FEBRUARY, 1975
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electronics TODAY INTERNATIONAL

HI-FI

IMAGE INTENSIFIERS
QUAD SOUND
SIX GREAT PROJECTS!

ELECTRONIC DETECTION IN ART: PROVING RAPHAEL CHANGED HIS MIND

Registered for posting as a periodical — Category C.

KILL THE HISS

keep the music

Until now tape hiss and other irritating noises prevented true high fidelity reproduction, so JVC invented ANRS (automatic noise reduction system) and incorporated this exclusive feature in the 1667U stereo cassette deck.

ANRS (automatic noise reduction system) as the name implies, ensures absence of tape hiss without sacrificing fidelity and musical reproduction and is claimed to be the world's best system by independent authorities.

Additionally the 1667U features the 'cronios heads' developed by JVC, that have a life ten times longer than ordinary heads. Naturally CrO_2/Normal tape selector switch, electrically governed DC motor, automatic stop mechanism and tape counter are all included.

For maximum recording ease the 1667U features two large VU meters, separate sliding volume controls and convenient push buttons. All this helps the 1667U boast of a frequency response of 30-16000Hz (±3dB) and a low wow and flutter of 0.15% RMS.

A 'must' for any serious stereo enthusiast, the 1667U stereo cassette deck, from JVC.

JVC
IF YOU'RE SERIOUS ABOUT SOUND

ANRS
Automatic Noise Reduction System

WT.GD54J.

electronics TODAY INTERNATIONAL

FEBRUARY, 1975 Vol 5, No 2.

main features

projects

reviews

news & information

COVER: Portrait of Pope Julius II by Raphael (1483-1520). Nearly five hundred years after its execution, scientists proved that the artist had overpainted the original. (Full story page 16 this issue). The portrait has been reproduced by kind permission of the National Gallery, London.

NEXT MONTH

PIONEERS OF RADIO

A definitive history of the early days

DOUBLE STEREO

Better than four-channel sound

PROJECTS

*SOUND/LIGHT TRIGGERED FLASH METER
*IMPEDANCE METER
*LINE AMPLIFIER FOR MICROPHONES
*SIXTEEN-TO-EIGHT CHANNEL SUB-MIXER
*ELECTRONIC SPEEDO FOR CYCLES

The feature articles listed above are included amongst those currently scheduled for our March issue. However, unforseeable circumstances, such as highly topical news or developments may affect the final issue content.

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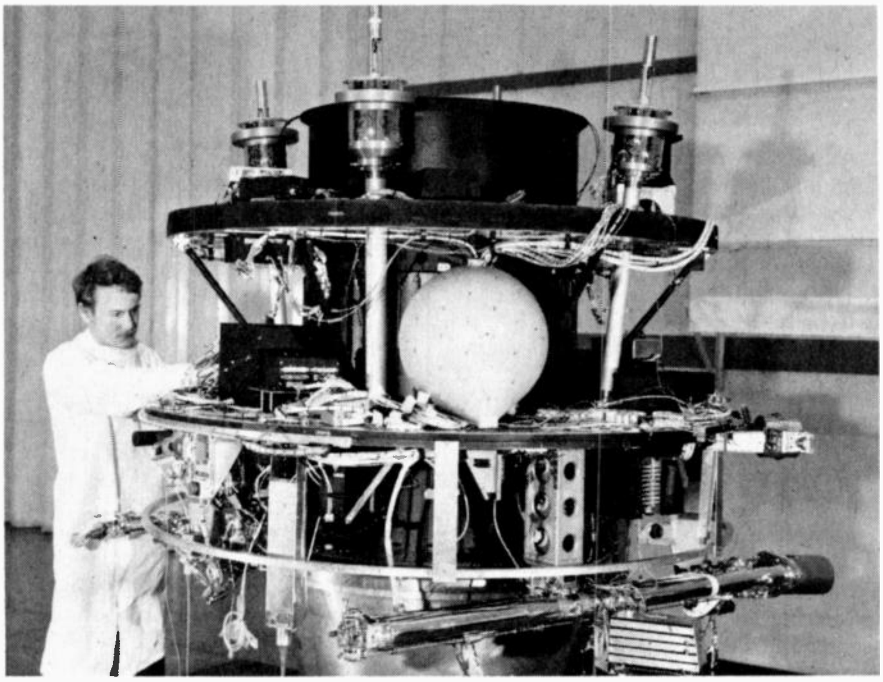
news digest

FIRST GEOSTATIONARY SCIENTIFIC SATELLITE FOR EUROPE



Work goes ahead on the Geostationary Orbital Satellite (GEOS) development 'model' at the Electronic and Space Systems Group of the British Aircraft Corporation in Bristol, south-west England. GEOS is being developed by the Satellites for Technology Application and Research (STAR) consortium of companies for the European Space Research Organisation under the prime contractorship of BAC.

The development model brings together for the first time the many sub-systems from the STAR consortium, together with the on-board experiment apparatus from the nine scientific groups in this multi-national programme. Its purpose is to resolve problems of functioning and electronic compatibility in advance of building the satellite flight model. GEOS is due for launch in the autumn of 1976 and will probe the nature of the electric, magnetic and particle fields in the Earth's magnetosphere.

In operation, data from the satellite's attitude in orbit is derived from on-board sensors and transmitted to the ground control station. Computed instructions sent to the satellite command its attitude and orbit control sub-system to release controlled bursts of hydrazine through small jet thrusters, the reaction from which is used to manoeuvre the satellite in attitude and position. To meet the needs of the scientists whose apparatus is carried by GEOS, it will be moved between positions of 15°W and 40°E while maintaining a constant geostationary orbit 35 900 km above Earth.

ELECTRONIC GUIDE FOR THE BLIND

Germany's Ernst Leinz GmbH are currently developing a lightweight optical device to enable blind people to detect obstacles in front of them.

The prototype units is about the size and shape of a torch. It converts optical signals into electrical signals the strength and frequency of which 'describe' the obstacle encountered.

At present the unit is in prototype form, but Leitz hope to have the devices in production by 1976. Price, it is hoped will not exceed A$300 or so.

US COLOUR TV SALES DROP

US sales of colour TV receivers fell drastically in November. Final sales were 30.6% down compared with the same month in 1973. The decline for the first eleven months of 1974 was approx. 14%.

ALUMINIUM PLATING

Unlike most other metals, aluminium protects itself against many forms of corrosion — by forming a self-healing layer of aluminium oxide on its surface.

Because of this, researchers have for many years tried to find ways of using aluminium to plate other types of metals — especially steel.

Few attempts were totally successful, normal electroplating methods cannot be used. (The so-called Brenner method works, but the process is costly and potentially dangerous.)

Now, however, a breakthrough appears to have made been by scientists at Israel's Tel Aviv University. Professor Eliezer Gileadi and Dr. Emanuel Peled have evolved a successful technique based on a potassium bromide and aluminium bromide solution in a mixture of aromatic hydrocarbons.

The technique has proven remarkably successful. The coating is said to be smooth, homogeneous, fine-grained and surprisingly ductile. "Coated parts", claim the scientists, "can be bent at right angles repeatedly without breaking or peeling off the aluminium coating."

So far all tests have shown that the new process should eventually cost no more than cadmium plating — the plating process is not complex. If this proves to be so, aluminium plating will challenge many existing forms of plating as well as introducing the possibility of new commercial manufacturing techniques. Aluminium plated steel screws, for example, could be used to join aluminium sections without the previous problem of inter-metal corrosion. A further area of possible innovation is in high temperature applications, for the melting point of aluminium is about 660°C compared with only 320°C for cadmium.

MICRO-LASER

A microscopic laser designed for powering optical communication systems has been built by scientists from California Institute of Technology and Japan's Hitachi Ltd. ▶

The laser – 1/60 inch long and 1/250 inch thick – incorporates an artificial periodic corrugation built into the crystalline substance, providing for oscillation and eliminating the need for conventional end-mirrors. The laser is constructed by growing five alternate layers of gallium arsenide and gallium aluminium arsenide, with the process interrupted after growth of the third, central layer to produce the corrugations.

CORDLESS HEADPHONES

Cordless headphones may soon by a reality. Siemens have just released details of a system in which headphones receive programme material via invisible infrared light 'flooding' the listening area.

The heart of the system is a new photodiode with an active area some 9 mm^2. This is installed in the headphones and picks up the frequency modulated infra-red radiation. A filter ensures that the diode picks up *only* infra-red.

The infrared transmitter consists of four LEDs type LD241. Their combined power output of 60 mW is adequate for even for quite large rooms.

Frequency response of the system is said to be excellent and the range extends right up to 100 kHz. Neither dark nor rough areas affect the received signal nor do the headphones have to pointed in any specific or general direction.

A working model of the system was exhibited at the recent electronica '74.

A BOOST FOR SODIUM-SULPHUR BATTERY RESEARCH

Cell from a sodium-sulphur battery is inspected by Dr. S. P. Mitoff. In background, a flame issues from the mouth of a furnace used in preparing the battery's ceramic electrolyte.

A contract for improvement of sodium-sulphur storage batteries has been awarded by the Edison Electric Institute (EEI) to the Research and Development Center.

The Edison Electric Institute funds will help support an extensive GE research program, begun several years ago, aimed at developing this relatively new type of battery for applications in bulk energy storage.

Conceived several years ago, sodium-sulphur batteries employ liquid reactants (liquid sodium and liquid sulphur) separated by a solid electrolyte (a ceramic compound of sodium, aluminium, and oxygen called beta alumina). To maintain peak efficiency and to keep the reactants in liquid form, the batteries must be operated at temperatures of 300° – 350 °C.

To date, the development of sodium-sulphur batteries has been beset by a number of problems, notably deterioration of the ceramic separator between the liquid sodium and the liquid sulphur.

Work under the new EEI contract, initially proposed by GE's Dr. Fritz G. Will and Dr. Stephan P. Mitoff, involves the modification and improvement of the ceramic electrolyte, the evaluation of factors affecting the life of sodium-sulphur cells, and the design and testing of new cells having improved cell configuration and seals.

Sodium-sulphur batteries may some day find application in certain types of electric vehicles. The widespread use of such vehicles within urban areas would eliminate the emissions now released to the atmosphere by internal combustion engines, thus reducing air pollution. Theoretically, an electric car equipped with sodium-sulphur batteries could travel as far on a single charge as a gasoline-powered automobile on a tank of fuel.

Through the Edison Electric Institute and the recently formed Electric Power Research Institute, the investor-owned electric utility companies in the United States are playing an increasingly active role in sponsoring research and development in the electric power field.

THIRTY DOLLAR DOLBY RADIOS SOON?

Even the cheapest of domestic radio receivers may soon have Dolby circuitry inbuilt according to Alan Gregory of the Signetics Corporation, manufacturers of the NE545 Dolby IC chip.

Gregory believes that the inclusion of the chip (which will be sold to manufacturers for less than a dollar (US) will increase the price of domestic receivers by two or three dollars at the most.

NAKAMICHI TO MAKE CASSETTE TAPES

Japan's Nakamichi Research are about to market their own line of high-precision cassettes specially designed for use with their top quality Model 550, 700 and 1000 cassette recorders.

Both ferro oxide and chrome tapes will be produced. The ferro tapes are based on an extra-pure ferro-crystal formulation, whilst the chrome tapes use a special formulation claimed to provide better signal/noise ratio, frequency response and top end output.

Both types of tape will be used in what Nakamich call a 'micro-precision' housing. These will be guaranteed to 'resist jamming and other tape foul-ups'.

The new tapes will be available shortly in both C60 and C90 form. Although specially made for Nakamichi's own cassette recorders, the tapes can of course be used in all other high quality recorders.

(Continued on page 11)

HUGE NATION-WIDE BULK BUYING OFFERS SPECIAL LOW PRICES

DOUGLAS HI-FI

Here are just some of the typical savings from Douglas Hi-Fi in Melbourne, Sydney, Perth and Canberra.

LINEAR DESIGN 169 HI-FI SYSTEM features Garrard automatic turntable, Shure magnetic cartridge, diamond stylus, connection for tape recording/playback, 24 watts RMS power. Heavy duty twin cone 8" speakers in acoustically-correct cabinets.
$189 complete, with 2 year warranty.

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AKAI MODEL GXC 46 D. THE GREATEST VALUE IN HI FI CASSETTE STEREO TAPE RECORDERS TODAY! Famous Dolby system, chrome tape switch, glass crystal ferrite head, automatic distortion reduction system. DOUGLAS HI-FI PRICE WITH 12 MONTHS WARRANTY $289.

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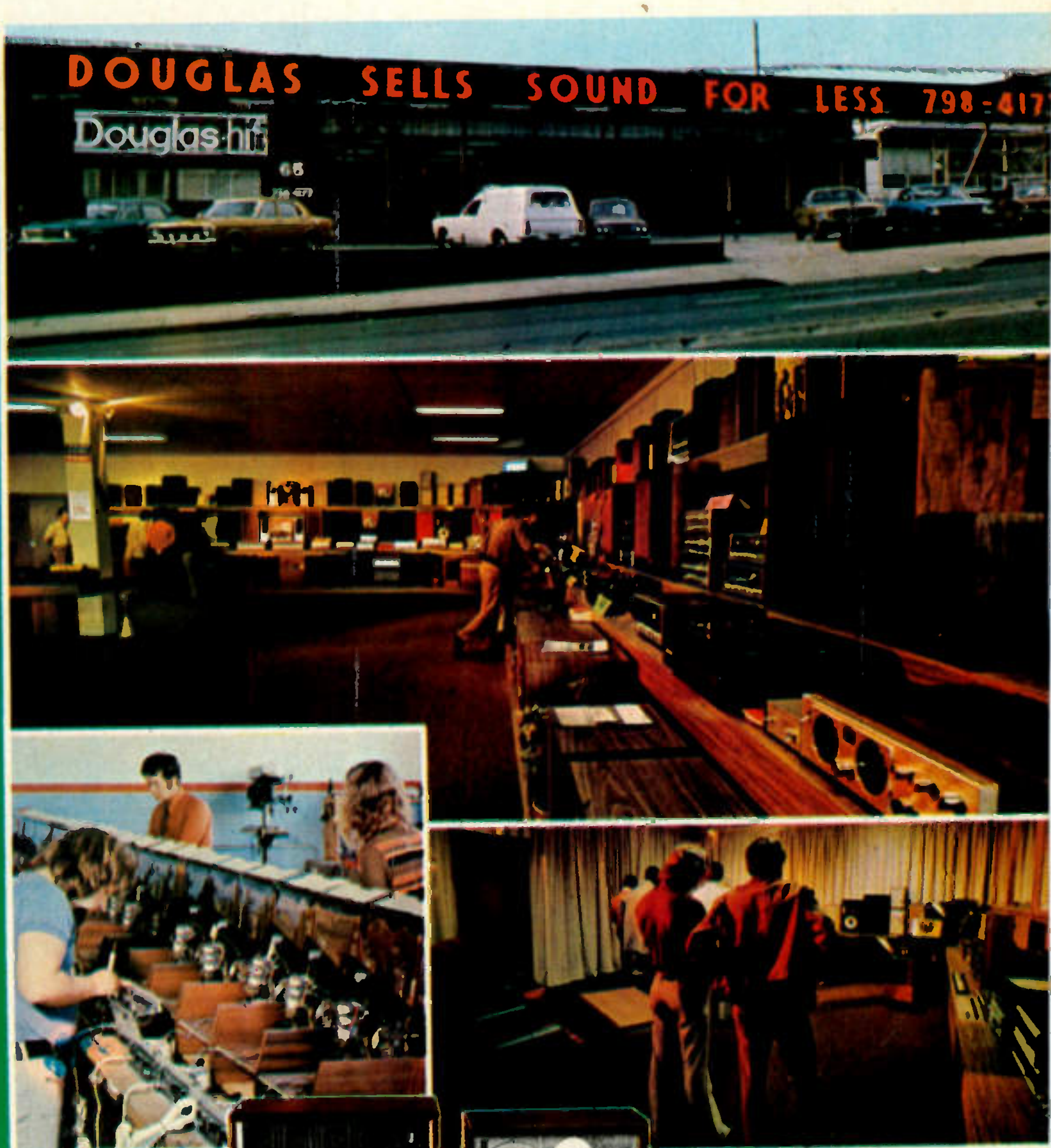

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BUY FOR CASH, LAY-BY OR EASY TERMS ARRANGED!

(Continued from page 6)

TALKING CONTROLS COMPUTERS

A series of general-purpose computer systems which are controlled verify by the human voice has been introduced by the EMI group. These revolutionary systems, the first of their type commercially available in the world, can recognise words spoken in any language, irrespective of vocabulary, accent or dialect, and even against the background sounds of an operational environment.

The ability to identify spoken words and convert them into digital signals overcomes the limitations of conventional methods of computer communication, eliminating the intermediate paperwork associated with data preparation. It is particularly suitable for increasing job efficiency in situations where manually-operated computer communication techniques cannot be applied because an operator's hands, and perhaps eyes, are already fully occupied.

The desk-top equipment will be marketed by EMI Threshold, of Hayes, Middlesex, a company formed jointly on a 60-40 basis by Britain's EMI Limited and Threshold Technology Inc., USA.

Apart from wide business usage, EMI Threshold systems can broaden the horizons of the physically handicapped. They can provide the means to be independent: controlling by voice many day to day functions such as room lighting, heating, telephone, radio and television, typing letters or making simple calculations.

The first system to be announced is the Voice Information Processor (VIP) 100, capable of accepting a vocabulary of up to 150 words or short phrases including digits. The equipment comprises a speech preprocessor unit, mini-computer, alphanumeric display, microphone headset and standard teletypewriter. The system is quickly programmed to accept instructions from up to 16 operators in sequence. The voice data of each person can be stored either in the system's memory, or on orthodox punched paper tape or magnetic disc.

Programming the system is easily done. Initially, the selected vocabulary of up to 150 words or phrases is inserted by teletypewriter into a mini-computer together with any programme of operations which the system will be carrying out later, from spoken instructions. Users of the system then 'train' the equipment to understand their individual pronunciation of the vocabulary by repeating each word either five or 10 times into a noise-cancelling microphone. The repetition of each word enables the VIP 100 system to obtain an average voice pattern from the slight variations which occur each time the speaker pronounces the word. The speaker's pattern for each word is then stored in the memory against the relevant vocabulary data inserted by teletypewriter. The system is now prepared for operation.

To use the system, each operator calls up his own voice pattern, identified by a reference number set on a control unit for speaker selection and word training. Each vocabulary word also has a reference number enabling the operator to call up any given word, at any time during use, from the computer for retraining should the operator's speech be affected by a cold or other causes since initially training the system.

As each word is spoken, it appears on a VDU providing the user to solely at a glance, that the computer has correctly understood the communication.

If, when checking the data on the visual display unit, the operator discovers he has made an error, this can be deleted simply by using a control word such as 'erase' or 'mistake'. The offending words are then cancelled allowing correct data to be inserted.

The VIP 100 costs around £stg12,500 in its basic form. An interesting optional extra is an audio response unit which will verify spoken information it has accepted by repeating it in electronically-generated speech.

In the United States two leading international airlines are now using these systems in conjunction with automatic handling equipment to improve the efficiency of passenger baggage sorting at airport terminals.

(Continued on page 13)

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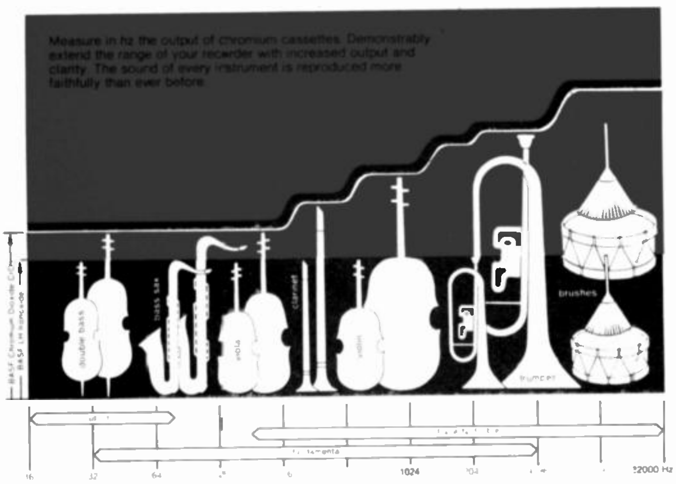

If BASF "Chrome" (Chromium Dioxide—CrO_2) really was chrome like a Mercedes grille, you'd have a beautifully visible demonstration of what CrO_2 cassette tape can do for cassette sound.

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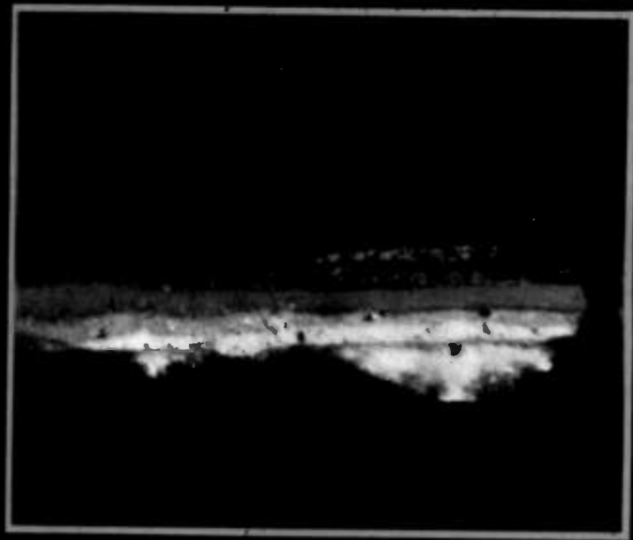


Colour microphotograph of cross-section of a pinhead size of paint removed from the green background of "Pope Julius II" (see page 23).

SCIENCE IN ART

– proving that Raphael changed his mind – nearly five centuries after.

by Dr. Peter Sydenham

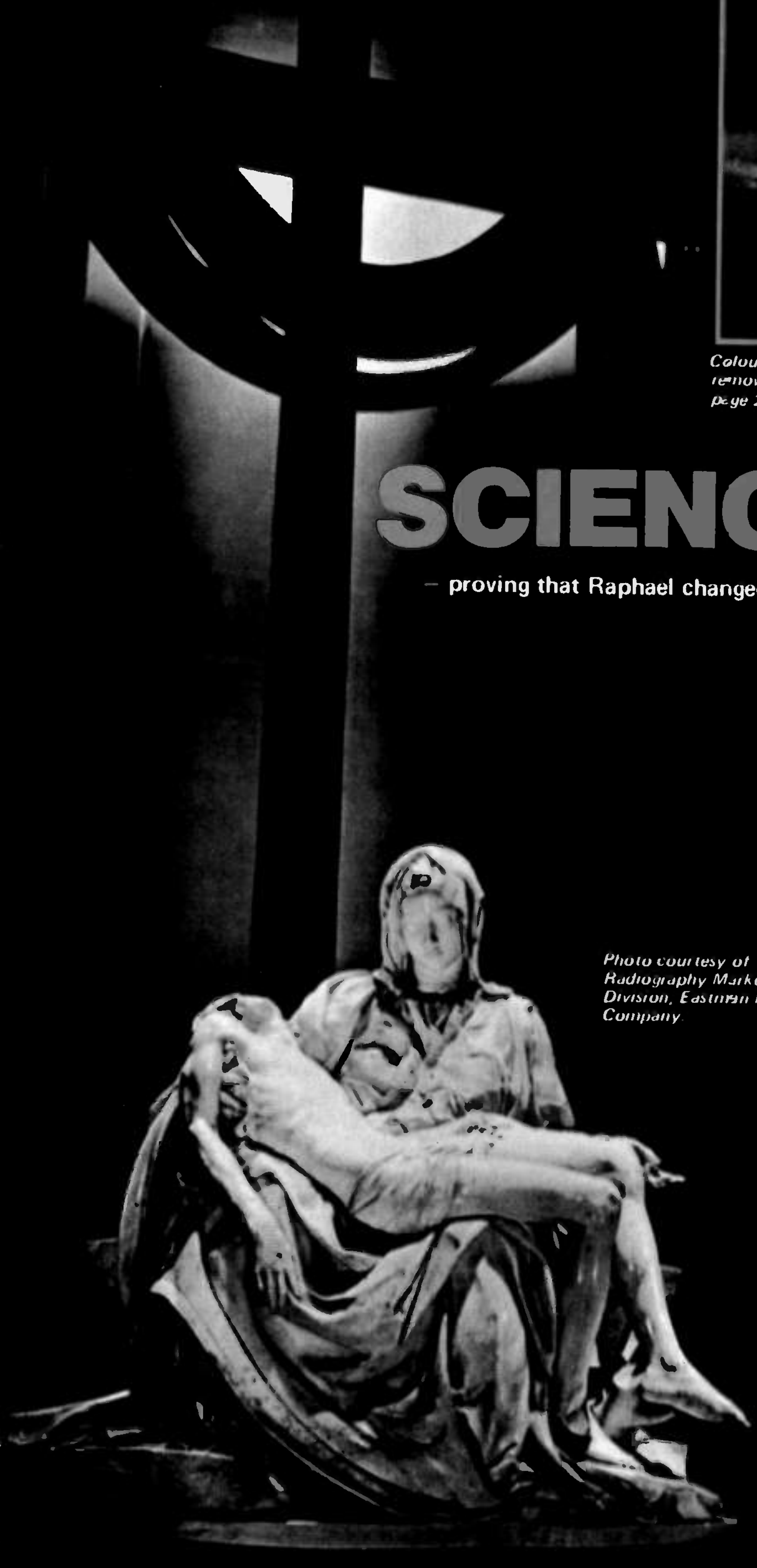


Photo courtesy of Radiography Markets Division, Eastman Kodak Company.

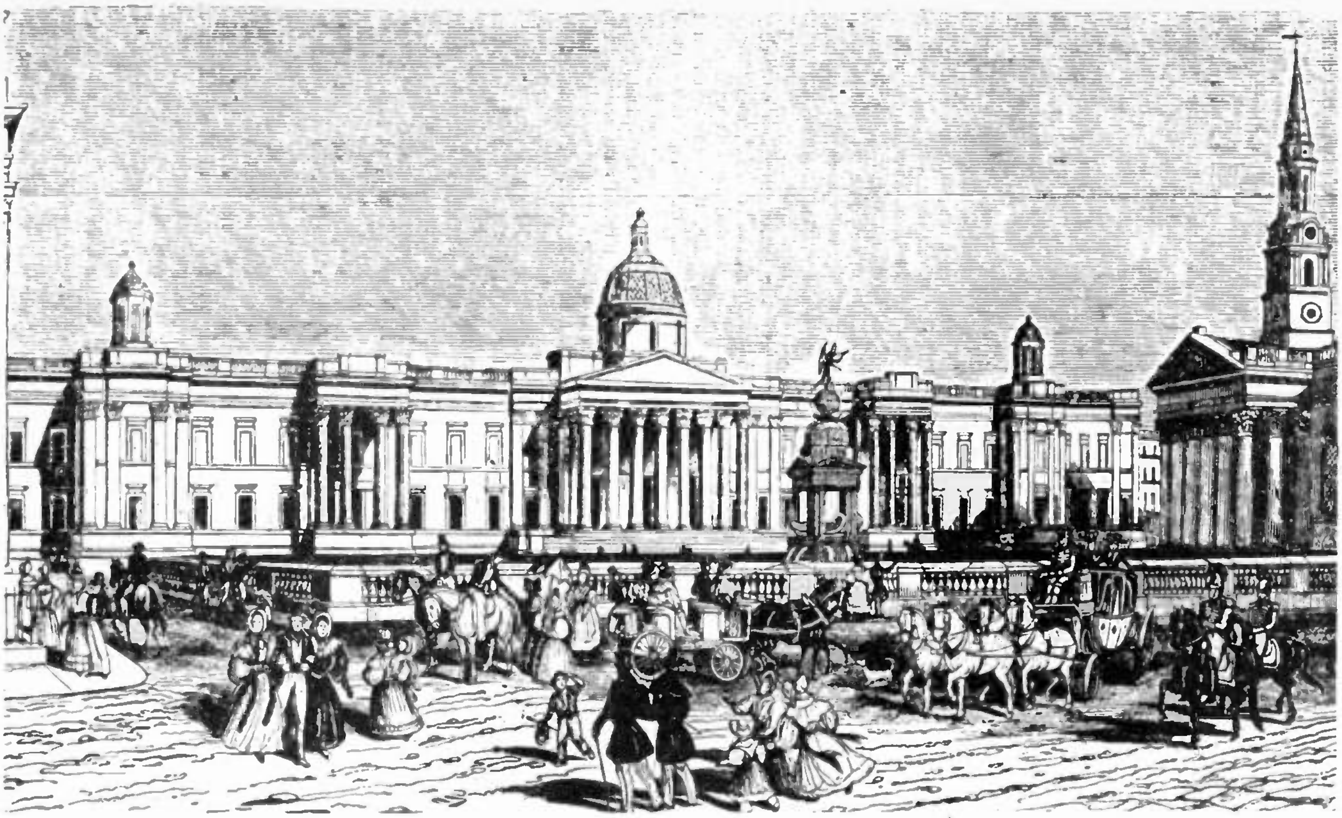


Fig. 1. London's National Gallery was built in 1837 — Nelson's column had not yet been erected.

BY 1978, Australians will be using a new National Gallery that contains many of the valuable treasures currently in the news. Whilst in London, our correspondent, Dr. Peter Sydenham of the University of New England, Armidale, N.S.W., visited the National Gallery to see how the most advanced gallery scientific group are using science to assist art.

Collections of antiquaria usually grow from the personal interest of one or more people who are interested in some intrinsic quality of the collection. It may be so that they can view the items on demand, or research the growth of a discipline. Others collect items just for the sake of collecting — or assemble a collection so as to make money. But regardless of the original intention, seldom are the collectors expert at maintenance or preservation. And all too often there are too little funds for adequate conservation anyway. So at some stage the collection is broken up by sale or moved as a whole into the care of a larger Institution where, we might naively imagine, things are then done

AN IMAGE LOCKED IN MARBLE

Michelangelo's definition of sculpture was "to free the image hidden in the block." This he did in his majestic La Pieta, a statue of dense Carrara marble that remained unmoved from St. Peter's Basilica in Rome until it was displayed in the Vatican Pavilion at the 1964 World's Fair in New York. Prior to moving the priceless sculpture, however, the Vatican Pavilion Committee asked Eastman Kodak to conduct an exhaustive x-ray examination to determine the extent of damage and repair which La Pieta was known to have incurred. The results were unexpectedly beautiful, as in the ghost of a face that appears above. Radiography also revealed much about the physical condition of Michelangelo's creation. They showed that (above) metal pins had been used to rejoin the broken fingers on the hand of the Virgin, and that at one time a "pious vandal" (to use one ecclesiastic's phrase) had drilled shallow holes (seen above) in the top of the Virgin's head for the purpose of affixing a halo, later removed. This and other information assured the custodians of La Pieta that the voyage to America would not be dangerous, and has proven useful in subsequent maintenance and repair of the sculpture.

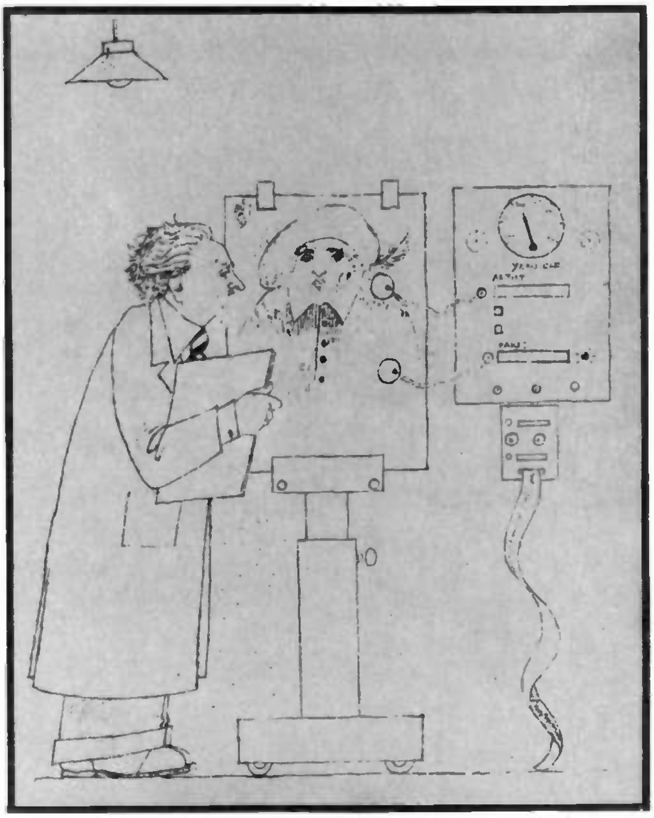


Fig.2. The museum scientist is rarely involved in detecting forgeries — the main role is to provide information that assists restoration and conservation. (Cartoon drawn by Marcus Rees-Roberts for a National Gallery publication).

SCIENCE IN ART

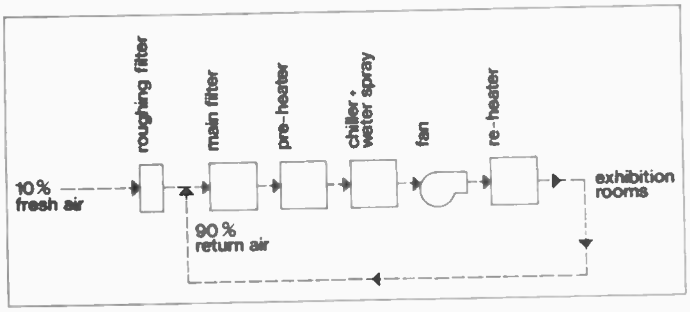


Fig.3. Block diagram of arrangement used to clean and correct humidity and temperature of air.

properly with the right priorities being allocated.

Large Institutions, although better endowed financially in the absolute sense, often face even more difficult problems in the setting of priorities; they must always make decisions in the light of current circumstances. Take, for example, the National Gallery in London where Britain stores a large proportion of its art treasures. Its history typifies what has often happened to valuable collections of old works.

In 1777, a member of Parliament, one John Wilkes proposed the erection of a modest "Noble Gallery" to house a certain collection of pictures then put up for sale. Wilkes' idea fell on sterile ground (at that time) it was not until the early nineteenth century that the idea was actually realised.

Then, John Angerstein, a rich merchant-collector, had built up a superb collection which was housed in a house in Pall Mall. On his death in 1823, various public-spirited noblemen, successfully lobbied the Government to buy the collection and its premises as the "foundation of a National Gallery". Sir George Beaumont and Rev. Howell Carr also donated their works to the cause.

So, in 1824 a new tradition began. The rooms in Pall Mall soon became overcrowded with the continually arriving new acquisitions and the Trustees began a search for a better home. By 1838 a new building (the one used today and which was designed by William Wilkins) had been built and brought into use as the National Gallery. This was not the end of the accommodation difficulty because the new building, shown in Fig.1., was originally shared with the Royal Academy. The lack of space and unenlightened public habits of the times rapidly turned the still-cramped rooms into feotid, miserable places wherein damage to the artworks became rampant – dust "an inch thick accumulated on the frames". The need for conservation was realised slowly and gradually various moves were taken in the right direction. In 1869, the Royal Academy moved to Burlington House overlooking the Mall – leaving the Wilkins designed building to cater solely for art.

Until 1855 the Trustees had little technical knowledge in their midst so truly scientific approaches to the problems of conservation were scant indeed. In that year, Sir Charles Eastlake became the first Director (rather than just the "Keeper") and this brought, because of his experience, some semblance of scientific approach into the Gallery's control. Eastlake, as a visionary buyer, provided the Gallery with 137 new priceless pictures at a time when costs were reasonable – the Director must play both art selector and conservator roles.

Some sound and potentially far-reaching advice on scientific matters had often been forthcoming before Eastlake's new appointment but usually to no avail. Faraday, for instance, in 1850, wrote of the dangers of the air pollution sources existing around Trafalgar Square – they used urine in those times to wash clothes and raw materials! The same report suggested air conditioning (which included humidification as well as temperature control) should be adopted; it had already been in use in the Houses of Parliament for 20 years but the Committee, in its wisdom, decided to merely cover a few of the

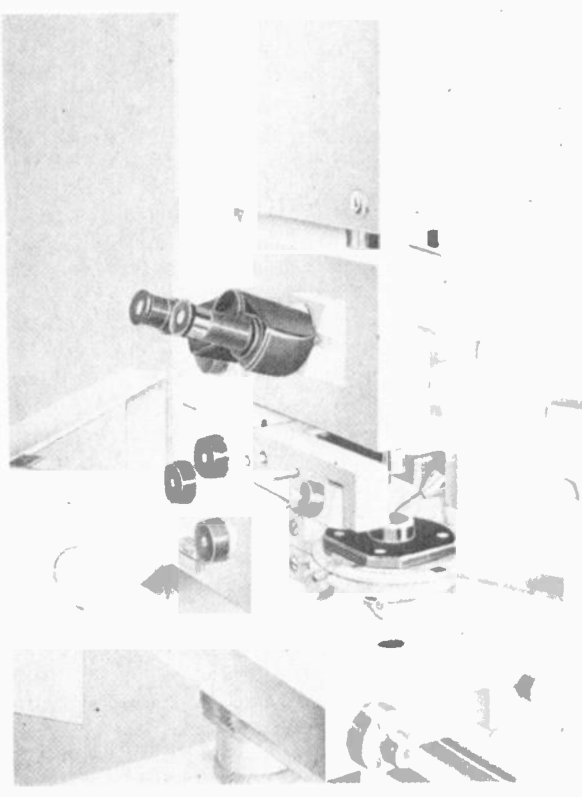
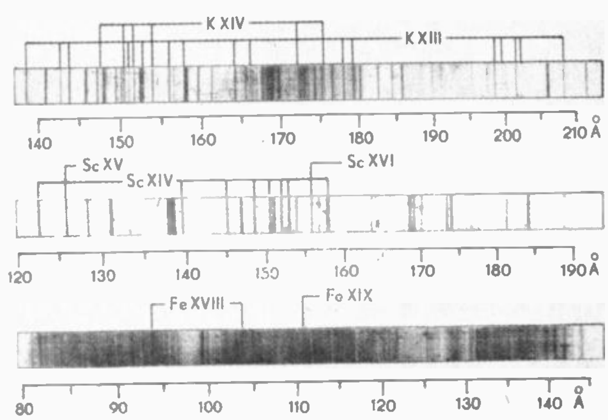


Fig.4. Laser end of the Ziess (Jena) LMA I, laser microspectral analyser. Emission produced at the central pointed spark electrode is viewed by a spectrophotometer that provides a spectrum photograph like that shown here.



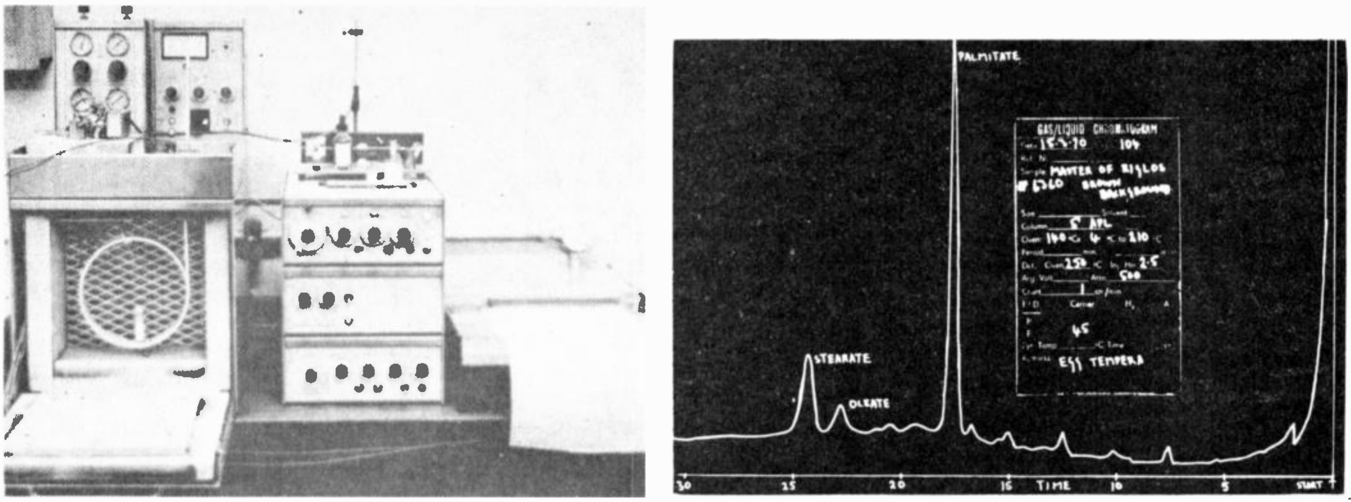


Fig.5. This Pye gas-chromatograph is used to provide chemical analyses of painters' mediums. Its chart output for egg tempera is given here (as recorded for an analysis of "The Crucifixion" by the Master of Ruglos).

works in glass as the improved preservation measures.

Science did eventually become recognised in the National Gallery for, in 1934, F. Rawlins was appointed as its first Scientific Adviser. Recommendations were again made for climate control but storage of the works in slate-mines during the Second World War did more to prove the point about climatory conditions than learned advice, and climate control gradually was introduced into the Gallery. Today, climate control is nearly total in the National Gallery – few collections anywhere else enjoy proper climate control.

The National Gallery now has a specific Scientific Department wherein three trained scientists devote their entire time to providing scientific assistance for the many kind of problems that arise in the Gallery. From the scientist's point of view there is need for more staff but the Trustees see that other priorities should use any spare funds. No doubt, with time, the ratio of scientific effort to total maintenance and acquisition costs will increase. How much effort should be expended for a collection with 2550 pictures of which many are purchased at over two million dollars each is the leading question.

Looking back on this account it is easy to suggest that unimaginative people were in control. Current opinion must, however, be tempered by the recognition that science, as we know it today (especially the electrical branch) was then in a stage of a gradual development running concurrently with the National Gallery's maturity. Modern measurement and control, adequate to handle many of the problems involved were not even close to reality until the turn of this century.

Compounding the problem of blending science and art is the fact that scientists and artists/art lovers often lie at the extreme ends of the physical knowledge and attitude scales. It was not surprising to hear in the past (and the situation still continues) such statements as "the pictures must breathe" and that "they will not stand the shock if climate control should break-down putting the picture back in the uncontrolled environment to which it is unaccustomed". Even now it is held by critics that 'daylight' is essential for viewing – scientists certainly could not agree as to what 'daylight' the artists are implying so how can there be a basis for such an argument.

For all of this, science is now allowed to play an important role in conservation, not only in the art gallery but in any kind of museum. Today, plenty of science can be brought to bear on art problems that the Trustees of the National Gallery have inherited from the past. For instance, the building looks fine as a monument but what was adequate in 1836 does not entirely suit today's overall requirements. The new Australian Gallery is starting from scratch giving someone else a new start where science can be effectively brought to bear.

Although there is clearly need for improved scientific effort at the National Gallery it still enjoys the distinction of being one of the most advanced galleries in the World in this respect. Much of the work of the modest scientific group is setting the pace for other galleries to follow.

Where can science help?

An art gallery, or any similar treasure-house, has to perform several simultaneous functions. It must house the collection in a suitable fashion, ideally with climate control; it must provide a secure environment not only against obvious theft but also against natural disaster and man-made destruction; it must provide experts and facilities for conservation, restoration, original research and, less commonly, for the identification of and the discovery of new finds.

As science is the systematic approach to gaining new information about a subject, virtually every aspect of an art gallery programme could benefit from the application of scientific effort. This fact is being recognised more and more with time.

On the use of the building, science can provide measurements such as climate variation and pollutant level but having figures is only part of the story, for the cost of control may not be acceptable – it is hard to imagine visitors being clad in sterile garments, entering via air locks to view works hanging in clean-air rooms like those used in the manufacture of semiconductors.

Similarly, so with security, the collection must be safe-guarded against theft and damage yet not appear to be over safe. Over-zealous security measures can detract from the visitors' experience. Theoretically the collection should also be in an atomic-bomb proof type shelter for we are the custodians of treasures which are also the right of the future generations.

Anyone who has been into the Pergamon Museum (The Eastern-blocs' equivalent to the British Museum) in East Berlin will know how a concrete block house structure spoils the overall experience of visiting works of art.

Matters of security and the building, therefore, tend to lie more in the hands of government bodies rather than the museums' scientific staff. At the National Gallery, the latter are only able to advise and suggest what is needed – the rest is left to the Department of the Environment.

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When it comes to assisting the professional art work of the gallery the scientist's role becomes vital.

