AUSTRALIA'S DYNAMIC MONTHLY

JULY 1972

40¢

electronics TODAY INTERNATIONAL

Solid-state watches

Electronics in the Olympic Games

WOW!

(Virtually none)

SONY®

Sony's greatest open reeler TC 730 has the smoothest tape transport yet achieved.

This is the greatest machine that has evolved from Sony's long line of great open reel recorders. Wow and flutter are an incredible 0.06% at 7½ ips. due to its 3 remarkable eddy current motors. And the range of features! Here are some:
Six-head function for recording and playback both ways permits tape/source monitoring while recording. Auto-reverse system with sensing foil automatically reverses in both playback and record modes. Mode selector provided with choice of CONTINUOUS REVERSE, REVERSE or REVERSE OFF. Automatic positioning pinch roller symmetrically positioned beneath the capstan assures extremely precise tape transport. Perfect auto shut-off — Motor stops and pinch roller is detached when tape fully unwinds or accidentally breaks. Sleeping switch stops tape and turns off power automatically on completion of tape. Scrape filter highly effective in cutting down modulation noise and tape hiss. Built-in monitor speaker (5W x 2 power output) with detachable reflector provide better monitoring performance. High-quality all silicon transistor circuitry including OTL (output transformerless), ITL (input transformerless) circuits. 40W (20W x 2) power output through a power amplifier. Capable of mike and auxiliary input mixing without external mixer. Equipped with public address facility. Switch for echo effect and sound-on-sound recording. Regulated power supply incorporated in deck section. Two headphone jacks — one for monitoring and the other for private listening with control for volume and tone as desired. 3 tape speeds; four-digit tape counter; either vertical or horizontal operation; built-in reel locks; large, easy-to-read level meters; tape selector; separate bass and treble tone controls; feather-touch piano-key operation.

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electronics TODAY INTERNATIONAL

JULY 1972 Vol. 2 No. 4

main features

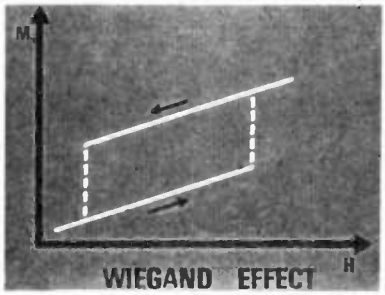
product tests

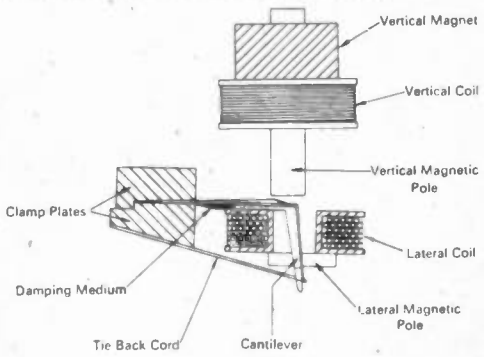
projects

reviews

news & information

COVER: Avia solid-state watch with digital readout is superimposed on a Motorola LSI chip, (full story on solid state watches – page 30 onwards).





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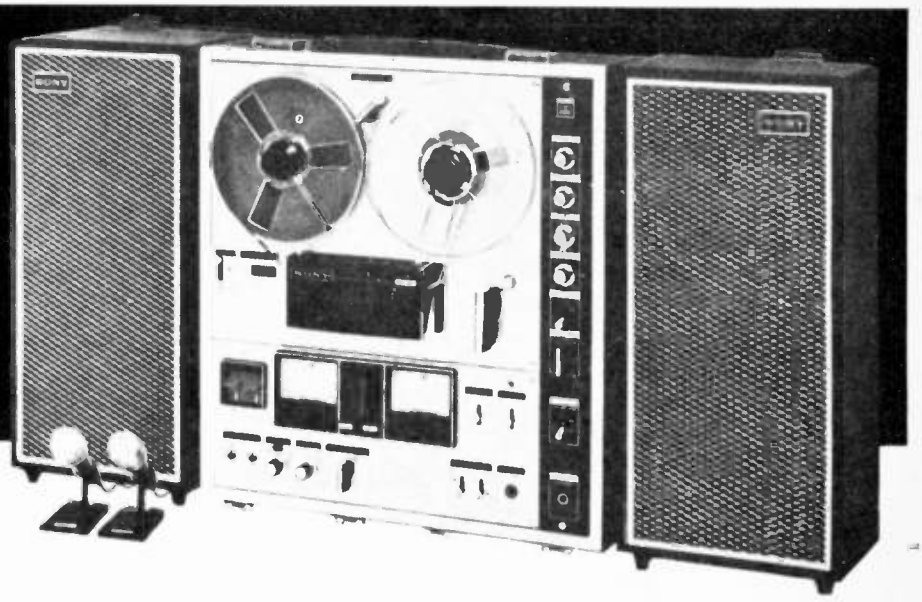

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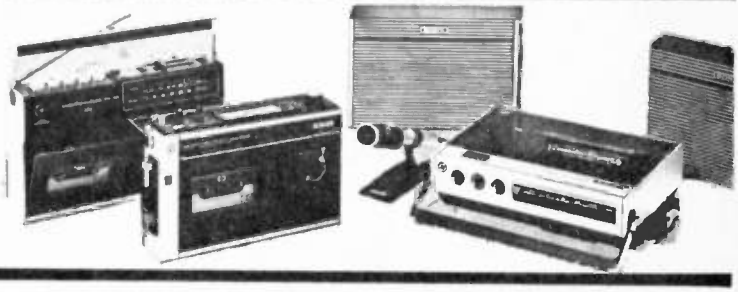

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1984 minus 12-and counting

Since the Doomsday Book, governments have demanded and recorded data about people and their activities. About births and deaths, marriages and divorces, incomes and taxes.

And this is not unreasonable, for in a democracy, privacy cannot be an absolute right. Democracy requires participation by its members at least some of the time and unreasonable privacy can threaten internal security and prejudice the rights of a society to those of an individual. But there must be limits to the extent to which such privacy may be given up.

The advent of computers with multi-million bit storage capacity has provided an enormous capacity to collect, collate, classify and process data about anything and everyone. It has offered enormous benefits in data assembly, retrieval and analysis – and enormous threats to the security of the individual.

As Professor Zelman Cowen stated in his 1969 Boyer Lecture, "the invaders of privacy are a massing army: they come from government and officialdom, from commerce and industry, from the mass media . . . they have little sympathy with the private man's claim to be left alone."

The problems and implications of privacy in today's computer society are many and diverse, but with the imminent introduction of data banks it is essential that society defines the degrees of freedom that it considers reasonable.

At a minimum level it is surely not too much to expect that operators of data banks be registered, and that written records be kept of data extractions, including a record of the nature of the data, the purpose for which the data was required and the person to whom the data was supplied.

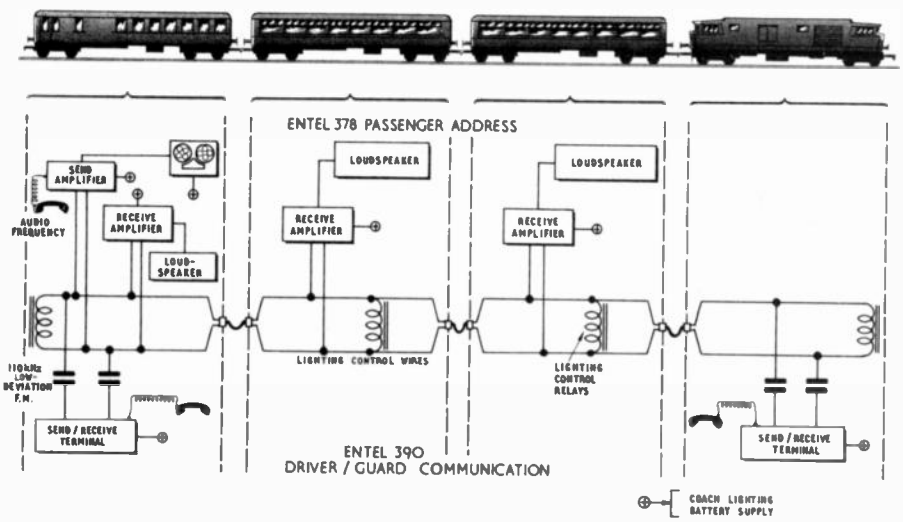
Further than this, and of paramount importance – any person about whom information is stored in a data bank must be entitled upon payment of a reasonable fee, to have a print out of that data at any time. And as it is possible for false or slanderous data to be inputted, either the data bank must seek the validity of all data from the individual concerned or be held legally liable if inaccurate personal data causes damage to that individual.

If the present freedom of computerized data bureaus is allowed to continue unchecked, the public at large will surely suffer unwarranted intrusion into its private affairs by public and private agencies – and this may have disastrous consequences.

Article 12 of the Universal Declaration of Human Rights adopted by the United Nations in 1948 states explicitly 'no one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, or to attacks upon his honour and reputation.'

news digest

TALKING IN TRAINS



British Rail's plans for 150 mph trains include improved communication systems between drivers and guards. Also planned are passenger address systems.

A range of equipment – known as EMTEL – has been designed specifically for this task by Britain's Nelson Tansley Ltd.

The main problem to be overcome was the impossibility of providing a special cable, running the length of the train, on which to carry the signals. The equipment was therefore designed to accommodate any continuous circuit, for example, the control wires for the lighting relays which (in British Rail), are the only conductors always connected throughout any passenger train. In this case, departure from the ideal of a 600 ohm noise-free line is caused by the connexion across the wires of many relay solenoids, the impedance of which is not only complex, but variable.

In the case of the passenger address system – consisting of a "SEND" amplifier driving "RECEIVE" amplifiers and loudspeakers in each coach – the terminal impedance of the line, and the audio-frequency signal is transmitted at a high level (10V at 1 kHz for rated 10W output to the loudspeakers). This reduces the effects of superimposed noise. Further noise reduction is obtained by a curtailed bandwidth of 300 – 5,000 Hz. The system is operated by the guard, who is provided with a telephone hand-set. Announcements, recorded on tape, may also be made.

Another system designed solely for communication between driver and guard, is capacitively coupled to the same pair of wires as the passenger address system, but the signal is transmitted as a low-deviation frequency-modulated signal at 110 kHz. Although well above frequencies used for train-control signals, this frequency does not cause too many matching and attenuation problems. A "SEND/RECEIVE" terminal is located in the driver's cab (or cabs, if more than one locomotive is in use) and in as many guards' compartments of the train as required. Each terminal is provided with a hand-set, with "Press-to-Talk" button, and a bulkhead-mounted electronics panel. The hand-set emits a call tone when a remote call button is pressed, the call being acknowledged by lifting the hand-set and pressing the "talk" button. Simultaneous operation of "talk" buttons gives duplex operation of the system, with a side tone caused by the heterodyne beat between the two carriers, which differ in frequency by a few hundred hertz. The tone helps to discourage indiscriminate "talking-through" which, it is felt, could result in vital information being misheard.

CONCORDE BAN?

Whilst we are currently bombarded with PR material extolling the 'virtues' of the Concorde supersonic airliner it is interesting to note that in the USA Senator Alan Cranston has introduced a bill, co-sponsored by Senators Edward Muskie and Caliborne Pell, to prohibit overseas supersonic transports from landing at any US airports or flying over US territory at supersonic speeds.

The SSTs which carry less than half the passenger load of a 747 make ten times as much noise on take-off and landing.

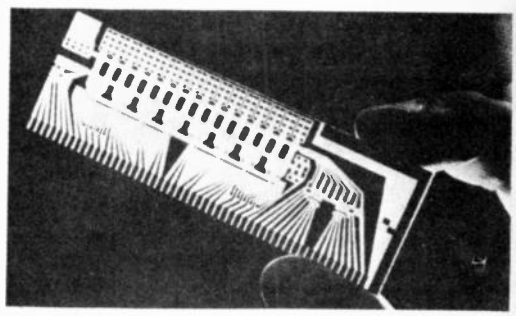
WORLD'S LARGEST RADIO TELESCOPE

A radio telescope, consisting of three arrays – arranged in a 'Y' formation – is to be built near Albuquerque, New Mexico, by the US National Science Foundation.

Costing more than $30 million, the telescope will be the world's largest scientific instrument.

Each of the three arms of the telescope is 13 miles long and consists of a railway track carrying nine fully steerable dish antennae. Resolution and sensitivity of the instrument should be at least one order of magnitude better than existing instruments.

NEW IC MANUFACTURING TECHNIQUE



In the USA, Bell Telephone Labs. have developed an experimental process for forming IC patterns directly onto ceramic substrates – in one operation.

The technique is said to eliminate many processing steps, including mask making, photo-resist application, and chemical milling. Apart from this clean-room facilities are not required.

A computer controlled neodymium YAG laser – with 960 Watts output and 250 nano-second pulse width – selectively vapourizes, or passes over, the drum rotated substrates which are coated with a thin gold film.

Here's $330 value for only $213.50 OR LESS!

The SANSUI 210A

And your new Sansui Model 210A stereo tuner amplifier will possibly cost you even *less*. What do you get? A powerful solid state stereo amplifier rated at 22 watts R.M.S. and worth *not less* than $150.

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INSTROL

SLASHES A.D.C. PRICES

ADC STEREO CARTRIDGES — AMERICA'S QUALITY CARTRIDGE

ADC 220X . . $17.00

ADC 220X. Type: Induced Magnet; **Output:** 6 mV at 5.5 cms / sec. recorded velocity; **Tracking Force:** 1 to 2½ grams; **Frequency Response:** 10 Hz to 18 kHz ±3dB; **Channel Separation:** 20dB from 50 Hz to 10 kHz; **Compliance:** 20 x 10^{-6} cms / dyne; **Spherical Stylus Tip Radius:** 0007" **Vertical Tracking Angle:** 15°.

ADC 10E mk4 . . . $51.00

Type: Induced Magnet*
Output: 4 mV at 5.5 cms / sec. recorded velocity
Tracking Force: .7 gram
Frequency Response: 10 Hz to 20 kHz ± 2 dB
Channel Separation: 30 dB from 50 Hz to 12kHz
Compliance: 35 x 10^{-6} cms / dyne
Elliptical Stylus Tip: Contact radius: .0003"; lateral radius: .0007"
IM Distortion: Less than ½"% – 400 & 4000 Hz at 14.3 cms / sec. recorded velocity
Vertical Tracking Angle: 15 degrees
Recommended Load Impedance: 47000 ohms nominal

ADC 220XE . . . $22.00

ADC 220XE. Type: Induced Magnet; **Output:** 6 mV at 5.5 cms / sec. recorded velocity; **Tracking Force:** 1 to 2½ grams; **Frequency Response:** 10 Hz to 18 kHz ± 3 dB; **Channel Separation:** 20 dB from 50 Hz to 10kHz; **Compliance:** 20 x 10^{-6} cms / dyne; **Elliptical Stylus Tip Radii:** Contact radius .0003". Lateral radius .0007"; **Vertical Tracking Angle:** 15°

ADC 550XE . . . $30.00

ADC 550XE. Type: Induced Magnet; **Output:** 5 mV at 5.5 cms / sec. recorded velocity; **Tracking Force:** ¾ to 2 grams; **Frequency Response:** 10 Hz to 20 kHz ± 2 dB; **Channel Separation:** 20 dB from 50 Hz to 12 kHz; **Compliance:** 35 x 10^{-6} cms / dyne; **Elliptical Stylus Tip Radii:** Contact radius .0003". Lateral radius .0007"; **Vertical Tracking Angle:** 15°.

SPECIAL INTRODUCTORY ADC OFFER . . . SAVE $13.00

J. H. TURNTABLE (complete) This outstanding turntable value consists of :—

(A) J. H. TURNTABLE	Belt drive, synchronous motor, unmeasurably small rumble, wow and flutter of better than 0.04%, negligible hum radiation, with 12" diameter of platter.
(B) LUSTRE ST510D ARM	A high precision universal arm, stylus pressure is adjusted by calibrated counterweight. Oil damped cueing lift is fitted.
(C) A.D.C. 220X	Magnetic cartridge. Tracking force 1½ to 3 grams, extremely linear and smooth frequency response.
(D) INSTROL 45 STAND	This aesthetically designed player stand is available in either oiled teak or walnut.

ALL THE ABOVE FOR ONLY **$90.00** **(Hinged perspex cover $11.80 extra)**

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Please send me your complete hi-fi catalogue and price list. I enclose herewith postage stamps or money order to the value of 50c. I understand that the 50c will be refunded on my first purchase.

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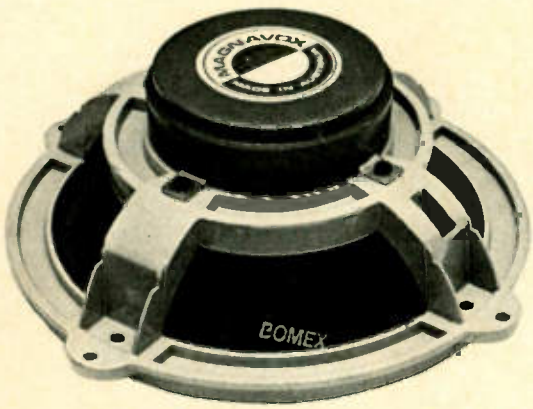
T207

INSTROL SPEAKER SYSTEMS

All the systems below are available in kit form. The cabinet kits come in either unpolished Queensland Maple veneer or unpolished teak veneer. All kits are complete, and include speakers, crossover networks (where applicable), cabinet kits, grille cloth and innerbond.

NEW MAGNAVOX 8-30 SYSTEM



Featured in "Electronics Today". It handles 30 watts RMS, features a new high performance 8" speaker, two 3" tweeters, and is available in cabinet 20 7/8" x 12 7/8" x 8 7/8" (1 cu. ft.) or 23 7/8" x 15½" x 10 7/8" (1.6 cu.ft.). Available in teak or maple veneer.

COMPLETE SYSTEM

Kit or Parts	$46.00 (1 cu ft), $58.00 (1.6 cu ft)
Built and Tested	$62.00 (1 cu ft), $78.00 (1.6 cu ft)

SEPARATE COMPONENTS

Enclosure kit (1 cu ft)	$19.00 (maple), $19.50 (teak)
Enclosure kit (1.6 cu ft)	$31.50 (maple), $33.00 (teak)
Built Enclosure (1 cu ft)	$32.00 (walnut), $33.50 (teak)
Built Enclosure (1.6 cu ft)	$48.50 (walnut), $51.00 (teak)

ECONOMY BASS REFLEX SYSTEM

Special 1970 design consists of a Rola C8MX speaker in cabinet 20" x 11" x 9". Ideal for low wattage.

COMPLETE SYSTEM

Kit of Parts (teak or maple)	$27.00
Built and Tested (teak or walnut)	$40.00

SEPARATE COMPONENTS

C8MX speaker only	$9.50
Enclosure kit	$16.50 (maple), $17.00 (teak)
Built Enclosure	$29.00 (maple), $30.50 (teak)

WHARFEDALE SPEAKER SYSTEM KITS

The Wharfedale Super Linton, Melton and Dovedale III are now available as build-yourself kits, featuring INSTROL quality cabinet kits in choice of maple or teak veneer.
The Super Linton kit employs and 8" and 3" speaker, frequency response 40-17,000Hz, cabinet 21" x 11½" x 9½", 15 watts RMS.
The Melton kit employs a 12" bass and a tweeter, cabinet 22¾" x 13" x 10", 25 watts RMS.
The Dovedale III kit employs a 12" bass, 5" mid-range and 1" tweeter. Cabinet 28" x 15½" x 10", 35 watts RMS.

COMPLETE SYSTEM

Super Linton kit (Unit 3)	$53.00
Melton kit (Unit 4)	$93.00
Dovedale III kit (Unit 5)	$127.00

SEPARATE COMPONENTS

Unit 3 encl. kit	$17.00 (maple), $19.00 (teak)
Unit 4 encl. kit	$25.50 (maple), $27.00 (teak)
Unit 5 encl. kit	$34.00 (maple), $35.50 (teak)

KEF SPEAKER SYSTEM

CONCERTO — The KEF Concerto contains B139 bass unit, B110 mid-range and T27 tweeter in teak cabinet 29" x 17" x 12". Frequency range 30-30,000Hz, Power handling capacity 25 watts.
CONCORD — The KEF Concord contains B139 bass unit and T15 tweeter in attractive teak cabinet. Frequency range 30-20,000Hz. Power handling capacity 25 watts.
CHORALE — The KEF Chorale contains B200 bass unit and T27 tweeter in teak cabinet 18½" x 11" x 8 5/8". Frequency range 35-30,000Hz. Power handling capacity 25 watts.

COMPLETE SYSTEM

Concerto System	$220.00
Concerto speaker & enclosure kit	$165.00
Concord System	$149.00
Concord speaker & enclosure	$113.00
Chorale System	$120.00
Chorale speaker & enclosure kit	$ 90.00

SEPARATE COMPONENTS

Concerto speakers & crossover	$140.00
Concord speaker & crossover	$ 89.00
Chorale speakers & crossovers	$ 75.00
Concerto enclosure kit only	$ 45.00
Concord enclosure kit only	$ 36.00
Chorale enclosure kit only	$ 26.00

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Please send me the following speaker systems and/or turntable systems, and/or cartridges. These will be sent by road transport or passenger rail, freight payable on receipt of goods. (except cartridges are freight free).

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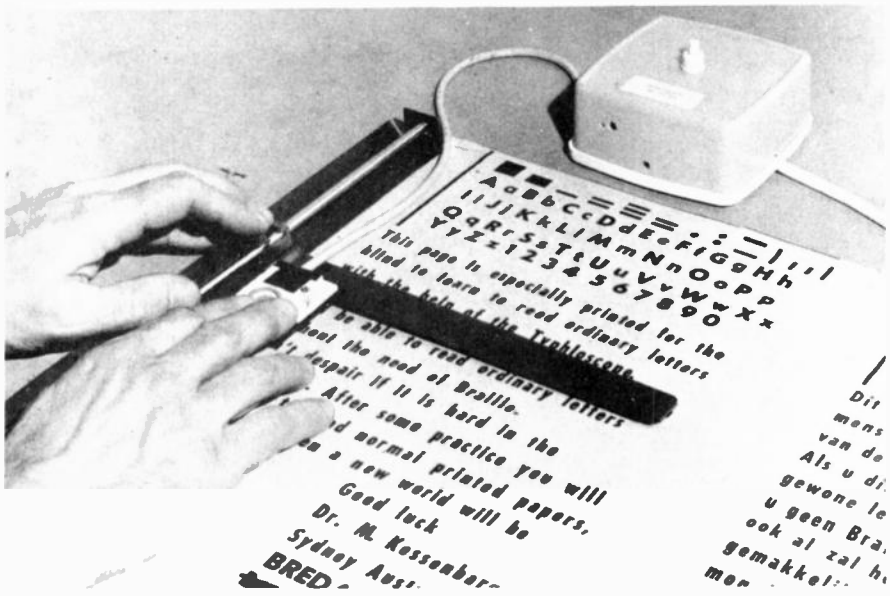
news digest



BLIND READ ELECTRONICALLY

An electronic device that enables blind people to 'read' ordinary type has been invented by Dr. M. Kossenburg, an Australian currently living in Breda, Holland.

Theory is that the entire alphabet is composed of only four different kinds of lines: horizontal, vertical, oblique and curved. When the small 'reader' unit is moved slowly along a line of type, guided by a rule, three photo-transistors on its underside detect the shapes of the lines forming the individual letters. Three corresponding magnetic vibrators signal the resultant patterns to the user's finger-tips. With practice, the combination and sequence of finger sensations enables the user to identify letters and numbers.

Following its presentation at the recent International Inventors Exhibition in Brussels, Dr. Kossenburg was awarded the "Prix Bernadotte" of 60,000 Belgian francs at a ceremony at the Swedish Embassy in Brussels.

PICTURES ON 'PHONE LINES

Japan's Matsushita company has developed a transmission system that enables pictures to be transmitted over ordinary voice telephone lines at relatively high speed.

The system uses a normal TV camera but transmits only one of the 50 fields normally transmitted per second. Data from the selected field is stored initially onto magnetic video tape at normal recording speed. Once the selected field has been recorded the data is then recovered but this time the machine is slowed down so that the selected field is extended in time from a fiftieth of a second to about 30 seconds. In effect this reduces the bandwidth required from 3MHz down to 3.4kHz.

The signals are then transmitted via the normal switched telephone network and recorded at the far end on video recorder. The recorded data is then speeded up and re-recorded onto a second video recorder. The system is arranged so that whilst one field is being transmitted and recorded, the previous field is displayed on a TV monitor.

Signal noise ratio of the system is claimed to 30dB, resolution is 200 lines horizontally and 170 vertically.

ARTILLERY COMPUTING SYSTEMS FOR AUSTRALIA

First-round accuracy, and speed and economy of firepower are major advantages of the new Field Artillery Computing Equipment (FACE), which has been ordered for the Australian Artillery from Marconi Space and Defence Systems Limited.

This very advanced fire control system not only provides greater accuracy but also eliminates the human errors which can occur if the efficiency of the Command Post team falls off due to battle fatigue. It also considerably reduces the training period compared with that required for previous manual methods.

The FACE system, already in service with British artillery regiments, both at home and overseas, provides complete firing data for field artillery. Target information and meteorological data

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news digest

as well as propellant type, charge temperature, and muzzle velocity for each gun, together with the type of ammunition, and the position of the gun are all fed into the computer system, using a specially-designed keyboard input in conjunction with a display which ensures that all relevant information is entered in the correct form. The firing data can be presented to the operators at each gun position on a compact display panel by the add-on Artillery Weapon Data Transmission System (AWDATS), or relayed by radio or telephone. The guns are then ready to fire.

Each unit consists of a control and display console and a general purpose digital computer. To this is added a programme loading unit, which enables the computer to be programmed rapidly for any type of gun, from a standard tape cassette.

The complete system can be mounted in a wide variety of military vehicles, from a Land Rover to an armoured Command Post Vehicle.

The order, worth approximately $2 million, has been placed by the Australian Department of Supply with Amalgamated Wireless (Australasia) and the equipment will be built by Marconi Space and Defence Systems, Hillend in Scotland. All of the equipment will be installed and commissioned by Amalgamated Wireless (Australasia), who are expected to start deliveries in the latter part of this year.

LARGE SCALE INTEGRATION

Our Cape Town (South Africa) correspondent tells us that a local chemical manufacturing organisation is entering the field of electronic equipment.

It is understood that the first electronic product from the organisation — Aparth–8 Products Ltd — will be an automatic colour bar generator. The company expects the unit to sell in large numbers throughout South Africa, Rhodesia, Angola, and certain parts of Queensland, Australia.

The company, located in Pasme Ajambok — are well known for their product called 'Klux — the ultimate detergent'.

TELEPHONE FOR THE DEAF

A telephone handset with an inbuilt volume control has been developed in the USA by Bell Telephone Laboratories. A switch in the handle enables users with impaired hearing to select a louder than normal listening level.

LITHIUM ORGANIC BATTERIES

Mallory & Co. has been granted an exclusive worldwide licence to manufacture and market lithium organic batteries under the patents and technologies of American Cyanamid Company, it was announced recently. Terms of the licence agreement were not disclosed.

J. David Ehlers, Managing Director of Mallory Batteries (Australasia) Pty. Ltd., said "The company plans initially to concentrate on the further development and manufacture of a three-volt lithium organic battery with characteristics considered especially suitable for government-related portable power applications". He said, "The battery has exceptionally high energy density, constant voltage discharge characteristics, a long shelf life and can be used over a wide range of environmental conditions".

Mr. Ehlers said that Mallory Batteries (Australasia) Pty. Ltd., will market those products in Australia in 1973. The parent firm, The Mallory Battery Company (U.S.A.) is establishing a pilot line facility in Tarrytown, N.Y., to produce several cell sizes of lithium organic batteries. Mallory also is developing other lithium battery systems, including a family of solid-

news digest

state batteries with rating of from 2 to 200 volts, or higher". He said "These batteries have potential use in medical electronics, time pieces, military devices and in other applications where high voltage density and reliability are required".

CD-4 LATEST

Latest from RCA is that the company has now solved their initial manufacturing problems with CD-4 four-channel discs, and production discs will be commercially available about the time that this issue of Electronics Today International is published.

The CD-4 system employs a high frequency sub-carrier as well as the normal two audio frequency channels.

By using a new vinyl compound which includes antistatic and anti-friction materials, disc life has been extended to the point where a satisfactory four-channel signal can still be obtained despite previous playing at least 100 times on a conventional low price stereo record player using a standard stereo stylus tracking at five grammes.

The new RCA CD-4 records produce normal two-channel sound if played via a suitable cartridge, stylus and decoder.

As these new RCA records are compatible with existing stereo systems the company intends eventually to market all their records in the CD-4 format, thus avoiding the necessity for dealers to carry double inventories.

The titles of the recordings to be released are not yet known, nor have the company released the name under which the discs will be marketed. We understand that the CD-4 designation will not be used.

NS ELECTRONICS ENTER SYSTEMS MARKET

NS Electronics Pty. Ltd. this week delivered its first electronic computer memory system to the PMG.

The system is the largest MOS integrated circuit system designed and built in Australia comprising 640,000 bits of buffer memory arranged in 8x80,000 bit format. It will be used as a frame store or television frame delay line by the Department in the development of video telephone and telephone conference facilities. Mr. W. (Bill) Lavery and the PMG Department's engineer worked closely with the Company's engineering staff in successfully producing this unique buffer store.

Jack Rutherford, NS Managing Director pointed out that as the complexity and density of integrated circuits increased, so the semiconductor manufacturer assumed the responsibility for some of the systems design. He therefore forecast an increase in systems engineering involvement by semiconductor manufacturers in the near future.

STANDARD GRAPHICAL SYMBOLS FOR SEMICONDUCTOR DEVICES

A new Australian standard for symbols for semiconductor devices used in electrotechnology has been published by the Standards Association.

It is issued as Australian Standard 1102, Part 5 and specifies graphical symbols for use in circuit diagrams and defines the principles governing their use. It establishes a number of basic elements and demonstrates a method of combining these to produce symbols describing complete devices.

Qualifying symbols indicating special functions or properties essential to the operation of the circuit containing the device are also defined and examples given of their use.

The symbols included are identical with those recommended by the International Electrotechnical Commission (IEC) in order to facilitate the exchange of information on equipment using semiconductor devices.

The standard also specifies reference designations for components. These are intended for uniquely identifying and locating discrete items on diagrams and for correcting them in parts lists, circuit descriptions and catalogues.

Copies of AS 1102 Part 5 may be obtained from the various offices of the Standards Association for $1.60 each.

Sizzling!

the only word to describe the extraordinary performance of the new Wharfedale "Denton" and "Linton" compact speaker systems.

Building effective compact speaker systems requires technical "*know-how*" and *experience* — and that's where Wharfedale really shines. For over forty years Wharfedale has been Britain's leading manufacturer of high quality wide range loudspeakers; Wharfedale advances in technology are very obvious in the all-new "Denton" and "Linton".

Two models of each unit are available . . . a two way system with an entirely new 8" bass reproducer and a 2" tweeter, and a three way system which specifies a 4" mid-range speaker in addition, to add further reinforcement in the "*presence*" frequencies.

A long throw voice coil is used in the bass speaker to provide restraint-free lower registers and the new 2" tweeter is the result of intensive Wharfedale research — high frequencies are smooth and satisfying. Large magnet structures offer greater sensitivity.

Now examine closely these brief specifications:

DENTON 2.

Size: 14" x 9¾" x 8¾"./Frequency response: 60-16,000 Hz. ± 3 dB./Power rating: 20 watts DIN./Speaker complement: 8" bass speaker, 2" tweeter./Crossover frequency: 1,400 Hz./Finish: Oiled teak or polished walnut.

LINTON 2.

Size: 19" x 10" x 9½"./Frequency response: 55-17,000 Hz. ± 3 dB./Power rating: 20 watts DIN./Speaker complement: 8" bass, 2" tweeter./Crossover frequency: 1,200 Hz./Finish: Oiled teak or polished walnut.

LINTON 3.

Size: 19" x 10" x 9½"./Frequency response: 55-17,000 Hz. ± 3 dB./Power rating: 25 watts DIN./Speaker complement: 8" bass, 4" mid-range, 2" tweeter./Crossover frequencies: 1,100 and 4,000 Hz./Finish: Oiled teak or polished walnut.

DENTON 3.

Size: 14" x 9¾" x 8¾"./Frequency response: 65-17,000 Hz. ± 3 dB./Power rating: 25 watts DIN./Speaker complement: 8" bass, 4" mid-range, 2" tweeter./Crossover frequencies: 1,100 and 4,000 Hz./Finish: Oiled teak or polished walnut.

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SG-WNP-4

Around the world, a thousand million people will watch the '72 Olympics on television. Here is a description of this — and other electronic technology involved.

In 1896, America's Thomas Burke ran the 100 metres in 12.0 seconds at the first Olympic Games of modern times. In 1968 his fellow countryman Jim Hines broke the tape in only 9.9 seconds.

But athletes do not break records by virtue of fitness and muscle alone. Engineering lends a hand.

Synthetic tracks, time measurement by computer, 'bright as day' floodlighting, sports orientated medical and diagnostic centres assist the athletes in their efforts to achieve peak performance.

Electronic technology helps competition judges make decisions and allows press, radio, and television journalists to report to all corners of the world.

For the 1972 Munich Olympics, the magnitude of the electronic technology involved is surprising. It includes five giant computers, 15,000 kilometres of wiring, 400 teleprinters, 50 data printers, 100 data display units.

For the global broadcasting of the Games a television centre has been built capable of sending 12 simultaneous picture transmissions and 60 voice commentaries in 45 languages. In addition a closed circuit television network will carry internal transmissions for the information of journalists and Olympic authorities. This system transmits 15 separate channels to 3000 closed circuit receivers.

Who won the pentathlon in the 1928 Games? What is the name of the captain of the Indian team? What decides the results of a judo contest? When do the archery competitions begin tomorrow? Can I reach Ausberg by train today in time for the canoe slalom?

Questions like this — and thousands of others — are handled by an electronic information storage and retrieval system based on a Siemens Model 4004/45 and a Siemens Model 4004/46 EDP system.

The storage system is of the multi-spindle disc type together with two standby magnetic card storages, and together holds over 150,000 information records — each of which may consist of hundreds of separate items.

A total of 72 information stations

ELECTRONICS

are set up in the press centres at the various competition sites, and also at focal points of visitor traffic. Each station consists of a data display terminal on which the answers from the computer appear, and a keyboard operated by a trained hostess. The 72 information centres are linked with the main computers via serial modems which permit a data transmission rate of 1200 bits/second.

Fifty of the data display terminals are connected with printers so that information displayed on the screen may be printed out.

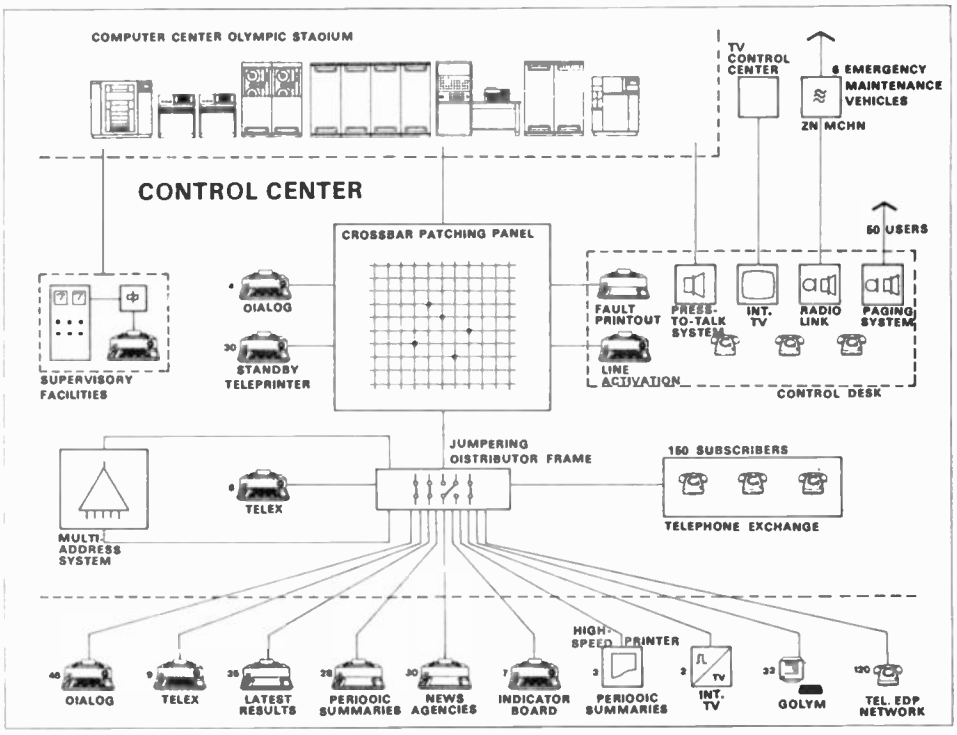
The largest section of the Olympic data bank, which has been compiling for two years, contains the personal data on the 10,000 athletes and 5,000 officials. The information system will be able to provide, for example, full name, date of birth, nationality, height, weight, marital status, number and sex of children, hobbies, club memberships, best events and previous successes and victories. The complete rules of all 196 events of the 21 Olympic sports and significant sporting terms in German, English and French are also stored. A daily summary of the Munich competition results will be fed into the information system during the night by means of a special up-dating service.

A particular advantage of this electronic information system is that the desired answer can be obtained very quickly from the vast source of information using simple search questions without spending time referring to keyword catalogues.

COMPUTER CONTROLLED SCOREBOARDS

Spectators at the most important sites will be informed of the progress and outcome of events primarily by means of large lamp-array scoreboards. The majority of the scoreboards receive their information from the main competition results system. The actual code conversion of information for the multi-bulb panels or lamp array of a particular scoreboard is generally formed by an associated "scoreboard control computer". A satellite computer, assists the main competition results system. It has the task of informing the spectators of every individual result, directing the athletics results either to the scoreboard for the track events, or the scoreboard for the field events.

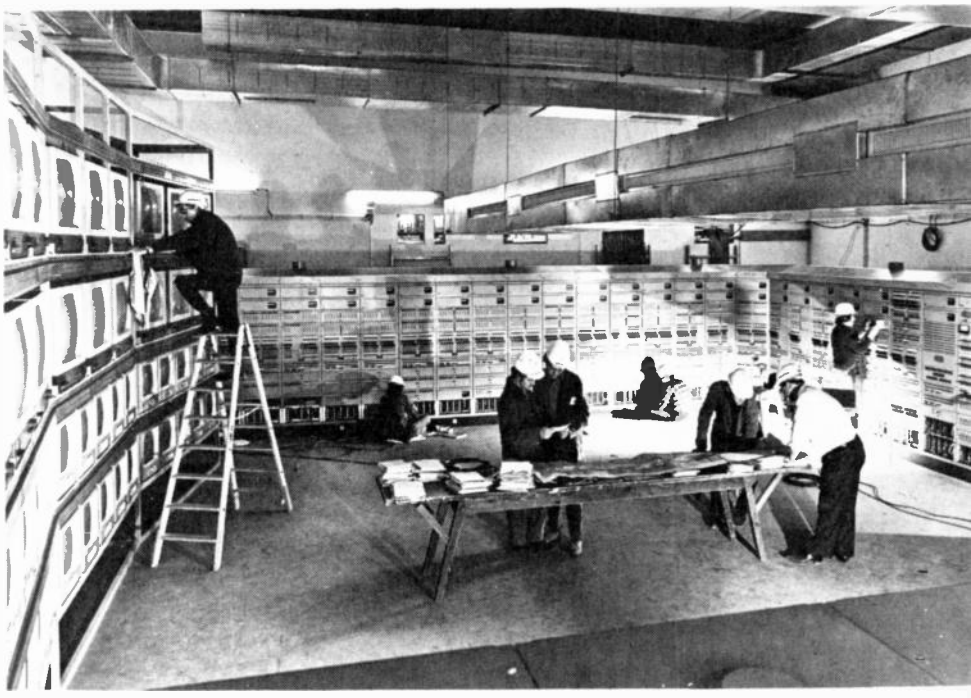
Main computer centre has been specifically installed for the '72 Olympics.



Control centre for the competition results system.

IN THE OLYMPICS

ELECTRONICS IN THE OLYMPICS



About a thousand million people all over the world will be able to watch the '72 Olympics on TV. Shown here is the TV Control Centre. The master monitor wall (seen on the left) has a matrix of 48 monitor screens – back, and right, are part of the total of 61 audio equipment racks.

Experience has shown that on-line control of large scoreboards at sports meetings is very difficult owing to the continually changing situation. A human "controlling link" is therefore generally required – between the computer and the indicator. Each scoreboard is accordingly associated with a separate control room, which accommodates both an output teleprinter with tape punch connected to the computer centre and the controls for the scoreboard. With just a few exceptions, the computer centre of the competition results system thus supplies the control rooms exclusively with tapes containing information in the format required by the scoreboard (up to ten 34-character lines) and with the associated logs.

After each new item of information has been checked by the control room personnel, it is immediately fed via a tape reader to the scoreboard control computer and thus to the scoreboard. Each scoreboard is associated with a data display terminal, by means of which the data to be entered may be checked, and where necessary, supplemented.

OLYMPIC STADIUM

Since the competitions in the two main sectors of athletics (track and field events) take a completely different form, two 20 x 10m lamp-array scoreboards have been provided in the Olympic Stadium. A total of six input keyboards can be connected to the satellite computer installed in the scoreboard control room. One such keyboard is installed in the time-keeping box and one in the distance-recording box. A total of 13 connecting points are available in the arena for the other input keyboards. Competition start numbers and results are transmitted to the computer via the appropriate keyboards. The computer adds data such as name and nationality (which had previously been stored under the start numbers), calculates where applicable the momentary placing, determines if the result is a world or Olympic record and then passes on the information in the correct format to the scoreboard. The display appearing on the scoreboard a few seconds after a track event has ended is at the same time the final result.

Third antenna currently being fitted to the Raisting Satellite Earth Station will send colour TV pictures around the world.

SPORTS HALL

The gymnastics competitions being held in the Sports Hall place high demands on the scoreboards. While standard small scoreboards are provided for displaying the individual performances on each apparatus, a large lamp-array scoreboard is used to follow the overall progress of the event. In this case too, the computer centre of the competition results system supplies the necessary information. In the event of short scoreboard texts, the computer ensures correct output format by completing the remaining empty lines with dots. The text in each tape is preceded by a code, which the scoreboard control computer identifies as the start-of-message code. The end of the text is indicated by an end-of-message code.

SWIMMING STADIUM

Because the swimming events are numerous and often follow each other

very closely, extremely high demands are also placed on the multi-bulb panel scoreboard in the Swimming Stadium. The list of competitors for an event appears on this scoreboard before the start of the race. The scoreboard panels displaying the times are, as an exception, connected on-line with the automatic timing system (touch pads in the swimming pool). The times thus appear on the scoreboard simultaneously with the finish of the race. With the aid of the internal scoreboard control computer it is also possible to display the placings. Independently of the direct display, the computer centre supplies final results lists upon completion of the competition, which can also be used for the scoreboard display, should it be required.

Further computer systems are used to provide data for the 4,000 journalists covering the events.

A total of 48 teleprinters, connected to the computer centre in the Munich Olympic Stadium, will be installed at the 31 locations of the Olympic contests. The computer centre consists of three computers together with magnetic tape devices, disc and drum storages and the various other equipment required for remote data processing. The moment the results of the contests are announced by the judges, this data is passed via teleprinter and telegraph line to the computer centre. In some cases the electronic timing device can be connected direct to the computer. "Validity checks" ensure that the computer promptly protests if it is presented with incorrect data by mistake. For instance, a computer "knows" that the times clocked by Olympic runners in the 100 metres must be somewhere around the ten-second mark. If it were told that a sprinter had covered the distance in 6.3 seconds, it would not mark up a new record but would detect the error and call attention to it.

PLACINGS AND QUALIFICATIONS DETERMINED AUTOMATICALLY

At the press centres and other locations, results lists will be printed out by 196 output tele-typewriters and high-speed printers. There will also be TV converters which reconstitute the data so that it appears in the form of written characters on the television screen.

The computer determines the placings of contestants, notes which athletes have qualified for the next round, represents graphically the pairings for boxing, judo, wrestling and fencing, and indicates any new Olympic or world record which may have been set.

This data processing and transmission system will have its finest hour when the final report on the Games is issued. At Tokyo it was two years after the end of the contests before the final summary of all results was on hand. In Munich the press will be handed the full final report on the last day of the Games!

TV COVERAGE

About a thousand million people around the world will watch the 1972 Olympic Games on TV. About 1200 radio reporters and 1500 technicians will collaborate in the sports broadcasts. There will be over 100 electronic cameras to cover the sports events and up to 450 sports reporters to give running commentaries. Approximately 85 video tape recorders, 12 slow-motion machines and 14 film scanners will sort out the mass of pictures and sound material for 13 video and 60 audio channels. Due account will also be taken of the requirements of more than 40 German and foreign broadcasting organizations whose needs may vary greatly within a very short period depending on when and what they want to transmit and on other unforeseen events. No TV broadcasting of such complexity has even been tackled anywhere before – not even when the Americans landed on the moon.

The first and second German TV programmes have joined forces in the "DOZ" (Deutsches Olympiazentrum Radio Television – German Radio and Television Olympics Centre) in order to co-ordinate technical and organization facilities. The heart of the DOZ facilities is the TV control room. It consists basically of 61 audio and 14 video-equipment racks with a total width of 41m. There is a master-control monitor wall made up of 48 monitor screens in front of which the controls for the largely pre-programmed switching sequences are located. The audio racks incorporate 800 buffer and distribution amplifiers, approx. 105 automatic identification keys, 1000 modulation controllers, 4000 crossbar elements, 105 monitoring units, 5000 cradle relays, together with 40km of a.f. cables and 20km of control cables. The amplifiers, modulation controllers and monitoring units were specially designed for the 1972 Olympics.

Besides the TV centre described above, there is also a studio in which the world programmes will be produced. Like the TV centre, this studio has a master monitor wall with 25 black-and-white and 10 colour screens. The technical facilities at the disposal of producers include two video tape machines with four-track audio recorders, a slow-motion machine, a film scanner, a projector slide scanner and a special TV colour camera for interposing texts, diagrams and still pictures. In addition to the generalised world programme, many broadcasting organizations will be transmitting so-called "unilateral" programmes which will be trimmed to the particular national audience in question.

The 'off-tube' complex permits reporters to comment on sports events at various locations without moving from the spot. They watch the events on a monitor and add a commentary for the particular broadcasting station. The 'off-tube' complex comprises 60 cabins with room for two

A total of 550 floodlight projectors are used in the main Olympic Stadium. This illustration shows one of the two main towers each with 144 projector units. The total installation draws over 2,000,000 Watts.

ELECTRONICS IN THE OLYMPICS

Seen here is one of the 550 metal halide vapour lamps used in the main stadium. Each lamp draws 28 kW.

commentators each, plus a common production studio. For on-the-spot commentaries from the sports facilities there are a total of 450 reporters positions. Sixty five of these are in the stadium opposite the finishing line.

For the first time ever at the Olympic Games, all the events will be recorded on tape in a video centre containing 18 AVR1 Ampex video recorders. The taped scenes can be played back on a slow-motion machine. There are also two scanners for converting filmed material into equivalent video signals.

MOBILE RADIO REPLAY SYSTEM

Live television coverage of events at sites which cannot be directly connected to the TV transmission network will necessitate the use of tributary radio links established at short notice and on a purely temporary basis.

The region of the radio-frequency (RF) band around 7GHz hitherto utilized for the outside broadcast television service is increasingly required for long-distance telecommunications. The mobile radio relay equipment for the outside broadcast television service therefore utilizes the hitherto unexploited region of the RF band around 13GHz. Another advantage of using this region of the RF band is that a large antenna gain can be achieved with relatively small antennae. The baseband of the radio relay equipment comprises a television programme channel for black-and-white or colour transmission and one or two sound programme channels. In the region between 12.611 and 12.989GHz any one of 28 RF channels – the separation of their centre frequencies is 14MHz – can be selected. One of these channels is therefore permanently assigned to each 13GHz radio link.

The transmitting station of the mobile radio relay equipment consists of a modulator for converting the video and sound signals from the baseband position to a frequency-modulated intermediate-frequency (IF) signal with a standardized mid-band frequency of 70MHz, a transmitter with flange-mounted antenna reflector for transposing the IF signal to the RF region around 13GHz, and also a control device; this contains the common power supply for the modulator and the transmitter and equipment for monitoring the system characteristics.

The coaxial cable which carries the video signal to the modulator can be up to 130m long. The attenuation/frequency response of the cable can be compensated for in stages by an adjustable equalizer. The sound signal modulates the frequency of a 7.5MHz subcarrier. After the video and sound signals have been combined via a network, the signal band is passed through a pre-emphasis circuit. A high-linearity balanced modulator with a steep characteristic – the oscillator frequencies lie in the region of 800MHz – converts the signal to the frequency-modulated IF signal. A parametric power modulator in the transmitter now translates the signal to the RF region. The modulation frequency (between 116 and 120MHz, depending on the transmission channel) is derived from a crystal-controlled oscillator. An oscillator power of more than 0.8 W at 13GHz is achieved by means of frequency multiplication (factor 108) and power amplification at 720MHz (20 W).

In the receiving station the receiver, which – like the transmitter – is directly connected to the antenna reflector, translates the frequency-modulated 13GHz signal (input power approx. 10^{-8} W) to the IF region. The demodulator reproduces the original baseband from the IF signal. Video and sound signals, for further processing in the studio for relaying to the omnidirectional transmitters, thus appear at the demodulator output. In the receiving station, too, there is a control device which contains the common power supply for demodulator and receiver and also equipment for monitoring the system characteristics.

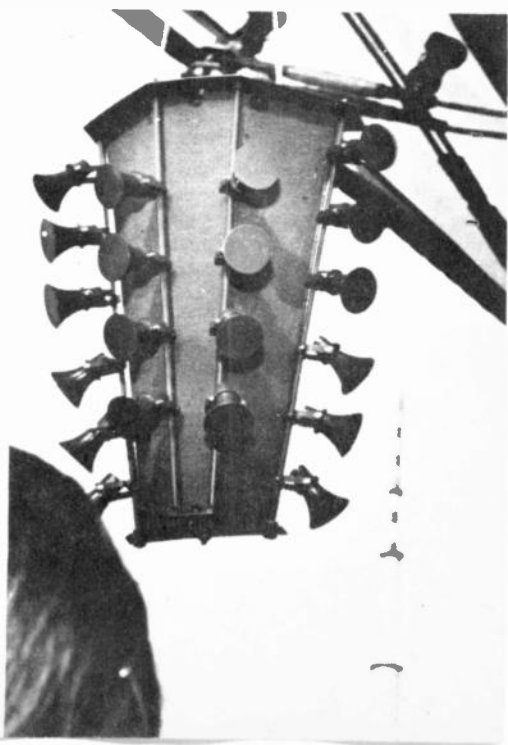
When they are to be used, the senders and receivers (housed in stable weather-proof cases), are set up together with their antenna reflectors on a tripod in the neighbourhood of the vehicle or are mounted on the vehicle on an extensible mast. The modulation and control devices, supervision devices (such as monitors and TV monitoring receivers) and measuring instruments for lining up the radio link are contained in the operations room of the vehicle. A service link inset enables speech circuits to be set up between the vehicle and the outside broadcast TV van, the studio and the public telephone network.

EXCLUSIVE NETWORK FOR TV REPORTERS

Television is going to be one of the most important sources of information for the broadcasting journalists.

A total of 400 outlets in the various studios and in the 60 commentators' cabins of the 'off-tube complex' will be supplied with 16 programmes, nine of these channels being located in the UHF range, six in the VHF range.

A single loudspeaker combination - weighing over half a ton – is the primary source of sound in the main Olympic Stadium. Our picture shows a model of this array, which will hang above the main stand and which will consist of 26 pneumatic and 54 cone speakers. These will be supplemented by smaller, vertical speaker arrays around the track.



Twenty nine amplifiers in various parts of the DOZ Centre, balance out the frequency response of the cable circuits and ensure an adequate level at the outlets, which receive their HF energy over stub lines.

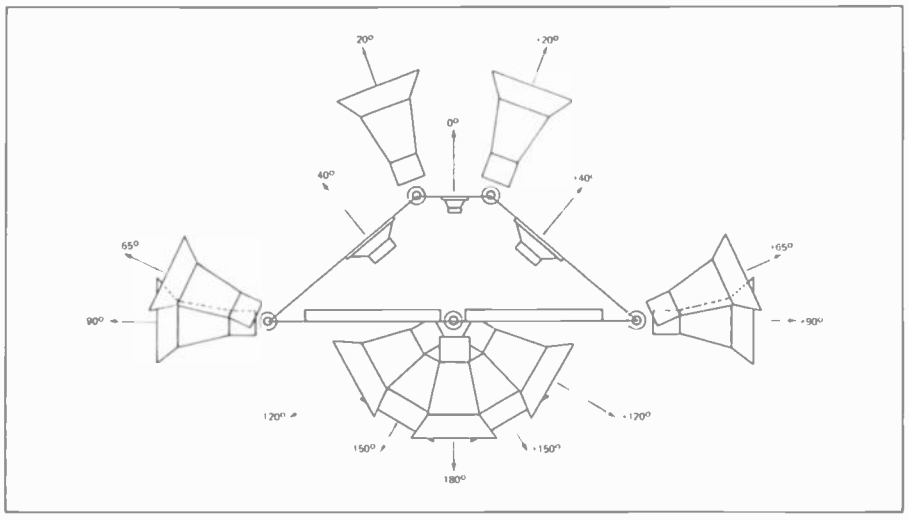
A remaining 2600 receivers of the television cable network can only be connected by VHF links – due to the relatively long transmission distances. These receivers are mostly located in the Olympic Stadium and in the Press Centre. Information stations for the general public, to be set up on the Olympic site and in its vicinity, will each be equipped with 12 television receivers. In order to provide at least 12 programmes at all these outstations despite the restriction to the VHF range, six special channels lying above and below (three in each case) the standard VHF range are used in addition to the six VHF channels available in the standard frequency range. The signals transmitted over the six standard channels are initially converted to the special channel frequencies by means of frequency converters in the central closed-circuit transmission system. Reconversion to the UHF standard channel frequencies is effected at transfer points at the individual competition sites and in the information stations. By way of distribution networks one such transfer is able to serve several hundred receivers.

A total of 10km of coaxial cable pass the signals to the various transfer points, the unavoidable line losses being balanced out by 14 broadband amplifiers, which amplify the frequencies from 40 to 272MHz.

SATELLITE LINKS

The Olympic Games will present long-range communications with a challenge of massive proportions. In meeting it, the Deutsche Bundespost has commissioned new communications links for the transmission of television and sound programme broadcasts, telephone calls, telex messages and data. Within the Federal Republic of Germany, new routes are accordingly being established and the capacity of already existing facilities enormously expanded. In order to enhance worldwide communications potential, the satellite earth station at Raisting is currently being equipped with a third antenna system.

The almost 300-metre high television tower at the Oberwiesenfeld serves not only as a symbol of the Olympic grounds, but of modern radio relay engineering as well. Radio links connect the tower to Stuttgart, Frankfurt, Nuremberg, Salzburg and over the Zugspitze to Italy. Most of the 4GHz radio relay equipment for these links has already been transferred from the Blutenburgstrasse telecommunications tower to its Olympic counterpart. Supplementing present facilities will be the new "Olympic Route", planned to connect Munich tower directly, via six relay stations, to the central switching terminal in Frankfurt, where Olympic television transmissions are fed into the networks of the Federal Republic of Germany and Eurovision.



This plan view shows the sound distribution of the multi-speaker array (bottom right – page 20).

Each of eight possible RF channel pairs can be employed optionally, either to carry one television programme and up to four sound programmes, or up to 1800 voice channels. The frequency band encompasses the RF range between 5925 and 6425MHz. The TV channels are adapted for the PAL, NTSC and SECAM systems. As with all other routes emanating from the Munich tower, the Olympic Route is secured by automatic standby circuits against link interruption or deterioration of transmission quality. Changeover to a standby route is accomplished at the 70MHz IF level. An IF switching distributor accommodated in the tower's switching terminal enables quick, uninterrupted and faultless management of the complex switching tasks.

The Olympic Route will be connected to the Raisting satellite earth terminal via a tributary link, for which a wideband radio relay system operating in the 7.5GHz range is being provided.

A third, supplementary antenna system in Raisting, scheduled for completion in the summer of 1972, will make possible the simultaneous transmission of several live, colour-TV programme broadcasts to America, Asia, and – most recently – Africa. Raisting III will be similar in construction to Raisting II with a 28.5 metre parabolic reflector and no protective radome. As with Raisting II, snow and ice are prevented from forming on the main reflector by several thousand infrared radiators. Raisting III's receive amplifier is directly coupled to, and rotates with, the antenna, thus reducing the connecting cable length and somewhat improving conditions for reception.

LIGHTING

Until a few years ago, the light conditions in a large stadium would have been completely inadequate for evening TV transmissions in colour. Meanwhile, the pre-requisites for such transmissions have been created by recent lighting engineering developments and progress. The metal-halide lamp specially developed for floodlighting the Olympic Stadium and other sports arenas in Munich has excellent colour rendering properties, an optimum colour temperature and a first-class luminous efficacy.

A mean vertical illuminance of 1,875 lx in all four main directions is specified for the stadium floodlighting. This requirement has been met by a high-capacity projector with a symmetrical highly polished and anodised specular reflector with a diameter of 80cm. The maximum luminous intensity is 3,500,000 cd at a lamp flux of about 300,000 lm. The lamp has a colour temperature of 6,000°K and a colour rendering index of over 80 and is therefore ideal for colour TV transmissions.

A computer was used in the designing of the floodlight installation. On the basis of these exhaustive calculations, a total of 550 of the above-mentioned floodlights forming a total connected load of about 2,000 kW were installed. The floodlights are mounted on two 65m high towers over the playing field, two groups on the

ELECTRONICS IN THE OLYMPICS

This X-ray intensifier unit is used in the medical centre.

roof and a number of supports under the stadium roof. The aiming angle of each individual projector is fixed to provide completely uniform illumination on the playing field.

AUDIO SYSTEM

The so-called "railway station effect", i.e. multiple echo due to differing sound station propagation times, generally presents great difficulties when installing public address systems in sports stadiums. This problem has been overcome in the main Olympic stadium, which holds 80,000 spectators. The sound comes out of a single loudspeaker combination installed under the transparent stadium canopy. The 80 loudspeakers of this combination are aligned so that all areas of the grandstand are uniformly irradiated with sound.

To prevent the spectators right under the combination from hearing the sound coming from it, this area – the so-called proximity zone – is served by two small loudspeaker battens at the edge of the sports field. The sound propagation time between between the battens and the spectators is shorter than that between the loudspeaker combination and the grandstand, so that the spectators have the impression (due to a law of acoustics) that the sound is coming only from the battens, i.e. from the front. Sixteen low-mounted loudspeaker battens are installed around the track for the sports field. They ensure that the music has the same beat for gymnastic shows and also when the national teams march into the stadium.

The loudspeaker combination – which weighs 500kg – has 26 pressure-chambers and 54 cone loudspeakers, some of which were specially designed for use in the Olympic stadium. They are connected together in groups which can be controlled individually. The object here, however, was to reduce the irradiation to the secondary sport's facilities outside the main stadium and also to the adjacent residential area.

The loudspeaker system is controlled by a mixing desk located in a special sound control room which is equipped with 15 fully transistorized amplifiers with an output of 100 W each, plus two tape machines and two record players each. The 20 microphones connected to the system are located in the announcer's cabin, the organising committee room, the box for distinguished guests, the sound control room and the sports directors room. There are another ten microphone connections available in the reporters' pits between the track and the grandstand which permit announcements to be made direct from the sports field.

MEDICAL CENTRE

Modern, top-performance athletic activity demands an effort on the part of the participants which extends to the physiological limits of human performance – and sometimes beyond. Therefore, about 300 doctors and some 1,400 nurses (both male and female), radiographers and laboratory technicians, ambulance men and masseurs will be responsible for the rapid and thorough medical care of the 10,000 or so competitors expected. For this purpose, an extensive medical centre is being set up on four floors of a building in the Olympic Village in Munich. The equipment is predominantly of a diagnostic nature and has been so conceived that it can be retained after the games to form a considerable part of the technical requirement of the private medical centre which is to remain.

The heart of the Olympic Medical Centre will be the floor for X-ray diagnosis. The second floor of the building is being provided with three X-ray facilities and all the associated requirements ranging from changing cubicles to high-voltage generators. The X-ray facilities all contain the sort of equipment that is used in modern hospitals, both by internists for comprehensive examinations of body functions, and by surgeons and orthopaedic surgeons for the establishment of exact diagnosis in injuries to the bones. The internal medical X-ray installation in the

Medical Centre comprises, in the main, a universal tilting unit on whose television monitor, details can be recognized even in brightly-lit rooms and which, if required, permits photographic documentation of the findings. With the aid of a spotfilm device, the image can be constantly observed until the radiographic exposure is effected.

