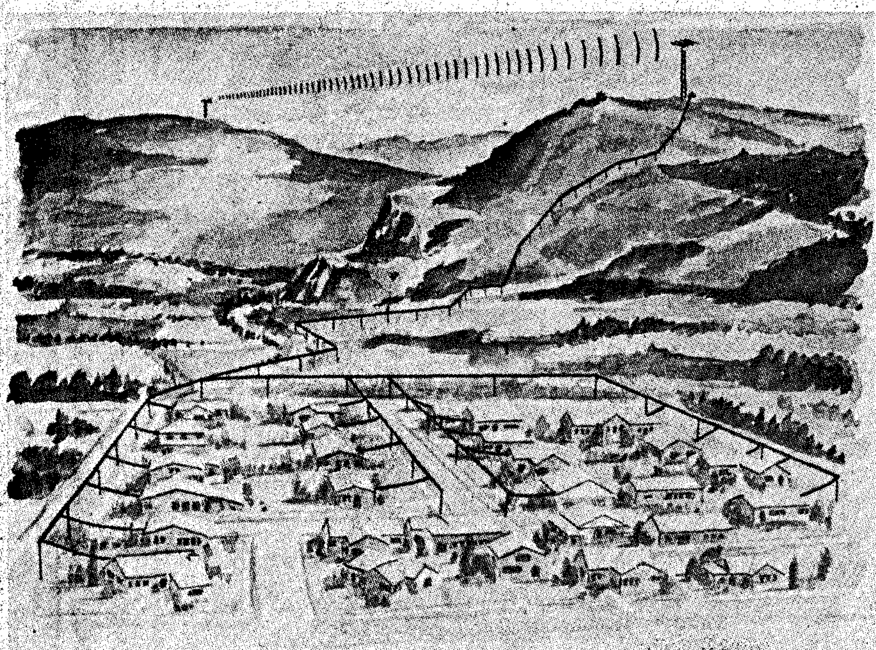
The first, which is an ongoing project, is a Community Antenna Television (CATV) system feeding over 120 homes in a privately-owned housing development. It is located at Buderim on the "Sunshine coast" and presently provides high quality reception to every home in the estate of the four channels from Brisbane, 90 km to the south. On completion of the present system upgrade, the number of channels will be increased to five, while removing co-channel interference presently encountered in the summer months on channel 2 from Brisbane. Thus upgrade has been made possible by the availability of signals from a translator 28 km to the north, so there will be two reception sources. Ultimately, 300 homes will be connected to the system, providing first-class reception of colour TV and FM stereo without the need for individual large antenna installations. In addition to the off-air channels, the system will have provision for local origination in colour on a spare channel, allowing programming such as movies news etc, directly on the system, should the residents desire.

The company has also designed a CATV system for the Brisbane City Council, which serves their employees at the Somerset Dam, 50 km NW of Brisbane. While this system serves only 14 homes, it is possibly the most technically advanced CATV system in Australia.

The area served is in a valley immediately behind a solid granite mountain, which is in turn behind an even higher mountain range. This combination of obstacles effectively blocked all television signals from Brisbane.

Stack 13 element cut-to-channel yagi arrays 2000 metres up the mountainside at the rear of the village receives 3 Brisbane channels. These signals are pre-amplified by underground CATV aluminium cable down the mountain. Before being distributed to the village, two more channels from Toowoomba are fed in from a second set of quad stacked yagis located in a separate antenna area. The five channels are then amplified and distributed throughout the village.

Features of the system include single-channel MOSFET preamps of our own design, these are remotely powered from a duplexer by the same cable that carries the signals back down the mountain. This system, which is installed and working, provides this little town with five high-quality television channels, where before there was none.



NEW MULLARD RADAR UNIT COULD ACT AS GUIDE DOG

A cheap, tough Doppler radar circuit, which could be used to guide blind people, has been produced by Mullard Research Laboratories (UK) — one of Philips' research centres.

The radar shows the direction and speed of objects, and because of its small size, it could be used in a number of applications including traffic light control and conveyor belt monitoring, as well as in an electronic guide dog system for the blind.

In a Doppler radar, use is made of the fact that the observed frequency of signals originating in an object increases as the object approaches the observer and decreases as it moves further away from him.

In the new device all microwave circuit functions, with the exception of the Gunn source, are carried on a single slice of alumina substrate, 18 x 16 x 0.5 mm.

This radar can be operated, without need for adjustment or modification, within the frequency band 9.3 to 10.6 GHz. The tangential signal sensitivity for an i.f. bandwidth of 4.5 MHz is -70 dBm.

The unit was designed primarily to be used with a slot line aerial on the alumina substrate but it can also be used with a waveguide horn.

The information given above relates to a laboratory model; development and production will be undertaken by Mullard Ltd.

BUBBLE MEMORIES

Bubble memories will replace tape recorders and computer disc and drum memories in aircraft and spacecraft within a few years, predicts the US Air Force Avionics Laboratory.

Such memories utilize the magnetic domains of very thin magnetic garnet material that contract into stubby cylinders a few microns in size under the influence of an external magnetic field. The laboratory currently is testing and evaluating a 10 000-bit module.

news digest

CHIPS ARE DOWN

Companies manufacturing basic calculator chips have grossly over-estimated the potential market — according to the US weekly 'Electronic News'.

Priced at US $6 to $8 last year, basic four-function eight-digit chips can now be bought for as little as US$3 each (in lots of 100 000).

Mostek confirmed that US$3 'was about right' for their devices, and Western Digital said that chips with a memory function were going for as little as US$3.50.

Several companies suggested that these prices could go lower still — US$2 each was mentioned several times.

The situation is being excerbated by a tendency for many Japanese calculator manufacturers to upgrade their products and/or buy from their own MOS sources.

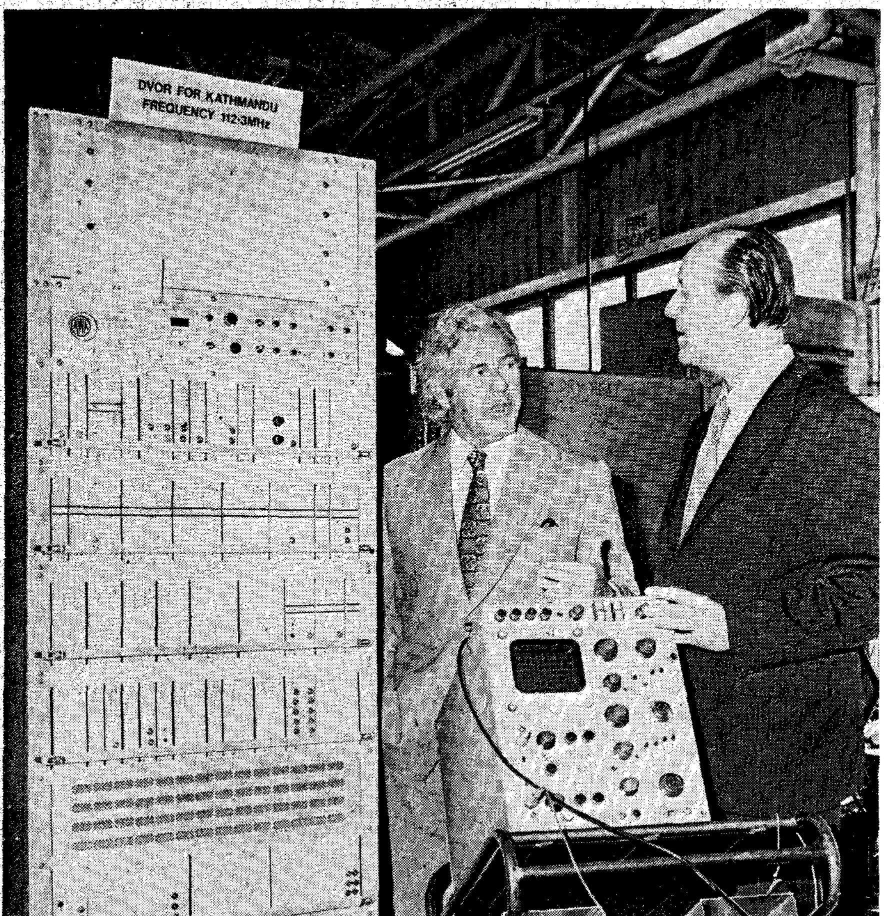
200 MILLION DEGREES!

An important advance in work on nuclear fusion is reported by scientists at the University of Texas, Austin. Dr. William E. Drummond, director of the university's fusion research center, says that a temperature of more than 200 million degrees Centigrade has been attained for some 50 micro-seconds in the center's Tokamak-type unit by turbulent heating of the plasma, a new technique developed at Texas and in the U.K.

AWA AIRCRAFT NAVIGATION AIDS FOR THE HIMALAYAS

A $650,000 contract has been awarded to AWA by the Government of Nepal for the supply and installation of air navigational aid equipment at Kathmandu, the capital city, and at Pokhara, about 200 km from Kathmandu. These units, Doppler VHF Omnirange (DVOR) and Distance Measuring Equipment (DME) will form part of a modern air traffic control system for Nepal.

Federal Minister for Science, Mr. W.L. Morrison (left) is pictured with AWA Commercial Manager (Engineering Products), Mr. J.D. Gilchrist, alongside a Doppler VOR unit at AWA's North Ryde works.



CEEFAX NOW A REALITY

The first commercially-viable public data broadcasting service is now available to TV viewers in Britain.

At an exhibition staged as part of the Fifth International Broadcasting Convention held in London during September, the general public had their first chance to see the service in operation. Days earlier the British Government had given approval for the introduction of an experimental service by the BBC and the Independent Broadcasting Authority (IBA) which administers Britain's commercial network.

Originally developed separately by the BBC and the IBA, the new service will operate within parameters agreed upon by both these organisations and BREMA, the body representing the receiver manufacturing industry. The receiver industry has developed add-on adapters for old TV sets and is currently working on circuitry to incorporate in new TV sets later this decade.

Presently being produced in custom built quantities only, the cost of the add-on adapter is approximately £800. Researchers and marketeers alike believe that this cost could be brought down to as low as £70 within two years.

The IBA has launched *their* campaign to win users (and viewers) in an elaborate colour booklet. Their name for the system is ORACLE (optional reception of announcements by coded line electronics). The BBC's broadcasts are under the title CEEFAX (from 'seeing facts').

Since late 1972, when both organisations began work on their respective systems, there has been increasing interest among broadcasters in the possibility of employing domestic television receivers for the display of data or graphical information in addition to normal programme material.

Now, at the press of selector buttons, TV users in the UK can receive the latest information on more than 100 topics, ranging from weather reports and motoring information, to world currency exchange rates and news headlines, in fact anything that can be represented in the written word. Such information may be viewed in place of the normal programme or be superimposed on the programme image. It is viewable in either monochrome or colour.

Deaf people, and those who are literate only in languages other than English, may now be able to fully enjoy television in the UK by selecting relevant sub-titles for each regular TV programme.

Eventually it is thought that it may be possible to transmit private letters using the system whilst normal channels are off-air in the early hours of morning. Such a scheme would require the addition of hard copy printout devices to domestic receivers and the connection of the system into individual homes via telephone lines.

The system will also be geared to providing absolutely local news (as community radio is capable of handling), as well as general wider-interest data. These refinements are thought to be at least three years away.

In a paper presented to the 1000 delegates to the convention, Mr P. Rainger (BBC) and Mr W.N. Anderson (IBA), said, "the most important feature characterising both systems, and one which differentiates them from most, if not all, other proposals, is that they cater for a relatively large amount of information, covering many topics, from which the viewer may choose. At the origination point of the data signal, the information to be offered to the viewer is assembled in pages with a standard format and one or more pages are allocated to each topic.

"The coded signals describing each page are initially generated using a keyboard device such as a tele-type-writer or a computer video-display terminal. The complete set of coded signals, constituting a 'magazine', can then be assembled in a purpose-built electronic core or in the magnetic disc store of a specially programmed computer system.

"The contents of the store are then transferred, in packets, to the allocated lines in the broadcast signal," they said.

Several other papers, dealing with more technical aspects of the service, were presented to the conference.

Data broadcasting systems utilise unused spectrum-space or time in the existing television and sound wave-forms, such as unused lines in the television field blanking period, to transmit additional data signals.

These signals are decoded by either an additional 'add-on' adaptor or optimally by new circuits within the television receiver.

This summary, although it does not mention, however briefly, all aspects in the specification for the unified system, indicates clearly that a system has been evolved which could provide a very attractive service to the user. The system is flexible and efficient, offers opportunities for receiver design advancements and has the potential for future development.

At this stage the specification of the system allows for eight magazines with up to 100 pages in each magazine.

Good reception of either of these systems will be possible wherever good UHF 625-line television pictures can be received in Britain, but difference between receiving this type of data and ordinary television is that where interference and ghosting have a serious effect on the appearance of an ordinary television picture, with this new system, these effects may cause errors in the display of information.

Despite this slight limitation, the applications of advancements of this British unified system seem endless. Many of the international delegates to the convention in London expressed their interest in the system for their home-markets and indicated that they had been and would continue to watch the developments of the system in commercial use.

SINCLAIR CALCULATORS

A special offer of Sinclair scientific calculators at the extremely low price of fifteen pounds sterling was made recently by the UK edition of this magazine.

The offer was more successful than either we or Sinclair ever imagined.

At the time this issue goes to press, ETI UK had sold over 7000 calculators and confidently expect the total to exceed 10 000. Sinclair's entire production line is now devoted to producing scientific calculators to fulfill the orders!

US COMPONENTS SALES SLUMP

New orders for electronic components slumped 7½% during the first half of 1974, compared with the same period last year, according to the US Electronic Industries Association.

Despite the fall, sales were still nearly 50% higher than comparable periods in 1966, 1967 and 1968.

SOLAR POWERED SPACE SHIPS

A desk-top model demonstrates an advanced lightweight 30 watts/pound solar array for space power. This system is designed to use the sun's energy to produce 25 kilowatts of electricity to supply very-low-thrust ion engines for Solar Electric Propulsion Stage (SEPS) propulsion.

The SEPS and arrays would be launched from the Space Shuttle into Earth orbit. Designed and built for NASA's Marshall Space Flight Center in Huntsville, Ala., by Lockheed Missiles & Space Co., Sunnyvale, Calif., the model demonstrates the mechanisms for multiple extensions and retractions of the solar panels during flight.

While solar arrays have been flown on many space missions, none has to date been extended and retracted on command. Partial or full retraction is desirable for Earth orbital operating during rendezvous and docking and planetary missions should the SEPS encounter meteorites or solar flares that could damage the solar cells.

Another reason for retraction will be to permit return of the SEPS and arrays to Earth via the Space Shuttle for refurbishment and reuse.

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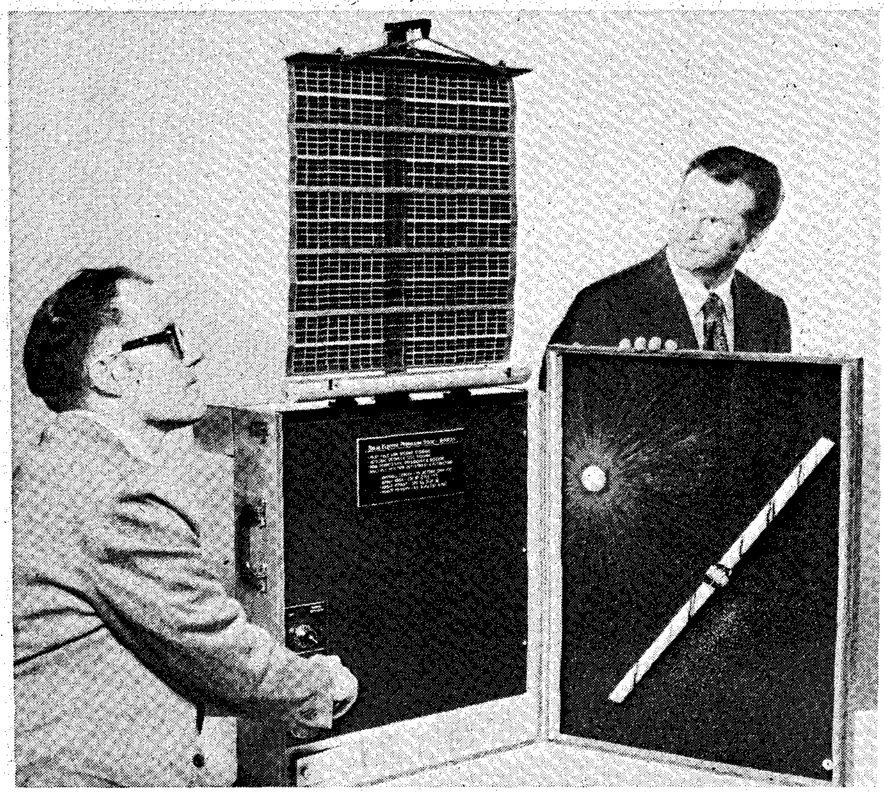

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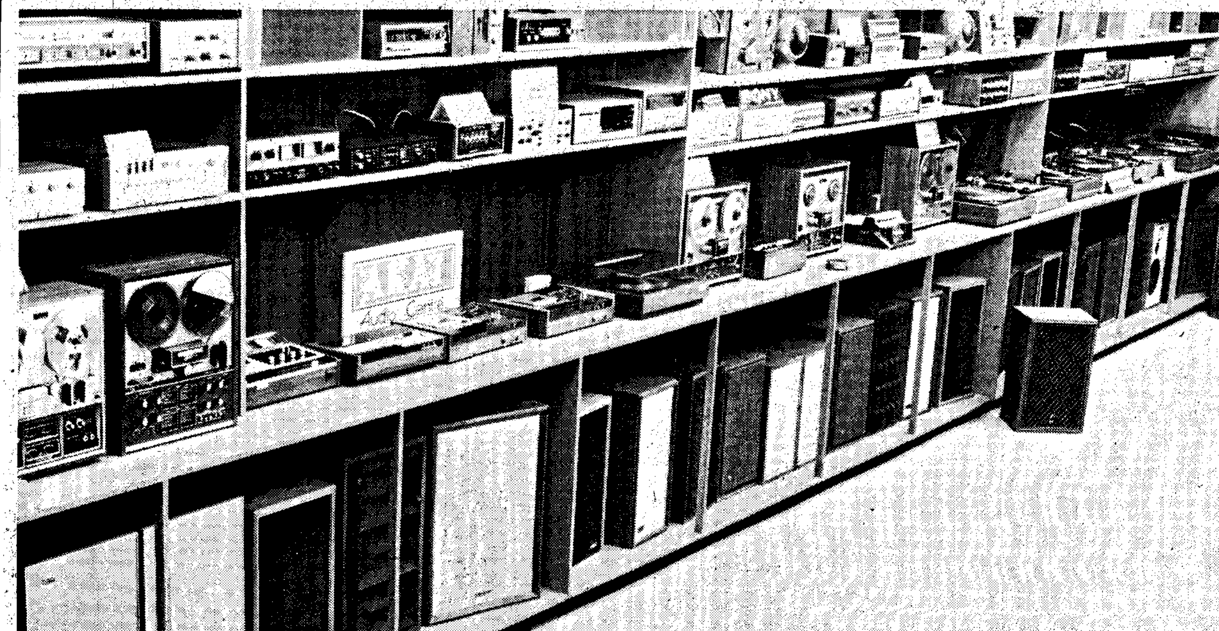

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news digest

Continued from page 7

CD4-ICS

TDK Fairchild will introduce a demodulator IC for the CD-4 discrete four-channel stereo system early next year.

The device, to be priced at from US$1.50 to US$3.33 per chip, is the first product developed by the TDK Electronics and Fairchild Camera & Instrument joint venture. Actual production of the CD-4 chip will be handled by FC&I, Mountain View, California.

The device will be made in a 16-pin plastic or ceramic DIP and features automatic loop gain control circuit, muting circuit, and sub-carrier display lamp drive circuit.

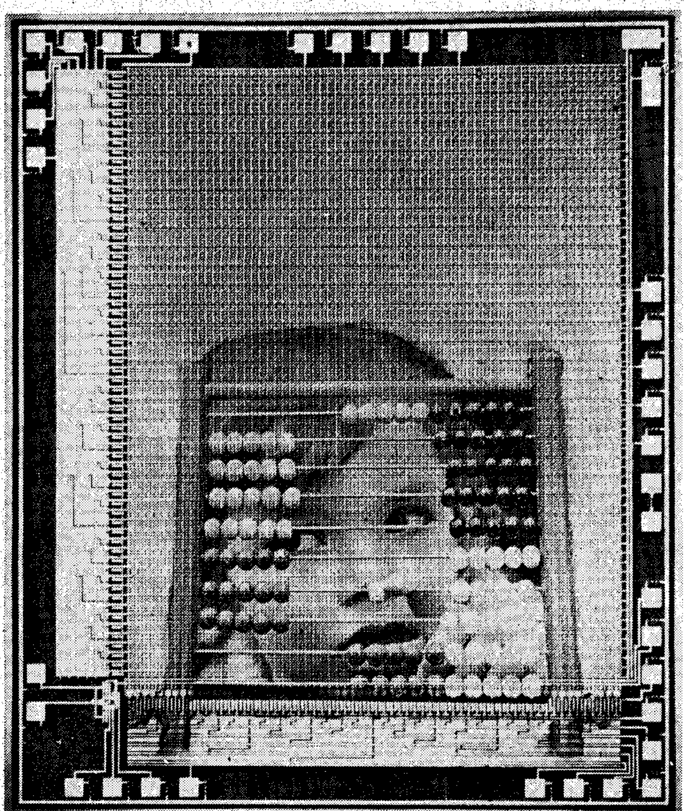
STATIC 4k MEMORY

For some time now, efforts have been made to increase the integration density of static memories. In the Siemens Research Laboratories a static MOS memory has been produced accommodating 4000 bits on 14.7 mm^2.

The memory is an integrated circuit in aluminium gate ESFI technology. This step forward was made possible by integrating the switching elements on an insulating substrate and employing a non-crossing conductor layout between the transistors and resistors in a memory cell.

An initial breakthrough on the way towards static ESFI MOS memory cells (ESFI = epitaxial silicon film on insulators) of high packing density was the development of a complementary MOS cell with five transistors and an area of 4000 μm^2. The second measure was to combine two complementary transistors and two load resistors in one cell in a non-crossing layout to obtain a flip-flop. In this way, the cell area was reduced to 2000 μm^2. The final step was to replace the select transistor by a diode and to use the power supply lines. It was thus possible to reduce the memory cell area again to 1500 μm^2. This is even less than the area required by MOS memories and bipolar memory cells.

Such memory cells have already been integrated in a configuration with 4096 bits. The chip area is then 14.7 mm^2: the actual memory matrix, the word and bit line decoders and the read-out circuit are accommodated in an area measuring 4.2 mm x 3.5 mm. The results of tests allow us to predict an access time of around 120 ns and a cycle time of about 170 ns for the production module. The power dissipation is 100 mW.



FERRANTI – POSSIBLE SALE

Both Plessey and English General Electric are reported to be interested in buying the semi-conductor division of Britain's financially-ailing Ferranti empire. Ferranti has over 17 000 workers at plants throughout the UK and is heavily involved in manufacturing electronic defense equipment for a number of European countries.

The company's financial problems came to light recently when it was revealed that the firm was overdrawn by more than £20 million.

The British government has provided monetary assistance — and because of this nationalisation of the company has by no means been ruled out.

NASA HOLOGRAPHY SURVEY

The NASA Technology Utilization Office has published a comprehensive survey on the subject of holography. The volume covers the state of development of holography and holographic techniques.

Entitled "Holography: A Survey", the 140-page volume was written by David D. Dudley of Computer Sciences Corporation, Falls Church, Va.

Unlike the human eye and camera film which record only the intensity of an object, holograms record true depth perception in three dimensions. Contemporary holographic techniques for recording and viewing objects are having an important impact in engineering, production and display applications.

In addition to optical holography, the volume covers recent developments involving microwave, acoustic, ultrasonic and seismic holography. Also discussed are such subjects as data processing, storage, pattern recognition and computer-generated holography. Finally, a comprehensive glossary of terms is included.

The paperbound volume sells for US$1.70 and can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. USA.

SOLAR POWERED WATCH

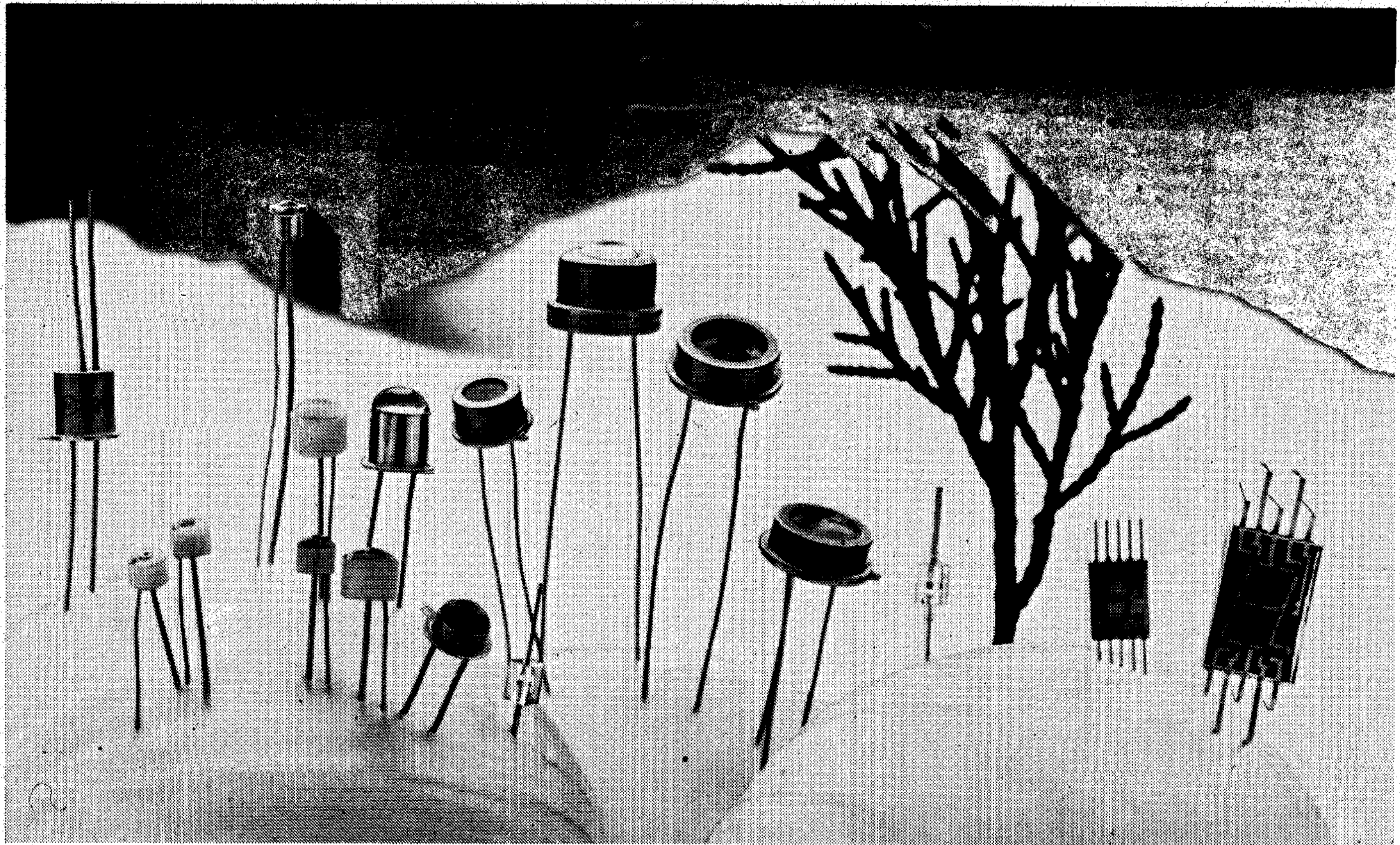
Production is now said to have begun on the light-powered Ragen Synchronar watch.

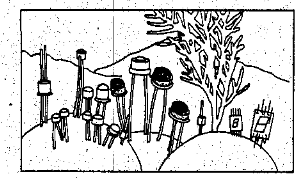
A feature of the LED digital watch is its 100-year calendar, which is pre-programmed to allow for monthly aberrations and leap years to the year 2100.

An average exposure to sunlight of 10 to 15 minutes per day claimed to be adequate to charge the watch.

Continued on page 15

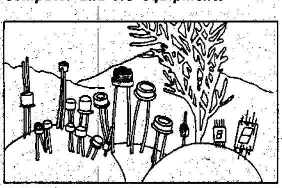
The complete range of Optoelectronic devices



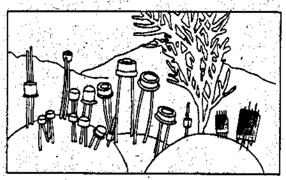


Photodiodes
OKI photodiodes are of diffused planar silicon construction, feature high performance and reliability and are suitable for application in computer peripheral equipment, process control, industrial control, photo-meters or any other design requiring light sensitivity.

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



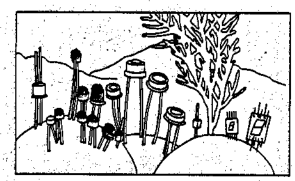
Phototransistors
OKI phototransistors are of planar silicon construction and are highly sensitive devices. They are particularly suitable for use in optical measuring equipment, control devices and other electronic applications.



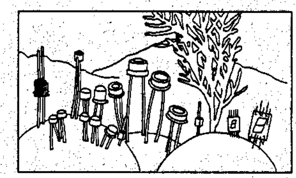
Solid-state Numeric and Alphanumeric Displays
OKI numeric displays are of GaAsP monolithic or hybrid, 7-segment composition. They are suitable for application in a wide variety of display apparatus. Features include high brightness with small current, numerals 0-9 and decimal point and rugged, vibration-resistant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

Typical applications include computer terminals, electronic desk and portable calculators, cameras, electronic wrist watches and various digital measuring instruments.

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



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



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

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

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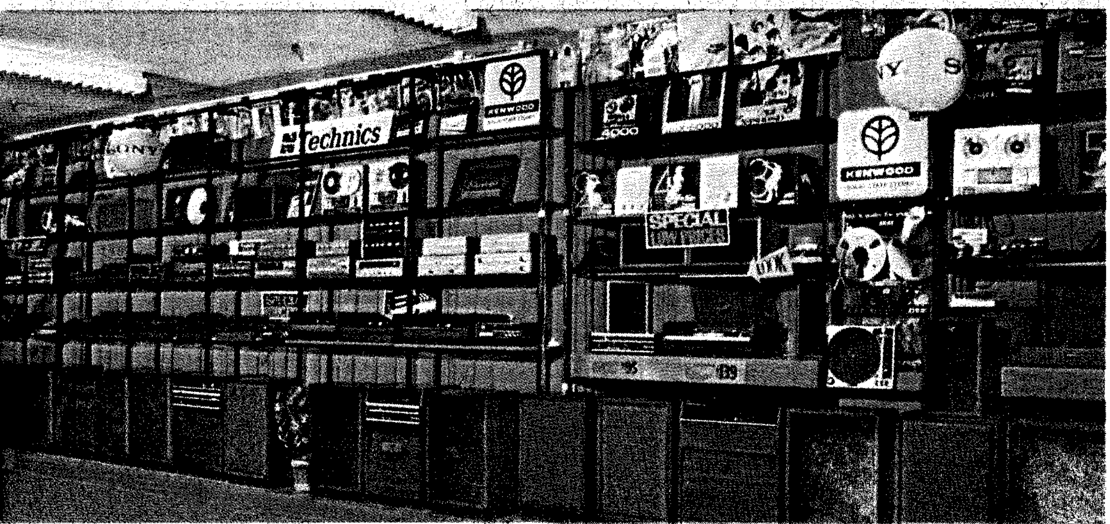

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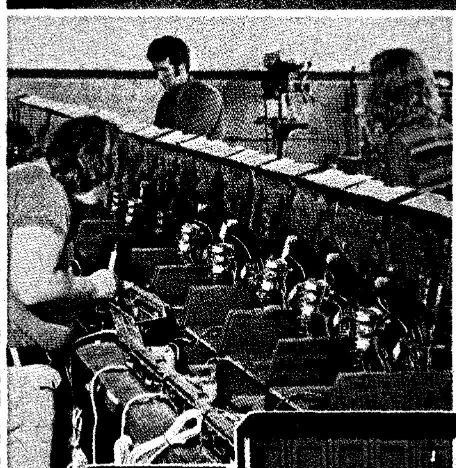

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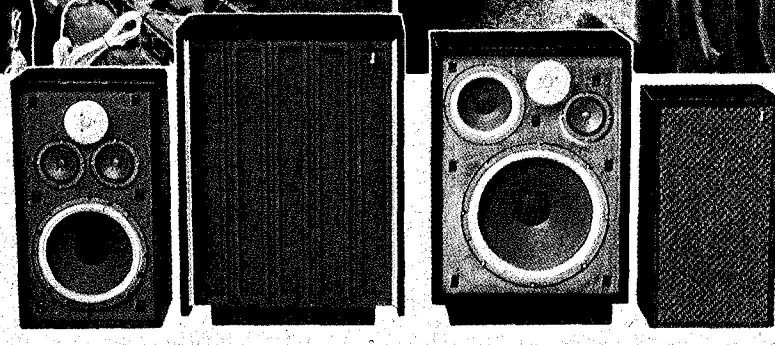


Douglas Hi-Fi have the complete range of the fabulous JENSEN Speakers **from $99 pair to $1099 pair.**

Continued from page 10

UK COMPANIES CEASE MONO TV TUBE PRODUCTION

In Britain, Philips Industries and also Thorn Electrical Industries are ceasing manufacture of black-and-white TV picture tubes.

Philips in fact are getting out of black-and-white TV receiver production altogether. The company is currently planning to close down its present plant at Squiresgate (Lancs) and to switch workers at its Croydon (Surrey) plant from TV assembly to video cassette recorder production.

The joint move means that no mono TV tubes will in future be quantity-produced in the UK. All will be imported.

Sales of black-and-white TV receivers have fallen in the UK from 1.5 million in 1972 to 990 000 last year and a projected 700 000 this year.

LINEAR TEMPERATURE SENSITIVE RESISTOR

A temperature-sensitive resistor, whose resistance varies linearly with temperature, has been developed by the Electronic Products Division of Corning Glass Works (Bradford, P.A., USA).

The resistance of the device is claimed to remain substantially linear over the range -20°C to +150°C. Nominal resistance at 25°C is 1000 ohms.

FOUR-CHANNEL TEST TRANSMISSION

Discrete FM 4-channel signals were transmitted by subscriber-type cable systems in San Jose and Santa Clara (California) during July.

Co-operating parties were Santa Clara University, Gill Cable, Inc., Teleprompter, CATEL (cable-FM equipment maker), and Matsushita Electric Industrial Co., Ltd. Signals were originated at the university's cable FM studio using a CD-4 discrete 4-channel record system and a prototype discrete FM 4-channel generator.

A survey of audience participants indicated that 98 percent found the sound "more exciting" than stereo. Of those in the market for new equipment, 86percent indicated interest in purchasing quad provided prices were in the $500 to $1000 range. Although no serious equipment problems were encountered during the test, it is thought that a small amount of hiss noticed on soft passages may be suppressed by running the carrier level 2-3 dB above that of stereo, to compensate for 4-channel transmission's poorer signal-to-noise ratio.

250 WATTS – CLASS D AMPLIFIER

A 250 watt per channel power amplifier weighing a mere 10 kg is shortly to be released by Infinity.

The unit utilises Class D operation – a technique in which audio signals are digitized before amplification. In operation the output transistors are switched at a rate exceeding 500 kHz.

Efficiency is claimed to be 96%, compared with 40% or so typical of the more commonly used Class B units.

GRAVITY WAVE DATA TRANSMISSIONS?

Future communications systems could well utilize modulated gravity waves propogating directly through the centre of the earth – according to a report given recently to the British Association by Dr. Drever of the Dept of Natural Philosophy, Glasgow University.

The notion is very much on the border-line between physics and science fiction as great controversy still continues as to whether gravity waves exist or not, however modern theory increasingly supports the idea of energy waves flowing across the universe in the way that light energy flows from the gigantic energetic disturbances in stars and galaxies.

NS INTO DIGITAL WATCHES

National Semiconductor has now officially entered the electronic digital watch market with six Novus time-pieces priced from US$125 to US$220 and three digital alarm clocks priced from US$35 to US$60.

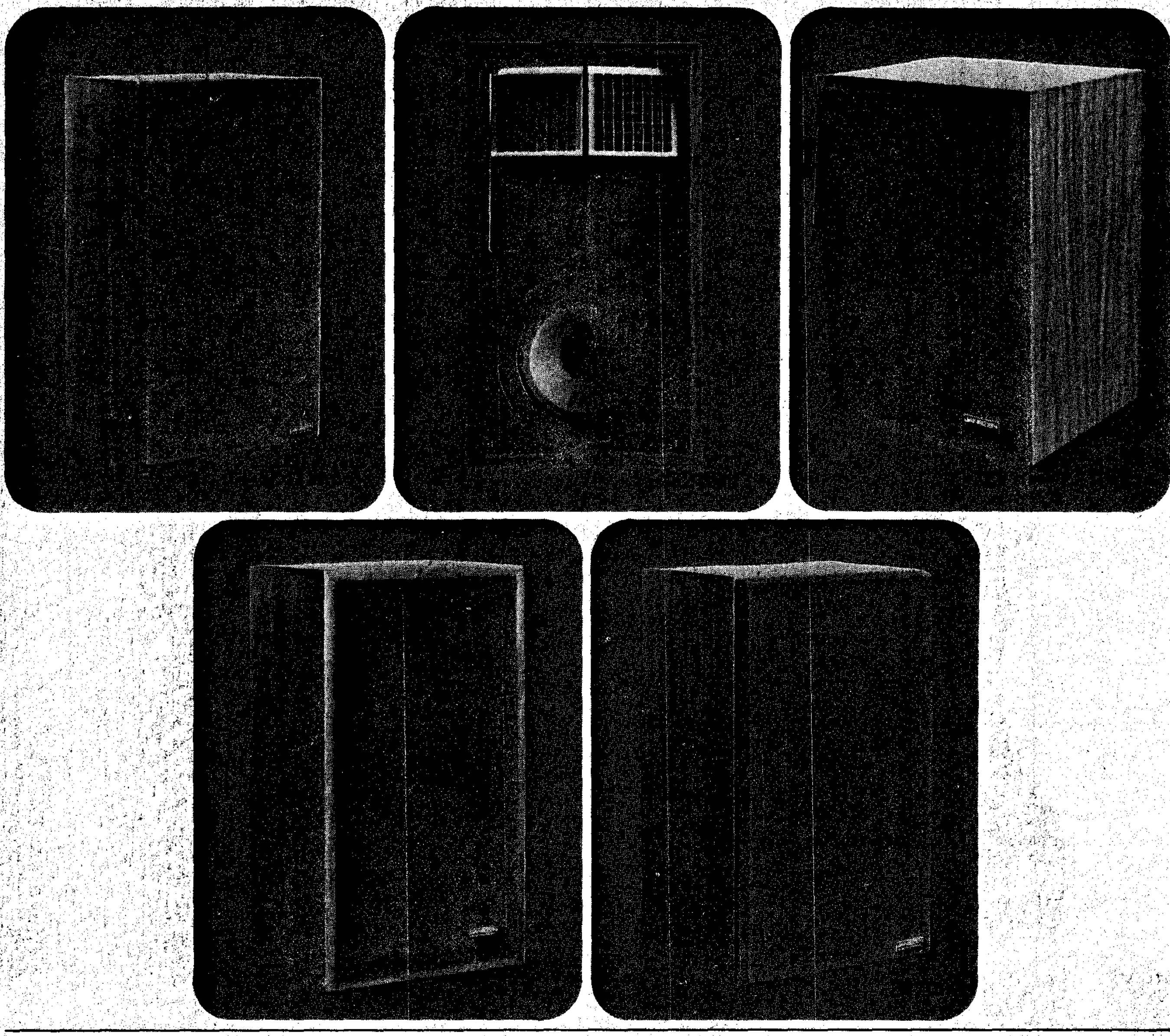
The complete line will be sold through jewellery and department stores. ●

SPECIAL OFFER

IC 555 TIMER

SEE PAGE 53 THIS ISSUE.

INCOMPARABLE JANSZEN



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INTERDYN

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Check the facts: Frequency response 20-75,000Hz. 12 watts RMS per channel, 50 watts total music power (IHF). All solid state electronics, all silicon output transistors. Pushbutton controls for power, speaker systems 1 and 2, volume, tape monitor. Headphone jack, facilities for ceramic and magnetic cartridges, tuner, tape recorder, auxiliary equipment. In handsome timber cabinet.

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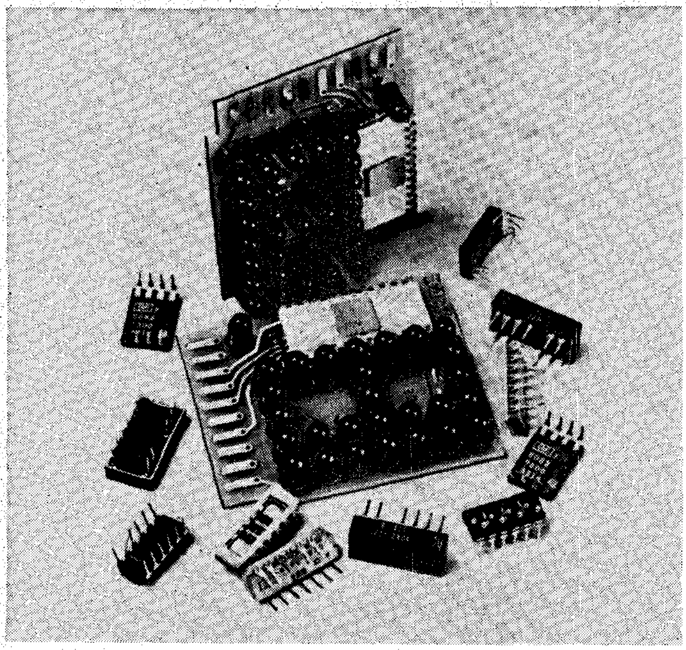
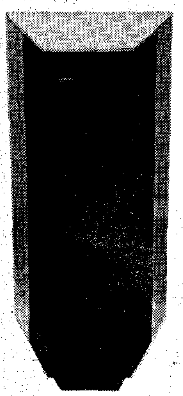


Goodmans

High Fidelity Equipment



Dimension 8

● 8 speaker system

L.F. radiator, 4 bass speakers, 2 midrange, 2 dome tweeters.
Nominal Power Input: 60 Watts
Impedance: 4 Ohms
Sensitivity: 4.4 Watts
Frequency Range: 30-22,000 Hz
Size: 30-3/8 x 14 x 12½
77 x 35.5 x 31.5 cms
Finishes: Teak, Walnut or White

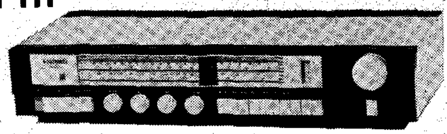
Goodwood

● 3 way system

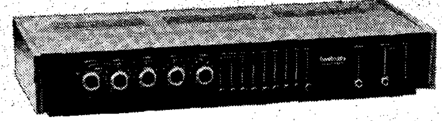
1 x 12" bass speaker, 1 x 4" midrange, 1 dome tweeter.
Nominal Power Input: 40 Watts
Impedance: 4-8 Ohms
Sensitivity: 9 Watts
Frequency Range: 35-22,000Hz
Size: 30 x 14¼ x 10-5/8"
Finishes: Teak or Walnut.

Model One-Ten Am/Fm Tuner Amplifier

Power Output:
50 Watts per Channel into 4 Ohms
Variable Tuning Ranges:
VHF FM: 87.5-108 MHz
Length: 584mm
Depth: 305mm
Height: 115mm
Finishes: White with discreetly coloured control tabs. Teak or Walnut finish case with brushed aluminium fascia.

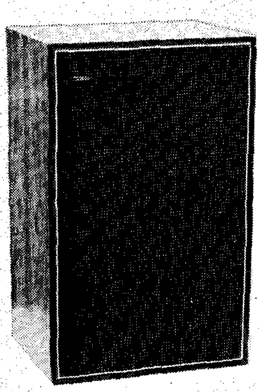


Amplifiers



Model Forty Forty Amplifier

Power Output:
35 Watts RMS per channel into 4 ohms
Total harmonic distortion:
Less than 0.1% at 30 Watts per channel
Frequency Response:
30 – 20,000 Hz ± 1.5 dB
Finishes: Teak, Walnut or White
Size: 22 x 11¾ x 3¾ ins.



Magnum S.L.

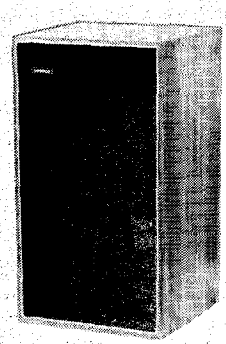
● 3 way system

1 x 12" bass speaker, 1 x 4" midrange, 1 dome tweeter.
Nominal Power Input: 40 Watts
Impedance: 4-8 Ohms
Sensitivity: 2 Watts
Frequency Range: 30-22,000 Hz
Size: 24 x 15 x 11-3/8
62 x 38.1 x 29 cms
Finishes: Teak or Walnut

Havant S.L.

● 3 way system

1 x 8" bass speaker, 1 x 3-3/8" midrange, 1 dome tweeter,
Nominal Power Input: 20 Watts
Impedance: 4 Ohms
Sensitivity: 4.4 Watts
Frequency Range: 45 - 22,000 Hz
Size: 18¾ x 10½ x 10½
48 x 26.5 x 26.5 cms
Finishes: Teak, Walnut or White



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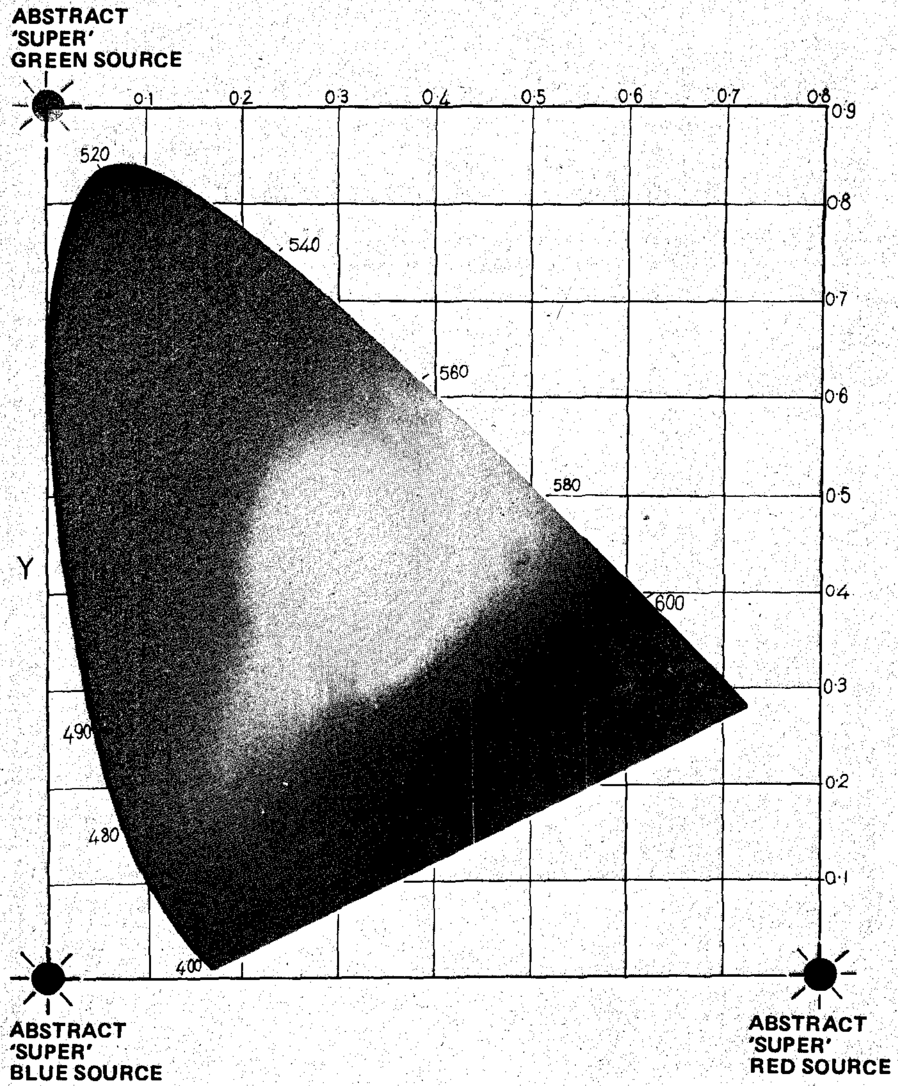


The aim of this series is to explain the basically simple principles which, when combined, make the near-miracle of colour television possible.

The intention is to avoid intensive explanations of any step in the process (as a specialist may require) since this would cause a general reader to feel adrift. Instead we shall describe the fundamentals which are essential matter for anybody seeking a broad understanding of colour television.

Fig. B. The C.I.E. chromaticity diagram which shows how all colours, including spectral colours which lie along the heavy line can be achieved by combining three 'super' fictitous primary sources.

UNDERSTANDING COLOUR TV

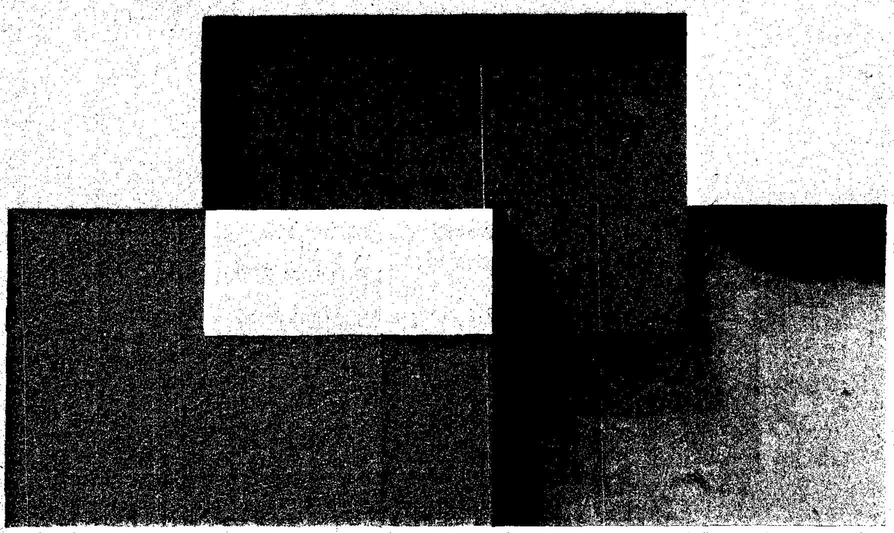


Fig. A. This illustration shows the effect of mixing varying proportions of light coloured red, green and blue. These are the additive primaries used in colour television displays.

THE PHYSICAL NATURE of colour was a complete mystery until 1666. Then, Sir Isaac Newton discovered that a single beam of sunlight passing through a wedge-shaped piece (prism) of glass becomes *dispersed* into a fan-shaped beam or *spectrum* of many brilliant colours.

We recognise the spectral colours as different wavelengths of light energy which were all present in the sunlight but have become separated by varying degrees of bending in the class wedge. For example, spectral green is a monochromatic (single wavelength) radiation of about 550 nanometres wavelength, Its frequency is nearly 1000 000 000 Megahertz!

The eye is sensitive to only a very narrow band of this spectrum. This band extends from 380 to 780 nanometres (1 nm - 10^{-9}m = 10A wavelength (Fig. 1).

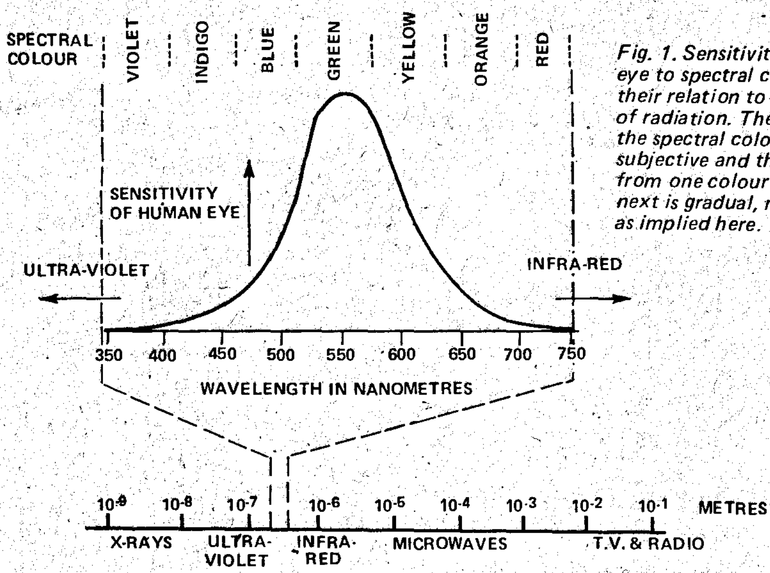


Fig. 1. Sensitivity of human eye to spectral colours and their relation to other forms of radiation. The names of the spectral colours are subjective and the transition from one colour to the next is gradual, not sharp as implied here.

Red is the colour sensation produced by wavelengths in the region of 700 nm and violet is the colour sensation produced by wavelengths in the region of 380 nm.

The colours at the ends of the spectrum (violet and deep red) appear comparatively dim, this is because the eye has less sensitivity to these wavelengths.

Although there is surprisingly great variation between people, an average response curve for the eye has been measured and is shown in Fig. 2. Those in electronics will notice that this curve resembles the response shape of a tuned circuit and it is a remarkable result of evolution that the peak is 'tuned' to near the wavelength of maximum emission from the sun. The eye does not judge colours by measuring wavelengths.

Instead the eye *seems* to contain three sets of nerves with different wavelength responses, and the sensation of colour seems to be a sensation of the relative proportions in which this triad of nerves is stimulated — see Fig. A. It must be stressed that this description is merely conjecture. It describes the way the eye reacts to known mixtures of wavelengths but has not yet been medically proven. Certainly though it is a reasonable conjecture, for if we combine three light sources (particular shades of red, green and blue light called *primaries*) and stimulate each nerve individually, any possible colour impression can be simulated by varying the relative strengths of the sources.

Figure A is a way of showing this. It is a colour triangle where each primary coloured light is shown alone at a corner and becomes mixed with one of the other two primaries as one moves towards one of the other two corners, or becomes mixed with both of the other two primaries as one moves towards the centre of the opposite side. At the centre is the colour 'white'. This is produced by near equal strengths of each primary. The precise position of white on the triangle is a matter of choice since, like any other colour, its separation from bordering colours is indistinct.

The colour triangle shows only the colours produced by different proportions of the three lights. It does not show the effect of brightening or darkening all three lights by the same factor. Doing this does not change the *colour* of any position on the triangle, it merely varies the *luminosity* (brightness) of the colour. Since luminosity information is absent from the triangle, the 'white' area could equally rightly be called light grey, medium grey, dark grey or black since this is the variation caused by varying luminosity. The reason brown was not found in the spectrum is now apparent: brown is merely the colour yellow with low luminosity. (Therefore a brown object brightly lit against an otherwise dark background, so the eye over-estimates its luminosity, appears yellow!) Also the nature of purple, a mixture of red and green which has no single place on the spectrum, becomes clear in Fig. A.

Artists may be questioning our choice of red, green and blue primaries since they have found red, blue and yellow to be the most flexible choice of paints to be mixed to give other colours. However our simulation of colours by *additive* mixing of lights is quite different from the process of paint mixing which is a *subtractive* process i.e.: the more coloured pigment is added to the mix, the darker the result because fewer wavelengths of light are reflected. An artist concocts his colours by removing some of the wavelengths present in white light (the colour of his canvas or of the base of his paints) until the right mixture is left. He can therefore start with more than one set of subtractive primaries, using more than three for best results (as is done in printing the colour pages of this magazine).

Although the combination of primary coloured lights to create new colours is fairly successful, some colours, including the spectral colours, cannot be simulated completely by any mixture. For example, spectral blue-green cannot be copied by mixing any other colours, spectral or otherwise. (Of course if we choose spectral blue-green as one of our primaries this particular problem is solved, but all the other spectral colours remain.) However, it has been found that any of these inimitable colours, if first modified by adding an amount of one of the primary colours, becomes a colour which *can* be simulated by combining the remaining two primaries. It is as though each primary to the spectral colour counteracts the negative quantity to produce a colour which lies within Fig. 2.

Since we cannot have negative light sources, spectral colours will lie

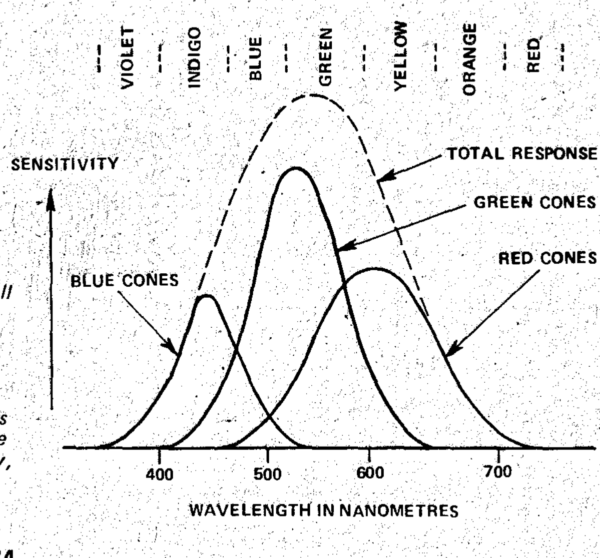


Fig. 2. The three hypothetical responses which combine to give the overall eye response in Fig. 1, (based on experimental data). From left to right the peaks are at blue, green and red which suggests that these colours could be used to influence each response individually, and in combination cause the eye to see any colour.

