APRIL

electronics TODAY INTERNATIONAL

HI-FI

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COMPUTERIZE —AND BE DAMNED

DIGITAL LOGIC SYSTEMS

HOW TO MEASURE POLLUTION

SONY's answer

Superlative hi-fi doesn't come cheaply.
The ultimate runs into four figures or even more. This Sony rig doesn't. Yet only the perfectionist would ask for better than this and even he mightn't tell the difference.
Ask to hear, in combination, Sony's TA-1055 amplifier (23w/RMS per chl.), PS-5520 belt-drive turntable, the 3-speaker SS-7200 enclosures and the TC-134SD Dolby* tape deck. They're Sony's answer to the quest for magnificent hi-fidelity at a three figure price.

*Dolby is a trademark of Dolby Laboratories Inc.

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APRIL 1973 Vol. 3 No. 1

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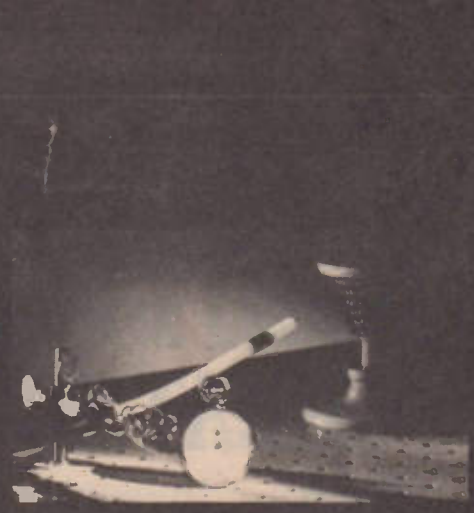
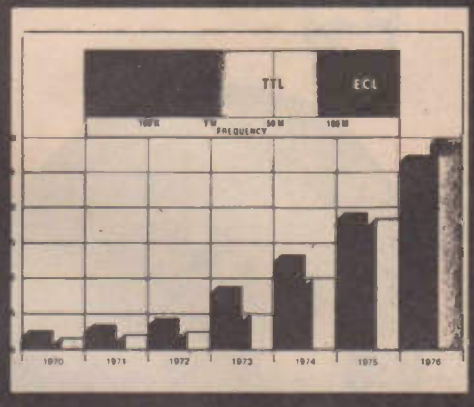
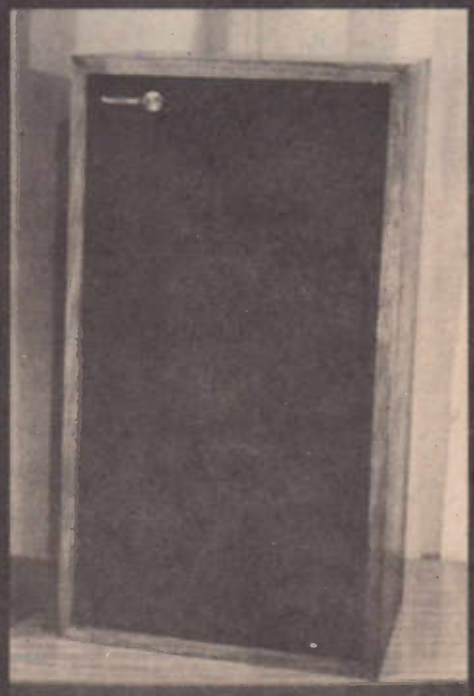
COVER: This ceramic work of art by Sylvia Halpern symbolizes transistor technology. It has been reproduced by kind permission of Fairchild.







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small speakers... GREAT SOUND

Here are the loudspeakers that make the Philips Quadreflect System the most exciting sound innovation of the seventies.

Illustrated are the tweeter (type AD0160/T8) and woofer (type AD7065/W8), just two examples of the imported Philips high-fidelity range.

Full details of all loudspeakers and enclosure designs available on request.

Write without obligation to ELCOMA, P.O. Box 50, Lane Cove, N.S.W., 2066 for your free 12 page booklet on the range of Philips loudspeakers.

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WHO SELLS THE GOODS?

FOR many goods, there is little justification for resale price maintenance — or restriction of retail sales outlets.

But in the latter case at least, such a policy is not invariably valid, and in our opinion the hi-fi industry represents just such an exception.

By its very nature, hi-fi equipment requires specialized marketing — and specialized after-sales service. At present — and indeed for the foreseeable future — this can only be satisfactorily provided by dealers who are conversant with the product, have the necessary technical knowledge and who are prepared to back these pre-requisites with adequate demonstration and servicing facilities.

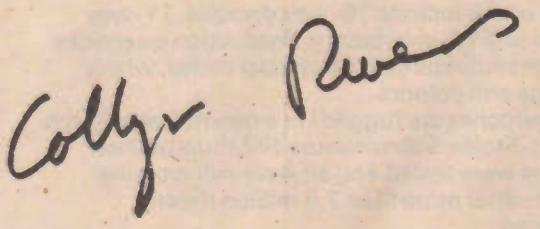
There is of course no absolute guarantee that good service *will* be available from manufacturer appointed dealers — but it is a very rare exception when it isn't.