The high energy required to drive the X-ray installation is provided by a 12-pulse diagnostic X-ray generator operated by three-phase current, which also includes all the necessary control elements. For surgical/orthopaedic radiography, the Medical Centre is equipped with a Bucky table (Multix) and a mobile floor-to-ceiling support. The unit is provided with a floating table top, electromagnetic brakes and a built-in Catapult Bucky cabinet.

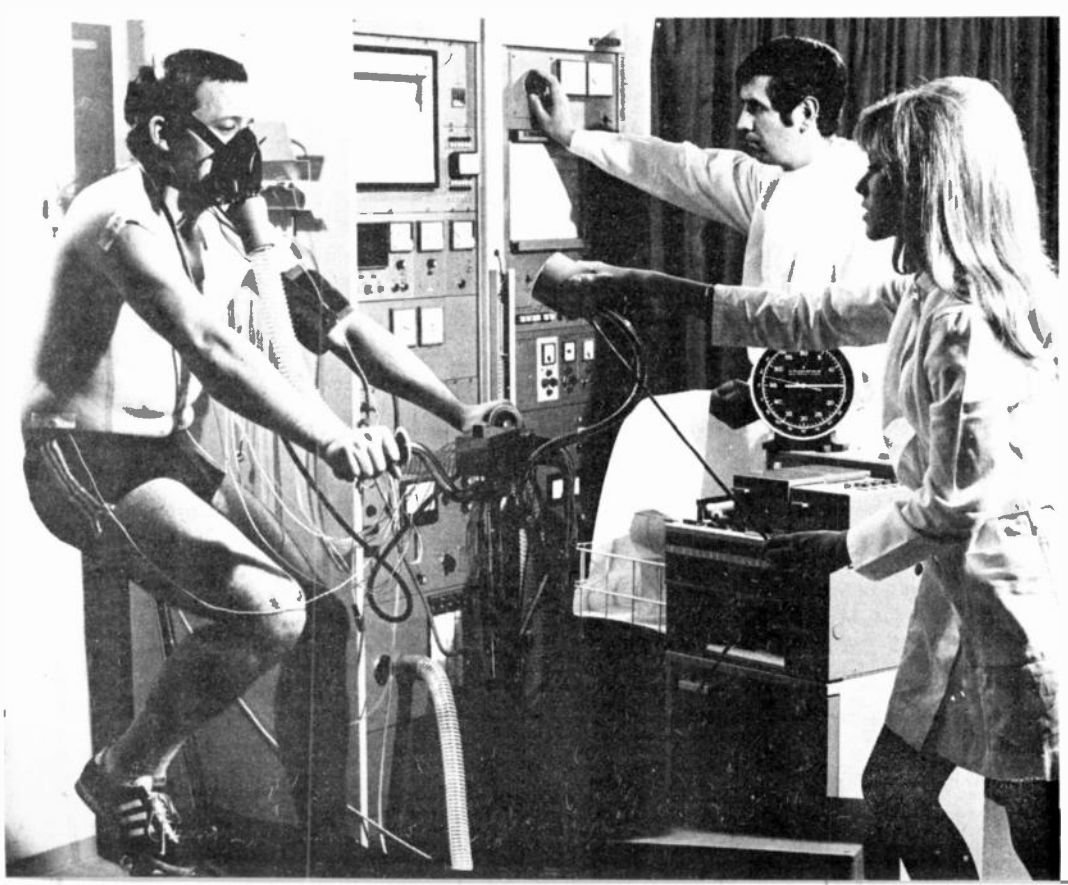
A special unit for the radiological determination of the heart volume and of the cardiac output makes it possible for a team of sports doctors to gain information as to the stress to which athletic activity subjects the human organism. The X-ray installation intended for these scientific examinations enables a true-to-scale representation of the heart to be obtained by effecting radiographs in two mutually perpendicular planes. In the X-ray department there is also a urological examination room and a number of equipment for use in the fields of surgery, anaesthesiology, orthopaedics and shock treatment.

The department of physiotherapy on the ground floor is provided with a total of ten pieces of equipment. Thus, for example, there is a "Neuroton 626", an exponentially progressive current unit for the complete diagnosis and treatment of paralytic conditions that can be caused by accidents. The pulse programme of this unit, together with the automatic pushbuttons and the pulse tabulator, guarantee operating simplicity. There are three each of the "Neodynator 625" (a unit for the treatment of pain after sports injuries) and the "Sonodynator 634". In the case of the latter unit, the combination of stimulation current and ultrasound gives rise to a potentiation of the analgesic effect. Three short-wave therapy units are available, two "Ultratherm 608 Superautomatik" and one "Siretherm 609", an ultra-high-frequency therapy unit for the direct heating of internal organs with a physiological temperature gradient.

The first floor is equipped to carry out different kinds of performance tests. Accordingly, the equipment comprises, in the main, three ergospirometric set-ups and two electrocardiographs. The ergospirometric set-ups make it possible to draw conclusions as to the physical efficiency of a test subject by measuring the respiratory volume, respiratory rate, oxygen consumption, carbon dioxide output and other data of the respired air analyzed by the unit. The two electrocardiographs are the model "Cardirex 6 T" a mobile, fully-transistorized direct-writing jet recorder for electrocardiography and phonocardiography.

In the in-patient wards on the third floor of the Olympic Medical Centre, there is a compact crash cart available for acute cardiac cases. The Clinocar contains equipment for cardiac diagnosis, artificial respiration and resuscitation, and an electrical cardiac pacemaker. In addition, there are a number of telemetric systems, a cardiac massage and ventilation unit and a three-channel electrocardiograph for rapid ECG recording. Several physiotherapy units, such as a short-wave unit, a Neodynator and a Sonodynator, complete the equipment of the wards.

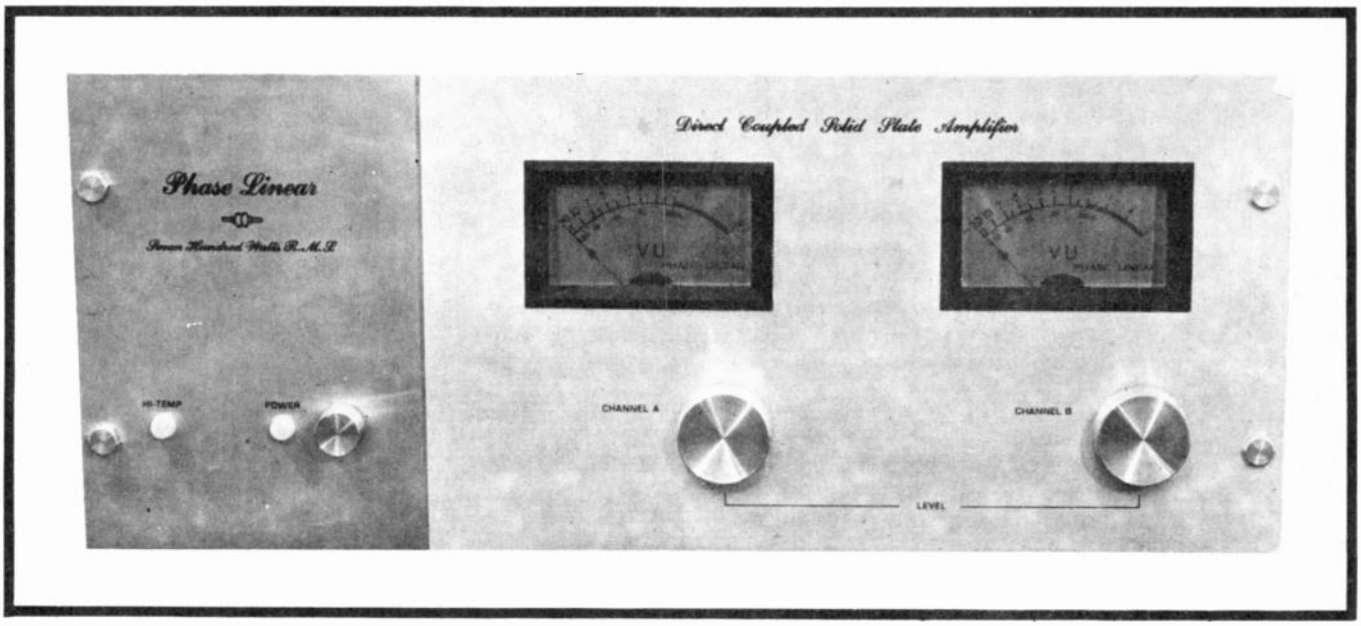
In order to provide immediate aid for injured athletes, the Olympic Stadium has also been provided with a treatment room. Here, a mobile X-ray image-intensifier unit (Siremobil 2) in conjunction with a special casualty transport trolley makes possible a particularly rapid and versatile X-ray examination. On this equipment, surgeons or orthopaedic surgeons can keep the operating field constantly under observation during operations or complicated examination procedures. In the Siremobil 2, the X-ray tube is located in one end of a C-arm having a diameter of just one metre. On the other end there is an image-intensifier tube and a television camera which transmits the fluoroscopic image to a TV monitor. In addition, for emergency cases, there is a cardiac massage and ventilation unit. ●



This 'spirometric' device is installed in the Olympic medical centre. The athlete undergoing examination pedals the bicycle-like trainer until he is out of breath; he then breathes through a mouthpiece attached to the equipment. From this instrument's analysis of the volume of intake, inspiration-expiration frequency, oxygen requirements, carbon dioxide production and other respiratory data, conclusions may be drawn as to the physical condition of the subject.

DESIGNING A 700 WATT AMPLIFIER

by Robert Carver, President and Director of Advanced Projects, Phase Linear Corporation.



In our review of the Phase Linear 700 Watt Amplifier, published in our March 1972 issue, we questioned the need for such a high power output for domestic listening. Here, Robert Carver presents his side of the argument.

A look at the best available power amplifiers shows that bandwidth, distortion, and noise figures extend far beyond the limits of audibility, and in some cases, even the limits of accurate laboratory measurement. It might be concluded that power amplifiers have reached such levels of perfection that further advances could not possibly provide any audible improvements and would be simply "gilding the lily". In any event, it would seem, for example, that decreasing distortion from 0.5% to 0.05% or increasing the signal-to-noise ratio from 90 dB to 93 dB (twice as quiet) would not have any audible effect.

This conclusion might be justified because the deviations from perfection introduced by the rest of the signal-processing chain (speakers, cartridges, and record surfaces) are several orders of magnitude greater than those introduced by the virtually perfect (by comparison) power amplifier. Further, it would seem reasonable to assume that two different amplifiers whose specifications in terms of power, distortion, frequency response, crosstalk, etc., are almost identical should be audibly indistinguishable from one another when compared in listening tests.

However, high fidelity enthusiasts have long observed that different amplifiers do, in fact, sound different and that some amplifiers seem to deliver a more robust low end along with sweeter, silkier highs. Yet their specifications, together with extensive laboratory testing and analysis can reveal no logical reason. A mystery. An engineer recognizes that a mystery is really only a lack of understanding born of insufficient data or the incomplete evaluation of existing data. In the case of the high fidelity power amplifier, it is simply that the human ear is capable of hearing and resolving on-going musical detail that has somehow eluded vast arsenals of laboratory test equipment.

SUBJECTIVE DIFFERENCES

Our own experiences are illustrated in the following experiments and examples. First, certain high quality

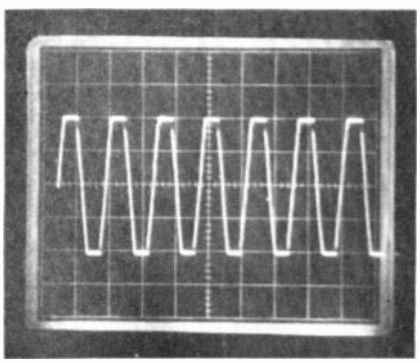


Fig. 1. Amplifier (1) with regulated power supply, is rated at 60 Watts per channel. Unit is seen here operating into an eight ohm load at clipping point of 60 Watts.

transistor amplifiers "sounded better" by a small margin than other high quality transistor amplifiers of identical power rating, in spite of the fact that the latter amplifiers had far "better" electrical specifications in terms of distortion, damping, bandwidth, etc. This difference in subjective sound quality was particularly dramatic when listening to high quality speaker systems using electrostatic components. Particularly, the high end was much airier and open, with much less apparent sibilance during high energy transients.

Let me digress a bit at this point and mention that particular care had been taken to eliminate the last vestige of crossover distortion in the inferior amplifier. At that point, we were virtually certain that crossover distortion was not the culprit. As shall be shown, this assumption proved to be valid.

The second observation was that two different high power, rather expensive transistor amplifiers introduced a mild "snapping" sound into the music when used with some acoustic suspension speaker systems. The "snapping" occurred primarily during low frequency high level passages and on some solo drum instrumentals. Interestingly, the snapping sound was not at all objectional during the drum solos – it tended to give each individual drum beat an added impulse and the illusion of tremendous transient response. However, on sustained low frequency notes, for example, the pedal notes of a pipe organ, the snapping was extremely annoying and clearly an indication of amplifier misbehavior.

In the third observation, in which a valve amplifier rated at 60 watts 'rms' per channel was compared with a transistor amplifier also rated at 60 watts 'rms' per channel, it was observed that the amplifier sounded somewhat more powerful. We discovered that we were able to increase the sound level significantly before objectionable distortion occurred when using the amplifier. In fact, the 60 watt/channel amplifier sounded the same, exactly the same, as a fine transistor amplifier rated at slightly over 100 watts/channel. Two valve amplifiers were used, both vintage models, a Citation II and a Marantz Model 9. The transistor amplifier was of modern design and is very highly regarded.

When all the transistor amplifiers included in our listening test were compared, an interesting pattern emerged – which was two-fold. First – relatively low power transistor amplifiers, those under 60 watts, and those built into receivers and integrated amplifiers did not exhibit *any* form of overt or obvious misbehaviour. The only real "fault" was their low power and consequent inability to produce satisfying music levels without severe overloading. On the other hand, two of the high power units exhibited the "snapping" phenomena and this we considered to be overt misbehaviour and a grevious fault. (As we shall see later, the trouble was due to the protection circuits.)

POWER SUPPLIES

The second part of the emerging pattern was that, given two transistor amplifiers of similar power ratings, it was found that units with a regulated power supply sounded the least powerful; that units with separate power supplies (two power transformers) sounded subjectively more powerful; and, interestingly, units with a single, common power supply sounded the most powerful.

Without exception, the units that appeared "most powerful" sounded significantly "cleaner" and more "open" compared with the other units. All amplifiers were operated at identical listening levels, and each was operating just below the point of audible overload using the "most powerful" sounding unit as the reference. All of these units had similar 'rms' power ratings. (As a matter of course, the ac power line voltage was adjusted slightly to give each amplifier identical continuous sine-wave power output.)

At this point, the task at hand is to identify the reasons for the subjective differences, on a rigorous, scientific level, and approach the problems from an engineering viewpoint.

The first investigation was to determine why some amplifiers with identical power ratings did not (subjectively) sound equally powerful. For our tests we used a commercially available 60 watt/channel amplifier with a regulated power supply and compared it with a unit specially built and designed for the experiment. It was designed to deliver 60 watts/channel with both channels in operation and it used a single unregulated power supply. An oscilloscope was installed across the speaker terminals and the test was arranged in the familiar A-B fashion. It was possible to switch from one amplifier to another instantly while simultaneously listening to music and observing the output of each amplifier on the 'scope.

It became immediately obvious why the second unit sounded more powerful. We observed that the second unit's output voltage would rise considerably higher prior to clipping than the unit with the regulated supply. It sounded more powerful because, in fact, it was more powerful when operated with music into a high fidelity speaker system.

To understand this, it is necessary to make a detailed examination of how the power supply of an amplifier affects the available output voltage swing.

The absolute value of the power supply voltage is what determines the maximum output voltage swing. If the power supply voltage is, for example, 63 volts, then the amplifier can deliver at its output terminals, up to 63 volts

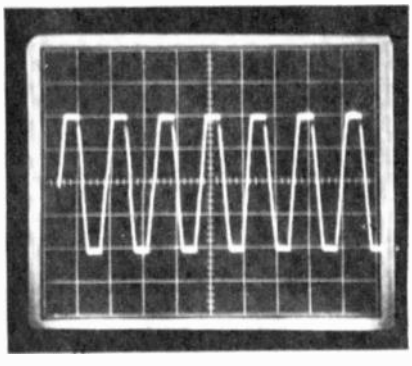


Fig. 2. Amplifier (2) is similar to unit (1) but has a dual power supply. Load and clipping point is the same as Fig. 1.

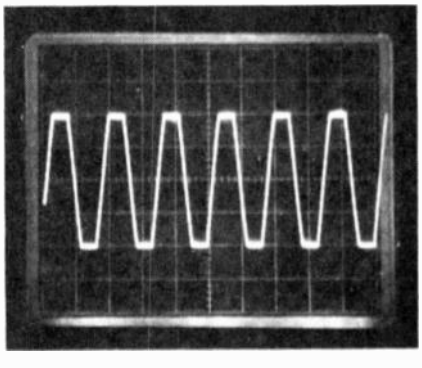


Fig. 3. This shows a specially built 60 Watt/channel amplifier with a single unregulated power supply. Load and clipping point is the same as for the amplifiers shown in Figs. 1 and 2.

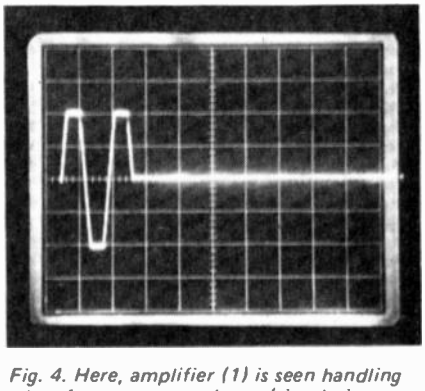


Fig. 4. Here, amplifier (1) is seen handling a low frequency tone burst (simulating a drum beat). Clipping is occurring at 60 Watts. Load is an infinite baffle 8 ohm speaker.

DESIGNING A 700 WATT AMPLIFIER

peak to peak. Once current begins to flow, as the amplifier is delivering power to the load, internal losses cause this voltage to plummet downward. In the case of a 60 watt/channel amplifier whose power supply is unregulated, the supply must be able to maintain 63 volts under full load with both channels operating into 8 ohm load resistors. Since the supply is unregulated, and yet it must somehow supply 63 volts, it must necessarily be designed to deliver a substantially higher voltage during no-load or higher impedance load conditions in order to compensate for internal losses. In the case of a typical transistor amplifier, voltage losses in the power supply are approximately 30%. Hence the power supply voltage must be an unloaded 95 volts.

A regulated power supply can be thought of as, "loss free" because its output voltage remains constant and does not vary from a no-load condition to a full load condition. In the case of the 60 watt/channel amplifier, it is regulated to 63 volts with only very minor variations.

And therein lies the reason that the amplifier with the unregulated supply sounds more powerful. Speaker systems are not of constant impedance; they vary over a wide range over their operating frequency from below 8 ohms to 30 ohms or more.

At resonance, the speaker impedance is at a maximum and if substantial power is to be delivered, the amplifier must have substantial output voltage capabilities. The expression for power if $P = V^2 R$. From this it is readily seen that if the impedance R increases, the voltage must increase or the power delivered will decrease. If the power supply is regulated, it cannot increase, and the available power under dynamic conditions is severely curtailed.

Oscilloscope photographs in Figs. 1 through 6 graphically illustrate these effects. Referring to Fig. 1, the 60 watt/channel amplifier with the regulated supply is being driven to the clipping point (point of overload) with a continous sine wave signal. Both channels are operating. Only one channel is shown in the photo. In Fig. 2, the unit with two power transformers in this power supply is being similarly driven to the clipping point. Figure 3 shows the amplifier with the unregulated power supply similarly driven. Notice that the clipping point is the same for all three units, 63 volts peak to peak. In Figs. 4, 5 and 6, a low frequency tone burst is used to simulate a drum beat. The load is an eight ohm acoustic suspension loudspeaker. The unit with the regulated supply (Fig. 4) clips at its previous voltage level, 63 volts. However, the units with the unregulated supplies (Figs. 5 and 6) are able to deliver a higher voltage prior to clipping. The unit with the single unregulated power supply is clipping at a voltage level approximately 30% higher than its sine-wave continuous clipping level. Thirty percent is almost a one third increase, and since power is proportional to the square of the voltage, the power increase is approximately 1.3 x 1.3 = 1.69. Almost seven-tenths more effective power is available from this amplifier.

From another point of view, for any given average power level the second amplifier will be clipping significantly less during musical peaks, and is thereby generating significantly less distortion. This is why the second amplifier sounded "sweeter and airier."

We repeated these experiments with our valve amplifier and compared results. We found that the unit behaved in a manner similar to the amplifier with the unregulated supply, with an interesting exception. When the valve amplifier was very lightly loaded (with a load of around 30 ohms or higher), its voltage swing could go extremely high, producing almost 50% more than the fully loaded condition. This high impedance load is the load condition that an electrostatic midrange or tweeter unit imposes. The power demands are rather moderate because the load impedance under dynamic conditions is relatively high, and therefore the voltage requirements of the electrostatic screens are high. Present day electrostatic middle and high-range screens require their power at high voltage levels, precisely where a valve amplifier excels.

These findings are summarized in graph form in Fig. 7. Notice that the "best sounding" amplifier (7C) can use additional operating area that is not available to the amplifier with the regulated power supply (7A). Figure 7B shows the operating area of an amplifier with two power transformers, and Fig. 7D depicts a 60 watt amplifier idealized to represent a "perfect" 60 watt/channel amplifier. Notice that the available operating area is almost twice that of the unit with the regulated supply. The "perfect" 60 watt/channel amplifier

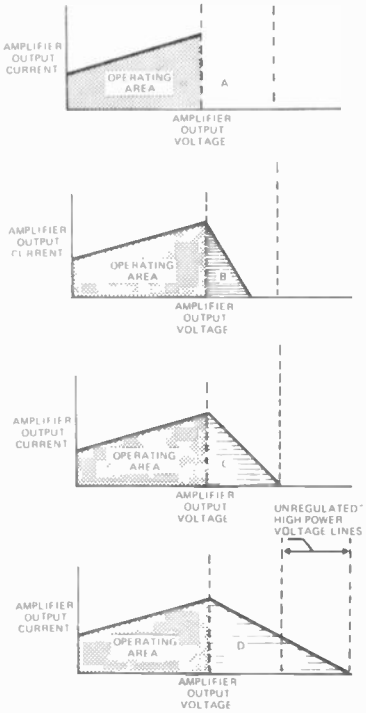


Fig. 7. These drawings illustrate why four different amplifiers – each rated at 60 Watts/channel – sound subjectively different.

A. this area cannot be used because of the tight power supply regulation
B. this area is available to an amplifier with dual power supplies.
C. this area is available to an amplifier with an unregulated power supply.
D. this area is available to an amplifier with an 'idealized' design.

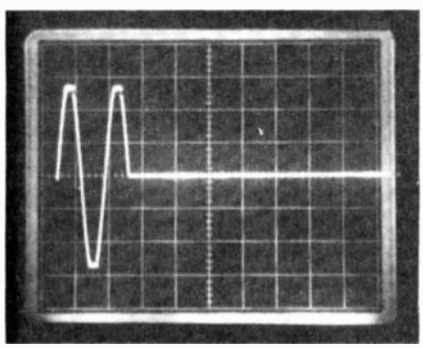


Fig. 5. Amplifier (2) handling the same tone burst – and with the same speaker load – delivers about 20% more voltage than amplifier (1) under dynamic music conditions. Clipping is occurring at just under 90 Watts.

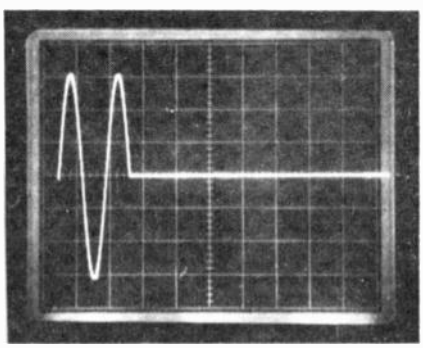


Fig. 6. Here, amplifier (3) – again with the same tone burst signal and speaker load – delivers about 30% more voltage than amplifier (1) under dynamic music conditions. Clipping occurrs at a level exceeding 100 Watts.

would have, as a design goal, a very high voltage power supply. It would sound very clean and very powerful. The high voltage design approach produces the very best possible "sounding" amplifier, but, as is often the case, there is a tradeoff against other desirable characteristics.

The liability assumed with the high voltage amplifier is that the normal operating temperature of the amplifier must be higher than with the conventional design. If the designer is willing to accept this drawback and is willing to design into his unit an extra margin of thermal stability, an amplifier using this approach would be without peer.

A detailed examination of high powered amplifiers in the 100 to 150 watt/channel range reveals shortcomings and problems unique to these units.

PROTECTION CIRCUITS

A severe design problem that must be undertaken when building a high power amplifier is to design an adequate protection device for the unit. All high power amplifiers must incorporate some form of protection circuit to prevent their destruction in the event of an accidental overload. The protection circuit must limit the output of an amplifier if it is operated into an improper load, but it must not *in any way* limit the output of the amplifier when operated into a proper, normal, or loudspeaker load. These two conditions represent conflicting requirements imposed on a protection circuit, in many instances these conflicting requirements have resulted in protection circuits that do not completely protect the amplifier, or worse, often limit the output in some manner that results in an audible degradation of the musical signal. In the most severe cases, outright amplifier misbehaviour results. Figure 8 is a 40 Hz output signal delivered into an 8 ohm resistive load. The power level is 150 watts. Note that the signal is perfect. Fig. 9 is the same amplifier operated into a complex load whose impedance is also 8 ohms. The load is an 8 ohm acoustic suspension loudspeaker. Notice the large spikes that are occuring on the downward slope of the sine wave. These spikes are caused by false trigger action of the protective circuitry built into the amplifier and cause the "snapping" sound sound mentioned previously. The spikes are called "flyback" pulses and are generated as follows. As the sine wave reaches its peak value and begins to decrease, the energy that has been stored in the magnetic field associated with the inductive component of the loudspeaker impedance is forced to flow back into the amplifier. The protective circuit senses this reverse energy flow as an overload and commands the amplifier output stage to shut down. This happens instantly, and when the output stage turns off, the energy is prevented from flowing back into the amplifier. The result is a large voltage spike due to the collapsing magnetic field in the loudspeaker.

An easily understood analogy is an automobile spark coil and a set of points. When the points interrupt the flow of current, the collapsing magnetic field inside the coil generates a high energy spark. In an analogous manner, the voltage at the loudspeaker terminals rises until clamping diodes (built into all large amplifier output stages) conduct and prevent any further increase. The audible effect is the "snapping" misbehaviour and occurs during heavy low frequency demands. (Fig. 10 is the same amplifier but with the protection circuits disconnected and operated into the loudspeaker load. Observe that the sine wave is again perfect.

Figures 11, 12 and 13 snow the output of an amplifier rated at over 100 watts operated into a loudspeaker system. In Fig. 11, the signal consists of a 15 kHz tone butst whose ON and OFF times are equal. Here the amplifier output response is perfect.

Figure 12 consists of the same 15 kHz tone burst but with the following characteristics. The OFF time is very long compared to the ON time. The repetition rate of the tone burst is very low, (in this instance, 500 Hz). This particular tone bursts simulates the simultaneous output of a low frequency musical note (the repetition rate) and a high frequency musical note (the internal tone burst frequency). This would, in a musical sense, correspond to the simultaneous reproduction of a low frequency woodwind note and, say, a harp. Notice that the first few cycles of the tone burst are limited and distorted. This is because the protection circuits in the amplifier confuse the simultaneous low and high frequencies with an overload and because of this they falsely trigger, and limit the amplifier output.

Figure 13 shows the same output as Fig. 12, but with the protection circuits removed. Again, note that the response is perfect.

The audible effect of this particular amplifier misbehavior is much more subtle than the previous example. The effects range from a slight "edginess" and "stridency" to outright breakup associated with the highs, as for example when an opera singer hits her high C at the end of an aria.

A general review of all of these photographs clearly indicates the need for improvement in power amplifier performance.

A perfect amplifier should be powerful enough never to overload, even during low frequency passages or musical peaks. The protection circuits should never falsely trip and generate distortion or amplifier misbehavior, yet must safeguard the amplifier against accidental short circuits or from any other form of abuse. An amplifier must also protect the loudspeaker from accidently dropped

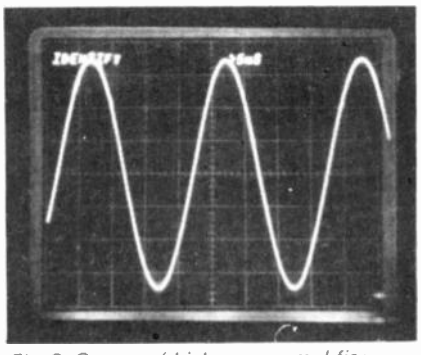


Fig. 8. Output of high power amplifier operating at 40 Hz into an ohm resistive load – power level is 150 Watts.

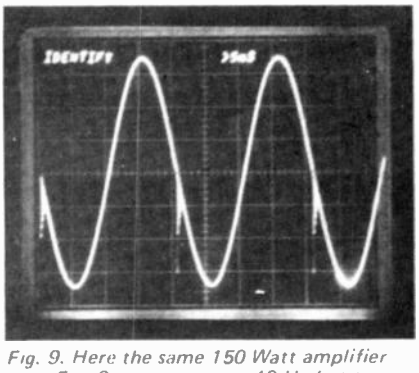


Fig. 9. Here the same 150 Watt amplifier as in Fig. 8 is operating at 40 Hz but this time into an 8 ohm loudspeaker. Power level again is 150 Watts. Tearing at the centre of the wave form is due to false triggering of protective circuits.

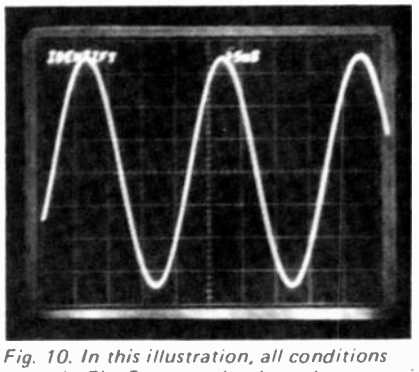


Fig. 10. In this illustration, all conditions are as in Fig. 9 except that here the protection circuits have been made inoperative.

DESIGNING A 700 WATT AMPLIFIER

tonearms or amplifier failures, and all of these qualities must be built in.

HOW POWERFUL

Simply stated, an amplifier should be powerful enough to prevent overload and clipping when operated at a satisfying listening level. Instant overload recovery is not enough.

The best speaker systems today obtain their smooth, wide range low distortion performance by significantly sacrificing efficiency. The best speakers are excellent, but require large peak power (and thus – output voltage capability) of an amplifier. Figure 14 shows a 120 watt amplifier reproducing the opening allegro piano note from Part III, of Beethoven's *Emperor* concerto performed by Rudolf Serkin. The volume level has been adjusted so the piano volume level approximates a live piano. The speaker is a Bose 901 which of course uses active equalisation. Observe that piano note peaks are being clipped. This leads to harshness and may cause listening fatique. Figure 15 is the same passage but with a 350 watt amplifier. Note that clipping does not occur. The sound is smooth, sweet, and open. The subjective volume level is identical in both cases. The average power level in both cases is approximately 38 watts.

If the goal is to eliminate the severe amplifier distortion that occurs on musical peaks and during low frequency passages, and if the best wide range speakers available today are utilized, a minimum of 200 watts/channel is required. A maximum of over 500 watts/channel is required when using some of the very latest, highly inefficient speakers. The important point to remember when dealing with these high power levels is that the peak to average power ratio of musical material is approximately 10:1. This means that when a 200 watt/channel amplifier is operating full tilt into a set of loudspeakers, the long time average power delivered to the loudspeaker is only 20 watts. In addition, these loudspeakers are designed safely to sustain extremely high impulsive power levels. For example, the new Acoustic Research LST loudspeaker system can safely sustain 1000 watts for brief time periods. It is this capability that will allow a high level drum beat, a low frequency pedal note, or an opera singer hitting her high C at the end of an aria to be safely accommodated by the loudspeaker system.

700 WATT AMPLIFIER

The first step in designing our Phase Linear 700 watt amplifier was to evaluate existing design approaches to high power. Primarily, the problem is one of obtaining the required high output voltage. Three hundred fifty watts at eight ohms (two channels), requires an unregulated power supply capability of over 200 volts. Until very recently, the very best existing transistors had sustaining voltages of only 120 volts, and, at that, a designer was pushing the state of the art to build an amplifier with a 120 volt supply (150 watts). The standard solution to higher voltages is to use low voltage transistors and use a step-up transformer or autotransformer at the output of the amplifier. The disadvantages of this approach are many. Excessive phase shifts through the transformer generate stability problems, increase distortion, reduce the bandwidth, and transformers are excessively heavy and expensive. We computed that an amplifier using step-up transformers or auto-transformers would weigh over 130 pounds!

A second design approach consists of connecting two (or several) low power amplifiers together in series to obtain the required high output voltage. Amplifiers connected in this fashion are said to be "in bridge" and their separate output voltages add together or double. Since power increases as the square of the output voltage, doubling the voltage would quadruple the power. For example, two 150 watt units in bridge would yield four times 150 or 600 watts.

This design approach is a fairly workable one, but it too suffers severe and fundamental drawbacks. The input and the output grounds are not common. Rather, they are "floating"

(Continued on page 118)

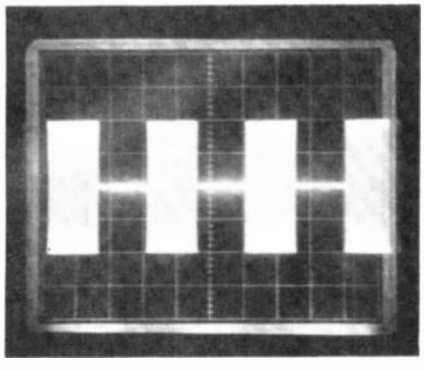


Fig. 11. This shows a 15 kHz tone burst from a high powered amplifier into an 8 ohm loudspeaker, the response is perfect.

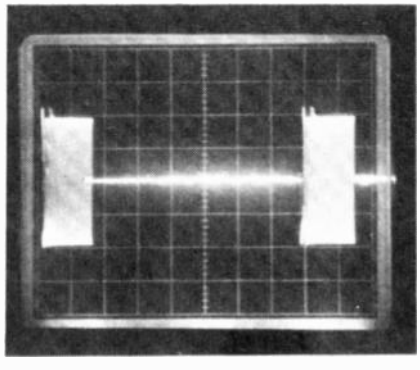


Fig. 12. Here the same 15 kHz tone burst (Fig. 11) is being repeated at 500 Hz. Limiting and distortion may be clearly seen on the leading edge of each burst. This is due to the protection circuits.

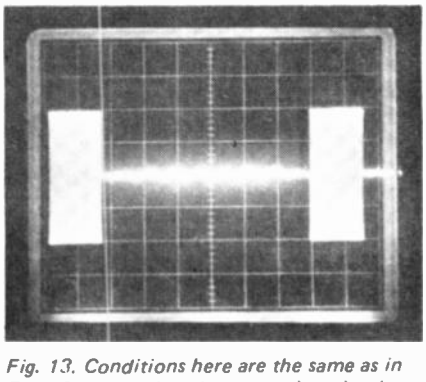


Fig. 13. Conditions here are the same as in Fig. 12 except that the protection circuits have been removed.

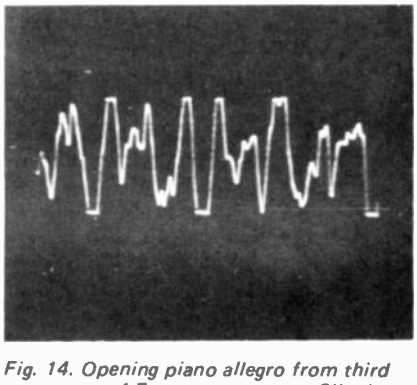


Fig. 14. Opening piano allegro from third movement of Emperor concerto. Clipping is occurring on peaks as amplifier overloads. Average power is 38 Watts. Amplifier is rated at 120 Watts/channel.

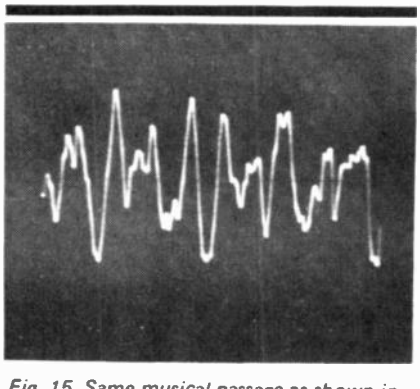


Fig. 15. Same musical passage as shown in Fig. 14 – but here the amplifier is a 350 Watt/channel unit. Note that no clipping occurs.

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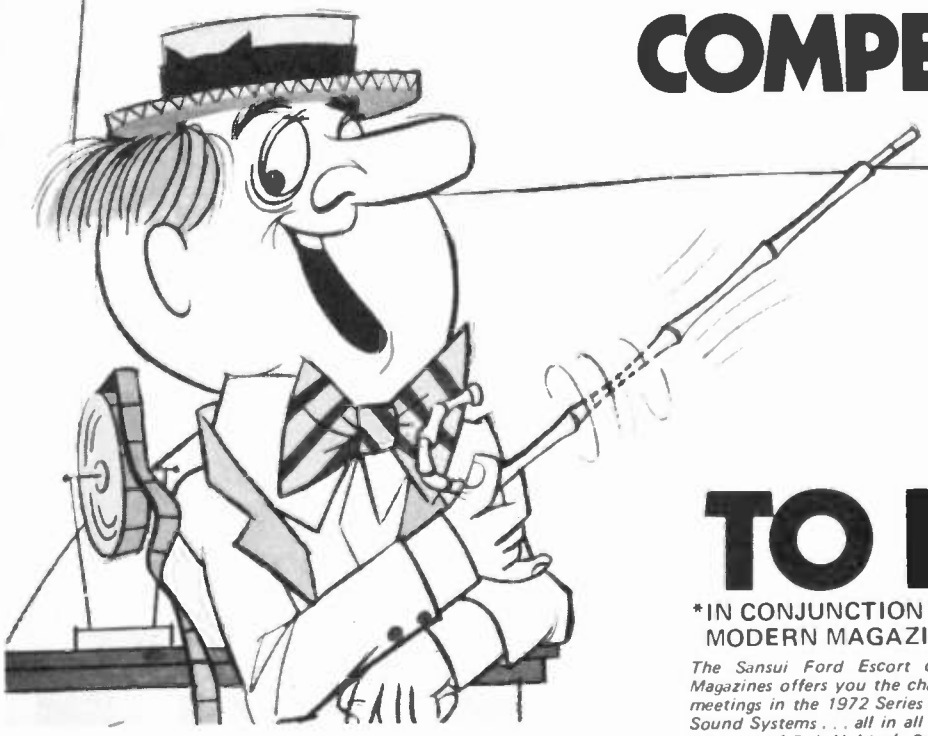

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CONDITIONS:-

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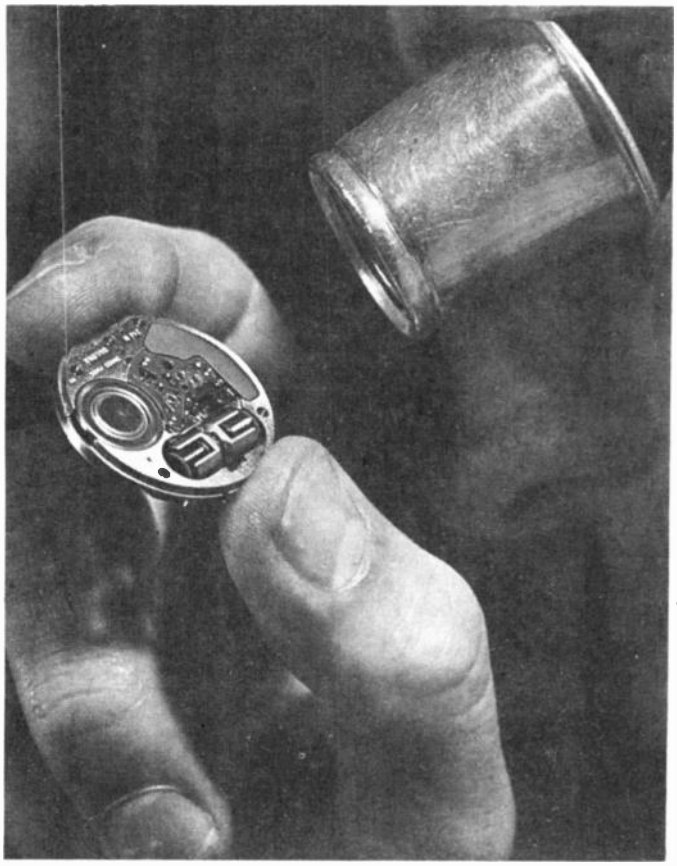
ELECTRONIC WATCHES

Fully solid-state watches without any moving parts are now a reality. Brian Chapman traces recent developments.



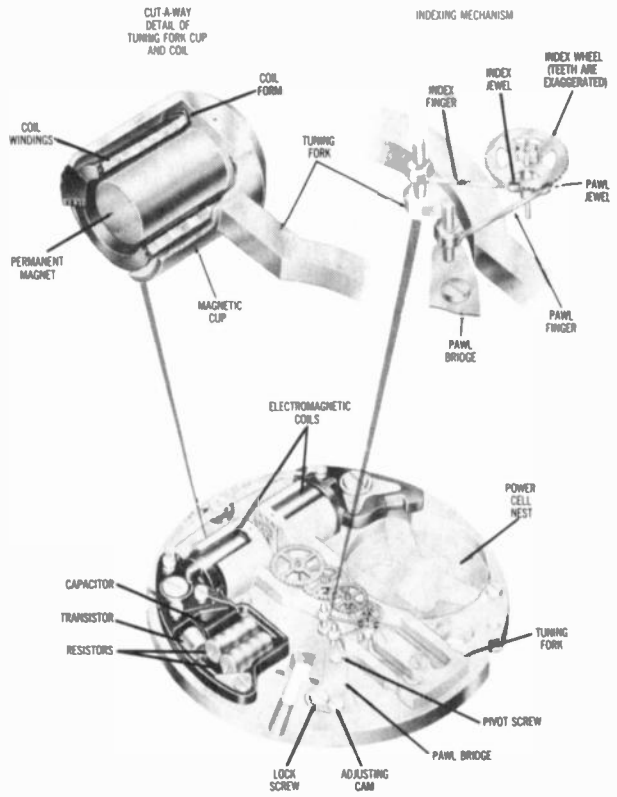


Fig. 1. The Accutron – major elements.

By 1980 the world watch industry will almost certainly be producing 300 million watches a year. This output can only be achieved by placing heavy reliance on automation, and simplification of watches' existing mechanical construction. Only an increase in productivity per capita will allow this output to be achieved whilst still maintaining competitive prices.

The horological industry has been well aware of these problems for many years and large sums have been invested in researching new methods and techniques. It is now generally agreed that the current trend towards electronic watches provides not only an answer to the productivity problems, but at the same time offers accuracy never before realised (or possible), in any wristwatch previously made.

TUNING FORK WATCHES

The first generally successful electronic watch, the Bulova Accutron, made its appearance in 1960. It was the first watch not to use a balance wheel and hairspring. Instead, the Accutron uses a tuning fork as the time keeping reference. The operation may be seen by reference to Figs. 1 and 2. The tuning fork forms the feedback path of a transistorized oscillator operating at a frequency of 360Hz and the vibratory motion of the fork is converted into rotary motion by a ratchet wheel and pawl indexing mechanism. This

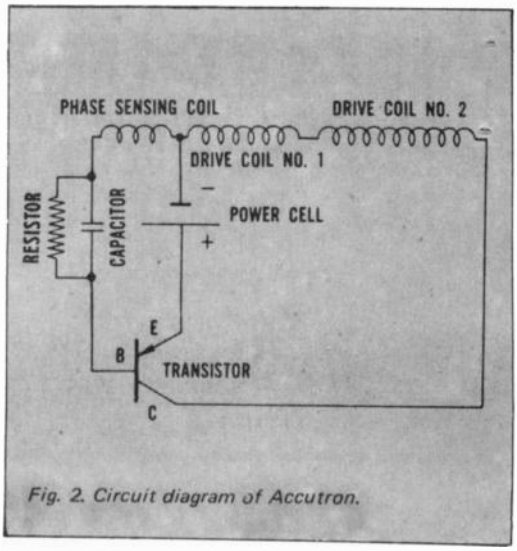


Fig. 2. Circuit diagram of Accutron.

construction reduces the number of moving parts from 23 to 12 – with consequent reliability increase.

Overall accuracy (of the Accutron) is greater than that for conventional movements – to such an extent that the standard Accutron unit exceeds the Horological Guild's standards for "Wrist Chronometers" by a considerable margin – see Table 1. This unprecedented accuracy for standard production models has allowed Bulova to offer a written guarantee of accuracy to within a minute a month.

Characteristic	Tolerance for Chronometer	Tolerance for Chronometer with mention	Inherent performance characteristics of ACCUTRON
	(all rates seconds per day)		
1. Regulation – Mean rate in 5 positions at room temperature.	–3 to +12	–1 to +10	–2 to +2
2. Mean variation in rate for above test.	3.2 max.	2.2 max.	less than 1
3. Largest variation in rate for above test.	9	6	less than 1
4. Rate difference between 6 up and dial up.	12 max.	8 max.	5
5. Largest difference in rate for any of the 5 positions tested and mean daily rate.	18	12	4
6. Rate-Temperature Coefficient in sec/day/° C from 4° C to 36° C.	1 max.	.6 max.	.3 max.
7. Recovery (change in rate as result of exposure to temperature test).	9 max.	5 max.	less than 1

Table 1. Comparison of Accutron with "Wrist Chronometer" standards.

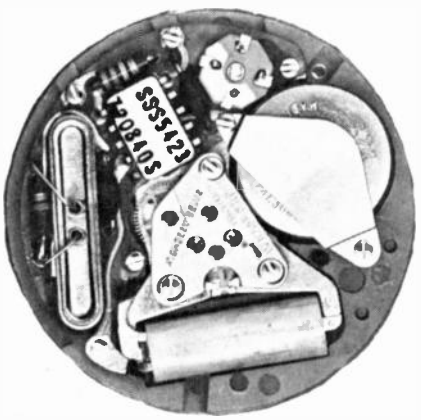
ELECTRONIC WATCHES

Whilst tuning fork watches went a long way towards alleviating the productivity problem, they still contained a relatively large number of moving parts and were fairly expensive. Obviously the ideal solution is an all electronic, fully solid-state watch, but until quite recently the technology to do this within the space available, and at a reasonable cost, had not been evolved.

But within the last few months two techniques have been developed which make the fully solid-state watch a reality and many manufacturers already have such units on the market. Typical among these are those of Roamer Seiko, Swiss CEH and Longines. Figs. 3 to 6 give the block diagrams and layout of these watches.

The first technique to find application was that of CMOS (Complementary Metal Oxide Semiconductor) integrated circuitry. The CMOS family of integrated circuits are characterized by extremely high packing density and very low power dissipation – the lowest of any logic form. In addition high volume production ensures low unit cost.

All these features are exactly those required for the electronic watch industry market and Motorola have been quick to see the application and to capitalize on it.



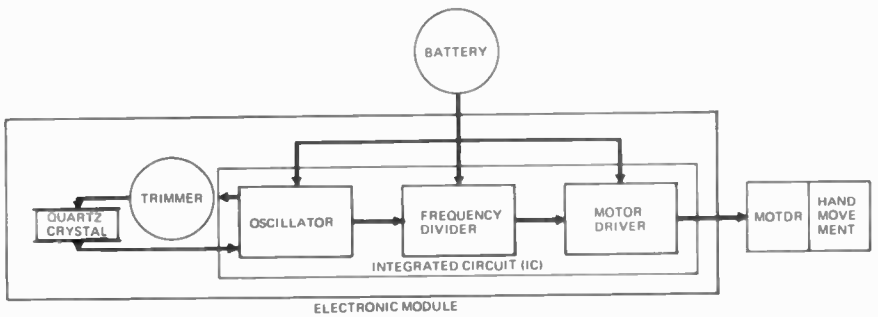
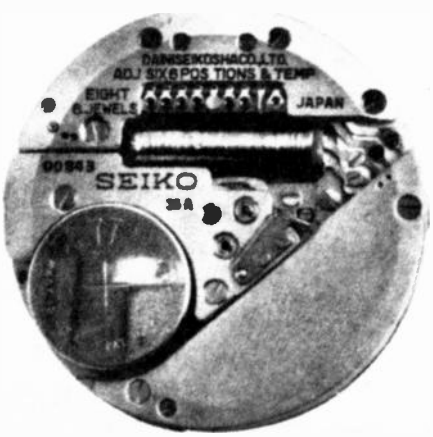


Fig. 3. ROAMER – The Roamer Micro Quartz uses an IC to divide down a 32.768kHz crystal to 0.5Hz. The square wave output drives a stepper motor and then the date/time gearing. The watch uses electronics supplied by General Time Corporation of the USA. Liquid crystal display model should be available at the end of the year.



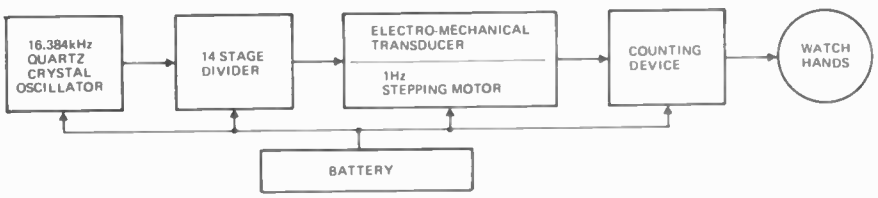
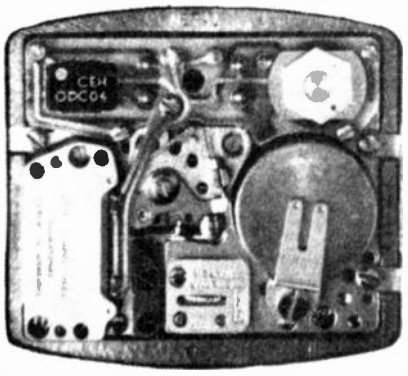


Fig. 4. SEIKO – The Seiko watch utilizes a 16.384kHz crystal oscillator divided down by an IC to 1Hz. The 1Hz pulse drives a six pole stepping motor in 60 degree increments and thence the second hand in one second increments.

ELECTRONIC WATCHES



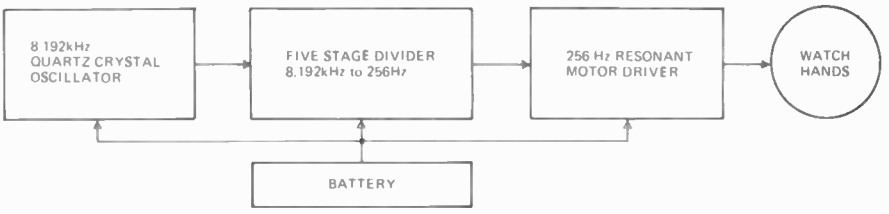


Fig. 5. SWISS–CEH – The Swiss Centre of Electronic Horology developed this movement for a number of member companies including Bulova and Omega. It uses an 9.350kHz oscillator and five stage IC divider to produce 256Hz which is fed direct to a motor. Gearing provides the remaining step down.

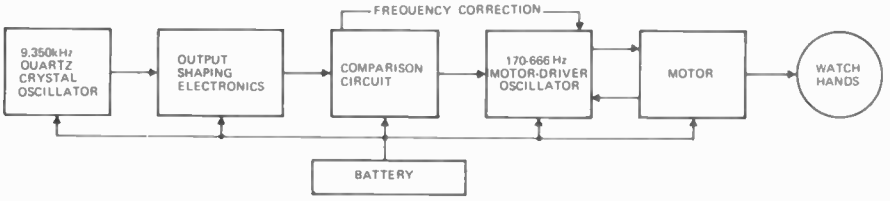


Fig. 6. LONGINES – The Longine watch uses a feedback system which compares the output of a 170Hz motor driver oscillator with the output of a 8.192kHz quartz oscillator. The error signal thus developed is used to correct the motor driver oscillator frequency. A discrete component circuit utilizes 14 transistors.

Motorola have marketed a complete watch kit consisting of three matched components. These are:

1) A silicon gate CMOS MSI (Medium Scale Integration) oscillator, divider and buffer circuit.

2) A miniature, precision quartz crystal, cut for 32.768kHz.

3) A micro-miniature stepper motor.

The kit is initially selling for approximately US$15 but Motorola confidently expect that this will reduce to about $3 US when volume of sales increase. Thus watches retailing for about $17 US or more will almost certainly be built in this fashion.

Apart from the components listed above, all that is additionally required to construct a watch are a trimmer capacitor, a micro-miniature battery, watch case, gearing, dial and hands. The quartz crystal operation provides an accuracy at least four times better than that attainable with tuning forks and will be within 15 seconds per month. Figure 7 shows the three components of the Motorola system in relation to a conventional watch case.

Within a few days of the announcement by Motorola Semiconductors that they had produced the necessary components for electronic watches, the ITT Components Group of Europe announced that they also had time

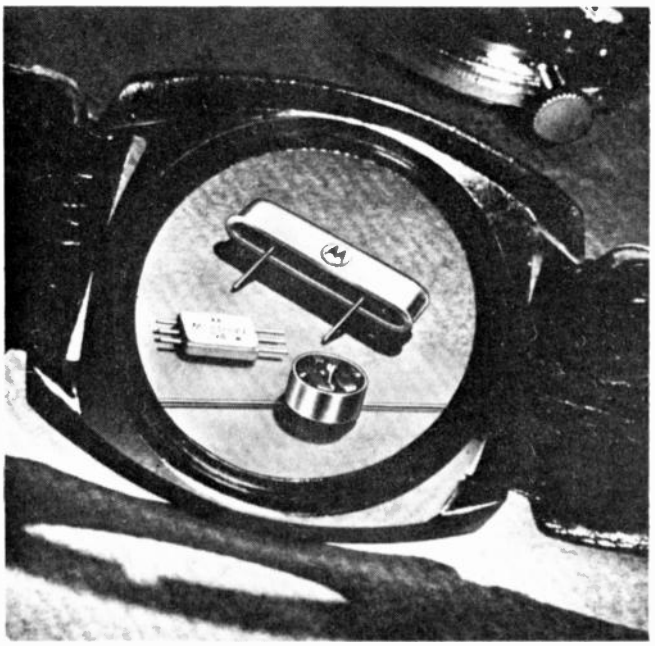


Fig. 7. Components of Motorola system in relation to conventional watch case.

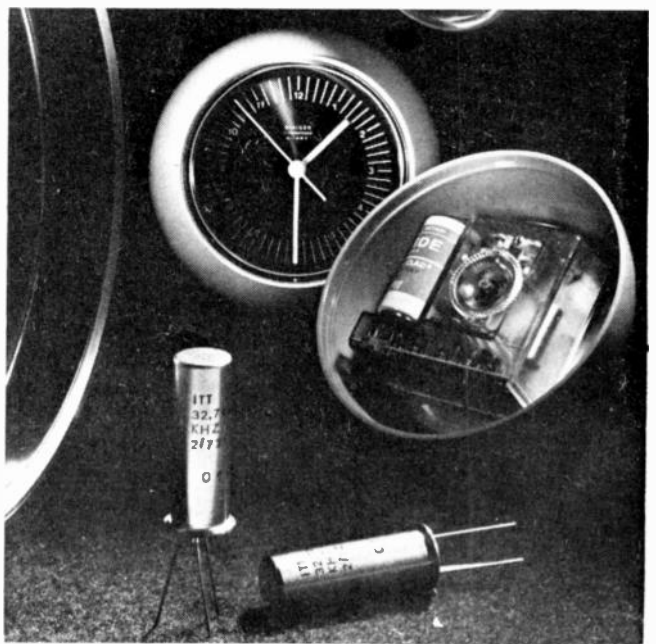


Fig. 8. The Staiger Chrometron which incorporates electronics by ITT.

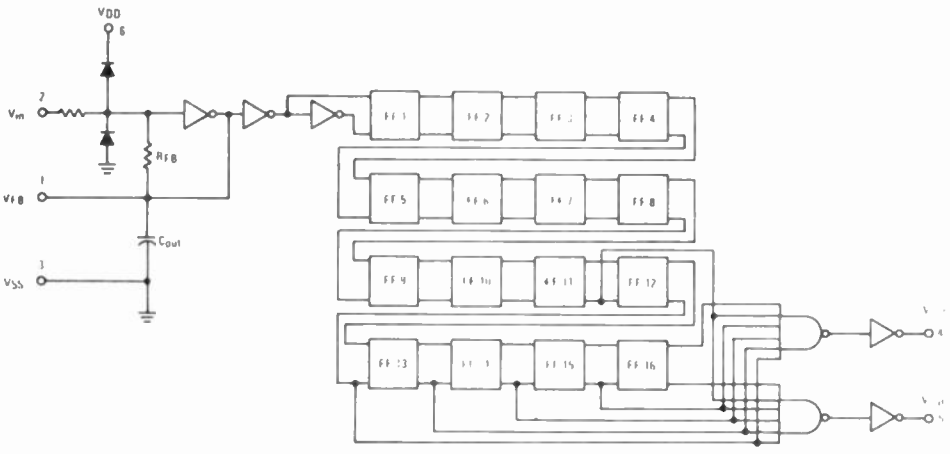


Fig. 9. Block diagram of the CMOS watch integrated circuit developed by Motorola.

keeping electronics available which had been used in the first electronic clock to be mass produced — the German made Staiger Chrometron, Fig. 8.

Both Motorola and ITT use crystals with frequencies of 32.768kHz whereas the newly released Timex watch has a 49.192kHz crystal. Unfortunately details of the Timex watch are not available and the principle of operation is somewhat of a mystery, particularly as the frequency used in the Timex watch is not a power of two.

THE MOTOROLA SYSTEM

The heart of the Motorola system is the CMOS integrated circuit, the block diagram of which is shown in Fig. 9. The operation of the system may be seen from Fig. 10. The basic time reference is a quartz crystal controlled oscillator consisting of a basic CMOS inverter circuit with a crystal and feedback resistor connected in parallel between the inverter output and input. Both input and output have capacitors to earth. As the feedback resistance can range from 10 ohms to several hundred megohms without appreciable effect on operating frequency or current drain, this component is also integrated into the monolithic chip structure.

Either of the two capacitors could be used to adjust the frequency, but because the power dissipation of a CMOS inverter is a function of output capacitance, the capacitor is fixed at about 22pF and is also integrated onto the chip. An external trimmer capacitor is then used across the inverter input to provide frequency adjustment. This is necessary in order to compensate for long term frequency drift of the crystal. The drift due to ageing of the crystal is typically two parts per million per year, that is, 30 seconds per year.

The oscillator output frequency is divided down to 0.5Hz by a chain of 16 CMOS flip-flops. A pair of NAND gates accepts the outputs from the last six flip-flops and produces two parallel trains of 31.25 millisecond pulses each at a frequency of 0.5Hz and separated in phase by 180°

Further inverters provide buffering and waveshaping before the pulses are fed out and combined to provide the motor with one drive pulse per second. For maximum power transfer these drivers are high current-capacity MOS FETs.

Because of stray capacitance, power dissipation of the complete chip is proportional to frequency and the first 10 flip-flops consume 99.99 per cent of the power. Therefore the counter performance, and power drain, is virtually independent of the number of flip-flops used.

Thus oscillator binary divider, waveshaping and buffering circuitry are all contained on a single monolithic MS1 chip fabricated by means of the silicon-gate CMOS process. The monolithic die measures 82 x 94 mils and contains 312 active devices. As explained previously, except for the external trimming capacitor, the oscillator passive components are also integrated.

POWER REQUIREMENTS

For a system current drain of 15μA at 1.5V, and a battery life of 12 months (8,760 hours), a 131 mA-hr battery is required. For the same life from a 1.3V battery and 13μA drain, a 114 mA-hr battery is required. Typical power consumptions are shown in Table 2.

THE QUARTZ CRYSTAL OSCILLATOR

The NT-cut, quartz crystal is a length-width flexure type crystal used in its fundamental mode of oscillation. An NT-cut crystal, while yielding performance levels equivalent to other low frequency crystal types, is unique in that it requires only 1/4 as much quartz.