UNDERSTANDING COLOUR TV

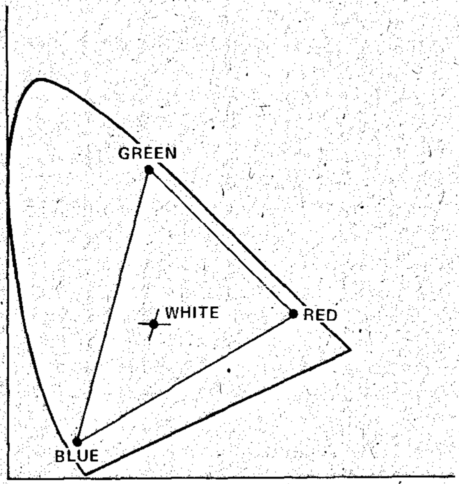


Fig. 3. A feature of the chromaticity diagram is that the colours achievable by combining any three primaries can be found by connecting them on the chart. The three dots above represent to scale the best television screen phosphors available for colour television. Therefore colour television can only reproduce colours lying inside the triangle.

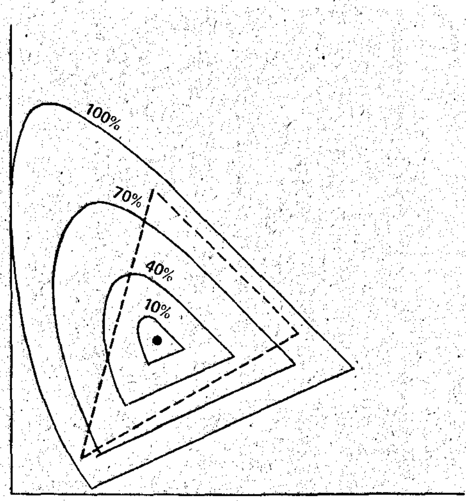


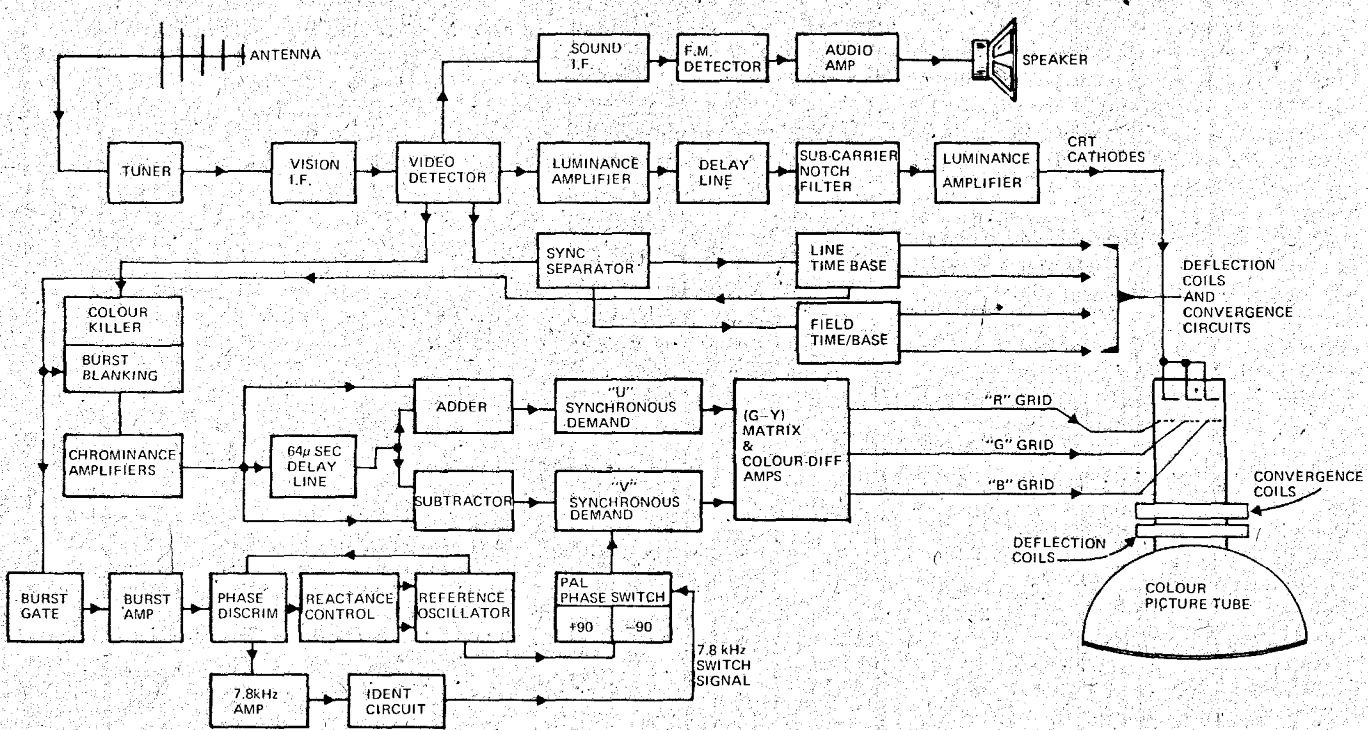
Fig. 4. Contours of four levels of saturation. Dot at centre is white 'zero saturation'.

outside any colour triangle drawn with real light sources at the corners. However the C.I.E. (Commission Internationale de L'Eclairage — the International Commission on Illumination) defined in 1931 three *abstract* primary colours which, if they existed, could be combined in suitable ratios to stimulate any known colour impression, including all the spectral colours. The usual presentation of the colour triangle using these sources is the 'chromaticity diagram' shown in Fig. A. Here the quantities of the primaries are given in 'tristimulus units' x, y and z, which have the property that units of different primaries can be assumed to give an accurate measure of the visual brightness of the resulting colour. Since brightness (luminosity) variation does not affect the triangle, luminosity can be given unity value and the triangle drawn like a conventional graph with only two variables, x and y, since the third z can be found for any colour position from $z = 1 - (x + y)$.

Much can be deduced from this diagram. For example it shows that any real colour triangle must have as its corner primaries three colours on the diagram — Fig. 3. Since no such triangle can be drawn to encompass the entire horseshoe, spectral colours can never be simulated.

SATURATION

Colours near the horseshoe boundary have a strong undiluted quality, the strongest being the spectral colours. Colours nearer to the white at the approximate centre of the horseshoe are paler or 'pastel'. The distance from white of a colour on the diagram is called its 'saturation' which ranges from 0% (white itself) to 100%



Block diagram of PAL colour receiver, it looks complex here, but in actuality it is a basically simple, logical device.

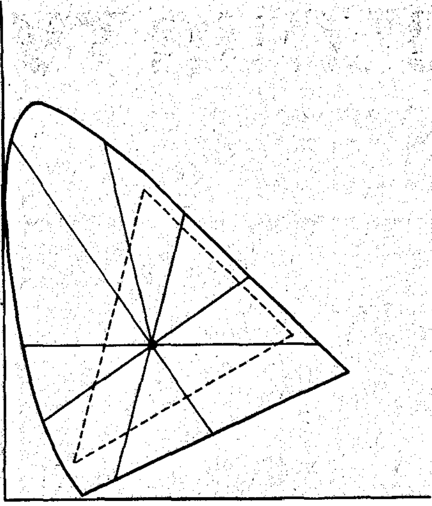


Fig. 5. Each radiating line joins colours of a particular 'hue'. White at the centre has no hue.

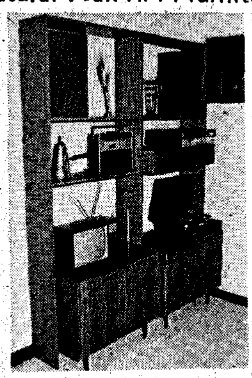
saturation on the border of the horseshoe – Fig. 4.

HUE

If we start at any 100% saturated colour and progressively desaturate it by adding white light, we travel from the boundary of the horseshoe along a straight line towards white. All colours along such a line are said to have the same *hue* and vary only in saturation. There is an infinity of possible hues – see Fig. 5. Note that a triangle of real primaries, as used in a colour television display, can simulate any *hue* but not at full saturation. Since 100% saturated colours are rare in nature the restriction is acceptable. Thus the question of how colour television can reproduce a rainbow spectrum is answered – the hues are reproduced correctly but some colours may lack true saturation.

CHOICE OF COLOUR VARIABLES FOR TV

We shall see in Part 2 of the series that because of the need for the colour television signal to be suitable also for monochrome receivers, luminosity information is transmitted in the form of a monochrome television signal and two extra streams of information are cunningly added to the signal for recognition by colour receivers only. These two extra signals are two variables which define positions of colours on the chromaticity diagram. There could be many choices of pairs of variables. Hue and saturation are a possible pair since they uniquely define any colour. However it is undesirable to use variables capable of specifying colours which cannot be reproduced. ●



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The logical layout of the controls gives you an immediate affinity with the unit, and there's a Lux model with just the power handling and performance to suit you.

LUX SQ 505X (Shown)
Electronics Australia: A listening test, using familiar speakers and source material, proved what a superb unit this is. Power output 30 watts per channel RMS, with both channels driven, for 0.04% distortion. Power bandwidth (0.04%—3dB) is 5Hz to 50kHz.

LUX SQ 507X
"Hi Fi For Pleasure" March '73 said: "Unhesitatingly met and frequently exceeded its exhaustive specifications in all parameters. Suitable for installations of the highest quality, it can provide ample power for all domestic applications, including the larger, low efficiency transmission line speakers. At 8 ohms, both channels, 61 + 61 watts are available. Singly driven, power rose to 80 watts. At rated output (50 + 50 watts) total harmonic distortion was 0.02% at 1kHz. Power bandwidth is 5Hz to 50kHz."

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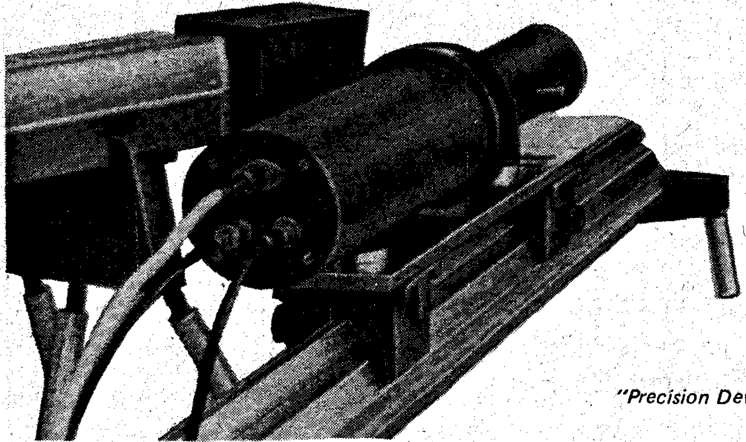
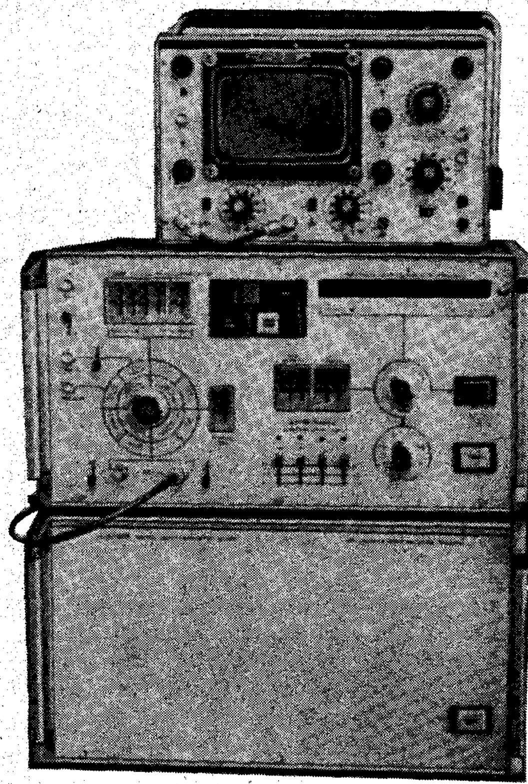
KSV735

COUNTING PHOTONS

How to extract ultra-low level signals from a high noise environment.

"Precision Devices" Laser Photon Correlation Anemometer.

OUR ABILITY to detect signals from any area of interest is largely limited by the extent to which noise signals (those that *look* like the desired signal but which come from unwanted sources) are present in the total output energy from the system being studied.

All practical signals contain noise: signal/noise ratio expresses the relative proportion of each.

When the ratio is much larger than unity little difficulty in detecting the signal is experienced. It is when it falls close to, or below, unity that special techniques must be brought to bear if the signal is to be extracted.

The uninitiated might feel that a signal containing as much noise as signal is close to useless. But it is possible, provided the noise is different in character to the signal in some way, to separate the two. By the use of certain very powerful methods it is possible to recover signals that are only 1/100,000th of the noise level.

An incredible amount of knowledge gained from research studies has been obtained under conditions where the signal/noise (S/N) ratio is extremely poor. Many experiments can be designed to work with large S/N ratios: this is fine if it can be achieved. However, many effects are not under the control of the experimenter, so when natural background swamps the signal there is no option but to employ advanced detection techniques. Examples include studies of atomic absorption, various forms of spectroscopy, audiometry, bio-medical stimuli response measurement, cochlea microphonics, doppler measurements, electro-luminescence, electron spin resonance, nuclear magnetic resonance, Zeeman effect, laser frequency controllers, Hall-effect probes, photometry, strain gauges, micro-wave studies and many more where signal enhancement is needed if anything useful is to be learned.

A large proportion of these examples are concerned with the measurement of optical radiation levels . . . those in the radiation band from infrared to ultraviolet. The usually applied methods for detecting the minute radiation signal energies involve looking at analogue properties of the light — the detector produces a continuous form of signal that has an amplitude proportional to the signal.

The most used method is the lock-in technique (also known under numerous other names, such as, phase-sensitive-detection, synchronous detection, coherent detection). In this method the photons collected in the detector (photomultipliers are the most usual form employed in high sensitivity work) are used to produce a voltage or current that is amplified and processed as an analogue signal entity. A good lock-in amplifier can detect signals as small as 100 pV or, in terms of current, 0.01 pA (10^{-14}A) which is certainly good but it is not the maximum attainable.

Our dual concepts of light tell us that it can be of a continuous nature or that it comes in discrete pulses of energy, called photons. Photons are fundamental quanta of electromagnetic energy occurring in the visible region of the electromagnetic spectrum. In the shorter wavelength region we have the nuclear particles that are handled as pulses for this range, pulse counting methods are used instead of analogue procedures.

It is not so surprising, therefore, to see the same approach to the problem has also been applied to light, considering it as photons. It is a relatively new concept in practice having its commercial origins about seven years ago when the methods were developed for chemical analyses.

Today several manufacturers offer equipment for detecting extremely low-light-levels that are buried in noise by the use of the digital photon counting method.

DIGITAL BETTER THAN ANALOGUE

The analogue lock-in methods of signal recovery, although good, are not as powerful as a well designed photon counter arrangement. Firstly, practical lock-ins cannot achieve the same degress of improvement in S/N ratio at very low light levels with a subsequent reduction in overall sensitivity. Secondly, analogue systems are prone to gain changes as the components drift in value with time. Digital counting is far less affected by gain changes, for signal amplitudes are not critical in digital circuitry. Thirdly, detector characteristics are time-dependent because of such things as leakage current variation, applied voltage variations, dimensional and chemical changes which, being analogue in nature, produce drift. If the detector can be used to detect signals that are digital at their source, these drift effects are greatly reduced.

Another important factor is that sophisticated signal processing systems nearly always incorporate digital computing machines, so signals already in a digital form are to be preferred as the need for an analogue to digital converter is avoided.

PRACTICAL CONSIDERATIONS OF DIGITAL LIGHT INTENSITY DETECTION

The energy of a photon is given by hc/λ where h (Planck's constant) and c (the velocity of light) are constant. This means that the pulse height of photons formed by visible radiation (and near to it) will have energy levels that are much the same. This fact is used to effect in noise reduction as we will soon see.

Each quantum of light landing on the detector should ideally produce a well-shaped pulse ready for counting. Furthermore the ideal detector should not generate pulses of its own, for these would appear as signal resulting in misleading answers. Photomultipliers are usually used; they come closest to the ideal, and have internal gain of around 1 000 000 with very little addition of noise.

In practice, as the system is made more sensitive, the signal will be found to contain stray noise generated in the signal background. It has been established that only some 6.15% of photons are detected in the photomultiplier and that it too generates noise pulses internally. These pulses arise from secondary emission on the dynodes, electron emission from the photo-cathode, and from emissions caused by external radiations fluxing through the photomultiplier. On top of these noise problems there is an unpredictable surface leakage current. A photomultiplier typically generates a background noise count of 10-100 per second from these sources.

SEPARATING NOISE PULSES FROM SIGNAL PULSES

The analogue lock-in method derives its signal extraction capability by limiting the bandwidth of the signal to very narrow limits, thus reducing the noise energy which is usually wide-band white noise. As the signal energy is all contained in the same narrow bandwidth the signal power remains unaltered but the noise power is reduced. The net result is a dramatic improvement in the S/N ratio. As the improvement is proportional to bandwidth, the longer the response time allowed, the better the signal enhancement.

In pulse counting a somewhat similar procedure is used by distinguishing between pulses of different height. It has been established that the signal pulses have amplitudes lying within well defined limits (the energy equation tells us this) and that the noise pulses (discussed above) have heights ranging from small to large with a uniform distribution of amplitude.

The principle used, therefore, to reduce the noise level of a pulse count is to accept only those pulses that lie within two defined levels of amplitude. Those that lie above the level are not counted and neither are those that lie below the lower level. The amplitude range wherein pulses are accepted is called the window; see Fig.1. By this means some, but not all, noise pulses are ignored, thus raising the signal to noise ratio. Noise pulses in the window are, of course, accepted as signal.

Another advantage of the window scheme is that the system is more tolerant of detector gain changes — for the following reason. A gain change effectively raises or lowers the position of the discrimination window but does not alter its width by much. Signals now accepted in the new area at the top of a raised window are balanced out by roughly equal losses in the area lost below. Provided the window width and mean height is chosen intelligently to suit the energy of the signals to be detected, this method is not affected much by gain changes. A similar argument applies for drift in the dc level of the detector output. In sharp contrast, the equivalent analogue method suffers directly from gain changes and drift.

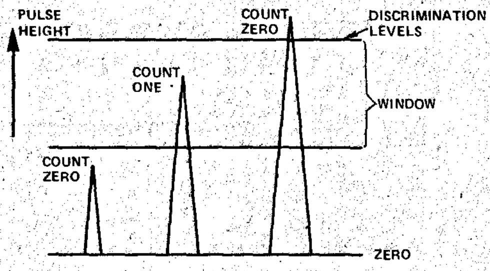


Fig.1. Pulses with height lying inside the two discrimination levels are accepted for counting. The central area is known as the window.

THE BASIC PHOTON COUNTER SYSTEM

The block diagram of the basic photon counting arrangement is shown in Fig.2.

The detector is coupled to the experiment with the known stray influencing effects screened out as well as possible. As the pulses from the photomultiplier are still very small in amplitude (maybe only microvolts), a low noise, very fast (1 ns rise time is used) preamplifier is needed to raise the signal to a reasonable level ready for acceptance by the discriminator. This stage has adjustable discriminator levels that form the window needed for the particular experiment concerned. After discrimination the remaining pulses are fed to the counter unit. The output of the counter can be displayed, fed to data storage, used to control a process or sent for further processing to provide information such as photon rate.

Typical count rates provided in commercial equipments, such as that shown in Fig.3, range from less than 1 per second to 10^8 per second using interval times from 1 μ to 1000 s.

As the signals are digital rather than analogue, the dc drift of the detector

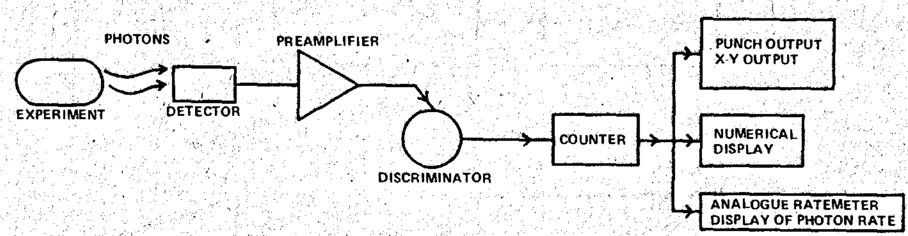


Fig.2. Basic block diagram of a photon counting system.

COUNTING PHOTONS

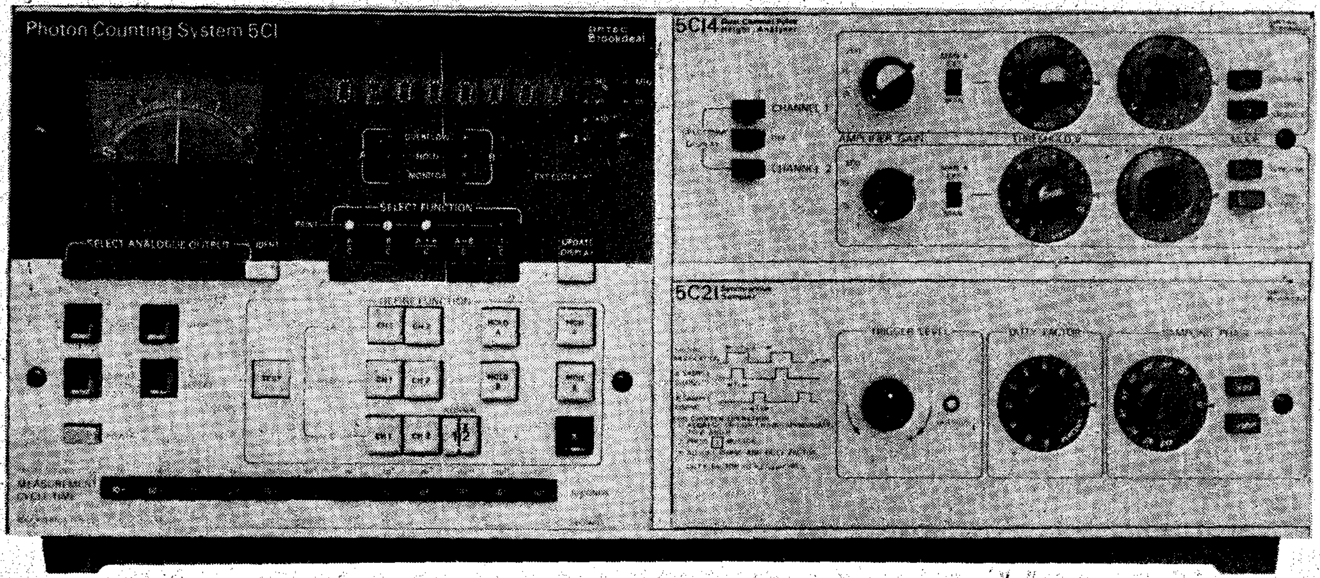


Fig.3. Front Panel of Brookdeal Photon Counting System 5C1.

with time does not impose a duration limit on the counting period. Very large intervals of counting can be used to improve the accuracy of the data by taking more counts.

IMPROVEMENTS TO THE BASIC SYSTEM

Several interesting improvements can be incorporated to improve the signal detection sensitivity. Let us look at these.

Compensating for light source variations — The number of photon pulses produced at the detector output is proportional to the intensity of the source illuminating the experimental area. Fluctuations in intensity will, therefore, alter the output, introducing error. As this source of error is systematic (we know where it is produced and how) it is feasible to monitor it and make corrections.

Figure 4 shows how this is achieved in the photon counter of Brookdeal. A second photodetector is set up to see the same source as is used to illuminate the experiment. This monitoring detector needs to have the same type of cathode but its gain does not have to be matched with that of the main detector. The Brookdeal system uses a second monitoring counter that is arranged as a preset count-level indicator. Both counters are cleared together, and counting begins. When the monitor count reaches its preset level it is used to inhibit counting in the main store. As the monitor counter fills each time for a given number of photon pulses, the value in the other counter must be the signal counts compensated for variation in the illuminating intensity.

Digital lock-in — The window concept can eliminate noise pulses that are unlike signal pulses on the criteria of amplitude, but it is unable to discriminate against those that look like signal.

If the light signal is chopped just before it enters the detector (a rotating blade is used) the detector firstly sees signal-plus-noise photons and then only noise photons, for the signal is screened from it. The signal still contains some noise . . . that from the strays in the experiment background . . but the method does reduce the noise contributed by the detector and strays entering its target.

Two counters are used to store the pulses produced, firstly with the chopper obscuring the beam, and then with the chopper open, the two being synchronised. The difference between the two count totals at any time is the signal count. Care has to be exercised with the starting and stopping times as these affect the accuracy of the procedure.

As the noise is random in nature it can be shown statistically that the effect of noise is reduced as the square-root of the number of counts taken. Hence, the longer the integration time the better the result and with photon counting this is not restricted by drift in the detector.

APPLICATIONS OF PHOTON COUNTING TO ANEMOMETRY

The flow of fluids can be studied at the microscopic level with laser

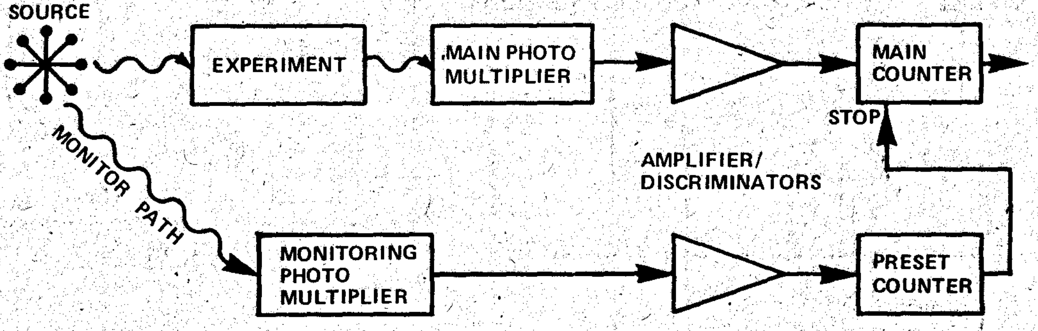


Fig.4. A second photo-multiplier is used to monitor the intensity.

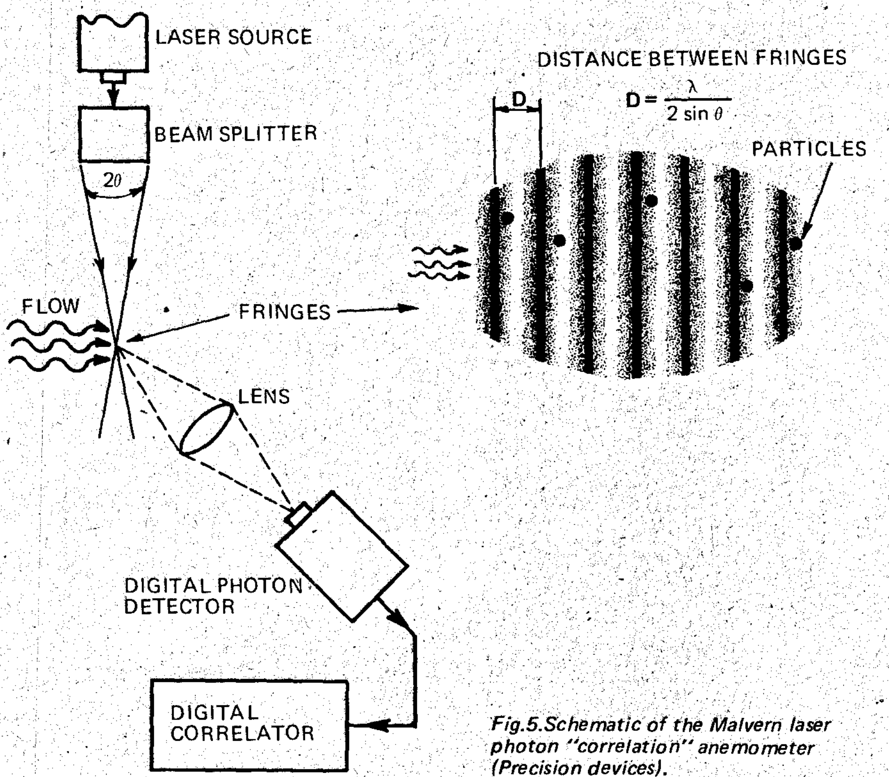


Fig.5.Schematic of the Malvern laser photon "correlation" anemometer (Precision devices).

doppler velocimeters (see E.T.I. Aug. 1972). These use a laser source to produce brief bursts of signal of only a few cycles long from the scattering particles moving with the fluid flow. The frequency of these bursts is related to the flow rate by virtue of the doppler effect.

A limitation to this method is that there is often need to add artifical scattering particles in order to gain a reasonable signal level for processing. Seeding is done with aluminium oxide, smoke particles or diesel fuel, but in many instances this is not feasible.

Since the E.T.I. article was published there have been many improvements and a number of alternative equipments operating on this principle are now marketed. The need to seed still exists however.

One method now available can measure velocity without seeding. It uses laser radiation but processes the signals by correlation rather than with the period measurements adopted in the earlier types.

Referring to Fig.5. the two laser beams converge to produce a fringe pattern in the flow under study. This pattern is viewed by a photon detector like those described above. Particles passing through the fringe-field scatter light to the detector with a signal strength that is greatest when the particles are passing the bright part of the fringe and lowest when in the dark part. In effect it appears as though the particles are bunched into the bright parts of the fringes.

The signal coming from the detector contains these scattered signals, but it is swamped by the general background level, so the whole must be processed in some way to extract the wanted information. This system does not need seeded particles for it can obtain a sufficient return from the microscopic structure of the fluid by virtue of the greatly enhanced sensitivity of the photon detector stage.

The key to enhancement is to use correlation methods to extract the time taken for a particle to traverse a cycle of the fringe. Flashes of light caused by the scattering particles in the flow result in pulse train bursts that have a periodicity related to flow rate. Figure 6 shows what these pulses would look like if the noise could be removed. With the noise added, the plot becomes a mass of pulses. If a section of this plot is recorded and multiplied with many different time-delayed versions of the same train, the plot of this correlated output looks like that shown in Fig.7. The period of the cosine wave produced by the correlator is the time taken for a particle to pass across a fringe pitch. Knowing the geometry of the fringe it is then possible to produce an output that is the velocity of the fluid.

In condition of turbulence, the correlogram takes the form shown in Fig. 8, looking like a damped oscillation. The envelope of the decay is a measure of the intensity of turbulence as is shown by the equation given in Fig.8. The complete system is shown in Fig.3.

This system is, however, unable to yield information about the direction of flow as the correlation procedure takes no account of which way the particles are going. If bi-directional flow exists the answer produced will be in error. This disadvantage can be overcome by addition of some more elements into the design.

The fringes, that are normally stationary, are modulated with electro-optic crystals, as shown in Fig. 9. This causes the fringe pattern to move from side to side with a small amplitude about the mean position. If the fringes are moving in the same direction as the flow the correlogram period is lengthened as shown in Fig.1; the opposite effect occurs if the fringe is made to move against the flow.

This information can be used to give

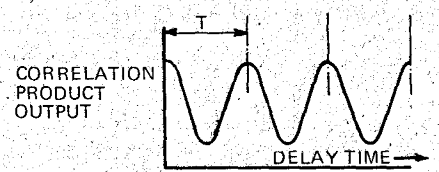


Fig.7. Correlator output for laminar uni-directional flow.

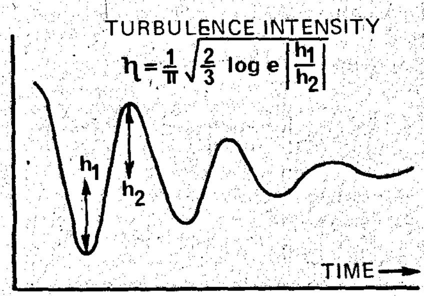


Fig.8. Turbulence produces correlator signals that enable the detree of turbulence to be estimated from the damping.

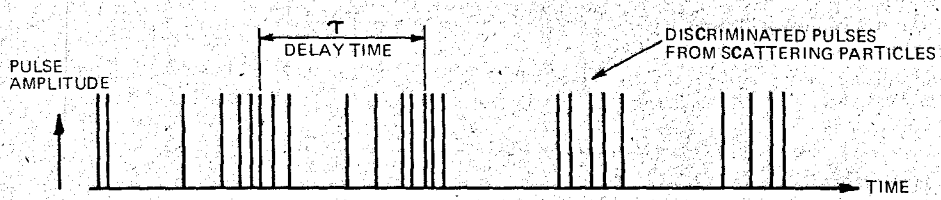
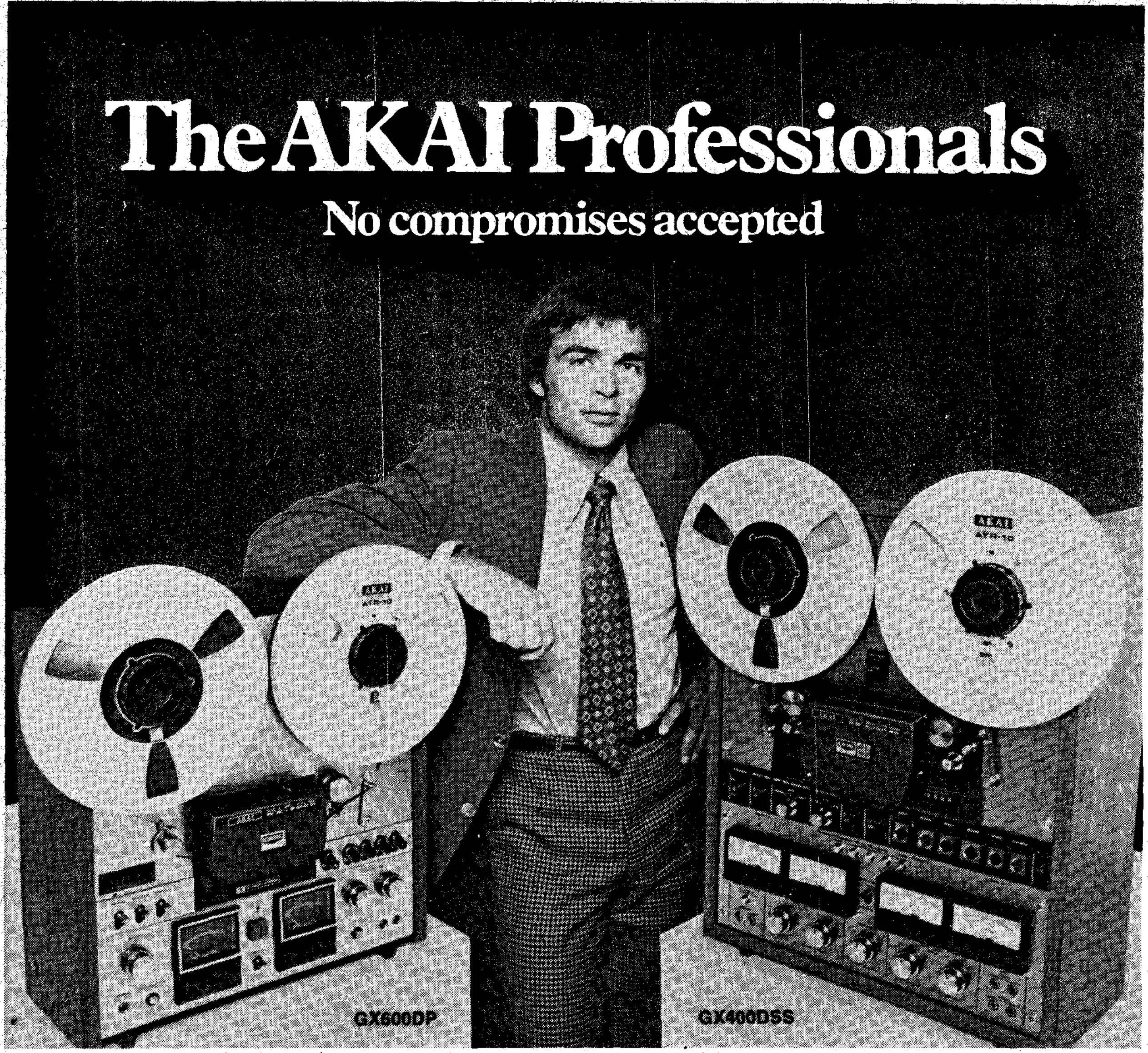


Fig.6. Pulse-time graph of light flashes in the noise could be removed.



The better a tape recorder works, the nearer it gets to giving you back on tape what you fed in.

Some tape recorders give you back sounds that only resemble what you fed in. There are things missing, like brilliance, depth and presence. There are things added, like wow and flutter, distortion, tape hiss and amplifier hum.

And that's not what you put in. Certainly not what you wanted back. This kind of tape recorder is plain dishonest.

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How does AKAI guarantee such honest sound? Through state of the art innovations like:

The GX head system.

Single crystal ferrite cores made in a high temperature furnace and set in glass. Glass cut so smooth by a jeweller that no composite particle can ever separate and cause head gap damage. Perfect head to tape contact and AKAI's exclusive focused field provide: improved sensitivity, no sound dropout and performance that always stays new.

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A unique inner rotor AC servo capstan motor enables voltage input to be stabilised. Resulting in constant perfectly controlled tape speed. External hum is also eliminated.

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Result: AKAI tape transport is second to none.

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The very real sound experience

GX-600 SERIES
Available in 4 track 2 channel, with or without Dolby and in 2 track 2 channel.
Reel Capacity: Up to 10½" reel
Tape Speed: 15 and 7½ ips (±0.8%) (Pro model)
Wow & Flutter: Less than 0.05% RMS at 15 ips
Less than 0.07% RMS at 7½ ips
Frequency Response: 30 Hz to 25,000 Hz (±3 dB) at 15 ips
30 Hz to 23,000 Hz (±3 dB) at 7½ ips
Distortion: Less than 0.7% (1,000 Hz "0" VU)
Signal to Noise Ratio: Better than 59 dB
Erase Ratio: Better than 70 dB
Cross-Talk: Better than 60 dB (monaural)
Better than 40 dB (stereo)
Bias Frequency: 150 kHz
Heads (3): One GX 2 track recording head,
One GX 2 track playback head,
One 2 track erase head.

GX-400 SERIES
Available in 4 track 4 channel, 4 track 2 channel and 2 track 2 channel.
Reel Capacity: Up to 10½" reel
Tape Speed: 15, 7½ and 3¾ ips (±0.5%)
Wow & Flutter: Less than 0.35% RMS at 15 ips
Less than 0.05% RMS at 7½ ips
Less than 0.08% RMS at 3¾ ips
Equalization: NAB curve
Frequency Response: Using low noise tape
30 Hz to 27,000 Hz (±2 dB) zero VU/15 ips
Distortion: Less than 1% (total harmonic distortion 1,000 Hz zero VU)
Signal-To-Noise Ratio: Better than 58 dB
Erase Ratio: Better than 70 dB
Cross-Talk: Better than 45 dB
Recording Bias Frequency: 160 kHz (±10 kHz)
Heads (4): 2-track recording GX head, 2-track playback GX head, 4-track playback GX head, full track erase head.

PKB70506

COUNTING PHOTONS

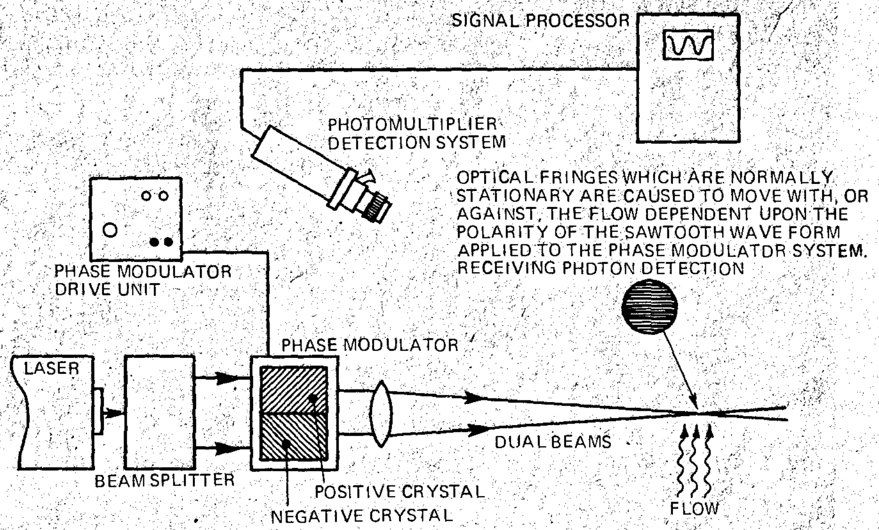

Fig.9. Addition of fringe modulation enables the direction of flow to be ascertained.

a measure of flow direction and being continuous in nature can be used to close the loop in a servo that controls the fluid flow rate, as is illustrated in the scheme proposed by Precision Devices – shown in Fig. 11.

It is interesting to see how correlator units have become accepted instruments that are added to systems as dedicated units. It was not so long ago that they were regarded as highly sophisticated research tools that took many a long day to build. No doubt we will soon see correlators produced on large-scale integrated chips that are wired into circuits in the same casual way that we use integrated amplifiers today. ●

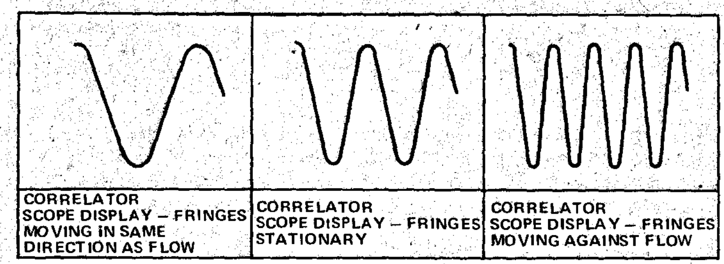

Fig.10. Effect of fringe movement on the correllogram.

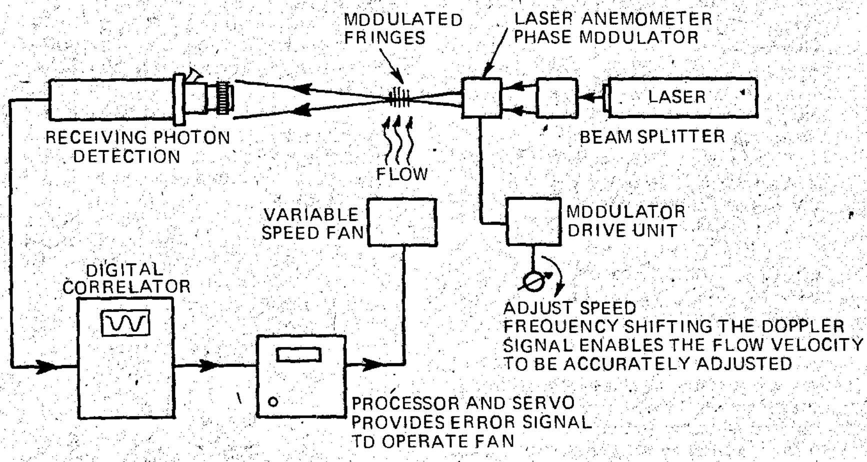

Fig.11. Use of the correlation anemometer to gain control of fluid flow rate.


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eti PRODUCT TEST

'One step nearer perfection'

PIONEER PL 51 Direct Drive Turntable

MEASURED PERFORMANCE PIONEER PL51 TURNTABLE WITH PIONEER PC50 CARTRIDGE SERIAL NO: TD13043	
Frequency Response:	20 Hz to 20 kHz $^{+1}_{-3}$ dB
Channel Separation at 1 kHz:	33 dB
Channel Difference:	0.3 dB
Sensitivity re 1 kHz at 5 cm/sec:	2.3 mV
Speed Accuracy:	accurately variable ±4%
Hum & Rumble:	−60 dB A-weighted
Wow & Flutter:	0.08% rms
Tone Arm Resonance:	7.5 Hz (see graph)
Dimensions:	48 x 41 x 18.5 cm
Weight:	11 kg

OVER THE YEARS there have been three basic systems for powering the ubiquitous turntable. All are supposed to meet and provide six primary parameters:

(i) They must revolve at a specified constant rotational speed.

(ii) The speed should remain constant even when the power supply from the mains varies.

(iii) They should operate without introducing vibration which can be detected by the record player cartridge (and even magnified to produce secondary problems).

(iv) They should have sufficient torque to overcome changes in the load with the tone arm at various positions on the record, and be able to bring the record player turntable up to speed in a minimum time.

(v) The motor should not produce a magnetic field which could induce hum into the pick-up system.

(vi) The units should be able to

operate for many hours, if not years, without serious deterioration.

Two types of motors have been used for this purpose over the years. Firstly, the *ac induction motor* which, whilst cheap, is nonetheless reliable, but follows fluctuations of the mains voltage, and secondly, the *synchronous motor* whose speed is determined only by the frequency of the alternating current.

In order to overcome the problems of noise and vibration from which some synchronous motors suffer, the best turntables have tended to utilise hysteresis synchronous motors which overcome these problems. Other motors, including servo-controlled dc and ac motors, are also used and recently we have seen a number of very cleverly designed record players featuring such systems.

Because the majority of the motors and systems that we have discussed run at higher speeds than the 33 1/3 or 45 revolutions per minute required by our turntable, it is necessary to introduce a speed change system between the motor and the turntable. This has been achieved in the past by two primary systems. The first, known as the idler driver system, is the most common and works on the principle of a rotating rubber idler providing a friction drive between the motor shaft and the inner face of the turntable rim. Whilst this system is well tried and proven, its critics point out with some justification that the rubber idler tends to wear out and that a certain amount of slippage is bound to occur. In addition, these systems tend to have a higher wow and flutter than their main competitors system which until recently were belt drive units.

The belt drive system uses a rubber or plastic belt of unusually high quality to act as a speed reducer between the drive motor and the pulley which is formed on the base of the turntable. Because of the elastic properties of the belt it is able to reduce motor noise and vibration transferred to the turntable, and thus reduce noise and rumble. The major problem with belt driven turntables is that they have a higher level of wow and flutter than their idler-driven competitors.

NOW DIRECT DRIVE

In the past three years a third and new breed of turntable has appeared on the market, and these feature very low speed motors directly coupled to the turntable. The motor shaft is also the turntable shaft. In these motors speeds are controlled by electronic servo mechanisms or through the use of multi-pole motors with sixteen or more poles.

We cannot comment on which of these two systems has the generally greater technical excellence (or higher cost) because some of the latest models of these respective classes, whilst in the country, have not yet been released for sale or review.

The Pioneer PL51 is what the manufacturers call "a professional direct drive stereo turntable with sophisticated dc servo-motor".

In appearance the turntable is not all that different from a number of Pioneer turntables which have

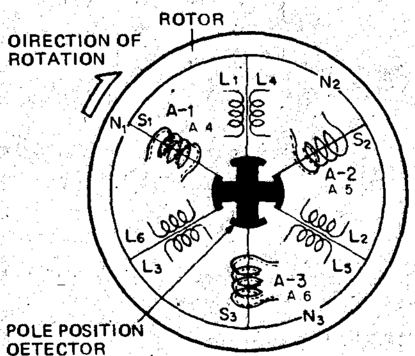
PRINCIPLE OF MOTOR OPERATION

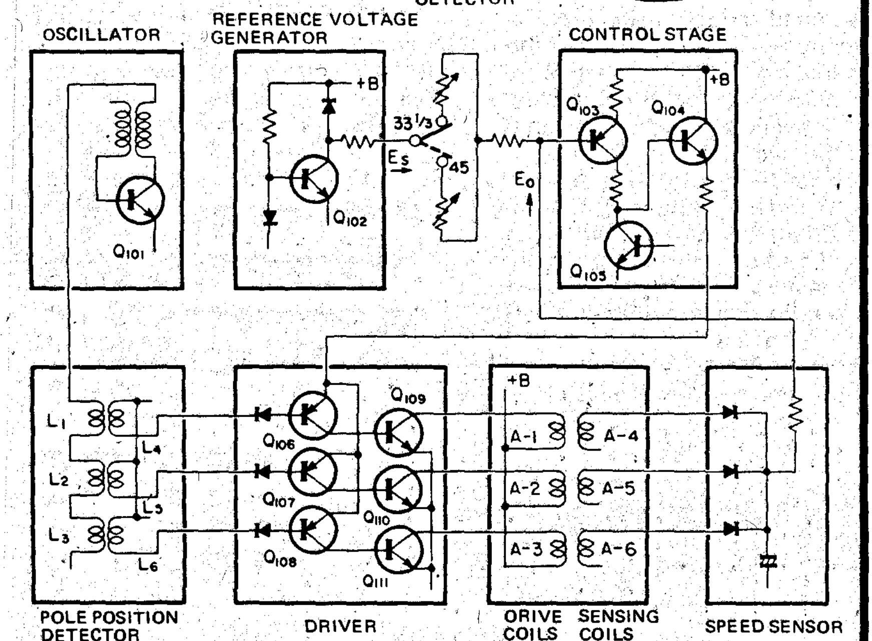
The outer rotor is accelerated in a clockwise direction, as one of three magnetic poles, positioned at 120° intervals on the rotor, is attracted by the electro magnetic field of one of three stator drive coils which are sequentially switched to provide a rotating magnetic field.

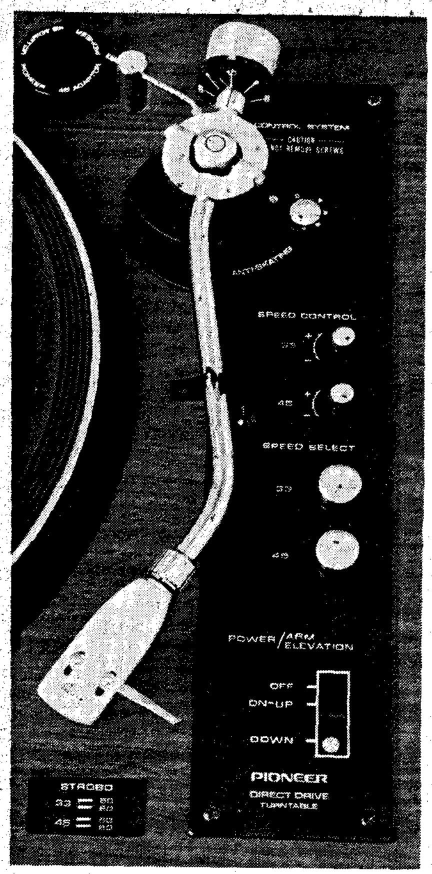
The switching sequence is determined by a pole position detector. Coils L1, L2 & L3 in Fig.1. are driven by an oscillator. The coupling to associated coils L4, L5 and L6 is a function of the position of the centre pole piece which is mechanically coupled to the rotor. In Fig.1, the coupling between L1 & L4 is tightest.

The voltage induced in L4 is rectified and used to switch power to drive coil A1, the rotor end of which becomes a south pole and hence attracts the north pole N1 on the rotor. The movement of this pole (N1) induces a voltage in the sense coil A4 which is rectified and compared with a speed reference voltage in a comparator which in turn controls a constant current source which determines the current in the drive coils and hence speed.

As the centre pole piece rotates, this sequence is repeated and the following drive coil is activated thus causing the rotor to turn.







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There's no doubt about it. TDK's great new Dynamic-series cassettes offer serious home recordists sound reproduction unequalled by any other cassette sold today. And the reason is very simple. *They deliver total performance!*

Total performance means more than just full-range frequency response and high-end sensitivity. It also means having the proper balance of all the other characteristics essential to reproducing "real-life" sound. Like high MOL (maximum output level). Broad dynamic range. Wide bias tolerance. High signal-to-noise ratio. TDK's Dynamic-series cassettes have them all!

You'll quickly discover this fact when you record your favorite music on one of TDK's Dynamic-series cassettes. You capture all the highs and lows, all the harmonics and overtones, all the emotion and feeling that gave the original performance its richness, fullness and warmth.

Look for TDK's "total performers" at quality sound shops everywhere. Extra Dynamic (ED) cassettes offer the discriminating audiophile an entirely new dimension in recording fidelity. Super Dynamic (SD), the tape that turned the cassette into a true high-fidelity medium, still has better-balanced total performance characteristics than any other brand made ... and is also available in open reel. And Dynamic (D) is an entirely new hi-fi cassette that provides budget-minded recordists with excellent quality at moderate prices. All provide optimum performance on any cassette recorder, without need for special bias.

For sound you feel as well as hear, discover the dynamic new world of TDK's total performers!

DYNAMIC-series cassettes are:

Extra Dynamic (ED): top-of-the-line, for those who want the very best. 45, 60 and 90 minutes.

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preceded it in production. For example, the smoked plastic cover of the turntable and the high quality friction damped spring loaded hinges are of comparable quality to the other units available.

The turntable features a high quality rubber mat on a 1.4 kg alloy die-cast aluminium turntable. The periphery of this turntable has four strobe rings engraved around it so that the platter speed can be directly checked using 50 Hz incandescent or fluorescent lighting — (i.e. normal room lights).

The controls are as simple as you could wish for. At the front is the operation lever, which has three positions — off, on-up, and down. Cueing across the turntable is a manual function as is returning the tone arm to its rest position. To operate the record player one simply places the record on the platter and selects "on-up". This turns the unit on, and lifts the tone arm from its rest position. The user then moves the arm across to the position desired over the record, selects "down", and the tone arm is cued directly to the point on the record below. To remove the tone arm from the record, one selects "on-up" again, whereupon the record arm lifts, one then manually returns the tone arm to the rest before selecting "off".

Immediately behind the operation lever are the two speed selectors. These are simple pushbuttons which electrically select the motor speed; behind these are two little adjustment controls for the 33 1/3 and 45 rpm settings (which provide ± 4% speed change).

The only remaining bit is a high quality 'S' shaped tone arm and good counterweight system, the lateral balance arm, and a good anti-skating control.

The plug-in head shell contains a Pioneer PC50 cartridge. This we have previously reviewed and found to be excellent — with a frequency response of ±3 dB from 20 Hz to 20 kHz.

The anti-skating control is easily adjusted in accordance with the stylus pressure chosen, and whilst we have still to find a perfect anti-skating system which compensates correctly for all positions on a given record, the system used in the PL51 certainly seems to do its job well.

Unlike many other manufacturers, Pioneer provide a service manual with the PL51. This gives fairly comprehensive details of the principle of motor operation.

In operation, the application of power turns on the primary oscillator whose output is fed to the pole position detecting circuits — three pairs of coupled coils. Depending on the degree of coupling between the mutual coils, voltage is induced in the detector coils which is then rectified and applied to a series of two stage transistor amplifiers, which power the drive coils Nos. A1 — A3 respectively. The rotating turntable induces a voltage in the sense coils A4 — A6 and these signals are rectified, summed, and applied to the control stage which acts as a constant current source for the first transistors in the driver stage, and by this means current control is effected on the drive coils.

Whilst this is a relatively simple feedback control system, in practice it works remarkably well and provides the lowest wow and flutter figures that we have yet measured. The manufacturers claim a figure of .06% (weighted rms). We found it to be 0.08% — as close as makes no odds.

The turntable is mounted in a cabinet which is claimed to isolate the unit from external vibration.

The isolators work quite well but do not provide sufficient attenuation of vibration caused by people walking close to the unit in rooms with wooden floors.

On the back of the cabinet are two RCA sockets and an earthing screw. A pair of screened low-capacitance cables are provided for connecting the unit to one's amplifier.

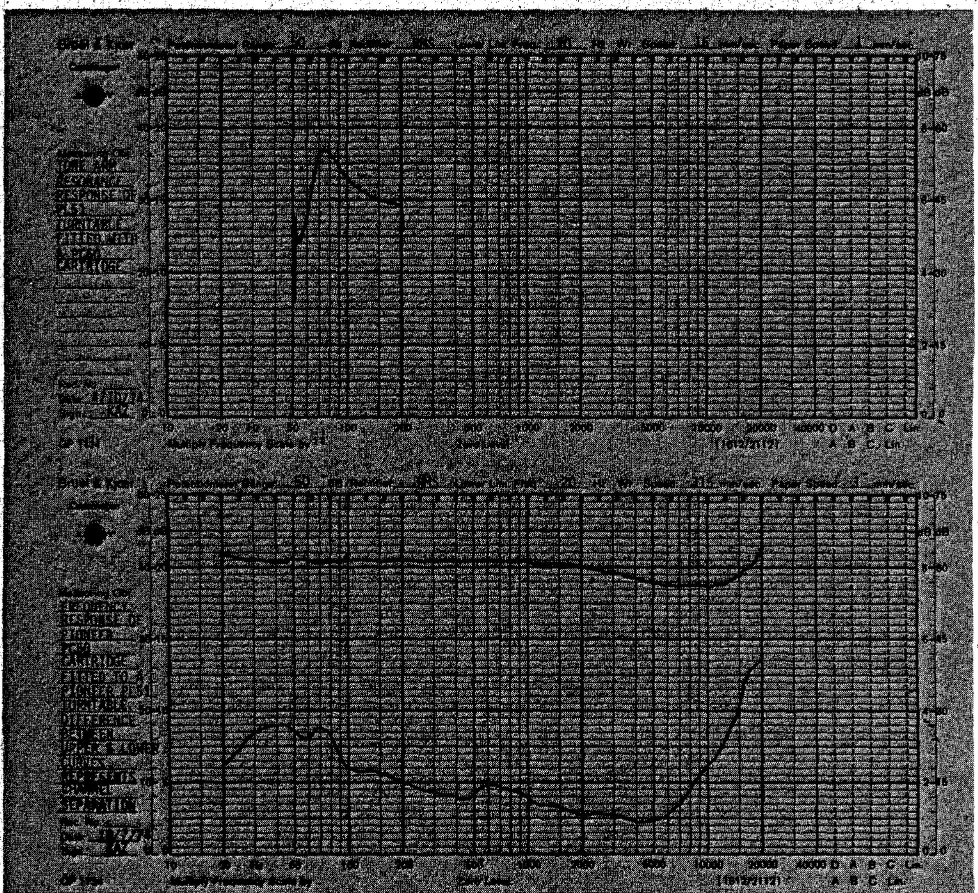
Fundamentally we must ask what is the use or advantage of a direct drive system of this type over and above the conventional systems which we have already described.