The scientists' main work is in providing information about restoration and conservation processes to the highly skilled restorers. Rarely is there need to play judge (as depicted by the cartoon given in Fig. 2) in cases of forgery. Fakes usually fail to convince on points that are picked up by the art expert — scientific methods (those using instruments) are secondary in making decisions. Occasionally, but not often, as we shall see at the end of this feature, science can act detective and point to more discovery.

The restorer is greatly assisted in his or her task — which can take up to several years to complete — by knowledge of pigment composition, of corrosion removal methods and of material structure. These points are, and have been, accepted for many decades now by nearly everyone as the vital requirements of the restorer. There is little glamour in this work and gradually improved chemical analytical methods which require little actual microchemistry procedure are finding application.

The core substance of gallery work is cleaning, restoring and conserving the pieces as they arrive into safe keeping. Cleaning involves removal of dirt and oxidised varnish. Research findings on solvents and electro-chemical corrosion reduction are applied here. Restoration involves ensuring that the medium is secure on its support; if not, remedying the faults and then the rebuilding of missing areas in as an exactly similar manner as first existed. The golden rule of all antique restoration is that no repair or alteration is carried out in a manner that is not reversible It must be possible to entirely remove the repair at a later date. The restorer should, ideally, add no permanent interpretation of his own.

Although much research has already been expended on corrosion mechanism, chemical analysis and strength of materials, the conservation/restoration scientist finds that many of the antiquarian problems in these fields have not been researched. Corrosion of metals over short periods is the main emphasis in engineering — not the slow decay of articles such as plaster, paper, wood and fabrics over centuries of time. For this reason alone, more research must be carried out as and when the demand occurs. Most forms of art deterioration occur so slowly that they often cannot be sensed in one man's lifetime. Surprisingly few groups are studying ways to detect deterioration more quickly. For example, only the National Gallery has equipment — and that is still in a prototype form — that can measure in an absolute way the changing colour of a painting. It seems the point that detection is the first stage to proper prevention has still not been taken by many museum trustees.

How science is applied.

Just as a compromise must be made between scientific staff and arts staff, then so also must one be made about the amount of on the spot equipment made available for the resident scientists to use.

The National Gallery has quite a range, as we shall see, but their demands often run to requiring the use of other instruments. In such cases the instrument is moved to the art work or the art work to another laboratory, such as the more extensive British Museum Research Laboratory. The instrument range of the National Gallery reflects the proven needs and, to a lesser extent, the special interests

Holographic interferometry can now be used to detect incipient damage in oil paintings. The technique has been devised by Italian scientists S. Amadesi et al and is fully reported in Applied Optics 13, 2009; 1974.

The painting to be checked is warmed slightly. Any detached areas disperse heat less than sound areas — thus their thermal expansion is greater. The damaged areas can easily be seen by comparing two holograms made five minutes apart.

Our example shows the technique used on Piere Francesco Fiorentina's 'Santa Caterina — a 15th century panel painting. The 'kinks in the second picture are the damaged areas.

of the staff. Garry Thomson, who heads the Scientific Department, has been largely responsible for setting up objective colour fading practices. Joyce Plesters, (whose husband is a restorer at the Victoria and Albert Museum), is the expert on pigment analysis.

In use, measurements and tests are made as needed and all data recorded in a dossier held on each art-piece. These files contain the information built up about the picture — where and when it was found; the history, where known; the work that has been carried out over the ages and the measurements made. Some dossiers are centuries-old. At present it is the dossier information that largely shows if the work is safely conserved — not objective measurements. The more that is known about the picture, both from static and dynamic viewpoints, the better the restoration.

Environmental control

Since the National Gallery was first conceived it has been obvious to those more skilled in science that a constant environment having the right temperature (about 20°C, but not vital) and relative humidity (55 per cent RH held to within 3%) would best preserve the total fabric of the artworks. Probably the greatest single cause of damage is repeated stressing of the art surface by repeated humidity changes. It is also important to control the noxious gases content of the air — especially SO_2 which forms sulphuric acid with condensation. Figure 3 shows the block diagram of the air conditioning system used. By using washed air methods, particulates and many gases are filtered out: it also enables the relative humidity to be controlled. Climate control, because it uses relatively straightforward technology, is left to the Department of Environment's responsibility. In certain cases the painting is given its own specially controlled environment — for example, hermatically sealed packing modules are being researched at present as a way to overcome transport problems.

Another aspect of environmental control is that the lighting intensity and quality must be up to standards laid down by art experts yet not be such that it accelerates colour changes because of harmful ultra-violet content. To this end natural daylight is made available in all rooms, entering via U.V. filter panels. To maintain a constant level many rooms have automatically moving venetian blinds that are controlled by photo electric cells monitoring the light level. For dull days natural light is supplemented by voltage controlled fluorescent

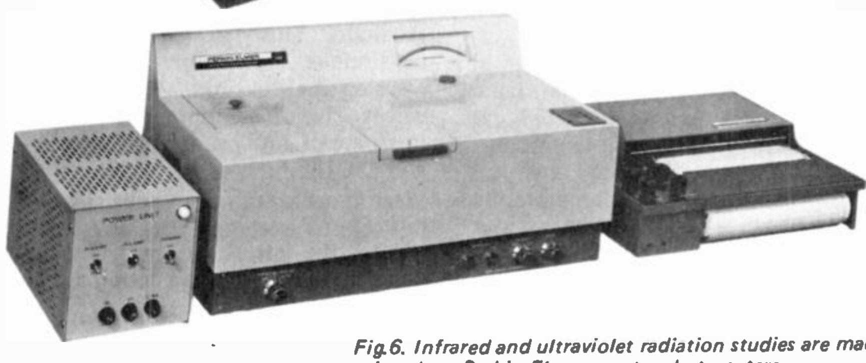

Fig.6. Infrared and ultraviolet radiation studies are made using these Perkin-Elmer spectrophotometers.

lighting, having dimming capability of 6:1. The ideal illumination level is 150 Lux and (between you and I) much of the time the so-called "natural light" is in fact very much artificial!

CHEMICAL ANALYSIS

A major part of the work-load of the Scientific Department is chemical analysis of materials of paintings — wood panels, canvases, paint pigments, varnishes. The restorer desires as much information about the work that is in repair as is possible.

Literally pin-head sizes of paint are removed from the repair area. The flake is then moulded into a small plastic block that is then polished across the flake so as to reveal its cross section.

Using a variety of microscope techniques cross-sectional colour photographs are produced that clearly show the various layers used by the artist. Such information does occasionally aid verification and identification of the artist or his school but not often. Study of the layers used mainly assists the restorer to rebuild the paint as the artist built it originally. In this way the same visual effect is repeated — the final appearance depends much on the underpaintings and composition of paints. In some cases, it is also possible to trace the history of a work, the penetration of one colour into cracks is a valuable pointer as to historical sequence of layer application. The microscope work needs little explanation.

Microchemistry is also used to assist identification of pigments but the move is toward analytic instrument usage. The newest tool purchased at the National Gallery is a laser micro-spectrochemical analyser, a new use to which the laser has been put.

In this instrument a small pulsed laser source is focussed onto the specimen of material to be analysed. A shot is fired producing a minute crater. This vaporizes the extremely small area of surface (selected by a simultaneous visual viewing magnifier) liberating various chemicals as gases. It is not easy to make a direct analysis of these gases but the task is made much easier if they are produced against a background of an electrical spark. The resultant combined radiation spectrum is recorded using photographic recording of the dispersed wavelengths. The emission production unit is shown in Fig. 4 along with a typical "fingerprint" spectrum. In use a spectrum recorded for a specimen is compared against a library of standard records. The extremely fine pit of the laser shot, about 10-100μm across depending upon what is desired, gives the analyst extreme detail of pigment composition enabling measurements to be made within the thinnest of paint

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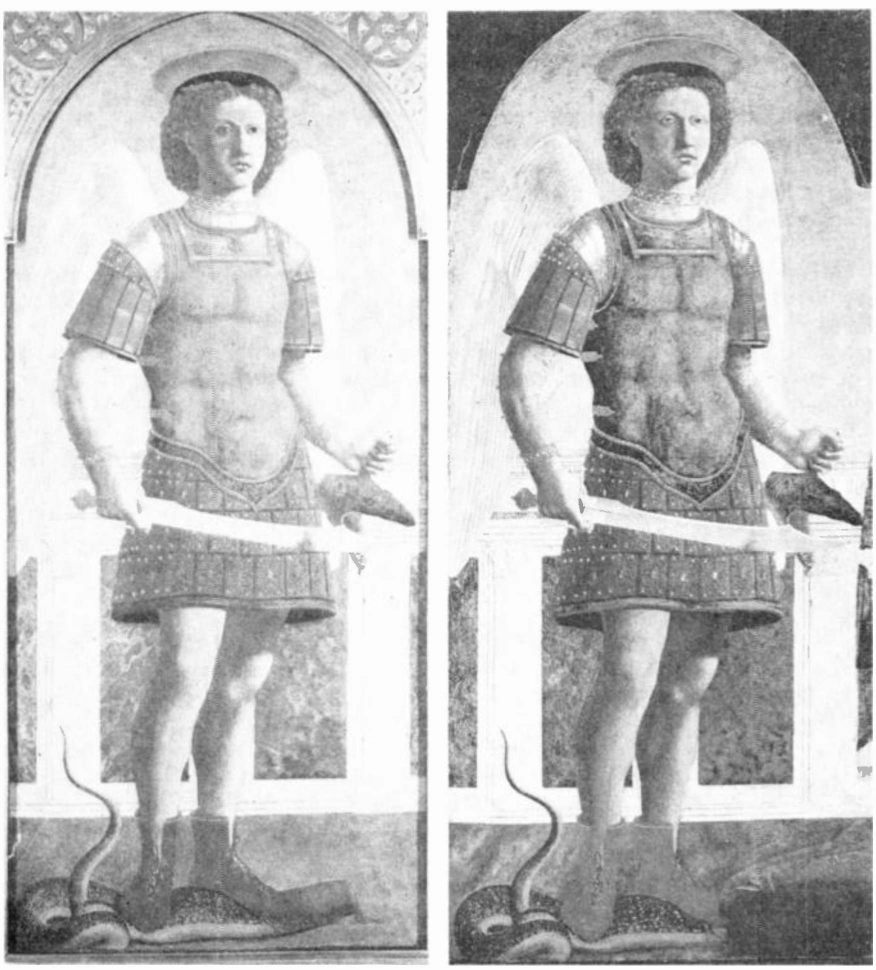
layers. At present the Gallery possesses some three thousand odd plastic-mounted flakes to be analysed this way!

Knowing about the pigment used is but one part of the need, for pigments must be secured with a medium that turns to a firm permanent binder with time. Artists used all manner of mediums and drying oils – egg tempera (yes, literally egg!); walnut, linseed, poppyseed oils. Whereas the pigments remain reasonably inert with time these latter do not and the gallery staff need to know what happens in order to identify the medium originally used. This, they do, using gas chromatography.

In the equipment used (and shown in Fig. 5) a sample is injected into the end of a long tube that is heated and packed with a suitable absorbent powder. The partitioning chemical process in the tube acts to separate the various chemical constituents so that they arrive at the other end at differing times. With the use of appropriate electronic detectors the various arrival times can be recorded. A trace, such as that given in Fig. 5, provides another type of "fingerprint" that tells the composition.

The laboratory also has proprietary spectrophotometers that enable the transmission/reflection characteristics of filters, paint surfaces and the like to be recorded. The two instruments are shown in Fig. 6. The sample is placed in the appropriate machine – one covers the radiation wavelengths in the ultra-violet (190 nm-800 nm wavelength) – where monochromatic light is radiated (or reflected) through the specimen and the intensity recorded This is repeated as a continuous scan with a range of wavelengths to produce an intensity versus wavelength plot. These instruments find use for checking U.V. and I.R. filter materials.

Many calculations are needed with the various analytical instruments. To reduce the effort a programmable desk calculator with coupled tape interfacing is available for use where needed. A one hundred channel data logger system is also used in various kinds of research tests. Many other methods of analysis exist – if the above methods do not suffice the staff make use of instruments in other institutions.



BEFORE CLEANING AFTER CLEANING

Fig. 7. X-radiographic examination of "St. Michael" by Piero della Francesca revealed an anomolous area under the final painting – bottom right hand corner.

Non-visible imaging

In 1895 Röntgen discovered the existence of X-rays and the principle of X-radiography rocketed into immediate use.

It is common knowledge that X-rays enable photographs to be made where high-mass contrast exists, metals in non-metal bodies, for instance. This makes the technique useful for viewing the hidden shape of massively corroded articles – it was used by the British Museum to restore the Bull Cup from Cyprus. It can also be useful in art-work studies, for the X-ray shot can reveal variations in the underlayers densities that are not visible to the eye, especially before the work is cleaned. The painting "St. Michael" by Piero della Francesca was shown in this way to be one part of a five panel altar piece for the Church of St. Agostino in the mid-1400's. In this case, X-rays provided the clinching evidence by revealing (see Fig. 7) a piece of drapery in one corner. All but one panel have now been located.

Another non-visible imagery technique is to image the picture in the infra-red radiation region. The gallery staff use a television system based on the "Resistron" camera tube which is sensitive around 1.75μm. I.R. methods can penetrate the paint layers to reveal the original artist's sketch made with charcoal or the like before painting was commenced. Such a sketch is a valuable clue to the actual artist, the school and the date. In this time, when remote-sensing is currently of interest for world resource mapping, one might be inclined to suggest that false-colour photography might be useful in art work but this is not so.

COLOUR CHANGE

I have already touched on the need to be able to detect deterioration with utmost speed – a century of subjective observation is not good enough.

Various tests can be made on substitute materials – they can be subjected to accelerated fading conditions of light and pollutants: the real test, however, is what is actually happening to the painting in question. Remarkably, no other gallery appears to have made attempts to find out how to make reliable objective measurements.

Working with Professor W.D. Wright (formerly of Imperial College, London) the National Gallery have

Fig.8. This special spectrophotometer has been developed to monitor changes in colour over long periods.

just completed a specially constructed prototype spectrophotometer. In use the painting is placed in front of its input viewing area, as shown in Fig. 8. The spot on the painting that is to be measured is brought into the correct place using a coincident optical viewer and past photographs. To ease this operation a fibre-optic bundle cord 'connects' the painting to the more massive spectrophotometer. Once set up, a monochromator, built into the unit, provides pure colour illumination that reflects from the picture to be registered in the photo-electric pick up sensor — a photo multiplier.

In this manner the reflection from an area of picture about 2 mm across is recorded for radiation ranging from 380 to 760 nm. Both reflectance and wavelength are automatically recorded thereby providing a 'fingerprint' of the chosen spot.

This equipment has been carefully designed to maintain long-term accuracy. As the components of the spectrophotometer undoubtedly alter with time, the equipment is periodically calibrated using standard colour ceramic tiles that are standardised with respect to national colour Standards). It is hoped that the method will prove to be so satisfactory that art experts in a century from now will be able to rely on today's results.

The spectrophotometer has not been in use long enough yet to provide deterioration data but without doubt it will provide vitally needed data much quicker than the traditional visual methods.

THE FASCINATION OF IDENTIFICATION

As I have said already the museum scientist is occasionally called upon to verify authenticity of a work. In the same vein, but more common, is the occasional chance find that occurs as the work is being studied to aid restoration and cleaning. For example, Prussian blue (based on ferric ferrocyanide) was accidentally discovered in 1704 and the fact was recorded in history. Hence, any use of it on works accredited before that date must be as additional, repainted areas, or the work must be a later copy. By knowing miriads of facts like this, scientists can provide valuable assistance.

To illustrate the remarks given here I shall outline the procedures of a recent instance. The National Gallery has a painting "Portrait of Pope Julius II" that was thought to be one of a few copies made of an original by Raphael (1483-1520). (Such copies would not be fraudulent paintings but merely copies intended for distribution to places where a Papal picture was relevant.) The Deputy Keeper, Cecil Gould, claimed that the Gallery's version was not a copy, but the original. He based his claim on X-radiographs and an ancient inventory number. Figure 9 shows the painting in question.

X-rays of the uncleaned version had revealed a more formal pattern — of cross-keys and papal tiaras — lying under the green background curtain. It appeared that Raphael had changed his mind after its original completion and had overpainted the background to provide less formality.

The painting was subsequently further examined — X-rays could detect differing layers but did not confirm relative dates at which they were laid down, nor the colours of the original background. A minute piece of paint was observed in cross section under the microscope — see page 16 — and a 100 by 120 mm colour transparency made of the paint layers.

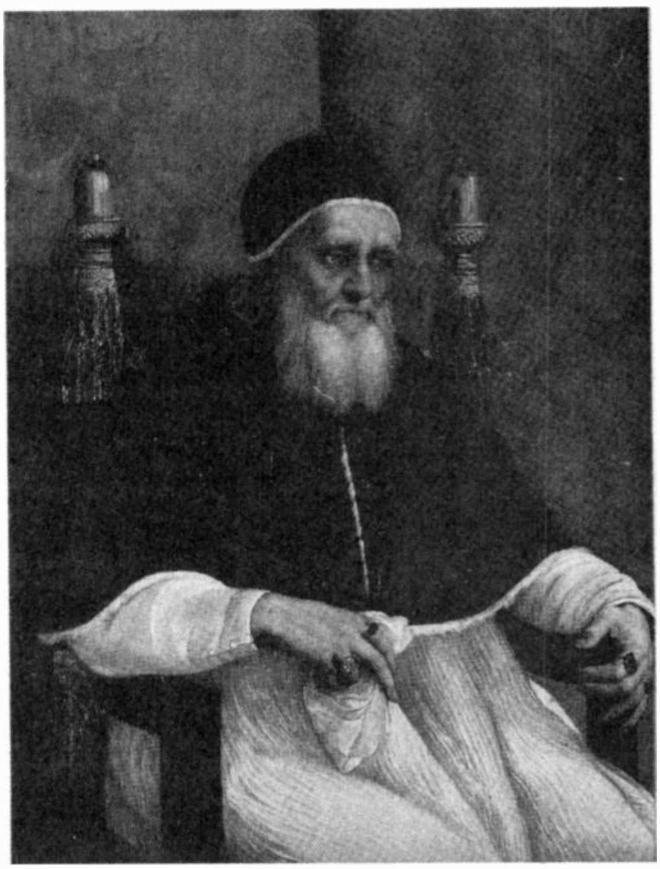


Fig.9. "Pope Julius II", now known to be the original, was painted by Raphael around 1500. The original background — cross keys can be seen now that the work has been cleaned.

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In total the paint is about 250μm thick with some layers being only 25μm; they are easily seen in the original photograph. The bottom layer is calcium sulphate (commonly called gesso). On this are clearly seen white and yellow layers covered by two green layers. The white and yellow layers are the hidden original background which was over-painted with green. As there is no dirt or varnish layer between the yellow and green, and as the paint filling vertical cracks had dried simultaneously with the bulk of the paint, it is concluded that all layers were put down together indicating a change of heart as it was painted.

Using gas-chromatography, other tests were made to verify that the drying oil medium for the green verdigris pigment was indeed in use in that period. It is now recognised that the National Gallery's painting is, indeed, the original — a fact that can largely be attributed to the use of sophisticated science.

> Just as we close for press, we have been advised of a grant of £14,000 to Prof W.D. Wright, emeritus professor of applied optics, Imperial College of Science and Technology, London, for the construction of a mobile spectrophotometer for use in art conservation (comprising a monochromator with optical link to separate measuring head and associated electronics for spectral reflection measurements to determine the effects of age on the colouring of works of art, and designed for incorporation in suitable transport to form a mobile unit).

THE PART SCIENCE CAN PLAY IN THE FUTURE

Scientific instruments and procedures provide information about a subject so as the cost of measurement methods reduces and their usefulness increases and is better recognised we should see a continual increase in the scientific effort devoted to the discipline. Newly created museums and galleries will have an opportunity given them that their predecessors were denied. Let us hope those making these decisions make the most of their circumstance for their efforts will surely be questioned by later generations.

Electronics Today International is especially grateful to Garry Thompson and Joyce Plesters of the Scientific Department of the National Gallery for providing a most informative visit for the author.

Further Reading:

"The Working of the National Gallery", Trustees of Nat. Gal. London, 1974 (published on occasion of 50th anniversary).
"Annual reports of National Gallery", especially 1969-70.
"The National Gallery", Michael Levey 1972, Pitkin Pictorials.
"Planning the preservation of our cultural heritage", G. Thomson, Museum, Unesco, Vol. XXV, p.15-25, 1973.
"Is science serving art", New Scientist, May 13, p.448-450, 1965.
"The conservation of Antiquities: Developments in planning", G. Thomson, Jnl of World History, Vol. XIV, p.24-47, 1972.
"Laser micro spectrochemical analysis", M. and L. Moenke, Adam Hilger, 1973, London.

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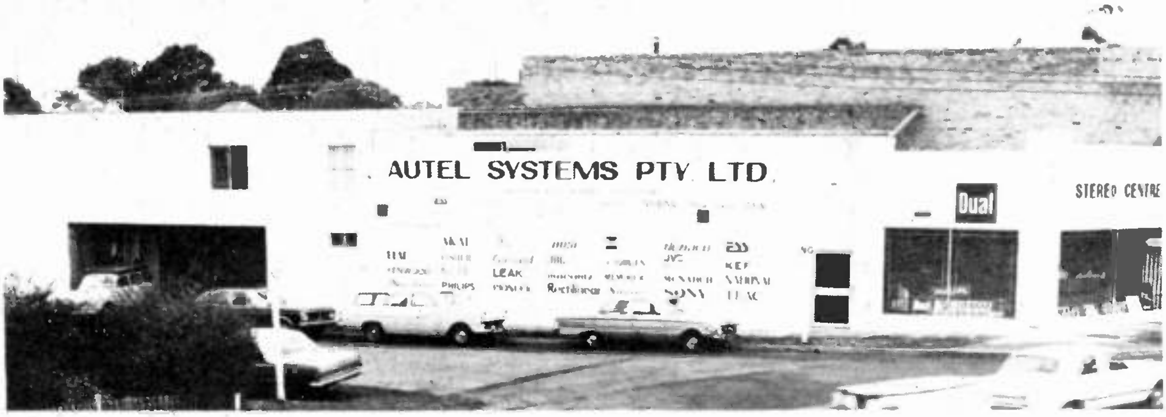

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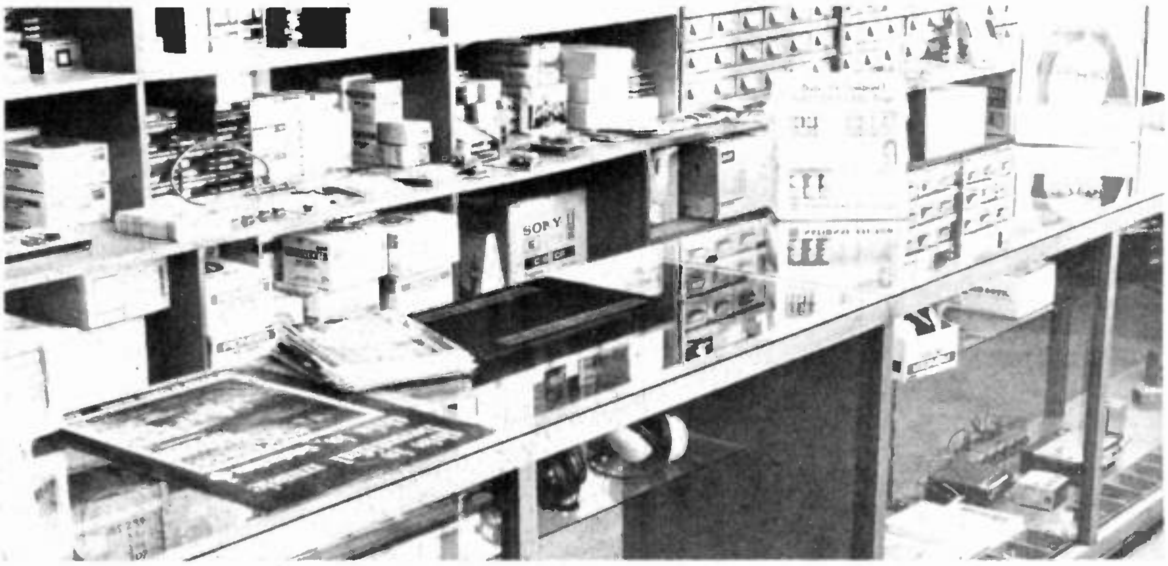

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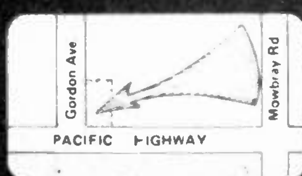

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IMAGE INTENSIFIERS -the electronic owls

Amplifying light images — where the wavelength is less than 0.0005 mm, Ian Sinclair reports.

WE USE TERMS like 'amplifier' and 'amplification' often without thinking too much about their meaning.

Certainly, 'amplify' means 'make larger', and this is what an amplifier appears to do to the amplitude of a signal. It is not what actually happens, though, and our use of words blinds us to what is actually happening, which is the *creation* of a new signal of greater amplitude under the control of the old signal. This is what actually takes place in a transistor or valve; the input modulates a current, and a *new* signal is obtained by passing the modulated current through a load resistor.

True amplification is achieved only in a resonant circuit at the resonant frequency; for even a transformer depends on an intermediate conversion to a magnetic field.

It is important to realise exactly what we mean by amplification when we speak of image amplifiers, devices which are of great importance in optical astronomy, military night-sights, and in low-light television.

The 'amplifiers' to which we are accustomed work reasonably well at low frequencies, but, when the time of one cycle of signal becomes comparable to the time which the charge carriers in the 'amplifier' take to cross the space between electrodes, the amplifying action fails. For example, if the time of one cycle of signal is comparable to the time taken for electrons to cross from the emitter to the base of a NPN transistor, signals of that frequency will not be amplified, for the control action fails.

It is impossible to control anything which has changed in the interval of control; this is probably most clearly illustrated by the action of a triode valve at high frequency. A signal makes the grid more positive so that electrons are attracted from the cathode, but, by the time the electrons have actually reached the cathode, the signal is negative, and the electrons are repelled again. This is shown in Fig. 1.

Another way of looking at this is to compare the wavelength of the signal with the dimensions within the amplifying device. If the wavelength is anywhere near the distance between electrodes, then amplification is unlikely to work. How, then, do we amplify light images, where the wavelength is around 0.005 mm? This is very much less than any spacing we can make between electrodes with existing technology. Yet light waves, which are identical in every respect (apart from wavelength and frequency) to radio waves, carry a large amount of energy, and ought to be capable of some sort of controlling action. The answer lies in the interaction between light and atoms.

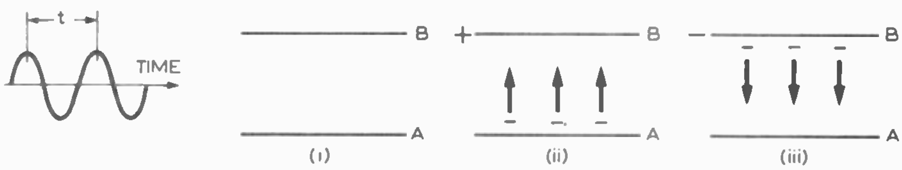
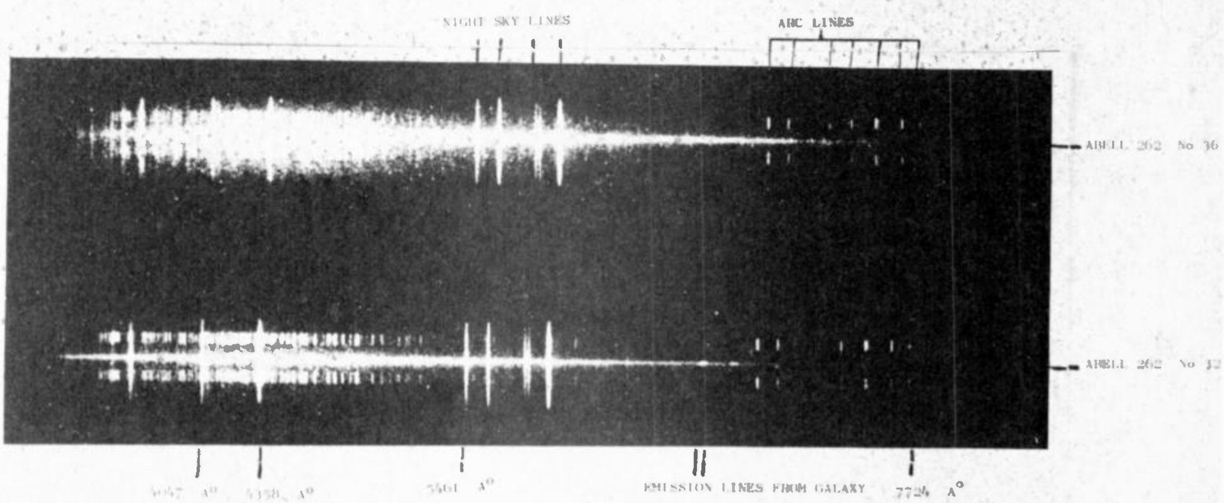


Fig. 1. Most electronic amplifiers depend on electrons (or holes) moving from some part (A) to another part (B). If (B) is positive, electrons move towards it, but if the signal at (B) is reversed before the electrons reach it electron movement will cease or be reversed.

How galactic matter is studied

The spectra of galaxies Abell 262 No. 36 (top) and Abell 262 No. 32 have been reproduced using the telescope of the Royal Greenwich Observatory and a three-stage image intensifier.

The emission lines above and below the galactic spectrum are from a copper-argon arc comparison source. (Photograph by courtesy of the Royal Greenwich Observatory.)



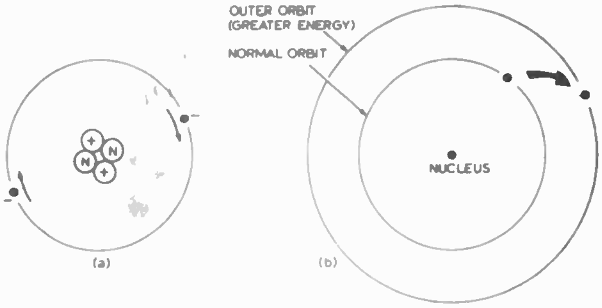


Fig. 2. LEFT: One way of visualising the atomic structure (see main text). The core consists of protons (+) and neutrons (N) with negative electrons/moving round it. RIGHT: If energy can be transferred to the electron, its orbit moves out. If it returns, the energy difference is released.

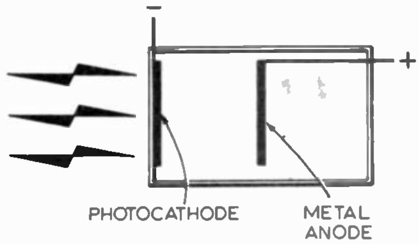


Fig. 3. Construction of a simple photocell showing photocathode and anode.

LIGHT AND MATTER

Atoms consist of protons, neutrons and electrons. The protons and neutrons make up most of the mass of the atoms, and the protons are positively charged. The electrons are of much lower mass, about 1/2000 of the mass of the proton or neutron, but have a negative charge equal in size (but not sign) to the charge on the proton. The number of protons in the normal atom always equals the number of electrons.

One of the early visualisations of the atom, long superseded but still useful, is of a hard core of protons and neutrons with the electrons spinning round like satellites, so that the diameter cf the atom, which is the diameter of the electron orbit is about a thousand times greater than the diameter of the core or nucleus. The diameter of the electron orbit can be increased by feeding in the correct amount of energy, in the form of raised temperature or as electromagnetic radiation of the correct frequency. This same amount of energy will be given off when the electron returns to its own orbit — as it always does when conditions permit. If sufficient energy is applied to the atom, the outermost electrons can be torn away from their orbits and removed completely from the atom to which they belong. This is shown in Fig. 2.

This last effect, when it is caused by light, is the *photoelectric effect*, investigated by Lenard in the 1880's, and explained later by Einstein (work which earned him his 1921 Nobel Prize).

Einstein's theory explains the observed fact, that electrons are torn away only by light whose frequency is greater than a critical value, the 'threshold' frequency. Brighter light of a lower frequency has no effect, it is the frequency which decides whether or not the electrons will be removed; though the *numbers* removed per second are dependent on the brightness of the light. Einstein's explanation was that the energy carried by any electromagnetic wave, radio or light, is decided by its frequency, and that the energy itself was contained in units, one unit being called a quantum. Brighter light means more units arriving per second, but the energy of a unit decides whether or not an electron will be liberated. This led to the very satisfactory picture of a unit of light liberating a unit of atom, and accounted totally for the measured effects.

The photoelectric effect is most noticeable with light and the frequencies close about it, such as infra-red and ultra-violet. Radio waves have too little energy per unit to have any effect on electrons in materials, which is why we have to liberate electrons by valve or transistor action to enable radio waves to affect them. Very short wave radiation, such as X-rays, has a wavelength of about the same dimensions as the atom itself, and so has very little electron liberating effect despite its great amount of energy per unit.

By using a natural substance whose electron energy levels are matched to the light frequency which we wish to amplify, we have solved part of the problem of amplifying light images.

PHOTOCATHODES

Not many materials are suitable for this purpose, and most depend on the metal caesium. Caesium is a metal of low density (about 1.8 times as dense as water), low melting point (it is usually liquid on a hot day), and very great chemical activity, so that it cannot be kept in air, nor allowed to come into contact with water. It can be stored and used only in a vacuum or in an atmosphere of gas with which it does not react. The same properties which make it an easy emitter of electrons also confer this high reactivity, so that this is a problem we must learn to live with.

The usual way in which it is used is in the photocathode, in which the sensitive materials, antimony and caesium are formed in a thin transparent layer over a glass plate in a vacuum. Figure 3 shows how a connection is made to the film, which is an electrical conductor, and a separate electrode acts as an anode. With a positive potential of a few hundred volts on the anode, current in the form of electrons will flow whenever the photocathode is illuminated.

The problem of keeping the materials away from air is neatly solved by evacuating the apparatus and generating the caesium from a mixture of chemicals in a nickel tube (caesium

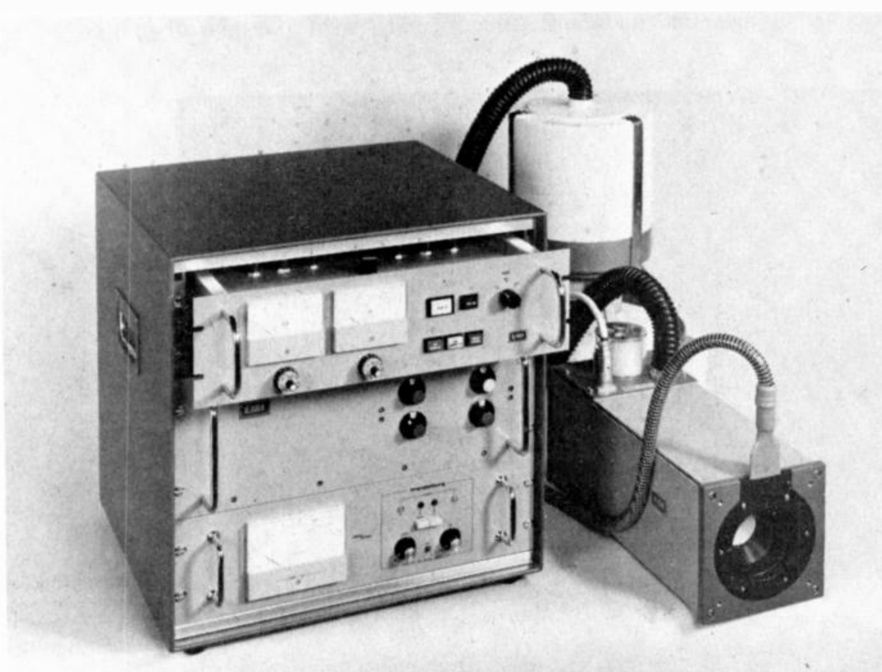


Image intensifier system (EMI type 2001)

IMAGE INTENSIFIERS -the electronic owls

chromate plus silicon powder) when the caesium is wanted. Since the mixture is not sensitive to air, it can be stored until needed, and the caesium released in the tube by heating electrically.

This solves part of the problem — converting a light signal into an electron signal with the number of electrons flowing being proportional to the strength of the light signal at any point on the photocathode. The other part of the problem is that of getting a light signal out which is of greater power than that of the input; the problem is made greater by the losses in the photocathode, which converts only a fraction of the light energy into electron energy.

PHOSPHORS

Once again, we have to make use of the behaviour of atoms in specially selected materials, in this case the group of materials termed phosphors.

Phosphors (not to be confused with the element *phosphorus*) are materials which emit light when struck by energy of other types, and a great variety of substances of this type are known. Some emit light on heating, some when struck by ultra-violet, most when hit by electrons.

The last group contains the phosphors which are of greatest interest to us for this purpose. These perform exactly the opposite of the photocathode function, but they are completely dissimilar materials, being mainly suphides of metals such as zinc and cadmium. The action is that the energy of incoming electrons raises the energy levels of a large number of the orbiting electrons within the phosphor atoms. After this excitation, the electrons return to their normal energy levels, giving off light to release the surplus energy. The amount of light given off depends on the number of electrons hitting the phosphor and also on the speed of the electrons hitting the phosphor. Once again, the efficiency is low, so that the energy of light given out is much less than the energy of the electrons striking the phosphor, the remaining energy being dissipated as heat.

What happens if we assemble the photocathode and the phosphor in one glass bulb and apply a few volts potential difference? Nothing worthwhile, unfortunately! The electrons released by the light hitting the photocathode have less total energy than the light. They then hit the phospor — with more loss of energy and release the output light, which has less total energy than the electron stream. The net result is a loss of light energy rather than a gain, but one important principle is proved: the image of the outgoing light is much the same as the image pattern at the input, proving that the conversion does at least work.

IMAGE INTENSIFIERS

To obtain a *gain* in light intensity from such a system of photocathode and phosphor, we have somehow to step up the energy of electrons which are the controlling factor.

There are two ways in which this can be done. One is to increase the energy of each electron by accelerating it to a much higher speed by means of a large potential difference applied between the photocathode and the phosphor. The other method is to increase the total number of electrons reaching the phosphor by making each electron from the cathode release a greater number of electrons from an intermediate stage. This latter method is called electron multiplication, and is similar to the method used in photomultipliers.

The problem in an image intensifier is made more difficult by the fact that we do not simply wish to increase the strength of a light signal, but also to preserve the shape of an image. Any process which we carry out on the electrons must therefore preserve their relative positions so that the electrons hitting the phosphor must be arranged in the same pattern as the electrons leaving the photocathode.

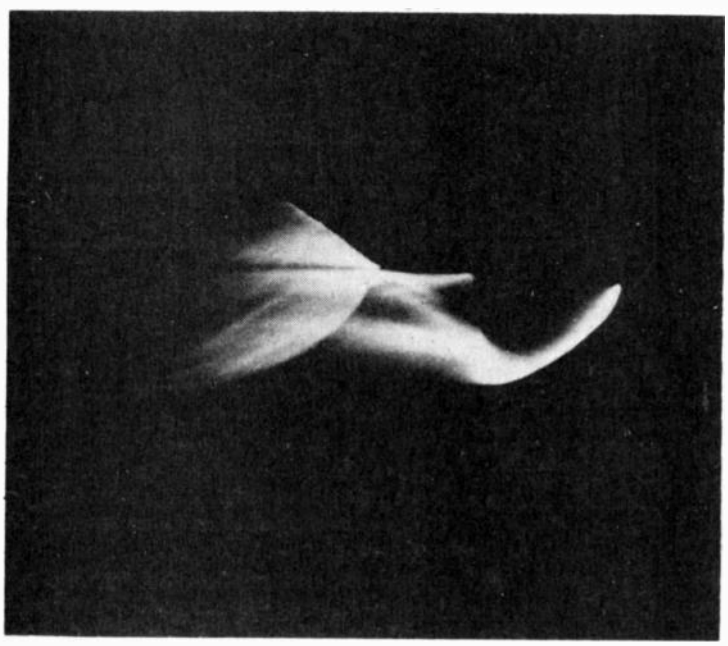
The two different types of image intensifiers using these different methods are the phosphor/photocathode type and the secondary emitting film type.

PHOSPHOR-PHOTOCATHOOE INTENSIFIERS

This type of intensifier has quite a long history, originating in World-War II as the infra-red night-sights. These were rudimentary phosphor-photocathode cells with a photocathode whose sensitivity extended slightly into the infra-red (a difficult task, as the low frequency of the infra-red compared to visible light means that infra-red carries less energy)

Figure 4 shows a typical photocathode/phosphor cell. With 20 kV between phosphor and photocathode, the output is a visible light image for an invisible infra-red input, with a small gain in power. The war-time applications were gun aiming and night driving (in convoys, with infra-red headlamps on the leading vehicle, and the rest following the infra-red tail "lights").

This type of night-sight, vastly improved by better photocathode and phosphor materials and recent



Ultra-high-speed recording of a streak record of plasma formed in nitrogen by carbon dioxide TEA laser.

Picture was taken via a John Hadland IMACON 600 camera and EMI multi-stage image intensifier tube. (Radiation focussed by 150 mm 81 germanium lens — modulation of forward going filament at 60 nanosecond intervals caused by partial mode-locking.)

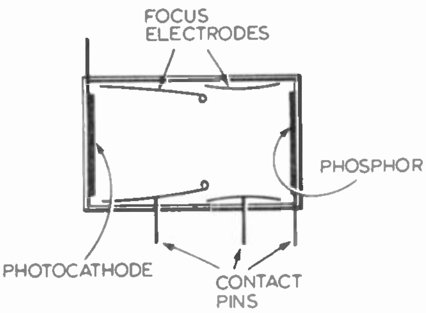


Fig. 4. Photocathode/phosphor cell.

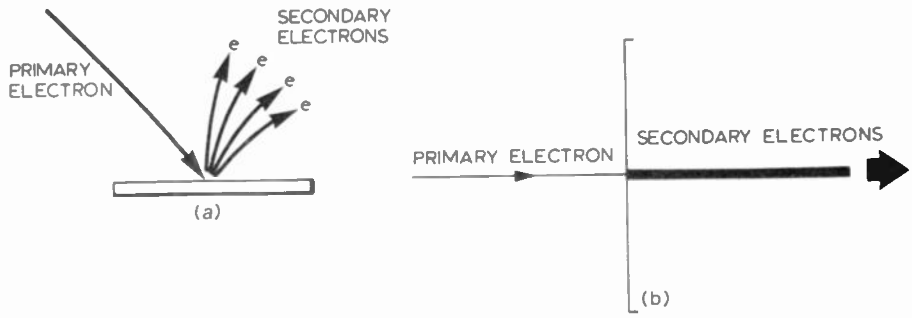


Fig. 5. Secondary emission of electrons by reflection (a); secondary emission by transmission (b).

improvements in materials and construction, is still in production and in use. From it, multiple cell units have developed, using the principle that a greater voltage between photocathode and phosphor will cause the losses to be overcome and establish some overall gain in energy.

The multiple cell units consist of several photocathode-phosphor units coupled together, as one might cascade stages in a conventional amplifier. With a high accelerating voltage across each portion, the total light gain can be very large, approaching 100 000 in some examples; this enables the user to view, as if fully lit, scenes in conditions where the only light source is the stars.

The problems of construction are, however, immense. Each photocathode has to be made in position, and the caesium vapour used for the processing of the cathode will ruin the properties of the phosphor if allowed to land on the phosphor surface. Since the phosphor surface is always in the same vacuum space as the photocathode, contamination would seem to be difficult to avoid. The usual technique is to keep the phosphor end hot and the photocathode end cool, so that the caesium vapour condenses on the cool photocathode surface, where it is wanted, and avoids the hot phosphor surface. Overheating the phosphor, however, destroys its properties, so that a very fine balance has to be struck. The easiest approach has been to make individual cells with fibre optic end windows and to stack them together, rather than to attempt to form several phosphors and photocathodes on surfaces within one tube.

SECONDARY EMITTING MULTIPLIERS

The other approach to amplification involves multiplying the number of electrons landing on the phosphor, and this is most easily achieved by secondary emission. When electrons accelerated by any voltage between about 100 V and 5 kV land on a material, their energy is sufficient to knock off, on average, more electrons than have landed. With some types of material, among which caesium is again prominent, the ratio of electrons released to electrons landing can be quite high (8 to 10), so that several stages of multiplication of this type can raise very considerably the number of electrons in a beam. For example, if the secondary emission ratio is 8, and four stages of multiplication are used, the total gain in terms of electron numbers will be 8^4, which is 4096; four thousand times in round numbers.

