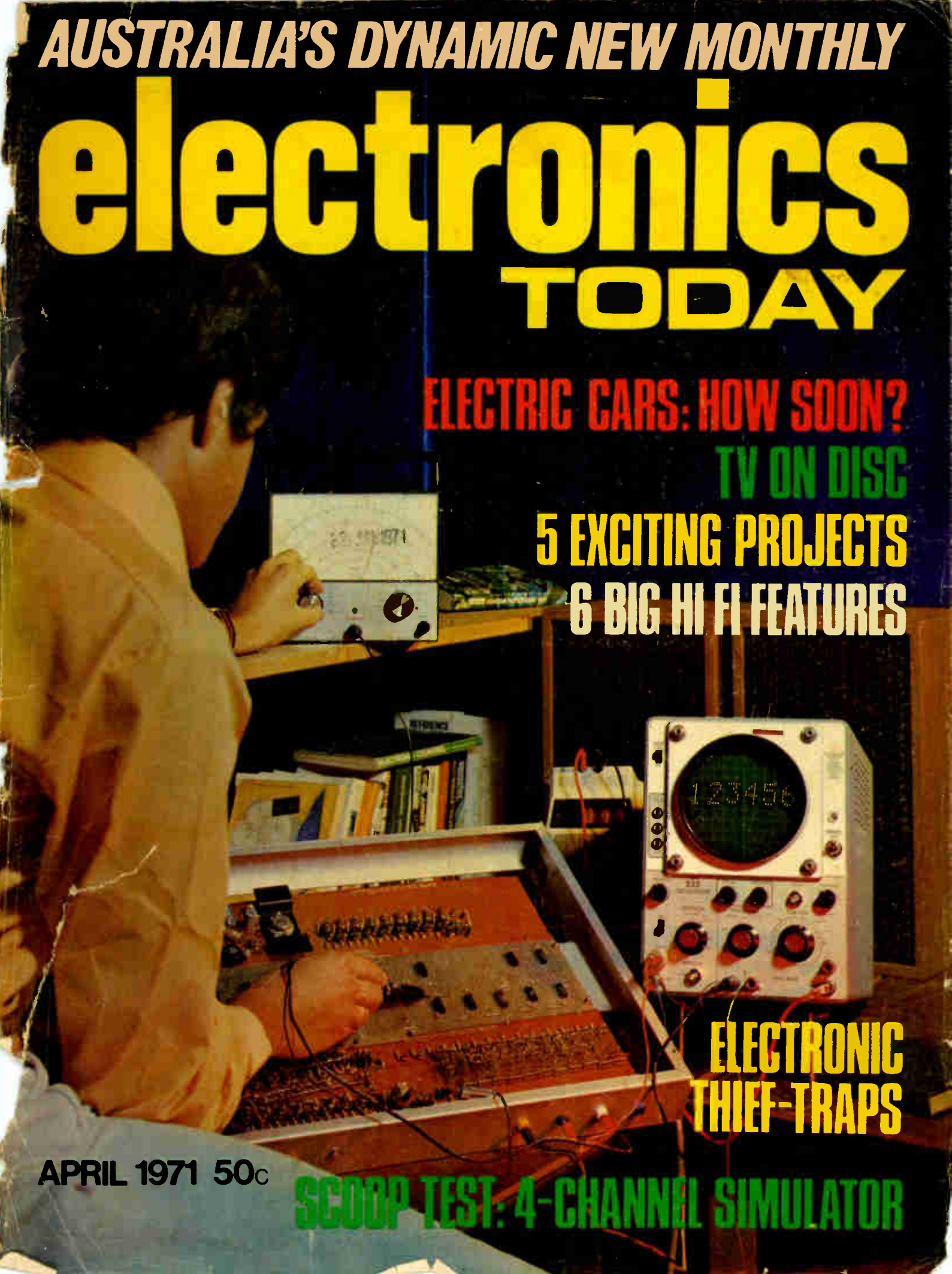
AUSTRALIA'S DYNAMIC NEW MONTHLY

electronics TODAY



ELECTRIC CARS: HOW SOON?

TV ON DISC

5 EXCITING PROJECTS

6 BIG HI FI FEATURES

ELECTRONIC THIEF-TRAPS

SCOOP TEST: 4-CHANNEL SIMULATOR

APRIL 1971 50c

Now-Sony's 'something for everyone' Stereo

She wants to play a cassette, he has his favourite reel. No problem! Sony's exciting new TC-330 plays both — in stereo. Here is the perfect stereo control centre, with all-silicon transistor integrated stereo amplifier. There's easy dubbing from reel to cassette or vice versa. Rich tone comes from 10 W total power. Two lid-integrated high compliance speakers. Separate treble and bass controls. Noise suppressor to cut out tape hiss. Public address facility,too. Stereo headphone jacks.

Superb tape recorder has three speeds, 7" reel capacity, two meters, 4 digit tape counter and auto shut off.
Cassette recorder features easy push button operation, simple loading, 3 digit tape counter, and tape end indication lamp (when used with SONY compact tape cassette).
Merely connect a turntable (Sony's PS1010 for example) to Sony's superbly styled TC-330 and you have the complete sound system. $425.00.

JACOBY MITCHELL

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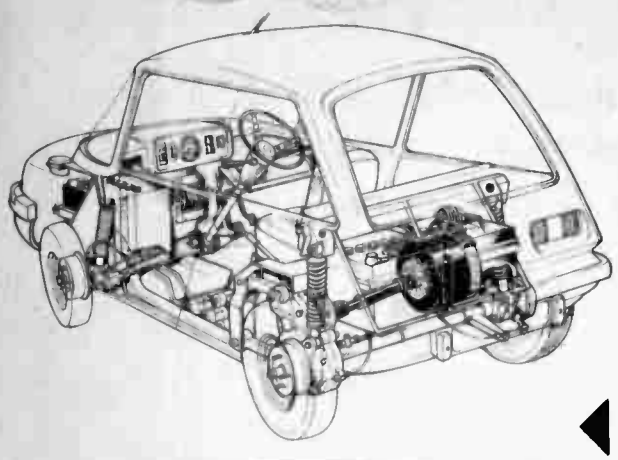

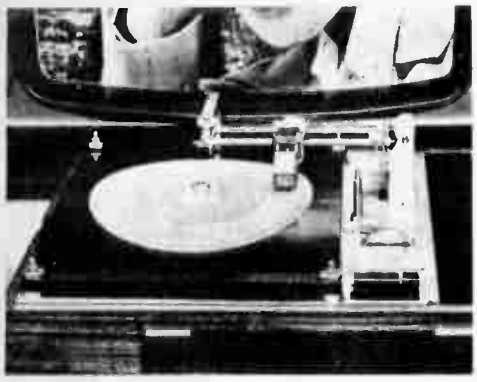

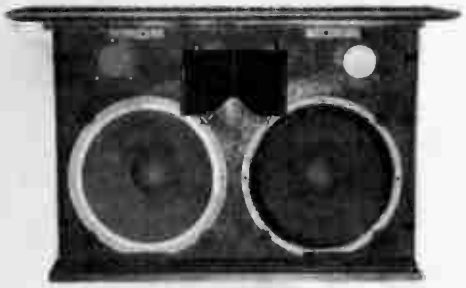

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electronics TODAY

APRIL 1971 Vol.1 No.1

main features

projects

product tests

reviews

news & information

COVER: A young Australian's experimental circuit converts standard oscilloscope into multi-digit counter. Photo taken in project laboratory of Electronics Today.

ENCEL BRINGS YOU GREAT VALUE AND QUALITY IN 4-TRACK TAPEDECKS — AUTO/REVERSE MARLUX 407 — ONLY $425.00!

The Marlux 407 has all the features that make a great recorder—push-button solenoid control of tape motion, hysteresis synchronous capstan motor, supply and take-up reel motors for smooth tape spooling, electrical speed change, tape tension control for standard and thin base tape, etc.
American High Fidelity Magazine reviewing Marlux 407 enthusiastically says—"the unit offers high performance and versatility in a well-engineered and handsomely-styled open reel format aimed at the serious home tape enthusiast. Especially notable are its low wow and flutter, low distortion, excellent signal to noise ratio, absolute meter accuracy and smooth extended response. Thanks to its careful engineering and construction it is a pleasure to use and to listen to."

"Stereo Review" Magazine was equally enthusiastic. "A carefully thought out and well-made machine. In an A-B comparison of input and output signals, virtually no difference could be heard between them at 7½ ips." Marlux 407 offers 4 heads which allow reverse play, plus off-tape monitoring. Frequency response—30-20,000 Hz @ 7½ ips; 40-16,000 Hz @ 3¾ ips. Two speeds—7½ & 3¾ ips; re-wind or fast forward time—less than 60 seconds for 1,200'.

As the magazine **"Audio"** says in its review—"Marlux 407 is certainly a lot of tape machine for the money. It would make a fine addition to any good quality stereo system, bar none!"
At the Encel price of only $425.00 it is outstanding value!*

MICRO QUALITY CARTRIDGES.

With replaceable diamond stylii. Those coded "e" have elliptical stylus. Those coded "/5" or "/7" have 5 mil and 7 mil conical stylii respectively. Stylii are interchangeable within the two ranges without the use of tools.

3100/e—Encel price $26.50. A top-quality magnetic unit approved for use in broadcasting stations throughout Australia in systems that meet the Australian Broadcasting Control Board standards.

3100/5—Encel price $21.50.

3100/7—Encel price $19.50. A ruggedly constructed unit giving high quality performance.

2100/5—Encel price $15.50.

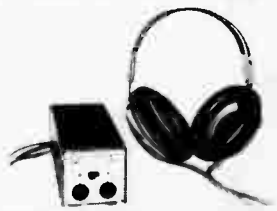
2100/7—Encel price $12.50.

MICRO MDP-3 DUST BUG.

Cleans recordings automatically ahead of the stylus. Weighted base requires no fixing. Encel price $4.50.

MICRO MSB-1 SHOCK ABSORBERS.

Eliminate or minimise turntable baseplate feedback (50-200 Hz). Suit all turntables. **Encel price (per set of 4) $12.50.**



RENOWNED STAX SR-3 STEREO HEADPHONES.

(with SRD-5 adaptor)

World's finest electrostatic headset. Hi-Fi News review states, "response is very smooth, with no obtrusive peaks or colouration . . . a sense of realness about the sound . . . comfortable to wear for extended periods. They are by no means expensive and are probably better than any other headphones at present available, certainly better than any we have tried."

Australian Hi-Fi in a recent review says: "We performed comparison tests between Stax headphones and our monitor speakers and decided that our monitor speakers will have to go! These headphones offer a performance, which, while not perfection, is the nearest thing to it which we have yet experienced in either speakers or headphones."

Encel price $76.50*

Note: Ask for copies of reviews from authoritative technical journals on all items marked*.

All prices quoted include Sales Tax.

LOOK AT ENCEL'S UNBEATABLE PRICES ON FAMOUS MICRO EQUIPMENT

MICRO MR-211 TURNTABLE.

A 4-pole hysteresis, synchronous, outer-rotor motor and feather-touch selector gives positive 33⅓ and 45 rpm. Static balance S-shaped tone arm, fully compensated, accepts standard ½" mounting cartridges. Oil-damped lift. Baseplate silver finished, mounted in wooden base with plastic cover. **Encel price $149.00.** (Cartridge of your choice extra.)

MICRO MR-111 TURNTABLE.

Engineered for high-quality reproduction. Vibration-free belt drive: 33⅓ or 45 rpm. Baseplate matt black. High-precision tone arm and hydraulic lift. **Encel price $72.50** (Cartridge, tinted acrylic lid and base extra.)

EE113A

ENCEL ELECTRONICS PTY. LTD.

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tomorrow starts today

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Welcome to the first issue of ELECTRONICS TODAY — a new monthly magazine covering all aspects of electronics, in Australia and throughout the world.

We've put the word TODAY in the title, but it's also a magazine of tomorrow — for in the fast-moving world of electronics tomorrow starts today.

ELECTRONICS TODAY is designed to appeal not only to enthusiasts but also to everyone who becomes involved in electronics, either casually or as part of everyday life.

And most of us are involved, in one way or another.

For electronics is everywhere and in everything. The milk in your coffee was electronically tested, your mail was electronically checked; and, appropriately enough, this very journal is electronically typeset through our own IBM computer — and printed on one of the most modern presses in the world — electronically controlled, of course.

Our constructional projects will reflect the extent to which electronics is becoming an intrinsic part of life today.

They will be practical — and they will work.

We will do our best to ensure that parts are available by advising kit and parts suppliers, at least two weeks before a project is published. We are making the necessary arrangements right now.

Our editorial format will be wide, covering electronics' ever-growing involvement in science, industry, commerce, education, space, behavioural science — from all over the world.

ELECTRONICS TODAY'S offices in Sydney, London, New York and Tokyo are teleprinter-linked to bring you the news as it happens.

Our approach will remain topical and practical. Topical because last month's news is this month's history, practical because electronics has become a way of doing things — of solving problems — it is no longer an end in itself.

This policy is reflected in our equipment reviews. We will outline what a unit does, who would use it, and how it would solve particular problems — plus the specifications for those who need them.

On the hi-fi scene, dramatic technical developments necessitate a whole new approach to equipment testing.

ELECTRONICS TODAY has anticipated these developments by retaining Australia's leading acoustical consultants as our testing authority.

Our test reports will be the most comprehensive and accurate reports ever published in an electronics magazine, either in Australia or overseas.

This is a time of change, of excitement, of achievement — and ELECTRONICS TODAY is a journal of this time.

news digest

P.A.R. CHIEF IN AUSTRALIA

President of Princeton Applied Research, Orest C. Chaykowski, was in Sydney in March, visiting his company's Australian agents — Tecnico Electronics.

In an exclusive interview, Mr. Chaykowski told ELECTRONICS TODAY that his company had increased export sales of their analytical, digital data, signal processing and biomedical instrumentation by 45% compared with the previous year. This achievement won a Nixon Export Award for 1970.

Princeton's Model 102 Fourier Analyser also won Industrial Research Magazine's IR 100 award as one of the most significant designs of 1969.

NEW AIRBORNE MAGNETOMETER

Brisbane-based geophysical survey company, QASCO, will add Varian's new airborne proton magnetometer and data acquisition system to their existing range of radiation spectrometers, infra-red scanners and similar research equipment.

The new system will assist QASCO's services in oil and mineral exploration, agricultural analysis, pollution studies, etc.

The magnetometer combines Varian's existing field sensing heads with a completely new electronics console. The complete system covers a magnetic field range of 100 kilogammas and has a sensitivity of ± 0.5 gammas.

The output from the magnetometer will be coupled into a type V-4991 digital data acquisition system. This unit processes the magnetometer data into a form suitable for direct computer entry.

Total cost of the new equipment is believed to exceed $100,000.

OIL–SLICK DETECTOR

Oil slicks, and the ship causing them, can be detected by a radiometer currently under test by the U.S. Coastguard.

The radiometer detects the temperature difference between the oil slick and the surrounding water.

The unit, which scans the suspected area from a high-flying aircraft, operates at 30GHz radiated from a 1/3rd metre horn antenna.

Current tests show that the unit can discriminate changes of 0.2 degrees Centigrade.

If the method proves as successful as present tests indicate, it will be possible to make positive identifications of polluting vessels.

IT'S A FAIR COW! (ELECTRONICALLY CHECKED)

An electronic method of determining the butter-fat content of milk is now in general use throughout Australia. Accurate repeatable measurements are essential, as butter-fat percentage is used as the basis for quality payment.

In operation the milk sample is filtered from a standard sample bottle and heated to a temperature of 60°C.

A four-stage homogenizer reduces fat globules to micron size. The homogenized milk is passed into a mixing funnel where it is diluted by a metered quantity of versene. This momentarily neutralizes the milk's protein content.

Monochromatic light is transmitted through the mixture as it passes through a flow-curvette. The resultant photo-metric output indicates the concentration of fatty globules in the mixture, and thus the percentage of butter-fat.

Despite the complexity of the technique, the instrument's standard deviation for repeatability is less than .015%.

BECKMAN APPOINTS ELMEASCO

Elmeasco Instruments Pty. Ltd., of Brookvale (N.S.W.), recently signed an agreement with Beckman Instruments, Fullerton, California, which appoints them Australian distributors for all products except the chemical divisions (represented here by H.B. Selby).

DATA CENTRE FOR MELBOURNE

A Data Centre opened recently in Melbourne by Hewlett Packard provides technical support in planning, installation and operation of HP products.

The centre is headed by Malcolm Kerr, Australasian Data Products Manager. Malcolm is assisted by Senior Systems Analyst Bruce Graham.

A similar centre will shortly be opened in Sydney. It will be managed by Johan Walter, who joined Hewlett Packard from Control Data Australia.

Services offered include information on specifications, capabilities, options, applications and pricing. If assistance is required for complex problems, systems analysts will perform problem definition and system configuration.

Two other services available are the assistance of experienced systems engineers and analysts in client development of special-purpose hardware and software, and the use of HP systems to develop and check out clients' own software.

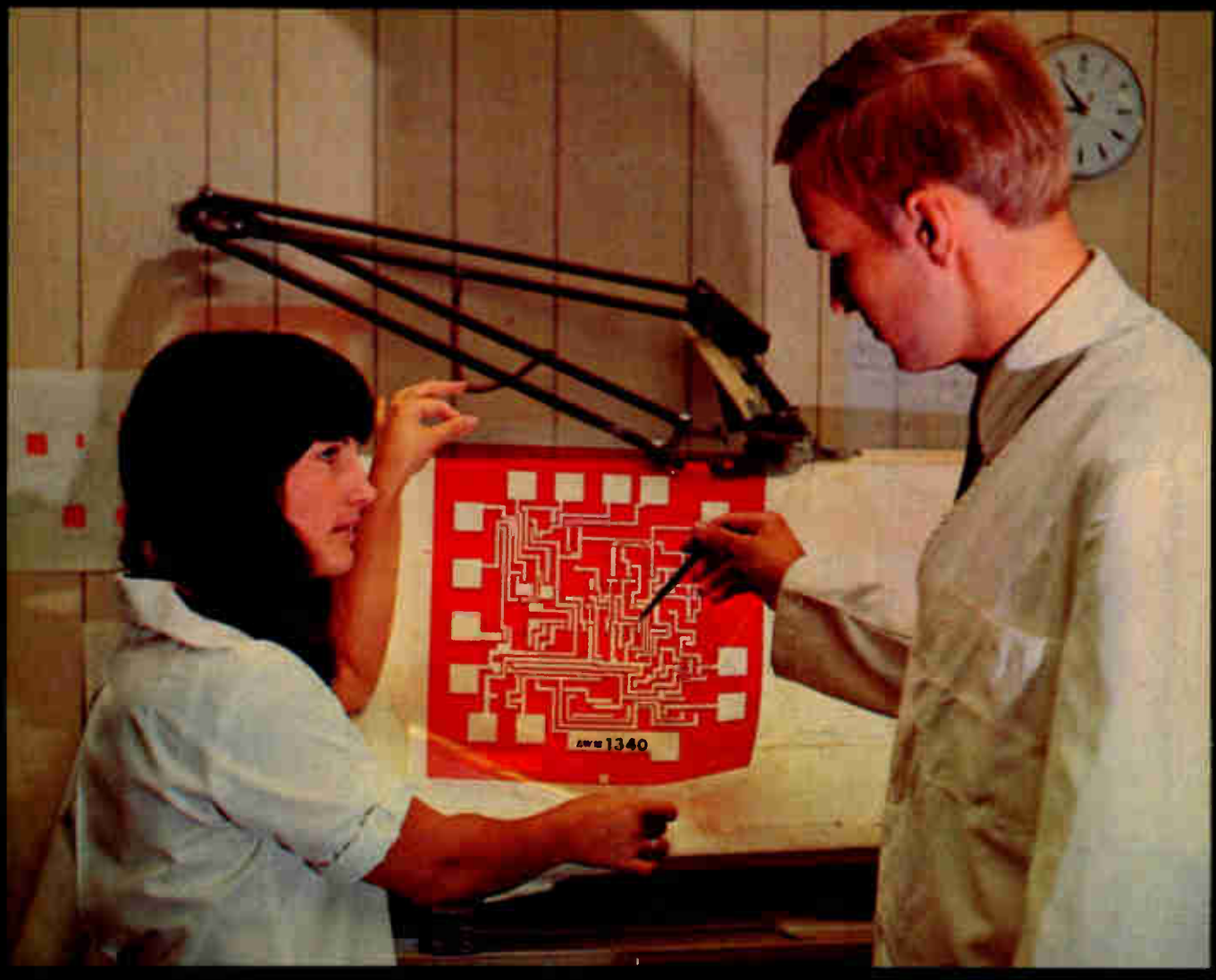
CELESTIAL RADIO SOURCES INDICATE CURVED UNIVERSE

Evidence is increasing that the universe, like the earth, has a horizon which limits vision. Part of this evidence comes from surveys of the sky which indicate that the number of discernible heavenly bodies declines at very great distances. If the universe extended infinitely in all directions, heavenly bodies would, presumably, be about equally distributed and visible everywhere in the same concentrations.

The concept of curved space is difficult for the layman to comprehend — but it is being increasingly buttressed by theoretical calculations on the nature of space and the behaviour of gravitational forces. As a result, few scientists today now believe that the universe is flat, or that it extends infinitely in all directions. *(see page 11)*

Introducing Millihelen

Latest addition to the metric system is said to be the Millihelen. Apparently unconnected with the Millihenry, the Millihelen is the unit quantity of beauty sufficient lo launch one ship.



LARGE–SCALE INTEGRATION IN AUSTRALIA

An integrated circuit may be less than 2 mm. square yet contain 200 transistors, diodes and resistors.

It's ironic that something so tiny could change an entire industry. But it's happening.

Traditionally, circuit design has been the province of the equipment manufacturer; now, with transition from discrete components to medium and large-scale integration, responsibility for such design is passing to component manufacturers.

Also, realising that his LSI chip forms most of a final product, more than one IC manufacturer has tooled up to make the whole of it. This trend is growing: watch the office equipment and small computer fields this year.

With growing usage of integrated circuits, countries are faced with the alternative of establishing a domestic IC capability — or losing most of their design initiative.

To ensure that Australia will not be at a technical disadvantage in this field, AWA and the Department of Supply have joined forces to set up a Micro-electronics Facility in Sydney, headed by Dr. Graham Rigby.

Our photos show two stages of IC manufacture at the Facility. TOP: Checking an IC design mask, cut 200 times full-size. RIGHT: Photographing reduced pattern onto a silicon chip. Pattern is then etched on chip, prior to diffusion processing.

THE ONLY QUESTION IS . . .

Sansui stereophonic.. or quadphonic?

Sansui design and performance is so advanced and outstanding that your quest for high quality stereo sound equipment is over. One question only remains . . . Sansui **stereophonic** or **quadphonic?** Either way you get the best of both audio worlds and true, lasting, sound satisfaction.

We've illustrated two fully compatible Sansui stereo systems for you. Each one could be complete in itself; however, as illustrated, these fine solid state stereo systems share a turntable and tone arm (the record sound source) and they're linked by the remarkable new Sansui Model QS-1 Quadphonic Synthesizer. This unit simply converts 2 channel sources into dramatically effective four channel stereo.

How does the Sansui QS-1 work? It takes the stereo signal from the pick-up and, through a complex electronic process known as "phase modulation", spreads the sound **across** and **around** your living room. You listen to Sansui sound — **satisfying sound that approaches the concert hall more closely than any sound you've ever heard.** And you don't move from the comfort of home!

With Sansui Quadphonic Systems you use standard stereo recordings. No existing stereo equipment becomes obsolete, additional costs are reduced to a minimum. Already heralded overseas as the **"audio event of this generation"**, Sansui Quadphonic sound represents the beginning of a revolution in the enjoyment of recorded music.

You can start with Sansui stereo . . . with the best Sansui stereo system you can afford. This can eventually become your **front** left and right system for quadphonic. The supplementary stereo system, which should be fully compatible, can be considerably less expensive. It could eventually become the **rear** left and right system when you move to Sansui Quadphonic. Let us call them systems "A" and "B".

Sansui System "A" is illustrated on the right. This system would suit the dedicated stereo enthusiast. An AU-666 solid state stereo amplifier is linked to a matched pair of Sansui Model SP2000 4-way 6-speaker systems. Frequency response is 10-40,000 Hz. and power handling capacity 35 watts R.M.S. per channel into 8 ohm speakers. Wide range personal listening through the Model SS-20 stereo headset matches the audio quality of these beautifully finished speaker systems.

Sansui System "B" has been specifically designed for the budget conscious music lover, but becomes an excellent system for eventual quadphonic use. It combines the popular all-silicon transistor AU-101 stereo amplifier with hand crafted SP50 speaker systems. In the foreground you see the low priced Sansui Model SS-2 stereo headset.

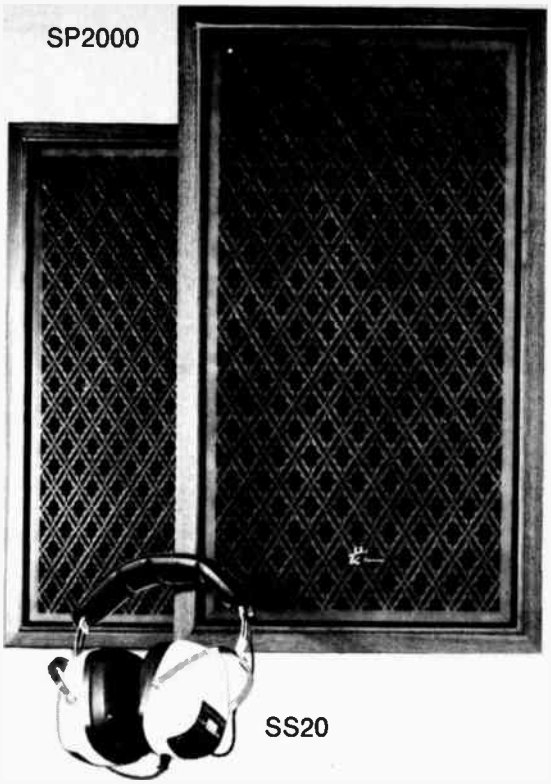
Sansui
SOUND SATISFIERS

AVAILABLE FROM ALL FRANCHISED SIMON GRAY DEALERS

SR1050C

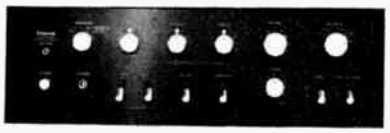
QS1

SP2000



SS20

AU666



The Sansui Model SR-1050C record sound source is common to both stereo systems.

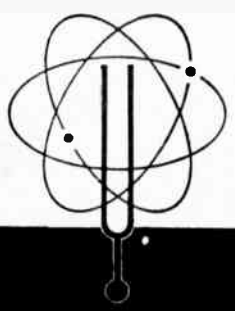
You can start with either of these Sansui systems . . . and, if you wish, build them up to a quadphonic system by simply adding the Sansui QS-1 Quadphonic Synthesizer!

Here are brief specifications of the Sansui equipment illustrated for the technically minded.

You can see and hear Sansui stereophonic or quadphonic at your franchised Simon Gray dealer — he'll be glad to give you detailed information.

Call and see him soon. He'll help you make that important decision . . . Sansui **stereophonic** or **quadphonic!**

Sansui
Model QS-1
quadphonic synthesizer
Converts 2 channel stereo sources to four channel stereo.
Exclusive "phase modulation" electronic process, with space-age micro circuitry.
Frequency response:
Front channel — 20-20,000 Hz. ±1dB.
Rear channel: Concert Hall 1 — 20-20,000 Hz. + 1, — 2 dB.



Sansui
Model SR-1050C
stereo turntable
Two speeds. Four pole hysteresis synchronous motor.
Belt drive. Heavy alloy platter, micro-balanced.
Statically balanced tone arm, with lateral balancer and inside force cancellation device. Induced magnet cartridge with 0.5 mil. diamond stylus.
Frequency response — 20-20,000 Hz. Stylus pressure only 2½ grams.

Sansui
Model AU-666
stereo amplifier
Frequency response: 10-40,000 Hz.
Output: 35 watts R.M.S. per channel into 8 ohm speaker systems.
Sensitivity: 2-180 mV.

Sansui
Model SP2000
speaker systems
Frequency response: 30-20,000 Hz.
Power handling capacity: 35 watts.
Speaker complement: 12" woofer, 6½" and 5" mid-range speakers; two 2" horn tweeters, one 1⅜" horn super tweeter.
Hand carved speaker grilles, selected walnut timber.

Sansui
Model AU-101
stereo amplifier
Frequency response: 25-40,000 Hz.
Output: 15 watts R.M.S. per channel into 8 ohm speaker systems.
Sensitivity: 3-200 mV.
Price: $139.

Sansui
Model SP50
speaker systems
Frequency response: 50-20,000 Hz.
Power handling capacity: 25 watts.
Speaker complement: 8" mid-range woofer, new horn tweeter.
Hand finished cabinets of selected walnut, hand carved speaker grilles.

Sansui
Model SS-2
stereo headphones
Frequency response: 20-18,000 Hz.
Weight: 12 ozs.

Sansui
Model SS-20
stereo headphones
Frequency response: 20-20,000 Hz.
Weight: 26 ozs.

SGSQ-1471

Sansui

Simon Gray Pty. Ltd.

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Developed from the famous Leak speaker range, the New Sandwich Speakers surpass any comparable size loudspeaker, combining stunning good looks with sheer technical brilliance.

They're 3-speaker systems giving a better tonal quality throughout the entire audio frequency range, by reducing the distortion and breakup that could occur in the mid-range of a 2-speaker system.

The new 3-speaker systems use a Leak Sandwich bass unit with a uniquely rigid cone diaphragm that practically eliminates distortion.

That's not all. This new Leak speaker has a multi directional treble unit. So you can hear the top notes wherever you're sitting.

Leak equipment carries a 3 year warranty against defective materials and workmanship.

And to accompany the sounds of the seventies, we've given you the looks of the seventies as well.

LEAK *the first name in high fidelity!*

news digest

Latest evidence supporting the curved theory comes from a sky survey conducted during the last five years by Drs. Beverley June Harris and John D. Kraus at the Ohio State University Radio Observatory in Delaware, Ohio. They observed and recorded 8,100 celestial radio sources which radiate at a frequency of 1,415 megahertz.

According to the two astronomers, theirs is the largest number of radio sources ever catalogued at one emission frequency. Most of these sources are relatively close to earth, but some are about 10,000 million light years away.

Drs. Harris and Kraus said these most distant objects are 'on the edge of the universe'. Analysis of statistics compiled in the survey show that the number of objects believed to be most distant gradually trails off. This drop-off in numbers is consistent with the theory of curved space, which calls for something resembling a horizon or universal limit of vision.

APPOINTMENT AT AURIEMA

Mr. Wal Buckland has been appointed Associate Director of Auriema (Australasia) Pty. Ltd., a member of Auriema International Group Inc.

Mr. Buckland's responsibilities will be the formation of a professional audio division. A member of the I.R.E.E. and the Audio Engineering Society of America, he was formerly manager of the Recording Division of E.M.I. Australia.

DATA TRANSMISSION AT ONE GIGABIT/SECOND

One Gigabit of data per second over a laser beam is Bell Telephone's latest development in high-speed data transmission.

Four different pulse streams, each transmitting 250 Megabits/second, are electronically multiplexed into one stream and impressed onto a laser beam through optical modulation.

The new system may replace current techniques in which data modulates individual beams which are then optically multiplied.

POLLUTION ANALYSER

Helping to clear smog-bound cities is a portable low-cost engine exhaust analyser developed by Sylvania Electric Products Inc. U.S.A.

The analyser draws exhaust gas samples from the idling engine into a preliminary filtering unit which removes water, soot, and all solid particles.

Carbon monoxide and hydrocarbon content is determined by measuring the absorbence of infra-red which is passed through the filtered sample, each gas absorbing a specific amount of light.

Solid-state electronics are used throughout and the equipment can be adapted to provide digital readout. The unit can be modified to record oxides of nitrogen and carbon dioxide.

COMPUTER PHONE EXCHANGE

The Overseas Telecommunications Commission (Australia) has placed an order for a $1.9 million computer-controlled international telephone exchange.

Announcing the order, Postmaster-General Sir Alan Hulme said the new exchange would be installed in the Commission's second international telecommunications terminal at Broadway, Sydney.

The contract for supply of the new exchange has been awarded to L.M. Ericsson Pty. Ltd., of Melbourne. Total cost of the project, including installation and ancillary equipment, is expected to be $2,555,000.

The equipment will be manufactured by the L.M. Ericsson parent company in Sweden.

The exchange, designated as a 'stored programme computer controlled switching system', will be capable of handling 1,340 overseas telephone circuits.

This will be in addition to the 630-circuit capacity of the Commission's present conventional 'crossbar type' automatic telephone exchange at the Paddington International Terminal.

Although at different locations, both exchanges will work in parallel, providing an important element of diversity necessary to ensure the security of Australia's overseas telephone service.

The new exchange is scheduled to go into service in 1973 and traffic growth predictions show that its capacity will be sufficient to cope with demand until at least 1975.

However, the exchange is capable of expansion and can form the basis of Australia's international telephone switching system until about 1985.

UNDERWATER METAL DETECTOR

A battery-operated underwater metal detector is said by its British

IF YOU'RE A MOTORIST
(and who isn't these days?)
YOU'LL WANT TO READ

This issue of ELECTRONICS TODAY features an exclusive report on a new, super--efficient radar speed meter now under consideration by traffic authorities in Australia. The report (pages 60 - 62) gives technical details and tells how the meter performed during our tryout. How will this meter affect Australian motorists, if adopted here? The answers are in ELECTRONICS TODAY's companion magazine, MODERN MOTOR -- May issue, on sale in the first week of April.

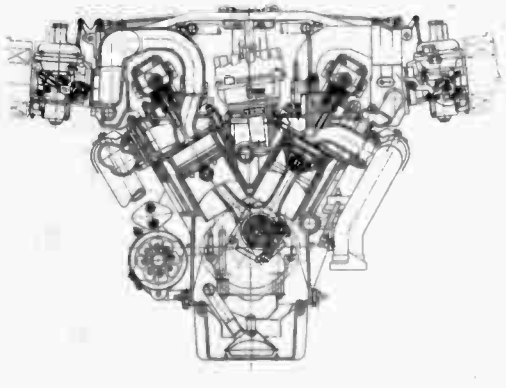
MODERN MOTOR also features a full report on a Sydney inventor's unique answer to the pollution problem -- a conversion kit for normal car engines that enables them to run on hydrogen produced electrolytically from ordinary tap water. An additional -- and latest -- development in the current world-wide drive to produce a fully practical electric car, surveyed this month in ELECTRONICS TODAY (pages 16 - 22).

modern MOTOR

AUSTRALIA'S TOP-SELLING MOTORING MAGAZINE

Produced by the publishers of ELECTRONICS TODAY, MODERN MOTOR brings you each month all the latest information on technical developments, new and coming car models, hard-hitting, searching road-test reports on newly-released cars, both here and overseas, plus free advice on your particular car problems.

Three typical features from the May issue:



Exclusive report on Jaguar's sensational new V-12 engine and the updated Mark III E-type body that wraps it up — a world scoop!

Road test of just-released performance kit for Cortina 440 that boosts maximum speed to 110 mph — with brakes and handling to match.

Photos, details of a completely new range of Fiats — and other newcomers at Geneva Motor Show.

modern MOTOR ALL NEWSAGENTS EVERY MONTH

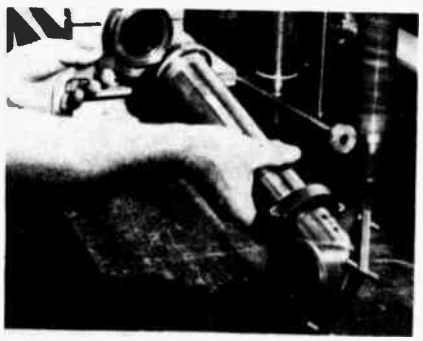
news digest

manufacturers to have greater sensitivity and range than any other model. Its uses include treasure hunting and locating underwater pipes and cables.

Manufactured by Littlemore Scientific Engineering, of Oxford, England, the detector functions by transmitting a high-power magnetic pulse from a coil, attached to a mounting rod, and analysing the resulting eddy-currents in surrounding objects.

Readings are taken from a luminous dial mounted on the rod. Operating depth limit is more than 200 metres.

Underwater pipes and cables are not only found by the instrument, but the depth at which they are buried is indicated. Detection distance depends on the size, shape and electrical conductivity of the object. A steel gas pipe, for instance, 9 in. diameter by ½ in. thick, would be indicated at eight feet, while a brass rod 2 in. by 12 in. would register at 25 inches.



PIPING 250,000 PHONE CALLS

Among innovations currently emerging from American research laboratories are a coaxial cable capable of transmitting 90,000 simultaneous telephone calls and a copper-lined steel pipe handling 250,000 simultaneous calls.

The new cable consists of 22 coaxial tubes, each approximately half-an-inch in diameter. Each tube can handle 9,000 uni-directional voice channels. One pair of tubes is held in reserve and switches on automatically when any other tube fails.

Extensive tests of a smaller version of the cable are now under way. When these are successfully completed, the full-capacity cable will go into regular long-distance service.

The second experimental system utilises a two-inch diameter copper-lined steel pipe to carry millimetre wave-length radio waves. A big advantage of this system is that repeater amplifiers are required only at 20-mile intervals; coaxial cables may require amplifiers at one-mile intervals.

Voice, television, picturephone and computer data is transmitted in pulse code modulated form.

The pipe system is scheduled for its first field trials in New Jersey in 1974, and is then to be expanded into the regular U.S. commercial telephone system in the late 1970s. (Abstracted from 'Science Horizons'.)

OPTIMUM RADIO DATA LINKS

Changing ionospheric conditions limit the reliability of high-frequency radio data transmission links. It is necessary to change the operating frequency throughout the day to obtain optimum error-free operation.

An adaptive system for improving data transmission is currently being investigated by the Electronics Dept. of Southampton University, England.

In their present theoretical model a particular frequency is chosen and transmission continuously monitored by superimposing a number of audio tones.

A falling level of ionisation will cause phase errors between the superimposed tones. By detecting and evaluating these phase errors, the rate of data transmission can be optimised to maintain frequency.

If, eventually, the rate of data transmission is reduced below an acceptable minimum, the system will automatically select a new pre-checked frequency.

The final proposed system will be entirely automatic, requiring no human supervision.

CONTROL ENGINEERING

Latest edition of 'Control Systems' features articles on the direct digital control of a steam generator; another article describes the updating of telemetry systems used by the Australian Gas Light Company.

'Control Systems' is a limited-circulation journal available to those professionally concerned with instrumentation and automatic control. Published by James Conran Pty. Ltd., Box 3349 G.P.O., Sydney 2001.

OPTIMIZED REFUSE DISPOSAL

Optimum combustion of waste products is assured by a British system based on static logic switchgear and associated electronic control mechanisms.

The system, installed at the headquarters of a Staffordshire furnace development company, combines cyclonic and rotary hearth principles to enable sewage, household and industrial waste to be reduced to an inert ash with maximum economy.

Housed in a control panel incorporating the switchgear and a central mimic diagram of the plant, instruments continuously measure and record furnace pressure, carbon monoxide level, oxygen level and furnace temperature.

On the basis of these measurements the static logic system maintains furnace operation at the required levels.

news digest

SHIP BERTHING RADAR FOR AUSTRALIA

The first Speed of Approach Measurement Indicator (SAMI) doppler ship berthing radar in Australia has been ordered by Utah Constructions Ltd. for installation at their coal-loading facility at Hay Point, near Mackay, Queensland.

Two units will be used to record the speed of approach of both bow and stern of bulk carriers of 120,000 gross registered tonnage berthing at the terminal, which is connected to the shore by a mile-long jetty.

The order for this equipment, which is made by the Marconi International Marine Co. Ltd. of England, has been placed with Amalgamated Wireless (Australasia) Ltd., Sydney.

SAMI, which is designed to assist pilots of large vessels to berth gently and safely, is installed on the quay to provide an exact indication of a ship's speed as she approaches her berth.

Extensive damage has been caused by large vessels berthing at off-shore terminals at speeds in excess of 11 feet a minute.

Speeds down to one foot a minute are indicated on SAMI which, in good weather, has a maximum range of two miles and a minimum range of five feet.

PATON INVESTIGATES DPM MARKET

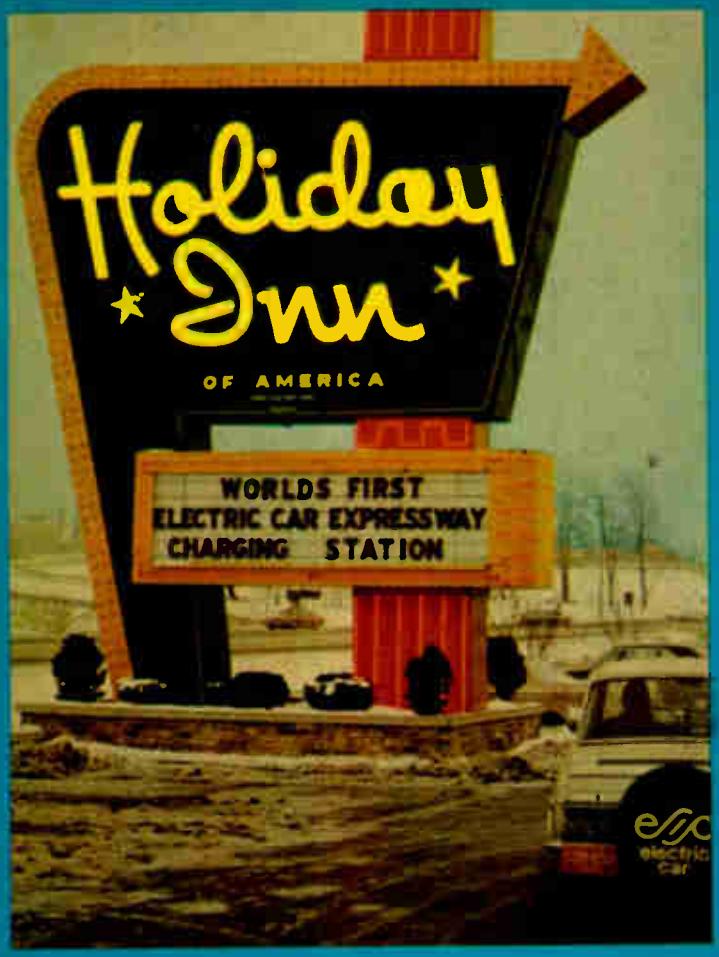
Digital panel meters greatly improve the speed, ease and accuracy of routine checks and measurements.

Problems inherent in analogue meters, such as parallax error, friction, hysteresis, reading error, etc., do not exist in their digital counterparts. So it is not surprising that more and more companies are entering the field.

The latest is Australia's Paton Instrument Co., who showed a prototype instrument at the recent CEITA exhibition. Paton's instrument is an integrating voltage to frequency converter using electroluminescent readouts.

READER REPLY SERVICE

ELECTRONICS TODAY offers a free coupon reply service to its readers. Reply coupons, and a list of advertisers taking advantage of this service, are on page 125. Use of coupons will ensure a quick reply to readers who want more information on a product.



ABOVE: Originally the first, this is now one of 35 stations with charging facilities for electric cars between New York and Los Angeles. RIGHT: Lead-cobalt battery powers this 40 mph, 150-mile range EFP chassis. BELOW: Converted Renault recharges in 45 minutes, has 70 mph top speed.

Electric cars are nearer than you think

POLLUTION— WATTS THE ANSWER?

THE PETROL ENGINE has powered motor vehicles since 1865.

It produces noise, smell, heat, carbon monoxide and unburnt hydrocarbons. It is a known threat to the ecology. It is thermally inefficient and mechanically improbable – a triumph of development over design.

Yet it continues, virtually without opposition.

Why?

For one very good reason.

One pound of 92 octane petroleum will produce 1.8 horsepower for one hour – will propel the average car 3½ miles. It contains usable energy equivalent to 1350 watt/hours.

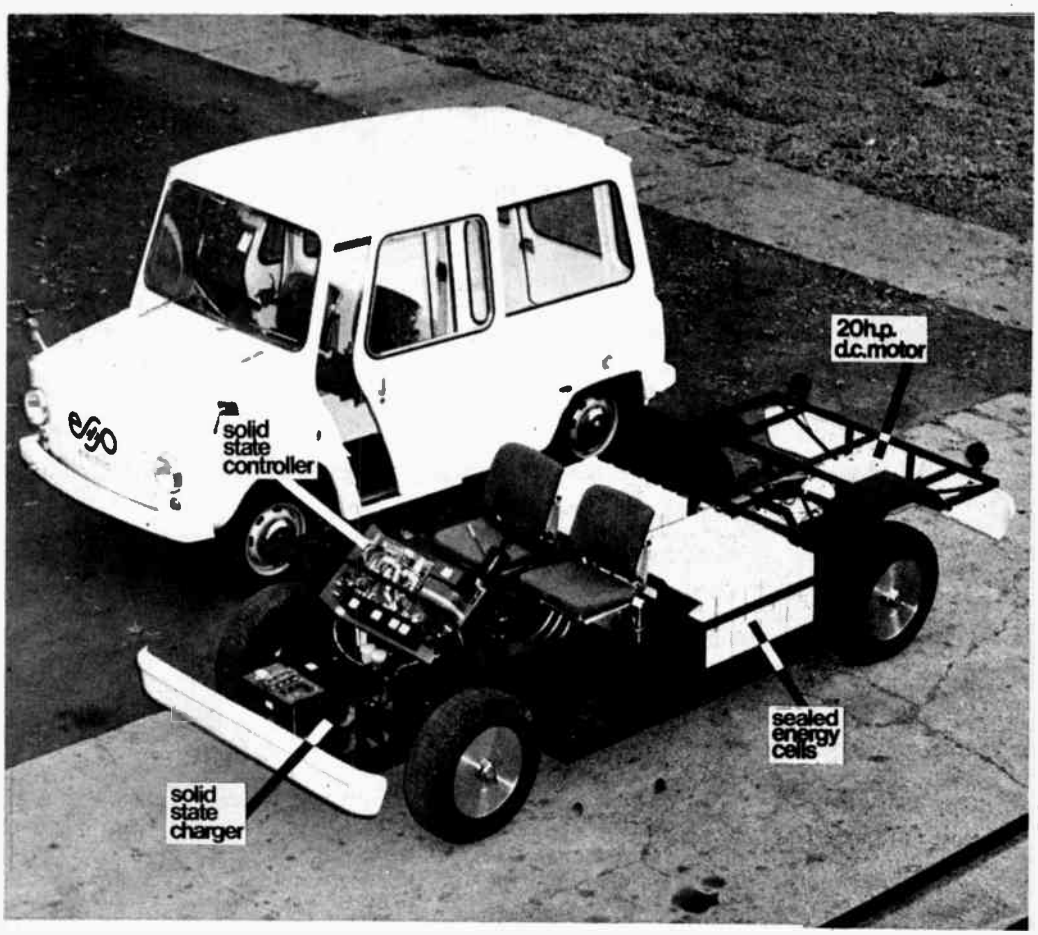
By comparison, the average lead-acid battery stores less than 10 watt/hours per pound – a difference of 135 to 1.

And that's a 135-to-1 reason, say the petrol protagonists.

Until recently they had a virtually unarguable case. Conventional lead-acid batteries with the storage equivalent of 10 gallons of petrol weigh close to 10,000 lb. – four times the weight of a Holden!

There's a lot of very serious gentlemen who feel that such things should not be – and they have backed their feelings with many millions of dollars. The future, they say, really lies in electrical propulsion.

They point to its advantages. Zero pollution, almost total silence, excellent torque at low speeds, no oil to change, no anti-freeze to add, no tune-ups to perform, no energy wasted when stationary. It's a convincing argument. IF the energy storage problem can be overcome, electric propulsion wins hands down.



Multipurpose electric vehicle chassis, produced by USA's Electric Fuel Propulsion Incorporated, forms basis for vans, cars and small buses. On-board fast charger makes daily range of 600-800 miles a possibility.

Zinc-air battery

Leading contenders in the search for more efficient energy storage are zinc-air, silver-zinc, and lead-cobalt batteries.

Zinc-air (or, more correctly, zinc-oxygen) batteries are being worked on by a number of large organisations.

Manufacturing rights to the original

Air pollution is a major problem of modern life, and much of it is blamed on conventional-engined vehicles. One answer is electric propulsion — and recent advances in energy storage and control have paved the way for this. Harold Dvoretsky and Collyn Rivers report . . .

POLLUTION-WATTS THE ANSWER?

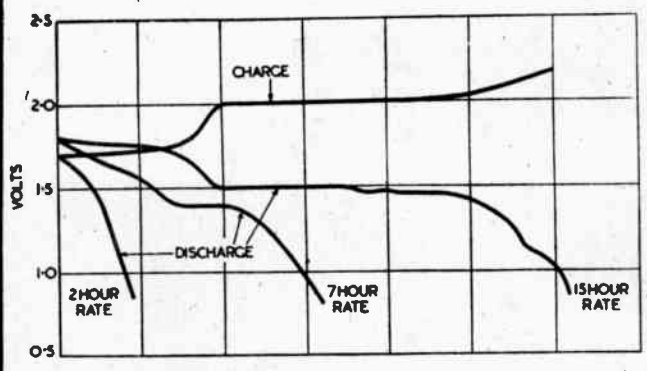
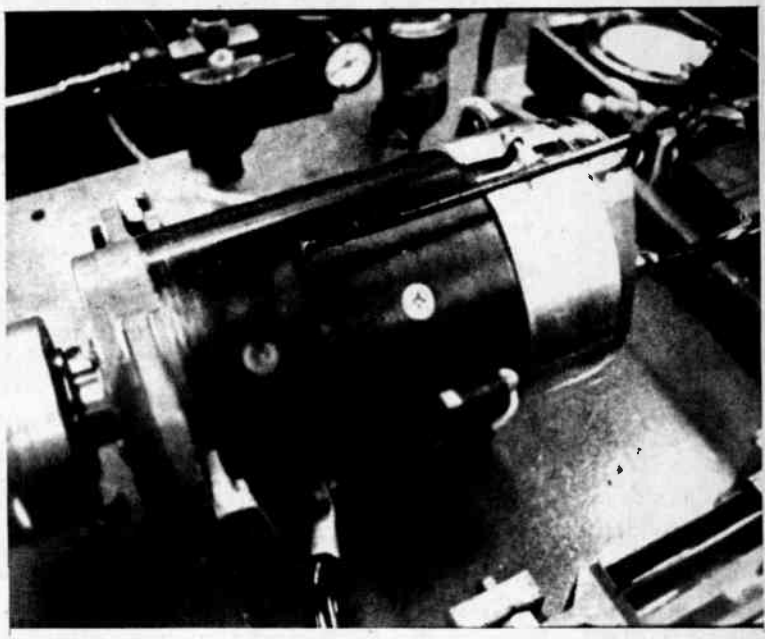


Fig. 1. Charge/discharge characteristics of silver-zinc cell.



Series-wound dc motor is one of a pair used in Ford Commuta.

Leesona Corporation battery were acquired by the British organisation Crompton Parkinson, who, together with British Leyland, are known to have been developing an electric car for the past three years. Both Leesona and Crompton Parkinson/British Leyland are secretive about current developments. Some indication is that three years ago the Leesona battery provided up to 50 watt/hours per pound and had good charge/discharge characteristics over a wide range of temperatures.

Another promising zinc-air battery is being developed by Britain's Exide Company, backed by the National Research & Development Corporation.

Their version of the zinc-air battery couples a fluidized zinc electrode with the best available air electrode. The fluidized zinc electrode has a large surface area, thus allowing high current operation at low area current densities.

Advantages claimed for the Exide system include discharge currents which exceed those obtainable from solid zinc electrodes, and freedom from dendrite formation which plagues the solid electrode design.

Yet another interesting development is a zinc-air battery from Energy Conversions – a company set up by GKN, British Ropes and British Oxygen. Energy Conversions, Ltd. previously worked with Pratt and Whitney on fuel cell development. They recently handed over this part of their research to the Harwell Atomic Research Division.

Lead-cobalt rival

Main opposition to the zinc-air design is the lead-cobalt battery developed by the Electric Fuel Propulsion Corporation of Detroit. Dr. Eric Kluger, Austrian-born director of the US company, was reticent about the design when we spoke to him in London recently – all he would say is that the batteries are tri-polar lead-cobalt units with recirculating electrolyte.

Our American office reports that the tri-polar batteries contain a number of cells, each of which has 29 or 30 positive plates and an equal number of negative plates. These plates are electrically bonded top and bottom by six bus-bars. Heat generated by the lower bus-bars causes automatic circulation of the battery acid (it is believed that the latest design uses a more positive method of electrolyte circulating).

A combination of cobaltous sulphate and other chemicals prevents deleterious oxidisation of the lead plates, or generation of toxic gases when the batteries are boost-charged at levels as high as 400-500 amps.

The tri-polar battery is claimed to have very low internal resistance and, unlike the lead-acid battery, it maintains practically constant output voltage until almost discharged.

Storage density is understood to be at least 40 watt/hours per pound, yet cost is said to be only 20% more than lead-acid batteries of the same watt/hour rating.

Silver-zinc and others

Still in the running is the silver-zinc battery developed in the 1930s by Professor Henri Andre, of Paris, and currently manufactured in Britain by Venner Accumulators.

This battery utilises the principle of the silver-zinc electro-chemical couple. The active materials are contained within two 'sacks' together with the electrolyte, which is in an absorbed state. The characteristics of the silver-zinc cell are shown in Fig. 1.

Storage density of the silver-zinc battery is 25 to 30 watt/hours per pound. High charge and discharge rates do not cause damage.

General Motors' Delco-Remy division produced a rather impracticable zinc-air battery which required the replacement of some 300 zinc plates whenever recharging was required. This company is also known to have researched lead-acid, nickel-zinc, silver-zinc and lithium-tellurium batteries.

Many other types of batteries are

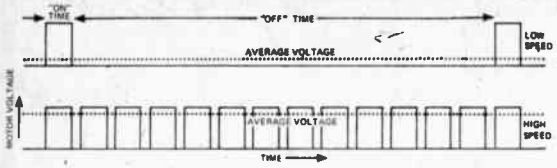


Fig. 2. How variable frequency, constant width pulses are used to vary drive motor input voltage and consequently vehicle speed.

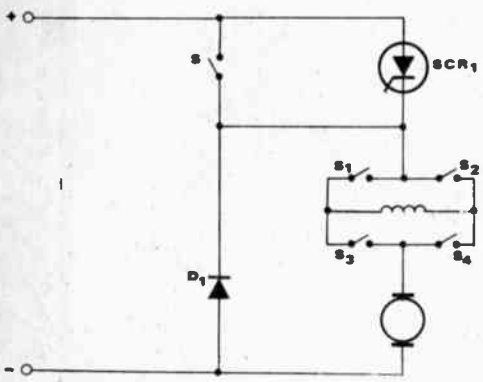


Fig. 3. Basic electronic speed control circuit.

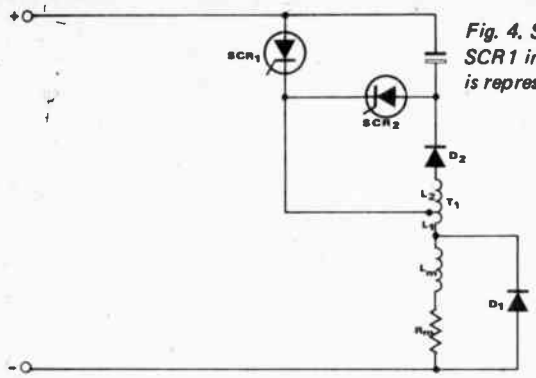
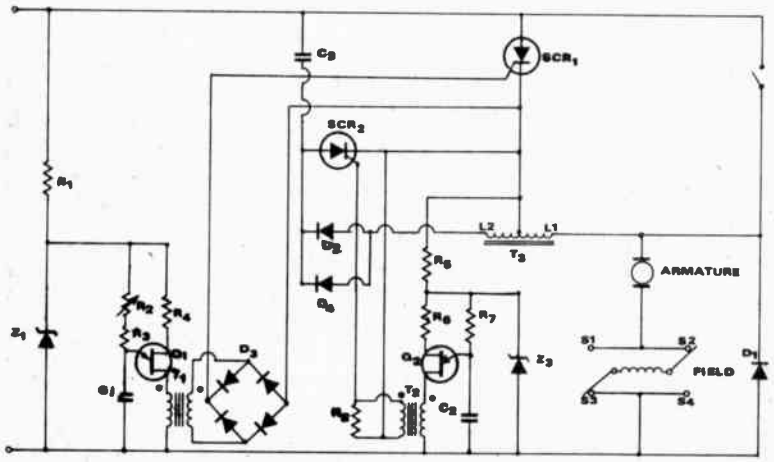


Fig. 4. SCR2 commutates SCR1 in Jones chopper. Motor is represented by LmRm.



RIGHT: Fig. 5. Typical speed control circuit of electric vehicle.

being developed by companies world-wide.

150 watt/hours/lb.?

The 'state of the art' is known to have exceeded 50 watt/hours per pound, and 100-150 watt/hours per pound may well be a reality, or at least within sight.

This may seem a long way off the 1350 watt/hours per pound that petrol produces – but to convert petrol into usable energy a heavy internal-combustion engine is required. This in turn requires a variable-speed gearbox or torque-converter before the power can be transmitted to the road.

A typical engine-and-gearbox assembly weighs 500lb. including accessories. Add a further 30lb. for radiator and water and a further 60lb. for the starter battery. The total is now close to 600 lb. The drive motor of an electric vehicle weighs little over 100 lb. – and even if a gearbox is still used, there will be a weight bonus approaching 450 lb.

At 150 watt/hours per pound that's the equivalent of over 4½ gallons of petrol.

The technological gap is closing.

To those accustomed to the claimed brake horsepower outputs of petrol-engined cars the power ratings of electric vehicles seem puny. A 20-horsepower motor in an electric passenger vehicle would represent the high-performance end of the range!

The explanation is simple. Petrol engines are frequently rated with all accessories removed and carburation and ignition tuned for maximum output. The manufacturers' figures represent the peak output for a short period of time. A realistic 'continuous power' rating is usually less than half the peak rating.

By comparison, electric motors are rated for 'continuous power'. They can be safely overloaded by several hundred percent for short periods. A 20-horsepower electric motor may well be capable of producing well over 100 horsepower momentarily.

We consider that the most likely drive system will be two- or four-wheel drive – possibly using a 'pancake' motor in each wheel hub. Electronic 'differentials' will be used. Total vehicle power will probably vary from 5 horsepower to 25 horsepower. Motor efficiencies are currently around 80 to 85% and may increase to 90% (compared with a petrol engine's 23-25%).