Until recently it was generally believed that the Restrictive Trade Practices Act limited the right of manufacturers to choose their own selling outlets, but a recent case, brought by Sydney Wide Stores Pty Ltd against Mikasa (Dinnerware) Ltd, has indicated that such selling outlet selection may in fact be perfectly legal.

No actual judgement was made at the hearing held before the Full Bench of the Commonwealth Industrial Court — because Sydney Wide withdrew their case. Nevertheless legal observers say that the withdrawal supports manufacturers seeking the right to appoint their own retail outlets — always providing resale price maintenance is not the test.

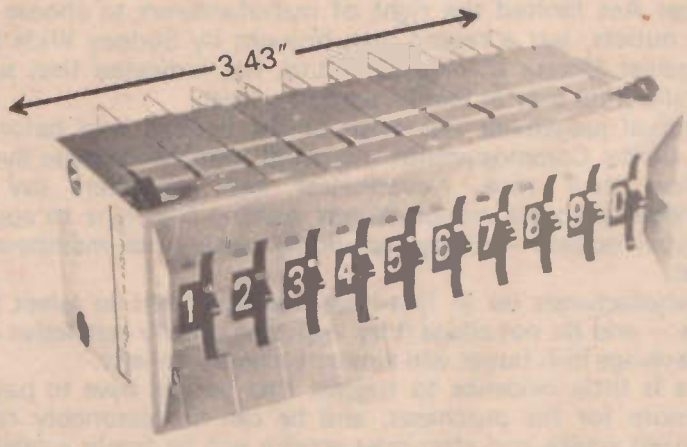
If manufacturers do in fact have this legal right to select their retail outlets — and do not abuse it by imposing unduly restrictive conditions — the average hi-fi buyer will almost certainly benefit.

There is little evidence to suggest that he will have to pay much (if any) more for his purchases, and he can be reasonably certain that specialized advice and after-sales service will be freely available. And if he is a knowledgeable purchaser and has no need of such facilities, then he is still free to make a deal on those terms.



WELL STACKED!

10 SM SWITCHES INCLUDING END PLATES STACK INTO LESS THAN 3½ INCHES



Priced from $1.46 per module.

That's right! The new Birch Stolec Subminiature SM thumbwheel switches are *really* slim (.312") which allows you to stack more to the inch. A real bonus where panel space is at a premium.
Output codes include 10-way decimal, 11-way decimal and 10-way binary. Production quantities can be manufactured with special codes, wheel markings and colours.
These switches are rugged! In a recent test, a batch of Birch-Stolec Subminiature SM thumbwheel switches were tested and all were still working perfectly after more than 2.8 million detent operations.

We will assemble your SM thumbwheel switches with end plates, divider plates and blank bodies in any combination to your exact requirement.
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SPECIAL PRICE **$479**

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10" SPEAKERS

featuring new controlled fibre length cone technology

*with Plessey controlled fibre length cone

Plessey is proud to announce the first release of a completely new 10" high fidelity speaker series—and at the same time introduce a significant new technology for improved speaker performance. The new C100 woofer and C100X wide range speakers are the ideal choice for the hi-fi enthusiast who wants to move up from the 8" speaker range without incurring the extra cost and larger enclosures of the 12" speakers.
With a cone area more than 1½ times that of an 8" speaker and the high performance characteristics of the new CFL technology, the new Plessey 10" speakers provide rich bass response and excellent overall performance.

The CFL technology

CFL—"Controlled Fibre Length"—is a new advanced technique developed by Plessey for manufacturing speaker cones. The length of the fibre used in the cones is a critical factor in the final performance of the speaker. Both frequency response and speaker efficiency can be changed considerably by varying fibre lengths. With CFL, Plessey can now assert rigid control over the basic paper pulp used to felt the cones. Fibre lengths and pulp densities can be varied to meet specific requirements, resulting in cones with optimum resonance/efficiency combinations.
Plessey CFL cones provide better **transient response, minimum distortion, smoother, richer bass, brighter top frequency performance and improved overall efficiency** in the new Plessey C100 and C100X speakers.

Write to us for the technical résumé "CFL — A New Loudspeaker Technology"

Plessey C100 woofer

This new 10" high fidelity bass speaker provides significant performance benefits in multi speaker applications. The curvilinear CFL cone with rigid apex produces a most satisfying rich bass, extended high frequency response and a valuable increase in efficiency. Full application details are available.

Plessey C100X wide range

An excellent high efficiency 10" speaker providing superb sound reproduction over the full frequency range. The CFL cone adds richness to the bass, improves transient response and provides a brilliant top performance to satisfy the most discerning enthusiast.

Enclosures

Full construction details for one, two or three way enclosures with suitable cross-over networks are available from Plessey Rola distributors, wholesalers or Plessey Rola direct.

Specifications

	C100X	C100
Power handling	20 watts RMS*	20 watts RMS*
Fundamental resonance	45 Hz	45 Hz
Voice coil diameter	1"	1"
Impedance	8 or 15 ohms	8 or 15 ohms
Frequency response	33 Hz—20 kHz	33 Hz—13 kHz

*in Recommended enclosure

Look for the Plessey CFL stickers. The CFL mark is your guarantee of a speaker with exceptional performance characteristics.