Most secondary electron multipliers use reflected electrons, however, and have no need to keep the electrons in any image pattern. For image intensifier use, reflection is undesirable since the direction of the secondary electrons cannot be well controlled (as shown in Fig. 5a) and it is greatly preferable to increase the electron numbers with no change in the direction of the beam. This is achieved by 'through-multiplication', using the second-emitting material in the form of a thin film, bombarding it with electrons from one side and obtaining, if all goes well, an enhanced stream of electrons from the other side. This method is shown in Fig. 5b.

For such a film we need material which can be produced in thin-film form, conducts electricity so that we can apply voltage to it and replace the electrons it loses, has a good secondary emitting ratio, and is strong enough to be self-supporting. This last point is important. Any material could be used supported on a metal mesh, but each mesh would cut down the electron flow (due to the number of electrons which would land on the metal of the mesh), and the combination of several meshes, would cause a coarse pattern, (a Moire pattern), to be visible at the output. It is much better if the material chosen can be attached to a metal ring at its edges with no other support.

Not surprisingly, no single material is suitable, and the films have to be made of several layers.

They start off as aluminium foil, very similar to the foil used in cooking, stretched over metal rings. Some of the thickness of the aluminium is then converted to aluminium oxide by treatment in sulphuric acid (passing a current between the aluminium and another electrode).

The oxide surface is then coated with a thin layer of potassium chloride. This is done by placing the aluminium film in a vacuum jar and heating the potassium chloride, placed in a molybdenum tray, to a temperature at which it evaporates, and the vapour lands on the aluminium oxide. The resulting layers have then the

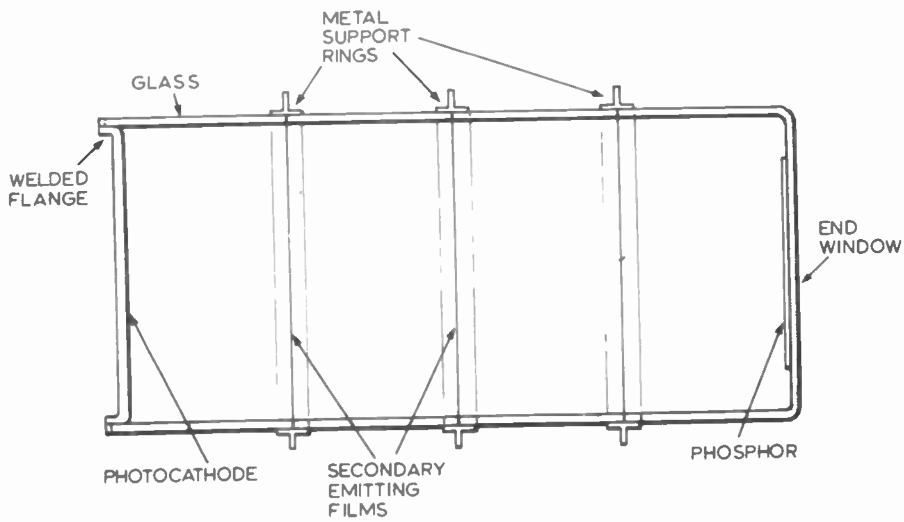


Fig. 6. Secondary emission intensifier.

IMAGE INTENSIFIERS -the electronic owls

properties which are needed, and can be mounted in the intensifier.

The complete secondary emission intensifier consists of a photocathode, several secondary emitting films, and a phosphor arranged in sequence in a tube of uniform diameter, as shown in Fig. 6. The films are produced outside the tube, as described, and the only processing which has to be carried out within the tube, during pumping, is the formation of the photocathode. Since this is carried out at the end of the tube opposite the phosphor, it is fairly easy to arrange that the caesium vapour from the photocathode has little or no effect on the phosphor; it seems to have little effect either way on the secondary-emitting films.

Using such a system, gains in light image intensity of several hundred thousand are possible.

USING IMAGE INTENSIFIERS

In each type of image intensifier, a magnetic field must be used to keep the electrons in the correct relative position. This focusing field is provided by a long coil (solenoid) completely surrounding the intensifier. In addition, accelerating voltages of several kV per stage must be applied to each type of intensifier, and this requires good insulation, since the overall voltage may be 50 kV or more.

The phosphors used to have to be aluminised. One reason for this is that it improves the efficiency of the phosphor by reflecting more light forward, another is that it helps to make the phosphor more resistant to caesium. An even more important reason in image intensifiers is that it prevents light from being fed back to earlier stages. This is not quite so important in phosphor-photocathode cells, as the gain per cell is not so very high, but in the secondary emitting tube type, it would be possible for the light from the phosphor to feed back to the input photocathode (since the secondary emitting films are partly transparent) causing full light output for no input. Similar precautions must be taken with the optical system to prevent feedback.

In astronomy, multi-stage image amplifiers have enabled us to achieve spectacular advances ~~in~~ the sighting of very distant or dim stars; the observatory at Kitt Peak has in particular specialised in the use of image amplifiers in astronomy. For night surveillance, whether for the study of nocturnal animals in the biological sense or for the detection of the less welcome nocturnal burglar, image amplifiers of the simpler type have been most useful. Their military applications are obvious; their non-military applications are continually expanding, enabling us to leave the owl far behind in our ability to see in the 'dark'. ●

So we thought you ought to know...

The new S.A.E. Mark III CM will not oscillate under any load conditions

regardless of phase angle

that's what it won't do.

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  8 ohms—greater than 200 w/chan.
- **Frequency response at 8 ohms**:
  ±.25 dB. 20 Hz to 20 KHz at full power.
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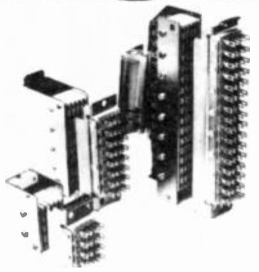

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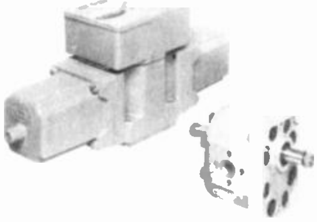

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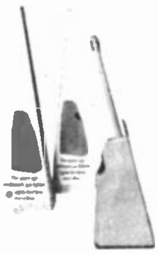

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Number of plants 8
Factory capacity 1 million sq ft
Employees 4 000

Plessey

From cover to cabinet, Pioneer's new PL-71 direct-drive stereo turntable was created to eliminate unwanted noise by getting you closer to the original sound.

The turntable platter is directly connected to the servo-controlled motor. No extra moving parts to shake, rattle and roll. No muddiness. No irritating distortion. As a result, wow and flutter is less than 0.05% (WRMS) and the S/N ratio is better than 60dB.

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High fidelity stereo. That's how perfection sounds.

QUAD ELECTROSTATIC LOUDSPEAKERS

ETI PRODUCT TEST

Twenty years have passed since Peter Walker first demonstrated his then new Quad ESL speakers at London's Waldorf hotel.

In the intervening twenty years, far more has been learned about loudspeaker design and evaluation — and the performance of ancillary equipment has improved almost beyond recognition.

When we first heard the ESL's we knew they were ahead of their time — but just *how far* ahead we are only now beginning fully to appreciate.

Louis Challis & Associates report.

Recommended retail price: Approx $400 each.

AT THE TIME of the Quad's development, electrostatic speakers were well known, but their major usage was restricted to tweeters where their transient response and exceptional performance at high frequencies resulted in their consideration for many speaker systems. Their limitations were equally pronounced — highly directional performance, constant breakdowns, and in some units non-linear distortion — often nullifying all their attributes.

The designers of the Quad system looked at these problems one by one and sought ways and means of solving them. The first and probably the most significant was that associated with the generation of non-linear distortion. This occurs in a conventional electrostatic speaker as a result of the non-linear force on the diaphragm which is proportional to the square of the distance that the diaphragm is away from the charge potential.

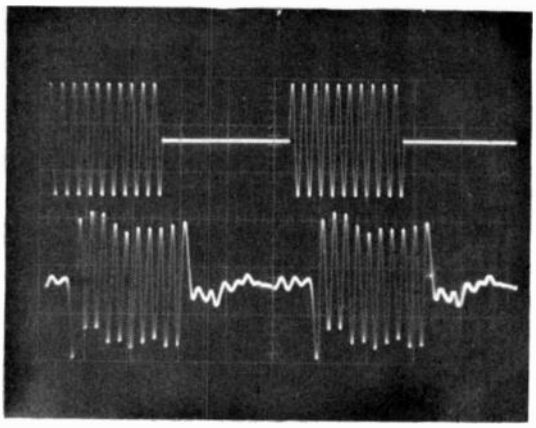
In the Quad this non-linearity is overcome by deriving the polarising voltage from a very high impedance voltage quadrupler. Once the required potential has been achieved there is apparently no further flow of current and the speaker acts as a large capacitor. Because of the high impedance of the charging circuit a constant charge is maintained and the diaphragm experiences a force proportional to the applied signal voltage.

Through this means, say the manufacturers, non-linear distortion is substantially reduced, and the acoustical output signal is a linear function of the applied signal.

A second problem is that electrostatic speakers tend to present an essentially capacitive load to the amplifier — a situation that many amplifiers resent — sometimes expensively. The literature supplied by the Acoustical Manufacturing Company glosses over this problem, simply stating that it has been overcome through using a series of segmental strip radiators which progressively increase the blade spacing and the area from the centre line of the speaker, together with suitable crossover networks. This is obviously an oversimplification and it is most probably in this region and in the design technology which resulted in their solution which put the Quad electrostatic speaker ahead of its major competitors.

In simple terms, the centre strip of the Quad electrostatic speaker takes the form of what could be called their main tweeter. The strips which lie on either side, with progressively increasing width, form mid-range and low frequency units.

Another problem which had to be solved was that of the poor vertical dispersion characteristic of strip radiators. Quad tackled this by using a curved front surface (see illustration). In theory this overcomes the major limitation of the very narrow dispersion angle, however in practice there are still limitations which not even Quad have completely obviated



Tone burst 8 kHz – 94 dB peak sound pressure level.

The warning is needed – there's 5000 volts behind the mesh panel.

THE QUAD ELECTROSTATIC LOUDSPEAKER SYSTEM
SERIAL NO: 34948

Frequency Response:	± 5 dB 50 Hz – 18 kHz	
Total Harmonic Distortion: (90 dB at 2 metres on axis)	100 Hz	0.5%
	1 kHz	0.4%
	6.3 kHz	0.4%
Electro-Acoustic Efficiency: (90 dB at 2 metres on axis)	4 watts	
Measured Impedance:	100 Hz	28Ω
	1 kHz	12Ω
	6.3 kHz	10Ω
Dimensions:	height	790mm
	depth	265mm
	width	880mm
Weight:	18 kg	

(but see article on page 46 of this issue).

MECHANICAL CONSTRUCTION

The Quad electrostatic speaker vaguely resembles an outsize electric radiator The curved expanded alloy mesh front panel is finished in gold (or black) and the whole assembly is mounted on three wooden feet.

A power supply is located at the rear of the unit. This is enclosed in an expanded-mesh box with mains socket, red bezel, and voltage selector facing the rear on the right side, and a pair of banana plug sockets for the speaker leads on the left hand side.

The main frame of the units appears to be of wooden construction and a layer of damping material is placed between the rear steel mesh and the internal diaphragms. The units provided to us for evaluation were black instead of the more conventional gold anodised face and gained nothing, in our opinion, with this choice of colour.

Personally we don't particularly like the Quad's appearance but this may well be a minority opinion. (Actually I rather like them! – Ed.)

HOW GOOD ARE THEY?

At the time of their introduction, the Quad speakers were undoubtedly the finest monitor loud speakers produced anywhere in the world. Their major attribute was colouration one or two orders less than virtually any other competing speakers. Added to this they had a transient response which was at that time described as superb.

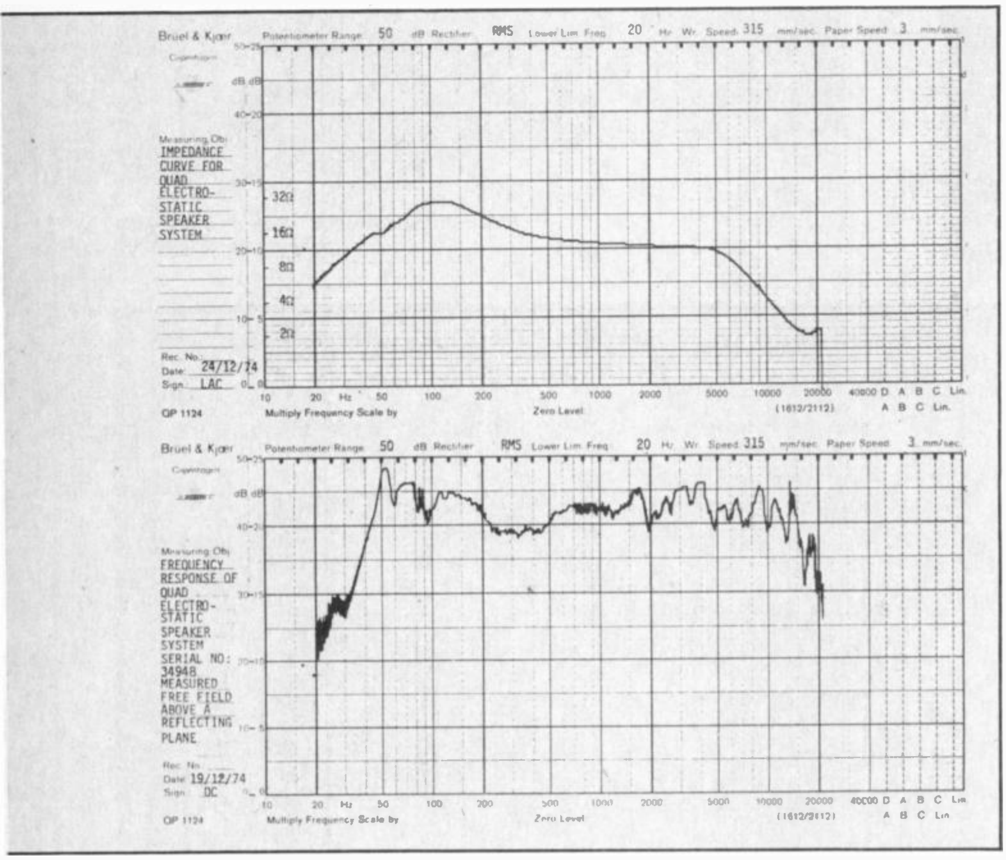
The aim of our investigation was to determine just how well this twenty-year-old system compares with the legion of new breeds of systems and speakers which have been developed since.

Our first series of tests were to place the Quad electrostatic speakers in an anechoic environment above a reflecting plane to plot out the polar patterns of each speaker at frequencies of 125 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz and 16 kHz, in both the horizontal and vertical planes. We used for this a ½" Pressure Microphone, Bruel & Kjaer type 4134S; Preamplifier, Bruel & Kjaer type 2619; and a Turntable, Bruel & Kjaer type 3922, coupled to our normal spectral analysis system.

The manufacturer's literature includes polar curves, which we presume show the horizontal plane as no commentary or description is provided. We could not reproduce the front to back discrimination that their curves showed at the high frequency end of the spectrum, but did achieve bandwidths between the 3 dB points that were comparable and if anything, superior.

Measurements in the vertical plane, however, were far more interesting. In particular they highlighted the problems of vertical dispersion which are a limitation of this system. Thus, at 16 kHz, the response is 10 dB down at ± 10° vertical angle, and is 20 dB down at ± 30° at frequencies of 4 kHz, 8 kHz and 16 kHz. This, we should point out, is still no mean effort but not really what one would expect or desire from a system which is intended for use as a monitor speaker. Out of fairness to the Quad, however, we must point out that there are virtually no other electrostatic speakers which have totally overcome this problem, other superlative speakers such as the B & W DM70's and the ESS amt-1's using the (non-electrostatic) Heil driver suffer from the same problem to some extent. This limitation should not necessarily deter people from using any of these fine speakers for home listening where the narrow vertical angle is unlikely to be noticed.

The frequency response of the Quads is exceptional and most probably still among the best yet achieved. Right through to 20 kHz it is every bit as good as the manufacturers claim – if anything it is slightly better. We performed this measurement above a single reflecting plane rather than in truly anechoic conditions and found that the frequency response from 50 Hz right through to 17 kHz has a



deviation of less than ± 5 dB. It would be regarded as being flat by most purists. Obviously, off-axis in either the vertical and to a much lesser extent in the horizontal plane, the frequency response drops with increasing frequency but this is true of most other speaker systems as well.

Our next test, which we regard as being of critical importance, was the tone burst response evaluation using the E.T.I. tone burst generator. The performance here, and the results achieved, were to say the least exemplary. The only speaker which has offered a superior performance at higher drive levels is the ESS amt-1 which can produce peak sound pressure levels in excess of 110 dB at two metres on axis. The manufacturer's literature and guarantees for the Quad electrostatic speaker specifically state that the maximum output of the Quad should be limited to 93 dB at two metres on axis, in fact Quad's 303 amplifier provided for the test was unable to produce such high levels.

Notwithstanding, within the manufacturer's rating limits, the response was as clean as we have ever encountered and certainly equal to the best that we have ever measured.

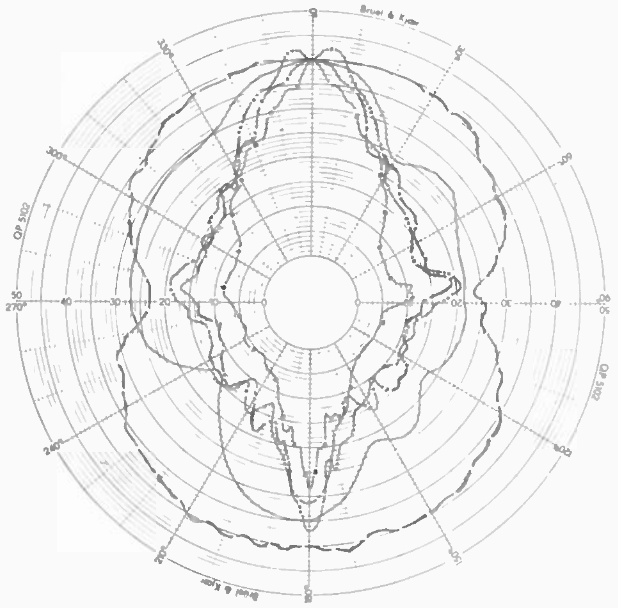
The impedance of the speaker is well controlled over the major portion of the frequency spectrum. This is most probably one of the greatest attributes of the Quad speaker for most other electrostatic speaker systems that we have measured have a response which rises at the top end of the spectrum.

Distortion characteristics are exemplary and certainly every bit as good as the best conventional systems available on the market.

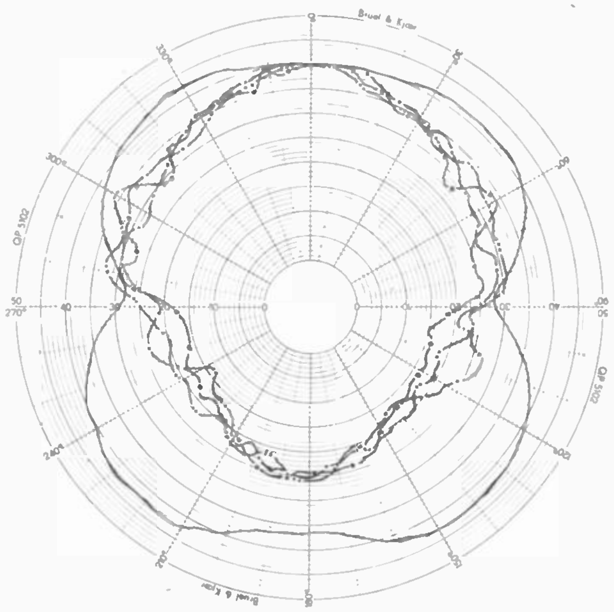
Our final series of tests consisted of a subjective evaluation between the Quad and other state-of-the-art speaker systems, including ESS, Fisher and A-R. At sound pressure levels below 93 dB (at two metres on axis) the Quad still exhibits the cleanest and most uncoloured sound imagineable.

The bass response cannot really cope with modern day rock but it must be remembered that this speaker was designed in another generation, years before "rock" had even been thought of, but for the classical purist we know of no other speaker which is superior in terms of colouration.

During our recent visit to Moscow to attend the I.E.C. Meeting of TC.29, we asked a number of design engineers, whose responsibility it is to develop new speaker systems for some of the top European manufacturers, what speaker they use as a yardstick. All but one said that despite all its known limitations the Quad electrostatic speaker still fulfills this role in their laboratories. ●



Vertical pattern at two metres (input, one-third octave filtered pink noise). [125 Hz – – – –], [1 kHz ––––––], [4 kHz – . – . – . –], [8 kHz – . . – . . – . . –], [16 kHz – o – o – o].



Horizontal pattern at two metres (input, one-third octave filtered pink noise). [1 kHz ––––––], [4 kHz – . – . – .], [8 kHz – .. – .. – ..], [16 kHz – o – o – o].

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Type of speaker	3-way 4-speaker
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Features (10SA-1)	
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Type of speaker	3-way 3-speaker
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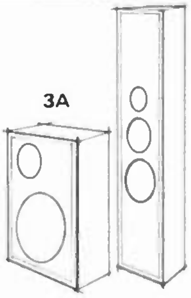

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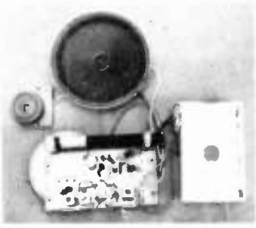

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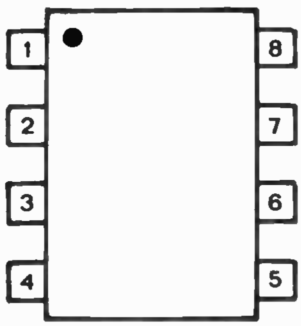
FUNCTION GENERATOR IC

How to use Signetics' NE566V integrated circuit.



1 GROUND
2 N.C.
3 SQUARE WAVE OUTPUT
4 TRIANGLE WAVE OUTPUT
5 MODULATION INPUT
6 R1
7 C1
8 +V

Fig. 1. Connections of the NE566V.

THE NE566V function generator is an economical integrated circuit manufactured by the Signetics Company. It can be used to generate a number of waveforms (such as triangular waves and square waves) up to a maximum frequency of about 1 MHz. The minimum frequency is determined only by the largest value of capacitor which can conveniently be used. A frequency of 0.001 Hz is easily obtainable.

The triangular wave output from the NE566V is very suitable for the testing of audio amplifiers for cross-over distortion and can often be used instead of a sine wave. The square wave output is suitable for testing the transient and frequency response of audio amplifiers. The triangular wave output may be converted into sine waves if necessary.

ENCAPSULATION

The NE566V is an eight pin device in a dual-in-line encapsulation. The connections are shown in Fig 1. Electrically equivalent devices are also available in a circular TO-99 encapsulation, but the dual-in-line device is slightly cheaper and very convenient to use.

BLOCK DIAGRAM

The block diagram of Fig 2 may be used to show the way in which the device functions. It is essentially an oscillator whose frequency can be controlled by the current flowing through R_1 or by the control voltage V_c.

The voltage V_c programmes a current through R_1, (voltage at pin 5 always equals voltage at pin 6) and this current charges C_1. As the current is constant (assuming a constant V_c) C_1 will charge linearly with time.

When the voltage at pin 7 reaches a certain value, however, the Schmitt trigger circuit is switched. This trigger circuit now causes a constant current to be taken from C_1, this discharging current being equal in value to the charging current which previously passed to C_1. Thus the potential across C_1 falls linearly with time until its value becomes low enough for the Schmitt trigger to switch back to its original state. C_1 then charges again.

The triangular voltage produced across C_1 is fed to a buffer stage, the output of which can be used as a source of triangular waves. If this buffer stage were not included, any current taken from the capacitor C_1 to drive another circuit would affect the linearity and frequency of the waveform.

The Schmitt trigger circuit produces a square wave output. This is fed through a buffer amplifier to the output pin 3. The trigger circuit is of the non-saturating type which provides short rise and fall times.

Both the triangular and square wave outputs have a 50 ohm impedance, so they can provide enough current to drive most circuits.

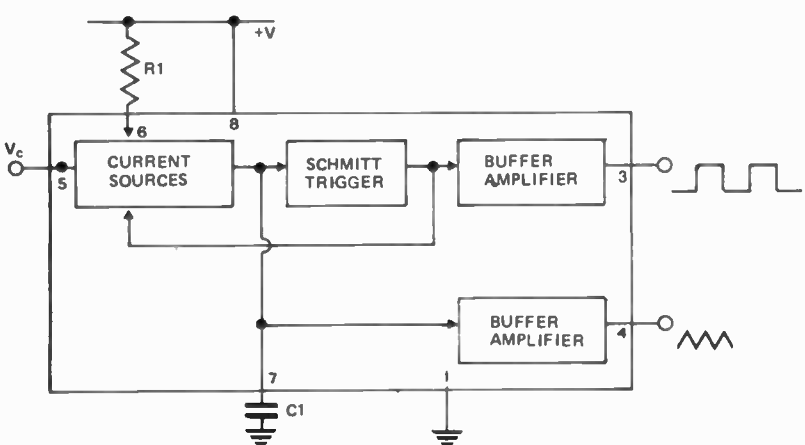


Fig. 2. Basic circuit of the NE566V in block form.

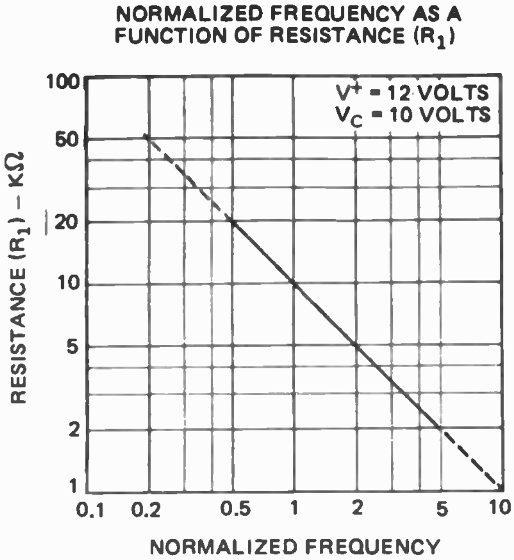
FREQUENCY

The transistors in the current source produce a voltage at pin 6 which is equal to that at pin 5. The current passing to or from the capacitor is therefore proportional to $(V^+ - V_c)/R_1$. The frequency is also proportional to this quantity. An approximate expression for the frequency is approximately equal to $2(V^+ - V_c)/R_1C_1V^+$.

The variation of frequency with the value of C_1 is shown graphically in Fig 3 for the case where $V^+ = 12$ V, $V_c = 10.5$ V and $R_1 = 4$ k ohm. The frequency of oscillation can also be varied by changing the value of R_1, but this resistor should always be within the limits of 2 k to 20 k ohm. This variation is shown in Fig 4 for the case where $V^+ = 12$ V, $V_c = 10$ V and the frequency is 'normalised'; this is, it is shown as a multiple of the frequency when $R_1 = 10$ k ohm. As R_1 changes from 2 k to 20 k ohm, the frequency changes over a 10:1 range. Larger changes in frequency can be made by altering the value of the capacitor C_1.

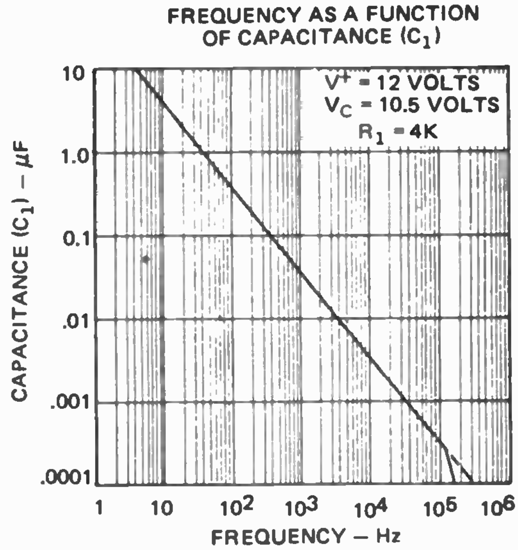
VOLTAGE CONTROL

The value of the control voltage, V_c, should be between ¾ V^+ and V^+. In



◄ *Fig. 3. How oscillating frequency changes as C1 as varied.*

► *Fig. 4. Relationship between the frequency of oscillation and the value of R_1.*



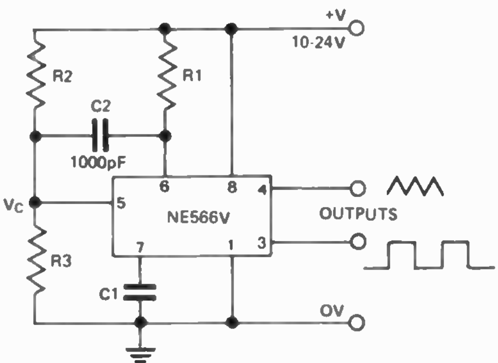


Fig. 5. Basic circuit for using the NE566V.

this range the frequency of oscillation is proportional to the difference between the voltage at pins 5 and 8. When V_c becomes very close to V^+, however, oscillation ceases.

BASIC CIRCUIT

The basic circuit in which the NE566V may be used is shown in Fig 5. It is recommended that a 1000 pF capacitor, C_2, be connected between pins 5 and 6 to prevent the possibility of oscillation in the precision current source.

If an oscillator with a single fixed frequency is required, the value of C_1 may be selected from Fig 3 with R_1 = 3.9 k ohm and R_2 and R_3 proportioned to produce 10.5 volts at pin 5 when V^+ is 12 V. Typical values for R_2 and R_3 are 1.5 k and 10 k ohm.

If an oscillator which provides a wide range of frequencies is required, the capacitor C_1 should be switched to provide a number of ranges. A value of 100 pF will allow a frequency of 1 MHz to be reached if R_1 is near the minimum of its permitted range. The values of C_1 may be increased by factors of ten; for example, 0.1μF may be used to obtain an output at about 1 kHz and 10μF may be used to obtain a frequency of 10 Hz or less. The writer has used a 10 000μF capacitor to obtain a frequency of less than 0.001 Hz.

If a continuous variation of the frequency is required in addition to the switched ranges, R_2 may be replaced by a variable resistor. When R_2 is a maximum, the frequency will also be the maximum of the range. Alternatively R_1 may be replaced by a variable resistor (of value 2 k – 20 k ohm), in which case the maximum value of R_1 will result in the minimum frequency of the range. If R_2 is made variable, R_1 may consist of a trimmer in series with a fixed resistor so that the maximum frequency of the range can be set to the desired value.

The frequency of oscillation varies somewhat with temperature and with the supply voltage, V^+. The variation with temperature is typically 200 parts per million per °C and with the supply voltage about 2% per volt.

POWER SUPPLY

The NE566V can operate from power supplies in the range 10 V to 24 V, the absolute maximum permissible voltage being 26 V. The current taken from the power supply by a typical NE566V is 7 mA.

The triangular wave output from a typical NE566V operated from a 12 V supply has an amplitude of about 2.4 V peak-to-peak, whilst the square wave output has an amplitude of about 5.4 V peak-to-peak. Both of these waveforms are imposed on a steady positive voltage. If they are to be fed into the input of an audio ►

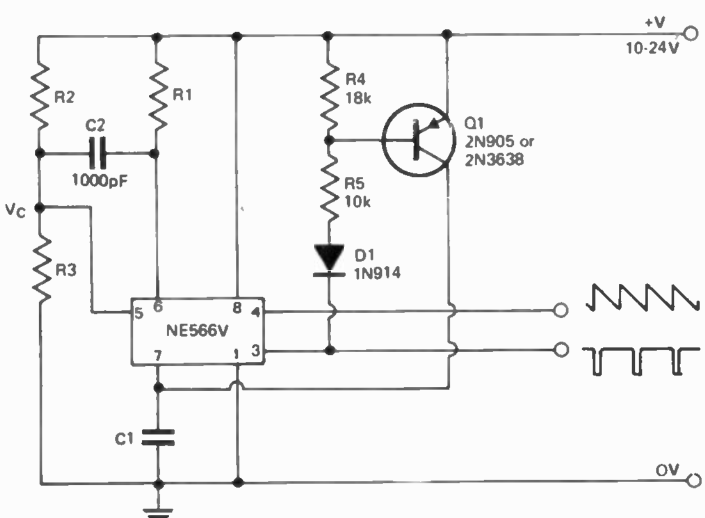


Fig. 6. Falling ramp generator.

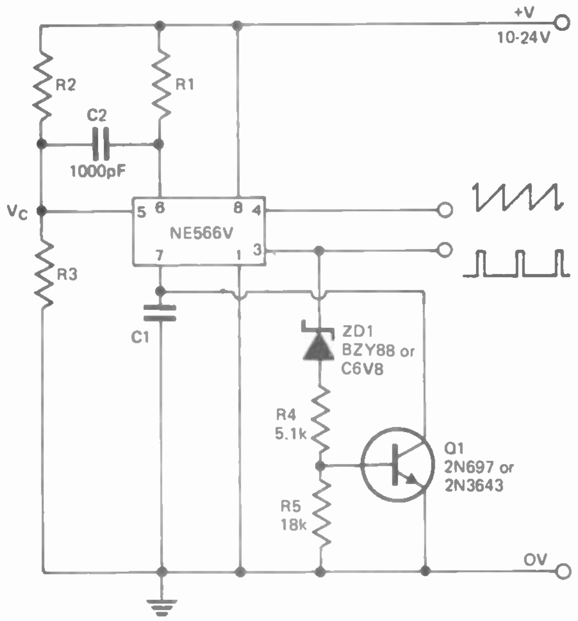


Fig. 7. Rising ramp waveform generator.

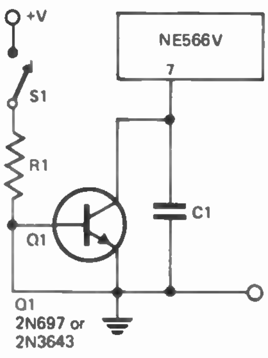


Fig. 8. A method of switching the oscillator on and off.

amplifier, a series capacitor should normally be used and some form of attenuator will also be required in most cases.

RAMP WAVEFORMS

It is easy to add a few components to the basic NE566V circuit so that it produces a ramp waveform instead of triangular waves and short pulses instead of a square wave.

The circuit of Fig 6 can be used to produce a falling ramp waveform in which the voltage falls linearly with time and then rapidly rises to its maximum value before falling linearly again. In this case short negative going pulses will be produced at pin 3.

The capacitor C_1 discharges in the normal way, as in the circuit of Fig 5, since the pnp transistor Q_1 is held non-conducting due to the base-emitter function not being forward biased. When the Schmitt trigger circuit inside the NE566V switches, however, pin 3 becomes more negative and this forward biases the base of Q_1 via D_1. Q_1 therefore conducts and rapidly charges C_1 from the V+ line. The Schmitt trigger circuit thus switches back to its original state after a very short time so that short negative pulses are produced at pin 3. The rapid rise of the voltage at pin 4 produces the falling ramp waveform shown.

RISING RAMP

A rising ramp waveform may be generated by the circuit of Fig 7. The capacitor C_1 charges through R_1 in the normal way, as in the basic circuit of Fig 5. During this charging time the output at pin 3 is in its low voltage state, so the zener diode ZD_1 is non-conducting and the transistor Q_1 receives no bias.

When the Schmitt trigger circuit switches, however, the voltage at pin 3 rises so that the zener diode ZD_1 conducts and a positive bias is applied to Q_1. This transistor therefore conducts and discharges the capacitor C_1 rapidly. The Schmitt trigger circuit then returns to its former state.

When either of the ramp generators of Figs 6 or 7 are used, one half of the triangular waveform for the basic circuit occurs in a very short time. The frequency of operation of the ramp circuits is therefore double that of the circuit of Fig 5 when the same component values are employed. Both of the ramp waveform generators can be used at very low frequencies.

The linear ramps generated by circuits of this type could doubtless be used as the basis of an oscilloscope time base, although the writer has not tried to use them for this application. They can also be used for the checking of audio amplifiers for crossover distortion.

TONE GENERATOR

The NE566V can be used to generate a signal which can be amplified and fed to a loudspeaker as a warning to people in the area. The circuit of Fig 5 may be employed, the power supply voltage being connected to the device when the warning tone is required. Alternatively the circuit of Fig 8 may be used; in this circuit the warning tone will sound when S_1 is open, for when S_1 is closed, the transistor Q_1 conducts and C_1 is held discharged.

F.M. GENERATOR

The circuit in Fig 9 shows how the NE566V may be used to generate a waveform which is used to modulate the radio frequency signal produced by a NE560B phase locked loop.

The frequency of the NE566V is determined by the value of C_1 and by the fine frequency control, RV_1. The

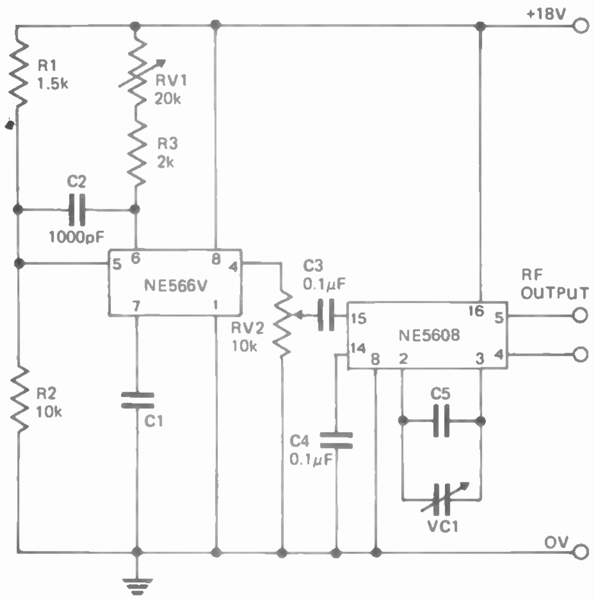


Fig. 9. A radio frequency f.m. generator.

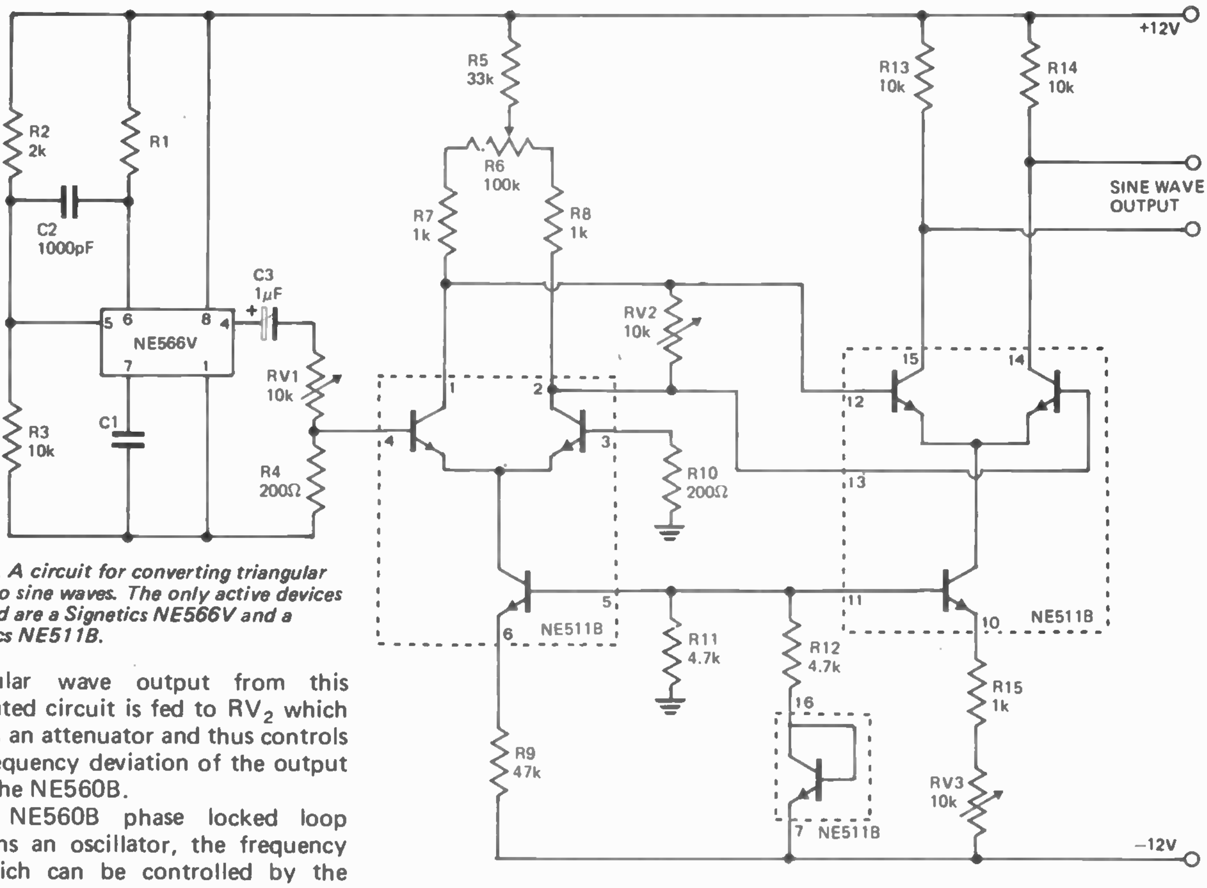


Fig. 10. A circuit for converting triangular waves to sine waves. The only active devices required are a Signetics NE566V and a Signetics NE511B.

triangular wave output from this integrated circuit is fed to RV_2 which acts as an attenuator and thus controls the frequency deviation of the output from the NE560B.

The NE560B phase locked loop contains an oscillator, the frequency of which can be controlled by the voltage fed to pin 15. The capacitor VC_1 is the fine tuning capacitor of this oscillator and determines the output carrier frequency.

Although the NE560B cannot be used to generate frequencies as high as the normal frequency modulated radio signals (around 90 MHz), all NE560B devices will operate at up to at least 15 MHz (typical devices up to 30 MHz) and therefore the fm output can be used as an intermediate frequency signal for receiver alignment. If one uses the output from pin 4 of the NE566V to deflect the spot of an oscilloscope, one has the basis of a 'wobbulator' which displays the response of an fm receiver on an oscilloscope screen.

SINE CONVERTER

The circuit shown in Fig 10 can be employed to convert the triangular wave output from a NE566V device into a sine wave. It employs the non-linear emitter-base junction of a Signetics NE511B device for shaping the waveform of the signal.

The NE511B is a dual high frequency differential amplifier which incorporates the associated constant current source transistors and a biasing diode in a single 16 pin dual-in-line encapsulation. All of the components shown within the dashed lines in Fig 10 are present in a single NE511B device.

The amplitude of the signal fed to the NE511B device is very critical if a good sine wave with a low harmonic content is to be obtained at the output. The variable resistors shown in Fig 10 must be adjusted carefully for minimum distortion at the output.

This sine wave converter cannot be used at very low frequencies, since the signal from the NE566V is capacitively coupled to the input of the converter.