The modern approach

Series wound motors will be used. This type of motor produces high starting torque and has other characteristics which make it very suitable for traction purposes. (The torque of a series wound motor is directly proportional to the product of flux and current. Since with a series wound motor these two factors are at maximum when starting, it follows that torque will also be at maximum.)

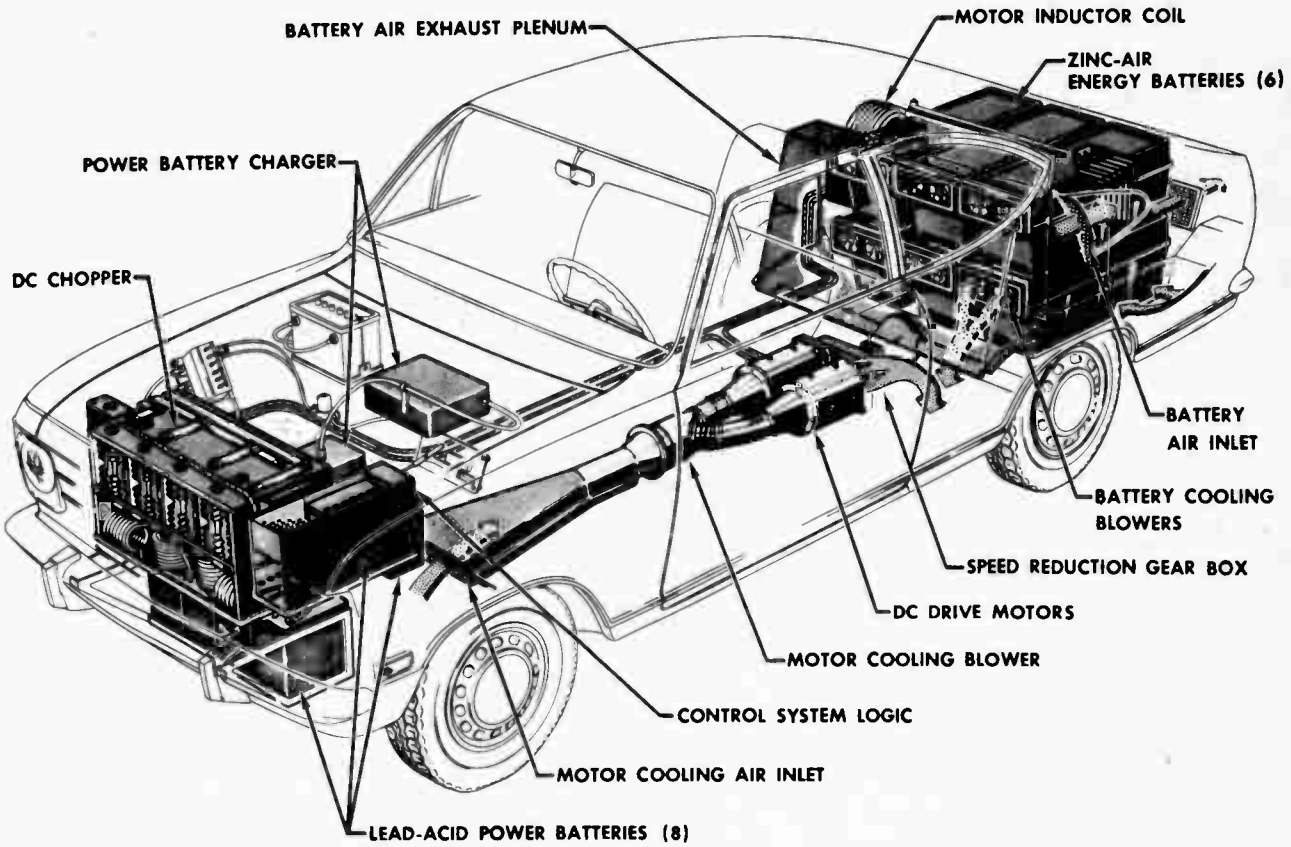
Early electric vehicles varied speed by switching a number of separate batteries in series and parallel combinations. The system was electrically efficient but speed could only be changed in discrete steps. If stepless control was required, power-wasting rheostats had to be used.

All this has gone.

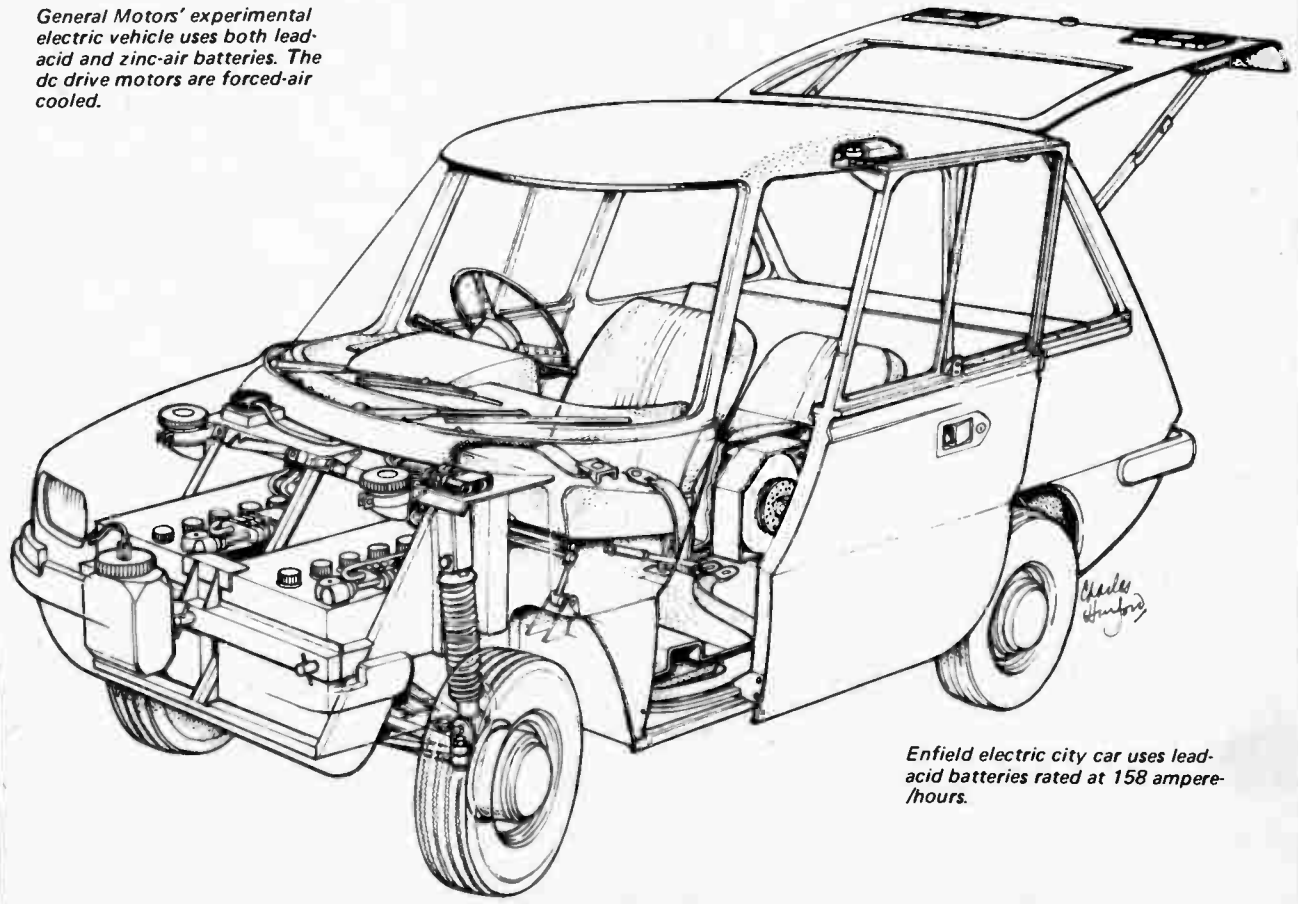
Solid-state electronic controllers provide smooth stepless speed control in nearly all actual and proposed electrically-driven vehicles.

The first solid-state controllers used paralleled power transistors to handle the heavy currents involved. The latest high-current silicon controlled rectifiers (SCRs) have ousted power transistors from this application. The method that will be used will almost certainly be the Jones chopper circuit shown in Fig. 4.

The action of the circuit is that of an extremely rapidly operating 'switch' in series with the drive motor. The 'switch' produces pulses of constant time duration but variable in frequency. Thus, by varying the frequency and keeping the pulse width constant, the ratio of 'on' time to 'off' time can be varied.



General Motors' experimental electric vehicle uses both lead-acid and zinc-air batteries. The dc drive motors are forced-air cooled.



Enfield electric city car uses lead-acid batteries rated at 158 ampere-/hours.

The effect is illustrated in Fig. 2. At low speed the ratio of 'on' time to 'off' time is very low, and thus the average voltage across the motor is low. As the 'off' time decreases, the average voltage increases and causes the motor to speed up.

The switching function is actually performed by SCRs. Figs. 3 and 4 show how they are used. (the method of commutating the load SCR is shown in Fig. 4 and is described later in the text).

Switch contacts SW1, Sw2, Sw3 and SW4 determine the direction of current through the motor field winding (and thus provide a forward and reverse drive). With contacts SW1 and SW4 closed, motor rotation drives the vehicle forward. With contacts SW2 and SW3 closed, the vehicle's direction will be reversed.

When stationary, all four switch contacts are open. To move off in a forward direction, contacts SW1 and SW4 are closed and the SCR chopper caused to switch at a low frequency. A small amount of power will now be applied to the drive motor. Acceleration is controlled by the frequency of the SCR chopper.

A switch shorts out the SCR when 80/90% of full power is reached. This action applies the full battery voltage across the drive motor.

Typical circuits

A typical circuit for a small electrically-driven vehicle is shown in Fig. 5. SCRI is the main load-carrying and chopping switch. It is triggered at a frequency determined by the setting of 'accelerator' potentiometer R2 in the unijunction oscillator circuit on the left-hand side of the diagram. Current flows through the motor field and armature winding and also winding L2 of the autotransformer This induces a voltage in LI, which in turn charges capacitor C4.

At a predetermined time interval after SCRI is triggered, the unijunction time delay (on the right-hand side of the diagram) triggers SCR2; this discharges C4, thus momentarily reversing the voltage across SCRI. SCRI is now turned off and awaits the next triggering impulse from the unijunction oscillator.

A high-current diode – shown in Fig. 5 as DI – protects the motor against high transient voltages generated when SCRI is turned off.

In practice the circuit will include overload protection – by a current limiting network – and provision of regenerative braking. This latter provision is one of the great advantages of the electric car. The kinetic energy of the moving vehicle is converted back into electrical energy and restored in the batteries; thus hardly any energy is lost during braking.

By comparison, heavy braking of a conventional car causes an energy loss roughly equivalent to opening a 1/8th-inch diameter tap in the bottom of the fuel tank.

In the past . . .

Electrically-driven vehicles have been in use since the early days of motoring. Camille Jenatzy's electrically-powered 'Jamais Contente' held the land speed record of 65.8 mph in 1899 – the first vehicle of any kind to travel a mile a minute.

The first electric car to be produced in England was designed by J.K. Starley, who was responsible for the introduction of the safety bicycle and was later associated with the Rover car.

First successful commerical in 8ritain, Crompton Parkinson manufacturer was W.H. Bersey, who made a number of omnibuses, cabs, vans, broughams and phaetons during the 1890s. The motors and batteries for these vehicles were made by Elwell-Parker at Wolverhampton.

Electric Vehicles build over 1000 electrically-driven vehicles a year. These are used mainly for bread, milk and laundry deliveries. The company is believed to be working on British Leyland's special project division to produce a vehicle having a range of 300 miles and a top speed of 60 mph.

The British Leyland project isn't Crompton Parkinson's only research assignment. Last December Britain's Department of Trade and Industry gave them an order for the production of two prototype elecrically-powered buses for use in city centres.

Scheduled for delivery late this year, these buses will be powered by conventional lead-acid traction batteries. They will give the 26-passenger bus a range of 30 miles in city centre traffic conditions.

The Department will lend the buses free-of-charge to transport authorities, enabling the latter to obtain first-hand knowledge of their operating characteristics.

In the present . . .

The most advanced electric vehicle in production right now is Electric Fuel Propulsion's Rambler Hornet-bodied EFP Electric. One of these took first place for electrically-driven vehicles in America's 1970 Clean Air car race. Performance included a top speed of 85 mph, a range of 125 miles, and fuel costs of less than one cent per mile.

Electric Fuel Propulsion's director Robert Aronson promises that the next model – called the Voltaire – will exceed 110 mph and have a range of 300 to 500 miles.

Present EFP vehicles are being purchased by electric utility companies and government agencies interested in pollution-free transport.

It is said that the company is presently negotiating with a car-leasing organisation and a number of fleet operators.

Like General Motors' experimental Sterlecs, the lastest EFP vehicle uses supplementary power to maintain battery charge. Electric Fuel Propulsion propose to use an already developed and patented fuel cell to trickle-charge the batteries. (GM vehicles used an 8hp Stirling engine coupled to an alternator).

Rowan city car shown at Electric Vehicle Symposium in Phoenix, Arizona, had 60 mile range. Fuel costs were less than one-third of a cent per mile.

POLLUTION-WATTS THE ANSWER?

Fuel cells

The fuel cell approach is also being researched in Britain by Lucas, who are working on a zinc-oxygen cell – current thinking, however, is generally toward direct oxidation of carbonaceous fuels.

The Chrysler Company has done some development using fuel cells and also an ingenious turbine-powered generator which charged the batteries.

The Ford Motor Company produced their electrically-driven 'Ford Commuta' in a great, but brief, blaze of publicity.

The vehicle has not been seen since. The company is currently working on an advanced power system using a sodium-sulphur battery and believes it will be ready for the market by 1975.

Another company prominent in electric propulsion is that run by 55-year-old Staffordshire engineer Alistair Carter. One of his designs is the Enfield 465. The power unit in the first prototype was a 48-volt dc series wound motor rated at 4.65 hp. Efficiency was quoted as being 83% The batteries were conventional lead-acid, rated at 158 amp/hours.

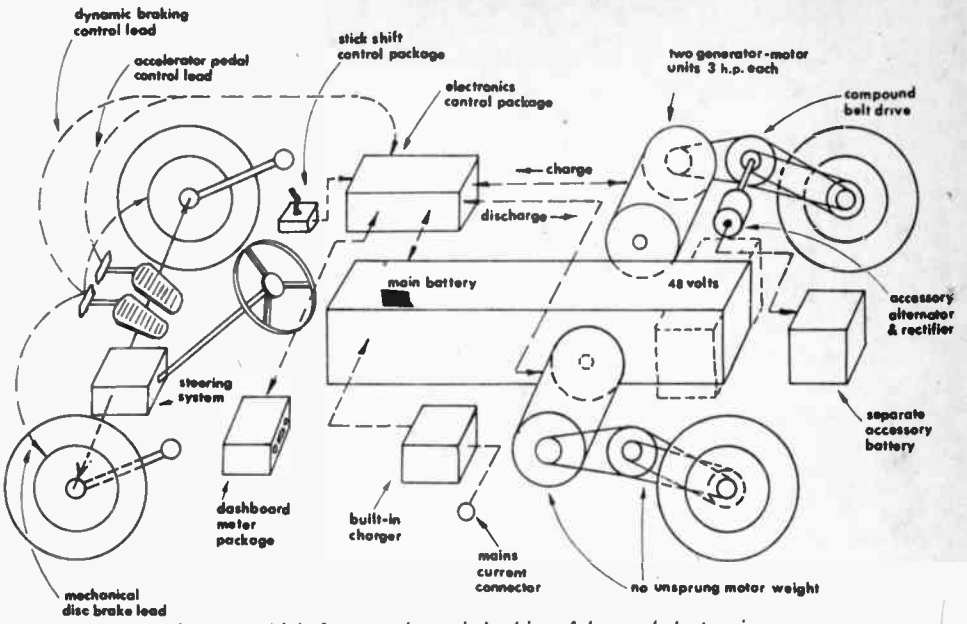
A later version of the car was shown at the Electric Vehicle Symposium at Phoenix, Arizona, in November 1969. The vehicle was intended primarily as a town car with a range of 60 miles. Fuel costs were claimed to be one-third of a cent per mile.

Another of Carter's designs highlights the problem of air pollution at major international airports. No less than 6 tons (1800 gallons) of fuel are used purely for taxiing by a Boeing 727 on each flight.

Carter's solution to the problem introduces 22" diameter electric wheel motors, each developing 154 hp. His plan – which is almost certain to be adopted – is to mount one motor in each wheel, on either side of the main undercarriage bogies. Electrical power will be provided by the existing diesel-electric starting trolleys which will be hooked onto the rear of the nose-wheel.

In Europe and Australia

Concern about world problems of pollution and noise, particularly those caused by internal combustion engined cars, has contributed to studies under way towards the formation of a European Pool of manufacturers of electric cars headed by La Voiture Electronique, Paris, France. The pool, as presently envisioned, would promote battery-electric vehicles in Europe, and would collaborate on an international basis with other interested organizations throughout the world.



Layout of Rowan city car; vehicle features dynamic braking. Advanced electronic speed control uses integrated circuit amplifier.

La Voiture Electronique reportedly brings to the proposed pool, brushless motors with electronic commutation and electric controls. It is described as a variable-reluctance motor having a wound stator and solid or plate-shaped rotor. These motors appear to be similar to those developed by General Motors for the US Army Tank Automotive Command, and to a thyristomotor used about two years ago by Tokyo Shibaura Electric Co in an experimental electric vehicle.

Production is under way – with a yearly output of 4,000 to 6,000 vehicles, selling at about $1000 each.

Yet another approach is an attempt to convert existing internal combustion engines to direct electrical propulsion.

The method involves passing a heavy electric current through water. The resultant electrolysis produces hydrogen and oxygen which is then burnt in the vehicles existing and unmodified, internal-combustion engine. Work is currently in progress in Australia and Spain.

This is an ingenious approach unfortunately confused by reports that the vehicles are powered by water. Water is used purely as a "working fluid", the energy source is electrical.

A common objection to electric propulsion is that the electricity generating network could never accommodate the enormous extra load.

However, even in the most unlikely event of all vehicles in a country being electrically propelled, the extra load is not totally out of the question.

The average motorist drives 25 miles a day, and this would require electrical energy of approx 10 Kilowatt/hours. Assuming 3 million such vehicles in Australia, we would need 30 million Kilowatt/hours per day.

The majority of cars are not used overnight, during the very time when there is excess electrical generating capacity. If batteries were to be charged at a 10-hour rate, our increased load would be down to 3 million Kilowatts.

As Australia's total generating capacity exceeds 13 million Kilowatts, the scheme is not totally impracticable – even assuming the unlikely event of no parallel increase in generating capacity. Moreover, it seems likely that fuel cells or some other form of supplementary energy will be used to augment the power obtained from the electricity authorities.

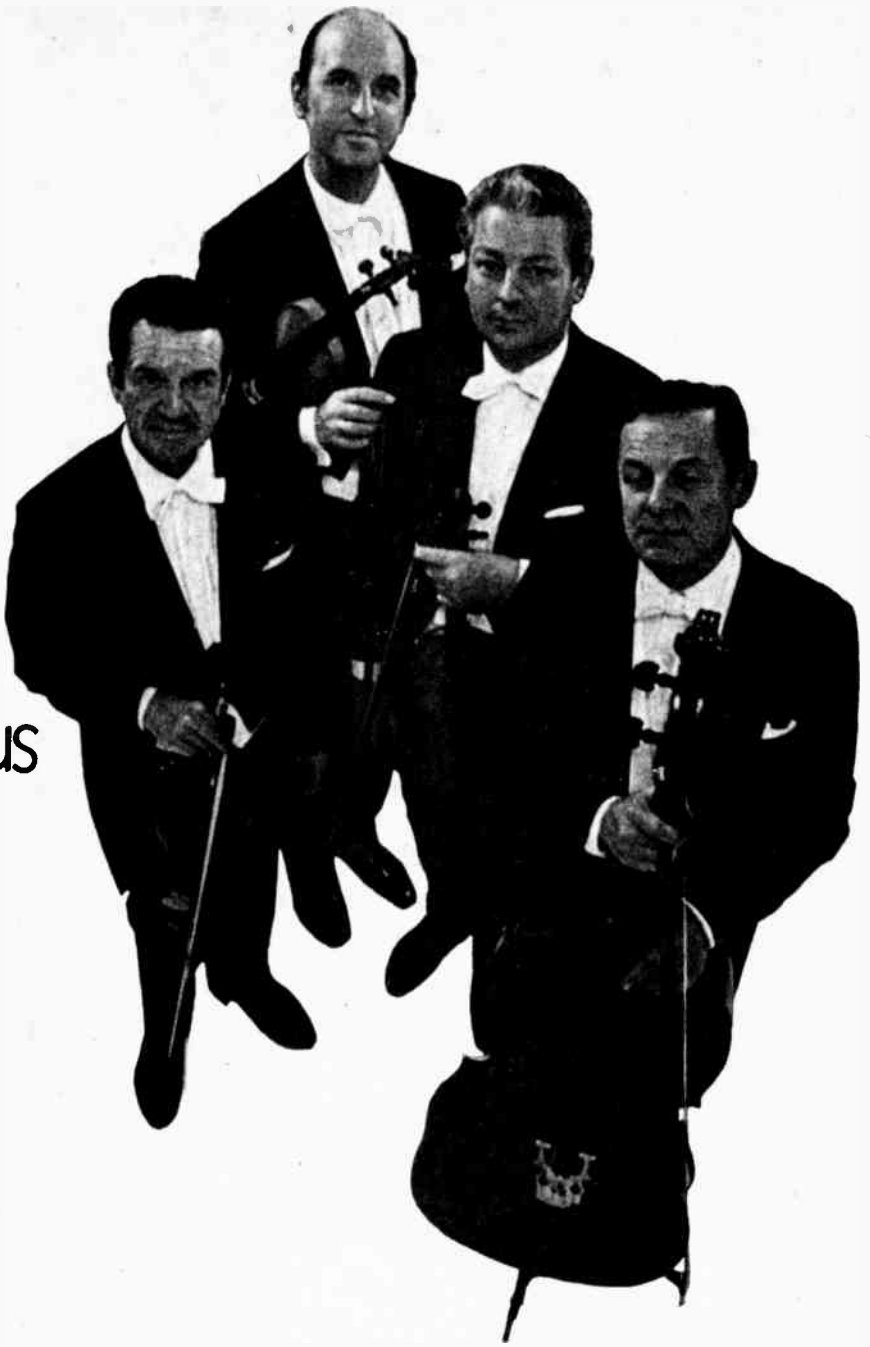
What of the future?

What, then, is the probability that electric propulsion will displace the petrol engine?

It is impossible to say at this stage – but, without doubt, all the big motor companies, many smaller organisations and electricity authorities world-wide are taking electrical propulsion very seriously indeed, and at least one major British company is expected to unveil a practical, small electric passenger car late this year, or early in 1972.

There is a growing pressure group both inside and outside the USA to ban the use of conventional-engined vehicles in crowded cities like London, New York and Paris. Although none of these cities has inversion problems like Los Angeles, the danger and nuisance value from petrol and diesel fumes applies to them all.

In the final analysis it will probably be ecology, not technology, that will be the determinant. ●



A Stradivarius becomes a Stradivarius again...with BASF LH-hifi recording tape

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ET PROJECT

$20 CONCERT HALL

Ingeniously simple system extracts data from existing stereo recordings to recreate concert-hall sound

A colleague has described mono reproduction as 'listening to an orchestra through a hole in a wall'. Stereo 'added a second hole'.

The analogy is not perfect. Good audio reproduction can be so good that it is virtually impossible to distinguish between the original and the recorded sound. This is particularly true of solo artists and small groups, especially when recorded in non-reverberant conditions.

Orchestral music can be a different matter – here the 'hole in the wall' effect is often apparent.

There are two main reasons for this. The first is the apparent juxtapositioning of the audience among the orchestra. The two appear to occupy the same place, with the audiophile listening from a position set apart from either – a position which has no spatial counterpart of any seat in a real concert hall.

The second reason is to do with reverberation. Orchestral music performed in a concert hall is reflected by a huge number of reverberant paths and patterns which add a richness of 'colour' to the sound generated by the performers. If played in an open space, the same music would sound thin – somehow musically underexposed.

Recorded music so often sounds like that – as if performed in a field. Clean, but sterile. Precise, but bearing much the same relationship to a live performance as cooking sherry to a vintage port. In fact, it is not uncommon for people whose appreciation of symphonic music has been obtained solely through recordings to be quite exhilarated upon hearing the real thing – 'Why didn't someone tell me it was like this?'

Quadrisonic sound is one answer. It works, but necessitates four-channel recording, four-channel storage, four-channel playing equipment. Perhaps it will be a commercial success. Perhaps not. No-one is really sure.

NOTE: The effect described in this article cannot be obtained by connecting extra speakers in series or paralleled with existing main channels. Either will merely cause apparent spatial dislocation of the sound source.

But why wait to find out? The data necessary to create the ambience of a concert hall already exists. It is right there – already impressed on many of your present LPs.

SEVERAL CHANNELS

There are several information 'channels' on a conventional stereo record. Not just two. Several.

There's the right-hand channel for the right-hand speaker – call it R. Then there's the left-hand channel for the left-hand speaker – call this one L.

Then there are three more.

There's the difference between the right-hand channel and the left-hand channel (R – L). And its complement (L-R). Finally there is L + R.

These extra channels contain data which is not recoverable from either R or L channels alone. This data is primarily reverberant sound and audience noise.

In normal stereo recording reverberant sound and audience noise is reflected throughout the recording area, but at a lower level than the direct sound received by the recording microphones. The reverberant sound is 'acoustically shadowed' by the direct sound and can be barely perceived when played back through a conventional stereo system. Even if it were audible, reverberant sound issuing from two forward-placed loudspeakers would indicate an apparent source incompatible with concert-going experience.

To overcome this 'acoustic shadowing' we use data extracted from

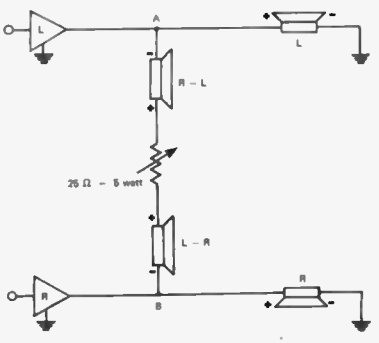


FIG. 1. Showing basic connections. Note the phasing of speakers.

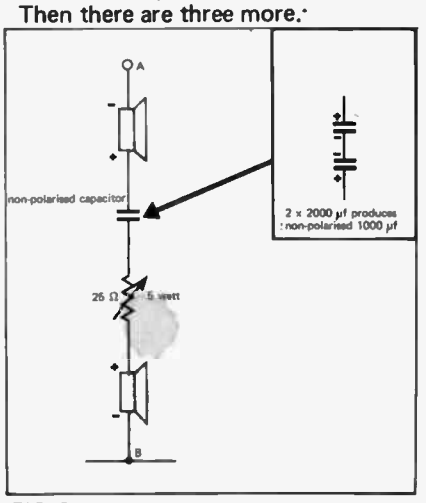


FIG. 2. Non-polarised capacitor protects system against dc levels (see main text).

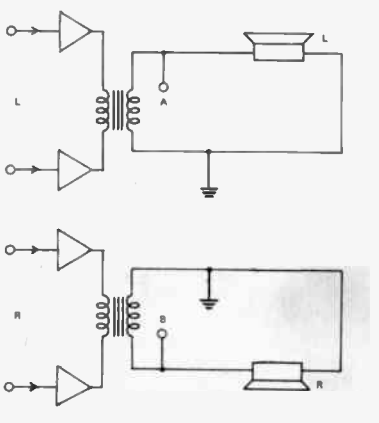


FIG. 3. Circuit in which isolation is provided by output transformers.

the difference between R and L channels. Sound which is common to both these channels is not used. Our additional channel produces no output, under conditions of identical R and L signals – it responds only to difference signals.

When a sound is made in a concert hall, reflections of this sound arrive back at the recording microphones in ever-changing phase relationships and time delays depending on the natural reverberation period and characteristics of the recording hall.

These reflected sounds will appear in our difference channel after the same intervals of time as in the original concert hall; thus, by utilising these sounds and playing them back via difference channel loudspeakers at the rear of the listening area, the 'ambience' of the original hall will be recovered.

There will be no impression of sound from the rear of the room. The orchestra will be in its normal place. The sound from the rear of the room will add to the sound from the front of the room in the same way that it does in a concert hall. The two sounds will combine to provide that richness of tone which is a characteristic of well-designed halls.

The same acoustical realism will apply to the apparent positioning of the audience. the audience will seem to be in their normal position in the body of the hall – and the listener will be sitting in this audience, not away from and behind them. The sound will be distributed more evenly about the room and there will be less necessity to sit in a 'favourable triangle'.

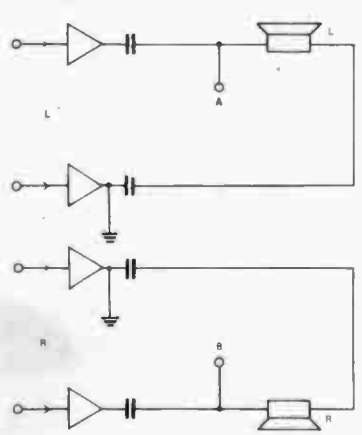


FIG. 4. In this circuit isolation is provided by blocking capacitors.

HOW IT'S DONE

As previously stated, our method of obtaining the 'difference' information is to utilise the R-L and L-R data. This is quite simply derived from the existing main channels.

All that is required is a pair of supplementary speakers connected differentially across the 'high' sides of these channels. The supplementary speakers are connected in series but oppositely phased. A 25 ohm rheostat adjusts their volume. (Some amplifiers may require isolating capacitors, and these are discussed later in this article.)

The additional speakers, together with some proportion of the series resistance, present parallel impedance paths across the existing main channel speakers. However, this additional loading is very low, occuring only when a difference signal exists between the two main channels. The average power level in the difference

Detail of enclosures, using two C60 Rola speakers. Enclosure dimensions depend on type of speaker.

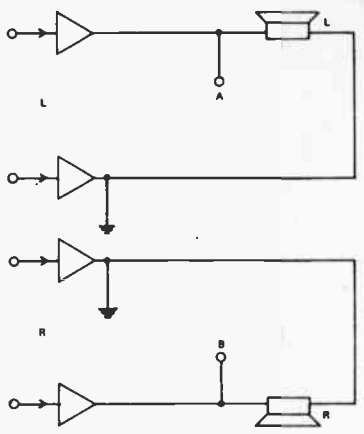


FIG. 5. A dc coupled circuit with zero potential in respect to earth.

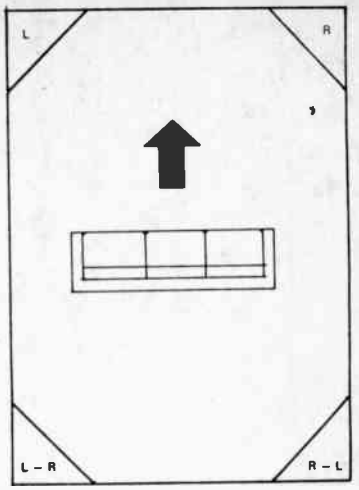


FIG. 6. Recommended installation. Note phasing of speakers.

channel will be around 2% of the total amplifier load. This will increase during passages in which sustained bass or percussion is recorded predominantly on one track. The worst case will be high-level signals occurring in both channels 180 degrees out of phase. This is a rare, transient phenomenon which an amplifier can easily absorb.

The difference channel may be added to many stereo systems merely by adding two extra speakers and a rheostat – as shown in Fig. 1. Other systems require the addition of a non-polarised capacitor – Fig. 2. The determinant is whether or not there is a difference in dc potential between the outputs of the L and R channels.

In all probability the outputs will be at zero potential with respect both to earth and to each-other. It all depends upon the output circuit of your amplifier.

The three most probable output circuits are:

1. Output transformers – Fig. 3.
2. Isolating capacitors – Fig. 4.
3. DC coupling – Fig. 5.

Check your amplifier carefully – preferably comparing the actual unit against the circuit diagram.

If the circuit is of type 1 or type 2, (Figs. 3 and 4 respectively), no blocking capacitor is required. If the output circuit is not of these types, a blocking capacitor MAY be needed.

Check with a voltmeter for differential dc voltage. Measure directly between the 'high' sides of the main channel outputs (the amplifier should of course be switched on, but with no signal applied). Watch out for reversed meter polarity – a differential voltage may be positive or negative with respect to your meter connection. If the voltage between the outputs exceeds a millivolt, a blocking capacitor MUST be used.

In all probability, if your amplifier is dc coupled (as in Fig. 5), there will be no dc differential voltage – but it is necessary to make sure: there is another type of dc coupled amplifier which may well have several volts between outputs.

The blocking capacitor must be a non-polarised electrolytic with a capacity exceeding 500 μf – preferably between 1000 and 2000 μf. The simplest way of obtaining a non-polarised electrolytic is to connect two normal electrolytics 'back-to-back'. Remember that, if a total capacity of 1000 μf is required, two capacitors (each of 2000 μf) will be needed.

The capacitor is wired in series with the additional speakers and rheostat and is readily housed in one of the speaker enclosures.

CHOOSING SPEAKERS

The choice of suitable speakers and enclosures is not critical. Naturally, the better the speaker, the better the result – but good results have been obtained from $3 units mounted on open hardboard baffles!

If speakers are purchased especially for the project, they should have a reasonably flat response from 40 Hz to 5KHz. Above this the response should preferably DECREASE – there is little ambience signal above this frequency and the decreasing response will limit any surface noise that may occur.

A pair of bookshelf speakers with tweeters removed will be quite effective; however, the larger the enclosure, the less extra load will be imposed on the amplifier. Two Rola type speakers have been found to be very effective.

The impedance of each additional speaker should not be less than the impedance of each main channel speaker. Nor should it be more than twice the impedance. Example – if the main speakers are 8 ohms each, the extra speakers should be either 8 or 15 ohms each.

The rheostat may be housed in a small case and mounted close to the main amplifier controls, or located within one of the additional speaker enclosures. Level settings are not very critical – and once the chosen level has been set, it is unlikely that it will need to be altered.

Place the speakers in the two rear corners of the room (observing the phase relationships shown in Fig. 6) and put on a well-balanced classical record – preferably a symphony or concerto. Adjust the rheostat so that the rear speakers contribute to the overall sound but cannot be identified as actual sound sources from more than a few feet away.

The results will largely depend on the recording.

The system is at its most effective when reproducing classical music from well-balanced recordings. The emphasis is on the well-balanced bit. A number of recording companies produce records and tapes with grossly exaggerated stereo spacing – and with these or with 'reprocessed mono' the system is valueless.

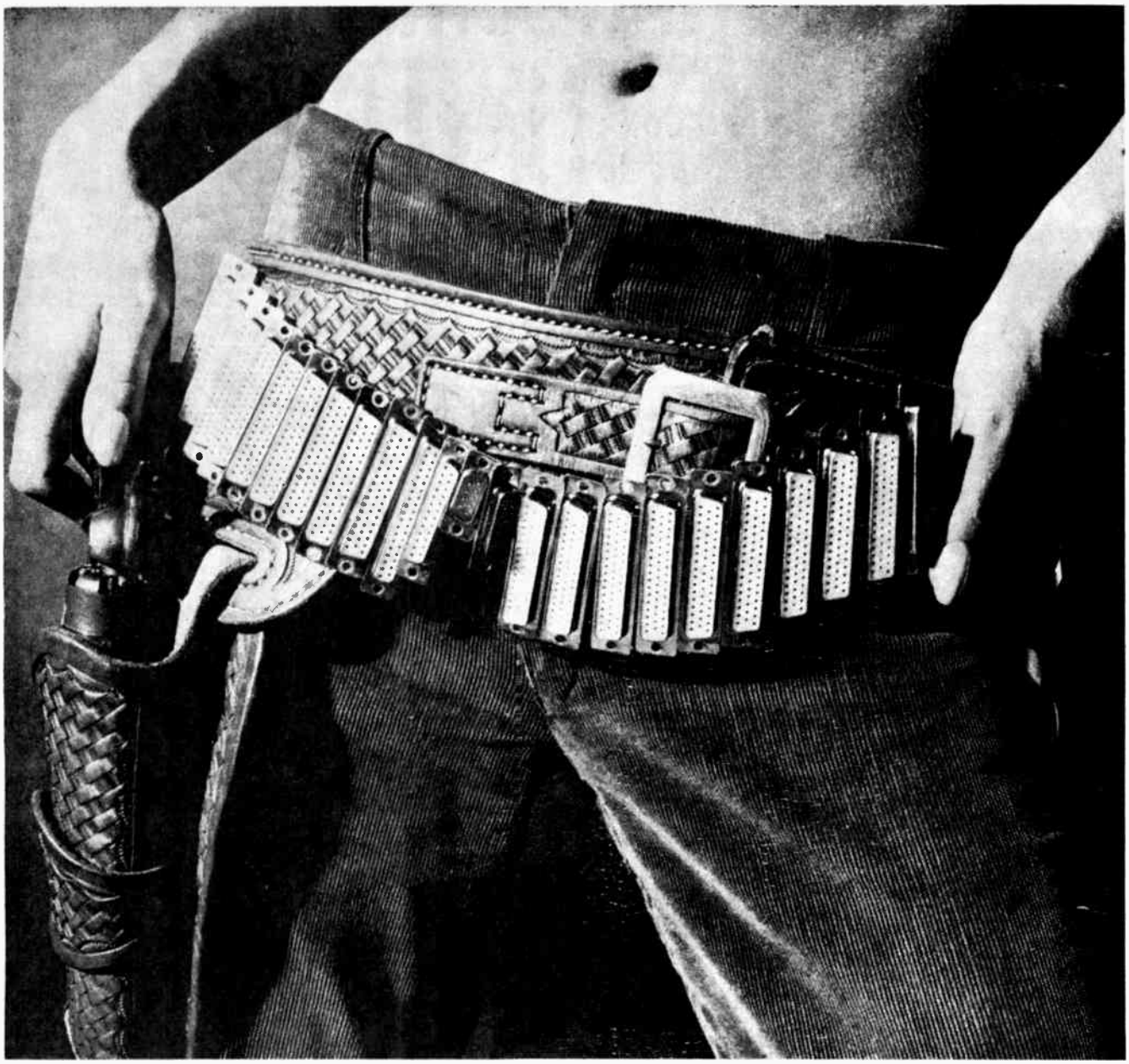
But who wants to listen to music like that, anyway?

CONSULTANT'S COMMENTS

Here's what our independent testing consultant had to say about this project:

"We have tried the system described in this article. We used two speakers, a 25 ohm potentiometer and two electrolytics – connected 'back to back' – all in series, and connected across the active terminals of our normal stereo amplifier.

"The results were quite startling. For less than $20 we approximated – though in a much less versatile form – the quadrisonic effect. The system is simple, inexpensive, and gives almost as good a result."



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ANALYSING RANDOM SIGNALS WITH A BOXCAR INTEGRATOR

By R. Blackwelder, Postdoctoral Fellow, Johns Hopkins University

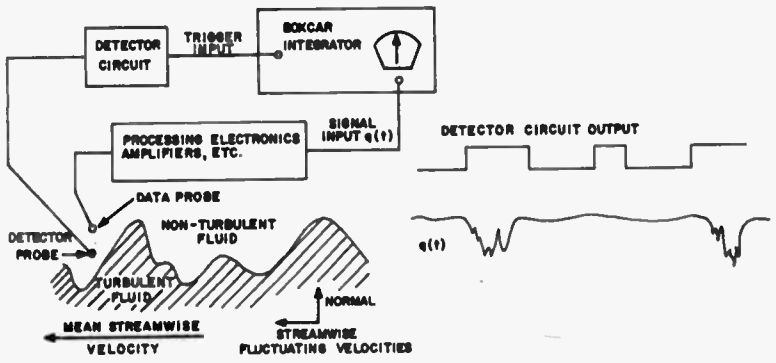


FIG. 1. Using the Boxcar Integrator for conditional averaging.

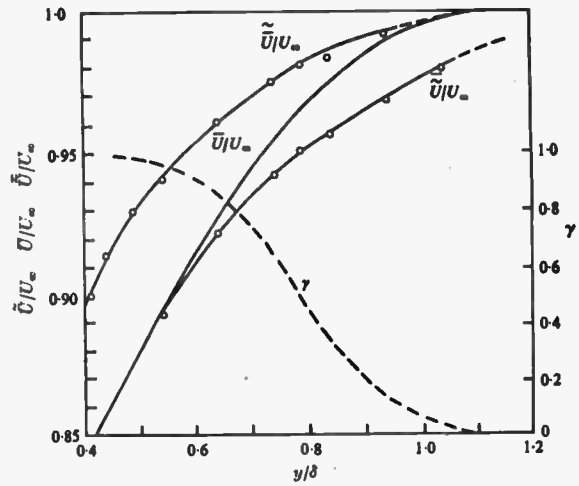


FIG. 2. Zone averages of the streamwise velocity component. (The intermittency factor at right is given for reference.)

BOXCAR INTEGRATORS are signal averagers designed primarily to extract repetitive waveforms from noise. In most cases, a command signal is available that triggers both the Boxcar and the occurrence of the waveform to be averaged. However, sufficient versatility has been designed into the instrument to permit the averaging of parameters for which periodicity cannot be imposed and is not inherently present, and for which no naturally occurring trigger signal exists.

The averaging of such aperiodic waveforms is usually referred to as 'conditional sampling' in a random process, and is one of the more novel uses of the instrument.

Examples of such random processes where conditional sampling is a useful technique are:

1. The outer edge of any free turbulent shear flow such as a boundary layer, jet, wake, etc., in which the flow field at a fixed point in space 'sees' two types of fluid – turbulent and non-turbulent – which sequentially alternate in a random fashion.
2. Clouds or gusts of wind in the atmosphere in which the average of a particular velocity component or the vapour content may be desired.
3. Transitional phenomena in fluid mechanics in which a laminar flow field erupts into turbulence in a completely random fashion.
4. Radioactive decay, in which case more details of the decay process may be desired directly after the emission of a particle from the nucleus.
5. Strong mass ejections away from a stationary solid boundary in a turbulent flow field, as found in reference 3.

All these phenomena have one characteristic in common; i.e., the events which are associated with the signal to be sampled occur completely at random.

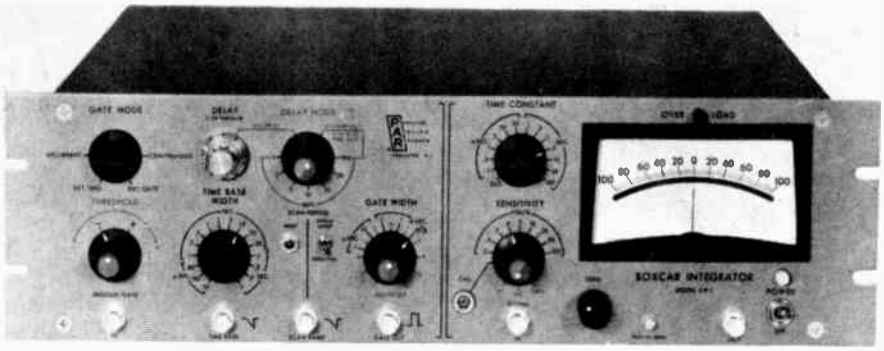
The underlying principle of conditional sampling in a random process is as follows. Assume the process under investigation is characterized by events occurring completely at random which are hidden in a background noise level. The signal containing the desired information may be associated with the events or with the period between the events. This signal may be continuous, i.e., receives contributions from both the events and the time interval between the events, or it may be discontinuous, i.e., receives contributions only during the events or the intervening periods. By using a detector to ascertain when an event has occurred, the signal can then be averaged during the events. In a similar manner, many other averages can be obtained, e.g., during the non-events, at a discrete time after the event occurs, etc. The experimental equipment and procedure will depend upon the particular application. Here a more detailed account will be given of example 1 above.

When a probe, such as a hot-wire anemometer, is placed in the outer region of a turbulent shear flow, the signal is strongly intermittent as parcels of turbulence, i.e., the events, and non-turbulent fluid sweep past the probe. This region of the flow field is very important in fluid mechanics because it is the area in which non-turbulent fluid is entrained into the turbulent flow. But conventional signal processing has been unable to provide insight into the details of this entrainment process.

By constructing a detector probe and associated circuitry to indicate when the probe is in a turbulent region or non-turbulent region, a detector signal can be obtained which is 1 when the detector probe is in the turbulent region and is 0 when in the non-turbulent region. With this detector signal, conditional averaging is possible with the aid of the Boxcar Integrator.

The detector signal is connected to the 'trigger/gate' input of the Boxcar Integrator and the signal to be sampled, q(t), is connected to the 'signal input' (see Figure 1). Note that the signal to be sampled can be any measurable flow variable, e.g., any of

electronics in Science



Boxcar Integrator manufactured by Princeton Applied Research.

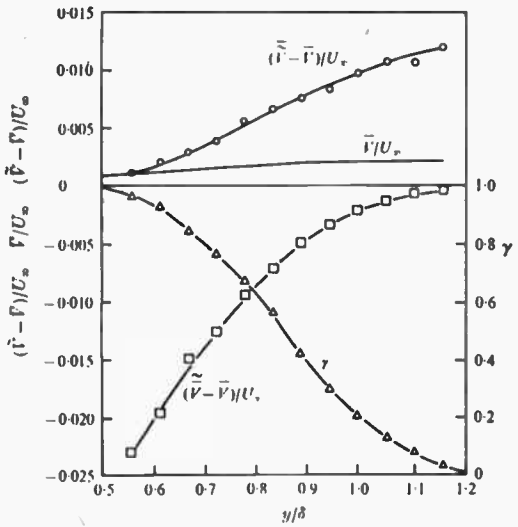


FIG. 3. Zone averages of the normal velocity component.

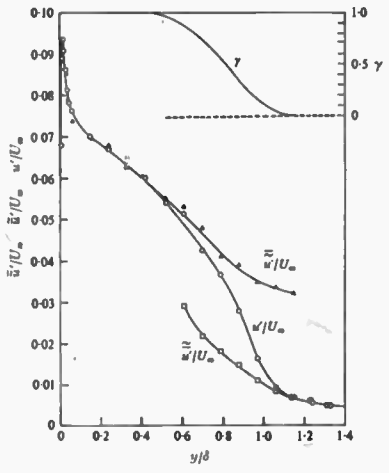


FIG. 4. Zone average intensities of the streamwise velocity fluctuations.

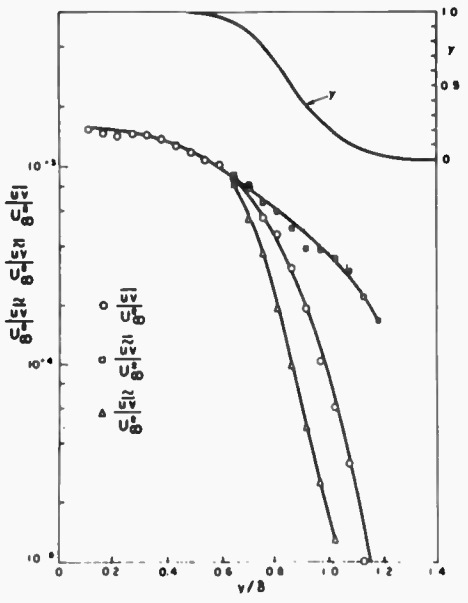


FIG. 5 (right). Zone averages of the tangential Reynolds Stress.

the three velocity components, the vorticity, velocity products, etc. With the 'gate mode' switch placed in the 'external gate' position and with a positive threshold, the Boxcar's output will rise asymptotically to the value of q averaged only in the turbulent regions if the locations of the signal probe and detector probe coincide. With a negative threshold the output of the Boxcar Integrator is the value of 1 obtained in the non-turbulent regions. The conditional average of the streamwise and normal velocity components in a turbulent boundary layer have been obtained in this manner and are given in Figures 2 and 3. Another use of this type of sampling is to obtain the localized rms values of the velocity fluctuations in the turbulent and non-turbulent regions, as shown in Figure 4. Furthermore, the velocity product, uv, which is important in the production of turbulence, can be conditionally averaged and is found in Figure 5 (from reference 2).

Other sampling modes are possible as well. For example, by placing the signal probe above the detector probe as shown in Figure 1, setting the 'gate mode' switch to 'external trigger' and with a positive threshold, a small variable duty gate is generated internally by the Boxcar Integrator every time an event occurs, i.e., the detector probe enters a turbulent region. Then, by traversing the signal probe above and below the detector probe and setting the gate width to be a small fraction of the time of an event, the value of q can be obtained at those instants of time when the detector probe enters the turbulent region. By merely reversing the polarity of the threshold, the same type of data can be obtained as the detector probe leaves the turbulent region.

Still another sampling mode is possible by using the 'scanning' feature of the Boxcar Integrator. In this operation the detector signal initiates a ramp function. At some delay time, τ, later, a variable width gate is generated. This variable width gate controls a switch into the integrating circuit such that the integration occurs only when the gate is 'on', i.e., the switch is closed. The time delay can be a fixed value, τ_o, or by using the "scanning delay" of the Boxcar Integrator, τ can be automatically increased from zero up to 100 minutes. For a fixed time delay, τ_o, the signal q(t) is sampled only during those periods when the gate is on. Thus, in the turbulent shear flow, averages can be obtained at some fixed time, τ_o, after the detector probe enters (or leaves) the turbulent regions. In the 'scanning delay' mode of operation, τ is automatically increased at a rate slow enough to provide ample integration time for each value of the time delay. The average value of q can then be obtained as a continuous function of the delay time after the detector probe enters the turbulent region.

Thus the Boxcar Integrator can and has been used in a random process. Its versatility not only allows the investigator to obtain better data concerning this type of process, but it provides the key for obtaining more details of a random process and paves the way for a more complete understanding of these natural phenomena.

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TV ON DISC

Since the earliest days of television, a simple way of recording TV programs has been sought. Indeed, as long ago as 1927 that great television pioneer, John Logie Baird successfully produced phonograph type recordings of his television signals.

In those days TV was a 30-line, 30 frames-per-second, non-interlaced system, and Baird used a 78 r/min disc for recording the picture; a second disc was used for the accompanying sound.

At that time the video bandwidth was in the order of 10-15 kHz. Present-day television requires a bandwidth of between 3 and 5 MHz – about 300 times greater.

Many factors combined to prevent satisfactory recording os such high frequencies and wide bandwidths directly onto regular LP-type discs.

First, the pickup would need a stylus of an impracticable miniature size, with a radius smaller than 40 microinches (.001mm.) in order to resolve the small wavelengths corresponding to the high frequencies of the system. Second, the mass of the stylus would certainly not be able to trace successfully the oscillations of the record grooves at rates up to several million times per second.

Some five years ago a team of inventors – Dr. Gerhard Dickopp, Edouard Schuller, Hans Joachim Klemp, Horst Redlich and Arthur Haddy, from AEG-Telefunken in Germany and Decca in England – started work on a phonograph type TV disc. Their efforts resulted in a revolutionary development – the Teldec (consortium owned by both companies) disc, which seems destined to become the video equivalent of the 33 1/3 -r/min LP hi-fi record.

Demonstrations were given for the first time in Berlin and London last summer and just recently in New York. Observers found black-and-white picture quality to be excellent, although occasionally there were noise streaks with some of the discs.

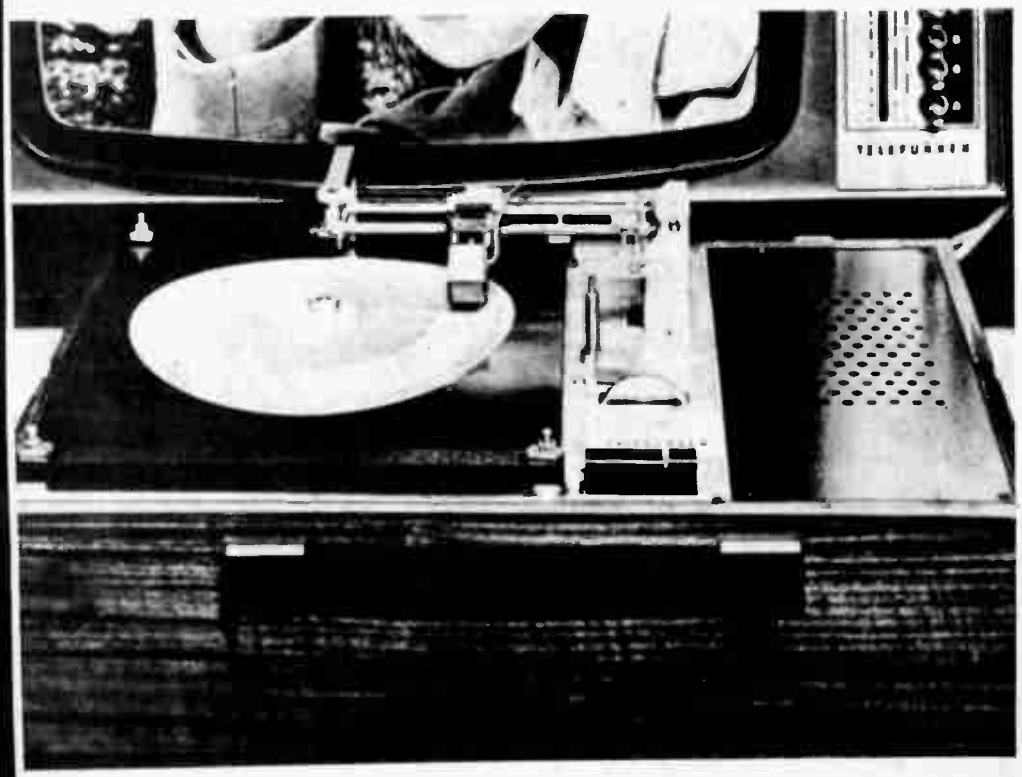
When the player is marketed, in about 18 months' time, it will probably sell for about $150 as a single player and $250 as an auto-changer. The manufacturing cost of records for one hour's playing time is estimated at between $2 and $3; retail prices will depend on the various markups and on the nature of the program material. For playback, the unit is connected by wire to the antenna terminals of a television receiver and the picture viewed by tuning to an unused channel.

Ultra-thin disc

Although it has been likened to the LP, the Teldec disc is notable for its many dissimilarities to present-day audio discs. In the first place it is very much thinner, being only one-millimetre thick, and is pressed from a sheet of PVC (Polyvinyl Chloride Thermoplastic material). In use it revolves once for every TV frame (two fields), at 1500 r/min for 50-Hz European television systems and at 1800 r/min for 60-Hz U.S. systems. The spacing between adjacent grooves on the disc is about 280 microinches (.007mm.) with a density of about 3500 grooves per inch (140 per mm.). The grooves on an LP are some 10 to 14 times wider than those are employed on the video disc.

The pickup is a pressure-sensitive piezo-ceramic unit instead of a velocity-sensitive cartridge, and it is moved across the disc surface by a positive mechanical drive – as opposed to the groove guiding the stylus, as on conventional records.

The groove modulation is hill-and-dale (up-and-down) instead of the lateral (side-to-side). The sound is



DIAGRAMS AT RIGHT:

Fig. 1. The mechanical assembly of the Teldec player. A motor drives a common shaft for rotation of the disc and also for moving the pickup assembly radially across disc surface. Fig. 2. Stylus tip in contact with the disc surface. The curved leading edge temporarily deforms the PVC surface. The pressure relief at the trailing edge of the stylus is transmitted to the piezoelectric ceramic element above.

LEFT: Protype of the video disc player recently demonstrated in U.S.

RIGHT: Both video and sound signals are in the extremely fine grooves of the video disc. The thin and flexible PVC foil used appears flimsy, but is actually quite tough and said to be able to withstand 1000 playings without damage. Disc is driven by a high-speed keyed center spindle; remainder floats on air cushion.

By AUBREY HARRIS – Chief Engineer, Electronic Systems, University of California, Santa Cruz.

Revolutionary disc may become the video equivalent of the long-playing hi-fi phonograph record

Reprinted from ELECTRONIC WORLD

carried on the same groove as the picture by pulse position modulation (PPM), which records the audio signals during the horizontal blanking portion of the video signal.

The video bandwidth is at present 3 MHz (black-and-white) with a signal-to-noise ratio of 40 db. It is expected there will be a colour version available within two years. The playing time is five minutes for a 9-inch disc and twelve minutes on a 12-inch disc.

The record discs themselves are produced very simply by speed press, using a metal matrix. The matrices are formed by an electroplating process (similar to that used in making phonograph records) from a master disc made on a master cutting recorder. The video input to this is from film produced by a flying-spot scanner.

The disc player

There is no actual turntable on the Teldec player; instead the disc is carried around at 25 to 30 revolutions per second by a central hub with a drive-pin device. The disc itself rotates on a cushion of air above a stationary platter. The airstream is produced in the machine and guided through cavities at the periphery of the hub (Fig. 1.). The air cushion produces a stabilizing effect on the disc foil, and the vertical disturbance at the surface of the latter is less than 0.002 in. (.050 mm.).

The drive motor, apart from turning the disc hub, also drives a traverse cable for moving the pickup assembly across the disc surface. A simple drum, cable and pulley arrangement is used to move the pickup by one groovespace dimension – 280 microinches (0.007 mm.) – for each revolution of the disc. Groove depth is between 20 and 40 microinches. Stop-motion effects can be produced by disabling the drive to the traverse pickup cable.

The pickup device is really the vital part of the whole system. The stylus itself is made of diamond or sapphire material and is rigidly connected to a piezoelectric-ceramic transducer. The electrical output of the transducer is taken from electrodes at its side and is in the order of 2mV.

An illustration of the stylus tip in contact with the disc surface is shown in Fig. 2. It will be seen that the tip is gently curved on its leading edge, so as not to damage the recorded surface, but it has a sharp, narrow, vertical trailing edge.

The diagram shows the stylus in contact with several complete cycles of the hill-and-dale recording and at first impression it is not at all clear how the groove information is detected.

The important point to remember is that the pickup is pressure-sensitive; the stylus compresses the several peaks under its leading edge. The stylus loading is relatively constant with respect to time but has an alternating component superimposed upon it, generated at the 'sharp' edge of the stylus as each of the peaks is relieved of pressure at the trailing edge of the stylus. It is this pressure change which is conveyed to the piezoelectric-ceramic unit and is then transformed into an electrical waveform.

The dimensions of the stylus itself are chosen so that no mechanical resonances appear within the frequency range of the unit, which would otherwise restrict its response. The size of the ceramic transducer is less than .008 in. (0.2 mm.) and the tracking force of the stylus is about 0.02 gram.