Another important advantage of the NT-cut lies in its ability to withstand shock. Because the NT blank is very thin, four-point support can be provided while maintaining a very slender package configuration. This accounts for the superior shock resistance quality: less than two parts per million frequency shift after repeated shocks of 1,000 G and 0.4 ms duration. The Motorola NT will survive shock levels as high as 3,000 G which is equivalent to an approximate one metre drop to a hardwood floor.

The MTQ21 crystal was especially

TABLE 2

"Worst-case" consumption data for Motorola 32.768 kHz system.

	1.5 V Silver Oxide	1.3 V Mercuric Oxide
IC	5.0 μA	4.5 μA max
Motor	10.0 μA	8.5 μA max
System Total	15.0 μA	13.0 μA max
Battery capacity required for 12 months (8760 hours) operation	131 mA-hrs	114 mA-hrs

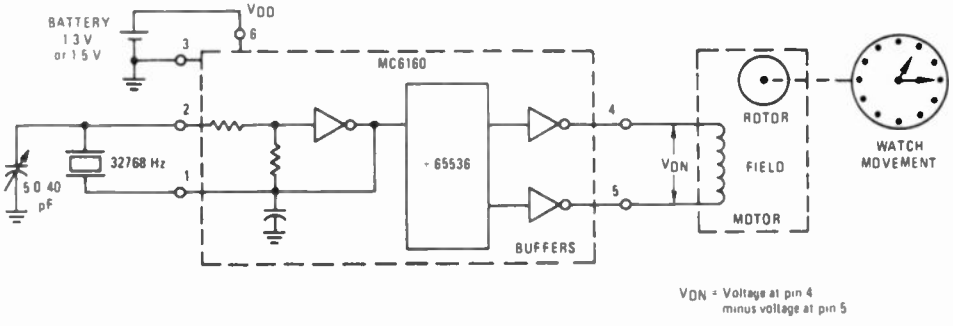


Fig. 10. Typical electronic watch system using Motorola components.

ELECTRONIC WATCHES

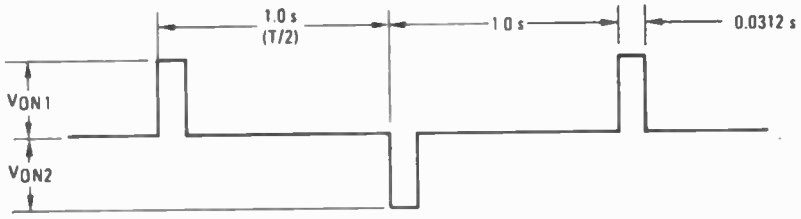


Fig. 11. Output waveform across Motorola watch motor.

designed for wrist-watches. The small size, low power requirement and CMOS oscillator compatibility are especially attractive in this application.

Why 32.768kHz? For minimum crystal size, the frequency should be chosen as high as possible. However, for minimum power dissipation in the integrated circuit, and extended battery life, it is desirable that the frequency be kept as low as possible.

32.768kHz represents a compromise frequency which yields a crystal size usable for a man's watch and a power requirement and size easily satisfied by presently available batteries. As circuit and battery improvements are made, it is expected that the frequency can be increased, to obtain smaller crystal sizes. These improvements would then permit the manufacture of even smaller watches.

THE MINIATURE MOTOR

The Motorola MTM series motor is a miniature motor of the rotary stepping type. These motors are unidirectional and rotate 180° each second, coming to rest after each rotation. The motors have sufficient torque, if proper reduction is provided, to drive a typical watch movement and day/date display. Average current consumption is only 8.5μA at 1.3V and 10μA at 1.5V. The typical signal driving the motor in the system described here is shown in Fig. 11.

The Motorola components are being incorporated in a large number of watches which are either on the market now, or are shortly to be released and it would seem that the heavy investment in this technology will pay off.

Electronic watches previously bore price tags of from US $595 to US $2,200, putting them well out of the working man's reach. However Timex have recently announced that their quartz watch will sell for $125 in the USA, a price which represents the first real market breakthrough.

Although Timex were first on the scene with lower prices, several companies are in hot pursuit — Seiko of Japan, Roamer and Avia to mention just a few — have all introduced quartz models at competitive prices.

The stepping motor, gearing and hands are the last remaining moving parts and these also have succumbed to the electronic onslaught. The technology which is being used to replace these components is that of liquid crystal displays.

LIQUID CRYSTAL DISPLAYS

Liquid crystals, as the name implies, are materials, which although in liquid form, have a crystaline structure.

There are many thousands of liquid crystal materials which may be considered to fall into three distinct groups, having different but interesting properties. The group that is of interest for electronic watch displays is known as "nematic crystals" and is more suitable for this purpose than any other known technique.

Nematic crystals are normally aligned with each other and appear clear. Whenever an electric field is applied the crystal alignment is destroyed and the material scatters the incident light and hence appears milky or cloudy.

Liquid crystals consume no power at all when clear and are only very poor conductors drawing very little current in the milky state. Additionally liquid crystal displays do not generate light, they only reflect or transmit it. Thus the higher the ambient light level — the brighter the display. Finally liquid crystals interface readily with CMOS IC's. All these factors make them ideal for watch displays and several companies are marketing "all electronic" watches. Societe des Garde — Temps SA, the producer of Avia watches plans to sell more than 20,000 of its new all electronic watches before the end of the year in the USA and in Europe. It is expected that the watch will retail for about $200.

This new time piece has been developed by SGT in collaboration

Fig. 12. The Avia electronic watch with liquid crystal desplay.

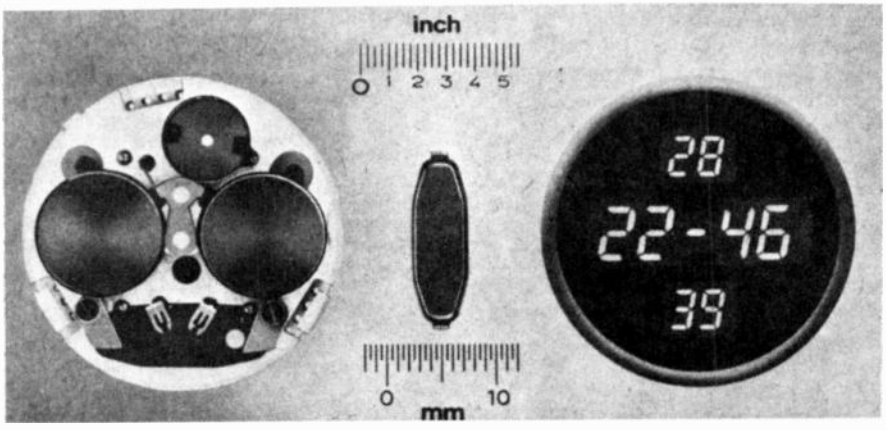


Fig. 13. The Ebauches SA electronic watch operates at 32kHz and has a liquid crystal display by Texas Instruments. The display gives day of month, hour, minute and second.

with Optel Corporation, Princeton, New Jersey, U.S.A. who are manufacturers of a wide range of liquid crystal displays. The hours and minutes are displayed by means of seven segment digits as shown in Fig. 12, and the seconds are indicated by the flashing of two decimal points between the hours and the minutes digits.

A second all electronic watch has been developed by Ebauches SA utilizing a crystal display from Texas Instruments. This will be marketed later this year by Longines at prices ranging from $30 to $300. (Fig. 13).

The Optel display is scheduled to be used by six other Swiss watch manufacturers including Omega and Ditronic SA – a union of five smaller watch companies.

Although liquid crystal displays are definitely here to stay, it is by no means certain that those at present being fitted to electronic watches are free of problems. Warnings can be found from many sources that liquid crystals have life problems.

Mr. Edward Kornstein, vice-president of Optel Incorporated was quoted as saying that he believed that electronic watches would be the first mass market for LCDs, but admitted that there were yield and manufacturing problems as well as lack of life test data, but *by next year,* this would all be solved.

Mr. Chuck Johnson, Motorola's marketing manager for quartz time-piece components, does not believe that LCDs will replace the mechanical motor driven watch display until the reliability, life and price problems are solved. (Motorola incidentally is also developing liquid crystal displays).

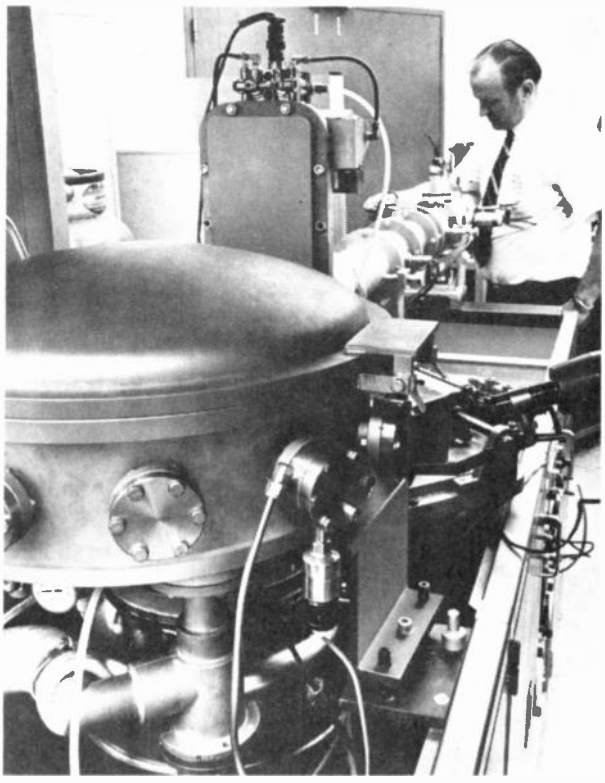
"In order for the watch makers to go LCD in a big way, life of displays will have to be longer than a year to 18 months," he said.

At present most manufacturers of LCDs are only forecasting a life of 2000 to 10,000 hours, that is, 2½ months to a year. Replacement at such intervals as this could certainly deter would be buyers. But it would appear that within the next two years the all electronic watch will capture at least a third of the total watch market. If prices of all electronic watches drop to the extent forecast, they may well in time, completely replace the traditional mechanical and hybrid types.

The only people likely to be unhappy at this prospect are Swiss watchmakers, who will now be faced with the fact that US dominance in the field of electronics will relegate these watchmakers to the role of assemblers of US movements into Swiss cases. ●

Ion Implantation

New semiconductor fabrication process improves electronic watch ICs.



Ion Implanter at Motorola's Semiconductor Products Division. Ion accelerator, shown, can implant up to 26 wafers automatically with precise control of both penetration depth and distribution of dopant atoms. Target wafers are contained in the vacuum sealed carousel, foreground.

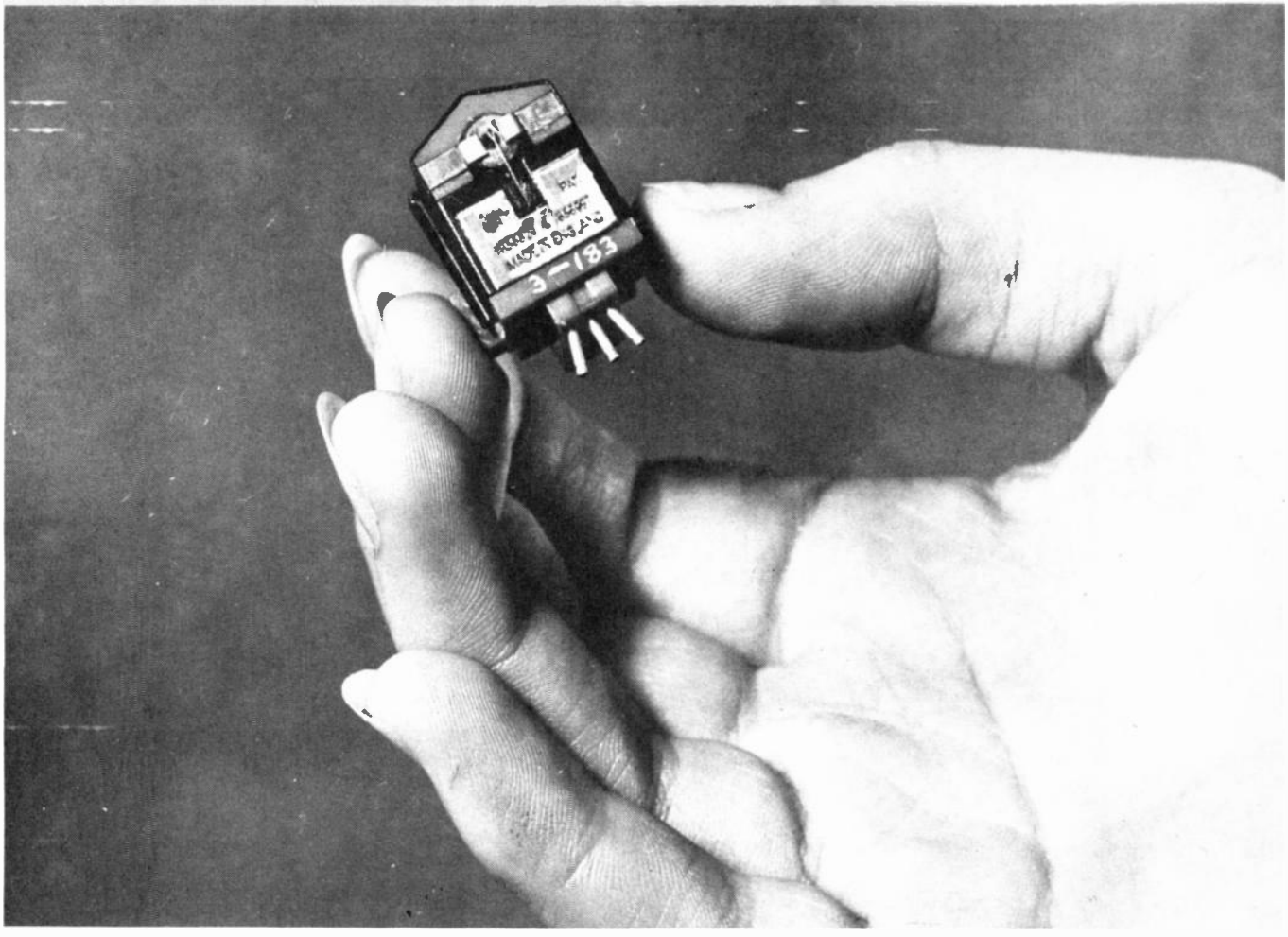
A NEW semiconductor fabrication process known as ion implantation is now being successfully used in the manufacture of CMOS (complementary metal oxide semiconductor) integrated circuits by Motora's Semiconductor Products Division.

First applications of this new fabrication technique have been directed toward the silicon-gate CMOS circuits that Motorola supplies for electronic wristwatch systems. These watches employ a quartz-crystal oscillator to generate an ultra-stable reference signal, which subsequently, is electronically divided down to a single pulse per second by means of the CMOS circuitry. The pulsed output drives a tiny rotary motor to turn the hands on the watch face. Heart of the quartz-watch system, the CMOS IC contains oscillator, binary divider, waveshaping and buffering circuits on a single 82 x 94-mil chip that operates from 1.5 V levels at only microwatts of power dissipation.

Combined with conventional semiconductor technology, ion implantation techniques will enable improvements in the performance characteristics of existing CMOS devices, improvements that could not be made easily without the implantation process. For example, the characteristically low threshold voltages that represent the major advantage of CMOS devices for wristwatch systems (enable year-long operation from a small, single cell battery) can be controlled with extreme precision with the implantation technique.

In contrast to the epitaxial refill technique, the method used today to fabricate the complementary-type material, ion implanatation introduces the dopant atoms into the semiconductor crystals by accelerating them to high velocities and directing them against the crystal surface. The ions penetrate the target material and remain imbedded in it. In this latter process, the depth of penetration and the distribution of impurity atoms is an exact function of energy and dose, both of which can be precisely controlled electronically. The final depth is achieved by a thermal redistribution process.

The extreme accuracy and control offered by the ion implantation process translates into high production yields and, consequently, into substantially lowered manufacturing costs. For that reason, the successful transition of ion implantation from research status to a powerful, new production tool is considered to be a milestone in the brief history of electronic watch components. ●



THE DECCA 'LONDON' CARTRIDGE

electronics TODAY INTERNATIONAL
product test

This new cartridge from Decca incorporates a number of ingenious design features.

IN its design philosophy the Decca 'London' cartridge is most probably unique. It is the result of considerable research work by Decca to improve their existing cartridge designs. The 'London' cartridge incorporates the 'positive scanning' system used in the model C4E and other previous Decca cartridges.

In the normal moving magnet design the sensing coils are located well inside the cartridge housing and the stylus movement is transferred via the cantilevered stylus bar to the magnet mounted midway along the bar. The 'London' cartridge has a shaped stylus bar clamped at one end and tensioned via a nylon cord at the stylus tip. A section showing the physical relationship of the cartridge components is shown in Fig. 1. As can be seen in the drawing the lateral movement is sensed just above the stylus tip, and the vertical movement is sensed at the top of the bar. This is what the Decca sales people have labelled 'Positive Scanning'.

Induced magnet cartridges are very susceptible to external magnetic fields, and previous Decca 'Positive Scanning' cartridges were prone to hum pick-up via the sensing coils, which being located directly above the stylus tip,

could not be effectively screened from stray magnetic fields. As most steel is usually magnetised to some degree these cartridges could not generally be used with steel turntables.

But nowadays most mass-produced and practically all top-quality turntables have aluminium platters, and hence the problem of hum pick-up from steel turntables has to a large extent been eliminated. Apart from this, modern hi-fi amplifiers have screened power transformers, thus reducing their magnetic radiation.

These fortuitous developments, together with the use of a more powerful magnet within the cartridge, have resulted in a generally acceptable signal to hum ratio from the new Decca cartridge under most possible situations.

In conjunction with Mullard, Decca's design engineers have considerably improved the magnet design and consequently it has been possible to markedly reduce the cartridge weight from approximately 14 grams, (the weight of other Decca cartridges), to a very respectable four grams and, at the same time, to increase the output to a claimed 7.5mV for a velocity of 5cm/second. The cartridge which we tested had an output of 10mV at a velocity of 5cm/second at 1kHz.

This increased output is primarily due to the use of the more powerful magnetic material which also results in a marked reduction of induced hum.

During the manufacturing process the armature in the London cartridge is "super cooled" in liquid nitrogen at −196°C. This process re-establishes what is known as the "Martin Site Structure" of the material. In simple terms, "super cooling" eliminates stress relaxation problems.

MEASURED PERFORMANCE OF DECCA LONDON CARTRIDGE

Frequency Response 20 to 20kHz ± 3dB
Channel Separation at 1kHz 22dB
Channel Difference at 1kHz 1dB
Output at 1kHz re 5cm/sec 10mV
Lateral Compliance – 12×10^{-6} cm/dyne (Maker's figure)
Vertical Compliance – 5×10^{-6} cm/dyne (maker's figure)
Price – approx. $60

SUBJECTIVE TESTING

Subjective tests indicated that a minimum three grams tracking weight is essential to minimize mistracking and distortion. At a tracking weight of 1.5 grams, the measured frequency response exhibited numerous spikes due to minor cartridge resonances throughout the frequency spectrum.

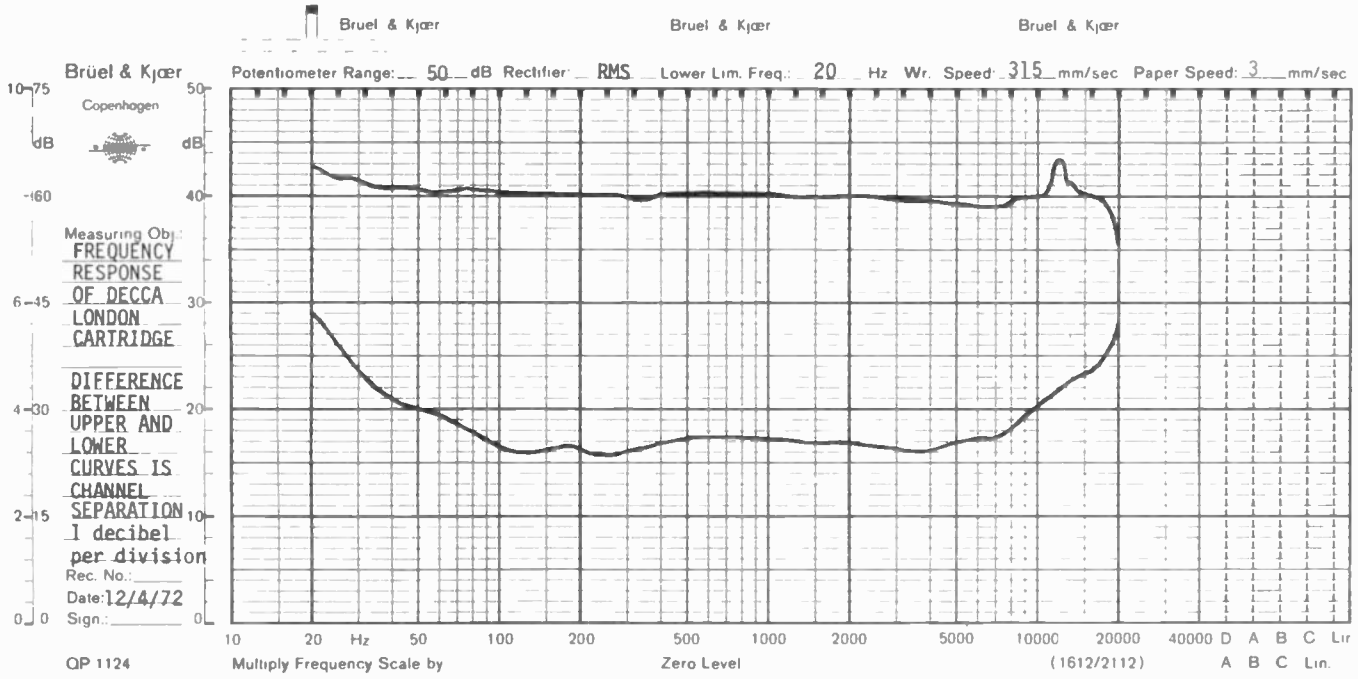
At three grams tracking weight, the cartridge exhibited a primary resonance at approximately 12kHz which resulted in some unnatural harmonics being accentuated. This resonance also resulted in slight distortion occurring on some instrument passages containing transients.

We tried the cartridge out on some of our favourite test records. The first record, the Shure "An Audio Obstacle Course" (TTR101), gave us a good picture of the overall trackability performance. The trackability at level 4 on orchestral bells and harpsichord exhibited slight mistracking. The next record we tried, "Everything you Always Wanted to Hear on the Moog" CBS-SBR235452 showed a somewhat "leaden sound" on high frequency passages. Other records sounded quite good and it was apparent that only certain instruments (with sharp attack times) are affected to a significant degree by the dynamic characteristics of the cartridge.

We next evaluated the performance of the cartridge on a square wave test record and found that the leading edge decayed less smoothly than is desirable and not as well as most other cartridges in the same price bracket. This test correlated well with the frequency response and showed that the high frequency characteristics were not all that could be desired.

The rising treble response gives this cartridge an effective crispness which many listeners will favour, and provided the velocities above 15kHz do not exceed 10 centimetres per second its performance is exemplary.

At first sight a possible disadvantage of the Decca design is that the whole cartridge must be returned to the distributors when the stylus wears out



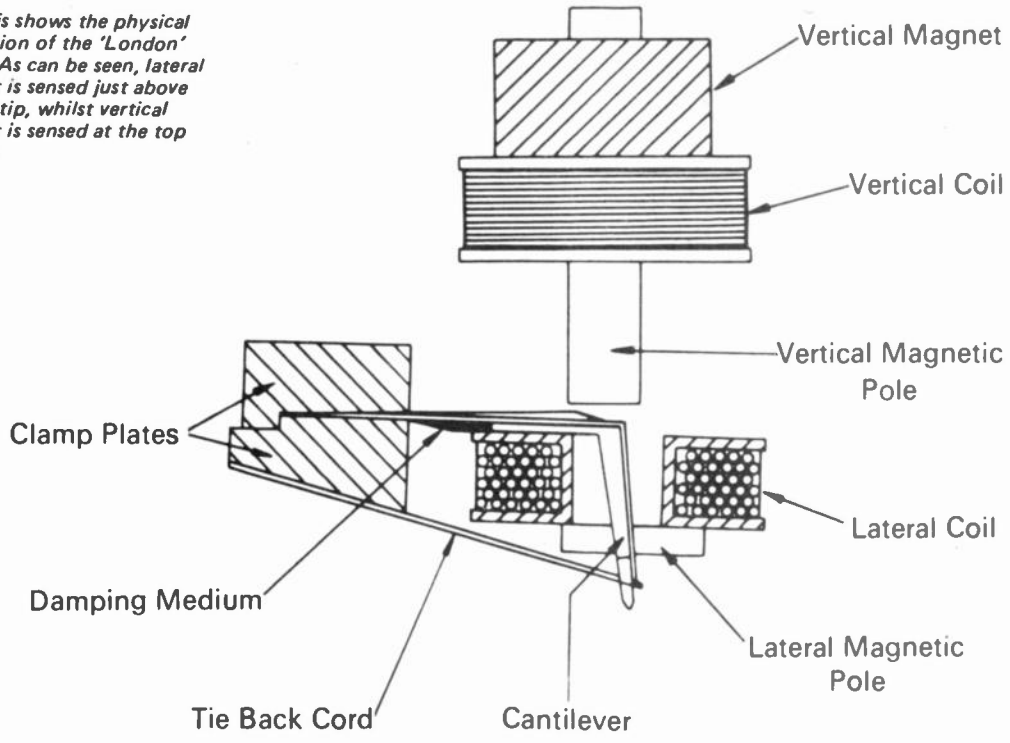


Fig. 1. This shows the physical configuration of the 'London' cartridge. As can be seen, lateral movement is sensed just above the stylus tip, whilst vertical movement is sensed at the top of the bar.

THE DECCA 'LONDON' CARTRIDGE

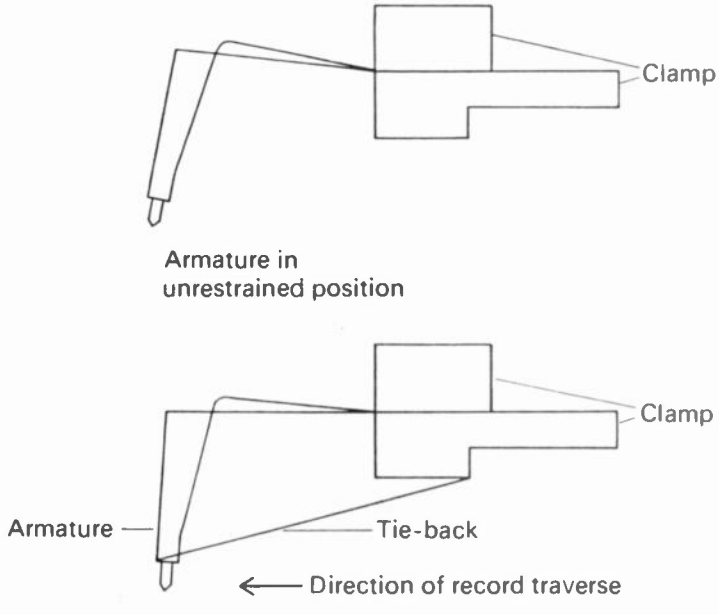


Fig. 2. The stylus and armature are restrained and tensioned by a fine nylon cord.

and exchanged for a reconditioned unit; for about the cost of a new stylus. But this is partially negated by the advantage that the reconditioned unit has been inspected and repaired by the manufacturer and carries the same 12 month warranty as a new cartridge against electrical or mechanical defects.

The Decca 'London' cartridge performs well in most respects, but in our opinion it is not quite the superlative cartridge that its manufacturer feels it to be.

Its performance is far better than the model that it superseded, nevertheless our tests have revealed a few minor deficiencies. For the great majority of users this cartridge will provide excellent crisp performance, but for the connoisseur its performance above 12-14kHz leaves something to be desired – primarily because of the resonance that can be induced by high velocities at high frequencies.

Overall we rate this cartridge as being a good performer with a few vices.

A little more development work could well result in the near perfection that we feel it is capable of ultimately providing. ●

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RADIO ASTRONOMY FOR AMATEURS

a series - by Roger Harrison VK2ZTB ex-VK3ZRY

The output of the detector is quite low – only millivolts in fact – and therefore a dc amplifier will be required to drive all but the most sensitive of chart recorders.

The circuit of an amplifier suitable for this purpose is shown in Fig. 1a. This circuit uses the commonly available 12AU7. A 12AT7 or 12AX7 may also be used. Preferably, the HT should be regulated – a suitable circuit using a VR 150/30 gas tube is shown in Fig. 1b.

Figure 2 shows a transistorized version of this valve circuit.

The transistors shown in the circuit diagram may be any of the following (in order of suitability) – AY1113, 2N3638, AC126, AC128. If the polarity of the power supply is reversed, npn transistors may be used – suitable types are – 2N3565, 2N3641, 2N3642, 2N3643, BC108.

This amplifier may be energized by a battery or regulated power supply. If temperature drift becomes a problem, this may be compensated by inserting a germanium diode (OA47, OA81 or similar) in series with the 820 ohm emitter resistor. Alternatively, a negative temperature coefficient thermistor may be wired in parallel with this resistor. It may be necessary to experiment to obtain optimum temperature compensation.

If greater sensitivity is desired, Q1 and Q2 can each be made into a Darlington pair. A similar type of transistor should be used for each half of the pair. The bias resistor for Q1 should also be increased to three to four times the previous value.

TIME CONSTANT

The output of the receiver contains random noise. Some of this is internally generated and some is externally generated, and apart from this there is a noise component of the astronomical source being observed.

To reduce the effects of this random noise a variable time constant circuit should be incorporated within the system.

The time constant is made variable to enable observations to be made of both long term and short events. A time constant of one to two seconds is desirable for short term events (such as Jupiter emissions, some solar events

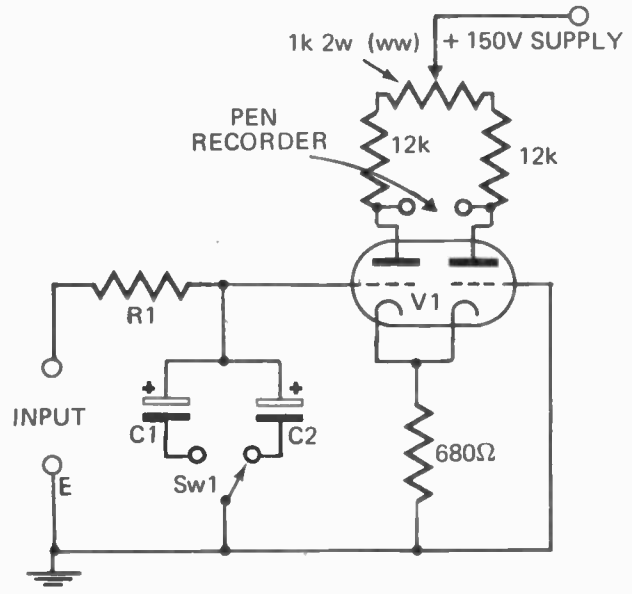


Fig. 1a. Circuit of dc amplifier for pen recorder.

V1 12AU7, 12AX7, 12AT7

Time Constant = R1 x C1 (in seconds) or R1 x C2
where R is in ohms and C is in farads

C1 and C2 should be mylar or tantalum capacitors. (See text).

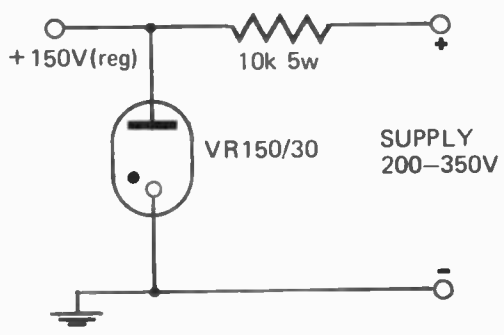


Fig. 1b. Power supply for circuit shown in Fig. 1a.

The great nebula in Orion shows the tumultuous mixture of super-heated gases and interstellar dust within which stars and their planetary systems must evolve.

RADIO ASTRONOMY FOR AMATEURS

The "Wide Range Voltmeter" (described in the February '72 issue) makes an excellent dc amplifier for driving a pen recorder. The 10mV, 30mV, 10V, 30V, 100V, 1000V and ac ranges may be omitted in this application. A time constant may be obtained by paralleling the input with a suitable value capacitor. As the input impedance is 10 MΩ, a 0.1 μF of 0.22 μF capacitor will give a suitable short time constant while a 0.47μF or 1.0μF capacitor will give a suitable long time constant (assuming no other load is placed on the detector output). The meter is of course replaced by the pen recorder. Mylar or tantalum capacitors should be used.

By using a slightly different arrangement, this voltmeter can be used to drive a pen recorder from the output of an infinite impedance detector. If the ac facility is retained, the output of the infinite impedance detector can be capacitively coupled to the input of the voltmeter and used in this fashion. The time constant is obtained by connecting a larger value electrolytic in parallel with the pen recorder meter coil. This value depends on the meter coil resistance of the pen recorder so that some experimentation may be necessary. A value of 1000μF is a good starting point.

For the circuit in Fig. 2, R1 should be between 100k and 470k. For a short time constant, C1 should be between 4.7μF and 10μF while capacitor C2 could be 50μF to 100μF. Good quality electrolytics or tantalums should be used.

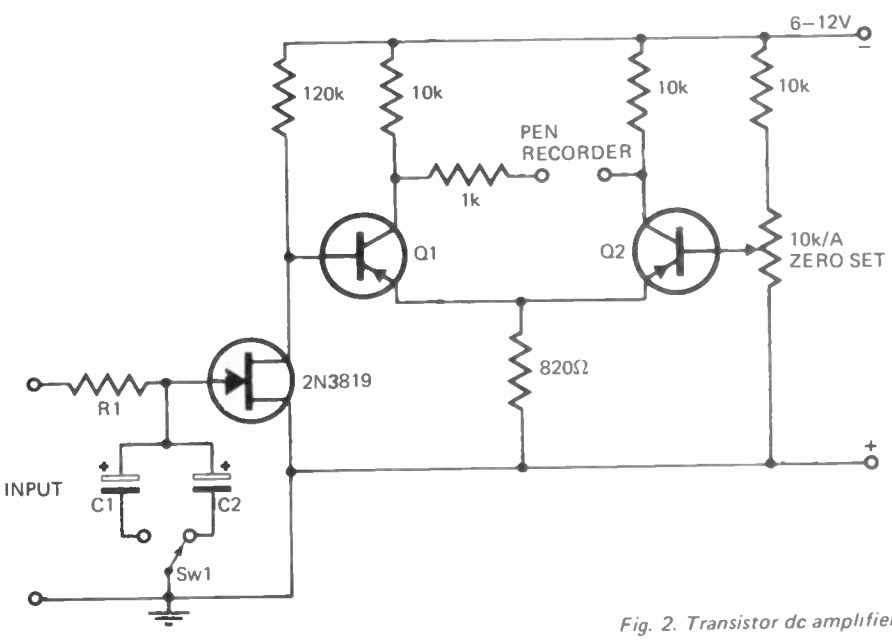


Fig. 2. Transistor dc amplifier.

etc) – a constant of five to ten seconds is adequate for events of longer duration.

The circuits shown in Figs 1 and 2 incorporate this variable time constant in their input stage – the effect – taken from an actual recording – is shown in Fig. 3. For these circuits, resistor R1 should be between 1M and 1.8M. A time constant between 0.5 seconds and 4.0 seconds should then be obtained using values between 0.47μF and 2.2μF for C1. Increasing 4.7μF and 10μF will increase the time constant accordingly.

ATTENUATORS

An accurate means of altering the overall gain of the system is a necessity. If a communications receiver is being used for observations in the HF spectrum, or as a tuneable IF for a VHF converter, gain controls will almost certainly be incorporated. The gain (ratio of input voltage to detector output voltage) should be calibrated and tabulated for various settings of the gain control/s.

Where the receiver does not have a gain control an attenuator is necessary.

The step attenuator, shown in Fig. 4, is suitable for inserting ahead of the IF system, or between the antenna and the receiver. It may also be used between the converter and IF input.

The unit provides attenuation down to 21 dB in 3dB steps. It has a characteristic impedance of 50 ohms. Note that each section of the attenuator is the same. For accuracy, 1% resistors should be used. (or accurately measured 5% resistors). Switches should be either miniature toggle or slide types.

Each stage of the attenuator should be shielded from the next and the whole attenuator unit further shielded to prevent pick-up of stray signals. A suggested form of construction is shown in Fig. 5.

A high impedance attenuator will be necessary between the detector and

P.R. – Pen recorder
0.5mA to 1.0mA type

Q1, Q2 – PNP: AY1113, 2N3638
AC126, AC128

NPN: 2N3565, 2N3641
2N3642, 2N3643
BC108

TIME CONSTANT = R1 x C1 or R1 x C2
where R1 is in ohms and C1 and C2 in farads

the chart recorder or dc amplifier imput. The circuit shown in Fig. 4 may be used if R1 and R3 are changed to 3.3M and R2 is changed to 180k.

SYSTEM ASSEMBLY

Systems may be assembled in many different ways and for a multiplicity of uses – to attempt to describe them all would be impossible.

Here then – and also in the next article in this series – are descriptions of two basic systems. One is for observations in the HF spectrum and uses a communications receiver (fixed channel or tuneable). The second system is for observations in the VHF/UHF spectrum and uses a frequency converter to IF technique.

For observations in the HF spectrum, particularly of Jupiter, a fixed channel or tuneable communications receiver is chosen.

Access must be gained to the detector output and leads brought out to a pair of conveniently mounted terminals to enable a chart recorder to be connected when required (Fig 6). Alternatively, the audio output may be rectified and fed to the chart recorder directly – in which case the audio gain control will perform the same function as the attenuator shown in Fig. 4. The loudspeaker may be replaced by a dummy load. The AGC circuit should be disabled.

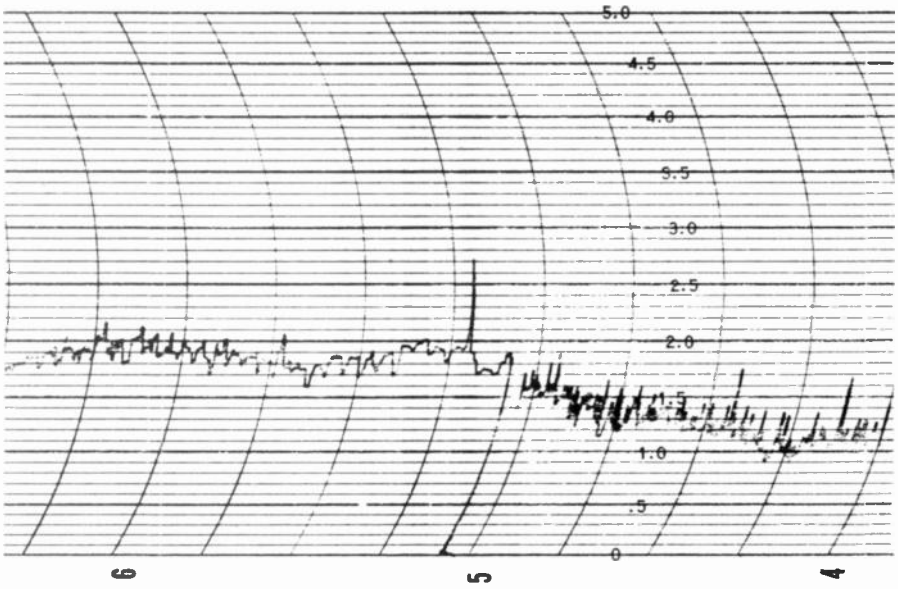


Fig. 3. This graph shows the effect of varying the time constant of the system. The left-hand side of the graph was recorded using a long time constant, the right-hand side using a short time constant.

ESTABLISHING INTERNAL NOISE

With everything connected, the communications receiver and ancilliary equipment should be switched on and allowed to warm-up for 15 to 20

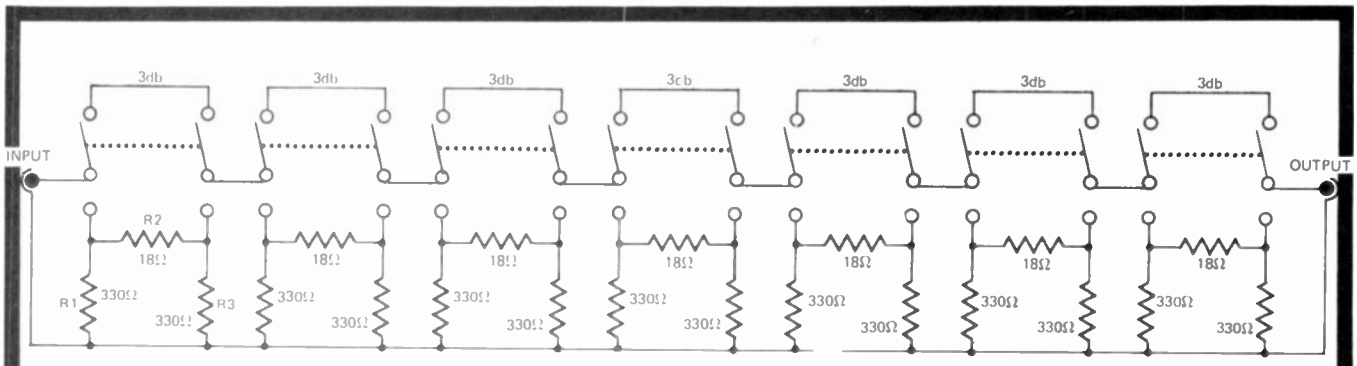


Fig. 4. Step attenuator – 50 ohms.

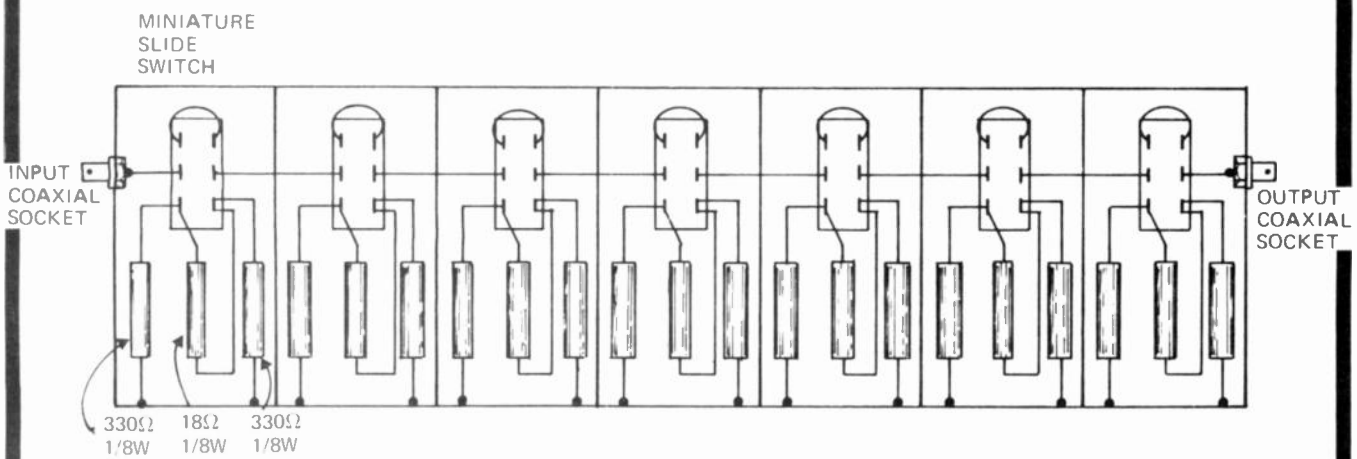


Fig. 5. Attenuator – suggested method of construction.

RADIO ASTRONOMY FOR AMATEURS

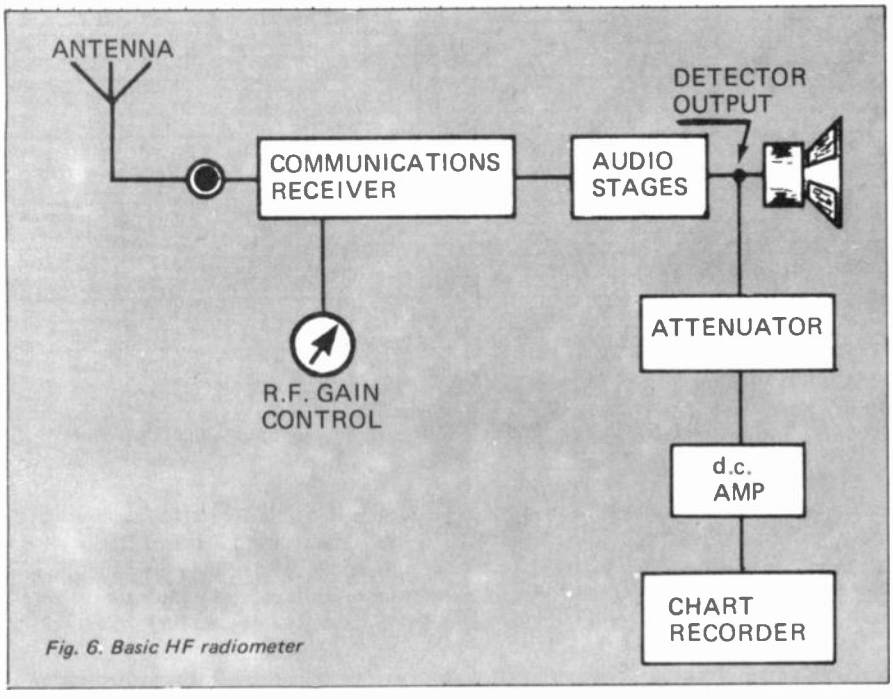


Fig. 6. Basic HF radiometer

minutes. If a dc amplifier is used in conjunction with the chart recorder this should be 'zeroed' and balanced at the end of the warm-up time.

If the receiver has a variable selectivity control, this should be set to the broadest position.

A 50 ohm resistor should be connected across the receiver input terminals. Then, using a short time constant and with full attenuation in circuit and RF gain at minimum, advance the RF gain meanwhile watching for movement of the pen on the chart recorder (chart drive should be off). The pen should only just move off zero when RF gain is at maximum. If the pen does not move, decrease the output attenuation until an indication is observed.

This point on the scale represents the internal noise of the receiver. Having established this point, the dummy load and the chart recorder should be disconnected from the system.

A dipole – resonated somewhere between 18 MHz and 22 MHz – should be connected and the receiver tuned to a clear frequency where only atmospheric noise can be heard (between 18 MHz and 22 MHz). Reduce the RF gain and reconnect the chart recorder. Slowly increase the RF gain while watching the pen on the chart recorder. If it reaches full scale, or nearly full scale, before maximum RF gain in reached, increase the input attenuation. With RF gain at a maximum it is desirable to have the chart recorder pen indicating 1/4 to 1/3 full scale deflection on atmospheric noise.

Unless the atmospheric noise at the time is very low, or the receiver has poor sensitivity at this frequency, recorder indication should be readily achieved.

Having determined that the system works, you are now ready to make a test recording. Switch to the shortest time constant (or no time constant at all) and let the complete system run for 12 to 24 hours with the chart recorder switched to the slowest speed. Check from time to time that there is no interference on the channel that you have chosen.

Upon examining the chart, you will notice that the signal rises and falls during the period of the recording. These rises and falls occur during the periods when the rotating earth sweeps the antenna past the various cosmic sources of noise, there is also general background cosmic noise and this is modified by variations in ionospheric absorption which attenuates the background cosmic noise. Atmospheric noise will be mixed in with this as well, but a general change in the noise level should be noticed. A section of the chart recording illustrating this is shown in Fig. 7.

A section of the technique of making and interpreting observations will be published at the conclusion of the constructional details. ●

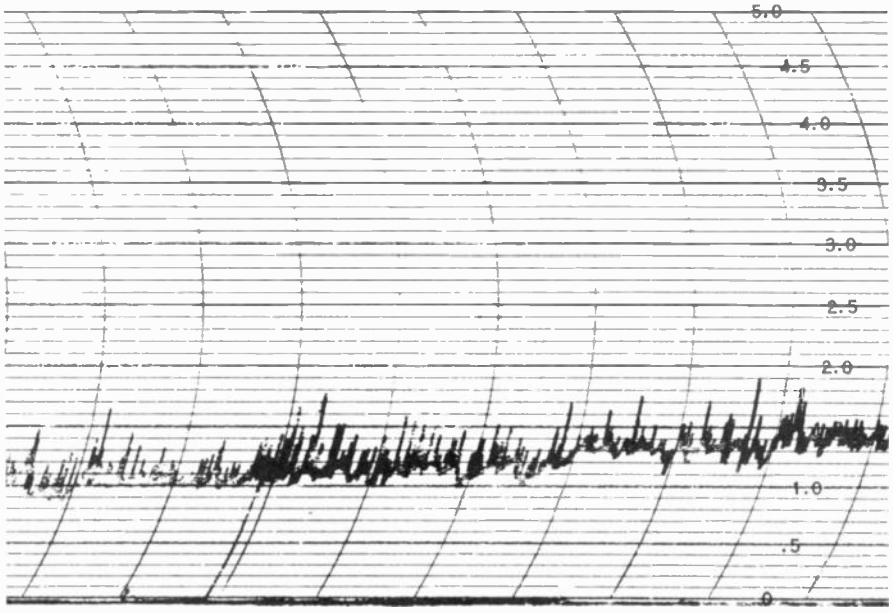
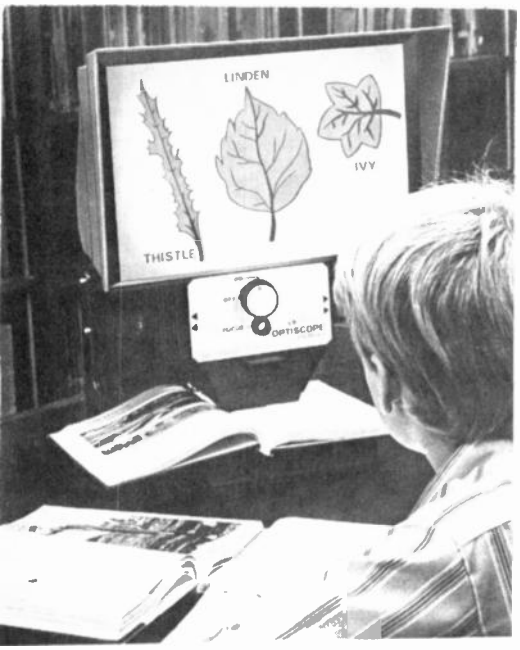


Fig. 7. Radiometer recording of cosmic noise at 20 MHz – recording time is 4½ hours approximately.



AID FOR BLIND

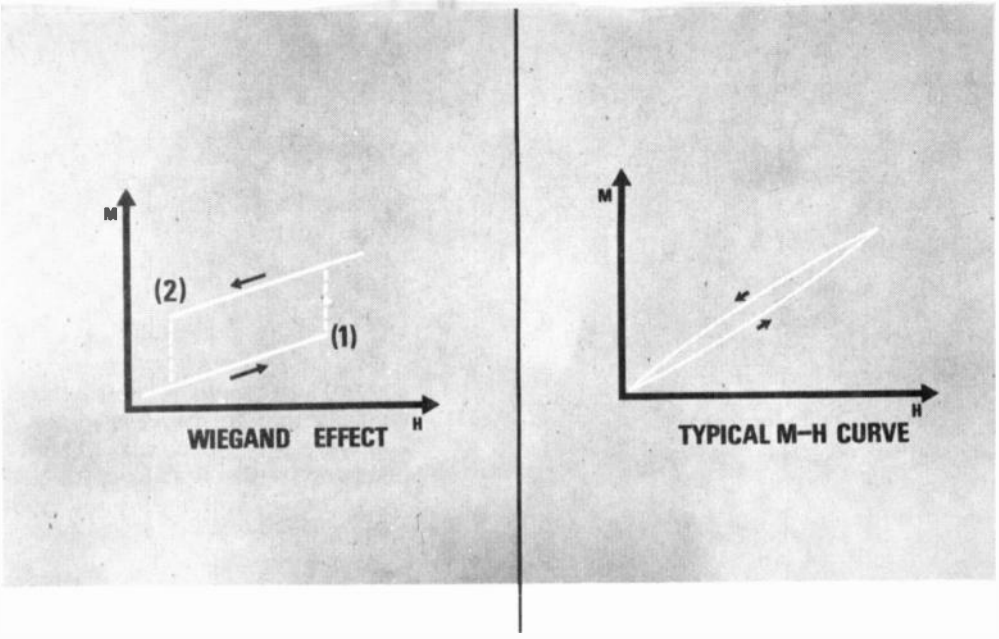
A COMPANY in Long Island New Jersey has developed a new medical instrument which will enable millions of legally blind persons to read.

The instrument known as the Optiscope Enlarger, allows many persons with low-vision capability who may be considered blind by legal standards, to read ordinary books, magazines, newspapers, letters and other printed or graphic material. The instrument is said to have advantages over high-magnification eyeglasses and telescopic and microscopic lenses by permitting the patient to see a larger field and to have the reading material at a comfortable and natural distance.

The Optiscope Enlarger operates by projecting a greatly enlarged, illuminated image of the graphic material onto a built-in 9 x 14 inch screen which is made of a polarized material to reduce harmful glare. The instrument relies on a patented light source to intensify the amount of light reaching the retina thereby increasing the ability to see images clearly. It also displays clearly illuminated, magnified images in full colour or black and white.

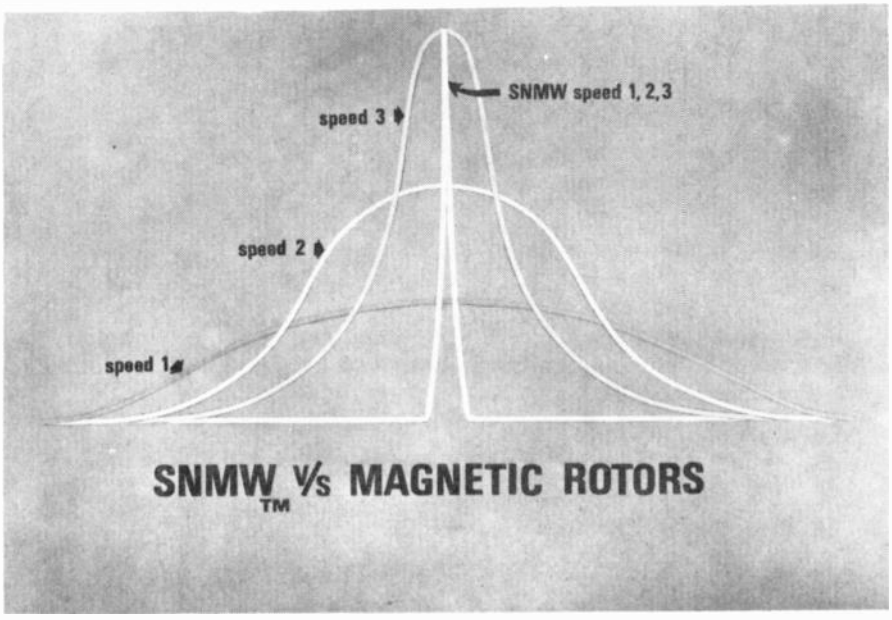
The manufacturers are Opaque Systems, Ltd., Hempstead, Long Island, N.Y. U.S.A. ●

The Weigand effect is explained by these graphs showing the relationship between the magnetization of the material (M), and the applied magnetic field (H). LEFT: SNMW wire. RIGHT: Ordinary ferromagnetic material.



THE WIEGAND EFFECT

Identical output pulses independent of relative mechanical velocity produced using new ferromagnetic material.



Comparison of the rate characteristics of the SNMW system and conventional magnetic rotors. The SNMW system is not affected by rate and thus generates a distinct pulse at low, medium or high rotor speeds.

A totally new method of magnetically generating electrical pulses has been developed by John Wiegand of the Comgeneral Corporation, an independent research and development company of Daytona, Ohio in the USA.

Unlike all existing techniques, the new method produces a clear distinct pulse regardless of rotor speed. It senses at very low speeds and produces exactly the same waveform at all speeds. It is the only known magnetic system that is not rate-sensitive.

The so-called Wiegand effect depends upon the unique ability of a ferromagnetic wire to suddenly change from one level of magnetization to a much higher level when subjected to a magnetic field.

In one application, a wire made of the special ferromagnetic material is initially magnetized to a predetermined level. The wire is brought close to an external magnetic field, and then at a certain critical field strength, a threshold switching action takes place, and the wire's magnetization suddenly increases to a new and much higher level.

A pick-up coil senses this sudden change in magnetic field and generates a pulse proportional to the rate of the change in field strength, but not in any way affected by the speed at which the wire approaches the magnetic field. Hence the characteristics of the generated pulse are independent of relative velocity. In this form the wire

and head have been registered as the SNMW system.

The significance of the Wiegand effect is most clearly explained by the following graphs showing the relationship between the magnetization of the material (M) and an applied magnetic field (H).

As the applied magnetic field is increased, at a determinable value the magnetization in the SNMW wire switches to a higher magnetization level virtually instantaneously (1). As the applied magnetic field is reduced, the magnetization curve retains its slope until point (2) when it switches back to a lower magnetic level. The change in magnetization is sensed by the read head which produces an output pulse with the following characteristics:

Pulse width of approximately 10^{-4} seconds.

Signal to noise ratio of approximately 40dB.

Minimum output voltage 50-250 millivolts.

Pulse polarity is inherently a function of direction.

Output not affected by temperatures over a range −95°F to +300°F.

APPLICATIONS

One obvious application for the Wiegand effect is electronic ignition systems for automobiles. As the pulse waveform is unaffected by uniform pulses will be generated regardless of engine speed, also pulses can be generated over a wide range of ambient temperatures.

The Wiegand effect does not rely upon mechanical contact for its operation, hence the system has virtually unlimited life in any equipment in which it is used. The system will operate in critical environments including aqueous, gaseous, organic solvents and in a vacuum.

The device is uniquely bi-directional and bi-polar. A different pulse may be generated whenever the wire passes the sensing head – either in forward or reverse – this is a significant advantage for the industrial process and control industry.

DATA STORAGE

The Comgeneral Corporation believes that the SNMW system offers a solution to the permanent data storage card problem. A card is formed using discrete wires and laminated plastic. The wires are coded with the necessary data in standard or unique codes. This card is then inserted into a reading device whenever the information is needed. The reading device senses the magnetic pulses generated by the passage of the wire which can then be transferred to a view screen or printer.

In addition to the rotary configuration for applications as ignition systems and the flat plane for card readers, the wire can be used as a disc, vane, or in bundles.

In a bundle each wire generates its own distinct pulse. Therefore, these wire bundles could be used in a coded key for a high security lock. The key would be placed in a lock and only the right combination of wires generating the right number of pulses would open it. In hotels, for example, each room lock would be coded to accept only a certain key and when a person checked out, the code could be changed instantaneously at no cost to the hotel.

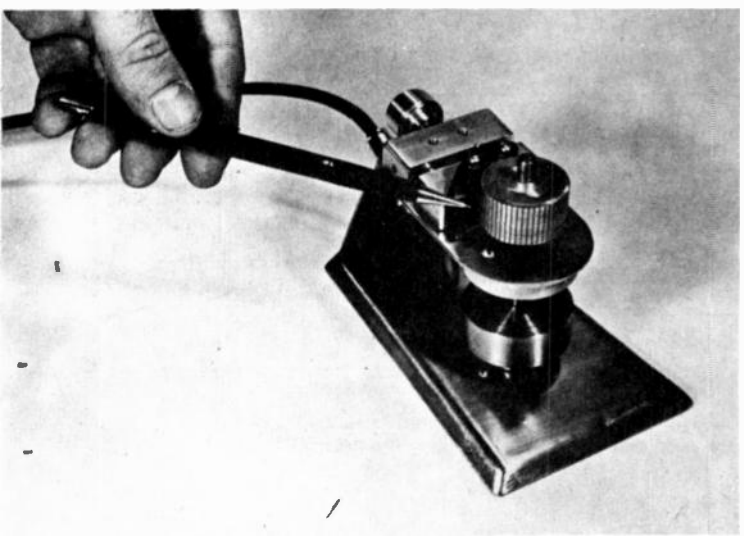
In addition to a rotary pulser, a card reader, coded key, simple switch and ignition system, Comgeneral has laboratory models currently under test that include shift registers, compass devices, magnetic field sensors, thermostat controls, and other magnetically operated devices.

Because of the wide range of potential applications, the manufacturers are planning to negotiate with companies wishing to develop specific product lines in their fields of interest.