Firstly, the direct drive system can and does generate less wow, flutter and rumble than the conventional system with which it competes.

Secondly, this level of performance can be maintained for a longer period with a lesser change in performance. For example, after four years normal use, a rim-drive turntable can be expected to have 50% more wow and flutter than it had when brand new. This can of course be corrected by changing the idler wheel (which should be done as a matter of routine anyway).

Of lesser importance than the other factors, the direct drive unit does not require any adjustment if the mains frequency changes because of the use of a regulator circuit to supply the dc motor supply.

There can be no doubt, however, in our minds that a direct drive system is one step nearer to the perfection for which many audiophiles strive, and the PL51 is a good example of how many of these improvements can be embodied in what is still a fairly simple turntable. ●



Tone arm resonance (note — divide frequency scale by 10).


Two things
Albert Einstein
could have put
to good use.
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EXTRA
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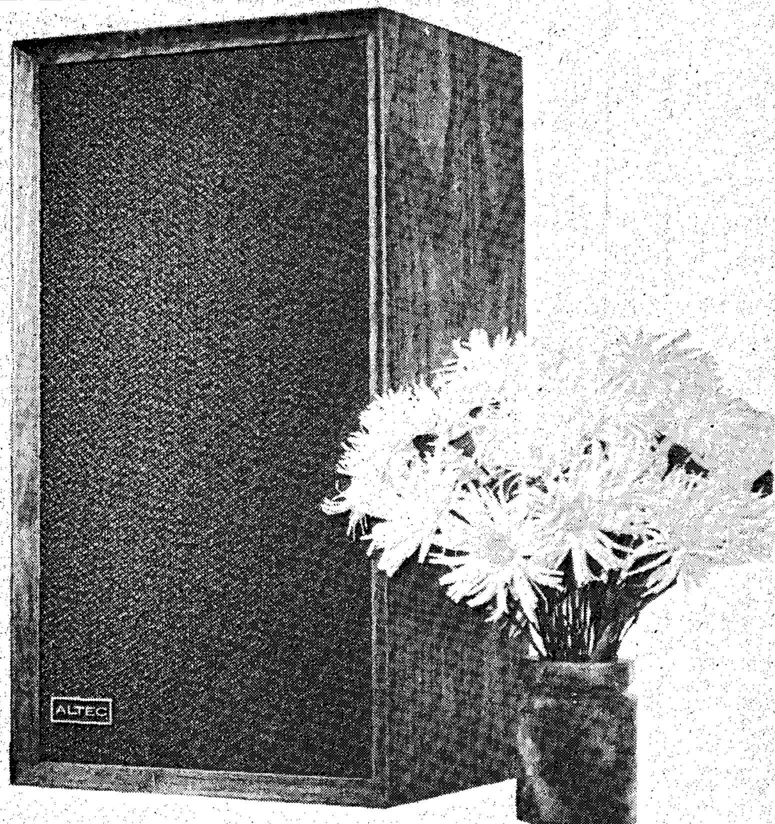

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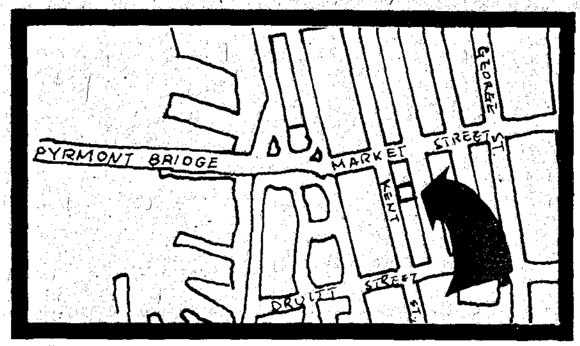

THE 555 TIMER

How to use this versatile IC.

TIME DELAY circuits are easily built if the time delay required is between a few microseconds and a few seconds.

But until recently it was usually simpler to use mechanical devices if longer repeatable delays were required.

Then in 1972 the US Signetics Corporation introduced their type 555 integrated circuit which was designed primarily for timing applications but has subsequently found a thousand and one other uses. It can for example operate in an astable mode switching continually from one state to the other.

The cheapest 555 IC is available for a little over $2.00. It is an ideal device for use by both amateur enthusiasts and professional circuit designers.

Various makes and types of the basic 555 design are now available. One of the simplest and most versatile is the Signetics NE 555V, (other similar devices are also available from other manufacturers — see below).

The NE 555V is an 8-pin dual-in-line package which is very convenient for the experimenter. Signetics' NE555T has a circular metal case with eight leads (known as the TO-99 encapsulation). The electrical characteristics of the two types are identical.

A close tolerance version of the 555 is available from Signetics as type SE555T (in the circular TO-99 package). Although the SE555T can operate over a much wider temperature range than the NE types, it is several times the price.

Electrically equivalent devices are available from Motorola under the types numbers MC1455 and MC1555 (the latter being the close tolerance version). National Semiconductor manufacture an equivalent device, the LM555.

Signetics also offer a 556 device. This contains two 555 units in a single encapsulation.

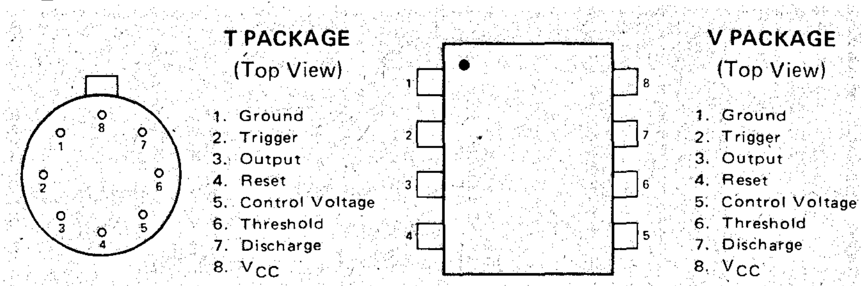

Fig. 1

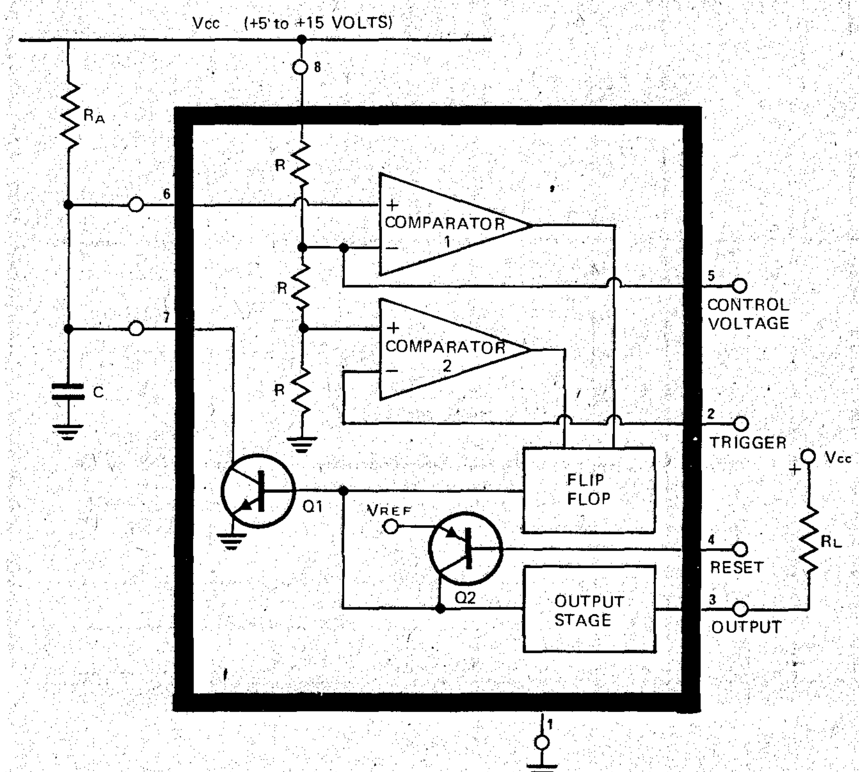

Fig. 2

CONNECTIONS

The eight connections of the 555 for both the dual-in-line and TO-99 devices are shown in Fig.1. Either of these devices may be employed in any of the circuits to be discussed.

SIMPLE TIMING

The operation of the 555 as a simple timer is described using the circuit of Fig.2.

A negative going trigger pulse fed to pin 2 starts the timing operation. The potential at the + input of comparator 2 inside the 555 is one third of the supply voltage, since the values of the three resistors marked R are equal. The trigger pulse must therefore fall below one third of the supply voltage to start the timing operation.

Before the trigger pulse is received, the internal transistor Q_1 is conducting. All the current which passes through the resistor R_A passes through the transistor; the external capacitor C remains uncharged. When a trigger pulse is received by pin 2 of the 555, however, comparator 2 switches the flip-flop and the latter cuts off Q_1. In addition, the switching of the flip-flop switches the output stage.

The current flowing from the positive supply line through R_A is now used to charge the capacitor C. When the potential across this capacitor reaches a value of two thirds of the supply line voltage, comparator 1 switches the flip-flop back to its initial state. We shall later see that the voltage which must be present across C for this switching to occur can be varied by the application of a control voltage to pin 5 of the device.

The switching of the flip-flop returns the output circuit to its quiescent state. In addition, it switches Q_1 to conduction and this transistor discharges the capacitor C ready for the next timing operation. The time delay provided by this circuit is equal to approximately 1.1 R_AC when no connection is made to pin 5. This is

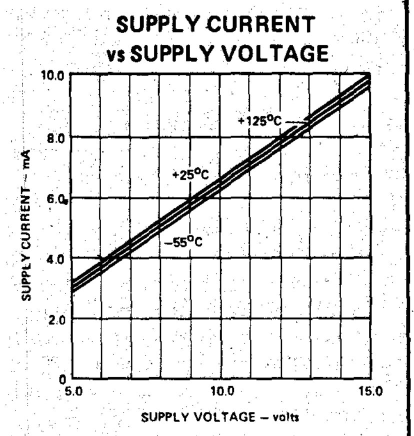

Fig. 3

the time taken for the capacitor C to charge to a value equal to two thirds of the supply line potential.

THE OUTPUT

In the circuit of Fig.2, the 555's output stage provides a change in the output voltage at the beginning and at the end of the delay period. The output voltage at pin 3 has two values; the 'high' value is only a little less than that of the positive supply line, whereas the 'low' value is only a little above ground potential.

Before the trigger pulse is applied to pin 2, the voltage at the output is in its 'low' state. It rises to the 'high' state at the moment of triggering and remains in this state until the end of the delay period, when it returns to the 'low' state.

If the circuit is connected as in Fig.2, current will flow through the load resistor when the output is in the 'low' voltage state, but only a small current will flow in the 'high' state. If, however, the load resistor is connected from pin 3 to ground, the large current will flow when the output is in the 'high' state. The maximum current which should be allowed to flow to or from pin 3 is 200 mA.

The output pulses from the 555 rise and fall very rapidly; the rise and fall times are typically about 100 ns.

SUPPLY VOLTAGE

The supply voltage to a 555 device may have any value between 4.5 V and 16 V, but it is wise to place an upper limit of about 15 V on the supply voltage to allow for possible variations.

The current required to drive the 555 is only a few milliamps, as shown in Fig.3. However, the current taken by the *output* must be added to this current to find the total power supply current required.

If the supply voltage is increased, the current flowing through R_A to the capacitor will be increased in proportion. However, the voltage across each of the resistors marked R in Fig.2 will also be increased in proportion to the supply voltage before comparator 1 is switched. Thus any change of supply voltage will produce a minimal effect on the value of the time delay, provided that the timing period is short compared with the rate of the supply voltage variation.

If the period of the power supply variations is much shorter than the delay period, a capacitor may be connected from pin 5 to ground. This holds the potential at pin 5 constant so that comparator 1 receives this constant reference potential. The timing period is short compared with the rate of the supply voltage variation.

If the period of the power supply variations is much shorter than the delay period, a capacitor may be connected from pin 5 to ground. This holds the potential at pin 5 constant so that comparator 1 receives this constant reference potential. The timing period is then almost independent of the supply voltage even if rapid variations of the latter take place.

TIME DELAYS

As has already been stated the time delay is equal to 1.1 $R_A C$. Thus one may use 100 k for R_A and 10 μF for C to obtain a delay of 1.1 second. If one reduces C to 10 nF and keeps R_A at 100 k, the time delay will be 1.1 millisecond. If R_A is 10 megohms and C is 100 μF, the delay will be 1100 seconds.

The maximum value of R_A which should be employed is about 20 megohms. A current of 0.1 μA (in a typical 555) passes to pin 6 of the device, the maximum value of this current in any 555 is 0.25 μA. If the value of R_A is 20 megohms, the current to pin 5 can produce an appreciable voltage drop across R_A.

See page 53 for full details.

When electrolytic capacitors are used, the leakage current may produce an appreciable voltage drop across R_A if the value of the latter is high. A typical upper limit for the value of the timing capacitor is 100 μF to 1000 μF. It may be necessary to select such capacitors for low leakage.

If you do use electrolytics don't expect the timing interval to be accurately related to the nominal value of the capacitor, since such components have tolerance which are typically -50% to +100%. Similarly, high-K ceramic capacitors can have very wide tolerances.

CONTROL VOLTAGE

The potential of pin 5 should not be within 0.75 V of the positive supply line voltage. It should be at least 1.5 V above the ground potential. This enables the transistors inside the device to operate correctly. If the supply voltage is 15 V, the full range of values of the control voltage shown in the table can be employed, namely from 0.1 to 0.95 times the supply voltage. If a smaller supply voltage is employed, however, the range of the control voltage which may be employed is smaller. For example, at the normal minimum supply voltage of 5 V, the value of the control voltage should not be smaller than 0.3 nor greater than 0.85 times the supply voltage.

The resistors marked R in Fig.2 each have a value of about 5 k. Thus one can vary the potential at pin 5 of the device by merely connecting a resistor

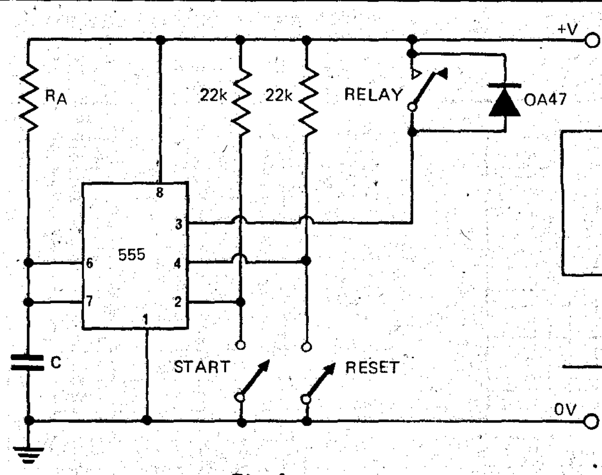

Fig. 4

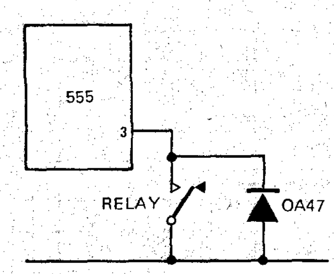

Fig. 5

THE 555 TIMER

from pin 5 to ground to reduce this potential or from 5 to the positive supply line to increase this potential. Generally a resistor of a few thousand ohms or more will be suitable.

RELAY OUTPUT

The 555 device can be used to drive a relay directly, provided that the delay period exceeds about 0.1 second. The relay used must not draw an operating current of more than 200 mA. It should operate with a coil voltage of about the same value as the power supply voltage used to drive the 555 (maximum 15 V).

A typical circuit for using the 555 to drive a relay is shown in Fig.4. The closing of the switch marked 'Start' commences the timing operation. The trigger pin 2 is returned via a 22 k resistor to the positive supply line to prevent false triggering.

If the 'Reset' switch is closed momentarily during the timing period, the circuit is immediately reset to its quiescent state and the timing ceases. A new timing operation will commence when another trigger pulse is applied to pin 2.

When the current passing through the relay pin 3 of the device is suddenly cut off at the end of the timing period, a high back emf is generated across the inductive relay coil. This back emf could damage the integrated circuit and must be suppressed by connecting a diode across the relay as shown in Fig.4. A gold bonded germanium diode has been found to be especially suitable for this application.

In the circuit of Fig. 4, the relay is normally closed, but opens during the delay period. If the relay is connected between pin 3 and ground (as in Fig.5), it will be energised only during the delay period. Thus one can choose whether one wishes to have the relay energised only during the timed periods or only at all other times.

Relay circuits of the types shown can be used to construct a photographic enlarger timer provided that R_A is made variable and C is switched. If the relay is connected as in Fig. 5, the closing of the relay can be used to switch on the enlarger lamp when the circuit is triggered; the lamp is automatically switched off at the end of the delay period.

TRIGGERING

The trigger input of the 555 is extremely sensitive, since the current required by pin 2 to trigger the circuit is only about 0.5 μA for 0.1 μs. Triggering can be effected merely by touching pin 2 with a finger. You can even trigger the circuit by moving your hand near to a wire connected to pin 2. This causes the potential of pin 2 to fall (by a capacitive effect).

It is possible for re-triggering to occur at the end of the delay period when an inductive load (such as the coil of a relay) is connected in the pin 3 circuit if an unsuitable diode (or no diode) is connected across the relay. This occurs only in the circuit of Fig.5. When the current passing through the relay at the end of the timing period commences to fall, the voltage transient produced across the coil is picked up at pin 2 and the circuit is re-triggered before the relay can commence to open. The only outward sign that this is happening is the failure of the relay to open at the end of the timing period. Gold bonded germanium diodes, such as the 0A47, appear to prevent this effect, but silicon diodes (such as the IN914) are not satisfactory.

OUTPUT VOLTAGE

The output voltage varies somewhat with the pin 3 current. This variation is shown in Fig.6 for the case when the output voltage is 'high'. It can be seen that the pin 3 voltage is roughly 1 V to 2 V below the positive supply line potential.

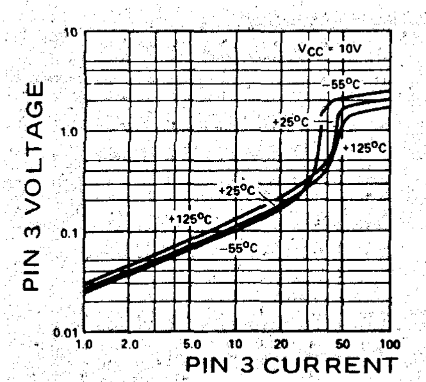

Fig. 6

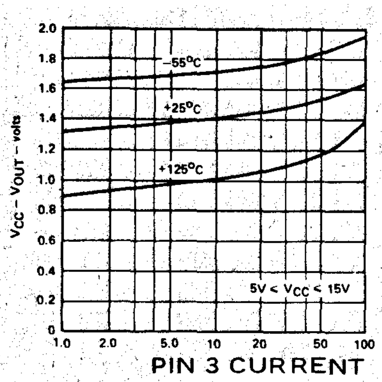

Fig. 7

Figure 7 shows how the 'low' output potential varies with the current to pin 3 when a 10 V supply is used.

ASTABLE OPERATION

The versatility of the 555 device is greatly increased by its ability to 'free-run' or operate as an 'astable oscillator. A circuit of this type which continually produces output voltage changes at preset intervals is shown in Fig.8. If desired, the load may be replaced with a diode in parallel with a relay (as shown in Figs. 4 and 5) and the relay will then close and open alternately.

In the circuit of Fig.8, the capacitor C charges through R_A and R_B in series, but when the internal transistor Q_1 of Fig.2 is switched to conduction, C discharges through R_B only. Thus the charging time is longer than the discharging time.

The capacitor C continually charges from a potential of one third of the supply voltage up to a potential of two thirds of the supply and then discharges again to one third of the supply. The charging time is $0.693(R_A + R_B)$ and the discharging time $0.693R_BC$. For most practical purposes, one may use the factor 0.7 instead of 0.693. The frequency of operation is approximately $1.44/(R_A + 2R_B)C$.

In the astable circuit of Fig.8, pin 6 is connected to pin 2. Thus when the voltage across C falls to one third of the positive supply line potential, the circuit is re-triggered and a new cycle commences automatically.

Operation of the 555 in the astable mode can be used to provide square wave output pulses for audio amplifier testing, etc. If the output is used to control a relay, the periodic opening and closing of the relay can be used to provide flashing lights on a Christmas tree or in a shop window. If R_A is made small and R_B is made large, the time for which the relay is open will not be very different from that for which it is closed.

In the circuit of Fig.8, it has been assumed that pin 5 is not connected. However, the voltage at this pin may be altered as described previously and this will either increase or decrease both the charging and the discharging times.

SIMPLEST ASTABLE CIRCUIT

An even simpler astable circuit is shown in Fig. 9. Only one resistor, one capacitor and the 555 are required.

When the output at pin 3 is in the 'high' state, C charges through the resistor R. Comparator 1 of Fig.2 switches the flip-flop when the voltage across C becomes equal to two thirds of the supply voltage. The output then falls to its 'low' value and C discharges into pin 3 through R. When the

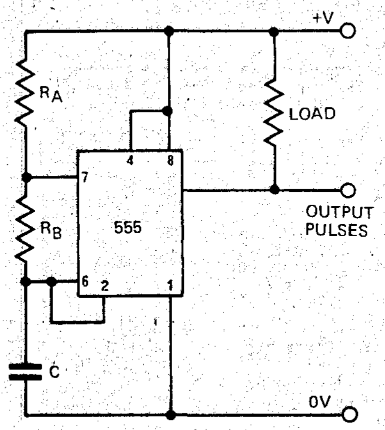

Fig. 8

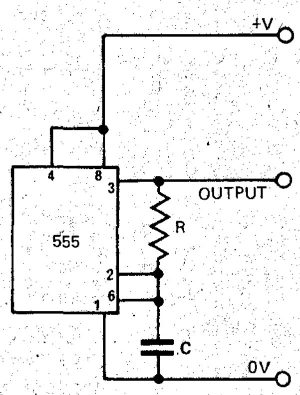

Fig. 9

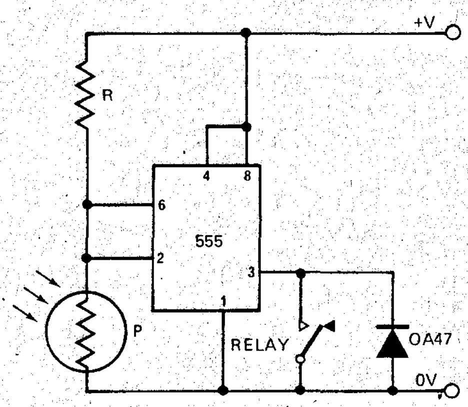

Fig. 10.

potential at pin 2 reaches one third of the supply voltage, comparator 2 of Fig.2 is switched and C then commences to charge again from the output which is now in its 'high' state.

The charging and discharging times are each approximately 0.7RC. If desired, a relay may be connected from the output to either ground or the positive supply line provided that a diode is connected in parallel with the relay as in Figs. 4 and 5. The relay will then automatically open and close whilst power is applied to the circuit.

PHOTOSENSITIVE CIRCUIT

Although it is intended for use as a timer in both the monostable and astable modes, the 555 is essentially two voltage comparators which switch a flip-flop and the output stage. It can therefore be employed to provide different output levels as the voltage at the inputs to its comparators changes.

The circuit of Fig.10 shows how the 555 can be used as a photosensitive switch. When the intensity of illumination falling on the cadmium sulphide photosensitive cell P rises, the resistance of this photoconductive cell falls. The voltage at pin 2 will therefore fall and when this voltage reaches one third of the supply voltage, comparator 2 of Fig.2 will switch the flip-flop stage and the output. The relay then closes.

If the light intensity subsequently falls, the resistance of the cell P rises and so does the voltage across it. When this voltage reaches two thirds of the supply voltage, the comparator 1 of Fig.2 is switched. This causes the output voltage to fall and the relay opens.

If the relay and diode are connected between the positive line and pin 3, the relay will close when the light intensity falls and will open again when it rises.

The opening and closing of the relay occurs at different levels of illumination. This 'hysteresis' effect is usually advantageous, since it prevents the relay from continually opening and closing (or 'chattering') when there are very small changes in the light intensity.

The type of circuit shown in Fig.10 could be used to switch office lighting or street lights on and off as the level of illumination changes.

The 555 device is a very versatile integrated circuit. We have considered a number of its possible applications in this article, but many more can be devised. For example, if the photoconductive cell P in Fig.10 is replaced by a thermistor, one could doubtless use the switching of the relay to control temperature. This would be another example of the use of the 555 as a comparator in an application not involving timing.

A variation of the basic 555 design is the 556.

This is in effect two 555 devices within a common package. Each half of the 556 behaves like a separate 555 timer and as such all of the applications described in this article are equally applicable to the 556.

One most useful application of the 556 IC is in obtaining extended time delays.

Both the 555 and 556 ICs use external timing capacitors, but even using low leakage electrolytics, these limit the normally practical timing range to a maximum of ten minutes.

However by using a 'divide by N' network between the two halfs of a 556, very much longer delays may be obtained.

The 556 timer may also be used as a tone-burst generator. In this application, the first half of the device is used as a one shot and the second half as an oscillator. ●

TABLE 1

Ratio of pin 5 voltage to the supply voltage	Factor by which R_AC must be multiplied to obtain the timing period.
0.105	0.1
0.2	0.223
0.3	0.357
0.4	0.511
0.5	0.693
0.6	0.916
0.7	1.203
0.8	1.61
0.9	2.30

Table shows the effect of pin 5 control voltage on the timing period, when pin 5 is not connected, its potential is 0.667 times the supply voltage.

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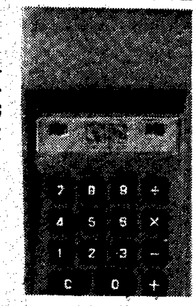

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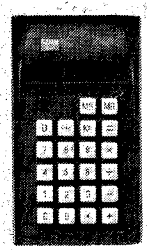

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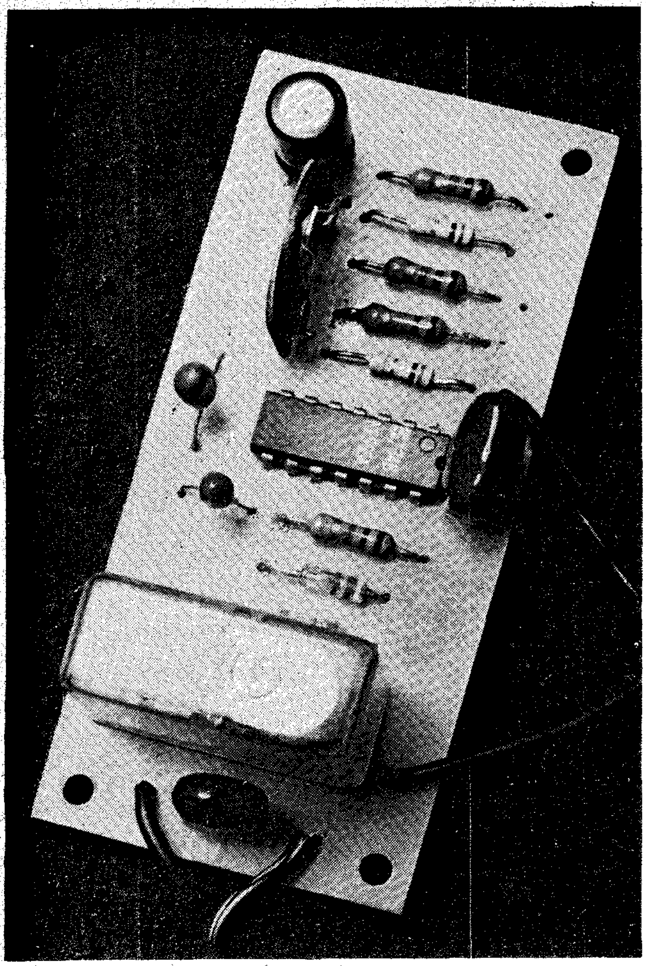
EM404 — 22c	5023 LED — 50c	2N3645 — 50c
EM408 — 28c	BC107 — 25c	2N5459 — 75c
A15A — $1.15	BC108 — 25c	2N3054 — $1.25
MB1 — $1.20	BC109 — 25c	2N3055 — $1.20
MB4 — $1.90	BC177 — 30c	AY6108/6109 — $2.00
PA40 — $6.00	BC178 — 30c	

PROJECT 313 CAR ALARM



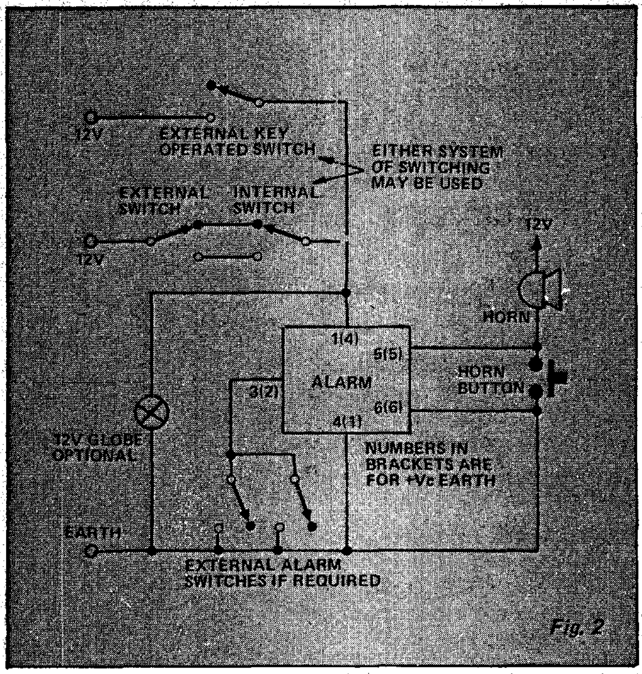


Fig. 2

Protect your car with this simple effective circuit.

ONE OF LIFE'S more devastating experiences is to walk out of your house in the morning and find that your car has disappeared!

But this need not happen to you, for an effective alarm system, as described here, may be quite easily constructed and installed at low cost.

The ETI 313 car alarm uses one single IC and a minimum of other components. It will, when actuated, blow the horn at one second intervals, and will continue to do so until deactivated by means of a key switch etc.

The alarm is triggered by any drop in the battery supply voltage caused by an increase in loading on the vehicle's electrical system. Thus, if a door is opened, the interior light will be activated and the increase in electrical load will trigger the alarm.

This operating principle simplifies installation, for practically all vehicles have courtesy lights activated by switches on at least two of the doors — and it is a fairly easy task to install further switches on the other doors if required.

Both the boot and under bonnet areas may be protected in a similar manner — indeed many vehicles have lights already fitted in these areas, if not, it is a simple matter to fit them into the circuit such that they come on when the boot lid etc is opened.

These lights are of course very useful apart from their alarm function, but remember — they must operate at all times, not just when the ignition is on.

The alarm is sensitive enough to be activated by anyone pressing the brake pedal — or even by opening the glove box (where a lamp is fitted of course).

The unit is designed for use with cars having 12 volt electrical systems. It may be used with either positive or negative earth systems without modification.

In addition to the power sensing alarm mode other precautions may be

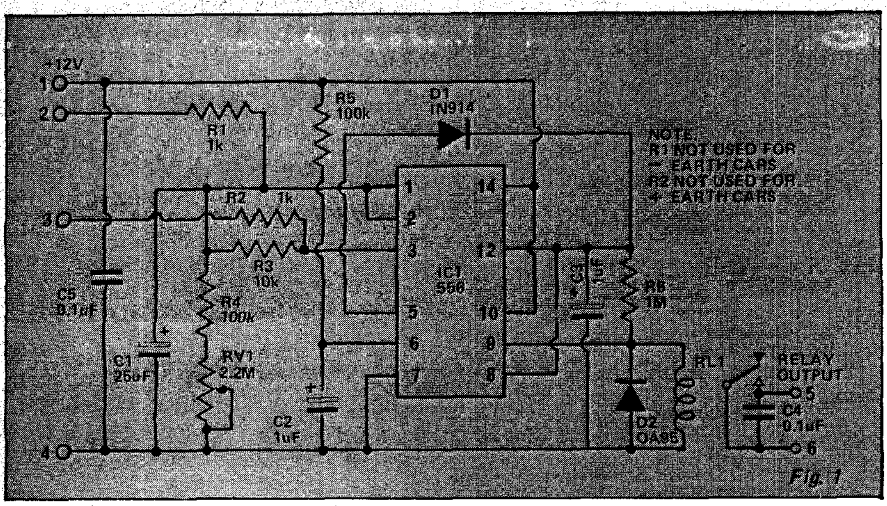


Fig. 1

taken by adding further alarm microswitches. For example microswitches may be fitted to the suspension such that if anyone tries to lift the car, in order to tow it away, the alarm will go off. If such switches are used they should be connected between terminal 2 or 3 or the alarm (see Fig 1 and 2), depending on whether the vehicle has a positive or negative earth system, and earth.

CONSTRUCTION

Construction of the alarm is extremely simple and anyone capable of using a soldering iron should not have any difficulty. All components, including the relay, are mounted on a small PC board as shown in the component overlay diagram.

Note the polarity of electrolytic capacitors, the IC and diodes. In particular make sure that the germanium diode D2 is mounted in the correct position and with the correct orientation. When soldering use a small, light-weight iron and preferably small gauge solder. Solder quickly and cleanly. Only apply the iron for sufficient time to cause the solder to flow around the joint. These precautions will ensure that components are not damaged by excessive heat. The unit should then be mounted in a small plastic, or metal, box.

Two different switching systems may be used to enable the alarm. Use either an external key switch mounted in a convenient, but not obviously seen location, or a two way system of concealed switches – one inside and one outside. The switch inside is used to enable the alarm (after opening the door) and the external one to disable the alarm before entering the car. This latter system has the advantage that anyone watching will not see where the external disable switch is located.

HOW IT WORKS

When a load, especially an incandescent lamp, is switched onto a battery the battery voltage will drop instantaneously and then return to normal. The amplitude and duration of this negative going spike in the supply is dependant on the size of the lamp used but is of sufficient amplitude, even with small globes, to trigger an alarm circuit.

The NE556 IC contains two NE555 timer ICs in a single case. One of the timer sections is used to detect the supply spike and to gate on the second timer which produces a one Hz output to the relay and horn.

Each timer section contains two comparators, a LOW comparator set at 1/3 supply and a HIGH comparator set at 2/3 supply. These comparators set a flip-flop which provides an output.

When the power is first applied, the voltage at pin 6 (input to the low comparator) is initially low for about half a second whilst C2 charges via R5. This sets the output of the flip-flop to a high state where it will remain regardless of further excursion in the voltage at pin 6.

The only way that the output may be set low again is for the input to the high comparator (pin 2) to be taken past its threshold. This threshold voltage is available at pin 3, and by using a voltage divider (R3, R4 and RV1) a slightly lower voltage is derived from it. This is used as a reference level to the HIGH comparator input (pin 2) Capacitor C1 is used to bypass any fast transients which may appear at the input (pin 2).

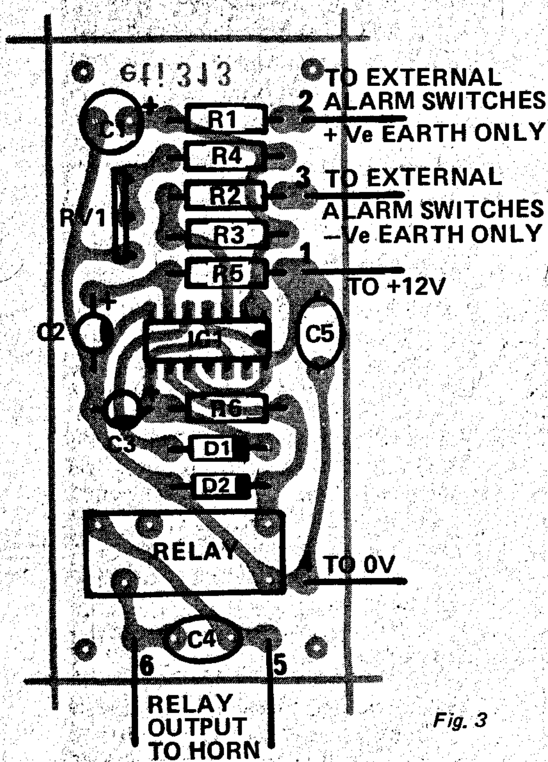
If the supply falls, the voltage on pin 3 will also fall. If it falls below the voltage at pin 2, the output will fall again to a low state and will stay there. The capacitor C1 will also be discharged via pin 1.

The second half of the IC is connected as a free-running multivibrator having a frequency determined by R6 and C3, of about 1 Hz. If the output of the first stage is high, the diode D1 will force the multivibrator to lock into the low state. When the output of the first stage goes low the multivibrator is freed to oscillate.

This one hertz output switches a relay which in turn controls the horn, or any other suitable device. The diodes across the relay prevent reverse voltages being generated which could damage the IC. This must be a germanium type for correct operation.

PARTS LIST – ETI 313

R1,2	Resistor	1k ½watt 10%	
R3	"	10k ½watt 10%	
R4,5	"	100k ½watt 10%	
R6	"	1M ½watt 10%	
RV1	Potentiometer	2.2 meg	
C1	Capacitor	25µF 25 volt electrolytic	
C2,3	"	1µF 25 volt electrolytic	
C4,5	"	0.1µF polyester	
IC1	Integrated Circuit	NE556	
D1	Diode	IN914 or similar	
D2	Diode	OA95 (must be germanium)	
RL2	Relay	12 volt 280 ohm coil, 6A contacts. Associated Controls type E3201 or similar.	
PC board ETI 313			
SW1	Switch	SPST key operated	
SW2,3	"	SPDT toggle (see text)	
metal or plastic box to suit.			



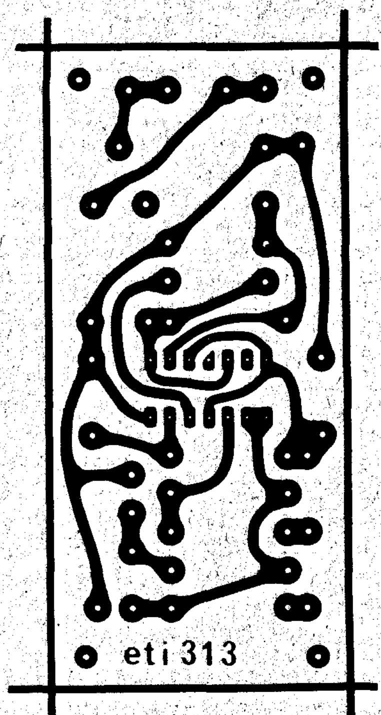
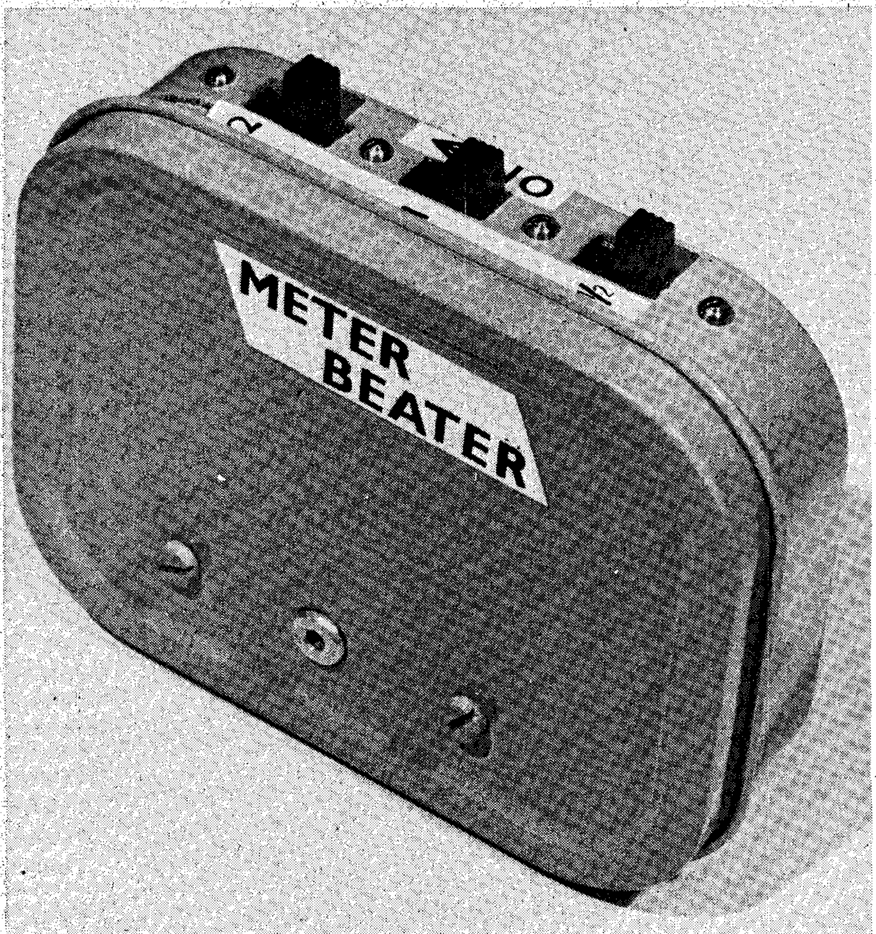


Fig. 3

PROJECT 229 METER BEATER



The completed unit. Note the crystal earpiece at bottom centre.

Build this simple 555 — based timer and avoid expensive parking fines.

FOR THE PRICE of two or three parking fines you can build the Meter Beater — and never get caught again!

The Meter Beater is simply a portable audible alarm which can be set for common parking meter periods — ½ hour, 1 hour and 2 hours. Several minutes before the expiry of the period it sounds a warning — giving you time to get back to your car. It is set by sliding one of the three switches visible in Fig. 1.

CONSTRUCTION

The prototype was constructed on a 47 x 55 mm piece of 0.1 inch pitch Veroboard. This may conveniently be mounted in a small tin such as that shown in the photographs. The Veroboard tracers should be cut in the pattern as shown in Fig. 2. Note that in the component overlay (Fig. 3) the components are drawn as seen from the opposite (component) side of the board.

Take particular care to orientate ICs transistors and electrolytic capacitors as shown in the component overlay. Use a lightweight soldering iron and solder quickly and cleanly. Take particular care with the CMOS IC, IC2, (See ETI August 74, page 80).

As tantalum capacitors have tolerances of +50% to −25% it may be necessary to select values for R1 and R2 to obtain the time required for the ½ hour alarm. Once this is set the other times are right.

PARTS LIST ETI 229

R3,4,5	Resistor	33k ¼watt 5%
R6,7,8	"	33k ¼watt 5%
R1	"	1M ¼watt 5%
R2	"	4M7 ¼watt 5%
RV1	Potentiometer	preset 1 megohm
C3	Capacitor	0.0047µF polyester
C2	"	0.1µF polyester
C1	"	47µF 6.4 volt tantalum
IC1,3	Integrated Circuits	NE555
IC2	Integrated Circuits	CD4024AE, MC14024 or similar
Q8	Transistor	silicon NPN type BC108 or similar
S1,2,3	Switch	DPST slide

Transducer — see text, metal box, spacers, nuts and bolts.

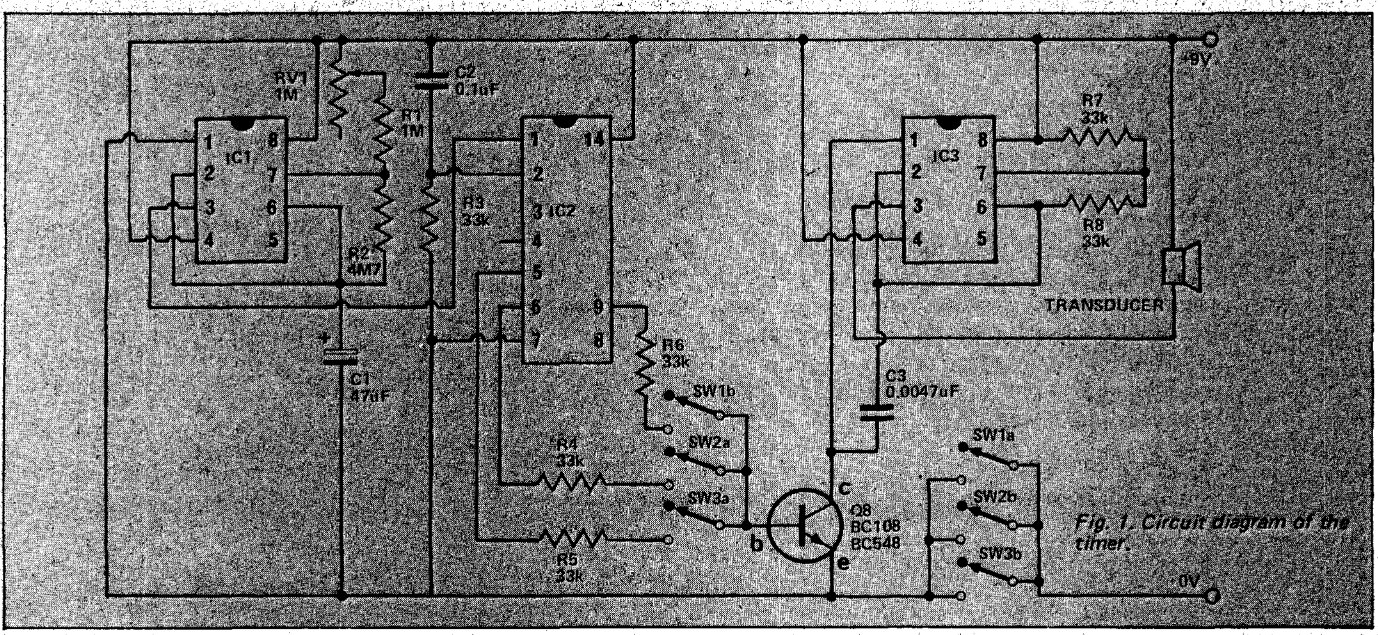


Fig. 1. Circuit diagram of the timer.

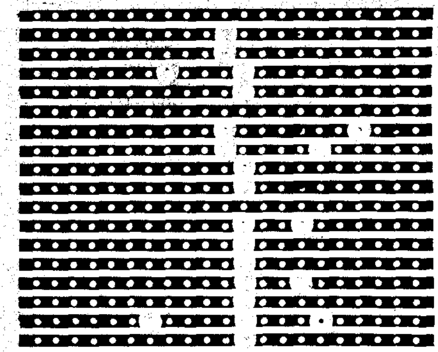
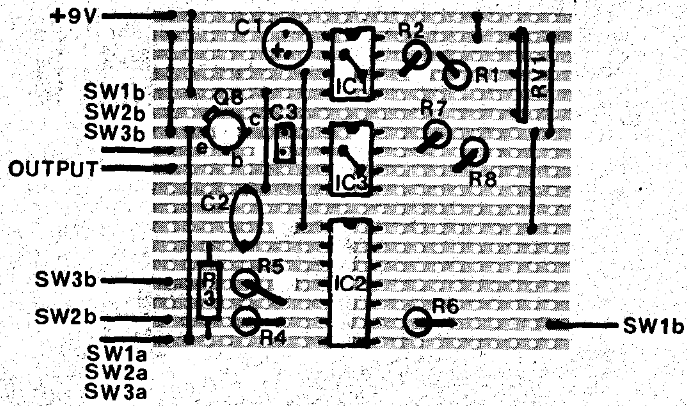


Fig. 2. Veroboard pattern. The tracks should be cut as shown. Full size 47 x 55 mm.

Fig. 3. Component overlay.



HOW IT WORKS

The Meter Beater comprises three elements – a 555 timer connected as a very slow-running astable multivibrator; a seven stage ripple counter; and a 555 timer connected as an audio frequency astable multivibrator feeding an output transducer.

Potentiometer RV1, R1, R2 and C1 are the timing elements associated with the first 555 timer IC1. At switch on, the output of IC1, terminal 3, goes high. About 5½ minutes later it goes low, and two minutes later it goes high again. This is shown in the timing diagram. The first high period is longer than subsequent ones because during the first period the capacitor C1 has to be charged from zero up to 2/3 of battery voltage, whereas in later periods the capacitor is charging only from 1/3 to 2/3 of battery voltage. Hence each full cycle lasts about 6½ minutes.

The output pulses from IC1 are connected to the input of the seven stage ripple counter IC2. For those not familiar with this device – it comprises seven, bistable multivibrators (flip-flops) connected in series. One output terminal of each flip-flop (FF) is brought out to a pin and they are named Q1 to Q7 in the pin assignment diagram Fig.5. Assuming all outputs are first set low, i.e. logic 0, then when the first negative going edge of the input pulse reaches the input of FF1, its output Q1 changes and goes high. When the next negative going edge reaches the input of FF1, its output changes again, i.e. goes low. See graph of output of Q1 on Fig.4. The negative going edges of the input pulse train are numbered 1 to 16. It can be seen that, at edge 2, the output of FF1 is negative going, and this, being connected to FF2 which is also negative edge sensitive, sends the output Q2 of FF2 high. It can be seen that the output of FF1 goes high at half the frequency of the input, and similarly, the outputs of the other FFs are at half the frequency of the preceding FF.

It can be seen that Q3 goes high after four negative going edges, Q4 goes high after eight negative going edges and Q5 goes high after 16 negative going edges.

It will be noted that only outputs Q3, Q4 and Q5 have been used in this project. Q1, Q2 and Q3 could have been used if IC1 had been made to oscillate much more slowly – but this would have involved higher timing resistors and capacitors – with associated problems of leakage current approaching charging current, and the consequent inaccuracy.

Now, reverting to the circuit diagram – it will be seen that each of the three switches is a double pole type and each performs two functions. One pole of each switch i.e. S1a, S2a and S3a connects the battery to the circuit, but S1b connects output Q3 to IC2 to Q8 (called Q8 to avoid confusion with the outputs of IC2) an NPN transistor used as a switch. S2b connects output Q4 to Q8, and S3b connects output Q5 to Q8. Thus when S1 (the ½ hour switch) is closed, the battery is connected and output Q3 is connected to Q8. After about 25 minutes the output Q3 goes high and turns on Q8. This energises the second 555 timer IC3, for which R7, R8 and C3 are the timing elements. These timing elements set the 555 in the astable mode at audio frequency. The output is connected to the transducer which provides an audible alarm. Similarly when S2 (the one hour switch) is closed, the alarm sounds after about 50 minutes, and when S3 (the hour switch) is closed the alarm sounds after about 1 hour 45 minutes. The amount by which the alarm is ahead of the exact meter period is greater with longer periods, and this allows for the fact that one probably goes further from one's car when it is parked for two hours.

For the device to work it is obvious that all outputs of IC2 must be set low at switch on. The IC has a reset terminal, Pin 2, which must be set high so that all outputs are reset to low, and must be set low to enable counting to proceed. R3 and C2 provide these functions. At switch on, Pin 2 is 'flicked' high by the pulse through C2, but as C2 charges (which takes very little time) Pin 2 is brought down to negative rail voltage, allowing counting to proceed.

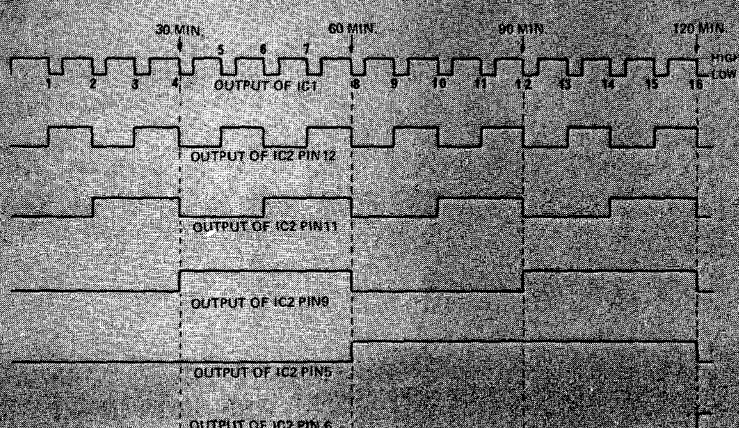


Fig. 4. Timing diagram for the unit.

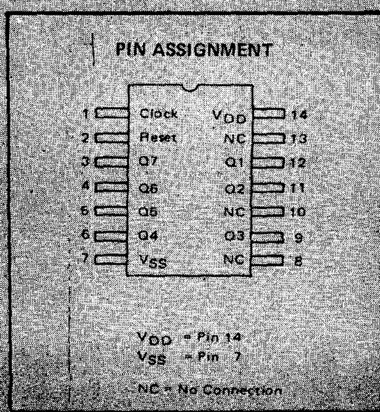


Fig. 5. Pin assignment diagram for the 555 timer IC.

OUTPUT TRANSDUCER

The output transducer used in the prototype was a hearing-aid earpiece of about 400 ohms. However these are quite expensive. Alternatively a cheap lapel crystal microphone, mounted on the outside of the tin box, makes a good 'speaker' or a crystal radio earpiece may be used. If a magnetic earpiece is available it may be also used provided that it is fed through a small electrolytic capacitor — say 4.7μF. All of these will work quite well but the best of all, if available, is the hearing-aid earpiece. Whichever device is chosen it is not worn in the ear, but mounted on the lid of the tin box, by means of a small aluminium strap. The complete alarm may then be slipped into a pocket where it is easily heard.

The inside of the tin box and the lid should be insulated with plastic sheeting before fitting the 'works'.

ADJUSTMENTS

The only adjustment provided is the preset pot RV1. This sets the duration of the "½ hour" alarm as close to half an hour as desired. However, as pointed out earlier, if the tantalum capacitor is well off the marked value, then a change may be needed to R1 and R2 to obtain the correct adjustment range for RV1.

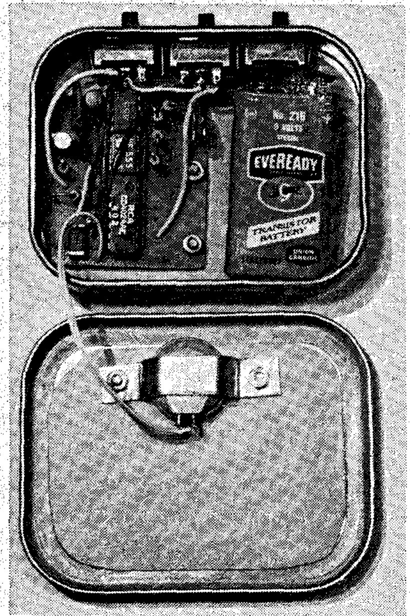
The switching transistor Q8 should be turned hard on, to obtain the maximum voltage across IC3. This may be checked by measuring the voltage across the transistor when it is on — i.e. the alarm is sounding. It should be less than 1 volt. If it exceeds 1 volt then the value of the base resistors R4, 5 and 6 should be reduced to ensure saturation.

USE

To use the Meter Beater, simply switch it on after putting your money in a parking meter, using the switch appropriate for the time for which you've paid. Put the Meter Beater in a shirt pocket and in due time it will sound off a warning that you must be heading back to your car.

OTHER USES

As will have been noted, only three of the outputs of IC2 have been used. The other outputs can be used for shorter or longer times if desired — up to nearly eight hours. Thus the unit is essentially a long period timer and may be adapted for such purposes as timing hire periods of, say, billiard tables; process timing; a medicine reminder alarm, and any similar long period applications.



Internal view of the completed timer showing how it is assembled into a small tin.

BATTERY LIFE

Battery consumption is very low — only about 4 mA, hence the 9 volt battery used should have a life of about 100 hours, at two hours use per day. ●

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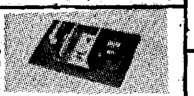

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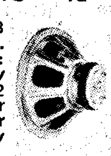

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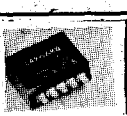

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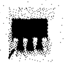

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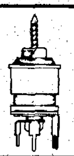

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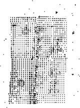

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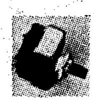

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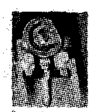

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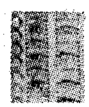

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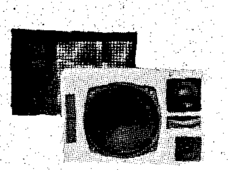

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KIT NO: BK 4-70. Contains 1 40W bass speaker, 1 mid-range speaker, 1 tweeter, 1 three-way cross-over unit. Price **$99.95** Post $3.50.

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Each kit also contains the following:— Complete set of plug and socket connections, connection cable, sawing and drilling templates, fixing and sealing material, assembly instructions and firm sign (Logo). Also supplied is a comprehensive 20 page information & Data manual. ENCLOSURE KITS for the above kits can be easily assembled since each part has been accurately finished and everything fits exactly. Each kit is prepacked with easy Step-by-Step instructions and comes to you in a handsome carton gift pack. Each cabinet enclosure kit contains the following: 4 Veneered side panels, 1 Veneered rear panel, 1 Loudspeaker panel, grill cloth, adhesive (Blue tube), cold wood glue (orange tube), brackets & screws, assembly instruction.

Cabinet assembly Kit No: HBS 4-50	$39.95 each Post $3.00
Cabinet assembly Kit No: HBS 4-70	$43.95 each Post $4.00
Cabinet assembly Kit No: HBS 4-100	$68.95 each Post $5.00

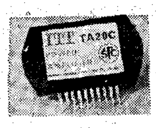
SUPPLIES ARE LIMITED SO GET ON THE 'BANDWAGON' WHILE YOU CAN. PLACE YOUR ORDERS NOW ... NEXT SUPPLIES AVAILABLE DEC. '74.

A & R TRANSFORMERS

Great savings for 'Hard to Get' Transformers. All Listed are 240V Primary.