The pickup head is attached to a small tube by means of a flexible connecting layer, and the tube is coupled with damping material to the traverse drive mechanism (Fig. 3).

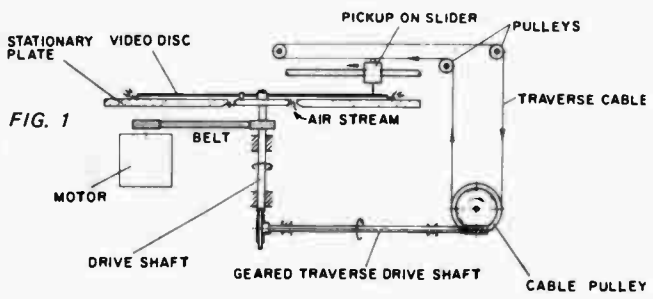


FIG. 1

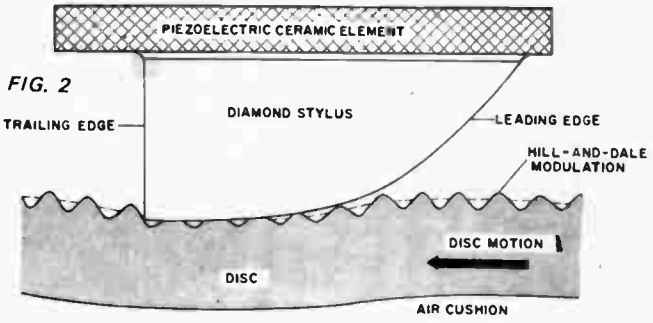
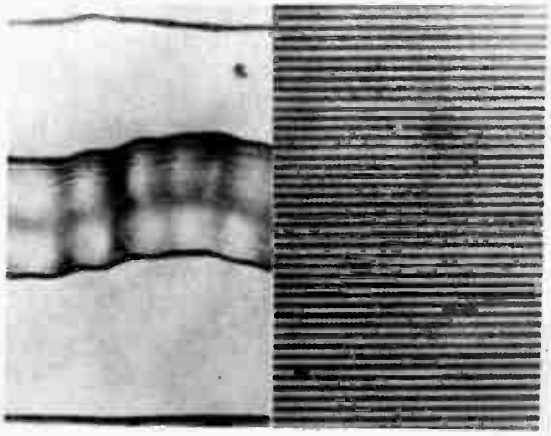


FIG. 2

RIGHT: Photomicrograph of grooves in standard long-play audio record (left) compared to much higher density grooves of video disc. Using vertical (hill-and-dale) recording, the video disc has between 3300 and 3800 grooves per inch while the conventional audio record may contain only about 250 to 350 grooves per inch.



TV ON DISC

In common with other wide-band modulation systems, Teldec uses FM signals for recording. This enables the bandwidth of some 16 octaves to be accomodated at an acceptable signal-to-noise ratio. It also means that all portions of the recorded waveform are limited to the same amplitude and thus the groove spacing can be held constant, with virtually zero clearance between adjacent walls.

With lateral-type disc recording there must be a relatively large clearance between adjacent grooves to allow large amplitudes to be accommodated or, alternatively, a variable groove-spacing technique adopted to allow greater spacing during high-amplitude parts of the recording. The constant groove-spacing also allows greater economy of recording medium usage because of the small 'land' (between-grooves) areas.

Teldec the winner?

The Teldec system is only one of several which are now available, or shortly will be, for playing television recordings. First there was the video tape recorder using magnetic tape of which there are now many versions, including both reel-to-reel and cassette types. The CBS Electronic Video Recorder (EVR) uses an optical film made by electronic beam recording and produced by a flying-spot scanner. RCA's Selecta Vision uses a holographic plastic film scanned by a vidicon for playback.

However, on the economic front, the Teldec device may well be the winner. The cost of the player unit is the lowest by far of any of those mentioned, as is also the price of the records. It is simple to use – much like a regular phonograph.

The disc also has many of the features of the other devices, such as stop motion. It is also claimed that the records are extremely wear-resistant and over 1000 playings can be made before the signal-to-noise ratio drops below 40 db. In addition, one advantage of the disc is that it can be made to start playing at any point in the whole recording and can be quickly moved to any other point – something that cannot be done easily with a tape or film system.

One characteristic of the Teldec system which it shares with EVR and Selecta Vision is that you cannot make your own recordings – you can only play factory-produced records. For making your own recordings, the video tape recorder is the only way at present.

It should also be noted that, as both the disc and the video tape recorder are waveform recorders, they are 'standard conscious'. That is to say, discs or tapes recorded at one television standard (e.g., the U.S. 525-line, 50 fields-per-second). This may not be much of a problem for the home video-recording enthusiast, but it could pose many problems in mass-production and distribution of educational and popular entertainment recordings.

Home entertainment and classroom instruction are obvious applications for the video disc; other uses are likely to be in vocational and sales training, advertising, and sales messages to both dealers and consumer. The disc may also find application in high-density storage of digital data for computer use, or storage of audio data alone for multichannel stereo records. ●

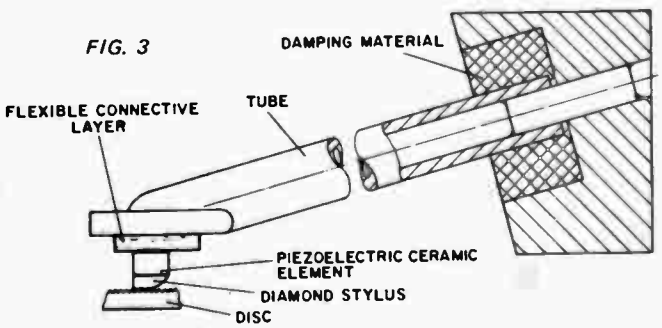
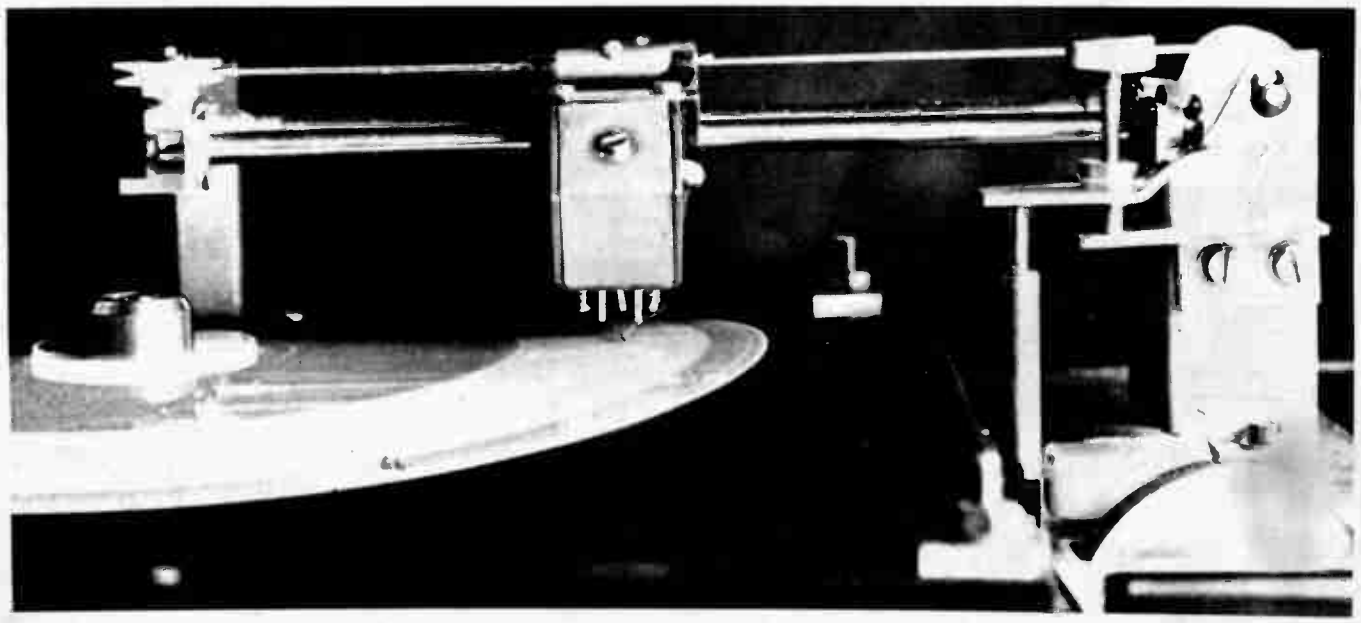
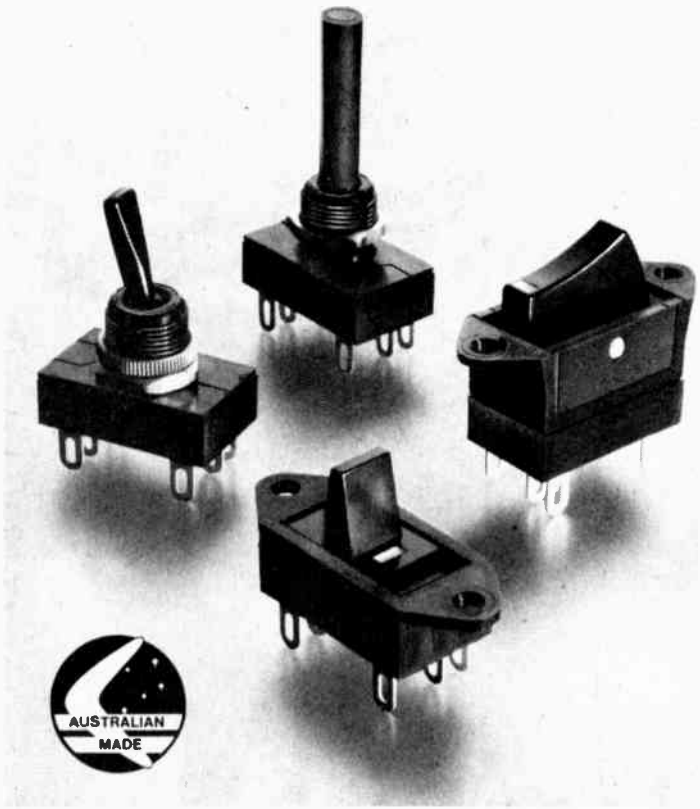


Fig.3. The pickup head assembly. The transducer is connected to the pick-up arm by means of an elastic coupling.

BELOW: Closeup of the pickup and slider arrangement used. A cable moves the assembly slowly along the radius of the disc. If the drive is disconnected, the stylus and transducer follow several grooves in the video disc, thereby repeating a small portion of the program.



Need a small mains switch?



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Terminals — solder lugs are standard. Quick connects will be available soon.

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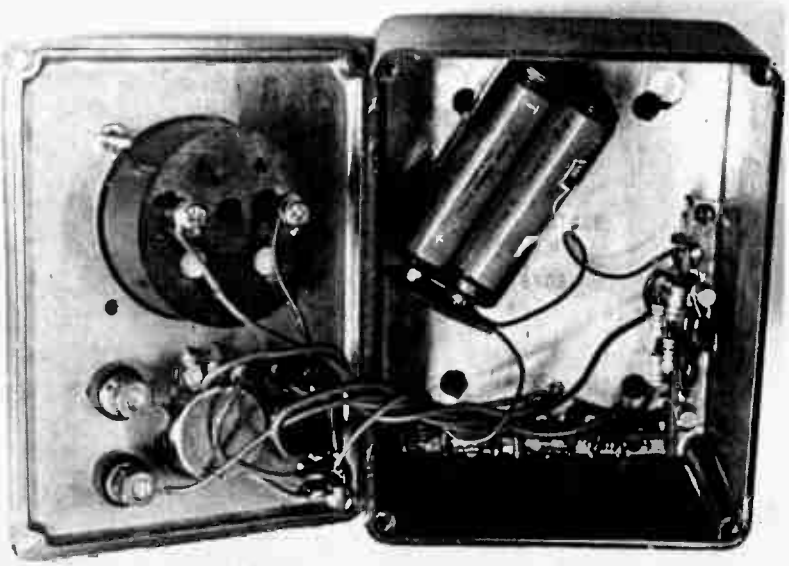
AD13

GREENER GRASS –ELECTRONICALLY

Details of prototype unit (layout is not critical).



ET PROJECT

Simple, inexpensive moisture meter tells you when the lawn needs watering – and when it's had enough

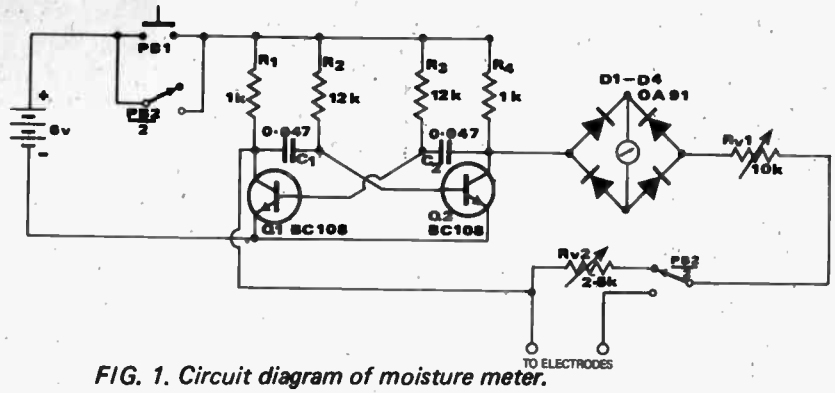


FIG. 1. Circuit diagram of moisture meter.

Grass doesn't require daily or even weekly watering. Nightly sprinkling is actually harmful – only the mosquitoes are fed.

For overdrinking damages plants as well as people: there is an optimum moisture content for each.

Grass lives on nutrients contained in the soil, and moisture is needed for dissolving these nutrients into a form that the roots can easily absorb.

Ideally these roots should be deeply extended. This can only be achieved by soaking the ground to a depth of at least five inches whenever the moisture content at root level falls below a certain minimum percentage.

The grass should never be watered lightly at frequent intervals. This encourages the roots to remain near the surface, where there are frequent changes in temperature and moisture content, and above the level of maximum nutrient concentration.

Moisture should be checked at root level

If the aim is to grow lush healthy grass, it is essential to know the soil moisture content at root level.

The meter described in this article tells you just this. It monitors soil moisture at root level and indicates when watering is required.

Change in resistance gives the clue

The resistance of soil varies with changes in its moisture content; thus, by measuring the soil resistance, we have a directly related measurement of soil moisture.

The device used to sense this change in resistance is simply a pair of bare copper wires, spaced a fixed distance apart. These are embedded in a block of plaster-of-paris which provides mechanical protection.

As the moisture content of the soil changes, the resistance between the two electrodes will vary.

In order to avoid electrode-polarising effects it is necessary to measure the inter-electrode resistance by using an alternating potential.

This is obtained from a free-running multivibrator (transistors Q1 and Q2). The alternating current from the transistor collectors is applied across the moisture electrodes and measured by a 0-1 milliamp meter connected across a full-wave diode bridge.

A 2.5K potentiometer is used as a dummy load to provide a battery and calibration check.

The circuit layout is not critical and may be assembled in any convenient form. We found that a die-cast aluminium box was ideal. Potentiometer RV1 must be externally accessible, potentiometer RV2 should be mounted internally.

The moisture sensor can be made in different forms. Main requirement is that it should have two electrodes, approximately 1½ inches long and spaced ¾ of an inch apart. One form of construction is shown in Fig. 2. The electrode structure should be encased in plaster-of-paris to provide mechanical protection. This will not affect efficiency, since plaster absorbs moisture as readily as the soil.

Installing the system

The moisture block is buried in the soil at lower root level (approx. 5" deep) and the leads connected to the meter.

The soil should now be thoroughly watered at a rate not exceeding one inch an hour, and the meter reading checked from time to time by depressing PB1. The meter reading will slowly increase until it levels off, indicating that the soil area of the block is saturated. Watering should be stopped at this point.

Now adjust potentiometer RV1 (whilst depressing PB1) to give full scale meter deflection. Release PB1 and depress PB2 – now adjust RV2 for full scale meter deflection. This latter setting will not require readjustment.

The calibration should be checked every time the meter is used. This is done by depressing PB2 and adjusting RV1 to full scale meter deflection.

The moisture reading is taken by depressing PB1 – full scale deflection indicates that the soil is saturated.

Watering is required only when the meter reading drops below 30% of full scale deflection. The period between waterings will vary with ambient temperature, humidity and rainfall but will rarely be less than a week – it may well exceed a month.

The meter unit may be mounted in a convenient place and wired permanently to the moisture sensing block. Alternatively, a number of moisture blocks may be used in different places and individually connected to the meter via a multi-way rotary switch – or each may be terminated in a non-corroding socket and checked from time to time by the now portable meter.

The system may be used to determine the watering requirements of all types of plants. The general principles outlined above apply to the majority of plants – that is, the sensing block should be buried at root level and the plant only watered when the moisture content of the soil falls below a certain level.

Try it – and just watch those cabbages grow!

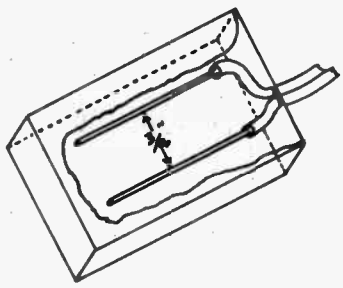
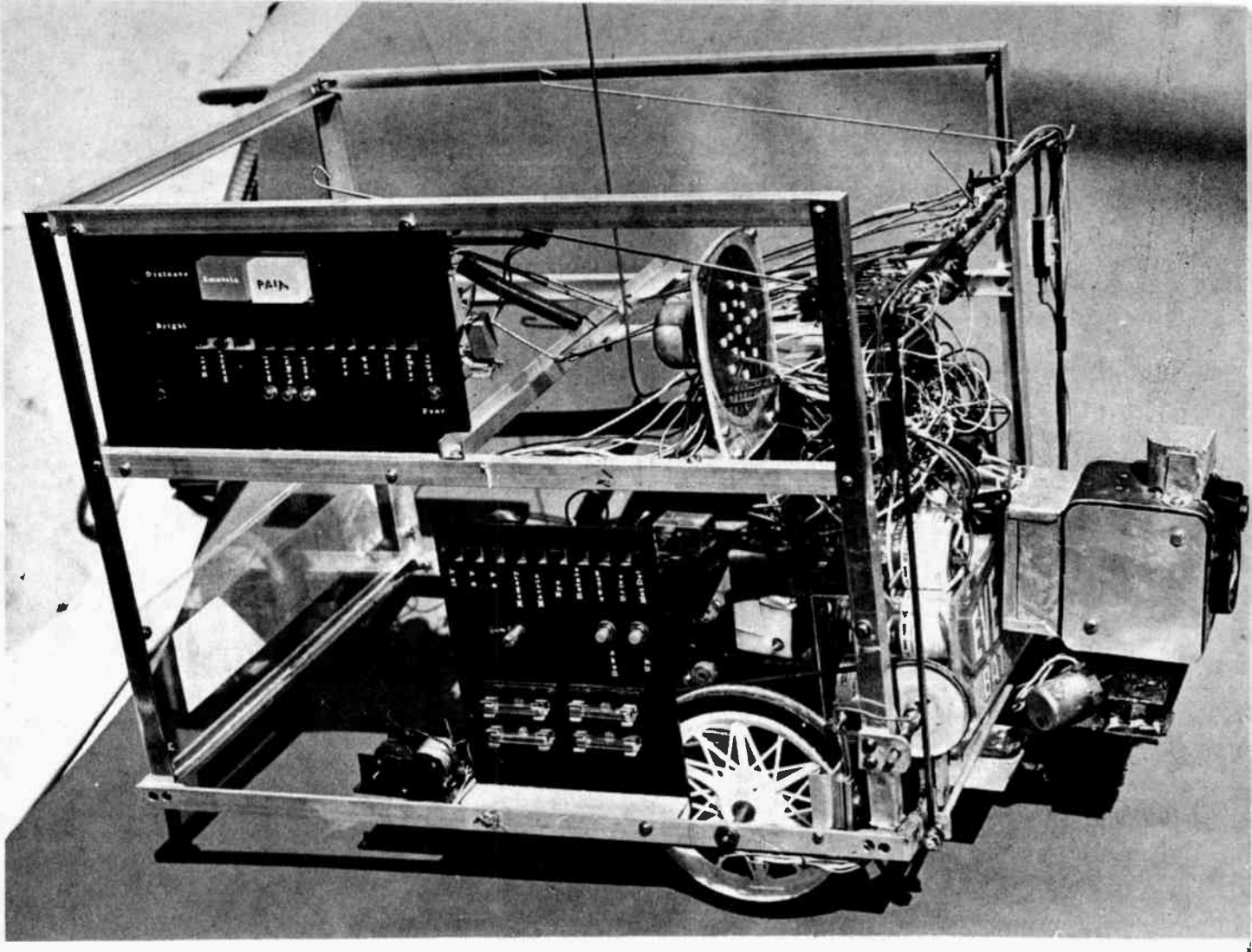


FIG. 2. Sensor block.

PARTS LIST

R1	*- 1K ½ watt resistor 5%*
R2	*- 12K ½ watt resistor 5%*
R3	*- 12K ½ watt resistor 5%*
R4	*- 1K ½ watt resistor 5%*
C1	*- 0.047 µf - 150V wk.*
C2	*- 0.047 µf - 150V wk.*
Q1	*- BC 108 or similar g.p. silicon n.p.n.*
Q2	*- BC 108 or similar g.p. silicon n.p.n.*
D1,2,3,4	*- OA91 or similar g.p. diodes*
RV1	*- 10K ½ watt linear potentiometer*
RV2	*- 2.5K ½watt linear potentiometer*
PB1	*- single-make push button*
PB2	*- 2 pole change over push button*



Meet MERV

IS it true that machines are incapable of intelligence, or can they in fact be endowed with reasoning power?'

One answer – in the form of an 82-page thesis – won the 1970 School Science Research prize for Cranbrook's 15-year-old Peter Vogel, then a fourth-form student at Cranbrook School, Sydney.

The thesis – 'An Investigation into Artificial Intelligence' – outlines Peter's reasoning and subsequent conclusions. It also describes in detail the design and construction of his 'mobile environmental response vehicle' (MERV) which, he suggests, qualifies as an 'intelligent machine'.

His thesis is predicated on definitions of 'instinct' and 'intelligence' which – characteristically – he formulated himself.

INSTINCT he defines as 'basic knowledge and motives possessed at birth, which is built on by the process of intelligence; instinct includes the method of carrying out intelligence.'

INTELLIGENCE, Peter says, 'is the process of drawing logical conclusions by correlating a particular experience with memory of previous experience and instinct.'

He qualifies these definitions by the admission that they are probably much too simplistic, but feels they are adequate for his purpose.

There are, he states, four basic requirements for an intelligent machine.

INPUT – a system for receiving data for processing.

MEMORY – some system for storing information and which can be altered readily.

LOGIC SYSTEM – capable of carrying out logical processes of intelligent reasoning.

OUTPUT – providing an external indication of the machine's intelligent activities.

MERV uses all four criteria for his life-purpose, which is 'self-preservation'. He roams about until he encounters an unknown object. He performs various tests on these objects and turns and moves away if the object is 'hostile'.

He incorporates an in-built

MERV stands for Mobile Environmental Response Vehicle. Its creator, Peter Vogel, built it to demonstrate his theory on artificial intelligence

LEFT: Function and cost, rather than aesthetics, determined MERV's final shape.

self-preserving 'instinct' plus the ability to acquire and store environmental knowledge which is used to 'preserve its life'. This ability Peter refers to as 'intelligence'.

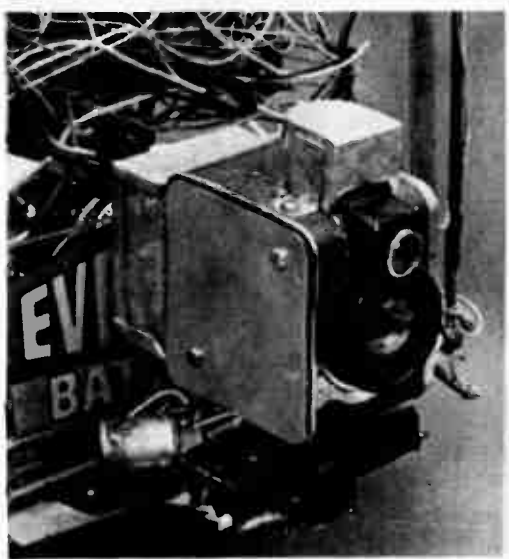
Having sensed the presence of an object, Merv goes through a predetermined sequence:

1. Stops at a 'safe' distance.
2. Tests to see what the object is.
3. Searches for memory of previously inflicted 'pain'.
4. Takes evasive action if deemed necessary, following intelligent reasoning.

A large number of sensors are required to effectively determine whether an object is 'safe' or 'hostile'. Peter describes a number of sensors, including:

a. An optical sensor which locates objects and stops Merv 10"-12" away.
b. A brightness detector.
c. Tone discriminators to determine whether objects are emitting 'hostile' sounds.
d. Heat sensors.
e. Sensors for determining hardness of objects.
f. Sensors for determining if objects are metallic or non-metallic.
g. Devices for determining size, smell, and taste.

Limited finances precluded the use of a large number of sensors — the builder realising that each additional sensor implied a doubling of the memory's bit capacity. It was necessary to compromise. The final choice was to test for brightness, test whether or not an object was metallic, and check on physical size.



ABOVE: Discarded box camera formed the basis of MERV's 'eye'. RIGHT: Manual programming panel gives visual indication of what MERV's sensors are registering and whether he is experiencing pain.

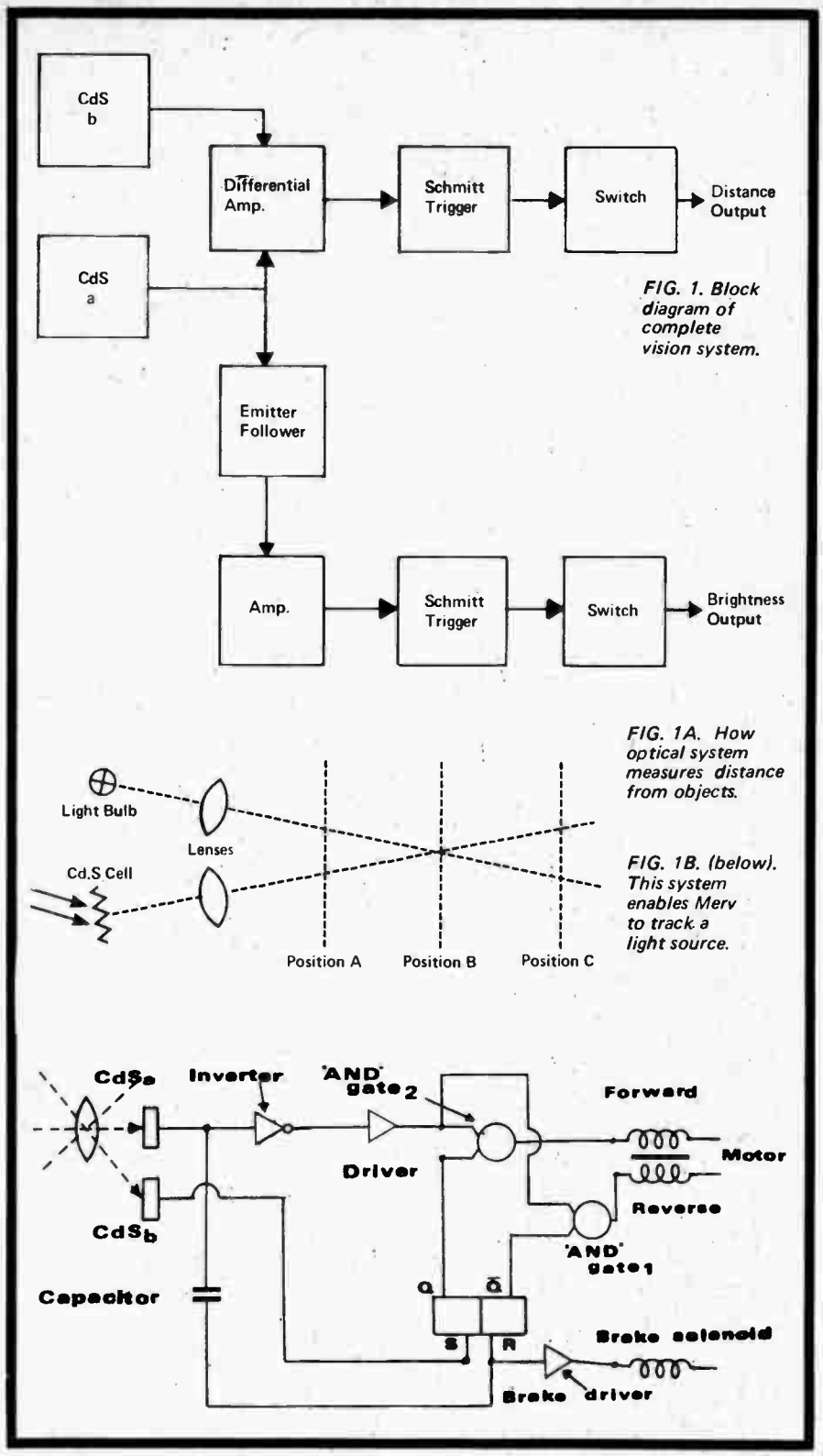
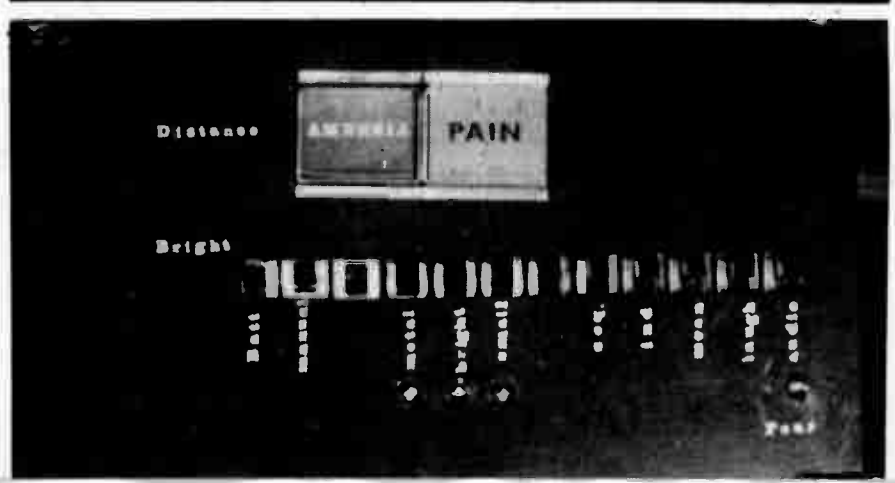


FIG. 1. Block diagram of complete vision system.

FIG. 1A. How optical system measures distance from objects.

FIG. 1B. (below). This system enables Merv to track a light source.



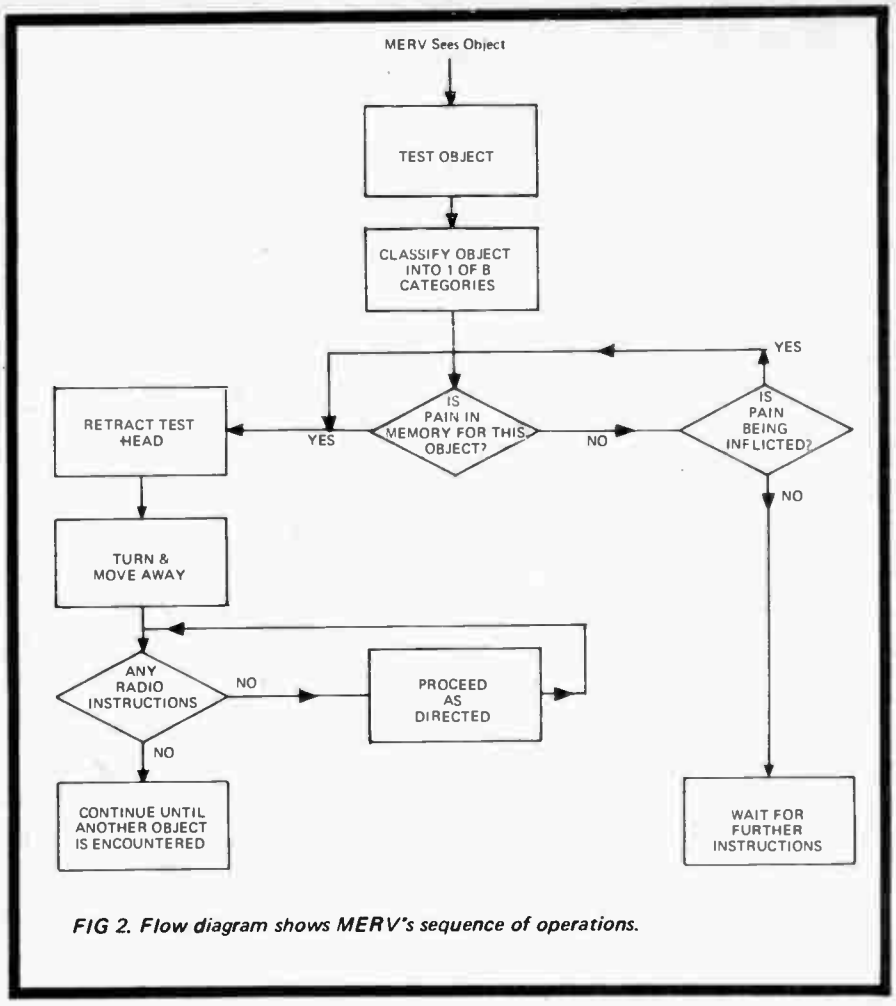


FIG 2. Flow diagram shows MERV's sequence of operations.

WHAT MERV IS

MERV consists of an aluminium-angle frame mounted on three wheels – two driven, and a third undriven and freely pivoting. The two front wheels are differentially powered by a single electric motor and steered by electromagnetically braking one or the other wheel. Direction is controlled via a dual-tone radio link (permission having first been obtained from the PMG).

The robot's vision has two functions. The system stops MERV at a predetermined distance from objects in its path and also determines the amount of light reflected from the object. The system is shown in Fig 1.

Motor-driven feelers sense the size of objects – these feelers fold in the middle, allowing MERV to turn and retreat if a response is 'unfavourable'. Two feelers are used, each free to move independently. Series connected switches sense the vertical obstruction of either feeler.

The inductance of a coil is changed if metal is brought into the immediate vicinity, and this principle is exploited in the 'metal' detecting circuit. Ceramic resonators were used in the final design.

A six-input diode-matrix (three direct inputs – three inverting) combines the signals from the three sensors and produces one out of the eight possible outputs – i.e., it recognises any combination of the three inputs. The output from the decoding matrix is fed to memory circuits.

Eight separate memory circuits are used – each basically consisting of an RS flip-flop. The total memory has the following characteristics:

a. Each memory circuit has an element which stays in a prescribed condition (SET) after triggering.

b. When a PAIN (pre-determined instinct) button is pressed, one element is switched into a 'pain-set' condition. The seven remaining elements remain in the condition they were in before the 'pain' button was pressed.

c. All memory elements can be cleared by pressing an 'amnesia' button.

MERV's instinct consists of circuitry which ensures that his approach to a problem-situation follows a predetermined pattern. Nothing short of a soldering iron can change it. 'This', says Peter, 'is analogous to human instinct – it is present at birth and does not change without external interference such as brain surgery".

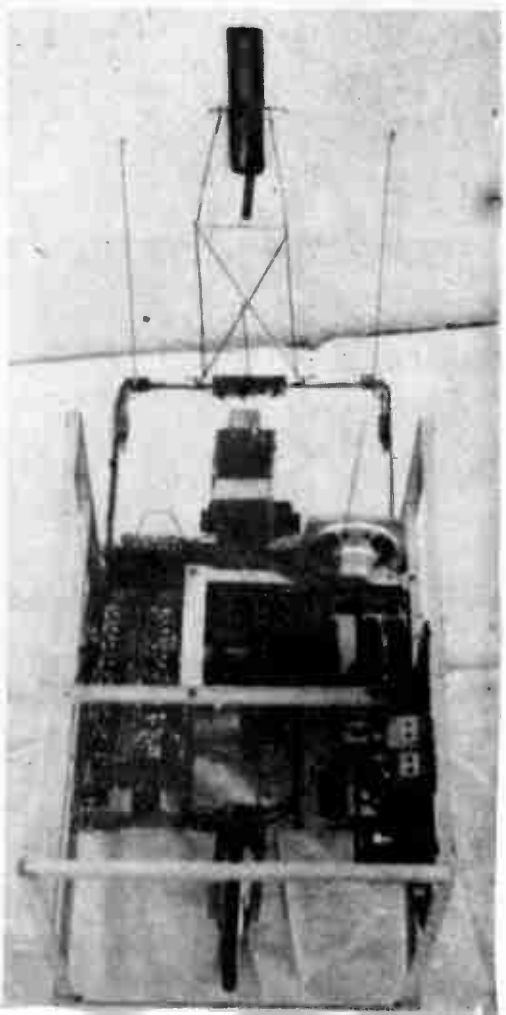
WHAT MERV DOES

The robot's predetermined behavioural pattern is shown diagramatically in Fig. 2 (a three-stage binary counter ensures that the correct sequence is followed). Starting at the top, MERV works his way down, carrying out the operations represented by the squares and making the decisions represented by the diamonds. All decisions are of a Yes/No nature and are made by standard logic gates.

MERV responds to 'hostile' objects by turning and moving away – the results of his actions are also expressed audibly. As he is controlled by the fear of pain and the pursuit of pleasure (pleasure being the absence of pain!), MERV's audible response is either a moan or a laugh. Both are generated electronically. The moan is a descending tone produced by a unijunction/transistor combination. The laugh response is produced by a similar circuit and consists of a descending tone modulated at 10Hz.

Individual steady tones are also used. These report the result of MERV's testing for size, composition and brightness.

Manual programming allows a 'pain' signal to be placed in a specific



Feelers extended, MERV tests a wall which he is approaching.

memory location before MERV tests an object. It is thus possible to determine which objects MERV fears before actual testing.

MERV can be directed to an object via the radio link or allowed to wander around until an object is encountered.

The memory circuits may be programmed to experience 'pain' when certain objects are evaluated, or — if power is momentarily disconnected — 'pain' signals may be locked into the memory in a quasi-random fashion.

In one experiment 'pain' was externally inflicted when MERV examined the following objects:

a. Black wooden box.
b. Brick.
c. Small white metal garbage can.
d. Large black metal box.
e. Upright broom.
f. Black toy car.
g. White four gallon drum.
h. Half-gallon plastic detergent bottle.

After programming to fear these objects, MERV reported on the following:

a. Chair — reported as a black wooden box.
b. Light-coloured book on end — reported as upright broom.
c. Family cat — no decision as cat was singularly unco-operative!
d. Electric iron — reported as garbage can.
e. Gallon bottle of sulphuric — as detergent bottle.
f. Hammer — as toy car.

Are these intelligent results?

'At first sight', says Peter, 'the answer must be no. But', he maintains, 'although the decisions are inaccurate, they are intelligent.

'Consider what a human would do under similar circumstances. Suppose he has never seen a bottle before. Give him a bottle of detergent and tell him what it is. He notes its important characteristics and stores them in his memory. The data will probably include:

Detergent bottle —
Light colour.
Fairly small.
Narrower at top than bottom.
Room temperature.
Not heavy.
Removable top.
Liquid inside.'

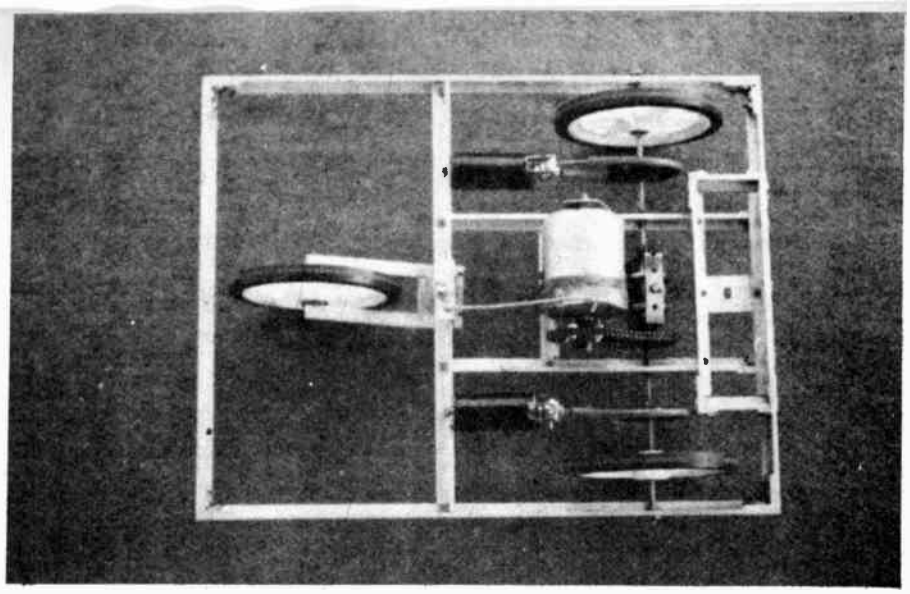
'Now give this person a bottle of sulphuric acid to evaluate. He notices qualities identical to the detergent bottle and, using his intelligence, draws the conclusion that this also is a bottle of detergent. If he remembered how the detergent smells, he would conclude otherwise — but within the capacity of his senses he has made an intelligent albeit a wrong decision".

Peter insists that, although MERV has limited discriminating ability, he does draw intelligent conclusions. 'He draws conclusions about what an object is by instinct — he is wired to do this — then he correlates this conclusion with previous experience by referring to his memory, to decide whether he is likely to receive pain. The conclusion may not always be a correct one, but it is the logical one consistent with the capacity of his senses and memory.

'It can be argued that MERV's operation is not similar to a human's process of intelligence in that MERV is wired to follow a fixed pattern, whereas a human "wires himself". But is this the case? Is it not true that humans are also wired to follow a certain pattern over which the individual has no control?'

Peter's argument is that humans, like MERV, are built according to a strict plan, which has provision for a section specifically designed to be used for memory and logic and which together make intelligence possible. The only important difference between MERV and the human, intelligence-wise, is the ratio between intelligence and instinct. 'MERV is governed by instinct much more than a human is because a human's intelligence is much more comprehensive than MERV's,' says Peter.

'The linking factors on MERV's intelligence are the amount of data available for him to work with and the limited capacity of his memory and logic circuitry. However, I see no reason why a machine as intelligent as a human could not be made, providing it has sufficient memory and its electronics are able to handle the amount of data stored in it.'



MERV's chassis, showing drive, steering and braking mechanisms.

BEHAVIOURAL SCIENTIST JAN VERNON COMMENTS ON MERV'S 'INTELLIGENCE'

Is it possible for computing machines to think?

No — if one defines thinking as an activity peculiarly and exclusively human. Any such behaviour in machines therefore would have to be called 'thinking-like' behaviour.

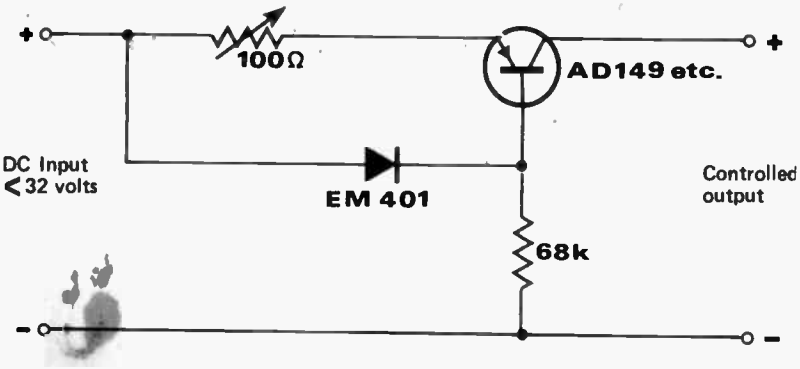
No — if one postulates that there is something in the essence of thinking which is inscrutable, mysterious or mystical.

These negative answers are regarded by many behavioural scientists as 'unscientific'. Edward Fergenbaum and Julian Feldman, of Berkeley, say the question is to be answered by experiment and observation, comparing the behaviour of the machine with that behaviour of human beings to which the term is generally applied. Negative answers they regard as 'unscientifically dogmatic'. Their goal of artificial intelligence research is 'to construct computer programmes which exhibit behaviour that we call "intelligent behaviour" when we observe it in human beings.'

Research is all-important — Paul Armer (head of RAND Corporation's Computer Science Dept.) points out that there exists a continuum of intelligent behaviour, and the question of how far we can push machines out along that continuum is to be answered by research, not dogma.

Armer goes on to say that 'there is a strong personal factor in the attitude of many negativists: to concede that machines can exhibit intelligence is to admit that man has a rival in an area previously held to be within the sole province of man.'

It must always be remembered, in any meaningful comparison of human/machine intelligence, that very little is known about human intelligence. At the moment our knowledge of learning mechanisms for problem-solving is rudimentary. Marvin Minsky states: 'You regard an action as intelligent until you understand it. In explaining you explain away.' ●



SIMPLE, EFFECTIVE CURRENT LIMITER

CURRENT LIMITING UNIT PROTECTS BOTH EXPERIMENTAL CIRCUITS AND POWER SUPPLIES

'The current-handling capability of electronic components to which power has been accidentally connected will be inversely proportional to the current applied. The annihilated components will invariably be the most expensive or irreplaceable in any given circuit'. — Murphy's Law of Selective Error.

Overloaded semiconductors can fail in a few micro-seconds — frequently before protective fuses can open the power circuit. Experimenters will be only too well aware of this heartsinking phenomenon.

These accidents can be greatly reduced.

ELECTRONICS TODAY'S simple and effective unit limits current input to any pre-set level.

The unit is versatile. It may be used with any dc supply up to 32 volts and, using the components shown in Fig. 1, provides controlled current — limiting from a minimum of ten milliamps to a maximum of two amps.

Construction is simple. In our prototype unit a diecast aluminium case provided adequate heat sinkage for the power transistor. The remaining components were housed internally. The layout is not at all critical and any method of construction may be used, providing an adequate heat sink is supplied for the series transistor.

The series transistor may be any germanium pnp unit which can handle the required maximum current: DI *must* be a silicon diode.

A 100-ohm potentiometer provides steplessly variable adjustment of the controlled output current.

In operation the unit is connected to a dc supply of the required voltage. A 0-5 Amp meter is shunted across the output terminals, and the safe operating current of the circuit to be tested is ascertained. Potentiometer R1 is adjusted until the ammeter reads the maximum current permissible.

The unit is now ready for use. The ammeter is disconnected and the circuit to be tested is connected to the unit's output terminals. Current flow through the circuit is automatically limited to the level preset by R1.

Both power supply and the circuit under test are protected and even a total short-circuit across the output terminals of the current-limiting unit will not cause the unit to exceed its set limits.

Bear in mind that you can never beat one of Murphy's Laws. But it's nice to break even sometimes!

PARTS LIST

1 germanium power transistor — 2N2869, AD149, AT1138A or similar.
1 silicon diode — EM401, AD4001 or similar.
1 25-ohm 5-watt wire wound potentiometer.
1 68K ½watt resistor, 10% tolerance.
1 8- or 10-lug tagstrip.
2 red insulated binding posts.
2 black insulated binding posts.
1 knob for potentiometer.
Sundry screws, nuts, connecting wire, etc.
1 heat sink — diecast aluminium case is a suitable form of construction.

ET PROJECT

WHO STOLE

Why those bass notes drop out of hearing when you turn down the volume. Jan Vernon, B.A., explains the Fletcher–Munsen effect.

HI–FI salesmen everywhere should honour the names of Messrs. Fletcher and Munsen – and their employers, the Bell Telephone Company.

These two engineers were the first to explain where all the bass goes to when the volume is turned down.

'Actually', they said, 'it doesn't go anywhere – it's right there all the time. You just can't hear it.'

They said that it's a physiological thing – and short of a long-term reliance on Darwin's theory of evolution, or linear physiological progressions, there's not much to be done. Unless, of course, you turn up the bass and treble boost.

But, of course, that's anathema.

Forty-one years have passed since the Fletcher-Munsen paper was published, but to most hi-philes they might never have been. In they come – amplifier under one arm, response curve under the other, bass and treble padlocked precisely at mid-position, indignation everywhere.

Just try to explain that the bass disappears precisely BECAUSE the amplifier has a flat response. They think you're out of your mind.

Yet that's what happens.

In fact, if the sound level is reduced to that of a softly-playing quartet, the loss of bass will approach 30 db – it will be inaudible.

The effect is shown graphically in Fig. 1. The curves show the sound intensities required to produce equal loudness at various sound levels. They illustrate the need to boost bass frequencies substantially, and to boost the treble to a lesser extent, when listening at reduced volume levels. If this is not done, bass and treble will appear to be lost during replay.

The knowledgable hi-fi purist is aware of all this. He knows that, as he reduces the volume, the bass and treble will decrease at a greater apparent rate.

This, he insists, is how it should be.

He points out that, as one moves from the front of a concert hall to the rear, the same effect will be apparent. The contra-bassoons and double basses will lose their fullness – and whatever happened to the triangle?

The argument seems reasonable enough. But the difference in sound levels throughout a concert hall is only a few db – even at the back it's still quite loud.

In the home it's a different matter. Sometimes one reproduces music at concert-hall levels – which typically cover a dynamic range of 40-100 db – at other times one prefers music at much lower levels. The range of preference is certainly greater than one would ever experience while moving around a concert hall.

The purist insists that, if one is philistinic enough to play music at 'unnaturally' low levels, then the loss of bass and treble is exactly as it would sound if it were heard approaching a concert hall some yards away – and that, he insists, is how you SHOULD hear it.

But most people listen to music at low sound levels not because they wish to experience the Myer Bowl from half-a-mile away, but because they just want a pleasurable audio experience at a soft level. It sounds a damn sight better if the bass and treble are still there.

There are two ways of achieving this – either with interconnected tone and volume controls (electrically or mechanically) or physically, by turning up the bass and treble controls when the volume is reduced.

Some amplifiers do, in fact, have 'loudness' controls which correct for the 'Fletcher-Munsen' effect – but these are regarded by purists with the same distaste as Graham Kerr would exhibit when contemplating a railway sandwich.

One eminent writer described them as "irrelevant' – 'unrelated to musical reproduction' – pseudo-scientific. He stopped short of insisting that, to appreciate Shostakovich, you must recreate the siege of Leningrad. Just.

Me? – I just wind up the bass. ●

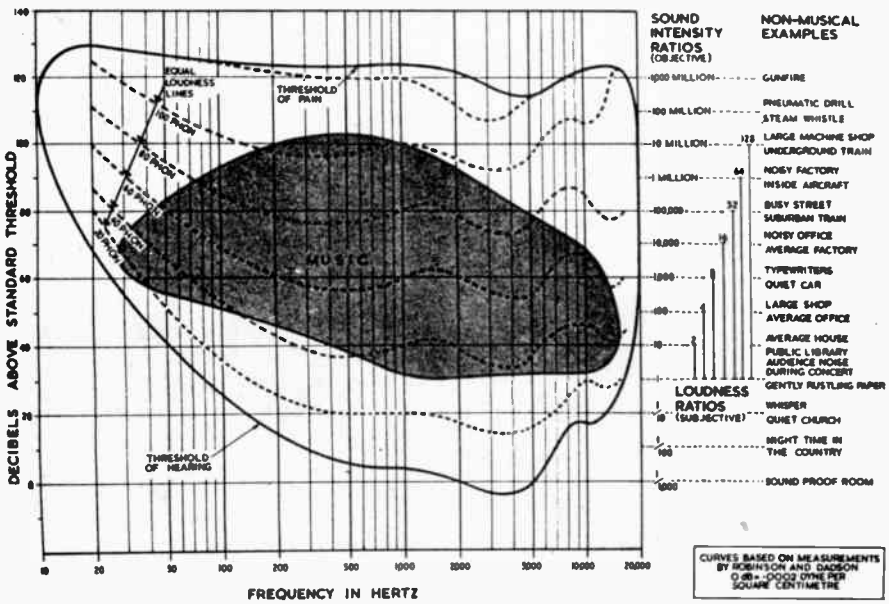
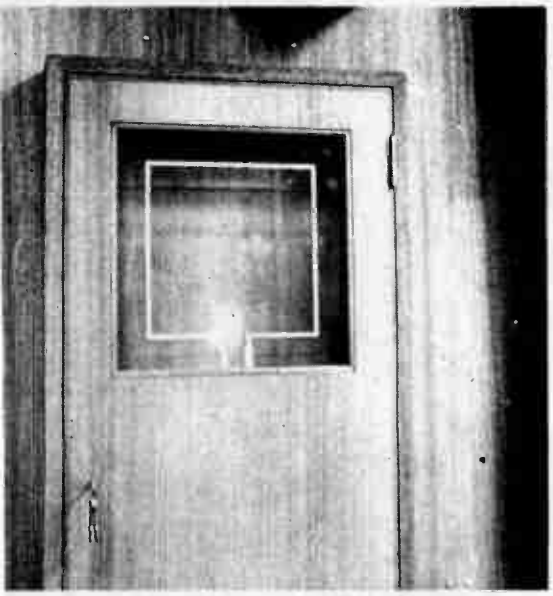


FIG. 1. Graph shows sound intensities required to produce equal loudness at various sound levels. Note the need to boost low frequencies when listening at reduced volume.

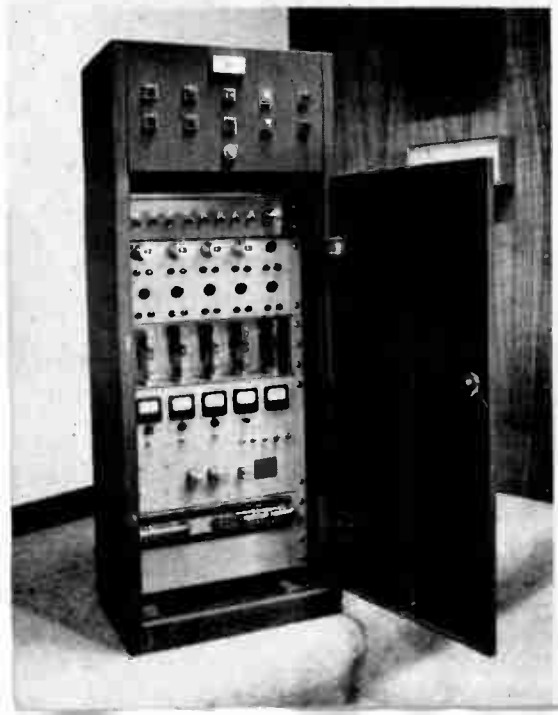

THE BASS?

ELECTRONIC



Metallic tape on this window is part of series loop around complete protected area.

Modern detection devices can see, hear, smell, sense an intruder — what chance has a burglar got when the full array of electronic gadgetry is used against him?



Multichannel uhf Doppler system is intended for industrial use.

A city's crime rate may rise dramatically when its population exceeds two and a half million. Recent studies have shown this to be true of cities around the world.

Major crimes will be organised with skill and enterprise which would astonish many legitimate businessmen. Strangers will no longer be recognised as such. It becomes easy for a man to hide.

There is little doubt that our major Australian cities will experience this phenomenon. In Sydney burglary has already increased to the extent that many insurers will no longer cover homes or business premises unless alarm systems are installed.

EQUIPMENT SHOULD MATCH THE RISK

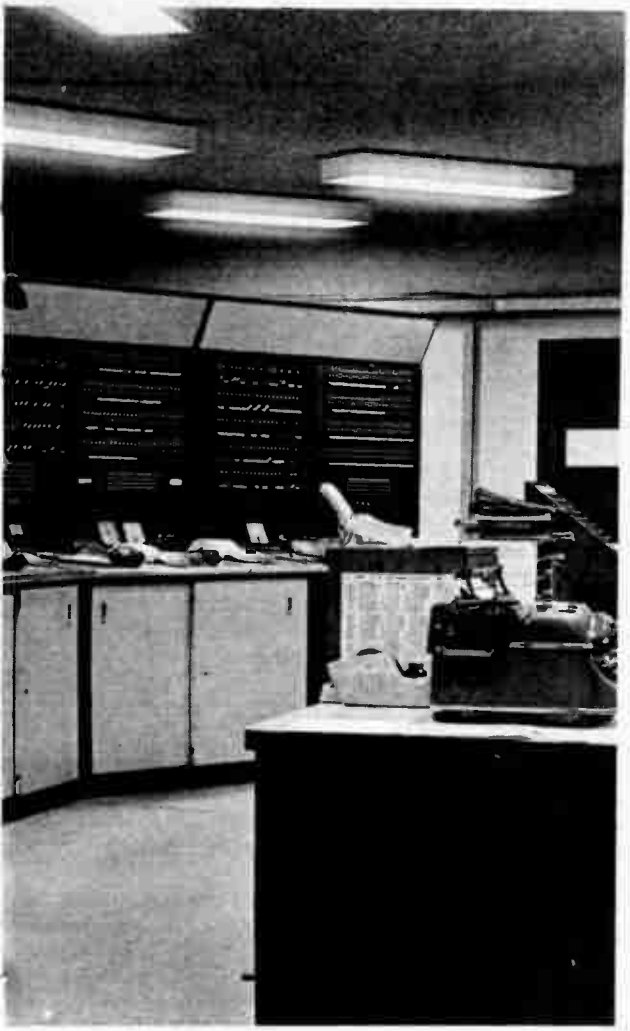
The protection required from an alarm must be related to the risk involved. An intruder alarm suitable for a suburban grocery store would not be adequate for a city jeweller. The jeweller's system would not suit the Reserve Bank.

It's very much a matter of 'horses for courses' — and a wide variety of 'horses' are available from the security industry.

IN THE BEGINNING . . .

The first electrically operated alarms were simple. 'Normally closed' switches were fitted to doors and windows and connected in parallel to a bell and battery. The switches were held 'open' by the closed doors and

WATCHDOGS



LEFT: One of half-a-dozen operators who keep tab on several thousand customers in central bureau of Electric Signals Pty. Ltd., Sydney — Australia's largest security organisation.

windows. If any door or window was opened, its associated switch closed and completed the bell circuit.

The system had failings. Switch contacts tarnished, wires broke, dry joints were not detected, burglars traced and severed leads.

To overcome these problems the 'closed loop' system was devised. A series loop was formed around the building. Metallic tape was glued to areas of fixed glass, and 'normally open' switches held in the 'closed' postiion by doors and windows. A small current circulated through the loop and held a relay in its closed position. If an intruder broke a window or opened a door, or if a break occurred anywhere in the series loop, the relay opened and change-over contacts applied power to the alarm bell.