AR49

PLESSEY
Rola

Plessey Rola Pty. Limited
The Boulevard Richmond Victoria 3121
Telephone 42 3921 Telex 30383
NSW: PO Box 2 Villawood 2163 Telephone 72 0133

Distributors: N.S.W.: General Accessories, Lawrence & Hanson Pty. Ltd., Martin De Launay Pty. Ltd. **Vic.:** General Accessories, Lawrence & Hanson Pty. Ltd., Radio Parts Pty. Ltd. **Qld.:** General Accessories, The Lawrence & Hanson Electrical Co. (Qld.) Ltd. **S.A.:** General Accessories, Gerard & Goodman Pty. Ltd. **W.A.:** General Accessories, Atkins Carlyle Ltd. **Tas.:** W. & G. Genders Pty. Ltd., Homecrafts Tasmania. **N.Z.:** Plessey (N.Z.) Limited, Rata St., Henderson, Auckland.

When you buy a TANDBERG tape recorder you get more than you bargained for.

Not only do you get a superb piece of precision equipment — you also invest in the Tandberg standard of reproduction . . . *"sound reproduction indistinguishable from the original"*. You get long term *reliability* — continuing *high fidelity performance* — and the pleasure of owning a professional instrument made by one of Europe's most famous manufacturers. Some of your hi-fi friends will be envious — but that's the price you must pay for your extra taste and discrimination!

Probably the most popular Tandberg model is the 4041-X. It features the proven Tandberg Crossfield Head which provides *wider frequency response*, a *superior signal-to-noise specification* and *more natural sound reproduction*.

The Tandberg 40-41X is a complete stereo system, with built-in stereo amplifier and wide-range speaker systems.

TECHNICAL SPECIFICATIONS

Frequency Response:
7½ ips – 40–20,000 Hz ± 2 db
3¾ ips – 50–16,000 Hz ± 2 db
1⅞ ips – 50– 9,000 Hz ± 2 db
Signal-to-Noise Ratio: (7½ ips.)*
60 db Quarter-track weighted
Wow and Flutter:
7½ – better than 0.07 % Weighted Peak
Heads: 4 precision-gapped, mumetal screened. One each for record, playback, erase and Crossfield (bias).
Speed Tolerance: Absolute tolerance ± 1.5 %.
Tape Speeds: 7½, 3¾, 1⅞ ips.
Motor: Asyncronous induction motor.
Transistors: 61 silicon planar and FET.
Pushbutton Controls: 2 each for selecting record and playback channels; start/stop/pause; normal/special mode.
Harmonic Distortion: From tape at 0 db record level less than 3 %.
Line inputs: Stereo with built-in magnetic/ceramic cartridge selector.
Output Power: Max. 2 x 10W continuous sinus RMS
Bass Control: ± 15 db at 100 Hz continuous.
Treble Control: ± 15 db at 10,000 Hz continuous.

See and hear the Tandberg 4041-X at all franchised Bleakley Gray dealers. Listen and *compare*. Tandberg superiority is clearly evident when you witness a demonstration, when you instal your new Tandberg, and years later — after hundreds of hours of musical pleasure.

As we say, when you buy Tandberg you surely get more than you bargained for!

Price: $690 inc. sales tax.*

Bleakley Gray Corporation Pty. Limited,
28 Elizabeth Street,
Melbourne 3000.
Please send me full technical information about the TANDBERG 40-41X and the name of my nearest Bleakley Gray franchised dealer.

NAME .....

ADDRESS .....

POSTCODE .....

* The price is a recommended price only — trade-in valuations on your old equipment can make a world of difference!

BG-T-473

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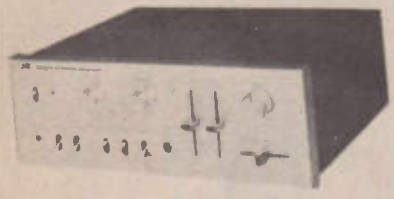

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15 R.M.S. per channel
High/Low filter. All facilities.

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Manual or Auto.
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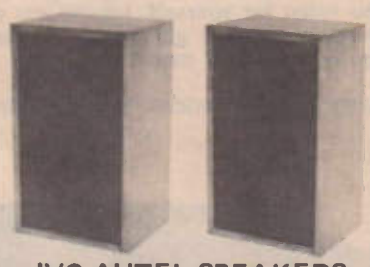
SYSTEM COMPLETE FOR $339.00

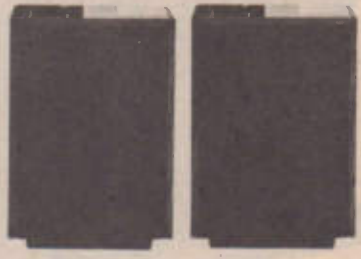


JVC AUTEL SPEAKERS
8" 2 way – 25 watts
R.M.S. 25 – 20 kHz

DUAL 1218, SHURE 91ED
Cartridge. Professional quality making a perfectly matched system.

TEAC AG 7000
80 watts R.M.S.
per channel
AM/FM Tuner –
2 tape circuits.

SYSTEM COMPLETE FOR $1195.00



JBL – Exact copies of the famous L55 speakers using JBL 5 + 2 speakers – unbelievable must be heard.