TYPE	SECONDARY	RATINGS	PRICE
1992	150-0-150 & 6.3V	1.7A	$10.00
1993	225-0-225 & 6.3V	2A	$ 9.00
2150	6.3 or 12.6V	2.5 or 1.25A	$ 6.95
2155	15, 12.6, 9.5, 8.5. 7.5 & 6.3V	1A	$ 6.25
5502	22 or 44V	2.5 or 1.25A	$ 9.00
5508	6.3 or 12.6V	4 or 2A	$ 7.60
5509	12.5 or 25.2V	5 or 2.5A	$11.00
5579	6.3V	1A	$ 5.50
6413	32V	2A DC FWD	$12.95
6672	30, 27.5, 24, 20, 17.6 & 15V	1A	$ 9.50
6978	15, 12.6, 10.5, 9, 7.5, 6.3V	2A	$11.25
7243	50,40,33,25 & 19V	2A	$15.00
7309	12V	2.5A (30VA)	$ 6.50
PS82A	BATTERY SAVER — 4½, 6, 7½ & 9V (Nominal Voltage)	0.1A	$12.25
PS164	BATTERY SAVER — REGULATED 4.5, 6, 7.5 or 9V	0.3A	$15.50
FERGUSON Low Height Power Transformers			
PF3596	2 x 6V each at 10VA	Aporox 1A	$ 6.00
PF3597	2 x 7.5V each at 10VA	ditto	$ 6.00
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 et 10VA	ditto	$ 6.00
PF3602	2 x 25V eech et 10VA	ditto	$ 6.00
PF2851	12.6V CT	150mA	$ 6.00
PF3577	56V CT	1.5A	$12.90
SCOPE	Soldering iron transformer	3.3V 30A	$10.20

All transformers listed above are subject to $1.25 P & P.



GREATEST OFFER OF HYBRID POWER AMPLIFIERS EVER MADE.

Full descriptive Data supplied with each one.

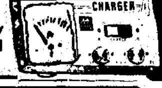
ITT TA-20 20 watts	$5.95
ITT TA-20C 20 watts	$11.95
Sanyo STK015 (TA10B) 10watts	$7.00
Sanyo STK032 (TA25C) 25watts	$15.75

P&P 35c.

'VORTEX' Stereo Cassette Deck mechanism with tape eject facility and resettable counter. Easily operated by 5 push-button (piano key) controls, and includes high quality 'ALPS' recording, play-back and erase heads. Tape speed 4.7cm (1-7/8") sec. Plus or minus 1.5%. Wow and flutter less than 0.25%. Operates on 240VAC. Full data and specifications supplied with each purchase. Our price now only **$29 post free.**

BATTERY CHARGER 4

An all purpose battery charger for — cars — caravans — motorbikes — power boats, etc. Provides a HIGH CURRENT BOOST charge to quickly energise flat batteries or a LOW CURRENT TRICKLE charge to maintain the charge in batteries which are used intermittently. Charger 4 has these unique features: • Large scale ammeter for monitoring charging rate • Plug selection for 6V and 12V batteries • Fully guaranteed for 12 months.
M.S.C. Price Only $29.95. Post and Packing $1.50



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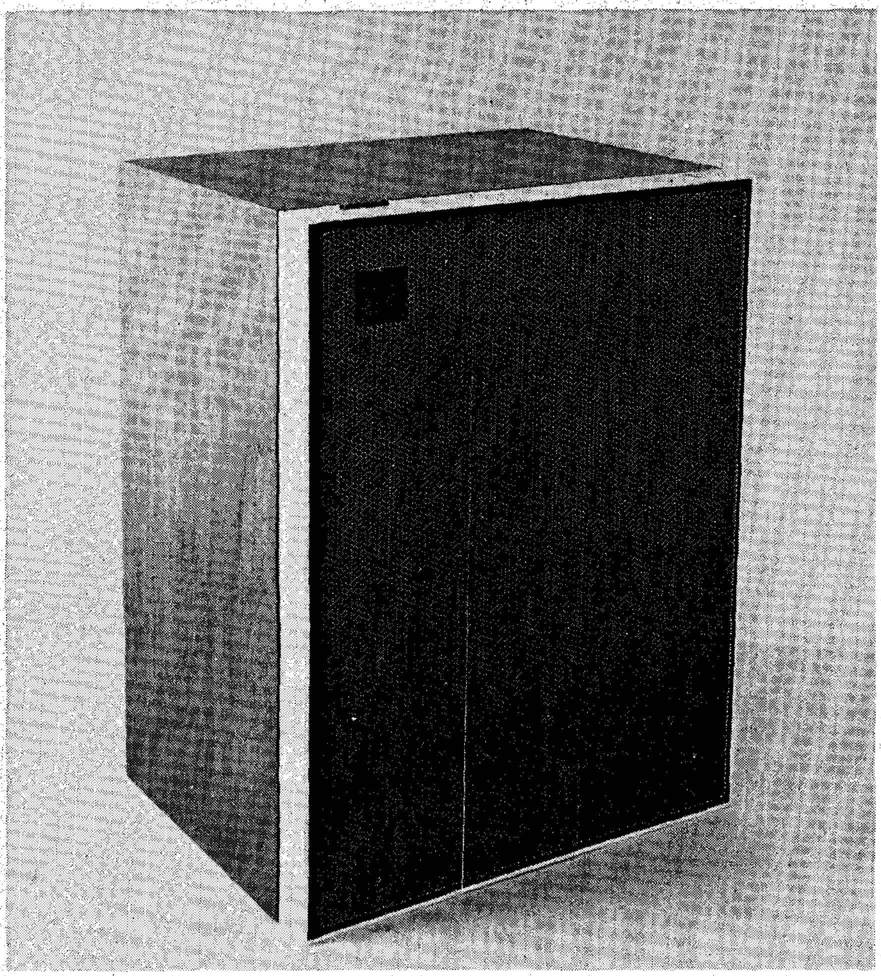
SCOOP REVIEW

ETI PRODUCT TEST

PHILIPS Motional Feedback Loudspeakers

Remarkable performance from truly bookshelf speakers.



EVERYBODY WOULD LIKE to own a loud speaker that takes up zero space, does not detract from the room's appearance, and provides the sort of performance that one has come to expect from large bass reflex type enclosures, but few small loudspeaker systems have low frequency performance comparable to their big brothers.

The first attempt applied to overcome this limitation was that proposed some ten years ago by Mullard, who introduced the concept of a small loud speaker system with low frequency response improved through the judicious use of bass boost. But this approach tends to result in a peaky response at the bass end. It also requires a loud speaker with plenty of low frequency travel, as well as a more powerful amplifier. Now, more powerful amplifiers are the vogue, so power is not a problem in itself, but even so the bass boost approach does not necessarily result in a substantially better or cleaner sound.

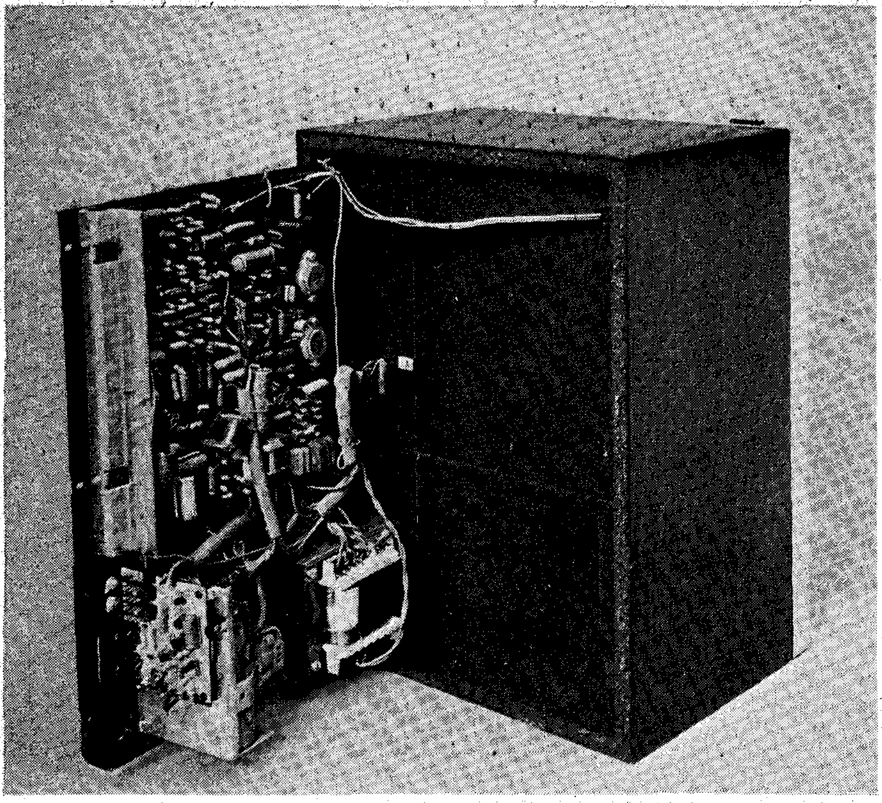
Philips' approach is far more complex. They place a small piezoelectric accelerometer at the heart of the low frequency driver and separately connect this up as part of their feedback system. This accelerometer generates a voltage proportional to the acceleration of the cone and this output is compared electronically with the original audio signal. Any difference voltage is returned as a corrective signal to the amplifier. In this way any non-linear motion of the cone (with reference to the original electrical signal) is corrected, and the acoustical signal produced becomes a more faithful reproduction of the input signal.

The speaker line up consists of an AD 8065/W4 MFB 20 mm woofer, an AD 5060/Sq8 120 mm mid-range speaker (both the mid-range and woofer have flexible surrounds to permit the long diaphragm travel required to provide the acoustical output at high levels), and the well proven AD 0160/T8 25 mm diameter dome tweeter.

These are mounted in a vented enclosure a mere 280 mm wide and 380 mm high. Apart from these drive units, the enclosure also houses two amplifiers, one rated at 40 watts (for bass), the other at 20 watts (to drive the mid-range and treble units). When one realizes that the total depth of the enclosure is a mere 210 mm, one begins to appreciate just *how* small the acoustical section really is.

One distinct advantage of such a small size, of course, is that the enclosure is tremendously strong and extremely rigid, and with one minor exception, free of any resonances.

Philips claim that the overall unit has a 60 watt continuous sine wave power



rating, but it would be almost impossible (except with pink noise testing) to truly drive both power amplifiers on a continuous basis to their maximum rating.

An electronic network is used to crossover (at 500 Hz) from the woofer to the mid-range speakers, and a passive network caters for the crossover between mid-range and dome tweeter – at 3.5 kHz.

Inputs are provided for connecting the Philips units to a preceeding pre-amplifier (one volt input) or to a pre-amp/power-amp combination (7.5 volt input).

Each speaker is provided with a special power lead, using a Continental power socket on the rear of the amplifier, and (nominal) eight metre long lead fitted with DIN sockets for connecting to the pre-amplifiers or drive sources.

The power amplifiers are located behind a hinged metal cover which has located toward its base, a red power on-off switch, a mains voltage selection switch, a mains input and mains output supply socket, two buttons for selecting drive sensitivity, and left or right channel respectively, and two DIN sockets for signal in and signal out respectively.

Included in the design is an electronic on-off switch which will only switch the amplifier on when it 'sees' an input signal and switches the amplifier off two minutes after it fails to see any new electronic signal. This is intended to reduce the power dissipation on the power amplifiers if the owner forgets to switch the unit off. The concept is good and is a useful design feature.

The total volume of each enclosure is 15 litres, of which six litres are taken up by the power amplifier. Thus the acoustic section is a mere six litres in volume – one of the smallest enclosures we have ever tested.

Our first interest was to determine how the unit sounded, and in particular whether its performance in the range 30 to 100 Hz could live up to the (advance) claims made by the manufacturers.

Our subjective test showed that the bass response is quite good down to 40 Hz, but without running more detailed tests we could not be readily sure how good or stable the unit was at frequencies *lower* than 40 Hz.

Free field tests showed that the frequency linearity in the range 50 Hz to 16 kHz is particularly smooth on pure sine wave testing, and every bit as good as the one-third octave band plotted-figures provided with the manufacturer's data sheet.

Performance under tone burst testing was particularly interesting. At 1 kHz the tone burst performance is quite good – not perfect but more than adequate. At 6.3 kHz, the tone burst performance adds at least an extra two cycles to the original signal as well as a small amount of subsequent ringing. This is a form of colouration which is audible, particularly so at high signal levels. The speaker does have a definite sound of its own and it is clear that at high drive levels the transient response is not as linear as could be desired.

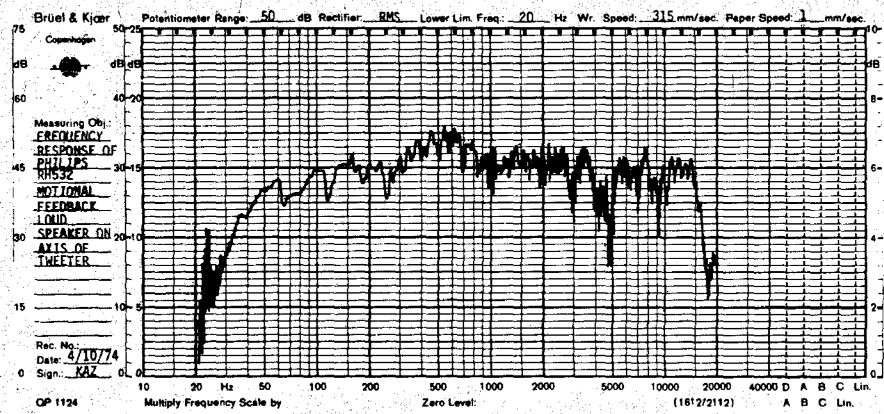
We found it interesting that the overall system distortion on sine wave testing is particularly low, with the total harmonic distortion being substantially better than most other speakers that we have tested and very much better than any other small system that we have tested.

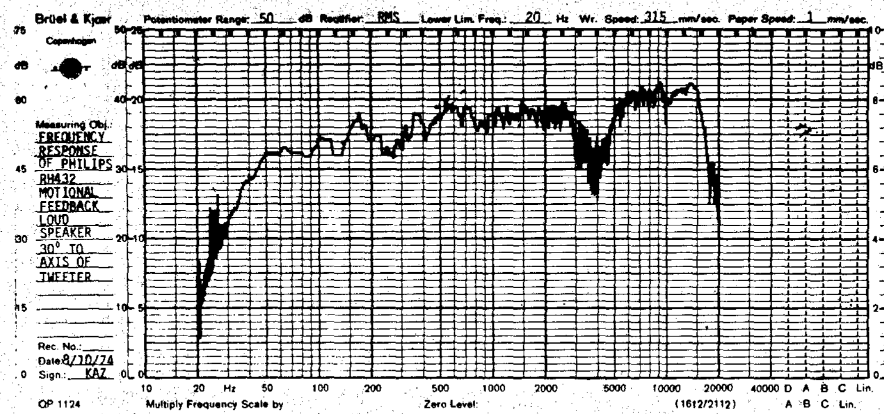
Philips do not want this system to be evaluated on the basis of size alone, for they state that its performance is as good as most large conventional speaker systems, and in this respect their claim is basically correct. Nevertheless we believe that the people who will buy this system will do so primarily because of its small physical size.

MEASURED PERFORMANCE OF PHILIPS RH532
MOTIONAL FEEDBACK LOUD SPEAKER
SERIAL NO: 13479

Frequency Response:	40 Hz to 16 kHz	$^{+5}_{-7}$ dB	
Total Harmonic Distortion: (for 90 dB at 2 metres on axis)	100 Hz	1 kHz	6.3 kHz
	0.7%	0.3%	0.35%
Sensitivity at 1 kHz: (for 90 dB at 2 metres on axis)	low	40 mV	
	high	3 V	
Cross-over Frequency:	500 Hz and 3.5 kHz		
Measured Impedance:	low	3 KΩ	
	high	25Ω	
Dimensions:	283 x 378 x 212 mm		

PHILIPS Motional Feedback Loudspeakers





HOW THEY SOUNDED

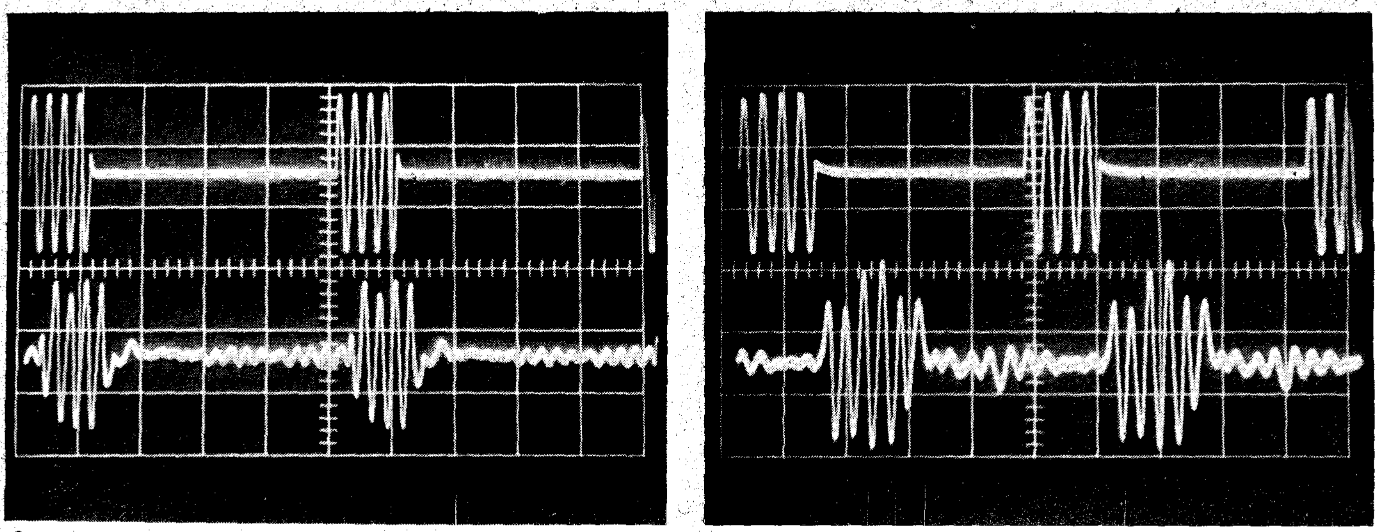
In live testing with high quality programme content, such as Sheffield Lab's *"Lincoln Mayorga & Distinguished Colleagues Volume III"*, CBS SBR235514 *"Kurt Vonneguts Slaughterhouse-Five"*, and the Philips special demonstration record Philips 6830 532 *"Revolution in High Quality Sound Reproduction"*, the system demonstrates excellent power handling capacity and a very clean response at levels in excess of 95 dB at 2 metres on axis, but does have noticeable colouration at higher frequencies.

Surprisingly, the performance in the critical region 30 Hz to 150 Hz is far cleaner and substantially better than could have been expected from such a system.

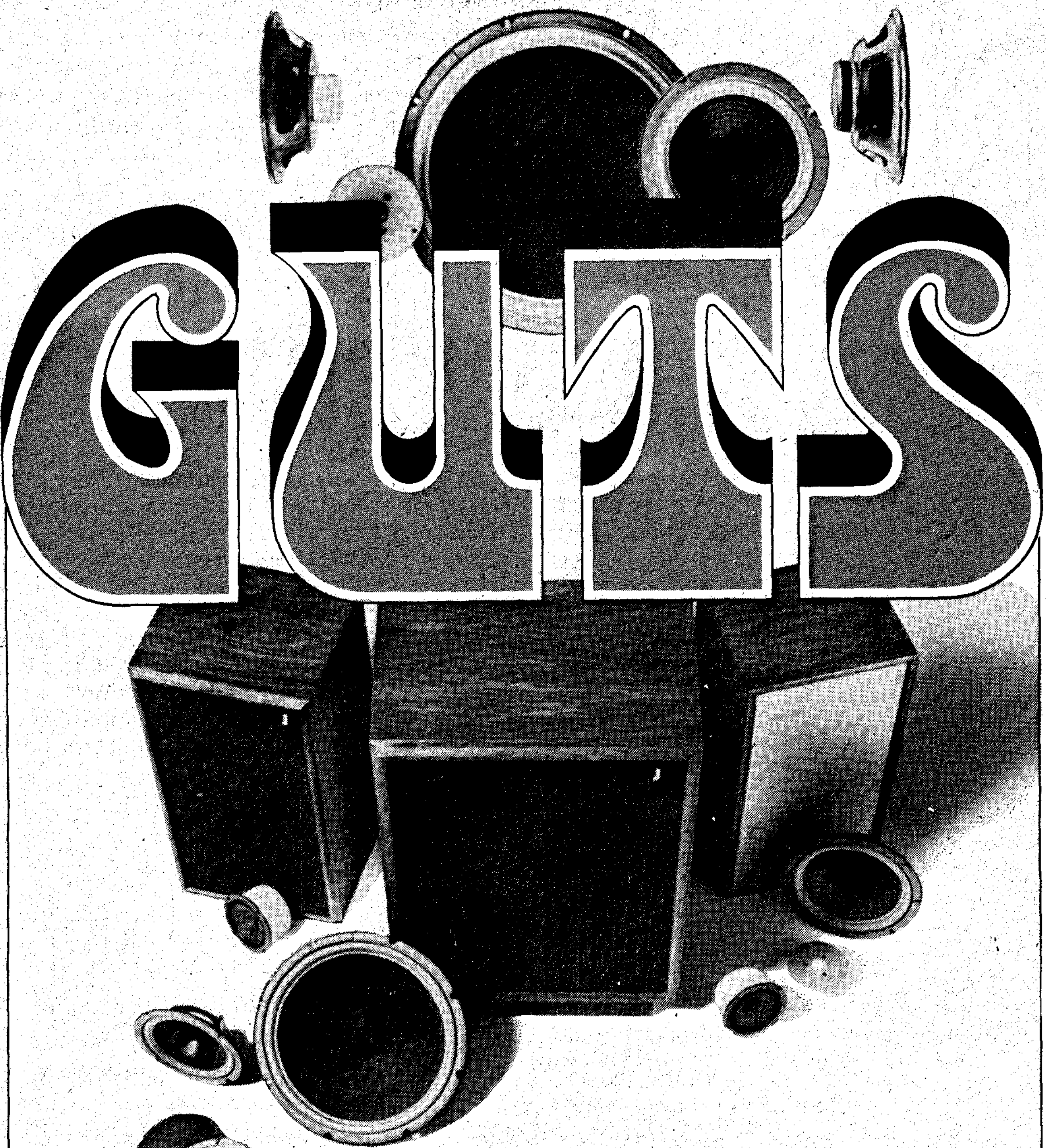
We were really impressed that the majority of the claims made for the speaker were substantiated by our subjective and instrumental testing. We have never before heard a speaker system anywhere near as small which could deliver comparable quality sound. In fact it is hard to imagine any other system which could deliver so much performance whilst utilising so little space.

When used in conjunction with one or more of the special Philips record players, tape recorders or preamplifier systems, which are under development, the motional feedback loud speaker system will offer a practical, compact, high fidelity solution to one of the biggest problems facing the modern day flat dweller. (The unit can of course also be used in conjunction with almost any existing pre-amp or pre-amp/power-amp combination — regardless of the power output.)

At a recommended retail price of $750 per pair, and considering the number of power amplifiers and their rating, the cost is far lower then might at first appear. ●



Our two tone-burst oscillographs clearly indicate how some minor colouration is generated in the treble register. LEFT: 1 kHz, RIGHT: 6.3 kHz — both at 4 ms/div. Oscillographs have been recorded using the ETI-designed tone-burst generator a feature of which is accurate control over starting and stopping phase angles and total number of cycles in each burst — note how cone movement continues at 6.3 kHz.



It takes guts to offer a 5-year warranty. Good guts.

Every Jensen high fidelity speaker comes with a 5-year warranty. It's the best in the business — an unconditional, 5-year warranty. And Jensen has the guts to give it to you. Good guts, as in our Models 4, 6 and 3, that have woofers with heavy magnets and Flexair® suspension for exceptionally clear sound. Or guts like our Sonodome® ultra-tweeters which respond well beyond audible ranges. Or, our mid-range elements with tuned isolation chambers to eliminate distortion. And special computer-designed crossover networks for optimum tonal blend.
It's everything you need for excellence in speaker systems. It's the good guts inside Jensen.

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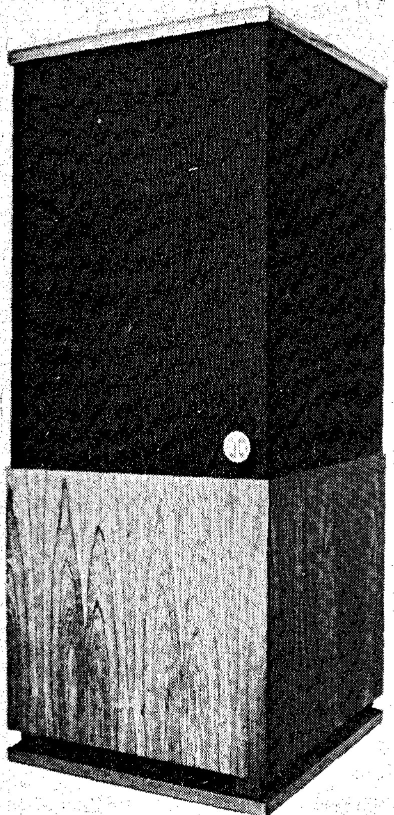
RTR Industries of California, to promote its products, use a phrase that has more meaning with each passing year . . . "total capability". If "High Fidelity" in reproduction is to be an end, "total capability" must be the means. In loudspeaker design, that demands a fundamental understanding of each speaker component. What better way is there to understand than to build. And this is exactly what RTR does, from the smallest tweeter and electrostatic panels, right up to the massive Magnum 25.

"HIGH FIDELITY" – "TOTAL CAPABILITY" – "RTR INDUSTRIES"

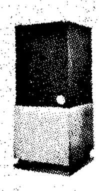
For the true audiophile, a means to an end.



A NEW CONCEPT

The RTR columns are a new concept in transducer application. Each elegant walnut enclosure houses multiple ultralinear butyl edge suspension woofers, one of which is planar resistive loaded. This technique yields maximum acoustic low frequency coupling, increased damping and a very smooth response curve. This powerful low frequency concept is the cornerstone of the RTR column speaker systems. The ideal speaker system should radiate uniformly hemispherically, and a RTR column achieves this ideal at the low frequency end of the spectrum. To achieve "total dispersion" at the high end of the spectrum, high frequency drivers are employed on three faces of the columns to produce an incredibly uniform polar energy response plot.

RTR column speakers, a "concert hall experience".

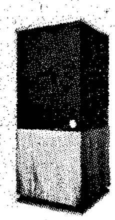


MODEL 88/D

Freq. Resp:– 40-18500 Hz. Size:– 11" x 26¼" x 11" Deep. Rec. Amp. Power:– 20-60 WRMS

MODEL 180/D

Freq. Resp:– 28-18500 Hz. Size:– 14" x 33¼" x 14" Deep. Rec. Amp. Power:– 25-60 WRMS



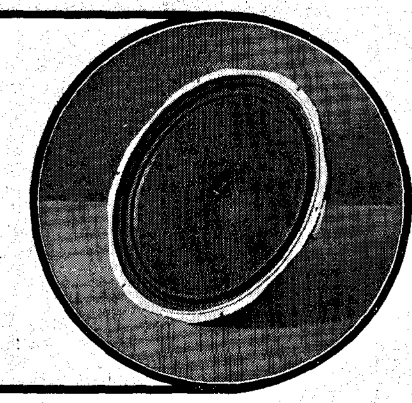
MODEL 280/DR

Freq. Resp:– 22-25000 Hz. Size:– 16½" x 39" x 16½" Deep. Rec. Amp. Power:– 25-100 WRMS

Go to your nearest RTR dealer, and have a "musical experience".

THE MAGNUM 25

The Magnum 25 is the largest transducer RTR builds . . . a 25" woofer with a 6" voice coil. It is the world's finest woofer and has no parallel.



SPECIFICATIONS

Power Handling:–	150 watts RMS
Free Air Resonance:–	12 Hz
Impedance:–	8 ohms
Freq. Response:–	15-800 Hz, properly loaded
B/L Product:–	7.5 pounds/amp.

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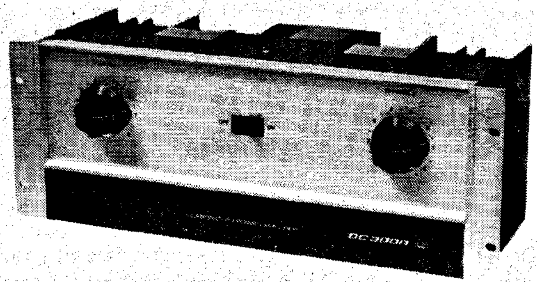
amcron

BY CROWN INTERNATIONAL

WHY is the AMCRON DC300/A often regarded as 'THE REFERENCE STANDARD'?



Because the DC300/A is the first totally redesigned amplifier since the original DC300. Most competitors are still using the six year old circuit designs pioneered by Amcron. Frankly, the DC300/A provides superior performance because of better design.

POWER YOU CAN COUNT ON

One of the DC300A's most outstanding features is that it has double the number of output transistors. Each channel has eight 150-watt devices for 1200 watts of power dissipation per channel. The DC300/A is rated at 190 W/CH at 8 ohms, 340 W/CH at 4 ohms, 500 W/CH at 2.5 ohms, or plug-in two parts for 600 watts continuous mono power at 8 ohms.

SUPERIOR OUTPUT PROTECTION

The DC300/A output protection circuitry is a radically new design which completely eliminates DC fuses and mode switches and further reduces service problems. It is superior in every way to the old VI limiting cricuit pioneered by Amcron and now used by most other high power amplifiers, since it introduces no flyback pulses, spikes or thumps into the output signal, whether operating as a single or dual-channel amplifier.
Gone to is the need the baby amp by carefully juggling load configurations. The DC300/A can drive any speaker load-in fact, down to 1 ohm.

LOWEST DISTORTION AND NOISE

The DC300/A's new IC front end sets new records for low distortion and noise. At the rated output, IM and harmonic is less than .05%, typically less than .025%, and hum and noise is −110 dB below the rated output, typically −120 dB.s,

WHAT DO THE CRITICS SAY:

Hirsch-Houck Labs. stated:
The Amcron DC300/A almost defies comment. No load we could apply – including short circuits and large capacitors – had any significant effect on its operating characteristics. Most engineers would probably be impressed, as we were, by the incredibly low distortion of this amplifier. The absence of "crossover distortion" was apparent in the very low power IM measurements, which reached a maximum of a mere 0.014% at just about 3 milliwatts output. It is, in short, a most impressive amplifier, one that has no flaws or functional weaknesses that we could detect.

The Absolute Sound Magazine stated:
"The AR's (AR-3) with the DC300/A acquired a smoother more musical high end than I had thought possible with these speakers. By comparison, the (other brand 700 watt amplifier) actually sounded grossly distorted. I can only postulate that Amcron has had more success in eliminating crossover notch distortion . . . there is no contest: The DC300/A is the best amplifier I have yet heard.
When you buy a DC300/A, you are buying more than just an amp. You are buying the Amcron company – a professional audio equipment manufacturer with a 26 year reputation for solid quality and lasting value. There are thousands of Amcron amps. in the field still working to their original specifications, and still outperforming most new amps.
The Amcron DC300/A! Still only **$795.00** R.R.P.

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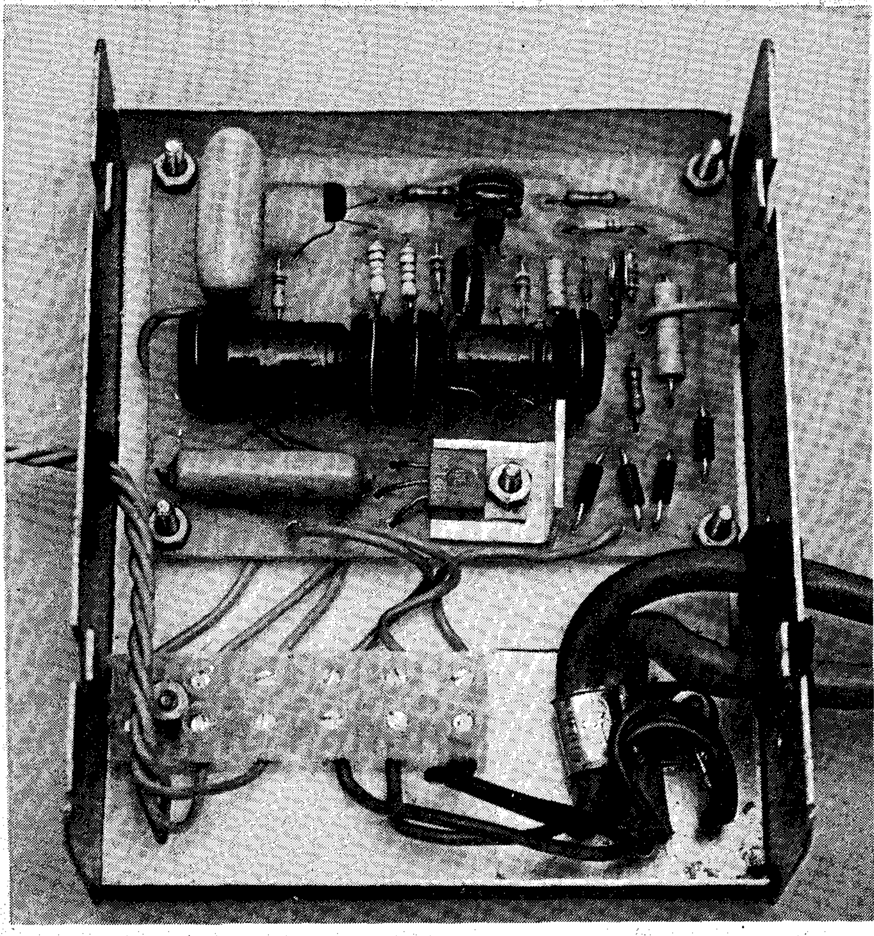


eti PROJECT 527

PUSH BUTTON DIMMER

Simple circuit allows light control from a number of locations.

MANY CIRCUITS for light dimmers have been published over the years (including some by us) which are of very simple construction, and which use a rotary potentiometer. Whilst such circuits are adequate in most respects — especially in terms of cost, there are some strong reasons for a more sophisticated dimming system.

The first objection to simple dimmers is that they usually have an unsightly knob by which light level is adjusted. A second objection is that the light level can only be adjusted from the position where the dimmer is mounted.

The dimmer described in this project can be operated from one or more remote positions — e.g. doors on opposite sides of a room, top and bottom of a long flight of stairs, bedside tables — or even from a control point beside your armchair.

The unit has an on/off switch and two (or more) sets of push buttons, one of which causes the light level to increase, smoothly from minimum to maximum in about three secs, and one which does the reverse. The adjustment may be stopped at any particular level, and that level will be maintained without change for periods up to 24 hours.

The dimmer will handle incandescent or fluorescent lamps up to 500 VA with the specified heat sink but, with a larger heat sink, may be used up to 1000 VA.

CONSTRUCTION

Wind the choke and transformer in accordance with the details provided in Tables 1 and 2. Be particularly careful to provide adequate insulation between the primary and secondary of the pulse transformers.

If a printed circuit board is used, construction will be considerably simplified. Mount all components on the board with the aid of the component overlay taking particular care with the orientation of diodes and transistors before soldering in position.

A small piece of aluminium (30 mm x 15 mm) bent at 90° in the centre of the long side, is used under the triac as a heatsink. The pulse transformer and the choke are mounted by means of rubber grommets and secured by tinned copper wire around the grommets and soldered into the holes provided.

After all components are soldered into place, and all external wires attached, the underside of the board should be washed with methylated spirits to remove any flux residue which could cause leakage.

The PC board should be mounted on spacers into an earthed metal box. A piece of insulation material, about 1 mm thick, should be positioned under the board to prevent any long component leads from touching the chassis.

A six-way terminal block should be used to connect all external wiring.

SETTING UP

All setting up, adjustments should be made using plastic, or well insulated tools. This circuit is live at mains potential and therefore dangerous to handle. BE EXTREMELY CAREFUL.

Potentiometer RV2 should be adjusted to obtain the desired minimum light level setting, (with the down button held). Adjust potentiometer RV1 for maximum light level (with the up button held) to just past the point where maximum light level is obtained.

If the lamp load is fluorescent more care must be taken with these adjustments. Additionally the setting up must be redone if the fluorescent loading is changed.

When adjusting the maximum light point on a fluorescent load, slowly increase the light level until the lights just start to flicker. Then turn RV1 back until there is just a noticeable drop in light level. This increased setting difficulty is due to the inductive nature of fluorescent loads.

If the required minimum light level cannot be obtained within the range of RV2, increasing R6 will provide lower light level range, and decreasing R6 will provide a higher level range.

PUSH BUTTON DIMMER

HOW IT WORKS ETI 527

As with most modern dimmers, we have used a *phase-controlled triac* for power control.

The triac, which may be regarded as a switch, is *turned on* by a pulse at a pre-determined point in each half cycle, and automatically turns off at the end of each half cycle.

Most conventional dimmers use a simple RC and diac system to generate the trigger pulse, but this dimmer is in effect voltage controlled. The 240 volt ac mains is rectified by D1-D4. This full-wave rectified waveform is clipped at 12 volts by R7 and ZD1. As no filtering is used, this voltage will fall to zero over the last half millisecond of each half cycle.

To provide the correct timing, and the energy required to fire the triac, a programmable unijunction transistor (P.U.T.) Q3 is used together with capacitor C3. A PUT also acts like a switch in the following manner. If the anode (a) voltage is higher than the anode-gate voltage (ag), the anode to cathode (k) path becomes effectively a short circuit.

The voltage on the anode-gate, is set by RV2 and, will be between 5 and 10 volts. Capacitor C3 is charged, via R6, and when the voltage across it exceeds that on terminal ag, the P.U.T. fires discharging C3 through the primary of pulse transformer T1. This induces a pulse in the secondary of T1 which gates on the *triac*.

As the voltage supply to R6 is unsmoothed the rise of voltage on capacitor C3 *will follow* what is called a cosine modified ramp. This gives a more linear change in light level versus control voltage.

Once C3 is discharged the P.U.T. may either stay on or turn off depending on the individual device. If it turns off it may well fire again if C3 charges quickly enough, but the operation of the dimmer is unaffected by either situation.

If C3 does not charge to the ag voltage before the end of the half cycle, the ag voltage will fall at the end of the cycle and the PUT will fire. This is an essential part of the operation as it ensures synchronization of the timing to the mains. It is for this very reason that the 12 volt supply is *not* filtered.

To control the charge rate of C3 (and hence the timing of the turn on of the triac within each half cycle) an auxiliary timing network of R5 and D6 is used. As the value of R5 is much less than that of R6, C3 would charge much quicker via this path. If we set the input to R5 at, say, 5 volts, the capacitor C3 would charge to about 4.5 volts quickly and then at the slower rate set by R6. This is called a ramp and pedestal type of charging (illustrated on page 73).

As a result of the initial start given by R5, the PUT would fire earlier, and the triac will turn on earlier, delivering more power to the load. Hence by controlling the voltage at the input of R5 we may control the output power.

Capacitor C2 is used as a memory device. It can be discharged by R1 via PB1 (up) or charged by R2 via PB2 (down). The capacitor C2 is connected from the positive side of the 12 volt supply and hence when the capacitor is discharged the voltage actually goes up with respect to the zero volt line.

Diode D5 is used to prevent the voltage rising above that set by RV1. The capacitor C2 is connected to the input of Q2 by R3. Transistor Q2 is a field effect transistor FET which has a very high input impedance. Hence the input current is virtually zero and the source tracks the gate voltage but at several volts level. (The exact voltage difference depends on the individual FET).

Therefore if the gate voltage is changed, ie, the voltage on C2, the voltage applied to R5 will also vary. By pressing either PB1 or PB2 the capacitor voltage and hence the triac firing point and the power delivered to the load may be varied.

Upon releasing the push buttons the capacitor will 'hold' this voltage — EVEN WHEN THE POWER IS SWITCHED OFF — for extended periods of time. The memory time is dependent on a number of factors as listed below.

1. A capacitor with a leakage resistance in excess of 100,000 megohm is required. Use a good quality capacitor, preferably rated at 200 volts. If necessary try different brands.

2. The pushbutton switch should be rated for 240 Vac operation. These types have greater separation and hence insulation between the contacts. By physically disconnecting the pushbutton it is easy to determine whether this is a cause of low memory times.

3. Leakage across the PC board could be a problem. It will be noticed that there is a track running from the source of Q2 which appears to go nowhere. This is a guard line to prevent leakage from high voltage components. If you are using different construction method make the junctions of R3 and Q2 and of R3 and C2 by mid air joints or by good quality ceramic standoffs.

4. The FET itself does have a finite input resistance. We tried many FETs without finding any that would not work. Nevertheless do not overlook this possibility.

The dimmer can be controlled from any number of stations simply by paralleling sets of pushbuttons. No damage will result from pressing both up and down buttons at the same time. However adding many stations increases the likelihood of leakage and consequent loss of memory time. The dimmer should be mounted in a dry dust-free position — as should the pushbutton. Do *not* try to use the dimmer or push buttons in a bathroom or kitchen as moisture will render the memory virtually useless.

TABLE I
CHOKE WINDING DATA

CORE
30 mm long piece of 9.6 mm dia ferrite aerial rod. (see main text).

WINDING
40 turns 0.63 mm dia (22 B & S) wound as two layers, each 20 turns, close wound using the centre 15 mm of the core only.

INSULATION
Use two layers plastic insulation tape over complete winding.

MOUNTING
Use a rubber grommet (9.6 mm I.D.) over each end and join to pc board using tinned copper wire in the holes provided.

TABLE II
PULSE TRANSFORMER WINDING DATA

T1
CORE
30 mm long piece of 9.6 mm dia ferrite aerial rod.

PRIMARY
30 turns 0.4 mm dia (26 B & S) close wound on the centre 15 mm of the core.

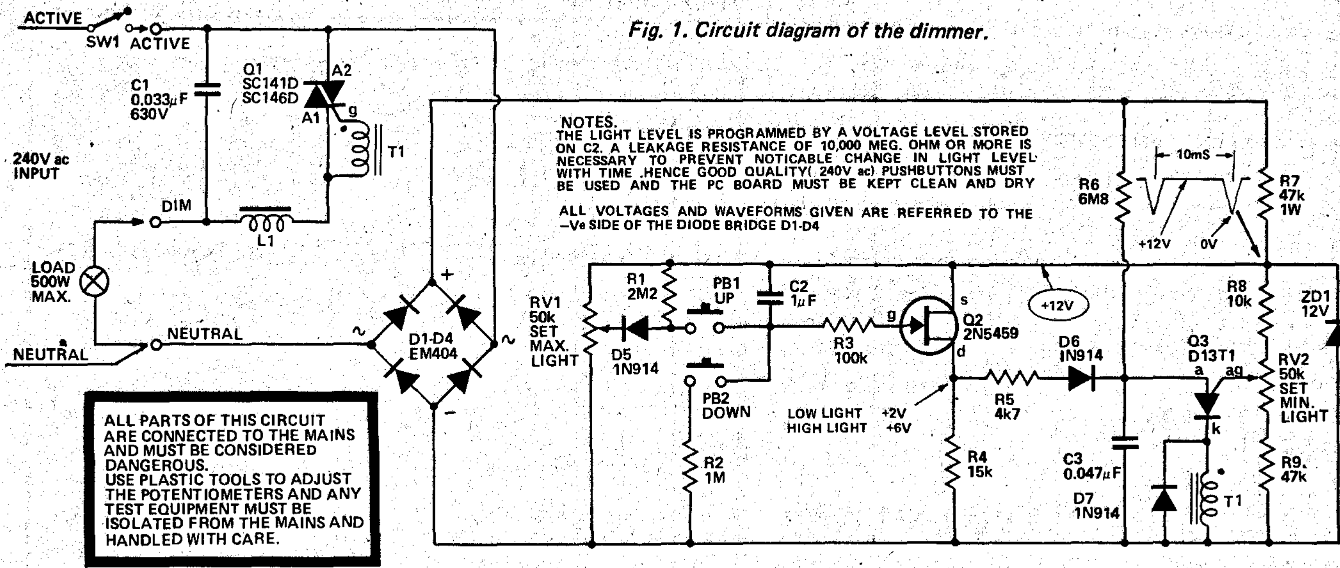
INSULATION
Use two layers plastic insulation tape over primary winding.

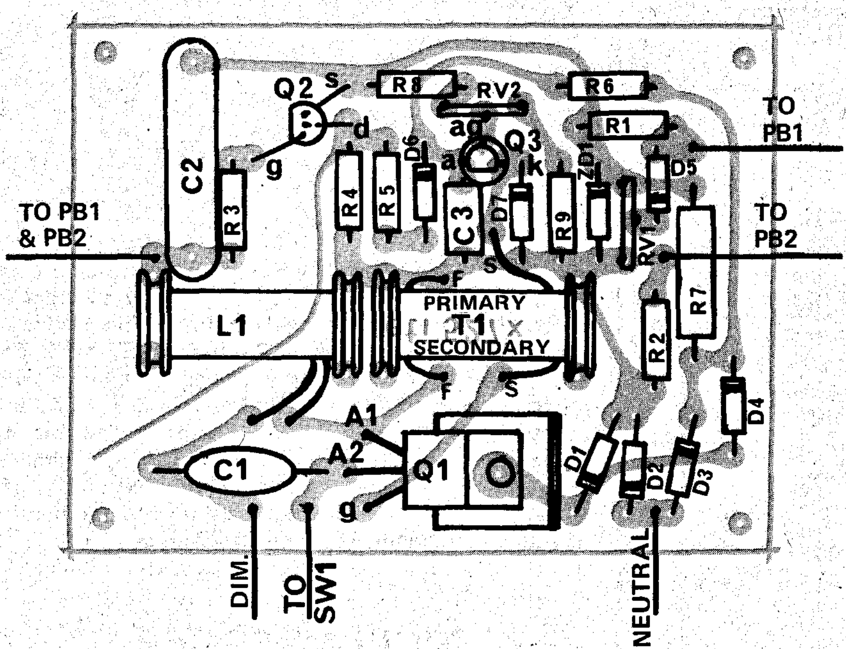
SECONDARY
30 turns 0.4 mm dia (26 B & S) close wound on the centre 15 mm of the core. Bring wire out on the opposite side of the core to the primary.

INSULATION
use two layers plastic insulation tape over complete winding.

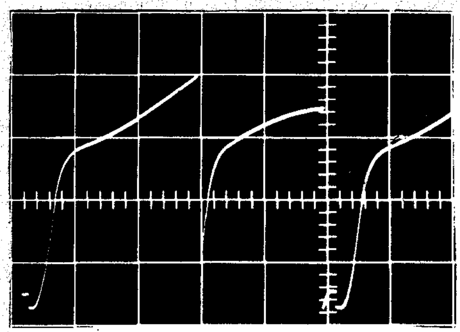
MOUNTING
use a rubber grommet (9.6 mm I.D.) over each end and join to pc board using tinned copper wire in the holes provided.

Fig. 1. Circuit diagram of the dimmer.





◀ *Fig. 2. Component overlay.*



Ramp and pedestal charging (dimmer set to provide about half light output).

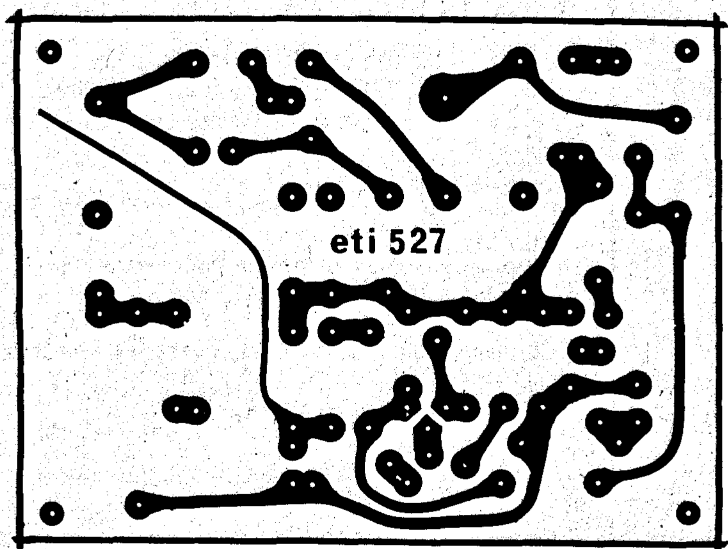


Fig. 3. Printed circuit board layout for the dimmer. Full size.

PARTS LIST – ETI 527

R5	Resistor	4 k7	½ W	5%
R8	"	10 k	"	"
R4	"	15 k	"	"
R9	"	47 k	"	"
R7	"	47 k	1 W	"
R3	"	100 k	½ W	"
R2	"	1 M	"	"
R1	"	2 M2	"	"
R6	"	6 M 8	"	"

RV1,2 Potentiometer 50 k trim type VSU or similar

C1 Capacitor 0.033 μF 630V polyester
C2 " 1 μF 200 V polyester
C3 " 0.047 μF polyester

D1-D4 Diode EM404, IN4004 or sim.
D5,6,7 Diode IN914 or similar
ZD1 Zener Diode BZX70C 12 or sim.

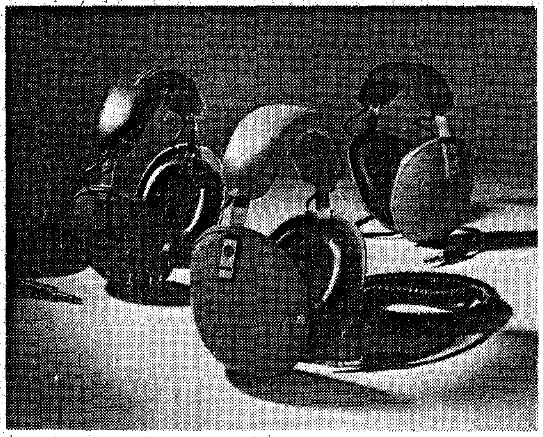
Q1 Triac SC141D, SC146D,
Q2 FET 2N5458, 2N5459 or sim.
Q3 PUT D13T1 or similar

L1 Choke see Table 1.
T1 Pulse transformer see Table 2.

PC board ETI 527.

6-way terminal block (240 V type)
Metal box
2 pushbutton switches, front plate, power switch

No noise nuisance.



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SPECIFICATIONS

	IMPEDANCE	FREQUENCY RESPONSE	MAXIMUM INPUT	SPEAKER UNIT	CORD	WEIGHT (without cord)
KH-71	8 Ω	20 ~ 20,000 Hz	0.5 WATTS	3"	3 m Cloth Cord (10 ft)	1.0 lbs (460 g)
KH-51	8 Ω	20 ~ 20,000 Hz	0.5 WATTS	3"	2 m Vinyl Cord (6.5 ft)	0.97 lbs (440 g)
KH-31	8 Ω	20 ~ 20,000 Hz	0.5 WATTS	3"	1.8 m Vinyl Cord (6 ft)	0.92 lbs (420 g)

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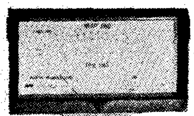

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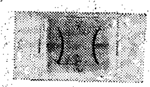

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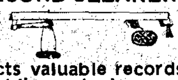

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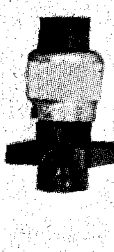

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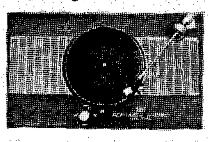

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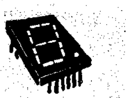

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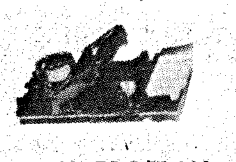

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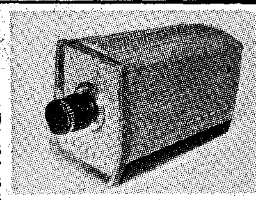

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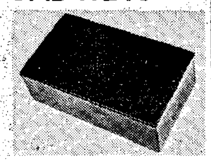

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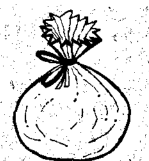

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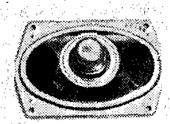

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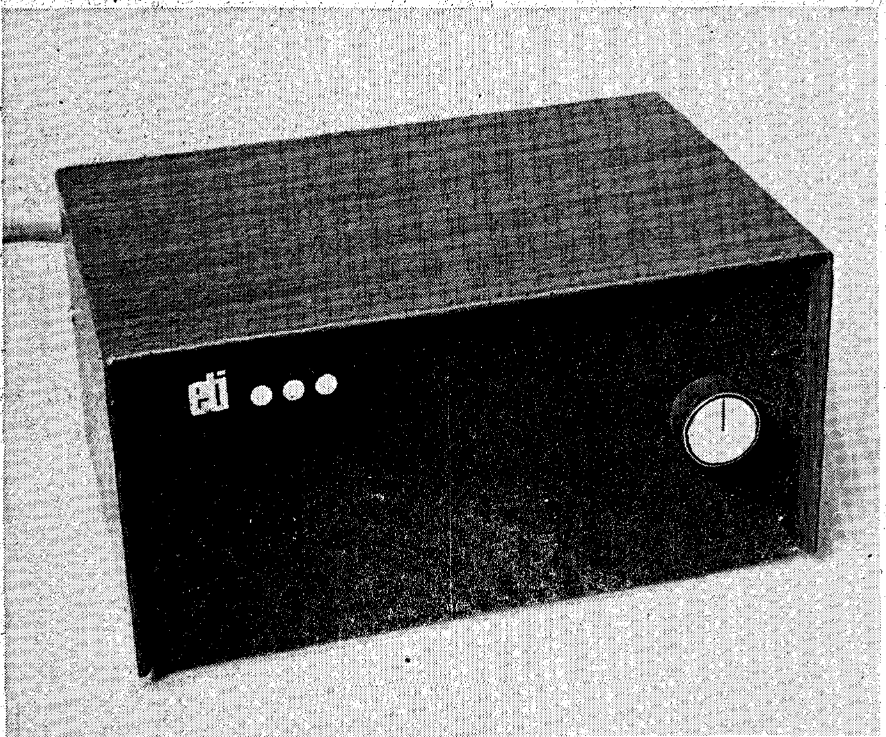
COLOUR ORGAN



ETI PROJECT 428

WARNING. All components on the board and the heat sink, upon which the triacs are mounted are at mains potential. Use extreme care as you would any exposed wiring carrying 240 volts. Avoid working on the unit whilst it is connected to 240 volt mains, make sure any test equipment you are using is isolated from earth, and that you yourself are well insulated from the floor by a rubber mat etc.

Produce all the colours of the rainbow in synchronism with your music!

THE SUBJECTIVE appreciation of music may be considerably enhanced by adding a coloured light display. If the three primary colours, red, green and blue, are projected onto a translucent screen, or some other diffuse material, and selectively modulated by the instantaneous amplitude and frequency content of the music you are listening to, the three colours mix to produce all the colours of the rainbow (as well as white) in synchronism with the content of the music.

A difficulty arises when you try to determine what frequency a 'blue' note should be, or for that matter red, green or any other colour. Bass instruments predominate the frequency range below 220 hertz. Vocals cover the midrange to about 1200 hertz. The higher fundamental notes of wind and string instruments complete the treble register to about 4000 hertz. Harmonics of course extend well beyond this.

It is generally agreed that red should represent low notes, green mid range, and blue the high notes. After much critical listening to tone oscillators and recorded music, in conjunction with light displays our panel of discriminating 'muso's' agreed that 'red' notes should extend to A — an octave below middle C. Green over the next three octaves and then followed by 'blue'. This is accomplished by dividing the frequency spectrum into three bands by means of filter networks. The amplitude content of each band is averaged and used to modulate the brilliance of the associated lamps.

For best effect, the direct light from the lamps should not be seen. It is not very stimulating, and in fact can be disturbing, to watch globes flashing on and off. However, the lights can quite readily be arranged to shine behind a translucent panel or be reflected off a wall. Alternately large diameter spheres made from crushed glass or plastic are available as standard lighting fixtures. We tried one that had been converted to accommodate three 100 watt coloured globes. Another simple effective arrangement we tried consisted of a cone which we made from a large sheet of translucent drafting film. This was positioned over our 250 watt floodlights mounted inside a five-gallon drum. Incandescent blue lamps are generally inefficient so we added an extra blue lamp in order to achieve colour balance. A lot of creative fun can be had trying different arrangements!

To keep this project as economical as possible we used only one control to vary the input sensitivity. Individual controls however can easily be added if desired. This involves substituting a log potentiometer with an appropriate series resistor in place of each of the resistors R23, R24 & R25.

CONSTRUCTION

We wound the line filter chokes, L1, L2 & L3, on three pieces of ferrite rod 30 mm long. These were cut from a 9 mm dia. aerial rod. To cut the rod, first file a V groove around the circumference of the rod at the point where it is to be cut. The groove need only be about 0.5 mm deep and can be cut with the sharp edge of a small triangular file.

Grip the rod in a vice, at the notch, being careful not to screw up the vice too tightly, as the material is also very brittle and shatters easily. Now give the rod a gentle tap and the rod will part cleanly. Wind the chokes as detailed in Table 1.