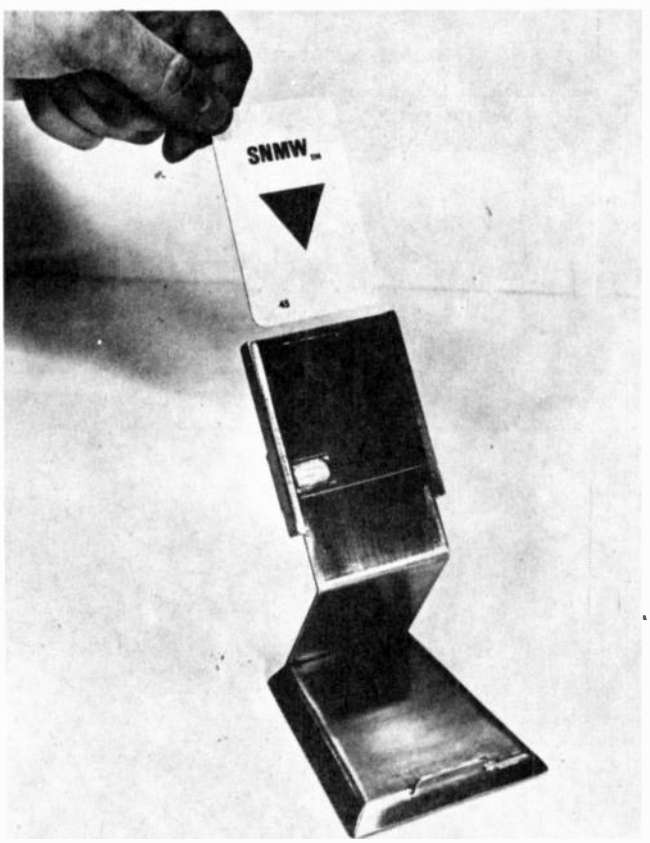
As the system is not as yet fully protected by patents, complete technical details cannot be released, however independent proof that the technique is viable has been provided by Professor Philip Wigen of Ohio University's Dept. of Physics.

Professor Wigens states *"I have completed my study of the patent applications and the basic technology. I found all of the properties of the wire to be consistent with the basic theories of magnetism.*

(Continued overleaf)



In this application a pulse is generated as each SNMW wire passes the read head.



Since each wire generates a distinct pulse, the SNMW system may be used for date storage and retrieval. A card is formed using discrete wires coded with the necessary data. Whenever information is needed, the card is inserted into the reading device which senses the individually coded pulses generated by the passage of the wires. There are no moving parts and response is virtually instantaneously available.

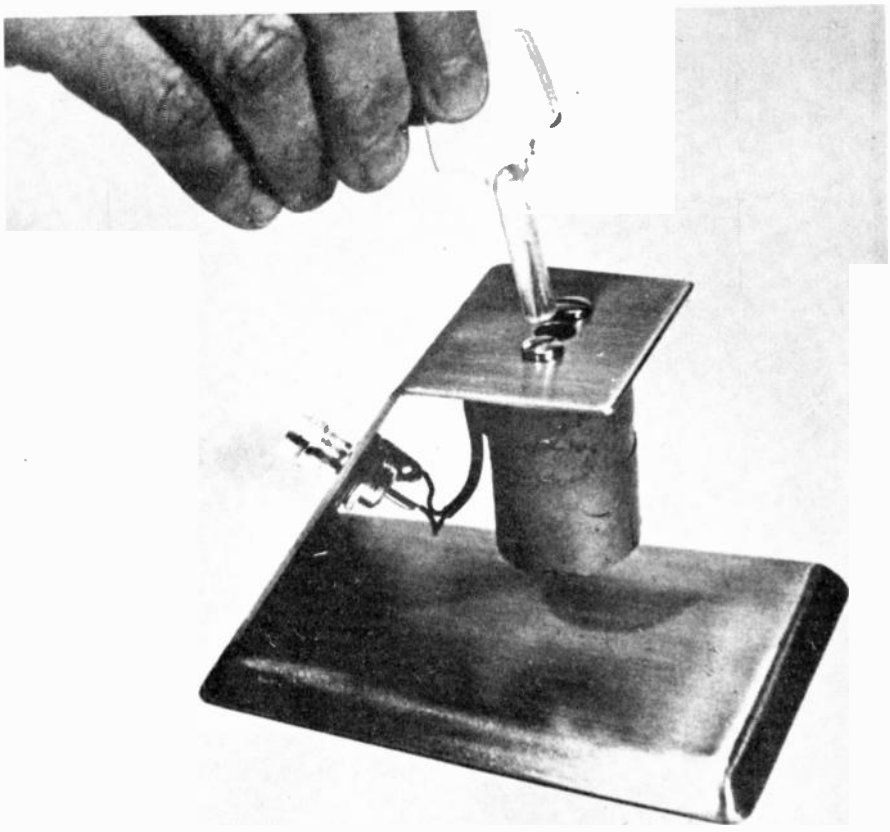
THE WIEGAND EFFECT

I have carried out some calculations that indicate the wire should produce a signal having a pulse width of the order of 10^{-4} seconds. The practical temperature range of operation should be from at least −70°C to 150°C or well within the operating range of most sensing devices.

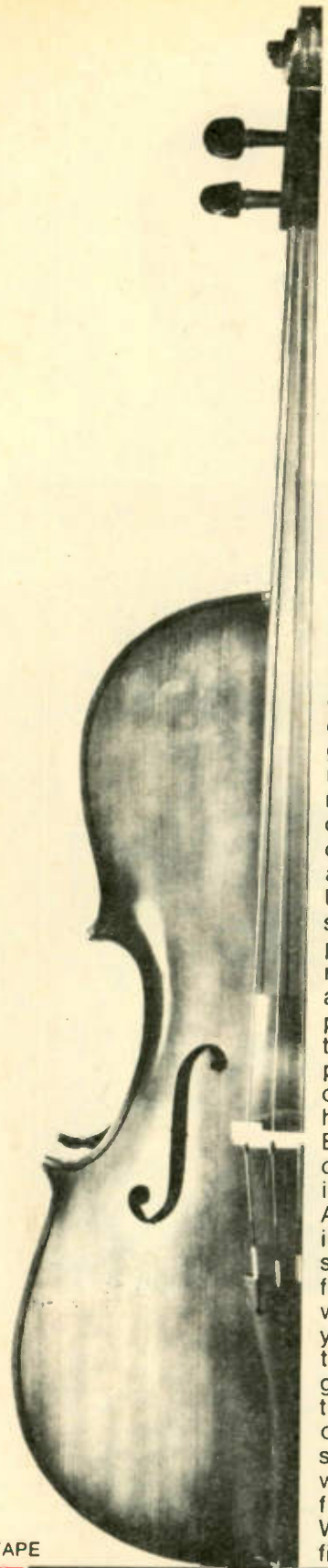
The materials in the wire are readily available and the wire can be processed in an inexpensive manner. Once processed, the wire will be magnetically stable and the signal is very reproducible.

Other physical properties of interest include the unlimited lifetime of the device, its solid state nature, and its velocity independent signal output. The signal will be observed in a variety of environmental conditions; gaseous, aqueous, organic solvents or vacuum. In corrosive media the device can be embedded in a noncorrosive material without effecting the operation of the wire.

The wire has unique properties and should have a large number of applications in a wide variety of devices." ●



This prototype high security lock utilizes the ability of the SNMW system to generate distinct pulses even when several wires are grouped together in a bundle. A lock would be coded to accept only the right combination of pulses to open a door. The individual key code can be changed whenever and as often as it is necessary at essentially no cost. And, tampering with the key or lock will destroy the code.



BASF's new Chromdioxid cassette brings you the other half of the fiddle

Only BASF's new Chromium Dioxide coating can give you a dynamic range good enough to reproduce the most subtle tops of a violin. Or the deepest notes of a double bass. Until now cassettes have had poor bass response– and even poorer treble response. They only gave you half the sound. BASF's new Chromdioxid lets you hear it all.

And BASF's new internal transport system prevents foul-ups, no matter what tape thickness you use. It also stops the wow and flutter you get from variations in tape tension. Chromdioxid cassettes give you sound quality that you would only expect from reel to reel. Without all the fiddling.

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BASF

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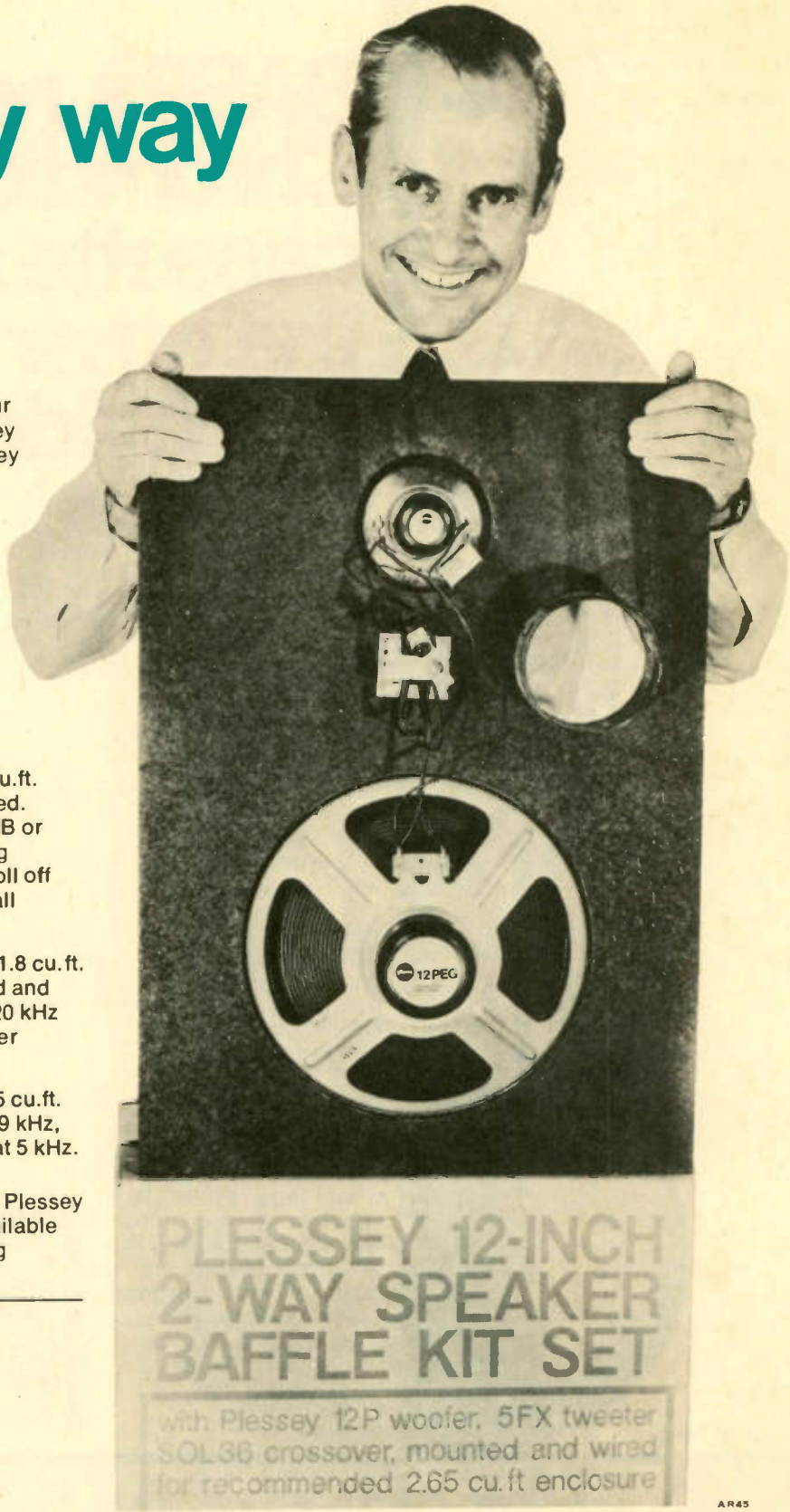

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THE MAGNAVOX 8-30 SPEAKER ENCLOSURE (REVISED)

A different tweeter, plus an LC cross-over network and presence control, upgrades this already excellent design.

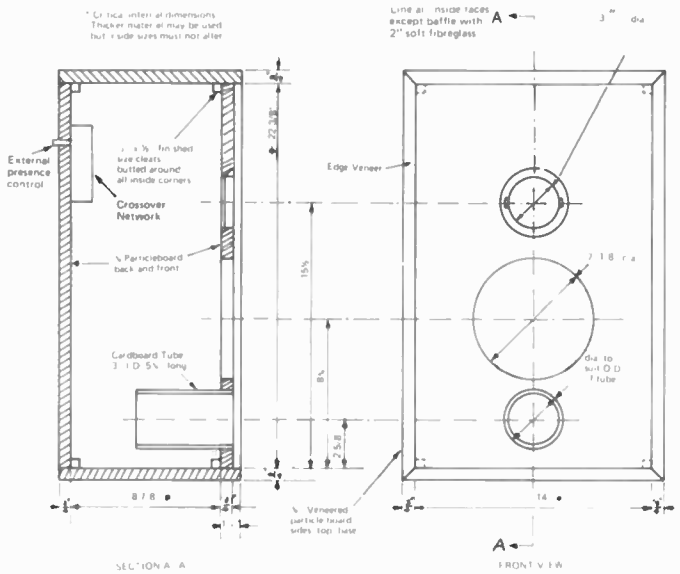


Fig. 1. Constructional details of the revised enclosure.

THE Magnavox 8-30 speaker project published in our August 1971 issue has proven an enormous success. So much so that many hi-fi manufacturers and retailers sell the completed units as a standard stock line.

In our independent review of these units – again in our August 1971 issue – our audio consultant said that 'if it were not for the tweeters letting the side down a little above 5kHz, we would most probably have been able to equate these speakers with the best speaker systems costing five to ten times as much'.

Since publishing this project many readers have asked us to investigate the possibility of using a tweeter with performance commensurate with the superb Magnavox 8-30 bass drive unit.

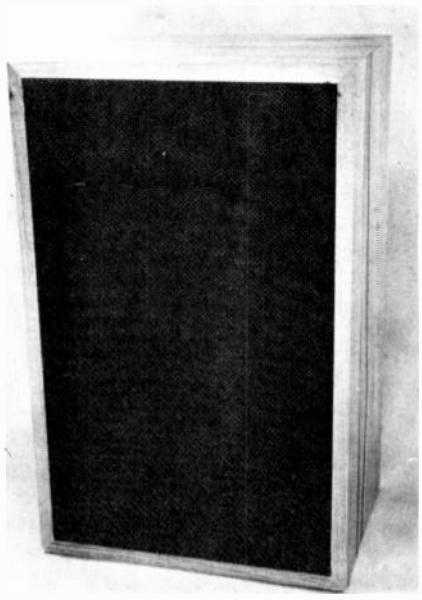
The opportunity for doing so arose when we initiated the design of our integrated audio system (published in this and the previous issue). We felt that it would be desirable to offer the choice of two different sized enclosures for use with this project – so we commissioned our consultants Louis A. Challis and Associates to investigate the possibility of using the basic Magnavox MP 31-018 enclosure and 8-30 drive unit in combination with the latest Philips 1" tweeter type AD 0160/T8, together with an LC crossover network, and also to use the same drive units and cross-over networks in an alternative smaller enclosure.

As may be seen from the graph of frequency response, the results have been extraordinarily successful, in fact the response is now substantially flat from 70Hz to 20kHz.

PRESENCE CONTROL

One minor problem that arose during initial development was that output of the 8-30 driver at low frequencies – and of the AD 0160/T8 tweeter at high frequencies – was greater than the midrange output of either. This resulted in a slight dip in the midrange – but not one of such magnitude that a midrange driver was really justified.

Our consultants have overcome this problem very ingeniously by including a 'presence' control. This in effect, 'lifts' the midrange frequencies by slightly attenuating the lower bass and treble.



ETI PROJECT 405(R)

The potentiometer associated with this 'presence' control has been brought out to a panel fitted to the rear of the enclosure – thus permitting the listener to adjust the sound to suit his own preferences.

Constructional details of the revised enclosure are shown in Fig. 1. The enclosure is basically identical with the earlier pattern – the only main difference lies in the front panel. Details are included later in this article explaining how to modify existing enclosures.

The construction of the enclosure is well within the capability of the average home carpenter providing he sticks rigidly to the dimensions shown, and ensures that the completed enclosure is airtight.

The enclosure is constructed from ¾" particle board. Thicker material may be used but if it is the external dimensions must be adjusted accordingly.

All dimensions are internal dimensions. Quite small changes in these dimensions will degrade the performance quite considerably.

All joints should be glued and screwed. The back panel must be a good airtight fit and should be held in position by at least 12 screws. A rubber sealing gasket should also be used if there is any doubt about the airtightness of the gap.

Line all internal surfaces with a 2" thickness of soft fibreglass

THE MAGNAVOX 8-30 SPEAKER ENCLOSURE (REVISED)

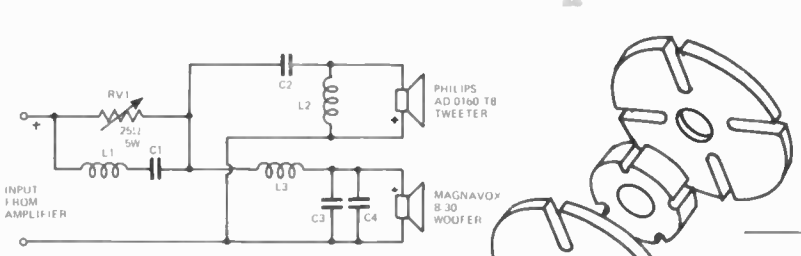


Fig. 2. Details of presence control and crossover network. Note polarity of tweeter. Potentiometer RV1 is presence control adjustment.

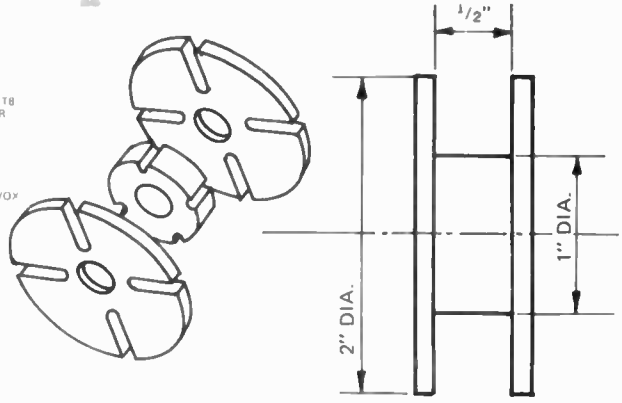


Fig. 3. Suggested construction of former for winding coils L1, L2 and L3. Wooden former is held together by centre bolt — here removed. Any suitable construction may however be used providing dimensions follow drawing on right.

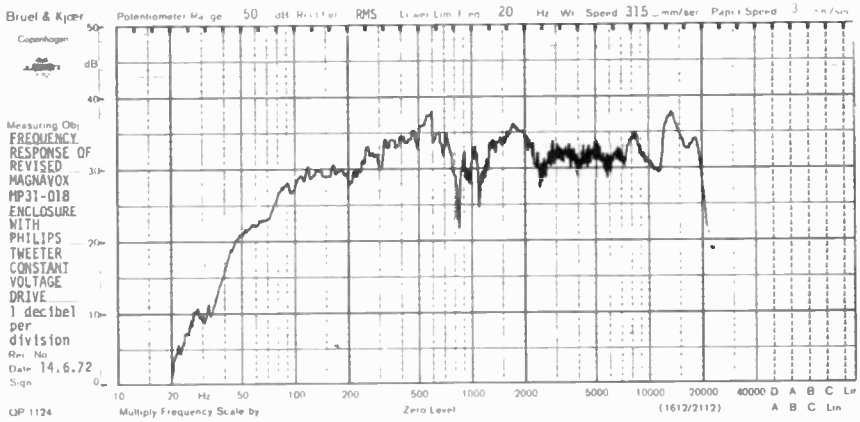
The main drive unit is mounted from within the enclosure but the tweeter *must* be mounted from the outer face of the front panel. A gasket, or some form of sealing compound, should be used between the tweeter mounting frame and the front face of the enclosure to ensure an airtight seal.

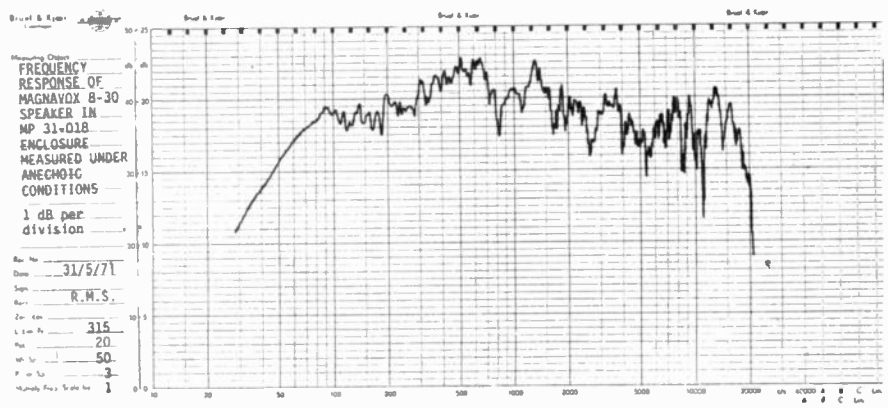
Details of the presence control and crossover network are shown in Fig. 2. The three coils L1, L2 and L3 used in each crossover network and presence circuit, each consist of 190 turns of 20 gauge B&S enamelled copper wire. These coils should be wound on a fabricated former — (one possible construction of which is shown in Fig. 3). Once wound, the coil should be supported by one of three or four ties, the former removed, and then dipped in clear varnish or laquer and left to dry. (Each coil will require about 4ozs of wire).

Capacitors C1, C2, C3, and C4 are Philips type 344 25685, 6.8μF, 100 V.

When assembling the crossover network ensure that the speakers are connected with the polarity as shown. The positive terminal on the Philips tweeter is identified by a red spot. The equivalent terminal on the Magnavox driver has a red insulating bush.

These components should be wired onto a suitable piece of veroboard and located within the enclosure in any convenient place. The speaker output terminals and presence control should be mounted on an aluminium or wooden panel recessed into the back face of the enclosure.





MODIFYING AN EXISTING 8-30 ENCLOSURE

Firstly, remove all internal wiring and both tweeters. Blank off the upper tweeter hole and mount the Philips tweeter in the lower hole — from the *outside* of the enclosure. As the original hole was chamfered around the edge it may be necessary to use a gasket to ensure an airtight fit.

Construct the crossover network and presence control system and wire into circuit as shown.

If possible replace the existing bonded acetate lining with a 2" layer — or add a second 1" layer. (This is not essential as the improvement in performance between the two lining thicknesses is fairly marginal.

THE SMALLER ENCLOSURE

Constructional details of the smaller enclosure will be provided next month. ●

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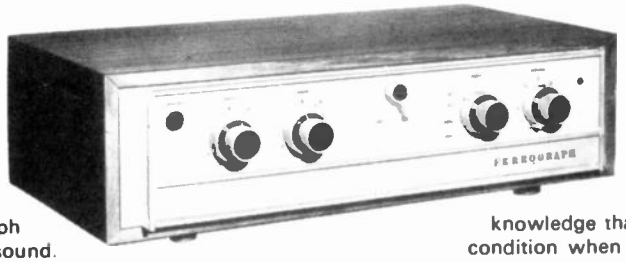

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HIGHLIGHTS OF THE EXHIBITION

The 9th Instruments, Electronics, Automation exhibition was held recently in London – Dr. Sydenham reports.

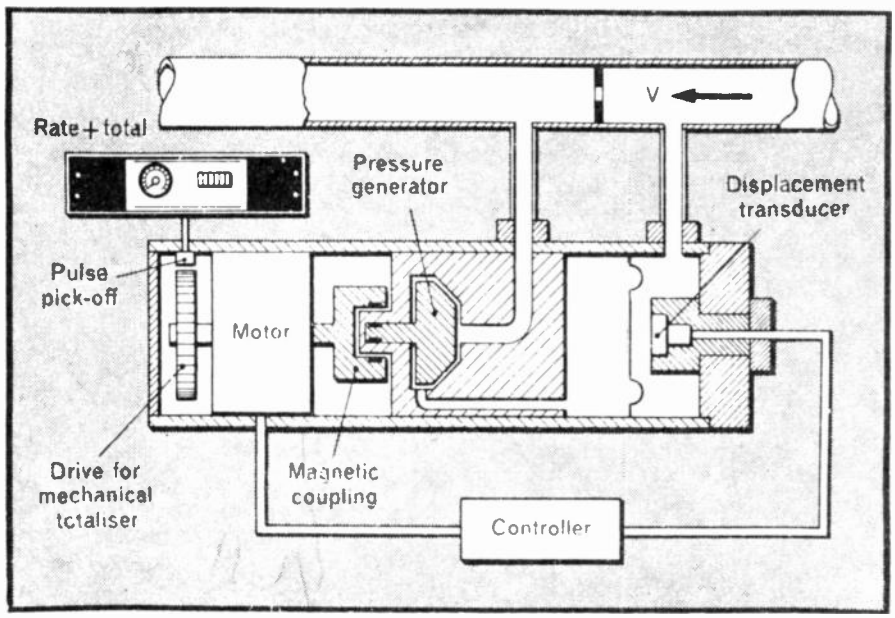


Fig. 1 Linearized frequency output from an orifice-plate flow meter.

The annual five-day international exhibition of instruments, electronics and automation, held at the Olympia exhibition site in London, is now over, leaving time for reflection.

Though not as dynamic as those seen a few years ago, when some stands had half-hour queues, it attracted several hundred exhibitors from many (but not all) major companies. The United States had a grouped exhibit, so did Ireland and a few industrial areas of Britain. Japanese products were noticeably absent.

The task of seeing and comprehending was as great as ever, due to the broad reference of the products. Having no axe to grind, let us now look at a few exhibits that were intrinsically interesting.

Coin changing machines are a familiar sight, but few would have used a banknote-changer. On the Sodeco stand was such a device, soon to become a familiar sight at some locations in British Rail terminals. These note acceptors are already in use in Germany, Switzerland, Holland and Italy. The note is inserted into a slot and transported to a test channel. Seven test conditions – such as size, thickness, metal strip position and opacity – are checked. If genuine by these standards, the note is accepted and a signal generated to operate the required device. It isn't available for high-denomination notes, and it will reject a small percentage of good notes.

There were a handful of light-emitting-diode (LED) displays. Monsanto exhibited green and amber circuits in which phosphor coatings provide the colour change from the usual red. There were hints of other companies releasing coloured LEDs, but no details were available. It was necessary to look hard for a liquid crystal display – one was found as a Digilin readout display unit in a panel meter. Its readability was certainly inferior to LED displays, but the cost was claimed to be less and the power consumption also much less, so there will be cases where liquid-crystal displays are a good choice once they become freely available. In all, the development of integrated displays is now reaching a flattening off point as cost reductions are no longer as dramatic in an absolute sense.

On a more specialized note, two companies released digital transient recorders. These equipments sample and store the analogue values of a transient signal in digital form. Reconstruction can then be made on a more convenient time scale. Datalabs offered a DL 905 recorder for the lower-price market whilst Bruel and Kjaer (B & K) had a model 7502 which is up to their usual standard of design and presentation.

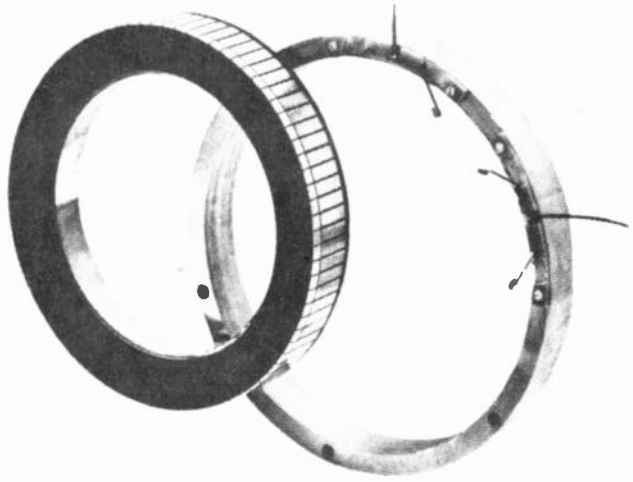
NOISE DOSE METER

A first for B & K at this exhibition was a noise-dose meter (model 4423) which is the first available unit to comply with the new British Department of Employments "code of practice for reducing the exposure of employed persons to noise". The instrument combines the important factors of noise duration and intensity via a standard ear response filter to provide an equivalent continuous noise-dose measurement.

Transducers were much in evidence. Dynamic Transmission Ltd exhibited an interesting system for fitting to existing orifice-plate flow meters. Although these meters are simple – a restricting hole in the flow produces a pressure change between both sides – the output is not linearly related to the flow rate. However, if the pressure differential across the plate is nulled with a motor driven pressure generator (Fig. 1), the speed of the motor is proportional to flow rate. Motor speed is measured as a frequency rate.

A Saratoga ultrasonic flow meter was on demonstration. This system uses two send-receive sonar displacement

HIGHLIGHTS OF THE EXHIBITION



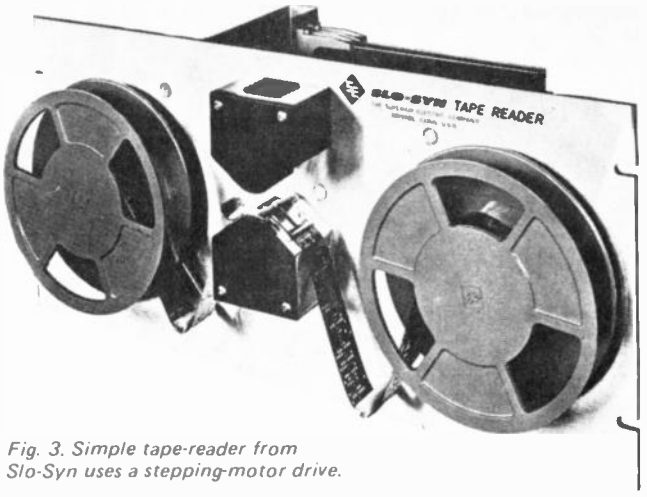


Fig. 3. Simple tape-reader from Slo-Syn uses a stepping-motor drive.

Fig. 2. This unframed dc torque motor from Moore Read produces a peak torque of 86 kgf/cm for 100 watts in input power, and has a no-load speed of only 100 rpm. Unit is 6.9" diameter.

transducers mounted across the stream at a small angle to the normal. By a doppler effect it is possible to determine flow with little influence in precision resulting from the temperature of density of the fluid. Nixon Instrumentation had an interesting NOVAR turbine flow meter on display. This miniature device has a small exposed PVC rotor of about 11mm diameter which rotates in jewels at the end of a slender rod. Rotation of the rotor is sensed using inductance variations as the tips of the blades move past the support spindle.

COMPUTER CONTROL

One cannot imagine an exhibition like this without a computer controlled exhibit. There were many but the attraction was obviously slight as the glamour is rapidly fading.

Gerber had a PC-740 automatic artwork generator complex working. In this system the operator indexes the input table onto each part of the roughly prepared printed circuit board. At each key position he commands the computer to read and store the coordinates. Repetitive features such as I.C. mounts and lines need be specified by key positions only. The computer fills in the repetitive features, including putting the lines, etc, on the nearest grid location. Punched cards are produced which are then used to operate an x-y digitally-controlled plotting table that moves an exposure head over film to produce the finished artwork. Gerber also operated a new large size drum plotter capable of plots to 1 by 40m, with an acceleration capability of from 0 to 45m/min in a mere 30 milliseconds.

The requirement for chart and drawing digitizers is widespread and in recent years the trend has gone to puck operated tables. In these the operator moves only a small circular sensor having cross-hairs in its centre. The units on display by D-MAC chase the puck from underneath the board. Once balanced, the x, y values are read out. This method greatly reduces operator fatigue, compared with methods in which the whole slide must be moved manually.

Their display attempted to accentuate the general-purpose use of such machines when coupled to visual display units (VDUs) and computers. Draughting for highways, buildings, circuits – in fact any drawing where rules exist – can possibly make use of such a facility, and a Bureau (MCB graphics) has been established at the Imperial College of Science and Technology to provide systems availability on contract basis.

LASER TRIMMER

Although lasers are usually obvious at any exhibition, they also are losing glamour and laser applications had to be sought out. On display by Laser Associates (who combined with the Royal Radar Establishment) (RRE) for the development, was a thick film resistor trimmer. This equipment uses a Nd:YAG c-w laser delivering 10 watts continuous power which is converted to 10kW peak pulse power by switching. It has been built to trim thick-film circuits made on ceramic substrates. Other lasers on display were incorporated into the now familiar optical tooling heads for industrial and survey alignment testing.

Printed armature motors are regarded as giving the ultimate in acceleration, especially for units rated in the kilowatt region. Even so, they have been slow to find extensive use because suitable amplifiers had not been available. Printed Motors, who manufacture printed armature motors in Britain, released details of greatly improved amplifiers and complete controlled units for numerically controlling an existing machine tool. Another reason for not using printed motors is that the full acceleration benefits are not usually attainable because practical design factors do not enable the load to be mechanically matched to the motor thus losing much of the response. For example, in a machine tool direct-coupled installation the motor is very much mismatched as a gear box is undesirable. Moore Read's answer has been to market d.c. torque motors which are of frameless design (see Fig. 2). Although having greater inertia than printed motors they are often more convenient to mount and may obtain overall better performance. Stepping motors were represented and the SLO-SYN agent had an interesting

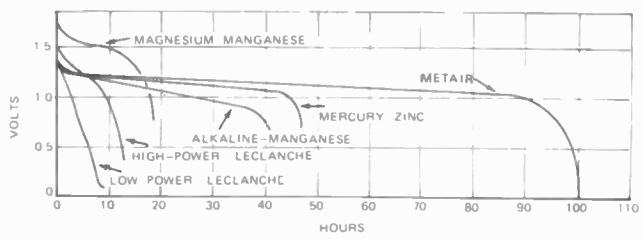


Fig. 4. This graph from Energy Conversions shows the performance of their new METAIR (zinc air) cells compared with conventional batteries.

tape-reader on display. Most tape readers have detents, gears or belts to advance the tape in rapid steps. The SLO-SYN design, (see Fig. 3) uses only a stepping motor drive which results in simplicity in itself.

An advance in batteries is the release by Energy Conversions of their Metair range of zinc-air primary cells. They are now available in most standard sizes for direct substition in torches, radios, toys, etc. (These should not be confused with zinc-air secondary cells under development for use in electric cars.) The batteries consist of an outer porous cathode and an inner zinc anode. Considerably greater life and reduced weight are distinctive features as seen in the comparison chart of Fig. 4.

The Department of Trade and Industry exhibited several current projects. From the Laboratory of the Government Chemist came an automatic method for rapidly determining the specific gravity of liquids at a rate of 20 tests per hour by a completely automatic equipment. The liquid is sent into a test chamber where a precision float is deflected by the buoyancy effect. Inductive proximity sensors detect the position and their output is digitized and recorded. The national Engineering Laboratory (NEL) exhibited a rugged, general purpose mechanical transmission testing circuit that uses optical gratings to provide angular signals of the input and output of the gearbox to be tested. The advance has been to build a portable unit that can be applied in-situ to an existing unit. After frequency changing of the output to obtain the same frequency as at the input, phase errors are a measure of total gear error. The Natural Physical Laboratory (NPL) exhibited a new design of scanning electron microscope which uses field emission cathodes to obtain a smaller size instrument with much the same performance as existing units. The Scientific Instrument Research Association (SIRA) displayed several equipments including an automatic surface-defect monitor for in-process paper and powder inspection. Warron Springs Laboratory (WSL) is the Government centre for process control research in the main. They displayed time sharing of a central computer bureau using the Post Office modem telephone-line links. Also shown was in-process viscosity measurement for substances such as paint, emulsions, creams and food stuffs.

To conclude, the industry is still showing signs of hard times but the exhibition was of great value to those who could afford a day or two to see it properly. It also gives manufacturers a chance to see their position in this highly competitive area of marketing.

THE SMALLER ADVENT LOUDSPEAKER

An excellent bookshelf speaker at a realistic price

electronics TODAY INTERNATIONAL
product test

The Smaller Advent loudspeaker bears some resemblance to its big brother, having the same unpretentious buff coloured grille cloth and the oiled walnut enclosure. The major differences are the size, and the replacement of the 1½" wide chamfered timber surround with a ¼" wide timber edge trim.

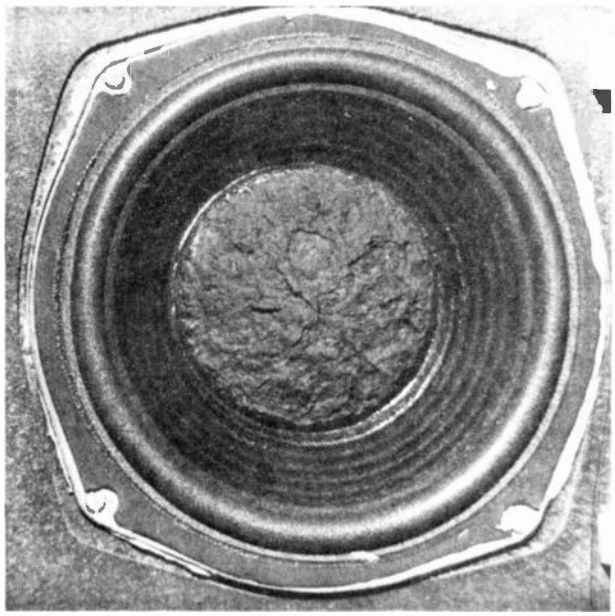
This makes the speaker appear much lighter in weight than it actually is. It also improves the visual effect of the speaker when located on a bookshelf.

With the exception of the depth, the Smaller Advent is a true bookshelf speaker having dimensions of 11½" high by 20" wide by 9¼" deep. The extra depth is mainly due to the speaker mounting panel being 1-1/8" behind the front edge.

The locally made enclosure is extremely well constructed from veneered particle board and totally filled with blocks of fibreglass.

The two speaker and filter network are imported from the US Advent Corporation, and consist of an 8" woofer with roll surround, a 7/8" domed tweeter and a simple high-pass filter network for the tweeter.

The woofer has a very large magnet assembly – measuring 3½" x 3½" x 1½" deep. There is an effective cone movement of approximately ½". The woofer is sealed into the enclosure with a tenacious putty to obtain an effective airtight seal.



The tweeter has a 2½" x 2½" x ½" magnet and is sealed into the enclosure with a cellular plastic seal which eliminates distortion of the mounting plate. The dome of the tweeter is very effectively protected with a heavy expanded mesh steel grille.

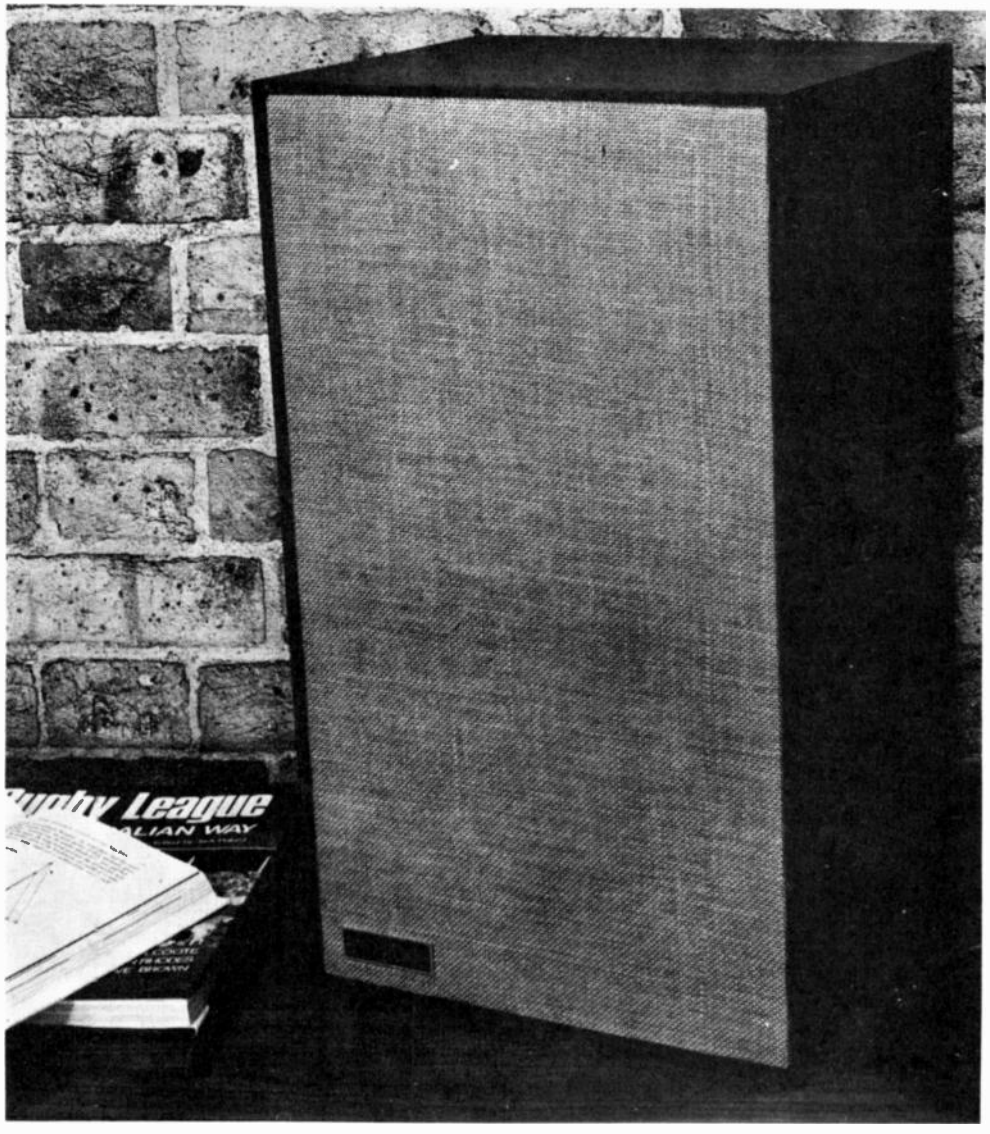
The crossover network consists of two capacitors, a resistor and a very simple iron cored inductor.

The design of the "crossover network" is cunningly contrived to provide good performance at minimum cost. This is achieved by placing the woofer directly across the input, and mechanically attenuating the high frequencies by means of a large dense fibre dome (which has a diameter of 4½").

After measuring the frequency response with the tweeter disconnected it would appear that this technique provides a smooth attenuation of the high frequencies over 2 kHz. Having achieved this aim it only remains necessary to provide a simple high pass filter, for the speaker to have a really smooth transition from the woofer to the tweeter.

The cost of this system is obviously minimal, as components that would be called upon to dissipate high powers are not required. Our only criticism is, that the slightly greater expense resulting from a better inductor, would most probably result in lower distortion above 2kHz.

All of the crossover components are glued to the back of the terminal panel which is itself glued into the opening in the enclosure back panel. External wiring is connected to screwed terminals – marked '0' and '4' ohms



to facilitate phasing of the speakers.

Wiring and operating instructions and a warranty card are stapled to the back of each speaker. The wiring and operating instructions give concise information on wiring sizes (although in American terminology), the speaker placement, multiple speaker connections and power handling. The section of 'Speaker Placement' gives some useful information on the effects of speaker location on bass response and treble response. The warranty covers the speaker against faulty workmanship and defective parts for a period of one year from receipt of Warranty Registration card, provided it is returned within 15 days of purchase.

Subjective assessment of the speaker's performance was surprising and the little Advent compared very favourably with its big brother "The Advent Loudspeaker." The only noticeable difference was the lower power handling capacity of the Smaller Advent Speaker. However it handled 25 watts average power (approximately 80 watts peak power) with only slight audible distortion being produced, even on heavy bass passages such as those produced by the bass guitar in the Warner Brothers Record, "Hand Made." (WS 1838). This power was more than adequate to produce levels that would satisfy any hard rock fan in an average sized living room.

After listening to so many really good speakers lately, we felt it necessary to conduct some A – B type comparison tests to maintain our ability to discriminate between the performance of closely matched high quality units. After listening to a number of well known speakers we feel that the Smaller Advent speakers can hold their own against any speakers selling at under $300.00. They have a clean reproduction and this is well balanced and smooth – provided the power level does not exceed their capability.

The nicest feature of these speakers was the exceptional low frequency response, which realistically handled the footwork in the passage Ay Mi Romera on side two of the Decca Record *Flamenco Puro "Live"* (PFS 4237).

Although the measured performance showed a peak at approximately 12kHz on the axis of the tweeter it was not objectionable and only produced a slight accentuation of high frequency harmonics which resulted in a crisp and more realistic production of the violin and cymbals. Overall the frequency response of the Smaller Advent was slightly *better* than that of its big brother. The laboratory measurements showed that the frequency responses were very similar with the smaller Advent having a slightly better top end performance.

The impedance curve was of particular interest, being down to 4.5 ohms at approximately 100Hz and 10kHz. This low impedance makes it impractical to operate these speakers in parallel with another pair of speakers unless the manufacturer's recommendations are adhered to.

These recommendations state that the Smaller Advents should be fitted with 3Ω resistors in series for parallel operation or wired in series with the other speakers. If these recommendations are not carried out the power output stage of many amplifiers could be permanently damaged.

Not long ago we made the bold statement that the AR6 speakers were "the best true bookshelf speaker systems that we have yet heard." We must now qualify this statement, because, although the Smaller Advent does not quite meet the depth

Measured Performance of smaller Advent Loudspeaker – Serial No 00001

Frequency Response
30Hz to 20kHz ±6dB

Total Harmonic Distortion

	100Hz	1kHz	6.3kHz
1 Watt	1%	0.5%	0.6%
5 Watts	3%	0.8%	0.8%

Electro-Acoustic Efficiency
0.15%

Cross-Over Frequency
Not Applicable

Woofer Resonance
In Free Air 16Hz
In Enclosure 45Hz

Measured Impedance
100Hz 4.5 ohms
1kHz 16 ohms

Enclosure Volume
0.696 cubic foot

Dimensions
20" high x 11½" wide x 9¼" deep

Weight
21 pounds

Recommended retail price $129 each.

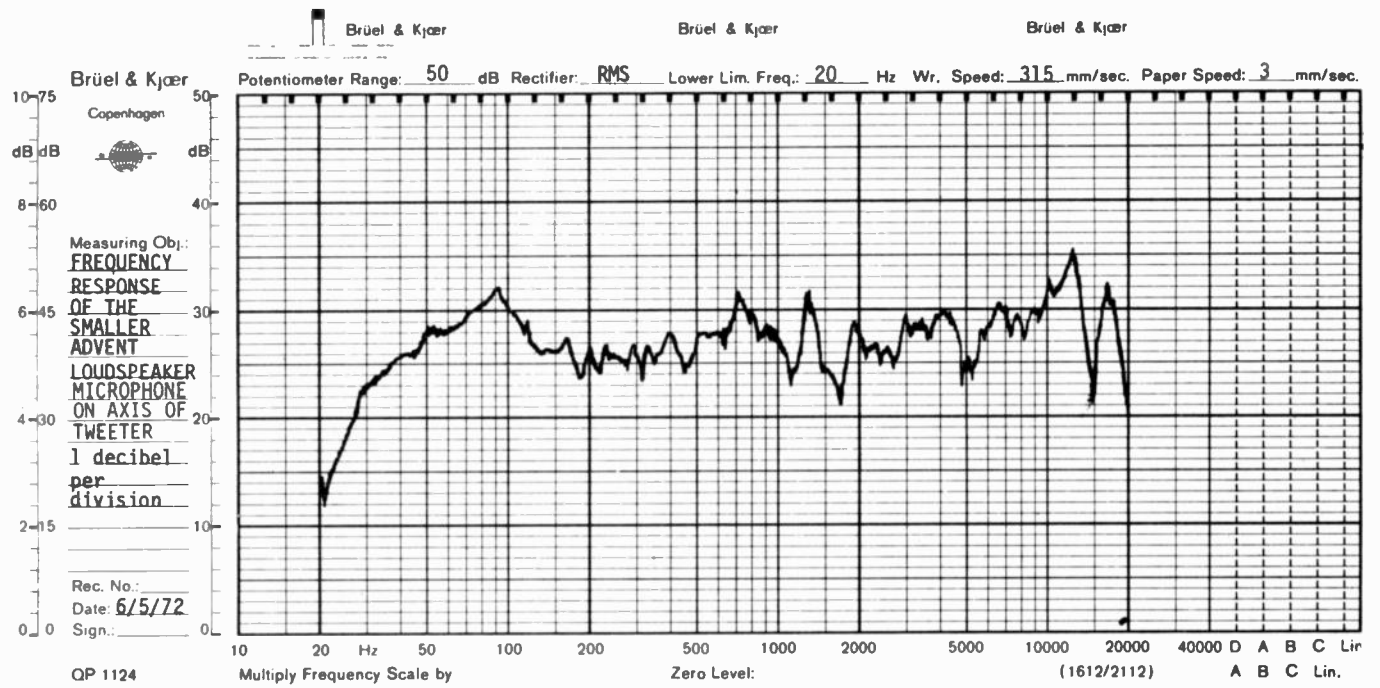
THE SMALLER ADVENT LOUDSPEAKER

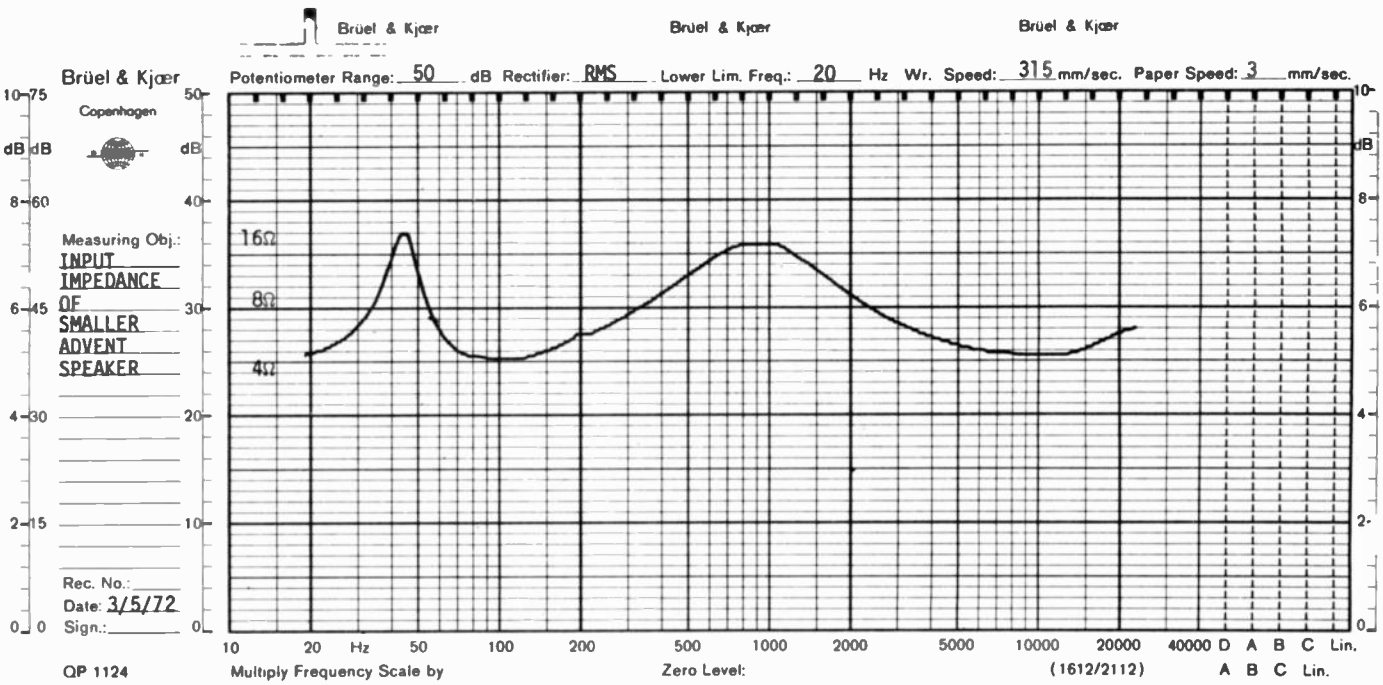
criterion, it is a true bookshelf speaker in all other respects. In terms of power handling capabilities the AR-6 is most definitely superior, but in terms of frequency response (particularly subjective, as well as measured) the Smaller Advent has marginally better performance.

The design aim of the manufacturer was to produce a smaller speaker to complement the larger Advent speaker. The Smaller Advent most certainly fits the bill and provides exceptional performance at reasonable power levels for a den, study or medium sized living room.

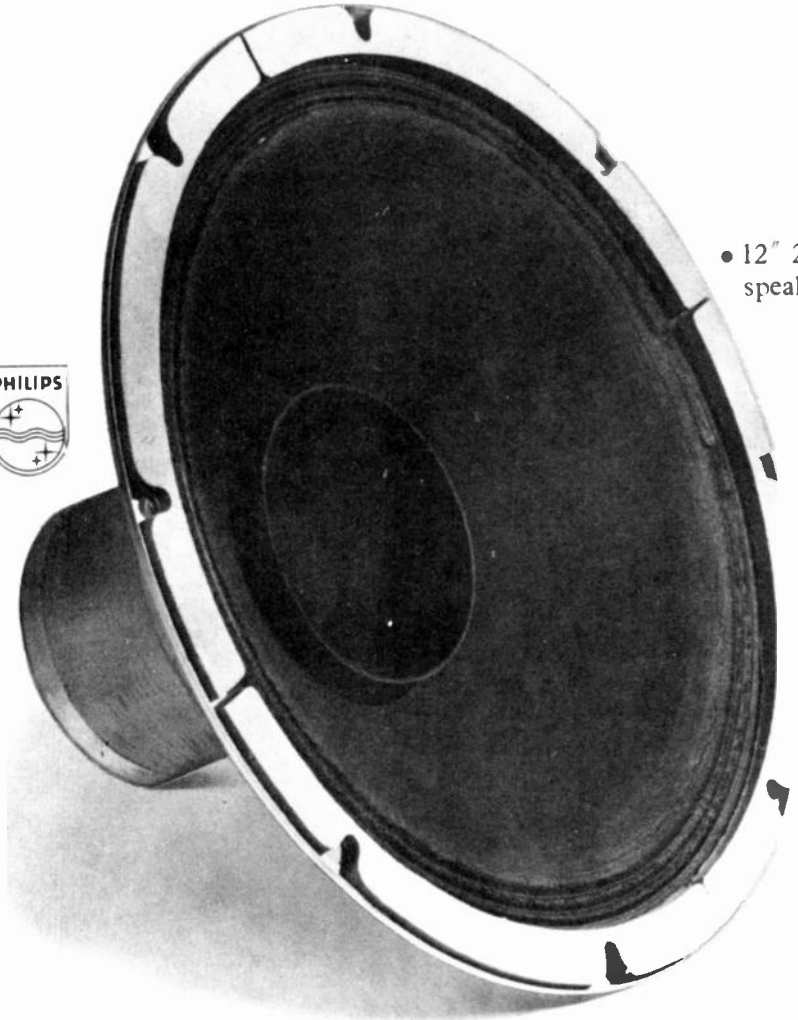
Inevitably connoisseurs will compare the AR-6 and the smaller Advent units for in many respects they are very similar. Broadly one must relate the marginally better performance and slightly lower price of the smaller Advent to the considerably greater power handling capabilities of the AR-6 and determine which parameters are most important for the particular application.

At a recommended selling price of $129.00 the Smaller Advent shows that it is possible to obtain a very smooth frequency response with a simple two-way speaker system at a realistic price and within the reach of most people. ●





Fidelity is the word for Philips loudspeakers.



• 12″ 20 watt wide range speaker.

• 1″ dome "tweeter"

Philips range of loudspeakers deliver exacting high efficiencies second to none in the world.

Philips are specified by leading guitar amplifier manufacturers and people who demand concert-grand fidelity in music because they know that they'll get top performance for a lifetime. Available Australia-wide.

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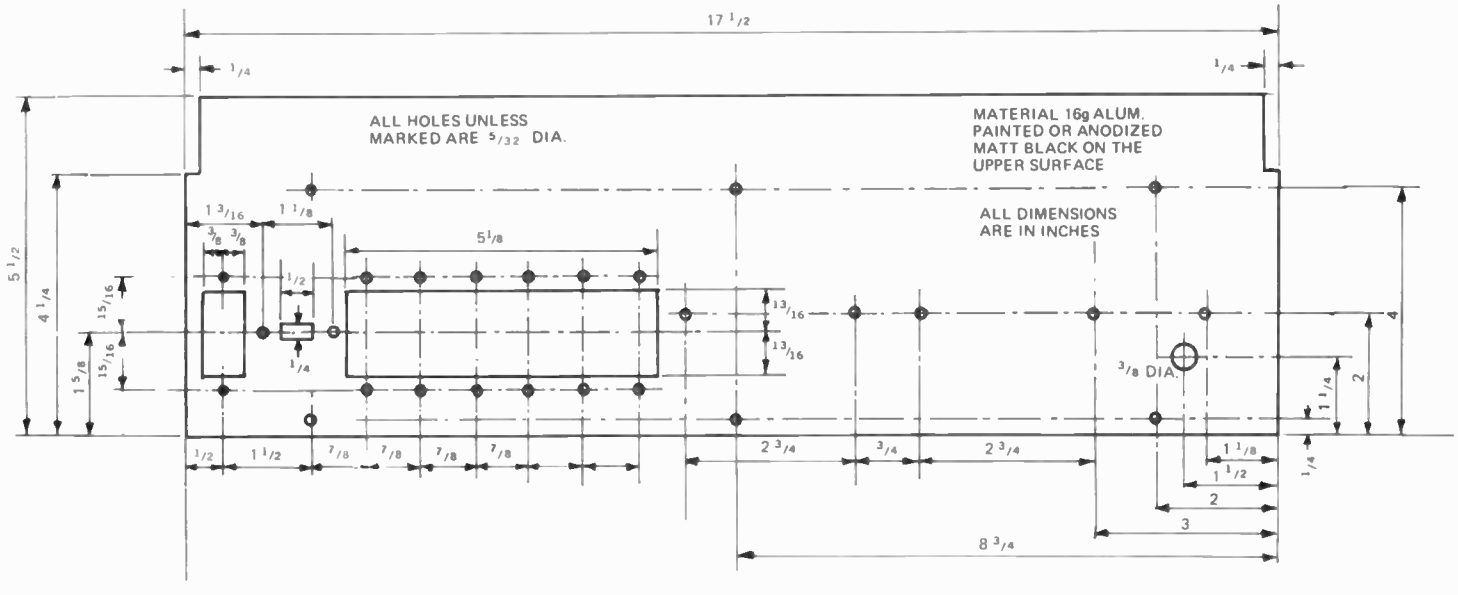
INTEGRATED AUDIO

Part 2 of the series gives details of pre-amplifier and metal-work.

ETI PROJECT 425

Fig. 1. Drilling details of 16 gauge aluminium rear panel.



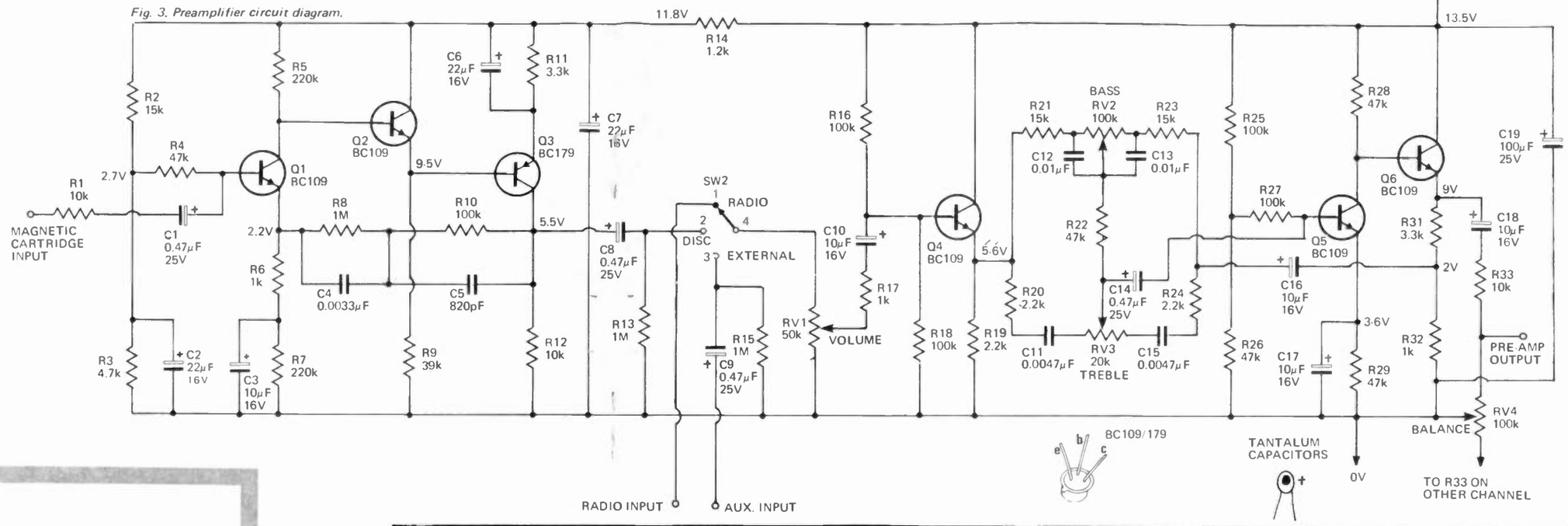
INTEGRATED AUDIO SYSTEM-ETI 425

the front support panel to clear the woodwork.