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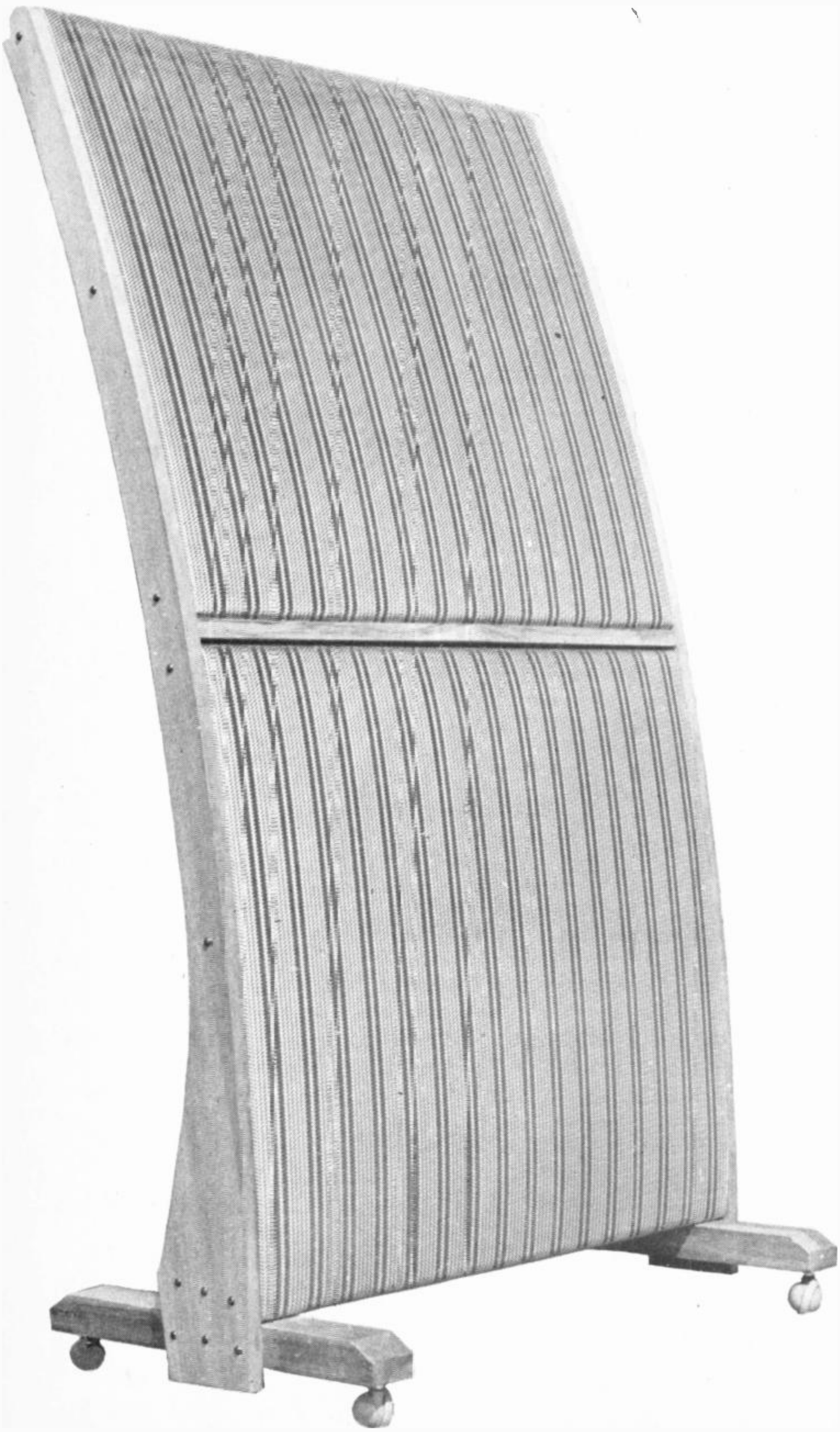
DOUBLE QUAD

— a step closer to ultimate sound, by Dr. T. Farrimond



ONE HAS ONLY to listen to music through a pair of good quality *electrostatic* headphones to realise that the auditory performance of most loudspeakers leaves a lot to be desired. Good quality headphones are, of course, easier to build. Low mass distortion-free units can be built at moderate cost since the physical size of the moving parts is relatively small. The close coupling between the earpiece and ear enables adequate sound-energy to be made available, hence realistic levels of loudness may be achieved without the need for large diaphragm displacements.

Full-range electrostatic loudspeakers are particularly difficult to build — in fact very few are available. The British Quad is probably the most familiar example of this type of speaker since it has been in existence for many years, but other brands are now appearing which tackle the problems in different ways and by so doing, generate a new range of subsidiary complications.

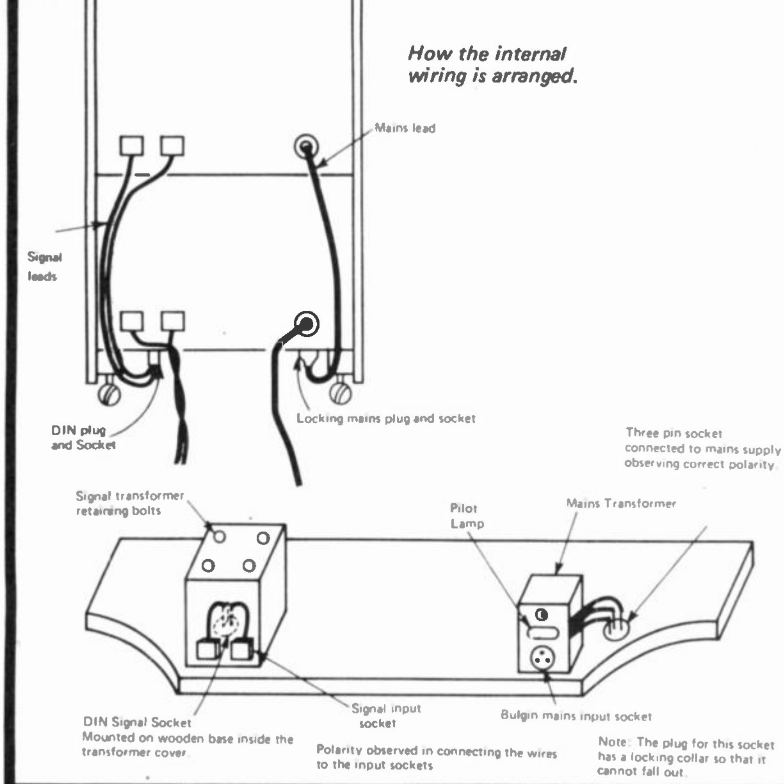
The Quad is a push-pull system in which a lightweight diaphragm is free to move in an air-gap between perforated static plates — so producing sound.

A limitation of such a speaker is that low frequencies (below 50 Hertz) may be restricted, since the large excursions of the diaphragm required for significant acoustic output may not be physically achievable.

In the United States, the Dayton Wright full-range electrostatic loudspeaker uses a system in which the charged plates are sealed in an atmosphere of sulphur hexafluoride. This confers two advantages over an air-spaced system: it gives a higher loading to the moving membrane — because of the density of sulphur hexafluoride relative to air; it also enables the voltages of the static plates to be increased because of the better electrical insulation properties of the gas. This in turn enables the spacing between plates to be increased, so allowing the diaphragm to be driven harder when reproducing low frequencies.

In general, a full-range electrostatic loudspeaker has certain merits relative to the majority of moving coil designs. It has low colouration since it is of doublet design and has no cabinet resonances. It has a lightweight diaphragm which is driven uniformly across the whole of its surface rather

STEP BY STEP INSTRUCTIONS



How the internal wiring is arranged.

SIGNAL INPUT:

(a) Remove rear wire mesh cover of lower speaker.
(b) Loosen the four retaining bolts on the signal input transformer and displace slightly to one side so that the wooden speaker base is exposed.
(c) Cut hole in exposed speaker base to take DIN socket.
(d) Wire DIN socket to shanks of transformer signal input sockets, observing polarity.
(e) Replace transformer.
(f) Staple signal leads carrying a DIN plug to speaker framework to carry signal to uppermost speaker.

MAINS INPUT:

(a) Cut hole in wooden speaker base near the mains input transformer to take three pin socket with locking collar.
(b) Connect three wires between the pins of the socket and the Bulgin socket mounted in the mains transformer corner (or to other appropriate wiring points which may be more easily reached and which preserve the correct polarity).
(c) Replace lower speaker rear mesh.
(d) Staple mains cable to edge of wooden framework.
(e) Terminate mains cable with Bulgin plug to energise uppermost speaker.

than from one small area, which minimises unwanted diaphragm flexing.

SPEAKERS IN PARALLEL

The advantages of driving two moving-coil speakers in parallel has been often stressed, for example by Gilbert Briggs, ('Loudspeakers', Wharfedale Wireless Works Ltd) but little has been written concerning the possible advantages of driving two full-range electrostatic speakers in parallel. One advantage, in the case of the Quad electrostatic, would be to double the amount of air acted upon. Also if the speakers were mounted vertically one above the other, high frequency dispersion would be improved. Because of the shape of the high frequency transducer of the Quad (which is a long narrow vertical element) the horizontal dispersion is approximately 70°. However the vertical dispersion is only 15° and this produces a beaming effect which results in changes in loudness of high frequencies when the listener moves his head. Such effects can be tiring and this is one of the reasons why "reflected sound" loudspeakers are preferred by many audiophiles. The construction of the double Quad system was undertaken with the aim of bringing about these improvements.

HOW THEY WERE MADE

Constructing double Quad speakers is quite straightforward. The wooden side pieces are removed and two extended wooden arcs screwed in their place. The arcs are constructed to continue the line of curvature of the front of the speaker grille. The angle of tilt of the complete assembly is then adjusted so that the uppermost speaker retains the same angle of inclination as a single unit mounted on the floor. The three feet of the Quad speaker are replaced by two parallel wooden extensions projected fore and aft from the speaker assembly. Four castors enable the unit to be moved quite easily and since the centre of gravity is well within the base, it is completely stable.

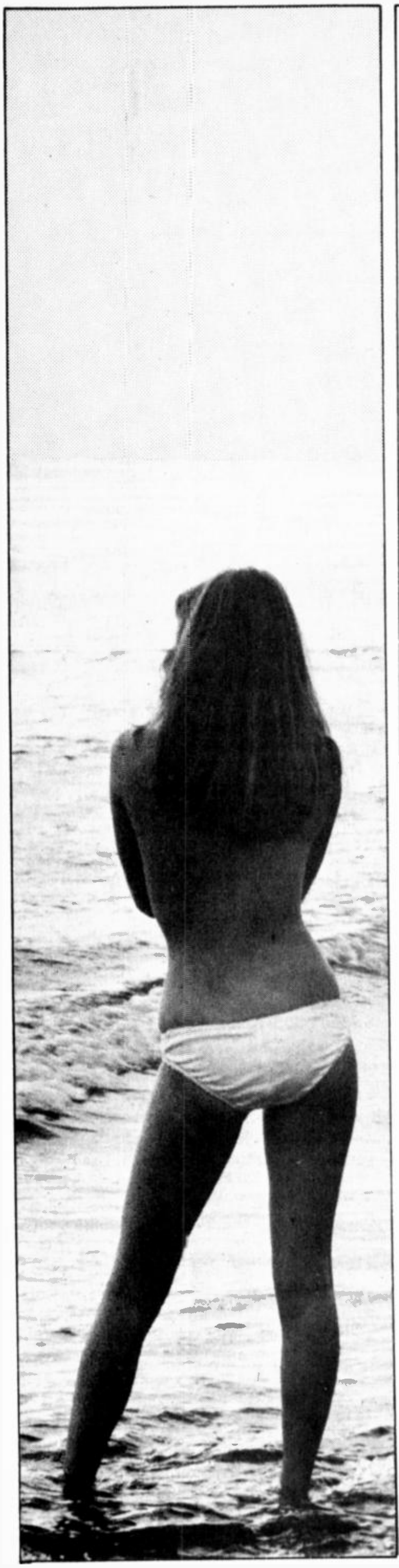
The complete double speaker construction is much more easily moved than the single Quad with its rather unstable tripod leg arrangement. This feature of the standard Quad is something which the manufacturers could well improve since even an obstreperous cat has on occasion tipped ours over!

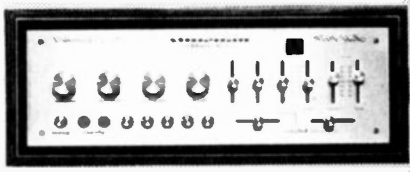
A danger to be avoided when loudspeakers are run in parallel results from the excessively low impedance which may be created; this may produce undesirable effects upon the amplifier. Modern direct-coupled amplifiers can supply large amounts of subsonic energy and therefore may damage a speaker if its impedance is very low. The Acoustical Quad amplifier has a capacitor output which blocks direct current and low-frequency signals and it is for this reason that the manufacturers of other amplifiers (for example Amcron, who produce the D-60 amplifier), recommended that a capacitor, in parallel with a four ohm resistor, be inserted between the amplifier and an electrostatic loudspeaker load when the direct current resistance of the input transformer of the loudspeaker is less than three ohms, (which it is in the case of the Quad speakers).

When driving Quad electrostatic speakers in parallel, the impedance of the double unit falls to three ohms at frequencies above 8 kHz, but this is not too bad compared with some electrostatic systems in which impedances may fall even lower than this.

It may perhaps be asked why one should go to all this trouble with electrostatic speakers when the problems could be solved by using moving-coil units which in general do not have the limitations of full-range electrostatic speakers. However in lengthy listening sessions involving moving-coil, hybrid and full-range electrostatics, full-range electrostatics seemed the most 'transparent'. Although at the extremes of frequency response some roll-off occurs, the detailed and accurate mid-range reproduction combined with an absence of bass colouration makes them difficult to beat. ●

A full review of the normal Quad speaker is published on page 36 of this issue.

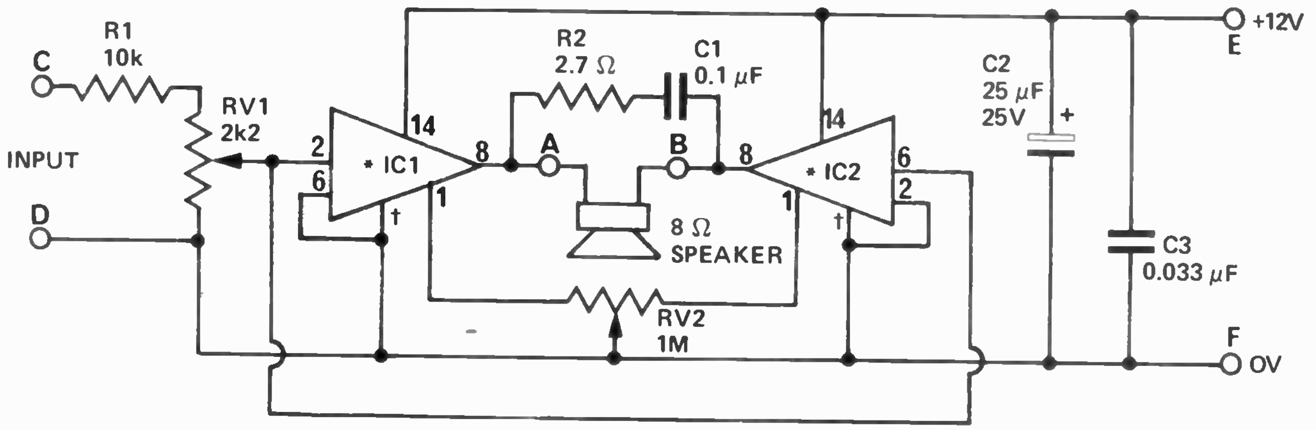




AUTO-AMP

Boost portable radio output in your car.

PROJECT 314



*IC1, IC2 LM380, SL60745
† PIN 3, 4,5,7,10,11,12

Fig. 1. Circuit diagram of the booster amplifier.

MOST portable radios and cassette players have a power output which seldom exceeds 100 milliwatts. Whilst this is entirely adequate for normal listening, many people find that it is entirely inadequate when such equipment is used in a car. There the extremely high noise level effectively drowns out such radios and one is left with the choice of buying a proper (and quite expensive) car radio, or, of forgetting about the whole deal.

However this problem can be overcome by using a small booster-amplifier to provide the additional power required. Such an amplifier should be powered from the 12 volt car supply and should accept an input from the earphone, or external speaker socket of the radio or cassette player.

The ETI booster amplifier has been designed to suit such applications and uses the inexpensive LM380 (or SL60745) ICs. Two ICs are connected in a bridge arrangement which provides an output of around five watts RMS (12 volt supply and 8 ohm speaker). The amplifier may be used to drive an eight-ohm speaker permanently mounted in a suitable position in the car.

CONSTRUCTION

The components should all be mounted on a small printed circuit board (or Veroboard etc) as shown in the component overlay diagram. If Veroboard construction is used it is preferable to mount the ICs, in line, such that a common heatsink may be attached to both ICs on each side. Each heatsink should be at least 25x50mm and be constructed from copper or tin plate.

PARTS LIST ETI 314

* R1	Resistor	10k ½W 5%
R2	"	2.7 ohm ½W 5%
* RV1	Potentiometer	2k2 Trim
RV2	"	1M Trim
C1	Capacitor	0.1µF polyester
C2	"	25µF 25V electro
C3	"	0.033µF polyester
IC1, IC2	Integrated Circuit	LM380, SL60745
PC Board ETI 314		

* The value of these components may vary for different input requirements.

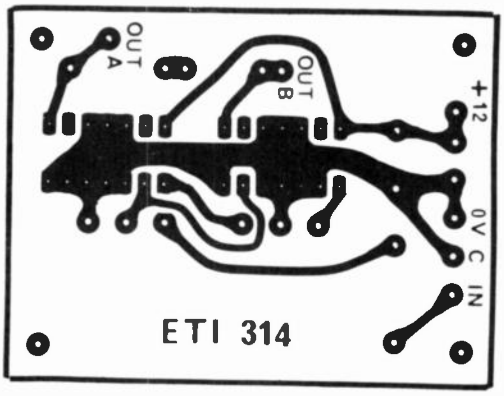


Fig. 2. Printed circuit board. Full size 50 x 65 mm.

Two preset potentiometers are provided for setting up the amplifier. The preset-volume potentiometer, RV1 should be adjusted to suit the output voltage available from the radio or cassette. Sensitivity of the booster is such that 5 watts output will be obtained (with RV1 at maximum sensitivity) with an input of 50 mV. This should be entirely adequate as most radios will provide in excess of 200 millivolts.

The balance potentiometer should be set for minimum dc through the speaker as detailed in the 'How It Works' section.

The compactness and simplicity of the amplifier enable it to be mounted in any convenient position, eg, even on the rear of the speaker itself! However, care should be taken to position it such that mechanical damage is unlikely to occur, and that adequate ventilation of the heatsink is obtained.

HOW IT WORKS – ETI 314

The LM380 (SL60745) is an integrated audio amplifier which, has a fixed gain of 50 (34 dB) and, can be connected in either inverting or non-inverting mode (ie output 'out of phase' or 'in phase' with the input respectively).

Two of these ICs have been used in a bridge arrangement which allows a higher power output to be obtained with the low supply voltage (12 volts) available from the car. To do this we drive both amplifiers with the same signal, but connect one for inverting, and the other for non-inverting mode. The speaker is now connected between them and thus receives twice the output voltage that would be available from a single IC.

The input required for full power output is about 50 millivolts. Hence we have provided an input attenuator to increase the input requirement to about one volt which will enable preset adjustment to suit most radios or cassettes.

We used a trim potentiometer on the board to adjust sensitivity such that full volume is obtained with the volume control of the source about half way up. If desired, a separate potentiometer may be used in place of the preset as a volume control.

Output voltage of the ICs is about half of the supply. However since the speaker is direct coupled, any slight difference in amplifier outputs will result in a dc current flow through the speaker. Potentiometer RV2 should be adjusted, with the aid of a multimeter, for zero volts across the speaker (or minimum current from the supply). Alternatively, if a multimeter is not available, make and break one speaker connection and adjust RV2 for minimum 'clicking' sound from the speaker.

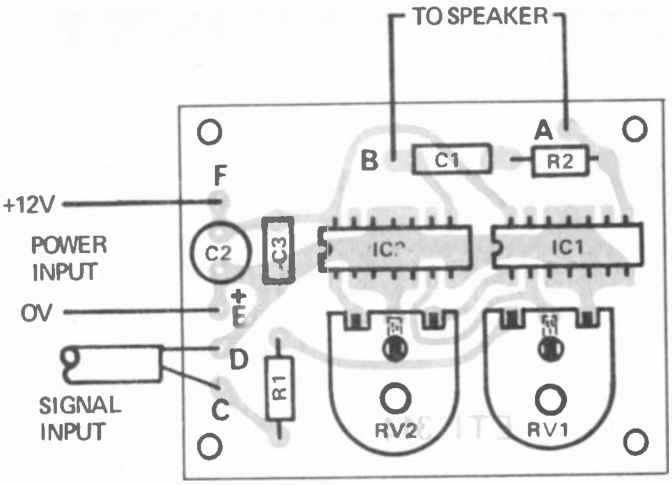


Fig. 3. Component overlay.

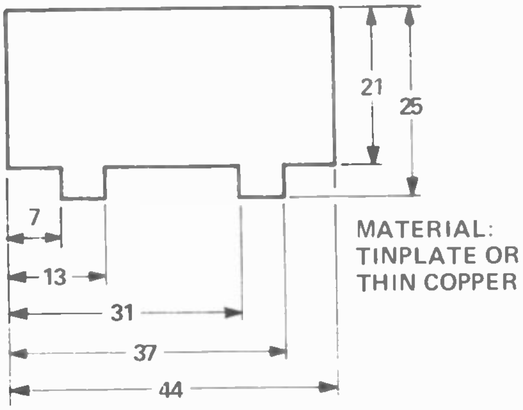
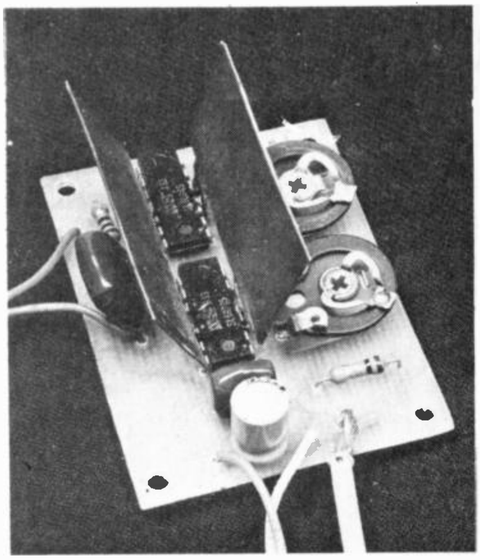


Fig. 4. Heatsink (two required) to be attached to either side of both IC's as shown in main picture.



We still have a small quantity of special uprated LM 380's (SL60745) left over from our special reader offer – page 39 December issue.

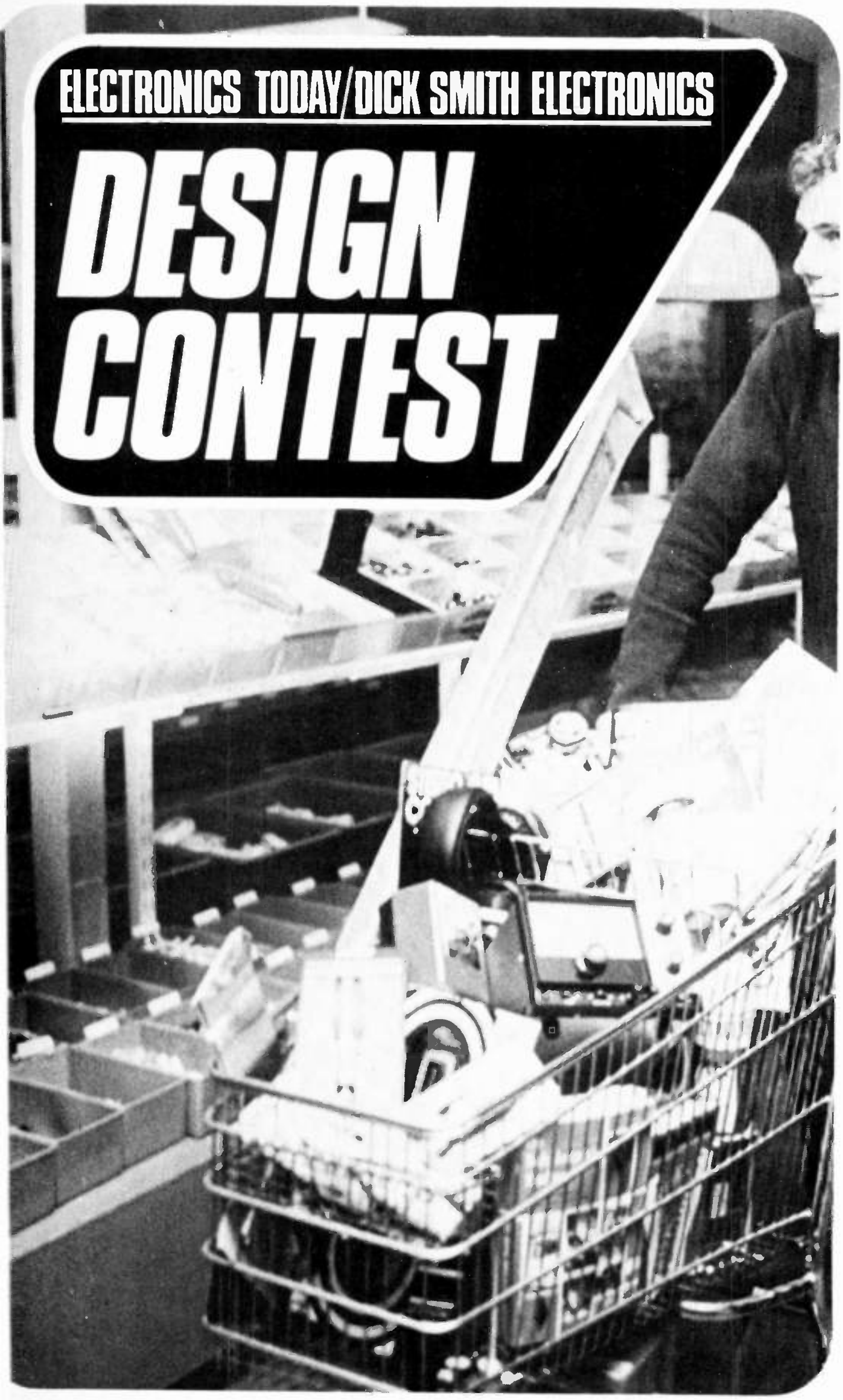
These are priced at $3.50 for two ($7 for four). Just send a cheque or money order, together with a normal-sized stamped addressed envelope to:–

'Special IC Offer',
Electronics Today International,
15-17 Boundary Street,
Rushcutter's Bay, NSW 2011.

SPECIFICATION

POWER OUTPUT		
12.6 volt supply 8 ohm load		5 watts
DISTORTION		
12.6 volt, 8 ohm, 1 kHz		
at 5 watts		3%
at 3 watts		0.5%
SUPPLY VOLTAGE		
Nominal		12 volts
MAX SUPPLY VOLTS		
	Speaker load	
LM380	8	15 volts
	16	22 volts
SL60745	8	18 volts
	16	22 volts
SPEAKER IMPEDANCE		> 7 ohms
FREQUENCY RESPONSE		
10 Hz – 100 kHz		$\pm^{0}_{3}$ dB
SENSITIVITY		
Maximum (no input attenuator) into 75 k ohm		50 mV

THE WINNING ENTRY



EXPERIENCE, according to someone we once worked for, is the ability to recognize a mistake when you make it for the third or fourth time!

If that definition is at all true, then we at Electronics Today are certainly gaining experience — for once again we grossly underestimated the number of entries in a competition.

This time it was the ETI/Dick Smith Design Contest (Oct. 1974). In this contest, entrants were invited to design useful circuits using any or all components on a prescribed list *plus* one item chosen from Dick Smith's catalogue (which was included free of charge within the issue).

Not only were there more entries than we'd expected, but the actual standard of many of the entries was of an extraordinarily high nature.

We ended up with well over 50 finalists and the ultimate choice of winner was difficult in the extreme.

Our final choice was of a most ingenious IC tester/logic trainer/breadboard unit/digital trouble-shooter designed by Mr B. A. Goddard of Moree, NSW. Mr Goddard presented his entry in two forms — one which met the terms of the contest in every respect, and a second one which included four LED's to provide BCD read-out.

The winning entry (with additional readout) is reproduced in this issue — substantially in the form in which it was received.

Congratulations Mr Goddard! — you have won your choice of Dick Smith Electronics' stock to a value of $250.

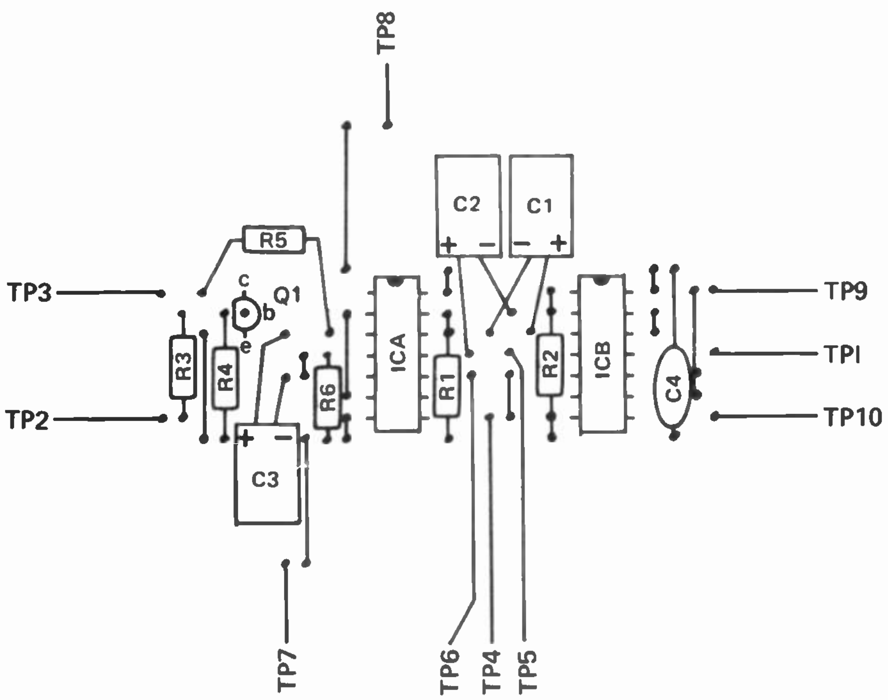
Another excellent entry was that for an NE 555 — based vehicle flashing turn indicator sent in by Mr John Hodson of Essendon, Vic. It sounds simple enough, but becomes less when one starts to design one.

This entry too is reproduced elsewhere in this issue.

A particularly interesting entry was that from Messrs Renoa and Trigg. This described a low-battery warning device specifically intended for medical instruments but adaptable for innumerable other applications as well.

Yet another was a most ingenious entry from Mr A. T. Torrens outlining an electronic flash capable of being triggered from sound, light or indeed any source that could be translated into a voltage change.

The latter entry will be published next month.



TTL super test

IC tester logic trainer/breadboard unit/digital trouble-shooter

ORIGINALLY conceived as a tester for checking out disposals dual-in-line T.T.L. integrated circuits, this device has also proven effective in the roles of logic trainer, breadboarding unit and digital trouble-shooter.

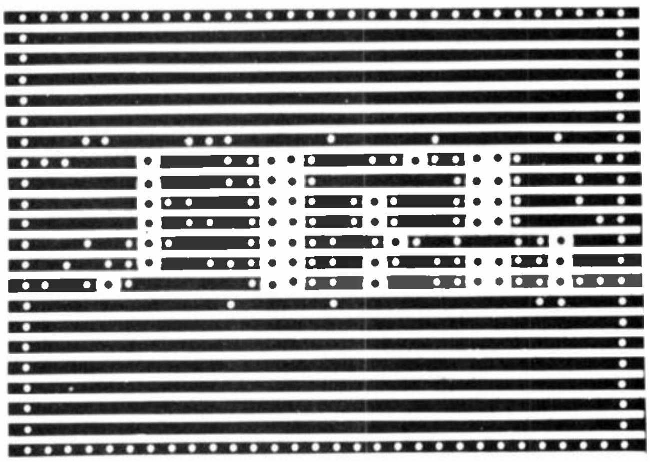
Two SN7400 quad NAND integrated circuits, together with an NPN bipolar transistor, have been adapted to perform the functions of multivibrator clock-generator, unipulser and pulse lengthener/detector, each function being located on a sub-board and brought out to banana sockets on the front panel.

Three EZ hook probes with banana plug terminations are provided. The use of banana sockets for probe entry frees the probes for use in conjunction with other equipment.

Logical 'I' and 'O' detection is available. Logic indication is by a red LED – alight for TRUE.

A 16 pin dual-in-line socket with base connections fanned to well spaced binding posts (Fig. 3B) is used for the testing of both 14 and 16 pin

(Continued overleaf)



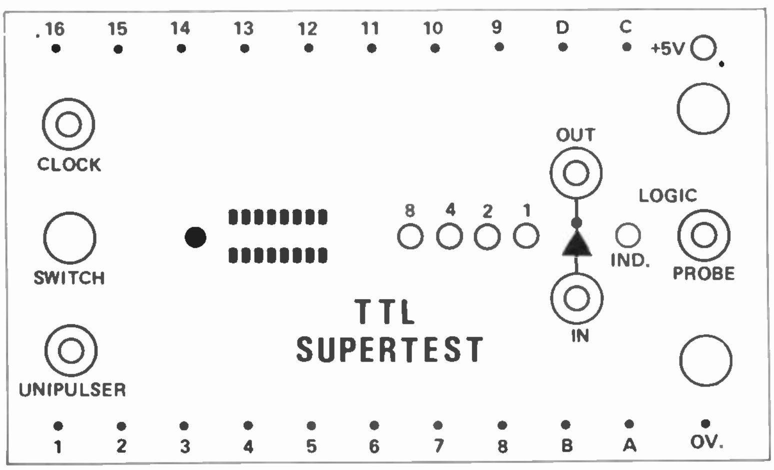
Veroboard pattern for sub-board. Dimensions are 3.75" x 3.12" x 0.1" pitch. Board is shown here as seen looking down onto copper side. Cut gaps in copper tracks with correct tool or a sharp drill. Ensure that track is completely broken.

BCD OPTION

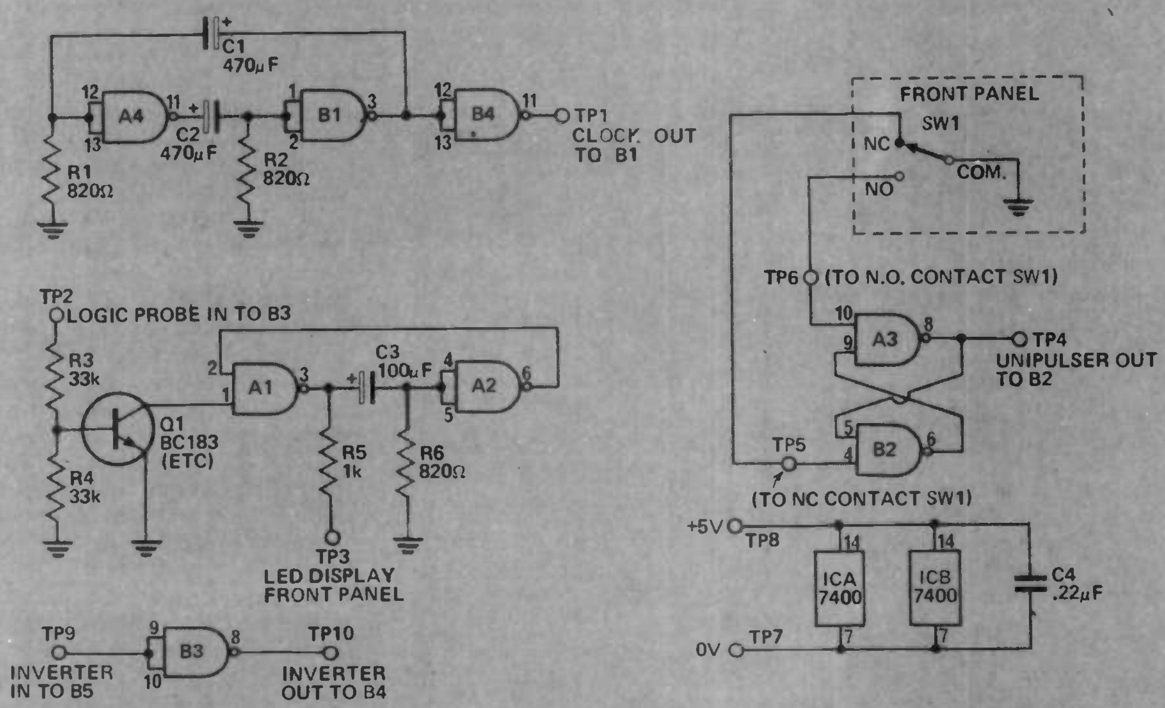
A useful addition to the Supertest project is a BCD readout facility consisting of four LEDs brought out through current limiting resistors to binding posts on the front panel.

The LED's, positioned in line and close together for easy interpolation, are fitted in the positions indicated on the layout diagram, using the islands provided on the front panel for mounting the associated resistors and binding posts. The posts should be clearly labelled ABCD and the LED's defined by their binary weightings of 1, 2, 4, 8.

For those enthusiasts who find continuous operation of the clocking multivibrator objectionable, the clock may be inhibited by isolating pin 1 of gate B1 and connecting this point via a toggle switch to ground. When the ground is removed the clock will operate normally. This switch can be located conveniently inboard of the unipulser switch. With the clock inhibited the clock output at TP1 will be a 'low'.



Front panel layout of unit (with optional BCD readout). Use printed circuit board as guide for marking out hole centres etc.



Circuit diagram of complete unit.

TTL super test

D.I.L. integrated circuits and also for breadboarding and training purposes.

The front panel is clearly labelled with carefully applied Electraset – lacquered to increase durability – and housed on a small black plastic utility box to give the completed unit a professional appearance.

Thirteen short leads – approximately 230 mm long – twelve terminated with small insulated alligator clips and one with banana plugs, complete the test kit.

The unit is intended to operate from an external power source of 5 V and this is normally provided by the digital equipment under test. But for casual purposes a 6 V lantern battery, connected via two forward biased silicon diodes, is a satisfactory and economical power source. Current drain is about 30 mA.

HOW IT WORKS

MULTIVIBRATOR CLOCK

The clock consists of a multivibrator formed by gates A4 and B1 and associated RC networks. The period of oscillation is about 0.8 seconds and the output is buffered by gate B4 to reduce loading effects.

The clock rate may be varied, if required, by altering the value of both capacitors. It is inadvisable to increase the value of the resistors beyond 2k as this may result in unstable operation.

UNIPULSER

The purpose of the unipulser is to provide a single, bounce-free pulse, at each depression of SW1, for use in testing counters etc.

The two gates A3 and B2 are interconnected to form a switched bistable (RS flip-flop). Normally pin 4 of B2 is grounded via SW1 and the resulting high at pin 6 is coupled directly to pin 9 of A3. As pin 3 of A3 is not connected, A3 sees both inputs as 'high' and its output will be 'low'.

When S1 is depressed pin 10 is earthed and pin 4 goes high. A3 output goes 'high' and this appears at pin 5 of B2. As both inputs of B2 are now high its output will transfer a 'low' to pin 9 of A3 causing its output to be locked into the high state regardless of any further bouncing of the switch contacts which would otherwise provide spurious input pulses to the counter under test.

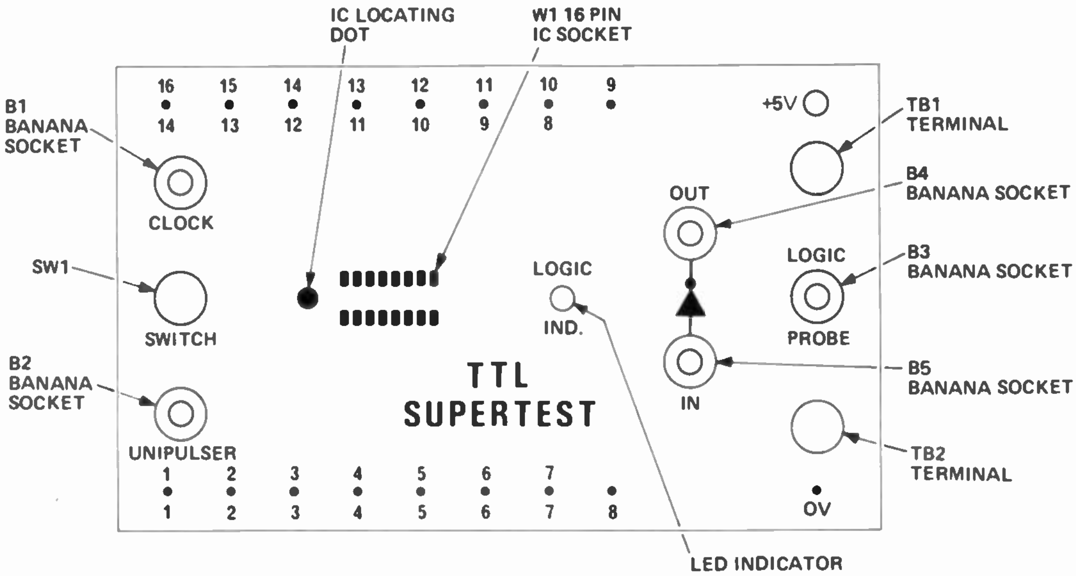
Releasing SW1 causes the flip-flop to revert to the state where A3 output is low.

PULSE EXTENDER

This simple circuit stretches very short pulses to about 100 milliseconds duration thus allowing them to be detected easily.

The two NAND gates A1 and A2, together with C3 and R6, form a monostable. Initially both inputs of A2 are held 'low' due to R6, its output is therefore 'high'. All inputs of A1 are thus 'high' and its output is 'low'.

If the input of A1 is driven 'low', by a short duration pulse, the output of A1 will go 'high' transferring a high via C3 to the input gates of A2. Output of A2, and A1 input, will go 'low' holding A1 output 'high'. Hence the LED indicator will be alight.



Front panel layout of basic unit — the associated printed circuit board is shown page 5. Scale approx 70% — use pc board as guide for marking out hole centres etc.

CONSTRUCTION

Prepare the sub-board from Veroboard by cutting the tracks as shown on page 53 and then commence wiring by fitting the resistors and links. Sleeve any long links with 'spaghetti'. Next mount the ICs taking particular care to orientate the notch (or dot) as shown in the overlay.

Mount the capacitors and Vero-pin terminal posts taking care to insulate the capacitor leads with spaghetti. As C1 and C2 are physically large, they should be laid on their sides and bound to the board with a length of spaghetti-sleeved wire.

After checking the board for errors, poor solder joints etc, it may be tested by temporarily wiring the LED between TP3 and TP7 — the lead closest to the flat on the LED being connected to the grounded terminal, TP7. The unit is then powered by applying +5 volts to TP8 (zero volts to TP7). The LED should flash briefly on application of power and then extinguish.

Connect TP2 to TP8 — the LED should light and then extinguish when the connection is broken. Observe that there is a pulse stretching action by flicking TP2 against TP8.

Connect TP2 to TP1. The LED should flash regularly at approximately 1 Hz. Now connect TP5 to TP7 and TP2 to TP4 in that order — the LED will be extinguished. Disconnect TP5 and connect TP6 to TP7 — the LED will light. Note that repeated disconnections of TP6 will have no effect on LED indication.

Disconnect TP6 and reconnect TP5

Capacitor C3 now discharges via R6 and after approximately 100 milliseconds the input to A2 will revert to 'low' and hence A2 output and A1 input will go 'high'. If both inputs of A1 are now 'high' (pulse not present) A1 output will go 'low' and the LED will extinguish. However if a pulse is present A1 output will remain 'high' and the LED lit.

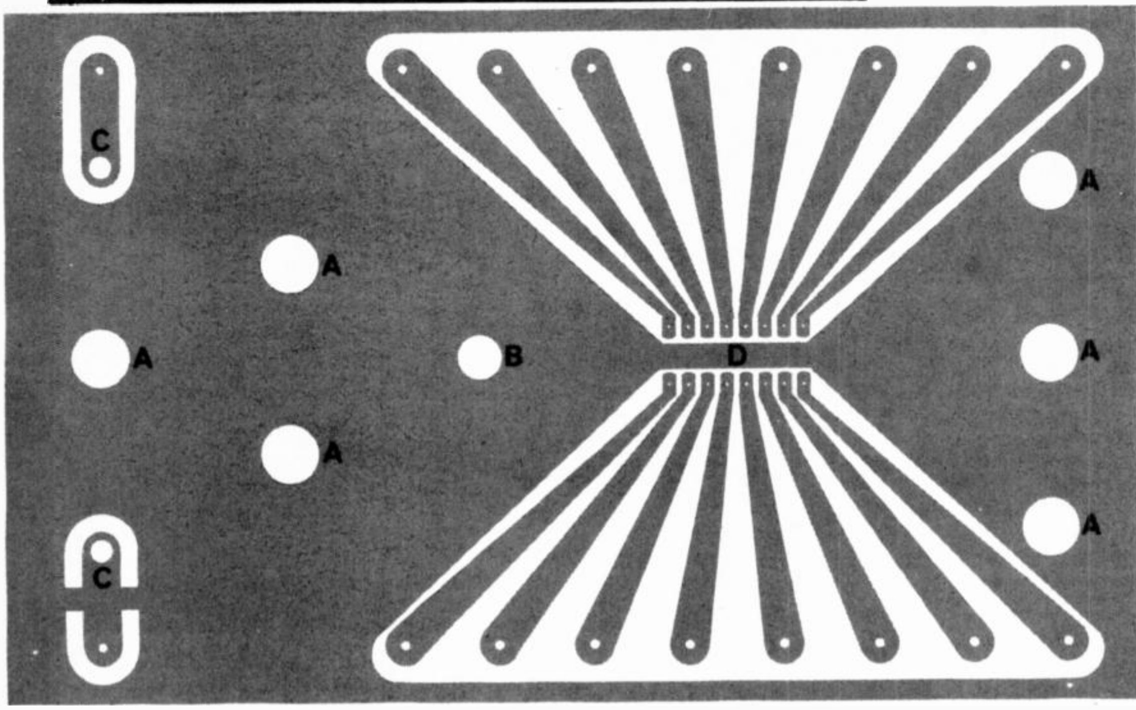
As a 'low' is required to gate A1, an inverter is required for logical '1' detection. This is performed by Q1. Q1 also acts as a current amplifier allowing the logic probe to be of reasonably high impedance. Resistor R3 provides a light load, for the disconnected outputs of operating ICs, thus allowing logic levels to be observed. Resistors R3 and R4 also form a potential divider such that Q1 does not draw excessive current at normal logical '0' levels.