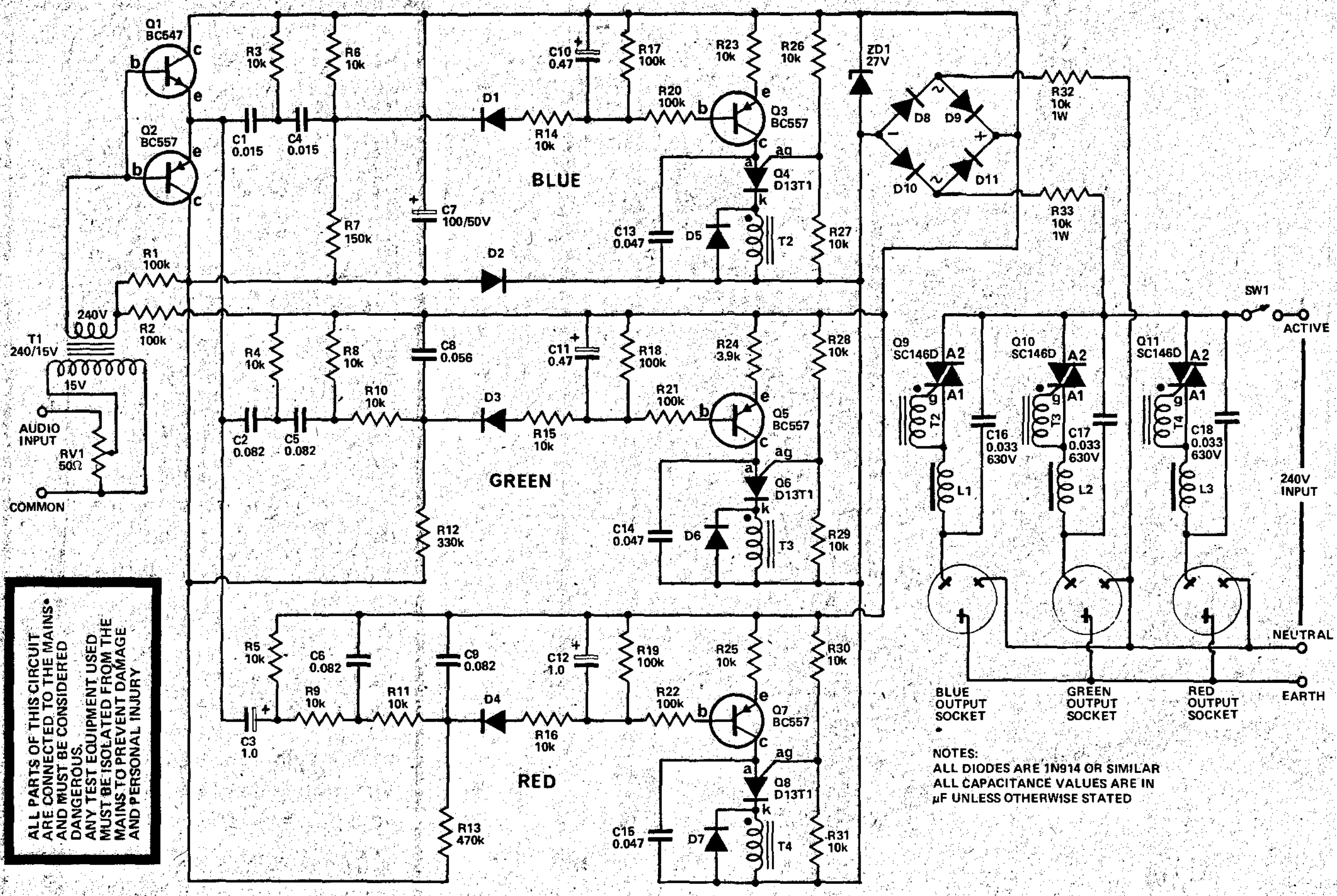
The trigger transformers are wound on pot cores having split bobbins, again as detailed in Table 1.

The heat sink should be constructed from a piece of aluminium as shown in Fig. 4. Carefully follow the component overlay, when assembling the board checking that all diodes, transistors and electrolytic capacitors are inserted the right way around.

The line chokes are secured to the PC board by tinned copper wire looped

Main text continued on Page 79

COLOUR ORGAN



ALL PARTS OF THIS CIRCUIT ARE CONNECTED TO THE MAINS AND MUST BE CONSIDERED DANGEROUS. ANY TEST EQUIPMENT USED MUST BE ISOLATED FROM THE MAINS TO PREVENT DAMAGE AND PERSONAL INJURY

NOTES:
ALL DIODES ARE 1N914 OR SIMILAR
ALL CAPACITANCE VALUES ARE IN µF UNLESS OTHERWISE STATED

Fig. 1. Circuit diagram of the colour organ.

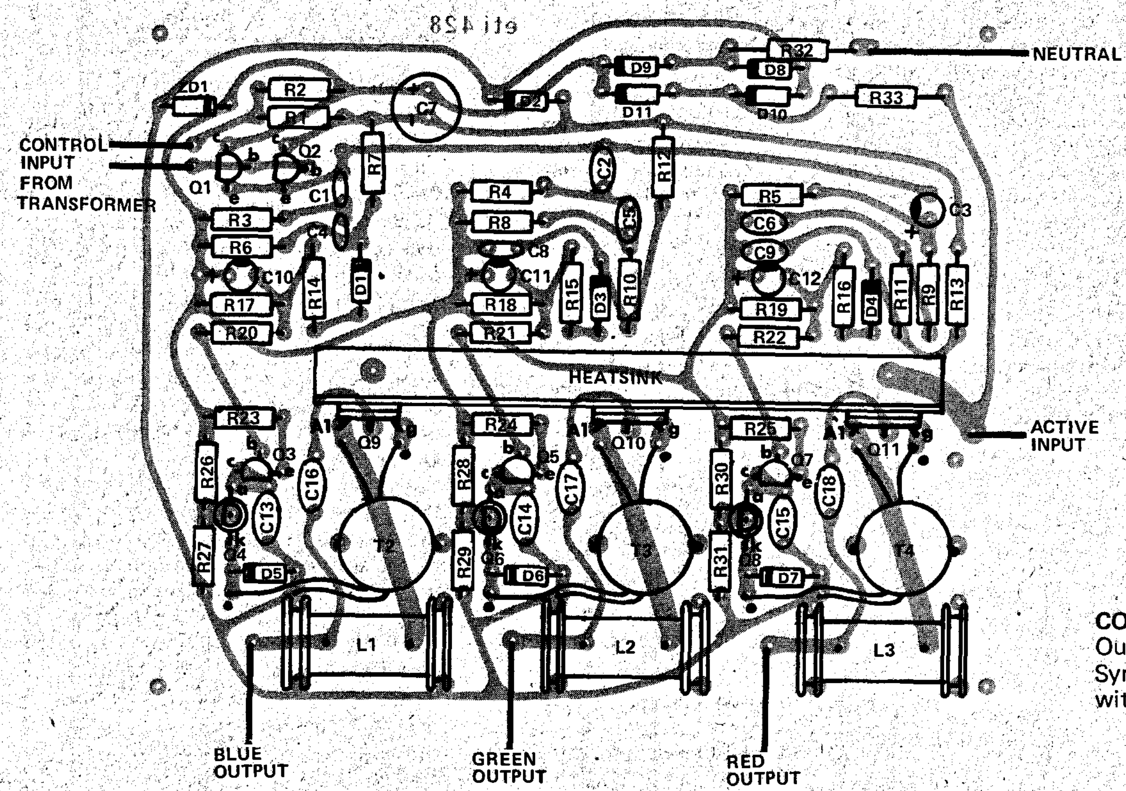
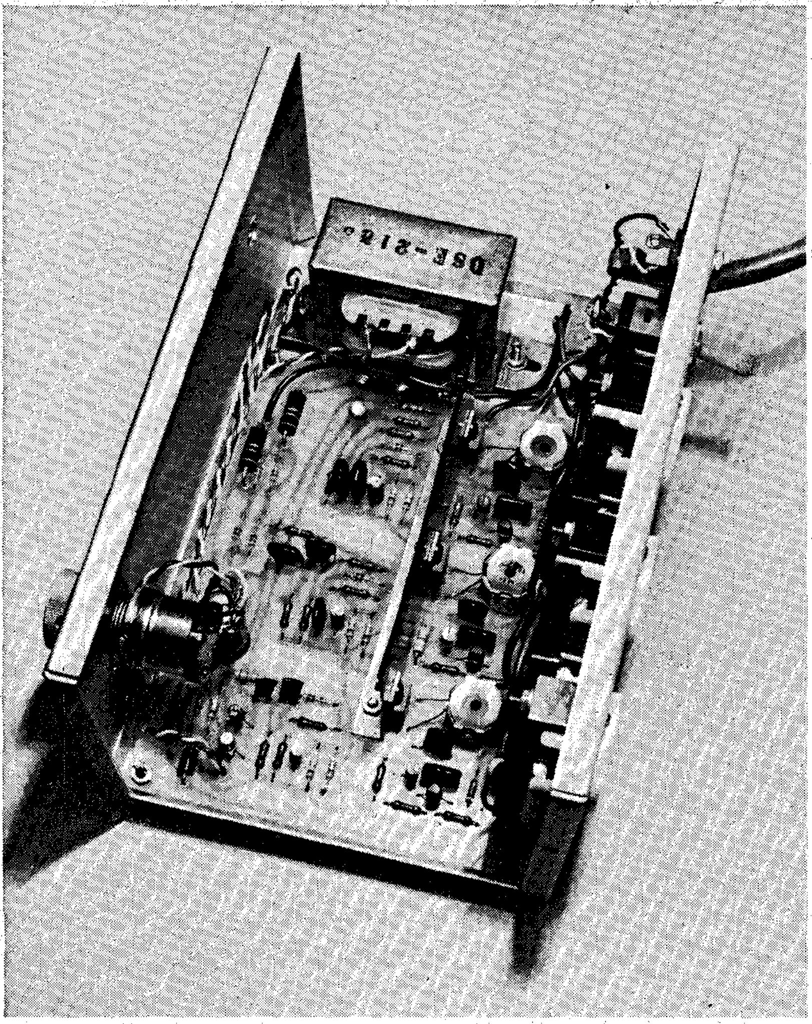


Fig. 2. Component overlay for the colour organ.

COVER PICTURE
Our thanks to artist Carole Symonds for her assistance with our front cover picture.



◀ *How the unit is constructed*

PARTS LIST — ETI 428

R24	Resistor	3.9k ½W 5%
R3,4,5,6	"	10k ½W 5%
R8,9,10,11	"	10k ½W 5%
R14,15,16, 23,25	"	10k ½W 5%
R26,27,28, 29,30,31	"	10k ½W 5%
R32,33	"	10k 1W 5%
R1.2.17.18	"	100k ½W 5%
R19,20,21,22	"	100k ½W 5%
R7	"	150k ½W 5%
R12	"	330k ½W 5%
R13	"	470k ½W 5%
RV1	Potentiometer	50 ohm 2W
C1,4	Capacitor	0.015μF polyester
C16,17,18	"	0.033μF 630 V (Soanar green cap)
C13,14,15	"	0.047μF polyester
C8	"	0.056μF polyester
C2,5,6,9	"	0.082μF polyester
C10,11	"	0.47μF 35V electrolytic
C3,12	"	1.0μF 35V electrolytic
C7	"	100μF 50V electrolytic

Q1 Transistor BC547, BC107 or similar.
Q2,3,5,7 " BC557, BC177 or similar.
Q4,6,8 " D13T1 or similar
Q9,10,11 Triac SC146D or similar

D1-D11 Diode IN914 or similar
ZD1 Zener Diode BZY88 C27 or similar

T1 Transformer 240V/15V A&R2155, DSE2155 or similar
T2,3,4 Pulse Transformer see table 2.

L1,2,3 Chokes see table 1.

SW1 Switch 240V ac 10A

PC board ETI-428

Heatsink to fig. 4.
Three 3 pin outlets ring-grip type 105 or similar.
Metal box to suit*
3 core flex and plug
7 rubber grommets
1 cable clamp
1 knob
terminal strip for mains connection.

*we used a box 210 x 100 x 140 mm made by Precise Mechanics.

HOW IT WORKS

Audio is fed to the input from the loudspeaker terminals of the amplifier. RV1 controls the input sensitivity and transformer T1 steps up the input voltage as well as providing safety isolation from the 240 volt mains on the remainder of the circuit. Transistors Q1 and Q2 provide a low impedance drive for the three filters and present a constant load to the transformer thereby keeping the level independant of varying frequency.

The 'red' channel is driven via a two stage 12 dB/octave low pass filter. The principal frequency determining components are R9, R11 & C6, C9. Diode D4 rectifies the signal which is converted to an average dc level by R16, R19, R22, C12. This varies the bias on transistor Q7 which operates as a constant current source.

The instantaneous current is set by the applied bias, and by the value of Q7 emitter resistor R25. The resulting constant current charges C15 and when the voltage across C15 equals the reference voltage set at the anode gate terminal (ag) of the programmable unijunction transistor (P.U.T.) Q8, the P.U.T. fires discharging C15 through the primary winding of trigger transformer T4.

The resultant pulse, from the secondary of T4, fires triac Q11 thus switching power to the red lamp. The firing cycle of the P.U.T. is synchronised to the 50 Hz mains by the unfiltered supply derived from Zener diode ZD1. Diode D7 bypasses the reverse flyback pulse from the triac and ensures the pedestal voltage of C15 remains constant.

The operation of the green and blue channels is similar with the exception of the filters. Components C2, C5, C8, R4, R8 & R10 form a bandpass filter for the green channel, whilst C1, C4, R3 & R6 make a high pass filter for the blue channel. Chokes L1, L2 & L3 in combination with capacitors C16, C17 & C18 are incorporated in order to reduce radio frequency interference.

Continued from page 77

round the grommets and then soldered to the board. As the triacs used are rated at 10 amps, the main limitation on the maximum load is the associated domestic wiring which would limit the total load to 2400 watts. We have designed the heat sinks with this in mind. If it is required to drive heavier loads the area of the heat sink should be increased and possibly triacs rated to carry higher current substituted. Of course then ordinary domestic power outlets should not be used.

A 300 millivolt input is sufficient to drive the lamps to full brilliance. At one hundred hertz the input impedance is approximately 12.5 ohms, accordingly any amplifier capable of delivering a watt or more would suitably drive the unit.

Set the amplifier volume control to the normal listening level, then adjust the input sensitivity control such that the lamps only light up to maximum brilliance on musical peaks. If this control is not set correctly the input level will be too high with the result that the lamps will all light up together regardless of the frequency content of the programme. If everything is working at this stage, you can now watch the changing moods and drift into happy ecstasy! ▶

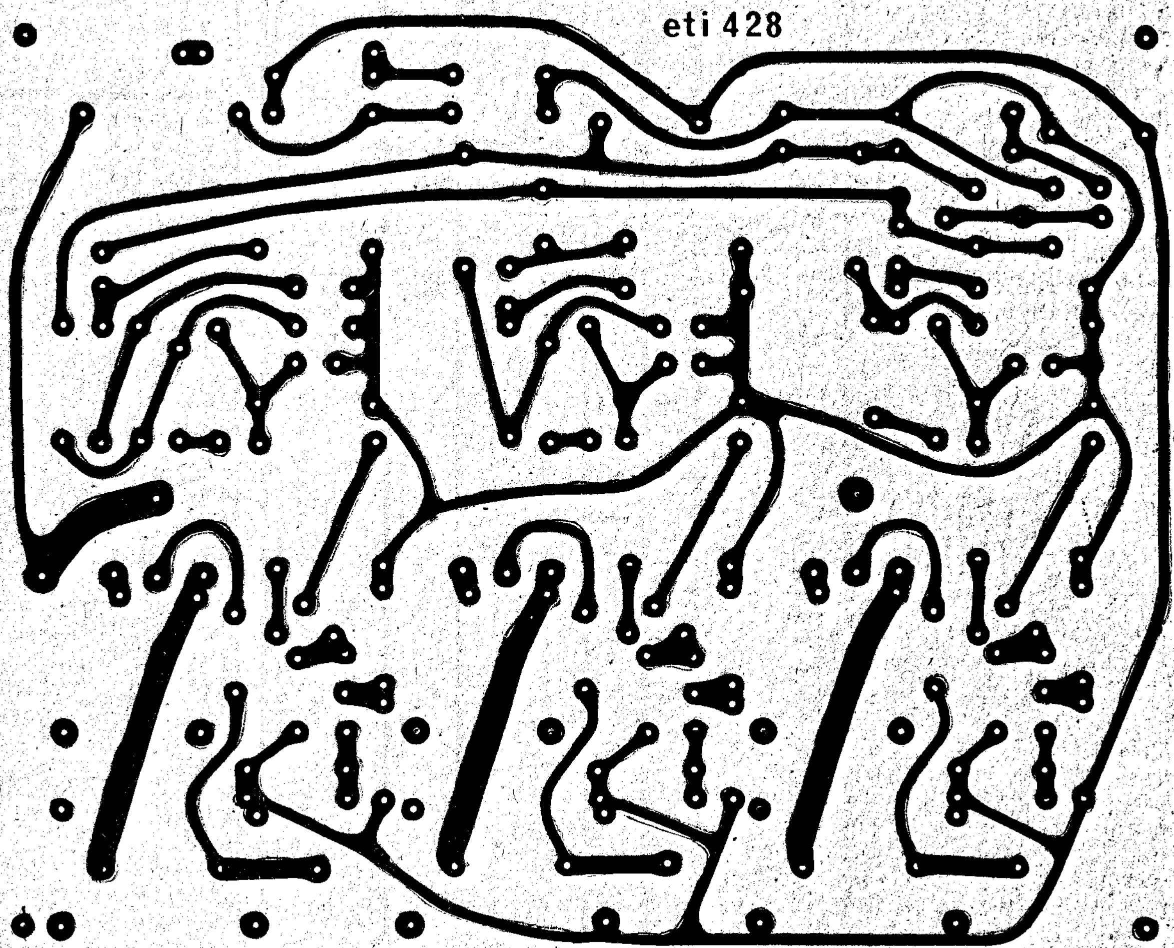


Fig. 3. Printed circuit board layout for the colour organ. Full size 127 mm x 158 mm.

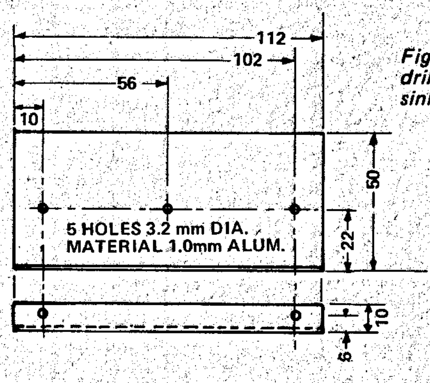
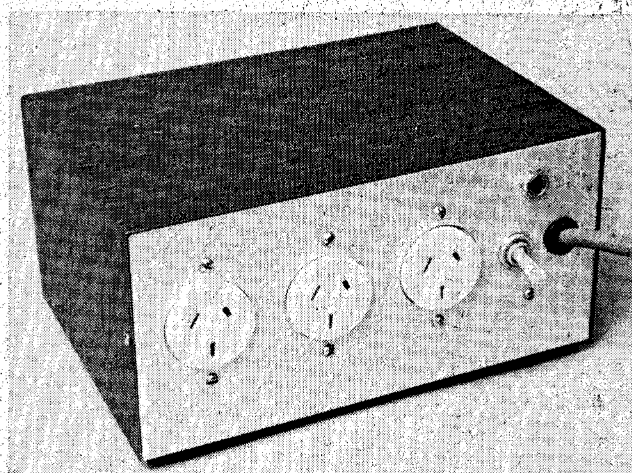


Fig. 4. Dimensions and drilling details for heat sink bracket.



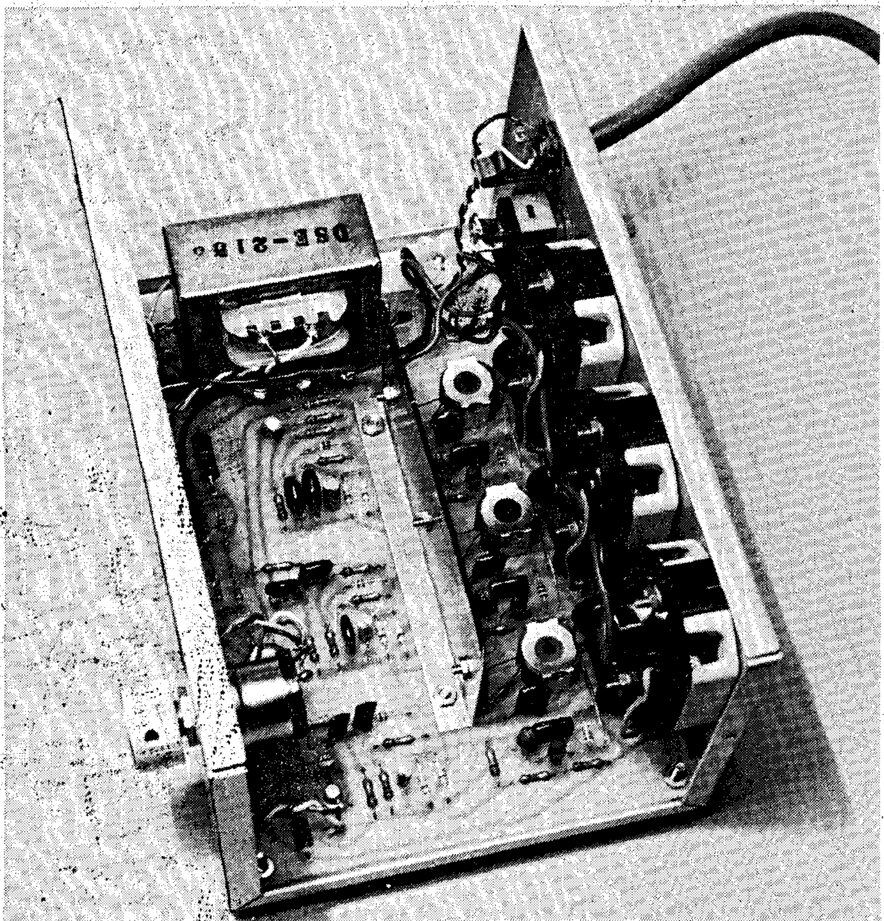


TABLE 1 — CHOKE WINDING DATA

L1, L2 & L3

Core	30 mm length of 9.6 mm dia ferrite rod.*
Winding	40 turns 0.63 mm (22 B&S) wound in two layers, each 20 turns, close wound using the centre 15 mm only of the core.
Insulation	two layers of plastic insulation tape over complete winding.
Mounting	use rubber grommet (9.6 mm ID) over each end and join to DC board by looping turned copper wire round grommets and secured into holes provided.

* Made from an aerial rod — file a groove around it at the desired cutting point then snap off.

TABLE 2 — PULSE TRANSFORMER — WINDING DATA

T2, T3, T4

Core	Philips P18/11 (any variation of P18 will do)
Former	Philips 4322-021-30280 (preferred) or 4322, 021, 30270
Clip	Philips 4302, 021, 20000.

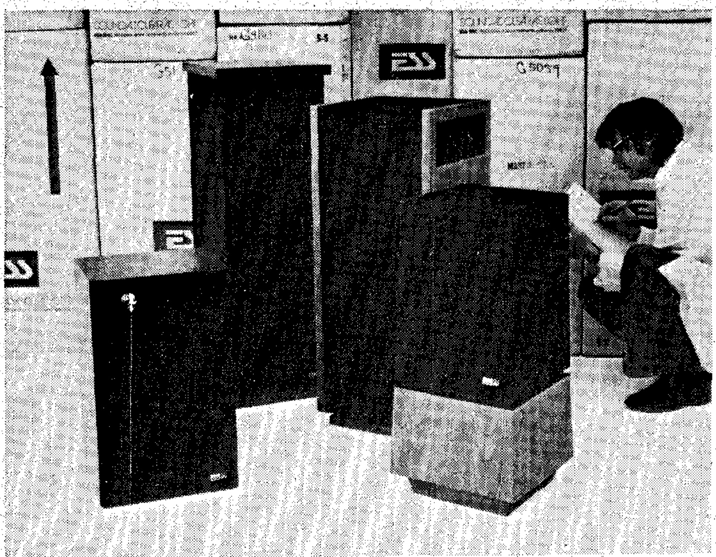
Winding (double section bobbin)
Primary — 30 turns 0.40 mm (26 B&S) one section
Secondary — 30 turns 0.40 mm (26 B&S) second section
Bring leads out at opposite ends of coil.

Winding (single section bobbin)
Primary — two complete layers 0.40 mm (26 B&S) close wound
Insulation — two layers of plastic insulation tape
Secondary — two complete layers 0.40 mm (26 B&S) wire close wound
Bring leads out at opposite ends of coils.

SOON THERE'LL BE FOUR ESS AMT SPEAKER MODELS AVAILABLE IN AUSTRALIA

**The classic amt-1 at $698* a pair.
The powerful amt-3 'Rock Monitor' multiple bass array at $997* a pair.
The new amt-1 'Tower' transmission line system at $898 a pair.
The new amt-5 'Reference Bookshelf' system at $396 a pair.**

*(*Increased prices due to devaluation)*



All these ESS loudspeaker systems incorporate a Heil air motion transformer — the revolutionary unit which applies the principle of "squeezing" air to create sound, and which brought to high-fidelity reproduction a transparency and dynamic transient impact beyond the capabilities of conventional mass-limited "pushing" drivers.

In the amt-5 — the least expensive and the physically smallest of the ESS systems — an exciting, newly-developed version of Dr. Heil's original unit is used — the ESS Heil "power-ring" amt tweeter. This unit operates with the same unique high-velocity "squeezing" principle of the larger Heil air motion transformer, to achieve dramatic equivalent benefits. It is teamed with a powerful 12" air suspension woofer for deep, high-impact bass and a defined, uncoloured midrange.

The new-to-Australia amt-1 "Tower" is a 6 foot quarter wave length transmission line system. It is a high performance, luxury version of the amt-1 — the speaker that introduced the Heil air motion transformer to the audio industry. Deep, full-bodied bass descending to 30Hz pedal tones is superbly matched to the open, detailed midrange and clear, pure highs that only the Heil amt can achieve.

As different to each other, in appearance and price, as the four ESS systems are, they all share a commanding advantage over conventional speakers . . . the revolutionary sonic benefits inherent in the unique design principles of the Heil air motion transformers. The benefits of clean, uncoloured frequency response. Superb stereo imaging and dispersion. Flawless and sensitive definition. And a square wave rise time of 15 microseconds for impeccable attack — incredible crispness and "bite".

Far more space than an advertisement allows is needed to describe the technical differences and the resulting audible benefits of the ESS Heil air motion transformer systems. We will be happy to send you full details if you will take a moment to complete and return the adjacent coupon.

Made in U.S.A.

ESS, Inc., C/- Megasound Pty. Ltd., 220 West Street, Crows Nest, Sydney. 2065. Phone: 922-3423.

Heil Air Motion Transformer is the registered trademark for ESS loudspeaker systems incorporating design principles invented by Dr. Oskar Heil and licensed exclusively to ESS Inc.

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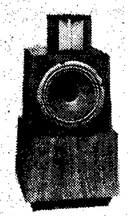
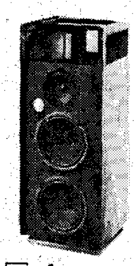
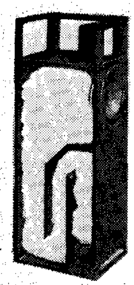
I would like full technical information on **all** the ESS loudspeaker systems. ☐.
The model most likely to fit my price budget would be



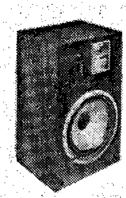
☐ the amt-1



☐ the amt-3
'Rock Monitor'



☐ the amt-1
'Tower' transmission line system



☐ the amt-5
Reference Bookshelf system

I already own a high-fidelity sound system. YES ☐ NO ☐

My preferred hi-fi dealer is *(name)*..
(This is for our information only & your name will not be passed on to any dealer you might specify.)

My present speakers are..

My present power amplifier is .... Model No. ....

I intend to retain ☐ upgrade ☐ my existing amplifier.

My present cartridge is..

My listening room dimensions are approximately..

I judge my listening room to be ☐ bright ☐ average ☐ dead.

ADDITIONAL COMMENTS/QUERIES..

....

....

....

ESS
Heil AMT loudspeakers
Sound as clear as light

Have A Happy Kitmas

No. 42 Varilight 1000W Dimmer E.A. April, 1973
Turn down the lights with this simple unit. Easy to build, easy to use, guaranteed results! The demand for this unit has been amazing. Many people have bought this unit so that they can set the background room lighting for watching T.V. This unit connects directly to the mains and should ideally be fitted by an electrician.
NOTE: Tinplate for chassis not included.
$7.50.

No. 45 Dick Smith Decision Maker
Yes or No? To be or not to be? That is the question. The Dick Smith Decision Maker will give you the answer at the push of a button. We designed this one especially for the vacillating businessman who has to make quick decisions but is plagued by indecision. Use it in the office, at home or going shopping. It uses two LED display and 3 transistors and runs off a 9 volt battery. Fully self contained. **$8.75** (P & P 75c).

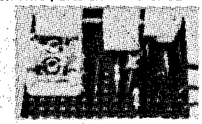
No. 47 Musicolour MKII Colour Organ E.A. December, 1972
Add an optic dimension to your hi fi. Enjoy the added effect of coloured lights varying in intensity and contrast in co-ordination with the frequency and best of your music. The unit, which runs off 240V divides the music into three broad frequency bands and there modulates three separate light "channels" of up to 1000W each. By changing the settings on each channel you can compose many different light concentos using the same piece of music. Can be used with any sound source capable of running phones. Works on voice too. Light up with your favourite radio announcer or commercial! **$59.00** (P & P $1.50).

No. 67 Ultrasonic Transmitter E.A. February, 1974
Based on our own imported Ultrasonic Transducer No. 105 and designs published in E.A. February '74, this little unit together with the Kit No. 68 Ultrasonic Receiver can be used as a doorway monitor or a burglar alarm system. It could also be used for remote control of various devices or even counting guests at a party — runs off a 9 volt battery. **$11.50** (P & P 75c).

No. 68 Ultrasonic Receiver for the Ultrasonic Transmitter
Designed basically for relay operation but can be altered to virtually any form of readout. It now includes our super-sensitive transducer. Runs off a 9 volt battery. **$17.50** (P & P 75c).

No. 11 Playmaster 143 Hi Fi Amp E.A. September, 1974
This unit is an improved version of the Playmaster 136 of which over 10,000 have been made. 12½ Watts per channel into 8 ohm at a typical 0.4% THD and within ±2 dB from 20HZ to 20 KHZ. Inputs are 2mV into 50K and 150mV into 500K. Noise figures 60dB down with all input open and 44dB X talk. An excellent unit which has been designed so that conversion to 4 channel can be made with a minimum of fuss. Ideal for the home environment and has provision for headphones. **$79.00** (P & P $3.00).

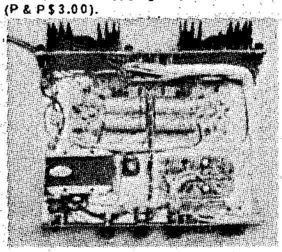
No. 69 ZN414 Receiver E.A. May 1974
The ZN414 is an I.C. which requires only two resistors, two capacitors, tuning gang and coil. 1.5 battery and earpiece to become a transistor radio. It can truly be built in a matchbox yet will give performance which will astound you. Can you afford not to build one! Includes all electronic parts and free circuits. **$6.75.**



No. 71 ET1 422 Stereo Amp Complete

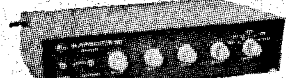
SPECIAL NOTE
Beware of cheaper prices. Our kit includes rear panel genuine METAL TO3 Pack 115W output transistors exactly to spec. No cheaper lower, power plastic types (special kit with cheaper plastic types for $115 not recommended).

This stereo amplifier kit is complete in all details and conforms with the E.T. design of May 1974. A guaranteed 50W RMS per channel into 8 ohm loads, from 20HZ to 20KHZ at 0.5 dB. Distortion less than 1%, typically 0.15%, many facilities including tape, tuner mike inputs, preamp output, main amp input at 3 basic sensitivities of 2.1mV, 210mV and 500mV. Kit comes complete in every way. Definitely the best build-it-yourself amplifier available and equal to many commercial units costing three times as much. Purchase the complete kit or build in these last stages. **$135.00** (P & P $3.00).



No. 105 1.5 Watt Amplifier ET1 225 E.T. May 1974
A small amplifier is virtually indispensable to the experimenter. Can be used as an amplifier, signal tracer, monitor etc. Its uses are innumerable. It is very easy to build, is not very particular as to layout and extremely low priced. Runs off 12 volt D.C. **$4.90.**

No. 106 Temperature Meter ET1 226 E.T. May 1974
An extremely simple "press to read type" temperature monitor. Ideal for use with a number of sensors in different localities e.g. pools, outside temperature, inside temperature etc. Range is from 0°C to 100°C. Runs off 9 volts. **$10.75** (P & P 75c).



BOOKS

COLOUR TELEVISION THEORY
G. Hutson, 326 pages. This book assumes the reader to have a working knowledge of monochrome television principles. It deals almost exclusively with the PAL system, but a chapter is devoted to the NTSC system. The text begins with an easy read chapter on "light" physics to give the reader a basis on colour mixing, chromaticity diagrams etc.; the principles are dealt with step by step in an easy to understand form. Practical circuitry and diagrams accompany the text, to give an interesting explanation. Colour plates are included to show relevant colour information. A chapter is devoted to transmission, and describes the difference between PAL, NTSC, and SECAM. In all, a complete, thoroughly absorbing easy to read text. This book is not only a must for all television technicians but of enormous interest and value to all interested in colour television. **We are getting entire Australian shipment, so this book is virtually available only from us. $12.50.**

New PAL Book

At last an Australian PAL book
PAL Colour TV for Servicemen by Cook, Wren 248p **$15.00.** This is a must. Written by an Aussie, this is the best book on Aussie PAL (and N.Z. too). Assumes B & W experience and covers theory in a not too technical way. Practical approach to solid state and IC circuits. Very thorough with heaps of diagrams, many in colour. Well written by a man with 30 years experience who set up training courses here.

Projects and Circuits from Electronics Australia $2.00. It's a beauty, all the popular tried and tested circuits from EA: Reaction timer, tape amp, bongos, microradio, train controller, tuner, novelties etc. etc. There's over 30 projects and 112 pages for only **$2.00.**

CHRISTMAS SUPER-SCOOP

We have 100 only **Jayem L55 FET Multitesters** for the real enthusiast at a knockout price. You'd normally pay the same for an ordinary meter but this one has 27 ranges, constant 10 Meg input impedance, battery operated and complete with vinyl case. The best Christmas gift at a saving of $10. Yes the L55 is yours for only **$33.50.** (P & P $1.00). But hurry. Special probes R. F. Probe $9.50. Temperature probe normally $11 now **$6.50**, 30kV probe normally $11 now **$5.** These are genuine reductions for the first 100 lucky customers.

KE117 2 station is a highly efficient solid state intercom capable of working over distances to 500 ft. Wall or desk mounting. Master has volume control. Supplied with 50 ft. cable. Normally $13.50. 100 only reduced till Christmas to only **$10.50.** Save $3.00.

For The Christmas Stocking

Add a tweeter to your system for only **$9.50.** Philips AD061/T8 handles 20W and covers 1.5 kHz to 22 kHz (full instructions in our cat.).

Battery Charger 4 from A & R has dual ranges -trickle or 4A, immune to shorts or accidental reverse connection. Charges both 6 and 12V batteries. Handsome tough case with meter. The best around at only **$24.00** (P & P $1.50).

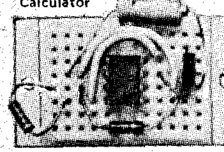
CIS460 Headphones feature the very latest styling with Mylar power cones giving a frequency response from 30 to 20,000 Hz. Independent volume controls built in. Only **$14.95.**

Electric Car Aerial adds a touch of class to your humble motor. Push the button and up she goes to an enormous 43". Suits 12V supply of either polarity. 12" underhang. Only **$21.00** (P & P $1.00.)

Car Stereo Speakers SKA046 requires only 2½" depth, nominal 6" diameter handles 5W, response from 130 Hz to 9 kHz **$16.00** a pair (P & P $1.00).

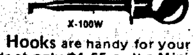
BABANI AND BERNARDS BOOKS

BP1	First Book of Transistor Equivalents and Substitutes	$1.00
BP2	Handbook of Radio, TV and Ind Tube and Valve Equivalents	1.00
BP3	Handbook of Tested Transistor Circuits	1.00
BP6	Engineers and Machinists Reference Tables	.50
BP9	38 Practical Tested Diode Circuits for the Home Constructor	.80
BP11	Practical Transistor Novelty Circuits	1.00
BP14	Second Book of Transistor Equivalents and Substitutes	2.20
129	Universal Gram-Motor Speed Indicator	.25
161	Radio, TV and Electronics Data Book	.75
196	AF-RF Reactance-Frequency Chart for Constructors	.40
202	Handbook of Integrated Circuits (IC's) Equivl. and Substitutes	2.00
RCC	Resistor Colour Code Disc Calculator	.25



Mini IC Socket from EI Instruments for your IC lashups. Gives them a better chance of working for only **$3.00** and saves so much frustration. Or blow **$26.00** on the proper breadboard. Both operate to 30 MHz.

Pop a box of **solder** in. Ersin Multicore **$4.40** in 16 swg (500g) or 18 swg at **$4.50** or 22 swg at **$5.90.**



EZ Hooks are handy for your test leads at only **$1.65** or the Mini at **95 cents.** Or how about a scope probe case from EZ at **$1.60?**

Perhaps your main Christmas present is a new car (ha, ha). Even if it isn't protect your vehicle with a **Cargard RB200** which is easily installed by any handyman. Highly recommended and supplied complete with horn at **$37.50.**

Don't forget a Telefix. If your set goes on the blink over the holiday period, how long will it take to get a serviceman? Anyone can locate 90% of faults caused by valves with Telefix. Only $2.50 (P & P FREE).

Denshi SR3A. The giant kit with 105 experiments, reflex radios, record player amplifier, wireless mic, burglar alarm, photoelectric warning device etc. This one has a 3 stage circuit board and special control panel with speaker switch, volume control etc. plus separate extension speaker for intercom etc. Solar cell included plus 46 modules morse key, earpiece, mic etc. Supplied with descriptive manual and excellent value at **$24.40.**

Going away for a holiday? Then hurry and get a **Watchdog** installed. From the same manufacturer as Cargard, here's a complete alarm system for your home. Uses modules comprising alarm and separate siren, plus speaker and 3 reed switches. No soldering, runs off 12V battery **$46.00,** or with 5 reed switches plus pressure mat and tape blocks etc. for **$64.00.**

DICK SMITH WHOLESALE P/L

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also at 361 Hume Highway, Bankstown Tel: 709 6600

VARIABLE SPEED SPEECH

Played-back recordings can be varied in speed without changing pitch!

THE PACE of modern technology has inevitably caused a demand for faster communications. We are all in a hurry. We need information *now*, and we cannot afford to spend too much time assimilating it.

In many areas improvements have been made which greatly facilitate the rate of information transfer. For example, in the computer field, getting the information in and out of the computer, rapidly, has been a continuing problem, but this has been alleviated partly by the development of such equipment as high speed printers, tape readers and CRT terminals.

In the audio/visual field special purpose projectors, multivision techniques and special television effects equipment have vastly improved the rate of visual information transfer.

But – where information must be transferred by spoken word – we have, until recently, made little if any progress.

In the fields of education, staff training, advertising, etc, some method of increasing the playback rate of recorded speech is urgently required. Such a system, known as VSC (Variable Speech Control) is now available.

THE PROBLEM

Average speech rates range from around 110 words per minute for ordinary conversation up to about 175 words per minute for the average news commentator. This is in sharp contrast to the average reading rate of around 300 words per minute rising to 1000 WPM or more for trained speed readers. Obviously the comprehension rate is far higher than practical speech rates.

On the other hand, a secretary endeavouring to type up the tape-recorded minutes of a meeting will find the speech rate about twice that for comfortable typing. Hence it is very desirable to be able to vary the playback rate over a range of half to twice the normal rate.

If you have ever played a record or tape at an incorrect speed you will be familiar with the effects of speed change. An increase in tape speed by any given factor results in an increase in frequency of all frequency components by the same factor. At best we get the "nutty squirrel" effect, at worst – an unintelligible gabble.

A decrease in speed results in an unintelligible rumble as all frequency components of the speech are lowered proportionately.

Although some special machines have been built for speech compression, these have been very expensive and hence not been within the reach of the average user. Over 60 million tape recorders are purchased each year for a variety of purposes and quite a large percentage of users would welcome a cheap variable speed device which would allow the playback rate to be varied to suit individual requirements. Such a unit should be available at a price which will allow it to be fitted to even the cheapest of cassette recorders.

THE SOLUTION

The pitch change-with-speed phenomena, and a method of eliminating this change, is best illustrated with the aid of Fig. 1.

Speech may be considered to consist of short segments of various tones, called phonemes which make up any particular sound. Assume that we take a 40 millisecond sample of a waveform and find that it is a tone of 150 Hz, as shown in Fig. 1a. If the tape recorder is now replayed at twice normal speed, the tone burst will be compressed into half the time, that is, it will now be at 300 Hz.

We want the time compression but *not* the frequency change, so, to eliminate the latter, we must delete half the tone burst and expand the

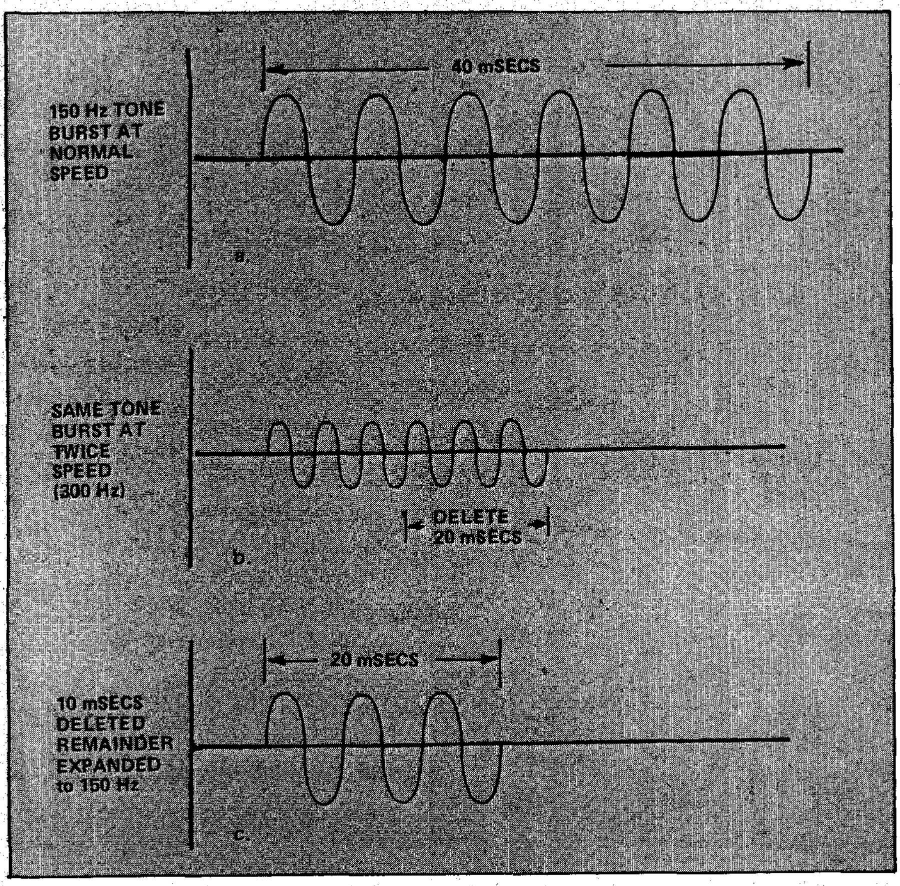


Fig. 1. The method of reproducing sound at normal pitch when replayed at higher than normal speed (in this case at twice speed).

remaining portion again. Thus we finish up with a tone burst of half the duration but at the same frequency, as shown in Fig. 1c.

This is in fact the principle of the new VSC system (Variable Speech Control). In normal speech there is a considerable amount of redundant information and the basic speech sounds are of around 100 millisecond duration. Hence by sampling the speeded speech and discarding redundant material the remainder may be stretched so that the resulting gaps are filled. Thus speech of normal pitch but at a much faster rate is produced.

The reverse process may also be used by compressing short samples and filling the resulting gaps with redundant material. This allows playback of speech at much slower rate than normal again with normal pitch.

There are two problems in this approach which must be overcome. The first is that the duration of the portion must vary to suit the change in speed. For example at three times normal speed two thirds of the sample must be discarded. The remaining one third is then expanded three times to produce gapless speech at the correct pitch.

The second problem is in expanding the remaining portion correctly. This problem may best be understood by reference to Fig. 2. Here we see the signal after speed up compared to the same signal when expanded (X2 speed). The delay required for each point on the waveform can be seen to increase with time during the sample period and some electronic means of achieving this must be provided.

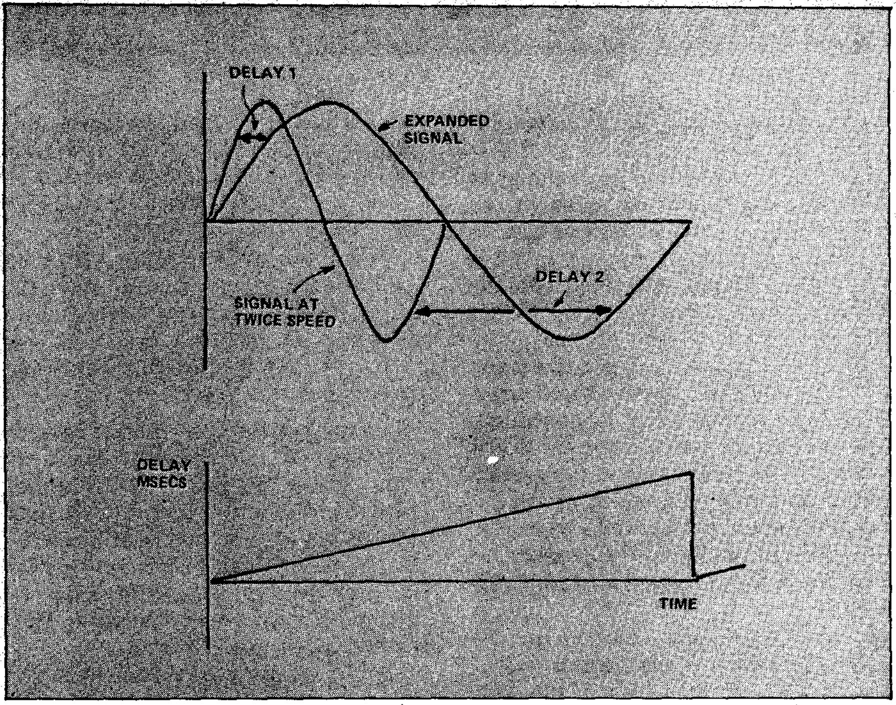


Fig. 2. When expanding a signal sample each segment of the waveform must be delayed, and the delay must increase linearly during the sample time.
This is shown by comparing the delay between pairs of points having the same phase angle, as for delay periods 1 and 2 shown above.

HOW ITS DONE

The heart of the new system is a new IC developed jointly by Matsushita Electric and Philips. Known as the MN3001, it is an LSI device consisting of 512 dual bucket-brigade stages on a single silicon chip. The two sections may be connected in series to obtain 1024 stages, or, may be used in parallel to obtain double the output voltage obtainable from a single section.

A bucket brigade device consists of charge storage capacitors separated from one another by MOSFETS. When the FETS are gated by means of a pulse the charge on one capacitor is transferred to the next. Thus by clocking the device with a train of pulses the signal is shifted down the chain. The direction of shift is controlled by using a two phase clock.

Thus the bucket brigade device is a shift register but, it is an *analogue* shift register because the amplitude of each bit is transferred by the charge transfer process. Thus an analogue signal input will be delayed by an amount which depends on the clock frequency. The lowest recommended clock frequency is 10 kHz and with a 512 stage device this gives a delay of around 26 milliseconds.

To return now to our VSC unit (Fig. 3) the audio signal, from the tape recorder head etc, is fed to the bucket brigade device. Instead of using a fixed clock frequency we gradually increase (or decrease) the clock pulse duration during the bit shifting process of each sample. Thus each sample bit of the analogue signal is subjected to a progressively greater (or shorter) delay. The net result is a signal having the correct frequency components but

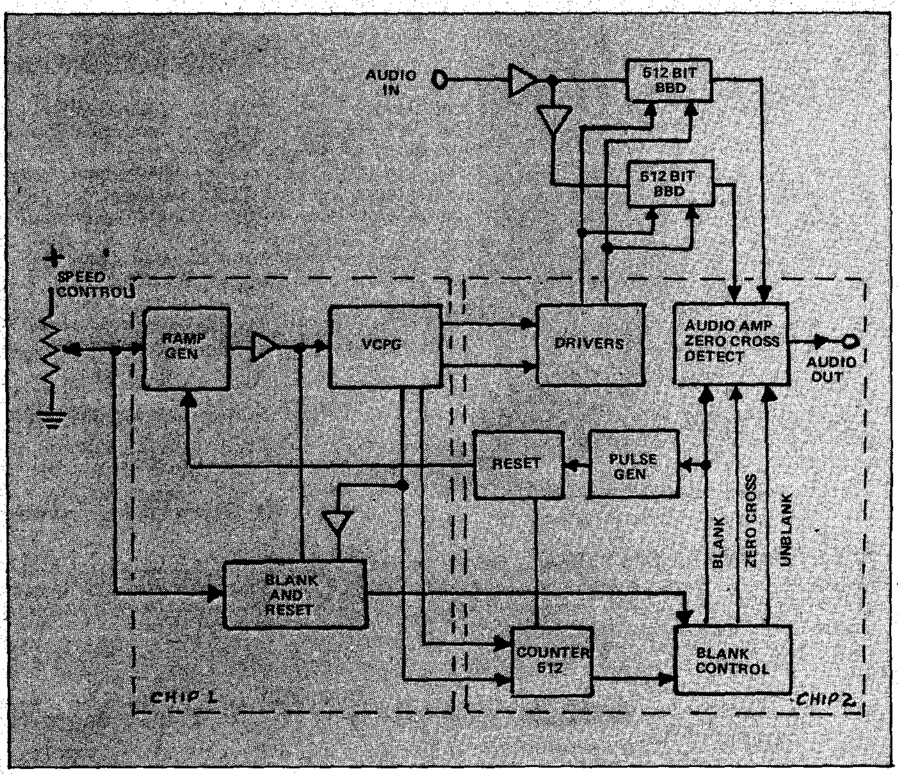


Fig. 3. Functional block diagram of the VSC system. Two chips are used for control and a third chip contains the dual bucket-brigade analogue shift reader.

being played back at a faster (or slower) rate.

The speed control potentiometer, as well as determining the speed of the recorder, provides a control voltage to a ramp generator. If normal speed is set, a ramp is not generated and the bucket-brigade device merely delays the signal without other change. If the recorder is speeded up, a positive going ramp is generated, and if slowed down a negative going ramp is generated. The ramp is passed to a VCPG (Voltage Controlled Period Generator) and as the ramp sweeps it varies the clock pulse period from the generator such that a progressively greater (or smaller) delay is obtained during the sample.

Before the ramp overdrives the period generator a comparator causes the amplifier to be blanked at the reset zero crossing point of the audio (to avoid annoying switching noise). At the same time the ramp is reset and a staircase counter is started.

During the next 512 counts the amplifier remains blanked allowing the sample stored in the analogue shift register, to be dumped out. At the end of the count the amplifier is gated on allowing the next sample to be loaded into the shift register.

Thus a discard period of 20 to 40 milliseconds is generated and the amplitude and polarity of the ramp will vary the playback rate from less than one half to three times normal speech rate.

Although only one bucket-brigade shift register is required, the use of two devices feeding a differential amplifier allows twice the output voltage to be obtained. Additionally, the differential amplifier will cancel out common mode noise, due to switching etc, thus improving the signal to noise ratio by 3 dB.

The development of the VSC process was carried out by a small group, specially set up in 1966, known as Cambridge Research and Development Group (CRDG). The basic design was first implemented with discrete FET storage stages and the advent of the Philips/Matsushita bucket-brigade devices was a fortuitous development which allowed an IC design to be immediately feasible.

The design is now to production stage and three licensing agreements have been concluded with Sony Corp, Matsushita Electric Co and with Magnetic Video Corp of US. Additional licenses are likely to be appointed in the near future. In fact as we close for press we have just heard that Hitachi's new TSC-8800 cassette recorder has the system built-in.

At present the VSL system is constructed on three chips, one for the dual BBD device and two for the control logic. This system will allow low cost tape recorders to be modified for VSC at reasonable consumer price levels.

It is expected that, in the future, the entire system will be integrated onto one chip, using CMOS techniques. Such a low voltage, low power device will make VSC a technique which will probably be incorporated in all low-cost dictation equipment and cassette recorders as a matter of course. ●

CABLE TV - the wired city

A new era in home communication and consumer services.

SHORTLY after the introduction of the telephone, affluent Parisians had their houses wired via *two* channels to an auditorium where concert performances were given. Here the performances were picked up by carbon microphones, relayed to the individual residences, where subscribers listened via earphones. The service was not a success since the non-existence of amplifiers limited the scope of the system.

But it anticipated a technology that is only now emerging. It is one that has all the portents of changing our life pattern more radically than any of the communications media to date.

Many futurists believe that we are on the brink of a communications revolution. In the next decade or so, two technologies will be instrumental in this revolution — the proliferation of satellite communications and the rapid expansion of cable systems.

The two technologies complement each other. Satellites make it possible to send signals over long distances; co-axial cables make it possible for scores of signals, originating either from far away or a homeowner's own neighbourhood, to be received by individual subscribers.

Cable TV (CATV) is somewhat misnamed. The name implies direct "piping" of TV broadcasts to individual homes, especially in locations where it is impossible to receive satisfactory signals directly over the air.

In reality, the concept of cable TV is more than that, for the cables would not only carry TV and radio programmes but would provide an *interactive* medium for every aspect of community and commercial communications.

In the 1950's many cable operators in the USA began to make their own programmes. As areas of distribution increased, micro-wave links were set up for linking central off-the-air receiving stations to "headend" receivers in various locations of high density urban areas.

The cost of links were far cheaper than cables. Coupled to some headends were small cablecasting studios generating local programmes. The cheapest forms of local programme were "automated". For example, a TV camera might be permanently pointed at a clock-cum-weather indicator and left unattended. The picture would be sent over an unused channel of the cable system to provide viewers with continuous time/weather information.

Aware of the potential, cable companies are planning the phasing-in of a diverse range of services. Ideas for cable system uses are almost inexhaustible, even though the technique is still in its infancy.

GETTING THE SIGNAL "HOME"

Fig. 1 shows how cable distribution is an extension of this system to incorporate microwave links to distribute off-the-air signals to more than one cable system in an urban area (this is far cheaper than running a cable between stations). Also if the distance exceeds about 15 kilometres, too many repeaters would be required.

The main distributor cable in a CATV system is the trunk line. It is usually one to two centimetres in diameter but may be larger. The larger diameter cables are used for longer distances since they attenuate the signals less. Amplifiers must be placed along the cable length to maintain signal strength at useable levels. These trunk amplifiers are particularly critical components. Each one

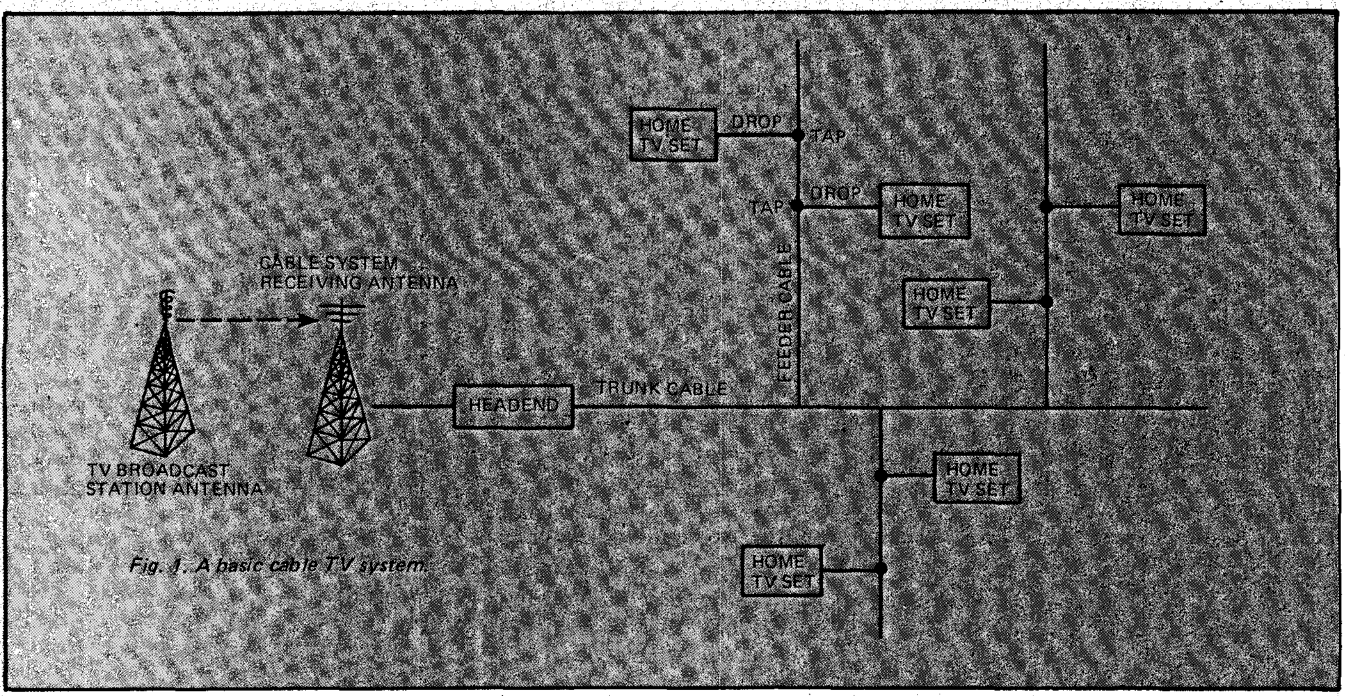


Fig. 1. A basic cable TV system.