The system is relatively cheap and simple. It is still commonly used. Providing it is properly engineered and installed, it provides adequate protection for houses and low-risk to medium-risk business premises.

Closed loop protection may not be sufficient if the guarded premises contain 'high-risk' goods. A truly professional criminal will locate and tape down micro-switches. He will detect magnetic reed switches by a pocket compass and disable them with second magnets carried for the purpose. Tape loops will be bridged across by jumper leads, and so on. In extreme cases he will not open any doors or windows. Entry will be made via floors or roofs and passage between rooms effected by smashing holes through adjoining walls.

SOPHISTICATED EQUIPMENT WILL DETER THE PROFESSIONAL

Fortunately the security industry keeps several jumps ahead, and systems are available to detect the most knowledgable and determined of criminals.

The arsenal includes phase-locked infra-red beams, ultrasonic and micro-wave movement detectors, proximity alarms, strain gauge bridges sensitive to the weight of one cigarette packet on a warehouse shelf, footstep detectors and closed-circuit television with pattern recognition facilities. Systems more sensitive than a cage of uptight geese — and less easy to tamper with.

All are tamper-proof to the extent that a thorough knowledge of their operating principle will be of no

ELECTRONIC WATCHDOGS

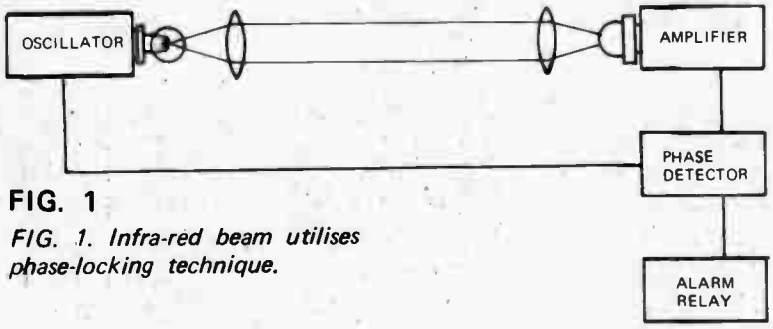


FIG. 1

FIG. 1. Infra-red beam utilises phase-locking technique.

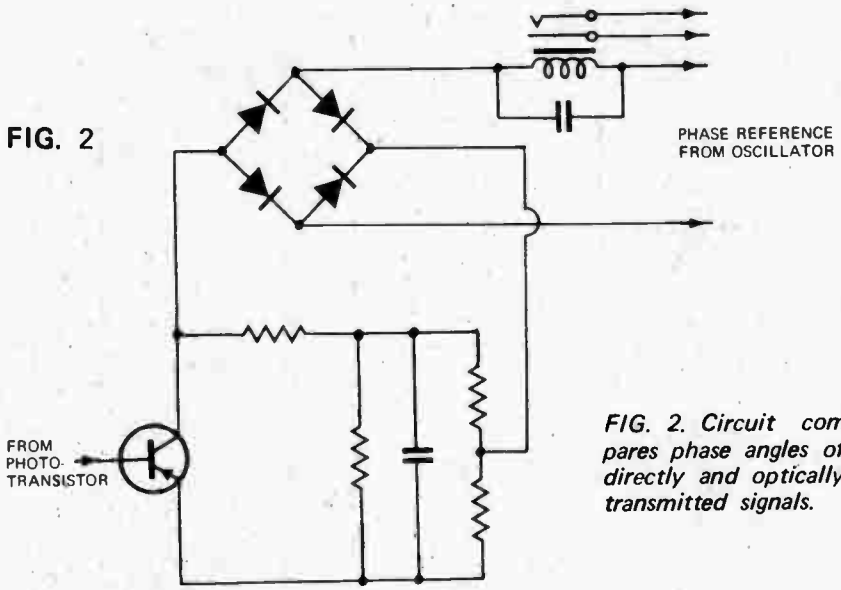


FIG. 2

FIG. 2. Circuit compares phase angles of directly and optically transmitted signals.

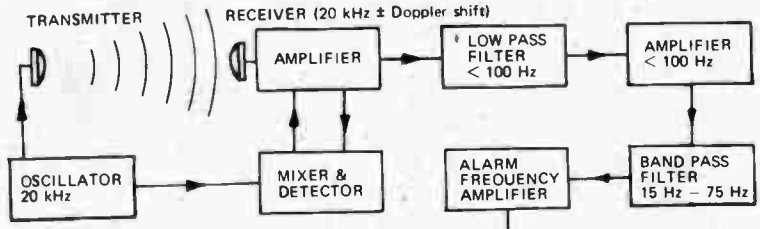


FIG. 3

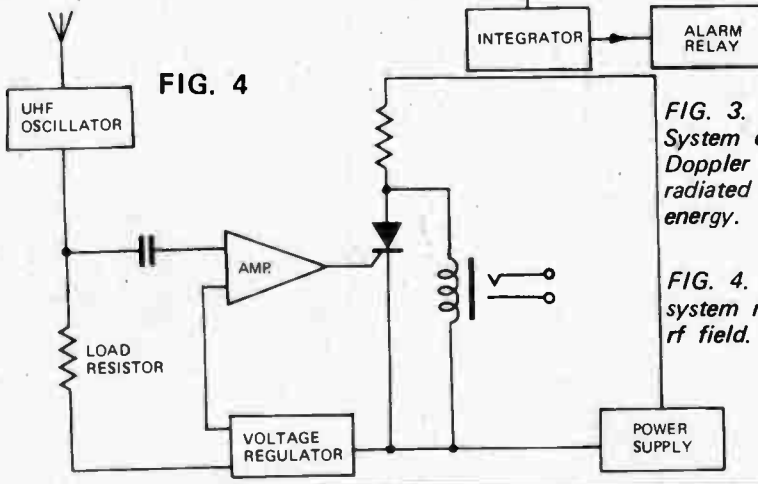


FIG. 4

FIG. 3. (above). System detects Doppler shift of radiated acoustic energy.

FIG. 4. UHF system monitors rf field.

assistance to a criminal. If anything it will deter him.

PROTECTION OF LARGE AREAS

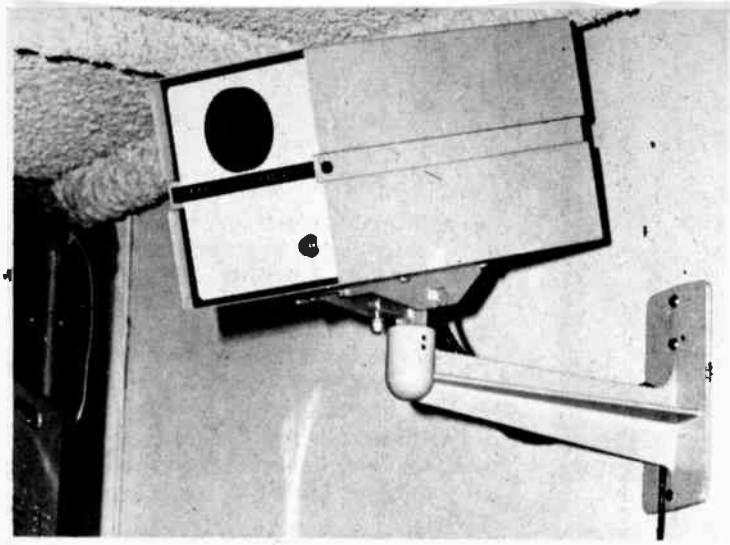
Protection of airfields and other large exposed areas is a difficult problem. An ingenious system developed by an American company uses two plastic hoses filled with glycerine and water, spaced a few feet apart and buried beneath the surface. Pressure transducers are attached to one end of each hose and the transducer outputs connected to a differential amplifier. A person walking towards the line of hoses will cause pressure fluctuations in the hoses, and of greater magnitude in the nearer hose. The difference signal will be amplified and caused to operate an alarm. Fluctuations caused by rain or thunder will cause equal pressures in the hoses and no output will be produced by the differential amplifier.

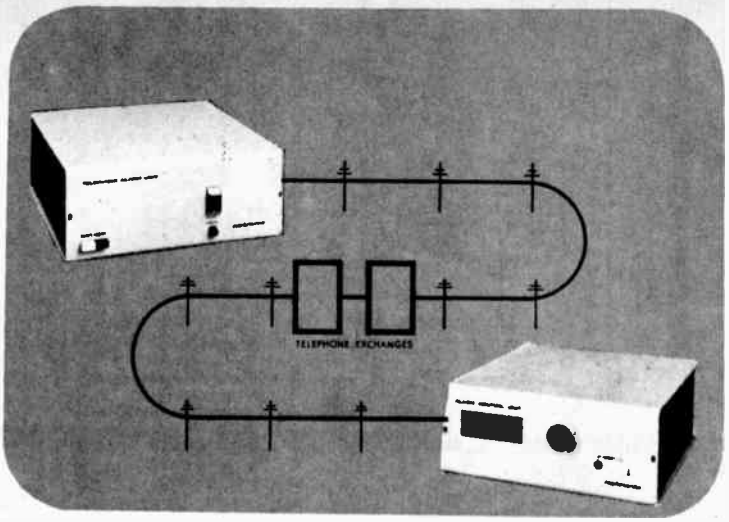
This system is often installed between two lines of perimeter fencing and will thus detect only people who have already scaled the first fence.

PERIMETER FENCES

Perimeter fences may be protected by photo-electric, or strain gauge systems. Photo-electric systems are described later on in this article.

A strain gauge is a transducer which provides a change in resistance when subject to mechanical strain. The gauge is simply a length of resistance wire glued onto backing material. Signals are obtained by bonding one gauge onto a section where strain can be expected (e.g., a fence upright) and a second identical gauge as close as possible to the first but in a position where no strain will be experienced. The first gauge will respond to all strain-producing signals — temperature, humidity, mechanical





LEFT: Innocent-looking dome is transducer of ultrasonic alarm system. ABOVE: Automatic camera, used mainly in banks.

Triggered by an intruder, alarm unit (left) automatically contacts control unit (right) via normal phone network.

loading – the second gauge is 'backed off' against the first and all variations except the required signal are cancelled out.

The gauges and appropriate resistances are connected in a Wheatstone bridge. An intruder climbing the fence will vary the resistance of one strain gauge, unbalance the bridge and thus cause an alarm condition.

The strain gauge bridge can be used in many other security applications and will be featured in a forthcoming 'Electronics Today' constructional article.

PHOTO–ELECTRIC BEAMS

One of the simplest electronic alarms is the photo-cell and associated light source. It is frequently used as a door monitor in small shops. With the light source covered by an infra-red filter the system can be used as a simple intruder alarm.

In its basic form the photo-electric beam can be disabled by shining a light onto the photo-cell. To overcome this, the majority of beams used in security applications use a modulating technique in which the light beam is chopped electronically or by a motor-driven vane. A band-pass filter in the receiver passes only the modulated signal.

PHASE–LOCKED BEAMS

A refinement of this technique is the phase-locked modulated beam. This is shown schematically in Fig I.

In this system a transistor oscillator modulates the filament of a tungsten lamp at a frequency slightly lower than the 50 Hz or 60Hz mains supply. supply.

An electrical reference of phase is supplied to a phase-sensitive detector in the receiver – Fig II. This circuit compares the relative phases of the reference signal and the modulated infra-red beam and holds the alarm relay closed whilst the two signals are in phase. If the beam is broken or any attempt made to defeat the system (by cutting the phase reference leads, or by shining a stroboscope into the receiver) the output from the phase sensitive detector will be reduced and the alarm relay will be released,

DEVELOPMENTS IN PHOTO–ELECTRIC BEAMS

Incandescent filament lamps are commonly used in infra-red beams. With input voltage reduced, their output is almost entirely infra-red. The reduced operating voltage lengthens their useful life by many times.

Their limitation is filament size. The divergence of an optical system is ultimately a function of the size of the light source, and using conventional incandescent globes it is not easy to produce the low divergence beam required for long-distance operation.

The recently introduced gallium arsenide electro-luminescent diode is virtually a point source and reduces the problem of divergence. These diodes are available with their entire energy output within the infra-red part of the spectrum. They are being increasingly used in optical beams despite the difficulty of aligning totally invisible beams.

ULTRASONIC BEAMS

Ultrasonic beams are frequently used in industry where their ruggedness and ability to operate in dirty environments justifies their cost. Their operating frequency is generally 40 KHz. They are not often used for intruder detection as their reliable operating range seldom exceeds 12-15 feet.

MOVEMENT DETECTORS

Thieves frequently conceal themselves inside buildings during working hours, to emerge later when work has stopped for the day. Alarm systems have consequently been developed which detect the presence of a human being inside the protected area.

The first commerically successful movement detector utilised the principle that any relative movement between a sound source and a receiver will cause a frequency shift. This effect is known as Doppler shift. It will also occur if the sound source and the receiver are stationary and some fraction of the transmitted energy is reflected from a moving object. Air movement will also cause a Doppler shift in the transmitted energy, and unless special filtering techniques are used, ultrasonic Doppler effect systems are prone to false triggering.

A block schematic of a typical system is shown in Fig. III.

An oscillator, operating at 20 KHz, energises a transducer. This may be a magnetostrictive type in which a coil surrounds an armature of nickel alloy rods fastened to an aluminium diaphragm, or a piezo-electric device generally made from barium titanate. The energised transducer floods the area with ultrasonic waves.

A frequency reference is taken from the transmitter and compared with the signal from the receiving transducer (mechanically and electrically similar to the transmitting unit). An intruder moving in the area will shift the acoustically received signal by an amount between 15 and 75 Hz. Thus two different frequencies will be received – one of 20 KHz. directly from the transmitter – and one of 20 KHz plus the Doppler shift of, say, 70 Hz. from the receiving transducer. The two signals are mixed together and a

FIG. 5

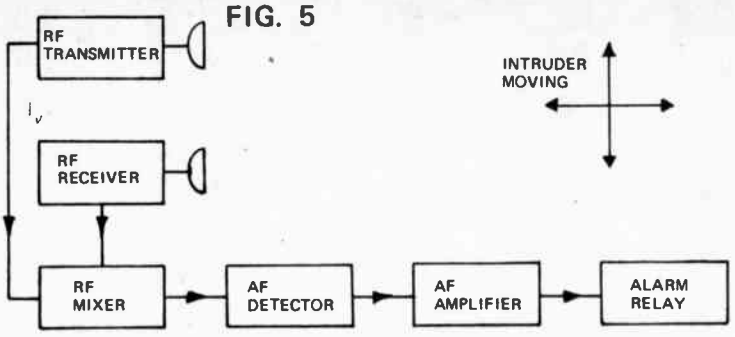


FIG. 5. Microwave motion detector utilises Doppler effect.

ELECTRONIC WATCHDOGS

low pass filter used to extract any component below 75 Hz. Additional filters are used to remove extraneous signals caused by fan and thermal turbulence (occurring mainly below 10 Hz).

Under ideal conditions of low ambient noise and attenuation a radiated power of 1/10th watt is sufficient to detect movement of an object 0.03 sq. ft. in an enclosed space of 200,000 cubic ft. In premises which have absorbent fittings considerably more power will be required.

UHF SYSTEMS

Another range of motion detectors uses ultra high frequency radio waves. One very successful system has a single valve uhf oscillator with a whip aerial directly coupled to the plate circuit. (Fig. IV). The oscillator load is both the aerial and its surrounding space. If there is any movement within this local space, there will be a change in oscillator loading.

Power for the uhf oscillator is supplied – via a load resistor – from a regulated dc supply. The load resister and an associated capacitor form a differentiating network. Thus a sudden change in the local field causes a sudden change in oscillator loading and a reflected change in the voltage drop across the load resistor. This change is differentiated and the subsequent pulse appears (after amplification) at the gate of an SCR, in the anode circuit of which is the alarm relay.

Other uhf systems operate in a similar fashion to the ultrasonic units and utilise Doppler shift as the detection method (Fig. IV).

It has been found that uhf movement detectors operating in the GHz part of the electro-magnetic spectrum are less prone to false alarms caused by large objects moving outside the walls of the protected area. The Gunn diode is an ideal oscillator for this purpose, and now that it is commercially available, it is beginning to be used in low-cost compact uhf. systems.

PASSIVE INFRA–RED

Every object whose temperature is above absolute zero radiates electro-magnetic energy. Most of this radiated energy is in the infra-red part of the spectrum and is directly related to temperature.

Infra-red energy bridges the gap between visible light and the micro-wave frequencies used in radar – it starts at deep red and extends from 0.75 microns to approx. 1000 microns.

The human body radiates energy at wavelengths predominantly between 3 and 8 microns. Although the energy level is very low, photoconductive cells – such as Philips ORP 10 – can detect a moving human target at distances of 30ft. A recently introduced American system operating on this principle uses a single passive sensor to protect an area 20ft. by 20ft. One amplifier and control unit serves up to eight sensors which can be placed in any location. It is claimed that the unit responds only to sudden changes in infra-red radiation and is not affected by noise, air turbulence or rfi.

FIG. 6

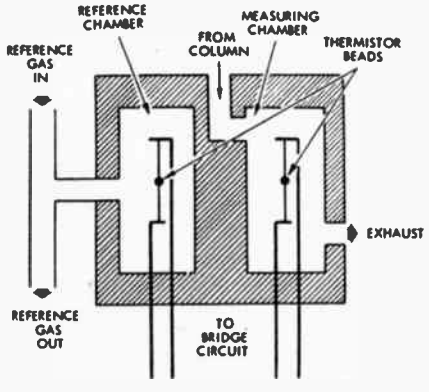


FIG. 6. Thermal conductivity cell compares sample against inert carrier gas. FIG. 7 (far right). Typical chromatogram of gas sampling.

THE VERY CANDID CAMERA

Closed-circuit television systems have been extensively promoted as the ultimate form of security. Experience has shown that it is not sufficient to use cctv alone. It has been found necessary to use a primary detector – such as ultrasonics – and to use cctv to view the area when an alarm is received; or to modify the receiver in such a way that an alarm is automatically raised if the picture changes.

A cctv system available in the USA uses a digital memory and comparator to obviate the need for a primary detector. When the camera is switched on and stabilised, an analogue to digital convertor translates 'bits' of the scan into a digital code stored on a magnetic loop which is synchronised with the scan.

The stored data is compared with each subsequent scan. Any major change in the data between scans activates an alarm.

ELECTRONIC SNIFFER

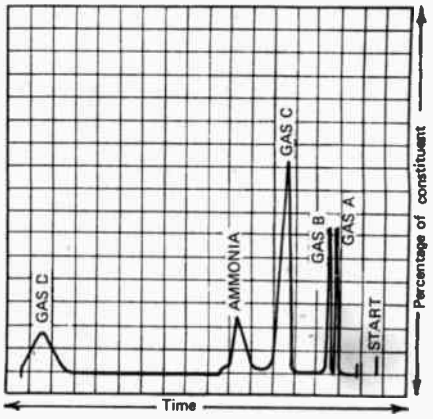
Chromatography is a method of determining the constituents of a complex gas or vapour mixture. The method – which can be a continuous process – may be used to detect the presence of a human or animal intruder.

The human body effuses a significant amount of ammonia, and this is frequently increased under stress. As an intruder detector, the gas chromatograph is programmed to report an increase in the ammonia constituent.

A gas sample is taken at frequent intervals from the protected area. This is combined with an inert carrier gas and forced under pressure through a glass or metal column packed with activated carbon or similiar absorbent. Constituents of the sample are retained for different periods by the

Continued on page 118

FIG. 7



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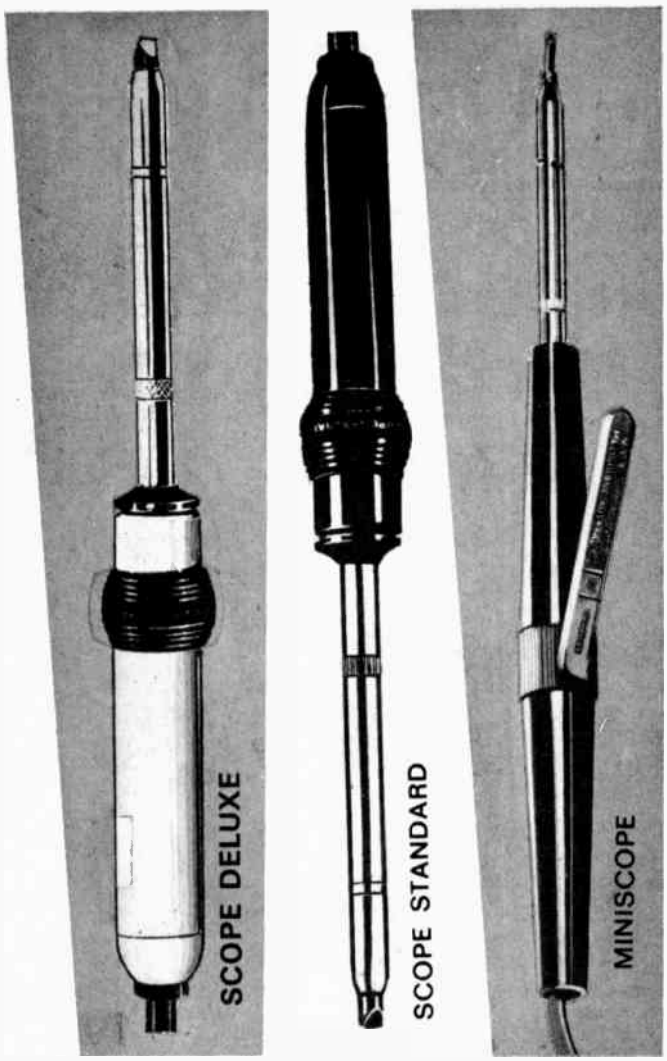

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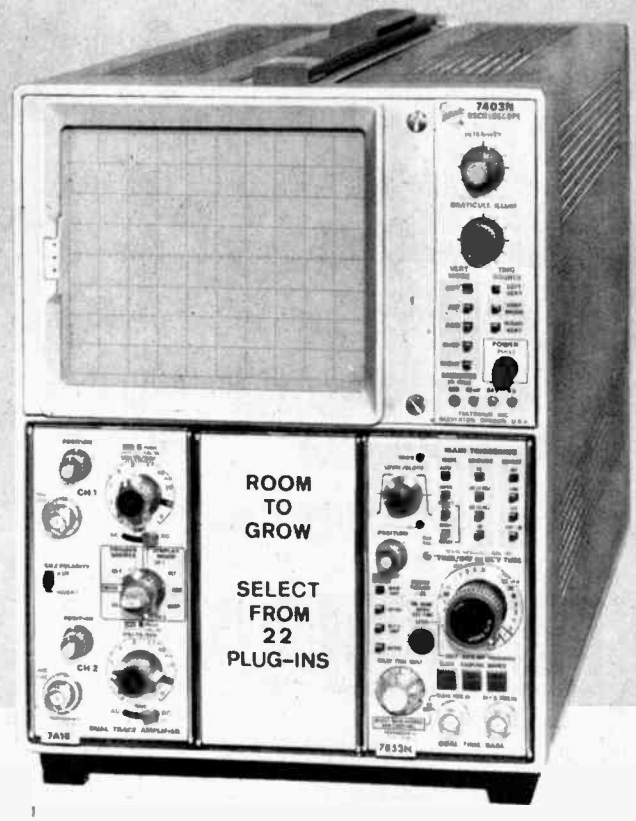

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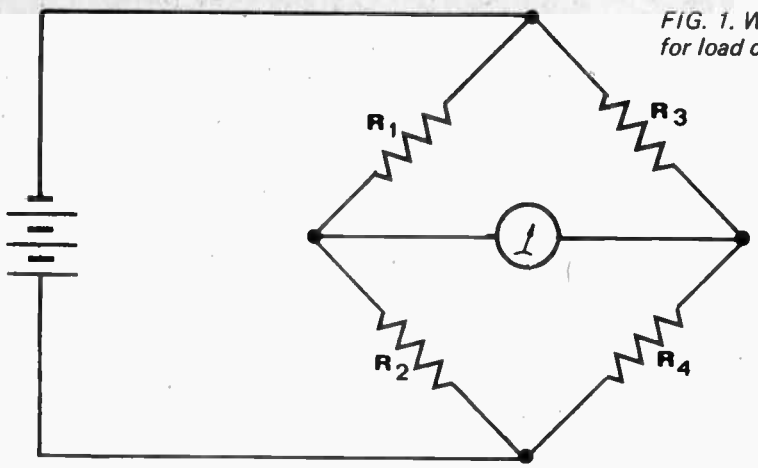


FIG. 1. Wheatstone bridge arrangement for load cell measurement.

The strain gauge bridge ensures hysteresis-free measurements of pressure and weight — load cells using this principle are in common use. J.W. Harris, of Guest International Limited, discusses recent developments which reduce errors and damage due to non-axial loading.

Advances in Weighing and Batching Systems

Weighing is probably the most effective control form in the process industries, being used for the control of batch mixes and final or intermediate checks on products in industries as diverse as steel production, paint manufacture, food processing, bakeries and pharmaceuticals. At the other end of the scale, even the packaging of items for the retail 'do-it-yourself' trade is often controlled by weight.

Much has been done over the years to automate this weighing and batching equipment, both to avoid human error and to save time in batching and checking operations. The normal operating method used is to incorporate positional sensors and set-point controls operated by the indicating pointer of the equipment.

However, as automatic systems become increasingly complex, these mechanical systems can be seen to suffer from several major disadvantages. First, it is necessary to translate the mechanical displacement of a pointer or lever into electrical signals, which can then be used for process-control purposes. This causes inaccuracies due to what is known as 'losses in translation'. Secondly, the mechanical system depends upon a balance arrangement involving moving parts and knife-edges, with the attendant difficulties of maintaining the accuracy of the equipment, due to wear. Finally, the balance system is, of necessity, a sensitive device, as its name implies — and, despite the complicated mounting systems which are often employed, it can still be considerably affected by extraneous conditions.

The advent of the resistive strain gauge has enabled the development of various devices, such as the load cell, to overcome these disadvantages. A strain gauge usually takes the form of a foil upon which a resistive track is deposited, by etching or other means. This foil is then bonded to a material which may be subjected to deformation. Thus, any deformation of the material under investigation causes similar changes in the bonded foil, and hence a change in resistance. By applying a voltage to the resistance, this change can be detected electrically and directly calibrated in terms of the deformation of the material under stress.

It has been known for many years that, provided the elastic limit is not exceeded, a load applied to a steel ingot or billet will cause a deformation which is linear and proportional to the load applied. This, then, forms the basis of most force-measuring transducers, and in particular of the load cell. Typically, four strain gauges are attached to a steel column; two measure changes in length of the billet or column when axial loads are applied, and two measure the subsequent circumferential changes. These four resistances, R_1, R_2, R_3, and R_4, are connected in a wheatstone bridge arrangement, as shown in Fig. 1, and the variations in resistance cause an unbalance of bridge network, and hence an output to the detector D, which is proportional to the load applied.

The analogue signal from the strain gauge bridge network can be connected directly to relay amplifiers, providing instantaneous switching and control devices. In addition, information can be provided that can be displayed on either analogue or digital instruments to give an indication of the value of the forces being measured; hence communications errors are minimal.

electronics in Industry

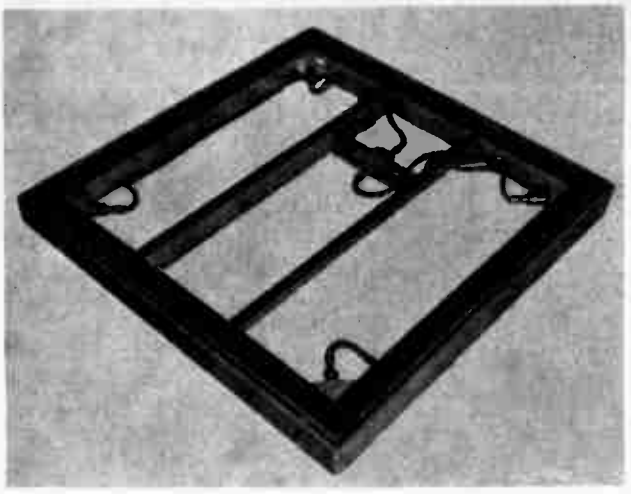


FIG. 2. Low-profile weighing platform.

The construction of a load cell makes it essentially robust, and it is able to function without attention in environmental conditions that would necessitate excessive maintenance for more conventional lever systems. For example, the British Steel Corporation's BOS Steel plant in South Wales uses 200-ton load cells to weigh ladles filled with molten steel. Here four load cells are used to support a weighing platform, which in turn supports the ladles. The load cells have been in use now for some years and continue to give excellent service, despite their hazardous situation. A contributing factor is that a load cell has no moving components in the accepted sense, thus there are no parts which will either wear out or require continual servicing to maintain the initial accuracy.

As industry grows to realise the advantages to be gained from the use of load cells for weighing and other force-measuring activities, there inevitably is an ever-increasing demand for improvements in accuracy. The term 'accuracy' is in itself misleading. Inaccuracies can crop up anywhere in the overall system, and thus the only 'accuracy' which is of any value is the overall system accuracy. The components of such a system typically are as follows:

(a) The transducers

(b) The connecting cables between the transducers and indicating instrument.

(c) An amplifier and/or convertor, which may precede the indicator.

(d) The indicator or controlling instrument itself.

Since bonded strain-gauge load cells are essentially linear devices, it is better to describe their so-called accuracy in terms of non-linearity, repeatability and calibration.

Although non-linearity can be defined in several ways, it is usually defined as being the maximum deviation from the straight line passing through the zero balance point and the point of output, for the maximum rated load of the transducer. This value is quoted as a percentage of rated full load and it is quite possible to achieve non-linearity figures, with the better commercially available load cells, of 0.05%.

Repeatability means the maximum difference between load cell output readings for repeated loadings under identical loading and environmental conditions. This value, also, is quoted as a percentage of full load output.

Finally, calibration means the comparison of the electric output against standard test loads for any individual transducer. This comparison is usually specified in terms of rated full load, but here the calibration procedure must be specified.

Recently a major breakthrough has been achieved in the quest for improved linearity and repeatability with the design and development of a radically new force transducer by the Bofors Company of Sweden. It was felt that there were many inherent problems with the conventional billet-type transducer, due mainly to the fact that this type acts only in compression, thus loads applied to it must be axial. Side loads in excess of 20% of rated full load cannot be tolerated and, in fact, it is only possible to achieve this value if the billet or core is supported by diaphragms preventing lateral movement. As a result of research into these problems of side loads, Bofors patented a new type of shear-force transducer which operates in the following way.

If a beam is rigidly fixed at one end and a force applied at right-angles to its free end, then stresses will be induced in the beam due to the bending effect of the applied force, and also the shearing effect of the load. It is a well-known fact that the bending effects of such an applied load are proportional to the distance of the point of application from the point of measurement. Thus, a transducer which depends on the bending forces as a means of determining applied load is extremely sensitive to the position of application of that load and would therefore be severely restricted in its applications. However, shear stresses are proportional to applied loads only and are not affected by the position of loading. Bofors therefore decided that the ideal transducer would be one which measured shearing forces only.

This decision had several beneficial side effects. First, since it is not required to measure bending forces, the sensing element – that is, the cantilever beam – can be made extremely rigid and, as a result, the transducer is able to withstand guaranteed safe overloads of 100% of rated full load. At the same time, it can withstand side loads of 100% of rated full load with no effects on output signal, and without causing damage to the transducer itself.

The second benefit derives from the fact that shear strains on a beam only occur in the plane of the applied load. This means that the transducer will only measure that component of force which acts in the plane of measurement. Therefore, if, for example, a platform is mounted on four shear-force type load cells, it will be able to accept side loads up to 100% of the rated load of the platform and still only register the vertical load placed on it.

The final benefit arrives as a result of the decision to use a cantilever as the basic design, since the installation of the transducer becomes extremely simple. This, in turn, drastically reduces installation costs, a factor often overlooked when discussing transducer prices.

During the development of the shear-force transducer it was found that, in order to reduce effects due to bending still further, a second beam should be rigidly attached to the free end of the cantilever and the load applied to this second beam. By making this second beam a cylindrical tube enclosing the primary beam, the strain gauges attached to the first beam are completely protected from environmental conditions.

Because of the cantilever design, the transducer can be incorporated in weighing platforms having a very low profile. For example, Fig. 2 shows a platform capable of weighing up to 8,000Kg (approximately 8 tons), and with an overall height of less than 10 cm. As a result, the platform is ideal for building into situations where overall height is a prime consideration.

As discussed earlier, there is no advantage in having an extremely accurate measuring device if it is to be incorporated into a system which

cannot utilise the opportunities offered. To this end, digital equipment has been developed for weighing, and for controlling weighing and batching operations. When used in conjunction with the new shear-force transducers, an overall system accuracy of better than 0.1% of rated full load can be achieved.

The analogue output from the transducers is fed, via an amplifier, to an analogue-to-digital converter which uses the dual-slope technique, thus rendering the equipment insensitive to interference of fluctuations in supply voltage. The output from the converter is used to drive a digital display unit which provides for polarity, overrange, and four complete digits. The unit can also be fitted with automatic taring facilities, enabling the nett contents of containers to be weighed and controlled.

The non-linearity of the equipment, from the best straight line through zero, is better than ± 0.01% of the nominal range of the equipment, which can be 2,000, 5,000 and 10,000. The resolution of the measurement can be adjusted to either one or two bits, enabling the user to avoid any ambiguity which might arise from fluctuations of the last digit, if the equipment is set to a resolution of one bit.

The equipment can be used as a simple weighing control in which role it can deal with up to three channels – each with a different capacity, if required – as standard. In this mode, it can be used to control simple weighing platforms, merely weighing and recording the results from the three channels. Alternatively, it can be used to control vehicle weighbridges, provision being made for recording vehicle registration, weight, and any other information which may be relevant.

Using the automatic taring facility, only the weight of the vehicle will be taken into account – errors arising as a result of accretion of dirt, snow, etc., on the weighbridge will thus be discounted. The equipment can be fitted with a card reader into which the vehicle driver inserts a card giving vehicle registration and tare weight. From this information, the nett weight will be calculated and displayed.

The equipment can also be used in this basic form for hopper or tank weighing. In the standard form, up to three tanks can be monitored and the contents weighed and recorded.

Finally, by incorporating a batching control module and various combinations of batching modules, complete mixing for batching processes can be controlled. Provision can be made for coarse and fine control of filling processes, and all weighing and batching processes can be both displayed in digital form, and recorded in either digital or analogue format.

Fig. 3 shows a typical system, equipped to handle a mixing process incorporating three separate components. The modules are designed for 19-in. rack mounting, and the compact dimensions of the units are immediately apparent from the illustration. The units of the complete system shown comprise, from the bottom of the cabinet, the system power supply unit, which supplies power for the system and for the transducers; the main unit comprising amplifiers, A-to-D converter, and the display panel; finally, the batching control module, together with three batching modules. ●

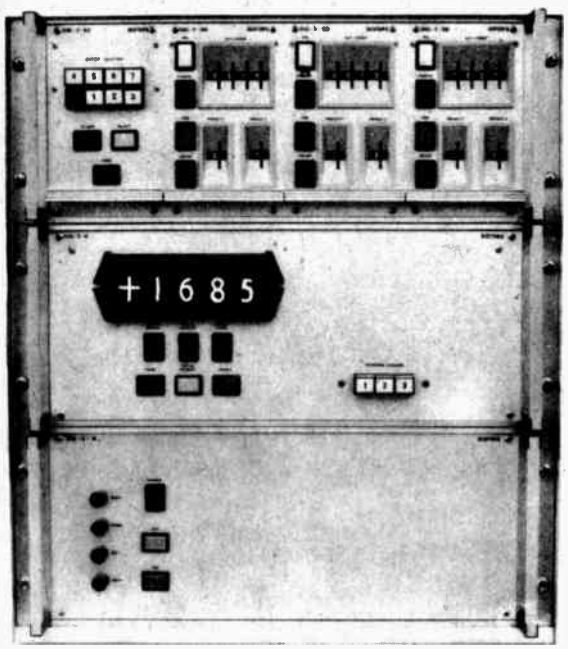


FIG. 3. Typical weighing and batching control system.

NEW SOUND FOR YOUR GUITAR

The normal guitar sound begins with a sharp 'attack'. This device removes the attack effect, producing a completely new and way-out sound, unlike that of any other instrument.

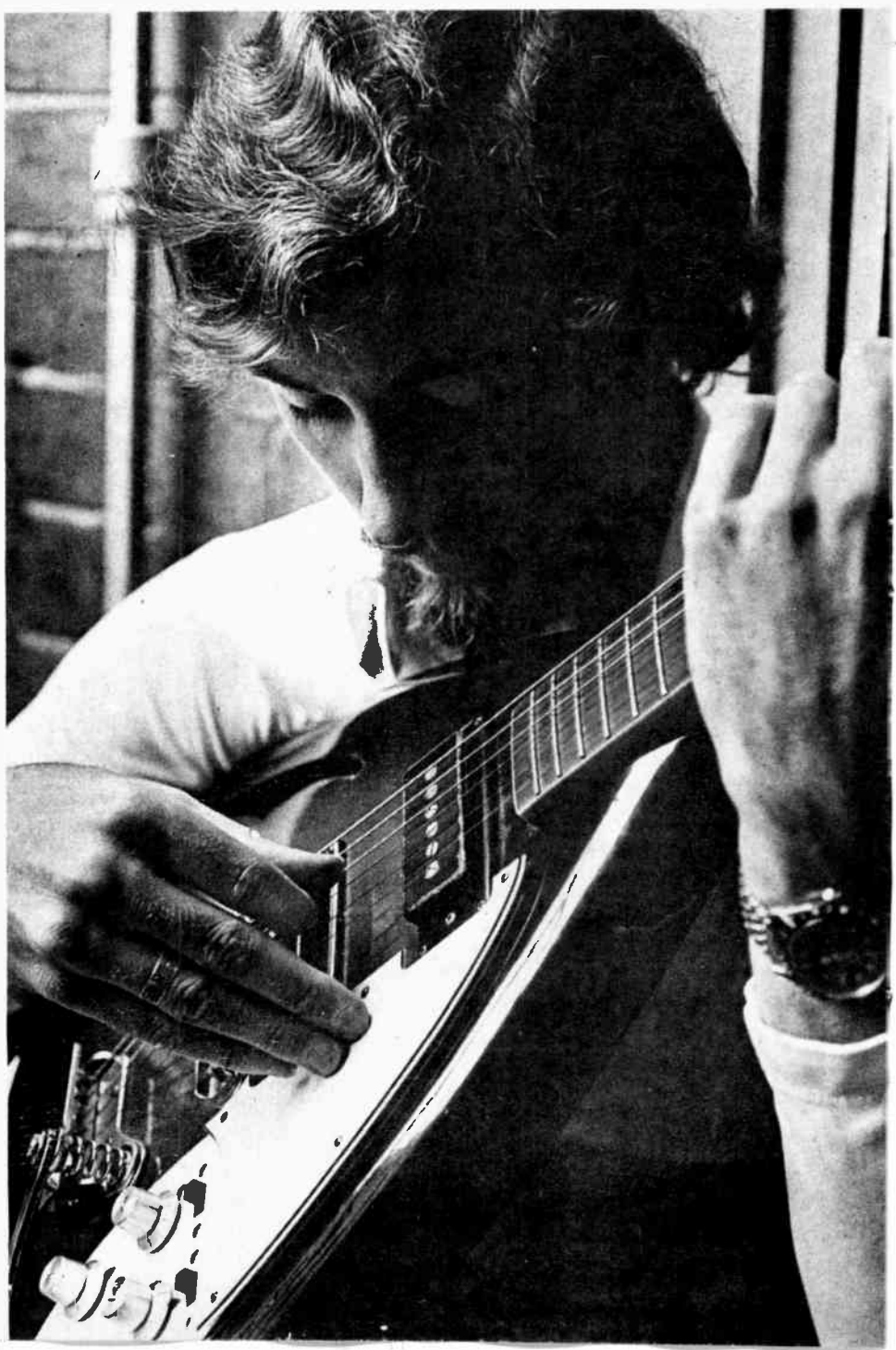
Every musical instrument owes its unique sound to a certain combination of inherent characteristics. For instance, the number of harmonics produced, combined with their magnitudes and phase relationships, play an important role in creating the instrument's distinctive sound.

Another important characteristic is attack time — the speed with which sound is built up after a tone is initiated. Reed instruments such as the clarinet produce sounds which can be described as 'soft' because they have a relatively slow attack, caused by the time it takes for the reed to build up to its maximum vibration. On the other hand, instruments such as the guitar have a very rapid attack because maximum amplitude vibration is started as soon as the string is plucked or struck.

By changing an instrument's attack, we can make it sound different and, at the same time, not like any other instrument. That is what the 'Attack Delay Unit' (ADU) does for the guitar. By slowing down the guitar's attack, a brand new sound can be obtained. The effect can also be produced by recording a guitar passage on tape and then running the tape backwards through the player. Instead of sharp, clean tones, a hard-to-describe 'whoop' is heard for each note played. Although the note is on pitch, it doesn't sound like it belongs to any known musical instrument.

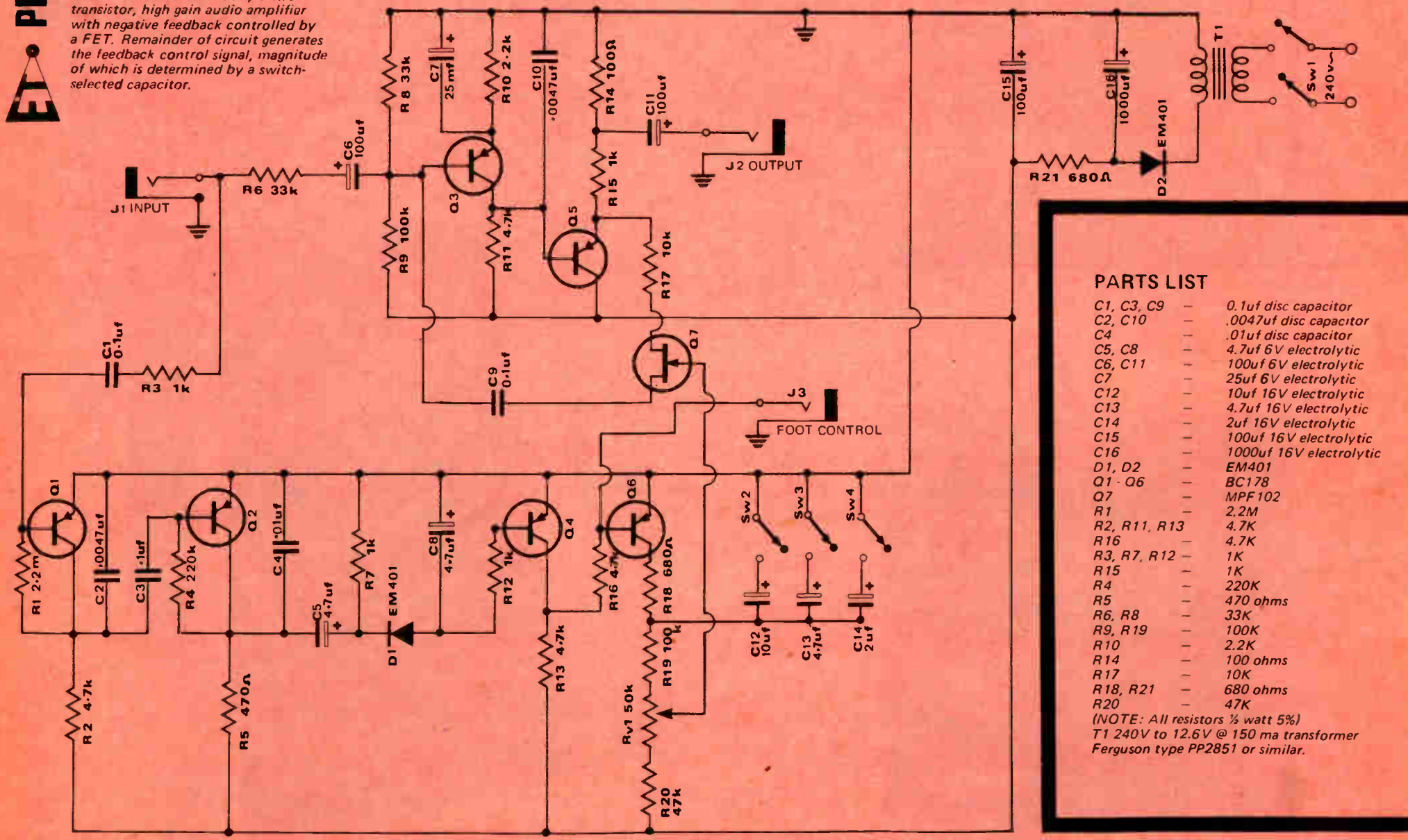
Using the ADU, attack can be delayed for a very short period so that only the sound of the pick hitting the string is eliminated, or it can be delayed so that the music builds up over the length of a run. A foot control switch makes it easy to delay particular notes selectively.

CONSTRUCTION. The circuit of the ADU, shown in Fig. 1, is fabricated on a printed circuit board whose foil



NOTE: Project is based on one originally published in 'Popular Electronics', but modified to suit locally-available components.

FIG. 1. Circuit is essentially a two-transistor, high gain audio amplifier with negative feedback controlled by a FET. Remainder of circuit generates the feedback control signal, magnitude of which is determined by a switch-selected capacitor.



PARTS LIST

C1, C3, C9	–	0.1uf disc capacitor
C2, C10	–	.0047uf disc capacitor
C4	–	.01uf disc capacitor
C5, C8	–	4.7uf 6V electrolytic
C6, C11	–	100uf 6V electrolytic
C7	–	25uf 6V electrolytic
C12	–	10uf 16V electrolytic
C13	–	4.7uf 16V electrolytic
C14	–	2uf 16V electrolytic
C15	–	100uf 16V electrolytic
C16	–	1000uf 16V electrolytic
D1, D2	–	EM401
Q1 - Q6	–	BC178
Q7	–	MPF102
R1	–	2.2M
R2, R11, R13		4.7K
R16	–	4.7K
R3, R7, R12	–	1K
R15	–	1K
R4	–	220K
R5	–	470 ohms
R6, R8	–	33K
R9, R19	–	100K
R10	–	2.2K
R14	–	100 ohms
R17	–	10K
R18, R21	–	680 ohms
R20	–	47K

(NOTE: All resistors ½ watt 5%)
T1 240V to 12.6V @ 150 ma transformer Ferguson type PP2851 or similar.

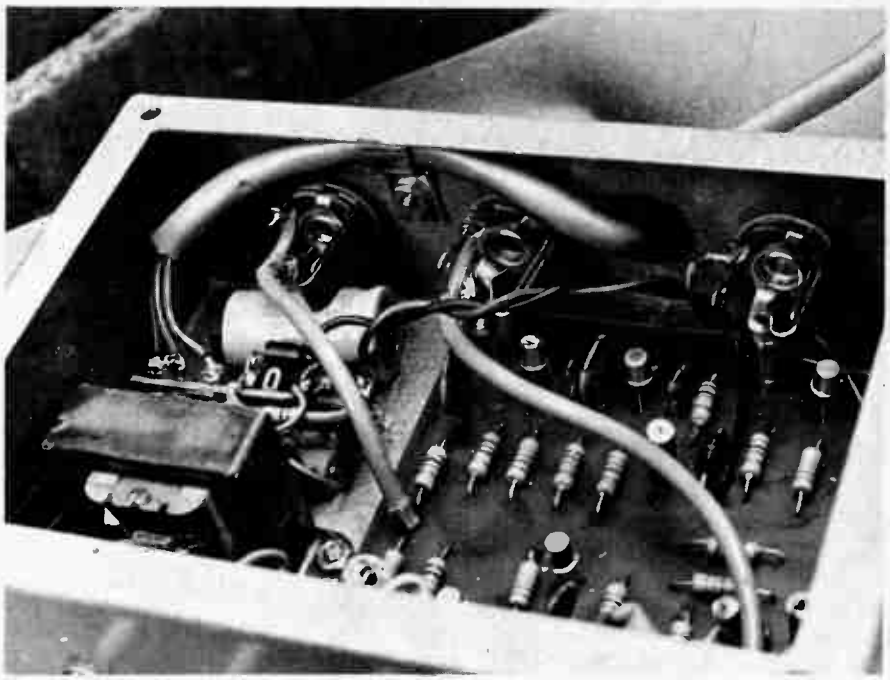
pattern is shown in Fig. 2. Once the board has been made (or purchased), install the components as shown in Fig. 3. Be sure to install the semiconductors and electrolytic capacitors correctly. Use a heat sink (such as long-nose pliers) on the transistor and diode leads while soldering to avoid possible thermal damage. Also, use a low-power (35 watts) soldering iron. Connect sufficiently long leads to the various external connection pads before mounting the board in the chassis.

Almost any type of metal chassis may be used as long as it will hold the PC board, the power transformer and the associated rectifier, and will permit the installation of four switches on the front and three phone jacks on the back.

The choice of switches for S2, S3 and S4 should be made carefully. During use, it may be necessary to manipulate these switches rapidly in various combinations, so they should have large paddle-type handles and operate with a light pressure. Any type of DPST switch rated at 240 volts ac may be used for power switch S1.

Do not ground either side of the ac to the chassis.

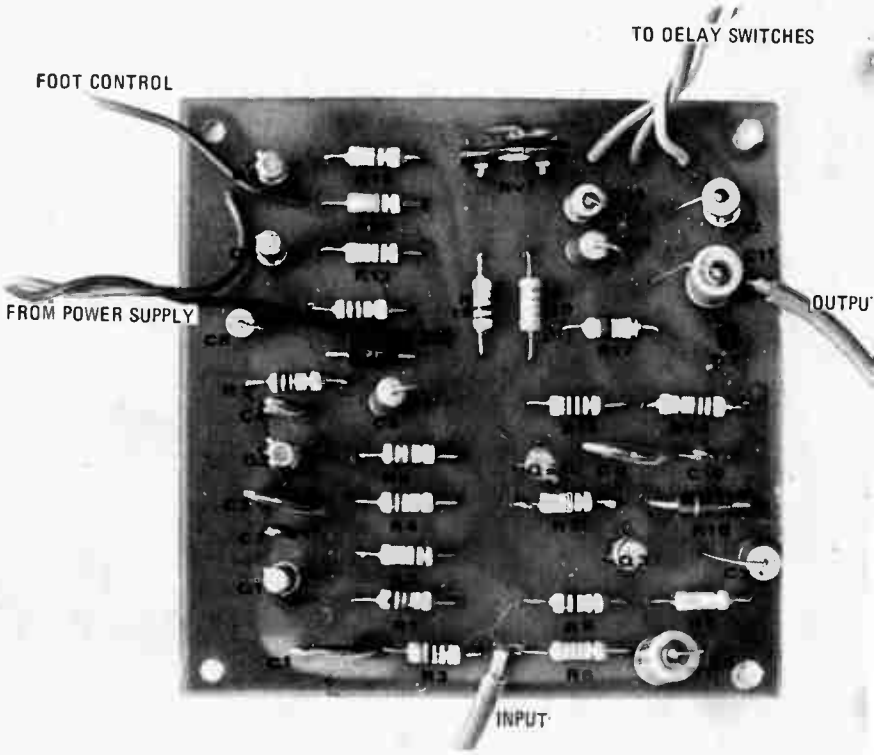
Mount the three capacitor-selector switches (S2, S3 and S4) on the front wall and three phone jacks (J1, input; J2, foot control; and J3, output) on the rear wall.



Interior of unit, showing power supply at left, main circuit board at right. Jack sockets for input, output and foot control are seen on rear panel.

FIG. 2 (below, left). Foil pattern of printed circuit board (full-size).

FIG. 3 (below, right). Component layout on printed circuit board.



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Tape speeds:	7½ ips and 3¾ ips	Wow and Flutter:	Less than 0.12% WRMS at 7½ ips
Reel size:	7" or smaller	Monitor speakers:	2 speakers 4 x 6 inches
Frequency response:	20—20,000Hz at 7½ ips 40—12,000Hz at 3¾ ips	Power output:	12 watts music power
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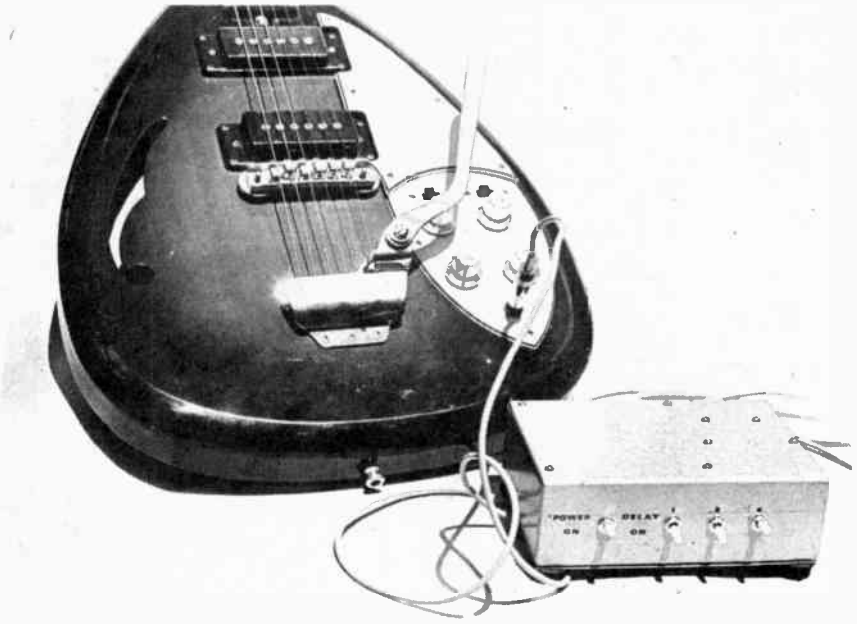


Completed prototype unit connected to guitar.

Mount the PC board on four ¼" insulated spacers so that RV1 will be accessible from the side. Wire the complete circuit as shown in Fig. 1. Put four rubber feet on the chassis bottom to keep it from slipping around when in use.

SET–UP. Prepare the unit for operation by running a short length of cable from the output of the ADU to your amplifier input and plugging the instrument output into the ADU input. For the time being, do not use the foot control switch. Turn the ADU on and set the delay to 4.

Since a certain minimum signal is required to operate the delay unit, the instrument's gain should be turned up almost all the way and the volume adjusted by using the amplifier's control.

The only thing that needs adjustment in the ADU is potentiometer RV1. At one end of this potentiometer's rotation there is little or no delay in the instrument attack; with the opposite setting, there is no sound for an instant and then the volume will come up full. Between these two extremes are a variety of settings which can be selected strictly as a matter of personal taste. Ideally there should be very little or no sound when the note is first struck, followed immediately by a noticeable increase in volume with a smooth glide to maximum.

OPERATION. The three delay switches on the ADU can be used singly or in combinations to yield up to seven different delays. The numbers above the switches represent some arbitrary unit of delay (which varies with the setting of RV1) and may be added together to get the longer delays. For instance, if switches 2 and 4 are down, the attack delay is 6 times longer than if only switch 1 is down.

Since the ADU requires a short, no-signal dead time for the circuits to reset, all strings on a guitar must be silenced before the next chord or note is struck. If single notes are being played, just lifting the finger from the finger board will ordinarily accomplish the deadening, but for chords with open strings it is necessary to deaden the strings with the palm of the strumming hand. The resetting time is actually very short (in the order of a tenth of a second), so very rapid runs can be played with the delay still occuring on each note.

The foot control switch is a single-pole, single-throw type and can be housed in a sturdy case of metal or a block of wood. The switch can be a push-on/push-off type, but experience has shown that a spring-loaded, normally closed switch works best. With this arrangement, selective delay can be accomplished, by pressing the switch when delay is desired and releasing it to sustain a note. ●

DOPPLER WITH A

ABOVE: Frame from Multanova radar unit's camera shows an offender clocked at 81 mph in 55 mph zone. Information includes car, speed recorded, location and time. BELOW: Moment of recording. Radar/camera unit at right, monitor at left in back of station wagon with needle on 81.

A new-type radar meter with camera attachment may be adopted in NSW. Our exclusive tryout showed that its computer-based circuitry is deadly accurate, scrupulously fair.

RADAR speed meters currently checking drivers in several Australian states are simple units.

Too simple – according to a number of people who have successfully challenged prosecutions based on radar evidence.

Their counter-evidence was based on the following claims:

1. The reflected signal is not necessarily constant. Interference from moving parts of vehicles (e.g. magnesium spoked wheels), overtaking vehicles or stray reflections can cause the received frequency to vary. Averaging such a mixture of reflected signals may cause readings unrelated to the speed of the monitored vehicle.

2. If there are several vehicles in sight, it may be difficult for the operator to correlate the recorded speed with the correct vehicle.

3. The equipment is subject to human error. The most conscientious of operators can take an incorrect reading, particularly at busy times.

True or false, these arguments certainly fall flat if applied to a Swiss-designed radar meter tested recently by Electronics Today.

This – the Zellweger Multanova – is truly a radar meter with a difference.

The unit monitors the speed of vehicles travelling AWAY from its antenna – checks that the speed is constant over a predetermined distance, indicates and stores that speed, waits a short while, then rechecks the speed and photographs the car together with details of location, date, time, and the speed registered by the unit's radar system.