It is very important to wire the unit so that earth loops are not formed. Earth loops, if present, will increase the hum level significantly. To avoid this problem, the earthing wiring diagram should be followed closely, earthing only at the points shown. Particular attention should be paid to the signal cables between the preamplifier and the main amplifier as the first stages of the main amplifier are earthed via the preamplifier. The sheath of these cables must therefore be continuous.

ON NO ACCOUNT SHOULD THE MAIN AMPLIFIER BE RUN WITHOUT THE ABOVE EARTH CONNECTION. DAMAGE TO THE MAIN AMPLIFIER COULD RESULT.

Fig. 3. Preamplifier circuit diagram.



HOW IT WORKS

When recording a disc the amplitude-versus-frequency response is modified so that stylus deflection is uniform with frequency. This is performed to a Standard due to the RIAA (Record Industry Association of America) which requires 13dB of cut at 100Hz and 13dB of boost at 10kHz.

On replay of the disc the signal must be processed with the inverse of the recorded amplitude-versus-frequency characteristic in order to produce the original signal faithfully.

In addition, high fidelity magnetic cartridges may have an average output as low as 2 millivolts. A high voltage gain is therefore required to enable the amplifier to be driven to full output.

The first stage of our preamplifier provides both of the above functions, RIAA equalization and a gain of 100 at 1kHz. Transistors Q1, Q2 and Q3 form a high gain (open loop) non-inverting amplifier. The gain is controlled by the feedback network R8, R10, C4 and C5. The actual gain of the amplifier at any frequency is approximately equal to the impedance of the network at that frequency, divided by 1000 (R6). The network is designed to provide an amplifier gain characteristic which gives the required RIAA equalization.

Switch SW2 selects the output of the equalization amplifier, the radio tuner or an external input as required and connects it, via the volume control RV1 and buffer amplifier Q4, to the tone control stage.

Transistors Q5 and Q6 are a high gain (open loop) buffered amplifier with feedback provided by the tone control networks. With both tone controls set to mid position, the impedances Z1 (emitter Q4 to base Q5) and Z2 (base of Q5 to junction R31 and R32) are equal. In this condition the overall gain from Q4 emitter to the junction of R31 and R32 will be unity at all frequencies, and to the emitter of Q6 the gain will be about four. As the tone controls are varied, the ratio of the impedances Z1 to Z2 will vary with frequency, and hence stage gain will vary with frequency.

Control RV2 provides either bass boost or bass cut, and RV3 provides treble boost or treble cut. The control RV4 differentially varies the channel gains to provide balance.

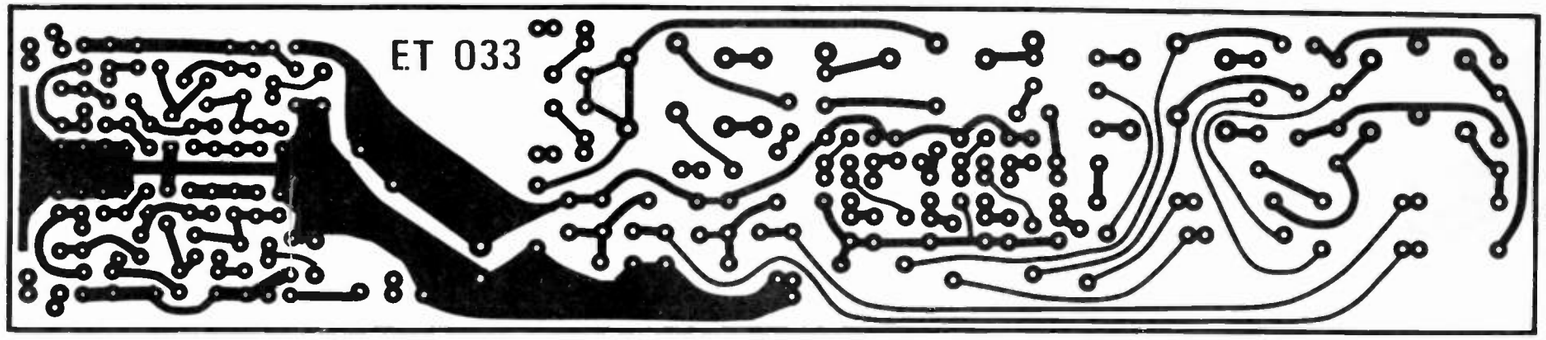
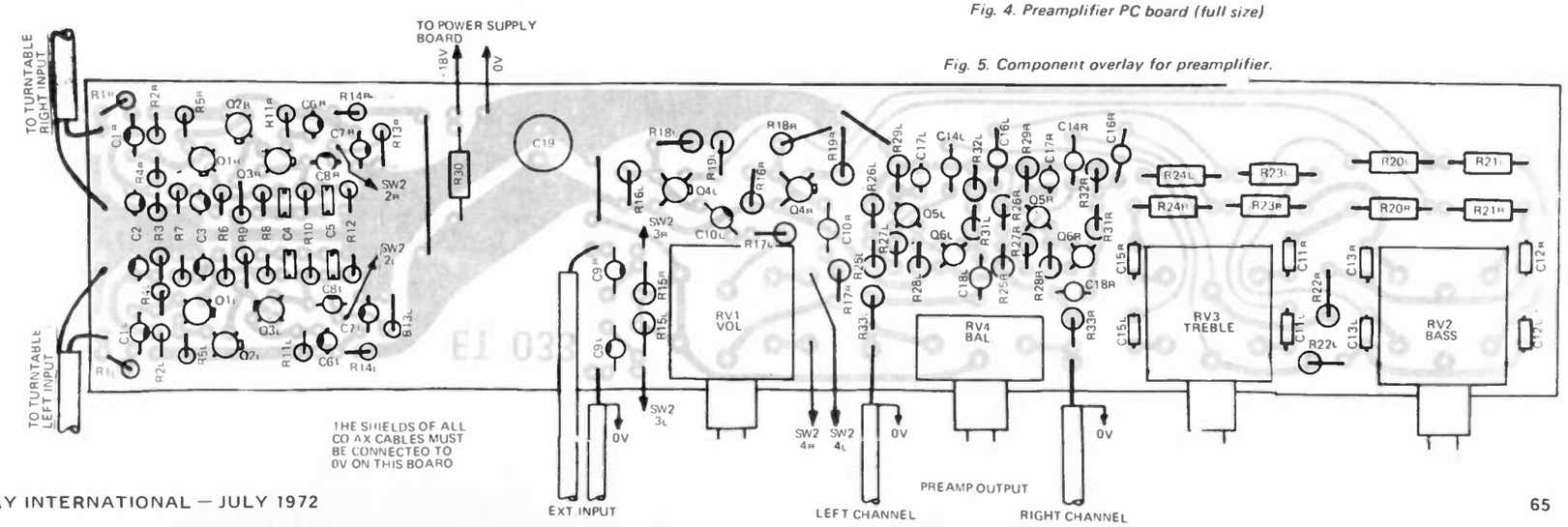


Fig. 4. Preamplifier PC board (full size)

Fig. 5. Component overlay for preamplifier.



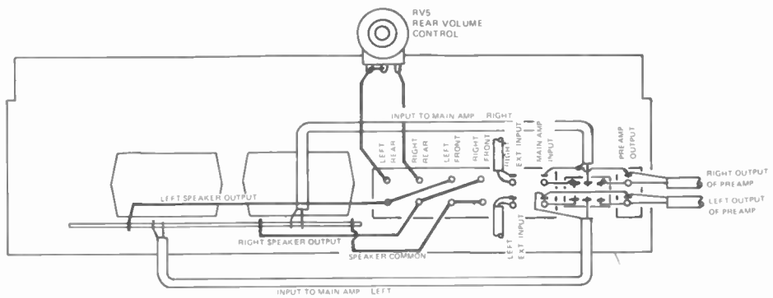


Fig. 6. Rear panel assembly and wiring detail.

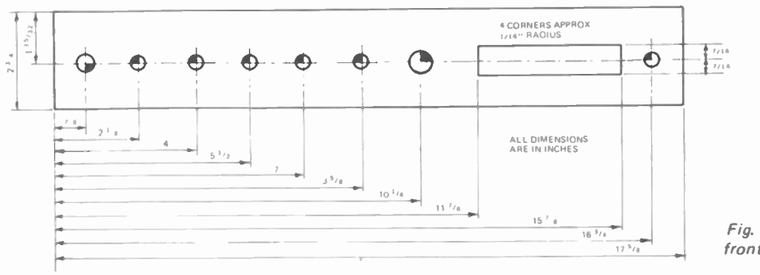


Fig. 7. Drilling details for front panel.

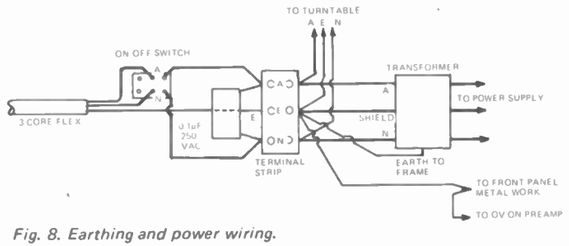


Fig. 8. Earthing and power wiring.

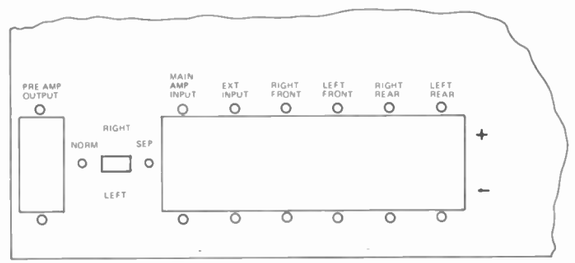


Fig. 9. Rear panel layout.

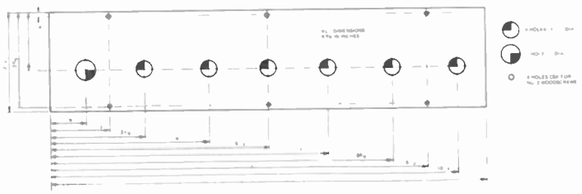


Fig. 10. Front support panel (18 gauge steel) drilling details.

ERRATA

There were two errors and a component change in the first instalment of the integrated audio system, published last month. These are:—

In Fig. 1, the hybrid amplifier circuit, C3 is shown with incorrect polarity, the positive lead should be connected to pin 10 of the IC.

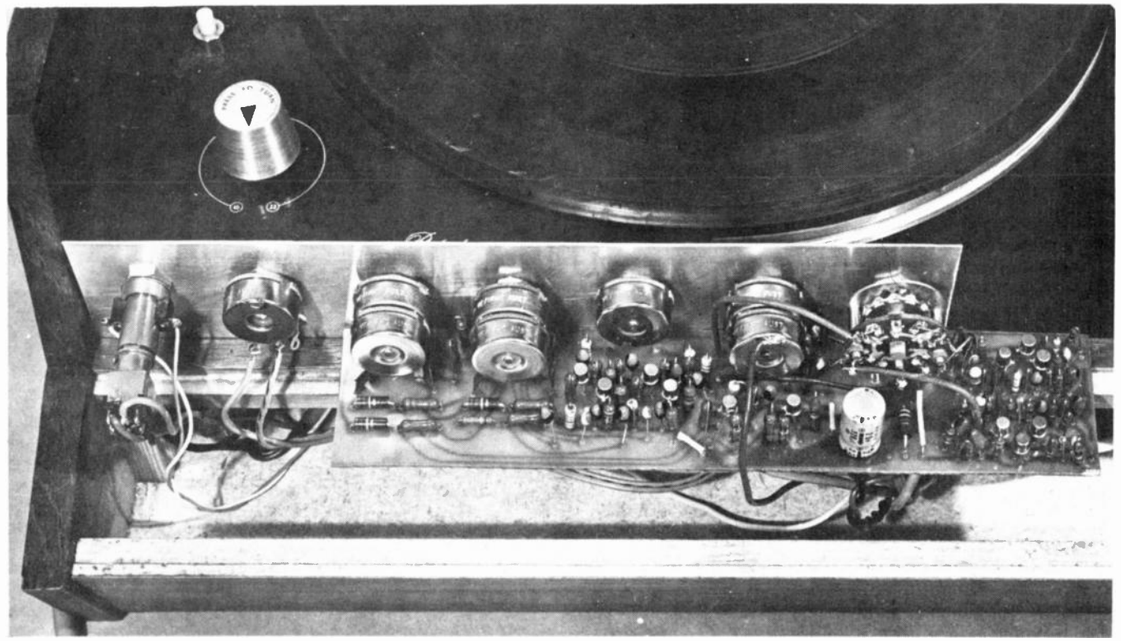
In Fig. 4, the power supply circuit diagram, diode D5 should be labeled D6 and diode D6 should be labeled D5.

Neither of these errors affect the component overlay or the PC board diagrams, which are correct.

Also in the power supply diagram, capacitor C10 which is shown as 0.1µF 630 volt working should preferably be an 0.1µF 250 volt ac working, AEE Miniprint type PME 271. These capacitors are specifically designed for use as suppression capacitors in 240 volt ac circuits.

SYSTEM-ETI 425

INTEGRATED AUDIO SYSTEM



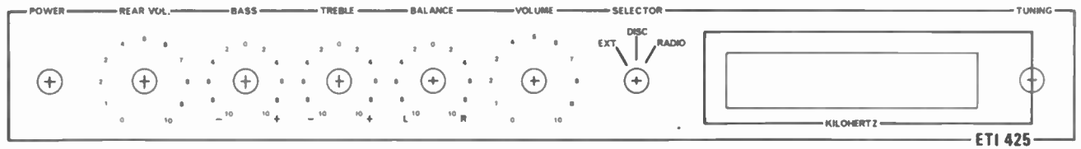


Fig. 2. Art work for 24 gauge anodised aluminium front panel.

LAST month we described the construction of the main amplifier and power supply of the integrated audio system. This month, we describe the construction of the preamplifier board and give details of the front and rear panel metal work. A wiring diagram is also given for power supply and earthing.

A suitable speaker system for use with this unit is described on pages 51 and 52 of this issue and next month we will provide details of the construction of smaller speaker enclosures which have almost identical frequency response to the larger units, but are perhaps more suitable to the portable applications of the complete system.

CONSTRUCTION

Space in the region of the control panel is severely limited. The instructions as to component type, size and placement should be closely followed otherwise problems may be encountered in later assembly stages. Mount all the components to the PC board in accordance with the instructions below and the component overlay diagram, Fig. 3.

Resistors in the equalization stages (R1 to R14) must all be ¼ watt rating. These resistors are mounted by bending one lead right around so that the two leads are parallel and inserting the component so that it stands vertically. Keep the overall height as low as possible. The resistors will be the highest components in this area and the other components should be mounted so that they do not protrude beyond resistor height. Pay particular attention to the orientation of transistors and electrolytics. The electrolytics should be of the TAG tantalum type as these are the smallest available.

The potentiometers used in the amplifier are IRH printed circuit board mounting types. These greatly facilitate construction and reduce the chance of wiring errors. Normal solder lug types may be used, if required, by taking wires from the lugs to the appropriate PC board holes. If standard potentiometers are used, make sure that the board is mounted not less than 3/8 inch from the rear of

PARTS LIST PREAMPLIFIER ETI 425

R1R, R1L	10k	¼w	5%	resistor
R2R, R2L	15k	¼w	5%	resistor
R3R, R3L	4.7k	¼w	5%	resistor
R4R, R4L	47k	¼w	5%	resistor
R5R, R5L	220k	¼w	5%	resistor
R6R, R6L	1k	¼w	5%	resistor
R7R, R7L	220k	¼w	5%	resistor
R8R, R8L	1 meg	¼w	5%	resistor
R9R, R9L	39k	¼w	5%	resistor
R10R, R10L	100k	¼w	5%	resistor
R11R, R11L	3.3k	¼w	5%	resistor
R12R, R12L	10k	¼w	5%	resistor
R13R, R13L	1 meg	¼w	5%	resistor
R14R, R14L	1.2k	¼w	5%	resistor
R15R, R15L	1 meg	½w	5%	resistor
R16R, R16L	100k	½w	5%	resistor
R17R, R17L	1k	½w	5%	resistor
R18R, R18L	100k	½w	5%	resistor
R19R, R19L	2.2k	½w	5%	resistor
R20R, R20L	2.2k	½w	5%	resistor
R21R, R21L	15k	½w	5%	resistor
R22R, R22L	47k	½w	5%	resistor
R23R, R23L	15k	½w	5%	resistor
R24R, R24L	2.2k	½w	5%	resistor
R25R, R25L	100k	½w	5%	resistor
R26R, R26L	47k	½w	5%	resistor
R27R, R27L	100k	½w	5%	resistor
R28R, R28L	47k	½w	5%	resistor
R29R, R29L	47k	½w	5%	resistor
R30	330	½w	5%	resistor
R31R, R31L	3.3k	½w	5%	resistor
R32R, R32L	1k	½w	5%	resistor
R33R, R33L	10k	½w	5%	resistor

C1R, C1L	0.47µF	25V	TAG Tantalum
C2R, C2L	22µF	16V	TAG Tantalum
C3R, C3L	10µF	16V	TAG Tantalum
C4R, C4L	3300pF	Philips type 630-332	
C5R, C5L	820pF	Philips type 630-821	
C6R, C6L	22µF	16V	TAG Tantalum
C7R, C7L	22µF	16V	TAG Tantalum
C8R, C8L	0.47µF	25V	TAG Tantalum
C9R, C9L	0.47µF	25V	TAG Tantalum
C10R, C10L	10µF	16V	TAG Tantalum
C11R, C11L	4700pF	100V	greencap
C12R, C12L	0.01µF	100V	greencap
C13R, C13L	0.01µF	100V	greencap
C14R, C14L	0.47µF	25V	TAG Tantalum
C15R, C15L	4700pF	100V	greencap
C16R, C16L	10µF	16V	TAG Tantalum
C17R, C17L	10µF	16V	TAG Tantalum
C18R, C18L	10µF	16V	TAG Tantalum
C19	100µF	25V	Elna type RB, electrolytic

Q1R, Q1L	BC109	transistor
Q2R, Q2L	BC109	transistor
Q3R, Q3L	BC179	transistor
Q4R, Q4L	BC109	transistor
Q5R, Q5L	BC109	transistor
Q6R, Q6L	BC109	transistor

RV1 50k dual, log, pc mounting, potentiometer IRH type CTS 45

RV2 100k dual, lin, pc mounting, potentiometer IRH type CTS 45

RV3 20k dual, lin, pc mounting, potentiometer IRH type CTS 45

RV4 100k single, lin, pc mounting, potentiometer IRH type CTS 45

RV5 25Ω single, lin, 3 watt potentiometer IRH type AW (fig. 10)

SW2 3 pole 3 position wafer switch PC board ET 033

front support panel (fig.10)
Anodized front panel. (fig. 2)

GOODMANS DIMENSION-8 LOUDSPEAKER SYSTEM

electronics TODAY INTERNATIONAL
product test

These new Goodmans speakers have excellent stereo spread.

THE Goodmans Dimension 8 are another one of the latest generation of unconventional speakers.

The enclosure is a truncated triangular prism, finished in oiled walnut, and standing on end on a black recessed base two inches high.

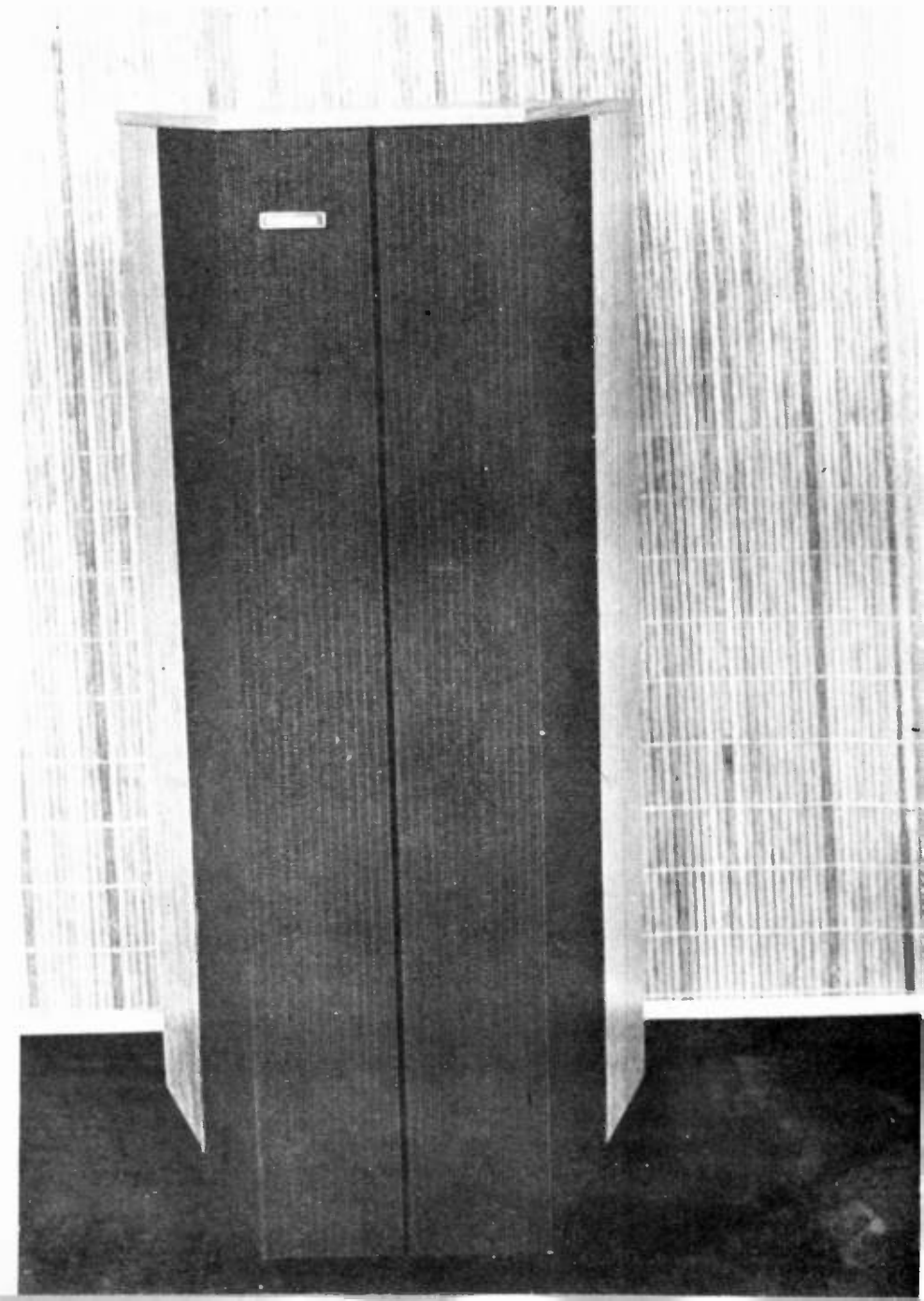
The black wrap-around grills cover the front face. This is the narrowest face and approximately half the width of the sloping sides. The rear face of the box has a square black grill recessed into it near the bottom and this covers a 12" diameter passive radiator.

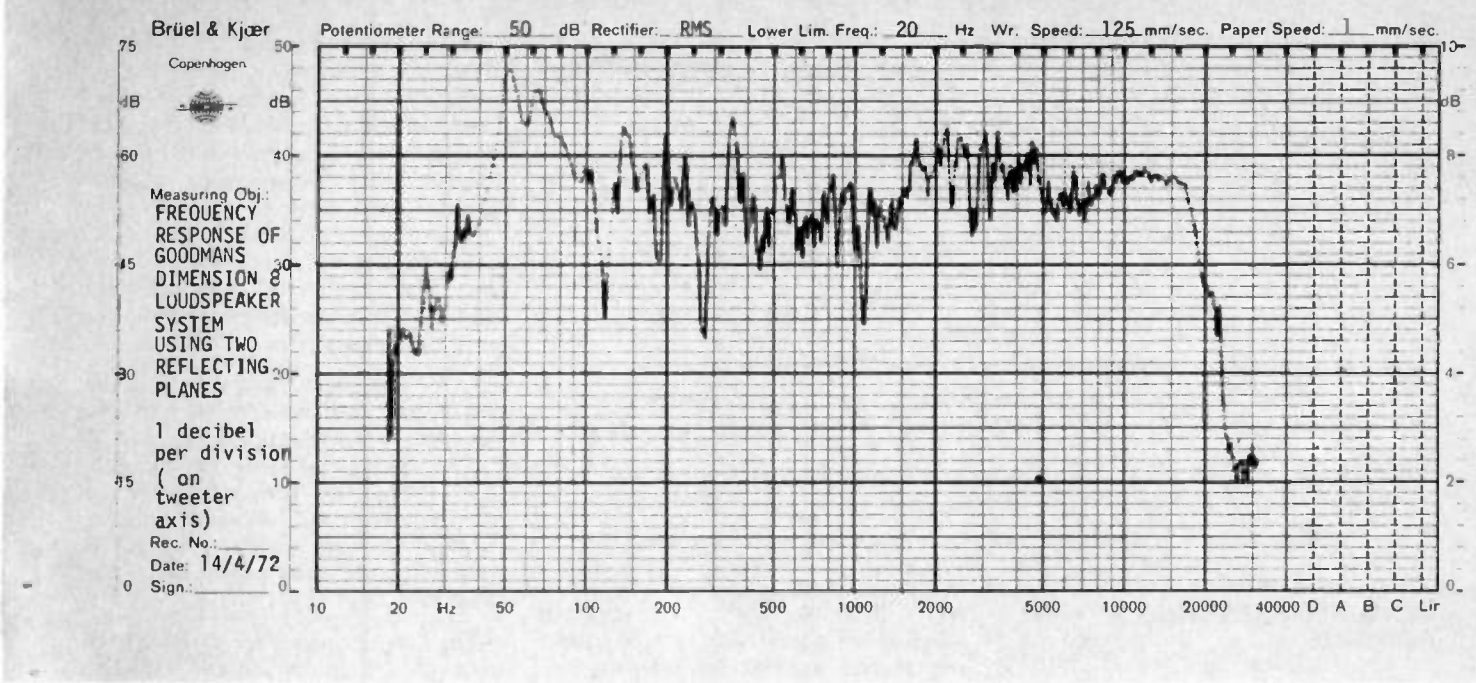
The bass response is handled by four 5" roll surround speakers and the 12" passive radiator. This radiator has two basic functions. Firstly, to dampen the movement of the woofers, secondly, to enhance the low frequency output. Normally the area of the passive radiator should be equal to the driver area. But in the Goodmans Dimension 8 enclosures the area of the passive radiator is approximately 20% larger.

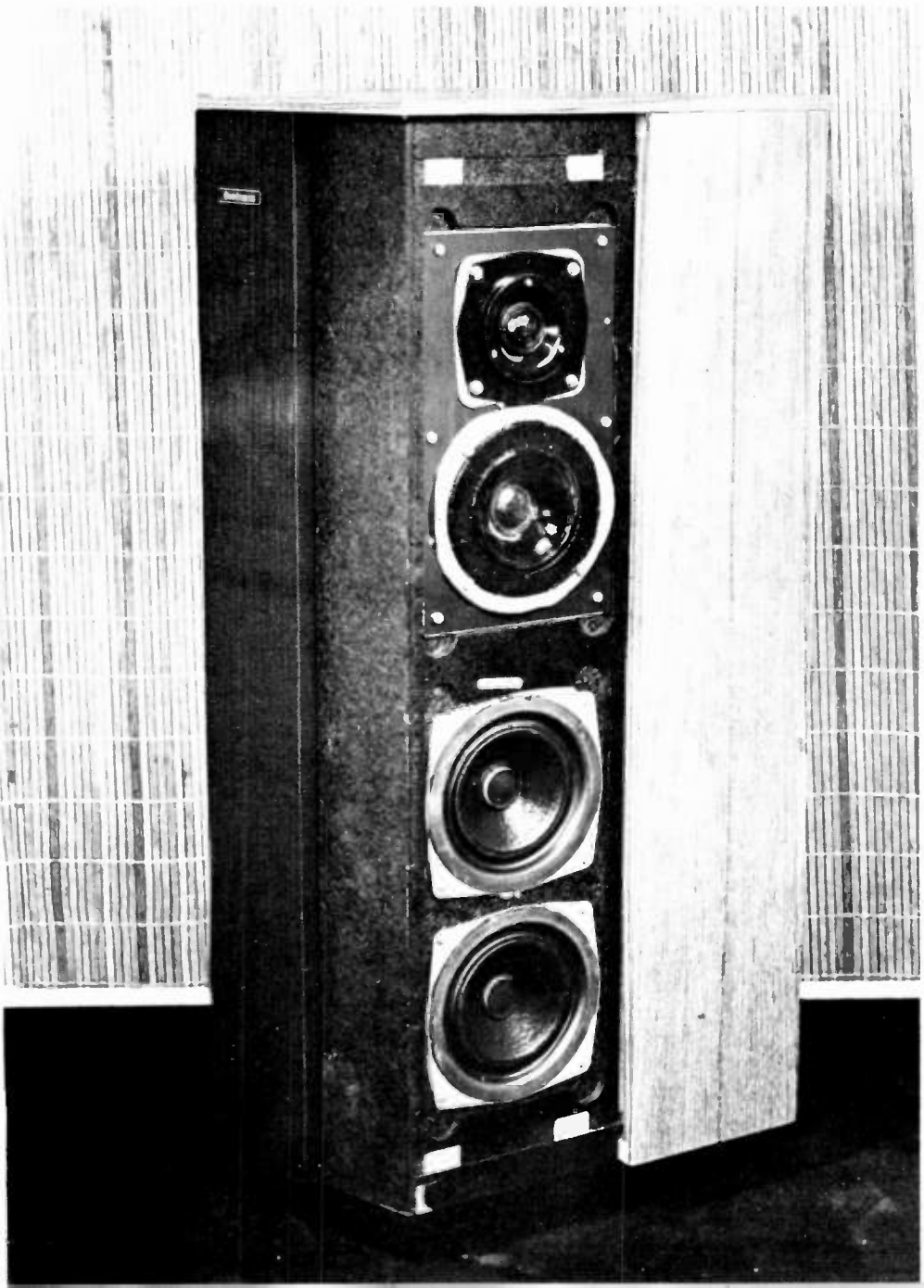
The four woofers are arranged in pairs at the bottom of each side face so that two woofers face left and two face right when viewed from the front. Directly above the woofers on each side, are a mid-range speaker and a domed tweeter. These are housed in a fibreglass enclosure to eliminate any reaction with the woofers.

The crossover networks are located in the base of the enclosure and consist of three LC circuits mounted on a printed circuit board (Fig. 1). Figure 2 clearly shows the response of each LC network with the crossover points being 700Hz and 5000Hz.

One very interesting feature of the design is the use of large blocks of foam plastic as the internal dampening medium. Most speaker manufacturers use fibrous materials such as fibreglass which have a much broader frequency







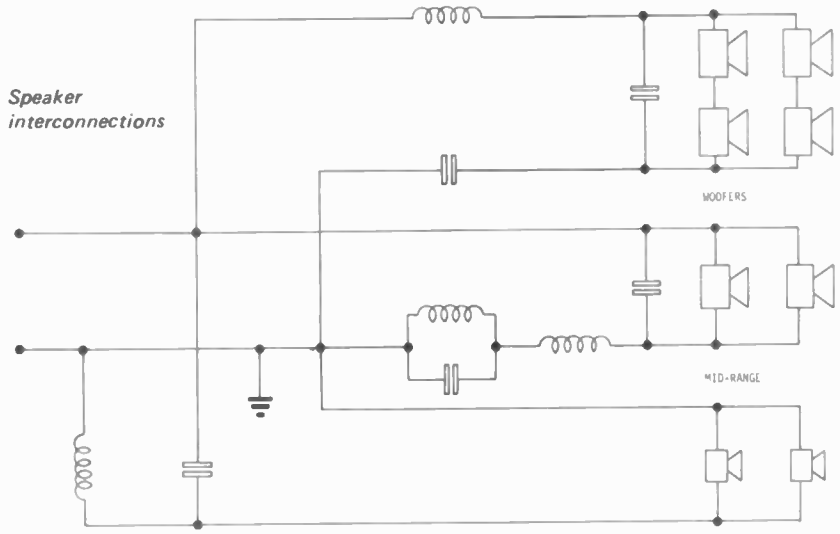
absorption characteristic and generally more effective dampening properties.

SUBJECTIVE TESTS

Subjective tests were conducted with the Warner Brothers record "Hand Made" (WB1838 CBS and "Everything You Wanted to Hear on the Moog." (CBS 235452). On both records (and others we listened to) a very distinct bass resonance was produced which could be best described as a 'boominess'. Measurements performed in the enclosure confirmed this resonance (as shown in the level recordings). The predominant point occurred at approximately 50 Hz. Except for this bass colouration the frequency response was quite smooth and extended to 20kHz.

Depending on the chosen listening position the high frequency response varied by as much as 30dB at 10 kHz as one moved from the front of the speaker enclosure to a position directly in front of the domed tweeters.

As with most unconventional speaker enclosures, the placement of the speakers is critical and can produce considerable difference in response. To obtain maximum performance the speakers should be placed in the corner of a room with hard reflecting walls and clear of any obstruction for at least four to five feet. This arrangement will provide additional short delay reflections which will reduce the loss of high frequency content directly in front of the speakers. The stereo spread produced by the Dimension 8 speakers was significantly better than that obtained with conventional speakers when arranged in this manner, and allowed greater flexibility in listening position, albeit at the expense of reducing space for other furniture.

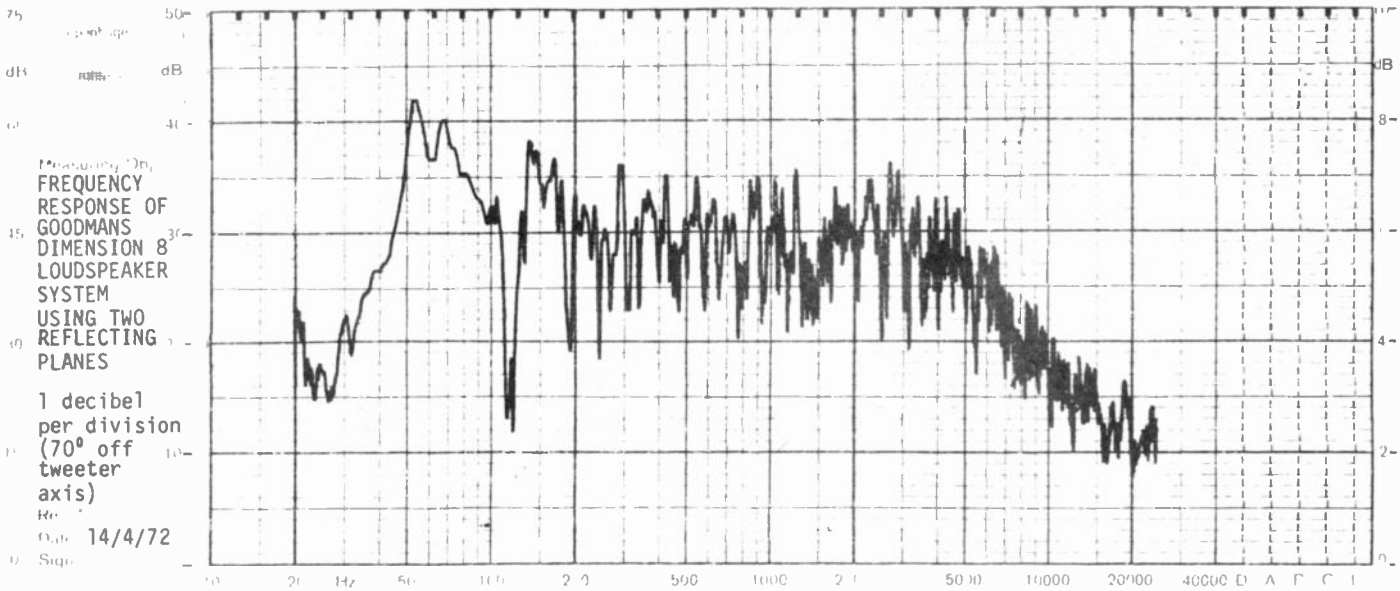


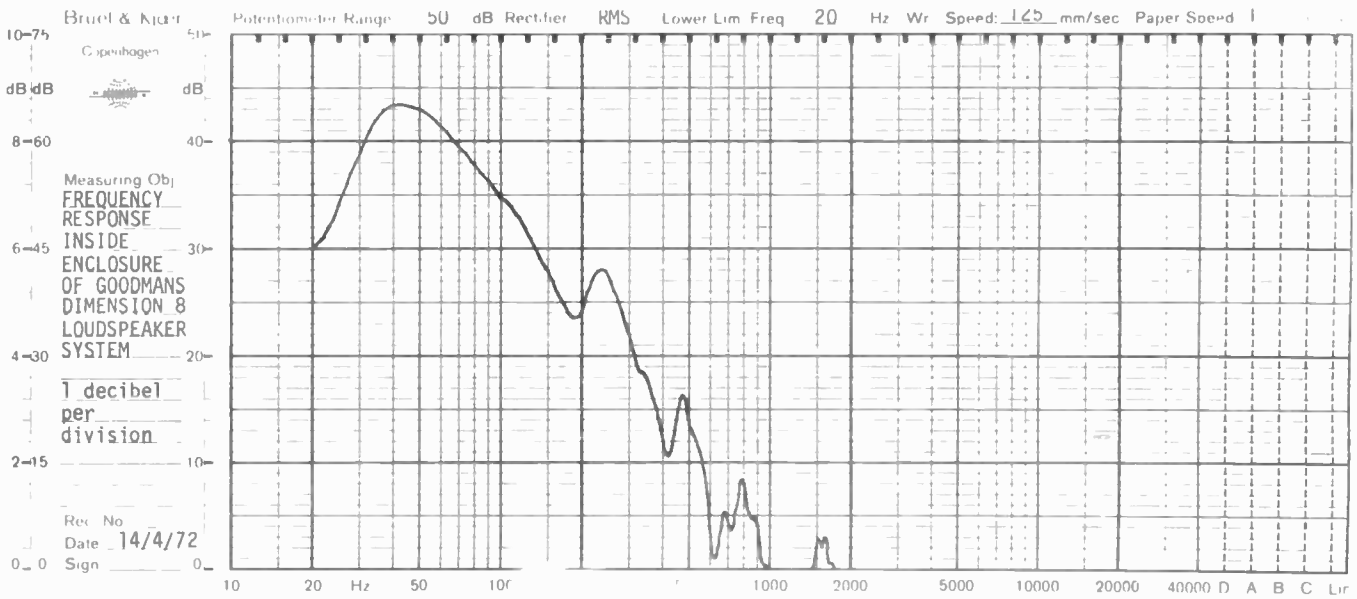
MEASURED FREQUENCY RESPONSE

Our measured frequency response was obtained with the speaker standing on a reflecting ground plane and turned so that no face of the cabinet was parallel with the reflecting plane behind the speaker and with the microphone placed on axis with the tweeter. The measured frequency response shows a number of drop outs at the low frequency end. These are partly due to interference between direct and reflected waves. Any measurement conducted with one or more reflecting planes will produce these drop outs and peaks and these will change in frequency depending on microphone position.

With the exception of the bass resonance the performance of the Goodmans Dimension-8 speakers is quite good. Because of the low efficiency of its enclosures an amplifier with approximately 50 watts average power output would be required to obtain adequate bass response.

The bass resonance could possibly be reduced by using a more effective damping media inside the enclosure. ●





MEASURED PERFORMANCE OF GOODMANS DIMENSION-8 SPEAKER SYSTEM

Frequency Response 70 Hz to 20kHz ± 6dB
30Hz to 20kHz ± 10dB

Total Harmonic Distortion

	100Hz	1kHz	6.3kHz
1 watt input	1.7%	1.1%	1%
5 watt input	3.5%	1.2%	1%

Electro-Acoustic Efficiency 0.16%

Cross Over Frequencies 700Hz, 5000Hz

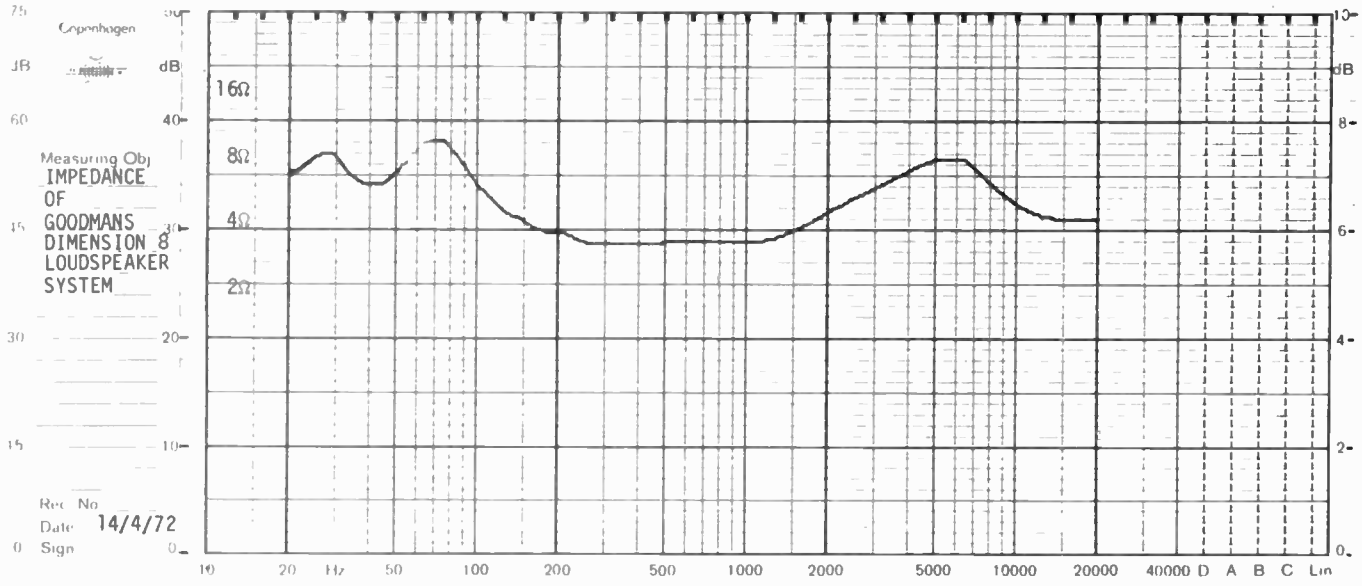
Woofer Resonance In Enclosure 48Hz

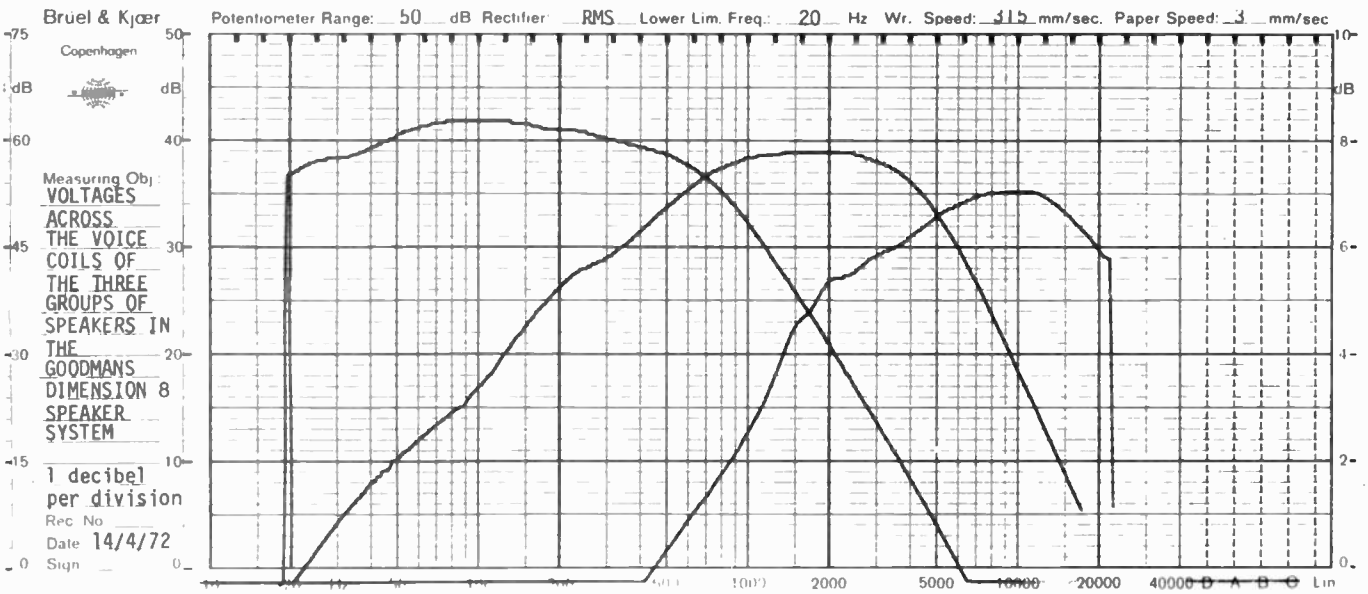
Dimensions 30-3/8" High x 14" Deep x 12-1/2" Wide

Weight 44lbs

Price. $588 (pair)

Rear face of the Dimension 8 speaker — the passive radiator is behind the woven grille.





PART 4

TRANSDUCERS IN MEASUREMENT AND CONTROL

In this article Peter Sydenham M.E., Ph.D, M. Inst. M.C. discusses ways of measuring tilt and alignment.

The force of gravity causes liquids to settle with a horizontal surface – and suspended objects to hang in a vertical direction. These two natural reference directions are used extensively in engineering construction, e.g., in the erection of buildings and bridges; in agriculture where drainage is vital; in road and railroad building to obtain smooth curves, and in the workshop when flatness or straightness is needed. The plumb line provides a perpendicular to the horizontal plane so each may be derived from the other.

The earth, being roughly spherical, has a curved level surface with the verticals being at different angles to each other at different locations. For most engineering structural requirements, however, it is adequate to regard the area of surface involved as flat. This curvature is roughly one part in 300,000 (0.1 mm in a 30 m distance) and this is only relevant in the construction of the most precise engineering structures, such as large nuclear accelerators.

If these phenomena are studied more closely it will be found that the liquid surface does not smoothly vary around the Earth in a spherical shape but takes up an undulating surface. This is the result of the varying gravitational forces brought about by the different distribution of mass in the Earth. The surface varies periodically in direction by a small amount, this being the result of the influence of the Sun and Moon which cause shape changes in the Earth. In geophysics these changes in the level surface or the vertical are monitored with great sensitivity in order to study the behaviour and composition of our globe. There are, therefore, many disciplines needing devices that can produce an electrical signal when deviations from the horizontal or vertical occur. In general, engineering inclinations need only be resolved to around an arc second at the best (but with a dynamic range of degrees), whereas in geophysical measurements the need is for the utmost in resolution with a range rarely exceeding arc seconds.

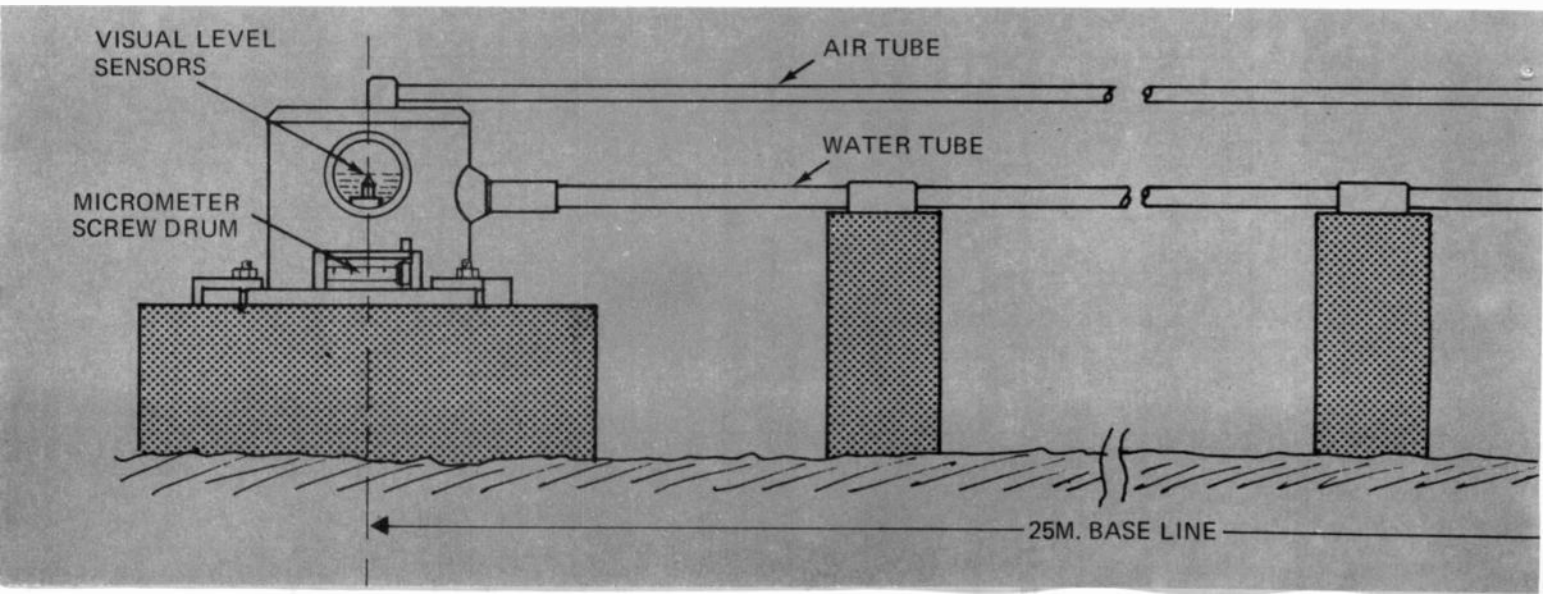
Another group of closely allied devices are those for measuring alignment. As many of these have levelling devices inbuilt, it is appropriate to discuss them together. An alignment device is capable of yielding measurement information about the degree of displacement of a point from a chosen line or plane surface, but usually there is no provision for deciding where that point is along the line.

TILT TRANSDUCERS

Liquid Level References

A large percentage of tilt transducers make use of water or mercury pools which are interconnected with a

Fig. 1. Side view of a water-tube tiltmeter.



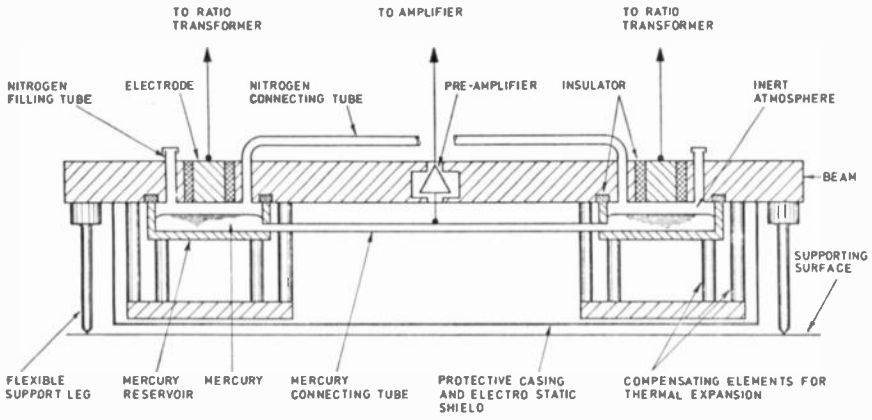


Fig. 2. Cross-section of a mercury cistern tiltmeter.

communicating tube. As tilt occurs the pool heights at each end vary relative to their container. The changes in height are monitored with microdisplacement devices such as were described in Part 1.

Tilt is basically an angular measurement, so it is apparent that the further the containers are apart, the greater the displacements resulting. A schematic view of one of a few water-tube tiltmeters installed in New Guinea for crustal movement research is shown in Figure 1. This unit does not have automatic recording but relies upon visual observation of a needle that is manually driven upward with a calibrated micrometer-screw -- to a position where its point just breaks the surface. Using the microscope viewing units provided to see when the surface is broken, it is possible to resolve a 3μm difference in height in the 25 m base line used, giving it angular discrimination of 10^{-7} radians.

Another application of the water-tube method is for monitoring the settlement of the structures of generating plants in power stations. It is not convenient to climb over the plant in order to read the individual levels. To avoid this, a system is used that enables the operator at a central point to pump up the level at each remote container in turn, until an electrical circuit is made by the liquid touching an electrode. He then reads off the level at that point from his end.

The leaning tower of Pisa is instrumented with a liquid circuit around its base. Transducers operated by floats give the tilt of the tower relative to the horizontal datum provided by the liquid. Diametrically opposite gauges provide differential signals that reduce errors due to level changes as the liquid heats and cools or evaporates.

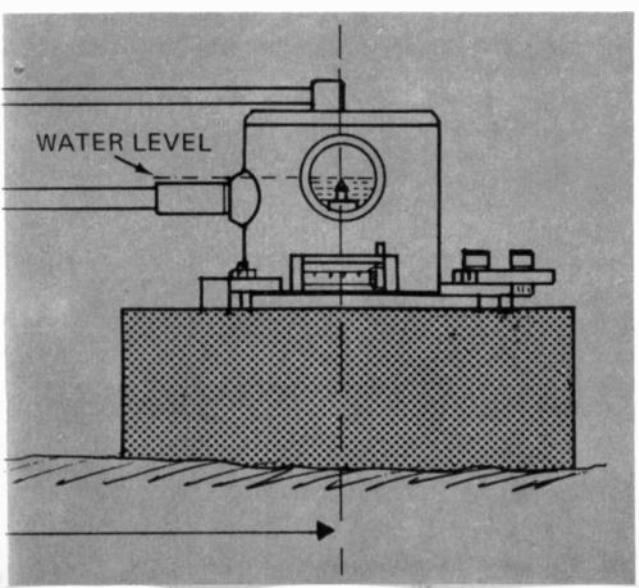
The largest type of liquid level measurement must be the sea-tide gauge. A common method uses a float driving a rotary transducer via a chain or wire. The units act with less than unity gain, for the amplitude of the movement is large. To obtain a well-conditioned response from the float, it has been found necessary to use a hydraulic filter consisting of a vertical tube containing the float with small entrance and exit holes that damp the rate at which the water can enter or leave the tube. This acts as a low pass filter removing the high frequency components.

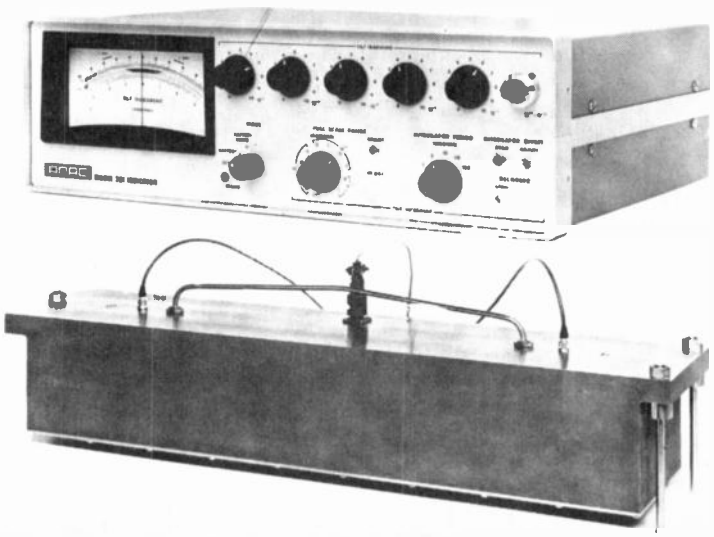
The main difficulty with an extreme sensitivity water system is how to sense the surface position. If greater resolution were available in the surface detection, the base-line could be shortened reducing the size of the equipment. By using a conducting liquid, the liquid itself can act as a common electrode in a differential capacitance sensing arrangement (see Part 1). For this reason several mercury-cistern tiltmeters have been developed that have extreme sensitivity with only centimetre baselines. A cross-section of the A.N.A.C. instrument originally developed at the University of Queensland, is shown in Figure 2. Above each mercury pool surface is an insulated electrode, these and the mercury form part of a bridge circuit which is completed by an electronic unit using ratio transformers. The unit, illustrated in Figure 3, can measure angular changes as small as 10^{-9} radians. This is two orders of magnitude better than the much longer water tube tiltmeter described above.

Not all tilt has to be measured with such exactitude. In building construction, for instance, the requirement is for only millimetre definition in metre distances. The familiar spirit level is the oldest form of liquid level in general use. In this a gently upturned curved vial contains a liquid in which a small air bubble is trapped; the bubble attempts to remain on the top of the curve. Sensitivity increases as the curvature flattens, and a good quality engineer's level can discriminate tilts from the horizontal of micrometres in a metre.

The bubble level has been automated by the British Aircraft Corporation. This unit has platinum electrodes set into the glass and the unit is filled with a conducting alcohol solution. As the bubble moves in the vial, the electrical resistance between the central and outer electrodes varies and the movement can be sensed using an ac

Fig. 3. Mercury-cistern tiltmeter with electronic unit.





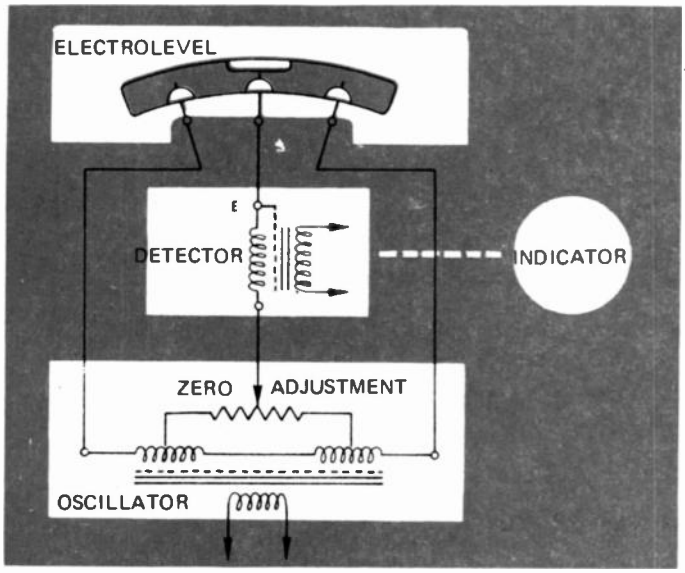


Fig. 4. Electrolevel tilt transducer using a vial filled with a conducting fluid.

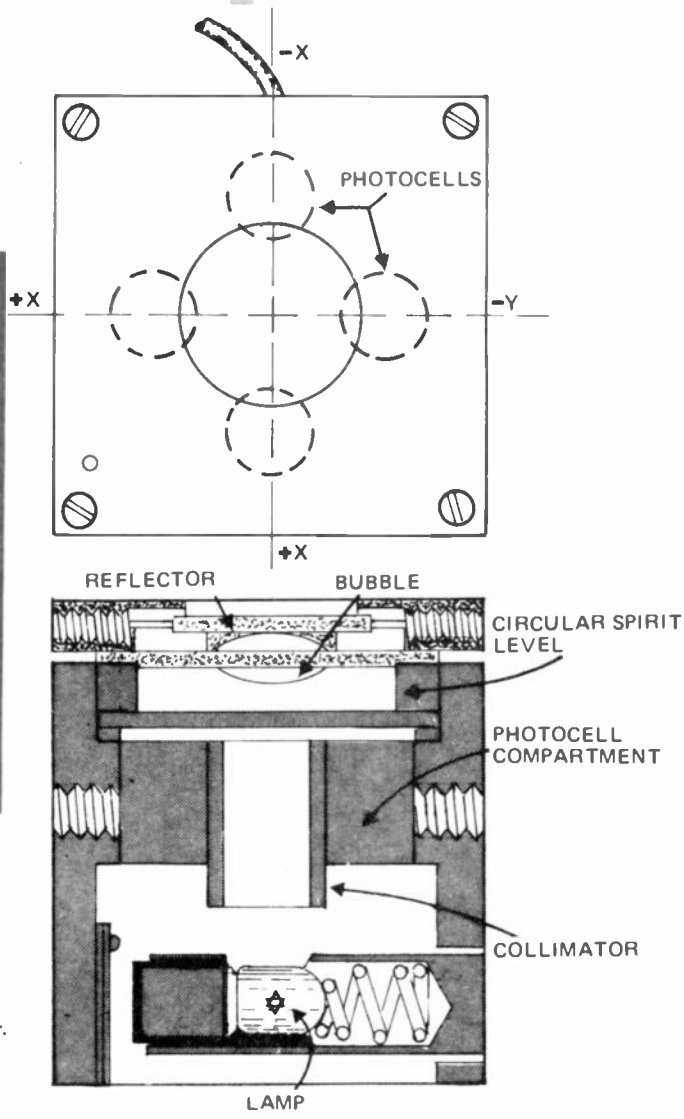


Fig. 5. The N.A.S.A. biaxial tilt transducer. This is capable of 15 arc seconds resolution in each of the axis of tilt.

bridge as shown in Figure 4. The most sensitive version can sense fractional seconds of arc with a settling time of less than a second.