INVERTER

The spare NAND gate, B3, is wired as an inverter. This allows inversion of the clock or unipulser outputs or 'low' logic detection using the logic probe.

PARTS LIST

ICA, ICB Integrated circuit SN7400
Q1, BC108, BC183L etc.
C1, C2 Capacitor electrolytic RB 470μF 16V
C3 Capacitor electrolytic RB 100μF 16V
C4 Capacitor 0.22μF 100V Greencap
R1, R2, R6 resistor 820 ohm ¼W 10%
R5 resistor 1k ¼W 10%
R3, R4 resistor 33k ¼ 10%
TB1, TB2 terminals type D7/C
W1 D.I.L. I/C socket 16 pin
Veroboard .1" pitch 3.75" x 3.12"
PC board fibreglass H.D. 6" x 3"
Veropins TP2142 (.1" pitch) (30) (or similar)
SW1 switch DPDT pushbutton momentary action
LED light emitting diode large c/w mount
E.Z. hooks type X-100W (3 off)
Banana sockets D107 (5 off)
Banana plugs D147 (5 off)
Alligator clips miniature plastic covered (24 off)
Solder, hook up wire, cambric sleeving, epoxy & insulation posts.
Zippy box size UB1 150 x 90 x 50 mm (or similar)



Printed circuit layout for basic unit. (shown full-size)

DRILL 'A' HOLES 8.0 mm DIA DRILL 'B' HOLES 6.4 mm DIA DRILL 'C' HOLES 3.2 mm DIA DRILL 'D' HOLES FOR IC SOCKET ALL UNMARKED HOLES DRILL PRESSFIT FOR BINDING POSTS

to TP7 — the LED will extinguish. Note that repeated interuptions of TP5 connection will have no effect on LED indication.

Connect TP9 to TP7 and TP2 to TP10 — the LED will be lit. Disconnect TP9 from TP7 — the LED will go out. Now connect TP9 to TP8 — the LED should still be out.

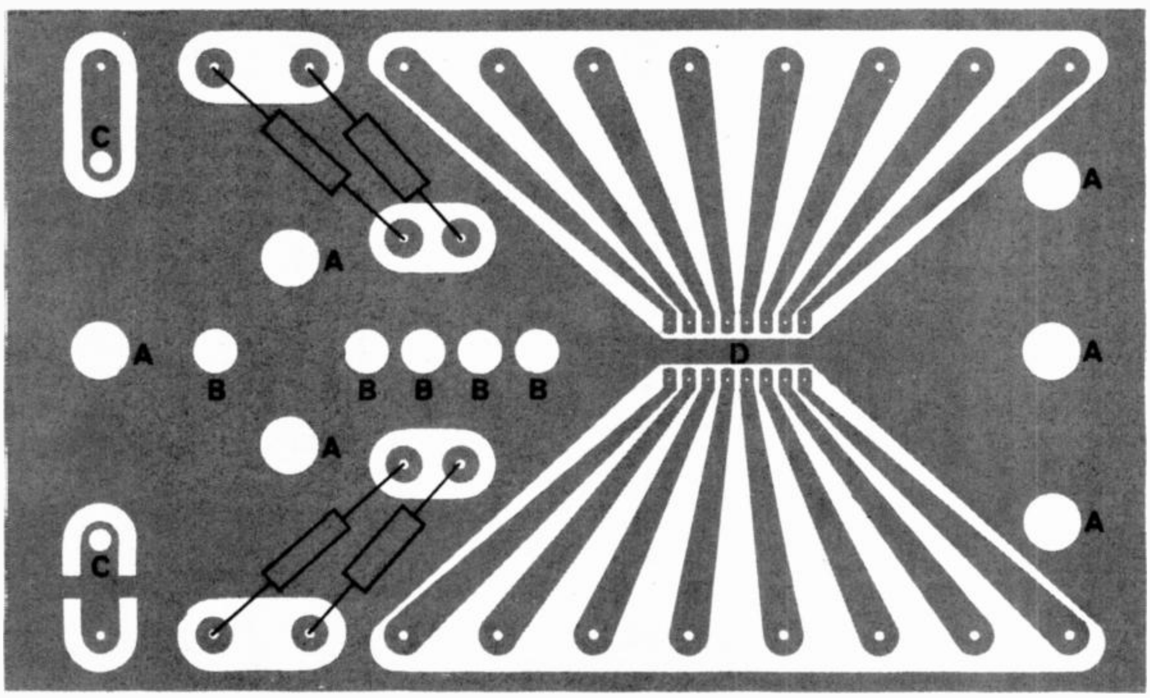
That completes testing of the sub-board. The banana sockets, IC socket, power terminals and unipulser switch should now be fitted to the front panel. Note that the common lead on SW1 is earthed to the panel ground-plane adjacent to the switch body.

Mount the LED using the plastic mounting clip provided, and solder the lead near the flat side of the LED to the ground plane. Take care, when bending the leads from the LED, to hold the wire near the base of LED with long nose pliers. Unless the strain is relieved as above, the leads are prone to break off at the base.

Mount four, half-inch insulated posts to the sub-board with screws and then, using 5 minute epoxy, cement the other end of the pillars to the front panel. When the glue is set unscrew the sub-board so that final wiring may be performed as follows.

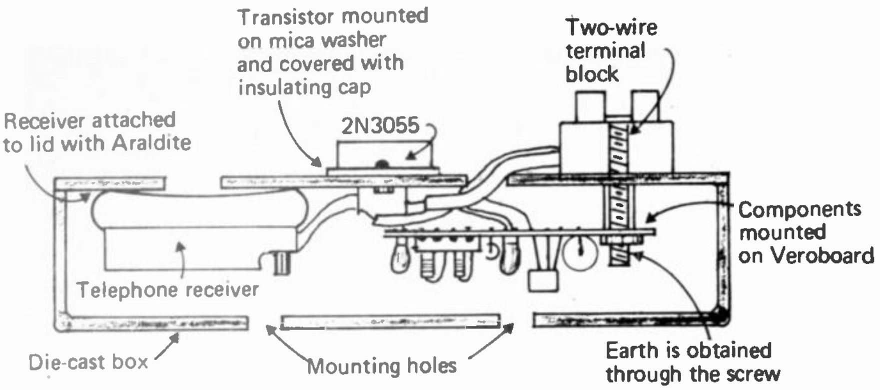
Connect TP1 to B1; TP2 to B3; TP3 to LED; TP4 to B2; TP5 to NC SW1; TP6 to NO SW1; TP7 to GND; TP8 to +5 V; TP9 to B5; TP10 to B4.

When all these connections have been made, the sub-board may be reinstalled on the front panel and the whole assembly mounted in the utility box. ●



DRILL 'A' HOLES 8.0 mm DIA DRILL 'B' HOLES 6.4 mm DIA DRILL 'C' HOLES 3.2 mm DIA DRIL 'D' HOLES FOR IC SOCKET ALL UNMARKED HOLES DRILL PRESSFIT FOR BINDING POST POSTS

Printed circuit layout for modified (BCD) unit (shown full-size). Note resistors. These should be about 470 ohms (330 — 1k will do) and connect the LED's to the appropriate binding posts.



Suggested method of construction.

This inherently reliable flash unit is not affected by voltage or load changes.

Solid-state flasher for cars

FLASHING TURN INDICATOR lamps on cars are invariably controlled by a thermal relay unit. Many of these units are fragile and unreliable. A further disadvantage is that the flashing rate is affected by the load current. Thus, connecting up a trailer or caravan may vary the flash rate beyond the legal limit.

The unit described has the inherent reliability of solid state components and is not affected by load current. Its flashing rate is independent of supply voltage, and should cost little more than a commercial thermal relay unit.

The flash rate and duty cycle can be varied (providing they remain within the legal limit – which is between 60 and 120 flashes per minute). It can be used in either a 6 V or 12 V system.

Details are shown for both +ve and -ve earth systems. A switch can be added to give an "all lamp flashing" mode as a warning signal at the scene of an accident.

CIRCUIT DESCRIPTION

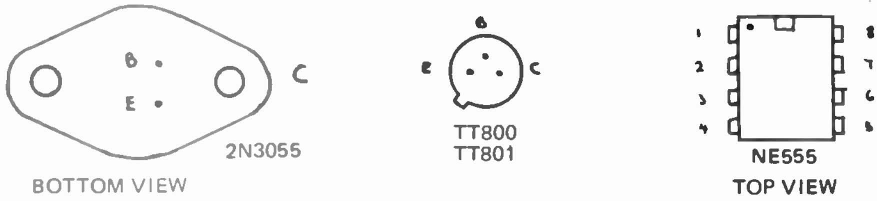
The solid state flasher unit consists of two sections, the adjustable timing circuit and the high current switching circuit.

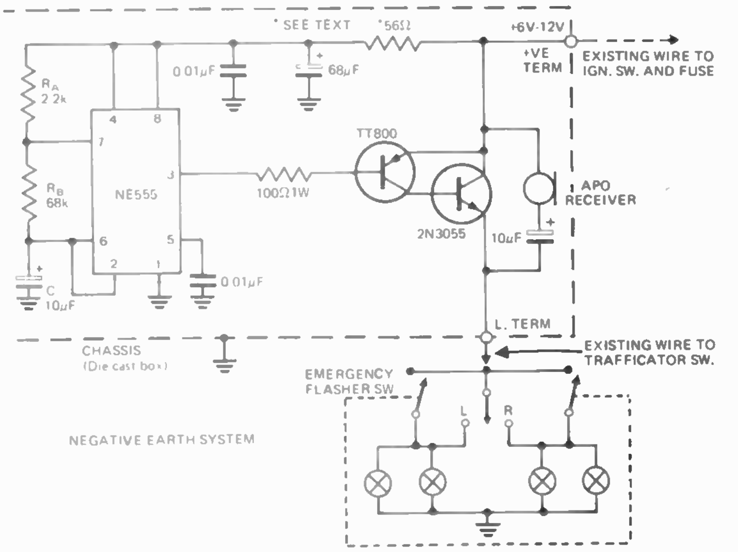
The heart of the timing circuit is Signetics' versatile integrated timer – NE555. It is used here in an "astable" or "free running" mode. Its frequency and pulse duty factor are determined by three external components R_A, R_B, and C.

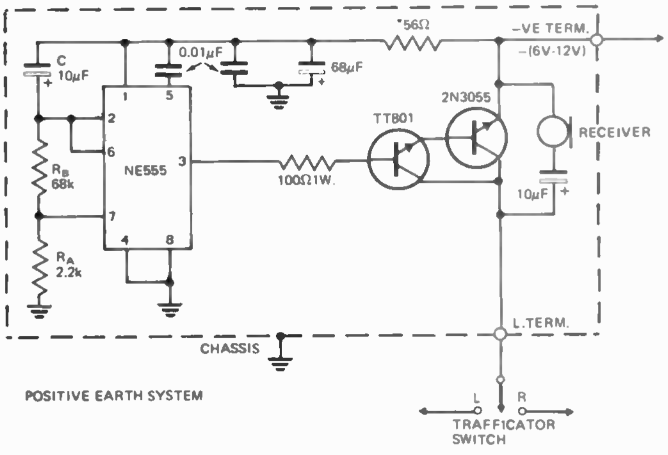
A flash rate and duty cycle of ½ sec on – ½ sec off is achieved using the values shown in the parts lists and Fig. 1, however for those who might wish to vary this the necessary calculations are shown elsewhere in this article.

The NE555 is decoupled from the supply rail by a 56Ω resistor and a 0.01μF capacitor in parallel with a 68μF tantalum. For 6 V auto systems, the 56Ω resistor is not really essential as the chip will operate from a Vcc of between 4 V and 16 V and still produce the same accurate timing. Decoupling capacitors are required across the supply to eliminate voltage spikes on the supply rail. The 68μF capacitor smooths out most of these spikes but it is just not quick enough (it has too much inductance) to ground the very sharp, short spikes that may damage the NE555, hence the 0.01μF capacitor which must be

This entry was received from Mr. J. Hodson of Essendon, Vic.







placed as close to the chip as possible.

The output (pin 3) controls a direct coupled Darlington transistor output stage that switches the current through the lamps, the 100Ω resistor limits the current from the chip. The circuit is energized continuously when the ignition is switched on but the power consumed is negligible. Only when the trafficator control switch is moved right or left, does heavy current flow through the 2N3055. The driver of the 2N3055 is not a critical type but seeing that this unit was designed to switch 10 amps comfortably a medium power transistor with a collector current of 1 amp was chosen.

The law requires that an audible indication be given to indicate that the trafficators are operating. This is achieved by connecting a telephone receiver earpiece across the 2N3055, thus producing the audible clicks.

Most cars have two pilot lamps on the dashboard to indicate right or left hand indicator operation. If, however, there is only one pilot lamp, it can be connected between the two sides of the trafficator lever, providing that the lamp can be completely insulated from the dash. Thus when one set of lamps is energised, the pilot lamp operates in series with the un-energised lamps, which, being of high wattage and with cold filaments, do not light.

It is also a good idea to provide an "emergency flash" mode to warn other drivers of a road accident, etc. A double-pole switch capable of handling the current (shown on the -ve earth circuit) will provide this. The extra load will not affect the flash rate or ratio, but one should check the fuse/s used in conjunction with the flasher unit to see if it will handle twice the normal current.

CONSTRUCTION DETAILS

The most convenient method of building this flasher unit is to mount the components on to the lid of a die-cast box. The main part of the box should be bolted firmly to the car chassis, thus providing the necessary earth. The receiver can be attached to the lid, using epoxy resin. The 2N3055 can be mounted on the outside of the lid, thus providing the transistor with a ready-made heatsink. This transistor must be completely insulated from the metal lid and a transistor cover must be used. The remaining components can easily be mounted on a small piece of Veroboard which in turn can be secured to the lid via the screw used for the terminal block. ●

VARYING THE FLASH RATE AND DUTY CYCLE

The charge time (the high or + ve output) is given by:—

$$t_1 = 0.685\,(R_A + R_B)\,C$$

and the discharge time (the low or — ve output) by:—

$$t_2 = 0.685\,(R_B)\,C$$

Thus the total period is given by:—

$$T = t_1 + t_2 = 0.685\,(R_A + 2R_B)\,C$$

The frequency of oscillation is then:—

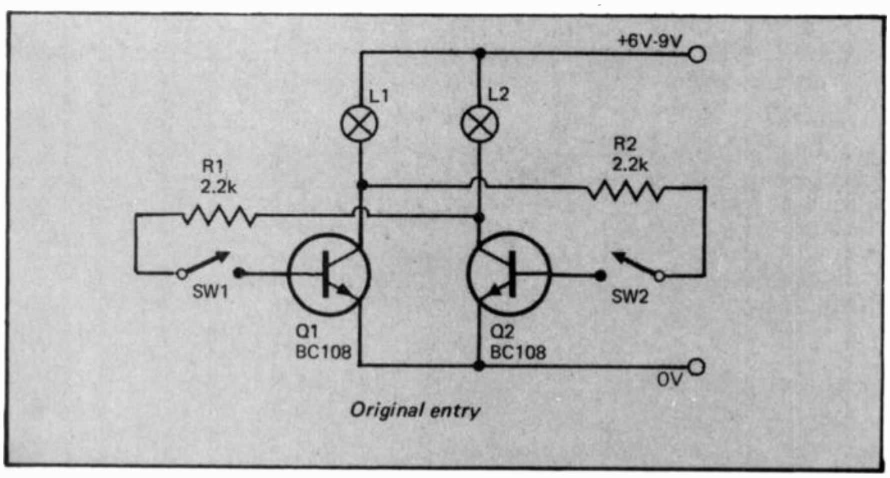
$$f = \frac{1}{T} = \frac{1.46}{(R_A + 2R_B)C}$$

The duty cycle is given by:—

$$D = \frac{R_B}{R_A + 2R_B}$$

Electronic Windicator

Circuit indicates which of two switches is first depressed.



Original entry

THIS CIRCUIT was thought up by Mr T. Tuck of Salisbury, South Australia. It's purpose is to indicate which of two switches is first depressed.

The circuit was originally designed for use in a game in which two players on command each try to press their respective switch before the other.

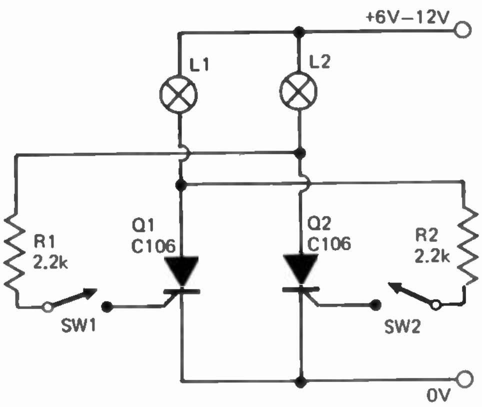
The first to do so causes 'his' globe to light, and providing he keeps his button depressed his opponent cannot cause his own globe to light until the circuit is reset by momentarily breaking the power input or by the winner releasing his button.

With minor modifications, the circuit may be used in quiz games and/or the lights replaced by buzzers (in the latter case diodes should be wired across the buzzers to protect the transistors from voltage spikes generated by the back emf).

Operating principle is simple. Assume switches SW1 and SW2 are open, both transistors Q1 and Q2 have their bases 'floating' – neither is turned on. Neither globe is alight.

Now assume SW1 is closed. The voltage at the collector of Q2 (which is high) will flow via R1 to Q1's base. Transistor Q1 will now be switched on thus lighting L1. Although SW2 may now be depressed the voltage at Q1's collector is too low to bias on Q2. So L2 cannot be energized.

One disadvantage of the circuit is that it is not self-latching. The winner must keep his button depressed until his opponent has conceded defeat.



The circuit is self-latching if the transistors are replaced by SCR's.

SELF-LATCHING

The modification shown here overcomes this disadvantage – at the cost of a slight increase in price.

Basically all that is required is to replace the two BC 108 transistors by two small SCR's. Almost any low current devices will do – C106's for instance. SCR's are self-latching devices so the first globe to be illuminated will stay that way – even though the winner's button is released – until the main power is momentarily broken.

Low-battery warning

Flashing light indicator warns of low battery voltage

THIS CIRCUIT designed by Peter Renou and Peter Trigg, of East Melbourne, provides an eye catching warning of impending battery failure.

The prototype device will be used in a hospital operating theatre in conjunction with battery operated medical equipment (powered by four 'pen-light' cells).

A moving coil voltmeter was not appropriate as, in the designers' experience, medical staff have difficulty in interpreting a voltmeter – and sometimes find themselves half way through an operation with exhausted batteries. Therefore, the requirements for the indicator were that:

1) the display be eye catching, easily understandable and provide a sense of urgency as the battery approaches exhaustion;

2) provide adequate warning of battery failure (at least 1 hour);

3) current consumption of the indicator be low in relation to the main equipment;

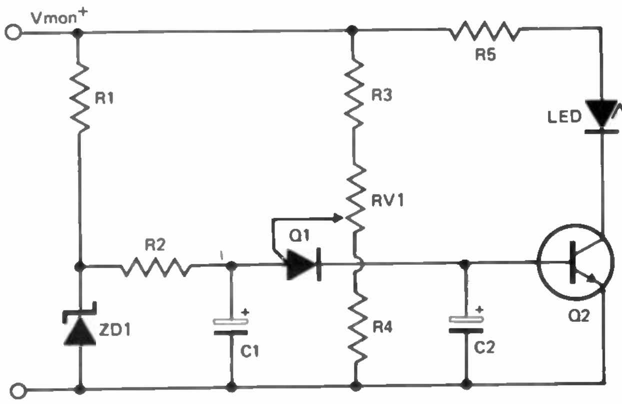
4) preferably, be more rugged and cheaper than a moving coil meter.

The design was based on a programmable unijunction transistor (PUT), because its threshold characteristics can be well defined, arranged to flash a light emitting diode (L.E.D.) indicator.

The circuit is shown in Fig. 1. The PUT (Q1) is used in a relaxation oscillator circuit. As the voltage being monitored (V_{mon}) falls, the voltage on the gate (V_g) falls whilst the anode voltage (V_a) remains essentially constant. Oscillation commences when V_g falls below V_a by 0.6 volts.

As V_{mon} falls further, V_g falls and the PUT triggers at lower values of V_a. Thus the cycle time shortens and the frequency of flashing increases giving a sense of urgency as the battery approached exhaustion. Transistor Q1 and C2 act as a pulse stretcher and amplifier to drive the L.E.D. display.

In the prototype the trigger point can be adjusted from 4.5-5.5 volts and the current drain when V_{mon} is 6 volts is 1 mA (controlled primarily by R1). This is considered acceptable as the device being monitored draws 17 mA. All the requirements have been met. The components are mounted on the printed circuit board of the main device.



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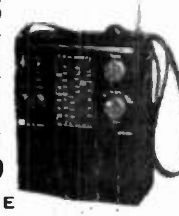

$59

SPECIAL INTRODUCTORY PRICE

SPECIFICATIONS

CIRCUIT: 16 transistors, 15 diodes, 1 varistor and 2 rectifiers. FREQUENCY RANGE: AM 535-1605 KHz, FM 88-108 MHz, TV1 56-108 MHz, TV2 174-217 MHz, AIR/PB2 110-174 MHz and WB 162.5 MHz. POWER SOURCE: DC 6 Volts. POWER OUTPUT: 350 mW (Maximum) 250 mW .(Undistorted). DIMENSION: 9 3/8" x 3 3/4" x 8". WEIGHT: 4 1/4 Lbs. (approx). SUPPLIED ACCESSORIES: Earphone, Batteries (4 size D).

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1 watt 2 channel transceiver with call system. 27.240 MHz. 12 transistor. PMG approved type.

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K.J. MILLBOURN

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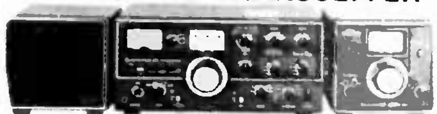

SP520 — TS520 — VF0520

Specifications

Frequency Range: 80 meter band — 3.50 to 4.00 MHz; 40 meter band — 7.00 to 7.30 MHz; 20 meter band — 14.00 to 14.35 MHz; 15 meter band — 21.00 to 21.45 MHz; 10 meter band — 28.00 to 28.50 MHz, 28.50 to 29.10 MHz, 29.10 to 29.70 MHz; WWV — 10.00 MHz.

Mode (Receive only) USB, LSB, CW.

Input Power: 160 watts on 80 to 15 meter band, 140 watts on 10 meter band.

Antenna Impedance: 50 to 75 ohms, unbalanced.

Carrier Suppression: 40 dB.

Unwanted Sideband Suppression: 40 dB.

Harmonic Radiation — 40 dB.

AF Response: 400 to 2,600 Hz (—6 dB).

Audio Input Sensitivity: High impedance (50kΩ) 0.5 μV for 10 dB (S+N)/N on 80 to 15 meter band. 1.0 μV for 10 dB (S+N)/N on 10 meter band.

Selectivity: SSB: 2.4 kHz (—6 dB), 4.4 kHz (—60 dB), CW: 0.5 kHz (—6 dB), 1.5 kHz (—60 dB), (with optional CW filter).

Frequency Stability: 100 Hz per 30 minutes after warm-up.

Image Ratio: 50 dB.

IF Rejection: 50 dB.

AF Output Power: 1 watt (with 8 ohms load and 10% H.D.)

AF Output Impedance: 4 to 16 ohms (Speaker or Headphone).

Tube and Semiconductor Complement: 3 tubes (2 x S2001, 12BY7A), 1 IC, 18 FET's, 44 transistors, 84 Diodes.

Power Requirements: 120/220VAC, 50/60 Hz; Transmit: 280 watts; Receive: 26 watts (with heater-off) or 13.8 VDC; Transmit: 15 Amp; Receive: 0.6 Amp.

Dimensions: 333 (13.11) wide x 150 (5.91) high x 335 (13.19) deep mm (inch).

Weight: 16 kg (35.2 lbs).

Nett. amateur prices

TS 520 $550.00, VFO 520 $95.00, SP 520 $25.00.

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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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Transmitter Frequency Tolerance: ±0.005%

RF Input Power: 1 Watt

Tone Call Frequency: 2000 Hz

Receiver type: Superheterodyne

Receiver Sensitivity: 0.7μV at 10 dB S/N

Selectivity: 45 dB at ±10 kHz

IF Frequency: 455 kHz

Audio Output: 500 mW to External Speaker Jack

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Current Drain: Transmitter: 120-220mA

Receiver: 20-130mA.

Price $49.50 per unit or $99.00 pair

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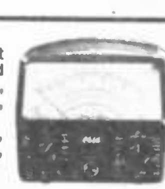

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DC/V: 0.5V, 2.5V, 10V, 50V, 250V, 500V, 1000V at (30,000Ω/V) 5000V (10,000Ω/V).
DC/A: 50μA, 1mA, 50mA, 250mA, 1A, 10A.
OHMS: 10kΩ, 100kΩ 1MΩ 100MΩ
db: —20 to +62dB
Signal Injector: Blocking oscillator circuit with a 2SA102 transistor.
Approx. size: 6-2/5" x 7-1/5" x 3-3/5".

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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"

SQUARE WAVE GENERATORS

Unusual multivibrator circuits produce fast rise *and* fall waveforms — by Laurie Cachia, B.Sc., C.Eng., M.I.E.E., M.I.E.R.E., M.I.E. Aust.

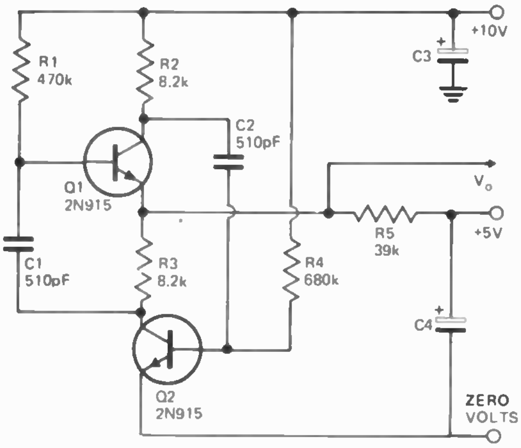

Fig. 1. This circuit supplies well-shaped square-waves.

CONVENTIONAL multivibrators generate an output waveform which is produced by a transistor switching out of conduction; apart from this both leading and trailing edges are slowed down by the loading effect of the feedback/timing capacitors.

Here are two unusual multivibrator circuits which do not suffer from the above limitations.

Both circuits produce square waves in which both leading and trailing edges are formed by a transistor switching *into* conduction — rise and fall time is typically 80 ns.

A further unusual feature is that, in both circuits, the output is derived across a low impedance point and is not capacitively loaded.

Consider Q1 to be on the onset of conduction. As I_c1 increases, $Q1_c$ falls in potential and, because of the coupling capacitor C1, $Q2_b$ drops also. Therefore I_c2 decreases, $Q1_c$ rises in potential and the coupling capacitor C2 causes $Q1_b$ to rise and hence I_c1 to increase still further.

The effect is cumulative and ends with Q1 conducting heavily and Q2 cut off.

Capacitor C1 charges up and $Q2_b$ rises towards the +10V line until Q2 is again forward biased and starts to conduct again. As I_c2 increases $Q2_c$ potential falls and causes $Q1_b$ to fall with it. Therefore, I_c1 decreases and $Q1_c$ potential rises causing $Q2_b$ to rise and I_c2 to increase still further. The effect is again cumulative and ends with Q2 conducting and Q1 cut off.

Capacitor C1 charges up and $Q1_b$ rises towards the +10V line until Q1 is again forward biased I_c1 starts to increase. The cycle of operation then repeats itself.

The frequency and the mark to space ratio for the square wave can be altered by altering the values of R1, R4, C1 and C2.

In general, the turn on time for transistors is shorter than the turn off time by about an order of magnitude. In the circuit of Fig. 1 the leading edge of the square wave (going positive) is produced by Q2 coming into conduction and the rear edge of the square wave is produced by Q1 coming into conduction. The rise time and fall time of the edges of the square wave are thus of the same order (80 ns)

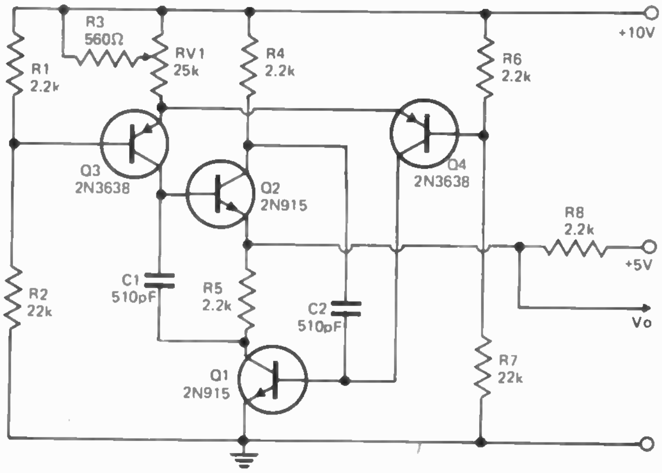

Fig. 2. Well-shaped variable frequency square-waves (5 kHz – 50 kHz) are supplied by this circuit, which is also capable of high frequency operation.

VARIABLE FREQUENCY SQUARE WAVE GENERATOR

A variation of the circuit of Fig. 1 is shown in Fig. 2. Here the feedback/timing capacitors C1 and C2 are charged up by the constant current generators Q3 and Q4. The magnitude of the charging current is governed by the voltage of $Q3_b$ and $Q4_b$ and by the value of the resistance in the emitter circuit of Q3 and Q4. Thus C1 and C2 charge up linearly at a rate determined by the setting of RV1 which therefore acts as a variable frequency control. ●

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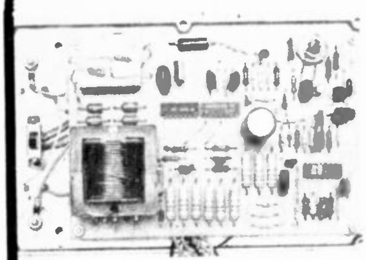

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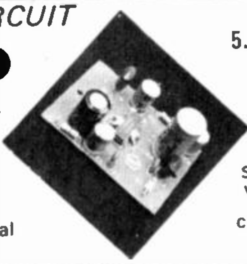

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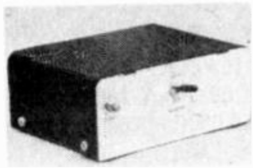

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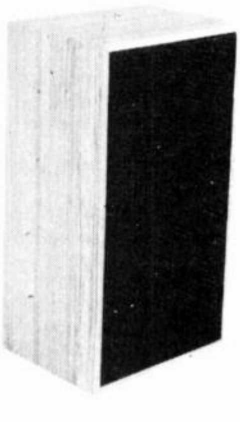

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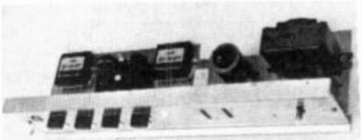

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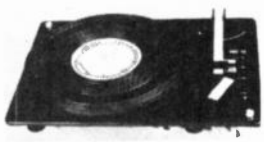

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CORAL 8. S15

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CORAL 10. S25

A fine 10" 3 way speaker system from Coral Audio Corporation (10SA-1), capable of 50W peak, 25W average power, and wide 40Hz — 20KHz frequency response. The capacitive type crossover network operates at 2KHz, 6KHz for smooth response and distinctive performance from each speaker individually. Comprises 10" free-edge woofer, 5" mid-range and 2½" tweeter, plus all accessories. Comprehensive instructions are provided. Impedance 8 ohms. Post/Package $2.00 each. **$25**

CORAL 12. S35

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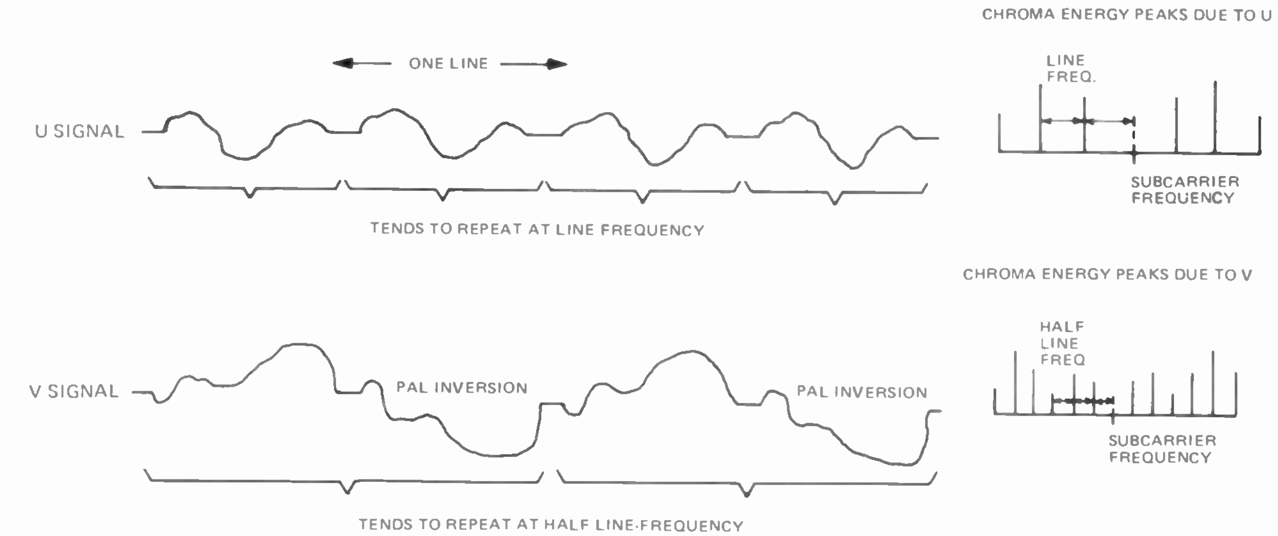
UNDERSTANDING COLOUR TV

by Caleb Bradley B.Sc.

This month – the PAL colour signal.



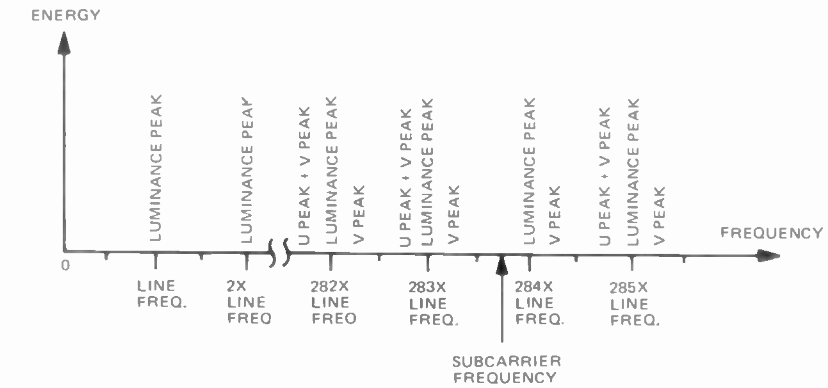


Fig. 23. Placing subcarrier frequency at 283.75 (line frequency) gives optimum interleaving of luminance, U and V energy peaks.

A PAL COLOUR television signal is similar to a monochrome signal except that it includes a high frequency subcarrier on which the colour-difference signals are modulated in quadrature. This subcarrier is known as the chroma signal. The frequency of the subcarrier is chosen with absolute precision to minimise the interfering effect of chroma on luminance. This involves the following factors:

1. The subcarrier frequency should be as high as possible so that any interference it causes on a monochrome picture is invisible from a reasonable viewing distance.

2. Since the colour-difference signals are allowed a bandwidth of about 1 MHz, the sideband energy of the chroma signal extends 1 MHz above and below the subcarrier frequency. The bandwidth of the composite television signal is limited to 5.5 MHz so the subcarrier frequency must be below 4.5 MHz to avoid excessive attenuation of the upper chroma sideband.

3. In Part 2 it was shown that interference between luminance and chroma can be minimised by placing the subcarrier frequency between any two harmonics of line frequency (15 625 Hz). This causes the predominantly line-harmonic energy

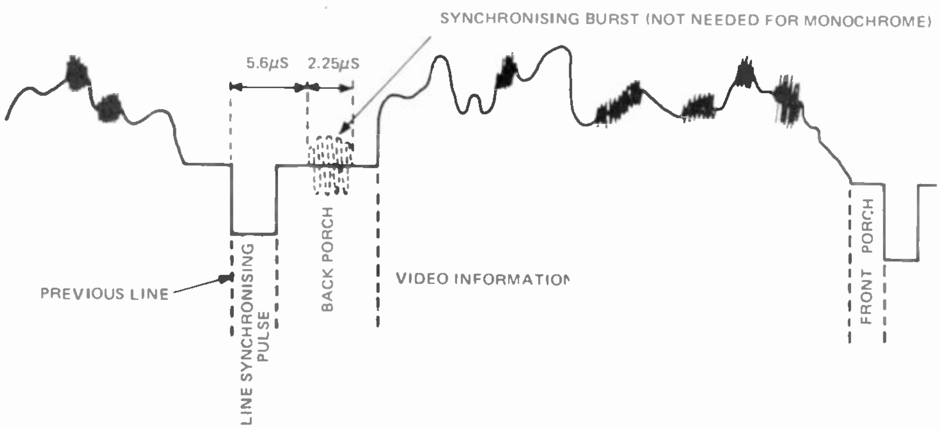


Fig. 24. Waveform of one line of a colour picture. A short 'burst' of unmodulated 4.43 MHz subcarrier is transmitted in the back porch period for reference oscillator synchronisation.

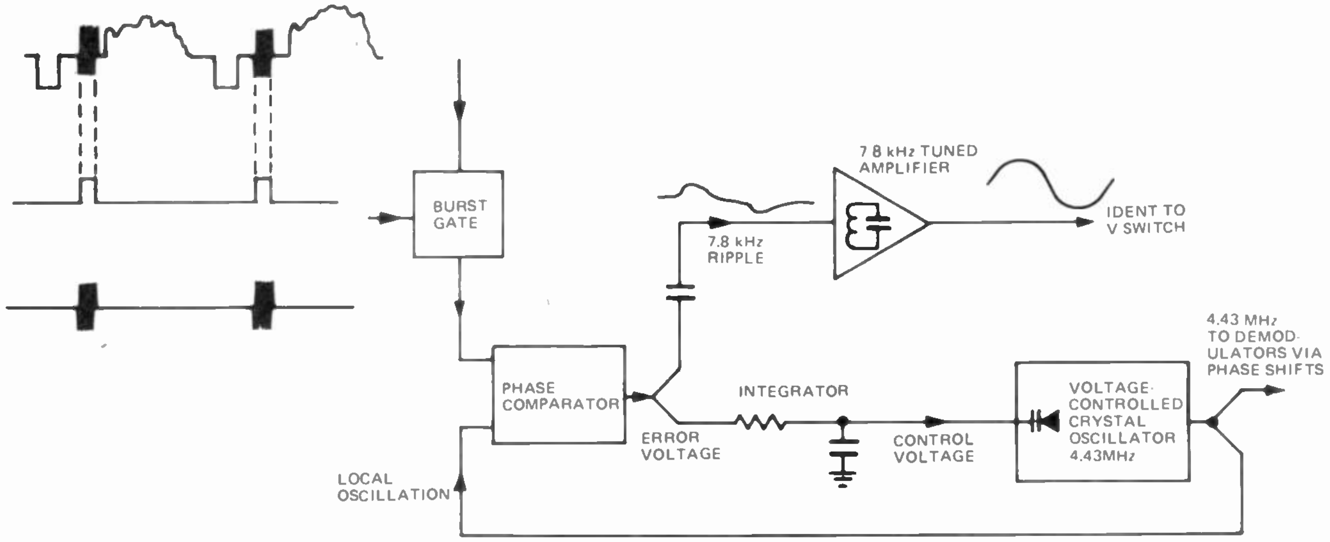


Fig. 25. The phase lock loop by which the reference oscillator phase is controlled by the burst.

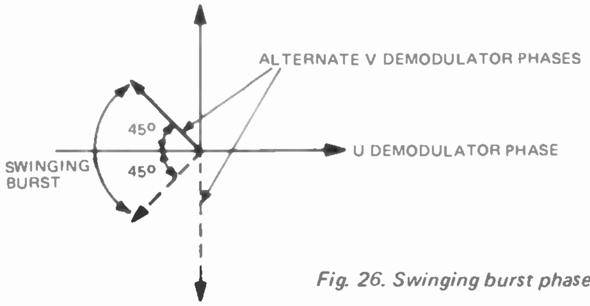
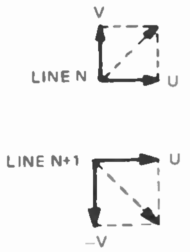


Fig. 26. Swinging burst phases.

contents of luminance and chroma to 'interleave'. So far, a reasonable choice of subcarrier frequency would seem to lie between the 283rd harmonic of line frequency (4.421875 MHz) and the 284th harmonic (4.437500 MHz), i.e. at 283.5 x (line frequency).

4. Since one of the colour-difference signals ('V') is reversed (or 'modulated' by) half line-frequency in the PAL system, the chroma energy peaks due to V alone are at steps of only half line-frequency either side of subcarrier frequency – see Fig. 23. To separate these peaks from the luminance peaks a better choice of subcarrier is 283.75 x (line frequency).



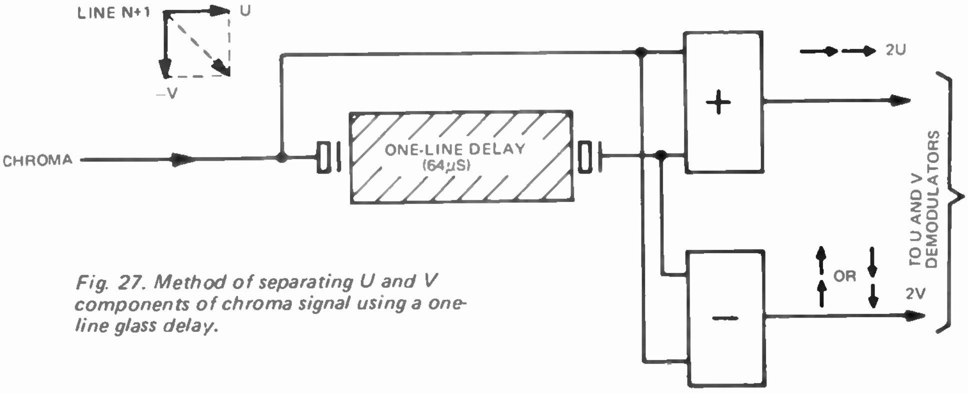


Fig. 27. Method of separating U and V components of chroma signal using a one-line glass delay.

5. Areas of saturated colour where the chroma signal is large suffer slightly from a fine dot patterning caused by the subcarrier frequency appearing as luminance detail. While colour sets are designed to reject the subcarrier from the luminance signal, older monochrome sets with good resolution may show the effect. The pattern is minimised if the dots and the spaces between them are in relatively staggered positions on adjacent lines. This is achieved by offsetting the subcarrier frequency by an amount equal to the rate at which each line of the picture is refreshed (frame frequency) i.e. 25 Hz.

Thus the final choice of subcarrier frequency for the PAL signal is:
(283.75 x 15,625) + 25 Hz
= 4.43361875 MHz

Broadcasters maintain this frequency accurate to a fraction of 1 Hz!

SUBCARRIER BURST

Colour receivers contain a reference oscillator which generates subcarrier frequency to drive the U and V demodulators. A quartz crystal is used to determine the frequency accurately but the oscillator can only be brought to exactly correct frequency and phase by a special synchronising signal included in every picture line of the colour signal. This is a short transmission of unmodulated subcarrier, just 10 cycles (2.25 microseconds) long, known as the 'burst'. Fortunately for monochrome/colour compatibility a monochrome signal contains a 'dead' period at the start of each scanning line, known as the back porch. The burst is inserted in this space – Fig. 24. Its position on the line is carefully defined so that a simple gating circuit in the receiver can extract it for controlling the reference oscillator. This is achieved by applying the local oscillation and the burst to a phase comparator which detects any error in the local oscillator phase and corrects it by means of a control voltage applied to the oscillator. The phase-lock loop so formed is shown in Fig. 25. The control voltage is usually applied to a varicap diode in the oscillator circuit; changing the control voltage causes the capacity of the diode to change and the change in load on the quartz crystal affects the oscillator phase.