The chance of a wrongful conviction is negligible. Unless there is certainty at every stage, the recording is automatically rejected. The meter will not complete a sequence every time a

DIFFERENCE

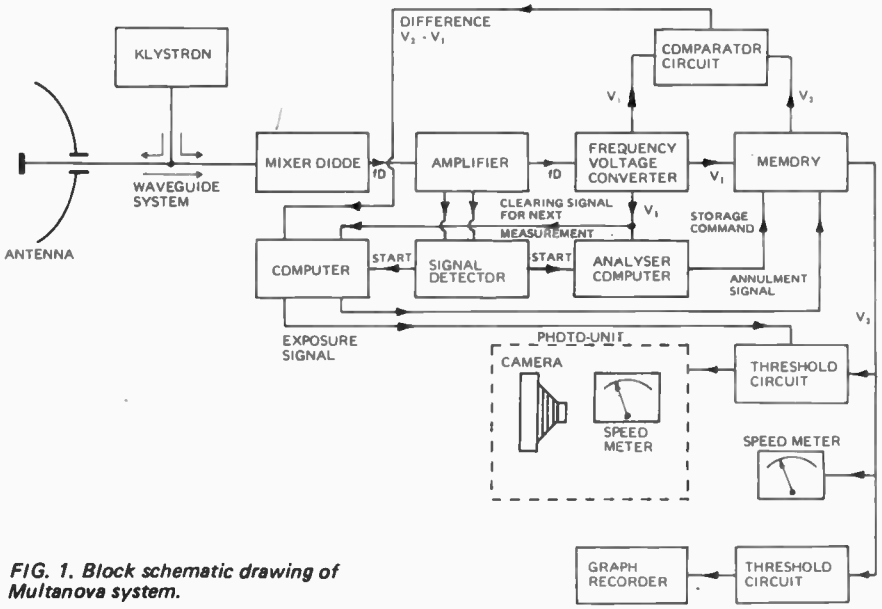
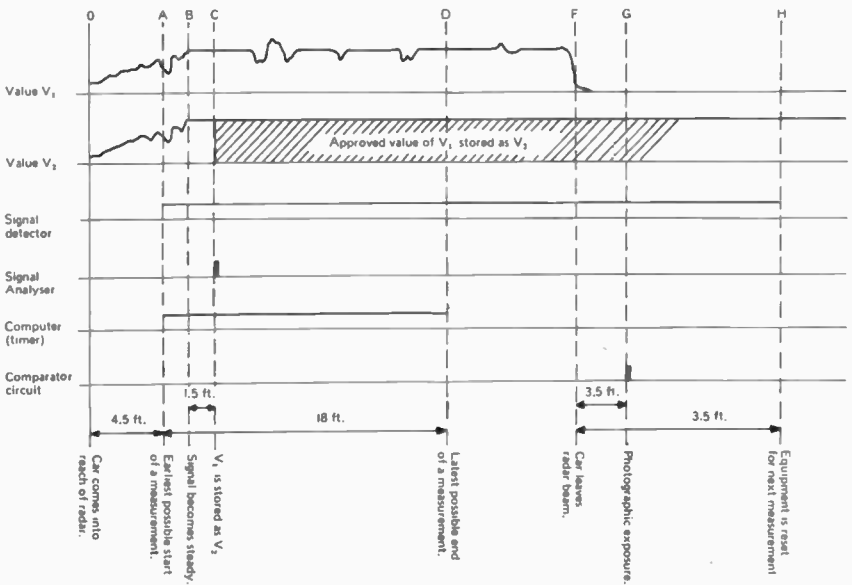
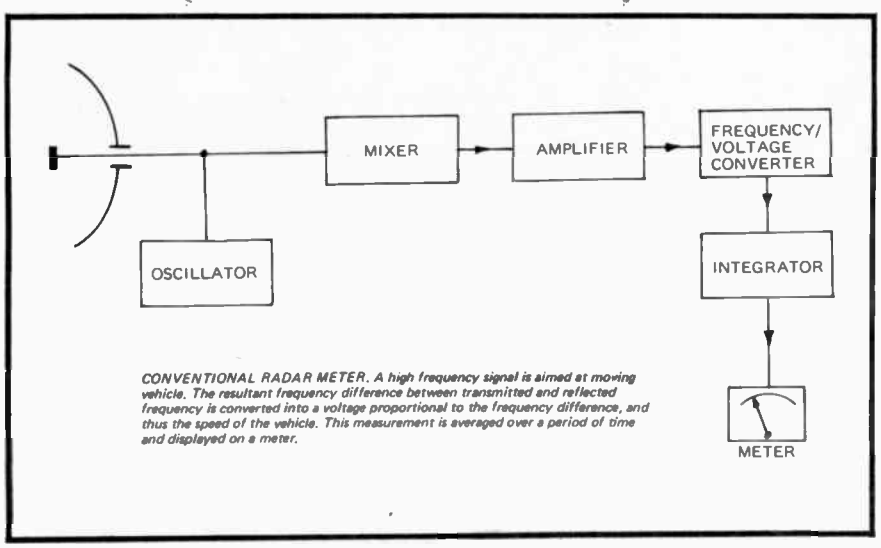


FIG. 1. Block schematic drawing of Multanova system.

FIG.2 (below). Sequence of events.





CONVENTIONAL RADAR METER. A high frequency signal is aimed at moving vehicle. The resultant frequency difference between transmitted and reflected frequency is converted into a voltage proportional to the frequency difference, and thus the speed of the vehicle. This measurement is averaged over a period of time and displayed on a meter.

car is checked – but whenever it does so, the answer is a correct one. Our experience with the meter indicates that it will complete a measuring sequence in nearly every instance on a quiet road, eight or nine times out of ten on a busy divided carriageway, and rather less than this in a mid-town shopping street, where interference is at maximum

METER USES DOPPLER SHIFT

A block schematic drawing is shown in Fig. 1. of the Multanova radar meter.

A 10,000 MHz signal generated by a kylstron is fed into a paraboloid antenna which radiates a narrow beam. A frequency reference signal is taken directly from the kylstron, and is heterodyned in a mixer diode with the signal reflected from objects in the width of the beam.

Any vehicle moving away from the antenna will cause the reflected wave to be frequency shifted by an amount directly proportional to the speed of the vehicle. (This is known as Doppler effect, and the change in frequency is called the Doppler shift.)

There will thus be an output from the mixer diode which is the difference in frequency between the transmitted and the reflected signals – i.e., the Doppler shift.

The Doppler shift frequency is amplified and fed into a frequency-to-voltage converter. The output of the converter is a voltage (VI) which is proportional to the Doppler shift and therefore to the speed of the vehicle.

Ideally, the output of the mixer diode (and hence VI) is a steady signal; however, in practice the output may be a number of signals varying in frequency, phase angle and intensity. Further processing is necessary before it can be assumed with any certainty that the output is truly a measure of the vehicle's speed.

SIGNAL IS CHECKED FOR INTERFERENCE

A characteristic of interference is quick changes in Doppler frequency. To determine whether the received signal is free from interference, VI is continuously monitored over a distance of 18ft. The voltage is assumed to be a true measure of speed if it remains constant within predetermined limits for a distance of 1½ feet over any part of the monitoring distance. The predetermined limits are calculated for each road speed by an internal computer and make allowances for acceleration and deceleration during the monitoring period. It is not possible to beat the meter by heavy braking or acceleration.

ABOVE: Analogue readout unit also contains monitoring and camera control circuitry. Control knob (right) is set on 50, so car clocked here at 47 mph won't be photographed. RIGHT: Paraboloid antenna and associated circuitry are in lower unit, camera and flash in upper.

As soon as the computer has approved the value of V1, it is passed on to a memory and stored there as V2 (see sequence diagram, Fig. 2).

This value (V2) is now indicated on the speed meter and – optionally – on a chart. (Both the meter and the recording charts are calibrated in mph.) The 1½ft. of constant speed required for a reliable measurement may lie anywhere within a range of 18ft. of the car's travel (points A-D of the sequence diagram). It may be, but most likely will not be, right at the beginning of this distance.

IDENTIFYING THE OFFENDER

At this point we have an accurate and reliable measurement of speed – or no reading at all –, but unless further steps were taken the task of allocating the measurement to the appropriate vehicle would now lie solely with the operator, either by visually reading the meter or by using the recording chart. There are also further problems . . .

It is not unknown for vehicles to be clocked at speeds over 85 mph in restricted areas. Stopping drivers from these speeds is a hazardous business. Traffic flow may be disrupted and additional police officers are required. For these reasons speed checks are often impracticable in locations where they are most needed.

Zellweger's solution is to eliminate the human error by automatically photographing the rear of the speeding vehicle together with indications of time, location and speed. Infringement notices are then served on a basis of motor registration numbers.

Since vehicles are identified by their numberplates, it is essential for these to appear in the photograph. Therefore the photographic exposure must be delayed until the rear of the monitored vehicle is in full view of the camera.

This necessary delay introduces the problem that the traffic situation photographed can differ from the situation at the time the original speed measurement was made. It may no longer be possible to correlate the measured speed with the correct vehicle.

So, to ensure reliability, a further safeguard has been incorporated.

The continuously monitored value (V1) is compared over the period C-D with the fixed value V2 stored in the memory. If during this period the variation between V1 and V2 is less than 3% for a period of time corresponding to 3½ ft. of travel, the measurement is deemed acceptable and a photograph will be taken.

When the vehicle leaves the radar beam (point F in the sequence diagram) V1 falls to zero. This is detected by the computer which, after a further delay corresponding to 3½ ft. of travel, triggers the camera by means of its threshold circuit.

If, on the other hand, V1 varies from V2 by more than 3%, interference is deemed to have occurred. In this case the camera is not triggered.

The equipment is reset for subsequent measurements by the signal detector circuit. This occurrs at a time corresponding to 13ft. of travel after the vehicle leaves the radar beam. The value (V2) of each measurement remains stored until replaced by a new value from the next measurement.

UNIT OBTAINS STATISTICAL DATA

Statistical data can also be obtained from the Multanova by the addition of a multiple totalizing unit. This automatically classifies and counts vehicle speeds in seven discrete ranges, each of which can be set between 15 and 93 mph.

In some countries – notably Canada – these statistics are used to determine the official speed limit for various road sections.

Canadian authorities set the limit at that speed which isn't exceeded by 85% of the drivers on a given stretch of road.

It is claimed that motorists are then more willing to observe the speed limit, since they feel they had a say in setting it.

Unfortunately, Multanova's totalizing unit was not available for testing in Australia.

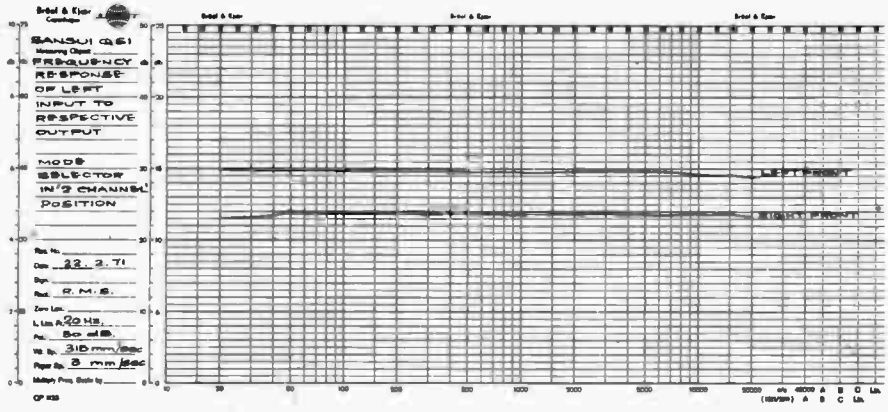
To sum up, the Multanova is a radar speed meter which tells the truth. With or without the optional photographic attachment. If there is any doubt at all about a reading, that reading is rejected.

One or two questions remain:

1. Is there any proof that there is a positive correlation between fining motorists for speeding and a subsequent diminuation in speeding behaviour? Proof – not just belief.

2. Does the length of time between committing the offense, and the subsequent apprehension, lessen the deterrent value of the device?

FOOTNOTE: This test was carried out jointly by ELECTRONICS TODAY and its companion magazine, MODERN MOTOR. For the motorist's angle on the Multanova radar meter, see the May issue of MODERN MOTOR, publishing in the first week of April.



Graph of unit's output in normal stereo mode. Graphs on page 65 show 4-channel synthesizing.

electronics TODAY

scoop test

Four-channel stereo is not yet here – but this new unit from Japan extracts a similar effect from conventional stereo recordings

Ten years ago, people writing in technical magazines were sceptical about stereo-recording and cast doubts as to whether the expense of obtaining a completely new amplifier and speaker system could be justified in terms of the resulting sound (unless you particularly wanted to listen to such things as ping-pong tournaments or the passing of steam trains).

Today almost every record playing system and tape recording system, with the exception of some portable units, is stereophonic.

Now we have come to an era where some new tape recorders, at any rate, have four channels – and it is probable that a four-channel disc will be available in the not-too-distant future.

In the meantime, systems are available which will 'synthesise' a four-channel signal from a two-channel system. One of these is the Sansui QS-1 Quadphonic Synthesiser.

This unit arrived fresh from the ship in a well-constructed package, with a 20-page brochure of operating instructions. Unfortunately no technical information was provided by the manufacturer, so the description of how the system works is based upon several hours of measurements in the laboratory. Whilst this description may be incomplete, it does give some idea of what happens.

The incoming stereo signals are compared by a comparator. If the signals are *equal*, the output signals are produced from the two front speakers. If the signals are *unequal*, then the output signals are produced from the corresponding front speaker and from the rear speakers in some predetermined fashion.

The actual relationship between the rear speaker outputs to the respective input signals is determined by the mode selector. On this unit, there is a choice of seven possible modes. The Two Channel mode gives normal stereo through the two front speakers. The Solo, Concert Hall 1, Concert Hall 2 and Normal modes all provide varying colorations of the signal through the rear speakers.

Measured performance for Sansui QS–1 Quadphonic Synthesiser

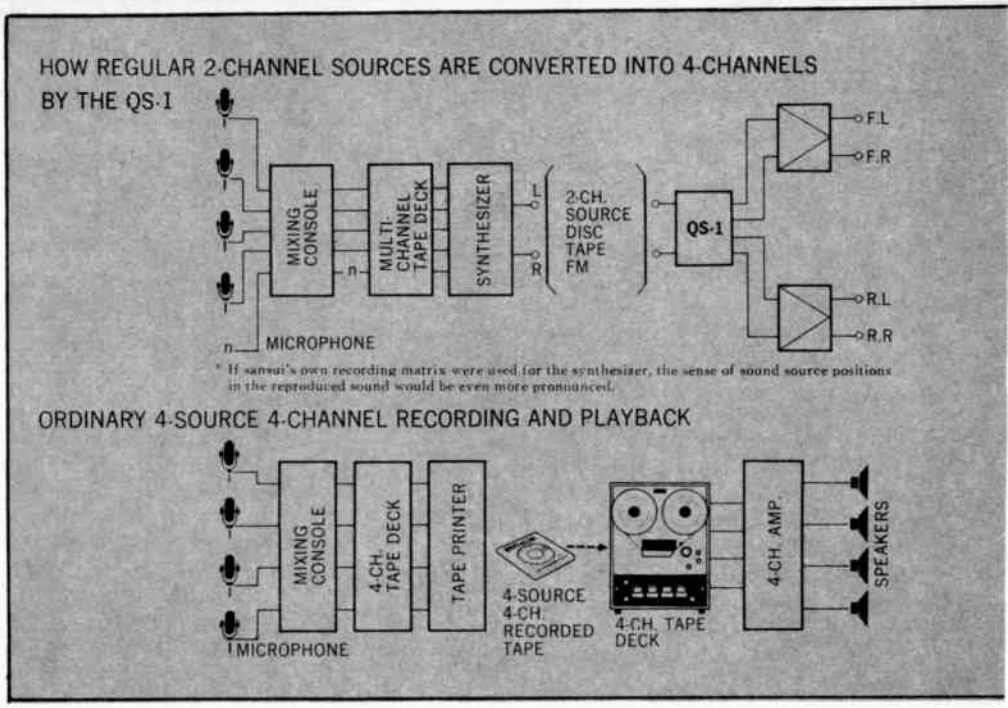
Serial No. 220120047

Frequency Response – front channels	-20Hz -20kHz ±1db
Frequency Response – rear channels	
Concert Hall 1	20Hz -20kHz ±1db adjacent channel +6db at 10kHz
Concert Hall 2	opposite channel +6db at 50Hz
Solo	-10db at 10kHz
Normal	+6db at 50Hz
Total harmonic distortion at rated input	less than 0.1%
Input sensitivity	
Two-channel	0.15V
Two-channel tape monitor	0.2V
Four-channel tape monitor	0.8V
Output level (at rated input)	
Four-channel low	0.2V
Four-channel high	0.7V
Two-channel record	0.2V
Four-channel record	0.7V
Integrated circuits	8
Transistors	20
Diodes	12
Zener Diodes	1
Dimensions	15 9/16" wide x 10 15/16" deep x 5" high
Power consumption (no signal)	13 watts at 240 volts input

Price – $179 including tax

(Note – an extra stereo amplifier and two speakers are also required)

SANSUI QUADPHC



ABOVE: Diagrams from maker's handbook illustrate unit's operation.

LEFT: Sansui Quadphonic unit on top of test amplifiers.

The actual difference in the coloration provided was not pronounced with the exception of Concert Hall 2, which has the bass content of one channel produced primarily through the rear channel of that side, while the treble is produced predominantly through the opposite rear channel. In actual listening tests, we found it hard to tell the difference between the Solo, Concert Hall 1 and Normal.

The remaining two switch positions provide a rotation of the sound through one-quarter revolution or one-half revolution if required.

The important thing to appreciate in the design and effectiveness of a unit such as this is that, when used with a two-channel programme source, the only information available is already contained in the two channels and it is impossible to recreate a sound which is closer to the original sound without the benefit of additional information. The resulting sound from the system cannot therefore be regarded as true quadrisonic sound, but more as an extensive of sterephonic sound designed to provide a more diffuse or enveloping sound field.

The effect obtainable from listening tests, while not quadrisonic, is impressive and very pleasant to listen to. After becoming accustomed to the Quadphonic sound, an ordinary two-channel, two-speaker stereo system seems to lack presence. It would appear, however, that there are a number of simpler methods of generating this effect than by using the QS-1 Quadphonic Synthesiser and an additional stereo power amplifier.

One consequence of the additions and subtractions carried out in the Sansui QS-1 is that there may be an increase in the distortion level of the signal appearing through the rear channel, due to the cancellation of the in phase components. This is particularly obvious if a monophonic recording is fed into the system. In this case, the only output from the rear speakers is the distortion caused by the pick-up cartridge or the tape head.

Construction of the unit is consistent with the newer range of Sansui equipment, with a design that is calculated to impress. The front panel is a matt-black anodised finish, while all the knobs are plain aluminium. There are four large illuminated VU meters – one for each output. The VU meters will make the system a real conversation piece and have obviously been included with the American market in mind, where appearance is a dominant selling feature.

The cabinet is of attractive oiled timber and particularly well-made. The controls are logically laid out and extremely simple to use. All patching is carried out from the rear, by means of well-labelled RCA type coaxial sockets.

The controls provided will prove to be a delight to all knob-twiddlers as there are three balance controls – front, rear and front-to-rear balance – as well as an input gain control and a normal main volume control. When these controls are added to all the controls on the amplifier, one has an impressive array of something like 18 knobs and possibly ten switches to play with.

The interconnecting wiring is also rather extensive, requiring up to 20 separate connections. We found that, while the connections are self-explanatory, the probability of error in the speaker phasing, or confusion of left and right channels, is very high.

The electronic testing posed some interesting problems. Because of the absence of detailed technical literature, it was by no means clear

ONIC SYNTHESIZER

SANSUI QUADPHONIC SYNTHESIZER

what or how we should be measuring in the system's performance. We therefore decided to perform a thorough analysis by feeding a signal into the left input and determining what came out of the four outputs with each setting of the mode selector, while keeping the three balance controls set in their nominal centre positions. Much to our surprise, we got an output from all channels in most settings of the controls.

Next test we tried was to feed identical inputs into both left and right channels. Under this condition we found that we got equal signals out of the front speakers and none from the rear speakers. The testing of the respective modes provided a total of 28 frequency responses which are included in the level recordings. Notwithstanding the completely different responses, the difference in the sound field produced by either of the combinations of speaker positions is not as great as may be expected.

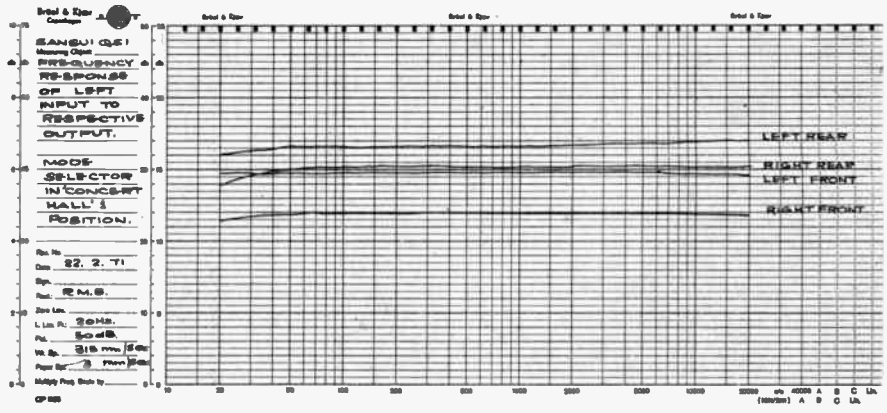
The electrical performance of the unit is particularly good, considering how little information it is given by a two-channel signal and considering the flexibility (or complexity) of its setting-up procedure.

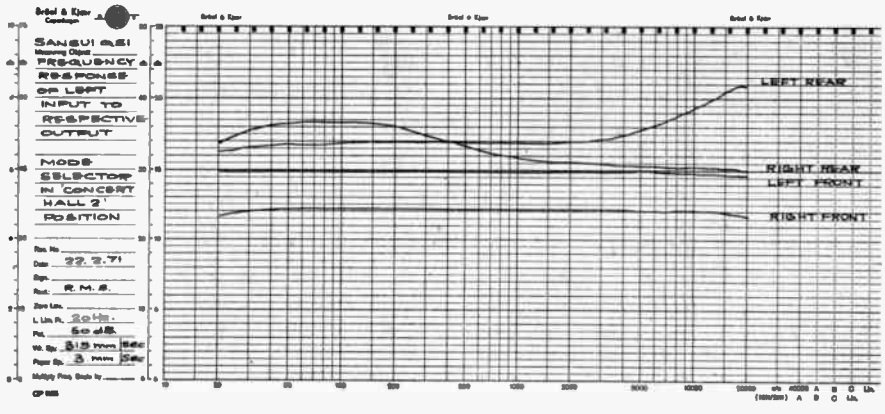
The full technical specifications are detailed in the attached table.

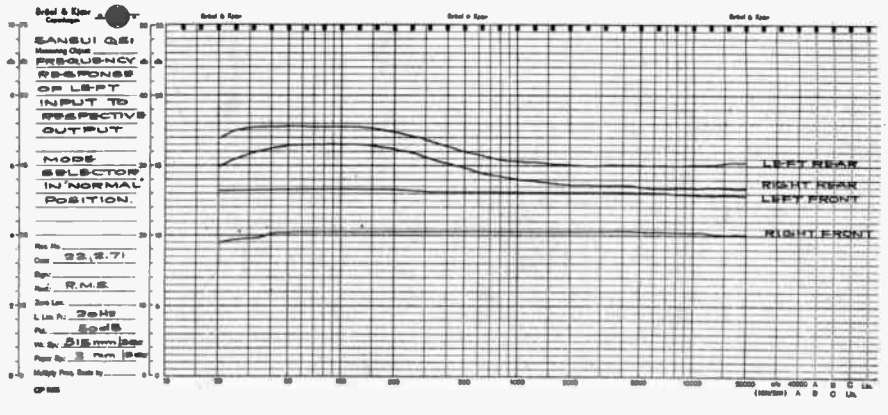
There is no doubt that the effects which can be derived by using the Sansui QS-1 Quadphonic Synthesiser are extremely impressive. As four-channel programme material becomes available to the public, it will prove to be an extremely useful adjunct to your present system, allowing the addition of another conventional stereo system instead of buying a new four-channel amplifier. We would therefore consider that it is a worthwhile purchase if you are contemplating four-channel tape and require four-channel reproduction – and also want the additional presence that the system can provide on two-channel programme material.

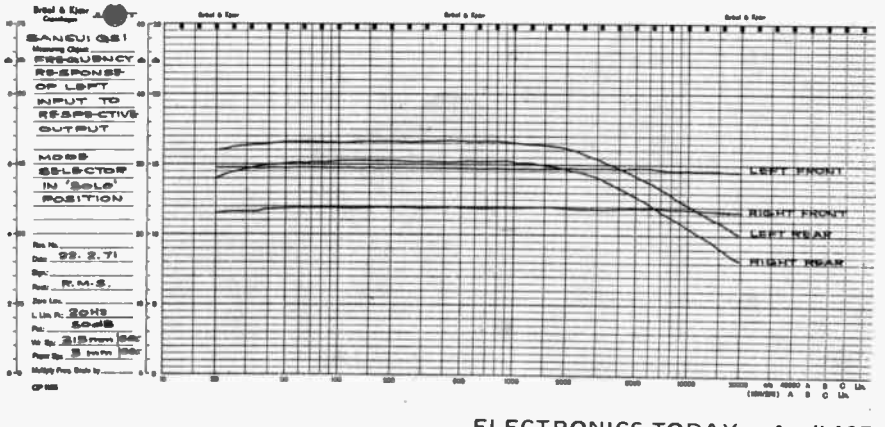
It is a different matter, however, if the system is envisaged solely for quadrisonic simulation of two-channel material.

In this case, until a hi-fi enthusiast has built up a system that is close to perfection, we would consider that his money would be better spent by improving the quality of the two channels that he has rather than adding two more channels and purchasing a Quadphonic Synthesiser.



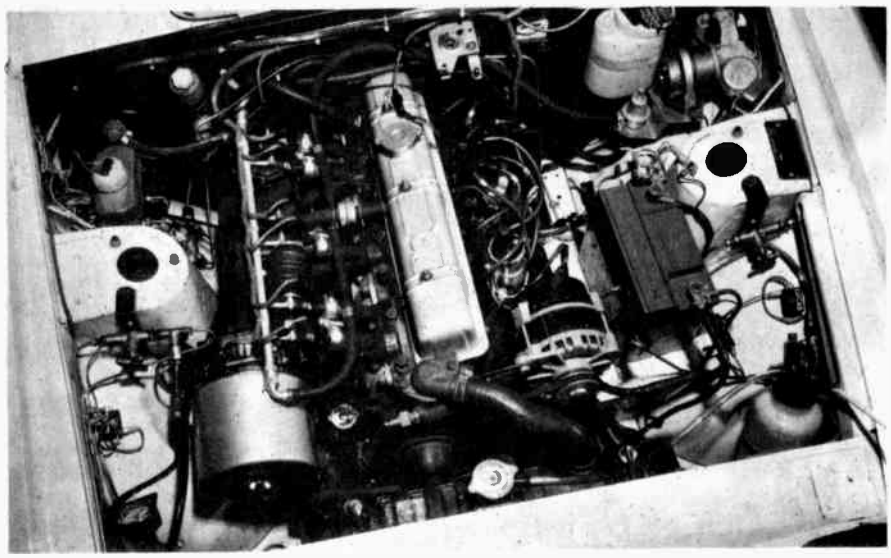






Graphs show outputs from Quadphonic Synthesizer in four operational modes.

ELECTRONIC MONITOR SAFEGUARDS DRIVERS



Engine bay of Triumph used as mobile test bed. Sensors monitor brake hydraulic pressure and fluid level, oil pressure, radiator coolant level and screenwash level.

A significant number of vehicle accidents are caused by mechanical or electrical failure of critical components.

An inbuilt monitoring system continuously checking eight vital functions has been developed by the British company, Joseph Lucas. The system has been fitted experimentally in a Triumph 2.5 PI.

If an alarm condition develops, an appropriate legend is illuminated on the display panel.

In order of priority, the functions monitored are:

1. Brake system
2. Brake fluid level
3. Oil pressure
4. Bulb failure
5. Oil level
6. Radiator coolant level
7. Brake pad wear
8. Screenwash level

The system consists of sensors, associated alarm circuits, an electronic discriminator unit and a facia panel display. An 8V stabilised voltage supply rail, and a single alarm rail, are routed around the vehicle to serve all the alarm circuits.

When an alarm state is reached, the appropriate alarm circuit is triggered to produce an output voltage on the alarm rail, the value of this voltage differing according to the condition being monitored: the more important the condition (as listed above), the greater its alarm voltage. The discriminator unit detects the voltage on the alarm rail and switches on the appropriate output transistor, so connecting bulbs in the display unit to illuminate the corresponding alarm legend.

Should two or more alarm conditions develop concurrently, the discriminator unit will respond to the greater voltage signal on the alarm rail, to give priority to the more urgent alarm.

Various types of sensors and alarm circuits are employed according to the use, as follows:

BRAKE SYSTEM

The brake system is monitored by a hydraulic sensor actuated by pressure differential: its alarm circuit is a simple resistor and transistor circuit which derives the appropriate output voltage from the supply and places it on the alarm rail should an alarm state develop.

BRAKE FLUID LEVEL

The sensor is designed for siting in a dual tank reservoir and has two probe electrodes and a third guard ring electrode. As long as an electrode is immersed in fluid, there is a conductive path to the guard ring. When fluid level in either tank falls below the probe, an output voltage is obtained from the alarm circuit, which is of integrated circuit form.

OIL PRESSURE

The sensor is a pressure-actuated on-off switch, operating in conjunction with an alarm circuit of the type used with the hydraulic sensor in the brake system.

BULB FAILURE

Stop lamp and flasher bulb sensors are series resistors in the supply feed to each bulb. The voltage dropped across each resistor is monitored by alarm circuits of integrated circuit form.

The sensors used for the remaining bulbs (main and dipped beam, side, tail, reverse, and numberplate) are photodetectors. Each photodetector and its associated alarm circuit, which is of integrated circuit form, comprises a single package. It is mounted in a lamp assembly so that the photodetector is unaffected by ambient light.

Should any bulb fail, an output alarm voltage appears on the alarm rail.

OIL LEVEL

A sensor exhibits low impedance when hot, and high when cool; it is housed in a dashpot in the sump. As long as an adequate oil level is maintained, heat from the sensor is removed to the surrounding oil, keeping the sensor cool. When oil level falls below the sensor, the latter becomes hot and the resulting impedance change is detected by the alarm circuit, which is of integrated circuit form.

RADIATOR LEVEL

A sensor and alarm circuit of the type used to monitor either oil level or brake fluid level is employed to monitor the level of coolant in the radiator. In some layouts it may be necessary to use two sensors to overcome surge problems when cornering, and this is shown on the car.

BRAKE PAD WEAR

The sensor is a contact inserted below the surface of the brake pad. As wear proceeds, the sensor is ultimately exposed and contact made. The alarm circuit takes the same form as that operated in conjunction with the pressure switch in the brake system.

SCREENWASH LEVEL

The sensor and alarm circuit are the same types as those used for monitoring brake fluid level.

ELECTRONIC DESPATCH

105 ELDRIDGE ROAD, BANKSTOWN 2200
(AT REAR)

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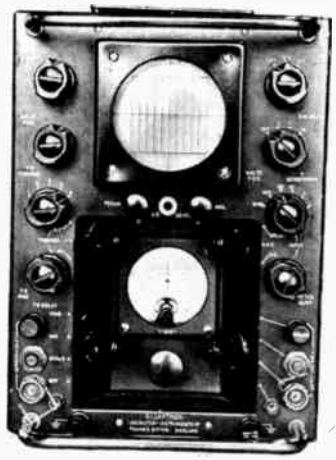

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BC109 NPN ...	75c	AF116N	75c
BF115	70c	ADY23	$1.50
BF179	$1.50	ASY50/53/54 ...	50c
OCP71	$3.50	2N5459 (MPF105)	$1.60
AC127	95c	2N3055	$2.50
AC128	85c	2N456A	$2.50
AC187	$1.00	2N513B	$4.00
AC188	96c	2N511A	$2.00

DIODES

OA91 (1N277)	27c	BA102	90c
BA100	35c	AA119	30c
BZY88/C12 (ZENER DIODE)			72c
BZY88/C9V1 (ZENER DIODE)			72c
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electronics in Education

Students at Trinity Grammar School (Kew, Victoria) put a test programme through their newly-acquired PDP - 8 computer.

Classroom Computer

ONE of the most exciting developments in secondary school mathematics teaching in Australia took place recently at Trinity Grammar School, Kew, Victoria, when a new computer typed out the answers to the boys' first computer programs.

The machine, a PDP-8/S, had been installed only a few days before and already the boys were eagerly writing, testing and running their own programs.

While not the first Australian secondary school to introduce courses on computer programming, Trinity Grammar is probably first to have purchased its own computer. For some time the Mathematics Centre has been operating as an applied mathematics laboratory, and the addition of a computer was a logical step forward.

Mr. John Skelton, Co-ordinator of the Mathematics Centre, has introduced a range of topics including statistics, numerical methods, surveying, and the use of the slide rule and mathematical instruments. In the past, it was found that hand-operated and electric calculators were inadequate for the volume of iterative calculations required by the classes. With the new high-speed general-purpose computer, the range and depth of topics can be extended.

Fifth form boys spend two hours each week at the Mathematics Centre, and about one-third of this time is devoted specifically to computer activities. They learn binary, octal and hexadecimal number systems, flow charting, program logic and computer methods for solving equations, constructing difference tables, integrating and generating such functions as log, sine and square root. Also how to prepare, program and data tapes, to call their program into the machine and to interpret the console lights.

Learning to prepare a problem in detail for the computer is even more important from the educational viewpoint. The FOCAL language used is quickly learned but sufficiently powerful to accommodate any program likely to be written by secondary school pupils. Already programs have been written involving series, equation solving and statistics, and some excellent suggestions for new problems have come from the boys themselves, who actually debug their programs directly on the teletype.

Third and fourth form boys are being introduced to the computer but are spending only half as much time in this work as the older boys. Nevertheless, before they reach the fifth form they will have covered sufficient ground-work to handle increasingly complex assignments.

Interest shown by the boys is reflected in the popularity of the school computer club. Members work under guidance studying electronics and constructing circuits such as flip-flops and random number generators, and thus gain useful practical experience in computer hardware.

In planning to introduce computer studies into a school syllabus, there is a choice of three procedures.

1. To purchase card or tape preparation equipment and hire a service computer. Capital and operating costs are low, but the system requires considerable organizational effort and suffers the disadvantage that pupils never acquire direct operating experience and may not overcome a feeling of awe for a remote computer. Further, they are denied the benefits of using a modern programming language in the conversational mode.

2. To hire a terminal connected to a large central computer. Although this costs more, the students will acquire a feeling for direct operation. For large classes some form of fast input device and off-line program preparation facilities will be needed.

3. To purchase a small computer. For less than $10,000 a machine can be obtained with 4K word memory, paper tape input-output devices, and a teletype. Such a machine can also be used for administrative work, and for computer-aided classroom instruction.

CURVE TRACER DISPLAYS SEMICONDUCTOR CHARACTERISTICS

Designed and developed by New Zealand's Central Institute of Technology, the CIT Curve Tracer aids the teaching of basic semiconductor characteristics. It enables a demonstration oscilloscope to display characteristic curves of a very wide range of devices.

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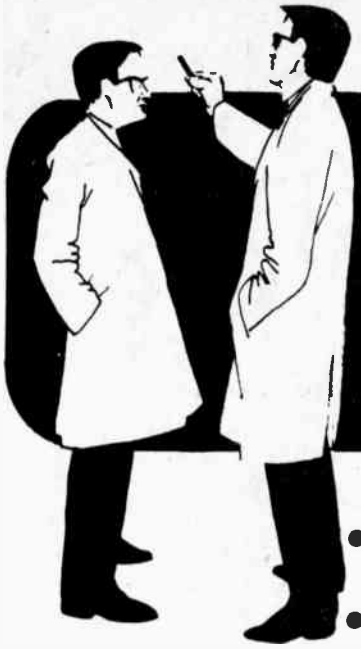
DIODES – The forward and reverse characteristics of silicon, germanium, point-contact and other diodes.



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TRANSISTORS – Characteristics of transistors including saturation and breakdown regions. Matching for similar or complementary characteristics. The effects of heat on germanium or silicon devices. The effects of reversing emitter and collector connections.

FETs – Drain characteristics of P-channel and N-channel devices, I Pss, VP, pinch-off. Matching for similar or complementary characteristics. The effects of heat. Reversal of drain and source connections.

PHOTO–DEVICES – Photo-diode and photo-transistor characteristics.

The unit is supplied with 72 semi-conductors of all types. These are mounted on cords which plug into the Curve Tracer.

Outputs from the Curve Tracer are:

X AXIS – Voltage across the semi-conductor: either positive-going or negative-going.

Y AXIS – Current through the semi-conductor: 34 milliamps maximum (340 milliamps for high power devices). This is presented as a positive-going or negative-going voltage to the oscilloscope Y amplifier.

CALIBRATION – An internal calibrator produces an L-shaped display.

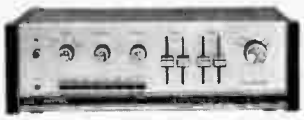
The selection of polarities and ranges is made automatically by programming cards. These identify the device connections and also illustrate the axes represented on the display.

Power requirements for the Curve Tracer are 230 volts, 50Hz, 20VA.

The CIT Curve Tracer is manufactured by Harding Signals Limited, 44 Wainu Road, Lower Hutt, New Zealand.

ENCEL HAS LOWEST PRICES ON HIGH QUALITY ROTEL AMPS

At Encel's unbeatable low prices these fine Rotel stereo amplifiers are outstanding value for money!

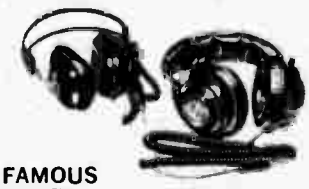


ROTEL RA 610

Reviewing this unit, Electronics Australia (January 1971, Page 109) says, "on test this amplifier performed impeccably. Harmonic distortion was less than 0.1% at 25 watts. Frequency response was exceptional with —3dB points at 6Hz and 200kHz. Square wave response was excellent and stability with capacitative loads was also good."
The new RA 610 offers 32 watts RMS per channel.
Housed in handsome wood cabinet and fitted with slide tone controls and extensive connection facilities on rear panel.
Encel price only $199.00.

ROTEL RA 310

Same high quality as the more powerful RA 610. 17 watts RMS per channel, with harmonic distortion less than 0.2% at rated output. Like the RA 610, this outstanding amplifier measures better than its quoted specifications on test. Encel price only $129.50.



FAMOUS ROTEL STEREO HEADPHONES

Model RH-711 (15-25,000 Hz). **Encel price $17.50**
Model RH-600 (20-19,000 Hz), only $9.50. Both headsets complete with 10ft. of cord and standard stereo plug.

Note: All prices include sales tax. Write for full INFORMATION on all these items. Technical reviews available on items marked★.

NOW ENCEL OFFERS BETTER SOUND FOR LESS COST WITH NEW 'SEAS' SPEAKERS

Australian enthusiasts have snapped up earlier shipments of famous 'SEAS' speakers so fast that Encel is now extending the range. Many more types will soon be available. 'SEAS' offer sound quality that no other speakers at a similar low price can match!

JUST ARRIVED 'SEAS' MODEL 21TV-GD

An 8½" dual cone unit.
Wide frequency range from 40-18000 Hz 8 ohm impedance, 16 watts power handling.
Encel Price $10.50

'SEAS' MODEL 25TV-ED

A 10" dual cone unit with frequency range from 25-15000 Hz 8 ohm impedance, 20 watts power handling.
Encel Price $12.50

'SEAS' MODEL 30TV-COAX

A 12" co-axial, wide range (30-20000 Hz) speaker. 8 ohm impedance, 24 watts power handling.
Encel Price $34.80

OTHER WANTED 'SEAS' SPEAKERS

MODEL 21-TV-EW

An 8½" "woofer" of exceptional response. Frequency range 35-2000 Hz impedance 8 or 15 ohms, 30 watts power handling.
Encel Price $24.80.

MODEL 25TV-EW

A 10" "woofer" with frequency range 30-1500 Hz. Impedance 8 ohms. 30 watts power handling.
Encel Price $29.80

MODEL 87H

(Dome Tweeter) High loading, low distortion speaker with frequency range 1,500-20,000 Hz. Impedance 4 to 8 ohms 35 watts power handling, with crossover network.
Encel Price $19.80

Note: All prices quoted include Sales Tax.

MADE FOR EACH OTHER . . .

Grace G 840 Arm and Grace F-8C Cartridge

Encel offers this famous Hi-Fi duo at the unbeatable price of **$99.00 (inc. sales tax).**
The ultra lightweight headshell accepts all standard ½" mounting cartridges.
There is no better arm than the renowned G 840. It is specially shaped and tapered for torsional and resonant stability and fully compensated for side thrust.
It moves with minimal friction on high precision gimbal mountings and is fitted with in-built oil damped lift and lower control. A calibrated rotary counterweight gives perfect adjustment of stylus pressure.

For maximum performance team the G 840 with the top ranked Grace F-8C magnetic cartridge (Encel price for cartridge alone—**$49.50, inc. sales tax).** This fine unit, with replaceable elliptical diamond stylus, has virtually flat frequency response and is ideally suited for laboratory testing of audio equipment. It maintains excellent separation well above 10kHz and tracks at minimal stylus pressure of 0.5-1.5 gms. Frequency range 15-25 kHz ± 2.5 dB-1 dB, with cross talk less than —30 dB (1kHz).

Write now for full technical specifications of these top line components.

G 840 — $49.50

F-8C — $49.50

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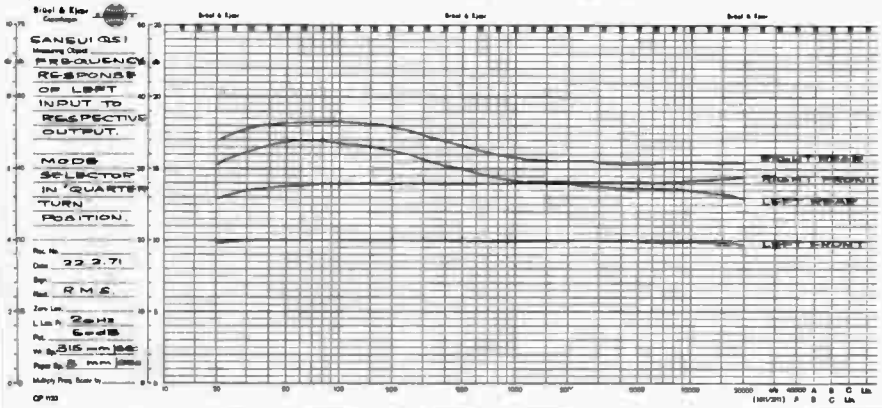
electronics TODAY
test procedure

Bruel & Kjoer level recorder provides graphical record of output at varying frequencies. Sample graph below was taken during our test of Sansui Quadphonic Synthesiser (see report, page 64).



HOW WE TEST

Our testing consultant -- registered with the National Association of Testing Authorities – explains how he assesses equipment for ET

Equipment testing methods have changed significantly in the past decade. In the late fifties total harmonic distortion of an average amplifier was between 1% and 3%, whilst distortion figures between 0.1% and 0.5% were considered excellent.

Today distortion performance between 0.1% and 0.5% is considered average for the newer transistor amplifiers, and many manufacturers claim less than 0.01% to 0.05%.

The measurement of such parameters requires the ultimate in precision measurement equipment and is typical of the rapid advances made by the electronics industry.

To provide our readers with the best possible analysis and evaluation of new products, we have arranged to have our testing conducted by an independent and NATA-registered laboratory, equipped with the latest automatic analysis equipment.

The laboratory is staffed by engineering graduates and has facilities equal to the best in Australia. These facilities allow the widest possible range of unbiased and factual measurements.

Test results will not be made available to the equipment supplier before publication; however, if the unit is obviously faulty, we will test another of the same type (a note to this effect will, of course, appear in the text) If test results show that the equipment does not meet its manufacturer's claimed specifications, this will be factually reported.

We will evaluate the performance of amplifiers on a standard graphical basis.

The results will be presented on calibrated graph paper with a logarithmic response for sensitivity, having gain (recorded directly in db) on one axis and a logarithmic frequency scale on the other.

These spectrograms (or level recordings) are produced automatically by an electronic measurement system.

All normal measurements will be taken with high wattage resistive elements loading each channel.

However, because the average user may accidentally disconnect his speakers, tests of overload characteristics and the ability of the amplifier to withstand short circuits and open circuits will also be made.

Test procedure – amplifiers

Our laboratory test reports will contain the following information:

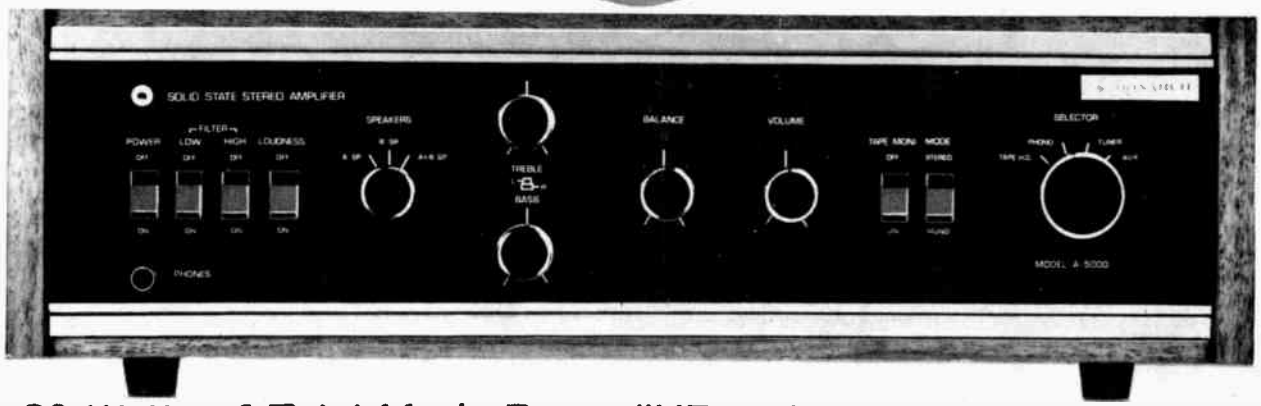
A full description of the amplifier including such details as serial number, number of inputs, their sensitivities, number of outputs and their impedances, switching facilities, main controls, auxiliary controls, size, weight, power consumption at full load and no load, numbers and types of transistors used, and type of

EQUIPMENT USED

Oscillators	*Bruel & Kjaer Type 1014*
" " "	*General Radio Type 1313A*
" " "	*Hewlett Packard Type 209A*
Meters	*Bruel & Kjaer Type 2606*
"	*" " " " 2409*
"	*" " " " 2204*
"	*Hewlett Packard Type 400H*
Level recorder	*Bruel & Kjaer Type 2305B*
Filters for	*Bruel & Kjaer Type 1613*
distortion	*" " " " 1614*
measurement	*" " " " 1617*
Resistance & ratio bridge	*E.S.I. Type P.V.B. 300.*

$ FOR $

The MONARCH A5000 sounds better than any Amplifier Ad. you've ever read!



*** 80 Watts of Total Music Power (IHF at 8 ohms) * Dual-channel IC Equalizer for perfect balance * Special Protection Circuit against overload * Latest all-silicon transistor circuitry**

Here is a truly solid state stereo amplifier which combines a noise-free preamplifier and a ruggedly built main amplifier in one gracefully laid-out chassis. It utilizes every engineering know-how of the very latest advances in transistor audio technology to offer laboratory precision performance for your home entertainment. The newest types of silicon transistors are used throughout the circuitry.

The well-designed and tightly regulated power supply assures the total music power of 80 watts (IHF) into 8 ohms. The ability of the power supply is such that the amplifier runs cool with 30 watts RMS each channel operation, without causing current drain to any section of the circuitry even during high level of musical transients.

The direct coupled driver stage, because of elimination of transformers, achieves extremely low distortion. At 25 watts output level the distortion falls as low as 0.2% to produce the pure clarity of sound.

The special protection circuit is proved to guard the driver and output transistors against overload or short-circuit. This is a device to automatically reduce or cut out input signal when over-load or short-circuit occurs. It is also automatically self-resetting to permit the amplifier to resume normal operation. An IC (integrated circuit) of a special type, which contains in one single unit a complement of both channel components in equalizer circuit, is used to provide perfect balance of input for optimum stereo.

Complete array of the front panel controls and switches offers versatile yet easy-to-operate facilities. Dual controls permit separate boost and cut of TREBLE and BASS for each channel. Speaker selection switch provides for operation of either one or two pairs of speaker systems separately, or both simultaneously. On the rear panel a MAGnetic-CERamic switch for choice of phono cartridge is provided. A continental DIN jack is also used for convenience for tape recording and playback.

Housed in the oiled walnut wooden cabinet with the distinctive style of the black panel, the A-5000 fits and enchances your decor.

Recommended Retail Price $189.

Australian Distributors

W. C. Wedderspoon Pty. Ltd.

Showroom: 193 Clarence Street, Sydney. 29-6681

A.C.T Homecrafts, Petrie St., Canberra
VIC. Douglas Trading, 191 Bourke St., Melb.
Southern Sound, 963 Nepean H'way, Moorabbin.
QLD. S. G. Hughes, 154-158 Arthur St., New Farm.
W.A. Leslie Leonard, London Court, Perth.
TAS. P & M Distributors, 87 Brisbane St., Launceston.
Sound Spectrum, 33 Regents Arcade, Adel., 5000.

WDS/FP

HOW WE TEST

overload protection. Salient features of the circuitry will be described.

Testing an amplifier calls for standard procedures.

The frequency response of the amplifier will be measured at nominal output power of 1 watt, 10 watts and full load.

Frequency response of tone controls and auxiliary control will be evaluated at a power level of 1 watt.

Distortion will be evaluated at the same power levels as the frequency response, unless stated otherwise. Distortion measurements will be made at 50Hz, 1kHz and 10kHz.

Intermodulation distortion measurements will be made at the same levels as main distortion measurements, utilising a two-tone test system.

Power bandwidth measurements will be made at 8 ohms and 16 ohms output impedance with both channels equally loaded. The mains voltage will be held at a constant 240 volts.

Damping factor and square wave response will be evaluated with 100Hz, 1kHz and 10kHz square waves applied.

If necessary, the phase response of the amplifier will be evaluated where such a measurement is considered relevant.

Where frequency responses are stated in the text, these will be given at the standard limits of ± 3 db (and also at ± 1 db if relevant).

Hum and noise levels will be measured at the maximum and minimum volume control settings and the results will be referred to the maximum power output. These levels will be determined in all cases with the input terminated in the correct impedance. The minimum gain noise measurements are particularly useful when the amplifier under test has a very high output power and consequently would often be used at 1/10th or 1/20th of its rated power.

Equipment used

The primary equipment used for analysis is manufactured by Bruel & Kjaer, of Denmark. This consists of a mechanically-connected beat frequency oscillator and level recorder, together with a measuring amplifier and electrically-connected filter unit. Frequency responses, gain distortion, cross talk, channel separation and many other parameters can be permanently recorded with a considerable saving in time.

Where necessary, the outputs from the oscillators can be filtered, and filters used in the analysis chain. Through this approach signals with less than 0.01% distortion can be produced and comparable distortion levels measured.

Tape recorders

A typical test for a tape recorder is more complex than for an amplifier. The parameters to be evaluated include most of those evaluated in an amplifier, together with wow, flutter, frequency stability with voltage changes, and other control functions.

The use of an automatic record-to-replay analysis system is essential to facilitate rapid evaluation of the tape recorder's frequency response.

The ergonomics of tape recorder design is particularly important and separates the best tape recorders from the rest. It is not evaluated by instrument testing but by the time-honoured procedure of picking up the handbook and trying out the instructions

Speakers

Speaker testing is carried out in an anechoic chamber, with extremely linear laboratory pressure-microphones measuring the acoustical response.

Manufacturer's graphs generally show a smoothed frequency response (by using a long averaging time). Our tests will show the true frequency response, and this will facilitate comparisons between various speakers and speaker systems.

Other products

The testing of record players, cartridges and other products calls for special equipment. This includes test records, correlators, wow and flutter meters, stroboscopes, voltage and frequency meters, calibrators, standard

Oscillator generates input signal used in testing amplifiers, speakers, etc.

PRE-PAK electronics

MAIL ORDER SERVICE:
P.O. Box 131, Kingsgrove. 2208.

SALES CENTRE—Phone 69 5922
103 Regent Street, Redfern. 2016.

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95 Regent Street, Redfern. 2016.

CITY SHOWROOM—Phone 211 2826
429 Pitt Street, Sydney. 2000.

POLYTRON MODULES

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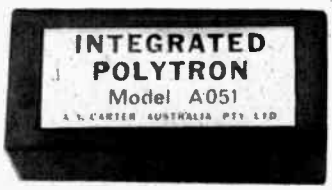


These miniature encapsuled modules, complete, pre-tested and guaranteed, are ideal for constructing an 8 transistor radio or tuner, and can be used separately in hundreds of different applications. To build a complete radio you need only add ferrite rod aerial, tuning gang, volume control, speaker and battery.

Model R010 RF Section — Mixer/Oscillator. 1 transistor circuit tunes 540-1600 KHz. Size 1¼" x 1" x ¾". Price **$3.95.**

Model I022 IF Section 455 KHz. 2 transistor circuit, 3 IF transformers, Pre-tuned. Size 2" x 1" x ¾". Price **$7.95.**

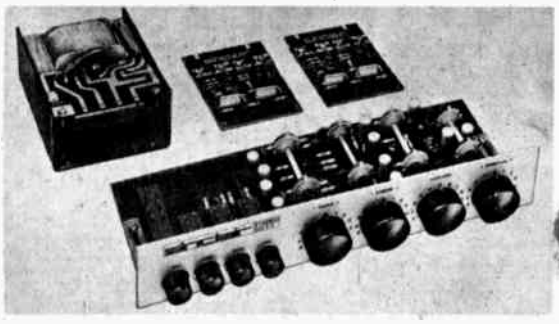
Additional parts required to build de-luxe 8 transistor radio.

Ferrite Rod Aerial	$1.00
Tuning gang	$1.90
Volume control 5K	$0.60
Speaker	$1.90
Battery holder 4x penlite	50c

Model A051 Audio Amplifier. 5 transistor circuit, maximum output 200mw supply volts 6v. Maximum current 55mA, input sensitivity 100Mv. Speaker impedance 8-15 ohms, Freq response 300Hz-15Hz. Price $5.95, Post 10c.

We supply complete instructions for use, including circuit diagram. Discount for club members 5%.

SINCLAIR STEREO SIXTY AMPLIFIER



A chassis and case, to original Sinclair specifications, is now available for the Z30 system. Exclusive to Pre-Pak Electronics. Price ..... **$12.00.**

This is your opportunity to buy a quality stereo amplifier which you can build yourself for almost half the cost of buying a similar commercially made amplifier.

Complete instructions are supplied for assembly.

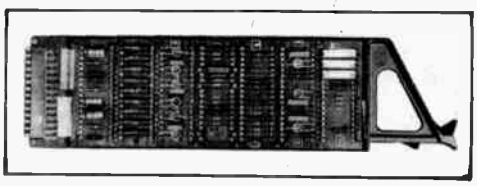
Stereo Sixty pre-amplifier	**$34.25**
Z30 20WRMS power amplifier	**$14.90**
Z50 40WRMS power amplifier	**$18.75**
PZ5 Power Supply (for Z30)	**$14.90**
PZ6 Power Supply Regulator (for Z30)	**$32.45**
PZ8 Power Supply Regulator (for Z50)	**$26.50**
PZ8 Power Transformer (for above)	**$15.90**
Active Filter Unit	**$26.50**
IC10 Integrated Circuit	**$14.90**

Trade prices available on request.

BARGAINS

IN COMPONENTS AND EQUIPMENT! NEW DISPOSALS CENTRE— 95 Regent St., Redfern. N.S.W.

We have dismantled two complete Honeywell computers, PLUS tons of army surplus, manufacturers surplus, and other disposals lines — all good clean, top quality, equipment selling at a fraction of manufacturers costs.



COMPUTER PANELS

Qty. 1-4	$2.50	Post 50c.
Qty. 5-9	$2.00	Post $1.00
Qty. 10-24	$1.80	Post $2.00

Sockets for panels 10c ea.

We also wish to buy Army, Navy or Air Force surplus, manufacturer's surplus, communication receivers, test equipment or any other type of electronic equipment which is in good condition.

HOW WE TEST

Measuring amplifier takes flat or weighted measurements of energy from 2Hz to 200kHz.

VU meters, vibration meters, tone burst generators and cathode ray oscilloscopes.

There are many other pieces of equipment which are used less frequently. These will be discussed in detail when relevant.

Standards are of paramount importance in a testing laboratory. Where suitable standards are available, they will form the basis for all tests conducted and will be clearly referred to in the text.

How an amplifier is tested

First task is to unpack the unit and examine the adequacy of the packing. This may seem trivial — but it allows us to evaluate the likelihood of your receiving the equipment in an undamaged state.

Secondly the handbook is checked for schematic data, lucid explanations of the functional operation of the equipment, and — last but far from least — the presentation of a circuit, to allow you or somebody else to check and repair the equipment in the event of failure.

Whilst some equipment manufacturers are particularly good in this respect (notably the Americans and Japanese), quite a few European manufacturers feel that they alone can produce new and novel circuitry and use this as an excuse for not providing circuit diagrams.

Next task is to plug the amplifier into the mains and connect the peripheral equipment such as record players, tape recorders and radio tuners.

There is no standard method of connecting speakers to amplifiers. The four most common methods are by jack sockets, DIN speaker sockets, screw terminals and, in a few cases, special plugs or clips.

Following the well-known principles of Murphy's Law, it is unknown for the speaker connections used in the last amplifier test to be suitable for the current amplifier test.

The first OPERATIONAL test usually involves a quick check to see that the amplifier works. The second involves a subjective evaluation of the amplifier with one of the standard test records used for this purpose. Once we are satisfied that the amplifier is working correctly, we proceed with the full instrument testing.

This involves the use of the automatic analysis system in which the amplifier becomes the central link in an analysis chain, with dummy loads terminating each output channel.

A signal from a sweep oscillator is fed through the main inputs and the output monitored by a system consisting of a precision laboratory measuring amplifier (such as the Bruel & Kjaer Type 2606) which then feeds its output into the level recorder.

The level recorder is a particularly useful device — undoubtedly the most often-used piece of equipment in the laboratory. It has the ability of converting an ac signal (whose intensity may vary over a 300 to 1 dynamic range) into a dc signal and recording this on logarithmic graph paper. This conversion is independent of the frequency of the signal and, up to a limit, independent of the rate of change of the signal level.

The actual conversion can be set to correspond to true rms, average, or peak, characteristics of the signal.

By means of a mechanical coupling, the actual position of the calibrated graph paper is made to correspond directly to the frequency of the oscillator which it drives.

The level recorder is set to trace out the frequency performance at three or more power levels, and is then set to measure second and third harmonic distortion in a similar manner, but using a filter (typically a stepped one-third octave filter) connected to the measuring amplifier.

Using these methods, measurements which would take a day if performed by conventional means are completed in less than half an hour.

Measurements of internal noise are achieved in a similar manner by terminating the inputs with the correct resistor and measuring the noise at the output of the amplifier. Channel separation is evaluated by connecting the analysis system onto the output of alternate channels.

If the amplifier has a particularly good specification, the system used for measuring distortion changes somewhat.

First, the output of the oscillator is filtered through an octave bandwidth filter to provide a signal with distortion less than 0.01%.

The analysis chain then consists of a one-tenth octave bandwidth passive filter type 1607, followed by a Bruel & Kjaer measuring amplifier type 2606 and filter set type 1614.