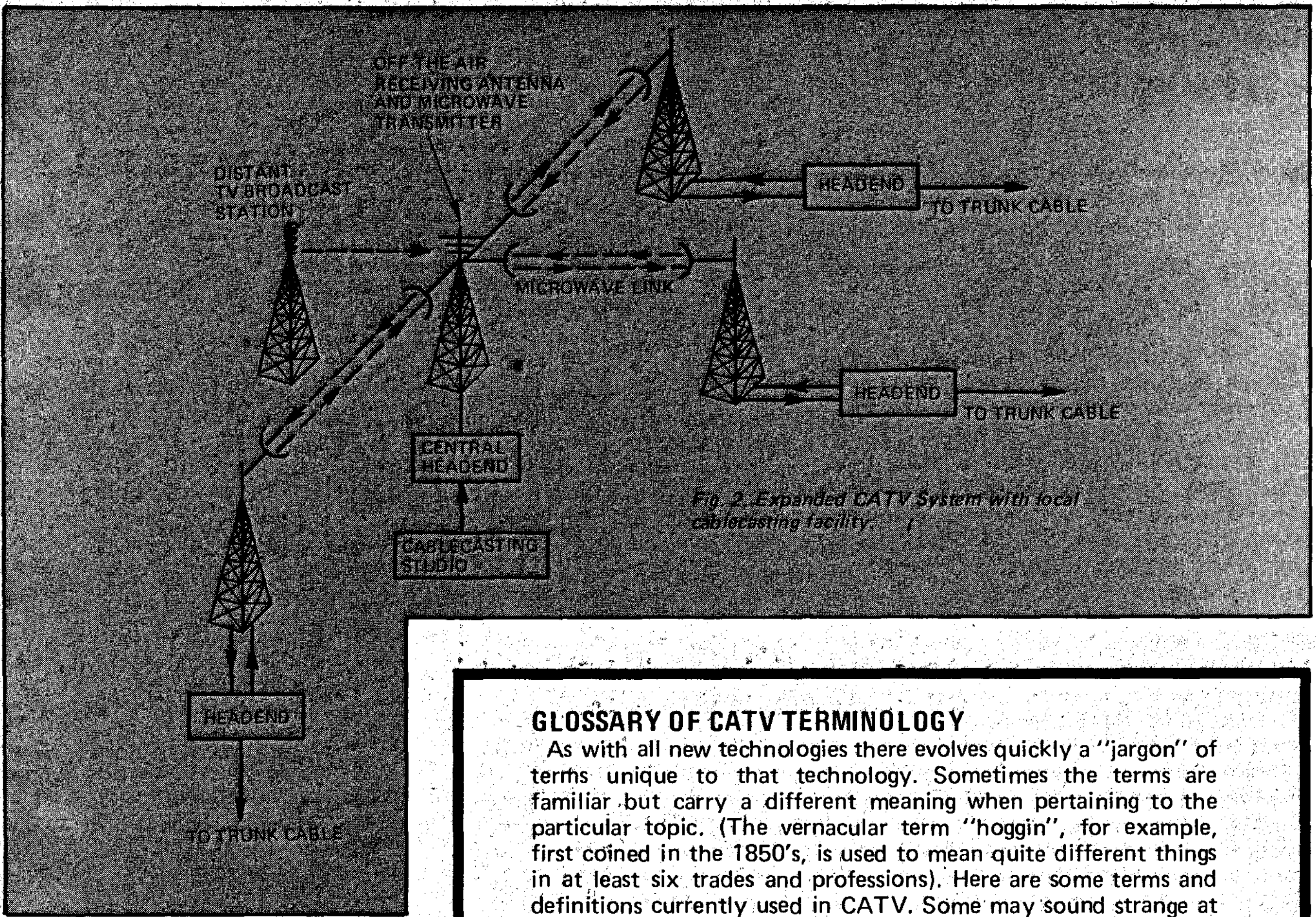


Fig. 2. Expanded CATV System with local cablecasting facility.

degrades the signal quality slightly, and their effect in series is cumulative.

There is a practical limit to the number of amplifiers that can be cascaded before the signal quality becomes unacceptable. Where cable competes with good off-the-air signal, this limit is somewhere in the region of 20 to 30 amplifiers — corresponding to a cable run of about seven to fifteen kilometres from the headend.

When a trunk cable passes a street or other area of high subscriber density, a smaller feeder cable is attached, (usually about one centimetre in diameter). The trunk and the feeder are connected through a "bridging" amplifier which electrically isolates the trunk to that area. Line extender amplifiers are used to boost signals with feeder lines so that more subscribers can be served. Since feeder cable is cheaper than the larger trunk lines, the practice is to maximise the feeder-to-trunk ratio for lowest costs.

A small drop cable brings the signals from the closest feeder line to the home. The drop cable is usually 6.0 to 8.0mm diameter. A coupler or tap connects the drop to the feeder cable.

This coupler presents a low resistance to signals flowing to the subscriber's home but offers high resistance to

GLOSSARY OF CATV TERMINOLOGY

As with all new technologies there evolves quickly a "jargon" of terms unique to that technology. Sometimes the terms are familiar but carry a different meaning when pertaining to the particular topic. (The vernacular term "hoggin", for example, first coined in the 1850's, is used to mean quite different things in at least six trades and professions). Here are some terms and definitions currently used in CATV. Some may sound strange at present, but should become commonplace in the future as the industry expands.

Cablecasting — Sending material originating from the cable operator's own studio facilities. These facilities are usually an appendage to a "headend".

Downstream — Direction of signals when sent from "headend" to subscriber.

Drop — Small cable which carries signal from "feeder" line to home.

Feeder — Secondary cable-spur used to distribute signals from "trunk" to residential streets or other high density subscriber areas.

Guard-Band — Band of frequencies used to separate "up" and "downstream" signals to prevent interference.

Headend — Sub-station, which processes off-the-air signals as well as adding signals of local origin. It then distributes them along the cable system to subscribers.

Home Terminal — The "black box" located in the home which interfaces the subscriber's TV with the "drop cable". Also incorporates selector for picking channels and "charge" facilities where "pay-cable" services available. Will also have a "data entry" terminal when two-way subscriber services become available.

Link — Microwave-link for connecting "headends" with a central off-the-air receiving station.

Pay Cable/Pay TV — Services offered via cable for which subscribers will pay extra charge over and above cable subscription fee.

Round-robin — Unidirectional cable-loop system proposed for two-way communication.

Sub-split/Low-split — Technique of separating "up" and "downstreams" signals on single cable systems.

Tap — Special linkage for connecting "drop" to "feeder" cable.

Trunk — Main distributor cable originating from "headend".

Upstream — Signal direction when subscriber communicates with "headend".

CABLE TV - the wired city

reverse signals. This prevents interference emanating from the subscriber unit from entering the cable network. Special two-way taps are used when interactive communication facilities are required.

At the subscriber's home, the drop cable may connect to a small impedance matching transformer, or more commonly now, to a selector box which incorporates a switch for facilities available on CATV.

In the USA, conventional one-way CATV costs the subscriber about $A40-$A50 per home if most of the construction is above ground. Assuming that 50% of households subscribe for a service, the system's initial construction cost is about $A80 to $A100 per household. Many CATV systems that distribute only broadcast-TV signals have been built for considerably less. Higher percentages of subscribers for a given area also reduce the cost substantially.

Incorporating extra channels for other facilities, including provision for two-way services, requires new technical approaches and undoubtedly will raise the cost of construction of such a system to about $A100 per subscriber. As with the simpler systems, the CATV companies absorb some of this in order to encourage new subscribers who would otherwise be deterred by the initial cost.

A US Department of Commerce study observes that in the USA alone: "Some 50 000 new engineering jobs will be generated over the next five years by the cable TV industry." This seems reasonable, in view of the things that cable TV can do besides entertain. "Technical personnel will be needed not only to instal and service cable systems but also to design auxiliary equipment — two-way TV — home print-outs — new cameras etc."

With the expansion of facilities, more channels are required than the 10 to 15 normally accommodated by a single cable system. Various methods are available for this and some are shown on Fig. 3.

Cable TV system manufacturers have not yet standardised on one system. Until they do it is virtually impossible for TV setmakers to incorporate a "cable compatibility feature" which will reduce the cost of interfacing a set with a cable system.

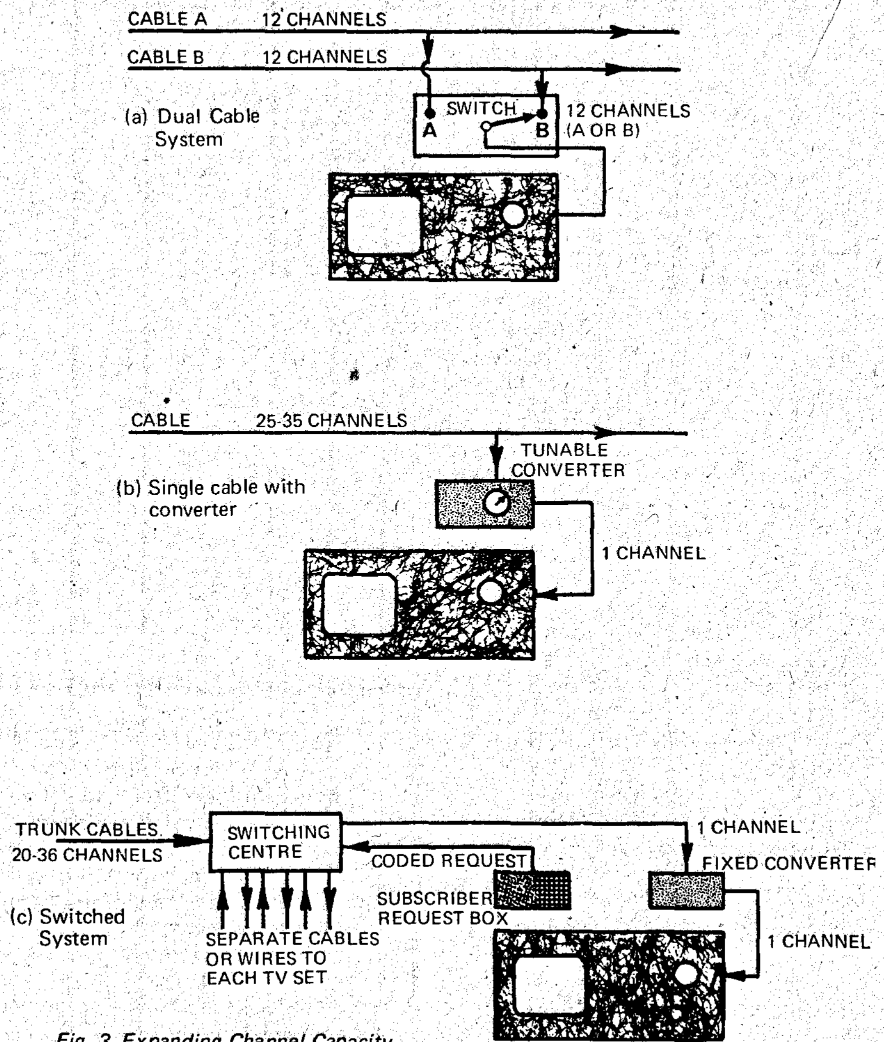


Fig. 3. Expanding Channel Capacity.

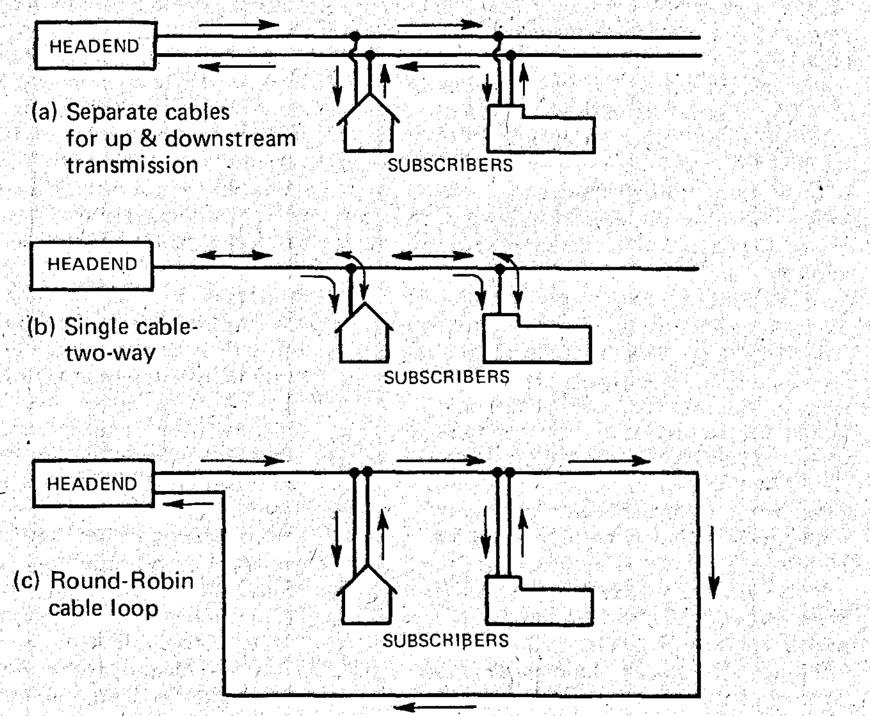


Fig. 4. Three techniques for two-way CATV.

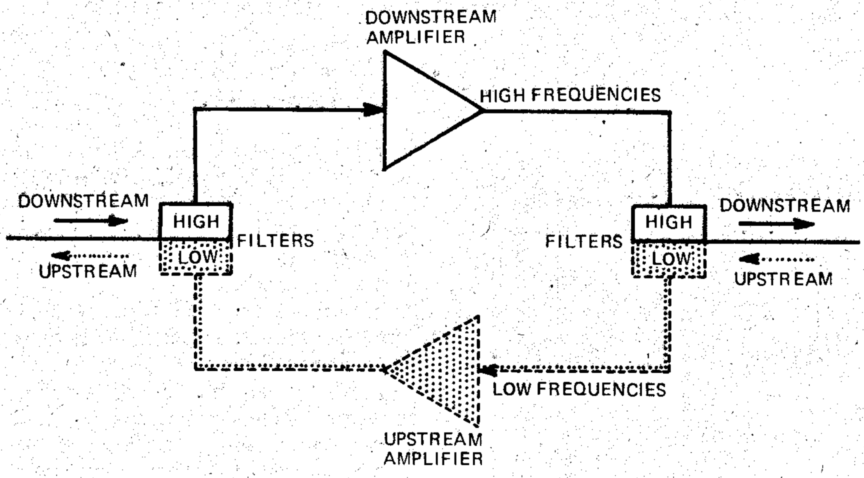


Fig. 5. Two-way amplifier system for a single cable CATV.

In the meanwhile a community's choice is between a dual cable system, a converter system or a hybrid of each.

TWO-WAY – TOMORROW'S CABLE SYSTEMS

Two-way CATV by definition requires a cable system that can transmit information in both directions. The chief technical difficulty today is that each TV set or subscriber terminal introduces some noise into the upstream transmission path, and the cumulative effect from a large number of subscriber terminals may be intolerable. Improved receivers, taps, filters, and other components have to be designed before two-way cable systems can accommodate the tens of thousands of subscribers contemplated in major markets.

Two systems have been considered for two-way technology. The first uses separate cables for up and downstream transmissions. In the second, both up and down signals are sent simultaneously on the single cable but on different frequency carriers (Fig. 4a, 4b).

A third as yet hypothetical approach would be to use a one way round-robin cable loop to bring signals to and from subscriber locations (Fig. 4c).

Having a separate cable for upstream transmission has few technical problems and offers more upstream capacity, but is expensive. An ordinary telephone wire pair used for upstream path would satisfy most communications authorities' requirements for "non-voice return communication", but would provide little capacity for future services.

With a single cable the installation is much cheaper, but actual transmission methods are more complex. A coaxial cable is a good bi-directional carrier medium. The most popular approach is to use the sub-VHF bandwidth below 54 MHz for upstream signals, retaining the 54-300 MHz bandwidth for downstream transmission. This is known as the "sub-split" or "low-split" technique.

Unfortunately amplifiers are unidirectional and require some by-pass path for signals going in the opposite direction. This is done by filtering to separate the frequencies (see Fig. 5). Since the filters are not as sharp as would be desired, a "guard-band" is used to prevent interference.

As a result, designers restrict upstream transmission to a range of 5-30 MHz, rather than 54 MHz. Thus the "sub-split" system limits the upstream bandwidth to about 25 MHz. This allows for not more than four standard TV channels.

PAY-CABLE – A TECHNOLOGY FOR NEW SERVICES

Pay-cable will be the first of the new services offered by most cable systems. Viewers will pay an extra charge to watch first run movies, sports events, theatre productions, and other special programmes.

Pay-TV movies have already proved successful in hotels and motels. New types of terminals will be required, to deny programmes to those who do not want to pay for them, and to record proper charges for those who do.

The simplest technical approach is to send pay-TV programmes on special frequencies – and supply the subscribers with suitable converters. To guard against subscribers from tapping in for free, pay-TV promoters usually code or scramble their signals at the headend. A decoder as well as a converter is then required at the terminal. More elaborate security methods would apply to private channels that only certain subscribers are entitled to receive. Private channels might be needed for police training classes or for assuring privacy for banking transactions in a two-way system.

Methods of charging the subscriber are varied. One suggested system would use a card – purchased in advance – shaped like a plastic credit card. This could be inserted in a special slot in the pay-TV terminal where the magnetically coded card would activate decoder circuits to provide an undistorted picture on the screen.

However whilst satisfactory for such a service this would not be practicable when related say, to "leasing" computer time on a time-sharing facility.

Since a cable system may have such a diversity of functions the major retarding factor for the expansion of the "wired city concept" is the lack of an optimised uniform standard. This is partially due to still outstanding technical problems, politics and inter-company rivalry. Everyone is trying to get on the bandwagon!

There are ever-mounting pressures from both the consumer and manufacturer for the "go-ahead" to adopt a system. Perhaps wisely, government authorities are taking a careful "wait-and-see" attitude.

The system eventually adopted will have to serve the community for at least several decades. Hence, it is essential that it will be a flexible one, catering for the easy assimilation of innovations that have yet to be conceived.

Perhaps the co-axial cable, with its associated problems is not the answer. Fibre-optic transmission lines could be chosen. Their new technology overcomes many of the limitations of existing systems.

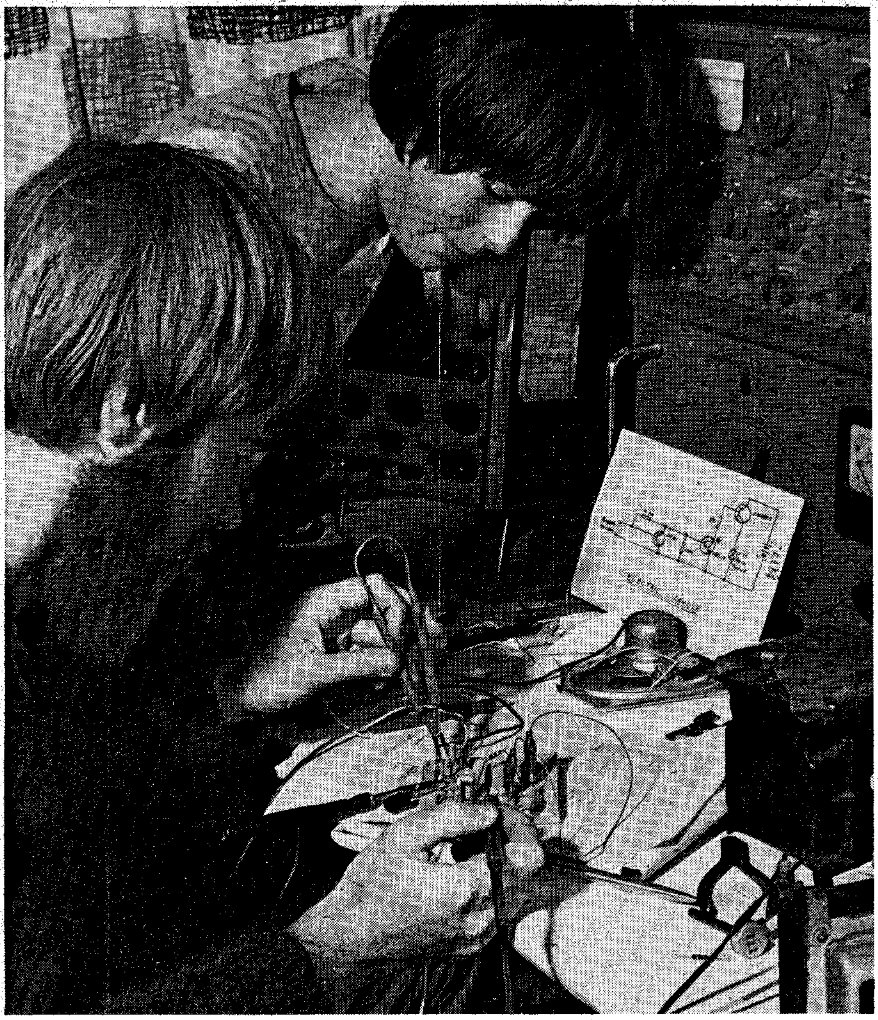
In Australia it was recently announced that an experimental cable system is to be tried out in Canberra. With the imminent introduction of colour TV broadcasting many people, especially in high density urban areas, will find themselves in "impossible" propagation areas. There, for a variety of reasons, reception of colour signals will be totally unsatisfactory.

This will obviously generate pressures for a cable system, or other alternative. Whilst on one hand desirable, it could lead to the introduction of a "premature" system which would offer little more than its primary purpose. It is hoped that interim alternatives such as communal antenna systems, or local re-broadcasting on highly localised UHF/SHF wavelengths might be used until a national standard for CATV comes to fruition. ●

CAMTEC

Eight-day holiday camps provide technology training for young people.

— A.J. Lowe reports



Why doesn't it work? Expert help and adequate test equipment soon solve problems of perverse projects!

EIGHT FULL DAYS of electronic construction; a store bursting with components; benches groaning under a mass of test gear; abundant projects to do; working prototypes to inspire; enthusiastic competent instructors to guide and help; other constructors nearby; a rack overflowing with free second-hand magazines; an amateur radio station to broadcast on; — does that sound like the electronic hobbyists dream?

To a hundred Australian high school students a year it's no dream, but a reality! This reality exists in a series of 'camps' (in buildings not in tents) known as CAMTEC, held each summer holiday at Mount Victoria, N.S.W. Three graded camps each year cater for high school boys in all grades — and girls from 5th and 6th form as well, at the senior camp.

Electronics is only one part of Camtec — photography is another. It's interesting how many people pursue both of these activities, and so Camtec meets their need.

ELECTRONICS

Beginners as well as advanced hobbyists, and those in between, find projects to match their skill and challenge their ambition. At the start of every camp a session is run for those who aren't so sure — and need to improve their touch with a soldering iron, their recognition of components, and their understanding of a multimeter, (in the interests of long life for multimeters as much as anything!).

Once past the preliminaries, campers select their programme. They may choose electronics or photography or a mixture of both. The choice of electronic projects is wide, and ranges from basic circuits such as multivibrator flashers to radio control gear for model planes. Novelties such as the magic electronic candle which lights with a match, and goes out when you blow (damply) on it, appeal to younger lads, while 10 watt amplifiers, and modulated light beam communications provide a challenge for the more experienced. In between are ever-popular sirens of all types — and the louder the better, (a release for aggressive instincts perhaps), model train controllers, reaction timers, proximity relays, slave flash units, intercoms, counters, adders, power supplies, oscillators, radios, mixers, and many more.

One project which grows year by year is a synthesizer. This is expanded effect by effect, and note by note as another astable is added. Being polyphonic it produces acceptable music, although the keyboard is still a simple static printed circuit affair. In addition to music the machine produces very realistic train noises (steam of course), and the crossing-a-bridge effect has to be heard to be believed.

RADIO

For those whose interest is mainly radio, the camp provides instruction for the Youth Radio Scheme exams run by the Wireless Institute of Australia. Each year several lads sit for these exams at camp, and the record of success has been very high. Training for Y.R.S. enthusiasts includes theory as well as practical work, and that moment of great delight — going on the air on the camp's radio station VK2BCT.

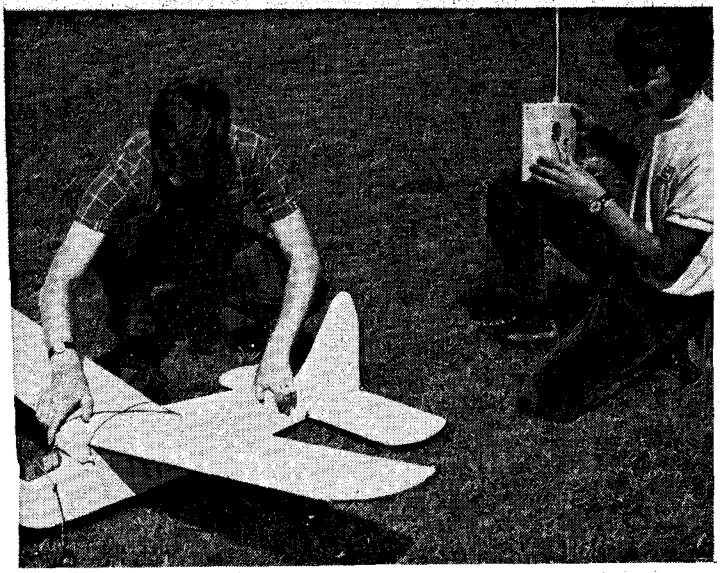
CONSTRUCTION

Construction styles vary from very simple 'bread board' work — using nails in blocks of wood as anchor points, to finished pc boards that no hobbyist would be ashamed to show. When possible, projects are housed in cases and completely labelled and finished. Lads who bring their own projects to camp, including those that won't 'go', get expert help to complete them.

Campers are allowed to take projects home for the cost of parts which, in most cases, could not be recovered anyway.

TESTING

To guarantee success with projects there is available a large amount of high grade test gear — signal generators, oscilloscopes, multimeters, bridges etc. Campers are shown how to



First flight — with newly built R/C equipment.

use this equipment, not simply to 'debug' a circuit, but to test performance of, say, an amplifier, and to see what is actually happening.

HISTORY

Camtec (formerly known as Camp Technology) is the now 10 years old realisation of a dream by a young electronics engineer, Rob Hockley of Sydney. Back in the early sixties he saw the growing enthusiasm for electronics as a boys' hobby, and saw that there was little opportunity for it to be pursued except in isolation — with all the frustration that can entail. He saw that camps existed for those who were crazy about camping, hiking, mountaineering, art, music, sailing — but nothing for those bitten by the electronic bug. Camp Technology was set up to cater for those interests under the auspices of the Inter-Schools Christian Fellowship, a branch of the Scripture Union.

It still is part of the I.S.C.F. range of camps offered to high schoolers each year. Campers and staff have come to Mount Victoria from as far as Melbourne and Brisbane. The staff, without whom of course the camps would be impossible, are firstly convinced Christians, and in addition deeply involved in electronics or photography at a professional or advanced hobby level.

Generous help is given by the universities and technical colleges with the loan of test gear (though the camp is progressively acquiring its own), and by the industry in the provision of components, material, batteries and much more.

FURTHER INFORMATION

Any reader wishing to know more about future camps should write or 'phone Mr. J. Wightman, 10/37 Eddystone Road, Bexley, N.S.W. 2207; 'phone (Sydney) 502-2083. ●

100 watt 144 MHz FM transmitter built and used by CAMTEC people.

FANE

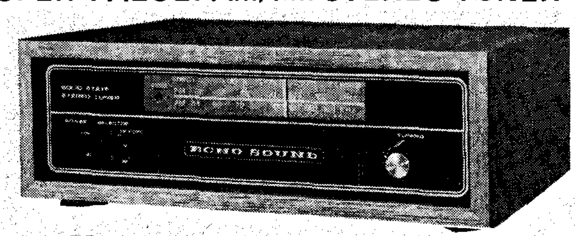
HI-FI BASS LOUDSPEAKERS FROM ENGLAND

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**

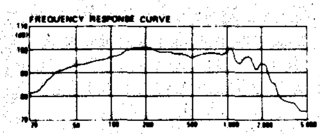
SUPER VALUE! AM/FM STEREO TUNER



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

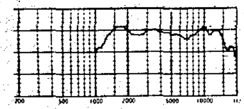
10" 10L-24 WOOFER



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**

1" H-22 DOME TWEETER

FREQUENCY RESPONSE CURVE



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**

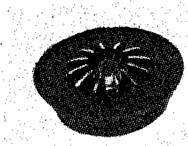
ES801 TONE ARM

$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**

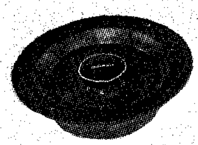
NEW RELEASE HOKUTONE LOUDSPEAKERS

HT-60 1" DOME TWEETER $13.50



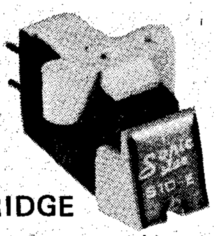
This magnificent unit features a combination of aluminium diaphragm and powerful magnet structure to produce an exceptionally clear non-resonant treble response. Efficiency is very high and dispersion is enhanced by the special acoustic diffuser surrounding the diaphragm.

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.

STAR SONIC S10E CARTRIDGE



The Sonic S10E cartridge is 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 ½" 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**

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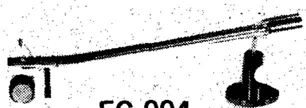

The EC-004 is most effective for removing dust from the path of the stylus whilst the record is being played. The super-fine brush effectively sweeps the grooves clean but does not damage the delicate record surfaces. At the same time a soft, plush covered cylinder treated with anti-static chemicals 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 **$4.50**

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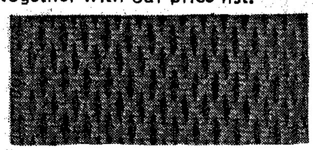

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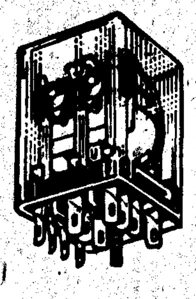

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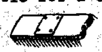

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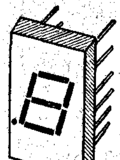

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A 7490 decade counter IC is used to give typical count rates of up to thirty MHz. A 7475 is used to store the BCD information during the counting period to ensure a non-blinking display. Stored BCD data from the 7475 is decoded using a 7447 seven-segment decoder driver. The 7447 accomplishes blanking of leading edge zeroes, and has a lamp test input which causes all seven segments of the display tube to light.

Kit includes a two-sided (with plated through holes) fibreglass printed circuit board, three IC's, DR-2010 (with decimal point) display tube, and enough Molex socket pins for the IC's.

Circuit board is .8" wide and 4 3/8" long. A single 5-volt power source powers both the IC's and the display tube.

CD-2 Kit Complete Only $10.95
Assembled and Tested $13.00
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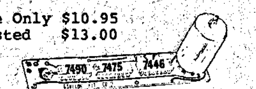
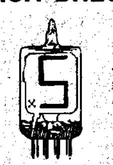


RCA DR2010 NUMITRON



RCA DR2010 Numitron digital display tube. This incandescent five-volt seven-segment device provides a .6" high numeral which can be seen at a distance of 30 feet. The tube has a standard nine-pin base (solderable) and a left-hand decimal point. Each $4.00

SPECIAL 4 for $17.50

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This kit is similar to the CD-2 except for the following:

a. Does not include the 7475 quad latch storage feature.
b. Board is the same width but is 1" shorter.
c. Five additional passive components are provided, which permit the user to program the count to any number from two to ten. Two kits may be interconnected to count to any number 2-99, three kits 2-999, etc.
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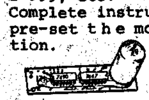

CD-3 Board Only $2.25
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ELECTRONICS -it's easy! PART 12

The operational amplifier — basic principles

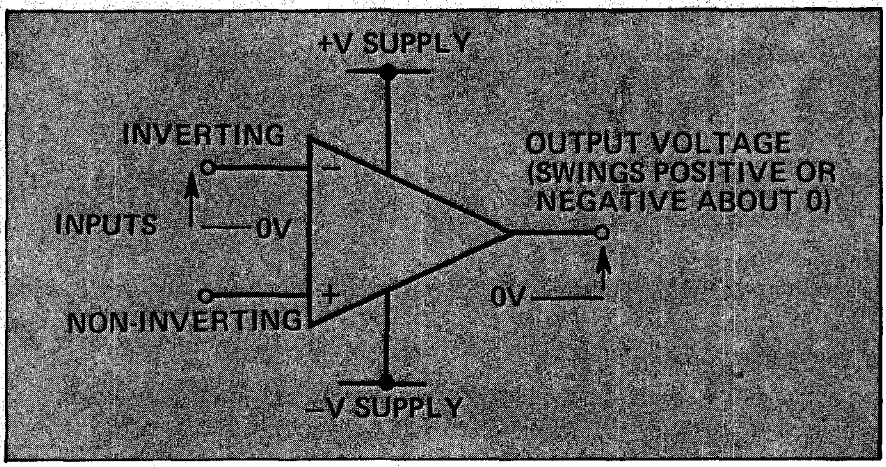


Fig. 1. The basic symbol and connections for an operational amplifier.

IN THE TWO previous sections we explored the role of basic amplifier circuits and investigated how adding extra passive components converts the basic active device into a practical amplifier building block.

These days the cheapest and most straightforward method of amplifying signals is to use one of the many, readily available integrated-circuit operational amplifiers (the op-amp). The methods of using op-amps are universal even though various types may differ in details such as stability and cost etc.

We will see that, provided the basic operational amplifier has a dc gain of 10 000 or more, and draws very little input current, the internal design is of little consequence.

The operation of the complete amplifier system (whether it be based on transistors, ICs or even valves) is determined primarily by the way components are connected around it. That is the basic op-amp unit can be made to perform literally hundreds of different functions by adding appropriate external circuitry. It is this extreme degree of versatility, plus the extraordinarily low price of IC devices that make op-amp techniques so attractive.

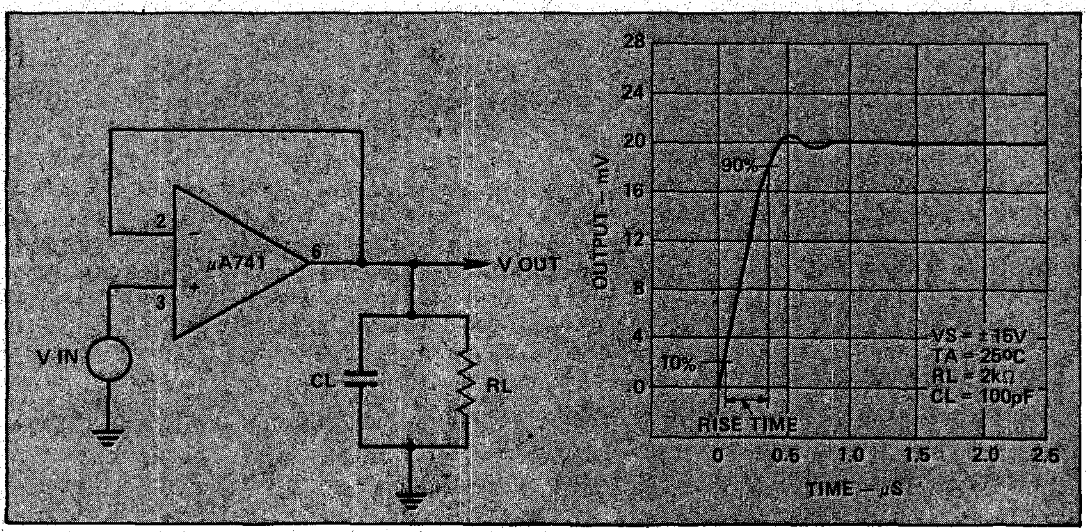
Before we move on to see how such versatility is achieved, we must study the terms used to describe the characteristics and performance of operational amplifiers.

LINEAR VERSUS DIGITAL

We have already described how a transistor stage may be used to amplify, with low distortion, continuously varying voltage or current signals. Circuits that perform this way — they increase the level of complex waveforms without changing them in any other way — are said to be LINEAR systems. By contrast, it is also possible to use the same basic active element so that it is either fully 'on' or fully 'off', depending on whether the input signal is above or below a preset level. The device actually moves through the linear region so quickly that it is no longer a linear device but a switch. There are many kinds of switching circuits and the entire range of such devices and circuits is loosely classified as DIGITAL (digital meaning ON/OFF or step by step operation). Digital devices and circuitry will be studied in more detail later in this course.

Integrated circuits, therefore, are catalogued by the makers as either linear or digital devices. The op-amp

Fig. 2. Transient response of a 741 type op-amp to a step input change. The test is performed using the circuit shown at left — basically a voltage follower circuit.



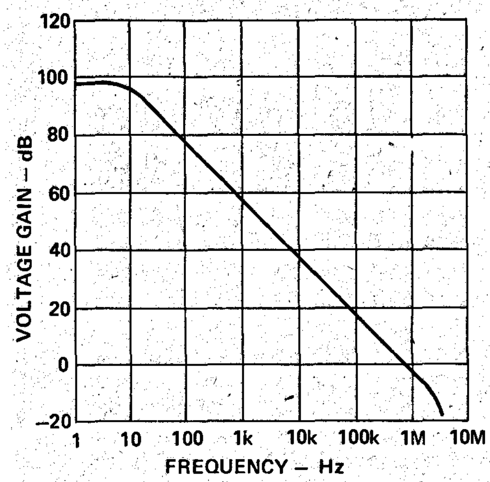


Fig. 3. The open loop (no feedback) frequency response of a 741 op-amp. The constant roll off of 6 dB/octave is built in to ensure stability.

selection form a sub-group of the linear range — others being voltage regulators, oscillators and special purpose units such as timing circuits. It is worth knowing that it is often possible to make a linear circuit perform a digital function but usually the reverse does not hold. In principle at least, the op-amp can be made to fulfill just about all signal processing black-box requirements but to conserve space and power, and to keep costs down, it is usually better to use special-purpose ICs for many applications. Selecting the right component is largely a matter of comparing the cost of various alternatives for the particular job. It may well be better to use a modified op-amp, or even a discrete circuit, to fill a special task rather than await delivery of an exactly right, but harder to procure, special IC.

COMMON LINEAR TERMS

These terms tie in with the general schematic for an op-amp, given in Fig 1. The amplifier itself does not necessarily require a zero/volt connection, it amplifies the *difference* between voltages at the two input terminals.

Large Signal Voltage Gain

This is the ratio of the maximum output voltage swing (under appropriate loading conditions) to the change in input required to drive the output from zero to this voltage. A typical value of gain is 200 000 with an output swing of ±10 V. The input change, therefore, needed to provide full output swing is a mere 50μV. This may seem alarmingly small — a copper to solder terminal connection (forming a thermocouple) will generate signals of the order of 5 to 10μV with small temperature changes! In practice, however, it is rare to use the full gain capability. Gains approaching infinity are necessary, however, so that the performance of the amplifier is entirely dependant on the input and feedback networks — not on the device itself.

Input Offset Voltage

A differential voltage of only 50 microvolts is necessary to provide full output swing. However due to manufacturing tolerances the matching of the input transistors may not be exact and a small offset voltage may be required at the input to balance the amplifier under no-signal conditions.

This voltage is normally less than 6 mV, but could be troublesome in a low level dc amplifiers. Therefore provision is made on most op amps for connecting a potentiometer to null out this voltage, thus making the output zero under no-signal conditions.

Input Bias Current

All operational amplifiers (and also transistor amplifiers) require a small steady-state input current called the input bias current.

Input Offset Current

The difference between the two bias currents in a differential op amp is known as the input-offset current, and is specified at a particular temperature. With equal resistances in series with the two input terminals, it is only this difference in bias currents which produces an offset error. When the input source impedances are high the effect of input-offset voltage is far less than that of bias and off-set currents.

A typical value of input offset current would be 50 nanoamps (50 x 10^{-9} amps), but may be much lower in more expensive op-amps.

Input Resistance

With one of the two inputs grounded, the input resistance is that seen looking into the other input. A general purpose op-amp exhibits around 0.5 megohm input resistance. Some better quality amps go higher and the ideal, as we shall see later, is an infinite input resistance.

Feedback, when applied, modifies this value considerably, may reduce it to zero (inverting amp) such that the input impedance is the value of the resistance in series with the input, or may increase it to several megohms (non-inverting amplifier).

Output Voltage Swing

This tells us how far the output voltage can change in both positive and negative directions. It will always be a little less than the supply voltage. For a supply of ±15 V a typical swing (without distortion occuring) would

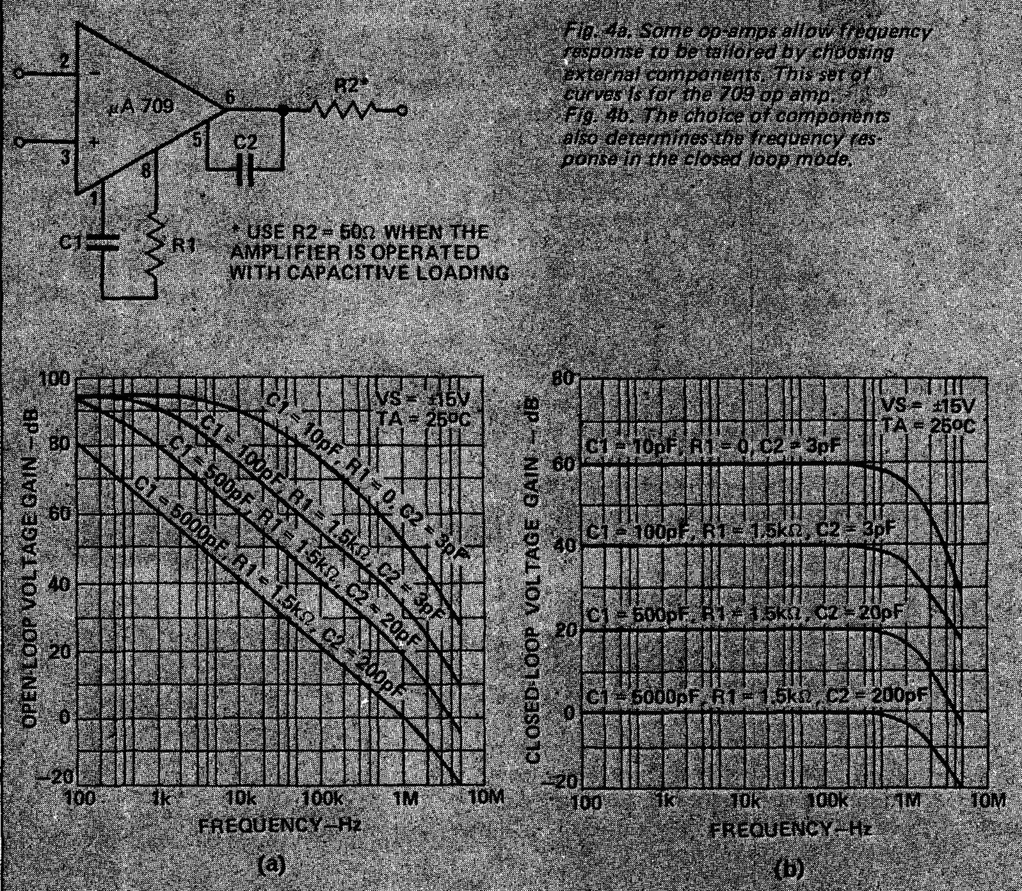


Fig. 4a. Some op-amps allow frequency response to be tailored by choosing external components. This set of curves is for the 709 op amp.
Fig. 4b. The choice of components also determines the frequency response in the closed loop mode.

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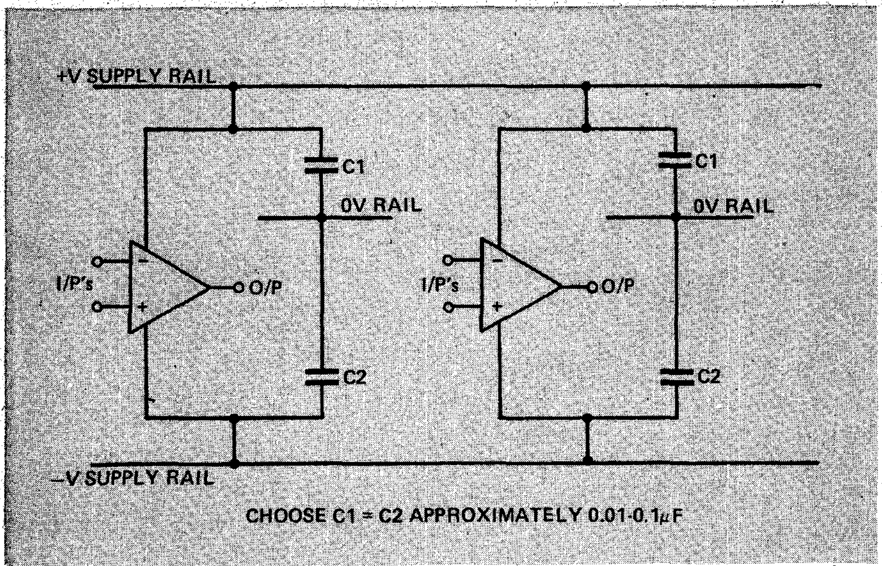


Fig. 5. Each op-amp should have decoupling capacitors across power supply lines to ensure that transients are not coupled from one amplifier to the other through the power rails.

be ±12 to ±14 V. Op-amps work satisfactorily over a wide range of supply voltages — voltages less than the maximum specified may be used.

Input Voltage Swing

This value must not be exceeded if the amplifier is not to be damaged. In most modern op-amps, such as the LM301, 741, etc, the inputs can be taken to the supply rail together and in some amplifiers may be taken to opposite supply rails (that is, 30 volts between them) without damage. However some older types such as the 709 may only withstand a common mode voltage of ±8 volts and a maximum differential voltage of ±5 volts.

Input common mode rejection ratio

This is the ratio of the input voltage range, to the maximum change in input offset voltage over this range. It is quoted in decibels being typically 80-90 dB i.e. if the inputs are moved by 10 V the offset voltage could change by 1 mV.

Output resistance

A typical value of output resistance measured into the output terminal with the output near zero volts) is around 100 ohms. This measurement is made with a small signal level and at approximately 400 Hz to avoid dc drift problems. This however is the open loop (no feedback) output impedance and is substantially reduced when feedback is applied. The maximum load which can be connected to an operational amplifier is not determined by the output impedance but by the current that the op-amp can supply (typically 10 mA).

Output power

The normal op-amp is usually designed for low power output only. If power is required a power stage of discrete transistors (or special power ICs) is added after the op-amp.

Supply Voltage Rejection Ratio

This relates the change in input offset voltage to the corresponding change in supply voltage producing it. It expresses how well the circuit ignores voltage supply variations due to mains fluctuations etc.

Typical values lie around 100 µV change per volt of supply change. In critical dc amplifiers the power supply, therefore, must be stabilised (that is, the voltage must not change with respect to zero). For example, if the design can tolerate only 10µV change in input offset voltage the supply must be stable to within 100 mV of its magnitude.

However for general applications rejection of supply voltage changes is sufficiently good that close regulation is not required.

Power consumption

Even when an op-amp is not providing an output, that is when the output voltage is at zero, the circuit still consumes power. This value is usually quoted for zero output conditions (the greatest internal power loss across them) and is in the region of 100 mW.

Peak output current

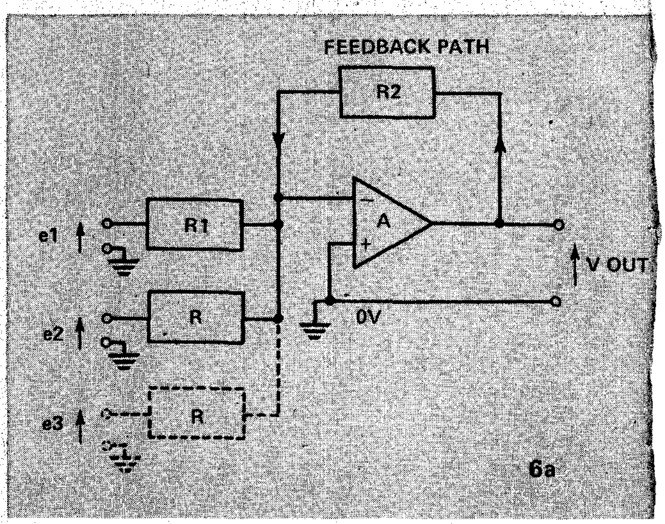
The output current must not exceed the stated value or internal permanent damage which may occur. Many designs, however, now incorporate protective circuitry that enables the output to be short-circuited without damage.

Dynamic response of operational amplifiers

A dc amplifier, by definition, apparently has no need to handle fast changing signals. In fact, it is quite normal for it to need a good frequency response extending to tens of megahertz. Examples of this are the wide band ac amplifier having a response down to dc and a dc amplifier which will faithfully reproduce a sudden voltage change in a control system. In such cases the system designer needs to know more than just the dc large-signal gain of the op-amp — he needs to know the gain at all frequencies.

The response of the op-amp to a step input voltage is called its transient

Fig. 6a. General circuit configuration for an inverting amplifier.
Fig. 6b. General circuit configuration for a non-inverting amplifier.



response. That is, this parameter defines how the output of the op-amp will follow an input change with time under closed-loop (with feedback) conditions. The usual way that this is quoted is by an amplitude/time graph — as given in Fig. 2 — which shows how the output changes when a 'perfect' step-rise in input voltage is applied. Note also that the diagram indicates the load resistance value, the capacitance of the load, the supply voltage and the device temperature: each of these will alter the shape.

A second dynamic characteristic is the frequency response. Figure 3 shows a typical response curve (note that such curves vary greatly with different amplifiers) for an op-amp without feedback (called open-loop operation). In general such curves always have the same basic shape; flat to begin with and then falling off at the same rate of 6 dB per octave (20 dB decade). There is a good reason for such a characteristic — it ensures stability in closed-loop working.

If the slope were increased the amplifier could introduce excessive phase shift. Thus the feedback could become positive rather than negative and the amplifier may oscillate. Some op-amps have facilities for the circuit designer to provide external compensation to the IC. This usually consists of an RC network or a single capacitor, the values being selected to suit the application. Figure 4 show how these values alter the frequency response of the popular 709 type of op-amp.

A third important dynamic term is Slewing Rate. A typical value is stated at 0.5 V/μs, meaning that the output can change no faster than half a volt in each microsecond. The value is quoted for a feedback connection of unity gain — at other values of gain the rate will be different. Thus although the amplifier may well handle a small signal at a given frequency a large

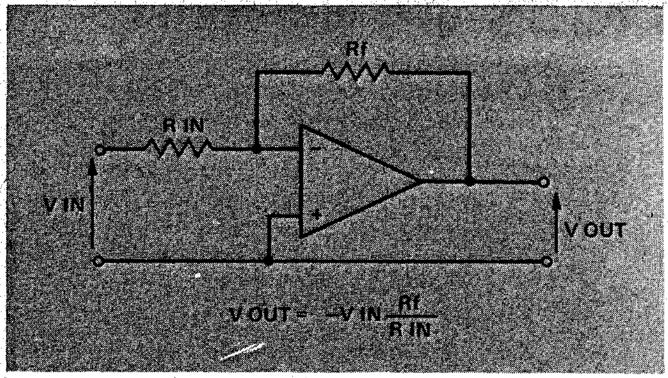


Fig. 7. In this configuration the stage gain is determined by the ratio of Rf to Rin — not by the device gain.

signal at the same frequency may well be distorted because of the slew-rate limitation.

The above terms are those commonly encountered. Other more obvious parameters are given — temperature range of operation, and lead temperature when soldering. The manufacturers of ICs also give a variety of curves for various parameters — voltage gain versus supply voltage, power dissipation versus temperature and many more. These are all helpful from time to time but, in general, the casual user will not need to explore them in depth.

THE MAGIC OF FEEDBACK

The basic op-amp will only accept very small input signals because of its enormous gain. At first sight this seems to be a peculiar way to go about things for surely the optimum would be to design the internal circuitry to give the gain needed and no more. We will soon see that there is a better, and more versatile way of obtaining any required gain (by adding a simple network to the amplifier). For this concept to work correctly, the amplifier must have a very high gain.

The two basic amplifier circuits are illustrated in Fig 6. The circuit of Fig 6a is an inverting amplifier and that of Fig 6b a non-inverting amplifier.

For the purposes of our discussion we must assume that the amplifier has an infinite input resistance and infinite gain. The input signal (in Fig 6a) is applied via R1 and the output is fed back to the input via R2.

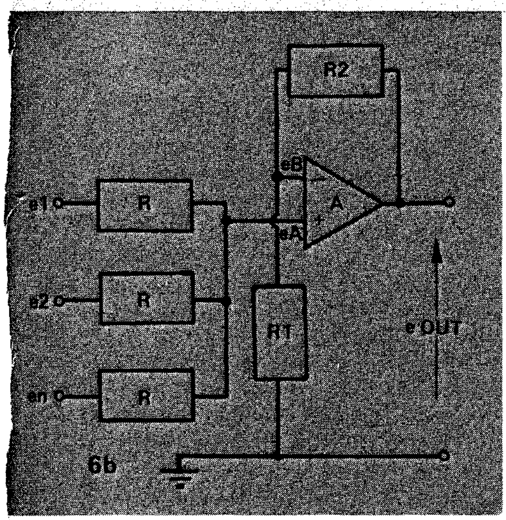
Thus, as the ideal amplifier draws no current, the current in R1 is

$$I_{R1} = \frac{e1}{R1}$$

and the current in $I_{R2} = \frac{eo}{R2}$

A theorem not yet covered (called Kirchoff's Laws) states that the sum of the currents at any point in a circuit must be zero. Therefore $I_{R2} = I_{R1}$

By Ohm's Law: $\frac{e1}{R1} = \frac{eo}{R2}$



Now the gain $A = \frac{eo}{e1}$

$$\therefore \quad A = \frac{R2}{R1}$$

How convenient! The gain of the amplifier may be set by adjusting the ratio of R2 to R1. In a practical amplifier there is some error because the input impedance is not zero and the gain is not infinite. But providing the amplifier open-loop gain is in excess of 10 000 the error may be disregarded.

For the non-inverting configuration it may be shown that the gain is

$$A = 1 + \frac{R2}{R1}$$

Hence it may be seen that any reasonable gain may be programmed by simply selecting two resistors, and that drastic changes in device open-loop gain will have little effect on the closed-loop gain.

The open-loop gain should be at least 10 dB higher than the closed-loop gain at all working frequencies to maintain frequency response of the amplifier within 3 dB. (See graph of open-loop gain versus frequency.)

The effects of using feedback are as follows:—

Inverting Amplifier

Output impedance is reduced by the loop gain. That is, if the amplifier has a gain of 10 and the output resistance is 150 ohms, the closed loop output impedance falls to 15 ohms.

As the amplifier always tries to keep its input terminal at zero the input impedance is equal to the value of R1.

Distortion is reduced by feedback by I/A.

Common mode rejection is improved and the stability is improved.

Non Inverting Amplifier

Output impedance is reduced by the loop gain.

Input impedance is increased by the loop gain, (but is limited by common mode impedance and resistances connected between non-inverting input and ground.

ELECTRONICS -it's easy!

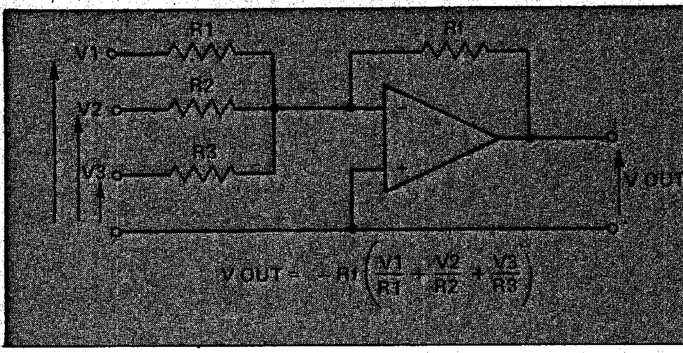


Fig. 8. If extra input resistors are added the amplifier sums the input voltages and amplifies them by the respective resistor ratios.

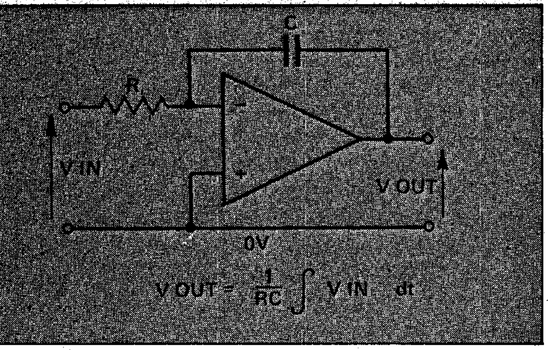


Fig. 9. To make an op-amp integrator we simply replace the feedback resistor with a capacitor. The gain of the stage is then determined by R and C.

Distortion is again reduced by I/A.

Common mode rejection is not good with this configuration, the amplifier is less stable than the inverting mode and the gain can never be less than unity.

INVERTING ADDER

The fact that currents are effectively summed at the inverting input terminal may be exploited as shown in Fig. 6a. The input signal voltages are summed by using a separate input resistor for each signal. The input signals are effectively isolated from each other as the summing point acts like a virtual earth.

Thus the output will be:—

$$e0 = -R2\left[\frac{e1}{R1} + \frac{e2}{R2} + \cdots \frac{en}{Rn}\right]$$

That is the output is the sum of the input voltages, each being amplified by the ratio of the feedback resistor to the individual input resistor. This simple circuit finds great use in audio mixers etc.