Occasionally there is need for two-axis level readout and for this the bubble method has been employed by NASA personnel in a different form. A circular bubble, forms a lens that modifies the distribution of light passing through it. A reflecting mirror is placed above the bubble. Four photocells, used as position-sensitive detectors, monitor the reflected light distribution providing readout of angle in both directions (Fig. 5).

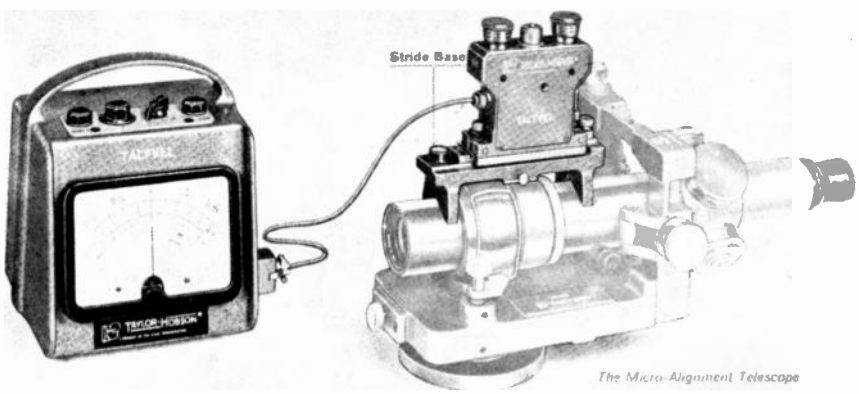
If the depth of the liquid is great, such as in the sea, changes in height can be monitored indirectly using the change of pressure head above a point deep down. In oceanographic research at the Horace Lamb Centre in Australia, the amplitudes of tides and swell are measured this way using a recoverable capsule which is placed on the ocean floor. In this is a pressure gauge transducer, recorder and power supply.

PENDULUM REFERENCES

As mentioned earlier, the vertical direction is directly related to the horizontal so pendulum devices can be used to measure tilt of the horizontal. Many tiltmeters make use of pendulums. The most straight forward type of pendulum is a mass hanging on a light suspension. Microdisplacement transducers are used to determine the position of the pendulum relative to the mounting frame. If size is not important, the pendulum can be as much as a metre or more in length to increase the sensitivity. Several tiltmeters are available commercially (at a price of many thousands of dollars) that can be lowered into a vertical borehole. In this application, liquid level devices would not be suitable due to the limited size of hole available. It is most important that the pivot point of the pendulum is precisely defined, for the angle of tilt is inferred from the displacement at the lower end together with length of the pendulum. The forces needed to deflect a pendulum are extremely small. For this reason feedback measurement is often used in which the pendulum position is restored by electromagnetic means in a force-balance technique. This helps to ensure that the measuring transducers are always in the same force-exerting position. Borehole tiltmeters often measure the tilt of two perpendicular directions.

If the microdisplacement device is extremely precise, as is possible with well developed capacitance

Fig. 6. An inductively-sensed pendulum tiltmeter being used with an alignment telescope to provide a horizontal line of sight.



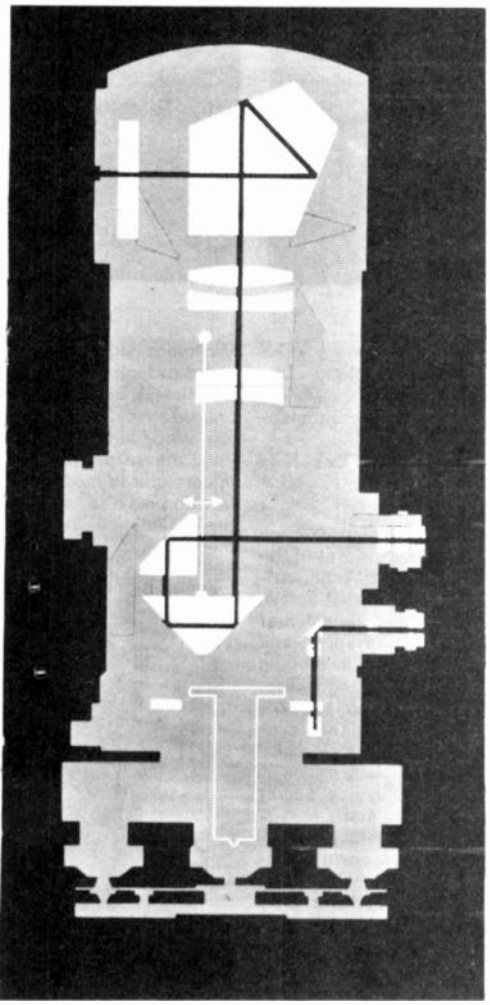


Fig. 7. Schematic of the Zeiss (Jena) automatic level. The prism always hangs vertically ensuring a level line of sight through the optical system. No electronics is used.

micrometer arrangements, the pendulum can be shortened. Professor Jones of the University of Aberdeen described small tiltmeters in Electronics Today, September 1971.

Inductive sensing of the pendulum position has been used in the Talyvel engineering tiltmeter. In Figure 6, a pendulum is used astride an alignment telescope to define a level line of sight.

A plumb-line, as well as defining a line in the vertical direction, is a tiltmeter pendulum of relatively greater length. Several instances of automated plumb bobs exist. The Russians have published details of a highly precise plumbing arrangement used during the erection of one of their large nuclear accelerators. It consisted of a steel wire plumb line having its bottom weight immersed in a damping fluid. A little above the bottom are two C cores arranged so that the wire forms the moving armature of a differential reluctance displacement transducer. They reported a centering accuracy of around 10μm which is the tolerance limit required in high precision engineering.

It is possible to build mechanical gain into a tiltmeter so that a larger movement occurs in the output member than in the member being driven by the tilt change. Before electronics, these methods were in vogue as there were no other ways to obtain adequate amplification of the small movements. Nowadays, however, electronic displacement transducers can easily sense the fine displacements resulting.

In surveying, the traditional bubble levelling instrument is being replaced by self-aligning or automatic levels. These use optical prisms which are suspended with fine wires so that the optical path always looks out in a level line to a precision of up to a few seconds of arc (in the precision models). There are a number of different methods used, Figure 7 shows just one. Surveying instruments are good examples of how other than electronic solutions to measuring problems may be the better to employ. In this instance the overall weight and, most important, the cost is less than the equivalent electronic method.

PLUMMETS

Before going on to alignment devices, a brief description of the devices used

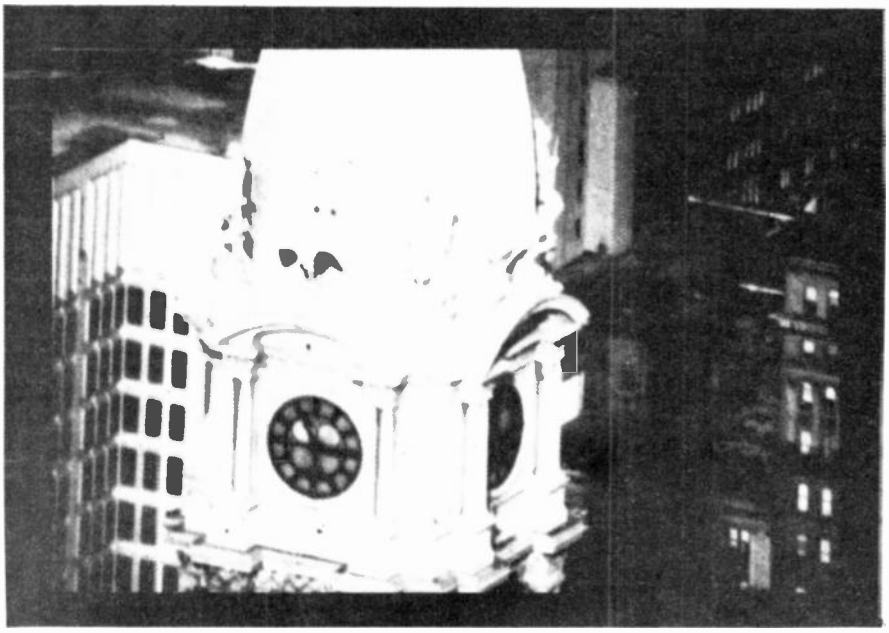


Fig. 9. The Dynalens image compensator removes vibration problems when using high powered telescopes.

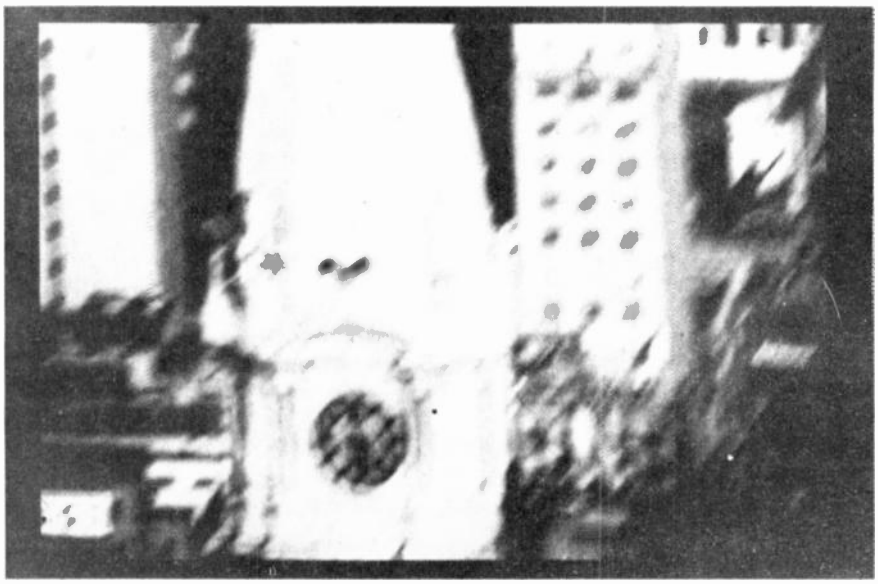
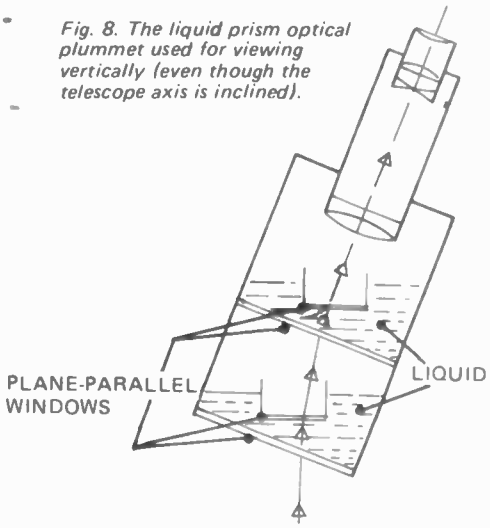


Fig. 8. The liquid prism optical plummet used for viewing vertically (even though the telescope axis is inclined).



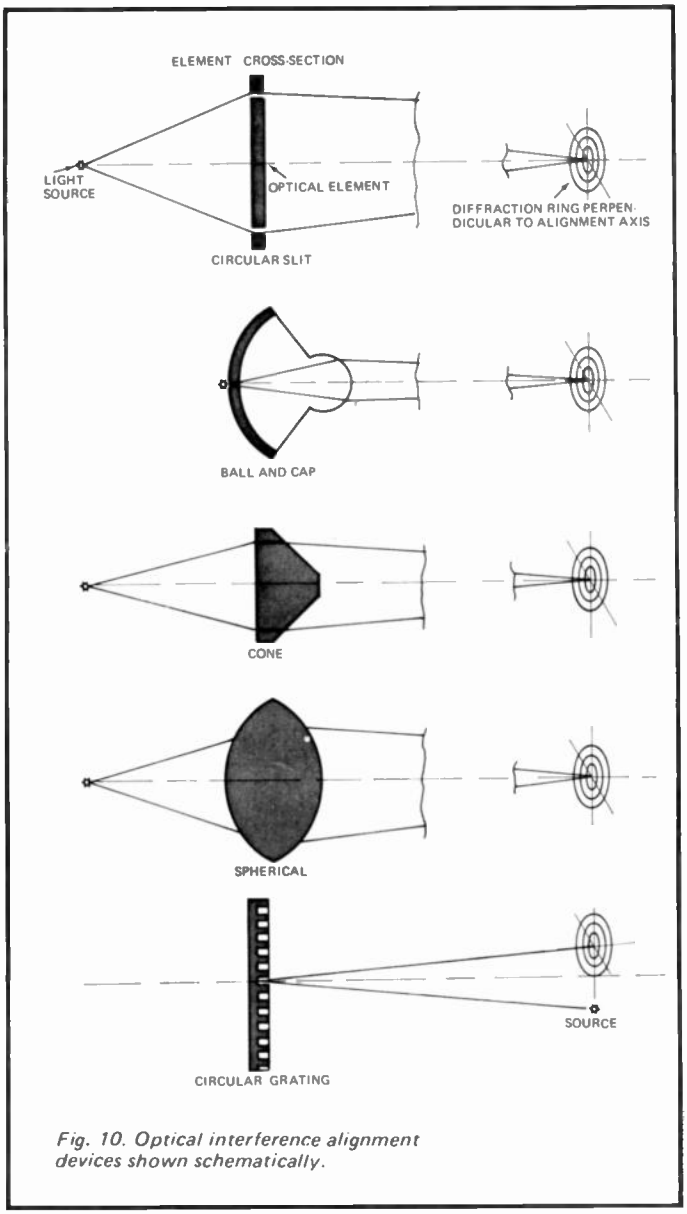


Fig. 10. Optical interference alignment devices shown schematically.

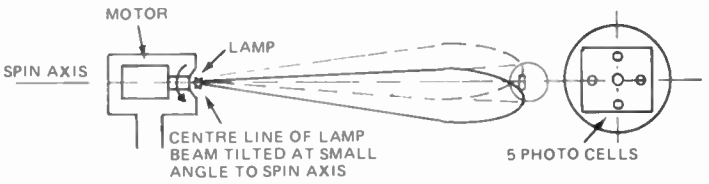


Fig. 11a Sperry

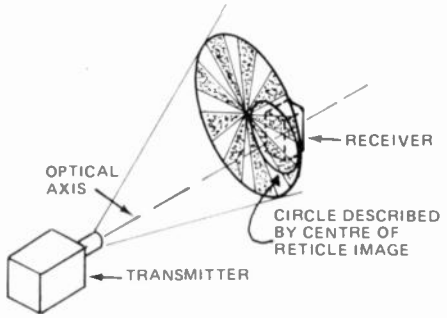


Fig. 11b. Yates-Hudswell.

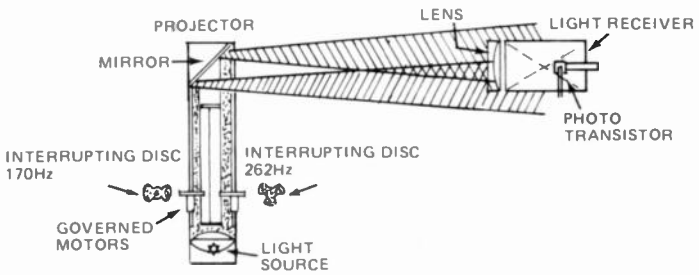


Fig. 11c Agricultural Institute.

Fig. 11a/b/c.
Spatially modulated optical alignment methods using conventional light sources.

to define vertical sight lines is needed. We have already encountered the automated plumb line. Other methods use optical techniques to define a line perpendicular to the horizontal. In astronomy the vertical is defined by using the surface of a large mercury pool as the horizontal reference. Similar, but much smaller pools are made for use with telescopes in the engineering optical-tooling setting-out procedure. At the top of the automatic level shown in Figure 7 is a penta-prism which provides a right angular optical path by careful manufacture of the angles between the surfaces. If the penta-prism is omitted, the visual path will be in the vertical direction. The same instrument is, therefore, easily adapted as an automatic optical plummet.

In mountain surveying operations it is often necessary to have a helicopter above a ground mark (with high precision) so that an electromagnetic distance measuring instrument can be used to read distances between ground stations. This is not easy, for the helicopter can wander in all six degrees of freedom. One solution is to use a ground-based television camera that is directed in the true vertical direction. A television monitor in the helicopter enables the pilot to see that the ground based camera views a reference mark on the underside of the helicopter. He hovers to keep the mark central in his screen.

IMAGE STABILISATION

An optical device which is useful when the observational platform is unstable is the liquid prism plummet. Figure 8 shows its principle. As the telescope tilts, the liquids flow to form changing dimension prisms which diffract the sight path in proportion to the tilt of the system. This helps to reduce the vertical sight path error caused by the tilt of the platform. Floating windows are used to overcome the vibrational effects on the surfaces of the liquid.

Gyros can be used to stabilise the position of a mirror, and in cases where the vibration is at a high frequency, a mirror spinning in the plane of its surface acts as a good reference. This method is used in bombsight equipments. It has also been used in high power binoculars to stabilise the sight paths. The gyroscope and the liquid lens have been combined in the Dynasciences Corp., Dynalens image motion compensator. Inbuilt inertially-stabilized directional references are used to sense deviations from the steady state position. Error signals actuate liquid prisms, via

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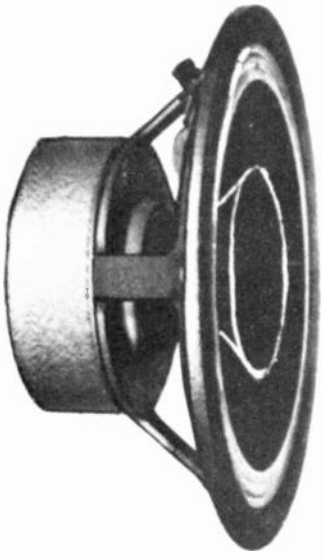

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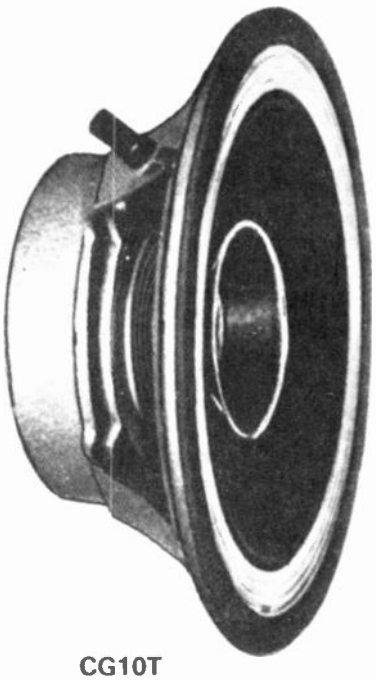

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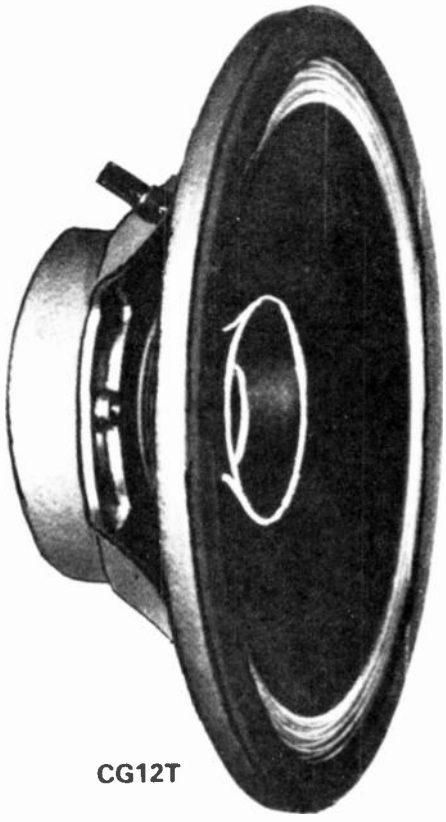

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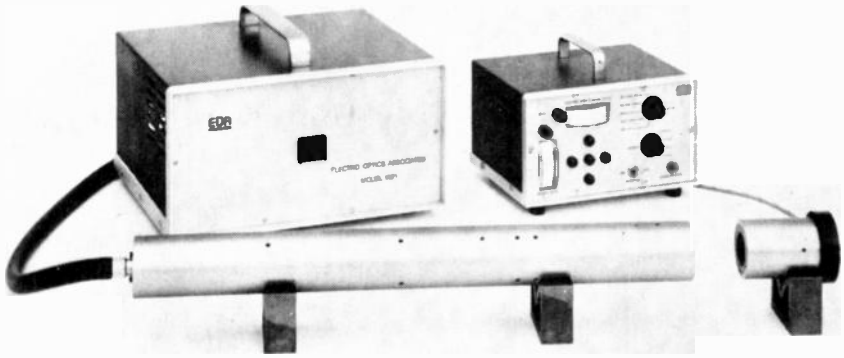

Fig. 12. Two axis, electrical readout, optical tooling laser.

electromechanical means, changing the optical axis to keep the sight path constant in space. This method has a much wider response bandwidth enabling it to cope in a broader range of circumstances. The dramatic difference between stabilized and unstabilized scenes, as viewed from a helicopter, is evident in Figure 9.

ALIGNMENT

A large number of situations require knowledge about straightness, flatness, parallelism, levelness, roll, pitch or yaw. At the high precision end of capability is the need to measure the flatness of machine tool beds, surface plates and optical components. Other applications such as agricultural drainage, pipe laying, pipe and pile borer guidance, road grading, concrete slipform paving and railway track tamping also share similar basic needs. Each require methods for measuring deviations from a given line or plane for measurement or automatic control purposes. Such techniques are called alignment methods and as always, no single method suits all cases, so various methods have been developed.

WIRE GUIDANCE

A tightly stretched wire provides an accurate line when viewed in the vertical plane. Special microscopes are available to measure deviations from the wire. These use a double image system that is correctly positioned when both are coincident. In the horizontal plane, allowance must be made for the catenary sag of the wire. The Sulzer factory in Switzerland issues a chart fo the sag values. British and Russian reports claim alignment precisions of 20μm along distances of 50m by this simple method.

A number of concrete paving and kerbing machines use preset wires to define the road level. Microswitches, actuated by electromagnetic wire position sensors, control the raising and lowering of the paving slip edge. The precision is not high but the requirements for such cases need only centimetre control. As the speed of road and rail transport rises, closer control is needed. In the high speed experimental British Rail track, millimetre precision has been achieved using slip-form pavers.

OPTICAL TELESCOPES AND COLLIMATORS

A graticule placed in the viewing system of a reasonably powerful telescope provides the observer with a line of sight. Precision telescopes made for alignment (one is illustrated in Figure 6) have the optical axis precisely located with the axis of the body. Inbuilt graticules and optical micrometres enable the observer to view targets placed along the line, for example, the bearing housings of a large engine.

An autocollimator is similar except that it has an inbuilt light source that radiates an image of a cross hair onto a mirror (placed at the point of interest)

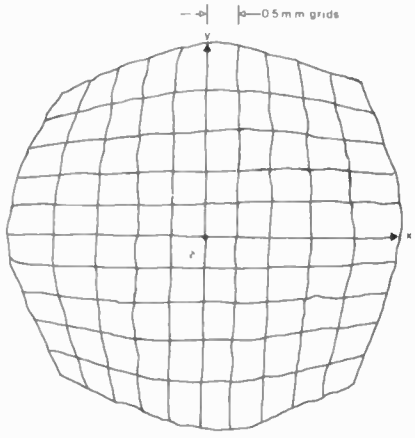

Fig. 13. A linearity plot of a two axis laser alignment readout system.

where it is reflected to appear in the viewing field alongside the original image. If the two images are coincident, the outward and return beams are in the same line of sight and the reflecting surface must be square to it. The autocollimator is, therefore, a sensitive angular measuring device. One of these devices is shown in Part 3 of this series – where it is used for setting the position of an angle encoder using a reflecting polygon. By using reflectors that remain at the same angle to their base, it is possible to measure flatness or straightness by calculation from the angular tilt of the surface (at chosen locations) and the position on the surface. Automatic readout autocollimators are available that have built-in position-sensitive photocells to give an electrical signal corresponding to the angular deviations of the reflected beam. A specially built unit, operating on this principle, is used to align spacecraft to within an arc second over a range of several hundred metres.

OPTICAL INTERFERENCE METHODS

In 1950, it was suggested in Holland that a circular slit would produce a diffraction ring along the optical axis, and that could be used for alignment, (Figure 10). The method works reasonably well, enabling alignment to be checked by viewing the fringes with a specially marked piece of perspex. The major defect was that many rings are formed and so the light energy in the central, important one of interest, is not large. By using a number of slits made as close as possible to the shape of the diffraction rings produced when light shines through a pin hole, it is possible to concentrate much more energy into the central bright spot or ring. These plates are known as zone plates. The National Physical Laboratory in Britain use these to provide a reference base, several hundred metres long, upon which alignment devices may be tested. There are many other ways to produce such rings and a few are shown in Figure 10. Only the latter is marketed for industrial use. Current research aims at providing electrical readout from such rings by scanning across them in order to determine the best centre.

Spatially Modulated Systems

If a beam of conventional light is radiated, it diverges to such an extent that the centre is difficult to detect with precision. Furthermore, the amplitude will vary with time due to changing atmospheric conditions. For this reason, various methods have been evolved in which the beam is modulated in a spatial manner.

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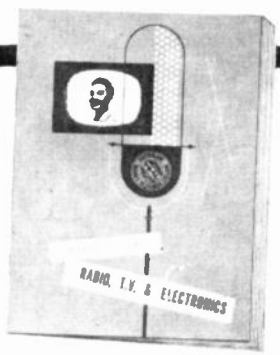

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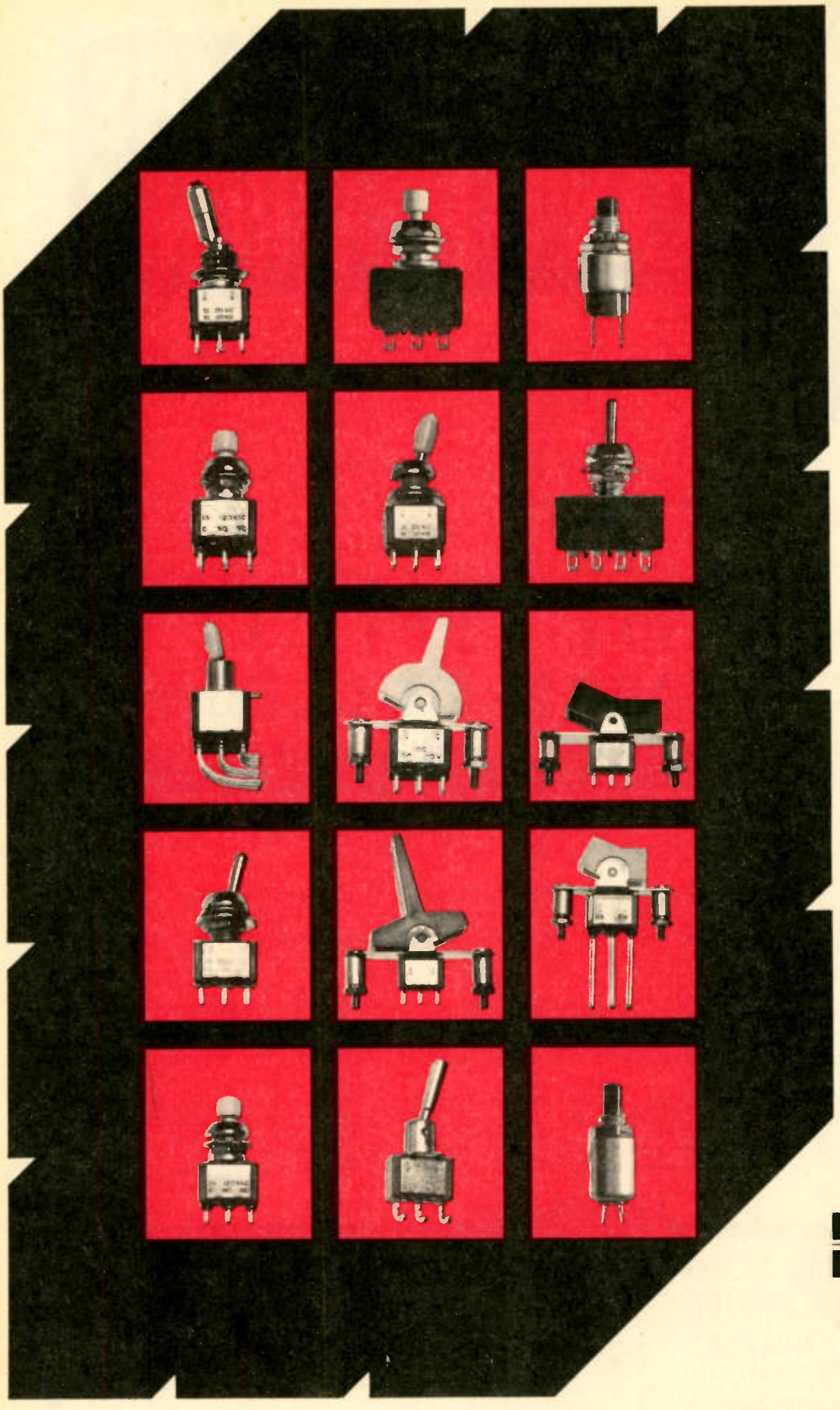

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A system developed by Sperry is shown in Figure 11. A motor rotates a slightly tilted optical system so that the optical axis nutates in space. A detector having five photocells is placed on the beam axis. If central on the detector, each of the four outer cells has an equal ac component and mark space ratio. In not aligned, error signals are produced. This method can resolve to 0.3mm in 30m distances and has been applied to an experimental road grader to hold the blade in a straight plane regardless of road surface. A pendulum sensor holds the blade's transverse angle in control.

The next method is adapted from a military tracking system. It is now used to control the ploughing-in of agricultural pipes in Britain. A spinning disk produces a spatial chopped beam that also nutates. This is sensed to see if there is any out of balance ac signals in a somewhat similar manner to the one described above, the difference being that frequency modulation results (not amplitude). It is claimed that this has a better signal to noise ratio in practice, for optical transmission in the normal air environment is less noisy to frequency effects than to amplitude.

A third system, developed by the National Agricultural Research Institute is shown also in Figure 11. In this a light source provides two beams closely parallel to each other. One is chopped mechanically at 170Hz, the other at 262Hz. The detector sees a spatial overlap of each frequency. When central it gives even amplitude signals at the two frequencies. This was used in an automatic pipe laying tractor.

Laser Alignment

The automated techniques mentioned above were devised before the laser was developed (remember the laser is only an invention of the last decade) and the sophisticated methods were needed to overcome the lack of an intense narrow beam of light.

Continuous-wave lasers are now used extensively in alignment, for the beam can be collimated to keep the beam width down to millimetres over hundreds of metre distances. For crude alignment, the beam can be viewed by eye (but not directly for fear of eye damage). Electrical output is generally provided by a quadrant silicon photocell position detector. One set of equipment is illustrated in Figure 12. Alignment lasers are now especially designed to ensure that the beam leaves the precision ground barrel in the centre and does not have significant angular variations with time. When using a quadrant detector, the two output signals are interrelated to an increasing extent as the spot moves from the centre. Figure 13 shows a typical calibration plot of the linearity obtained from the x and y axis signals. In the centre the curves are the closest to a square, which is the ideal. A typical set-up using laser alignment equipment is shown in Figure 14. If the time axis of a pen recorder is synchronized with the machine slide rate, the two axis alignment errors can be plotted automatically as the slide advances along the planer bed. Traditional manual methods could give similar accuracy but were tedious and extremely slow.

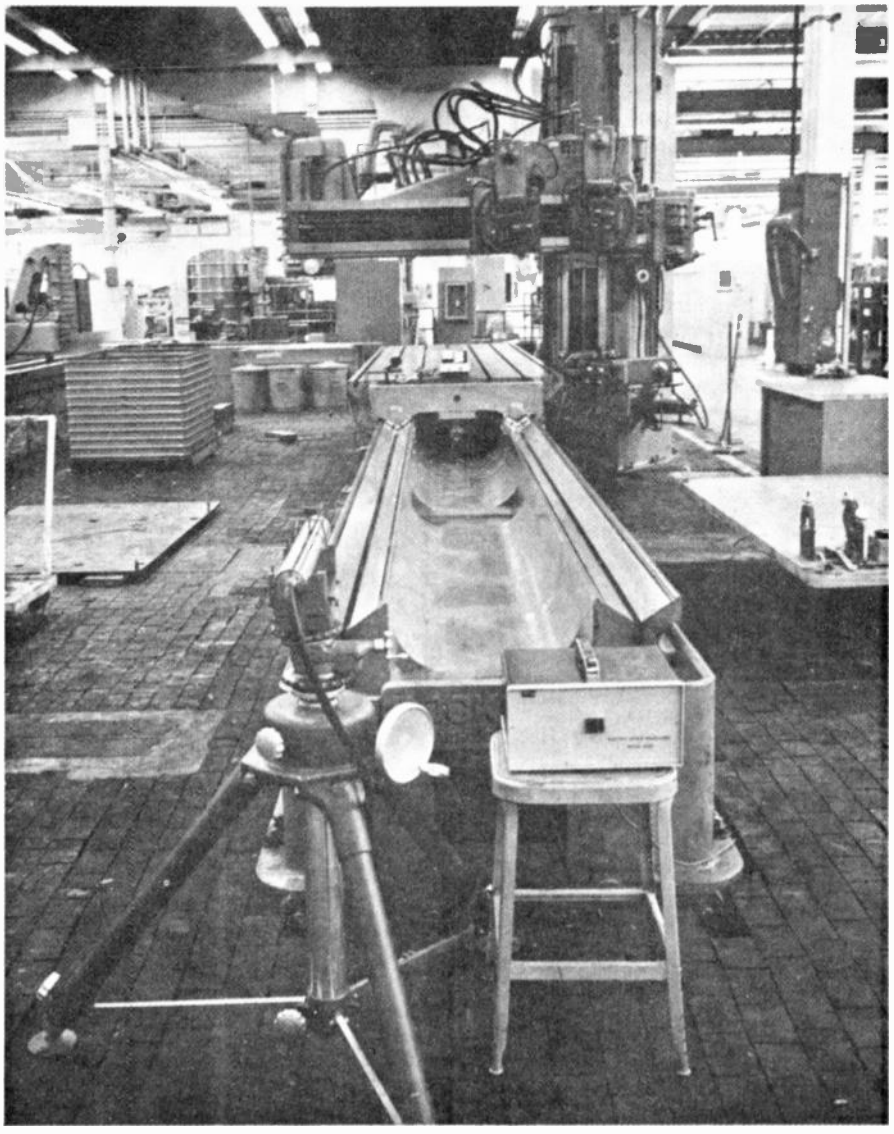

Fig. 14. Testing the straightness of travel of a planer.

Alignment methods provide means to measure straightness. If constant grade is desired for instance, then the alignment device is used in conjunction with a level defining method to set the line in the correct direction and plane.

Finally, on the subject of alignment measurement, mention should be made of the use of inertial guidance. A gyroscope, once set going, produces torques if its non-spinning axes are rotated. By sensing the torques it is possible to hold a straight line in space without the need for a physical reference position. One interesting problem described in the Russian literature was how to monitor the alignment and grade of pipes already buried. This was solved by making a small wheel-driven mole that drove itself through the pipe. It carried a gyro unit, recorder and distance meter. By synchronizing the recorder chart speed with the driving wheel and plotting the instantaneous grade at all times from the gyro, a plot of straightness was obtained.

Many applications of measurement and control require position to be transduced, not just length, angle, alignment or inclination. In the next part we shall consider how the various devices described in this and the previous parts are combined to yield two and three dimensional positional data. ●

PIÈCE de RÉSISTANCE

"OHM my God!" wrote one entrant to our resistor cube problem – ETI, June issue – "if that's what you call making a problem a bit harder, I'd hate to attempt one you'd really stiffened up". (May one assume that when he finally departs this earth he expects to meet with some resistance? – Ed.)

But despite his remarks this reader submitted the correct answer of 122 ohms – as did twenty others, the first ten of whom will receive a year's free subscription – starting with the August issue.

The full results are tabulated below – together with a very strange statistic – discovered by our Assistant Editor, Brian Chapman.

To all entrants – thank you very much indeed for your efforts – we only wish we could extend our bounty to you all.

Complete Kirchoff Solution (Assuming 100 volts applied)

Junction Point	Voltage	Resistor	Current (Amps)	Voltage Drop
A	100	R1	0.342	34.2
B	65.8	R2	0.134	24.1
C	41.7	R3	0.144	17.2
D	58.9	R4	0.274	41.1
E	55.2	R5	0.204	44.8
F	34.6	R6	0.208	31.2
G	0	R7	0.278	41.7
H	43.3	R8	0.130	15.6
		R9	0.137	20.6
		R10	0.197	34.6
		R11	0.346	43.3
		R12	0.066	11.9

Star Delta Transform Resistance Values

R13	400	R19	553	R15	145	R31	414
R14	333	R20	664	R26	196	R32	812
R15	600	R21	453	R27	110	R33	390
R16	420	R22	205	R28	567	R34	991
R17	420	R23	208	R29	548	R35	496
R18	336	R24	257	R30	401	R36	424

Note: Rounding off all resistor values to nearest ohm gives answer of 122 ohms.

A problem of this nature can only be solved by Ohm's Law if symmetry exists. For example consider the Wheatstone bridge shown in Fig. 1. If all resistors are the same value, and assuming a voltage applied to the bridge, then by symmetry the voltages at points A and B will be equal and hence no current will flow in R5 and it therefore may be disregarded. Thus the network would simplify to that shown in Fig. 2. and the total resistance may be calculated from the series/parallel combinations.

If symmetry does not exist, points A and B would be at different potentials and the above simplification could not be used.

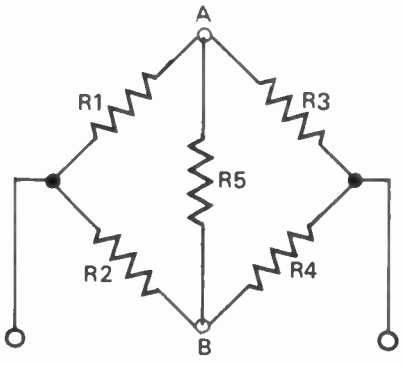

Fig. 1. Wheatstone bridge.

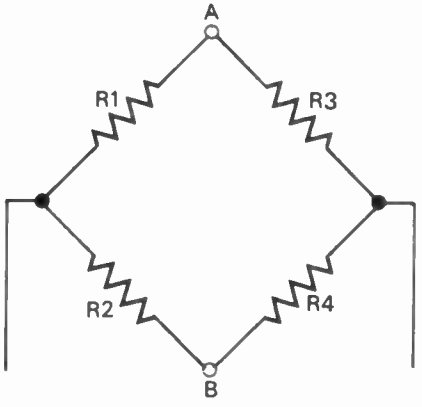

Fig. 2. R5 may be deleted from bridge if symmetry exists.

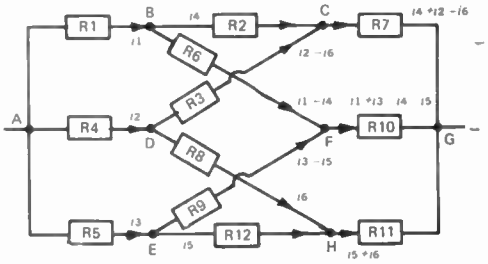

Fig. 3. The resistor cube redrawn in one plane for clarity.

There are several basic methods of solving assymetrical networks such as that in Fig. 1. These include Kirchoff's Laws, and the Star Delta Transformation theorem.

KIRCHOFF'S LAWS

Kirchoff's Laws are:–

1) The sum of the current flowing into and out of any point in a network is zero.

2) The sum of the voltages between any two points in a network is the same regardless of the path traversed.

The resistor cube may be seen to be a three dimensional version of Fig. 1. For clarity we have redrawn it as shown in Fig. 3.

Using Kirchoff's First Law we assume:–

A current
- i_1 flows through R1
- i_2 flows through R4
- i_3 flows through R5
- i_4 flows through R2
- i_5 flows through R12
- i_6 flows through R8

Then

$i_1 - i_4$	flows through R6
$i_2 - i_6$	flows through R3
$i_3 - i_5$	flows through R9
$i_2 + i_4 - i_6$	flows through R7
$i_1 + i_3 - i_4 - i_5$	flows through R10
$i_5 + i_6$	flows through R11

Using Kirchoff's Second Law and assuming 100 volts across the points A to G we may say that where V_D equals voltage drop.

WINNING ENTRIES

	Answer	Method		Answer	Method
J. Kennewell 1/22A Lake Street, Warners Bay, 2282.	121.96	Kirchoff & matrix analysis	E.H. Charles 8 Karnak Road, Ashburton, Victoria, 3147.	121.96238	Star-Delta Transform
J. Foster 26 Avenue Road, Mosman, 2088.	121	Kirchoff	C.J. Jenkins 10A Hannan Street, Maroubra, NSW, 2035.	122	Kirchoff
J.C. Bonnett 8/156 Lipsett Tce, Brooklyn Pk., S.A. 5032.	121.962380	Kirchoff checked by CDC-6400 computer	W. Spaulding 7 Spring Street, Abbotsford, NSW, 2046.	121.89	Star-Delta Transform
R. Dluzniak 3 Newbury Street, East Kew, Victoria, 3102.	122	Kirchoff & matrix analysis	D.E. Schwalm Box 216 Cheney, Washington, 99004 U.S.A.	121.96238	Kirchoff
G.C. O'Brien 10 Glenvale Road, Glen Iris, Victoria, 3146.	121.9	Kirchoff	J. Robinson 33 Emu Road, Glenbrook, NSW, 2773.	121.96	Star-Delta Transform

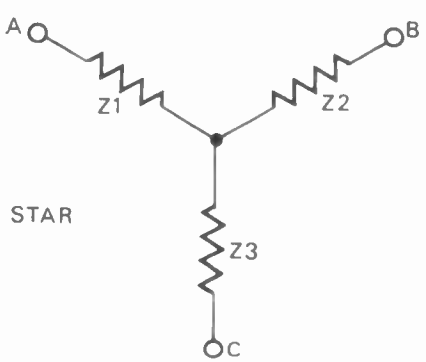

Fig. 4a. Star network.

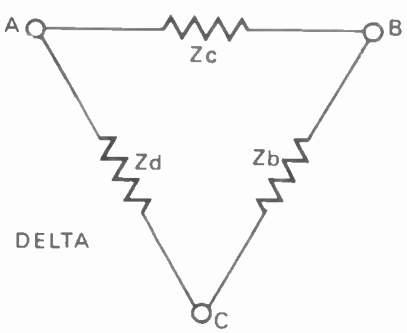

Fig. 4b. Delta network.

$V_D R1+V_D R2+V_D R7=100$

and since V = IR we get:—

$100i_1+180i_4+(150i_2+150i_4-150i_6) = 100$

Which simplifies to:—

$100i_1+150i_2+330i_4-150i_6 = 100$

(path R1, R2, R7). Similarly by using all the possible independent paths from A-G, we obtain six equations.

$$\begin{aligned}
100i_1+150i_2+330i_4-150i_6 &= 100\\
350i_1+100i_3-250i_4-100i_5 &= 100\\
420i_2+150i_4-270i_6 &= 100\\
150i_2+220i_5+340i_6 &= 100\\
100i_1+470i_3-100i_4-250i_5 &= 100\\
220i_3+400i_5+220i_6 &= 100
\end{aligned}$$

We now have six simultaneous equations in six unknowns which are most easily solved by use of determinants/matrix methods or more laboriously by traditional algebra. We only require to know the total current from A to G and this is the sum of i_1, i_2 and i_3.

These are i_1 = .34217761 amps
i_2 = .27402335 amps
i_3 = .20372400 amps

but adding these and dividing into 100 ($R = \frac{E}{I}$) we get 121.96238 ohms from A-G.

We also checked the result using a programme on our Honeywell computer to solve the six simultaneous equations.

Many readers, when redrawing the network, considered that there was symmetry. However this is not the case. No simplification of the problem by this means is possible.

STAR-DELTA TRANSFORMS

The second method, although still laborious, is perhaps easier to use if you do not understand advanced methods of solving simultaneous equations.

The Star Delta Transformation Theorem may be stated as follows:—

Any Delta (Pye) network may be replaced by an equivalent Star (Wye) network without upsetting operation. And conversely — any Star network may be replaced by an equivalent Delta network. That is, if we have a network between points A, B and C as shown in Fig. 4a, it may be replaced by that in Fig. 4b.

The transformation formulae are:—

Star to Delta

$$Zc = \frac{Z1xZ2+Z1+Z2}{Z3}$$

$$Za = \frac{Z1xZ3+Z1+Z3}{Z2}$$

$$Zb = \frac{Z2xZ3+Z2+Z3}{Z1}$$

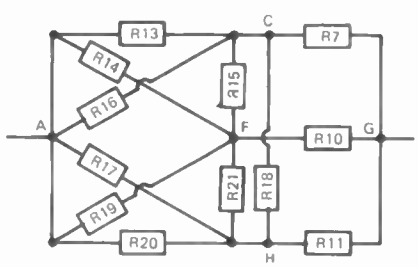

Fig. 5. The network after three star to delta transforms.

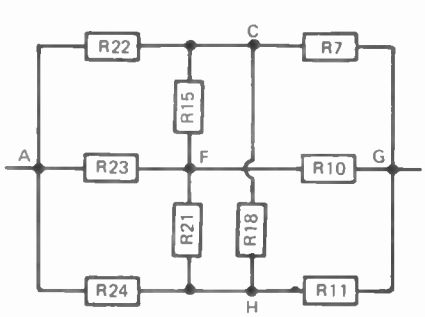

Fig. 6. After eliminating paralleled resistors.

STATISTICS OF ENTRIES

Entries Received	120	
Correct Answers	20	
Methods Used	**Total**	**Correct**
Kirchoff's Laws	32	13
Star-Delta Transforms	21	7
Sundry – Paralleling or Simplification	67	nil
Correct Answer	121.962 ohms	
Most Common Incorrect Answers	75 ohms	21 entries
	118 ohms	17 entries
Answers Derived Using Computers	6	4 correct
Lowest Answer	0.0027 ohms	
Highest Answer	710 ohms	

Odd Statistic – of the 21 entrants giving 75 ohms as the answer, 20 came from Victoria and one came from Tasmania. All remaining answers were divided more or less equally over the rest of the States. The weather perhaps?

Due to factors beyond our control the June issue was on sale later than our normal publishing date in some States. Because of this, the closing date for entries was extended until June 9th. The above statistics are for entries received up until that time.

Delta to Star

$Z1 = Z_aZ_c/(Z_a+Z_b+Z_c)$

$Z2 = Z_bZ_c/(Z_a+Z_b+Z_c)$

$Z3 = Z_aZ_b/(Z_a+Z_b+Z_c)$

Now referring again to Fig. 3 we may transpose the three networks at points B, D and E from star to delta.
Thus we transpose

R1,R2,R6 to R13,R14 and R15
R3,R4,R8 to R16,R17 and R18
R5,R9,R12 to R19,R20 and R21

and obtain the network of Fig. 5.

Now we find that

R13 and R16 in parallel gives R22
R14 and R19 in parallel gives R23
R17 and R20 in parallel gives R24

We now have reduced to Figure 6. The next step is to transform the delta network R15, R18 and R21 into a star network R25, R26 and R27 which gives the network of Fig. 7.

Using the star to delta transform three more times on the networks at points C, H and F, (R22, R25, R27 to R28, R29, R30) (R23, R26, R10 to R31, R32, R33) (R24, R27, R11 to R34, R35, R36). gives us Fig. 8. which is a simple series parallel network.

Although as said before, the method is cumbersome, it does move step by step and is easier if your mathematics are shaky.

We ran a computer programme for this method also and obtained the same answer as for the Kirchoff method. As a point of interest, the computer running time was 35 seconds for the simultaneous equation programme, and three seconds for the star delta transformation.

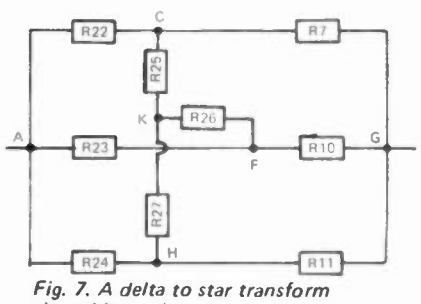

Fig. 7. A delta to star transform gives this result.

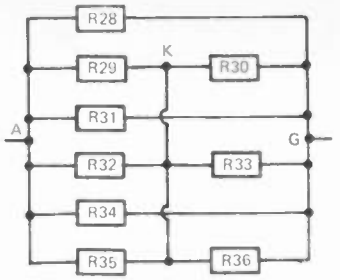

Fig. 8. Three more star to delta transforms give a simple network which can be resolved by Ohm's Law.

THE TEN OHM CUBE

Now to return to the cube with 10 ohm resistors in each leg. Due to symmetry, points B, D and E are at equal potentials, as are points C, F and H. These points may therefore be joined giving R1, R4 and R5 in parallel (3.33Ω), R2, R6, R3, R8, R9 and R12 in parallel giving (1.67Ω) and also R7, R10 and R11 in parallel (3.33Ω). As all these groups are in series, the total resistance is 8.33 ohms. This problem is indeed a simple one – as we said. ●

I only hope that in posing your problem what should have been your "piece de resistance" did not, for many people, turn out to be their "cul de sac". – J.K., Warners Bay, NSW.

Your idea of "just a bit harder" is a bit optimistic. 17 major operations of transformation, are, in my view, a LOT harder than the three simple operations required in the "all 10Ω" case.

Keep up the good work on a stimulating and informative magazine – it is a pleasure to read it! – I.G.F., Ingle Farm, 5098.

Despite the symmetry of the matrix I couldn't see any short cuts so I used a computer to do the calculation after dividing out the factor of 10. I got: I_2 = .0134A, I_6 = .0208A, I_3 = .0144A, I_8 = .0130A, I_9 = .0137A, I_{12} = .0066A. Total current three network is .0819A which by Ohm's Law gives a resistance of 121.96Ω or 122Ω.

Incidentally, I checked my solution of the matrix problem by using the Jacobic iteration after solving initially by Gauss-Jordon reduction via a matrix package on the computer (CDC-6400) – J.F.B., Brooklyn Park, SA.

I hope I have here the correct answer. I reasoned that the total resistance must be that value obtained when the separate paths which the current may take to get from A to G are connected in parallel. There are six such paths of three resistors each, and these when used with the parallel resistance formula give an answer close to 75Ω. I am in doubt as the 'correctness' of this as I heard a rumour at school that the 10Ω cube has a value of 10Ω which is precisely twice that obtained using the formula.

Anyway I'll try 75Ω because I cannot find a mathematical reason for saying 150Ω – J.S. Vaucluse, 2030.

Mean is 121.51Ω which will be within 1Ω of correct impedance.

I agree with K.H. In the short time since your journal appeared in the stalls I have spent many hours pushing figures and like him arrived at many different solutions. If I'd known the trouble when I started I wouldn't have. – C.M. Nedlands, W.A.

The answer is 121.96Ω and I'm sticking to it, every last (incorrect) decimal place of it.

i.e. Resistance from corner A to corner G = 122Ω.

Ye Gods! As I said, I don't think it is the simple way! – J.R. Glenbook, NSW.

Unless I have made an arithmetical error, which is quite likely, the resistance of the cube on page 120 of your June issue is – 127Ω – R.J.M. Doncaster, Vic.

Please find enclosed the working I used to arrive at the resistance between points A and G.

This resistance is 148.14Ω.

Looking forward to a year's subscription – I.M. Goodna, Qld.

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Max Power TC 25°C	Product	Polarity	Package	LV_{CEO}	V_{CE} Sat	h_{FE}
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115 W	AY8149	NPN	TO3	60	1.1 V @ 4 Amp	20-150 @ 4 Amp 4 V
115 W	AY9149	PNP	TO3	−60	1.1 V @ 4 Amp	20-150 @ 4 Amp 4 V
115 W	AY8150	NPN	TO3	40	1.1 V @ 4 Amp	20-150 @ 4 Amp 4 V
115 W	AY9150	PNP	TO3	−40	1.1 V @ 4 Amp	20-150 @ 4 Amp 4 V
35 W	AY8170	NPN	TO66	40	1.5 V @ 3 Amp	Typ 30 @ 3 Amp 4 V
35 W	AY9170	PNP	TO66	−40	1.5 V @ 3 Amp	Typ 20 @ 3 Amp 4 V
35 W	AY8171	NPN	TO66	60	1.5 V @ 3 Amp	Typ 30 @ 3 Amp 4 V
35 W	AY9171	PNP	TO66	60	1.5 V @ 3 Amp	Typ 20 @ 3 Amp/4 V
25 W	2N4054	NPN	TO66	55	1 V @ 1 Amp	25-100 @ 2 Amp/4 V
10 W	AY8139	NPN	TO5	40	6 V @ 1 Amp	Typ 15 @ 1 Amp 2 V
10 W	AY9139	PNP	TO5	40	6 V @ 1 Amp	Typ 35 @ 1 Amp 2 V
10 W	AY8140	NPN	TO5	60	6 V @ 1 Amp	Typ 15 @ 1 Amp 2 V
10 W	AY9140	PNP	TO5	60	6 V @ 1 Amp	Typ 35 @ 1 Amp 2 V

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Less money.

FC 51 - 3

DOLBY USE WAYNE KERR TESTMATIC

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The Testmatic at work at Dolby Laboratories. It can do its 58 measurements on an all-clear board in 6 seconds flat.

'If the Wayne Kerr Testmatic did not exist, it would have been necessary for us to invent it'

Dave Peacock, Head of the Test Department, Dolby Laboratories Inc.

The heart of a Dolby System noise reduction unit is a small but complex circuit board. In six-by-seven inches are assembled no fewer than 507 resistors, capacitors, diodes and transistors.

On that score alone, fault-finding is a major operation. And as Dolby's policy is to make all processors interchangeable, they have to guarantee the stability of every part of the circuit. So their electronic checkout procedure entails 58 separate DC measurements.

Said Dave Peacock, head of the Test Department: 'An interesting thing about our board is that it is specifically designed to suit the Testmatic. We began by making a thorough search of the market to see if there was a testing machine that would suit us. Had the Testmatic not existed, we should have had to invent something very like it ourselves.

'How has it done? Well, on average we get about 2·5 faults a board. Half of these are DC faults. Thanks to Testmatic, finding and correcting them take only 10 percent of our electronic checkout effort.

'We've costed it, and we know it has saved us more than £1,000 in a year – using the TM60 for a mere 2½ hours a day. But we're stepping up output, so next year the saving should be even more impressive.

'Any teething troubles? . . . I wouldn't say so. We hit a small snag about a year ago but the Wayne Kerr service was so prompt that the whole thing was really a non-problem . . .'

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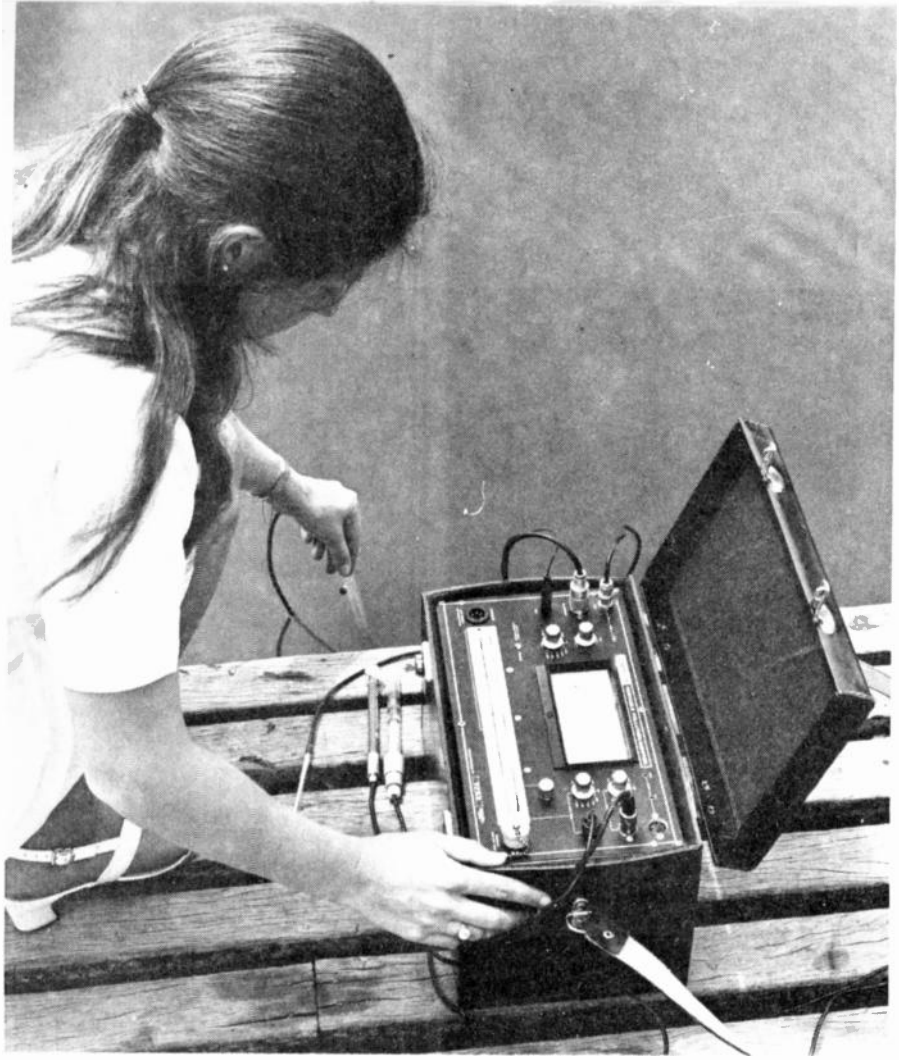


POLLUTION DETECTOR

This Australian-made instrument is attracting world-wide attention.

Worldwide concern over pollution has been demonstrated to an Australian company which recently released news of its portable pollution tracking equipment.

Within four weeks of the news of its development being released, the company, Townson and Mercer Pty Ltd of 318 Burns Bay Road, Lane Cove, NSW, had received more than 500 enquiries for details from potential buyers overseas.

A few weeks later sales had been made in Malaysia, the Phillipines, New Zealand and Japan.

Particular interest was shown in this equipment by universities, civic authorities, research organisations and private industry.

The detector is used specifically for tracking pollution in lakes, rivers, dams and other waterways, It can be slung over the shoulder in a leather carrying case and is virtually a complete water testing "laboratory'.

Working from an internal, rechargeable Ni/Cd battery it can be taken anywhere to provide readings on water temperature, suspended solids, dissolved oxygen, conductivity, pH, flow, depth, or a number of other factors.

Basically it consists of a series of ion selective probes placed in the water being tested. Measurement is provided quite simply by pushing a button and noting the readings shown on a clearly graduated meter.

The detector provides a simple answer to the complex problem of transporting and operating a number of laboratory-type instruments in the field. It also eliminates the need to take large samples continuously to laboratories for analysis.

By continuously sampling, while moving up a river flow, it is possible to track down how and where pollution is reaching the waterway. Instant meter readings provided by the probe on the concentration of the pollutant enable tracking by a simple "hot or cold" technique.

Company officials say the major response to this equipment has come from organisations and companies in North America, Africa and throughout Europe.

They say the high level of overseas interest is caused primarily by the world-wide trend of government authorities towards setting limits on pollution levels. Industry and research groups needed equipment, such as the portable pollution tracker, to determine conditions existing in their particular regions.

Once maximum pollution levels are set, even greater use can be made of this equipment, to maintain a constant check that levels do not infringe government regulations or impair the environment.