This system is capable of measuring distortions as low as 0.005%.

Testing of intermodulation distortion involves feeding the amplifier with two test tones whose frequencies are generally well-separated (typically 270Hz and 110Hz). The two test frequencies are combined in a resistive combining unit which separates the two oscillators and prevents interaction.

The output of the amplifier is analysed for harmonic products. These typically occur at frequencies $f_1 + f_2$ $f_2 - f_1$ $2f_2 \cdot f_1$, and so on.

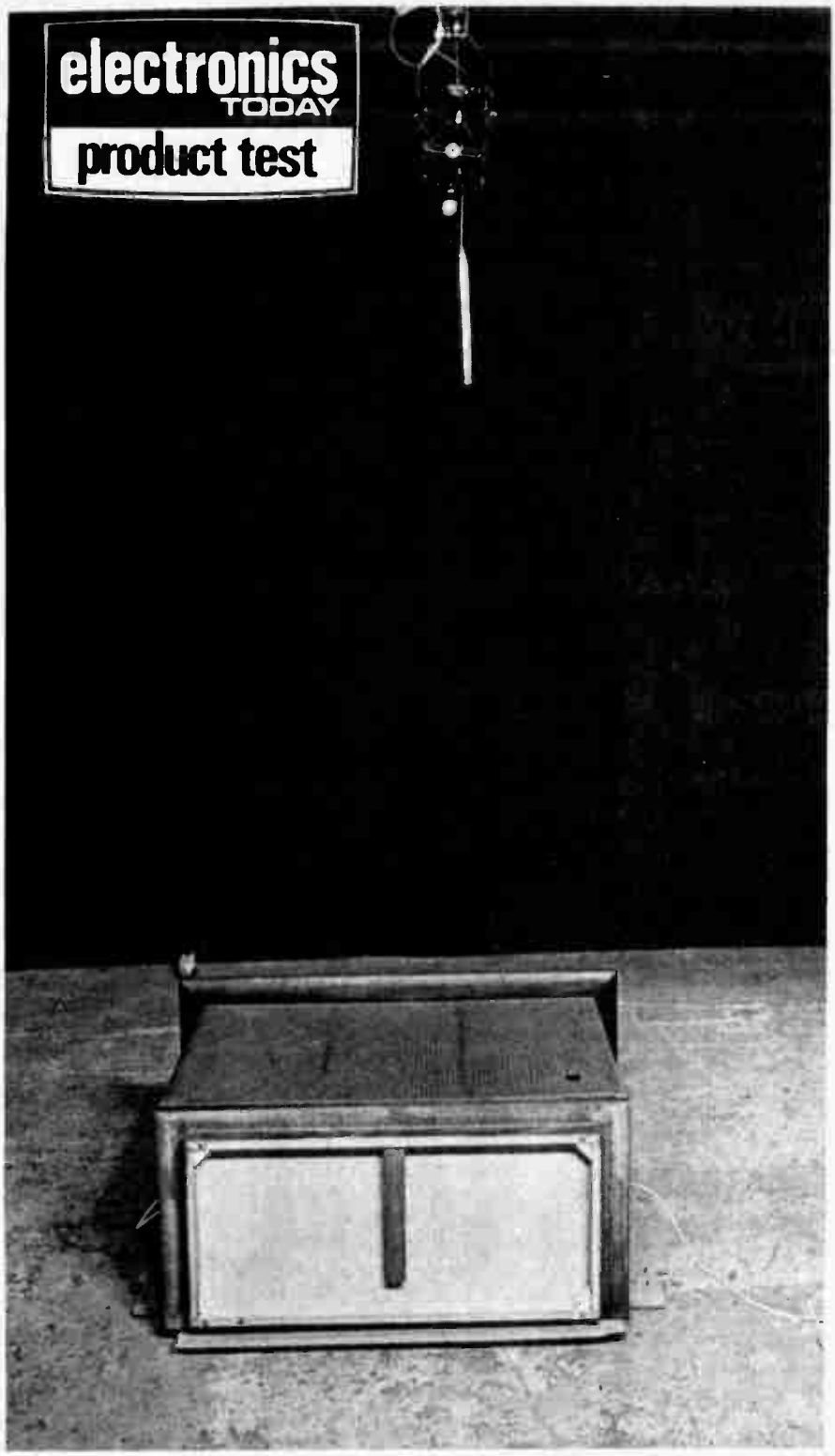
The relative level of the frequency components facilitates the rapid evaluation of intermodulation distortion.

The last test which we carry out is dependent on the data specified by the manufacturer.

This test involves the application of an open circuit condition and a short circuit condition. This determines the amplifiers' ability to cope with what we regard as an exceptional condition in the hands of the average user. The test is applied unless the handbook specifically advises otherwise.

Generally the latest amplifiers come through this test particularly well — but it's the sort of test that neither the manufacturers nor importers care to try deliberately. To the owner it's strictly taboo.

Finally the amplifier will be subjectively assessed for a week or two — generally in the home of one of our testing staff.



JBL Sovereign 1 S8R speaker under test, with microphone suspended over it.

Many years ago an advertisement showed a man sitting outside his house which was designed as a giant exponential horn in formed concrete. The message was simple – you didn't need a house like that to obtain good low frequency performance or high fidelity.

What the advertisement didn't tell you was that you still have to spend money if it's perfection that you're after.

The James B. Lansing Corporation, of U.S.A., don't advertise concrete exponential horns – but some of their equipment is massive in size and rather expensive. Their speaker systems and components are fully imported from the United States. As well as making speakers, they make an extensive range of power energisers designed and built to drive their speaker systems.

During the past two years their penetration of the local market has been dramatic, culminating in their selection as suppliers of speaker elements for the Sydney Opera House sound system.

The Sovereign 1 speaker systems are unusual, first because of the degree of care and attention with which they are made, and secondly because they employ a 15" diameter woofer with long throw diaphragm, together with a 15" diameter passive radiator. Whilst the concept is not unusual in the smaller enclosures, this is the first time we have seen it applied to such large speakers in a 3-way speaker system.

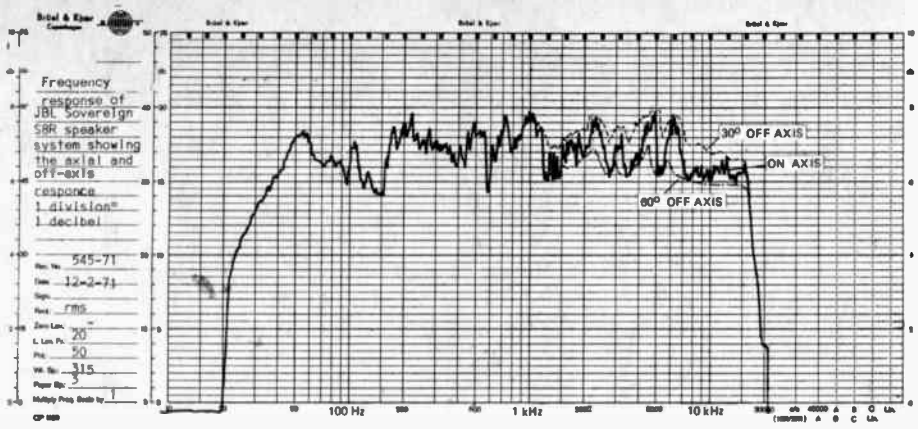
The operating principle of the passive or auxiliary radiator is based on the stiffness of the passive radiator's suspension. At high frequencies it acts as a portion of the baffle, but at low frequencies it radiates the pressure energy received from the enclosure, thus increasing the effective radiating area of the main woofer.

The speaker line-up consists of an LE15A, 15" diameter woofer with a flexible roll surround, and a PR15, 15" diameter passive radiator with a controlled stiffness surround which determines the frequency at which the two speakers stop acting in unison.

Smooth response to below 20 Hz

The LE15A has a free air resonance of 20Hz and, together with the PR15, provides a smooth low frequency response to less than 20Hz. The

A TASTE OF



LE15A has a grain-oriented Alnico V magnet weighing 19½ lb. and a 4" diameter edgewound flat copper ribbon voice coil. The air gap flux density is 11,000 gauss and the total flux is 450,000 maxwells.

The second speaker in the line-up is a 375 driver, which provides the frequencies between 500 Hz and 7 kHz. The 375 has a magnet which weighs 32 lb., is 7" diameter and has a 4" diameter edgewound voice coil. The air gap flux density is 20,000 gauss. The driver is rated conservatively at 35 watts rms but is capable of producing considerably more power than this; based on music power, ratings in excess of 100 watts may be obtainable.

Next component is the HL93 horn and acoustical lens which provides the matched dispersion for the 375 driver. This employs 11 plates set at an angle of 30°. These are shaped to provide a precise hyperbolic curvature so as to spread the sound through 120° in the lateral plane, but to restrict it to approximately 40° in the vertical plane. Finally, an 075 ring radiator produces the high frequency components. This provides the output from 7 kHz to the ultrasonic region beyond 20 kHz.

The 075 is very efficient and offers unusually good high frequency dispersion. With a 20 watts rating and 18,000 gauss flux density, it is a very potent tweeter. The voice coil of the 075 is made from a fine aluminium ribbon wound on edge. This is attached to a lightweight dual ring, clamped both on its inside and outside diameters.

A system such as this reduces spurious modes so effectively that total harmonic generation is less than 3% at inputs of less than 6 watts rms. The voice coil and diaphragm radiate the sound energy through a machined aluminium horn. This horn has a narrow slit at its base which is transformed into a short, smooth exponential section.

Each Sovereign 1 S8R system has two inbuilt crossover networks, an LX5 for the 500 Hz crossover frequency and an N7000 for the kHz crossover frequency. These have wire wound attenuators at the back of the cabinet, so that the system components can be balanced to suit individual tastes and room requirements.

Each cabinet is solidly constructed from ¾" thick veneered particle board with internal framing and adequate damping. The woodwork is given an 'antique' finish, to make it appear like a well-preserved piece of furniture.

ABOVE: Graph shows frequency response of JBL Sovereign speaker.

The period style cabinet work will not suit all decors — but there is no denying the quality of the workmanship, nor the thought that has gone into its design.

The cabinet is 40" wide, 27" high and 20" deep. Because the width is so great, the designers have made a left-hand and right-hand speaker with the 075 ring radiator moved from one side to the other. Personally we would have preferred two tweeters, but the results were good with only one.

The front of the cabinet is acoustically transparent and readily detaches to reveal the speakers, each clamped in position from the front.

The 15" speaker and the passive radiator are symmetrically mounted on either side of the cabinet, with the horn lens between them. The ring radiator is fixed above one of the 15" diameter elements.

Because each system weighs 152 lb., we were presented with a number of problems. Normally we would perform our subjective appraisal prior to carrying out detailed performance measurements. This time, however, the size and weight of the units precluded this approach and the order was reversed.

The size of the units was greater than our anechoic (echo-free) room could handle, and because of this we performed our tests under semi-anechoic conditions.

Speaker with grille removed. Woofer is at rear of photo, passive radiator at front, high-frequency components at right.

MONEY

WE TEST THE $2,800 J.B.LANSING SOVEREIGN 1S8R SPEAKER SYSTEM

3 SIMPLE STEPS TO RECORD PLAYING SUCCESS.

1. INVEST IN THE BEST TURNTABLE AVAILABLE. THORENS

Choose from the Model TD-125 or the TD-150 Mk. II. Then you can share the opinions of leading overseas reviewers: *"the best three-speed manual we've ever tested"* — ("High Fidelity"), *"wow and flutter were as low as we've ever measured"* — ("Stereo Review"), *"a favourite contender in the best turntable category"* — ("Audio"), *"it would be hard to imagine a unit that performs better"* — ("Electronics World").

Examine Thorens specifications closely and critically. The new Model TD-125 features: ● Transistor governed 16-pole synchronous motor ● ±2% speed control on all speeds ● Belt drive ● 7½ lb. 12" turntable ● Wow and flutter ±0.08% ● Rumble —68dB. ● Fine Swiss craftsmanship.

The lower priced Thorens TD-150 Mk. II offers: ● 16-pole synchronous motor ● Belt drive ● 7 lb. 12" diameter turntable ● Two speeds — 33⅓ and 45 rpm ● Wow and flutter ±0.09% ● Rumble —65 dB.

When you've purchased your Thorens turntable . . .

2. ADD AN ORTOFON M15 STEREO CARTRIDGE.

After many years research, Ortofon have designed a new stereo cartridge which maintains the proud traditions of the Ortofon name. Featuring new principles, the high performance standards which have made Ortofon world famous have been preserved in the new Series M15 and MF15. Over 80% of professional users such as the radio and television stations (and recording studios) specify Ortofon equipment.

BASIC SPECIFICATIONS:

Weight of cartridge: *5 grams.*
Frequency response: *20 Hz. to 10 kHz. ± 1 dB. 20 Hz. to 20 kHz. ± 2 dB.*
Recommended load: *47 k ohms.*
Channel separation at 1 kHz. *Greater than 30 dB.*

Having equipped yourself with a fine player and cartridge . . .

3. KEEP YOUR RECORDS CLEAN WITH WATTS EQUIPMENT.

Airborne dust and dirt are the greatest enemies of your records and cause untold amounts of noisy interference.

We recommend:

THE WATTS "DUST BUG" . . . which cleans the record, removing dust and static charges as the record plays. Surface noise is reduced considerably.

THE WATTS "DISC PREENER" . . . designed expressly for records which have not had previous anti-static treatment. The "Disc Preener" keeps new records like new.

THE WATTS "MANUAL PARASTAT", Model Mk. IIA. . . . is a dual purpose record cleaner designed to maintain new records as new and to restore fidelity to older discs.

Ask for a copy of the Watts Guide to Record Cleanliness when you visit your record store.

**It's easy to follow the Three Steps to Success. Call at your nearest franchised Simon Gray dealer's showroom. He'll be delighted to tell you all about Thorens turntables, Ortofon stereo cartridges and Watts record cleaning equipment!*

SG TOW 3/71

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Head Office: 28 Elizabeth St., Melbourne, Vic. Tel. 63 8101*, Telex 31904; **Sydney Office:** 22 Ridge St., North Sydney, N.S.W. Tel. 929 6816; **Canberra Office:** 31-33 London Circuit, Canberra City, A.C.T. Tel. 49 6050. **INTERSTATE REPRESENTATIVES: N.T.:** Pfitzner's Music House, Smith St., Darwin. Tel. 3801; **Q'land:** Sydney G. Hughes, 154-158 Arthur St., New Farm, Brisbane. Tel. 58 1422; **S.A.:** Elico Sales Pty. Ltd., 7-9 Osmond Terrace, Norwood, S.A. Tel. 63 4844; **Tas.:** K. W. McCulloch Pty. Ltd., 57 George St., Launceston. Tel. 2 5322; **W.A.** Athol M. Hill Pty. Ltd., 613-615 Wellington St., Perth. Tel. 21 7861.

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Please send me all the facts about: (a) Thorens turntables; (b) Ortofon cartridges; (c) Watts record cleaning equipment . . . and the name of my nearest franchised Simon Gray dealer.

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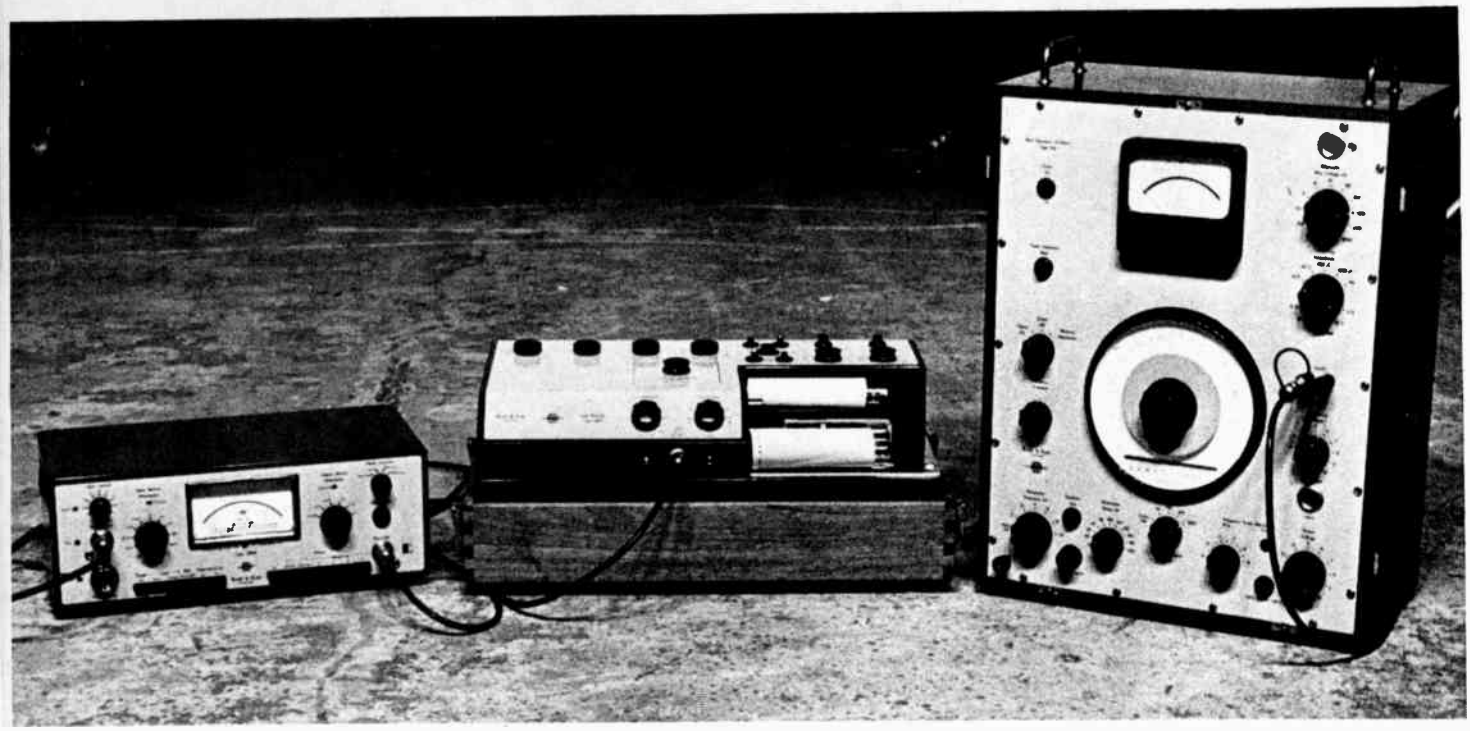


Equipment used in test included a Bruel & Kjoer beat frequency oscillator, measuring amplifier and level recorder.

A TASTE OF MONEY

The tests showed that the bass frequency response of these speakers is better than that of any other speakers previously tested by this laboratory. The efficiency of the speaker is equally superior.

The unusual efficiency of the speakers means that you can generate shattering levels of 110 db with only a few watts of energy – and if you use a truly high-powered amplifier, levels of over 120 db are effortlessly, even if painfully, achievable. The measured output was 106 db ± 5 db at 6' on axis from a 1 watt input.

Even at the highest rated levels there is no trace of audible distortion. With inputs of over 60 watts per channel the distortion does start rising, but at a lower rate than any other speaker system which we have seen. This must be, in part, due to the use of the large magnets and the long throw voice coils, and to pressure horns for the frequencies above 500Hz.

The measured frequency response of the speaker system is 30Hz to 18kHz ± 6 db under idealised home listening conditions. The uniformity of sound pressure level over a 100° arc in the horizontal plane is unusually good, and better than ± 3 db compared with the figures measured on the axis. (See accompanying level recording.)

Testing the subjective performance of the speakers near to their rated capacity called for the use of a good amplifier with flexible peripheral equipment. Regrettably, the room we used for the subjective testing was not really good enough – but the facilities it offered compensated for this.

The equipment we used consisted of a JBL SA660 solid state amplifier with inputs from a Revox · A77 tape recorder and a PC2020L record player fitted with Shure M91E cartridge. More important, the amplifier was wired to a switching panel to facilitate instantaneous switching to a further four sets of speakers (all JBLs) of various sizes, from half-cubic-foot volume right through to the Sovereign 1 enclosures.

Performance from test records

We played a series of tapes to get the feel of the system, then switched to selected test records.

First record used was Simon and Garfunkel's 'Cecilia' from 'Bridge over Troubled Waters' (CBS SBP 233794). This record was used to test the dynamic low frequency performance. The bass response was superb, producing the same feeling we had on hearing our first multi-sound track film. The definition and presence were incomparably better than we had expected.

The second test record we tried was one we often use, but this time it sounded different; not that it was inferior – rather we were capable of hearing bass content that we had never heard before, and we were just a little surprised.

Third record played was Hugh Montenegro's 'Colours of Love', Track 5, 'Na Na Hey Hey Kiss Him Goodbye' (RCA LSP4273). The response was very good, and we were aware of a tendency to overbright response. This was primarily due to the room being too 'live' – without enough furnishings or absorption. We also tried a series of other records, including Tchaikovsky's 1812 Overture and other varied music.

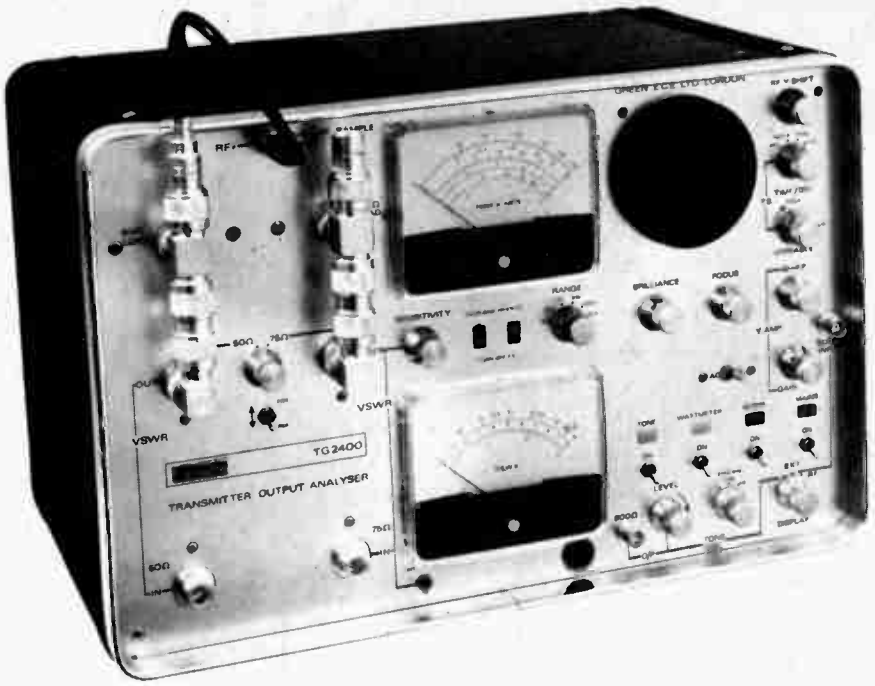
Our impressions of the JBL Sovereign 1 S8R speakers are that these systems offer excellent performance, low distortion, good dispersion in the horizontal plane, exceptional efficiency, very good frequency response, and an appearance designed for people who have a conservative taste.

Before you race off to buy one or two, the suggested list price is $1,414 each.

We suggest that you might buy one this year and the second next year, when you've saved up the money.

TECHNICAL SPECIFICATION OF J.B. LANSING SOVEREIGN 1 S8R SPEAKER SYSTEM

Frequency Response	*30Hz – 18kHz ± 6db*
Power Handling Capacity	
Below 500 Hz	*60 watts rms*
500Hz to 7kHz	*greater than 35 watts rms*
above 7kHz	*greater than 20 watts rms .*
Sensitivity	*1 watt input equals 106db referred to 0.0002 microbar at 1kHz*
Directional Characteristics	*± 3db with respect to on-axis frequency over 100° arc.*



TG 2400 The Complete Transmitter Test Lab.

The Green TG 2400 Transmitter Output Analyser contains separate operational modules to function as a complete R.F. source or transmitter test set on SSB, AM, FM, or CW. A wide range of frequencies and power levels is accommodated.

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FM Conversion Unit

One integrated circuit, plus a few inexpensive components, enables an AM radio to receive FM signals. Peter Vogel built this unit for $9.

This simple FM conversion unit uses an integrated circuit and a few extra components, and functions as a high-gain IF amplifier, limiter and discriminator.

The AWM 1306, manufactured by AWA, is probably the best IC available for this purpose at the moment. This IC has an RF bandwidth of 1 MHz at the –3db points and is primarily intended for use with the usual IF of 455 kHz, although it will work reasonably well at 2 MHz. The gain at 455 kHz is typically 90 db, at 2 MHz, typically 80 db.

The unit to be described can be added to almost any receiver with an IF of 455 kHz to produce good-quality audio from FM signals. It is, of course, possible to receive FM on an AM receiver by using 'slope' detection, but such a system does not produce very good-quality audio, nor is the full noise-suppression capability of FM realised.

The circuit of the IF strip demodulator is shown in Fig. 1. The MPF 102 is a low-cost FET, connected as a source follower, which presents a high impedance to the source of signal and matches this into the low-impedance of either a ceramic filter or the input of the IC (about 1.2 Kohms).

When used with the Murata filter supplied, the unit exhibits excellent bandpass characteristics for FM, but unfortunately the filter is quite costly. Unless the IC is to be used as basis of a complete FM receiver, the filter can usually be dispensed with, a capacitor being fitted in its place.

The IF passband of the receiver to be used for FM should be wide enough to prevent distortion as the carrier is deviated (deviations of up to 15kHz are commonly used by amateurs), yet narrow enough to prevent interference from strong stations on a close frequency. This calls for a rather wide, flat-topped IF curve, which can be easily achieved using the Murata filter.

If no filter is used, fairly good results can still be obtained by finding the optimum takeoff point in the receiver by experiment. Our unit used no filter and did suffer from interference when a local station was operating about 100 kHz above the received signal. Generally, however, results are quite acceptable without the filter.

The output of the IF amplifier and limiter is fed to the input of the quadrature discriminator section. The discriminator coil is the only coil required. The DC output for FSK or AFC can be taken from pin 6 if required, and the audio output from pin 5 can be adjusted by means of the 25K preset potentiometer.

Simple to build

Our unit was built on a small printed circuit board supplied with the complete kit of parts. This kit, which includes everything except the ceramic filter, is available from the source mentioned at the end of the article.

The unit can be easily assembled in

FM conversion unit assembled on circuit board (actual size).

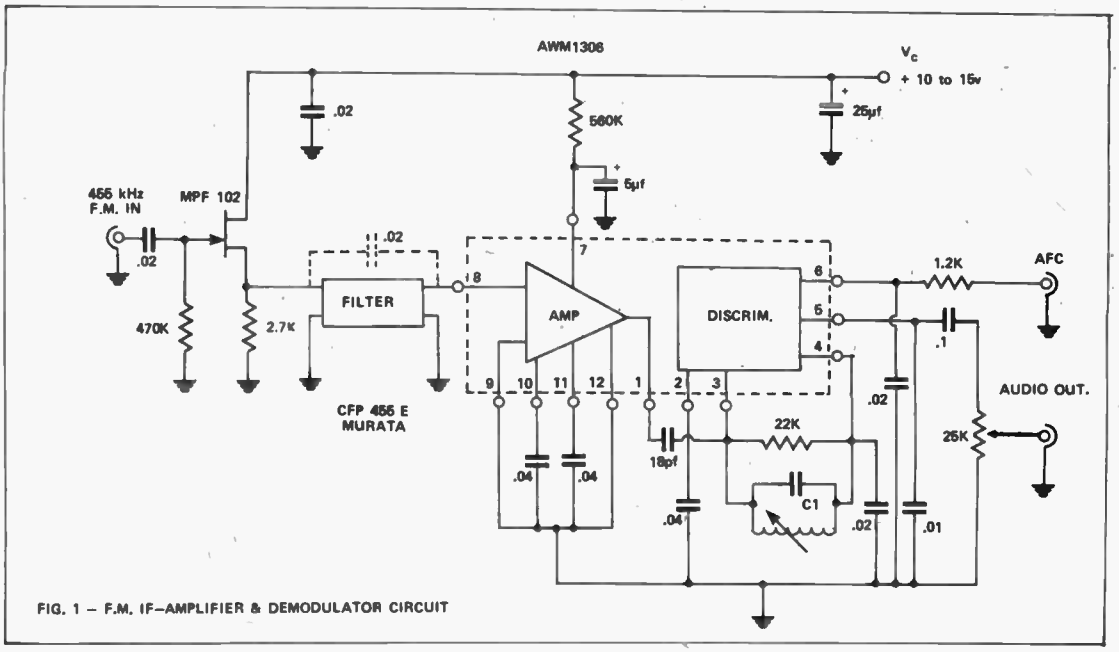


FIG. 1 – F.M. IF–AMPLIFIER & DEMODULATOR CIRCUIT

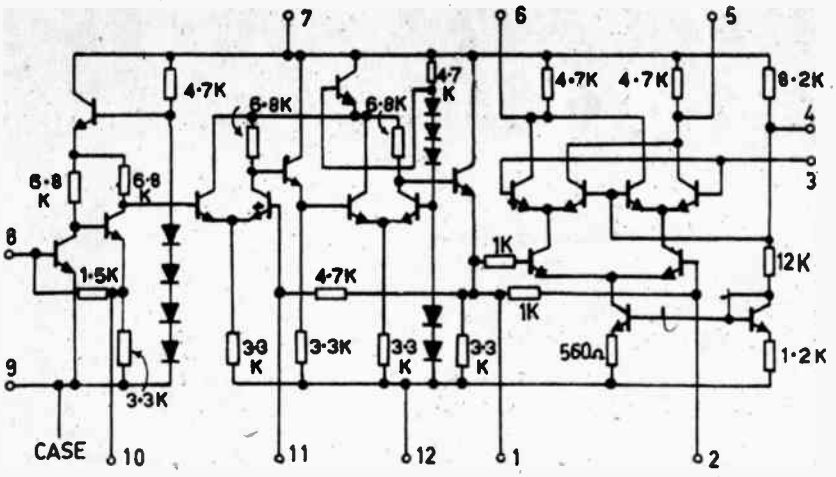


FIG.2 – SCHEMATIC OF AWM1306

FM Conversion Unit

30 minutes – all that's required is some care in soldering components to the printed circuit board. Be careful to prevent solder running across to parts of the pattern, and remember that excessive heat might damage the components or board.

The board should be mounted as close to the takeoff point as possible, the input connection being made with a short, rigid wire. The circuit to which it is connected might be slightly de-tuned, but this can easily be re-peaked. The unit can be left in circuit permanently, FM-AM selection being carried out by switching the audio amplifier of the receiver to the FM or AM detector as required. The only adjustment necessary is the quadrature coil, which should be adjusted for zero volts between pins 5 and 6 while receiving a signal for the desired frequency, or simply for best audio quality.

The 12 volt power supply can be taken from a voltage doubler running off the receiver's heater line, or from the receiver's H.T. via a zener diode. This supply must be well-smoothed.

No problems were encountered with our kit. However, the following points should be noted:

1. Do not use an oversize soldering iron for the job, and do not apply too much solder.
2. Make sure the IC is properly orientated – wrong connections can damage the IC.
3. Remember to ground one side of the power supply. Provision is made for grounding either negative or positive on the printed circuit board.
4. Remember to include limiting resistors if the signal is taken from a high voltage point.
5. Check wiring (including power supply polarity) before switching on.

What you will hear

Most FM activity is on the amateur 2 and 6 metre nets, on 52.525 MHz and 146 MHz respectively. Also in the 2 metre band is an amateur translator located at Dural, which transmits on 145.9 MHz and is probably the most effective FM channel.

For the more ambitious, Australia Oscar-6 – an orbiting amateur translator on the VHF-UHF bands – will, if successful, provide international contacts on these bands; as will Moonray, an amateur translator projected to be placed on the moon. Quite sophisticated equipment will be needed to work these translators, but this is by no means beyond the ability of most enthusiastic amateurs.

Description

The AWM 1306 is a monolithic linear IC with principal applications in narrow-band FM receivers where low power dissipation is important. It consists of a high gain 1MHz amplifier-limiter and a quadrature FM dsicriminator. Supply voltages are internally regulated to allow for a large range of external supplies and the input impedance is set for matching typical ceramic IF filters. Complementary outputs from the discriminator provide for simple dc alignment and external bypassing is non critical.

General characteristics

Package:	*12-pin hermetic TO-5*
Max. Storage temp:	*150°C*
Operating temp. range:	*0°C to 70°C*
Supply voltage range:	*4.5 – 12V*
Power dissipation (typ):	*12mW*
RF gain (typ):	*90db*
RF Bandwidth (-3db):	*1MHz*
Input impedance (typ):	*1.2k*
Recovered audio (max):	*200mV*

A.W.A URGES FM

INQUIRY INTO FREQUENCY MODULATION BROADCASTING – PRECIS OF EVIDENCE SUBMITTED BY A.W.A.

Introduction of FM broadcasting was advocated by Amalgamated Wireless (Australasia) Ltd. at the Australian Broadcasting Control Board's current inquiry in Sydney.

In its statement of evidence, A.W.A. said the FM system would improve the technical standard of broadcasting for a substantial number of people whose present service was unsatisfactory. It would also enable additional programmes to be provided in areas which lacked an adequate choice of programmes.

Stations transmitting educational and service type programmes could also be established.

The Australian broadcasting system was incapable of meeting present-day requirements in that its capacity for expansion was limited and the technical quality of the service it provided was inadequate by modern standards.

Existing facilities should be supplemented by a new system, operating in the ultra high frequency band and using frequency modulation.

It should be introduced progressively and allowed to operate in parallel with the existing system for a period sufficient to enable a listening audience to become established. Subsequently, the two systems should be developed on a fully integrated basis to produce the best possible overall broadcasting system.

Assuming that sufficient frequency space would be allocated to FM, to meet sound broadcasting needs for a considerable future period, an abundance of channels would appear to be available in the early developmental stages – and it was probable the Board would receive many demands to use these channels.

The Company believed it essential that the use of the band be planned, having regard to the ultimate requirement of the services to be provided, and demands should be considered in the light of this criterion.

Apart from the planning of channel allocations, the development of FM in the UHF band would involve consideration of many basic engineering questions.

An Australian system need not be compatible with any previous standard. Its design would present unique opportunities for the application of advanced principles. The evolution of an improved system would benefit the community for many years to come.

The new system should incorporate facilities for the stereophonic transmission of programmes at the outset.

A.W.A. stated that the technical capability of the new system should be such as to cause negligible deterioration, in the useful service area, of the programme matter being transmitted.

When technical standards were being developed, a working group on which the manufacturing industry is represented should be established to assist the Board and ensure that it has access to all available information.

The Company also submitted:

Plans for the introduction of FM should provide for the simultaneous development of the national and commercial services in any area. The national service may be developed on the UHF band by providing for the transmission of a second ABC programme in areas where only one such programme is available now, and for the transmission of a third ABC programme in capital cities and nearby areas. The commercial services should be developed by permitting existing licensees to operate UHF services in parallel with their present MF services, using either their MF programme or a special programme for the UHF transmission. Transmitter powers and locations should be planned to ensure that the service area boundaries of a commercial UHF station should be substantially similar to those of its MF transmission.

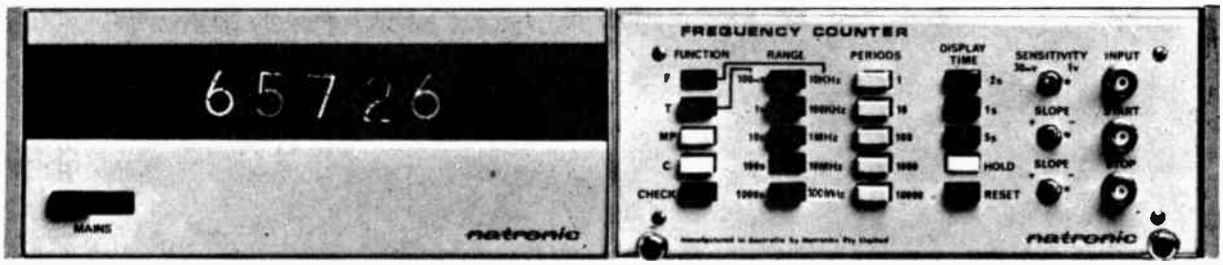
For a period to be nominated, perhaps ten years, no new commercial licence should be granted to establish an additional station, either UHF or MF, in an area served adequately by an initially licenced UHF station. However, new stations could be licenced to improve service in areas not so served.

The plan for the introduction of the UHF service should provide for the new system to be developed, area by area, in logical phases in accordance with an approved programme.

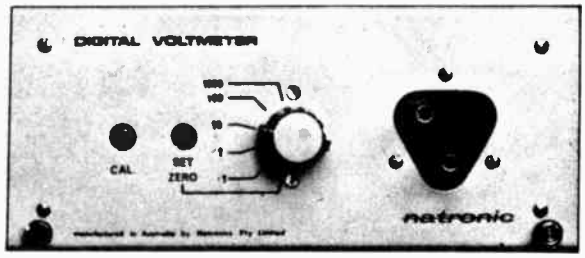
Plans for developing further the Australian broadcasting service should be based upon integration of the MF and UHF systems, exploiting the advantage of each to the best possible advantage in the complete system.

The inquiry continues.

TWO FOR THE PRICE OF ONE



Frequency counter plug-in module type 5040 and basic main frame type 501



DVM plug-in module type 50410

Modular construction enables the Natronic 500 series of digital instruments to be used for accurate and repeatable measurement of a large number of variables. The instruments are constructed as a basic main frame with interchangeable plug-in modules.
Frequency counter plug-in module type 5040 and basic main frame type 501 combine to form a 100MHz frequency counter with facilities for period timing and event counting.

DVM plug-in module type 50410 and basic main frame type 501 combine to form a highly accurate integrating digital voltmeter. Principal features of the instrument include excellent zero stability, 0.02% accuracy maintained over a wide temperature range and good rejection of common and series mode interference.

A main frame with botn plug-ins available for what you would normally pay for one instrument.

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Features

* Versatile stereo amplifier unit incorporating novel design concepts and displaying thin configuration.
* Black face gives distinction to dial plate that is illuminated when power is turned on.
* Selector mechanisms designed with piano-key touch allows all controls to be done easily just with fingertips. Slide-rule type mechanism also ensures smooth control of volume, tone, and balance.
* Adoption of FET for FM front end provides the following merits:
  (1) Improvement of image ratio and elimination of station interference.
  (2) Less cross-modulation and elimination of trouble at time of large input under strong electric field.
  (3) Improvement of S/N ratio and sharper sensitivity.
  (4) Spurious radiation is decreased to eliminate disturbance of other television or radio sets.
  (5) Less drift results in stabler operation.
* Audio amplifier unit is designed with complementary symmetry OTL system that employs epitaxial transistors of low noise and triple diffusion type power transistors of excellent frequency characteristics, with the result that the unit displays exceptionally low distortion and superlative frequency characteristics. T.H.D. of main amp is 0.8% at 25W output, and frequency characteristics ±1 dB at 20–50,000Hz.
* Set is conveniently provided with many input terminals -- PHONO terminal that allows use of both MAG and X'TAL pickups, TAPE HEAD terminal, TAPE MONITOR terminal and AUX terminal.
* TAPE REC/PLAYBACK terminal incorporates RCA type PIN JACK and also a DIN CONNECTOR which conveniently allow monitoring with speaker or headphone while recording on tape.
* Full use of silicon transistors for all units from FET of FM front end to 100-Watt power amp.
* Stable FM MPX circuit
  Silicon transistors employed for 19-kilocycle pilot signal amplifier circuit guarantee stable operation of set over a wide range of thermal environment.
  Two-diode 38-KC doubler and four-diode switching unit provide the set with superlative characteristics of 35 dB channel separation and 0.5% distortion.
  Reception of stereo broadcast waves automatically lights the stereo indicator lamp to ensure accurate catching of elusive stereo broadcasts.
* Highly dependable protective systems
  Set incorporates silicon transistor and silicon diode protective circuits which completely protect power transistors even when output terminals are shorted inadvertently. Automatic release comes about when cause of short-circuit is eliminated. Transistors are therefore virtually damage-proof. Also, use of overcurrent protector eliminates any need for troublesome replacing as in case of fuse; pressing the red pushbutton is all that's needed.
* Others
  The set, as described above, incorporates many convenient features such as the headphone jack that allows pleasant listening without disturbing others, the DIN type connector for REC/P.B. that can be connected just by a single cord, the FM – AFC switch that permits stabilized tuning even to delicate FM broadcasts and the tuning meter which affords easy tuning to the desired broadcasting station.
  Also, the set allows two speaker systems to be used just by working the switch.

Specifications

Music power (IHF) at 1KHz	100 Watts at 8 ohms
Continuous power at 1KHz (R/L)	25/25 Watts at 8 ohms
Harmonic distortion at 1KHz	Less than 0.5% to 20 Watts
Power bandwidth (IHF)	30 to 30,000 Hz at 8 ohms
Frequency response	20 to 50,000 Hz at 8 ohms
Signal to noise ratio	AUX. 70 dB, MAG. 60 dB
Damping factor	65 at 8 ohms
Bass control	±10 dB at 50 Hz
Treble control	±10 dB at 10,000 Hz
Input sensitivity	Mag. 3mV, X'tal 50mV, Tape head 1.5mV, Tape monitor 100mV, Aux. 50mV
Frequency range	AM 535 – 1605 KHz, FM 88 – 108 MHz, SW 4–12MHz
Usable sensitivity	AM 10μV, FM 1.3μV (IHF)
FM signal to noise ratio	65 dB
FM selectivity	35 dB
FM harmonic distortion at 1KHz	0.3%
FM image rejection	60 dB
FM cross modulation	70 dB
FM capture ratio	3 dB
FM stereo separation	35 dB

Auxiliary Circuit

FM/AM tuning meter, FM stereo indicator lamp, REC/PLAY BACK DIN connector, Stereo headphone jack, SCA filter, Circuit breaker, Separate bass and treble controls (slide rule type), with loudness and balance control (slide rule type). Speaker system switch, and AFC defeat switch. Tape monitor switch, Stereo-mono switch, Loudness control switch

Transistors	36
Diodes	27
Function controls	AM, FM, Phono, Tape head, AUX.
Antenna FM	300 ohms balanced type
AM	Ferrite rod with EXT. antenna terminal
Power voltage	117/230 Volts, 50/60 Hz
Power consumption	110 Watts maximum
Dimensions	432×114×305mm (17×4½×12")
Weight	8.2 kg (18 lbs.)

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AUDIO NEWS

CONVOY OPENS NEW PREMISES

'EACH PERSON has his own individual requirement in regard to musical reproduction,' says Malcolm Goldfinch, of Convoy International.

'Professional consultants can advise and demonstrate, but it is the individual who has to determine, by his own senses, that sound system which is exactly what he requires within his budget.

'It is for this reason that our Technocentre has been created.'

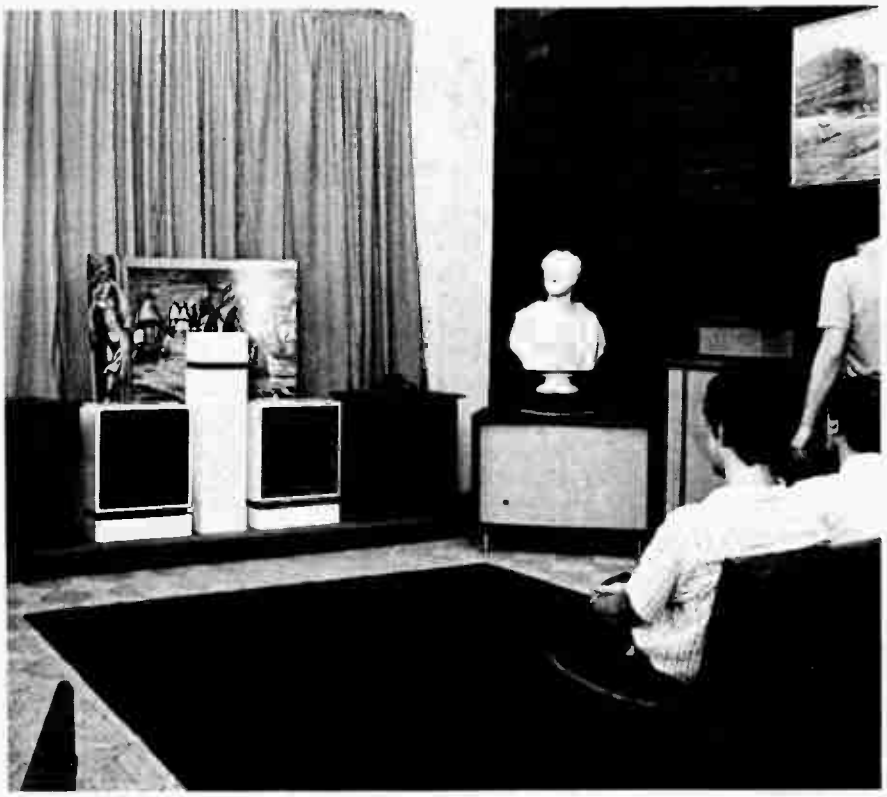
The Convoy Technocentre, recently opened in spacious new premises in Woolloomooloo (Sydney), has a series of studios in which sound equipment can be linked together in compatible systems and at varying price levels to suit every budget.

There must, of course, be a relationship between the cost of hi-fi equipment and its performance and durability. Convoy openly accepts this and provides three separate studios, each covering a particular area of quality and cost.

The three studios are separated from the main offices and shop area, and this separation provides a very relaxed and pleasant atmosphere in which to discuss and determine one's needs.

One suspects that from Malcolm's point of view it is also very effective – and frankly one hopes so, for a great deal of thought and effort has obviously gone into the planning and execution of this project.

A most refreshing change from the hard-selling clamour of the discount houses.



Equipment for the connoisseur is demonstrated in largest of Convoy's three studios.

LATEST TREND: UNIT AUDIO

Britain's recent Audio Fair showed an ever-growing trend toward unit audio systems.

These packaged systems, known generically as unit audio, bring together all the constituent bits and pieces – amplifiers, radio, record turntable – in variously styled units. These, together with a pair of speaker boxes, sit neatly on a bookshelf or blend suitably into the room decor.

Unit audio offers better-quality sound that is possible with an ordinary radio or record player, and there are models available in all price ranges. Above all it is easy to buy, as it is offered as a complete matched system.

In Britain, unit audio manufacturing is now virtually an industry within an industry.

The indication is that last year around 180,000 unit audio systems will have been sold, at an average price of $200. This makes the British home market worth $36 million. What's more, say the experts, the market is expanding at an annual rate of 20 percent.

There is every indication that this pattern will be repeated in Australia.

LEFT: HMV model 2416 stereo system from British Radio Corporation, shown at recent Audio Fair. It consists of a VHF stereo/amplifier with separate speakers. Equipment has an output of 25 watts per channel (speech and music rating), is finished in walnut veneer.

Deccasound Compact 3 system has an AM/FM radio tuner with Multiplex decoder; output is 15 watts per channel. Two speaker enclosures (each with two-unit system) sit beneath cabinet when not in use. Performance of this equipment, also shown at Britain's Audio Fair, is in the hi-fi class.

COMPONENT NEWS

FET–INPUT OP–AMP

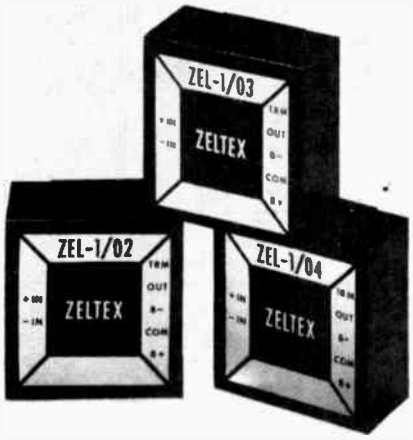
Zeltex, Inc., has announced the availability of a new series of FET-input operational amplifiers for use in differential, inverting or non-inverting circuits.

All four amplifiers use the same circuit and have identical specifications but are available in four different packages; the Model ZA 801 T1 in a 12-pin TO-8 can, Model ZA 801 D1 in a 14-pin DIP, the 14-pin hermetically-sealed DIP Model ZA 801 E1, and the ZA 801 M1 in a modular flat pack. This new concept of 'total package availability' provides mechanical capability with virtually any system design.

Key specifications for all four packages include:

dc gain (at rated load):	100,000 min.
output:	±10V at 7mA min.
unity gain:	4MHz typical
full power output freq:	200kHz typical
voltage drift:	50μV/°C max.
common mode rejection:	10,000:1 (±10V) typical
bias current:	25pA, max.

Full details from Racal Electronics Pty. Ltd., 47 Talavera Road, North Ryde, N.S.W. 2113.



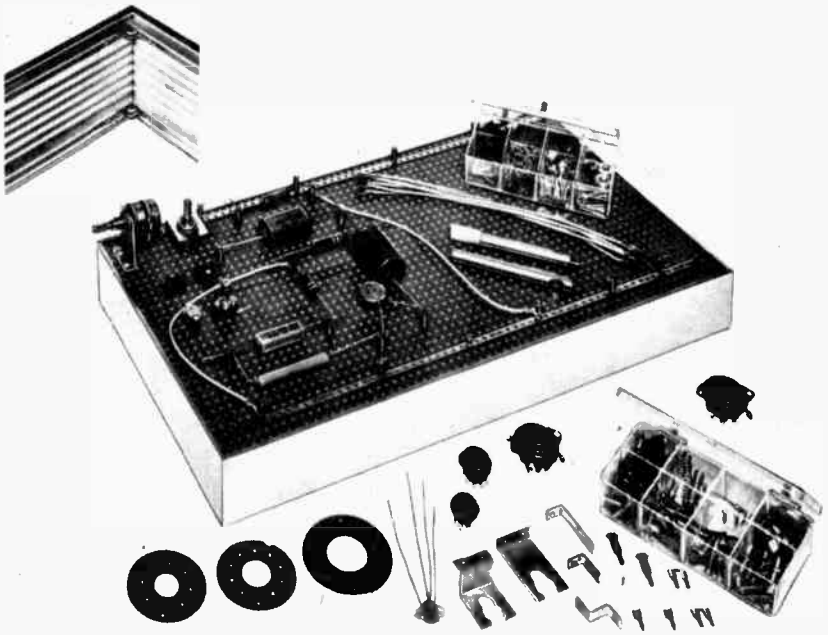
LOW–COST OP–AMPS

From Zeltex, Inc. come three new low-drift, low-cost operational amplifiers. Offshoots from the popular "ZEL-1" amplifier, the new models have been designated ZEL-1/02, 03 and 04. They feature a maximum input voltage drift of 2.5, 5 and 10μV/°C respectively. Suggested applications include high-gain inverters, comparators and buffers.

Other key specifications common to all three units include a dc gain of 500,000 minimum, 50nA input bias current, a CMRR of 20,000 to 1, 6V/μs minimum slew rate, and only 2μV of noise (maximum). The amplifiers are internally frequency-compensated and input offset voltage is adjustable to zero by an external trim pot.

The amplifiers have built-in short-circuit-to-ground protection and the encapsulated in a plastic/epoxy package which measures 1.13 x 1.13 x 0.64 inches.

Full details from Racal Electronics Pty. Ltd., 47 Talavera Road, North Ryde, N.S.W. 2113.



INGENIOUS POTENTIOMETER ▶

A miniature potentiometer from the Bourns Corporation incorporates an ingenious drive wheel mechanism giving a 4:1 reduction. The cermet resistance element is claimed to provide excellent temperature stability.

Full details from W.G. Booth Pty. Ltd., P.O. Box 131, Richmond, Vic. 3121.

SAVE SET–UP TIME ON ▲ EXPERIMENTAL CIRCUITRY

The Vector experimenter's chassis kit is a new and convenient method of setting up and testing circuits rapidly without having to solder and unsolder connections. It provides quick assembly of experimental circuitry with simple hand tools.

Construction is highly flexible and, if necessary, parts can be readily cut to sizes other than those supplied.

The main wiring deck consists of a sheet of phenolic laminate 3/32" thick, having a uniform pattern of punched 0.093" diameter holes spaced on 0.265" centres. If other hole-pattern boards are preferred, such as 0.062" holes on alternate 0.1" centres, these may be obtained as accessories and will slide into the chassis grooves.

ALUMINIUM EXPANDABLE CHASSIS. Special extruded aluminium side rails, 2" wide, are provided for the chassis. These rails, which have 0.1" grooves for holding circuit boards or covers, quickly slide together at the corners to provide a neat screwless exterior.

The grooves on the interior surfaces support 'Vectorbords' or other panels, either at top, bottom, or in-between. *(over)*

The panel may be fitted to the top groove while being worked upon and can subsequently be moved to a lower groove, if desired.

The chassis can be expanded by clipping in extension side rails which are obtainable as accessories.

UNIQUE SOLDERLESS TERMINALS. Quick set-up is achieved by the use of Vector 'push-in' Springclip terminals, T30N-1 and T32A.

These Springclips hold up to six component leads without soldering or crimping wires, with a contact resistance of less than 0.01 ohm. The wires need only be pushed into a slot or through the coils of a spring, are not damaged and need not even be cut short. This allows for re-use and eliminates possibility of heat damage to expensive components.

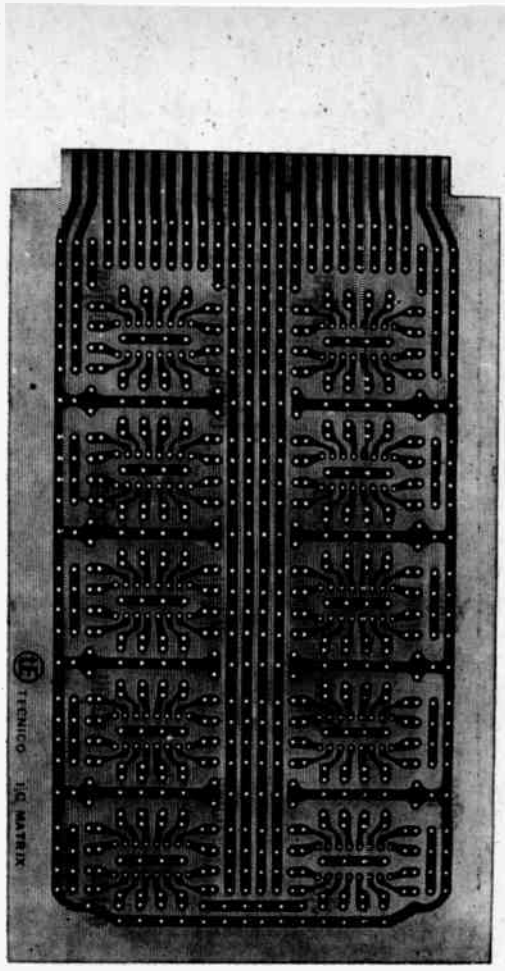
Full details from IRH Components Pty. Ltd., The Crescent, Kingsgrove, N.S.W. 2208.

MATRIX BOARDS FOR DUAL IN-LINES

Time-saving matrix boards, for breadboarding with integrated circuits are now available. Made of G10 1/16" glass epoxy, the boards are already drilled to hold up to ten, 14 or 16 dual in-line integrated circuits. Overall board dimensions are 7 7/8" x 4¾".

Two types are available – type GCN 383, unplated, and type GCN 410 with gold-plated edge connectors.

Full details from Tecnico Electronics, 53 Carrington Rd., Marrickville, NSW 2204.



SOLID-STATE READOUT

Brilliantly clearly-formed letters only 0.1-inch high, low power consumption and low cost are said to be opening wide new areas of application for Hewlett-Packard's newest solid-state numeric displays.

The manufacturers state that these displays are suitable for use in many types of miniature equipment – such as portable test and measuring equipment, portable calculators, very small panel meters, clocks and even watches. For a brightness of 100 foot-lamberts, only 1.6 volt at 3ma/segment is required.

The new units, known as the 5082-7200 series, are monolithic solid-state (gallium arsenide phosphide) numeric indicators. Each is a 7-segment planar-passivated display.

Three, four and five-digit displays are available in both 14-pin dual-in-line and FLAT PACK form.

Character encoding can be performed by commercially available 4-line BCD to 7-segment decoder driver. Displays are wired for strobing, and thus only one decoder-driver is required for each display, only 8 + N lines are required to access a display (N = number of digits).

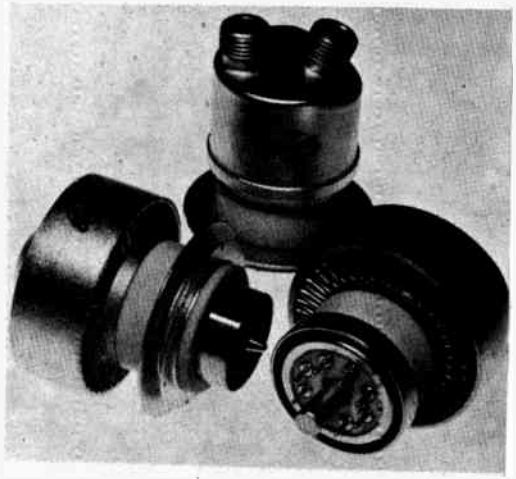
Display modules are TTL and DTL compatible.

750 WATTS AT 890MHZ FROM TETRODES

A new range of tetrodes from Varian Pty. Ltd. are adaptable to such widely diversified applications as low distortion linear amplification, high reliability air-ground communication, wideband VHF distributed amplifier service, frequency agile systems, synchrotron accelerator service and RF pulse generation.

The 4Cx600/4Cx800 Eimac series tetrodes are ruggedised, compact radial beam devices combining a high gain-bandwidth product and an extremely low intermodulation distortion level.

Full details, circuitry and application information can be obtained from Varian Pty. Ltd., 38 Oxley Street, Crows Nest, N.S.W. 2065.



HIGH THRESHOLD ICs

The R & D laboratories of SGS (Societa Generale Semiconduttori) have developed two new high-level logic circuits, H122 and H124, thereby increasing the SGS high-level logic family – the family of high threshold integrated circuits – to a total of 10 elements.

The H122 is a quad 2-input NAND gate and the H124 is a dual 4-input NAND gate. Both devices have passive pull-up outputs to allow wired-OR operation. Like all other elements in this family, they offer the advantages of 5V DC noise immunity, high signal levels, wide supply voltage tolerances and high fan-out.

These features make the high-level logic family particularly suitable for industrial, avionic and telephone applications, where very noisy environments prohibit the use of a low threshold integrated circuit.

Features are:

Wired-OR capability.

Wide range of supply voltages – 10.8 to 20v.

High DC noise immunity – 5V (typ.) at V_{CC} = 15V.

High fan-out – 10 (worst case).

The H122 and H124 are ideal for application in industrial equipment where, until now, discrete components have dominated.