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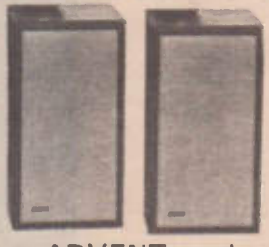
Tested in excess of 40 watts/channel before clipping. Base, Treble, midrange control, Hi-Filters plus all facilities.



Large **ADVENT** speakers.
Designed by the man who made A.R. speakers famous for reproduction.

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Plus Shure 55E Cartridge.

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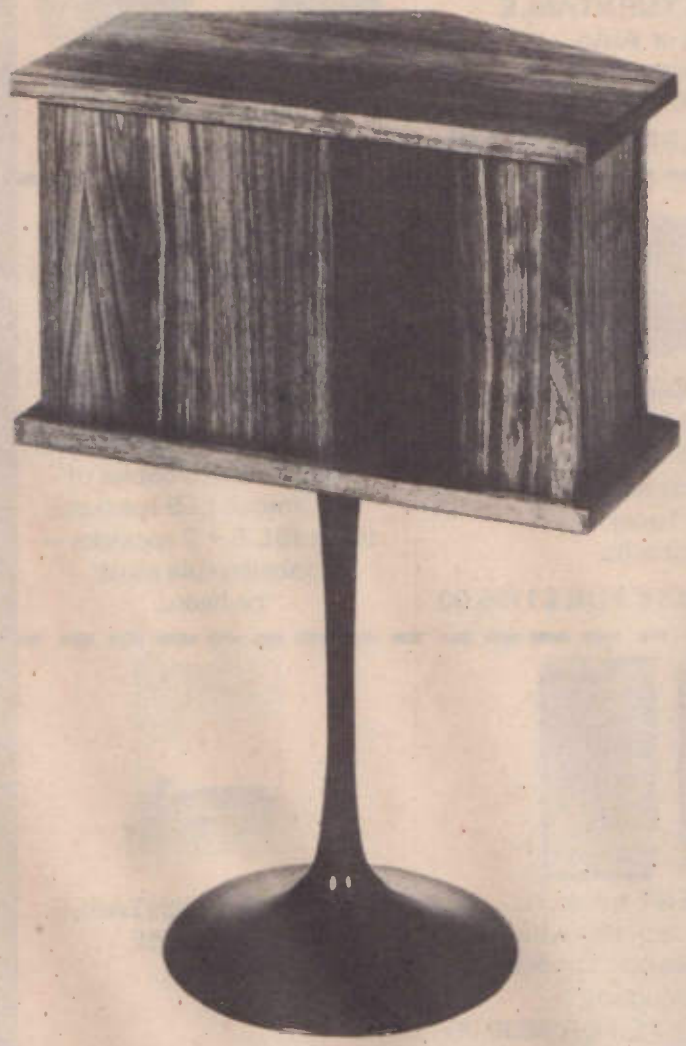
OPEN THURSDAY NIGHT

The rave reviews keep coming...

"The Bose 901 is, indeed, one of the finest speaker systems it has ever been my pleasure to hear. I have lived with it now for several months, so that I am quite sure of what I say . . . it is the sound itself that remains paramount. The 901 is characteristically smooth. Everything is simply there . . . I urge that you listen for yourself. I think you will have to agree that Bose has, in a single giant step, produced one of the finest speaker systems ever made."

Larry Zide—American Record Guide—December 1969.



1. Norman Eisenberg—High Fidelity
"you feel you've made some sort of stereo discovery . . . if your own response to it is like ours, you'll be reluctant to turn it off and go to bed."

2. Julian Hirsch—Stereo Review
"all the room-filling potency of the best acoustic-suspension systems, combined with the tautness and clarity of a full-range electrostatic speaker . . . I have never heard a speaker system in my own home which could surpass, or even equal the BOSE 901 for overall 'realism' of sound."

3. Bert Whyte—Audio
"the illusion of an orchestra spread across the wall is uncanny . . . To hear a thunderous low 'C' organ pedal . . . or a clean weighty impact of a large bass drum is truly impressive . . . There is no doubt that the much-abused term, 'breakthrough', applies to the BOSE 901 and its bold new concepts."

4. Hi-Fi Buyers Guide
". . . its over-all sound quality so clean that the listener is almost unaware of the electronics between him and the instruments . . . The sound? The 901 is very possibly the only speaker to date to pour forth in true concert hall fashion."

5. Stereo & Hi-Fi Times
"but the proof of the pudding inevitably is sound. And it is here that the BOSE 901 stands clearly away from the crowd . . . What a lovely sound those speakers produce! . . . Listen to Columbia's 'Carmina Burana' on this speaker and hear what a chorus should sound like! . . . these speakers provide a quality that is not to be matched."

6. Elementary Electronics
"conclusion. The BOSE 901 speaker system delivers the most natural stereo sound, creating the illusion of being in a concert hall, with a uniformity of frequency response and freedom from distortion that is unbelievable, particularly if the listener takes into account the physical size. It is our opinion that this is the speaker system to own, regardless of price, if one wants the ultimate in listening pleasure."

Your inquiry will bring you complete reprints of these unprecedented reviews and a list of franchised BOSE dealers in your area. Ask your dealer for an A-B comparison of the BOSE 901 with the best conventional speakers—**regardless of their size or price.** Then, go back to your present speakers—if you can.