Since the burst is present for only 3½% of a line, an integrating capacitor is needed to store the control voltage between bursts. The integrator also makes the phase lock more resistant to interference.

SWINGING BURST

The U and V demodulators require different phases of reference oscillation and these are obtained from the reference oscillator by simple phase shift networks. While the U

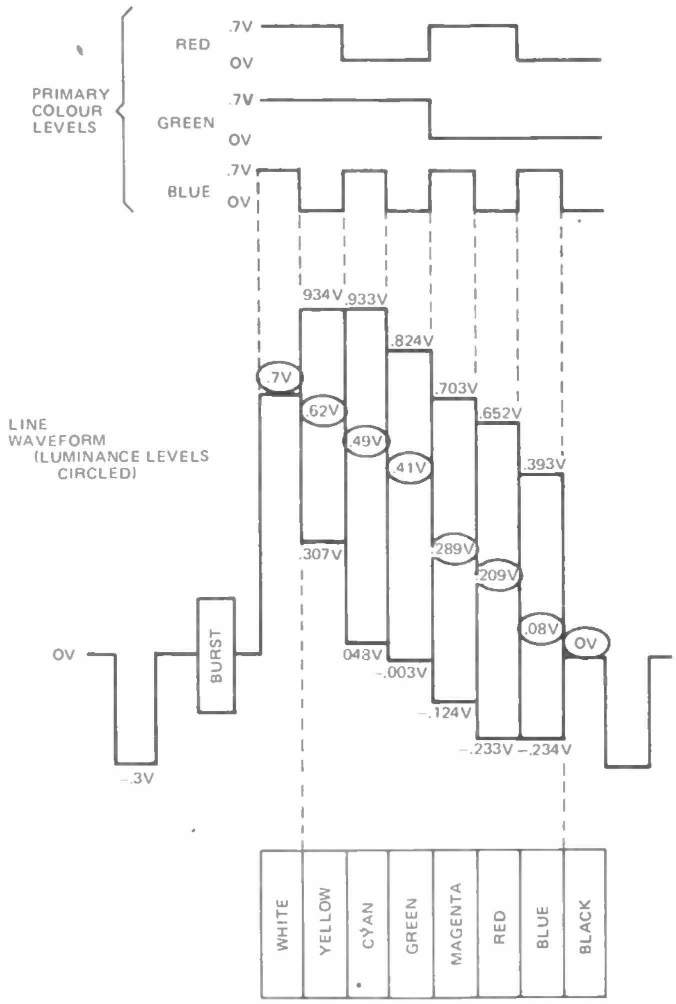


Fig. 28. 100% amplitude, 100% saturation colour bar pattern and waveform. Levels are shown relative to OV = black level.

demodulator needs a fixed phase, the V demodulator needs different phase (± 90°) on successive lines to match the PAL switching at the transmitter — see Fig. 26. Some receivers switch the V signal itself instead of the demodulation phase; this achieves the same thing and in either case an electronic reversing switch working at half line-frequency (7.8 kHz) is needed. The switch phasing must match the transmitter for correct V demodulation. The burst is used to synchronise the V switch as follows.

The bursts do not have uniform phase, instead they alternate ± 45° on successive lines. These swings are not intended to be followed by the reference oscillator and to prevent this the integrator in Fig. 25 has a time constant much longer than one line. Therefore the reference oscillator settles at the *average* phase of the bursts which is the –U axis. The purpose of the swinging burst is to produce a small 7.8 kHz ripple in the error voltage from the phase comparator. This ripple is picked off by a tuned amplifier to give a 7.8 kHz signal known as the *ident*. The ident conveys the phase information needed by the V switch. Without it the V switch would only have a 50% chance of starting in the right phase every time the set is switched on.

PAL-D (Delay)

Although under ideal conditions U and V can be separated from the chroma signal by correctly phased demodulation, the phase errors which occur in real situations cause Hanover blind colour errors. Although these are less objectionable than the corresponding hue errors in the simpler NTSC system (since the eye tends to integrate the errors to see near-correct colours) most PAL receivers use the PAL-D refinement by which Hanover blinds are entirely eliminated. This involves passing the chroma through a one-line delay unit. The delay consists of a ceramic transducer which converts the chroma into ultrasonic (4.43 MHz) vibrations which travel a carefully measured path through a glass block to a second transducer which converts the vibrations back to an electrical signal. The block is ground to give a 64 microsecond delay. In Fig.27 the direct and one-line-delayed chroma signals are both fed to two stages: an adder where the alternate line phased V components cancel out leaving U alone, and a differencer where the U components, being similar on successive lines, cancel out instead leaving alternating V. Thus U and V are separated *before* the demodulators. This is not essential but gives the advantage that phase errors (Fig. 22 last month) are averaged out between adjacent lines electronically without Hanover blinds appearing. A minor consequence of PAL-D is that vertical colour resolution is slightly reduced but this is far preferable to Hanover

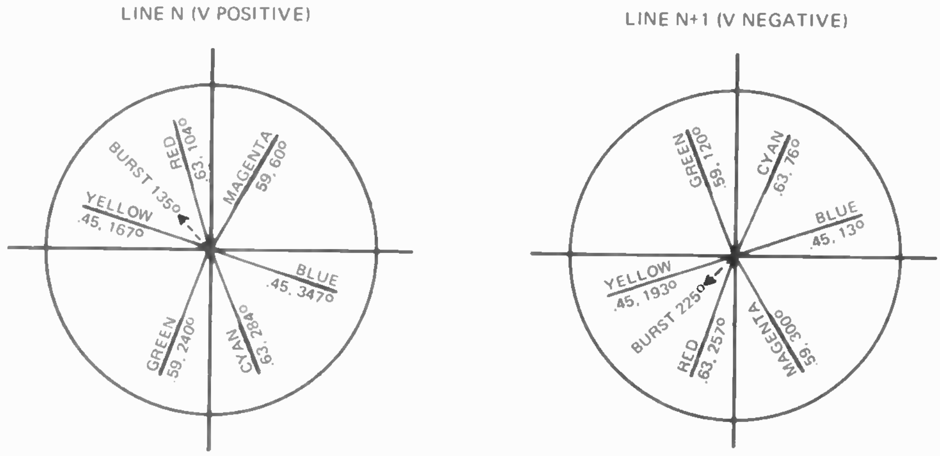


Fig. 29. Chroma and burst vectors on successive lines for colour bar pattern.

blinds. The delay line in Fig. 27 must be trimmed to one-line period to within a fraction of a subcarrier cycle or the circuit will cause permanent Hanover blinds!

When PAL was introduced it was expected that slightly cheaper PAL-S (simple) receivers without a chroma delay line would be made. In practice the cost of the mass-produced glass delay line is so low that virtually all PAL receivers are PAL-D type.

COLOUR BARS

A standard pattern of colours is enormously useful for checking receiver performance – the colour bars pattern is shown in Fig.28. The sequence of colours is chosen to give descending luminance levels from left to right so that a monochrome receiver displays steps of grey from white to black. The separate red, green and blue signals which make up the bar pattern are shown in Fig. 28; they are generated electronically for accuracy. If the receiver decoder is working correctly the red, green and blue beams of the display tube will be controlled by these signals. This is readily checked by switching on each beam in turn and counting the number of bars of colour displayed.

The peak excursions of the composite luminance chroma waveform are given in Fig. 28. The luminance levels are found from:

$$E_Y = .3E_R + .59E_G + .11E_B$$

The peak-to-peak chroma amplitudes are found by summing vectorially the U and V values for each colour found from the equations given in Part 3 i.e.

$U = .493\ (E_B - E_Y)$ where $E_B - E_Y = .7E_R - .59E_G - .11E_B$ and $V = .877\ (E_R - E_Y)$ where $E_R - E_Y = .3E_R - .59E_G + .89E_B$

The amplitudes of the resultants are the same for +V and –V lines, only the chroma phases change. The chroma phase for each colour is shown in Fig. 29. Note that black and white have no chroma signal.

The colour bar pattern in Fig. 29 is the most basic but the 100% amplitude, 100% saturation colours do not often occur in real pictures. Therefore other versions of the pattern where amplitude or saturation is reduced are often used. This does not affect the vector angles in Fig. 29, only the luminance or chroma amplitude respectively.

COMPLETE RECEIVER

The delay line in Fig. 27 and the phase lock loop in Fig. 25 are the heart of a receiver colour decoder which will be described next month. ●

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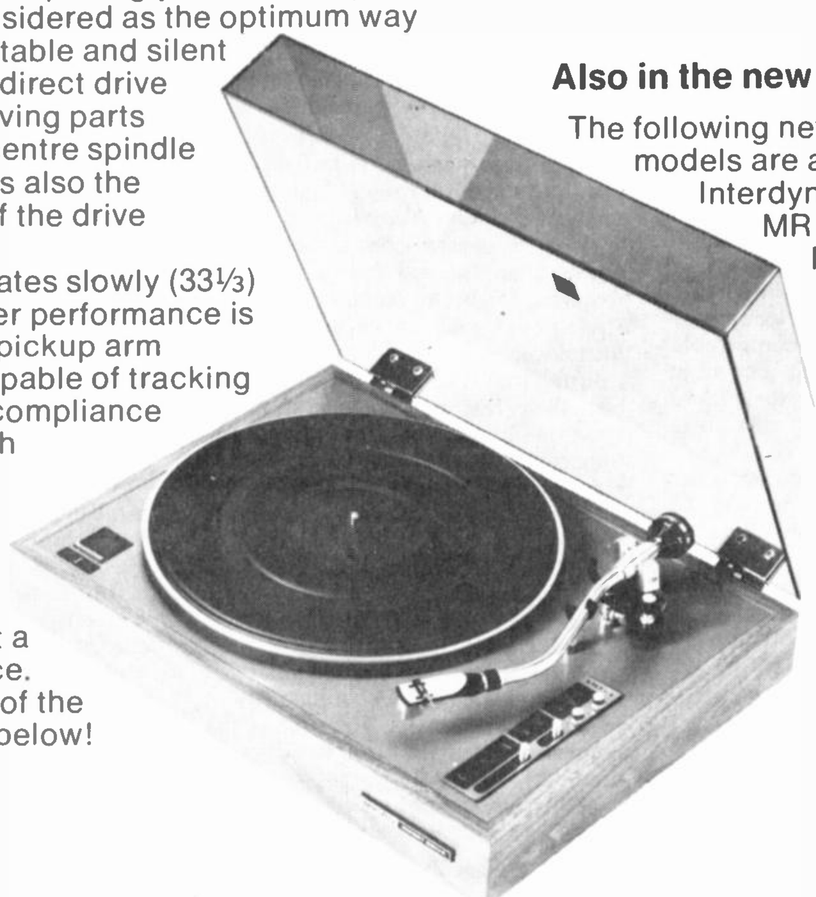

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ELECTRONICS -it's easy! PART 15

How regulated power supplies work.

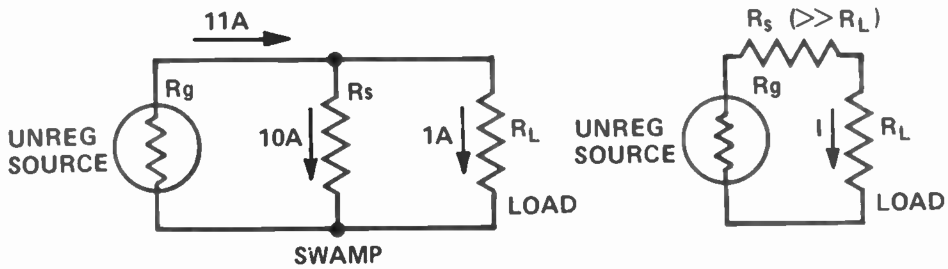


Fig. 1. Regulation can be slightly improved by:
(a). Voltage regulation – an additional shunt load.
(b). Current regulation – an additional series load.

WE HAVE SEEN how the regulation of a power supply is related to its effective internal resistance. A voltage source requires low internal resistance, whilst a current supply requires maximum internal resistance for best operation.

PASSIVE METHODS

A simple and very elementary method of improving the regulation is to impose a dummy load on the supply that is much greater than the normal load. Figure 1a shows a swamping load of 10 amps in parallel with 1 amp. If the real load, (the smaller) varies by a value comparable with 1 amp, far less change occurs in the total load drawn from the supply – the output voltage, therefore, changes less.

This method improves regulation for load changes, but does nothing to guard against input supply changes. Furthermore, it is clearly inefficient. Note that R_L is now connected to a lower source resistance – that of R_g in parallel with R_s. The reduction in resistance is, however, not great.

If a constant current through the load resistance is required a similarly crude method is to place the load in series with a resistor that is much greater than the load value – as shown in Fig. 1b. It can be seen (from Ohms law) that I will now remain constant over a wider range of R_L variation.

Again there is a disadvantage, the input voltage must be raised to drive the same current through the increased resistance circuit. Furthermore, if this is done, R_s wastes considerably more power than is used in the load. As required, for better current regulation, R_L now sees a higher source resistance.

Both circuits are used occasionally but their real relevance is that the same basic principle (modifying the impedance of the supply) is used in more sophisticated supplies. These supplies use special non-linear components and active devices to provide much better regulation with considerably less loss of power.

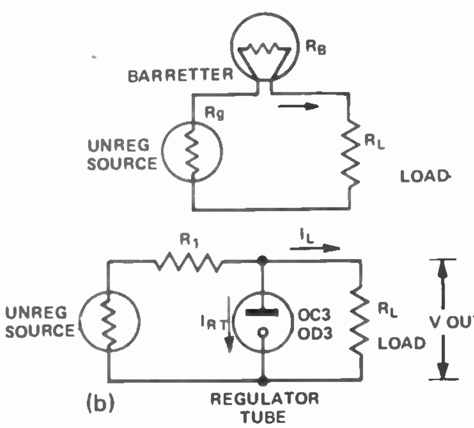
NON-LINEAR DEVICES

Before low cost semiconductors became widely available in the form of regulating diodes (Zeners) and regulator integrated circuits, designers used the barretter current regulator and the gaseous-tube voltage regulator. These are still found in older equipment but would not normally be used in new designs.

The barretter contains an iron filament in a hydrogen filled envelope and is used in series with the load. Over a reasonably wide range of voltage (100-200 V) the load current remains constant to within 20% (typical value would be 300 mA). By today's design standards they waste power and run extremely hot. Regulation occurs because an increase in current through the filament (see Figure 2a) causes its resistance to increase thus tending to reduce the current to its previous level – R_s, in Fig. 1b, increases with increasing current. Note that the current itself provides a feedback effect (via heating of the filament) that controls the current. The use of feedback (but in a more effective way based upon active elements) is the secret of obtaining really good regulation, as we shall see later.

The gaseous-tube voltage regulator is a gas-filled two-electrode valve which, once the gas is ionised into conduction, provides a reasonably constant voltage drop between its electrodes with varying current values flowing through the ionised gas. Again these are seldom used today, being more suited to voltages much larger than those needed in semi-conductor work (they strike and operate at around 100 V).

In use, the regulator is wired in parallel with the load, the two being fed from the supply via a series resistor, as shown in Fig. 2b. If the input voltage increases (assuming a constant load) the total current must rise. But as the VR tube maintains constant voltage across itself, the load current remains steady and all the excess current flows through the VR tube. Thus the voltage drop across the series resistor increases so that the voltage applied to the load remains the same.



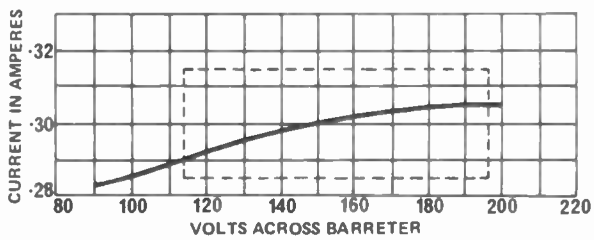


Fig. 2 (a). The barretter tube regulates by the increase in resistance with temperature (and hence current) of an iron-wire filament.
(b). The gaseous-tube voltage regulator operates by virtue of the constant voltage which appears across a gas discharge over a wide range of current.

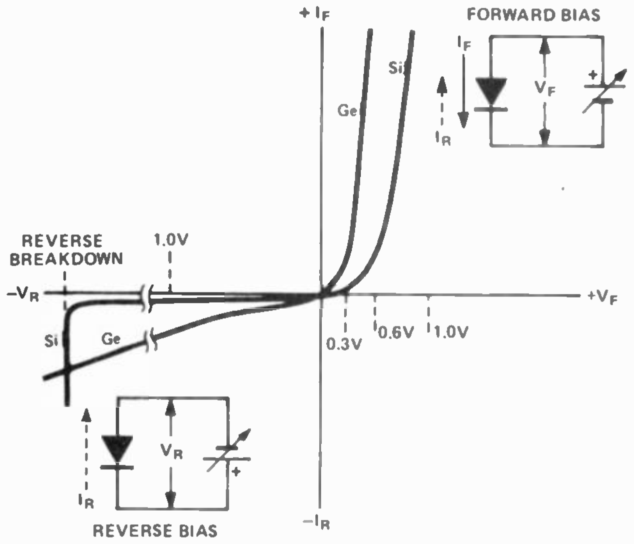


Fig. 3. Forward and reverse bias characteristics of germanium and silicon diodes.

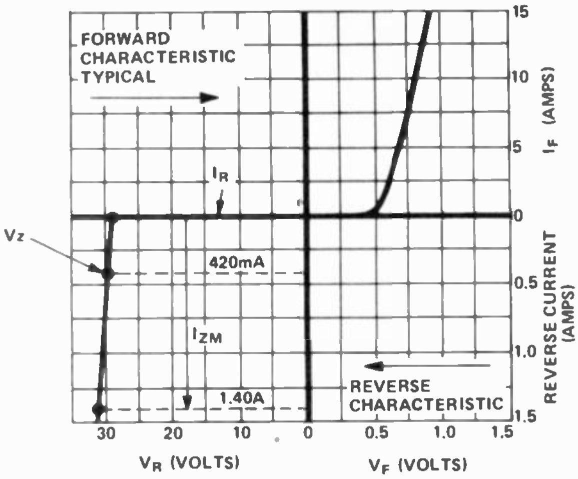


Fig. 4. In a zener diode the reverse-breakdown region is used to provide a constant voltage as current demand varies.

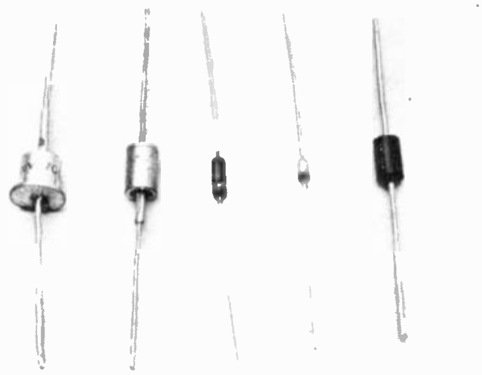


Fig. 5. Zener diodes are manufactured in a wide variety of packages. The larger capacity (not shown here) units are usually mounted on heat sinks if run at their maximum rating.

The effectiveness of the compensation depends upon the rate of change of the voltage-current characteristic of the device. The barretter represented in Fig. 2a changes some 200μ A/V. A flatter curve would imply a current that changes less per volt and this is to be preferred.

Neither of these two devices has a particularly low V/I ratio and neither, therefore, is able to provide close control over wide ranges of input change.

Negative temperature coefficient NTC resistors — more commonly called thermistors or varistors — have a similar voltage-current characteristic but the slope is in the reverse direction, that is, increase in current increases their temperature which, in turn, decreases their resistance. They are not suited to regulator design where constancy is desired but are useful in providing the reverse effect, for example, when wired in series with a load, that could be damaged by switch-on current surges. An NTC resistor suitable for such use might have a resistance of 3000 ohms cold reducing to 200 ohms when heated by 100 mA passing through it.

ZENER DIODES

The current-versus-voltage characteristics of both germanium and silicon diodes are illustrated in Fig. 3. In the forward direction (positive voltage at anode with respect to cathode) the devices operate, as shown, in the right-hand region of the graph.

It can be seen that once the forward voltage across the diodes reaches 650 mV for silicon (or 350 mV for germanium) it remains substantially constant over quite wide excursions of the forward current. Thus forward-biased diodes could be used as constant-voltage regulator elements but only at the low voltages mentioned above or at multiples of these voltages (using diodes in series).

If a conventional diode is reverse biased its operating characteristic will be as shown on the left hand side of Fig. 3. Very little current (microamps) will flow until the reverse voltage reaches a comparatively large value when the current starts to increase much more rapidly. In a germanium device the voltage across the diode will still increase relatively slowly with increasing current, but in a silicon device the voltage across the diode now remains substantially constant regardless of further increase in current. This point is known as the Reverse Breakdown Point.

In a normal diode the rapid increase in reverse current causes the semiconductor junction to overheat and the device may fail. This breakdown effect occurs at voltages between two and a half volts and several thousand volts depending upon the material and construction of the semiconductor junction. However, this seeming disadvantage may be put to work in specially constructed devices known as Zener diodes.

Zener diodes are invariably silicon devices which have been specially designed to operate within the reverse-breakdown region, without damage, provided that the maximum-specified power dissipation (VxI) is not exceeded.

DYNAMIC RESISTANCE OF ZENER DIODES

Ideally, a Zener diode should maintain a constant voltage across itself with varying current through it. However, practical devices don't behave quite like that. In Fig. 4 we see, from the typical characteristics of a 30 volt, 50 watt device, that if the current through the device changes by 1.0 amp, the voltage across it will change by 2 volts. This may be expressed as a resistance as follows:—

By Ohm's Law $\frac{\Delta V}{\Delta I} = R$ i.e. $\frac{2}{1} = 2$ ohms

As this resistance is the ratio of changes of voltage with respect to current it is a dynamic quantity, and is therefore known as the Dynamic

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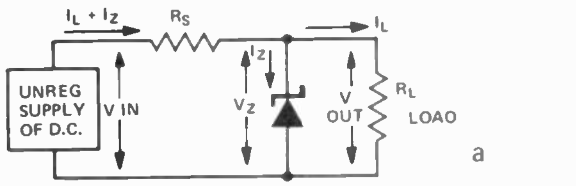

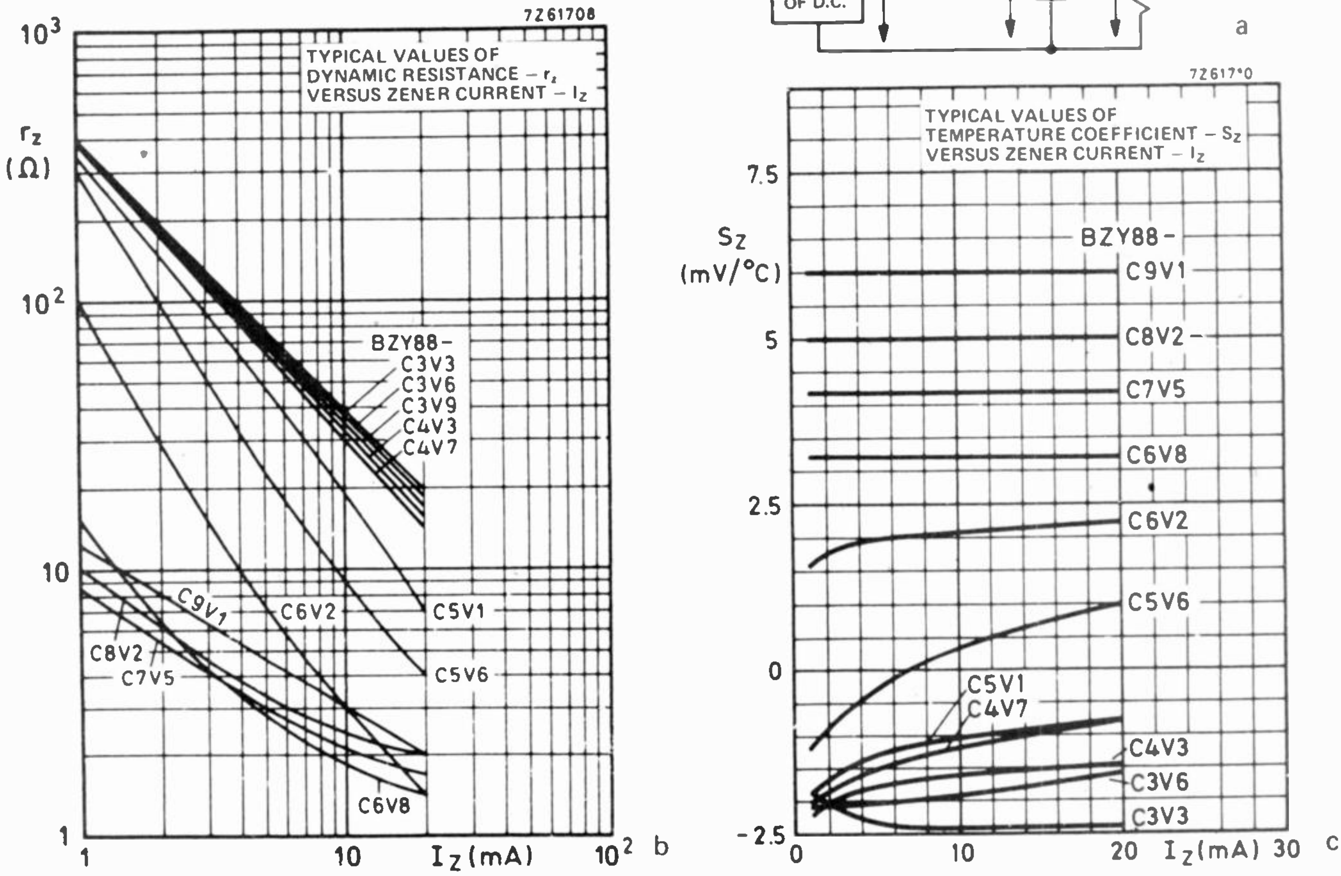

Fig. 6. (a) Typical Zener diode regulator. (b) dynamic resistance of BZY88 series Zeners. (c) temperature coefficients of BZY88 series diodes.

Resistance of the Zener. It tells us how well the Zener will regulate the voltage with changes in load current.

Thus a Zener having the desired reverse-breakdown voltage may be used to replace the gas-regulator valve shown in Fig. 2b. Any load connected across the Zener will see a source impedance which is the parallel combination of the dynamic resistance of the Zener, and the internal impedance of the power supply.

TEMPERATURE COEFFICIENT

The reverse-voltage characteristic of the Zener is temperature dependent, the extent of this dependancy being determined by the designed Zener voltage and power dissipation. For example in typical 400 mW devices the temperature coefficient ranges from -2.5 mV/C° for a 2.7 volt Zener to +26 mV/C° for a 30 volt Zener. Zero temperature coefficient is obtained with a device having a nominal voltage of 5.6.

Where Zener regulators are required to have minimum temperature coefficient and higher than 5.6 volt rating, several diodes with temperature coefficients which cancel may be used in series. For example, if 9.8 volts is required with zero temperature coefficient, a 3.6 volt -2.0 mV/C° diode may be used together with a 6.2 volt +2.0 mV/C° diode.

REGULATOR DESIGN

The circuit of Fig. 6 is that of a typical Zener-diode regulator stage. The series resistor, R_s, must be large enough such that when the load current is at its minimum (Zener current at maximum) the power dissipation rating of the diode is not exceeded, and small enough to ensure that when the load current is maximum (Zener current at minimum) the voltage across the load does not fall below E_z (Zener voltage). Additionally the Zener current should always be at least one tenth of the maximum load current. The optimum value of R_s may be calculated from

$$R_s = \left[\frac{E_{s1} - E_z}{1.1\, I_{L1}}\right]$$

Power in R_s = $(1.1\, I_{L1})^2\, R_s$ and maximum Zener dissipation may be calculated from

$$P_z = \left[\frac{E_{s2} - E_z}{R_s}\right] - I_{L2}\; E_z$$

where

E_{s1} = minimum supply voltage
E_{s2} = maximum supply voltage
E_z = zener voltage.
I_{L1} = maximum load current.
I_{L2} = maximum load current.

For example assume that we have a car battery supply that varies from 11 to 14 volts and from this we wish to obtain a stabilized 6 volt supply at currents from 40 to 60 mA.

The nearest available Zener voltage is 6.2.

Thus $E_{s1} = 11$ $I_{L1} = 0.06$ A
$E_{s2} = 14$ $I_{L2} = 0.04$ A
$E_z = 6.2$

$$\therefore R_s = \frac{11 - 6.2}{1.1 \times 0.06} = 72.7$$

use nearest preferred value 68 ohms.

The power rating of this resistor must be

$$(1.1 \times 0.06)^2 \times 68$$

= 296 mW – a ½ watt resistor will do.

$$P_z = \left[\frac{14 - 6.2}{68}\right] - 0.04 \quad 6.2$$

= 463 mW

Hence a suitable device from the Philips range would be a BZY96C6V2 which has a power rating of 1.25 watts and a nominal Zener voltage of 6.2.

Where Zeners with power ratings greater than one watt are used a heat sink will usually be necessary. Note also that the supply voltage must *always* be greater than the Zener voltage if regulation is to be maintained – at least 10% higher is a safe minimum value.

The Zener voltage regulator is widely used throughout electronics. It may be used as a basic regulator as in Fig. 6, or, it may be used to provide the reference voltage for more accurate and powerful regulators which make use of active devices as well.

The aim of good voltage supply design is to achieve lowest practical effective internal resistance. The Zener does this reasonably well, for the load sees only the dynamic resistance of the Zener which is much lower than the source impedance. As a rough guide the dynamic impedance R_z of the Zener, varies (according to device) from 30 ohms per volt of the Zener, downward to fractional ohms per volt. If one Zener stage cannot provide enough stability it is quite practicable to join stages in cascade. Each stage thereby lowers the effective source resistance (because stages are connected in parallel) but, more significant is the fact that input voltage variations are more adequately attenuated, each stage running from a progressively better stabilised source. Fig. 7a shows a typical dual stage supply. Figure 7b is the preferred method, of providing the same illustrated 5.6 V, for in this alternative all of the diodes have optimum temperature stability.

Zeners also have other uses – to clip and hold voltages at fixed levels and to convert sine-wave signals to square-wave signals.

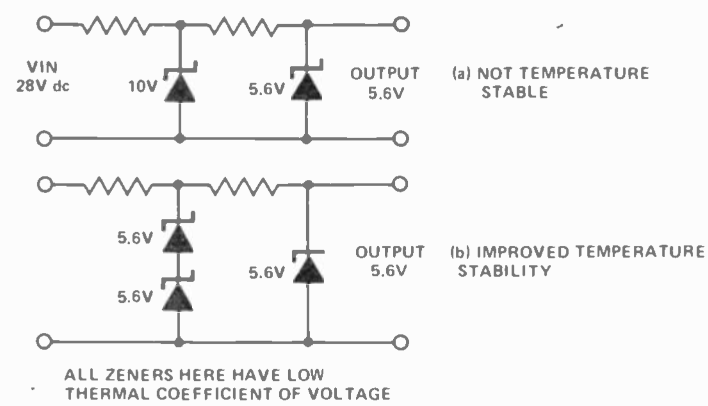

Fig. 7. (a) Cascading Zener regulator stages improves voltage stability. (b) Selected Zeners are often joined in series to achieve the lowest temperature error.

ACTIVE COMPENSATION

Although the Zener can provide a relatively low dynamic resistance value, it is possible to provide still lower resistance by incorporating active amplifiers into the regulator circuitry.

If the actual load voltage is compared with a constant reference-voltage source, it is possible to determine if the output is greater or smaller than required and by how much. Having made such a comparison, the difference, called the error signal, can be used to modify the incoming signal accordingly. This is the principle of feedback. Figure 8 shows how feedback is used in the electro-mechanical type of supply regulator. These regulators are used where loads are high and the unwanted changes occur only relatively slowly.

In operation the output of a basic rectifier is smoothed by a capacitor (C) to provide the required output voltage. The output voltage is compared with a reference voltage and the difference between them (that is the error) is amplified. The amplifier output drives a motor such that a tapping on the ac transformer is changed – thus reducing the error.

Thus, by using feedback, changes in output voltage are rapidly sensed and the input quickly compensated. The feedback amplifier and control actuator (the motor in Fig. 8) need not be precision devices – they can be quite crude in fact – but the reference voltage must have better stability and accuracy than is required from the output.

The reference voltage is quite often, and effectively, supplied by a Zener. As the Zener now only has to supply a reference voltage, and not operate over a wide range of current, its operation will be much more stable. That is, its dynamic impedance will not be a source of error. Additionally, the Zener current may be set at a level which gives optimum temperature stability.

Although electro-mechanical

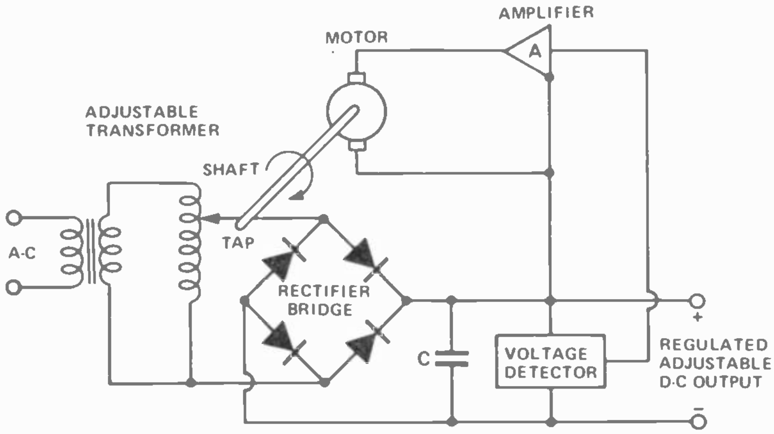

Fig. 8. Superior regulation is obtained by using feedback – as demonstrated by this electromechanical form of regulator.

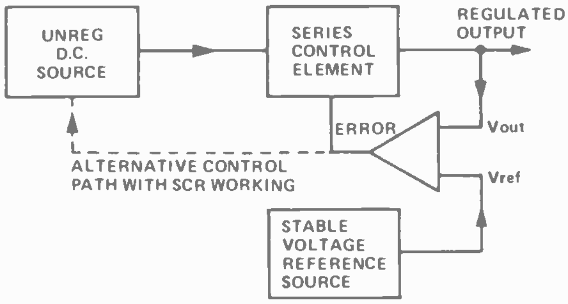

Fig. 9. Generalized diagram of active feedback type regulator.

regulators have their uses, the majority of regulators for low-power electronic systems now use totally solid-state components to build systems such as that shown in Fig. 9.

A wide range of control methods are used using such devices as transistors and integrated circuits, silicon controlled rectifiers (SCRs) and saturable reactors to achieve fast and accurate regulation.

The voltage reference is again generally derived from a Zener network. However, precision units may use a Weston standard cell or a special high-stability Zener arrangement. Yet another kind of regulator may use an external varying voltage as the reference in the feedback system. With such supplies the output is made to track the varying input voltage — these are called programmable supplies.

SHUNT REGULATORS

We have seen how the basic Zener arrangement may be used to provide a shunt path around the load thus stabilizing load voltage. By reducing the current range required of the Zener diode it is possible to improve the regulation and to reduce the power handling required of the Zener. Figure 10 illustrates how a transistor is added to the basic Zener circuit to produce a more precise shunt regulator.

Now the Zener regulator only has to supply the base current of the transistor which in turn controls the much larger collector current.

To see how the regulator works let us assume that the current demanded by the load falls. The voltage across the load would tend to rise (due less voltage drop across the series resistor R) and this would cause the base-emitter voltage on the transistor to rise (as V_R is held constant by the Zener). Hence the transistor draws more current to compensate for the current shed by the load. That is the current drawn through the series resistor R is held constant, current not needed by the load being shunted by the transistor.

As the transistor provides current gain ranging from tens to hundreds, the current variations demanded from the Zener are reduced by the same factor, with consequent improvement in règulation. Although not immediately obvious, feedback is used in this circuit. Voltage changes across the load appear at the base of the transistor which acts to reduce the original change to zero.

One vitally needed characteristic of a general-purpose power supply is that the output should be capable of being short-circuited without damaging any components. The shunt regulator does just this — a shorted output merely connects the emitter of the transistor to collector, thereby reducing the voltage applied to the device. The transistor therefore cannot be damaged by a shorted output. Such a supply is, however, inefficient, especially at light loads, for shunt regulators act always to dissipate the same maximum amount of power — either in the load, in the shunt element or in both. Hence, at zero load the unit wastes as much power as the maximum safe load would consume, and if ever the load is disconnected the transistor must be capable of passing the full load current.

SERIES REGULATORS

The Zener reference may be used to control a transistor in series with the load such that a constant voltage appears across the load. Figure 11 is the circuit of such a basic series regulator.

The operation of a series regulator may most easily be understood by considering the transistor and load to be an emitter follower circuit. We know from our previous theory that an emitter follower maintains its emitter at V_{be} (0.6 volts for silicon) less than the voltage at its base, regardless of the value of the collector supply. Thus the transistor, because of the Zener reference voltage at its base, varies its impedance and hence the voltage dropped across itself, in order to maintain a constant voltage across the load, regardless of load current and supply-voltage variations.

As the transistor has a large current-gain the Zener diode again only has to supply a small current range and regulation is therefore improved. However, the transistor must be capable of withstanding the full load current and of dissipating fairly high power. The series regulator is more efficient on light loads than the shunt regulator but if the output is short-circuited the transistor in a series supply will be destroyed (unless protected in some way), as the full supply voltage and base drive is applied to it.

IMPROVING SERIES REGULATORS

The simple series regulator, just described, is a great improvement on the simple Zener regulator but may still be improved further by additional circuit refinements.

Figure 12 show the schematic diagram of a typical series regulator supply. The ac transformer has two secondaries the first of which provides dc to the regulator and hence the load via a bridge rectifier and smoothing capacitor. The second winding provides a separate supply to a Zener regulator. As this winding does not have to supply the varying load current — only the steady Zener supply, regulation of the reference

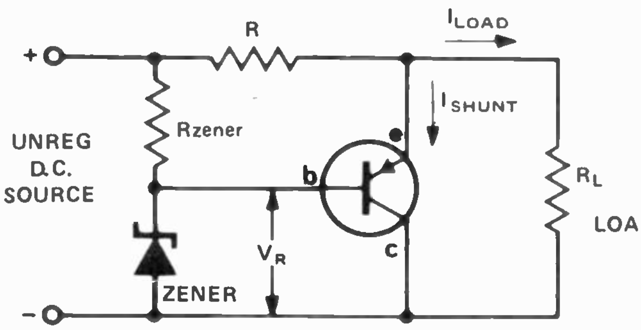

Fig. 10. Basic shunt regulator uses transistor to maintain constant load current on the unregulated dc source.

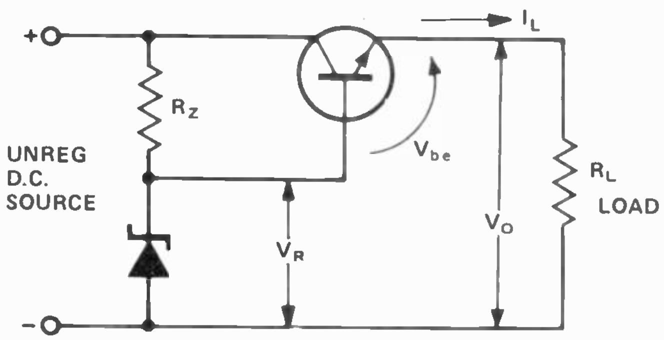

Fig. 11. The series regulator also relies on feedback to control voltage drop across a series-pass transistor.

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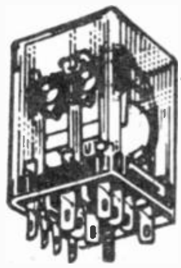

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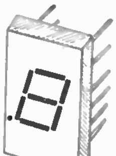

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Circuit board is .8" wide and 4 3/8" long. A single 5-volt power source powers both the IC's and the display tube.

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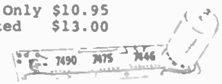

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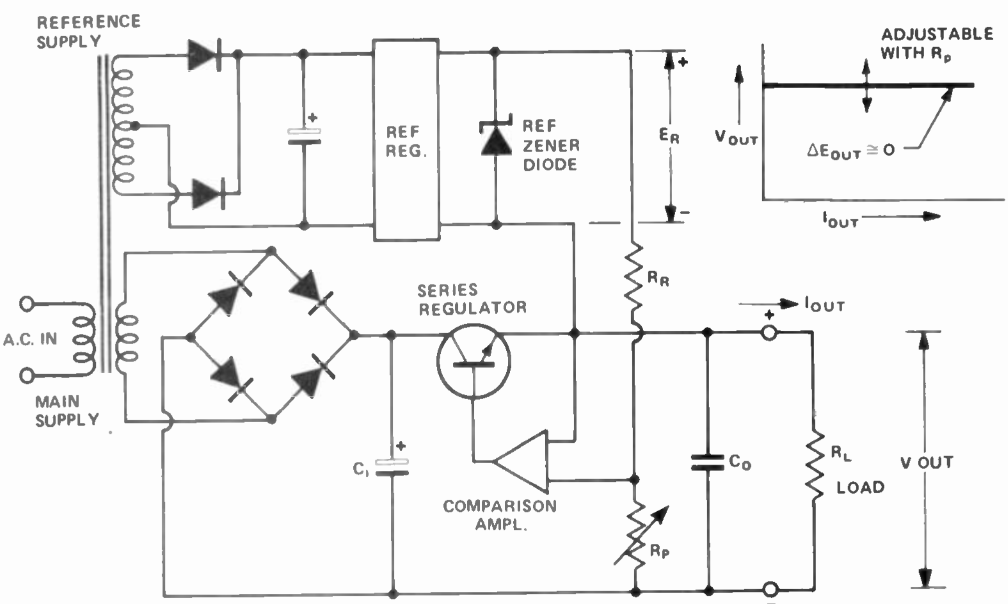


Fig. 12. This schematic diagram of a Hewlett-Packard series – regulated constant voltage power-supply illustrates the design philosophy of precision supplies.

Zener is considerably improved. In addition a temperature compensated Zener may be used which could have a temperature coefficient as good as 0.01%/C°.

This very-stable Zener reference is compared to the output voltage of the supply by a differential-operational amplifier. Thus the Zener does not have to supply any appreciable current. This results in still further improvement in regulation. The operational amplifier provides a change in base current to the series regulator in such a direction as to correct any error between the output voltage and the Zener reference.

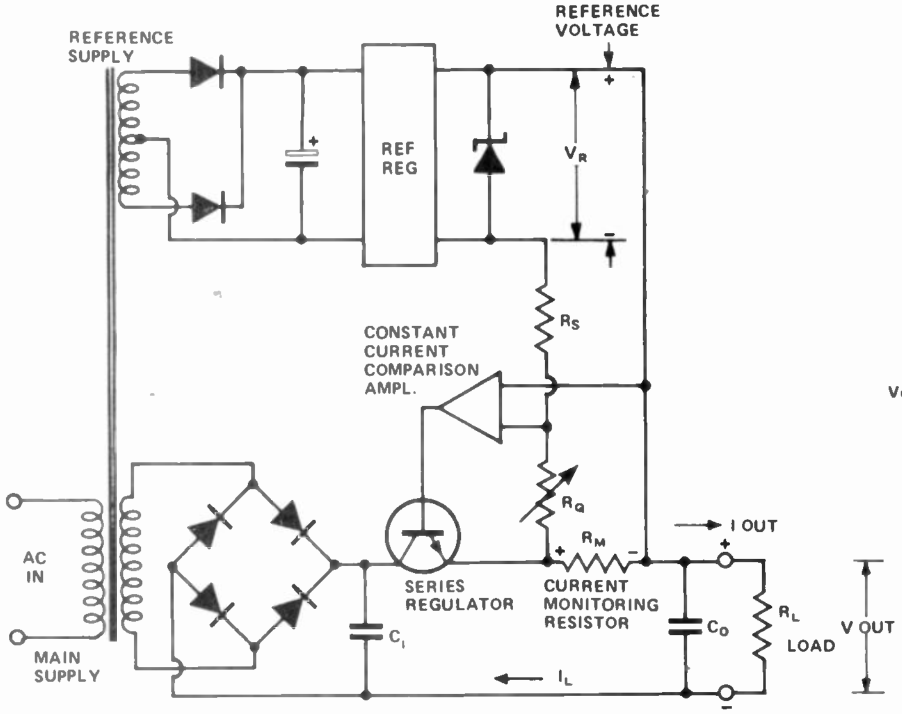
CONSTANT CURRENT

In some applications – magnetic circuits, focussing coils, semiconductor testing – the requirement is for constant output current regardless of load changes. Loads connected to such supplies are connected in series, rather than in parallel as is the case for voltage regulated supplies.