Other fields of application are computer peripherals, telecommunication systems and avionics.

Details from Warburton Franki, 372 Eastern Valley Way, Chatswood, N.S.W. 2067.

DESOLDERING WITHOUT TEARS

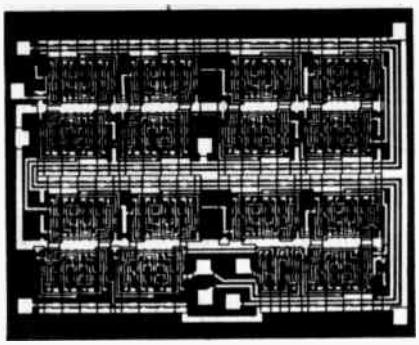
A simple and effective method of desoldering utilises an impregnated metallic wick.

All sizes and types of joints or connections can be desoldered.

Using a standard soldering iron, the wick is held onto the joint to be desoldered. After a one-second application all solder is drawn up into the braided wick, leaving the joint clean, free and ready for immediate resoldering.

Applications include the home entertainment and appliance industry, computer manufacturing and servicing, and telephone/communication organisations.

Full details from Royston Electronics, 22 Firth Street, Doncaster, Vic. 3100.



Fully integrated data transmitter - 203 transistors, 172 resistors on 6 mm² chip.

FILTER WITHOUT COILS

In data transmission, as in almost every other field of electronic engineering, the trend is towards micro-miniaturization. The objective is to produce cheaper, more reliable circuits. To transmit data signals on telephone channels, modulators and filters are required. Unfortunately, when designers tried to miniaturise these circuits, they met an apparently insoluble problem. Coils, which with capacitors determine the frequency response of a filter, are extremely difficult to reduce in size. So the designers examined ways of developing a filter without coils.

Dr. Leuthold of ETH, Zurich, at that time working in the Philips Laboratories at Eindhoven, evolved the theory of what is now known as the binary transversal filter. This consists of a resistor matrix connected to tappings on a flip-flop shift register. With a binary input signal it acts like a filter. Whilst not exactly equivalent to an LC filter, it can be made to act in a similar way in the desired frequency range. To do this, Dr. Leuthold made the shift frequency, which samples and shifts the input signal through the register, equal to a high multiple of the input bit frequency.

The new digital filter solved one problem but generated another – choosing a suitable method of modulation. To limit the spectrum of the modulated signal with a digital filter, the modulator output must take the form of a synchronous two-level signal. This virtually ruled out conventional two-step (up and down) modulation, which would require analogue filtering again.

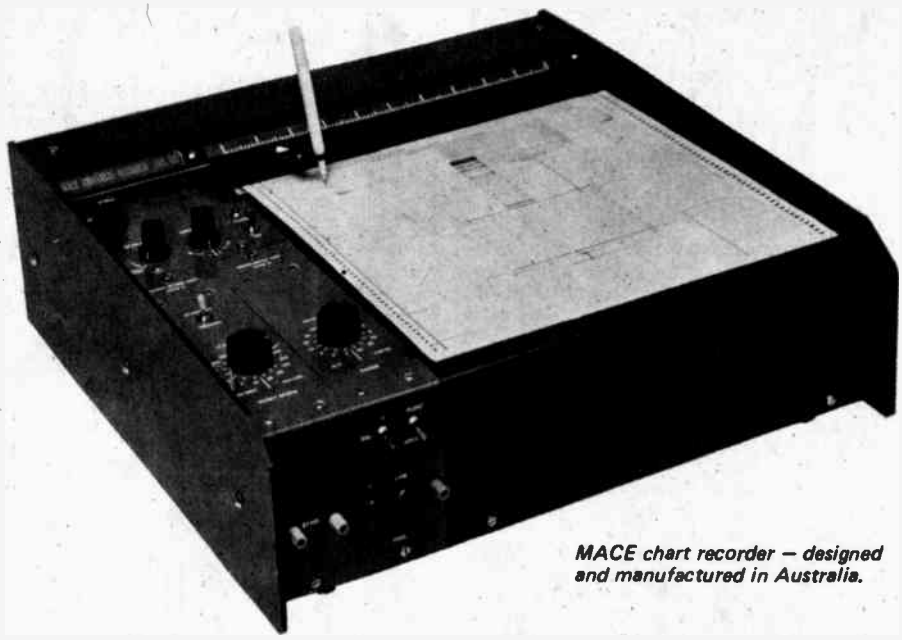
The alternative, direct modulation on a carrier within the signal band, results in 'fold-over' distortion. And, using square wave modulation, to other undesirable modulation products.

Nevertheless Philips decided to adopt the technique. They modulated the binary signals on a square wave carrier and got a mixture of the sidebands of all the odd carrier harmonics. Seemingly a complete mess. Yet, by making the carrier a multiple of half the bit frequency, both wanted and unwanted components occur at the same frequencies in the spectrum. Surprisingly, the unwanted components could be filtered out by adjusting the values of resistors in the filter matrix.

The new data transmitter, comprising flip-flops, logical AND-gates and resistors worked and was, in principle, suitable for integration. Philips concentrated all 203 transistors and 172 resistors on a single chip 6 mm^2, with resistance ratios accurate to within ± 1%. This chip can be used for 2400 bits per second in a 300 – 3400 Hz voice band channel. With proportionately higher sampling frequency the same chip can also be applied to high speed data links. It operates at temperatures from – 100°C to + 100°C.

A similar technique can be used for an integrated data receiver. This needs an additional analogue to digital encoder and consequently another chip.

EQUIPMENT NEWS



MACE chart recorder – designed and manufactured in Australia.

WORLD'S FASTEST MEMORY

AN LSI (Large Scale Integration) memory claimed to have the world's fastest access time (of 60 nano-seconds) has been announced by Japan's Nippon Electric Company.

The memory is composed of eight blocks of 128 words x 72 bits. Each block is made from two memory planes having 32 N-channel MOS (Metal Oxide Semiconductor) memory circuits of 16 words 19 bits, 16 bipolar word-drivers, and 24 digit-driver circuits.

Nippon claim to have made a technological breakthrough with a technique involving the covering of the silicon elements with an alumina layer.

It is understood that the memory will be commercially available soon.

AUSTRALIAN–MADE RECORDER

DESIGNED and manufactured in Australia, the MACE Universal Laboratory Recorder FBQ 100 is a flatbed instrument which produces accurate pen recordings on a strip chart. It is used with analytical equipment such as spectrophotometers, gas chromatographs, etc., and has a wide range of applications in industrial and scientific laboratories.

A particularly important feature of the instrument is its ability accurately to measure and record weak signals in the presence of large interference voltages.

The recorder is extremely versatile because of its plug-in modular concept which enables the characteristics of the recorder to be adapted to suit specific requirements.

The signal to be measured is connected to the input unit and is amplified to feed the pen servo system. The servo causes the pen to be driven by a fast response torque-motor to a position on the chart which is proportional to the input signal.

The chart is driven past the pen by a stepping motor controlled from the plug-in chart speed unit (electronic gearbox). The chart speed unit generates stepping pulses which cause the chart to move in increments of 1/8th mm. The speed of the chart is a function of the stepping pulse frequency.

Clear recordings are obtained from low-cost disposable nylon-tipped pens. These pens are supplied in a range of colours, so that recordings may be colour-coded if desired.

The general standard of construction is first-class. It is good to see equipment of this standard manufactured in Australia.

The MACE recorder was designed by Measuring and Control Equipment Pty. Ltd. and is manufactured and marketed by NIC Instrument Company.

Full details from NIC, Essendon Airport, North Essendon, Vic. 3041.

ULTRA–CLEAN AIR

MANY medical and industrial situations require environments which are virtually free of particulate and biological matter.

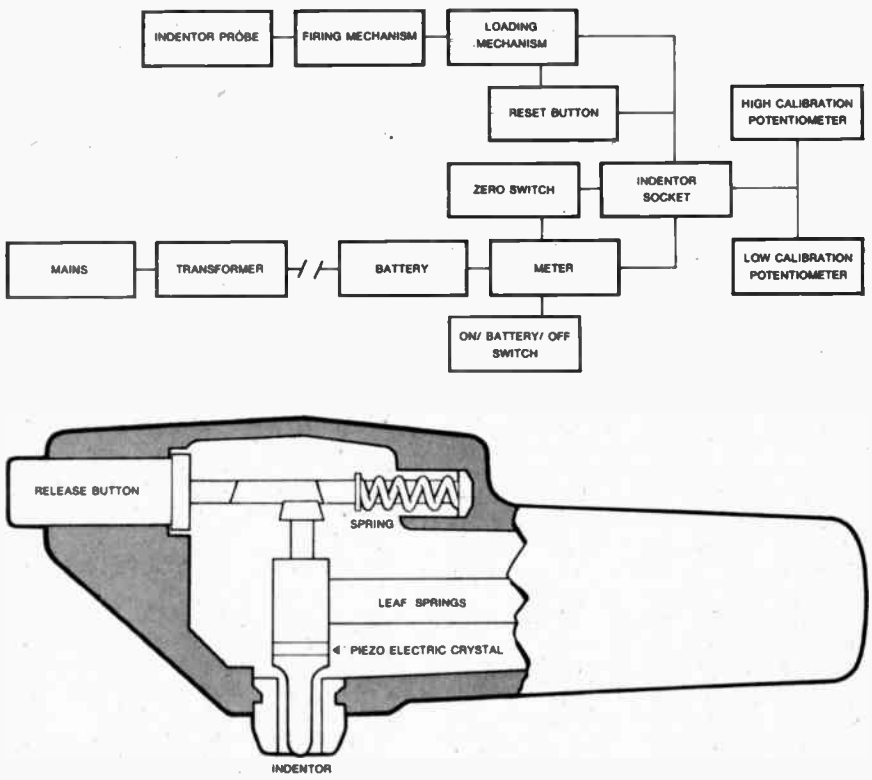
It has been found that the cleanest possible work place is in a gentle flow of air issuing directly from a wall or ceiling of high-efficiency filters. This flow of ultra-clean air displaces particles and biological matter in an entire room or work place, just as a piston removes exhaust gases from a cylinder.

By maintaining a uniform air velocity and a streamline pattern moving in one direction only, all particles generated by objects and people are immediately swept away in a predictable direction, with no chance of airborne cross-contamination occurring across the face of the filters.

An example of modern contamination control equipment was shown at the recent CEITA exhibition by Gelman Clemco Pty. Ltd. They displayed a Console Work Station Series CF 142, designed for use with high magnification microscopes or where other delicate precision work is performed.

The filters used in this console remove more than 99.97 of all particles 0.3 micron and larger, and 99.99% of all microbial matter. For integrated circuit manufacture or biological applications 99.99% of 0.3 micron particles and 99.999% of microbial matter can be removed.

Laminar-flow station provides ultra-clean air.



ARL hardness tester utilises piezo-electric transducer. Left, complete unit; right, schematic drawing and a cutaway of indenter head.

Particular features of the CF 142 include vibration level of less than 100 micro-inches rms, and noise level less than 65 db on the A scale.

Full details can be obtained from Gelman Clemco Pty. Ltd., 2 Whiting St., Artarmon, NSW 2064.

ELECTRONIC HARDNESS TESTER

CONVENTIONAL methods of hardness testing involve pressing a component such as a diamond into the surface of the material being tested.

A predetermined force is exerted to produce an indentation, the depth and cross-sectional area of which are then measured and translated into a recognised system of units.

This method is not easily applicable to parts incorporated in an overall structure, as a considerable force is required and supporting mounts are necessary.

A new instrument, designed and manufactured by Applied Research Laboratories, is said to overcome these problems.

An indentor tip strikes the surface of the material with a predetermined kinetic energy. The resistance to this energy, which brings the tip of the indentor to a halt, generates a hardness signal through the resulting deceleration on to a piezo-electric crystal.

The indentor tip used is a tungsten carbide hemisphere. This is firmly attached to the piezo-electric crystal, which is sandwiched between two accurately positioned leaf springs.

The indentor is drawn up on to a spring-loaded platform, triggered by releasing this platform, and driven into the specimen with a known and repeatable kinetic energy.

After the indentor has contacted the specimen, a decelerating force returns along the indentor and is applied to the piezo-electric crystal, which produces a voltage proportionate to the deceleration force. This voltage is shown as a reading on a meter which is calibrated logarithmetically in terms of the varying hardness of each specimen.

DIGITAL COUNTER/TIMERS HAVE 15MHz CAPABILITY

A new range of digital instrumentation is claimed to fulfill the requirement for both general-purpose and specialised measurement in the allied fields of frequency, time and event measurement.

All these functions are combined in the model KS615, said by the manufacturers – Perini & Scott – to be a truly universal instrument. It counts events, measures frequencies and periods of repetitive waveforms, measures the ratio of two input frequencies and measures time intervals between two related or unrelated events.

For specialised purposes all three functions may not be required. The manufacturers are therefore marketing the instrument in three other basic forms.

All instruments in the 615 range have digital readout utilising six non-blinking readout tubes. The manufacturers state that monolithic integrated circuits have been used in the interests of reliability.

All enquiries to Perini & Scott (A'sia) Pty. Ltd. P.O. Box 163, North Sydney., N.S.W. 2060.

FEMTOAMPERES, TERAOHMS, PICOCOULOMBS

A new digital electrometer multimeter reads millivolts, femtoamperes, and picocoulombs in 34 decade ranges with dc output capability.

Applications include long-term measurements of phenomena such as mass peaks, luminescence, pH, Hall potentials, etc.

The unit provides 3½ digit display with 100% overranging, and the decimal point is automatically positioned when changing ranges. Display rate is adjustable from 24 readings per second to 2 readings per minute. Polarity selection is automatic; and the digital display is blanked during overload, a feature which averts erroneous readings when 200% of the full-scale range is exceeded. As soon as the overload is removed, the digital display returns.

The unit operates up to 100 volts above ground and it recovers almost immediately from overloads up to 500 volts. Analogue outputs are provided, including one at unity dc gain which is accurate to 100 parts per million. *(Continued overleaf)*

Keithley Instruments' digital electrometer.

Keithley's 615 Digital Electrometer is all solid-state, using negative feedback for stability and accuracy. The analogue to digital converter is a dual-slope integrating type which provides immunity to line-frequency pick-up.

As a VOLTMETER the Model 615 has a range from 100 millivolts full scale to 100 volts with an input resistance of 10^{14} ohms across 35 picofarads. The manufacturers state that it is an excellent instrument for such applications as measuring voltages on FETs without loading, or the potential across a capacitor without discharging it. Using the built-in shunt resistors, the input resistance can be varied in decade steps from 10 ohms to 10^{11} ohms.

As a PICOAMMETER the unit has a range from 1 picoampere full scale to 100 milliamperes and is characterised by short rise times, low IR drop and excellent long-term stability. Because the unit can operate with input capacitances up to 5000 picofarads, long input cables and capacitive sources can be accommodated. The unit is claimed to be excellent for such applications as measuring currents in photomultiplier tubes, ion detectors, and current semiconductors. Measurements can be made in either the shunt resistance (normal) mode or in the resistance feedback (fast) mode.

As an OHMMETER the unit uses a two-terminal, constant-current method to measure resistance from 10^{3} to 10^{14} ohms in eleven linear decade ranges. The instrument can also be used as a constant-current source from 10^{-12} to 10^{-15} amperes when a compliance voltage at 100 volts or less is acceptable.

As a COULOMBMETER the unit measures from 10^{-5} to 10^{-11} coulomb full scale. With the range/function selector switch in one of the coulomb ranges and the feedback switch in 'fast' mode, it can measure electric charge directly in coulombs.

The PRINTER OUTPUT CARD – an optional accessory – gives the unit a BCD positive output representing each of the four digits plus range, polarity, hold and read command, overrange, and zero check. The 1-2-4-8 positive logic BCD output permits convenient interface to printers or computers for data storage and on-line data processing.

Full details from Warburton Franki Ltd., P.O. Box 182, Chatswood, N.S.W. 2067.

DIGITAL MULTIMETER USES LARGE-SCALE INTEGRATION

THE new Advance Electronics DMM2 digital multimeter covers 17 ranges for ac and dc voltage, current and resistance.

The instrument is completely portable, and the manufacturers claim that the design ensures ease of operation by non-technical operators.

All functions and ranges are selected by pushbuttons. The display has a maximum reading of 1999 with automatically positioned decimal point. Overrange and reverse polarity indications are provided.

The counting and storage functions are performed by a single LSI (Large Scale Integrated Circuit) package.

Details from the agents – Jacoby Mitchell & Co. Pty. Ltd., 469-475 Kent Street, Sydney, N.S.W. 2000.

VERSATILE NEW SCOPE

SOLARTRON'S new CD 1740 wideband oscilloscope offers comprehensive facilities in a lightweight compact unit.

The manufacturers claim that the design is optimised to provide the wide bandwidth and bright display demanded by the high speed digital circuits now in widespread use.

Applications include computer servicing, production testing and TV system use. Built-in protective devices make the CD 1740 suitable for use by operators of all levels of skill. Incorrect control selection, or the application of high voltages to the inputs, causes no damage.

Ergonomically arranged controls make the CD 1740 easy to use. Push buttons and lever switches are used for all mutually exclusive selections. Rotary switches and controls carry out incremental or continuous changes.

The display has an 80 x 100 mm internally deposited graticule with 2 mm divisions on the major axes. The 10% and 90% levels are marked to simplify rise-time measurements.

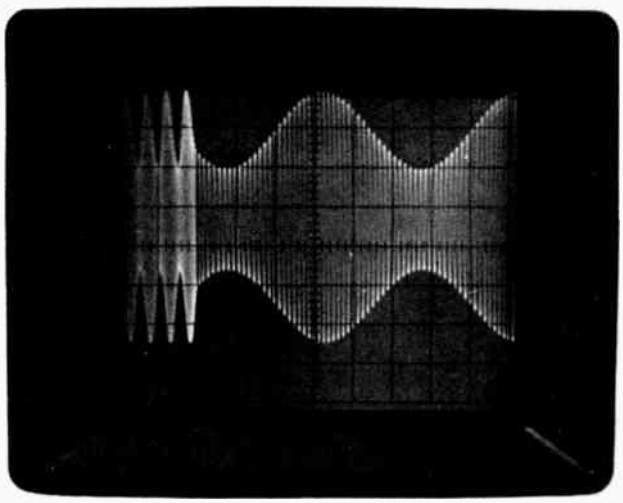
The standard phosphor tube has a writing speed fast enough to allow a 2 cm single shot 50 MHz sine wave to be recorded, using an f/1.9 lens, object/image ratio 1:1 and 10,000 ASA film.

A general purpose, wideband, two channel amplifier provides calibrated sensitivities of 5 mv/cm to 20 mv/cm at frequencies from dc to 50 MHz.

Dual, single and additive modes of operation are provided.

Fully protected (600V) matched FET inputs give an excellent overall temperature coefficient and freedom from drift.

Full specifications and further details from Solartron Electronic Group Ltd., P.O. Box 138, Kew, Vic. 3101. ●



A.M./F.M. waveform shown on screen of Solartron's new CDI740 oscilloscope.

Advance Instruments' digital multimeter provides multiple test facilities at low cost.

who needs 40 watts r.m.s.?

Obviously, from the demand for the Wharfedale "Rosedale", many music lovers have this substantial acoustic power requirement. Few speaker systems can handle 40 watts R.M.S. — and *only a handful do it well.* For sheer power handling capacity — free of colouration — the Wharfedale "Rosedale" leads this select group of high quality speaker systems.

With its 15" bass reproducer completely isolated from the 5" mid-range speaker and the 1" high pressure tweeter, the "Rosedale" has an effective frequency range of 35 — 20,000 Hz. Naturally it's a glorious piece of furniture which will grace any tasteful domestic environment. Measuring 24" x 23" x 13½", finishes available include oiled teak and polished walnut. The Wharfedale "Rosedale" will complement the highest quality amplifiers and signal sources.

But you live in a *flat!* Don't worry — you've not been neglected by Wharfedale. The "Denton", a bookshelf compact, has been designed specifically for you. It measures only 15" x 9¾" x 9" but has a conservatively quoted frequency response of 65 — 17,000 Hz. This covers every musical instrument, every overtone.

With a specially designed "Deltaflex" surround for the 8" bass/mid-range speaker, the major problem of small enclosures . . . *cone break-up* . . . has been solved by Wharfedale sound engineers. The speaker only reproduces the signal fed to it — and the result is clean bass registers and accurate *"presence"* in the mid-range. A separate 1" tweeter handles all notes and sounds over 1750 Hz. Power rating of the "Denton" is 15 watts R.M.S.

These two fine British speaker systems are representative of the Wharfedale range; you can hear them all at your franchised Simon Gray dealer. When you do, listen for the *musical transparency* that identifies Wharfedale — for this intangible quality is the *reason* for Wharfedale's international success.

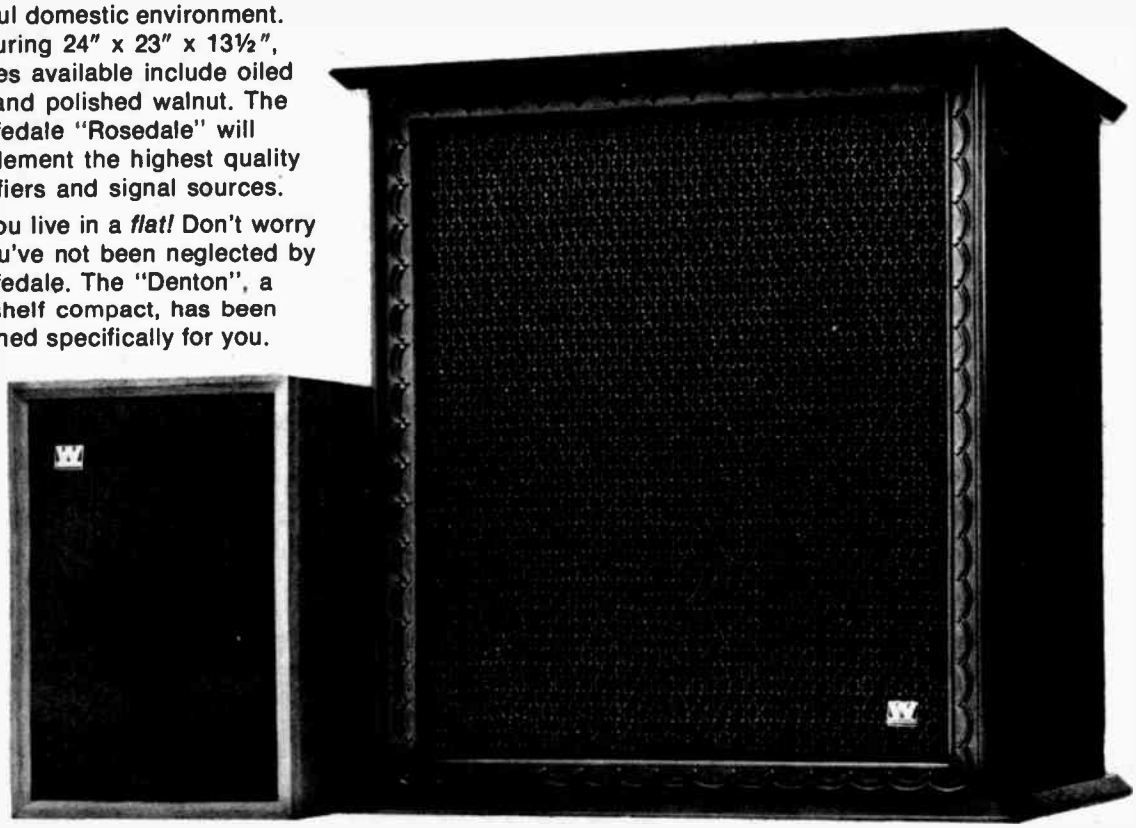
Simon Gray Pty. Ltd.,
28 Elizabeth Street,
Melbourne. 3000.

Please send me details of the Wharfedale speaker range, particularly the .....

NAME .....

ADDRESS .....

..... POSTCODE .....



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WHARFEDALE

The modern electronic organ can simulate almost any instrument in an orchestra with uncanny fidelity. This article, by a leading innovator in the field, explains how the various sounds are produced.

Special Sounds of Organ Music

ONE of the fanciest boxes of tricks available to the average person is the modern electronic organ. It outsells the piano because it's easier to play. Unlike other instruments, an organ responds to an elementary type of button-pushing.

When you press a button known as a key, for instance, the volume doesn't depend on how quickly or how hard you push, as in a piano, and the pitch doesn't depend on precisely where you place your finger, as on a violin. If you want a sound like an oboe or a flute, the organ doesn't require you to learn any delicate manipulations of lungs and lips; all you have to do is press another button labelled OBOE or FLUTE. And if you want to produce a vibrato, you need go through no finger-wiggling or breath-modulating gyrations; you just press a button labelled VIBRATO.

In fact, just about all you do need to learn is the right sequence for pressing the buttons. And, if you go very slowly at first, it still sounds good – because, unlike a piano, the organ continues to give out tones at full strength as long as you feel like holding the buttons down.

Probably the most interesting thing about an organ is that it has many 'voices'. It isn't restricted to one tone color, like a flute. The keyboards of the Schober theatre organ, for example, contain 48 plastic handles above the keys. These handles are labelled CELLO, VOX HUMANA, CLARINET, BRASS TRUMPET, PICCOLO, and so on. Each produces a distinctive voice or tone. How? That's what makes an organ so interesting.

Organ tones fall into groups depending on how they're produced and how they sound. There are four families: flutes, dispasons, reeds, and strings.

A simple sound

The flute family includes all voices which, like the orchestral flute are bland in tone color, with no sharpness or brilliance. The basic flute voice is produced by a sine-wave oscillator. Since a sine wave has no harmonics, the tone is completely smooth. Several organs use a pure sine wave. The drawback is that only one kind of flute voice is available. A pipe organ, on the other hand, produces many flute sounds, most of which do have some harmonics and thus are not completely bland.

A more versatile way of producing flute voices is to pass complex tones through low-pass filters. An organ may produce from its tone generators a wave-form which is essentially sawtooth, as in oscilloscope photo A. (All scope photos were made using a tone generator and filters from the Schober recital organ. Don't be confused because the sawteeth are upside-down in relation to the more usual presentation. That happens because the organ uses pnp transistors so that the flyback pulses – which are so fast as to be invisible on the scope – are positive-going.

It is not enough to deal with one musical pitch; we must see what happens to sounds and waveforms over a wide range of pitches. We shall therefore use five pitches in this article – the first, second, third, fourth, and fifth C's on a standard 5-octave organ keyboard. The frequencies are approximately: 65.4, 130.8, 261.6, 523.5, and 1,047 Hz. We shall refer to them in the order of C1, through C_5. C_3 is the normal pitch of middle C.

To produce one kind of flute voice, we can pass all five of these tones (and, of course, any other tone that may be keyed during the course of a musical selection) through the single compound low-pass filter of Fig. 1. Oscilloscope photos B, C, and D show the resulting waveforms from three of our sawtooth C tones. (An amplifier stage has been placed between filter output and scope, so the waveforms are inverted with respect to photo A.)

In B, the lowest frequency, filtering has had the least effect. The flyback

By Richard H. Dorf
President Schober Organ Corporation.

pulse is highly visible, meaning that much upper narmonic content has disappeared. The tone sounds far smoother than a sawtooth.

In photo C, which is at middle-C frequency, the slopes are more similar, rounding at the bottom is more pronounced, and the sound is still smoother. And in D, the pitch of C_5, the wave is very close to a sine. These differences in smoothness of sound are normal in pipes and other instruments.

The filter of Fig. 1 yields a tone color known as 'open flute' – the sound of a flute pipe which is open at the top and contains both odd and even harmonics.

Both pipe and electronic organs can have several kinds of open flutes. They differ principally in how much harmonic content they have, and thus how smooth and 'mellow' they sound. Electronically, the differences depend simply on how much low-pass action the filter gives. If the resistors or capacitors of Fig. 1 were smaller, more harmonics would be passed, and vice versa.

A different kind of flute tone is produced from pipes whose upper ends are closed or 'stopped'. In these stopped flutes, only odd harmonics appear; the evens are missing entirely. Any tone which does not have any even harmonics has a peculiarly hollow or woody sound. The waveform of any tone composed entirely of fundamental and odd harmonics is instantly recognisable because it is symmetrical above and below the base line. A square wave is a typical example – and so, in fact, is a sine wave which has no even harmonics (because it has no harmonics at all). Any waveform that is symmetrical, however complicated its shape, will sound hollow and 'hooooooey'.

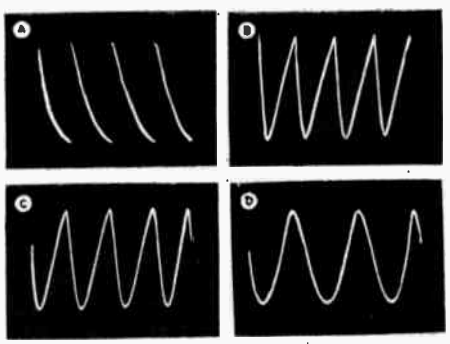
The stopped flutes are produced exactly like the open flutes – with a low-pass filter – except that the source tone is approximately square instead of sawtooth. Fig. 2 shows a flute filter with low-pass action slightly different from that in Fig. 1. If we apply square waves for C_1, C_3 and C_5 to the input terminal the waveforms of photos E, F and G result at the output. Comparing with photos B, C and D, you can see that about the same low-pass action has occurred – but in E, F and G every waveform is symmetrical. The resulting flute tone seems more flutey, just because it lacks even harmonics and sounds more hollow.

Diapasons

In a pipe organ, flute tones are produced by pipes which are relatively large in diameter for their length. This relationship of diameter to length can be varied widely, since it is only the length which affects pitch. The larger the diameter, the better the fundamental and lower harmonics. As the diameter becomes smaller and the lip of the pipe across which the air is blown is lowered, the fundamental and lower overtones decrease in power, so that by comparison the sound is more

Fig. 1—Open Flute filter is 3-part, low-pass. Fig. 2—The Stopped Flute filter (below) has a square-wave input, is low-pass.

Fig. 1



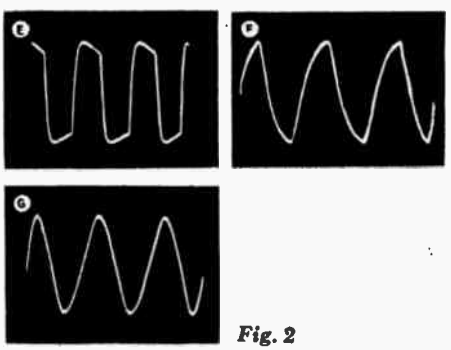
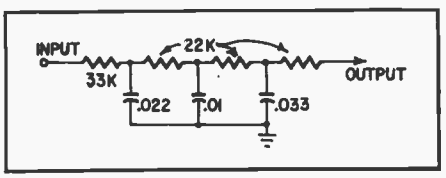
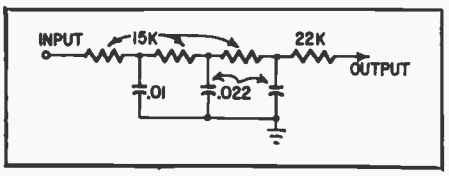


Fig. 2





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One pipe-organ sound is completely unimitative of any other instrument. Called the diapason tone, it comes from pipes which are usually of smaller diameter than flutes, with lower lips. They are tailored so that the fundamental is still strong but not so overpowering as in flutes. Thus the upper harmonics are more evident and give a peculiar kind of life and vibrancy to the tone without harshness or shrillness. Diapason tone is known as the backbone of the organ. It is the peculiarly pipelike sound everyone automatically thinks of in connection with church music.

In most electronic organs, diapason tone is produced in just the same way as flute tone — with low-pass filters. The filters are designed to be less effective, however, so that they do not lop off upper harmonics so severely. A refinement in certain organs is the deliberate addition of a certain amount of second harmonic. That is easier than it might seem. The key switching is done in such a way that at least two tones an octave apart are switched by every key and are available separately. The filter is fed mainly by the tone of lower pitch, but some tone an octave higher is added through resistance coupling. Of course, the higher tone is the second harmonic of the lower tone.

Fig. 3 is an open diapason filter. The capacitor values are lower than in Figs. 1 and 2, meaning less filtering-out of higher harmonics. The main input is frequency f, and that is the apparent pitch of the resulting tone. Frequency 2f, an octave higher, is added to reinforce the second harmonic. Photo H shows the waveform when f is middle C (our C_3) and C_4 is added through the 82K resistor.

Formant theory

Why does one string, reed or brass instrument sound different from others? A trumpet, a cornet and a French horn sound quite different, though the sound is initiated the same in all three. All cellos look about the same, use the same strings and are played in the same way; yet any string player will tell you that one cello can have a wide variation in tone color from another. Why? It's due to the formation of sound waves in the instruments.

The filtering action of reed and brass instruments usually includes one part of the spectrum in which response is emphasized. For example, a particular instrument may emphasize all harmonics which fall at and around 1,000 Hz. In that instrument, then, a fundamental tone of B (123.5 Hz) would have an emphasized eighth harmonic. D (147 Hz) an emphasized seventh. E (156 Hz) a strong sixth. G (196 Hz) a prominent fifth, B (247 Hz) an emphasized fourth harmonic, and so on.

This spectrum segment over which the instrument produces extra strong output is known as its 'formant'. It is almost entirely the formant that determines the characteristic sound of the instrument. The formants of various instruments centre on different frequencies, and those formants may be either concentrated or rather diffuse. A strong formant is like a tuned circuit of high Q: the response emphasis is great and is confined to a small bandwidth. A weaker formant represents lower Q; its passband is much wider and its peak much lower.

Any of these spectrum characteristics of an instrument can be provided just as well by an electrical filter. The oboe filter of Fig. 4 is a good example. Resistor R and the tuned circuit form a voltage divider across the input sawtooth signal source. The impedance of R remains the same at all frequencies, but that of the LC combination has a pronounced peak at about 1,600 Hz. The Q of an inductor suitable for this purpose is fairly high, so the resonant rise is steep and the emphasis band narrow. If you can hear in your mind the sharp, whining sound of the oboe, you will not be surprised that a filter like this can reproduce it.

Photo I shows the oboe waveform at middle C (C_3). The oboe is what I would call an 'extreme' reed, with a very sharp formant — so much so that in addition to its bandpass action the LC circuit actually 'rings' in response to the sawtooth pulses and produces the damped wave train of photo I. The amount of ringing depends on the Q of the inductor. If the inductor has too high a Q, the tone can be quite harsh; a shunt or series resistor will soften the oboe voice.

The trumpet filter of Fig. 5 does use a resistor to lower the tuned-circuit Q. It is in series with the inductor. The sound of the trumpet tone that results is much freer, not at all nasal or buzzy, and has plenty of fundamental coming through. Photo J shows the trumpet waveform at C_3 and photo K shows the output of the same filter two octaves higher at C_5.

The clarinet is a reed instrument with hollow and woody tone. To reproduce its sound, we start with square waves. They sound hollow, you will recall, because they are lacking in even harmonics. The clarinet filter of Fig. 6 has a tuned circuit with about the same resonant frequency as that of the oboe filter in Fig. 4 — but the sound is as different as night is from day, because the difference between filtered square tones and sawtooth tones is so great to the ear. Of course, other elements accentuate this difference. The Q is reduced by the 2,200-ohm resistor, and the low-pass

Fig. 3

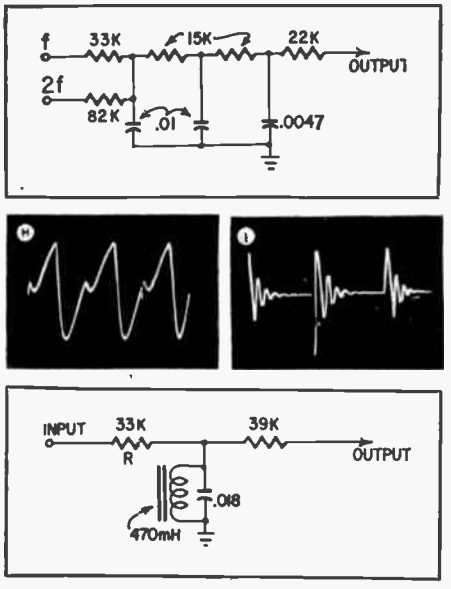

Fig. 5

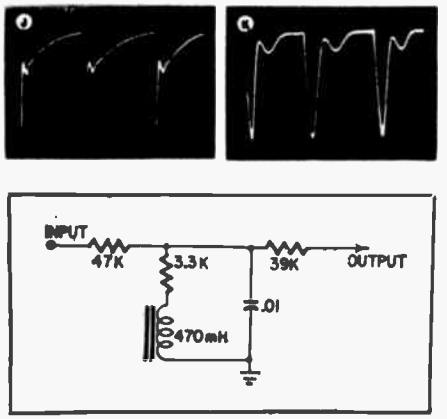

Fig. 4

Fig.3—Diapason filter uses moderate low-pass action on a pair of sawtooth inputs. Fig.4—Tuned circuit acts sharply to accentuate one segment of the tone spectrum. Fig.5—Resistor softens tone by reducing Q of the resonant circuit. Trumpet sound.

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section at the input removes the harmonics, helping to achieve the smooth, mellow effect of the clarinet. Photo L shows the clarinet waveform at C_3 and photos M and N show waveforms for C_4 and C_5.

String voices

The so-called string voices of a pipe organ are made by pipes that are narrow with respect to their length. Fundamentals and lower harmonics are suppressed, making the upper harmonics stand out. None, however, is very good imitations of orchestral string instruments.

In an electronic organ, shaping spectrum response is so easy that imitations of string tones are possible. Unfortunately, only steady-state tone can be imitated easily. The transient effect on an actual string instrument — bowing sounds, variations in vibrato, and the like — are such an important part of our impression of violin, viola and cello that even an electronic imitation is never convincing.

The basic and most brilliant string voice is created by a simple high-pass filter, a small capacitor between a source of sawtooth tone and the load. That transforms the sawtooth into a sharp pulse (photo O) which simulates (actually exaggerates) the pulse-type excitation of a string by the rough hairs of a bow. The sound thus generated is so buzzy it is not very useful musically.

From the organ designer's standpoint, the string-instrument body is pretty much another formant producer. Obviously it does not allow all harmonics generated by the strings to be heard equally; it shapes the spectrum, much as does an oboe body, but infinitely more broadly. String stops for an organ can therefore be designed as formant filters. But, instead of using LC circuits to achieve narrow peaks in response, low-pass and high-pass RC filters are combined to give more gradual transition from one part of the spectrum to another.

Fig. 7, a diagram of a cello filter, is an example of this combination of effects. The series .022-μF capacitor and 47K resistor yield the high-pass action. The 0.1-μF capacitor in series with the 1,800-ohm resistor to ground boosts low frequencies to produce the full tone of the cello. Above 800 Hz, the capacitor becomes a short circuit and there is simply 1,800 ohms to ground. Below that frequency, the impedance becomes larger and larger, so that response rises. The small .0047-μF capacitor begins its effect about 3,000 Hz; it is there simply to eliminate unwanted buzziness. The one network therefore passes highs, boosts bass, and attenuates ultra-treble. The result is a shaped spectrum response which delivers a cello-like tone.

Cello-filter waveforms confirm its effectiveness. Photo P is at C_1. The original sawtooth has become more pulselike as its top is flattened out. There is still plenty of high harmonic content, as you can see from the almost invisible start of the flyback. But the bottoms are rounded off and the flyback is not quite invisible, indicating that top harmonics have actually been cut down some.

Photo Q is an octave higher, at C_2. Since the fundamental is higher, the high-pass section has less effect. And in photo R, another octave higher, high-pass action is practically gone; the sawtooth ascenders are about at their original slope. Ultra-highs are still cut off, however — more so than before. Listening to the output of this filter with a variable-frequency source gives your ear the idea that the tone quality is identical throughout the range, even though the waveform and actual harmonic makeup change.

Designing organ stops

If what I have said suggests that voicing an organ is simple in terms of circuitry, you are right.

What is not so simple is deciding what voices should be on an organ and just what they should sound like. Thousands of sounds have been used at one time or another, and hundreds are used commonly. The question of which should be on a particular organ model can be decided only by experience, taste and objectives.

It is not enough that certain voices sound good or authentic. The designer must first provide as many voices as costs allow that are useful for the most kinds of music. The voices he chooses must also combine well for a large variety of effects. And, unless the organ is strictly for an old ladies' home where anything not completely soothing might give someone a heart attack, he must design reed and string voices which are sharp, loud and blatant, in addition to flutes and diapasons which are more basic and have more foundation tone.

Above all, his selection of voices must include enormous DIFFERENCES. If most of the voices of an organ sound about the same, the whole purpose of this exciting palette of tone colors known as the organ will have been defeated. ●

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Fig. 6

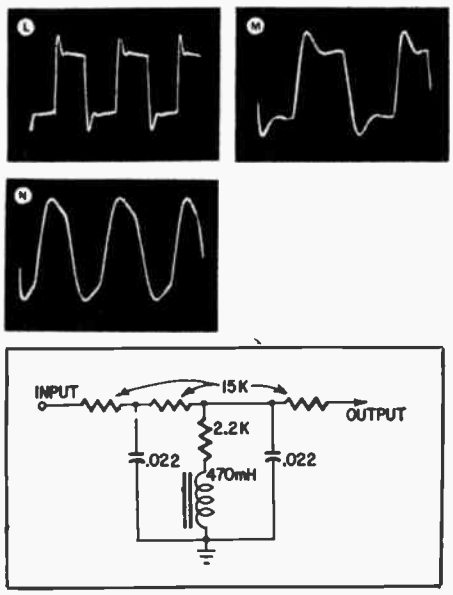

Fig. 7

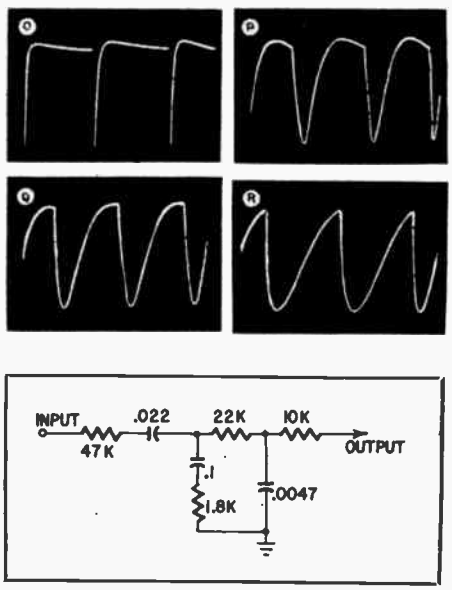

Fig.6—Clarinet filter has low-Q format circuit fed by symmetrical input waves. Fig.7—High-pass and low-pass filter shapes response with handpass characteristic and produces cello-sounding tones.

RECORDINGS... CLASSICAL

BARTOK — Concerto for Orchestra; KODALY — Dances of Galanta. Chicago Symphony Orchestra, conducted by Seiji Ozawa EMI OASD 2531. Stereo.

If the Concerto for Orchestra were, as has been suggested, a good orchestral showcase and little more, I should have no hesitation in calling this interpretation ideal. Taken very fast, it manages to be at once spectacular and bland.

Though I have always enjoyed the work on a much more satisfying level than that, and without suggesting that it is some kind of compendium, I would particularly recommend it to anyone wishing to become acquainted with the forms and textures, and the tone of thought of serious composition in this century.

There is the very marked influence of Debussy in the transparent, aerial and precise, yet organic figures following the noble and spectacular theme for strings in the first movement.

But there is a grave dark tone offsetting this that is very much Bartok's own – a tone evocative of that peculiar poised 'weight' of European cities, of calm thought late at night. There is a possible satire of Stravinsky's neo-classical period in the second movement, and there are the very much modified influences of Schoenberg and Webern, evoking the agile but controlled flight of the European imagination. There are lovely rural feelings as well, of peasants dancing, and there is the beautiful distilled simplicity of melodies such as the one in the third movement, which twice interrupts a strange dance figure.

Ozawa, as I have said, takes the work at an unusually fast pace, and I cannot see it as being a complete success. The spectacular parts are fine; so are the folk melodies, also the satirical sections, and those figures reminiscent of Debussy mount one on the other in a light but dazzling succession.

Lost, however, is the air of mystery from the fourths which seem to rise up out of the earth at the opening of the work, lost the passion, and entirely lost are those moments of freezing stillness from which the strings emerge with drawn-out intensity. The Kodaly, which completes the recording, seems to me quite superb. The recorded sound reflects the performance of Bartok: very good, but lacking a really exciting presence. – J.C.

BEETHOVEN — Symphony no. 9, 'Choral'. DECCA PFS-4183. Heather Harper (soprano), Helen Watts (alto), Alexander Young (tenor), Donald McIntyre (bass). London Symphony and Chorus, conducted by Leopold Stokowski.

"If only these gentlemen would introduce some novelty into their programmes it might be interesting, but they do not. They offer the same old symphonic stock-in-trade, and we shall have the usual demonstrations of the different methods of conducting Beethoven's symphonies. Some of them hurry the symphonies, others drag them; and the greatest sufferer will be poor old Beethoven . . ."

Debussy was right; we should impose a ban on performances or recordings of Beethoven's symphonies, or of his music in general, if only because hardly anyone does justice to the music. And yet how many 'virtuosos' of the baton or what-have-you are, as ever, tempted to try some of the music out. Last year's Centennial did not – fortunately – swell the record catalogues with yet more 'complete symphonies' by this or that 'Kapellmeister', although one shudders to think how many awful live performances were heard the world over.

If one can judge by the two standby complete sets of the symphonies, that of Schmidt-Issertedt for DECCA and the slightly older Karajan on DGG, then the day of fine Beethoven is over, at least of the Ninth, for example: both have choral finales which are honestly botched affairs, and I frankly do not see what others have purported to have seen in them. Beethoven remains, I dare say, the hardiest test of the conductor's art. Setting aside the matter of temperament suitability, the Symphonies are harsh with regard to a conductor's abilities as to phrasing, rhythm and dynamics – everything, that is.

Certainly, no-one can accuse Stokowski of lack of novelty in his programming. He, of all people, remains one of the most daring conductors living. But Stokowski is not normally associated in people's minds with Beethoven, and doubtless the still strong reputation of Stokowski as a showman ('Fantasia'), the supreme tamperer of texts, tends to keep most people from his renditions. Barely seven years ago just about everyone in Britain would have shuddered to even take Stokowski seriously, and it is perhaps with not a little irony that he is today treated with something approaching deference. A pity, since, at his age, it is highly unlikely that we shall ever get new recordings of his Mahler, for instance, which were quite often superb.

Nevertheless, it was with a lot of caution that I finally decided to hear this new recording of the Ninth. Aside from the fact that I was definitely afraid of Stokowski's very real propensity for show, I also doubted that a conductor of his age would display the rhythmic vitality so necessary to this symphony: one recalls the second Bruno Walter performance, for instance, with much regret. But let me say at once that this is a great performance, and one would have to go back to the Furtwangler, Kleiber, Klemperer, Toscanini, Walter (NY Phil.) readings to find one comparable. It is not surprising that, in comparing Stokowski's reading to others, one finds one must look back to that Romantic generation of conductors – for Stokowski does belong to that generation, and this performance bears out the chronological fact.

The outstanding fact about this performance is Stokowski's willingness to present the Symphony as a living organism and not some technical problem to be quickly done with, as is only too common with present-day notables (though one hastens to add that even the latter are barely capable of achieving the mere technical aspects in the Symphonies). Stokowski may not manifest the 'long breath' of the great German conductors, but he is always aware the Symphony is a grand as well as living whole. This is not the Beethoven that is also a collection of peculiar rhythmic or melodic slices: a whole, consistent as it is moving.

In his performance Stokowski reveals what a master he is of transition (a forgotten art): there is drive, and naturalness in what must be one of the best first movements I have heard, and in this same movement Stokowski is unafraid to be powerful (the coda is remarkably awesome). There may be a lack of precision at times in the woodwind, but one is not tempted to quibble where there is greatness. The Scherzo is vital, and yet without that 'here we go again' feeling which usually besets one after the first movement. The Adagio is as romantic as one would have it – not like Furtwangler's certainly, for Stokowski is not as overly concerned as Furtwangler with the 'melos' in the Ninth – but valid in its own right.

If there are any real weaknesses in this performance, it is in the final choral movement; but lest I be misunderstood, let me say that no conductor to my mind (not even those previously mentioned) has ever given the finale as it should be. If one is inclined to think that the fault does not lie with Beethoven, then one must admit the finale encompasses so many moods and variations of feeling that to get it off adequately with attention to all these variations is perhaps impossible; as hopeless, in fact, as certain moments of the 'Missa', late quartets and sonatas.

In addition, it is enough of a problem to have a chorus that can do this movement well, but to have a quartet that must be more than adequate to be stirring: and great voices (names), more often than not, do not carry out Beethoven's intentions well. In this regard, it is well to note that only two quartets on record have ever surpassed themselves: Toscanini's and Klemperer's. Otherwise there is ever that wobbling bass or alto, that non-heroic tenor, the soprano that misses that one important note. How many disappointing Furtwangler's quartets are in this regard!

It is to Stokowski's no mean credit that he presents this finale as stirring and as coherent as is possible. It is truly a last movement and not some vocalizing aside. More important, there is never that helpless disintegration of forces that besets Karajan's

or Schmidt-Issertedt's finales. Stokowski does not have the quartet to carry out his wishes, but he does manage to get the most out of them. Perhaps another problem is that the recording in this movement is not as clear or vivid as in the first three.

A Ninth therefore really worth having, and certainly way above the competing versions. Recording is (as I said) vivid, except in the finale. Surfaces are not the best, at least not the two copies I was able to hear. Both also have what sounds like a very awkward tape splice in the second half of the Adagio (side 2). But, if one can locate fine copies, then this certainly is the only recent Ninth to have – J.A.

BEETHOVEN — Piano Concerto No. 3. Daniel Barenboim, piano. New Philharmonia Orchestra, conducted by Otto Klemperer. EMI OASD 2579. Stereo.

This concerto is a milestone, both in Beethoven's development and in the development of the form itself. Although in many ways it still reflects the accepted Haydnesque and Mozartian methods, there are moments of storming, almost extramusical force, and passages of unearthly calm, both of which are typical of the great revolutionary Beethoven.

For all that, a classical rather than a romantic reading is appropriate. For this reason, the performance under review caused me enough to indicate that, even given the contemporary tendency to take certain of Beethoven's works very slowly, this must surely be one of the slowest performances on record. I had fears that the reading would thus be a romantic one, but these fears were soon dispelled.

The orchestral part is mightily slow and measured, revealing things in it which, I must confess, I had not heard before. Only at one point – shortly after the piano entry – does Barenboim seem ill-at-ease at this slow speed. Just momentarily does he seem to want to hurry things along a bit, but he soon settles down to Klemperer's slow pace, and thereafter it is Klemperer who shows a very slight tendency to quicken the orchestra.

One might have thought that Barenboim was a little out of his class, but this is certainly not the case. He seems inspired by Klemperer's reading of the work, and I have never heard him play better. He asserts himself grandly in the cadenzas and produces some beautifully quiet playing in the first movement coda.

There are other recordings of this work which must be recognised as being definitive of their kind, particularly Arrau's – but when I feel that I really want to get into the music, this version is the one I will play, despite the rather noisy surface of my copy. Fidelity is excellent. – K.W.

BARTOK — Piano Concerto No. 2; STRAVINSKY — Concerto for Piano and Wind. Stephen Bishop and the BBC Symphony Orchestra, conducted by Colin Davis. Philips SAL-3779 Stereo.

If a case can be made that the most romantic, expressive or even impressionistic works, if they are any good, can be appreciated on the level of 'pure music', it is pointless to reverse the process with this music and try to read the abovementioned qualities into it.

This is unarguably pure music, absolutely pleasurable from beginning to end, and this interpretation does nothing to obstruct that pleasure. Nor, in fact, does the very brittle sound quality detract from one's enjoyment. In some ways it enhances it.

Davis and Bishop have made a brilliant, articulate and exhilarating dialogue between piano and orchestra, within a faultless rhythmic continuum. The whole thing is like a cool, delicious wind.

In line with Stravinsky's neo-classical thinking, his concerto recreates the concerto-grosso style of the seventeenth century; but although it works in that way, to me it has little of that tone. The contrapuntal writing for brass is the sort of thing that has obviously influenced the jazz rock group Blood, Sweat and Tears, and – perhaps not unnaturally – it sounds more like a forerunner of that to me, at this point in time, than an echo of something more archaic (which is not to say that the group in question are any more than pretty good). The piano part – and this enhanced by the brittle, almost jangling piano sound – often has the unsentimental, jaunty vivacity of ragtime.

Even the solemn grandeur of the second movement reflects a detached but nonetheless passionate delight in the stately and the sonorous. This is lovely music, beautifully played.

The things which should first strike the listener in the Bartok are the sheer delight in pianistics and the endlessly fascinating procession of textures. Stephen Bishop's virtuosity is here quite extraordinary.

Horns and trombones have the slightly strained quality such instruments take on when they have lost some of their mellow overtones, as is the case on this recording – but, all in all: unimpeded pleasure – J.C.

MOZART — Symphony No. 40 in G; HAYDN — Symphony No. 104 in D; 'London'. Vienna Philharmonic Orchestra, conducted by Herbert von Karajan. Telefunken—DECCA SMD-1212 (Ace of Diamonds 50D-233) Stereo.

These symphonies represent two of the most mature works of their composers, Mozart's Fortieth belonging to the immortal group of the 'last three' (written in the incredible space of three months) and Hadyn's 'London' to that group of three (102, 103, 104) written for the King's Theatre, Haymarket, in 1795.

The performance of these two works is altogether remarkable. The Mozart is full of unhappy agitation – even in the last movement (played very fast) we can sense something ominous. Karajan gives this symphony quite a romantic flavour and this, I feel, is correct – here is a composition in which Mozart combined romanticism with classicism in equal proportions (he even used atonal passages in the recapitulation of the last movement). The Haydn symphony is, on the other hand, quite humorous – listen, for instance, to the effect in the last movement created by the very fairly controlled 'ritardandi' and the exactness of the pauses.

Phrasing in both symphonies fills me with wonder: the way in which Karajan moulds one phrase with the next in the Mozart is remarkable, while that of the second movement, in particular, of the 'London' is most moving. In fact, I can say without hesitation that for these two symphonies I have yet to hear better phrasing. The orchestra has that precision which comes only from great conducting, and yet its marvellous tone is in no way impeded – you only have to listen to the haunting opening of the strings in the Mozart. The balance of the orchestra is excellent. These are, in brief, dramatic performances, lending true pathos to the Mozart and graceful humour to the Haydn.

A reissue by DECCA having been recorded when Karajan was chief conductor of the Vienna Philharmonic, the sound is nonetheless excellent and well spread.

Very strongly recommended. – C.W.

MOZART — Violin Concertos No. 4 and 5. Pinchas Zukerman and the English Chamber Orchestra, conducted by Daniel Barenboim. CBS SBR 235394. Stereo.

Sadly, the Mozart violin concertos do not feature very often in concert performance. All five were written before Mozart was twenty years old, and I think that they are very beautiful, particularly numbers four and five.

The performances on this record are quite marvellous. Both works are played with great verve and authority. Zukerman, at twenty, appears already to be a great virtuoso violinist. For me his tone is a bit too hard, but this is compensated for by his extremely musical playing.

Barenboim gives perfect support and has the English Chamber Orchestra playing as well as ever.

Two very fine performances, carried off with great elan. Some surface noise, but fine sound. – K.W. ●

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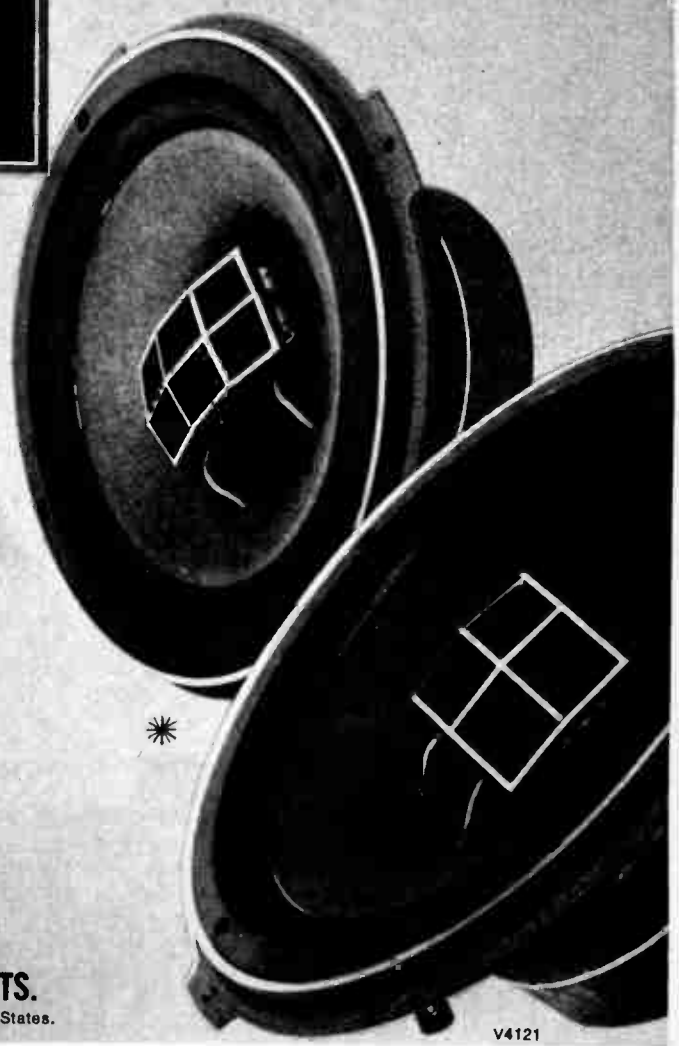

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RECORDINGS... JAZZ

QUINCY JONES — Gula Matari, A & M SAML — 933977. Stereo. Includes Bridge Over Troubled Water, Walkin', Hummin.

As well as famous veterans such as Ray Brown and Milt Jackson, there are present on this recording men such as Herbie Hancock, Ron Carter and Jerome Richardson, whose talents had been somwhat obscured – for Australian audiences at least – by their having come into full flower around the time record companies began to realise what a big money-spinner the rock thing would be.

Not that any of them really stretch out here – but they all add their beautiful unique touches to what is a very nice recording indeed.

The interplay between Ray Brown walking with elastic strides on air, Milt Jackson spilling out evenly like silvery liquid and Herbie Hancock (on electric piano) popping chords onto the crest of the beat, fitting an intricate chromatic scurry into the tiniest spaces – this, at the beginning of 'Walkin" is a rare delight. The ensuing orchestration is unremarkable but quite satisfying, including a full-bodied brass statement of the descending part of the theme at just the right moment, and nice bright touches such as flute and trumpet playing together. Jerome Richardson's continuous, running soprano solo is the best on this track, and the best on the record, with the possible exception of Major Holley's marvellous rocking, grumbling burst of voice and bowed bass in octaves of 'Hummin'.