You can hear the difference now.

BOSE

AUSTRALIAN DISTRIBUTORS
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Bose systems may be purchased from the following Australian dealers:

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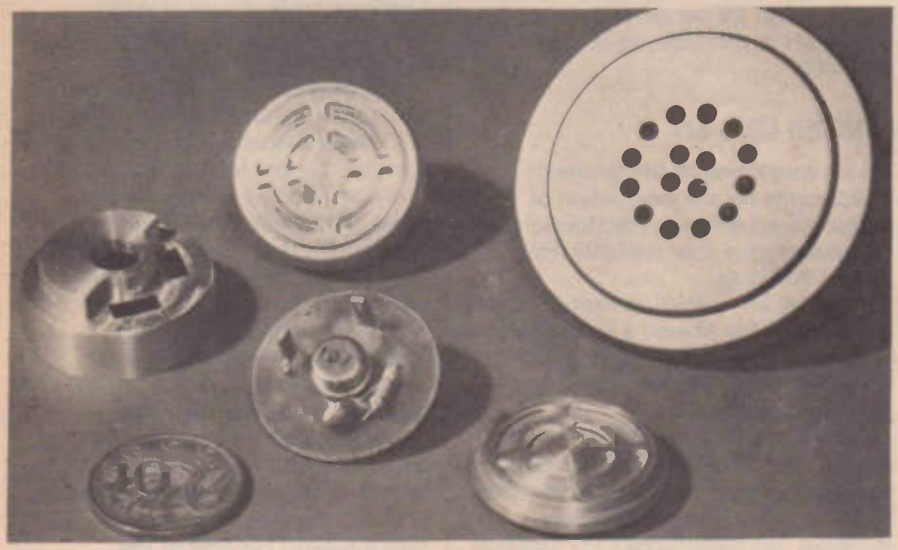
ACT: Homecrafts, Petrie Street, Canberra. 2600
WA: Leslie Leonard, London Court, Perth. 6000
VIC: Douglas Trading, 191 Bourke Street, Melb. 3000
TAS: P. & M. Distributors, 87 Brisbane Street, Launceston. 7250
QLD: Stereo Supplies, 100 Turbot Street, Brisbane. 4000
SA: Sound Spectrum, 33 Regents Arcade, Adelaide. 5000

news digest

APO TEST ELECTRET MICROPHONES



Greater voice clarity, longer life and a saving of millions of dollars in operating costs are the objectives of extensive tests by the Australian Post Office of new types of telephone microphones.

Known as active microphones, they are intended to replace the carbon microphone in use in most of the world's telephones. Because of its inherent high distortion, the carbon microphone has become the limiting factor in improving the quality of the whole telephone service.

The search for a better, low-cost microphone is part of continuing research by Post Office engineers who want to improve telephone instruments to the point where they will require no service calls during an average 12-year life.

In an attempt to discover an alternative long-life, low-cost and high fidelity microphone, designers followed two courses, both of which took advantage of the availability of a cheap electronic amplifier small enough to fit in the microphone case.

Amalgamated Wireless (Australasia) Ltd. has developed a new type, the electret active microphone.

An electret, the electrical equivalent of a magnet, is essentially a piece of insulating material which will retain an electric field almost indefinitely.

The foil electret used in the microphone consists of a piece of special plastic film between the surfaces of which is a permanent electric field. Mr. Mototara Eguchi, a Japanese Professor of Physics is credited with having made the first electret. A.W.A. scientists have invented a new process to produce electrets with life expectance of more than 1000 years.

The electret microphone developed by A.W.A. has similar properties and performance to a ceramic active microphone under test and will also be field-tested by the Post Office. In laboratory tests, the electret active microphone has given superior performance over long distances.

Coupled with a new telephone circuit designed by Post Office engineers, the active microphones should reduce the use of expensive heavy-gauge cable thus saving huge capital outlay on new installations.

BETTER CONTROL OF VEHICLE FLEETS

A method of automatically feeding back to a central control point precise information on the position of buses along a given route has been developed in Britain, and is at present under trial by a major British fleet operator.

The method, developed by Moore Reed & Co., of Walworth Industrial Estate, Andover, Hants., can be used equally well for other types of vehicle fleet and is expected to improve efficiency of operation, particularly at periods of peak traffic.

To operate the system, a continuous counting device, driven from a vehicle's gearbox, provides a read-out directly proportional to the distance travelled. Data are encoded and transmitted by radio to a central control point where the vehicle's position, together with that of all others under the system, can be shown on a visual display.

In the trial fleet, encoders are driven by means of a common take-off from the speedometer drive. Another method is to 'tap in' the device to the gearbox. In this case, the design of the unit's gear assembly ensures that maximum continuous input speed does not exceed 600 rpm.

The Vehicle Monitoring Encoder requires an input of 10 V to 30 V and can operate at ambient temperatures from minus 5°C to plus 85°C. Together with its reduction gearbox it is housed in a cast-aluminium case with all joints and bearing housings sealed for maximum protection from dirt and water. Total weight of the assembly is about 4 lb. (1,8 kg).

Design of the unit is claimed to be such that no maintenance is required before about 200 000 miles (321 850 km) — or about five years' operation.