USING OP-AMPS TO DO ARITHMETIC

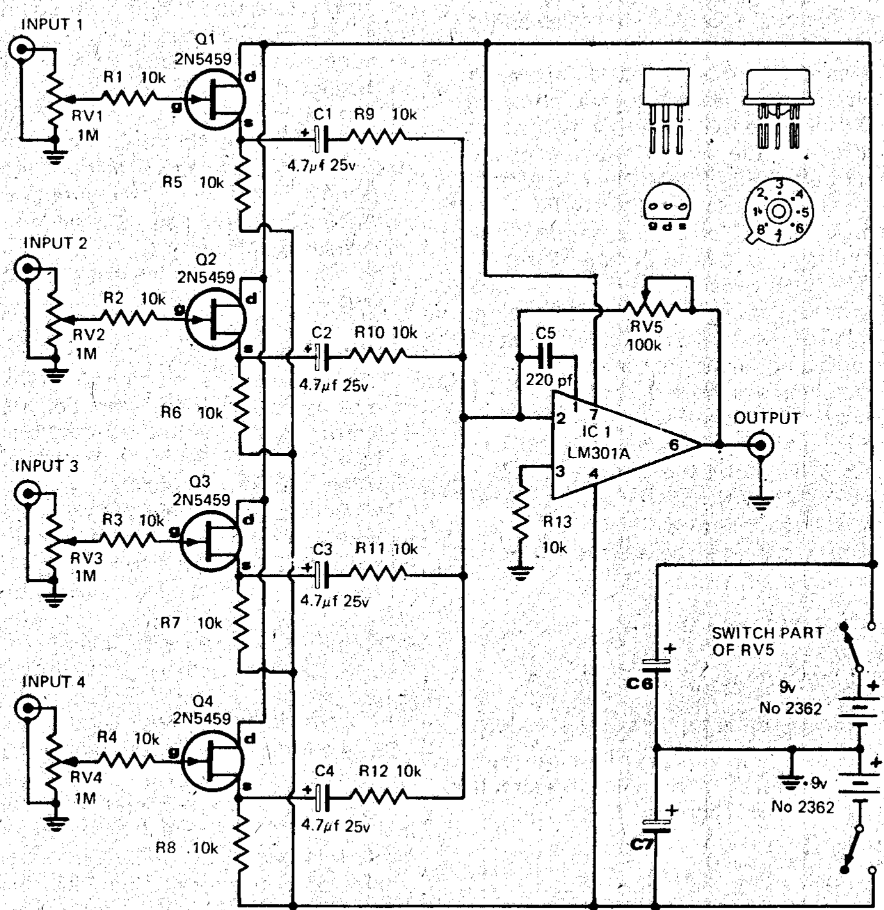
The simple summing circuit described may be used to do arithmetic. For example assume we needed to continuously solve the problem X = A+2B. We could simply apply a voltage proportional to A through an input resistor of 10 k to an amplifier having a feedback resistor of 10 k. The second input voltage proportional to B is applied through a resistor of 5 k. Thus the amplifier has unity gain to A and multiplies B by 2. These voltages are summed to provide our required function of 'X'. This is the basis of analogue computers. Analogue computers consist mainly of a group of operational amplifiers configured to solve a particular mathematical expression.

Other mathematical functions are also easily achieved. Subtraction is done by putting the input to be subtracted through a unity gain inverter before summing.

INTEGRATION WITH AN OP-AMP

In many electronic instrumentation circuits there is need to integrate a signal with respect to time. For example there may be a call for a time delay having a precise timing interval. The integrator circuit uses a feedback impedance that is a capacitor — not a resistor. (The theory still holds when the impedances are of any type — R, L or C or even mixtures; it is the mathematical manipulation that becomes difficult.) It can be shown that the circuit given in Fig 9 has the following output to input relationship.

Fig. 10. This audio mixer accepts four input signals and combines them. Variable gain is provided by RV5. The circuit is basically a summing op-amp.



$$V_{out} = \frac{1}{RC} \int V_{in}\, dt$$

($\int$ integration symbol)

The formula tells us that the output voltage is the true undistorted integral of the input signal with respect to time and that the value of R and C decide the gain of the stage.

The integrating op-amp circuit finds use as a ramp generator, as a basis of repetitive signal generation and is invaluable in solving mathematical equations in the analogue computer.

Although only one input resistance is used here it is quite feasible to use a number of input branches to combine summing with integration.

The above circuits, based on op-amps with feedback, provide just a few of the many arithmetical operations that can be obtained.

Combinations of different op-amp circuits can perform multiplication, division, squaring and square root functions, and solve simultaneous and differential equations. In normal electronic practice such op-amp circuits are used to provide accurate signal processing at low cost. Indeed, in many instances it is preferable to use analogue computational circuits in preference to digital methods — each case must be decided upon its merits in terms of cost, size, speed and versatility.

With these principles in mind it is relatively easy to untangle what is happening in a seemingly complicated circuit like that given in Fig. 10.

This is a four-input mixer (ETI project 401). In this case the four inputs are amplified by field-effect transistors then ac coupled by capacitors and 10 k resistors to the inverting input of the op-amp which is connected as an adder. The second input is earthed via a resistor of similar value to the input resistors as this aids stability. The 100 k feedback potentiometer, RV5, provides variable gain — volume control, therefore, by adjusting the Rf value to change the combined gain. A 220 pF capacitor is needed to adjust the performance of the op-amp as dictated by the maker — it is not part of the summing circuit proper.

Figure 11 illustrates one way of using an op-amp integrator. The gain of the stage is 1/RC = 1/10k 100µF = 1. Note again that the positive input is earthed via a 10 k resistor. When an input is applied the output rises linearly with time and could keep going until the maximum available voltage is reached. Before this occurs the switch is closed, discharging the 100µF via the 100 ohm resistor. The result is a ramp signal that restarts its climb when the switch is operated and released. The switch may of course be an electronic one and such circuits are used to obtain sawtooth waveforms which are useful for a wide variety of applications.

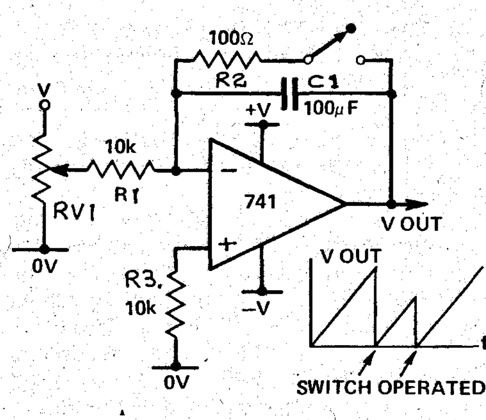


Fig. 11. The integrator may be used to generate sawtooth waveforms.

THE LIBRARY

If you have not already obtained a good set of application notes on the many uses of op-amps now is the time to act for they will prove invaluable when building your own systems.

It matters little whose notes are obtained. The basic op-amp circuits have remained reasonably stable for several years now. Perhaps the only point to consider is to ensure that the op-amp specified is both available and an inexpensive choice.

ELECTRONICS – in practice

INTEGRATED circuits (whether linear or digital) are produced in a variety of packages (illustrated in Fig.12). The methods of mounting are different for each form and the beginner would be wise to restrict himself to dual-in-line, TO5 or TO99 versions. Care should also be taken not to overheat the devices when soldering.

Mounting sockets are available for around 40 cents each and these are invaluable for the experimenter — allowing an IC to be used many times without damage. However even at 40 cents the sockets are dear when compared to current IC prices of around one dollar. So a socket may not always be a justifiable expense.

An alternative is to mount the IC on a small piece of matrix board and wire in leads for input, output and power connections. This provides robust connections by which the amplifier may be wired into experimental circuits again and again without damage.

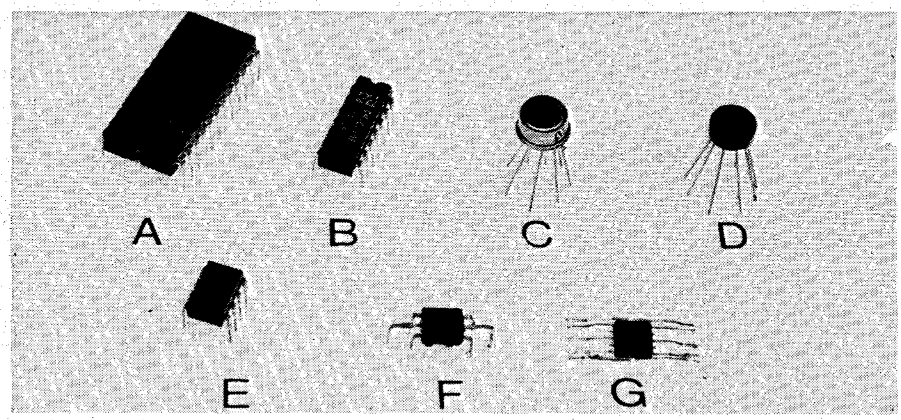


Fig.12. Typical integrated circuit packages. (a) 24 pin dual-in-line. (b) 14 pin dual-in-line. (c) TO5 metal can. (d) TO105 plastic. (e) 8-pin dual-in-line. (f) case 643A (used for low price consumer devices) (g) TO86 flat pack.

A MULTI-PURPOSE AMPLIFIER

An operational amplifier is an ideal amplifier for experimental use. It enables a wide range of gains (or attenuation in the inverting mode) to be obtained and is hence very useful in the experimenter's workshop.

It is surprising how often a little extra gain or attenuation is needed when experimenting with electronic circuitry. Often the need is temporary, in order to establish what gain is required in a particular circuit. Once this has been established the unit is replaced with the simplest stage that will do the job — e.g. a single transistor.

This project provides such a general purpose amplifier having a gain adjustable from 0.1 to 100, and with a choice of inverting or non-inverting operation.

The circuit given in Fig 13 is based on a Fairchild application note and uses the currently cheapest op amp, the 709 series. As power drain is low two dry cells may be used thus avoiding the expense of a mains power supply.

To obtain non-inverting or inverting operation, a changeover switch has been included to ground the appropriate input to the op amp. Components C1, R4 and C2 have been chosen to obtain the maximum bandwidth of 0.5 MHz.

The output impedance of the unit is less than an ohm but the peak output current should not exceed 20mA. The power dissipation of the amplifier must not exceed 250 mW so even 20mA may be too much under some circumstances.

The input impedance in the inverting mode is the value of R1. Hence if a higher input impedance is required then R1 should be increased. Note that R2, R3 and RV1 must also be increased proportionately to maintain the gain ratios.

Do not use values in excess of 10 megohm as stray capacity and leakage resistances will then affect stability and accuracy.

CONSTRUCTION

The form of construction is largely a matter of individual preference. We suggest that a small diecast box be used. By mounting the switches and potentiometers through the bottom of the box (rather than onto the lid) the lid may be removed for access.

The gain control should be marked by experimentally verifying gains at various positions of the control. A multimeter may be used to compare input and output, to determine gain, but use a low frequency (e.g. 400 Hz) from a low impedance source, so that the accuracy of the multimeter itself does not affect results.

USING THE AMPLIFIER

Basically the unit is a single-input, variable-gain dc amplifier. We have seen in the theory section however that it can be used for other purposes.

To use the unit for amplifying ac, use a capacitor in series with the input to isolate any dc component of the previous circuit. Make sure that the reactance of the capacitor is less than the value of R1 at the lowest frequency of interest.

To mix signals, simply add additional 10k resistors from each input to the summing point (pin 2).

An integrator may be constructed by replacing R2 and RV1 with a capacitor.

Thus, as well as being a useful tool, the amplifier may be used to increase your understanding of op amp techniques.

A major feature article on operational amplifiers will be published in ETI next month.

There will also be a special reader's offer — two LM380 op-amp IC's for less than the normal cost of one!

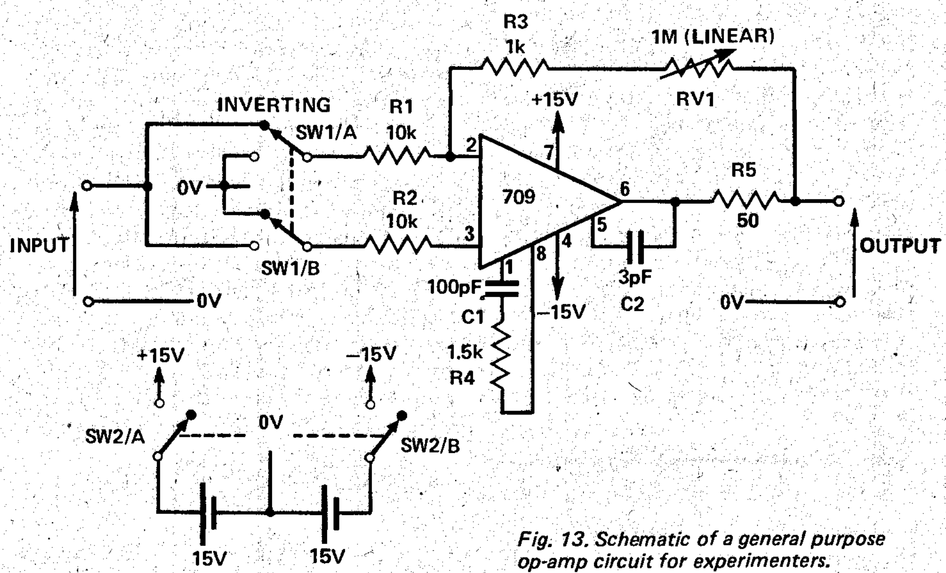


Fig. 13. Schematic of a general purpose op-amp circuit for experimenters.

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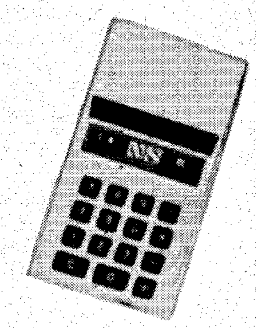

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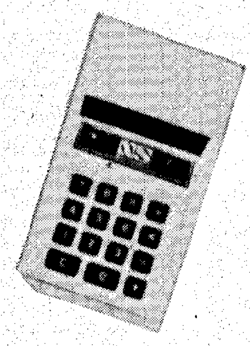

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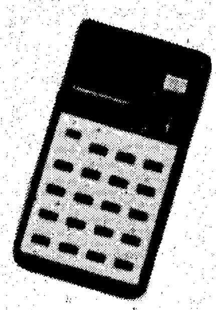

- Add, subtract, multiply & divide
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- Weight: 180g approx. (batteries incl.)

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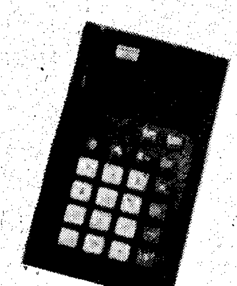

- Add, subtract, multiply & divide
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- Percent Key
- Automatic constants
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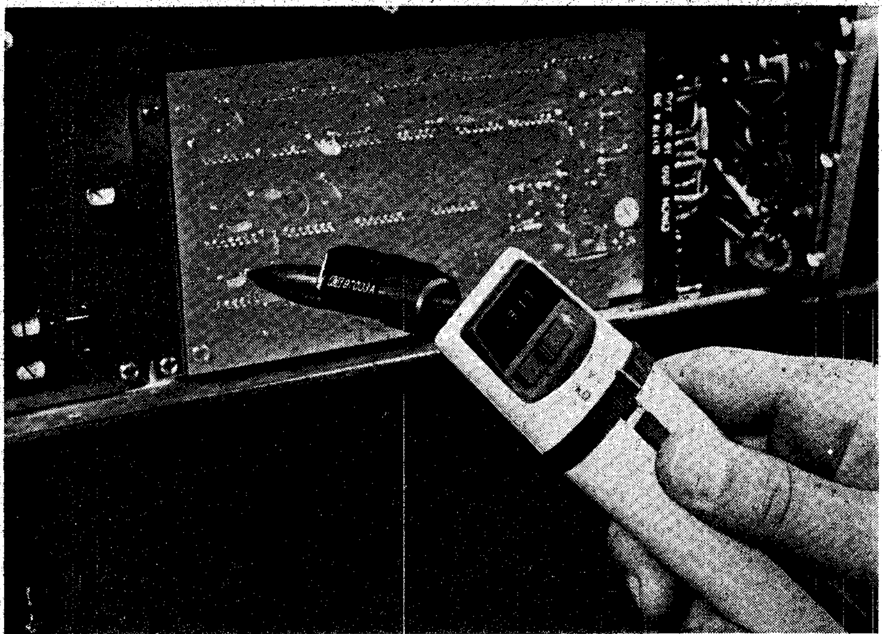
EQUIPMENT NEWS

RF PROBE FOR H-P MULTIMETER



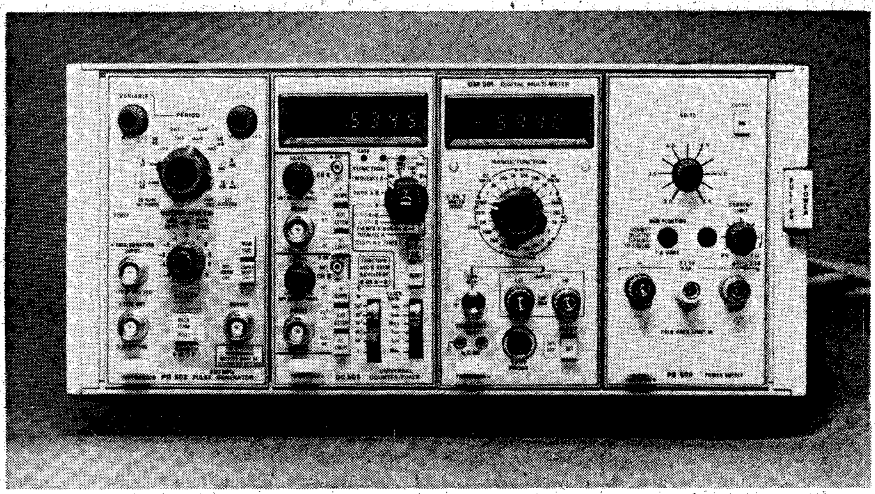
A new rf probe adds 100 kHz to 500 MHz ac measurement range to Hewlett-Packard's Model 970A Digital Multimeter. Accuracy within this frequency range is claimed to be greater than 1 dB. Voltages from 0.25 to 30 volts full scale are measured with this new model 97003A RF Adapter. Maximum ac input is 30 volts rms plus 200 volts dc.

The basic, pocket-sized 3½ digit multimeter measures ac and dc volts and ohms. Its ac voltage range is from 100 microvolts to 500 volts, 45 Hz to 3.5 kHz. Input resistance on the ac range is 10 megohms. The Model 97003A extends the usefulness of the multimeter into the rf region. Input resistance of the adapter is greater than 25 000 ohms, shunted by less than 4 picofarads.

The Model 97003A is a peak detector calibrated to read the rms value of a sine wave input. It converts the ac input into a dc voltage. Thus, the 970A must be set to dc volts when the rf adapter is used. No other adjustments are necessary since the Model 9700A is fully autoranging with autopolarity.

Further details: Hewlett-Packard Australia Pty Ltd, 31-41 Joseph St, Blackburn, Vic. 3130.

TM 500 DIGITAL-LOGIC HIGH PERFORMANCE PACKAGE



Conceived with the digital integrated circuit designer and user in mind, the Tektronix TM 500 Digital-Logic High Performance Package is composed of three specially selected test and measurement modules and a power supply which plugs into a new, high-current power mainframe. The measurement modules are a pulse generator, digital voltmeter and a digital counter. The power supply is a new module with output voltagea and currents tailored to IC requirements. These plug-ins are part of the Tektronix TM 500 series of modular test and measurement instruments. This expanding line of more than 30 plug-in modules and power mainframes can be combined in various configurations to meet a wide variety of specific needs.

The High Performance Package includes a PG 502 Pulse Generator, a DC 505 Digital Counter/Timer, a DM 501 Digital Multimeter and a PS 505 Power Supply, all in a TM 504 power mainframe.

The PG 502 Pulse Generator features repetition rates up to 250 MHz, narrow pulse widths and fast risetimes, as well as independent top and bottom level control. Front panel controls provide manual trigger, squarewave output, complementary pulse output for high duty factors, and selectable back termination in the pulse output circuitry.

The DC 505 Universal Counter/Timer is a two-channel module with direct counting capability to 225 MHz, and interval and pulse width resolution of 100 picoseconds. Its seven operating modes are: frequency counting, frequency ratios, period timing, interval timing, width timing, electronic event counting, and manual event counting. Single-shot pulse width measurements down to 10 ns and triggering on signals as short as 5 ns are possible. An A during B mode opens new verification and troubleshooting possibilities in high speed logic circuits.

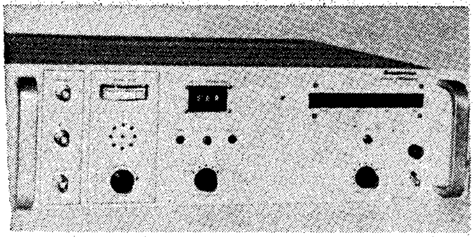
The DM 500 Digital Multimeter module provides all of the standard multimeter functions, along with a direct-reading temperature probe. The standard measurement capabilities include dc and ac voltage and current, and dBm and dBV. With the temperature-measuring feature (which is switch selectable to centigrade or fahrenheit) the user can locate hot spots in densely packed circuitry, verify operating temperatures of logic IC's, test relay drivers, and monitor outputs for the effects of temperature variation.

The PS 505 Power Supply module is a 3.0 to 5.5 Vdc adjustable floating supply, and in the power mainframe it can supply up to 4 A. Since either side of this floating supply can be referenced to ground, it is ideal for use with both TTL and ECL circuits.

The TM 504 power mainframe is a new addition to the TM 500 line. It is a heavy duty unit, with a large primary power supply and additional bracing and stronger supports. The TM 504 is suitable for bench use as well as transport to the field. All regular TM 500 plug-ins will fit into any of its four compartments, and its right hand compartment has special connections for high current modules such as the PS 505 Power Supply plug-in.

It is recommended that a Tektronix 485, 7904, or other high-performance oscilloscope be used in conjunction with this package in order to take full advantage of its capabilities.

WWVB TIME SYNCHRONIZER



Datametrics has introduced a new Model SP-465 WWVB Time Synchronizer. This unit provides an economical and direct method for disseminating time and frequency information in synchronization with NBS Radio Station WWVB broadcasts anywhere within the boundaries of continental United States. Time, synchronization accuracy of 1 millisecond and frequency synchronization to 1 part 10" is claimed.

The Model SP-465 is a valuable aid for engineers requiring time correlation of data gathered from different remote locations, as well as serving as a primary standard for the public utilities and metrology standard laboratories for time and frequency calibration.

Further details: John Morris Pty. Limited, P.O. Box 80, Chatswood, NSW 2067.

SEMICONDUCTOR CURVE TRACER

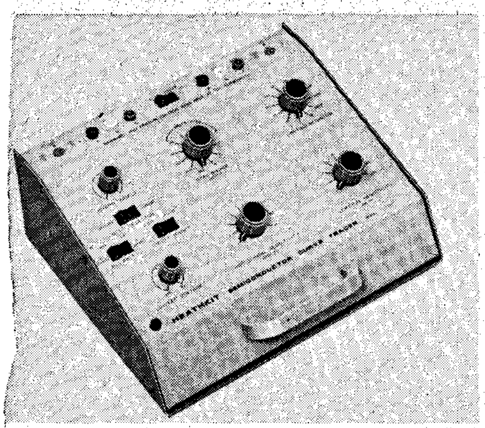
Recently released by the Schlumberger Heath company is the model IT 1121 semiconducter curve tracer.

This unit is designed as an accessory to most conventional oscilloscopes to enable display of the operating parameters of semiconductors. The majority of semiconductors can be accommodated including SCR's, TRIACS and FETS.

Operating voltage is up to 200 V and for lower voltages a 1 amp sweep is possible.

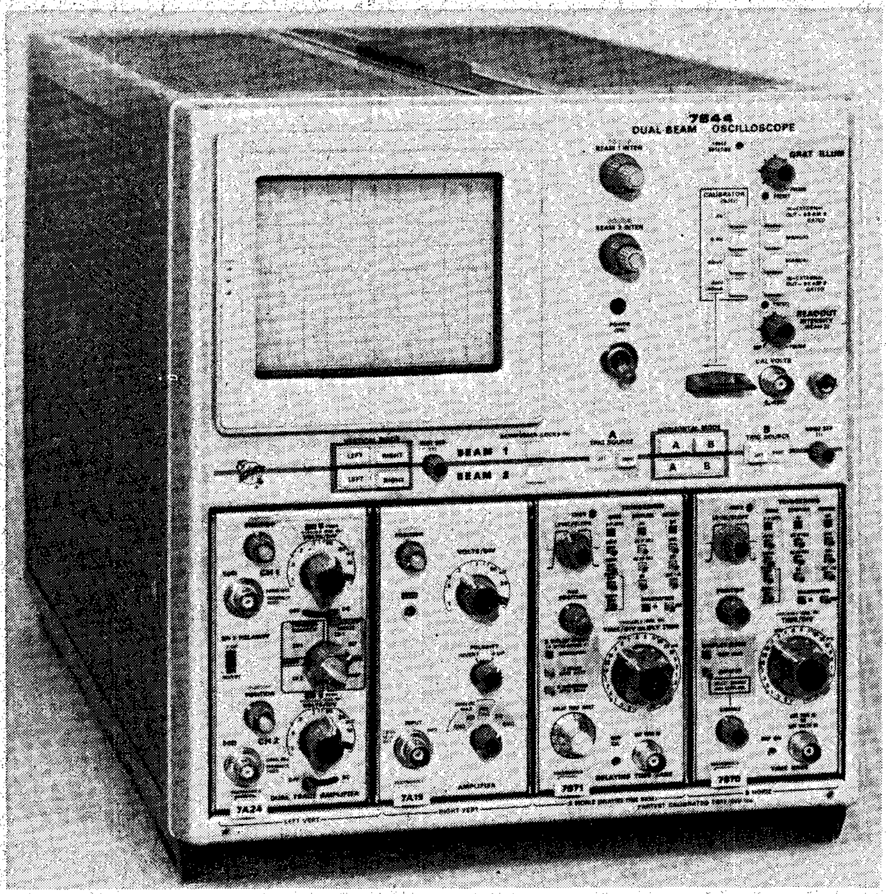
To facilitate accurate operation an inbuilt calibration voltage is provided.

Further details: Schlumberger Instrumentation Australia (Pty) Ltd., 112 High Street, Kew. Vic. 3101.



EQUIPMENT NEWS

DUAL-BEAM OSCILLOSCOPE HAS 400 MHz BANDWIDTH, PLUG-IN FLEXIBILITY



A 400-MHz bandwidth, dual beam oscilloscope which is optimally suited to analyzing simultaneous, fast, single shot events or fast events occuring at very slow repetition rates was introduced today by Tektronix Australia Pty. Limited.

The 7844 is essentially two oscilloscopes in one, where both independently and simultaneously use the same cathode ray tube (CRT) display area.

A second version introduced at the same time, the R7844 is functionally identical to the 7844 but is installed in a rackmount cabinet.

Based on TEKTRONIX flexible 7000-Series, the 7844 and R7844 have four compartments for which the user can select from over thirty different plug-ins to create the combination of performance range and package price to suit his requirements.

A 400 MHz bandwidth mainframe – making it the fastest dual-beam oscilloscope on the market – the 7844/R7844 can be combined with a wide range of input amplifiers to give just the system bandwidth needed. For example, with a 7A24 amplifier, the bandwidth is 300 MHz at 5 mV/div sensitivity. Or, with a 7A2IN direct access plug-in, the badnwidth is 1 GHz at less than 4 V/div.

Both the 7844 and R7844 offer vertical and horizontal crossover. Any combination of the two available vertical amplifier positions can be combined with any combination of the two horizontal positions for either or both beams. The most significant application of vertical crossover is to view non-recurring events simultaneously at two different sweep speeds.

If crossover is not required, the oscilloscopes can be ordered in an Option 21 configuration, which retains all features except crossover.

Both oscilloscope beams have full use of the eight centimetre by ten centimetre CRT screen. Full scan overlap allows simultaneous use of the full screen by both beams for observing signal coincidence.

Digital characters displayed on the CRT face – a Tektronix exclusive feature – give quick reference to the selected vertical deflection factors and horizontal sweep speeds. By installing any of five digital measurement plug-ins, in lieu of an analogue plug-in, a wide variety of digital measurement data can be displayed on the CRT along with the analogue trace.

Both graticule illumination and CRT character readouts can be pulsed by an external trigger or at a rate dependent upon sweep speed. When photographically recording single shot events, the graticule and/or character readout can be prerecorded before the event, or post-recorded following the event's capture on film.

A-3 X-Y LABORATORY RECORDER

A new multi-range flat-bed X-Y recorder to be introduced by Philips this year offers high sensitivity, high writing speed and wide recording area, thus meeting the specific needs of research and development laboratories. Designated the PM 8125, the new DIN A3 recorder features 14 calibrated measuring ranges on both X and Y axis, starting at a very low 0,05 mV/cm, and going up to 1 V/cm. Variable span provides over-lapping on all ranges. Most significant however is the very high writing speed of 500 mm/s, which allows for accurate recording of fast changing signals, into the smallest details.

The design of the PM 8125 is based on the highly successful PM 8120, and A4 flat-bed X-Y recorder which has proven its outstanding features and high reliability in a wide range of applications.

The PM 8125 uses a null balance potentiometric measuring system with solid state amplifier and a new MOS FET chopper, this together with a dc servo system – tacho generator feedback provides the high recording accuracy of ±0.25%, and a claimed reproducibility of ±0.1%. The measuring system also features electronic overload protection and both gain and damping are factory adjusted. The inputs are floating and guarded, while temperature drift is below ± 0,2μV/10°C over an operating temperature range of 5 to 40°C.

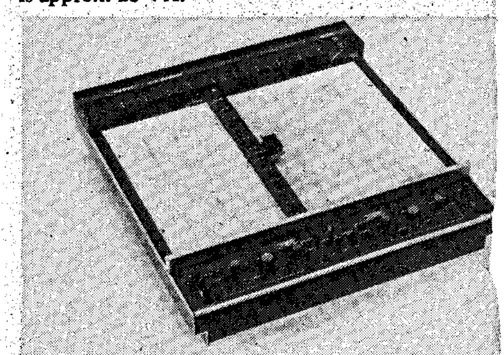
The zero position of the PM 8125 can be continuously adjusted over the full scale and can be conveniently checked at the push of a button. An additional fixed offset of -100% can also be push-button selected.

Recordings can be made on any kinds of paper up to DIN A3 size, while the actual recording area is 250 x 380 mm. An electrostatic chart hold system is used and pin point light guides facilitate chart alignment.

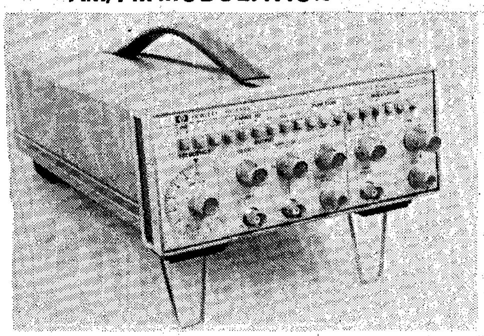
The writing system accepts hard glass pens or nylon fibre tips and disposable ink cartridges of 3 cc. Penlift is electrical and remote pen-lift control is provided as standard.

An optional plug-on time base unit allows the recorder to be used for X-t and Y-t measurements.

The PM 8125 measures 150 x 482 x 450 mm (HxWxD) and weighs 15 kg. Power requirements are 100, 117, 217 or 235 V ± 10%, 50 and 60 Hz and power consumption is approx. 25 VA.



NEW 0.1 Hz TO 13 MHz FUNCTION GENERATOR HAS INTERNAL SWEEP AND AM/FM MODULATION



With two independent function generators in one package, this new Hewlett-Packard Model 3312A Function Generator gives the user the ability to generate a vast number of different waveforms. All of the more commonly used waveforms, plus those generated using the modulator, make the Model 3312A useful for sonar testing, pulse doppler testing and shock wave simulation as well as the traditional applications such as amplifier, receiver, filter and logic circuit testing.

The main generator covers 0.1 Hz to 13 MHz in eight ranges, and the modulator generator delivers signals from 0.01 to 10 kHz. Both the main and modulation generators provide, sine, triangle, square, pulse and positive and negative ramps.

The main generator can, by pushbutton control, be triggered or modulated by the modulation generator to provide sweep, AM, FM or tone bursts. The start/stop phase for trigger or burst can be varied from the front panel, and single or multiple cycles are selected by a rear-panel switch.

Output of the main generator is 10 volts peak-to-peak into 50 ohms for all waveforms. A four-position attenuator with a variable control adjusts the output over a 60 dB range. Dc offset up to 10 volts peak-to-peak is also included.

Dial accuracy is ±5% of full scale. Sine wave flatness is within ±3% (maximum output amplitude) from 10 Hz to 100 kHz and better than ±10% from 100 kHz to 10 MHz. Sine wave total harmonic distortion at maximum output amplitude is less than 0.5% from 10 Hz to 50 kHz.

For triangular waveforms, deviation from the best straight line at 100 Hz is less than 1%. Square wave rise and fall time is less than 18 nanoseconds at full rated output.

Using the voltage-controlled oscillator (VCO) input for external frequency control, a sweep range of 1000 to 1 can be obtained. Simultaneous FM and AM is also possible using the VCO input.

This new Model 3312A will operate on line voltage of 100, 120, 220 or 240 +5%, -10% at line frequencies from 48 to 440 Hz. Power consumption is less than 25 volt-amps. The instrument weighs 3.52 kilograms (7lbs, 12oz).

Further details: Hewlett-Packard Australia Pty Ltd, 31-41 Joseph Street, Blackburn, Vic. 3130.

EQUIPMENT NEWS

MULTI-CHANNEL COLOUR DISPLAY MONITOR

Derritron Electronics Limited of the UK, have introduced a multi-channel monitor to display in four colour vertical bar form up to a maximum of 40 channels of analogue signal inputs.

The equipment consists of a (330 mm) 13" Trinitron colour tube and an interface drive unit with a range from 16 to 40 channels using four channel modules.

Red, green and orange display the signal level amplitude, the fourth colour, blue provides a horizontal calibration graticule and vertical channel selection indication. Adjustable colour threshold levels provide high and low threshold indications across all channels. A low level on each bar is indicated in green, the colour changes to orange at normal operating levels between low and high threshold settings and to red above the high threshold setting.

Typical applications for the Multi Channel Colour Display Monitor are: The remote monitoring of large quantities of discrete signals where analogue meters have previously been used. Display of transducer outputs to temperature, pressure load and strain of complex machinery installations such as steel rolling mills or power generating stations. The individual channels from a broadcasting or recording mix-down desk. The simultaneous display of control and controlling functions of a multiple servo system. Any telemetered data with or without external synchronisation.

Further details: British Merchandising Pty Ltd, 49-51 Kent Street, Sydney 2001.

MINIATURE ANALOGUE TAPE RECORDER

A miniature analogue tape recording system that can retrieve large quantities of information yet measures only a few cubic centimetres is claimed to be the smallest of its kind.

Its four-channel recording capability provides for cross-referencing of data in such a way that one parameter can be measured accurately relative to another. Each channel can store the equivalent of 3.5 million separate items or increments of information.

Data can be logged continuously for up to 24 hours. The unit possesses a true dc level recording capability and its frequency limitation is around 2 kHz. For long-term data logging, the device may be operated remotely for over three months.

As a result, the Microlog Tape Recorder is particularly suitable for the measurement of pollution levels, water levels, temperature, traffic flow, pH, salinity, and physiological parameters; and for recording events, acceleration and summations in a wide variety of industries and in different environments.

The recording unit is a miniaturised instrument-grade analogue cassette recorder measuring only 100 mm by 80 mm by 40 mm and weighing less than ½ kg complete with batteries and input amplifier. Two versions are offered, suitable for short-term and long-term experiments respectively. Both types utilise miniaturised plug-in amplifiers for handling all types of transducer signal.

Further details: Oxford Instruments Aust. P/L, 138 Bourke Road, Alexandria, NSW 2015.

DIGITAL TRACKING VOLTMETER

The VID Tracking Voltmeter from Gay of Milan, marketed by Arlunya, is an instrument which, in addition to operation as a normal dc digital voltmeter, has a peak reading memory voltmeter capability with the ability to read "maximum" or "minimum"

A new "continuous conversion" principle is used in which the tracking voltmeter continuously follows the input signal, providing a steady state indication when the input is constant, and continuous updating when the input changes. When the input changes only the variation is digitised to cause an increase or decrease in the displayed value (and bdc) output and hence this "tracks" the input signal.

As a conventional dvm, the tracking voltmeter provides accuracy of ±0.05% of reading, ± 0.02% of range with automatic polarity indication on four ranges of ± 0.9999 V, ±9.999 V, ±99.9 V and ±999.9 V. The floating input provides an impedance of 10,000 M on the 1 V range and 1.1 M on the other three.

These specifications apply both for the normal mode and for the "maximum" and "minimum" peak holding memory modes. In the "maximum" mode the polarity switch can select either positive or negative peaks, whilst in the "auto" polarity position the absolute peak value (greater of positive or negative) is displayed, the polarity indicator acting as a polarity memory.

The uniqie "minimum" mode features the capability to measure and store the minimum instantaneous value of a varying dc voltage, for example a fast voltage drop.

The Gay Milano VID tracking voltmeter is only 180 x 50 mm panel size by 220 mm deep. Weighing 1.8 kg, it requires only 15 VA mains power.

Further details: Arlunya Pty Ltd, P.O. Box 113, Balwyn, Vic. 3103.

CORRECTION

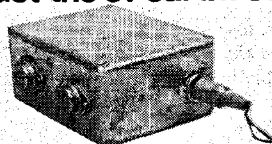
In the October issue, the Hobipak Advertisement carried a price of 75c for a 4000/75 V Pigtail type. This should have read $4.75. The publisher regrets any inconvenience. See Hobipak advertisement this issue page 27.

KITSETS SOUN

KIT'S KOLUMN

Firstly this month, a cheerio call to Alfred E. Neuman of Gore Hill. It's a nice thought Alf, but we don't sell lifesize replicas of me, so you'll have to make other arrangements. What might solve some of your problems is that now we can supply all kits (not me) complete to the last screw. It's worth the journey from your place to our place to get decent stuff, isn't it? Why, we even get people coming from as far away as Bankstown . . .

Got the 6v car blues



Alright, stop weeping. I know you can't buy a decent 6V radio or tape player. Why not buy a 12V one? What you do is build this beaut converter. Push your miserable 6V in one end and 12V comes out the other. Sorry Bug owners — not suitable for headlight conversion. P & P $1. **$19.50**

Orgies in colour

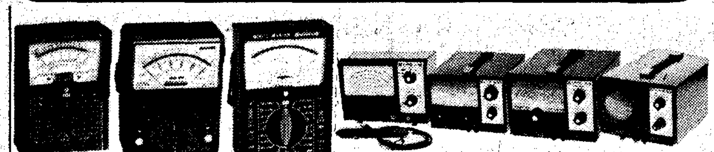
Went to a party where someone had one of our Moodcolour 4 units hooked up to his Hi-Fi. Mick Jagger sings purple. Bowie's orange. The Fugs are blue. That's all I care to remember. All you lechers will love this. 4ch, each with adjustable bandwidth and 1kW load capability drive colour floodlamps. (You supply). Handles mono or stereo. Try it on your SFX album and blow your mind. Even the cabinet looks sexy. Erotic. Exotic. A wonder it hasn't been banned. Easy construction provided your hands aren't still shaking. P & P $3. **$71**

HE says I have to start answering your letters. OK. I'll start next month. Meantime. . . Keep your iron hot —

Kit

STEINTRON WILL NEVER FORGIVE US: 10" SPEAKER SYSTEM, NOW $68

V100. Not a kit. Advertised in our last catalogue at $79. Down $10 for November **only** and while pre-budget stocks last. 10" woofer; 5" midrange; 1½" dome tweeter. Handles 30 watts RMS, has response 20-20kHz. Complete, ready to hook up to any decent amp. Timber enclosure 22½" x 13" x 11½". Freight $10 each. Two for $138, or price **each** for **November dated orders only — $69.**



Multimeters & Test Equipment

University Graham Multimeters: CT500: DCx6; ACx5; Current x 4; resistance x 4. Up to 5,000V DC. 20K ohms per volt DC; 10K ohms per volt AC. O'charge protected. P & P $1. **$19.95**

Model MVA50 Multimeter 5DK ohms per volt D.C. with 5 D.C. ranges, 5 current ranges; 4 resistance ranges; 5 AC ranges. Can measure up to 1,000 volts and 10 amps. Only P & P $1.00. **$29.95**

MVA100: DCx7; ACx5; Current x 6; resistance x 4. Measures 10 amps AC & decibles. 100K ohms per volt. P & P $1.50 **$42.50**

All with test leads and batteries.

Trio Test Equipment.

VT108 FET VOM 8 ranges 0.5 to 1,5kV, 11 Mag input, ± 3% accuracy. Ohms from 0.1 to 1000 Meg. Memory feature. **$85.**

AG202A Audio Generator covers 20Hz to 200k Hz 10V rms output. Sine and square wave. External sync. **$94.**

CO1303A 75mm Scope has 20mV cm sensitivity covers DC to 1,5MHz input R & C of 1 Meg and 30pF. **$170.**

SG402 RF Generator covers 100kHz to 30MHz in 6 ranges. Output 0.1Vrms. High low attenuator. Modulation at 400Hz. **$76.**

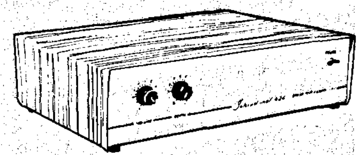
Registered Pack/Post $3.00.

KITSETS

SYDNEY: 402 Kent St. Sydney, 29 1005. **DEE WHY:** 21 Oaks Ave. Dee Why, 982 9790. **ADELAIDE:** 12 Peel St. Adelaide, 87 5505. **BRISBANE:** 293 St. Paul's Tce. Fortitude Valley, 52 8391. **MELBOURNE:** 271 Bridge Rd. Richmond (Gallery Level, Church St. entrance) 42 4651. **PERTH:** 557 Wellington St. Perth (Opp. new bus terminal), 21 3047.

As you-know-who reads our ads pretty closely, we're not going to give away any secrets as to how we get our prices so low. This month, we're having some particularly generous spasms despite the pleas of our accountant. Have a dekko at this lot. . .

Everything goes boinngg



ETI'S superb new spring reverb unit. Our kit gives you everything you need to build it. More sophisticated and versatile than the 1972 version, in that it has its own mixing facilities and stereo operation. Use between preamp and main amp, or after disc preamp, or high level input and preamp. Input 100mV-1V. P&P $2. **$49·5**

Sound leaves most 8" and 10" systems for dead! Specially designed and vented 1.6 cu. ft. enclosure, houses the new Plessey CFL (Controlled fibre length) C12PX 12" twin cone, wide-range speaker covering the bass and mid-range and the crystal-clear Plessey X30 1" dome tweeter covering the highs. Frequency response: 30-20,000 Hz. Power Handling capacity: 30 watts RMS. *OUR SPEAKER ENCLOSURE COMES PRE-ASSEMBLED AND VENEERED and requires only a small amount of final-assembly and strip veneering to complete! EACH 12" SYSTEM FOR ONLY **$49·99**

PLESSEY ROLA LOUDSPEAKERS

All with Plessey's "CFL" — Controlled fibre length — for optimum resonance/efficiency combinations. All 8/15 ohm.

Small round & elliptical
X30: 20W/RMS. 3kHz-30kHz. 3-15/16". P&P 50c. **$7.50.** C6MR: 20W/RMS. 450 Hz-6600Hz. 6-9/16". P&P 50c. **$8.00.**

Low frequency woofers
C80: 20W/RMS. 35Hz-8kHz. 8-1/16". P&P 75c. **$12.50.** C100: 20W/RMS. 40Hz-11kHz. 10-1/16". P&P 75c. **$13.50.** C1TP: 30W/RMS. 35Hz-8kHz. 12-3/32". P&P $1.25. **$19.80.**

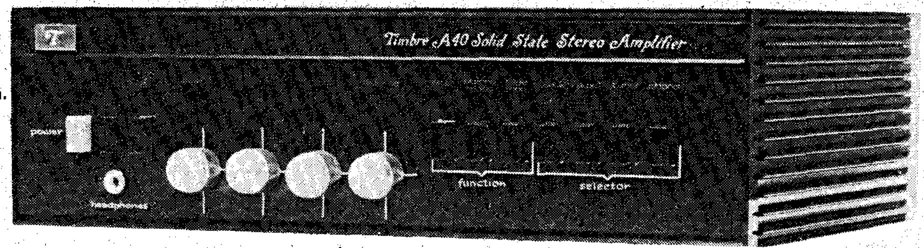
Wide range twin cone
C12PX: 30W/RMS.* 35Hz-13kHz. 12-3/32". P&P $1.25. **$21.00.** 12UX50: 50W/RMS*. 40Hz-13½kHz. 12-3/32". P&P $1.25. **$39.90.**

*System power with suitable cross-over network and/or recommended enclosure.

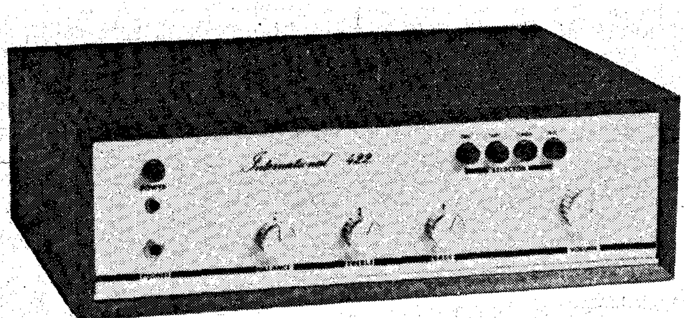
D SUPERMART

FAMOUS "TIMBRE" 40 WATT AMP NOW COMES IN A KIT.

We sell this same "Timbre" (pronounced tambra) A40 amplifier all over Australia ready made for $220, and even then it's a good buy. 40 watts per channel RMS both channels driven into 8 ohms. 20-20kHz; ± 1 dB, and better than 0.1% distortion. Kit comes complete with wired and pre-tested circuit modules to make your job easy and fast. P & P $3.



$169

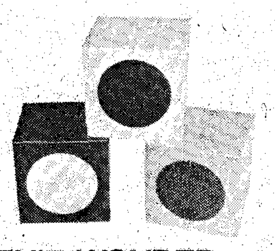


U-BUILD STEREO AMP HUGE 50 WATT PER CHANNEL $115

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 $3.

SAVE ON THE BSR P128 TURNTABLE

In our opinion, this is the best value for money in its class. Single play automatic, its square section pickup arm is fully counterbalanced, with calibrated stylus pressure control for tracking accuracy. 4 speeds. Rumble better than -35dB. Wow better than 0.2%. Flutter better than 0.06%. Complete with base, tinted cover, slide-in magnetic cartridge. P & P $3.
($5 more at you-know-who's).



WEENIE WONDER WHOPPER SPEAKER

Our incredible Cube 55. Cabinet only 6" x 6" x 6", yet the speaker handles 10 watts RMS! Response is 45 — 18kHz (equal to 10" twin cone speaker) voice coil has phenomenal 1½" throw. Black, red or ivory. P&P $1.50. **$14.95.** If you want the 5" full range speaker without the cube cabinet, it will cost you $7.50 plus $1 P&P

Our showrooms are open normal business hours as well as Saturday mornings. Come in and have a nosey round, or bring us your electronic problems — we're delighted to help anytime . . . no charge!

Use this coupon for mail order. Please don't send cash. Remit by Postal Order or crossed cheque, made payable to Kitsets (Aust) Pty Ltd. Send to P.O. Box 176 Dee Why 2099. For PMG/COD delivery, call 982 7500 (Area code 02) anytime (24 hour service) and tell us what you want. Orders are despatched within 24 hours. Please fill out form carefully and PRINT all details NEATLY. If your order comes in looking like a second-hand pakapoo ticket, we have to hang on to it until you send us a furious letter. And that doesn't do either of us any good.

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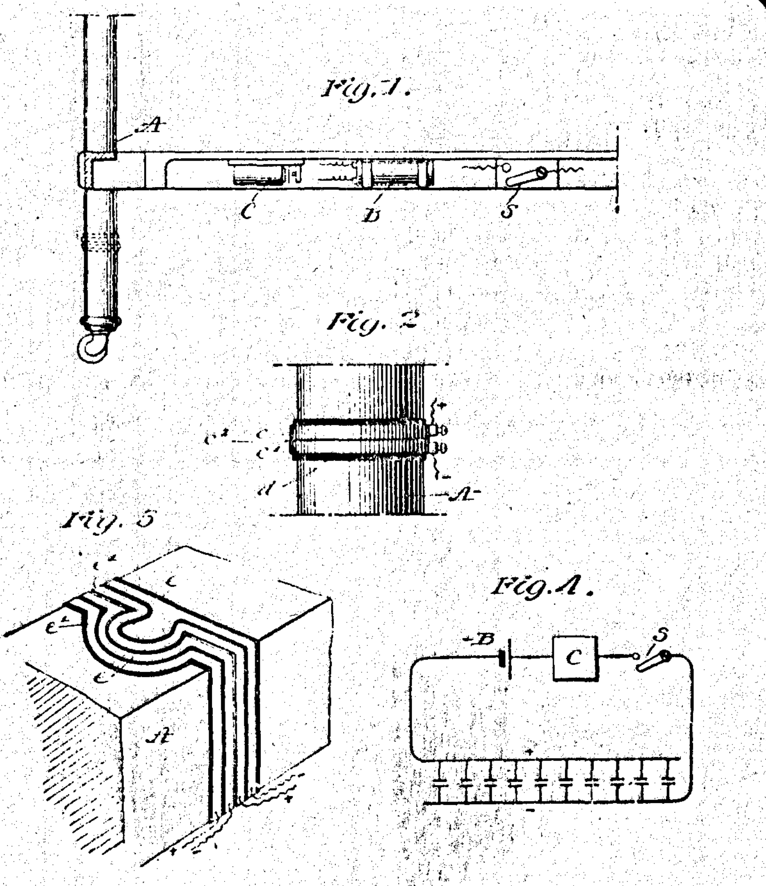
HOW MANY	NAME OF GOODS AND CODE NUMBER IF GIVEN	PRICE EACH	P & P EACH	SUB TOTAL
	If you want your order sent registered (advisable) add 75c			
	ITEM TOTAL: add column A.	REMITTANCE TOTAL: Add Column E		

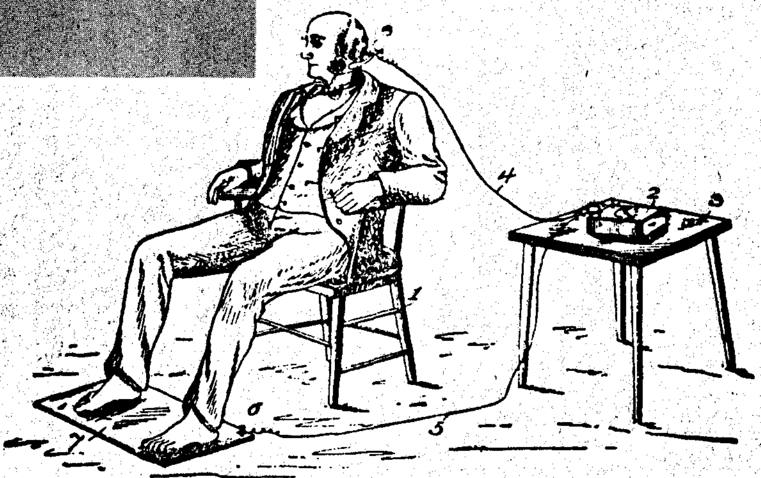
SENSORS ON

Medical electronics – 1800's style!

SINCE ELECTRICITY was harnessed in the laboratory at the start of the nineteenth century, the inventor has attempted to make use of it to cure ailments. Around 1830, the electromagnetic rotating generator was added to the already existing frictional methods of creating electricity. It was not long before the induction coil was also developed, finally giving the electro-medical practitioner a choice of high voltage continuous currents, low voltage sinusoidal currents and high voltage impulsive currents which he could apply to the hapless patient in order to 'cure' various ailments. Indeed even today shock therapy and other forms of electrical treatment are still used as there is some useful basis to the concepts. Rather than discuss the routinely used methods in those good old Victorian days, I proposed to bring your attention to a couple of electrical methods that were rather



by Talus



hard to believe but nevertheless really were patented. They are both somewhat humorous to us now but we should remain humble when rushing to condemn the inventor of a century ago.

Have a good laugh but then reflect upon which might be the gaffes of our time.

The electrical bed-bug exterminator.

In February of 1898 a patent application was lodged (U.S. patent number 616049) to protect the idea of exploiting a electrical technique for preventing bed-bugs climbing the legs of the 'brass' bedstead.

The patent figures are represented in Fig. 1 — they will explain the inventor's idea. Mounted into the bedframe are a battery, induction-coil and what appear to be capacitors. The switch enabled the capacitors to be charged via the induction coil to a nice high voltage.

Clearly the idea was to electrocute the bug as it made the circuit across the rings around the leg or across the rings placed around the socket joint where the frame couples with the bed. If the shock did not kill the bedbugs, it would, said the inventor persuade them to go to another, unprotected bed.

Extracting poisons with electricity.

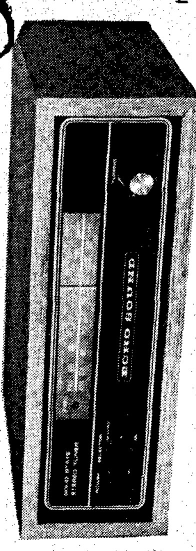
Another patent also granted in the U.S. patent office, related to the "new and useful Improvements in the Electrical Extraction of Poisons from the Human Body" (Patent no. 606887 of 1898).

Whereas the bedbug exterminator had a valid basis, this one is a right tall story. Figure 2 is the illustration provided by the inventor as a "full, clear, and exact description of the same, . . . , in which the patient seated in a chair, the electric battery, and the conducting-wires leading from the electric battery to the positive and negative plates, which in the illustration are shown applied to the back of the neck of the patient and at the same time to the bare feet of the patient or person receiving treatment".

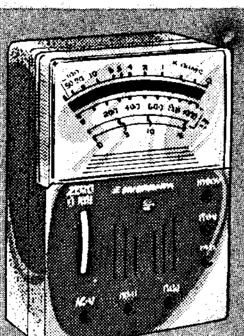
The inventor went on to explain how vegetable poisons were extracted by using the appropriate "vegetable receiver" — the contact made to the body. For animal poisons a chunk of steak was recommended.

In operation, claimed the inventor, the receiver is made in circuit to the negative electrode, the circuit completed and, hey presto, the poison will be drawn out by the current to deposit on the copper plates.

"From six to eight treatments of a half an hour each in duration will generally extract all of the poison of whatever kind it may be, and the copper plate will show as bright and clear as it was at first" — I'm not surprised there was no change in the plate. ●



PROVEN PERFORMANCE MICRONTA® MULTITESTERS



POCKET MULTITESTER

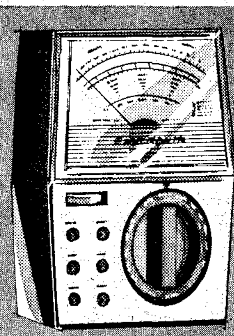
8.95

1000 Ohms/Volt AC/DC. 8 ranges. Handy for home & work shop. Easy read 2 colour 2" meter. With convenient thumbset zero adjustment; mirrored scale eliminates parallax. Very compact.
22-027

18 RANGE 20,000 OHMS/VOLT

15.95

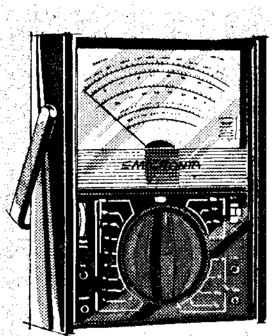
Low priced VOM with 'expensive model' features. Single knob range selector with separate 'off' position. 3" meter, pin jack connections. Accuracy 3% on DC, 4% AC. Leads, battery, instructions.
22-201



25 RANGE 20,000 OHMS/VOLT

21.95

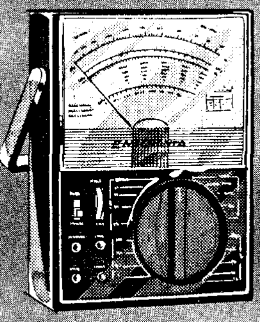
Highly sensitive full range tester. 4" meter with colour coded, mirrored scales. Single knob range selector. With leads, battery and instructions.
22-202



27 RANGE 30,000 OHMS/VOLT

25.95

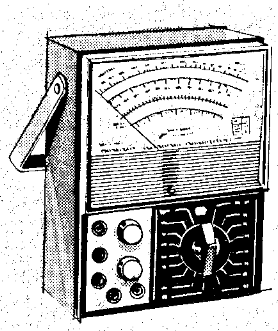
High accuracy for servicemen, technicians, lab work. 4" meter, banana jack connections, polarity reverse switch. Leads, battery, instructions.
22-203



43 RANGE 50,000 OHMS/VOLT

29.95

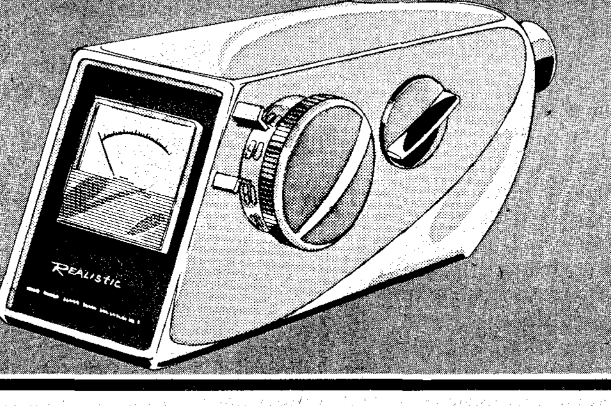
Range-doubler circuit for more accurate readings both current & voltage. Ideal low voltage transistor servicing. 4¼" meter. Leads, battery, instructions.
22-204



27 RANGE 100,000 OHMS/VOLT

39.95

One of the finest portable/bench models available. Fast accurate testing. Meter double jewelled 4" D'Arsonval Protection circuit. All extras!
22-205



REALISTIC®

INCREDIBLE LOW PRICE ON SOUND LEVEL METER

49.95

An absolute must for audio buffs. Test sound levels in nightclubs, *factories, soundproof rooms,* stereo and PA systems. Reads 60-116 dB in five 16 dB ranges. Extremely accurate. Has external monitor jack. 1-v minimum output. Built-in battery tester. Compares favourably with $200 units! Tandy sell quality for less!
33-1028

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TANDY ELECTRONICS

THE WORLD WIDE SUPER MARKET OF SOUND FOR 52 YEARS

COMPONENT NEWS

FERGUSON TRANSFORMER UPGRADED

(Full size)

The Ferguson transformer type PF 2851 has been revised to meet the construction and insulation requirements of Australian Standard C126.