'Hummin' is here one of those sleepers which start as gentle rockers and gather strength as they go along. Voices are deployed quite effectively in the beginning and it's, you know, nice, until Grady Tate begins snapping the off beat ever more vindictively, and Major Holley comes roaring in to set the whole thing rocking nice and hard, like we like it. These guys still do it the best. I was standing listening to this in a record bar in the city – everybody had stopped and was listening to it – and about this time kids started to ask me what it was. It's like that.

'Gula Matari' is a quite effective exercise in exotica, and 'Bridge' again starts off rocking nicely in three before it's brought to a rousing peak by vocalist Valerie Simpson, the fine brass and four gospel voices.

This will be deservedly popular. Sound is superb. Exactly right for the music. – J.C.

KID ORY — FLETCHER HENDERSON. HIT ST 5114. Stereo, also available in mono. Side 1: KID ORY — Panama Rag, Sugar Foot Stomp, Muscat Ramble, High Society, That's a-Plenty, Weary Blues. Side 2: FLETCHER HENDERSON — 12th Street Rag, Sugar Foot Stomp, My Pretty Girl, Business in F, Tiger Rag, Milneburg Joys.

This record suffers from the absence of liner notes and any indication of recording dates or players. However, side 1 is undoubtedly the Kid Ory Band during its long stay at San Francisco's Hangover Club in the 1950s.

The band is rough and gutsy, carrying on the tradition of the old-time New Orleans Street parades. In fact, most of the players concerned came up in that period and have been playing in much the same style since early in the century.

Leader Ory is in his seventies and his side-men are not much (if any) younger. Featured trumpet is the late Mutt Carey, a compatriot of Bunk Johnson, Freddie Keppard and the early Louis Armstrong.

All the tunes are jazz standards. Some of them lose a great deal in presentation due to stodgy tempos.

The group plays with gusto, but there is always the feeling that someone is about to hit a clinker – and sometimes someone does.

The drummer is the mainstay of the band, and a nice liquid clarinet comes through from time to time.

There is applause from a live audience, and it would appear the numbers are taken from tapes actually out during a performance at the club. Ory is still active in music on America's West Coast.

Side 2 features some of the great bands led by colored pianist and arranger Fletcher Henderson in the late twenties and early thirties. The arrangements are surprisingly modern and, although complex in parts, never lose their swing.

Master tenor-saxist Coleman Hawkins is featured on all tracks – and as he left the band in 1934, they must have been cut before that date.

Also featured are brilliant trumpet players Henry Allen, Tommy Ladnier, Joe Smith and Rex Stewart.

That fine trombonist Jimmy Harrison, who died at an early age but was the inspiration for such men as Jack Teagarden, Vic Dickinson and Tommy Dorsey, is heard on several tracks playing some beautifully phrased and swinging solos.

In addition to Hawkins, the sax section – a model for its day and age – had Don Redman, Benny Carter and Buster Bailey. Bailey was for years the band's featured clarinet soloist, and he struts his stuff here in fine style.

Reproduction on both sides is excellent and a tribute is due to the manufacturers, considering the conditions under which the originals were cut.

This record is a budget-price special and a must for jazz lovers and collectors of jazz historiana. – M.A.

CANNONBALL ADDERLEY QUINTET & ORCHESTRA — Experience in E by W. Fischer and Joe Zawinul, Tansity by D.A. Axelrod, Dialogues for Jazz Quintet and Orchestra by Lalo Schifrin. Capitol ST 484. Stereo.

This is a mixture of the old Third Stream thing and bits of what Miles Davis is doing now. Oddly enough, I think it could have worked, had more imaginative use been made of the orchestra. As it is, the record is redeemed by the fact that everyone seems to be having a hilarious time and Cannonball is in pretty good form.

The trouble with the orchestral stuff is the same as it has always been with Third Stream music: there are cursory nods towards several styles of modern classical music – the style but not the substance – and these often interspersed with rather commercial 'middle-of-the-road' devices hiding behind a bit of arty electronic static. Really, about the only completely successful Third Stream recording I ever heard was 'Jazz Abstractions' with Gunther Schuller, Ornette Coleman, Eric Dolphy and Company.

However, there are some enjoyable sounds here – and both Cannon and brother Nat solo brilliantly on 'Tensity', which in the parts where the orchestra cuts out gets a little of the feeling of 'Bitches Brew'. The writing for strings here would be alright for a film soundtrack.

Dialogues for Jazz Quintet and Orchestra makes about the best use of orchestral textures, though it's certainly nothing extraordinary. Good interplay at the beginning between Cannon's open-grained alto and the dry, wiry string figures. Cannonball plays beautifully. An archaic brass chorale later leads to a timeless rolling blues of infinite charm.

Sound is good, with a bit of control-board mucking about with Nat's sound. All-in-all quite worth having, I would say – but if you really want to hear Cannonball, get 'Country Preacher'. – J.C.

CHARLES MINGUS — Mingus at Monterey. America AM 001 & 002. Stereo. Ellington Medley, Meditations on Integration, Orange Was the Colour of Her Dress Then Blue Silk; Jackie Byard, John Handy, Charles McPherson, Buddy Collette, etc.

The sound on this double album ($6.00 the set) is mainly pretty bad. It was recorded by Mingus, with his great sense of that which should be preserved, on his own tape recorder. It is true, as Mingus says on the sleeve, that if you turn it way way up you will hear it somewhere near the way it sounded on the day. However, it should not be long before you have forgotten about the sound, for this is some of the best jazz ever recorded.

The occasion was a triumphant one for Mingus. The long piece 'Meditations On Integration' met with ecstatic and sustained applause – and no wonder. The rest of the set is occupied by jazz that is often brilliant, including an Ellington medley with a roaring 'A Train' – but 'Meditations On Integration', while remaining jazz throughout, contains some of the best music of any kind that you are ever likely to hear anywhere.

The composition, played by Mingus's sextet augmented by two additional trumpets, a trombone, tuba and two extra reeds, lasts about thirty minutes. It begins with Mingus bowing the theme on his bass to the hushed crowd – and how beautifully he plays – moves through some rather Turkish-sounding ensembles until altoist Charles McPherson takes off on a muscular, racing solo, paced in another tempo by exciting Ellingtonian brass blasts.

This rousing section gives way to a little miracle: Mingus, Jackie Byard on piano and

recordings... JAZZ

Buddy Collette on flute together improvising entirely superb chamber music. How vastly superior this is to the orchestrated sections on the Cannonball Adderley record reviewed here! In fact, one is not likely to hear the sensitivity, skill and expressiveness displayed here often surpassed by musicians in any field. Any musician, any listener should be filled with admiration and delight, hearing this magical conversation between these men whose instruments are truly part of them.

The trumpet reintroduces the Turkish feeling without breaking the mood too abruptly – in fact, it is a passionate extension. The whole band soon erupts in a free-blowing holocaust of sound, some of which – anchor notes here and there – must be written. There is a wildly-blown reprise of the theme at the end. Then silence. Then a bucking spasm from the band, a shriek from the brass, then silence again. Then the wild applause.

This is a record to possess jealously. – J.C.

DON CHERRY – "MU" First Part. Actuel 529.301. Stereo. Don Cherry, pocket trumpet, piano, Indian flute, bamboo flute; Ed Blackwell, drums.

This is one of an exotically packaged series of recordings which present a cross-section of avant-garde jazzmen (for want of a better term), but largely those who are most strongly influenced by their African 'heritage'.

Singer Leon Thomas gives a good indication of their tone of thought during an interview for 'Jazz and Pop' magazine.

'You see, in the springtime, the earth is laying there like . . . come get it, come get it. And that's when the cats used to get it with those plows. Hit her with hoes, open her up and she'd say "aahhh" – plant the seeds, cover it back up, and in nine months she'd yield a harvest. But she can't do that no more, so she says "What about me?" Even the waters that nourish her can't get to her no more. They run off in rivulets, because there's pavement everywhere. She's suffocating.

This recording is a hard one to talk about without straining credibility. First, I think anyone interested in arguing intelligently with what I have to say should listen to earlier Cherry – with Ornette Coleman, or with Gato Barbieri – to establish the fact that the man is an unusually brilliant and articulate trumpet player. A first hearing of this might persuade one that his flute and piano playing is much more competent than his trumpet work.

Cherry is one of those select few who could at his best persuade you for a while that his was the only way to play trumpet. Although somewhat indebted to Miles, he played almost stylelessly in a sharp bright tone an amazingly intricate but seemingly artless stream of chattering phrases, almost like birdsong. On first hearing him, around 1960 I think, one was not sure that he really knew what he was doing all the time, or whether he was just blowing through the instrument and plunging the valves up and down as fast as possible, more or less allowing the instrument to play itself. Since then we've learned to follow his phrases, and we've been able to discern a district and conscious style.

He's now shed that style, as though in direct flight away from any trace of glibness.

In his first solo after stating the Turkish folk style theme he seems at first to be just juddering and scrabbling along like Don Ayler – which method is effective in the Ayler context. I played trumpet until a couple of years ago, and it is possible to get an effect like this simply by blowing within a certain register and twiddling the valves. A series of notes can be pitched off each valve position, so chances are that lip pitching and valve position will coincide to make some sort of a note each time a valve is depressed; but I can guarantee that Cherry is definately 'playing' here, though the brassy but oddly delicate effect is pleasurable either way. The more you listen, the more you deliberate. There is the odd moment when you get that feeling, which Louis Armstrong's Hot Fives and Sevens give you every other chorus, that a certain phrase is just so good it must have been an accident.

Cherry gets two distinct sounds. A bright brash one and a mellow slightly muffled one, which would seem to be achieved not by muting but by playing up against a wooden wall. Actually, he gets two versions of the open sound – a much more ringing and 'professional' sound with less half valving when he comes back to state the first variation of the theme.

He also gets a lovely exotic sound, and plays extremely well, on flute. His brief piano solo shows him to have a beautiful concept and fine touch. Blackwell generally takes a secondary role and is very fine, particularly behind the flute, where at one stage he alternates two rhythm patterns giving the feeling of a missed beat. This is tricky but delightful to hear.

I enjoy this record more each time I hear it. I think that it's an intimate and fine piece of music-making to lie back and let enter your head, or have accompany calm thought or any artistic or craft work you may be doing. Piano is recorded rather remotely, but the sound is generally good. – J.C.

TONY WILLIAMS LIFETIME – Turn It Over. Polydor (not yet released). Drums, Tony Williams; Bass, Jack Bruce; Guitar, John McLaughlin; Organ, Larry Young.

At long last this record is being released! Probably my favourite group at the moment – it has the best of everything – perfect rhythm section and one hell of a front line!

Tony Williams will be known to you as Miles Davis' drummer, Jack Bruce comes from many good rock groups (e.g. Cream), guitarist John McLaughlin had been gigging around many English R & B type bands when Miles Davis 'found' him and let him develop his style in his extremely stimulating presence. McLaughlin has a completely new sound and conception on guitar – rather than just playing harmony chords or single-line phrases he uses the guitar as tone coloration, setting a mood rather than being just a 'backing-up' instrument.

Larry Young on organ, a relatively new name to rock people, has been around for quite a few years playing a refreshingly new style (all organists usually sound like Jimmy Smith).

This album is the second for Tony Williams Lifetime, and probably the more successful because of the addition of a bass player. Although just as wild, it seems to be a lot more 'together' – Larry Young isn't relied upon to be the rhythm section as well as a soloist, he now can get on with some improvisation.

But the mainstay and master-mind is definitely Williams with his very forceful drumming, being at once THE rhythm section, and also a soloist. (A rock drummer shouldn't have to just keep time.)

I won't review each track separately, this

is a sound that you yourself have to evaluate.

My favourite tracks are 'Big Nick' by John Coltane, for the beautiful solo of Young and the driving drumming of Williams, who never just plays rhythm – he plays all over the place, blinding figures that play around the beat, never settling on one figure, but continually changing with Young's improvisation. 'Once I Loved', a song written by Antonio Carlos Jobim, has been changed into a mystical, eerie piece with the use of the organ playing sustained dissonances behind Williams' vocal. McLaughlin playing very spaced-out phrases rather as tonal accompaniment to the vocal.

'Vuelta Abajo' is rather like 'Sunshine of your Love' in conception, using a small bass figure as the original song – each instrument builds around it, taking that figure and adding to it. This is collective improvisation at its best.

One final point. Don't be misled by what you may have heard about the sound reproduction. It is exceptionally clear and undistorted, with a good balance, and each instrument can be heard clearly and separately – but I do stress that this record must be played VERY, VERY LOUD. P.S. ●

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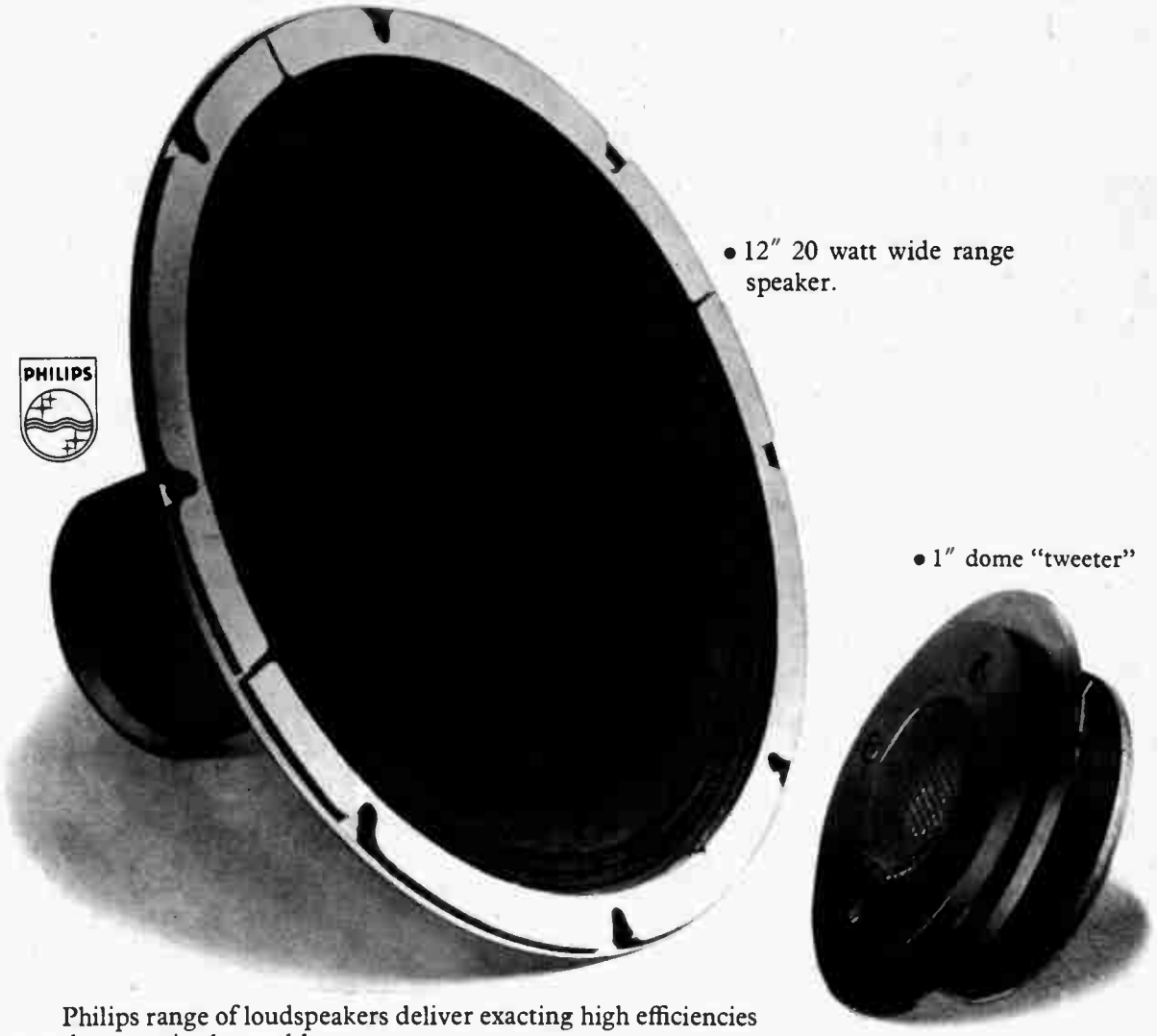

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RECORDINGS... POP TRENDS

Well, I de-Clare...

JOHN CLARE surveys the current Pop scene

Have you ever stopped outside a discotheque and wondered that anyone could enjoy the horrendous noise which sometimes issues from such places? The singer raves frenetically in a demented region beyond emotion, trying at whiles to turn his throat inside-out; the lead guitar keeps up a hellish caterwauling, returning often to the same painfully bending and stretching note.

Well, it's like this, I think: many of the younger generation see this extraordinary outpouring as a continuous maelstrom of colour and energy on that level where frequency, intensity, amplitude, of sound or of light, are reduced to vibration. They do not so much appreciate this music as give themselves up to it and allow it to act on them.

Some Africans live with the sound of drums, almost constantly. Someone or something diffrent enters their area an; the drums change rhythm, a wave of agitation or of welcome passes through the region. No doubt there is conscious artistry on the part of the drummers, and no doubt there are fabled drummers, just as there are superstars – but generally the drums are just unthinkingly experienced, moods are transmitted as naturally as through caresses or blows.

Much contemporary popular music is meant to be experienced more or less in this way – think of the parallel between the situation I described at the oeopening of this article and the classic line uttered by Europeans in old films about darkest Africa: 'Oh, those maddening drums!' To those who have become attuned to it, the music opens up the subconscious with its 'freaky' sounds and insistent rhythms – it acts, in short, like a drug – although it should be stressed that the music of the young has not yet begun to approach the power or the subtlety of nuance of African music.

Of course, all music acts on one; but there is a tendency in some heavy rock music to dispense with that other element of musical enjoyment – conscious appreciation of form and of beauty. Indian music has always had a hypnotic element intended to heighten one's perception and thus one's sensual, intellectual and emotional appreciation of the music itself. Some rock music is concerned only with acting on your emotions and nervous system. Formally it may be quite repetitive and boring – much heavy rock is still based on twelve-bar forms, or on repeated riffs of even shorter duration – but once it has begun to act on you, your own mind will supply a kaleidoscope of colour and shapes in the form of internal hallucinations.

Uriah Heep's 'Very 'eavy, Very 'umble' on the impressively-packaged Vertigo label is straight heavy rock, endlessly repeated riffs, moronic discotheque stomping and all. It's splendidly archetypal, and it does give off a certain 'buzz'. Get this and, say, Grand Funk's 'Closer to Home' on EMI – which is more lively and exciting to my mind – if you want to know where it's at in the straight heavy field.

Some groups have used a battery of extramusical sounds – some electronically produced, some natural sounds electronically distorted or interpolated straight – to aid the penetration of the subconscious. Drugs have no doubt got something to do with people's wanting to do this, but it is also part of a general tendency to grope back towards a more instinctive and mystical awareness, to bring one's inner world out into everyday actuality. There are dangers in taking this too far, of course, just as there are dangers in keeping the imagination too strictly confined – but these considerations are beyond the scope of this article.

Probably the Beatles started the ball rolling in what we might loosely call the pop world, with 'Sgt. Pepper's Lonely Hearts Club Band' but recent experiments include Spooky Tooth's 'Ceremony' on CBS and Pink Floyd's 'Umagumma', 'Set The Controls For The Heart of the Sun' and 'Atom Heart Mother' on EMI. The first light show I ever saw was provided by Pink Floyd in a very theatrical presentation in London.

Spooky Tooth, usually a straight heavy rock group, are aided on 'Ceremony' – a series of songs with rather harrowing religious overtones – by Pierre Henry, who is better known as a composer working with electronics more or less in the same areas as Stockhausen, Cage, Xenakis, etc. The overall tone of the recording is both lurid and bleak, and even the joyful songs are forced and hard. There is a lot of inventiveness on the record, however, and it is a good reference if you are more than casually interested.

Pink Floyd have their own electronic equipment. Lined up on an airfield on the cover of the double album 'Umagumma', it is a frightening array. For all that, the records since that one have been marked by a general paucity of sonic variation. 'Uma' seems to contain just about everything they can do, and it is very well worth having.

Many of the Floyd things are based on a very simple melodic line – sometimes modal and folky, sometimes in blues form – and a heavy but flowing rock rhythm. Around this central thread move their galaxy of sounds, sometimes related to it, sometimes not. For instance, a very high-pitched pinging might begin, a nagging sound so high above the melody line that it makes little difference whether or not it is 'in tune' with it. This may be joined by a siren-like wailing, then sighing voices recorded with a great deal of resonance to sound like one huge instrument, and perhaps the sound of a heavy prop-driven aeroplane rumbling subliminally in the distance. The melody grows fainter.

Now one 'sees' the monotonous progress of the melody and rhythm as though from a long way off through the universe of weird floating sounds – a rather sad, all but forgotten caravan through space. As there is really no progression, the line being quite repetitious, the song seems to be going nowhere in a timeless void, and it is the listener who is drifting away. Bach gets something of this feeling in his harpsichord continuum, but that is in fact changing subtly and developing harmonically bar by bar in a grand inevitable progress. The resemblance is superficial.

Finally, the song disappears and the sounds take over. You may be conscious of a persistent gremlin whining as of some insect just out of vision, near your ear, and in fact the recorded buzzing of a fly is used on one track; a rather nasty device, for the fly gets swatted. Screams which seem to scrape the ceiling of your skull, sounds which seem to herald some presence which never materialises, sounds which have no sensual or emotional meaning, which yet hold some mysterious significance. Madness yawns before you.

Of course, it would take a lot more than this to drive a normal person mad – listen to this long enough and you will find the effect wearing off, such is the stabilising mechanism of the brain. Sometimes, too, the sounds are orchestrated in a rather more inspiring way, so that they coalesce in momentary visions of unearthly loveliness: shifting luminescent curtains like the Aurora Borealis, slow-motion spindrift, gigantic leaping flames such as you see in telescopic films of the sun.

It was not necessarily electronics which sparked all this off. Avant-garde jazzmen have been doing these sorts of things for quite a while by exploring the limits of acoustic instruments (though electronics is now figuring in this field as well) and they have to my mind succeeded in creating a music which is valid and strong. They in turn are indebted to both serial composition and the sounds of Africa and Asia.

The question I have arrived at is, of course: will the electronics become the music, the medium the message – will sounds programmed to produce a desired response eventually replace music as we know it?

Not immediately, anyway. There is in fact a certain move away from what are termed 'heavy' and 'freaky' sounds. The English group Fotheringay were producing quite lovely material in the folk rock idiom before they broke up, and you can still hear them on the recent release 'Fotheringay' on Festival (Island series). Donovan's 'Open

POP TRENDS

Road' on CBS is also a very nice one to have.

Others have turned to country sounds, or to good old rock-and-roll in the manner of Chuck Berry and Little Richard. And of course there is the influence of jazz (jazz has influenced the popular music of the day since the 1920s). But all these things have an element of Eastern hypnotics – it's not as though people had turned en masse to, say, Mozart on the one hand or Gilbert and Sullivan on the other; so we could easily slide back before we really got clear of that area. And the electronic gear is here to stay.

However, the truth is that freaky sounds only work until one is tired of them, and only that music has emotional, spiritual and formal strength, as well as consciousness-altering properties, will last.

For an example of superb musicians using electronic sounds – as well as acoustic – to make joyful and strong spontaneous music, one could not go further than 'Miles Davis At The Filmore' on CBS. Except that is not yet released in Australia. I, for one, will be be making a nuisance of myself at CBS, imploring them to release it, though I have imported a copy for myself.

In the meantime I would recommend your hearing the records leading up to it: 'In A Silent Way' and 'Bitches Brew'. There are several reasons for my singling out the work of Davis, despite there being no electronic sounds other than those made by the musicians on electric instruments: electric pianos, guitar, bass, organ at the Filmore – and Miles plays his trumpet through an amplifier and a loop echo delayer in some passages.

For one, 'Miles At The Filmore' seems to me the ultimate rock statement as well as being brilliant jazz. Miles and his men are virtuosi of high musical intelligence, stemming from a young but strong tradition of improvised music. They have brought their knowledge and brilliance into an area where many are using unusual sounds and African-derived rhythms as gimmicks or for idle indulgence.

Miles has tied together the many influences – of avant-garde jazz 'free' collective blowing, of floating modal lines (which he helped pioneer in jazz ten years ago), of black rhythms, of the electric sound, even the influences of atonal music in the ethereal clusters which rise up off the powerful rhythm; and he has made of this firstly Miles Davis Music, and secondly a direction which many have begun already to take.

The music is of course largely improvised, a constant and miraculously complex interaction, which takes it right away from that feeling of having someone carefully calculate effects that will freak you out. At the same time, the experience and sensitivity of the musicians precludes the possibility of a disjointed rave.

'In A Silent Way' is very gentle. In previous recordings the drums had kept up a terrific barrage of cross-rhythms. Here they often just tick away the time as the other instruments swim through a silken atmosphere in a slow-motion hand-over-hand rhythm. The electric pianos, however, are continually bubbling and popping up off the beat. Again there is that feeling of space. It is quite remarkable, the way the soloists can play with considerable abandon without actually destroying the atmosphere.

'Bitches Brew' is much tougher stuff, heavy and powerful like some indominatable force moving over the countryside. Two drummers are used, and sometimes the beat gets turned completely around, sometimes it is only implied through an agitated section, sometimes the electric pianos, flashing and pinging, stitch it all together – but it always comes out right, and you can always feel it pacing tigerishly through everything. The more you hear it, the more deeply satisfying does the record become.

'Miles At The Filmore' makes even greater use of electronic sounds – we will review it fully when it is released – and in my opinion it stands right in the vanguard of this kind of endeavour.

One day, perhaps, sounds will be programmed to make you happy or sad, or to drive you round the bend – but for now there is too much unique and indefinable satisfaction to be derived from the works of the intellect and the imagination. – J.C.

BUDDY MILES — We Got To Live Together. Mercury 6338 028. Stereo. Runaway Child, Walking Down The Highway, Easy Greasy, We Got To Live Together, etc.

After listening to several pallid English jazz-rock groups, and a couple of dull American big-name heavy rock groups, it was a thing wondrous to hear how these gentlemen of colour carved them

effortlessly in every department. In Spades.

I am sometimes accused of being a bit of a Ubangi-lover. Well, some of my best and some of my very worst friends have been American and West Indian blacks, but all that aside, Negroes have simply been the strongest force in popular music this century, and for a long time the only influence towards any sort of spontaneous creativity.

This record should give you some idea of what I am talking about. It is difficult to decide whether to place this in a rock or a jazz category, but why bother? This is black music, with elements of gospel music, blues jazz and rock. They get something of the same fierce snapping beat as Sly And The Family Stone – but theirs is a much broader sound augmented with brass and reads.

'Walking Down The Highway' didn't kill me, but all the other tracks generate a terrific excitement which impels you to join in, either by singing or dancing, or by drumming with your hands or playing anything handy.

The sound balance leaves something to be desired. The solos in particular are under-recorded. – J.C.

MAX MERRITT AND THE METEORS — Stray Cats. RCA SL101906 Stereo. Good Feelin', Peace Brother Peace, Proud Mary, Hey Jude, etc.

Here we have a Dynaflex recording – just leaving the music aside for a moment – Dynaflex being a new profile for records exclusive to RCA. We haven't the space to go into it this month, but the background is indeed very quiet, as claimed. The other claimed advantages seem feasible, too – elimination of warpage, etc.

A pity, then, that three factors of production have militated against the music here: Max Merritt's voice, Bob Bertles' alto sax and Stewart Spear's drums are recorded without presence. Bob's alto solos are particularly fine and, though quite clear, have not the impact they should have – unless you turn your set way up.

Max's voice sounds very worn-out to begin with. It should be credited to his musicianship and 'heart' that he is able to stay so well in tune with his voice carrying such an unwanted cargo of fuzz and sludge, and being so diminished in itself to carry the weight.

The brass backgrounds are recorded much as we have heard brass recorded of late, and I do not entirely agree with it, though there is plenty of impact. We shall go into this at another time.

I found the record a little disappointing, though there are some good things on it. Bertles plays brilliantly, and Max is quite moving on their good arrangement of 'Hey Jude'. The boozy 'party' track has a nice feeling to it, and there are lots of other nice touches – but if I did not know that they were an Australian band, nor how exciting they are live, there is a possibility that I may not have given it such close attention. Awful confession. – J.C. ●

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NEW LITERATURE

DATA SHEET PD 305 from Plessey Ducon gives full specifications of the company's professional series SD3M mica capacitors designed for operation at 500, 300 and 100 VDC working.

This range of silvered mica capacitors is similar in construction to the current Ducon SD6M series of MIL Approved capacitors.

Construction features high-grade mica plates with fired-on silver electrodes. These are stacked and fired into a rigid and stable block which is then protected by dip encapsulation and epoxy impregnation.

The SD3M series provides a wider range of capacitances and working voltages, as well as a reduction in size compared with the MIL approved series. A crimped lead version is also available.

Plessy Ducon Pty. Ltd., P.O. Box 2, Villawood, N.S.W. 2163.

WHAT is meant by auto-tracking? How can ground loops in multiple loads be avoided? What is the difference between a constant voltage/constant current power supply and a constant voltage/current limit supply? These questions and many others are answered in a new edition of the Hewlett-Packard DC Power Supply Handbook (Application Note 90A).

The book is written for the user rather than the theorist. It discusses both traditional and unusual applications and problems of regulated power supplies.

Available from Hewlett-Packard, 22 Weir Street, Glen Iris, Vic. 3146.

DECEMBER issue of TABS, published by Rank Strand Electric, contains articles on the reopening of Ford's Theatre in Washington (where Abraham Lincoln was assassinated in April 1865) and a most interesting contribution describing lighting equipment used at an operatic performance at Hintlesham.

TABS is a regular publication of interest to these professionally involved with theatre lighting. Available from Rank Strand Electric Ltd., 29 King Street, Covent Garden, London W.C.2.

BROADSHEET describing the full range of JBL speakers, amplifiers and enclosures is available from Auriema (A'Asia) Pty. Ltd., 443 Kent St., Sydney 2000.

FROM Summit Electronic Systems, a leaflet outlining their range of eight capacitor discharge ignition systems. Of particular interest is their totally sealed marine unit, claimed to withstand extremely severe environmental conditions. The manufacturers state that this unit meets or exceeds relevant military and aeronautical specifications.

Summit Electronic Systems, 54 Fox Valley Road, Wahroonga, N.S.W. 2076.

HUGHES Aircraft Company have published a four-colour brochure describing their pulsed bonder model HPB360. The unit is a fine-wire thermocompression bonder operating on pulsed heat principles, thus eliminating the need for steady-state pre-heating of circuit elements, substrates or packages.

Brochure is available from Royston Electronics, 17 Burwood Road, Burwood, N.S.W. 2134.

RECEIVED – the Jan./Feb. issue of The Microphone, official journal of the Australian Tape Recording Societies. Contents include details of a four-input microphone-mixer and a review of record manufacturing techniques.

Copies and details of membership from The Secretary, Box 9, G.P.O., Crows Nest, N.S.W. 2065.

FROM The Australian agents for Farnell Instruments – a four-page brochure describing a range of digital logic modules. The modules, which may be interconnected, provide logic systems suitable for industrial applications, educational instruction and advanced project work.

The range of logic functions includes – Dual 4 input NOR, 8 input NOR, 4 x 2 input NOR, Half Adder or exclusive OR, four-sequence phase detector, 4-2 input AND, 2-4 input AND, etc.

Details from Sample Electronics, 370 Albert Street, East Melbourne. Vic. 3002.

BROCHURE describing Hewlett-Packard's new 1000 measurements/second, four-digit, 0.03% accuracy digital multi-function meter.

Available from Hewlett-Packard, 22 Weir Street, Glen Iris, Vic. 3146.

CATALOGUE of miniature rotary switches manufactured by RCL Electronics Inc. has been received from RCL's Australian distributors, W.G. Booth Pty. Ltd.

The range of RCL switches described in the catalogue extends from single pole 24-way, to 12 pole two-position. One, two, three, four, six or twelve poles per combination are available with any combination of shorting or non-shorting action on the same deck.

W.G. Booth Pty. Ltd., P.O. Box 131, Richmond, Vic. 3121.

ALSO from W.G. Booth Pty. Ltd., RCL's latest catalogue of precision resistors. RCL resistors are available in very wide range of power ratings and tolerances. Temperature coefficient of standard RCL resistors is ± 10 ppm/°C, special resistors are available with coefficients as low as ± 2 ppm/°C. Tolerances available extend from ± 1.0% to ± 0.002%.

W.G. Booth Pty. Ltd., P.O. Box 131, Richmond, Vic. 3121.

ELECTROBIT Co. have produced a leaflet describing their dual-in-line package-style reed relays.

The relays are suitable for high-density packaging and are compatible with integrated circuits.

Electrobit, 26-28 Kent Rd., Mascot, N.S.W. 2020.

BOOK REVIEWS

THE USE OF LATERAL THINKING — by Edward de Bono. Jonathan Cape. $2.95.

A young student was given an aneroid barometer and a problem. The problem? – To measure the height of the university's administration building.

The student went into the quadrangle and, using the barometer as a protractor, calculated the height of the building. 'Seventy-three feet', he told his tutor. Having ascertained the method the tutor sent the student back to 'do it properly'.

This time the student climbed to the roof, tied a length of string to the barometer and lowered it to the ground. He measured the string and reported to his tutor that 'the building was still seventy-three feet high'.

Predictably, he was sent out again and this time tossed the barometer off the roof onto a patch of soft grass. He timed the fall with a stopwatch and from elapsed time calculated the distance – 'seventy-four feet'.

The tutor, in the last vestige of self-control, insisted on a 'proper answer'.

This time the student tracked down the caretaker and swapped the barometer for an architect's plan of the building: 'Seventy-two feet nine inches'.

The tutor's reaction is unknown. The point of the story is that each method of measurement was more accurate than using the barometer 'properly'.

This is the type of thinking that Edward de Bono contends is of great relevance to management.

Briefly, de Bono considers that people tend to think vertically – often with no real appreciation or understanding of the problem they are trying to solve. They try to find answers before asking themselves what the question is. He suggests a lateral approach to problems rather than the traditional way of small logic progressions, each predicated on a more or less certain basis – the traditionalist's argument that, if each small step is correct, then the ultimate conclusion must be correct.

'But,' says de Bono, 'it may be essential to be WRONG in thinking – not in action – at some stage. This enables one to move far enough from the old pattern to restructure it. One may even have to move through what one can call an "intermediate impossible".'

As an example of the 'intermediate impossible' de Bono quotes an experiment in which children were asked to design a platform that could travel over rough ground. One solution was a cart which sprayed 'smooth stuff' in front, travelled over it, and sucked it up again at the rear.

It sounds ridiculous like that, says de Bono – but hold onto the 'intermediate impossible' for a time, and you realise that the child had 'invented' the caterpillar track.

De Bono continually stresses the importance of defining objectives – he quotes the classic example of a company which had outgrown its building. Staff turnover was high, due to some extent to a severe shortage of lifts. Employees often had long waits before they could leave the building.

The engineer's approach was predictable – more or bigger lifts, or else move to larger premises sooner than planned.

But the problem was staff turnover – not slow lifts. Luckily a lateral thinker arrived on the scene and solved the problem for $10. The solution? – He put mirrors on the walls near the lifts. The staff became so engrossed at watching each other in the mirrors that they forgot about waiting for the lifts. And that, believe it or not, is a true story.

De Bono's book will be fascinating reading for almost everyone involved in design, management, computer programming, or any aspect of decision-making. It may even reassure those of us who see several answers of equal validity to many questions in an I.Q. test.

You may not agree with all his theories, but many are being seriously studied and implemented by some of the biggest companies in the world. If de Bono can influence Unilever, IBM and British Petroleum, he must be taken very seriously indeed. – C.R.

AMATEUR RADIO TECHNIQUES — by Pat Hawker (G3VA). 3rd Edition, 1970. Soft covers, 208 pages; over 470 diagrams and circuits. Published by the Radio Society of Great Britain — RSGB. Australian price $3.55.

First edition of this book, published in 1965, was a collection of articles with the title of 'Technical Topics' originally published in the RSGB bulletin by Pat Hawker. The articles in the bulletin (now 'Radio Communication') began in April of 1958, and the present third edition is thus a collection of the best articles over a period of 12 years, plus some additional material. In contrast to the second edition, published two years ago, it offers some 30 percent more information, mostly added at the end of each section.

As the author states in his foreword to the third edition, 'this is not a book which aims at competing with or displacing the standard handbooks – but rather at extending the reader's awareness of new techniques and providing a source book for many useful circuits and aerials. An ideas book rather than a constructional manual or conventional text book.'

Indeed it is an ideas book, crammed with hints and useful circuits and information. Section 2 – 'Components and Construction' – is a particularly useful one for the beginner, outlining all the common pitfalls of component selection and usage, which all too often are only learned by sad experience. This is an area which is almost entirely neglected by standard texts; in fact, the writer has not seen a better treatment of the subject.

The book is entirely non-mathematical in its treatment and is written in a conversational manner which makes for interesting reading. Theory is discussed in general terms, the advantages and disadvantages of various circuits and arrangements being discussed in a way that will appeal to the home constructor. The general theory discussion is then backed by a selection of typical circuits – including quite a few contributed by leading amateur experimenters.

An indication of the coverage of the book

is given by the section headings, which are as follows:

1. Semiconductors.
2. Components and Construction.
3. Receiver Topics.
4. Oscillator Topics.
5. Audio and Modulation.
6. Power Supplies.
7. Aerial Topics.
8. Fault-Finding and Test Units.

An appendix and an index complete the volume. The appendix lists the IF frequencies of the better-known commercial communications receivers. This, of course, is invaluable to those involved in servicing such receivers, as little headway can be made in alignment without this information, which is often difficult or impossible to obtain.

The wealth of practical hints and variety of circuits and ideas makes this book a must for every amateur's shelf, whether he be a beginner or an old-timer. If you don't have a copy, get one. If you have a previous edition, the modest price and extra material content could make replacement worthwhile. – B.C.

HI—FI YEAR BOOK, 1971 — edited by Colin Sproxton, published by IPC Ltd. 442 pages, $3.15.

The introduction states that entry is primarily limited to equipment conforming to German standard DIN 45-500 (details of which are given) or, in the case of tape recorders and microphones, to units costing more than 50 pounds and 5 pounds respectively.

Although it is not stated in the text, presumably a further condition of entry is that the equipment is either made or available in Britain.

This is reasonable for a book primarily intended for sale in the British Isles. However, many items of equipment currently available in Australia are not included.

Although all specifications quoted are supplied by the manufacturers, the recently introduced (and strongly enforced) British Trades Description Act ensures that these specifications are accurate.

As the book's editor points out, lack of a standard specification format makes it difficult to compare the performance of competitive equipment; but this is a criticism of the industry's standards rather than the book.

Equipment covered includes pickups, motors, tuners, amplifiers, tape recorders and decks, magnetic tape, test tapes and discs, microphones, speakers and enclosures, aerials, etc. Also included are a number of extremely ugly equipment enclosures.

Apart from equipment specifications, the Hi-Fi Year Book 1971 contains six articles on hi-fi topics. One of these deals with VHF/FM and is not currently relevant in Australia.

The remaining articles are – Distortion, Noise & Dynamic Range, by Gordon J. King; Demonstration Discs, by W.A. Chislett; Hi-Fi Limitations & Specifications, by John Borwick; Taking the Plunge, by Colin Sproxton; ABC of Pickup Parlance, by Donald Aldous.

The article 'Demonstration Discs' suggests that hi-fi is best demonstrated by 'light, spectacular recordings' and lists a number of such recordings. Included in the lists is Delius' 'In a Summer Garden', from HMV, and 'A Taste of Tijuana' by the Mexicans.

John Borwick's article on 'Hi-Fi Limitations and Specifications' is written in his usual clear style. We would, however, query his statement that 'the amount of power needed for realistic reproduction depends a bit on the efficiency of the speakers'. Surely, with speaker efficiencies varying from 20% to less than 0.5%, the amount of power needed depends a very great deal on the efficiency of the speakers.

There is a lot of information in this well-produced book. Not all of it is relevant in Australia and much equipment available here is not included. Nevertheless, to those deeply interested in the subject the book should be well worth its price. *(over)*

Our review copy was supplied by the Technical Book Company, Melbourne.- C.R.

A DICTIONARY OF COMPUTERS — by Anthony Chander, with John Graham Robin Williamson. Penguin Books. $1.30.

The esoteric language used by computer specialists is exposed. The authors of this book translate 3000 computer terms in English so simply understandable that one can only wonder why most of the 3000 terms were devised in the first place.

The dictionary also contains a large number of articles on systems analysis, programming, etc.

We recommend this extremely valuable and comprehensive book. – C.R.

INTRODUCING COMPUTERS — by F.J.M. Laver. Her Majesty's Stationery Office, Holborn Viaduct, London EC 1.

Good book providing basic understanding of computers. ●

ELECTRONIC WATCHDOGS

Continued from page 48

adsorbent and emerge from the column (together with the inert carrier) in inverse order of adsorbence.

Various methods are used to determine the percentage of each constituent in the sample. The most common of these compares the thermal conductivity of each constituent plus the inert carrier,against the carrier alone, and plots the result as percentage against time. A thermal conductivity cell is shown in Fig. VI and a typical plot in Fig. VII – note that the graph is read from right to left.

Once calibrated for use, any ammonia constituent in the gas sample will appear at the same known interval of time after the total sample has been introduced into the column. If a reading is obtained from the thermal conductivity cell at this time, exceeding a preset level, an alarm circuit will be energised.

The gas chromatography system is vritually tamper-proof; however, the sampling speed is slow and a quickly-moving intruder may not be detected until he has left the area. Recent development undertaken for the American armed forces is said to have overcome these problems.

REPORTING SYSTEMS

The traditional alarm bell is still the best audible alarm for private and small-risk business use. Despite the folklaw which insists that the public do not pay attention to alarms of this nature, the type of criminal who attacks homes and small businesses most certainly does.

Alarm bells are essentially low power devices and their effective range is less than 100 yards – but their abrupt onset attracts attention and their high frequency components can be heard above normal background noise. Being a mechanically resonant device, the conversion efficiency of a bell is very high.

Sirens have the power handling capability required for long-distance transmission and their distinctive sound is clearly differentiated from background noise. Their characteristic rise and fall in pitch is attention-producing. The vast majority of sirens are motor-driven. Some electronic sirens have been produced, but at the present time their power outputs cannot compete with the motor-driven types.

A noise-making device WILL deter the MAJORITY of intruders – nevertheless the really professional criminal will disable a bell or siren before attempting entry. Some of the methods for doing this are most ingenious – and regrettably cannot be printed here.

Where such a risk exists, the alarm system will be connected either by private telephone line or automatic dialling unit to a security company central bureau.

WHAT OF THE FUTURE?

Intruder detection systems are approaching the level of development where it is possible almost totally to secure an area against intrusion, and much current development has as its objective the production of existing systems which are cheaper to buy and simpler to install.

A major criticism of many security systems is their high percentage of false alarms. This is typically 97-98%, and whilst a high percentage of these are due to clients leaving doors and windows only partially closed, far too many are caused by sub-standard design and construction and/or poor installation. In one area of England the problem has become so serious that the local police force has warned that it will no longer answer alarm calls unless the percentage of false alarms is reduced.

The problem is one of which the security industry is well aware and is actively trying to solve.

As in so many fields, the quality of an installation is probably – but not necessarily – related to price. The Crime Prevention Dept. of your local police headquarters will be aware of the strong points and the failings of available equipment and will provide every assistance in planning an installation. ●

FOOTNOTE: Next month's issue of ELECTRONICS TODAY will feature a project for constructing a comprehensive intruder detection system.

take your pick

Six outstanding data modems all designed to fill a particular slot in the data transmission speed spectrum. High speed data transmission equipment covering the range 1200 bps to 9600 bps with an unrivalled reputation for reliability and efficiency. Let's take a closer look at two of the latest additions to the range.

MODEM 5500/96 Transmits and receives data at the exceptionally high speed of 9600 bits per second over data grade telephone lines. Modem 5500/96 is the first in the Racal-Milgo range to provide an integral adaptive equaliser which automatically adjusts for changes in line characteristics – Hands-off automatic.

MODEM 3300/36 Economical 3600 (optional 2400) bits per second data transmission over leased and, where permitted, dial-up telephone lines. Also contains a 150 bps "backward" channel. Modes of operation full duplex and half duplex. For full information or a demonstration, write or telephone

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Now AMPEX "600 Series" professional tape, previously available only to TV, broadcasting and recording studios, is available to you for home use through your franchised Simon Gray Dealer.

Ever wondered why professionally recorded tapes sounded better? While equipment plays a major role, the importance of tape in professional use cannot be over emphasized. Now, for the first time, AMPEX professional audio tape is available to the consumer. That's not all the good news. Because production has been substantially *increased*, the price has been *reduced*.

What are the big advantages of AMPEX professional tape? Precise oxide formulation, maximum dynamic range, uniform tape output and the exclusive "Ferro-Sheen" tape surface which extends head life . . . also improving high frequency response and eliminating "breaking-in" periods.

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If you own a high quality tape recorder or tape deck, you will appreciate the difference AMPEX professional tape can make. You'll agree with discriminating audio engineers in leading studios all over the world — the top professionals who demand the highest possible standards. *Settle for nothing less — use AMPEX professional tape!*

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SPACE URCHIN

Carnarvon tracking station's precise C-band radar system, FPQ-6 is currently engaged in tracking a special type of radar-reflective balloon.

The object is to obtain information on high-altitude wind strengths and directions as they may affect space vehicles.

The balloon's official title is Balloon Meterological Radar Reflective. This somewhat cumbersome name has been replaced by the more colloquial one of 'Jimsphere'.

It was also valuable in the Apollo 14 project in that the sphere provided an excellent target to enable the FPQ-6 radar and its operating staff to reach peak performance for the critical trans-lunar insertion manoeuvre which occurred directly over Carnarvon during the second earth orbit of the Apollo 14 mission.

Carnarvon's FPQ-6 radar is one of two high-precision radar systems in the manned space flight network and the only one in the Southern Hemisphere.

More than 180 engineers, technicians and support staff employed by Amalgamated Wireless (Australasia) Ltd. operate and maintain the Carnarvon station under contract to the Department of Supply.

The helium-filled Jimsphere is launched from the ground and tracked from some 150 metres (480 feet) altitude to its ceiling of about 18 kilometres (60,000 feet).

Ascent rate is about five metres a second, during which readings of radar range, azimuth and elevation are automatically recorded every tenth of a second on magnetic tape by the radar's computer amassing over 8.5 million 'bits' of data during a 60 minute track.

The computer also provides large-scale plots on an X-Y plotboard of the balloon's ground track and altitude above the earth's surface, superimposed on a map of W.A.

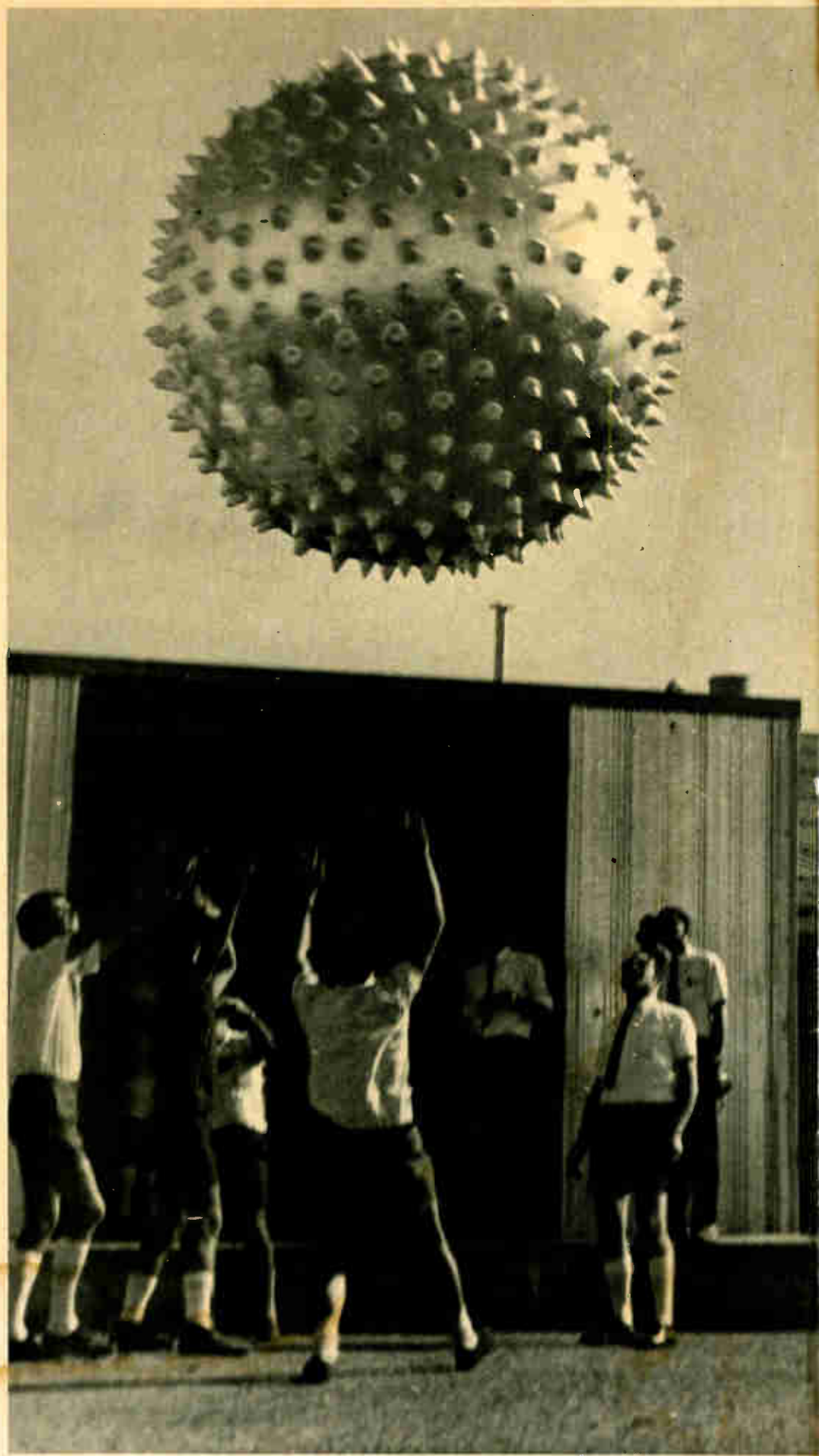
The recorded data is analysed at the Marshall Space Flight Centre in U.S.A., along with similar data from other sites, to determine wind shear and turbulence.

In the Jimsphere project, data is also being obtained from radio-sonde balloons launched at the same time by the local airport's meterological department. These transmit temperature, humidity and pressure during ascent and provide spot checks on wind direction and velocity for comparison with the FPQ-6 data.

Two Jimspheres will be launched each week over a 12-month period.

An aluminised mylar sphere two metres in diameter, the Jimsphere is covered with 398 conical roughness elements over its entire surface. Each roughness element stands three inches high and has a three-inch base diameter. Two simple pressure relief valves maintain the helium pressure within the sphere to five millibars above local atmospheric pressure, thus maintaining a constant sphere size and minimising the possibility of bursting.

'Jim' is completed by a 100 gramme ballast weight contained in a patch on the sphere's surface which doubles as a holding point for the balloon's filling and launch crew.



Launching a 'Jimsphere' at Carnarvon tracking station.

If you don't buy it at Douglas Trading you'll probably pay too much!

When Melbourne's sound equipment specialists release their special purchases, enthusiasts from all over Australia reach for their cheque books and save, save, save!

Low prices go hand in hand in high quality at Douglas Trading. We believe you CAN have the world's best without having to pay the world for it. Wherever you live, whatever you want, be sure to check the Douglas Trading price on ANY piece of equipment before you buy anywhere else. Call in, phone or write!

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Just Released! AKAI GX-365 Professional Stereo Tape Deck and Full Recorder. 3 motors, 3 heads, automatic continuous reverse, automatic shut-off, sound on/ with and over sound plus a score of other exclusive AKAI features including the "all new" glass and crystal ferrite head to give 150,000 hours guaranteed life! Price on application.

Above:
It's hear before you buy at Douglas Trading — every piece of equipment is linked to pushbutton comparators!

New shipment!
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AKAI X-160D Tape Decks.
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*Integrated Circuit (IC).
*All Silicon Solid State.
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Sony Super Special Tape Deck — 630-D with 4 tracks. 3 speeds, 3 heads. Professional Full Control . . . echo effects, sound on sound, truly a magnificent model. Exclusive to Douglas Trading.
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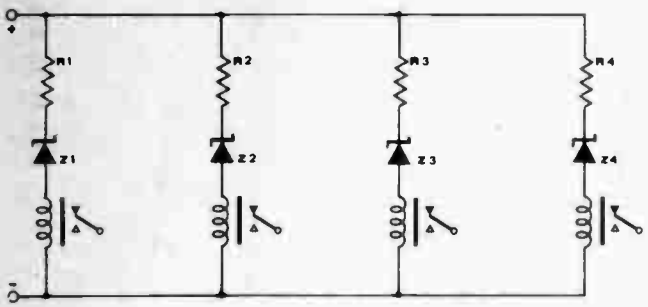
Monarch — the King of Hi-Fi Systems! Made to Douglas Trading specifications to give you the best Hi-Fi ever, at the price. Models range from a low $195 (like the one in the foreground above) and just look what you get for your money . . . Powerful solid-state amplifier. 20 WATTS RMS power. Bass and Treble controls. Loudness control. Top-quality magnetic cartridge anti-skate diamond stylus. 2 heavy-duty wide-range speaker systems housed in attractive hand-crafted cabinets.

Below: A visit to Melbourne would not be complete without a visit to Douglas Trading's first floor sound lounge. See $100,000 worth of equipment from speakers to stylus comparators and HEAR it in action!

TECH-TIPS

USES OF ZENER DIODES

SEQUENTIAL CLOSING OF RELAY SERIES



This circuit provides sequential closing of a relay series by appropriately increasing an applied voltage.

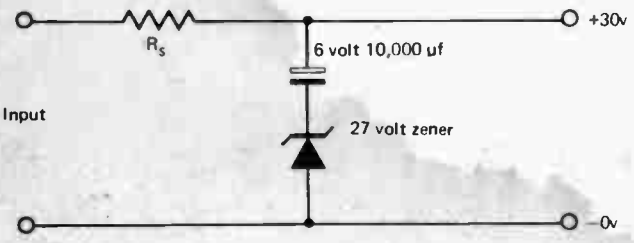
All relays have similar coil resistances but are in series with zener diodes of different voltages.

As the applied voltage exceeds the zener's breakdown voltage, that zener will conduct, thus energizing its associated relay.

The exact voltage at which each relay is energized is determined solely by the zener diode, and not by individual relay characteristics.

By using 5% tolerance zeners from 3.9 volts to 30 volts, 22 selective steps can be obtained.

ZENER DIODE LIFTS CAPACITOR RATING



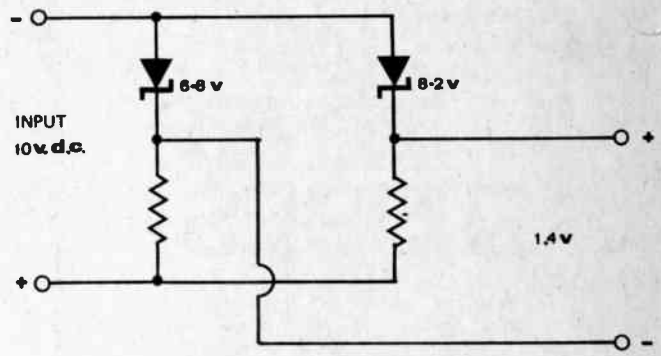
Electrolytics combining large capacity and high working voltage are bulky, expensive, and frequently difficult to obtain.

A drastic reduction in the voltage rating required is achieved by the connection of a series zener diode. In this example a 27 volt zener in series with a 6 volt electrolytic filters a 30 volt line.

CAREER OPPORTUNITIES

TECH-TIPS

LOW REGULATED DC VOLTAGES



For some purposes it is necessary to use regulated dc voltages lower than can be obtained from commercially available zener diodes.

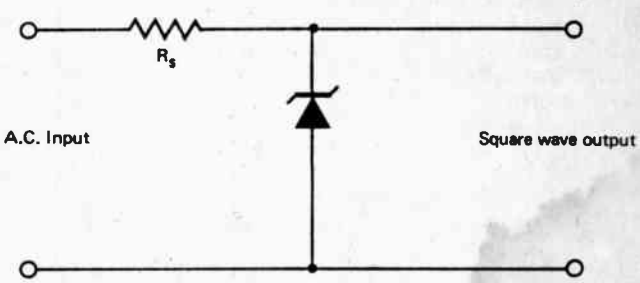
This can be achieved by using two zener diodes of different voltages and utilising the potential difference between them.

In the example shown, 6.8 volt and 8.2 volt zeners provide the required 1.4 volt difference.

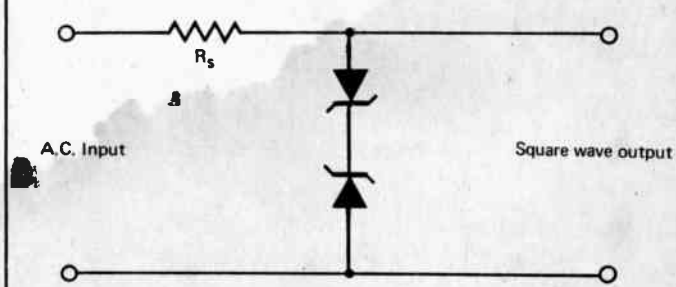
One such application is the supply voltage for gallium arsenide emitters which, typically, require 1.4 volts ± 0.05 volt.

In general, temperature compensation is excellent as both zeners tend to drift in the same direction — either positively or negatively, depending upon voltage. It is inadvisable to use zeners which bracket 5.6 volts, as below this voltage zeners have a negative temperature coefficient and above 5.6 volts they have a positive temperature coefficient.

SIMPLE SQUARE-WAVE GENERATOR



A zener diode clips one half-cycle of the input sine-wave in this simple square-wave generator. The zener voltage must be a small fraction of the input voltage for acceptable results.



If a larger output is required, opposed zener diodes may be used to clip both halves of the input sine-wave.

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