COMPUTER CHIEF WARNS CITY

More shocks in the computer industry were forecast by the head of Britain's largest independent computer service company.

Speaking to the press following the opening of the computer industry's biggest trade show, Computer 72, Bryan Mills, joint Computer Director of the CMH Computer Management Group, warned the industry that they were misleading their customers. Mr. Mills also predicted the collapse of yet more major companies in the service bureau sector and advised shareholders to get out quickly while they still have time.

'We at CMG are concerned with the introspective attitude that persists in the computer industry,' Bryan Mills began.

'And I feel it is pertinent to make this point very strongly today on the

news digest

opening of Computer 72 here at Olympia. This is purely a trade show for the computer industry. If businessmen believe they will learn something from it, they are only fooling themselves. A businessman wants his problems solved – all he will find at Olympia is a confusing display of techniques and hardware.'

'Unfortunately the mystique of computers has not been dissipated' Mr. Mills continued. 'The majority of businessmen do not understand them. As a result so-called computer professionals wield a vast amount of power within a company by their control of the computer department.

'It is estimated that 80 per cent of the computer installations in the UK are being run inefficiently. Yet one continues to see commercial organisations taking on computers, whose annual running costs exceed their normal profits.

'This kind of empire building has also led to the creation of pseudo computer service bureaux, created as a spin-off from a company's data processing department. Some of these operations are being financed by Britain's largest public quoted companies.

'Shareholders in companies who have computer bureau subsidiaries should start asking questions. Often the real picture – that of an organisation which is milking its parent – is buried in the accounts. Soon these computer service companies will start to be shut down; they cannot be subsidised for ever.

'Running a computer service company is just the same as running any other business – it should become profitable after the initial investment. The trouble is that the bureau industry has not been around long enough for financial management to know what makes a company profitable in this market. They have to accept the advice of their computerised whizz kids.'

Concluding, Bryan Mills stated; 'Computer service bureaux represent a market in Britain approaching £70 million a year. Yet few people realise that less than 25 per cent of the companies in this industry are really profitable.'

PRINTED COIL KIT

A kit containing all the necessary components for the production of prototype printed coil transformers and inductors is now available from Plessey Windings.

Using the kit, a development engineer can produce for himself a compact, lightweight and highly stable printed coil which fulfils the requirements of his individual circuit.

The kits are designed to cover both the RF and AF ranges and, once the engineer has developed his transformer or inductor using the kit, Plessey Windings can manufacture the identical coil in production quantities at competitive prices. Automated production facilities ensure both quality and speed of manufacture.

The printed coil principle, developed by Plessey engineers, enables a small, stable, high specification coil to be assembled within the confines of a small pot core. The coil is constructed from a series of identical spirals.

Since each spiral has its own finite inductance, leakage inductance and distributed capacitance (all of which can be accurately determined), the sum of these parameters making up the complete inductance can be very closely controlled.

Printed coil kits are available from: Plessey Ducon (Components), Christina Road, Villawood, N.S.W. 2163, Australia.

SHOCK REPORT

Most people have experienced the uncomfortable effects of static electricity when, for example sliding across the seat of a car and getting out, or walking across a carpeted floor and opening a door.

These electrostatic discharges from a person are not felt unless the body potential is 1500 volts or more. The Australian Defence Standards Laboratories (DSL) have been examining the problems of charges on insulated persons, since the energy involved can be as high as 200 microjoules – quite enough to ignite hydrocarbon-air mixtures (typically requiring 200 microjoules) or set off explosives (0.2 microjoule) or interfere with computer programs.

Nowadays, most people are well insulated because of the widespread use of synthetic materials for the soles of shoes, which can have resistances as high as 10^{12} ohms. Socks make very little increase

(Continued on page 125)


When second
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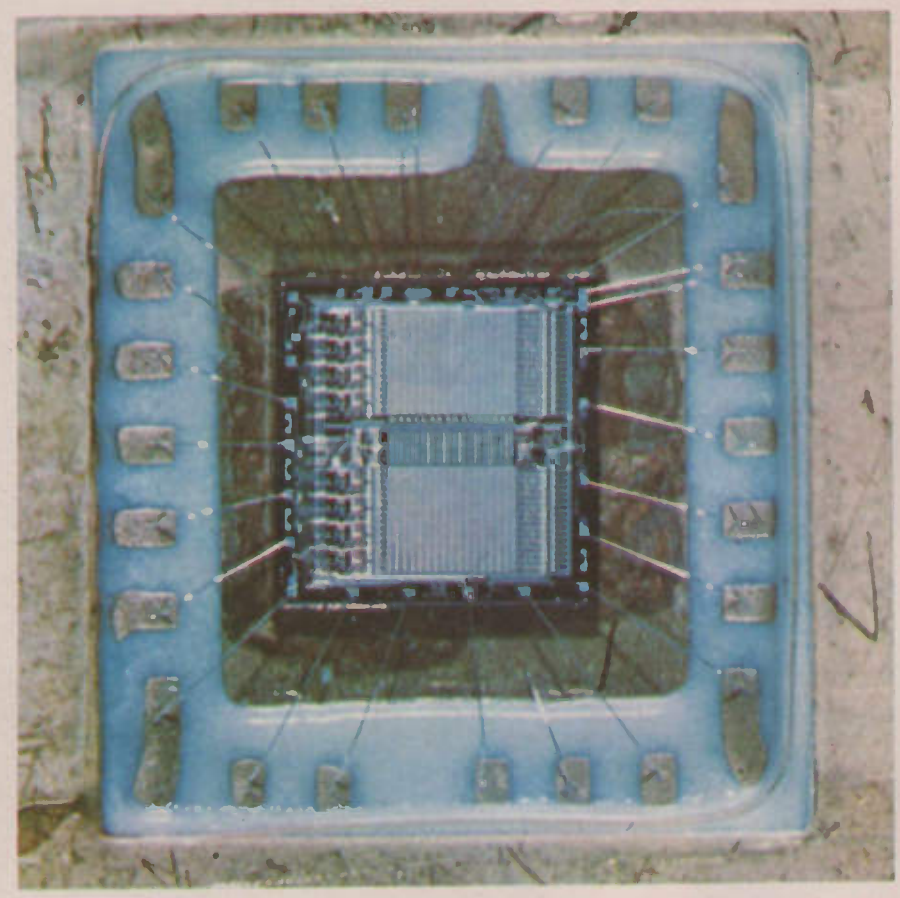
DIGITAL LOGIC-