Ohms Law tells us that a certain value of current is related to voltage via a fixed value of resistance. Hence constant current supplies can make use of a small series resistor to monitor the output current by virtue of the voltage developed across the resistor. This voltage is then compared with a reference (the actual value is a matter of design choice, the lower the series resistance the lower the voltages and losses involved) in much the same way as for a stabilised voltage supply. The differences in circuitry needed can be seen by comparing Fig. 13 – that of a well-designed constant current unit – with Fig. 12.

By combining these two concepts into one supply a combined constant voltage and constant current unit is formed (denoted CV/CC). This holds a constant voltage up to a preset maximum load current whereafter it provides constant current.

Power supplies designed to provide variable output for experimental purposes, or equipment (or component) testing are often subject to severe or extended overloads. Units such as these are generally equipped with various protective devices that safeguard not only the power supplies themselves but also the loads that they are driving. These various protective circuits will be described in this series next month . . . ●



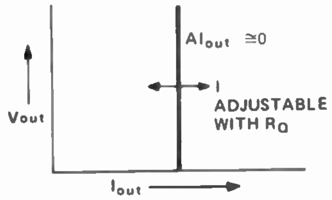


Fig. 13. Constant-current control is easily obtained as an extension of the constant-voltage supply. A series sensing resistor produces a voltage which, in conjunction with an error amplifier, controls the series pass transistor to maintain constant current.

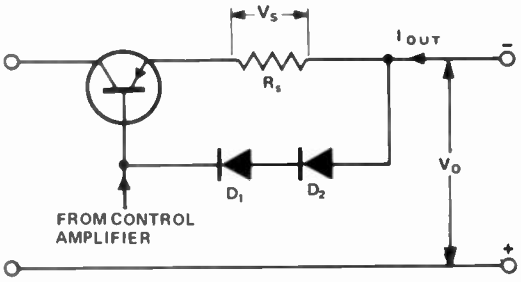


Fig. 14. Automatic current limiting is obtained with a series sensing resistor. This method of control is often used in series-pass voltage regulators.

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TRANSISTORS

DEVICE	FUNCTION	CROSS REF ** SK	HEP	HFE	VCEO	VCBO	VEBO	IC(A) AMP	IB(A) AMP	TOT DIS (WATTS)	FREQ MHZ	CASE	PRICE
PWR AMP AUDIO													
40411	..	3036		35 100	80	90	5 0	30	15	150	1 5	TO-3	$3 75
40636	..	3027	704	20-70	95*	95*	7 0	15	7 0	115		TO-3	1 95
2N3714	..	3036	704	25 90	80	100	7 0	10	4 0	150	4 0	TO 3	2.59
2N3715	..	3036	704	50-150	60	80	7 0	10	4 0	150	4 0	TO 3	2 75
RF PWR AMP													
2N5320	..	3512	53002	30 130	75	100	7 0	2	1 0	10	50	TO 5	1.65
2N5322 (P)	..			30 130	75	100	7.0	2	1.0	10	50	TO 5	1.75
2N5321	..	3512	53010	40 250	50	75	5 0	2	1 0	10	50	TO-5	1.65
2N5323 (P)	..	3513		40 250	50	75	5 0	2	1 0	10	50	TO 5	1.65
PWR DRIVER													
2N5679 (P)	Audio/RF		53031	40-150	100	100	4 0	1 0	0 5	10	30	TO-5	1.70
2N5681				40-150	100	100	4 0	1 0	0 5	10	30	TO 5	1.70
AUDIO DRIVER													
40594	..	3024	53002	70 350	95*		4 0	2 0	1	10	1.0	TO-5	1.45
40595 (P)	..	3025	53031	70 350	95*		4 0	2 0	1	10	1 0	TO-5	1.65
2N5781 (P)	..			20 100	65	80	5 0	3 5	1	10	1 0	TO 5	1.75
2N5784	..		53002	20 100	65	80	5 0	3 5	1	10	1 0	TO 5	1 75
2N5864 (P)	RF & Audio			25 500	70	90	5 0	1 5		8 75	50	TO 39	1.35
40348	..	3044	243	30 125	·40	60	7 0	1 5	0 5	8 75·	1 6	TO 5	1 72
40544	..	3045		35 200	50*	50*	5 0	0 7		7 0	100	TO 5	.79
GEN PURP AMP													
2N2895	RF & Audio	3024		40 120	65	120	7 0	1 0		1 8	120	TO 18	1 25
2N930A	Lo Noise	3039	50	100 300	60	60	6 0	03		1 8	45	TO 18	95
2N2219A	Audio UHF Amp/SW	3024	53001	75 375	40	75	6 0	8		1 8	300	TO 5	1 05
2N2846	High Speed Sw	3024		30 120	30	60	5 0	8		3 0	250	TO 5	1.55
HF GEN PURP													
2N3933	VHF/UHF Amp	3039	56	60 200	30	40		002		2	750	TO 72	1 55
40894	VHF/UHF RF Amp	3039		50 250	12	20	2 5	05		3	1200	TO 72	1 10
40895	VHF/UHF Mix, Osc	3039		40 250	12	20	2 5	05		3	1200	TO 72	95
40897	VHF/UHF IF Amp	3039		70 250	12	20	2 5	05		3	800	TO 72	.90
2N5179	LoNoise, Amp, Osc, Mix, Conv	3039	709	25 250	12	20	2 5	05		3	2000	TO 72	1.10
2N918	VHF/UHF Amp Mix, Conv	3039	709	20 Min	15	30	3 0	05		3	600	TO 72	95
2N2905A(P)	DC, VHF, Amp Hi Sp Sw	3025	708	100 300	60	60	5 0	6		3 0	200	TO 5	1.15

** Manufacturers' (SK – RCA, HEP – MOTOROLA) Suggested Cross Reference *External Res (R_{BE}) = 100 OHMS

TRANSISTORS ARE NEW, FIRST QUALITY, BRANDED DEVICES — ON HAND FOR IMMEDIATE SHIPMENT

RESISTORS

15	ohm	5%	1w Corning	Film	.08
15	ohm	5%	25w Ohmite	WW	.75
28.7	ohm	1%	1w Dale	Film	.25
75	ohm	5%	8w Ohmite	WW	.39
102	ohm	1%	½w Corning	Film	.15
200	ohm	5%	5w Intl. Tect.	WW	.30
220	ohm	10%	½w Stackpole	C Comp	.07
330	ohm	5%	½w Stackpole	C Comp	.10
390	ohm	5%	2w Allen Bradley	C Comp	.25
450	ohm	5%	5w Dale	WW	.30
500	ohm	5%	1w Allen Bradley	C Comp	.19
620	ohm	5%	½w Stackpole	C Comp	.10
681	ohm	1%	¼w Dale	Film	.20
750	ohm	1%	¼ Dale	Film	.20
1	Kohm	1%	½w Corning	Film	.15
1	Kohm	5%	10w Dale	WW	.35
1.2	Kohm	1%	1w Intl. Rect.	C Comp	.25
1.6	Kohm	5%	½w Stackpole	C Comp	.10
2	Kohm	1%	¼w Dale	Film	.20
2	Kohm	5%	5w Intl. Rect.	WW	.30
2.15	Kohm	1%	½w Corning	Film	.15
2.4	Kohm	1%	5w Intl. Rect.	WW	.50
2.5	Kohm	5%	25w Ohmite	WW	.75
2.7	Kohm	5%	5w Dale	WW	.30
3.01	Kohm	1%	½w Electra	Film	.15
4	Kohm	5%	10w Dale	WW	.35
4.7	Kohm	1%	½w Corning	Film	.15
5.6	Kohm	5%	2w A.B.	C Comp	.25
7.5	Kohm	5%	½w Burroughs	C Comp	.10
8.25	Kohm	1%	½w Electra	Film	.15
9.09	Kohm	1%	½w Corning	Film	.15
9.1	Kohm	5%	2w A.B.	C Comp	.25
10	Kohm	1%	½w Corning	Film	.15
15	Kohm	10%	½w Stackpole	C Comp	.07
17.4	Kohm	1%	½w Corning	Film	.15
20	Kohm	5%	1w A.B.	C Comp	.19
23.7	Kohm	2%	¼w Corning	Film	.15
39	Kohm	1%	½w Corning	Film	.15
51	Kohm	5%	½w Burroughs	C Comp	.10
75	Kohm	1%	½w Corning	Film	.15
100	Kohm	1%	½w Corning	Film	.15
120	Kohm	5%	½w Burroughs	C Comp	.10
130	Kohm	5%	½w Stackpole	C Comp	10

CAPACITORS

.0033	mfd	100V	5%	Skottie mylar axial	$ .10
.0047	mfd	100V	10%	G.E. mylar axial	.09
.0047	mfd	100V	10%	Gen. Inst. mylar axial	.09
.01	mfd	200V	20%	Aerovox paper axial	.05
.02	mfd	100V	1%	Sprague mylar axial	.15
.1	mfd	600V	3%	Aerovox paper axial	.20
.1	mfd	400V		Aerovox paper axial	.20
.1	mfd	200V		CDE paper axial	.15
.1	mfd	200V		Aervox paper axial	.15
.5	mfd	400V	10%	Gen. Inst. mylar axial	.35
1.0	mfd	200V		Aerovox axial	.20
2.0	mfd	200V	20%	Aerovox axial	.20
4.0	mfd	350V		Sprague Elec axial	.45
5.0	mfd	25V		Gen. Inst. Elec axial	.15
10	mfd	150V		Sprague Elec axial	.30
30	mfd	300V		Mallory Elec axial	.35
60	mfd	350V		Mallory Elec axial	.75
1,000	mfd	100V		Sangamo Comp grd can	2.65
1,000	mfd	50V		CDE Elec axial	1.25
2,000	mfd	15V		Mallory Elec can	.85
6,000	mfd	25V		Sangamo Comp grd can	3.75
50	mfd	285V		I.C.C. oil imp bathtub	.60

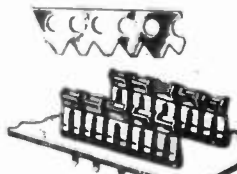
SWITCHES

SPST	1A Momentary Return P.B.-A.H.&H.	.25
SPST	15A Micto switch Flat leaf	.50
DPST	5A Micro switch Pin plunger	.75
DPST	10A Micro switch-mini Pin plunger	.65
4P3T	6A Slide Stackpole	.25

MISC. COMPONENTS

1 ohm 25w 5A Memcor wire wound pot.	1.95
100 ohm ½w Bourns EZ trim WW 30 turn pot	1.50
10 Kohm ½w Bourns EZ trim WW 10 turn pot.	1.50
MDA 962 Motorola fullwave bridge 10A 100V	4.95
AEX 43 1 TEC selenium Rectifier	05
IN 2990A Motorola 33V 1w zener diode	1.95
LA 2751 Fenwell Thermister 550 100	.75
6113 Elwood Thermal	75
Panel Light PTT red DPST SW W Mount Tec	95
Panel Light red Neon W/NE 2 Bulb Snap Mount	45
4 Terminal Chassis Count Terminal Strip	10/.25
Chassis Mount Cable Clamp ½" Nylon	15/.25

molex
I C TERMINALS



0.1" SPACING FOR STANDARD DIP SOCKETS.

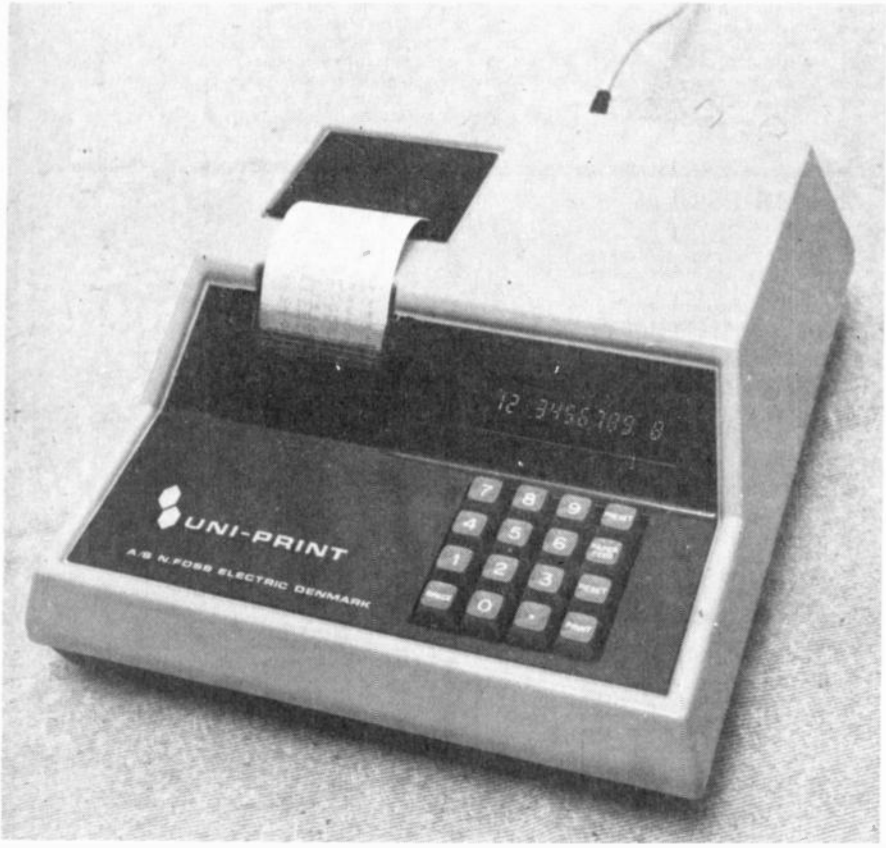
SUPPLIED IN STRIPS TRIM TO DESIRED LENGTH.

2 - 50 TERMINAL STRIPS $2.26

THESE COMPONENTS ARE NEW, UNUSED, FIRST QUALITY DEVICES

EQUIPMENT NEWS

DATA PRINTER WITH DISPLAY



Foss Electric have introduced a printer designed for use in data handling where print-out, manual entry and additional information, automatic numbering and visual control of data are required. The printer can act as an interface for transference of data to storage.

The print-out principle is a thermal system with resistor-heated bar printing on special thermo sensitive paper – 13 characters plus one special sign in 7-segment code. The glass thermo-printing head has super-imposed thin film resistors with max. power requirements 7 x 1.2 W for 800 msec.

Printing rate is 800 m/sec/line including line feed.

Various input modules are available, from seven characters to ten characters plus three digit automatic numbering. Input code is parallel 4-line 8-4-2-1 BCD.

Keyboard controls enable additional data or identification to be entered, paper advance to be over-ridden etc.

Further details: Foss Electric (Aust) Pty Ltd., 251 Condamine St., Manly Vale, 2093.

DATA GATHERING

Memodyne Corporation announces a new family of electro-mechanical and electronic components for remote data gathering and central data processing.

Heart of the system is a standard Philips tape cassette. Data is recorded incrementally bit-by-bit on a low power, high density digital cassette recorder and read out at a central station in standardized computer forms including parallel word outputs, 9 track IBM compatible tapes or Teletype/RS232 serial data.

Several options are available at the recording sites, from simple transports to complete front panel controlled instruments. The reading systems utilize a modular concept permitting the user to acquire only the necessary components for a serial digital output or a parallel 8 or 16 bit word output or a computer controlled output. Further outputs include Teletype, RS232C and a complete cassette to IBM 9 track tape converter.

The OEM versions are particularly suited for applications in computer terminals, key to tape systems, display systems, and mini-computer peripheral applications.

Low power, high density units are suited for remote or portable data logging requirements where battery power is a criteria.

Versions are available as read only, write only, and read/write switch selectable with a variety of input/output formats. These recorders operate over a temperature range of 0 to 60°C at relative humidity levels of 0 to 95% under shock and vibration conditions in excess of 2.0 G.

A short form catalogue covering all Memodyne incremental digital cassette recorders and instruments is available from Arlunya Pty. Ltd, PO Box 113, Balwyn, Vict. 3103.

FREEZER ALARM

Gearing & Watson (Electronics) Ltd of the United Kingdom, manufacturers of process control equipment have released a device which may be incorporated with freezers at point of manufacture or may be installed in freezers already in use, by the owner without the use of tools.

If the freezer has broken down, a slow but steady rise in the temperature will occur. When the temperature inside the cabinet is warmer than –15°C, the alarm will operate. A failure of this nature may be undetected for some time unless an alarm unit is fitted.

Further detail: British Merchandising Pty. Limited, Box 3456 G.P.O., Sydney, N.S.W. 2001.

COMMON INTERFACE POINTS TOWARDS DO-IT-YOURSELF INSTRUMENT SYSTEMS

Although the day has not yet arrived when anyone can simply plug together any desired combination of instruments and accessories to create a functioning instant system, a long step has been taken in that direction.

Ten bench-type Hewlett-Packard instruments, 10 accessories, and three different calculator/controllers, all available now, conform to a single interface standard, that of the Hewlett-Packard Interface Bus. This is the standard that was the model for the draft Recommendation released in Bucharest recently by Technical Committee 66 of the International Electro-technical Commission for ballot among IEC member nations.

The HP Interface Bus makes it possible to interconnect a wide variety of devices, and with minimum added engineering to form complete systems. These may be as simple as a DVM and a data logger, or they may combine as many as fifteen elements in a calculator-operated system. While several different complete calculator-controlled systems have been offered by Hewlett-Packard already this year, it is only at this time that the company has broken out the interconnecting hardware, the accessories, the manuals, and the training programs with which users may create their own systems, tailoring them economically to solve their own individual measurement, test and control problems.

Bench-type, bus-compatible signal source and stimulus instruments now available include the HP 3320A/B and 3330A/B Frequency Synthesizers (0.01 Hz to 13 MHz), the 8660A/B Synthesizer Signal Generators (10 kHz to 1.3 MHz), and 8016A Word Generator (9 x 32 bit memory, bit rates from 0.5 Hz to 50 MHz). Bus-compatible measuring instruments include the 3490A Digital Multimeter, 5345A Electronic Counter, the 5340A and 5341A Automatic Microwave Counters, and the compact 5300B series electronic counter/multimeters. Newly introduced, to capture and record results, to serve as a simple controller, even able to scan multiple digital-output devices via the HP-IB; is the Model 5150A Alphanumeric Thermal Printer.

Accessories for use with the Bus, with which a vast variety of purposes can be accomplished, include a 40-Channel Scanner (Model 3495A), an ASCII-to-Parallel Code Converter (Model 59301A), a Digital-to-Analog Converter (Model 59303A), a Numeric Display (Model 59304A), a Relay Actuator (Model 59306A), a VHF Switch (Model 59307A), a Timing Generator (59308A), a Digital Calendar/Clock (Model 59309A), a Teleprinter/RS-232 Interface (Model 59400A) and a Common Carrier Interface (Model 59403A). There is a variety of interface cables.

While control of a simple system may be by scanning with the Thermal Printer/Scanner, whole programmed systems including those capable of decision-making responses may now be formed using Hewlett-Packard desktop calculators as controllers. System Users' Guide Manuals describe how to assemble and program systems using the HP 9820A, 9821A, and 9830A Programmable Calculators as controllers. User-written programs for 9820A-operated systems are stored on magnetic cards; 9821A and 9830A Calculators have built-in cassette facilities on which user programs may be accommodated.

The HP Interface Bus concept is, of course, applicable to computer-controlled systems. Initial systems design efforts at HP have, however, concentrated on calculator-controlled systems, and it is expected that these will constitute the bulk of early applications.

Early in 1975 Hewlett-Packard plans to begin customer courses on the application and use of the HP Interface Bus. These will concentrate heavily on programming, which in large measure will determine the effectiveness of the new hardware. Included in the cost of these seminars are extended Users' Guide Manuals, which will also be separately available.

A typical application of the interface bus system is described in our next item.

FANE

HI-FI BASS LOUDSPEAKERS FROM ENGLAND

10" The model B101/10LR is a 10" loudspeaker with a 2" voice coil working within a 10,000 guass magnet structure, total flux 100,000 maxwells. The free air-resonance of the loudspeaker is 25Hz thus making it suitable for a small sealed cabinet of between 1½ and 2 cu.ft.

Efficiency is higher than might be expected from a sealed cabinet and power handling is 20-25 watts r.m.s. **$34.50**

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**

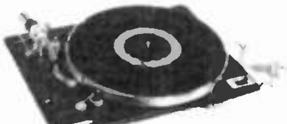
12" The model B122/12LR, like the B122/10LR described above, is also suitable for sealed cabinets but because of its more powerful magnet structure a volume of about 3 cu.ft. is required to ensure the speaker gives its optimum performance. **$49.50**

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**

5" The Fane 505 x 5" mid-range loudspeaker employs a special cone material which is doped to remove any irregularities in response. Useful frequency range is 400-4.000Hz and sound quality is very neutral. **$24.50**

1" The Fane 1" Dome Tweeter DD1 is a newly developed soft-dome tweeter with a useful frequency response from 4,000Hz to 20,000Hz. Efficiency is medium to high. **$23.50**

NEW CHALLENGE TURNTABLE SEMI-AUTOMATIC BELT-DRIVE



SPECIAL INTRODUCTORY OFFER **$99.50**

- The automatic arm return is achieved by a very simple and effective mechanism which ensures years of trouble free operation.
- Oil damped cueing lever permits instant selection of any record track without having to reject the tone arm.
- Heavy cast platter, belt-driven by a syncronous motor, reduces rumble, wow and flutter to negligable proportions.
- Tone arm features anti-skate, lateral balance and removeable headshell fitted with magnetic cartridge. Fully adjustable counter balance weight with independent scale allows easy adjustment of stylus pressure.
- All connecting cables and plugs are fitted to the turntable.
- 12 month guarantee.
- Walnut base and tinted perspex cover with adjustable tension spring hinges available as an optional extra $29.00.

NEW 3-WAY SPEAKER SYSTEMS OF EXCEPTIONAL QUALITY

Developed by exhaustive and thorough testing, these new 3-way speaker systems combine wide, flat frequency response with genuine high power capability. (Available in Kit form or completely assembled.)

CHALLENGE SYSTEM 1

CHALLENGE H-22 DOME TWEETER
The development of dome tweeters has been a major project of most loudspeaker manufacturers of recent years. The H-22 dome is one of the latest designs. The 1" diaphragm is made of carefully selected metallized polyester material which is of very small mass to allow maximum efficiency. **$8.50**

SPECIAL MID-RANGE SPEAKER
An outstanding 5" mid-range loudspeaker developed by one of Germany's leading loudspeaker manufacturers. It employs carefully selected cone material and a special cone termination to ensure flat response and high efficiency. A protective cover is fitted to the rear of the loudspeaker to prevent interference from air pressure developed within the cabinet by the bass speaker. **$15.90**

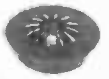
CHALLENGE 10L-24 WOOFER
This robust 10" unit features a 4 layer wound 1½" voice coil which allows it to handle 30 watt r.m.s. comfortably. The combination of extremely rigid cone and low-fundamental resonance of 35 Hz in free-air ensures deep, positive bass when used in the recommended enclosure sizes. **$16.90**

CHALLENGE HP 1 HIGH-POWER CROSSOVER NETWORK
features 4 inductors including a high-efficiency air-wound 3.55 Mh choke in series with the bass speaker. 3 crossover capacitors are also used. Crossover points are 500 Hz and 4 000 Hz and the rate of roll off is 12dB/oct. **$14.50**

The **CHALLENGE SYSTEM 1** can be purchased as components only as above or completely assembled and tested in 2 cu.ft. walnut veneered cabinets at **$179 pair**

FANE 15" 3-WAY SYSTEM

HOKUTONE HT-60 1" DOME TWEETER



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. **$13.50**

Special Mid Range Speaker
Details as above in system 1. **$15.90**

FANE B152/12LR 15" WOOFER

Details as per FANE advertisement on this page **$59**

CROSSOVER NETWORK $14.50

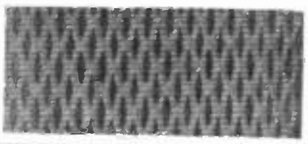
This system, based on the Fane 15" woofer, can be purchased as components only as above, or completely assembled and tested in 3 cu.ft. walnut veneered cabinets for **$300 pair**

CROSSOVER CAPACITORS

Our wide range includes 2.2 mfd mylar film $1.20 each, 3.3 mfd mylar film $1.40 each, 5 mfd NP Electrolytics 40c each, 10 mfd NP Electrolytics 45c each, 16 mfd NP Electrolytics 50c each, 30 mfd NP Electrolytics 60c each and 60 mfd NP Electrolytics 90c each.

SPEAKER GRILLE CLOTH

An attractive selection of speaker grille cloths are available ex stock at very reasonable prices. Free sample pieces are available on request and will be forwarded per post anywhere in Australia together with our price list.



CROSSOVER CHOKES

A comprehensive range is now available of high power, high efficiency inductors in the following values, 0.25 Mh, 0.35 Mh, 0.5 Mh, 0.75 Mh, 2.2 Mh and 3.55 Mh. Prices range from $1.00 to $5.00 each.

CROSSOVER NETWORKS

A wide range of professionally designed networks are now available at very reasonable prices. Recommendations and quotes can be supplied, providing full details of loudspeakers intending to be used are provided.

Challenge
HI-FI STEREO PTY LTD

**96 PIRIE ST.
ADELAIDE
STH. AUST. 5000
PHONE: 223 3599**

EQUIPMENT NEWS

QUIET NEW THERMAL PRINTER

A quiet new thermal printer, Model 5150A from Hewlett-Packard, accepts data from BCD (binary coded decimal) or ASCII sources and prints up to 20 columns of alphanumeric information. Modular in construction, it is available in many different configurations including some in which it functions as an instrument-system controller.

The 5150A prints 5 x 7 dot-matrix characters at faster than three lines per second on heat-sensitive paper, available in rolls or fan-folds. Reliability and light weight result from simplicity of design – the use of a thick-film thermal print head, no inking systems, print wheels or hammers; the paper advance mechanism has only two moving parts.

The printer's mainframe contains a power supply, control logic, and print mechanism. Input interfaces are provided by the use of plug-in circuit boards. Option 001 interfaces the printer to the HP Interface Bus or directly to most ASCII-coded data sources, such as minicomputer outputs, with a full 20-column, 64-character readout. Option 002 interfaces BCD ±8421 coded instruments through 10-column inputs; up to two such interfaces may be installed. There is a standard 16-character BCD alphanumeric set, and various special character and column formats are optional.

With the Option 003 Scanner installed, the 5150A Printer can scan the digital output of as many as 13 ASCII-coded instruments, via the Hewlett-Packard Interface Bus. The scanner acts as a system controller, providing automatic data acquisition ability. It also provides source indentifiers on the print-out for easy data interpretation.

Available for either BCD or ASCII measurement systems, the Option 004 Clock provides times along with the data on the printout. The clock can also control the time interval between data samples.

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

TEMPERATURE MEASUREMENT DATA

The John Fluke Mfg Company of U.S.A. manufacturers of digital instrumentation have recently released a "Guide To Temperature Measurements" in the form of a wall chart.

The chart lists the various types of temperature sensors available and their relative advantages and disadvantages.

Copies of this wall chart are available from:

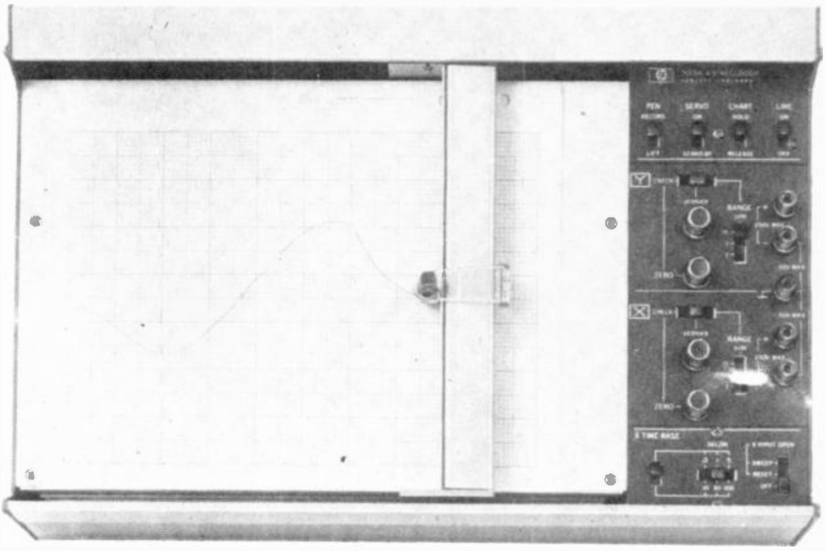
Elmeasco Instruments Pty. Limited, PO Box 334, Brookvale, NSW, 2100.

TWO NEW LOW-COST X-Y RECORDERS

A new line of 8½" x 11" X-Y recorders is announced by Hewlett-Packard. Model 7010A is introduced especially for OEM applications; Model 7015A is a laboratory model.

The model 7010A has, as standard features, 100 mV/div sensitivity, mechanical pen lift, universal pen holder which accommodates most commercially available fibre pens, electrostatic paper holdown, and continuous duty dc servo motors. Slewing speed is 20"/sec with peak accleration of 500"/sec in the X axis and 1000"/sec in the Y axis. Common mode rejection is 130 dB

EQUIPMENT NEWS



Model 7015A Laboratory X-Y Recorder.

dc and 90 dB under room ambient conditions.

Options available include 10 mV/div or 1 V/div sensitivity, electric pen lift, metric scaling, single range time base of 1 sec/div or 10 sec/div, and a carrying case.

The Model 7015A is an 8½" x 11" laboratory X-Y recorder for general purpose laboratory use in schools and small laboratories. It has three ranges 0.01 V/in, 0.1 V/in, and 1.0 V/in (0.01 V/cm, 0.1 V/cm, and 1.0V/cm), mechanical pen lift, universal pen holder, continuous duty dc servo system, and electro-static paper holddown. Slewing speed, acceleration and common mode rejection are the same as the Model 7010A.

Options offered include electric pen lift, time base with six speeds (0.5, 1, 5, 10, 50, 100 sec/in or 0.1, 0.5, 1, 5, 10, 50 sec/cm, metric calibration and a carrying case.

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

TWENTY THOUSAND COUNT MULTIMETER ANNOUNCED BY FLUKE

A new automatic digital multimeter, the Model 8600A, using the latest LSI technology has been announced by the John Fluke Mfg. Co., Inc, Seattle, Washington, manufacturer of precision electronic instruments and automatic test systems.

With a basic dc accuracy of 0.02%, the Fluke 8600A features five ranges of dc volts, five of ac volts, five of dc current, five of ac current and six of resistance. Autozero and autorange are standard. For minimum loading, up to 1000 megohms input resistance is offered.

All dc ranges from 200 millivolts through 1200 volts are continuously protected to ±1200 volts or 1700 volts peak ac. Ac bandwidth to 100 kHz offers 10 microvolt resolution. From 200 ohms full scale through 200 megohms full scale, the 8600A takes a continuous 250 Vrms or dc. A front panel fuse protects all ac and dc current ranges from 200 microamperes full scale to 2 amperes full scale.

A rechargeable built-in battery pack provides up to eight hours off-line operation. TTL/DTL compatible isolated printer output is available. Two 8600A's may be mounted side by side in a standard EIA rack. Weight is 1.6 kg or 2.1 kg with batteries.

Further details: Elmeasco Instruments Pty. Ltd., P. O. Box 334, Brookvale, NSW, 2100.

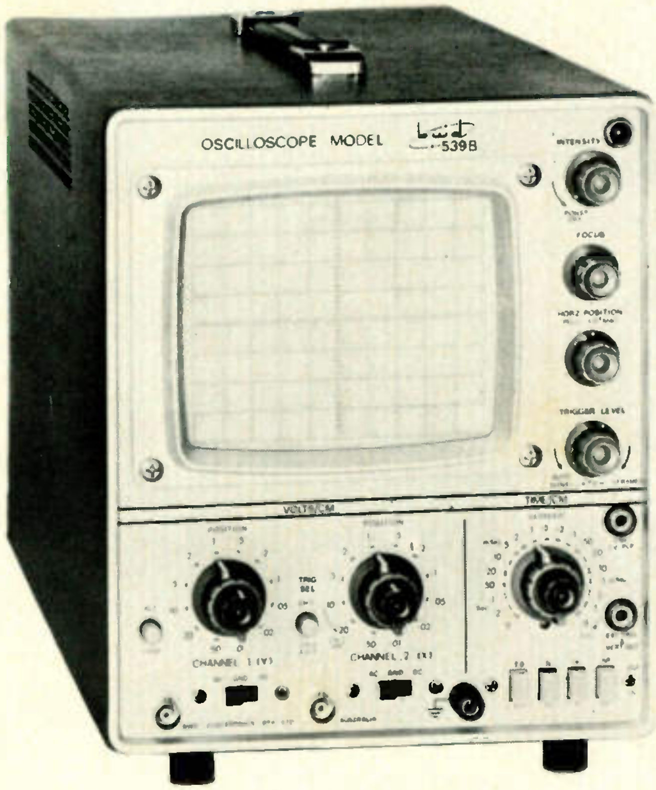
DC-16 MHz Dual Trace oscilloscope The New BWD 539B

With These Outstanding Features

- Amplifiers:
  DC to 16MHz-3db) Both
  20nSec Rise Time) Channels
  10mV to 50V/cm)
  3Hz to 30kHz) Single Channel
  at <500μV/cm) Cascaded

- Time Base:
  100nSec to 2.5s/cm time range
  1Hz to >25MHz Auto Triggering
  TV line and frame trigger.

- X Amplifier:
  Identical X-Y operation
  DC to 2MHz-3db
  100mV to 50V/cm
  1° Phase shift from DC to >100kHz.



PLUS

- 5% calibration Y,X & T.B. including a 10% line voltage change.
- 1% fast rise time calibration wave, transition <2° of power line zero crossover.
- 3.3KV EHT and an 8x10cm display.
- Push button operation simplicity and AC-GND-DC amplifier switching.
- 3cm of deflection at 30MHz and a time base that locks solidly to it.
- Vertical amplifier and time base outputs.
- 0° to 50°C operating range.

$ 414

F.I.S. Australian Capital Cities
Plus Tax if applicable
12 months warranty.

If your work involves Calculators, Office Equipment, Colour TV broadcasting or Servicing, Data Transmission, Process Controls, Communications or Education then

DON'T DELAY – GET ALL THE DETAILS OF THIS FINE VALUE IN OSCILLOSCOPES TODAY.

1955 TO 1975 – 20 YEARS OF AUSTRALIAN DESIGN INNOVATION

WINNER OF AWARD FOR OUTSTANDING EXPORT ACHIEVEMENT

THE MAJORITY OF OUR INSTRUMENTS CARRY A DEFENCE STOCK NO

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Designers and Manufacturers of the finest electronics instrumentation.

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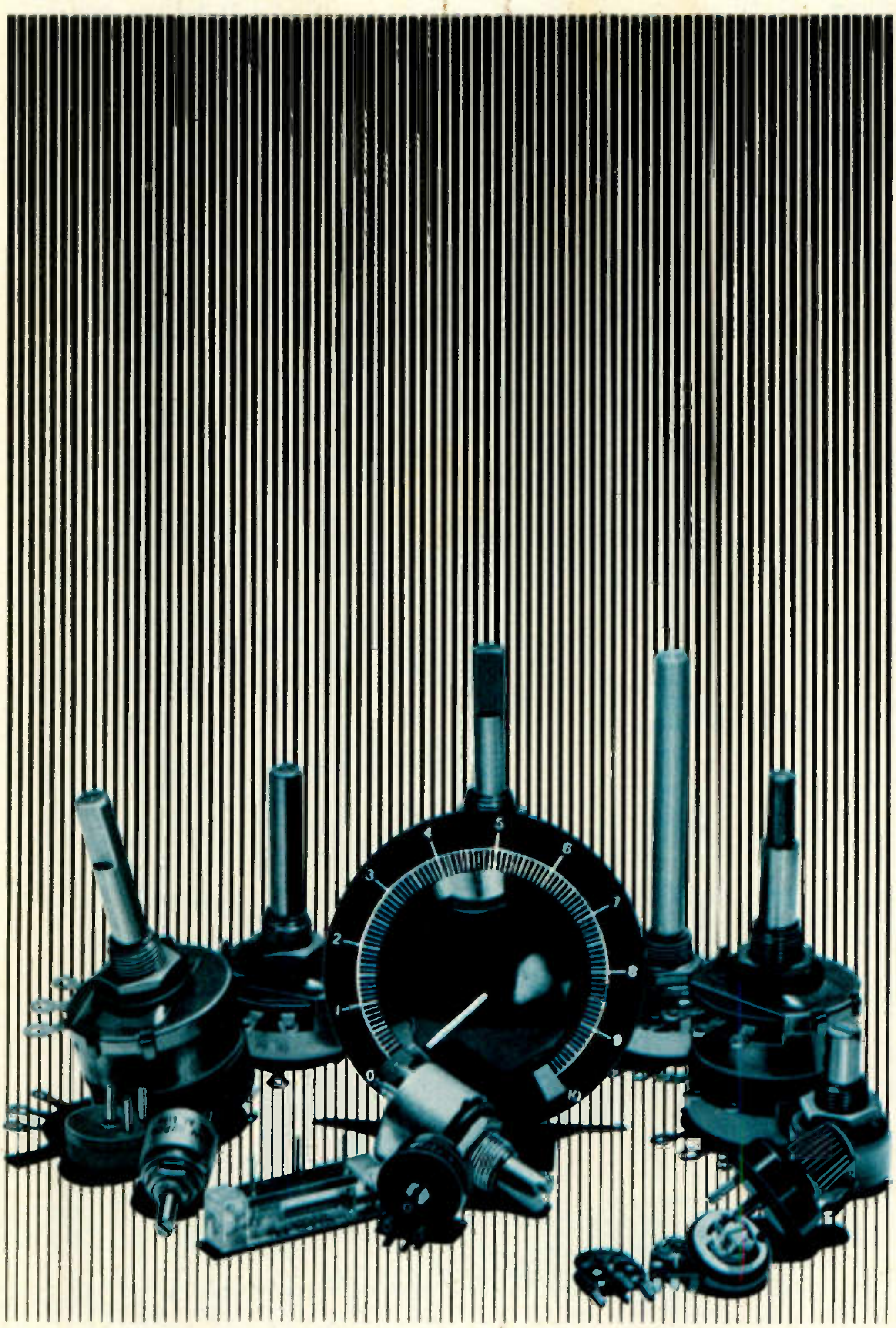
- W.A. Cairns Instrument Services PH: 25-3130
- QLD. Warburton Franki (Brisbane) Pty. Ltd. PH: 52-7255
- TAS. Associated Agencies. PH: 23-1843 and from B.W.D. agents around the world.

PLESSEY PROFESSIONAL CONTROLS



Plessey provides the widest selection of Professional class carbon and wire-wound resistive controls of both commercial and DEF Qualification standard.

The range offers miniature potentiometers rated upwards from 50mW to power rheostats of 500W, together with a choice of resistances, tapers, shafts, mounting arrangements, ganged and dual types and specials to suit customers' specifications. Ganged potentiometers with track matching to within 1.6db. are available for stereophonic equipment, test instruments and other applications.

Potentiometers employ a hot moulded carbon track construction giving extremely low electrical noise throughout a long, trouble-free life. Life expectancy is in the order of 9 million cycles of rotation with a resistance change of no greater than 1%

Plessey potentiometer tracks consist of a phenolic moulding loaded with carefully controlled proportions of conducting carbon filler providing superior power dissipation and temperature coefficient characteristics compared to carbon film types.

A standardised range is available ex stock. Literature is available on request to the Professional Components Division.

PLESSEY

Plessey Australia Pty Limited
Components Division
Box 2 PO Villawood NSW 2163
Telephone 72 0133 Telex 20384

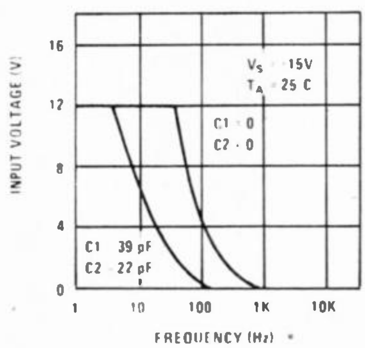
MELB: Zephyr Products Pty Ltd 56 7231
ADEL: K. D. Fisher & Co 223 6294
PERTH: H. J. McQuillan Pty Ltd 68 7111
N.Z.: Henderson (N.Z.) 6 4189

AC99/R2

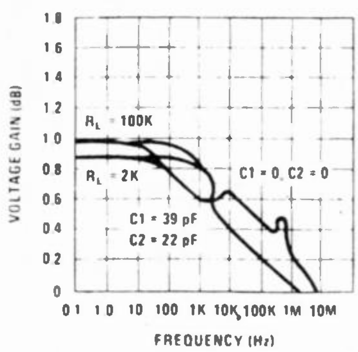
THE LM0901A11410904510 NON~OPERATIONAL AMPLIFIER

An ideal amplifier for many worthless applications.

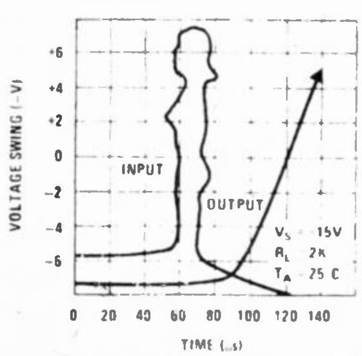
Large Signal Frequency Response



Open Loop Frequency Response



Female Follower Pulse Response



THE LM0901A114109045IC is a macropower, low performance, degraded circuit operational amplifier designed to have a no load power dissipation of less than 0.553 W at V_s = ± 1 pV and less than 200 W at V_s = ± 2 pV. Open loop gain is greater than 0.001 k and input bias current is typically 200 A.

FEATURES

■	Typical low upset voltage	10.13 V
■	Typical low upset current	59 A
■	Typical low noise	30 Vrms
■	Simple frequency comprehension	
■	Marginal bandwidth and slewrate	
■	Output short circuit susceptible	

The LM0901A141109045IC may be substituted directly for paper weights and fish lures. High power consumption, low open loop gain, and excessive input characteristics make this Turkey an ideal amplifier for many worthless applications such as hamster powered instruments or noise amplifiers.

DEFINITION OF TERMS

Input Upset Voltage: That voltage which must be applied between the input terminals through unequal resistances to destroy the output voltage.

Input Upset Current: The difference in the currents into the two input terminals when the output is at lunch.

Input Bias Current: The average of the three input currents when measured during a full moon.

Input Voltage Range: The range of voltages on the input terminals for which the amplifier operates within the city limits of Melbourne.

Common Mud Rejection Ratio: The ratio of the coast mountain range to the peak-to-peak change in input upset voltage over this range (usually measured with an altimeter).

Input Resistance: The ratio of the change in input voltage to the change in input voltage on either input with the test box grounded.

Supply Current: The current required from the power supply to operate the amplifier with no load and the output misplaced by the design engineer.

Output Voltage Swing: The peak output voltage swing, referred to zero, that can be obtained without clipping (which should be avoided since it carries a 15 yard penalty).

Large-Signal Voltage Gone: The ratio of the output voltage swing to the change in input voltage required to drive the output from zero to Wollongong.

Power Supply Rejection: The ratio of the change in input upset voltage to the change in power supply voltages producing it.

Transient Response: The closed-loop step-function response of the amplifier under vague signal conditions.