With the addition of PF 3786 and PF 3787 it now forms part of a trio in the "Ferguson" stock range which have been designed to meet the small power and small size requirements of the electronic industry.

These transformers are claimed to be the smallest locally manufactured stock types available, suitable for connecting to 240 volts 50 Hz mains.

The three transformers have two identical secondary windings which may be series or parallel connected. The choice of voltages are, 6, 12, 14, 18, 28 and 36 approximately 2.5 VA with no load volts being in the order of 25% above these values.

Further details: Ferguson Transformers Pty Ltd. 331 High Street, Chatswood. NSW.2067.

PHASE CONTROL IC

A new (SL 440) control circuit announced by Plessey Semi-conductors provides variable phase control of power switching elements (such as triacs) in a variety of domestic and industrial applications. These include lamp dimmers, automatic lamp faders and motor speed control systems, as well as precision firing control of Ignitrons for high current welding systems.

Included within the circuit is a servo amplifier, a voltage controlled variable delay pulse generator, a load-current limit/inhibit safety facility, a cross-over detector and an internally stabilised low voltage dc supply which can be derived from the mains by simple low cost components.

In operation, an external timing capacitor is charged during each half-cycle of the supply waveform (50 or 60 Hz) at a constant rate which is controlled by the voltage output of the servo amplifier. When the charges reaches an internally defined level the conduction control circuit generates a 50 nano second (typical) firing pulse to trigger the triac. The cross-over detector resets the timing cycle when the supply waveform passes through zero, by completely discharging the timing capacitor during this time. The servo amplifier thus directly controls the conduction time of the triac and hence the power delivered to the load.

The servo amplifier allows for the facilities of electronic programming, tachometer feedback control or with just one extra capacitor gives automatic fading for light dimming.

Alternatively the servo amplifier can be by-passed and linear control of conduction angle effected manually by means of a high resistance potentiometer fed from the stabilised dc supply. This facility provides for accurate ganging of multiple power control circuits.

Encapsulation is in a 14 lead dual-in-line ceramic or plastic package.

Commercial enquiries should be addressed to Professional Components, Plessey Australia Pty Ltd, Christina Road, Villawood, NSW. 2163.

MINIATURE CRYSTAL OVEN

A miniature crystal oven has been added to the wide range of quartz crystal associated products manufactured by Marconi.

The new oven has a capacity of 6.8 mm diameter and a depth of 6 mm to accommodate components housed in standard JEDC TO-5, TO-39, TO-99 or TO-100 outline packages. It is particularly suitable for use with microminiature crystal oscillators covering the 6-140 MHz frequency range, and with Q111 and Q115 crystals covering the 6-200 MHz frequency range. Both these types use TO-5 packages.

Ovens will maintain components at temperatures of 80°C, plus or minus 2°C, with an improvement factor of typically 80:1. (The improvement factor is the ratio of change in ambient temperature to the resulting change in oven temperature).

Versions are offered for operating temperature ranges from minus 10°C to plus 70°C or from minus 40°C to plus 70°C with supply voltages of 12 V, 15 V, 20 V or 24 V. Warm-up time from plus 25°C to within one degree Celsius of final oven temperatures is 90 seconds at a consumption of 6 W for the wider-temperature version; for the narrower-temperature version it is 3 minutes at 2.8 W. Typical steady operational power consumption is 1 W for all versions.

Overall dimensions of the F3034 Oven are 25.5 mm by 15 mm high. The equipment is designed for mounting on 0.1 in (2.55 mm) grid printed circuit board.

Further details: Amalgamated Wireless (A'sia) Ltd., 422 Lane Cove Road, North Ryde NSW 2113.

QUARTZ CRYSTAL FILTERS

A continuing programme of development of monolithic type quartz crystal filters has resulted in AWA adding two more 10.7 MHz filters to their existing range:

These locally manufactured filters were specifically designed for FM Mobile and SSB Communication equipments with bandwidth requirements of 7.5 kHz and 3 kHz respectively.

These acoustically coupled resonators achieve greater reliability, lower aging rates, and reduced size with improved economy.

Each filter is available in hermetically sealed enclosures of either 18.5 x 12 x 15 mm or 42 x 25 x 21 mm outlines.

The use of computer aided design for the manufacture of the filter elements and the electrode shadow masks provide a service for the custom design of other monolithic filters.

Further details: Crystal Section, Amalgamated Wireless (Australasia) Limited, Engineering Products Division, 422 Lane Cove Road, North Ryde, NSW. 2113.

NEW TANTALUM CAPACITORS FROM SOANAR

Soanar Electronics Pty. Ltd., announce the introduction of a new and improved tantalum capacitor to their already extensive range of stock capacitors.

The new 'TAD' tantalum capacitors are produced by entirely automatic assembly methods to ensure constant high reliability and low cost, and offer the advantages of tantalum at prices comparable with aluminium electrolytics.

The superior dielectric provides high temperature stability, low leakage characteristics and long operational life. The absence of liquid electrolyte removes normal vacuum-pressure-altitude restrictions and ensures a low equivalent series resistance over a wide temperature range.

Uni-directional leads for P.C.B. mounting, small size and flame-resistant resin-dipped construction ensure 'TAD' tantalums are suitable for all by-pass, decoupling, blocking and filtering applications in entertainment, commercial and industrial electronic equipment.

Further details: Soanar Electronics Pty. Ltd., 30 Lexton Road, Box Hill, Vic. 3128.

THE BEST THINGS IN LIFE ARE ALWAYS WORTH WAITING FOR ESPECIALLY AN INSTRUMENT FROM bwd

Demand is GREAT, but when we manufacture such high quality and back it with a fast service facility (should you ever need it) is it a wonder? Model bwd 539A is just one of the oscilloscopes in our wide range that colour TV engineers consider well worth waiting for.

MODEL bwd 539A DUAL TRACE OSCILLOSCOPE

VERTICAL AMPLIFIERS
DC to 12 MHz −3dB (both channels). (Flat within 5% over the entire video band width). 10 mV to 50V/cm in 12 steps.

TIME BASE — 200 n sec to 2.5 sec/cm including X 5 magnifier & 5:1 vernier.

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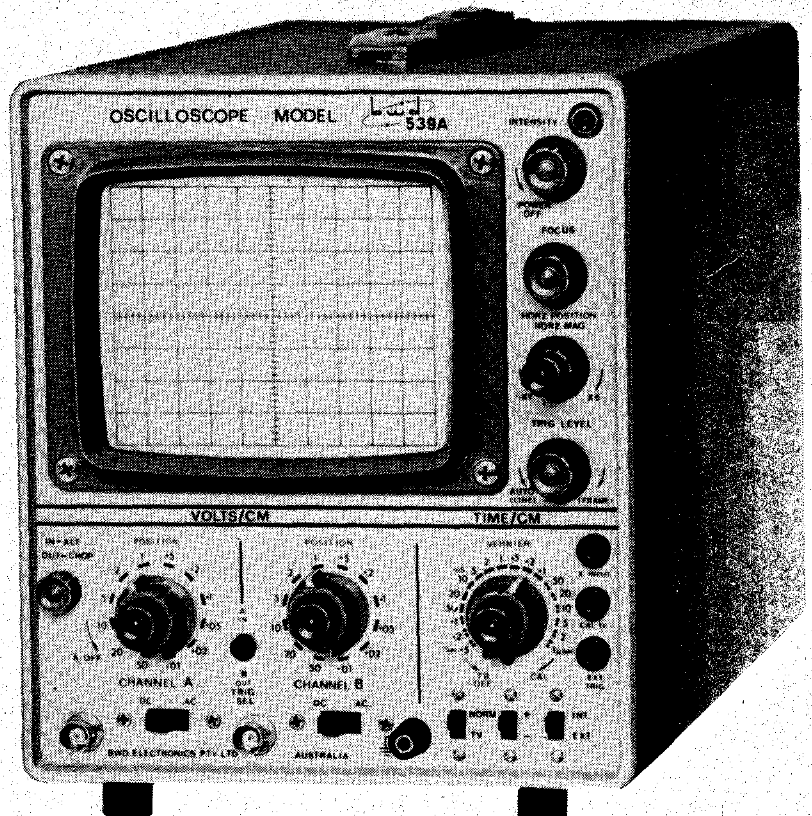

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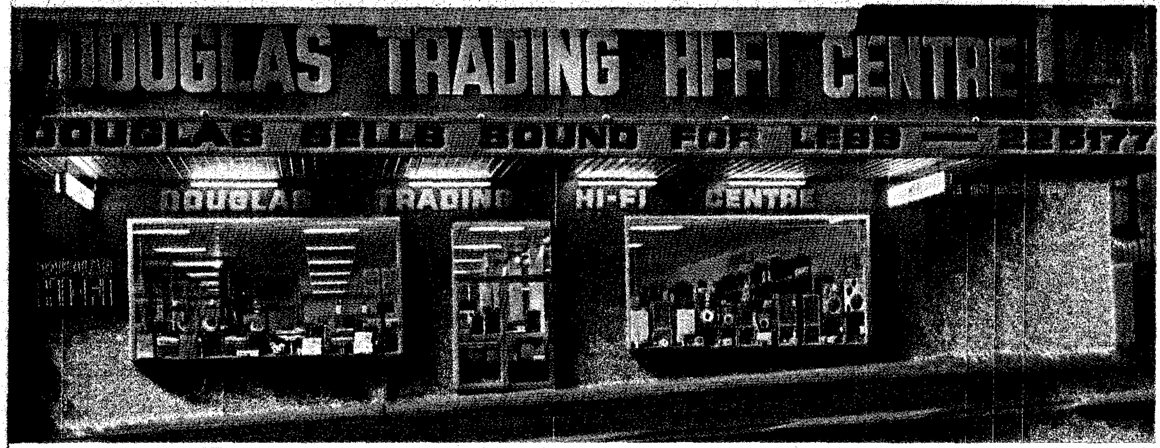

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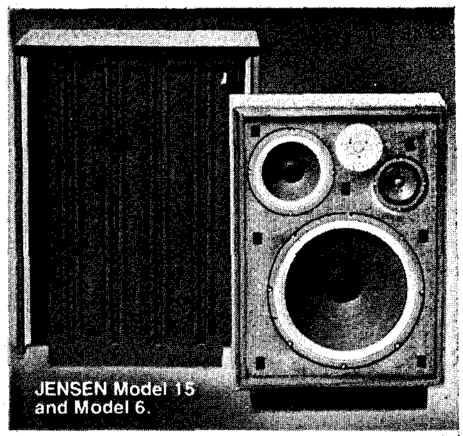
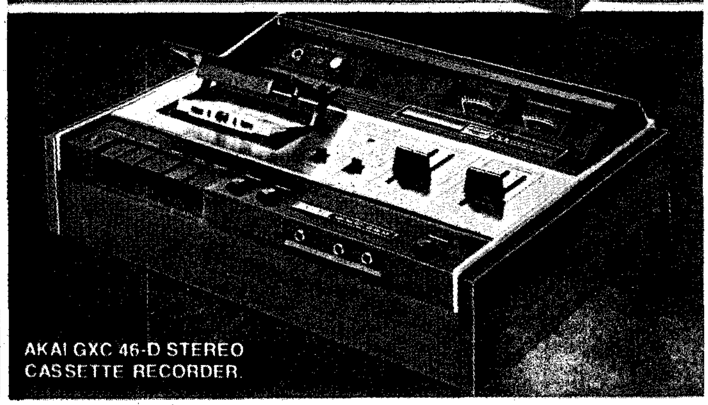

JENSEN Model 15 and Model 6.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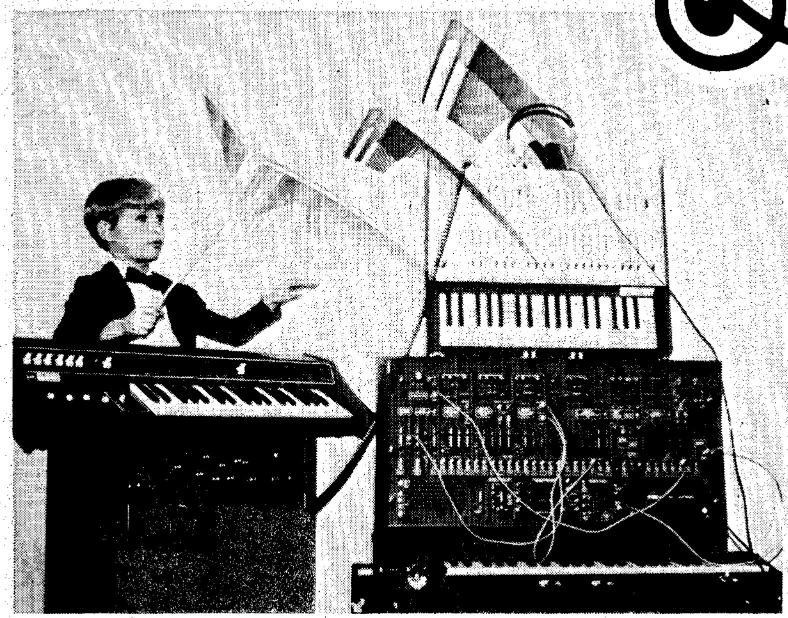

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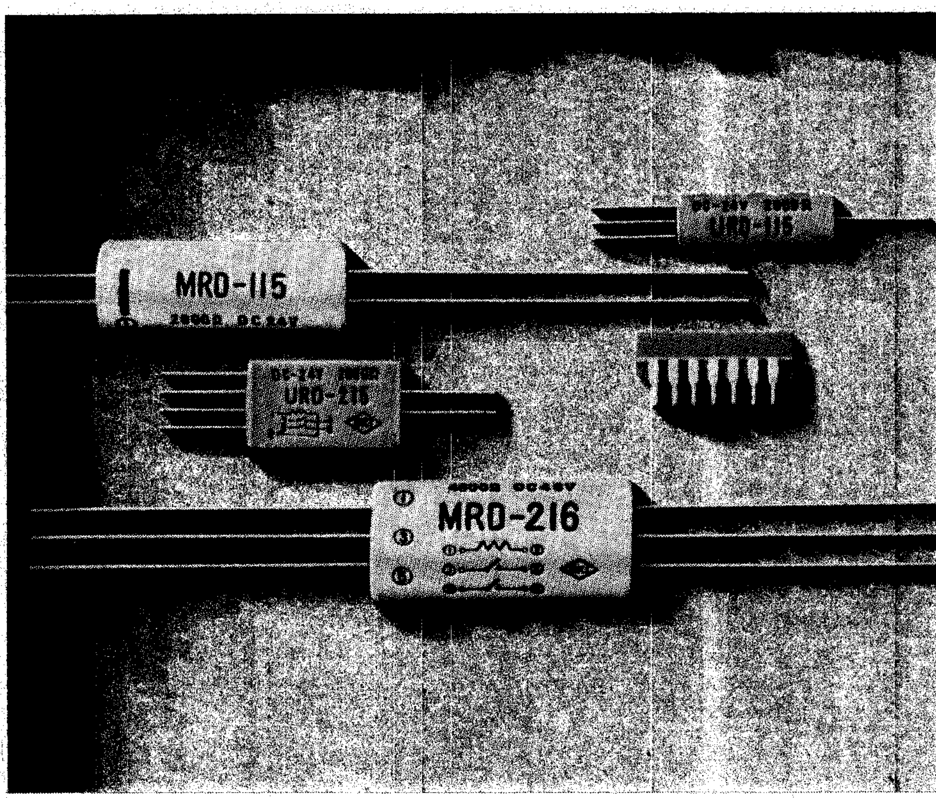


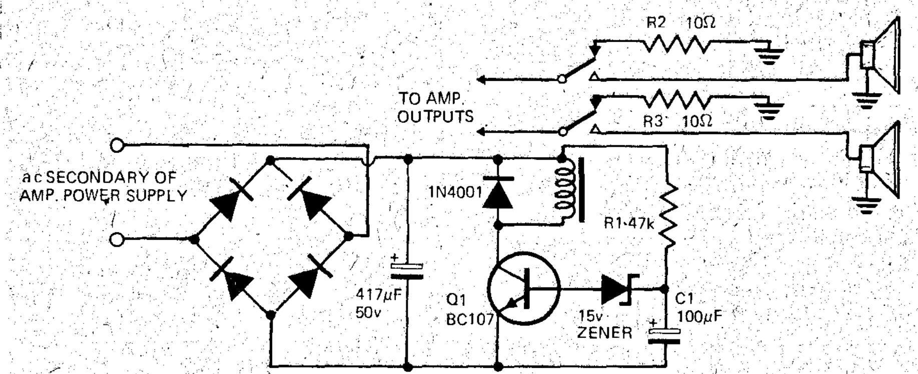
PLESSEY

AC98/R1

IDEAS FOR EXPERIMENTERS

A potpourri of circuits, ideas, hints and tips.

PLOP ELIMINATOR



Many hi-fi amplifiers cause an only-too audible 'plop' in the speakers when switched on. The 'plop' is not only disconcerting but can also be damaging to low-power capacity speakers.

The plop is generally caused by the momentarily high inrush current to the series output capacitors.

The circuit shown here brings the speakers into circuit only *after* charge on the output capacitors has been established.

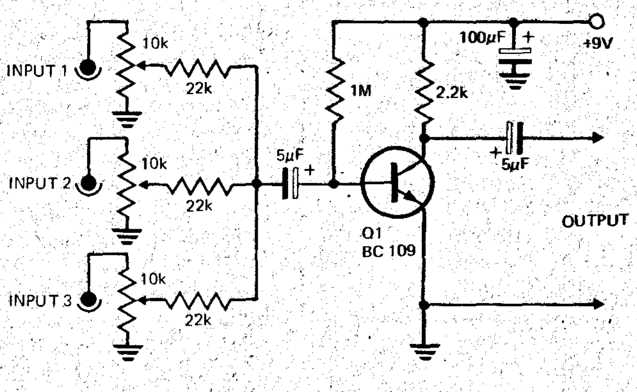
The unit is connected by wiring the rectifier bridge input to the AC secondary winding of the amplifier power supply.

Immediately the amplifier is switched on. C1 charges through R1. When the voltage exceeds the Zener voltage of the diode in series with the base, the transistor conducts and closes the relay.

As soon as the power is shut off, the small smoothing condenser quickly discharges itself through the relay and de-energises it.

The two resistors R2 and R3 provide an alternative path for the onrush current when the amplifier is switchd on.

ONE TRANSISTOR AUDIO MIXER

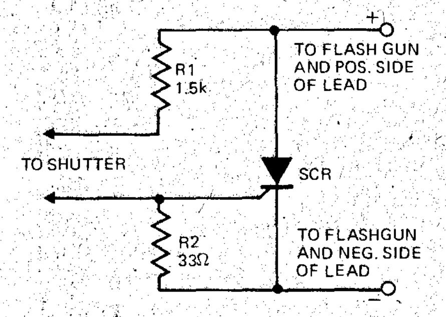


Three inputs are shown on our circuit but more can be added if required.

Each input has its own level control.

Sensitivity is 500 mV output for 25 mV input. This is more than adequate to drive most amplifiers.

SHUTTER SAVER



This three component device will keep sparks out of your camera shutter, when using a flash gun, by letting an SCR carry the firing current.

Closing the contacts in the camera shutter applies a triggering voltage, developed across the divider R1, R2, to the gate of the SCR., so firing the SCR and hence the shutter. The value of R1 must be as high as possible, but low enough to carry the needed gate current which may vary from 0.5 mA to a few milliamps. The value of R2 must be sufficiently high to develop necessary gate triggering voltage. R1 and R2 may need to be varied with SCR selected. The SCR should have a rating of 200 volts. If the device is used with a battery-capacitor flash, which operates at about 22 volts, R1 and R2 must be adjusted to suit.

The components can be assembled in a plastic pill tube, fitted in the middle of a flash lead.

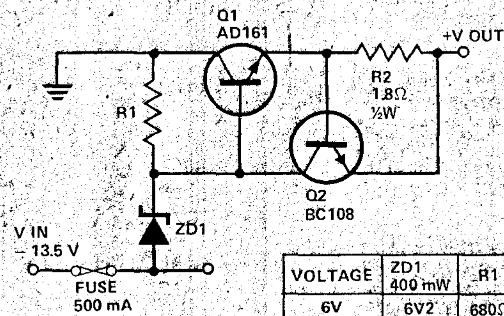
As the name of this section implies, these pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory.

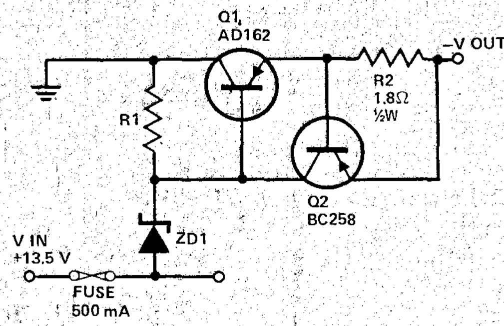
Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we provide constructional details.

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

LOW VOLTAGE STABILIZERS HAVE SHORT CIRCUIT PROTECTION





VOLTAGE	ZD1 400 mW	R1
6V	6V2	680Ω
7.5V	7V5	390Ω
9V	9V1	220Ω

These short-circuit protected stabilisers give 6, 7.5 and 9 V from an automobile battery supply of 13.5 V nominal, however, they will function just as well if connected to a smoothed dc output from a transformer/rectifier circuit.

Two types are shown for both positive and negative earth systems. The power transistors in each case can be mounted on the heatsink without a mica insulating spacer thus allowing for greater cooling efficiency.

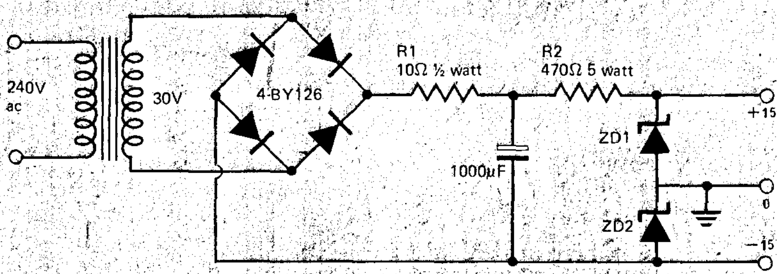
Both circuits are protected against overload or short-circuits.

The current cannot exceed a value of 330 mA. Under normal operating conditions the voltage across R2 does not rise above the 500 mV necessary to turn Q2 on and the circuit behaves as if there was only Q1 present.

If excessive current is drawn, Q2 turns on and cuts off Q1 protecting the regulating transistor.

The accompanying table gives the values of R1 for different zener voltages.

DUAL POLARITY SUPPLY POWERS OP-AMPS

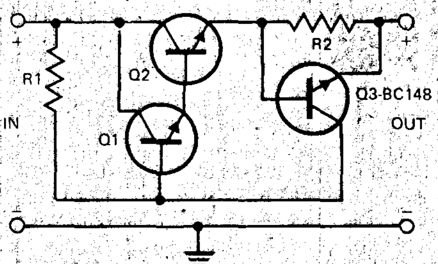


ZD 1 and ZD 2 = 15V ZENER DIODES – BZX70 C15

Ever been bothered by the lack of a dual supply for your op-amp circuits? This simple circuit gives positive and negative supply from a single transformer winding and one full-wave bridge.

Two Zener diodes in series provide the voltage division and their centerpoint is earthed. (N.B. the smoothing electrolytic must not be earthed via its case).

ELECTRONIC FUSE



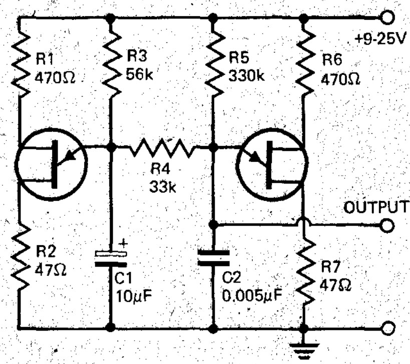
Imax	R1	R2	Q1	Q2
5.0A	100Ω	0.12Ω	BFY50	2N3055
0.5A	1k	1.0Ω	BC107	BFY50
0.1A	4.7k	3.7Ω	BC107	BFY50

Here is a circuit for protecting modern transistorised gear which requires a faster action than can be provided by an orthodox fuse.

Transistor Q2 is saturated by base current supplied by Q2, which is itself turned on by R1. The overall voltage drop between input/output is in the region of 2V. If a momentary surge in current or a short circuit in the load appears then the voltage drop across R2 will increase and when it reaches about 0.7V, Q3 will begin to conduct and its collector emitter voltage will drop to about 0.3 V. This in turn cuts off Q1 and Q2 thus breaking the supply current.

The tables gives circuit values for various currents. These are suitable for supply voltages up to 45 V.

STEP FREQUENCY OSCILLATOR

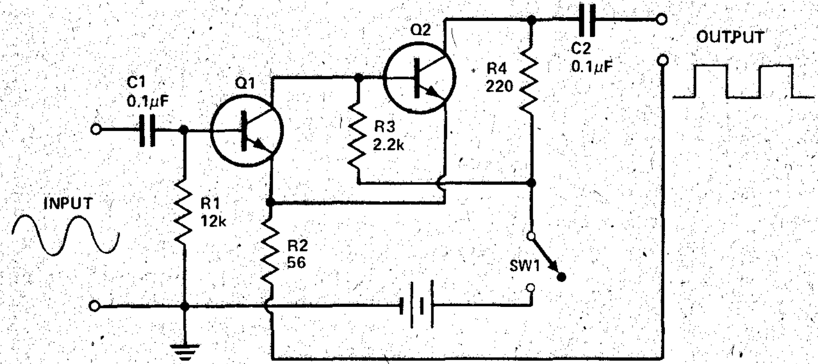


This circuit will produce a continuous sequence of increasing frequencies (in steps) until the highest is reached. The system then resets itself and starts again.

Two unijunction relaxation oscillators are cross-coupled together. On switching on capacitors C1 and C2 start to charge up through R3 and R5. The time constant C2-R5 is shorter; Q2 fires first and discharges C2. As C2 charges up again it will draw current through R5 and R3-R4. This will shorten the Q2 time constant, and in progressive cycles, as C1 charges up slowly, the Q2 time constant will keep shortening till Q1 fires, at which stage C1 will discharge and the whole cycle begins again.

Various sound effects can be obtained by varying R3, R4, C1 and C2.

SINE/SQUARE WAVE CONVERTER



Many audio generators only give a sinusoidal output. However a square-wave output is often useful too.

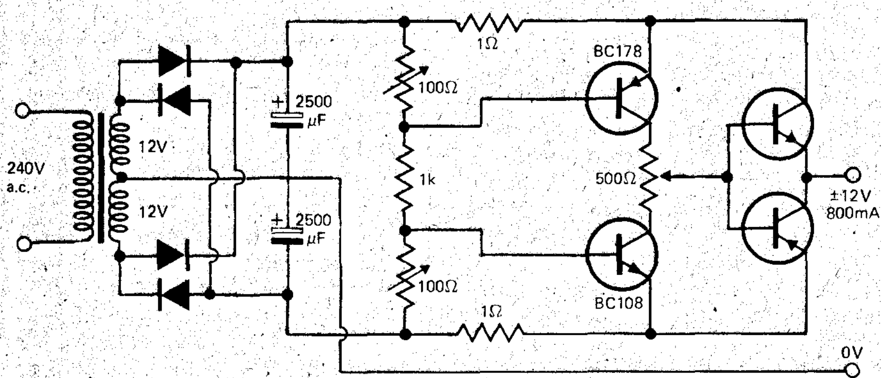
This circuit will square any sinusoidal input over the range of 20 Hz to 30 kHz with an output of about one volt, input signal should be about 400 mV.

The waveform obtained is of much better purity than obtained by a diode squaring circuit. The circuit is in fact suitable for use where square waves with a fast rise-time are required.

Transistors are germanium NPN types such as AC 127.

The power supply is 1.5 V and consumption is in the region of one to 2 mA.

VARIABLE POWER SUPPLY GIVES POSITIVE OR NEGATIVE OUTPUT

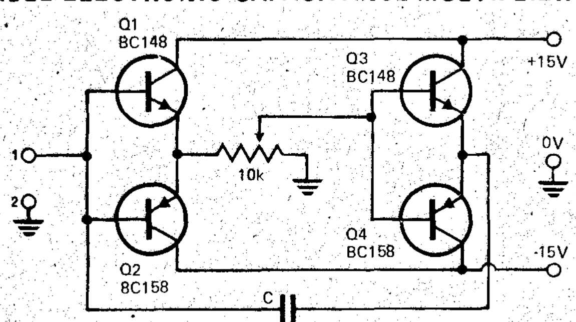


A variable power supply using complementary output transistors is capable of swinging the voltage at the output from +12 V through zero to — 12 V.

The two output transistors can be types BD 135 — BD 136. These are both cut off when the 500 ohm potentiometer is centred.

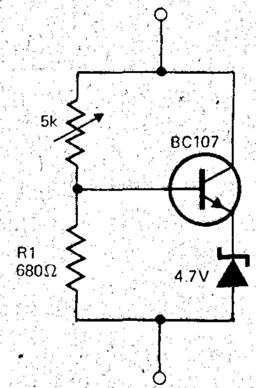
Rotating the potentiometer in either direction will give positive or negative output voltages up to 12 V and 800 mA. The series resistors (1 ohm) monitor output current and when this exceeds a level preset by the 100 ohm trimmers will current limit the output.

A VARIABLE ELECTRONIC CAPACITANCE MULTIPLIER



The circuit shown permits (with the aid of a potentiometer) the adjustment of capacitance appearing across terminals 1 and 2. The capacitance swing is of the order of 1000 — 1, the minimum value being determined by the value of the capacitor C. By substituting a thermistor for the potentiometer, temperature dependent capacitance is obtained.

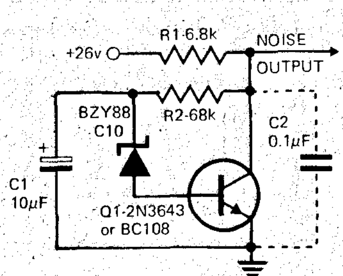
A VARIABLE ZENER DIODE



The circuit shown behaves like a Zener diode over a large range of voltages. The current passing through the voltage divider R1 — R2 is substantially larger than the transistor base current and is in the region of 8 mA. The stabilising voltage is adjustable over the range 5 — 45 V by changing the value of R2. The total current drawn by the circuit is variable over the range 15 mA to 50 mA. This value is determined by the maximum dissipation of the Zener diode. In the case of a 250 mW device this is of the order of 50 mA.

When stabilising higher voltages or operating at higher currents it is necessary to fit a small heatsink to the transistor.

WHITE AND PINK NOISE GENERATOR



A basic noise generator can be built using one transistor and a Zener diode.

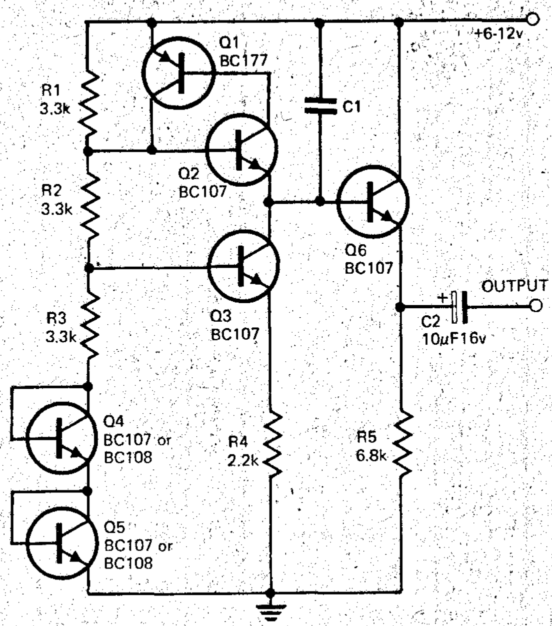
The 10 volt Zener acts as the noise source and also stabilizes the transistor operating point. Adding capacitor C2 will change the output from 'white' noise to 'pink' noise.

Output level for components specified will be about 15 V for white noise and about 14.5 V for pink noise.

The transistor should be a BC 108 or 2N3643 — other similar transistors will do.

IDEAS FOR EXPERIMENTERS

STABLE HIGH-LINEARITY SAW-TOOTH GENERATOR



In this circuit two transistors Q1 and Q2 are connected so that they operate as a unijunction transistor.

Capacitor C1 is charged by a constant current source made up of transistors Q3, Q4 and Q5. This ensures a linear voltage rise. As soon as this voltage rises to the value as found at a point A of the circuit (less the base emitter voltage of Q2), the transistors Q1 and Q2 become conducting and C1 is discharged very rapidly.

The voltage rise across C1 is very linear and is applied to an emitter follower stage. This ensures that there is no shunting effect by the load circuit which could be detrimental to the linearity of the output waveform.

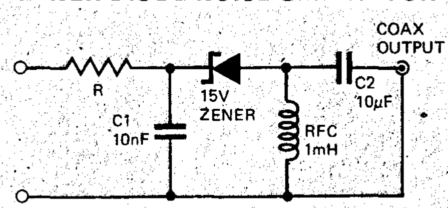
The potential divider chain (R1-R2-R3) contains two transistors strapped as diodes and ensures good stability of the oscillator for variations in both supply voltage and temperature.

Frequency of operation can be calculated from the formula:

$$f = 1/R4 . C1$$

where C and R are expressed in ohms and farads and f in Hz.

ZENER DIODE NOISE GENERATOR



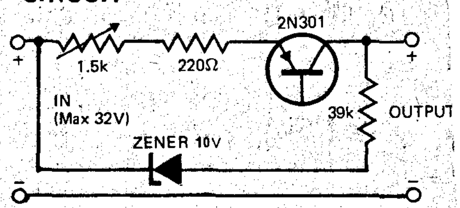
Zener diodes generate quite intense internal noise. This noise level is in the region of 30 dB above the inherent thermal noise and extends out to 150 MHz or so.

The circuit shown here may be used for adjustment of VHF converters and other receiving equipment.

It is energised by a dc source. The resistance R is adjusted so that between 6 and 8 mA flows through the circuit.

Capacitor C2 should preferably be ceramic. The signal output should be fed via a coaxial cable.

SIMPLE CONSTANT CURRENT CIRCUIT



A series transistor is used as a variable resistor for this constant current supply.

The output current is held within 10% over a range of loads from a short circuit to 500 ohms. The required current is set by the potentiometer. The transistors specified will handle voltages up to 32 V. ●

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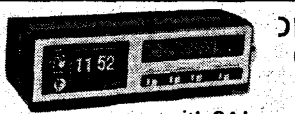

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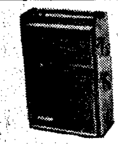

SPECIFICATIONS

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.

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SPECIFICATIONS, NC-310

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Receiver Sensitivity: 0.7µV at 10 dB S/N
Selectivity: 45 dB at ±10 kHz
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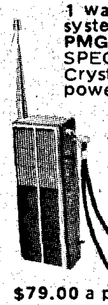
SIGNED K.J. MILLBOURN



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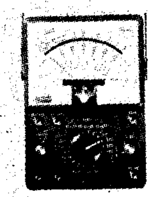

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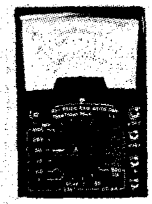
AC/V: 6V, 30V, 120V, 300V, 600V, 1200V (10,000Ω/V).
DC/V: 3V, 12V, 60V, 120V, 300V, 600V, 1200V (100,000Ω/V)
DC/A: 12µA, 6mA, 60mA, 300mA, 12A.
OHM: 2kΩ, 200kΩ, 20MΩ, 200MΩ
db: -20 to +63db.
Audio Output: 6V, 30V, 120V, 300V, 600V, 1200V AC
Battery: Internal
Approx. size: 7½" x 5½" x 2¾"

THIS MONTHS SPECIAL

Magnavox 8-30 speakers $14.95



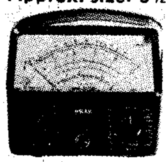
MODEL OL-64D/P MULTIMETER

20,000 ohms per volt. DC volts: 0.025, 1, 10, 50, 250, 500, 1000 (at 20K o.p.v.), 5000 (at 10K o.p.v.). AV volts: 0-10, 50, 250, 1000 (at 8K o.p.v.). DC current: 50uA, 1mA, 50 mA, 500 mA, 10 amps. Resistance: 0-4K, 400K, 4M, 40 megohms. DB scale — 20 to plus 36 dB. Capacitance: 250pF to 0.02uF. Inductance: 0-5000 H. Size: 5¾ x 4-1/6 x 1¾ in.

CT-500/). $16.75

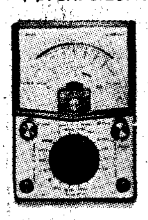
Popular, medium-size, mirror scale. Overload-Protected.
AC/V: 10V, 50V, 250V, 500V, 1000V, (10,000Ω/V)
DC/V: 2.5V, 10V, 50V, 250V, 500V, 5000V (20,000Ω/V)
DC/A: 50µA, 5mA, 50mA, 500mA.
OHM: 12kΩ, 120kΩ, 1.2MΩ, 12MΩ,
db: — 20db to +62db.
Approx. size: 5½" x 3-5/8" x 1¾". **p.p. 50c**

A-10/P $55 p.p. $1



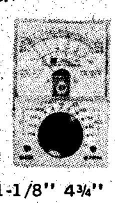
Giant 6½" Meter, inbuilt signal injector. Overload Protected.
AC/V: 2.5V, 10V, 50V, 250V, 500V, 1000V, (10,000Ω/V).
DC/V: 0.5V, 2.5V, 10V, 50V, 250V, 500V, 1000V at (30,000Ω/V) 5000V (10,000Ω/V).
DC/A: 50µA, 1mA, 50mA, 250mA, 1A, 10A.
OHMS: 10kΩ 100kΩ 1MΩ 100MΩ
db: —20 to + 62dB
Signal Injector: Blocking oscillator circuit with a 2SA102 transistor.
Approx. size: 6-2/5" x 7-1/5" x 3-3/5".

H10K1 MODEL L-55 FET MULTITESTER



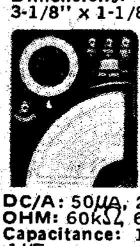
This amazing instrument features a 20 Meg ohm input impedance, 36 ranges from 300 mV full scale to 1200 volts and can measure as low as .2 ohm! Comes complete with probes and carry case.
$42.95 p.p. 75c.

MODEL C1000 $6.95 p.p. 50c

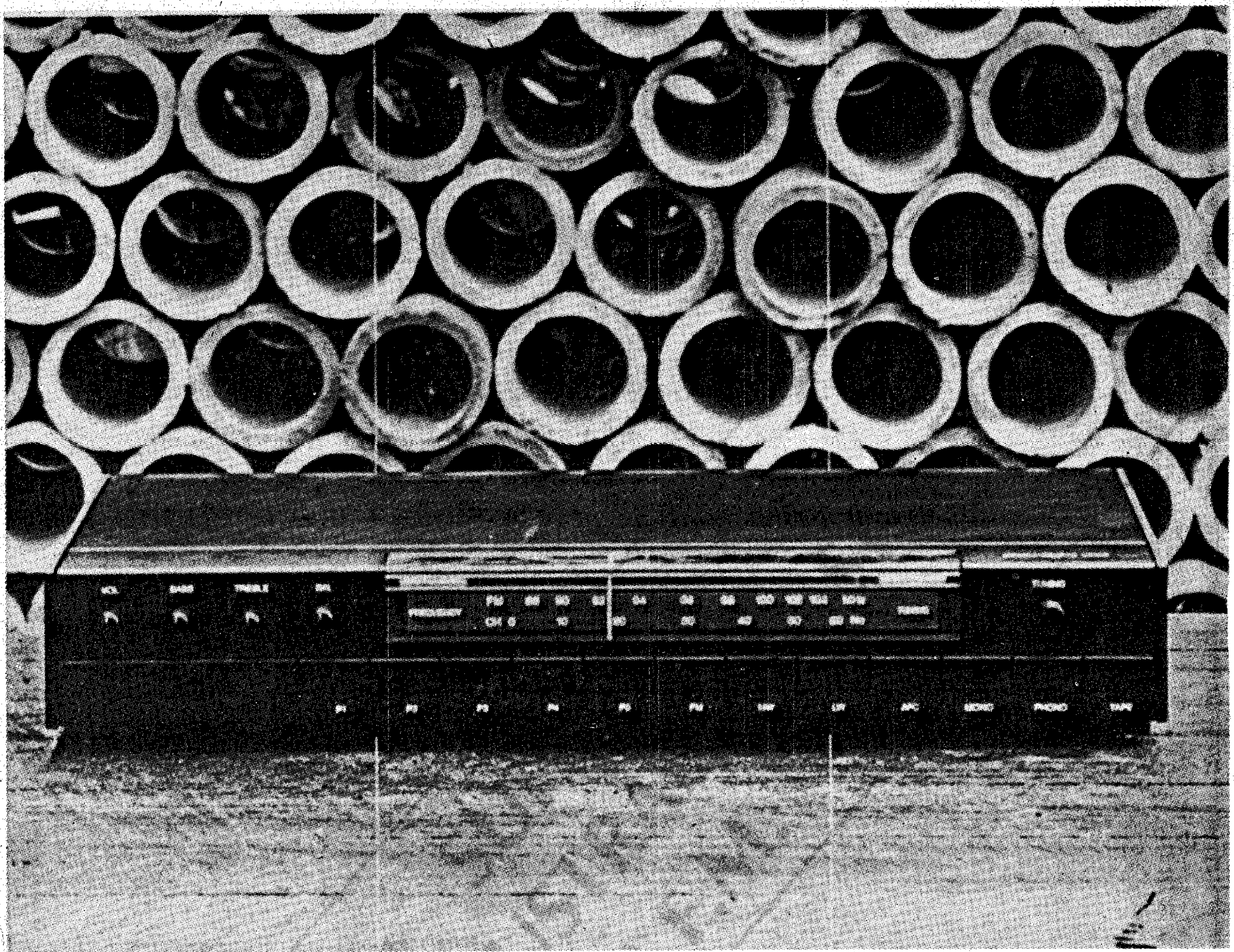


is the ideal low cost pocket meter.
AC volts: 10V, 50V, 250V, 1000V (1000Ω/V).
DC volts: 10V, 50V, 250V, 1000V, (1000Ω/V)
DC current: 1mA, 100mA
OHMS: 150kΩ
Decibels: -10db to +22dB.
Dimensions: 4¾" x 3-1/8" x 1-1/8" 4¾" 3-1/8" x 1-1/8"

200-H. $13.50 p.p. 75c.



90° quadrant meter. Pocket size.
AC/V: 10V, 50V, 100V, 500V, 1000V (10,000Ω/V).
DC/V: 5V, 25V, 50V, 250V, 500V, 2500V (20,000Ω/V).
DC/A: 50µA, 2.5mA, 250mA
OHM: 60kΩ, 6MΩ
Capacitance: 100pF to .01-µF, .001µF to .1µF.
db: -20db to + 22dB.
Audio Output: 10V, 50V, 120V, 1000V Ac.
Approx. size: 4½" x 3¼" x 1-1/8"



scan-dyna 2000

— a new model in the Scan-Dyna series of Hi-Fi receivers. This new unit has the modern elegant design and advanced circuit techniques characteristic of all Scan-Dyna products.

The low, dark look and well-placed control knobs ensure that the Scan-Dyna 2000 receiver will look in place on most book-shelves.

Output is 2 x 25 watts (sine-wave power — into 4 ohms) — impressive considering the price.

Frequency ranges include FM, MW and LW. The Scan-Dyna 2000 has five preselected FM stations plus all facilities required in a Hi-Fi receiver.

PRICE $289.00

DURATONE IMPORTS
3a Botany Street, Phillip,
A.C.T. 2606
Phone: 82 1333

Amplifier-section:

Power output:	2 × 25 W sinus/4 ohm 2 × 40 W music/4 ohm
Distortion:	Less than 1%/max. output
Frequency response:	20-20,000 Hz ± 1.5 dB
Effect band width:	10-60,000 Hz
Signal-to-noise-ratio:	Better than 85 dB/max. output
Channel separation:	Better than 50 dB, 1 kHz
Inputs:	PU inp.: 47 Kohms/2 mV RIAA, Tape inp.: 470 Kohm/200 mV

FM-section:

IF:	With ceramic filters
Tuning range:	87-104 mHz
Pre-selected stations:	5 diode tuned
IHFM Sensitivity:	1.8 μV
Limiting:	1.8 μV/3 dB
Signal-to-noise-ratio:	1.8 μV for 30 dB/100% mod 1 kHz
Distortion:	0.4% for 100% mod., 1 kHz
Capture-ratio:	2 dB
Channel separation:	Better than 35 dB, 1 kHz
Frequency response:	50-15,000 Hz ± 1.5 dB
Pilot suppression:	19 kHz better than 30 dB 38 kHz better than 40 dB

AM-section:

Tuning range LW:	145-360 kHz
Tuning range MW:	510-1,660 kHz
Sensitivity:	1 μV/3 dB signal-to-noise ratio
Signal-to-noise-ratio:	53 dB/1 mV

Control ranges:

Turning knobs:	Tuning, volume with power-switch, bass, treble, balance
Pushbuttons:	Tape, phono, AFC, LW, MW, FM, mono, 5 pre-selected stations FM

Connections:

FM-Antenna:	300 ohm balance, AM-Antenna and earth wire, phono, tape
Speakers:	2 × stereo (4-16 ohm) headphones

Other data:

Indicators:	Meter for AM-FM tuning Meter for pre-selected stations
Power supply:	220 V/50 Hz
Semiconductors:	2 IC's 47 transistors 25 diodes
Dimensions:	25 cm deep 55 cm wide 9 cm high
Color:	Black
Weight:	5,2 kos.

Scan-dyna 2000 meets specifications for DIN 45500

INTERNATIONAL ELECTRONICS UNLIMITED

[illegible]TAL INTEGRATED CIRCUITS

	Ea.		Ea.		Ea.
7400	$ .19	7447	$1.15	74141	$1.23
7401	.19	7448	1.22	74145	1.15
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	2.49	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 $19.95

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 . . $ 7.95; Stereo . . 14.95

Hi Voltage Power Transistors – Prime Quality

Typically 40 Beta at 50 MHz. 10W, 1A max TO-5

NPN	400 VOLT	$2.45 ea.	With combined
NPN	300 VOLT	1.20 ea.	total of 100
NPN	200 VOLT	.75 ea.	trans – 15% Off

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 lpps output BCD mux with spec. sheet 6.95 ea.

MM 5313 28-pin any readout 6 digit lpps 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

MVIO8	Visible red TO 18		.25 ea.
MV50	Axial leads micromini dome	.25 ea.	5/1.00
MMV5020	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	$1.09 ea.
MCT2	Transistor	.69 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	5 V Regulator 200 ma	TO-5	1.10 ea.
309K	5 V 1A Regulator	TO-3	1.65 ea.
310	Voltage Follower Op Amp	TO-5	1.19 ea.
311	Hi perf. Volt. Compartr.	MINI-DIP, TO-5	1.05 ea.
319	Hi-Speed Dual Compartr.	DIP	1.29 ea.
320	Neg. Reg. 5.2, 12, 15	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 OIP	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	OIP	2.69 ea.
380	2 Watt Audio Amp	OIP	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.
703	RF-IF AMP	MINI-OIP	.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	OIP	1.19 ea.
741	Comp. Op AMP	MINI-OIP, TO-5	.35 ea.
747	Dual 741 Op Amp	TO-5 or DIP	.79 ea.
748	Freg. Adj. 741	MINI-OIP	.39 ea.
1303	Stereo Pre-Amp	OIP	.89 ea.
1304	FM Mulpx Stereo Oemod	DIP	1.19 ea.
1307	FM Mulpx Stereo Demod	DIP	.82 ea.
1458	Dual Comp. Op. Amp.	MINI-DIP	.69 ea.
LH2111	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.
3905	Precision Timer	DIP	.65 ea.
7524	Core Mem Sense AMPL	DIP	1.89 ea.
7525	Core Mem Sense AMPL	OIP	.89 ea.
7534	Core Mem Sense Amp	OIP	2.59 ea.
7535	Core Mem Sense Amp	OIP	1.15 ea.
8038	Function Generator	DIP	4.95 ea.
75451	Dual Peripheral Oriver	MINI-OIP	.39 ea.
75452	Dual Peripheral Driver	MINI-OIP	.39 ea.
75453	(351) Oual Periph. Oriver	MINI-OIP	.39 ea.
75491	Quad. seg. driver for LED readout	DIP	1.55 ea.
75492	Hex digit driver	OIP	1.69 ea.

Please specify which data sheets are required with order. Add $.50 per data sheet for items priced less than $1.00 each.

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BETTER THAN BOSE!

That's right. Even though Bose are the most highly reviewed speakers in the industry; even though critics proclaim "Bose is best, big or small, high or low" — now there are two speaker systems better than Bose 901 and Bose 501!

BOSE 901 SERIES TWO

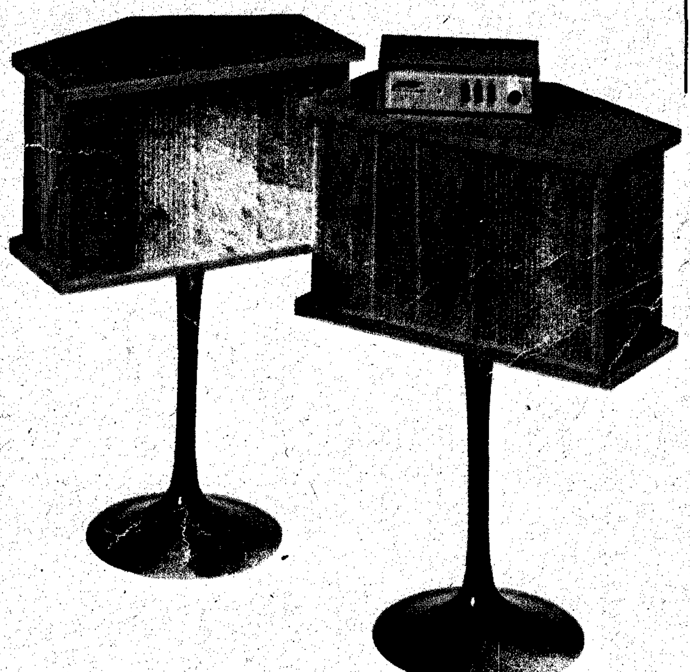
Introducing the Bose 901 Series Two — it's everything that the original 901 was, and more: • Multiplicity of acoustically-coupled full-range drivers • Flat power radiation • Completely new Active Equalizer design, suited to program source variations never available before, and adapted to a much wider range of room environments (even drapes) • and SYNCOM™ II Speaker Computer quality control testing.

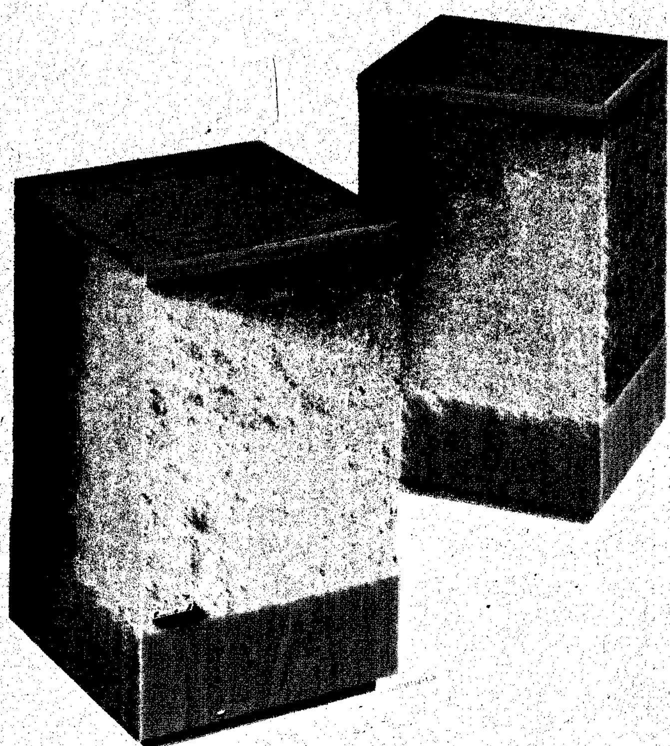
BOSE 501 SERIES TWO

Also introducing the new Bose 501 Series Two — the other speaker with direct and reflected sound, and flat power radiation, at a price far lower than you'd expect to pay.

The new 501 Series Two features: • A new tweeter with double the magnet size of the original 501 and four additional components in the crossover network, for improved high frequency response and power handling capability • and 100% selection and matching of the woofers and tweeters with the SYNCOM™ II Computer — the unique computer designed by Bose and put into operation in August 1973 to achieve a new level of speaker performance.

We invite you to challenge us! Compare the Bose 901 Series Two to any other speaker, regardless of size or price; and compare the Bose 501 Series Two to any speaker up to the price of the 901 Series Two. You be the judge. If we have done our homework correctly, the comparison will be interesting and short!





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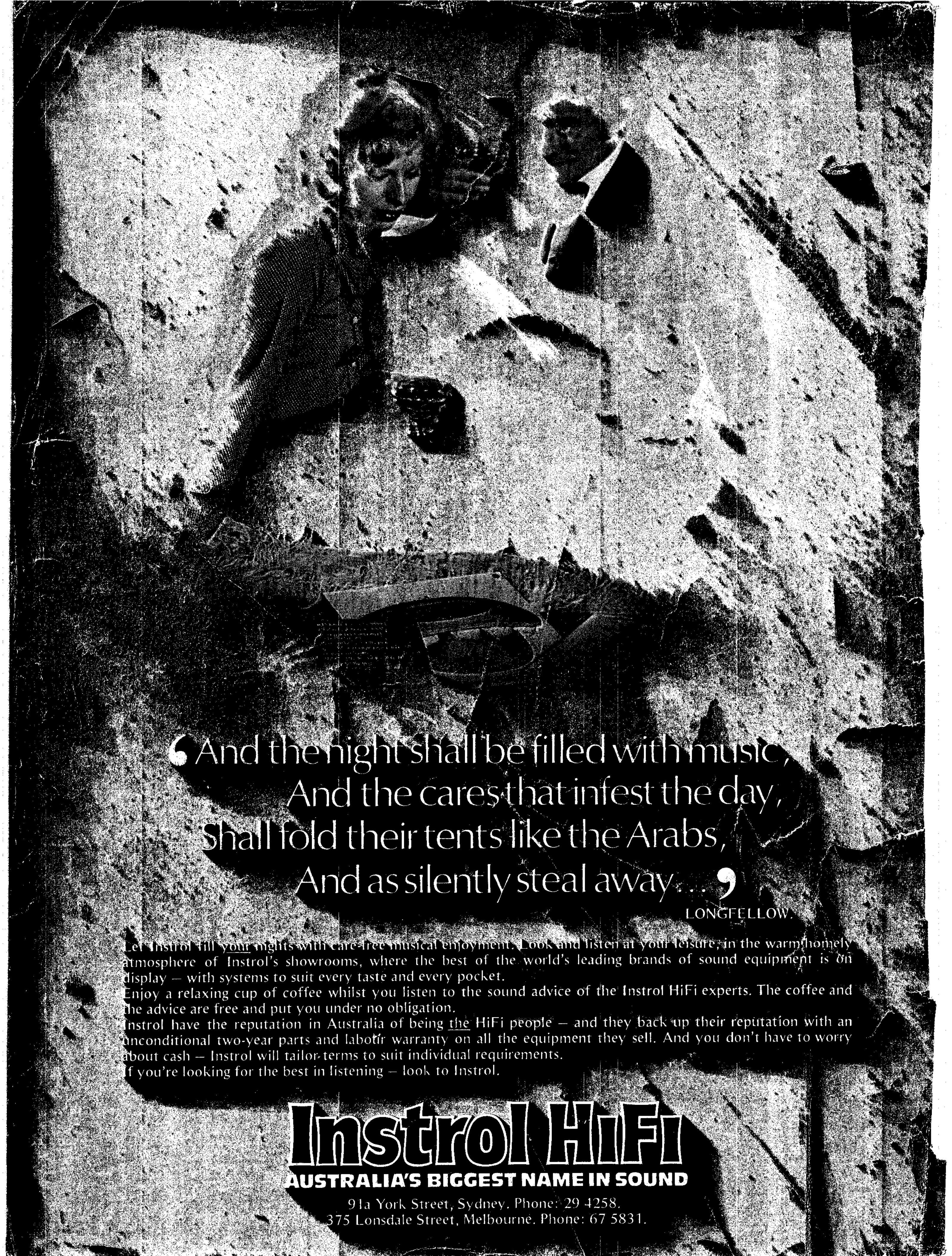

‘And the night shall be filled with music,
And the cares that infest the day,
Shall fold their tents like the Arabs,
And as silently steal away. . .’
LONGFELLOW.
Let Instrol fill your nights with care-free musical enjoyment. Look and listen at your leisure, in the warm homely atmosphere of Instrol's showrooms, where the best of the world's leading brands of sound equipment is on display — with systems to suit every taste and every pocket.
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