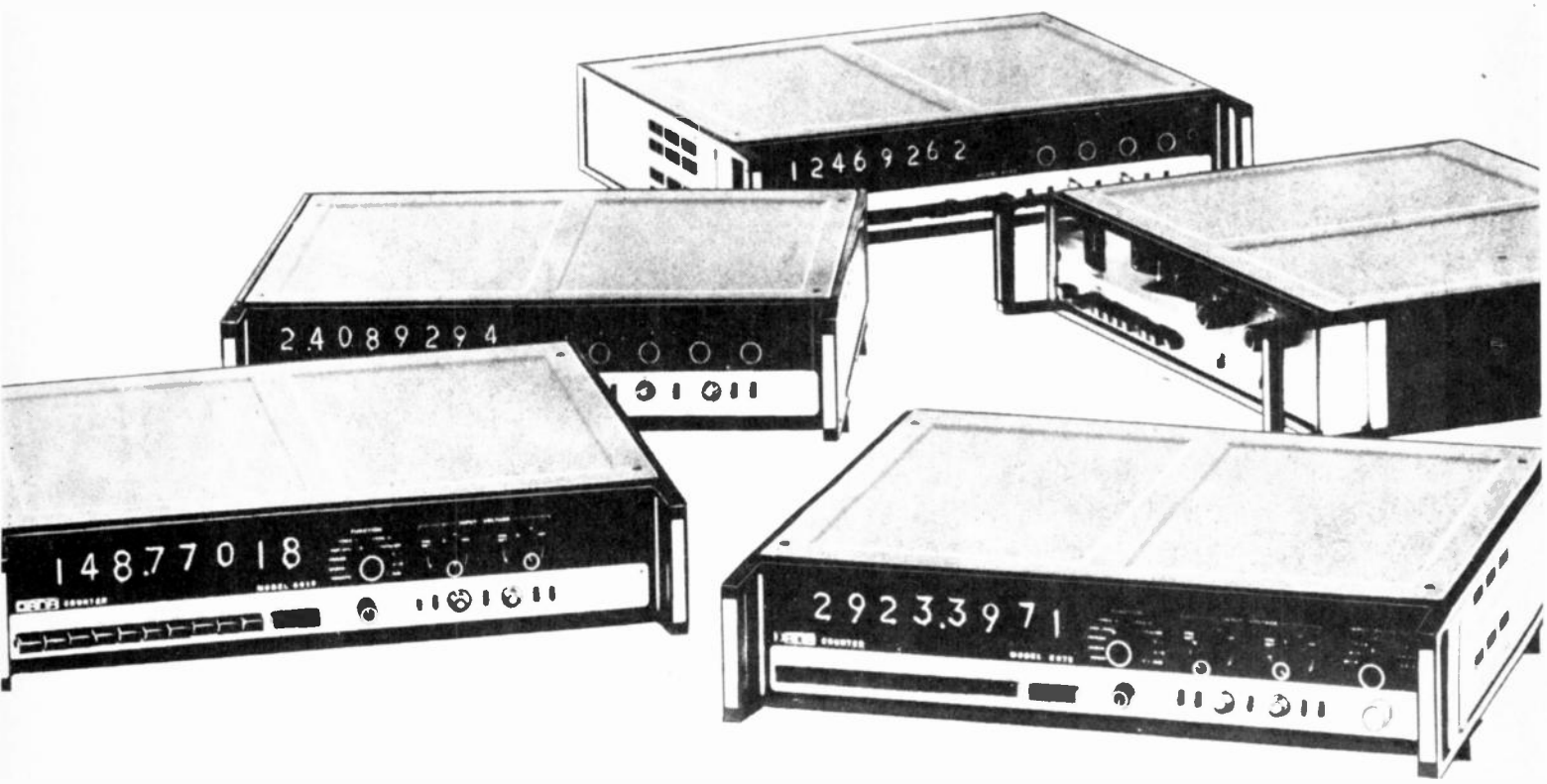
Townson and Mercer claims there is no similar equipment manufactured anywhere in the world and that capital cost has been maintained at a surprisingly low level.

To date, overseas organisations that have bought units include a privately-owned manufacturing company in the Philippines which would monitor its own effluent, a meat processing plant in New Zealand, and a university in Malaysia.

Within Australia, units are being used by the Department of Health in Sydney, while in Canberra the Forestry School uses the equipment for catchment area research. In the warm waters off the Queensland coast, a private company is using another for marine research.

With the high level of interest in this Australian designed and manufactured equipment, it may not be long before water researchers and investigators throughout the world are walking along the banks of rivers and lakes with this unique portable pollution device.

five new counters



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8000B Series

Digital Electronic Counters for versatility and reliability *without* multiple plug-ins.

Each counter in the series provides 4 measurement modes: Frequency, Period, Multiple Period Average and Totalise. An additional 4 modes are available on some models providing extended frequency range to 550 MHz, Time Interval, Time Interval Average and Frequency Ratio.

NO LONG WARM-UP DELAY. This is eliminated by use of a TCXO, which also achieves optimum versatility and accuracy in a general purpose counter. (A higher stability TCXO and a range of oven oscillators are options.)

INPUT SENSITIVITY. Normally 50 mV to 550 MHz while an optional amplifier will increase this to 1 mV with automatic triggering. This high sensitivity allows frequency measurements with up to 99% AM present on the signal.

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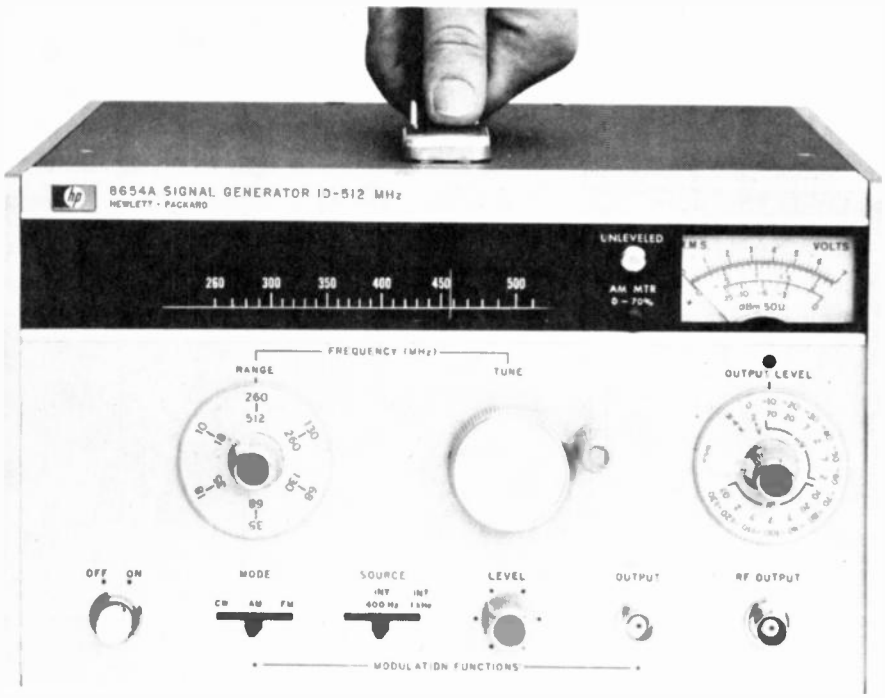
EQUIPMENT NEWS

512 MHz SIGNAL GENERATOR



According to the manufacturer, the new Hewlett-Packard model 8654A Signal Generator has a calibrated, automatically levelled power output, versatile modulation capabilities and superior frequency stability.

The instrument has a frequency range of 10 to 512 MHz and is said to be eminently suitable for testing receivers, amplifiers, antennae, and filter networks in the laboratory or on the production line. Its compactness allows it to fit easily into mobile, airborne and shipborne test locations, and it is rugged and lightweight enough to be used for field maintenance and service applications. Extensive RF shielding is used, permitting receiver sensitivity measurements at the one-microvolt level.

The Model 8654A generates power levels between +3 dBm and −120 dBm (into a 50 ohm load), over its full frequency range, and the power output is claimed to be accurate within ±1.5 dB plus attenuator accuracy (±0.5dB in the 10 to 50dB range; ±1.5dB in the 60 to 120dB range). Output power is automatically levelled to within ±1dB over the entire frequency range, and a front panel meter displays the output level in dBm and volts. Additionally, a rear panel uncalibrated auxiliary output is provided for use with a counter or other equipment.

Stability is specified as 0.002% or 20 parts per million over a 5 minute operating period after a one hour warm-up. Typically, it will recover specified stability within 5 minutes following a frequency band change. The frequency accuracy is stated to be ± 2% after 30 minutes warm-up, and residual FM is less than 5 parts in 10^7 peak.

Internal oscillators provide amplitude or frequency modulation at 400 Hz and 1000 Hz, and external modulation can also be used. Amplitude modulation percentages from 0 to 80% can be read on the front panel meter.

For further details, write on company letterhead to Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, Victoria, 3146.

DEC ANNOUNCES NEW PDP-11

Digital Equipment Australia have introduced a new low cost member of the PDP-11 family – the PDP-11/10. This is the lowest cost PDP-11 to be offered to the Australian market.

The new PDP-11/10 consists of a central processor, 8k 16-bit words of 900 nanosecond memory, direct memory access channel, powerfail and restart unit, automatic priority interrupt, and console terminal interface. The installed price is 45% less than the cost of previously available equivalent PDP-11s.

The lower cost of this compatible PDP-11 is said to be attributable to a totally new implementation of the PDP-11 architecture, lower cost of the DEC-manufactured memory system, and the economies of very high volume production.

Further details from Digital Equipment Australia Pty Ltd, Sydney NSW 2060.

COMPUTER DESIGNED FOR RUGGED CONDITIONS

To prove the ruggedness of a new type of computer "memory" it has been repeatedly bashed with a hammer during tests in Britain. The equipment went on working to its accustomed accuracy of a one in ten thousand millionth chance of error.

The memory system, designed to keep its accuracy when jolted on the back of a moving vehicle or operated under Arctic conditions, has already passed British Navy trials.

Backed by Britain's National Research Development Corporation (NRDC) the Series 100 Disc Memory System has developed by a firm called Process Peripherals for process control under arduous conditions. Previous equipment could maintain an accuracy approaching that of the new system only under laboratory conditions.

A typical small computer with a store capacity of 4,000 words can have its memory store expanded to 250,000 words with the new disc memory.

The equipment consists of a ferro-magnetic disc carrying on 64 separate tracks 4,200,000 pieces of digital information. This means that 256,000 words of 16 bits, or binary digits, are packed at a density of 2,500 bits an inch around each track.

Another feature of the disc memory system is that data cannot be lost – the system simply has another go when it has been disrupted by an electrical or mechanical fault, or by gross mishandling.

Further details from: Process Peripherals Ltd., The Broadway, Thatcham, Berkshire, England.

KIT TO ASSESS HARMFUL NOISE

An auditory hazard kit has been developed for general industrial use by a British firm. The kit may be used as part of a factory's comprehensive programme to protect the hearing of operatives. Alternatively, it may be fitted with accessories and employed to assess the nuisance caused by individual vehicles or by general traffic.

The standard kit consists of a sound level meter, a high-stability acoustic calibrator, a windshield and a meter microphone. The whole is contained in a leather carrying case with a flap down the front; it weighs 11b 10oz.

The battery-powered sound level meter provides direct read-out of noise level from 50 dB to 130 dB in several overlapping ranges. It meets British Standards specifications for accuracy, and can be used in ambient temperatures ranging from 14°F to 140°F.

EQUIPMENT NEWS

A high-stability moving-coil microphone feeds a transistor amplifier, and fast and slow damping facilities are provided. A level recorder can be connected, if desired.

A self-contained calibration unit produces an accurate and stable sound pressure level in a fully enclosed cavity so that the meter can be checked in most acoustic environments.

Air-turbulence effects are minimised by a windshield fitted over the microphone.

Further details from: Cosmocord Ltd, Acos Works, Eleanor Cross Road, Waltham Cross, Hertfordshire, England. Australian Agents: Amplion (A'asia) Pty Ltd, 29 Major's Bay Road, Concord, NSW 2137.

PRODUCTION PC BOARD TESTER

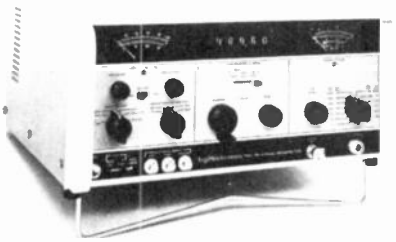
Wayne Kerr have recently announced the release of their Testamatic TM60 automatic PC board tester in Australia. Using the TM60 is claimed to result in substantial cost savings in the production of electronic equipment.

The TM60 is a simple dc tester which is designed automatically to test up to 59 points on a PC board sequentially within 5 seconds. Read out indicates "OK" or the location of any defective point in the circuit, together with a HIGH or LOW indication. Programming is relatively simple using the combined jig/programme board which can be readily stored when not in use.

Testamatic costs only a fraction of computer systems' costs.

Further information or a demonstration is available from Warburton Franki Adelaide, Brisbane, Melbourne, Perth, Sydney.

NEW AM-FM-PULSE SIGNAL GENERATOR



A new signal generator in the 9.5 MHz to 520 MHz range offers AM, FM, and pulse modulation.

The new instrument, now available from LogiMetrics, Inc., also features a five-digit frequency readout LED display on the front panel. It is said to be the lowest priced generator of its type to offer this display.

The FM, which can be used independently or with AM or pulse modulation provides calibrated deviation of 10 kHz, 30 kHz, 100 kHz or 300 kHz. Deviation is read directly from a meter on the front panel, eliminating the need for additional instruments or time-consuming calculations. Distortion is claimed to be less than 0.5% (at 75 kHz deviation).

The Model 750 is claimed to have an accuracy of ±0.001% to 0.05% of frequency – at least one order of magnitude better than previous instruments of this type. The unit is all solid state and function controls are grouped on the front panel for easy use.

The rf output is 1 volt and is automatically leveled to within ±½dB.

Harmonics are at least 30 dB below the carrier, it is claimed, and other spectral purity characteristics are remarkably clear.

The signal generator can be used on a bench or rack mounted. Its front panel is only 7" high and 16¾" wide.

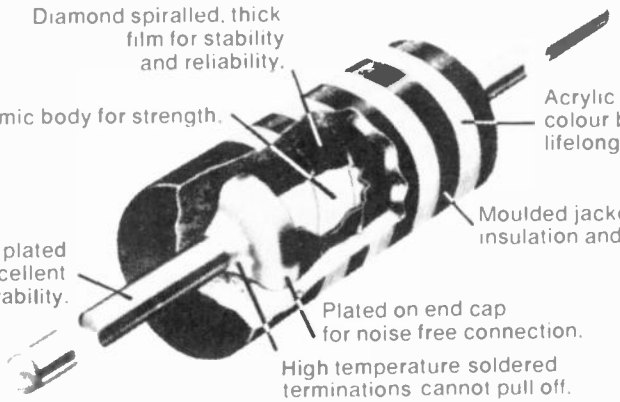
Further details from: Elmeasco Instruments Pty Ltd, PO Box 334, Brookvale, NSW, 2100 or P.O. Box 14 St. Kilda South 3162.

MULTICHANNEL THERMAL RECORDER

For the first time, a multichannel thermal writing recorder uses Z-fold recording paper instead of rolled chart paper. Z-fold charts can be thumbed through like book pages, eliminating the need to unroll many yards of paper to examine part of a recording. The 500 foot, Z-fold chart pack loads with no threading.

Called the Hewlett-Packard Model 7414A Thermal Writing Recorder, this new unit is a 4-channel oscillographic recorder using a

The very best of all...



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AVAILABLE IN 3 MODELS RN¼ RG¼ AND GL½ WITH TEMPERATURE COEFFICIENTS 100; 150; 200 AND 500 ppm/°C AND TOLERANCES OF ± 1, ± 2, ±5%.

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W.A. Simon Holman & Co.Pty.Ltd. **Telephone 8-2271.**
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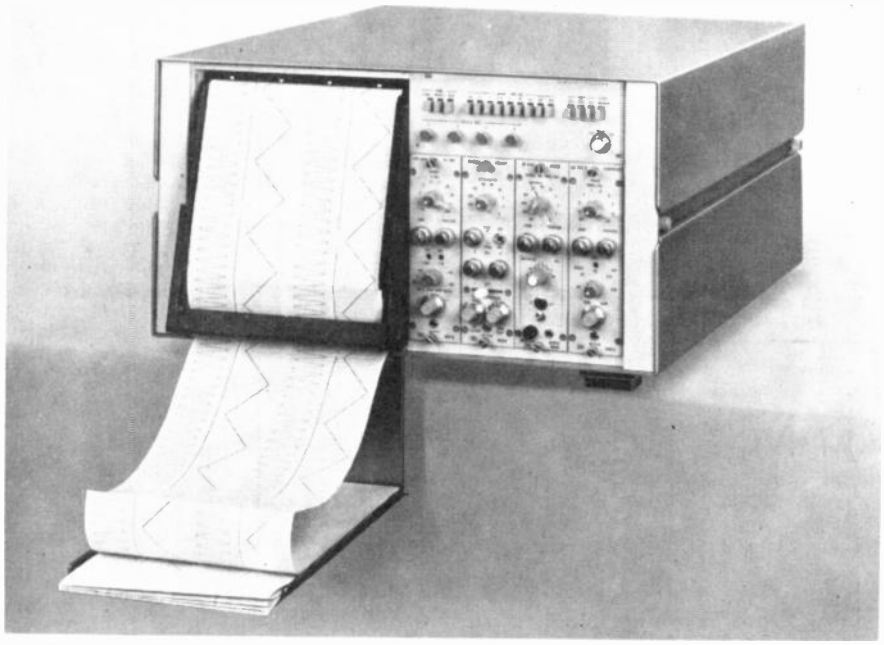
IRH THE COMPONENT DIVISION OF IRH INDUSTRIES LIMITED

B2249

EQUIPMENT NEWS



hot-tip stylus. The thermal writing tip is said to have a long life and writing is rectilinear. A closed-loop, pen position feedback system is claimed to give 99.5% trace linearity.

One compact bench-top package includes the recorder mainframe and four plug-in signal conditioners. The Model 7414A is said to be the smallest 4-channel recorder to use plug-in signal-conditioning preamplifiers. The full range of Hewlett-Packard 8800 Series plug-ins is available for use with the recorder.

Nine chart speeds ranging from 0.25 to 100 millimeters per second are selected by pushbuttons. Frequency response of the recorder is within ±0.5 db from dc to 50 Hz with 50 mm full-scale deflection. Frequency response drops by less than 3 db at 100 Hz with 10 mm deflection.

Useful for biological and industrial applications, the Model 7414A can be mounted on a rack or a mobile cart. It measures 19 inches wide by 11-7/8 inches high by 24 inches deep, and weighs 95 pounds.

Further details from Hewlett-Packard Australia Pty. Ltd., 22-26 Weir Street, Glen Iris. Vic. Tel: 20-1371.

NEW PUSHBUTTON FUNCTION GENERATOR FROM KROHN-HITE

The Model 5400A Function Generator which incorporates a new symmetrical control to allow pulse repetition rate to be set independently of pulse width, and also provides an independently adjustable triangle slope, has been introduced by Krohn-Hite Corporation, Massachusetts, a leading designer and manufacturer of active filters, oscillators, and function generators. The Model 5400A covers the frequency range from 0.002 Hz. to 5 MHz. and produces sine, square, triangle, ramp, and sawtooth waveforms as well as an auxiliary 5 volt peak-to-peak square wave. In addition a unique sine shaping network minimises sine wave impurities normally found in conventional function generators.

Maximum output of the Model 5400A Function Generator is 30 volts peak-to-peak, amplitude is controlled by a 70 dB pushbutton attenuator and vernier which is said to permit operation down to 0.5 millivolt peak-to-peak. All waveforms may be positioned around zero ±10 volts with a dc offset control. An external control voltage of 10 mV to 10V can be used to provide a 1:1,000 frequency sweep range.

Further details from: Warburton Franki Adelaide, Brisbane, Hobart, Melbourne, Perth, Sydney.

TDK re-invents tape

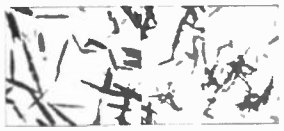
TDK Super Dynamic (SD) Cassettes record the full range of music without missing a note or skipping a beat. Make even low-priced recorders sound great!

When we set out to make a cassette tape as true to sound as the most expensive reel tape we found we had to re-invent cassette technology. The result is TDK Super Dynamic (SD) Cassette Tape and the only combination that meets the most critical professional standards and actually improves the performance of your cassette recorder. There's nothing else like it!

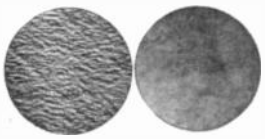
Look at these TDK exclusives

Superfine tape coating for super dynamic sound

8 times as many magnetic particles as conventional tape. Superfine Gamma Ferric Oxide particles for better signal-to-noise ratio and much wider dynamic range without distortion.

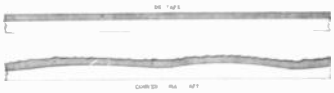


Micropolished surface for better frequency response



TDK particles are densely and uniformly packed into the tape coating. Mirror-smooth lubricated surface means less wear on the recorder head.

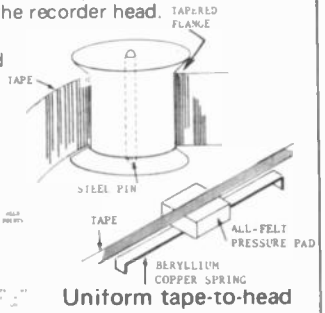
Good enough for high-speed computers



The thickness of the binder and oxide coating is controlled to within 4 hundred thousandths of an inch. No chance of signal dropouts because the coating is constantly in contact with the recorder head.

Tape rolls true, won't ride up and down

Only TDK SD tapes have a tapered flange and a stainless steel pin, (instead of plastic) for perfect head-to-head alignment.



Unique TDK clamp grips at two points instead of one

Tape won't loosen or break under stress. Precision hubs reduce friction, – keep the wind steady and even.

Uniform tape-to-head contact at all times

High quality beryllium copper spring holds its tension permanently. Durable all-felt pad won't twist or yield under stress.

TDK CASSETTES have more than 20 precision parts to ensure peak performance even after years of use. Conventional cassettes have fewer than 10 parts.

Don't ask for tape. Ask for TDK. If your dealer doesn't have it, phone us. We'll tell you who does.

TDK SD CASSETTES

available in C-60, C-90 and C-120 sizes. Also the remarkable value TDK Low-Noise Cassettes. C-30 from about $1.49 and C60-C90. Also TDK SD and Low-Noise in reels.

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METERS: MO65 0-5 mA., $3.50; MO65 100 mV., $3.40; MO65 50 mV., $3.40; MR2P 1000 volt DC, $3.50; MR52 5 mA., $3.50; MR2P 100 mA, $3.40; P25 0-10 mA., $3.50; P22 500 uA., $4.00. Postage 40 Cents.

VALVES: 1AX2, $3.52; 1B3GT (DY30), $1.77; 1F5G, $1.50; 1R5 (DK91), $2.25; 1S2 (DY86), $1.77; 1S4 (DL91), $3.64; 1S5 (DAF91), $2.13; 1T4 (DF91), $2.13; 1U4, $2.13; 5AS4, $1.61; 5U4G/B, $1.61; 5X4G, $2.82; 5Y3GT, $1.38; 5Z3, $2.82; 6AB7 , $4.11; 6AC7, $0.50; 6AG5, $0.50; 6AJ8 (ECH81), $2.37; 6AK5 (EF95), $1.80; 6AL3 (EY88), $1.84; 6AL5 (EAA91), $1.39; 6AM5 (EL91), $2.37; 6AM6 (EF91), $2.28; 6AN7A (ECH80), $1.90; 6AN8, $3.06; 6AR7GT, $2.28; 6AU4GT/A, $1.84; 6AU6, $1.61; 6AU7, $2.87; 6AU8, $3.06; 6AV6, $1.35; 6AW8A, $1.93; 6AX4GT, $1.84; 6B8, $3.88; 6BD7 (EBC80), $1.30; 6BE6 (EK90), $1.68; 6BH5, $1.61; 6BV7, $1.61; 6BW6, $2.25; 6BW7, $2.28; 6BX6 (EF80), $1.61; 6BZ6, $1.61; 6CA7 (EL34), $3.58; 6CM5 (EL36), $2.65; 6CQ6 (EF92), $2.59; 6CQ8, $1.86; 6DQ6A, $2.65; 6DT6, $1.61; 6DX8 (ECL84), $1.93; 6EH7 (EF183), $1.84; 6EJ7 (EF184), $1.84; 6EM5, $1.62; 6ES6 (EF97), $2.25; 6G8G, $3.06; 6GV8 (ECL85), $2.05; 6GW8 (EC186), $2.05; 6H6G/T, $0.50; 6K8, $3.99; 6K8G/T, $3.41; 6L6, $5.85; 6M5 (EL80), $1.53; 6N3 (EY82), $1.32; 6N7GT, $3.99; 6Q7G/T, $2.94; 6S2 (EY86), $2.25; 6S4/A, $2.82; 6SJ7, $0.75; 6SL7GT, $3.18; 6SQ7, $3.18; 6U7G, $0.75; 6V4, $1.10; 6V6, $3.64; 6X2 (EY51), $2.40; 6X9 (ECF200), $2.09; 6Y6G, $3.18; 6Y9 (EFL200), $2.30; 12AT7 (ECC81), $0.75; 12AU6, $1.78 12AU7A (ECC82), $1.72; 12AX7 (ECC83), $1.95; 12BE6, $2.02; 12SN7GT, $3.18; 16A5, $2.15; 16A8 (PCL82), $2.46; 17Z3 (PY81), $2.25; 30, $0.50; KT66, $6.20; KT88, $7.05; 6146 (QV06-20), $7.29; OA2/150C2-4, $1.46; QV03-12, $2.34.

CASSETTE TAPES: B.A.S.F. C60, $1.45; B.A.S.F. C90, $2.85; B.A.S.F. C120, $3.70; Goldring C60, $0.99; Goldring C90, $1.50. Postage 20 Cents.

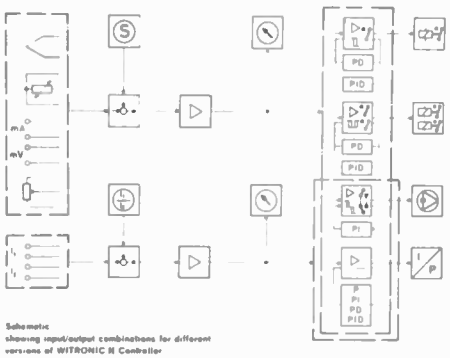
RESISTORS: Poly Pack of 100 Resistors. 33 values of ½ and 1 watt rating. Price $2.00, post paid.

NEW BEZEL LAMP HOLDERS: Complete with 6-volt globes. Colours: Red, Green, White, Orange, Blue or Lemon. Price 58 Cents each.

MODEL C-1000 POCKET MULTIMETER: 1000 ohms per volt. AC volts: 0-10, 50, 250, 1000. DC volts; 0-10, 50, 250, 1000. DC current: 0-100 mA. Resistance: 0-150K ohms (3K centre). Two colour scale. Range selector switch. Dimensions: 3½ x 2¼ x 1 inch. Price $6.75, postage 30c.

EQUIPMENT NEWS

MODULAR PROCESS CONTROL INSTRUMENTS



Schematic showing input/output combinations for different versions of WITRONIC II Controller

A new range of control instrumentation – called Witronic II – has been introduced by Philips Industries Limited process control manager, Barry Semmens.

Witronic II represents a wide range of electronic on/off controllers, two- and three-position controllers with PD or PID control mode, PI controllers for motor actuators and PID controllers with continuous output.

The controllers are designed for direct input from thermocouples, resistance thermometers, resistance transmitters or from any mA or mV source. The controllers for thermocouple input have a built-in cold junction compensation circuit which can be switched off if required.

Witronic II instruments are of modular design and consist of three basic modules: input circuitry, feedback circuitry and output circuitry. In addition, there is a built-in two-wire transmitter supply.

In the case of the controllers with continuous output, the rate (derivative) action is generated by a separate R-C circuit and a separate amplifier ahead of the control amplifier. This "rate before reset" action ensures that even with large disturbances, saturation does not occur, that control action occurs before the variable crosses the setpoint, so even at start-up, overshoot is kept to an absolute minimum.

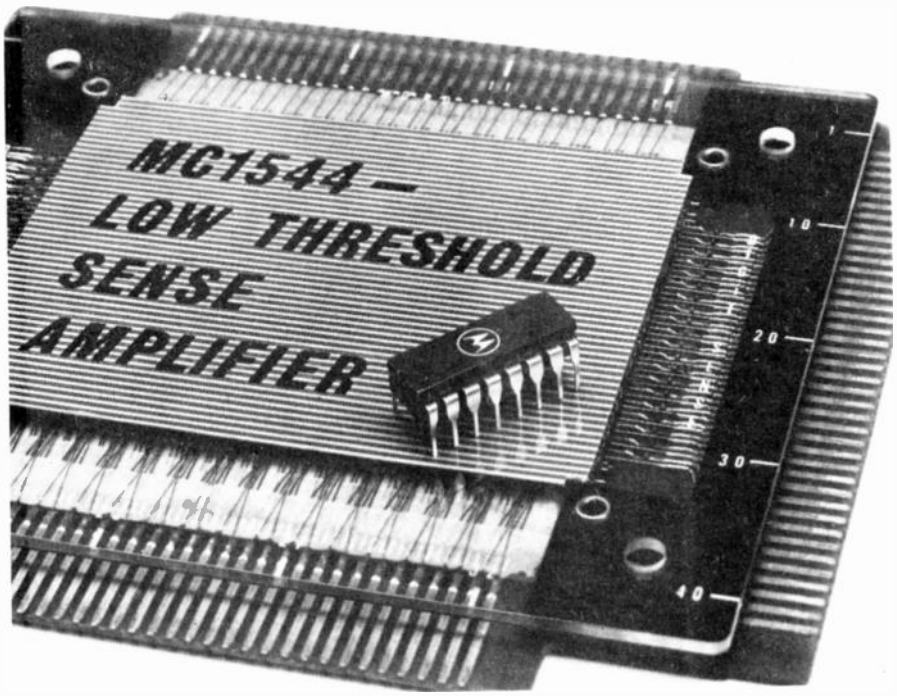
Although relatively cheap in price, the new controllers are highly reliable and accurate precision instruments. The accuracy of the generated setpoint is stated to be within 0.1%, the threshold sensitivity is within 0.02%, and the linearity between the generated error signal and the output signal is within 0.5%.

The companion instrument to the Witronic II controller is a manual loading station which has the same width as the controller but is only 48 mm high and can fit very neatly below the controller. In this configuration the overall face size of 96 x 144mm matches optically with the range of panel-mounted Philips PCS instruments.

Further details from Philips Industries Ltd, 95 York St, Sydney, 2000.

COMPONENT NEWS

4-CHANNEL SENSE AMPLIFIER



Applications requiring high-speed, low-level sensing such as plated wire and thin-film memories are well suited to Motorola's MC1544 four-channel sense amplifier. It features a threshold of only ± 1 millivolt with internal capacitive coupling to allow faster cycle times in plated wire memories.

The new device allows easier utilization of the features of plated wire memories – faster speed, and non-destructive and non-volatile storage.

Further details: Motorola Semiconductor Products, 37 Alexander St, Crows Nest, NSW.

PHOTO POTENTIOMETER

A revolutionary device announced by Photain Controls is called a "Photentiomatic" and is in fact a light controlled potentiometer.

It consists of strip of photoconductive material (either Cadmium Sulphide or Cadmium Selenide is available) 21mm long by 0.5mm wide mounted on a ceramic strip and is complete with lead wires. When connected to a suitable input voltage (up to 25vdc) and subjected to a moving strip of light it provides an output voltage which is directly proportional to the position of the light on the strip of photoconductive material.

Further details from Photain Controls Limited, Randalls Road, Leatherhead, Surrey, England.

TRANSMITTER TRANSFERS DATA FOR COMMUNICATION PERIPHERALS

Due to a rapidly expanding communication-orientated peripheral market, a need has developed for a versatile input/output data transfer for communications data terminals. The Motorola MC2257L terminal transmitter provides this by converting parallel binary input data to serial output form. At the same time, the MC2257L internally provides timing and control functions, an odd or an even parity bit, one character of buffer storage, and error detection.

Asynchronous and synchronous modes of operation are possible with this terminal transmitter. In the asynchronous mode Stop and Start bits are generated automatically.

Words ranging from 5 to 8 bits in length can be selected for entry into a buffer storage register. Information is entered in parallel and stored until transmitted in serial form. Both input and output are TTL compatible.

Used together with a companion MC2259L terminal receiver, the MC2257L transmitter completes a two part, communication-oriented, input/output data interface. Some other typical MC2257L transmitter applications include input/output functions for CRT terminals, keyboards, and minicomputers. Many terminal receivers with asynchronous inputs can be bussed into one MC2259L transmitter to provide a multiplexed synchronous output. In these applications the MC2257L performs the function equivalent to 30 TTL ICs.

Further details from Motorola Semiconductor Products, Suite 204, Regent House, 37-43 Alexander Street, Crows Nest, NSW. 2065.

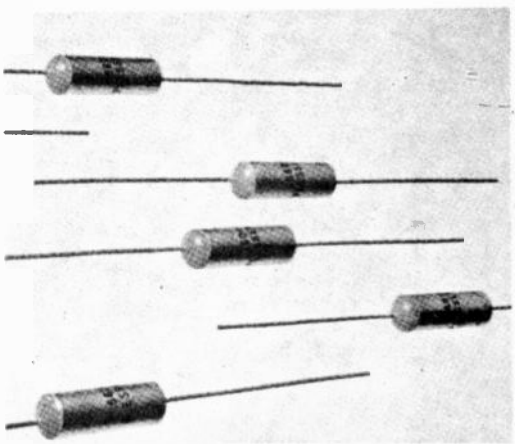
E-CELL DATA SHEET

A four-page product data sheet, PD 2076, from Plessey Ducon gives detailed technical information concerning the F-cell marketed by the company's Professional Components Department.

The E-Cell is a reversible electronic integrator with non-volatile memory for timing, integrating and counting. The leaflet indicates applications for the E-Cell including timing, current – time integration, pulse counting and memory, use – time measurement and repetitive timing and control.

A brief description of the device is accompanied by diagrams showing its construction, its equivalent circuit and a typical operating curve. Full characteristics of the E-Cell are presented numerically and graphically.

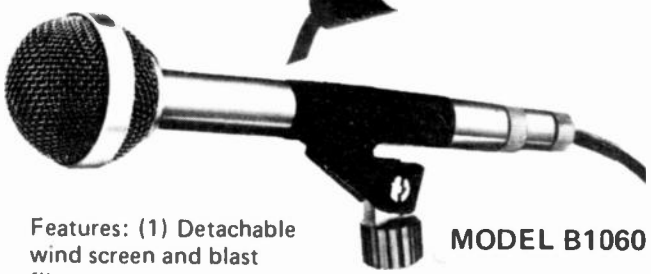
Copies of this publication are available from Professional Components Department, Plessey Ducon Pty Limited, PO Box 2, Villawood, NSW, 2163.



TTC

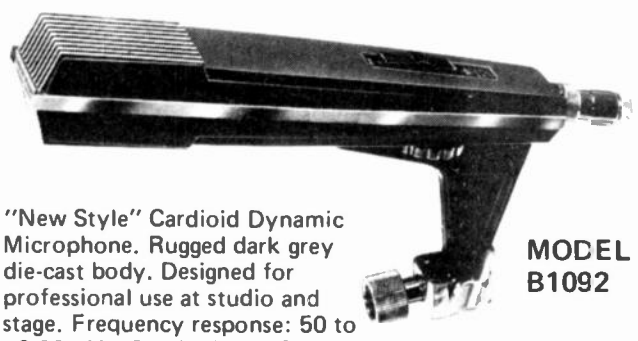
HIGHEST QUALITY

MICRO PHONES



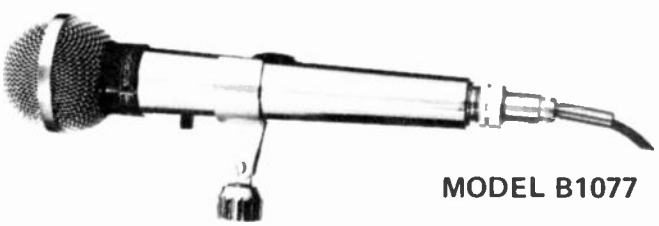
Features: (1) Detachable wind screen and blast filter, suppresses wind noise and close talking pops. (2) Ideal for use with public address systems, inside or outside; for recording music or speech. (3) Attractive stainless steel case with black acoustical wind screen. Lightweight, compact design. Frequency Response: 80-13,000 Hz. Impedance: 50K and 600 ohms Pattern: Omni-directional. Diameter: 5/8". Cable length: 72 inches.

MODEL B1060



"New Style" Cardioid Dynamic Microphone. Rugged dark grey die-cast body. Designed for professional use at studio and stage. Frequency response: 50 to 12,000 Hz. Sensitivity: -72db ± 3 at 600 ohms, -52 db ± 3 at 50K ohms. Large die-cast screw to detach microphone from holder. Dimensions: 9" long x 1-¾" wide x 5-½" high. Complete with cable and dual impedance plug.

MODEL B1092

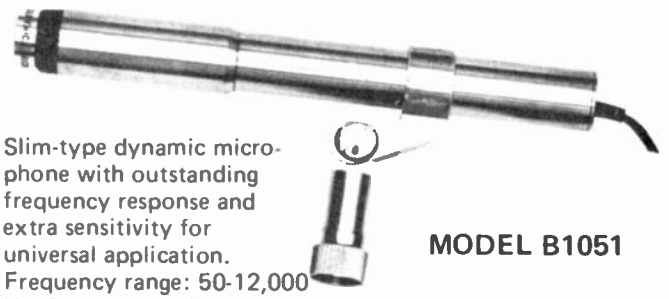


MODEL B1077

This microphone is carioid and dynamic, featuring a built-in wire mesh screen with special filters that provide protection from wind and explosive breath sounds. 50K and 600 ohms dual impedances selected by slide switch. Incorporates a built-in heavy duty on-off slide switch. Professional appearance microphone with gold plated finish. Supplied with detachable 10-foot cable. Sensitivity: -72 db at 600 Ohms, -54 db at 50K Ohms. Response: 50-15,000 Hz.

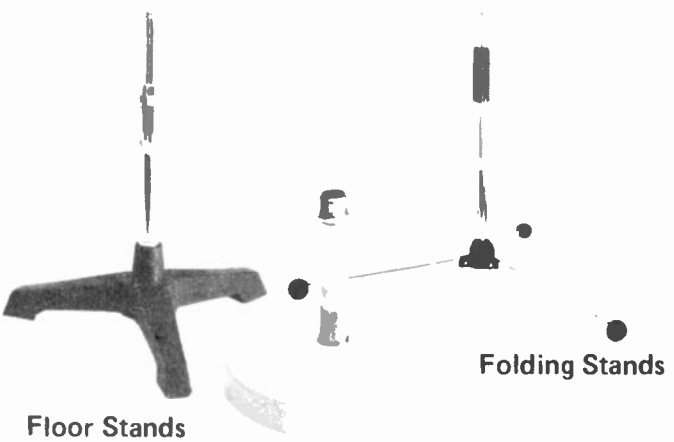
MODEL B7105

Super Cardioid Electret Condensor microphone, with 20 ft. cable, mike holder, and wind screen. Battery powered, battery fits inside case and has life of approx. 8000 hours. 600 ohm impedance. Frequency response 30-16,000 Hz. flat. Dynamic range more than 95 db. Cradle suspension, desk stand, folding stand and floor stand optional extra.



Slim-type dynamic microphone with outstanding frequency response and extra sensitivity for universal application. Frequency range: 50-12,000 Hz. Sensitivity: -57 db. Impedance: 50K ohms. Complete with 6-foot shielded cable and 5/8" x 27 thread adaptor. Attractive satin chrome finish with black cap.

MODEL B1051



Floor Stands

Desk Stands

Folding Stands

All microphones individually packed in display box and are available from leading Hi-Fi dealers or

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SOLE AUSTRALIAN AGENTS

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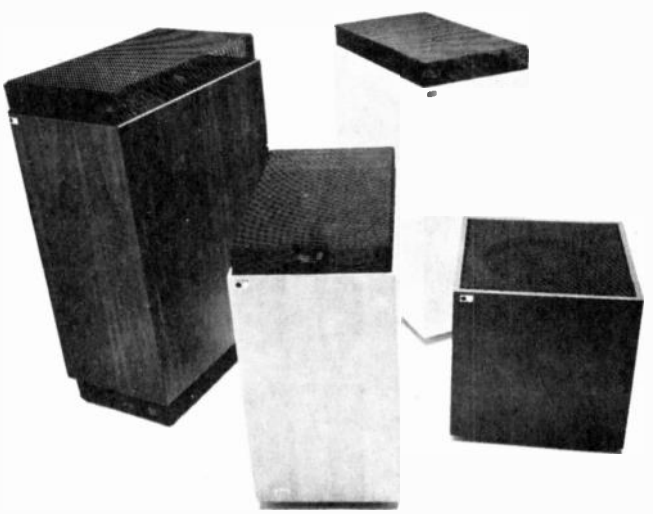
The amazing case of the house with the moving walls.

This is a house in Frenchs Forest. With moving walls.
It's true.
They move outwards.
Before your very ears.
The explanation has nothing whatever to do with the supernatural.
Or at least not as we normally understand it.

The reason — the owner has a pair of Sonab speakers.
Sonab speakers are omnidirectional.
They fill an entire room with rich true stereo sound.
Instead of that one short static line you get from conventional forward facing systems.
But they also have another unique feature.

Listen to Sonab speakers, close your eyes, and you'll find that the effect is of moving the walls behind the speakers outward. Away from you. The whole room seems to open up. It's a difficult phenomenon to describe. But it's one that every Sonab owner has experienced.

If you're cynical there's only one way to prove it to you. We'd like to come demonstrate the effect in your own home.
Just invite us.

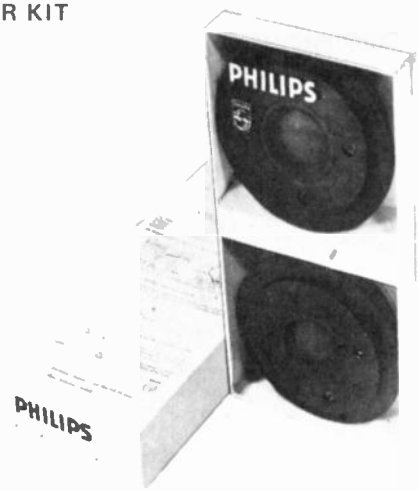


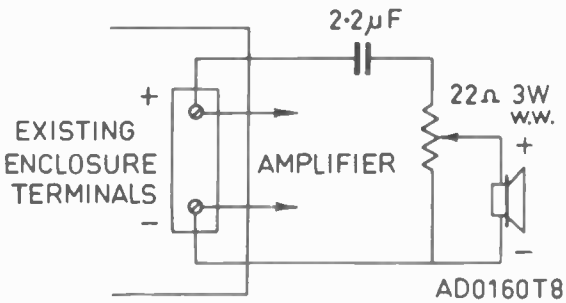
Sonab

Sonab of Sweden Pty. Ltd., 114 Walker Street, North Sydney, N.S.W. 2060. Telephone : 929 4288/4554.

AUDIO NEWS

TWEETER KIT





A new tweeter kit from Philips is claimed substantially to improve the reproduction of existing stereo systems.

The kit consists of two AD 0160/TS 12 1" high fidelity dome tweeters, complete with coupling capacitors and instructions for connection to any existing speaker system.

According to Philips, the distortion has been reduced by forming the speaker diaphragms as parts of a surface of a sphere.

Such a shape enables the sound waves to leave the cone without interfering with one another, and this, plus the fact that the whole moving structure of the tweeter is extremely light, is claimed to result in excellent transient response and relatively high efficiency. Due to the incorporation of a copper ring, which in conjunction with the speech coil, acts like a short-circuited turn on a transformer, the impedance of the speaker is kept virtually constant over the whole frequency range.

These speakers do not necessarily require to be mounted in existing loudspeaker cabinets or enclosures nor do they need any significant baffle area. They may simply be mounted on an 'L' bracket of matching wood and placed on top of, or to one side of, the enclosure. The sound radiation pattern is 180° at all frequencies up to 20kHz, the power handling capacity 20 watts each channel and the cross over frequency is 4kHz or higher.

AUSTRALIAN ACOUSTICAL SOCIETY.

This year the NSW Division of the Australian Acoustical Society will be hosts to other divisions, the associated professions, industry and friends in a National Acoustical Congress at Terrigal on the Central Coast (September 29-October 2). The venue will be at the Hotel Florida which was the scene of the very successful 1969 Congress.

The Conference theme will be Noise Legislation and Regulation and proceedings will be divided into working sessions spread over three days.

In each session, prominent authorities will speak or present papers on pertinent aspects of acoustics such as:–

Hearing Conservation and Industrial Noise
Acoustic Requirements in Buildings
Industrial Equipment and Domestic Appliance Noise
Community Noise Annoyance.

Reprints of papers to be presented at the Conference will be bound and issued to delegates. After the conference, a very limited number of copies will be available for direct purchase from the Society.

Early registration is essential because of the limited accommodation.

The address of the Conference Secretary is:–

Dr V. Mason,
School of Mechanical & Industrial Engineering,
University of NSW,
PO Box 1,
KENSINGTON. NSW 2033.

POWER AUDIO AMPLIFIER

The Italian Society Generale Semiconductori has developed and put into production a new high current monolithic power amplifier. Designated TBA 641, it is available in two alternative packages.

The design of the die has been optimised to achieve a peak output current of 2.5A. The very low saturation voltage of the large geometry output transistors plus the bootstrap circuit enable very high efficiency to be achieved.

These characteristics, coupled with a supply voltage range from 6V to 18V, make the TBA641 suitable for use in high quality portable radio receivers, tape recorders, record players, hi-fi equipment, television receivers, car radios and in many industrial applications requiring high output power, low distortion and high reliability. For example, with 9V supply the TBA 641A will produce an output of 2.2W with a 4Ω load. The TBA641B, with 14V supply, will produce an output of 4.5W with a 4Ω load.

In addition the TBA 641 features low quiescent current (16mA at Vcc = 14V), self centering bias, direct coupling of the input, low equivalent input noise (3.4 μV at Rs = 22KΩ, BW - 10KHz, Vc = 14V) and high voltage supply ripple rejection.

Further details from Warburton Franki, Adelaide, Brisbane, Melbourne, Perth, Sydney, Wellington, NZ.

NOISE REDUCTION UNITS FROM TEAC

New from TEAC are a range of 'add-on' noise reduction units, specifically intended for home tape recording applications. TEAC state that these units may be used with any recorder, reducing tape noise and hiss to very low levels – extending the upper frequency response and improving the overall signal/noise ratio.

Three units have been announced. The AN-180 is a simultaneous record/playback unit incorporating the Dolby 'B' system. Inbuilt microphone and line preamplifiers provide mixing capability. VU meters dual function as level indicators plus Dolby calibrators. Internal test-tone facilities are provided together with individual output controls etc.

An economy version, the AN-80 is a simplified version of the AN-180. Third unit in the range is the AN-50 which is intended for external use with the TEAC series 20 cassette decks.

AKAI 1800SS RECORDER

In our test of the AKAI 1800SS four-channel tape recorder – last month's issue – we inadvertently referred to the unit as the 1800S in the title of the article and in one or two places in the copy. Our apologies to any reader who was confused by our error.

RUN-IN RACKS FOR AR TURNTABLES

When an AR turntable is packed at the factory it is, literally, slightly used. It has been run in for 48 hours, and then given a final workout in one of AR's test rooms.

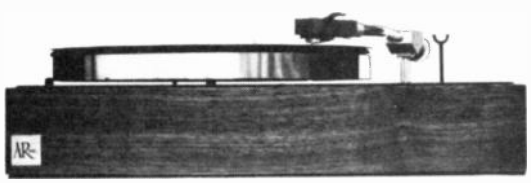
The tests, which include measurements of rumble, wow, flutter, speed accuracy, and speed regulation, are made on every AR turntable. Any turntable that doesn't meet NAB specifications for professional broadcast equipment is rejected. A day rarely goes by without rejections — manufacturing processes aren't perfect.

AR's quality control borders on the fanatical. It is one reason the AR turntable has been rated number one by so many equipment reviews and comparison surveys, in a field of competing units costing up to twice as much.

The unique design of the AR turntable makes it insensitive to floor vibration or acoustic feedback. Its miniature synchronous motor and belt drive make the AR turntable inaudible during operation.

The rigid quality control makes AR's 3 year turntable guarantee possible. **All** repair costs are covered, parts, labour, shipping and even a new carton when one is needed.

$169 RRP complete with arm, oiled walnut base and dust cover.



Acoustic Research Inc.
Massachusetts, U S A

All AR audio equipment is on demonstration at the AR *Music Room* in the Sydney showrooms of the Australian Distributors.

Australian Distributors

W. C. Wedderspoon Pty. Ltd.

Showroom. 193 Clarence Street, Sydney. 29-6681

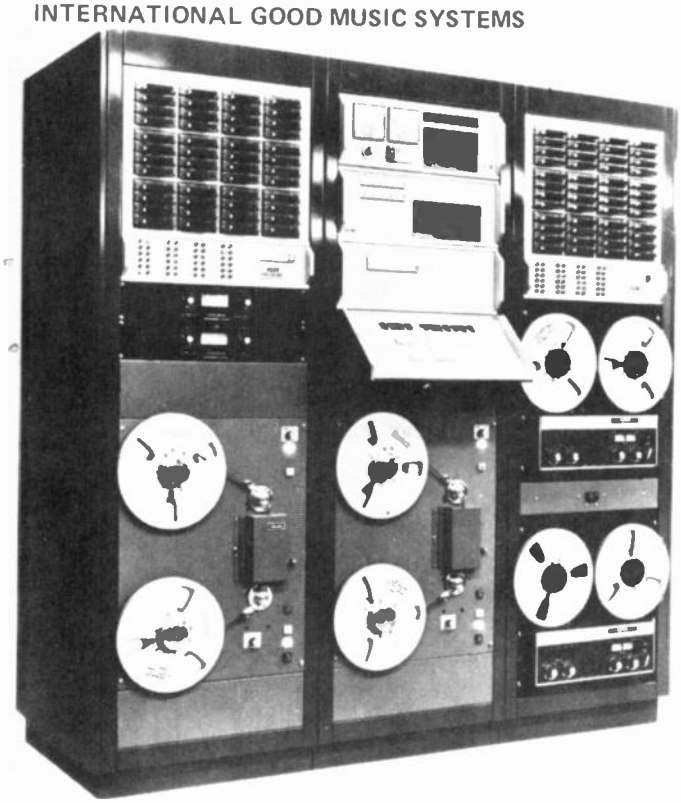
AR sound equipment may be purchased from the following Australian Dealers:

N.S.W.: Magnetic Sound, Sydney. Photo Hi-Fi, Sydney. Sydney Hi-Fi, Sydney. Paxton Photographics, Sydney. Milversons Hi-Fi, Chatswood. DynaStereo, St. Peters. Newcastle Hi-Fi, Hamilton. VIC.: Douglas Trading, Melbourne. S.A.: Sound Spectrum, Adelaide. A.C.T.: Home crafts, Canberra. W.A.: Alberts Hi-Fi, Perth. Leslie Leonard, Perth. QLD.: Brisbane Agencies, Fortitude Valley.

WD24/FP

AUDIO NEWS

INTERNATIONAL GOOD MUSIC SYSTEMS



Plessey Electronics Pty Limited has been appointed Australasian representative for the International Good Music range of broadcast systems which, is claimed to include the most advanced programming equipment available to the broadcasting industry.

The outstanding programming flexibility of the Series 500 control unit – the basis of the IGM system – includes being able to prepare 24 hours of different material in advance and being able to change format instantly to meet special requirements.

Material programmed is on a 'real time' basis and additional live or recorded material introduced into a programme does not affect timing of important segments following.

A random select memory provides memory capacity at 25 steps and can be expanded to virtually any length. The standard unit provides 200 step memory, control and audio switching of up to seven sources. Keyboard operation allows on-air programme changes as required and readouts of current event and next event codes. MOS type integrated circuits are included in the sophisticated circuitry.

TDK CONTINUOUS-LOOP CASSETTES

The TDK company has brought out a line of special-purpose continuous-loop blank cassettes in playing lengths of 1, 3 and 6 minutes. Each contains a quantity of heavy-duty TDK SD cassette tape sufficient for the specified playing time, with the ends spliced together so that it will repeat indefinitely in any normal cassette player. The cassettes are designed to operate in the forward direction only, and have automatic internal brakes to lock the tape in place when it is not in use. Although only one of two tape tracks of the cassette can be recorded in conventional cassette machines, there are specially designed units with head-shifting mechanisms that will also engage side two, thereby doubling the record-play time.

now-the perfect combination

after 42 years of dedication to the reproduction of true sound. The new Akai amplifier and the SW125 speaker.

The New Akai AA5200 Amplifier—latest in the long line of fine Akai products is this exclusively designed masterpiece providing clear, distortion-free performance at all sound levels. Outstanding features include multiple speaker connections, provision for 2 tape decks or recorders, single-ended push-pull circuit delivering 80 watts of music power. Power bandwidth of 20 to 45,000 Hz faithfully reproduces full dynamic range.

Akai SW125 Speaker—the world's first speaker featuring L.T.P. the ultimate in sound. SW125 features a highly advanced 3-way speaker system comprising a 10″ woofer with specially treated cone, a 5″ mid-range and 2″ horn type tweeter housed in a handsome oiled wood cabinet. An ideal match for the AA5200 amplifier.

AKAI

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AK.11

RECORDINGS... CLASSICAL

REVIEWERS: Tanya Buchdahl, John Araneta

MOZART: Requiem K.626. Edith Mathis, soprano; Julia Hamari, alto; Wiestaw Ochman, tenor; Karl Ridderbusch, bass; Konzertvereinigung Wiener Staatsopernchor, Wiener Philharmoniker, conducted by Karl Bohm. DGG Stereo 6530 143. Text included, in Latin/German/English/French.

This is the last piece Mozart ever wrote, and the piece around which there has been built a story concerning Mozart's death, like the story of the freak thunderstorm at the hour of Beethoven's death – all true, but all highly romanticized. A certain Count was in the habit of commissioning composers to write a work which was then passed off as his own. The agent who was sent to Mozart appeared as "the mysterious stranger in grey" whom Mozart was convinced was a messenger from Death commissioning him to write his own requiem. In poverty and sickness he started what promised to be one of the greatest pieces of music in existence, but he died before it was finished, leaving only the Introit/Kyrie, the first 8 bars of the Lacrimosa and a number of sketches. And so one of his students diligently set about piecing it together as best he could. His effort is commendable and surprisingly good, but as the work progresses it unquestionably sinks below the sublime inspiration of the first two movements. It demonstrates quite clearly the perfection of writing which *is* Mozart's, the unquestionable rightness of his music which nobody can reproduce. The requiem is Mozartean, but not Mozart.

The Kyrie which of all the Kyrie/Christe movements I know, I find the most moving, on this recording is taken very slowly which works very well, particularly in the fugue "Christe Eleison" in which all the voices attack with convincing vigour. It's followed by the tempestuous Dies Irae and again the movement is taken slowly – too slowly I think, as are all the choruses except the first. Thematically and therefore musically, the Kyrie and Dies Irae are thesis and antithesis: the former is a gentle prayer for mercy and eternal rest, the latter a hell-fire warning of the impending Judgement day – a Day of Wrath and Doom! So this particularly slow Kyrie would have been much better followed by a Dies Irae played presto, spitting the syllables out like bullets.

The most strained chorus is the Agnus Dei, which is taken so slowly as to seem an affectation on the conductor's part – the time spent in deep-breathing exercises before it is anybody's guess. I dislike listening to any piece in which I start wondering when the singers are going to run out of breath. It's the means intruding on the end (which is also one reason why Beethoven's vocally torturous choral music is not as great as his instrumental – very often you're waiting for some soloist or chorus line suddenly to collapse in ignominy). It's quite a pity in this case because the choir is obviously well trained and has a good feel for the music.

The solo movements fare much better; all four soloists sing well though the tenor is rather weak in places; Mathis sings magnificently in the Recordare and Ridderbusch excellently in the Tuba Mirum, the movement with the trombone solo (actually written by Mozart) which Einstein called a "painful fact" (even more painful for Australians because of an uncommon similarity with the theme music of "Blue Hills").

Technically the recording is excellent; it's a pity about the overdone slowness though, it tends to make a funeral march of it. I mean, it *is* a funeral piece but it is a mass commending the dead person to God, so the idea textually ergo musically is not This Poor Bloke Down There In The Ground but on Sending This Man's Soul Up There; not putting down but reaching up. – T.B.

CARL ORFF – TRIONFO DI AFRODITE Soloists, Czech Philharmonic Chorus, Prague Symphony Orch. Vaclav Smetacek Supraphon Suast 1120877.

It seems strange Trionfo di Afrodite has fared less well on records compared to either Carmina Burana or Catulli Carmina. This third installment to Orff's tryptich on mundane joys is as clever, tuneful and direct as the two previous cantatas, and at least as risque as Catulli, utilising as it does some of the more lascivious texts of Catullus, Sappho and Euripides to depict Graeco-Roman marriage rituals. But then Orff is no longer as fashionable as he used to be in the early fifties when this music served as unpretentious relief to the mostly serial or serioso music being written even then. There is, naturally, a fine amount of truth in the statement, common enough nowadays, that once you've heard an Orff piece you've more or less heard them all. And certainly in Trionfo, some antecedents (Stravinsky's Les Noces especially comes to mind) rather unashamedly present themselves. But we do not have to enjoy masterpieces all the time and as entertainment I do enjoy Orff's tryptich every now and then.

Vaclav Smetacek and his forces deliver a romp of a performance, most matters rather creditably done. His bride and bridegroom, however, merely negotiate their difficult music and with only an inkling for the ardente, sospirato, esultante, con calore, con estrema intensita Orff had in mind.

For all the liveliness of this production, everyone seems rather inhibited, to put it rather lightly. It remains to be seen whether DGG's yet to be released Trionfo betters this presently only available recording. I myself dare not hope so since conductor Jochum's recent remakes of Carmina Burana and Catulli are decidedly less exciting than his now deleted mono only recordings. And Jochum's old Trionfo was certainly devilishly thrilling. It still seems too much for most recording companies to provide complete texts and translations of either Catulli or Trionfo and this Supraphon disc provides a mere synopsis of the proceedings, not even a complete Greek and Latin text to follow. We are still rather surprised, perhaps, at what our ancient forebears could write. Sound on this disc is good if not particularly overwhelming. J.A.A.

HANDEL: Dixit Dominus. Helen Donath, soprano; Aafje Heynis, alto. NCRV Vocaal Ensemble, Amsterdam Chamber Orchestra cond. Marinus Voorberg. Philips stereo SAL 6500 044.

A really magnificent record in all respects. This setting of Psalm 109 is very much in the Italian style and is such is very difficult in parts, but no one seems to have more than the slightest discomfort. The amazing thing is that the choir consists of only 17 singers – the quality and volume is that of twice the number. Moreover, there is virtually no individual variance in pitch which so often makes a small group sound third-rate; one voice at variance with twenty is drowned out but one against another three sticks out like a sore thumb.

Aafje Heynis sings with real feeling in the aria "Virgam virtutis tuae" (No 2) which is ideally suited to her smooth, lyric voice; and so does Helen Donath in the aria "Tecum principium" (No 3) which she sings with wonderfully sensual sweetness.

The orchestra is precise and watches all the details without losing any of the lush richness – and without making it pompous which is the Great Handelian Myth. The recording quality too is first rate, as is usual on full-price Philips. Come to think of it, I don't recall ever having heard a less than first-rate technical performance on this label. The balance is superb, every voice and every line comes out clearly in its own right, and the sprightly cembalo playing by Leni van der Lee has just the right amount of attention; it's an instrument which is notoriously difficult to balance in recording.

If I had to choose the best movements I think it would be Nos. 4 and 7: No. 4 "Juravit Dominus" is a difficult chorus and No. 7 "De torrente" is a moving Pergolesi-like slow movement, in which the three women soloists (Donath, Heynis and 2nd soprano Trudy Koeleman) wind their voices in and out, under and over one another in a manner which made my spine

CLASSICAL

tingle. But that was a difficult choice and the whole product is a masterpiece of singing, conducting, playing, recording tasteful cover – the lot. – T.B.

BEETHOVEN – Symphony No. 6 "Pastorale" Overture "Prometheus" Colin Davis, London Sym. PHILIPS 6580 050.

Another reissue on PHILIPS UNIVERSO series. Attractive enough at the price ($3.95) and with typical "music appreciation" notes on "the world around the music" – very useful for schools, I suppose. This performance is certainly a good one. It is straight forward and impeccably played. But what is lacking here is any feeling for what can make the Pastorale a magical experience. Colin Davis traverses Beethoven's countryside with an almost cold-blooded lack of regret. This is a reading, nothing more. Nothing excites Davis to seek for any subtleties, not even the storm. Its main attraction, then, is the price tag. Anyone really interested in this music must not hesitate to look elsewhere. J.A.A.