ABSOLUTE MAXIMUM RATINGS

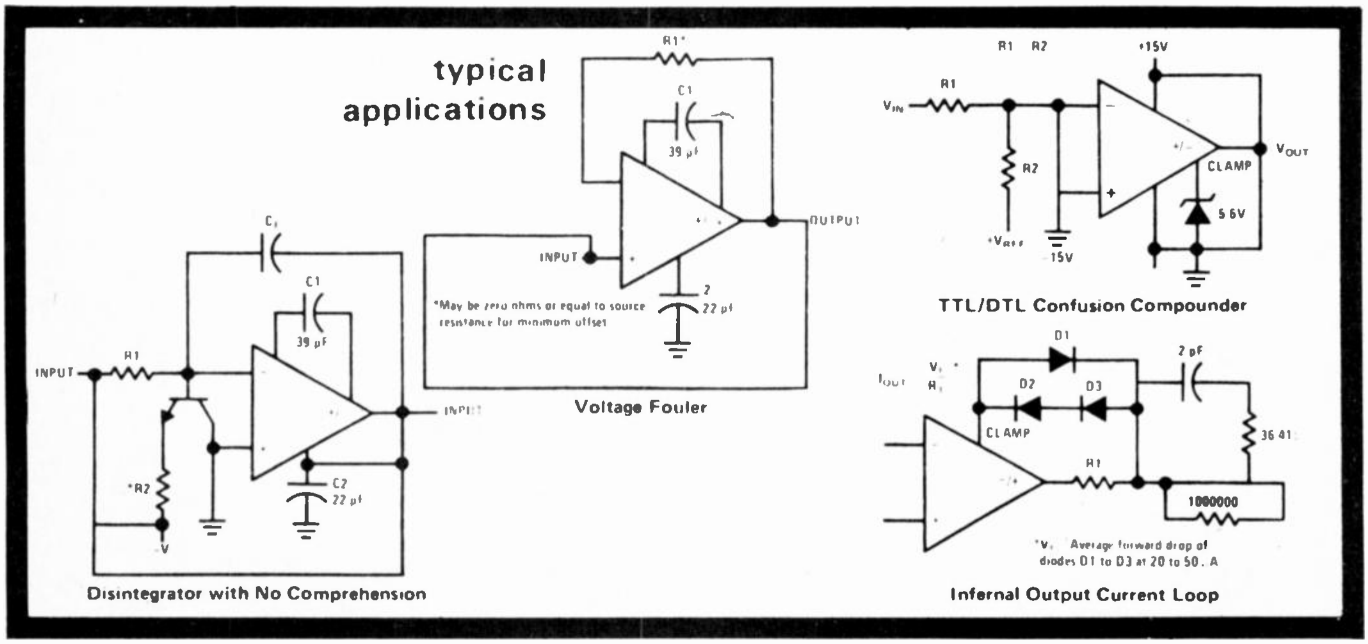
Supply Voltage	±2 pV
Power Dissipation (See Curve)	640 W
Differential Input Voltage	±7 fV
Input Voltage	$\pm V_S$
Short Circuit Duration	11 femtoinches
Long Circuit Duration	27 nanomiles
Operating Temperature Range	22°C to 35°C
Storage Temperature Range	−35°K to −10°K
Lead Temperature (Soldering, 10 seconds)	289°F

ELECTRICAL CHARACTERISTICS (Note 1)

PARAMETERS	CONDITIONS	CRUMMY PART			CRUMMIER PART			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Upset Voltage	$R_S \leq 1k$, $T_A = 25°C$		10.1	12.5 24.0		22.0	25.0 57.0	V V
Input Bias Current	$T_A = 25°C$		200	100 300		300	200 300	A A
Input Upset Current	$T_A = 25°C$		59	201 1004		207	360 1009	A A
Sloppy Current	$V_S = \pm 2$ pV, $T_A = 25°C$ $V_S = \pm 2$ pV		80	425.6 450.3		80	425.3 450.6	µA nA
Voltage Gone	$V_S = \pm 1$ pV, $V_{OUT} = 10V$, $R_L = 109k$, $T_A = 25°C$	25	60		25	60		nV/V
	$V_S = \pm 1$ pV, $V_{OUT} = 10V$, $R_L = 183k$	10	30		10			nV/V
Output Voltage	$V_S = \pm 1$ pV, $R_L = 12k$, $T_A = 25°C$	10	11.5		10	11.5		V
	$V_S = \pm 1$ pV, $R_L = 32k$	9			9			V
Common Mud Rejection Ratio	$V_S = \pm 1$ pV, $V_{IN} = 1V$, $R_S = 1k$	70	90		70	90		lb/kton
Power Supply Rejection Ratio	$R_S = 1k$, $V_S = \pm 1$ pV to ±2 pV	0.1	0.2		0.05	0.1		dB
Equivalent Input Noise Voltage	$V_S = \pm 1$ pV, $R_S = 1k$, $T_A = 25°C$, f = 500 Hz to 500 Hz		30	86.53		30	91.74	Vrms
Average Temperature Coefficient of Upset Voltage	$R_S = 310k$		3.0			3.0		V/°C
Average Temperature Coefficient of Bias Current			0.3			0.3		A/°C
Rise Time	Monday $\leq T_A \leq$ Friday	6:15		6:45	6:15		6:45	A.M.

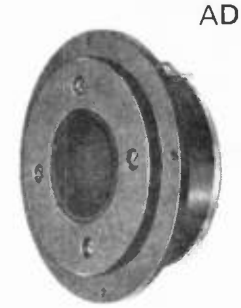
Note 1: The specifications apply for $\pm 1\text{ pV} \leq V_S \leq \pm 2\text{ pV}$, with +input compensation capacitor, C1 = 39 MF, −input compensation capacitor, C2 = 22 MF, 22°C to 35°C, except in January or Belgium. Testing is performed at $V_S = \pm 1.7326$ pV, except on Friday when we drink beer instead.

We are indebted to National Semiconductor for permission to publish these extracts from their latest data sheet.



PHILIPS LOUDSPEAKERS

AD 0160/T



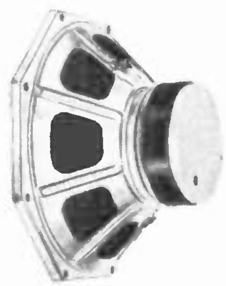
1" High Fidelity Dome Tweeter

AD 0160/T8 1" Dome Tweeter	$8.00 @
AD 5060/Sq8 5" Squawker	$12.50 @
AD 8065/W8 8" Woofer 20W	$12.00 @
AD 10100/W8 10" Woofer 40W	$33.00 @
AD 1265/W8 12" 30watt Woofer	$24.00 @
AD 12100/W8 12" 40watt Woofer	$35.00 @
2 way Crossover	$7.95 @
3 way Crossover	$12.50 @

AD 5060/SQ8

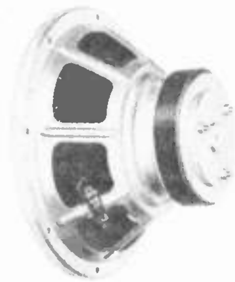
5" High Fidelity Mid Range

AD 8065/W8



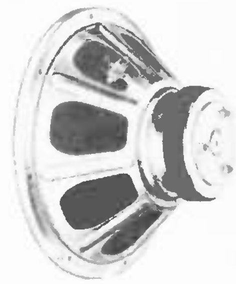
8" High Fidelity Woofer

AD 10100/W8



10" High Fidelity Woofer

AD 12100/W8



12" High Fidelity Woofer

PHILIPS KITS No. 1
2-AD 8065/W8
2-AD 5060/Sq8
2-AD 0160/T8
2-3 way Crossovers
Total Price $82.00

PHILIPS KIT No. 2
2-AD 10100/W8
2-AD 5060/Sq8
2-AD 0160/T8
2-3 way Crossovers
Total Price $122.00

PHILIPS KIT No. 3
2-AD 1265/W8
2-AD 5060/Sq8
2-AD 0160/T8
2- 3 way Crossovers
Total Price $120.00

PHILIPS KIT No. 4
2-AD 12100/W8
2-AD 5060/Sq8
2-AD 0160/T8
2 3-way Crossovers
Total Price $120.00

CORAL 12" SPEAKER KIT 12SAI
2 - 12" 30 watt RMS Woofers
2 - 5" sealed back squawkers
4 - 1" tweeters
Crossovers etc.
Full price $70.00

CORAL 10" SPEAKER KIT 10SA1
2 - 10" 25 watt RMS woofers
2 - 5" sealed back squawkers
2 - 1" tweeters
Crossovers etc.
Full price $50.00

CORAL 8" SPEAKER KIT 8SA1
2 - 8" 15 watt RMS woofers
2 - 4" midrange speakers
2 - 1" tweeters
Crossovers etc.
Full price $30.00

BOXES FOR 12SA1 $35.00 each
BOXES FOR 10SA1 and 8SA1 $30.00 each

WE ALSO STOCK INNERFOND AT $1.80 PER SQ YD
SPEAKER CLOTH (for front of box) 60" by 36" . . . $12.00

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Phone: 747-2931

COMPLETE MAIL ORDER SERVICE
All goods available at competitive prices. Please write or ring for a quote . . . allow a sufficient amount to cover Freight when ordering.

River ohm micro resistors 1/16w

River Ohm micro resistors are eminently suitable for low power applications where long life, economy, microminiature size, high stability and close tolerance are required. The resistive element is of a CERMET construction encapsulated in a heat resistant insulating paint in standard international colour codes for ready identification

Leads are of solder coated copper wire with a minimum 15 mm length and 0.3 mm diameter. Excellent solderability is ensured when using either manual or dip soldering techniques.

Characteristics
Resistance value: 30 ohm to 100 K ohm $\pm$ 5%, E-24 grid
Wattage rating: 1/16 W.
Maximum operating voltage: 100V/Maximum overload voltage: 100V/Temperature coefficient: + 700 p.p.m./°C

PLESSEY

Plessey Australia Pty Limited
Components Division
Box 2 PO Villawood NSW 2163
Telephone 72 0133 Telex 20384

MELB: Zephyr Products Pty Ltd 56 7231
ADEL: K. D. Fisher & Co 223 6294
PERTH: H. J. McQuillan Pty Ltd 68 7111
N.Z.: Henderson (N.Z.) 6 4189

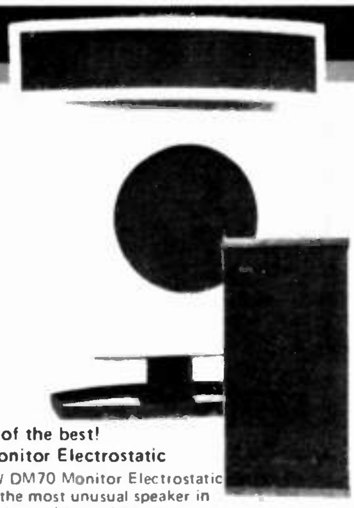
AC100/R1

B&W
the royal family of sound

What makes B & W speakers different from every other speaker? It is the visual assurance that not only do they sound good, but they are, in fact, without unexpected peaks and valleys. Each B & W is checked in the factory on a special anechoic test section so that the handling performance of your speaker is plotted by B & K instruments from lowest to highest frequency. See the response of your speaker before you buy.

**recommended retail price*

The best value DM2 A Monitor Acoustic Line
For those who would like the crisp realism of the DM70 but in a smaller package, there is the DM2 Monitor, also less expensive. It is worth your while to make the comparison between the superb DM70 and the DM2 Monitor with its third order Butterworth cross-over network and 8th wave acoustic wave line system in an internal folded tapered pipe. Three speakers with superb straight line frequency response across the whole spectrum. In teak, white and walnut.
$475 per pair*



The best of the best! DM70 Monitor Electrostatic
The B & W DM70 Monitor Electrostatic speaker is the most unusual speaker in the world. It combines a bass pump with a 30.5 cm piston with a free air resonance of 18 to 22 Hz. in a baffle type chamber which produces high power, low frequency wave forms with exact fidelity below 400 Hz. On top is a free standing electrostatic semi-circular array of 9 speaker units that have no moving parts. From 400 cycles up to well beyond human hearing levels, these exclusive B & W units reproduce sound just as it is at the microphone. You must hear these speakers to credit their faithful reproduction. In white and walnut.
$1100 per pair*

The mighty atom DM4 Monitor
So small in size, but enormous in sound reproduction from high to low frequency. This is the speaker that has just astounded critics all over the world. They said this type of sound could not come from a speaker just over one cubic foot. Walnut.
$366 per pair*

B & W D5 Sound Value
A small speaker but a wonderful performance and at an extraordinarily keen price for those who want B & W quality on a budget. This speaker is a remarkable investment in quality sound. Only a little above the budget priced speaker but its fidelity and real timbre has to be heard. Walnut.
$199*

B & W DISTRIBUTORS — **VICTORIA**: buy — rite Electronics, Geo. Hawthorne, Southern Sound, Toms Hi Fi, Tivoli Hi Fi. **SYDNEY**: Technocentre, Insound, Arrow, U.R.D., Milversons — Chatswood & Parramatta. **SOUTH AUSTRALIA**: Sound Spectrum. **A.C.T.**: Duratone.

KITSETS

KIT'S KOLUMN

I don't know what part of Oriental philosophy or pride it is that makes them want to write and produce their own leaflets, instruction books and so on, but it sure provides us with some laughs from time to time.
For instance L&G Hi-Fi gear.
Expense account poked his head around my door the other day (he's got that sort of head) and dumped some leaflets and clippings onto my desk.
"You know about L&G," he said blithely, "so we've decided that you can write the kolumn about it next month."
Well, if there's one thing I know about L&G, it's this — you can write about it until you're blue in the face and anywhere else it might count, but it still won't tell you what you want to know. It might with other makes, but not with L&G.
Baby, you gotta **see** it. You gotta **hear** it.
I mean, are you really going to believe someone who promises "listening pleasure for all ages, from innovative youth to the discriminating fuddy-dud."? Are you?
Then there's the lovely bit on the back page of the colour brochure.
"L&G colours and designs are aimed at a total involvement in sensual experience, not just your ear."
I think I know what they mean. But I'm also afraid that I know what they're getting at. In all, the L&G colour brochure is priceless for its incredible English. It's a mixture of the very worst avant-garde verbosity, with a sprinkling of colloquialisms, and some desperate try-hard phrasing that doesn't fit anywhere. If you can get a copy, lay your hands on it fast. It's a collector's piece.
NOW — having got that off my clothesline, let me reiterate: With L&G, to know what it's all about, you have to see it and hear it.
See it, because it's so terrifically different from anything else and (depending on yourself) tremendously exciting.
Hear it, because that's where it's all at.
That's what you're buying. The **sound**.

Personally, I can't separate the beaut sound from the great colours. Who ever decided that Hi-Fi equipment should all be brown and black, anyway?
Naturally, we've got the whole L&G range. Speakers; FM/AM receivers; the superb model T1200 FM/AM stereo tuner; turntables; and stereo amps.
How does it compare? A friend of mine described L&G thusly —
"In its price class, it outperforms most of the others; in its performance class, it underprices most of the others."
Which is as neat a way of putting it as I have yet heard. L&G. It's going to be **the big** name in Hi-Fi this year. Don't say I didn't tell you.

. . . .

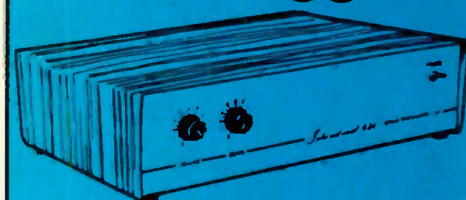
Got this lovely present through the post (it was ten cents short on postage) from my earnest admirer, Alfred E. Neuman, of Gore Hill. I assume it was from him anyway, it was all written in pencil. Anyhpw, I've given poor Alf a pretty rough trot, what with not answering his phone messages, or reply-paid telegrams, or invitations written on matchbook covers, so I'd like to thank him for being so nice about it all, and sending me such a nice gift. It was one of those optical peephole devices for fitting in doors so you can see who's there. However, Alf, your instructions weren't entirely accurate. Firstly, the device should be mounted at eye level — not chest level. Secondly, the viewing end should be on the inside of the door, not the outside. I'll leave a biscuit out for such a good try, anyway. Next month — a very special surprise for you.
Apologies department: to the guys at the APO who weren't mentioned last month when OTC was; and to the unsung electronic and Hi-Fi heroes at some of our larger high schools. Don't rip your magazine so you can put our ad on your noticeboard — let me know who you are and where you are, (write to me at Head Office) and I'll try and convince expense-account to send you a free ad-sheet each month, OK?
Keep your iron hot,

Kit

STEINTRON WILL NEVER FORGIVE US: 10" SPEAKER SYSTEM, NOW $69

V100. Not a kit. Advertised in our last catalogue at $79. Down $10 for February only and while pre-budget stocks last. 10" woofer; 5" midrange; 1" 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 **Feb.** dated orders only — $69.

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.

$49·50

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.

RESISTORS

Look at these . . . ¼W & ½W: $2.00 per 100 of one type or $2.50 per 100 mixed, or 3 cents each. 1W: $4.00 per 100 of 1 type, or $5.00 per 100 mixed, or a miniscule 6 cents each. P&P: under 100, add 50c. For each 100, add 80c.

CAPACITORS:

This is it. Any electrolitic capacitors we have in stock are reduced this month. From the normal price, you cut 10% OFF.

10% OFF

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 50K 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 **$29.95** P & P $1.00.

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 Meg input, ° 3% accuracy. Ohms from 0.1 to 1000 Meg. Memory feature. **$79.**

AG202A Audio Generator covers 20Hz to 200k Hz 10V rms output. Sine and square wave. External sync. **$89.**

CO1303A 75mm Scope has 20mV cm sensitivity covers DC to 1.5MHz input R & C of 1 Meg and 30pF. **$165.**

SG402 RF Generator covers 100kHz to 30MHz in 6 ranges. Output 0.1Vrms. High low attenuator. Modulation at 400Hz. **$69.**

Registered Pack/Post $4.00.

Low priced Valves

Not low quality — just low price. 6 of the most-used T.V. receiver valves at prices that make it worth stocking up big. They're Matsushita ("National") so you know they're good. Don't fall for cheap-jack rip-offs others offer. These are really top grade. We'll keep supplying them as long as our stocks hold out. Mix types any way you like to get the low quantity prices. Special quotes on orders over 100. Minimum order, 10 mixed valves.

TYPE	LIST PRICE NORMAL PRICE	PRICE EACH FOR MIX OF 1 – 50	50 – 100
1S2	$1.98	$1.20	$1.10
6AL3	$2.00	$1.20	$1.10
6BL8	$2.00	$1.20	$1.10
6MB8	$2.10	$1.20	$1.10
6CM5	$2.90	$1.90	$1.80
12AV7	$1.92	$1.20	$1.10

pack/post 50c

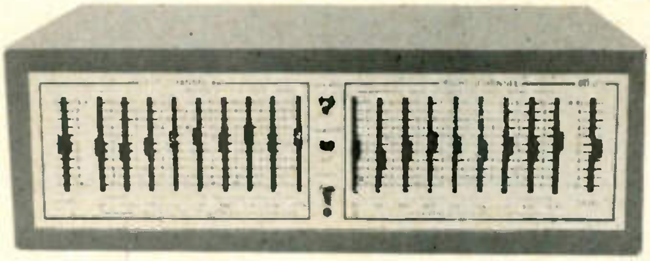
SYDNEY: 400 Kent St. Sydney, 29 1005. 657 Pittwater Rd., Dee Why. 982 9790. **ADELAIDE:** 12 Peel St. Adelaide, 87 5505. **BRISBANE:** 293 St. Paul's Tce. Fortitude Valley, 52 8391. **MELBOURNE:** 271 Bridge Rd. Richmond (Gallery Level, Church St. entrance) 42 4651. **PERTH:** 557 Wellington St. Perth (Opp. new bus terminal), 21 3047.

FM ON L&G IS AOK

Seriously though, folks, with transmission starting soon, it's about time you examined our great L&G stereo tuner amps. And if you don't know about L&G yet, you just haven't been shopping. 20W RMS and 30W RMS models. $299 & $349 and worth every last cent.

BUILD THE NEW ETI GRAPHIC EQUALISER: COMPLETE KIT~$94

ETI 427 (October 1974). Nobody has a perfect room and so even the greatest Hi-Fi system can sound a bit off. Usually, a unit like this would cost you a leg and a half, but now you can get into the big league without getting poor. Broadly, your Graphic Equaliser will compensate for speaker and room deficiencies, and show you pretty dramatically that you don't have to put up with resonances and dips. The ETI 427 has nine filters spaced at octave intervals in each of two channels. Construction is relatively easy, but if you're a beginner, you'll need someone to hold your hand. Complete kit includes prewound coils, veneered cabinet, screws, nuts, and so on. P&P: $3.50.



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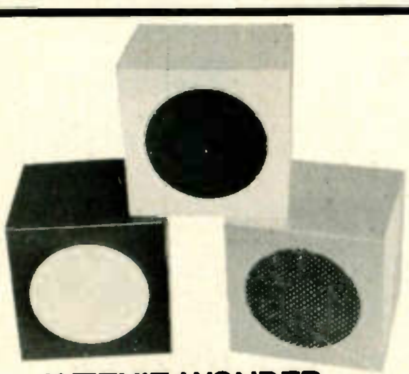

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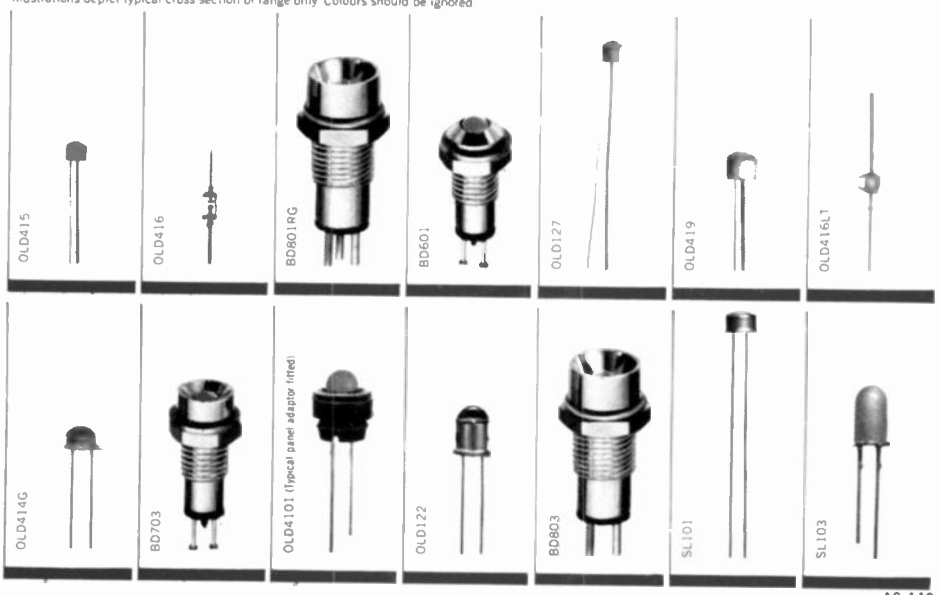

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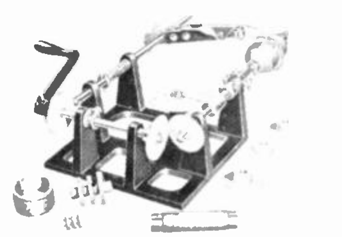

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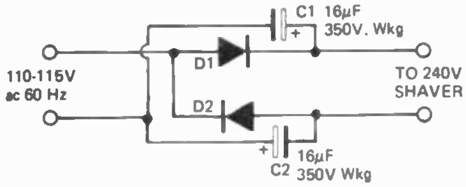
TRAVELLER'S SHAVER ADAPTOR



D1 and D2
BY 127 or similar

Many overseas countries have 115 volts mains supplies. This can be a problem if your electric shaver is designed for 220/240 volts only.

This simple rectifier voltage doubler enables motor driven 240 volt shavers to be operated at full speed from a 115 volt supply.

As the output voltage is dc the circuit can only be used to drive small ac/dc motors. It cannot be used, for example, to operate vibrator-type shavers, or radio sets unless the latter are ac/dc operated.

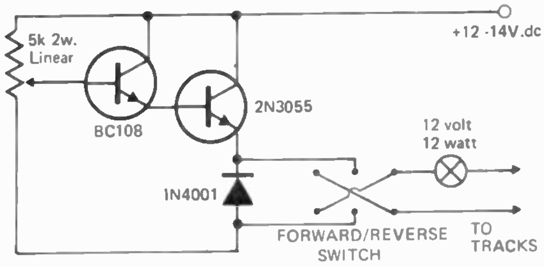
SIMPLE MODEL TRAIN SPEED CONTROL

Two transistors, a diode and a potentiometer can be used in place of the large and expensive rheostat usually provided in model train controllers.

Virtually any npn small signal transistor may be used in place of the BC 108 shown, likewise any suitable npn power transistor can be used in place of the 2N 3055.

The output transistor must be mounted on a suitable heatsink.

Short circuit protection may be provided by wiring a 12 volt 12 watt globe in series with the output. This will glow in event of a short circuit and thus effectively current-limit the output, it also acts as a visual short-circuit alarm.



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.

IMPROVED SCR CROWBAR PROTECTION

Conventional SCR crowbar power supply overvoltage protection circuits have some drawbacks.

In the conventional circuit the SCR is connected directly across the output of the power supply. For normal operation the negative gate bias on the SCR is such that it remains in the non-conducting condition.

In the event of an overvoltage at the load terminal the sense amplifier applies a positive voltage to the gate, causing the SCR to conduct and effectively short circuit the output so protecting components in the load circuit.

Provided that the series regulator has a current-limiting circuit and that it has not failed, the SCR should maintain its protection until the mains input has been disconnected. In fact unless the overvoltage is caused by a fault in the power supply unit itself, interruption of the mains input is all that is necessary to reset the system.

However, the protection should be fully effective even in the event of a failure in the power supply, as it is potentially the most hazardous in terms of damage to the load.

Internal power supply faults must be considered because they are usually of a sustained nature. In addition to component failure, faults can arise from external causes such as the ingress of swarf or moisture when the equipment is unattended, so that the SCR in a conventional arrangement may have to carry a significant overload for a fairly long period.

It must also be remembered that a fault in a power supply may prevent the current-limit circuit functioning, but the current drawn may not be sufficient to blow the fuse.

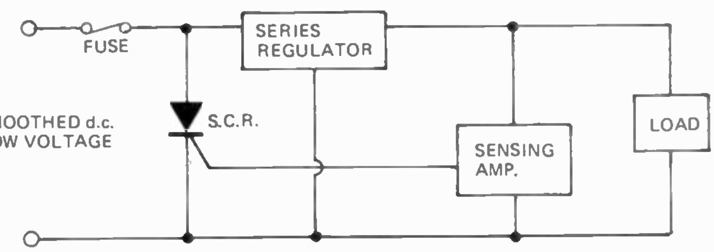
By transferring the SCR from the output to the input of the series regulator, full protection against power supply faults is obtained. In the event of an overvoltage the SCR will pass the full short-circuit unregulated current, so that the fuse will blow every time.

In addition the heavy current is only passed momentarily so that complex heat sinking is not required.

This arrangement also gives complete protection against damage due to mains voltage surges, not only to the load circuit but to the power supply as well. However, this arrangement provides only minimal protection against incorrect connection of a separate high voltage source.

Some protection is afforded when a momentary high voltage is applied via a fairly high source impedance because the series regulator emitter-follower would be subjected to a reverse voltage when the SCR went into conduction and would act as a moderately low impedance diode.

Virtually no protection is provided against the application of sustained spurious voltage but even with the conventional arrangement little protection would be provided against a fault of this kind.



For instance, the load and the sensing amplifier are likely to be damaged before the SCR operates, or if it does operate and the incorrect voltage is not removed quickly it would probably be destroyed.

In the light of experience the engineers at Weir Electronics claim that the modified configuration provides better protection than the conventional method. Some degree of compromise is inevitable, but the fact that a positive fuse replacement action is required to restore the supply every time with the second method is in itself a safety factor.

Weir Electronics UK.

CONTINUOUS WEIGHING SYSTEM

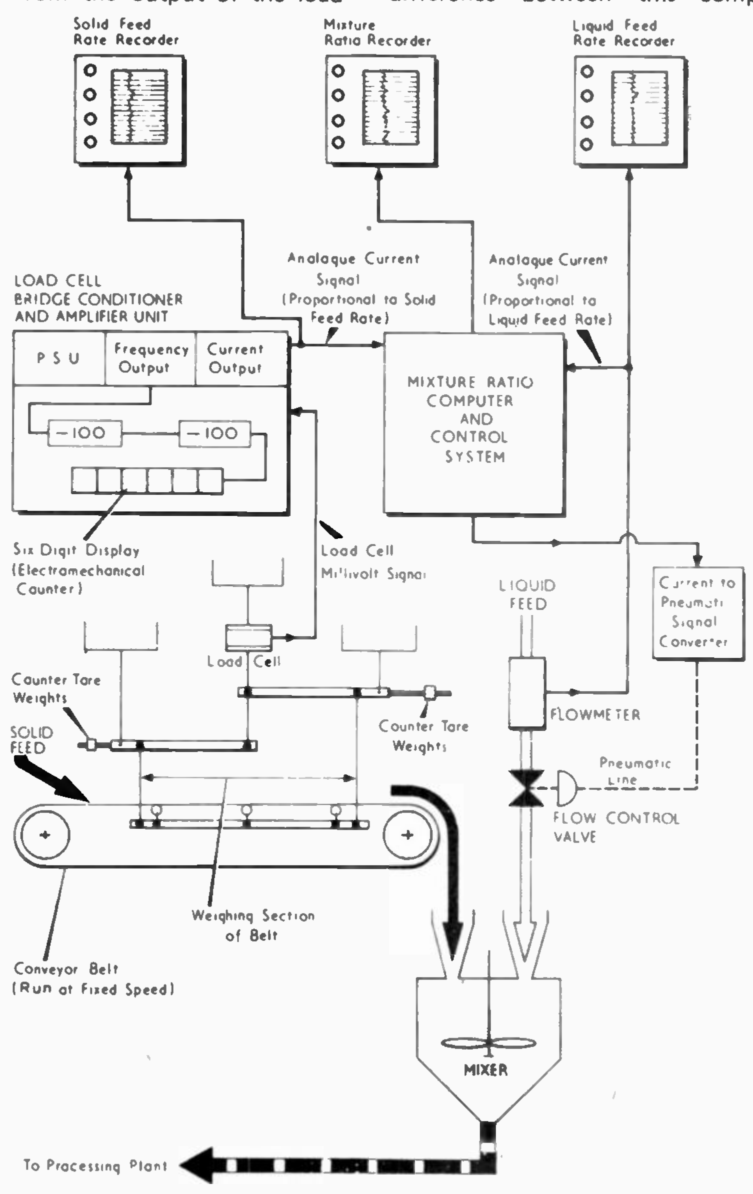
This ingenious conveyor belt weighing system uses a precision load cell made by Transducers (CEL). The system's purpose is to measure the weight of a 'wild' feed of solid pulpy material so that it can be exactly ratioed with a controlled liquid feed to produce a mixture of precisely proportioned constituents.

One unusual feature of the weighing system is that two separate signals are derived from the output of the load cell. The first is a conventional 4-20 mA current signal that at any given moment is proportional to the weight of solid pulp (in either layered sheet or 'crumb' form) being fed onto the constant-speed conveyor belt and then into the mixer. This signal is compared with the analogue current signal derived from a flowmeter measuring the rate of liquid feed, so that the ratio of the two feed rates can be computed immediately. Any difference between this computed ratio value and the desired pre-set value generates a corrective feedback signal, which is used to adjust a liquid flow control valve and thus restore the solid/liquid proportion to the correct value at all times.

The second signal derived from the output of the load cell — a 0-25 lb type DC12T precision model — is a series of pulses, the total number of which is directly proportional to the weight of solid material that has been fed into the mixer. The system is calibrated so that one pulse is equivalent to 1 kg of solid feed, and the sequence of pulses is fed to an electromechanical totaliser in order that the total weight of solid feed delivered can be displayed digitally.

Signal conditioning and amplifier units are also used. These provide three levels of damping to filter out unwanted noise from the system and thus ensure accuracy.

Transducers (CEL) Ltd.
Trafford Rd., Reading, UK



A MEMORY THAT LEARNS

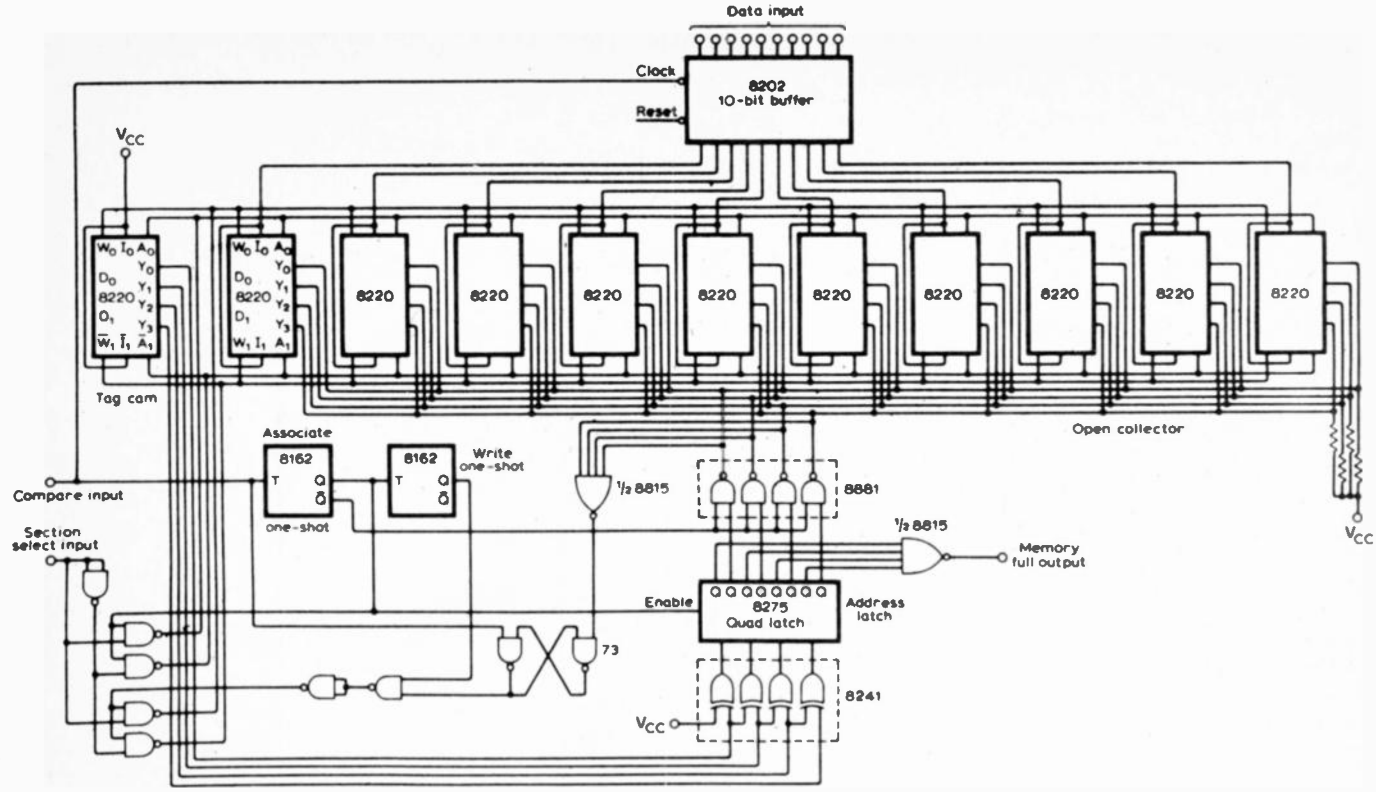
There is currently a great deal of interest in Content Addressable Memories (CAMs) and they are finding use in more and more applications. However, it is probably true to say that the novel characteristics of the CAM have not yet been fully realised.

The CAM is simply a memory with the ability to make a comparison between data already stored and data which is presented to the input. When several CAMs are connected in an array it is possible to apply feedback in such a way as to make a word which has just been read from the memory the next address. Circuits such as these can be made to generate or recognise sequences of digital words.

In the recognition mode, for instance, a CAM array with associated external logic could recognise a dangerous sequence of events in a process control system and could be made to take the appropriate action or altert staff to the impending danger.

Here is a memory constructed from Signetics 8220 CAMs, which has the ability to reject or accept new data depending on what is already in the memory. Once the memory has learned a data word, it will not accept another identical word. In addition, the memory automatically decides at what address new acceptable data is to be stored and ensures that new information is not written into locations which are already occupied.

Each 8220 is a CAM capable of storing four words of two-bits and the memory as a whole can store eight 10-bit words. Although the storage



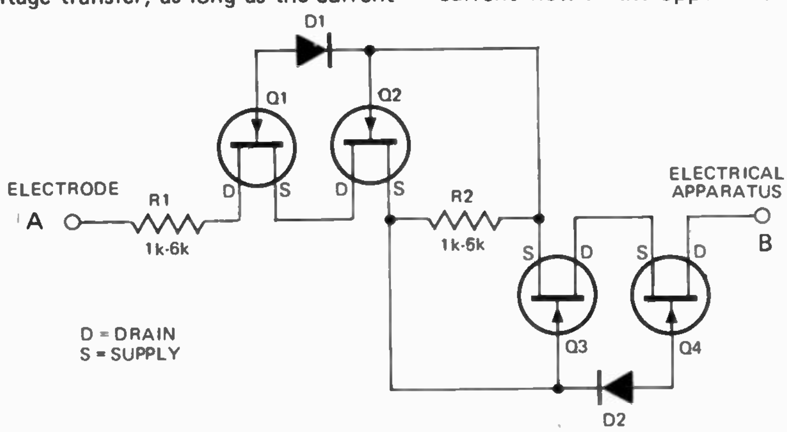
capacity of the memory is 80-bits (8 x 10), eleven CAMs are employed which together have a capacity of 88-bits (11 x 2 x 4). The eleventh CAM has been called the tag CAM because it keeps track of the locations within the memory which are occupied, and allocates a new address for acceptable information.

The memory is sub-divided into the two sections of equal capacity and either of the two sections can be selected using the "section select input". Input data is presented to the 10-bit buffer and the "compare input" is activated. This clocks the data into the buffer and initiates a comparison process in which each word already stored within the memory is compared with the data in the buffer. If a location within the memory is found to carry data identical to that within the buffer, one of the 8220's Y outputs will go 'high' and the write command will be inhibited. If no accurate match is found, the data in the buffer is written into the address specified by the 'tag' CAM. Exclusive-OR gates connected to the Y outputs of the tag CAM specify the next available address and ensure that memory locations are filled successively. The address at the outputs of the exclusive-OR gates is latched into the quadlatch before the 'write' command is available to the CAM array. Thus the Y lines of unavailable memory locations are forced to logic '0'.

CURRENT LIMITING CIRCUIT

Danger of accidental shock exists during the use of electrocardiographs and other electrical apparatus that are connected directly to the patient. As part of the Skylab program, a circuit was developed to prevent accidental shock through electrodes to the test subjects.

The circuit allows undistorted signal voltage transfer, as long as the current remains low. If a high current begins to flow from the electrode terminal A toward apparatus terminal B, it will produce a potential difference across resistor R2 (left side of R2 will be at a higher potential than the right side). This potential biases the gate electrodes of the field-effect transistors, Q3 and Q4, to produce an extremely high impedance. Similarly, a current flow in the opposite direction is cut off by a bias on the gates of Q1 and Q2.



This circuit effectively protects the patient from dangerous shock that could be caused by a failure in the electrical apparatus. When a 1000 Hz signal at 141 Vac (rms) is applied to the terminals of the network, the current is limited to approximately 87μA.

This circuit can also be used to protect sensitive electrical measuring instruments.

Lyndon B. Johnson
Space Centre

SIMPLE DIGITAL VOLTMETER

This meter, which was designed by Don Aldridge of Motorola Semiconductors, is a closed-loop system that uses a clocked binary counter feeding a digital-to-analogue converter to produce a staircase ramp. The output of the converter is

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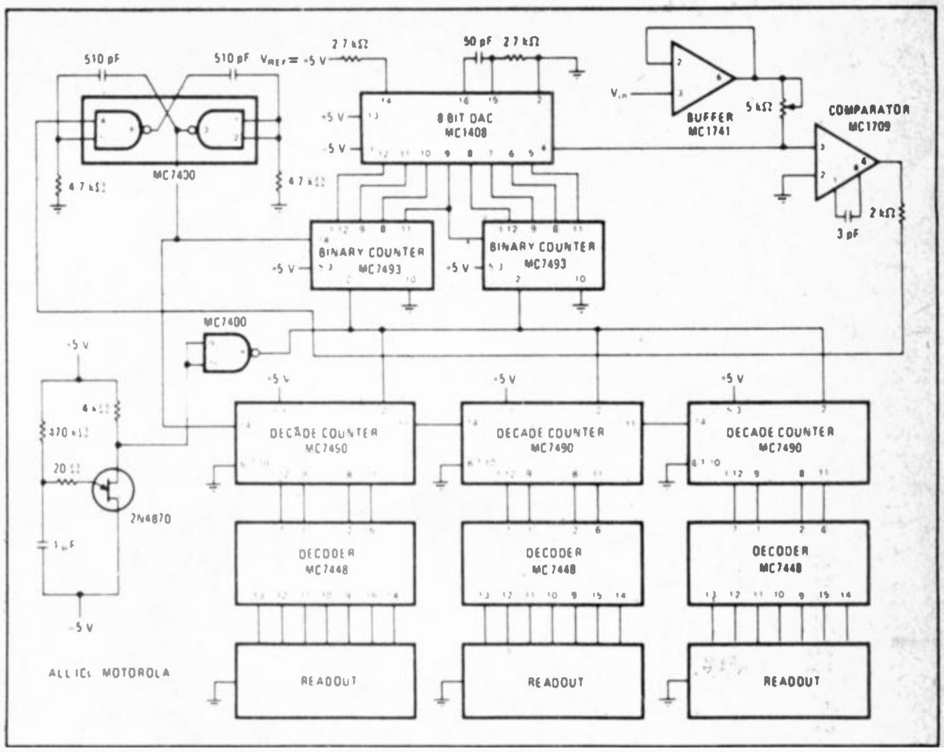
IDEAS FOR EXPERIMENTERS



compared to the unknown input signal, and the clock pulses are terminated when the input signal level and the staircase function level are equal. The number of clock pulses occurring during the comparison process are therefore proportional to the voltage of the unknown input signal.

Clock pulses are generated by two cross-coupled TTL NAND gates at a frequency of 330 kHz so that 256 pulses can be counted in less than a millisecond. Such a high-speed clock has two main advantages: counting can be done without causing display flicker and the need to have latches to store the previous total count while the system is sampling is obviated. The clock pulses are applied to two sets of counters — a binary counter chain in the feedback loop that controls the converter, and a binary-coded-decimal counter chain that provides an easy interface with the seven-segment digital readouts.

The D/A (MC1408) converter generates an output sink current that is proportional to the value of the applied digital word. The maximum full-scale value of this current, which is typically 2 mA, is set by a reference voltage and a reference resistor. The convertor's output current is compared with the current from an input buffer amplifier which, in addition to giving the meter a high input impedance, supplies an output current of up to 2 mA for comparison with the output of the converter.

A second amplifier acts as a high-gain comparator to stop the clock when the current ramp from the converter exceeds the current from the input buffer amplifier. A unijunction-transistor oscillator is used to reset both sets of counters so that the unknown voltage is resampled about every 0.5 seconds, and BCD-to-seven-segment decoders convert the outputs of the BCD counters to the proper format for the seven-segment light-emitting-diode displays.

For the components used here, the meter can measure up to 2.55 V (to within ± millivolts) in 10 mV steps. Different full-scale values can be obtained by using suitable input voltage dividers or by providing the appropriate fixed-gain, rather than the unity-gain, input buffer shown. ●

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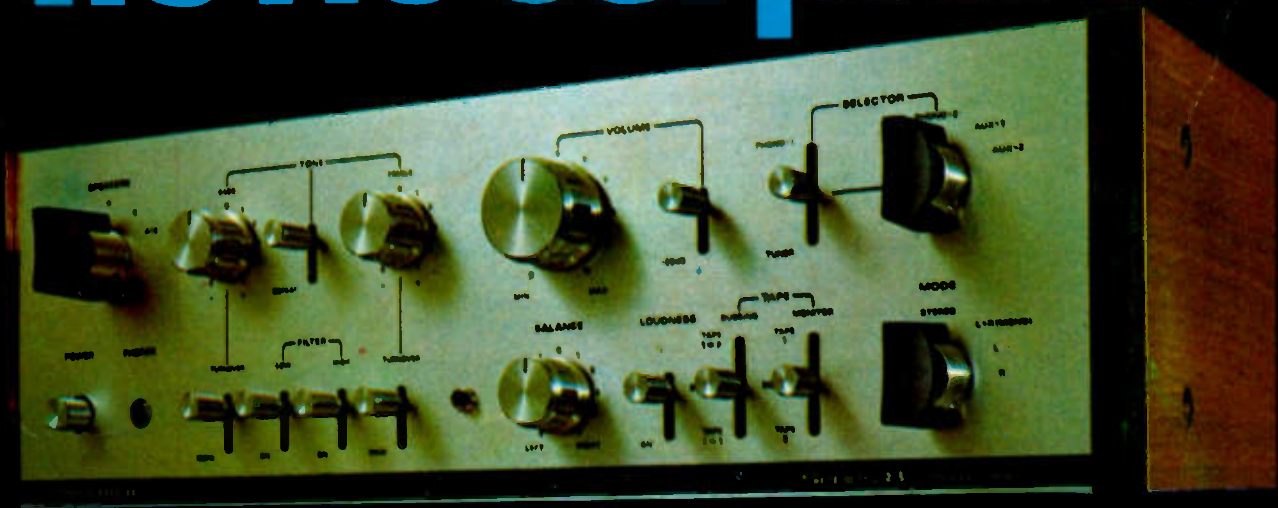

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