PITY the poor beginner in electronics these days — new components and new techniques are radically altering equipment design. In fact the total body of electronic theory is doubling almost every 15 years, and the exponential rate at which new applications are being found for electronics, in domestic as well as commercial fields, is making it difficult for even electronic whizz-kids to keep up-to-date.

Nowhere is this more evident than in the field of integrated circuitry. No sooner has one become used to a particular IC technology — than another one appears. We are sure that a lot of our readers are feeling a little dazed by it all, and in an effort to reduce their bewilderment, we have produced this summary of developments in the field of digital logic.

In the 1950's, the American aerospace industry was getting into gear for the space race and urgently required miniaturized, low-weight circuitry for rocket-borne instrumentation and control equipment. In

This erasable read-only memory from National Semiconductor is a fine example of large-scale MOS integrated circuitry.

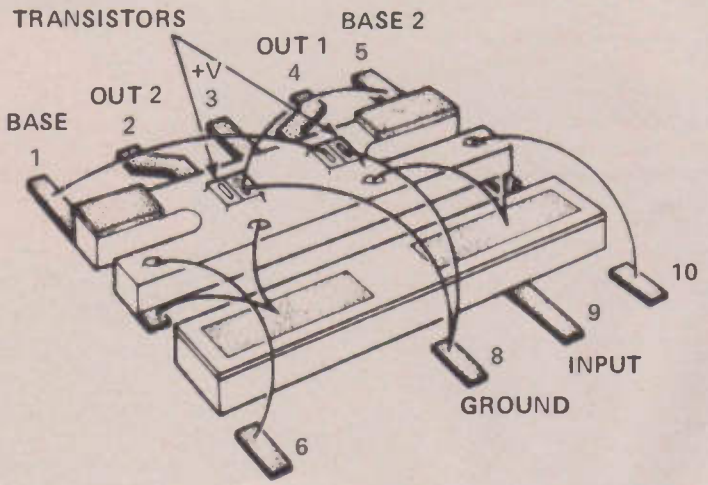


Fig. 1. The first integrated circuit developed by Texas instruments in 1959 used the "mesa" process. The device is a flip-flop and was the forerunner of the Resistor-Transistor Logic family.

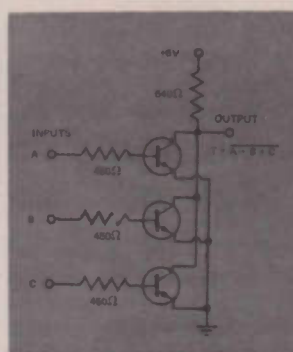


Fig. 2. A typical RTL circuit, in this case a "NOR" gate, in which the output is a "1" only if all inputs are at logical "0". Any input receiving a "1" will result in an output of logical "0".

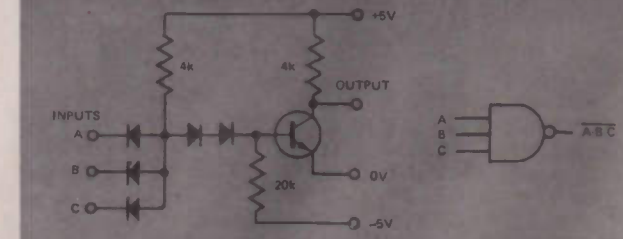


Fig. 3. The DTL "NAND" gate shown offers improved speed and fanout over RTL. The gate has a noise immunity of about one volt and a propogation delay of 50-1000 nanoseconds. The logic symbols for a "NAND" gate is shown at right.

a summary

The development and characteristics of digital logic families — Technical Editor Brian Chapman reports.

1957, in response to this need, Jack S. Kilby of Texas Instruments invented the first integrated circuit, for which he received the National Medal of Science in 1969.

WHAT IS AN INTEGRATED CIRCUIT?

This question is perhaps best answered by the Electronic Industries Association definition: "An integrated circuit is the physical realization of a number of electrical elements inseparably associated on, or within, a continuous body of semiconductor material to perform the functions of a circuit." That is, the IC contains on the one chip of semiconductor, all the resistors, capacitors, diodes and transistors necessary to implement a particular circuit function.