LISZT – Piano Concertos 1 & 2. Byron Janis (piano) Moscow Philharmonic, Kiril Kondrashin (in No. 1) Moscow Radio Orch., Gennady Rozhdestvensky (in No. 2). PHILIPS 6582 003.

Janis obviously has a formidable technique for these tired concertos. Nevertheless there are moments particularly towards the end of both works when he seems to lose control and the momentum is somewhat lost. These instances are always minor enough, however, and never really detract from these otherwise technically fine performances. Both Russian orchestras accompany with verve if not always with the greatest refinement. At the PHILIPS UNIVERSO price ($3.95) these performances are certainly more than acceptable and the recording is always vibrant and clear. But for not much more, one really can acquire a performance that is not only tremendously exciting but also remarkable. The Richter-Kondrashin recording (PHILIPS SAL 207) is furthermore wholly believable, which is what one likes to expect in this music. Richter does not sound tired of the music as I suspect Janis and his colleagues are, and I feel this is a quality one must avoid in this music. J.A.A.

BEETHOVEN: Piano Sonatas; no. 23 in F minor Op. 57 (Appassionata), no. 32 in C minor Op. 111. Alfred Brendel. Philips Stereo SAL 6500 138.
BEETHOVEN: Piano Sonatas; no. 29 in B Op. 106 (Hammerklavier), no. 24 in F sharp Op. 78. Alfred Brendel. Philips Stereo SAL 6500 139.

Alfred Brendel is one of the best pianists alive today, and if you don't believe me, listen to these records. It's very easy to turn Middle Beethoven into kitsch and Late Beethoven into an empty mockery – there are plenty of pianists who avoid this but amazingly few who really understand what they are playing, for example the great Beethoven pianists Arrau, Kempff and Backhaus. Now we have two more great interpreters, Barenboim (the only pianist I know who can express total calm) and Brendel, with his light, clear touch and the rave virtue of being able to stay off the pedals when so required.

He plays the Op. 78 as it was intended, a token of friendly affection for Therese von Brunswick, simple though written in the rather fumbly key of F sharp major (six sharps). But the other three sonatas are much more interesting, because they are major essays of three different kinds.

The 'Appassionata' is the second sonata of the Middle and most popular period. It retains the early brilliance and witty originality (Beethoven after all was known in his day as a virtuoso pianist, not a composer) but hasn't gone into the late personal intensity and near-incomprehensibility. But all the signs are there: the hands playing octaves apart, the use of the trill as part of the melody rather than an ornament, and the rarefied subtle use of the diminished seventh. Brendel plays magnificently – he saves the first double-forte chord sequence from sounding like a lapse into bad taste, he projects the blunt stubbornness of the final movement's presto ending, the unmistakeable Beethoven perversity, just to mention a few delights.

The 'Hammerklavier' is the second sonata of the Late period and one of the most difficult pieces in all piano literature both technically and emotionally. It is only recently that pianists have dared to hazard it. Here is the fully-developed late style with all its trademarks, its intellectual and emotional gymnastics of near-manic proportions, and in the last movement all combined in a mammoth fugue of harrowing profundity. Like the 'Grosse Fuge' string quartet Op. 133, one's first impression of it is disbelief, of wondering what stunt Beethoven was trying to pull. It's no stunt, just one of the greatest piano pieces ever written, and Brendel has come closer than anyone else I have heard to playing it properly. No faceless technical perfection, no muddy inaccurate emotionalism, but beautiful balance between the two.

The Op. 111 is a different proposition again. It's the very last sonata, and I happen to think it is one of the most sublimely beautiful and moving pieces of music in existence. It's universal but intensely personal at the same time, which is the way it is with all great art. It has only two movements, allegro and aria with variations (another form which Beethoven developed just about to its limits), and as Brendel points out in his excellent cover notes it is theses and antitheses. The drama and passion of the first movement is countered by an aria of almost naive simplicity and incredible beauty – "simplicity as the product of complexity: distilled experience." Which is a pretty neat way of putting it. Again Brendel plays superbly, though purely as a matter of taste I prefer Barenboim's recording because he uses more weight and rubato in the first movement. But that's only taste, and there's no doubt that Brendel's performance is first rate, containing meticulous attention to detail, brilliant technique, and real personality which he projects through his very moving expression. And he keeps Beethoven's sense of humour too, which appears all the way through to his last work. You can't describe where to find it or what it is, it's just a feeling you get that Beethoven was laughing at something, probably himself. Which makes it a wider experience. – T.B.

RECORDINGS... JAZZ

REVIEWERS: Bert Williams, John Clare

TIN LIZZIE DAYS – Pearce-Pickering Ragtime Five Tin Lizzie Days; Rose In Her Window; Don't Monkey With It; Maison Bleu; Good Time Stomp; After I Say I'm Sorry; Felicity Rag. Cook Good Cabbage; Say It Simple; Bouncin' In Rhythm; Sweet Patootie Elite Syncopations; American Beauty Rose; Piping Hot. Swaggie S1293.

Tom Pickering is a big wig in Tasmania's State Library – the State Librarian himself, or the assistant State Librarian. Maybe both.

He is also one of Australia's best jazz clarinetists and most interesting tenor saxophonists. And, judging by this record and its predecessor, Jazzmania, definitely our best jazz singer. By jazz singers, I mean those who are influenced in their singing directly or indirectly by Louis Armstrong, Jack Teagarden, Wingie Mannone, Jelly Roll Morton. People like Roger Bell, Will McIntyre, Dick Hughes, Ade Monsbourgh, George Tack, Frank Johnson and the late Warwick Dyer.

Pickering sings on five tracks of this worthy new record – Tin Lizzie Days, Don't Monkey With It, Good Time Stomp, Say It Simple, Sweet Patootie. He has just the right rasp to his voice so that it never sounds contrived. His diction is fine and his feeling for jazz unquestionable.

Roger Bell, in his sleeve notes, says Pickering's voice has "the rough grained, hoarse, good humor of a wet airedale . . . it is perfectly suited to this material and points up the purity of his clarinet nicely."

Pickering's clarinet tone is purer than it used to be admittedly, but somehow I've never thought of it as pure at all – until Roger Bell said so.

It's rather paradoxical – something like the tone of Bud Freeman's latter-day tenor saxophone. Some of Freeman's later playing has a tone as pure as Marcel Mule's, but somehow it comes out unmistakably as Bud Freeman's.

Anyway this is a damned fine record and the highest praise I can give it is that it comes up to the standard set by Jazzmania. No tired old warhorses here. There are two rags by Scott Joplin, which are played precisely but not pedantically, two rare Edmund Hall tunes (which may have first had an airing on that great clarinetist's Petite Fleur album), Maison Bleu (a Pearce original which would have delighted Sidney Bechet and Wally Fawkes.

Honi soit qui mal y pense, but those words to Dave Dallwitz's and Ade Monsbourgh's Don't Monkey With It do sound oh-so-rude and ever-so-shocking until Pearce plays his Take It From Here phrase to Tom's verbal clue identifying "it".

Monsbourgh also composed Piping Hot which, as a rag, scarcely suffers by comparison with Joplin's Elite Syncopations and Felicity Rag.

Good Time Stomp is a joint composition by Pickering and Pearce and a reminder that Tom used to call his band of the late 40s and early 50s Tom Pickering's Good Time Music. Good Time music is a particularly apt description of the music on this record. It is not of the smile-darn-ya-smile look-how-unspeakably-jolly-we-are variety. Rather the rich laugh and the gentle smile.

Ian Pearce's piano playing here is as authoritative, swinging and pertinent as it was on Jazzmania.

The introduction he plays on After I Say I'm Sorry, incidentally, sounds peculiarly Australian, with doubtless quite unconscious echoes of Graeme Bell and Will McIntyre. Tom's tenor playing suggests Eddie Miller on this one.

Ian Pearce played trumpet in Tom Pickering's Barrelhouse Four in the early days of the Australian jazz revival with Rex Green on piano and Cedric Pearce on drums. He came to Melbourne in 1948 and played trombone with both Graeme Bell and Tony Newstead and later went to England where he played with Mick Mulligan. How he there got the nickname of Wylie is one of the funnier and more respectable episodes of George Melly's book, Owning Up.

The rhythm works of Don Sheppard, bass, Michael Colrain, drums, and Oscar Smith, guitar, banjo, contributes enormously to the success of this record. Colrain's playing here is better than on Jazzmania, on which it very occasionally had a tendency to be ricky-ticky. Smith's guitar solo work is very tasteful and his banjo is just right for the rags.

Pedants' points Maison Bleu should be Maison Bleue. What Can I Say Dear? is the title of the composition given here as After I Say I'm Sorry. – B.W.

LOUIS ARMSTRONG V.S.O.P. VOLUME 8. French CBS 62753. Lazy River, Georgia On My Mind, Chinatown, I Got Rhythm, Stardust, All Of Me, Between The Devil and The Deep Blue Sea, Keepin' Out Of Mischief Now, Lawd, You Made The Night Too Long etc.

Last month we reviewed the second record of this series, which included some of Armstrong's greatest early jazz performances. This, the last in the series (they are the two they sent us) has Armstrong fronting a band which can sound very like Guy Lombardo and coming on as the great showman. These tracks, which include at least four marvellous trumpet solos, some not so good ones by Armstrong's standards, and sixteen lighthearted vocals which show where Dean Martin got most of his slurred, behind the beat phrasing, were recorded between late 1931 and March 1932. Swaggie have a series which carries on from here, in similar vein through to the early forties.

It is an odd thing to consider that Armstrong's musical gifts were almost incidental to his massive and sustained popular career. Like Marlene Deitrich, Maurice Chevalier, Al Jolson, Elvis et al he was a popular image: the handkerchief, the perspiration, the teeth, the shaking belly laugh. While all great popular musical figures had something going for them musically, I would hesitate to ascribe musical genius to any of them except Louis. No, not even Hendrix, nor even Ray Charles would I unhesitatingly call genius in the light of all the great musical figures who have trod the earth. Louis, yes.

Thus, there is a dual interest in these rather strange old tracks. Much of it is firmly dated – as popular art which truly embodies its time must be dated and must in some degree hold a curious insight for us of a time past. The trumpet solos, mainly the ones on the second side, are timeless, tell us very little of any specific period – in fact they are futuristic, innovatory, as was Beethoven's music. Louis had it both ways. He must have been the happiest man in the world. J.C.

STAN KENTON. Stan Kenton At Brigham Young University. Quadriphonic/Stereo. Compatible ST-1039 (CBS-Sony SQ matrix system)

We won't devote too much space to this double album because it is available only through Creative World, Inc. Box 35216, Los Angeles, California 90035. I am often sent Kenton albums, both old and new, so I thought I'd let the Kenton fans among you know what Stan's up to and how you can get his records.

Kenton opened my ears to a lot of sounds when I was a teenager, and I used to take great delight in playing a Kenton record to my strictly rock and roll friends and seeing their astonishment as the cataclysmic dissonances thundered out. Now I would rather hear Little Richard, though it still gives me a charge to hear a Kent band blast off. I know that rock fans today would go out of their minds hearing them live, just for their great breadth of sound – something you just can't get with three guitars,

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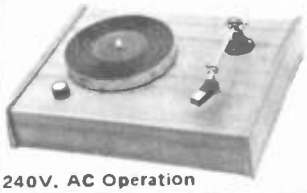

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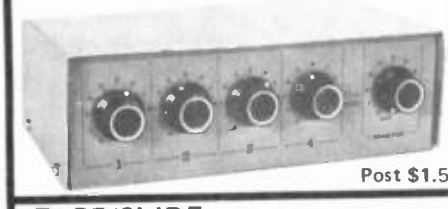

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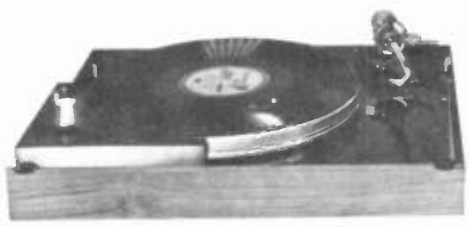

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JAZZ

however loud. Perhaps it was the accessibility of the sounds – like a catalogue of what you could do with instruments waiting for someone to take it all and give it a deeper meaning – which made it pall. Gil Evans or Ellington, for instance, I still dig even more than Little Richard.

So much for my likes and dislikes. This is a recent Kenton band performing to a young enthusiastic audience in Mormon country – and how like Mormon architecture Stan's music can be! It is much looser and possibly even louder than earlier bands and there is a heavy concentration on Latin rhythms, making it pretty accessible to a rock audience. They generate an undeniable excitement, which only starts to sound superficial after you've heard one side – to my ears anyway.

Stan opens the proceedings by promising his audience that they are going to take a bath in sound. The promise is definitely fulfilled. J.C.

MILES DAVIS – Miles Davis Live CBS – Double Album. Musicians include Miles Davis, trumpet and electric trumpet with wa wa device, Keith Jarrett, piano; Jack de Johnette, drums; Joe Zawinul, Chick Corea, Herbie Hancock, keyboards; John McLaughlin, guitar; Airto Moreira, percussion; Dave Holland, bass; Gary Bartz, Steve Grossman, alto and soprano saxes; William Cobham, drums.

It is hard to decide whether Miles has worked the only really successful jazz rock fusion, or whether he has just taken rock and turned it into another kind of jazz; given it the flexibility and adventurousness of jazz improvisation while retaining the simple and sustained cathartic quality of rock.

One could be excused for thinking: alright, electric rock has opened up some extraordinary tonal possibilities, but nobody seems to be particularly interested in exploiting them (what Pink Floyd usually does is to graft effects, often intriguing ones, onto fairly straight-forward rhythms and melodies; they rarely achieve a true integration of electronics and music in the way Hendrix's tonal distortions were *part of the music*, or Duke Ellington's growling and talking brass). It's as though Hendrix and The Who had done it all and everyone else was satisfied to stay within that spectrum.

Miles Davis listened to rock records almost exclusively for a few years before emerging with his electric sound. It's rumoured that Clapton had been recommended for the band, and that Miles listened to him in the studio, shook his head and left. Obviously Miles was not going to bring out a band that would be, well, just another rock band. Miles did not emerge as part of the rock scene. He emerged about five years in front of it.

Around the time Miles was professing his dislike for the then avant garde in jazz he was actually listening to Ornette Coleman's "new thing" every night in New York. Bill Motzing, late sound man with Blood Sweat and Tears was there too. He told me that he waited two years before detecting any of Ornette's influence on Miles's playing. In terms of his reputation Miles was too cunning and in terms of his own artistic satisfaction too intelligent to just begin copying what either rock players or the new jazzmen were doing. He waited until he'd absorbed it and transformed it into something entirely his own. On this double album are several different bands. Each is a variation of Miles's concept, each could only have been led by one man.

What Miles and his men do with what is amazingly enough the same basic eight or four to the bar which sounds so antedeluvian under Black Sabbath or Grand Funk, is practically beyond comparison. Their amazing time feel is hinted at on a record Howlin' Wolf made for Chess (I remember one track which starts off with two rhythms going simultaneously: a feeling like that of those footways which move in segments in fun parlours; before dropping into the basic beat with an abruptness which throws your heart up into your mouth) but Miles goes way beyond that.

Sometimes they will impose a complex cycle over the basic beat. Then they will leave everything out except an accent in this cycle, an accent in the next. The effect is cryptic, almost unbearably tense. The accents start changing, swapping from one man to another. Ping . . . when's it coming? . . . Zap! You feel that you are being sniped at. Sometimes they will pull the rhythm pattern slightly out of phase – and they will continue to play like that, all conversing with each other, all developing individual ideas, all out of phase, without ever losing the basic pulse. As one man they will snap it back together. Tension and resolution. That's what music is largely about. Nobody makes music quite like these truly amazing musicians who must surely be able to read each other's minds.

Further, they've all developed a kind of shorthand: single inflected notes, tiny chromatic clusters clinging to the very cliff edge of a time change, sometimes popping and bubbling like rhythmically phrased serial music – in fact like the sudden shifts and darts of some cellular process. The earthy and the ethereal commingle, as in this changing life. Rhythm and melody are one. The music seems as full of amazing forms as a coral reef, but it is not cluttered, because there is no redundant note: everything is played in response to something else, except for Miles' statements which are like the voice of god. Where he uses the wa wa, though, Miles gets more involved in conversation with the others than he has done previously.

Parts of this double album are actually the closest Miles has come to straight hard rock. It is not so loose and adventurous, but damn near. Jarret and de Johnette are superb and Miles' too brief open solos are some of the most intense he's ever recorded. Probably the best introduction to Miles of all his recordings. Sound is superb, though the trumpet could have been up a shade.

Unbelievable through headphones. J.C.

RECORDINGS... POP TRENDS

REVIEWER:
Michael Delaney.

"MALO" – Malo. Kinney. Stereo BS 2584. Pana – Just Say Goodbye – Cafe – Nena – Suavecito – Peace.

The drawback about Malo is that they're trying to ape the approach pioneered by Santana without that self-same fluency and detail afforded to the multiple rhythms. This ten-piece Latin group led by Jorge Santana tends to force itself upon each of the six cuts with a formal jazz design marked obvious by the unsophisticated brass/keyboard figures. They've tried to project, that random development with regard to melody, safeguards the spontaneous without actually becoming involved to the point where anything outside a quick guitar/percussion passage ever occurs to warrant their enthusiasm. There's a whole lot of beautiful feeling gone down into this album but it's all been misdirected due to their lack of knowledge. Malo doesn't really know how to use tone and texture. There's just not enough contrast between light and shade and differentiation between tempos. It always seems to fall a little below the mark no matter how hard they seem to try.

Malo is a good band simply because they sound like they're having fun with the music. They utilize their limited range with flair and imagination but it still makes them look like a second grade rip-off from Santana. "Just Say Goodbye" is the one track that features a tangent approach to the percussive rhythms. It's a haunting love song – low key atmospheric and close to the most worthwhile thing on the entire album. It makes you realize that Malo is going to be one helluva good rock/rhythm band once they get their own identity into focus. As things stand at the moment there's not much room for another Latin American big band due mainly to the monopoly imposed by Jorge's brother Carlos. The essential difference between the two outfits is nothing more than the youthful excitement of Malo compared to the ageless technique of Santana. Malo tries real hard to be subtle – but the mere fact that they've got to try, leaves them at an immediate disadvantage. They're not a soft group and shouldn't delude themselves into thinking that they are because it'll soon sap all the guts out of their form. "Pana" and "Suavecito" stand as the other highlights. Production is amazing once you consider that the album was recorded in L.A.'s old Pacific Studios – the stomping ground of West Coast musicians circa 1960. Malo is going to be a good band but I'll hold my breath till album No. 2 before I say anything more. M.D.

"DOMINO" – Van Morrison. Kinney. Stereo. WS. 2487. Domino – Crazy Love – Calle Me Up In Dreamland – Cyprus Avenue – Come Russing – Madame George – Blue Money – Brand New Day – Slim Slow Slider.

Van Morrison is quite fascinating. He just about defeats any attempt to either describe or illuminate his character in much the same way as Stephen Stills. His style does it level best to defy comparison due to the eclectic influences that predominate throughout. Each song sounds a bit familiar mainly because of the insistent jazz phrasings evident in his more pronounced balladic approach. "Domino" can't really be called a rock 'n' roll album as the energies involved relate to narrative blues.

Morrison is a tasteful performer. His music is at once deceptive and perplexing – not unlike Stills in a much less neurotic frame of mind. The central form adds continuity to his style by focusing on several simultaneous directions. This permits him to act as both poet and interpreter without a loss in the dynamic interplay. He has a natural restraint that checks every move. Morrison is one of the few American based solo artists who hasn't developed a false refinement inhibiting subtlety and colour.

"Crazy Love" is perhaps the finest song for his emotive images. The arrangement is constantly underplayed so as to allow complete scope for each nuance to take form. "Madame George" – a cut from his first Kinney album "Astral Weeks" – is the one major highlight due to the nature of the concept. It's interesting to note that Morrison has never employed this particular mode outside that debut disc. More's the pity because it proves time and again to be his most distinctive.

The general effect is mellow – less than energetic; sombre in tone. "Cyprus Avenue" ventures nearest in design to the "Astral Weeks" mode despite the laboured atmosphere. "Come Running" is the obligatory raver along the lines established by the title track "Domino". Somehow this composite album comes together in a very appealing way – Morrison is an addictive songwriter. He has the ability to hold people spellbound. This guy sure has come on since the days as lead vocalist for Them. I bet you can still remember "Gloria" and "Baby Please Don't Go". Righ. – M.D.

"AMERICA" – America, Kinney. Stereo BS 2576. Riverside – Sandman – Three Roses – A Horse With No Name – Children – I Need You – Here – Rainy Day – Never Found The Time – Clarice – Donkey Jaw – Pigeon Song.

The thing that'll always sell America to any audience is the smile running through their songs. They might sound predictable if not imitative in approach but you're still going to find it hard not to react along with their facile beauty – innocent and free; almost bashful. This English trio late of New York has enjoyed a routine evolution with particular strength placed on the acoustic elements in so far as their Messiah seems to have been Crosby, Stills & Co circa "Suite: Judy Blue Eyes". In actual fact their whole style has been hatched by integrating the harmonic tenderness of the former with Bread's cocktail romanticism as per "Make It With You." From all of this they've devised a way to sing about love without ending up maudlin. America produce songs with a great deal of heart that seldom cross the demarcation line that separates the noteworthy from slop

The reason America can communicate so thoroughly has little to do with their musical standard as such, although it does count to a small degree. This band is a success because their essential character is both gentle and considerate – the gentlest I've heard since Seals & Crofts first discovered the mandolin. They respect music and worship its abilities to transform fact into fantasy – the most effective method to reach out and touch the dreams within us all.

There's nothing on their first album that you'd call brilliant, if you were out to criticize with values based on their original content, simply because it's eclectic by nature and amorphous in function. America viewed from this angle would no doubt appear to be an ultimate rip off. But it's all to do with their loveliness – the counterpoint and multiple phrasing; swift harmonies and guitar combinations that glow and shimmer and glide. It's all to do

with the elusive imagery and the cascading warmth about each tune whether it be a ballad such as "I Need You" or an up tempo cut like "Riverside". America can remain lyrically sensitive whilst contributing more to the tonal balance of their style disassociated from the voice. They work around their range of textures limited as it may be and make them complement each other without undermining the initial mood. America purely refuse to introduce contrasting sounds thus maintaining complete simplicity and precision. So what if "A Horse With No Name" appears to be a pinch from Neil Young. It just doesn't figure like that these days because the song itself is beautiful and that can only be the final estimation regardless. Production is fine. "America" is a magnificent debut record from what promises to be an equally magnificent group. Get into it now and avoid the rush. M.D.

"FRAGILE" – Yes. Kinney. Stereo SD 7211. Roundabout – Cans & Brahms – We Have Heaven – South Side Of The Sky – Five Percent For Nothing – Long Distance Runaround – The Fish – Mood For A Day – Heart Of The Sunrise.

Yes have developed into one of England's top bands simply because they've realized the need for a high degree of technical precision to support their complex style. It breaks down to a case of having sufficient skill and insight to utilize the available sound without misdirecting the major influences – most of which relate fully to a modern classical theme.

"Fragile" – their fourth album – finds the group concerned more with the expression of separate characters than that of the general approach as a unit. This is quite possibly the most significant thing about the record because they've been able to both compromise and counter balance the two aspects without either one suffering as a result. Yes have reached the point where they've been forced to introduce the personal ideas of each member as a move to prevent the composite range from stagnating. This enables them to maintain their overall identity whilst engaged more with individual pursuits – the best of which are channelled back through the band as new material. "We Have Heaven" – a multi-vocal suite by singer/songwriter Jon Anderson – and Rick Wakeman's "Cans & Brahms" stand out as the most successful of the five solo projects contained herein. The latter is an adaptation of an extract from Brahms' 4th Symphony In E Minor. It just goes to show how far a rock band can progress if they're prepared to play music and not spend every moment trying to get it on.

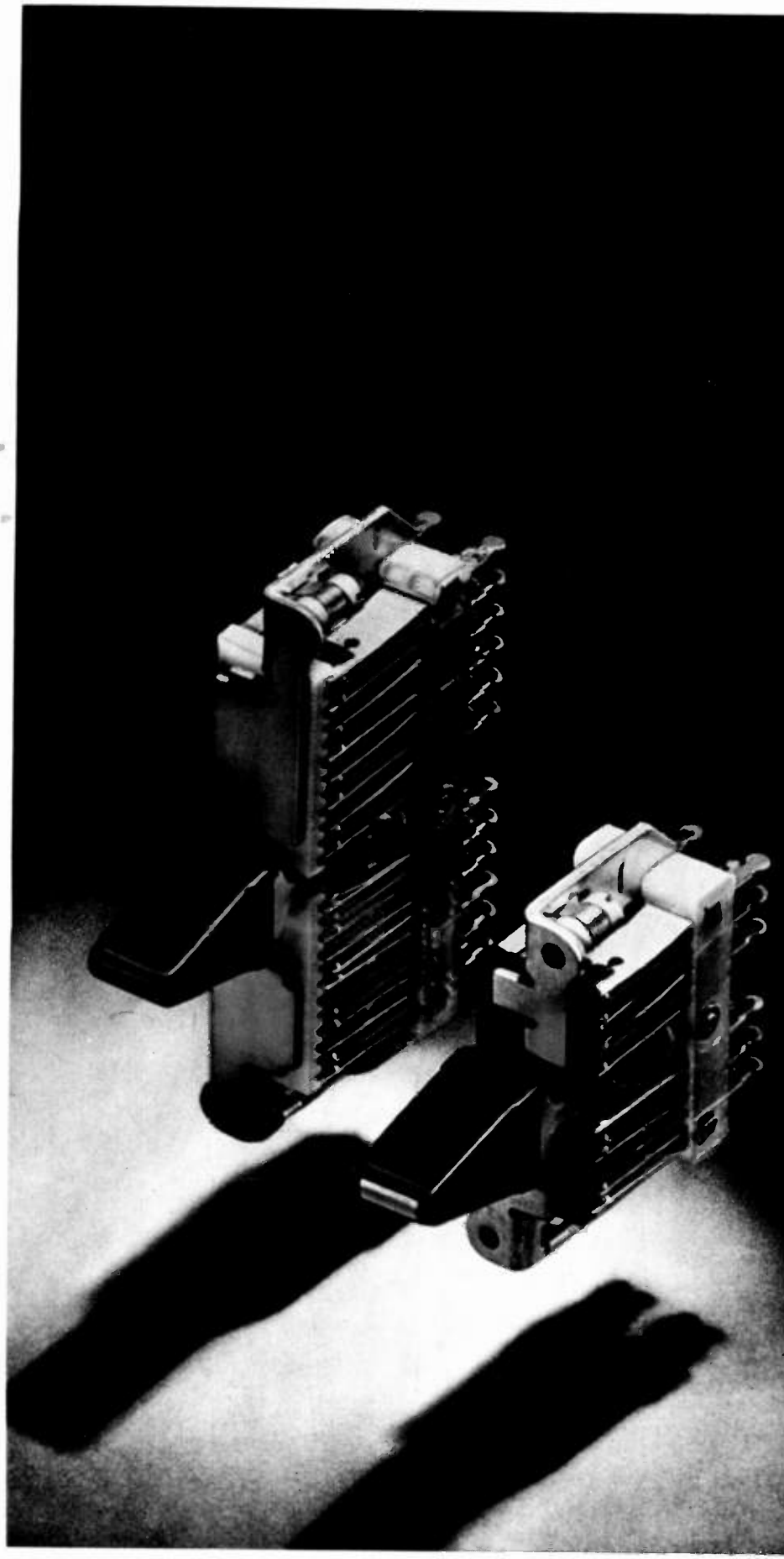
Yes occupy a unique position compared to most other 'name' outfits because their sum is equal to the whole. This band works with such a permissive flexibility in both method and design that it can juxtapose instrumental structures from motion to movement without conflicting with the score. "Heart Of The Sunrise" was built on a Stockhausen premise where each tempo/texture is forced through a number of simultaneous changes with the resultant rhythm handled in counterpoint. It's a matter of stretching and editing the melody to create an atmosphere unrestrained by a mere voacl passage. "South Side Of The Sky" was written along similar lines except for the pronounced lyric that takes its strength from the percussion and not the guitar/keyboard as one would expect with Yes a la "Roundabout".

I'd say that "Fragile" will end up as their definitive album because it seems to be a perfect climax to four years on the road. It's Yes at their peak and they're not going to get much better. Buy some. M.D.

"MARY CALLED JEANIE GREENE" – Jeanie Greene. Kinney. Stereo EKS 74103. Yes I Do Understand – You Know Who You Are – Put Your Good On The Line – Thank God He Came – Like A Road Leading Home – Swaziland Remembered – Joa-Bim – Mighty Time – Magdalene's Medley – Pre-Recognition – Only The Children Know – Peter Put Away Your Sword – Going Home.

As a singer/songwriter Jeanie Greene explores well-defined areas of White Gospel with a deceptive poignancy that prefers detail in arrangement to both depth of mood and contrast in performance. Her songs could have gone down as light hymnals had it not have been for the over-zealous production that seems to embellish everything except her own voice quite out of the context. There's just so much unnecessary background movement that her soul has been all but suffocated in the vast reservoir of pseudo-spiritual Memphis muzak. Jeanie's message is based on the simplicity of her religious devotion not on the excellence of her Muscle Shoals producer Don Nix. I'm almost certain that she could have done herself greater justice without resorting to a sound cross between Isaac Hayes and The Staple Singers. This simply serves no purpose other than to provide an ego boost for the boys in the back room.

The most unfortunate thing about this album is that the songs just weren't meant to support the intricacies of an orchestral backing. There's too much of a strain placed on each tune and this just projects further the conflict between the artist an; the poor co-ordination. Jeanie's songs are essentially introspective pieces that neither demand nor expect more than an ample acoustic base. "Joa-Bim" and "Going Home" are the best examples of her work mainly due to the lack of instrumental motion. She just sings and sings. And that's why they're so good. "Peter Put Away Your Sword" stands alongside "Only The Children Know" as the two cuts that appear most suitable for the rather lush accompaniment. But even these tend not to sound authentic despite the obvious restraint self-imposed by director Jay Pruitt. "Mary Called Jeanie Greene" lacks feel and this is the most important aspect about Gospel. Half-measures that force compromise can only result in musical anaemia. I would've thought that Don Nix could've done better particularly due to the fine work on his own solo album "Living By The Days". I've heard worse. M.D.



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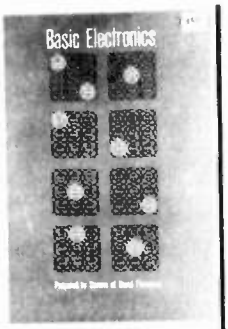

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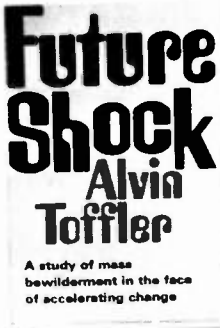
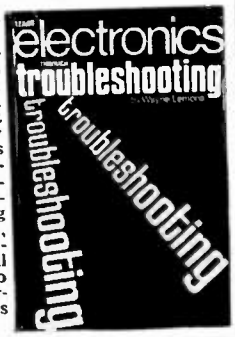
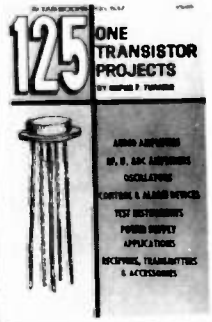


LEARN ELECTRONICS THROUGH TROUBLESHOOTING — WAYNE LEMONS. 8½" x 5½", 576 pp $12.75. In this excellent book, illustrated by many photographs and drawings, the subject matter is presented in terms of practical troubleshooting situations and simple, reproducible examples. These facts will be indispensable to the technician entering the electronics field.



HOW TO FIX TRANSISTOR RADIOS & PRINTED CIRCUITS — LEONARD C LANE. $6.15. Semiconductor Fundamentals, How Transistors Work, Basic Amplifiers, RF and IF Stages, Detectors, AGC, and Audio Amplifiers, Auto Radios, FM Radios, Facts, Tools, and Testing, Servicing Methods, Printed Circuits, Troubleshooting Charts.

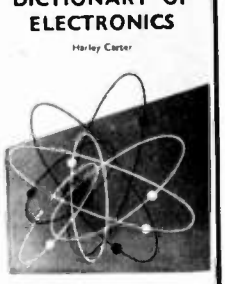
RADIO RECEIVER SERVICING GUIDE — ROBERT G. MIDDLETON 96 pages, $6.45. General Troubleshooting and Isolating Procedures, Troubleshooting in RF and Mixer Stages, Servicing Intermediate Frequency Amplifiers, Troubles in the Audio Section, Automatic Volume Control Troubles, Troubleshooting Power Supplies, Restoring Antique Radio Receivers.



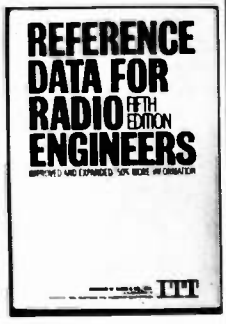
104 ONE TRANSISTOR PROJECTS — 192 Pages. $4.95. Circuits are offered to the student who wants to set up and test typical circuits for his own instruction. For the designer who wants ready made building blocks and for the hobbyist whose amateur interests will be served by pre-designed pre-tested circuits.

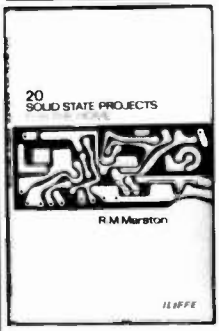
THE WORLD OF TOMORROW — K. GOLDSTEIN. 10" x 7½", 128 p.p. Well illustrated in colour, $3.95. Board a Time Machine and travel a century into the future. Explore the oceans and outer space. Imagine creating and living in tomorrow's world! An excellent gift book for budding young scientists and engineers.

DICTIONARY OF ELECTRONICS — HARLEY CARTER. 410 pages, many illustrations. $5.95. Contains concise but explanatory definitions from many branches of Electronics, including radio, television, communication, radar, electronics instrumentation and industrial electronics,. Essential information for engineers, students, technicians and apprentices.



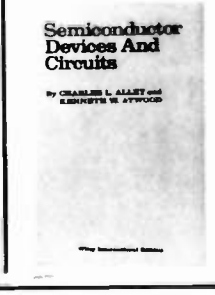
REFERENCE DATA FOR RADIO ENGINEERS — Fifth Edition. $25.00. More than 100 engineers have helped create this edition which contains the wealth of data needed in electrical and electronic engineering. Written by professionals for professionals.





20 SOLID STATE PROJECTS FOR THE HOME — R.M. MARSTON. 96 pp. $5.50. Well detailed with clear and concise circuit description. Projects include automatic light, two station intercomm., lamp dimmer, baby alarm, electronic battery, electronic timer, model train controller.

COLOUR RECEIVER TECHNIQUES — T. D. TOWERS $6.50. Students and especially bench engineers will find this book of great value in understanding and servicing colour T.V. Receivers. Book is simple and clear with minimal use of maths and a logical "painless" guide on the PAL System.



SEMICONDUCTOR DEVICES AND CIRCUITS — ALLEY AND ATWOOD. 490 pages. $8.50. Semiconductors, Junction Diodes, Junction Transistors, Common-Emitter Amplifiers, Device with High Input Impedance, RC-Coupled Amplifiers, Transformer-Coupled Amplifiers, Small-Signal Tuned Amplifiers, Direct-Coupled Amplifiers, Multistage Amplifiers, Power Amplifiers, etc.

BASIC ELECTRONICS PROBLEMS SOLVED — 190 pages. $6.15. Known as a "cheat book". Helps clarify basics encountered in any electronics course. Particularly for those without extensive maths background. Explains how to get the job done in logical simple steps, with rules, aids and directions.

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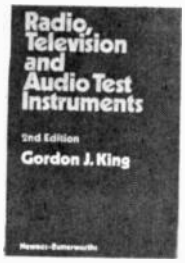
REVIEWERS: Brian Chapman, Jan Vernon



RADIO, TELEVISION AND AUDIO TEST INSTRUMENTS, by Gordon J. King. Published by Newnes-Butterworths, London, 1972. 199 pages, 9¾" x 6", hard covers. Review copy supplied by Butterworths (Australia) Pty. Ltd., Australian price $12.70.

Originally published in 1962 under the title "Radio and Television Test Instruments, this new edition complements, without overlapping, the series of servicing handbooks by the same author.

Although it is possible in the main to make do with a screwdriver and a simple multi-meter, sooner or later the technician will be faced with a situation that demands the use of more advanced test equipment.

To use test equipment correctly, and to maximum advantage, requires a knowledge of the characteristics, operating principles and limitations of the instruments concerned. It is very easy indeed to come to a wrong conclusion by not understanding the measurement errors introduced by the instrument itself – for example, the error caused by loading a circuit with a low input impedance voltmeter.

Hence it is vital that users of test equipment gain knowledge of the instruments they intend to use and perhaps more importantly – methods of measurement. This book provides an excellent introduction to test instruments in general and the way to use them.

An introduction to instruments opens the book and is followed by sections on the application of dc and ac meters. The latter sections contain all the basics concerning various types, their use, shunts and multipliers and measurements of various physical parameters.

Following are sections on specific classes of instruments such as electronic meters, signal generators, oscilloscopes and then sections on instruments for valve and transistor testing, colour television and audio equipment.

The text is clearly and simply written and is well illustrated with circuit diagrams, pictures of instruments and waveform photographs, etc.

The book is very suitable for technicians and home experimenters wishing to advance themselves in the art of measurement in electronics. – B.C.

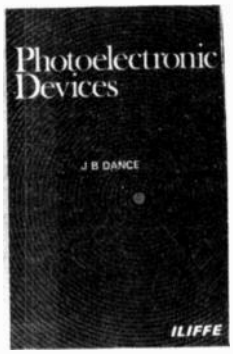
SOLID STATE PROJECTS FOR THE EXPERIMENT. By Wayne Green. Published by TAB Books 1971, 224 pages, 8½" x 5½", soft covers. Review copy supplied by TAAB Books. Australian price $3.95.

Here is a collection of 60 projects for the experimenter – radio amateur or hobbyist covering a wide range of interesting devices and equipment. The accent in the main is on equipment for the radio amateur. Wayne Green is a radio amateur himself and has edited this collection from the pages of a prominent American amateur-radio journal.

The opening section of the book deals with the practical use of semiconductors and IC's from the point of view of the amateur. The next two sections of nearly 100 pages treats receivers, transmitters and associated amateur radio equipment such as filters, converters and modulators, etc. Lastly there are sections on test equipment and power supplies.

An unusual project is included in the final section which should be of interest to many people. Details are given of a miniature vidicon television camera for closed circuit use. The camera provides a video output and is very simple. Full details are given of the construction together with winding data for the deflection and focus coils. The only problems are obtaining a vidicon at a reasonable price, and changing the line and frame time bases for Australian standards. Conversion to Australian standards should be relatively easy for anyone with reasonable ability.

The book is good value for the amateur radio experimenter as a source of useful and practical equipment projects. – B.C.



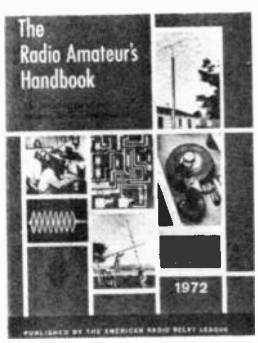
PHOTOELECTRONIC DEVICES, by J.B.Dance, M.Sc., B.Sc. Published 1969 by Iliffe Books. 172 pages 8½ x 5½, hard covers. Review copy supplied by Butterworths Pty Ltd.

Photoelectronic Devices provides an outline of the operating principles of all the important types of devices which detect or produce radiation in the ultra-violet, visible or infra-red regions of the electro-magnetic spectrum, with the exception of television camera tubes.

Commencing with a section on semiconductor fundamentals, the book progresses through separate sections on photoemissive materials, photoemissive diodes, photomultiplier tubes, homogenous semiconductor devices, junction photodiodes, image intensifiers and converters, and then finally, electroluminescent devices.

Chapter layout consists of an introductory theory section followed by an application section containing illustrative circuit diagrams and drawings wherever necessary. At the end of each chapter an extensive list of references is given so that further material on any topic may be readily found.

The presentation of the book is simple and uncomplicated by a great deal of mathematics, although relevant formulae are given wherever required. University and technical college students will find this book a valuable source of data on a subject which is growing in importance at an astronomical rate. — B.C.



THE RADIO AMATEUR'S HANDBOOK, 1972, by the Headquarters Staff of the American Radio Relay League. 49th edition, 1972, published by the League. Over 650 pages 6½ x 9½, soft covers. Australian price $8.00. Review copy supplied by the League.

The following comment by the American Radio Relay League, Inc came with the review copy and we can only agree with the statements therein.

"The 49th edition of The Radio Amateur's Handbook contains the most extensive revision and update ever attempted. Radio technology, especially in the areas of solid-state devices, has been changing at a rapid rate. Thus, in the 1972 edition 13 chapters have been rewritten to cover new devices and new techniques. The book has been completely reorganized to make individual material easier to find.

The changes incorporated in the 1972 edition will undoubtedly enhance the reputation of a book that has been published yearly since 1926, the only technical book on Time Magazine's list of all-time best sellers. The primary emphasis of the book is on practical approaches and practical details of the radio art. This no-nonsense format has made the Handbook popular in classrooms, research laboratories, libraries, and industrial organizations, as well as in the homes of radio enthusiasts.

Among the new sections contained in the '72 Handbook, which has been expanded by 50 pages, are digital logic devices, linear IC's, hf and vhf antennas, broadband amplifiers, filter networks, converter designs, and ssb techniques. A new 28-page chapter on frequency modulation and repeaters has been included. Two hundred new drawings and charts have been used to present the current state of the art in all areas of amateur communications." — B.C.

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AUSTRALIAN Tape Record Society offers tape library, "The Microphone" Journal, audio visuals, round robins, tapesondence, sales enquiries, PO Box 130, Hornsby, NSW 2077. Please enclose a stamped addressed envelope.

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DESIGNING A 700 WATT AMPLIFIER

(Continued from page 28)

above chassis ground and any attempt to use such an amplifier in a multiple unit installation would raise havoc with the grounding system. Another drawback is that a stereo amplifier would require four separate amplifiers connected internally to obtain two channels; this plus the required double power supply would even further add to the complexity, weight and cost.

Solving the primary problem of transistor voltage breakdown required close work with a major transistor manufacturer. The basic power transistor used in the 700 watt amplifier design is a 600 volt television horizontal sweep transistor. This basic power transistor was modified extensively in order to obtain the best suitability for high power amplifier application. Energy breakdown levels, current gain, pulse safe operating area, and other transistor parameters were carefully adjusted in order to optimize their use.

Another of the many problems associated with transistor amplifier design is the problem of crossover or "notch" distortion. Historically, this was a severe drawback in early transistor amplifiers. It was successfully solved by allowing the output transistors to operate in a mode which was somewhat less efficient than ideal and represented one of many engineering compromises. In order to eliminate crossover distortion, it was necessary to allow a small amount of idling current to flow at all times. This idling current would generate a small amount of heat but was perfectly acceptable for small, low voltage amplifiers that had at most two pair of output transistors. For a large 700 watt amplifier, the amount of heat that would be generated by idling current flowing in 24 output transistors would be excessive. It was necessary to incorporate a novel biasing circuit that would allow the output stages to operate without idling current (pure class B) and simultaneously and completely to eliminate crossover distortion. This biasing circuit is used in integrated circuit "op-amps" but had previously never been applied to power amplifiers. The success of this approach depends on the careful attention to specific power transistor parameters in the low current region. Crossover distortion appears as high intermodulation distortion at low levels. The best transistor amplifiers have attained IM figures of well below 0.05%. Our production 700 watts units attain IM figures at 750 milliwatts of between 0.01% and 0.02%.

Speaker protection is accomplished by a "crow bar" circuit in which heavy fault-current (for example, caused by accidently dropping a tone arm, or an output transistor failure) is forced to flow through a pair of fuses rather than through the loudspeaker. Since the "crow bar" forces heavy fault-current to flow through the fuses and not through the loudspeaker, they open immediately and prevent any possibility of damage.

The problem of amplifier misbehavior caused by false triggering of protective circuits was solved by incorporating a totally new protection circuit design which monitors, from microsecond to microsecond, the *energy** that is being absorbed by the output transistors during normal operation. All previous protection circuits have monitored the *current*, or in the case of large amplifiers, the *power*.

The energy limiting approach results in an amplifier that can provide approximately three times as much power as an amplifier equipped with current limiting or power limiting circuits.

Whenever a loudspeaker engineer makes an attempt to extend or smooth the frequency response of his design, or to lower the distortion, the laws of physics demand that the loudspeaker become ever less efficient.

These two facts of life, the conflicting requirements of sonic perfection versus loudspeaker efficiency has always set an upper practical limit on loudspeaker performance. The recent availability of truly high power amplifiers has allowed speaker designers a new freedom and without question, the best speaker systems of tomorrow will be capable of truly awesome performance. ●

*(*Energy is the time integral of power. Expressed mathematically, Energy, E = V1 dt, where V = voltage, 1 = current, and with the limits of integration chosen, to be over one half cycle of the waveform.)*

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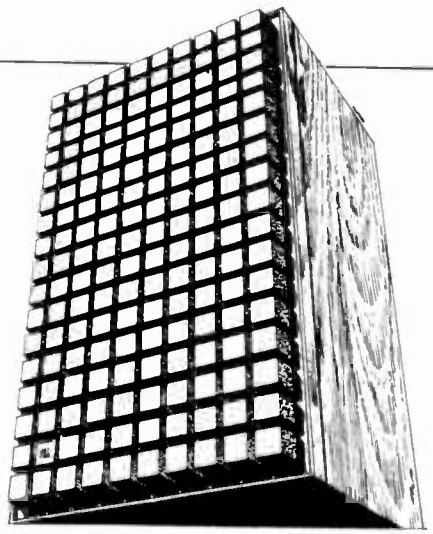

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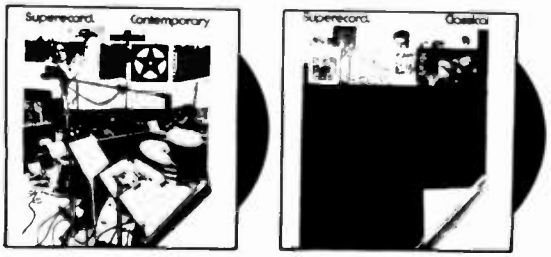

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LETTERS FROM OUR READERS

LOYAL READER

I will be returning to England very soon — will I be able to buy Electronics Today over there? — **RK. Perth, W.A.**

* Surely. We now have an English edition of Electronics Today International. It is basically similar in content and style to the Australian edition but carries a certain amount of local news and local advertising. You will find it on sale all over the UK, Holland, and Scandinavia. Bon Voyage!

TURNTABLE TURMOIL

In your article 'Four-Channel Sound' (ETI June 1972) you stated that the JVC Nivico CD-4 discs may be played on any conventional record player provided a special cartridge and stylus is used.

Another magazine that I have read states quite clearly that the JVC turntable is the *only* one that may be used.

Are JVC trying to pull the wool over our eyes or something? — **D.B. Bankstown, NSW.**

* JVC can hardly be held responsible for inaccuracies in editorial copy over which they have no control. The JVC company has never — to our knowledge — claimed that theirs is the only turntable that can be used with the CD-4 record.

To the contrary, they state quite clearly in their own booklet explaining four-channel sound "A special cartridge and stylus for playing the CD-4 system 4-channel record is necessary . . . a 4-channel pick-up cartridge (including stylus) is necessary. Other components may be those of the conventional 2-channel stereo record player"

Our original statement is therefore correct. Any, and we repeat, any, good quality turntable may be used for CD-4 discs providing the correct four-channel cartridge and stylus is fitted.

FOUR CHANNEL SOUND

Your article on "4 Channel Sound" was excellent — you've summed up all the various methods perfectly.

With certain types of reels/cartridges/records etc — the "4 Corner" effect sounds impressive, further, with certain records/tapes etc, you do obtain an excellent ambience effect from the rear channels.

For instance, try the JVC CD-4 record "Carmen" played through the appropriate JVC equipment, and then while the record is still playing — cut the rear channels. You've now got ordinary two-channel stereo, and in my opinion, its as obsolete as Wellington boots.

In my opinion also, the days of the records and four-channel open reel tapes are numbered. I can see the 8-track four-channel cartridge taking over. I've got every method of producing four-channel sound in my home, and the method I like best of all is playing a JVC four-channel cartridge (via a JVC 1202 deck) feeding this into a pair of TEAC AN-80 Dolby noise suppressors, which feeds into a Sansui Q5-1 Synthesiser, which feeds into either the V7E JVC Amp or the Akai AA1600 amp. (! — Ed.) The sound is magnificent. The frequency response may not be as good overall compared to an open reel at 2½ ips, but as you know, the quality of the tapes used in cartridges is improving all the time and you will find that in not too distant future, all good quality cartridges will be recorded using the Dolby process, and when these are played back via Dolby equipment, you're going to obtain superb quality — entirely free of any background noise.

Keep the reviews etc. on four-channel developments going in your magazine — they are really instructive. — J.A., Latrobe, Tas.

ERRATA

Unijunction Q1 shown as 2N2946 in Fig. 1. of Part III — Practical Guide to Triacs — should be type 2N294C. The UJT is made by General Electric and has an input impedance greater than 1500 Megohms. A UJT type 2N2646 may be used in place of the 2N294C device if only short time delays are required.

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2	2N3055 Transistors	$3.00
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3	ORP12 Photo Resistors	$2.00
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PAK. 16. IBM Silver-wire change-over Relays. Suitable for 20 to 48v operation. Precision computer grade and complete with bases. One each of the following: 4 pole change-over, 6 pole change-over, 12 pole change-over. The 3 for **$1.35** plus 20c post.

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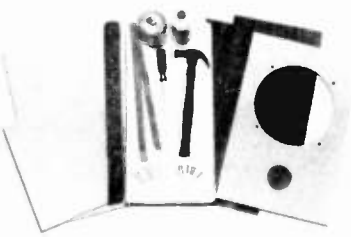
SPEAKER KITS



Now available — laboratory engineered speaker enclosure kits, featuring the latest iron-on teak, maple or walnut wood veneers. You can build these kits yourself for half normal price. Each cabinet precisely cut to ensure 100% professional success with a minimum of knowledge and tools. Only tools required —screwdriver and hammer. All materials including nails, screws, innerbond, grille cloth, timber and veneers are supplied, together with easy-to-follow instructions. 1.4 cu. ft. enclosure (suits 6" or 8" speaker systems) vented or unvented, only **$16.00** ea. Post $1.50. 2 cu. ft. enclosure (suits 8", 2 x 8", 10" or 12" speaker systems) vented or unvented, only **$23.50** ea. Post $2.00. 3 cu. ft. enclosure (suits 2 x 8", 10" or 12" speaker systems) vented or unvented only **$27.50** ea. Post $2.50. Magnavox 8-30 system 1 cu. ft. only **$16.00** ea. Post $1.50. Magnavox 8-30 system 1.6 cu. ft. only **$22.50** ea. Post $2.00.

DOORBELL KIT

A must for every home—easy to fix—efficient audibility. Kit consists of the following: Federal Electric 3" under-dome bell for 3V. D.C. or 5V. A.C. use, One Flush mounting push-button switch and 50ft. of twin P.V.C. Bell Wire. Fantastic value, only **$2.00** plus 40c post. (Illustrated.)

FLUORESCENT TUBE INVERTOR

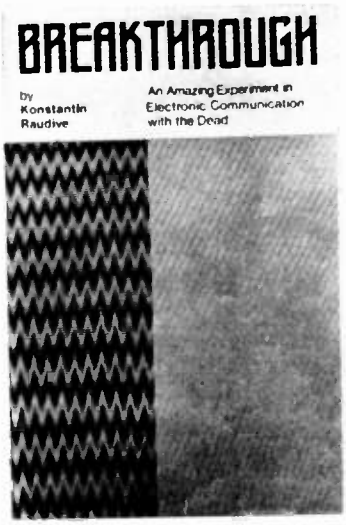
An amazing 12V D.C. to 240V A.C. invertor designed to operate any fluorescent tube to 13W max. rating. Foolproof circuit, compact size 4"x1½"x1¼". Easy to install Price **$9.95.** Post 35c.

VOICES FROM THE DEAD!

Dr. Konstantin Raudive maintains that life after death is a reality which can be scientifically proved. The results of these experiments have been the subject of discussion at scientific congresses and in the international press. Mr Peter Hale, scientific adviser to the British Government, took part in the investigations and stated, "from the result I must state that something is happening which I can no longer explain in normal physical terms."

It appears incontrovertible that some sort of "breakthrough" has been achieved.

Physicists, psychologists, philosophers, theologians — all testify to the authenticity of the voice phenomena. Fantastic! Yes — and the simple recording techniques required are given in full detail.



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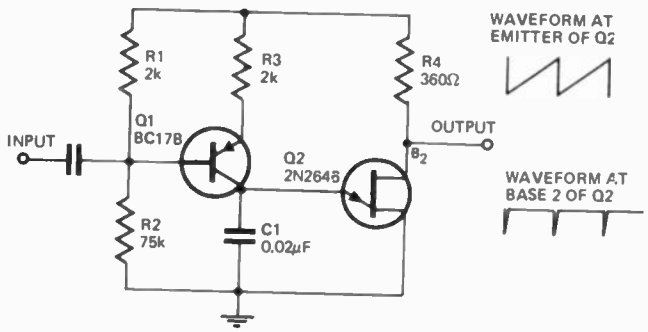
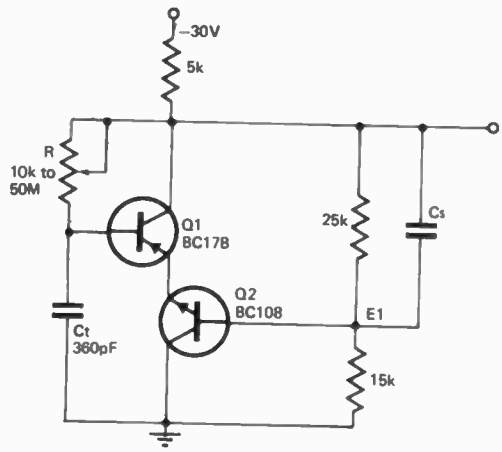


SIMPLE VOLTAGE CONTROLLED OSCILLATOR

With the component values shown the unijunction oscillator has a centre frequency of 8kHz. When an input signal is applied to the base of Q1 the current flowing through Q1 is varied, thus varying the time required to charge C1. Due to the phase inversion in Q1 the direction of output frequency change is 180 degrees out of phase with the input signal. The output may be used to trigger a bistable flipflop.



WIDE RANGE OSCILLATOR

An oscillator with a frequency range of 5000 to 1 may be constructed using the circuit shown. The timing resistor R may be adjusted to any value between 10k and 50Meg to obtain a frequency range from 400kHz down to almost 100Hz. Returning the timing resistor to the collector of Q1 ensures that Q1 draws its base current only from the timing capacitor Ct. The timing capacitor recharges when the transistors are off, to a voltage equal to the base emitter voltage of Q2 plus the base emitter drops of Q1 and Q2. The transistors then start into conduction. Capacitor Cs is used to speed up the transition, a suitable value would be in the region of 100pF.

TECH TIPS

Circuits described and illustrated in this section are derived from manufacturers' application notes, readers' letters etc. They have not necessarily been tested by this magazine.

The section is intended primarily as a source of ideas for electronic engineers.

Because of the nature of the information we cannot enter into any correspondence concerning any of these circuits, nor can we provide any constructional details.

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Nixdorf Computer — ELECTRONIC TECHNICIAN

This very progressive Computer Company requires the services of an Electronic Technician to service their VISIBLE RECORD COMPUTERS — Applicant must be suitably qualified and have had experience on digital equipment.

The successful applicant will be responsible for computer component servicing.

Salary negotiable. Superannuation will be applicable after a qualifying period.

Please contact the
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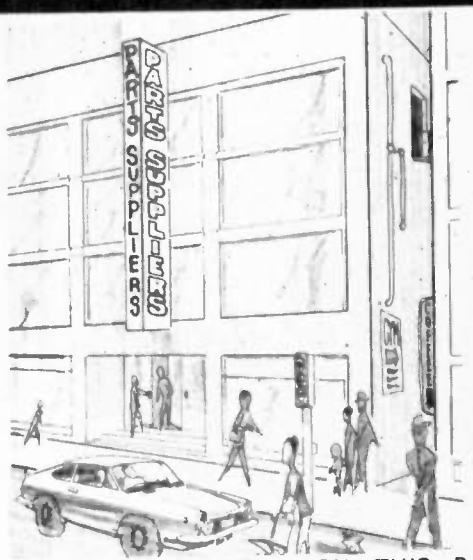

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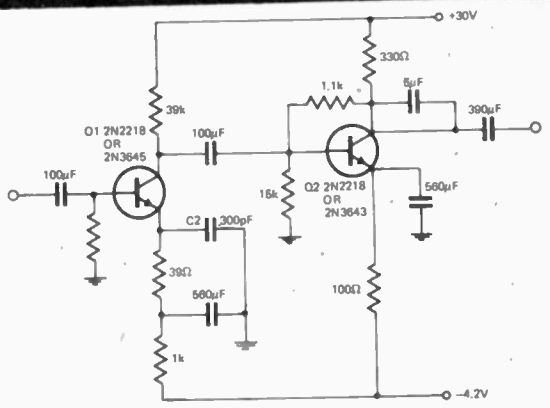
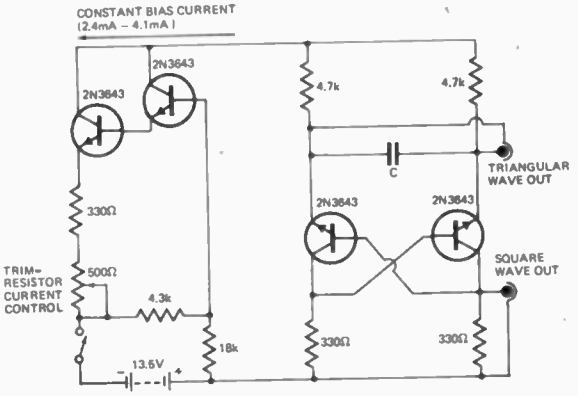


VIDEO POWER AMPLIFIER

The amplifier shown has a frequency response of from 5Hz to 30MHz and is capable of giving a 10 volt output into a 100 ohm load. The circuit provides 26 dB gain and has excellent stability and linearity.



WIDE RANGE MULTIVIBRATOR

In the circuit shown the multi-vibrator section is driven by a constant current generator. This causes the square wave across C to be flat and the triangular wave across resistor R to be linear. When the constant current is varied, the repetition rate of the multi is varied by 70% with the current control, and from 5Hz with C equal to 100 microfarad, to over 2.5mHz with C equal to 330pF.

Voltage to frequency conversion may be performed by injecting an analogue voltage into the base of the first current regulator transistor.

Bi-directional record and playback tape deck
Model A-4070
● 4 Ferrite heads (6 head function) ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .06% at 7½ ips ● F/R 25 to 24,000 Hz at 7½ ips ● S/N ratio 58dB

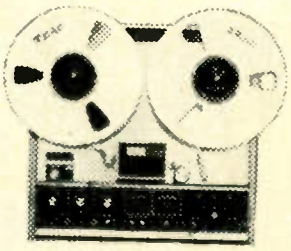
Make music- not noise

You may not realise it, but until now, even the best tape decks allowed a degree of noise during recording and playback. This may have been all right for conventional tapes, since they were far from perfect.

But with the recent introduction of the low noise/high output tapes, it's no longer permissible.

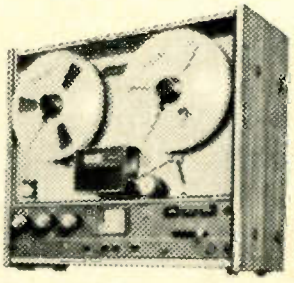
Which brings us to a new generation of decks by TEAC. And TEAC calls them Superior Sound/Low Noise decks: decks designed to get the most out of the low noise tapes as well as the conventional types.

Five of these new generation decks are described here. If you'd like to know more, write to us and we'll send you further information (catalogue, dealer list and price list) on the unit(s) that interests you.



Stereo Tape Deck
Model A-3300
● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .06% at 7½ ips ● F/R 25 to 24,000 Hz ● S/N Ratio 55dB

Stereo Tape Deck
Model A-1230
● 3 heads-4-head function ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ Ips ● S/N Ratio 55dB



Automatic Reverse Stereo Tape Deck
Model A-1250
● 3 heads-4-head function ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB

Combination Head Stereo Tape Deck
Model A-1030
● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● One motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB ● Auto. Shut-off

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