THE FIRST IC's

The first integrated circuit used the 'mesa' process (see Fig. 1). The transistors were formed on small raised areas called 'mesas' produced by etching away unwanted material. The other components were mounted on small pieces of silicon and connections were made by gold bonding-wires to complete the circuit. Operation of this circuit was not entirely satisfactory, and it was not until the invention of the planar process, by Fairchild, that the IC success story began.

The planar process is a technique of manufacturing semiconductors or integrated circuits in which a mask is used to restrict the diffusion of dopant (i.e. the impurities that make transistor action possible) to those areas required for the transistor or diode structure. The etching stage, to isolate devices as in the 'mesa' process, is thus not required.

RESISTOR-TRANSISTOR LOGIC-RTL

The first logic family to be evolved using the planar process was Resistor-Transistor Logic, commonly known at RTL. RTL contains resistors and transistors, only, and requires a supply of from 3.0 to 3.6 volts. A typical RTL NOR gate, shown in Fig. 2, consists simply of a number of transistor switches in parallel. This logic family is economical to use, provides easy system design and interface with discrete components, and has a high speed/power product. Some of its main disadvantages are: the resistors consume a lot of chip space, thus preventing the integration of complex functions; noise immunity to transients and RF pickup etc. is low, and the gate fanout is low. i.e. only three to five gate loads can be connected to each gate output before performance is affected.

Circuit operation depends on resistor values, and current hogging can occur if the resistors are not all equal.

In spite of all the above disadvantages, RTL circuits found rapid acceptance in 1960/61, and because of their low price, are still used in some applications today.

DTL LOGIC

The next major logic family which was developed is known as Diode-Transistor Logic, DTL. The devices of this logic family contain diodes as well as resistors and transistors. Initial devices were integrated forms of discrete component design — such as shown in Fig. 3. Later devices replaced the input diodes by transistors. This reduced the input current requirement and hence allowed much higher fanouts. Similarly, a double emitter follower in the output stage of DTL logic devices increases the output current capability, and, because of the lower output impedance, lowers the noise pickup on output lines.

Fig. 4. A TTL positive NAND gate using a multi-emitter transistor in the input stage has same noise immunity and speed as DTL but propagation delay of only 13 nanoseconds permitting speeds up to 20MHz.

Typical DTL logic has reasonable power dissipation, speeds of about 4MHz for a flip flop, and a propagation delay of around 25 nanoseconds per gate. The disadvantages of DTL are low noise immunity, especially in the high state where the input impedance is high, rapid change of voltage thresholds with temperature, speed slowdown with capacitive loading and lower speed than many other logic families.

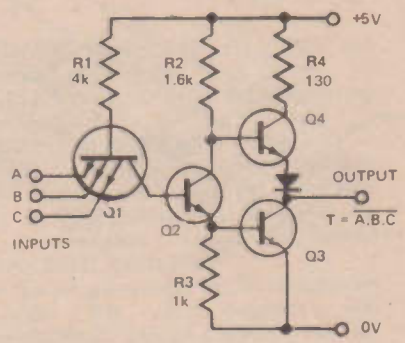
Nevertheless DTL, which requires a supply of 5.0 volts, has all the advantages of RTL plus ease of interface with TTL (see following) and a relatively high fanout, of around 10.

HTL LOGIC

A variation of DTL logic which is still widely used is HTL, High Threshold Logic. This logic family is designed for high noise immunity and uses Zener diodes in the input lines. A supply of 15 volts is used and power dissipation is consequently much higher. Principle application of these devices is in industrial equipment or environments where high noise levels are encountered. It has the added advantages of stable operation over large temperature changes and is easily interfaced with other discrete componentry such as relays and amplifiers etc. The disadvantages are inevitably higher cost and higher power dissipation than conventional DTL.

TRANSISTOR-TRANSISTOR LOGIC – TTL

TTL is basically another form of DTL but is notable for having achieved more popularity than any other logic form to date. It has higher speed and greater driving capability than DTL, and indeed has the highest speed of any saturated logic. (Saturated logic transistors never operate in linear mode, they are either saturated, or cut off.) The flip-flop toggle rate of 20MHz and a propagation delay of 10 to 15 nanoseconds satisfies many computer applications and hence, as a result of large volume sales, TTL is available from practically every manufacturer at very low cost. Again, because of acceptance by the computer industry, there is a wide range of complex functions available, making system design a relatively easy task.



The TTL gate is an excellent example of how economical circuit improvements which would not otherwise be practical with discrete components become possible with integrated circuit technology.

A typical TTL gate is shown in Fig.

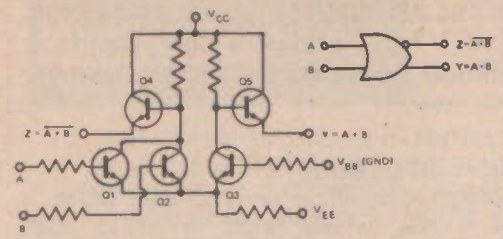


Fig. 5. The basic ECL gate configuration. High-speed performance results from the non-saturation operation of high Ft transistor current switches.

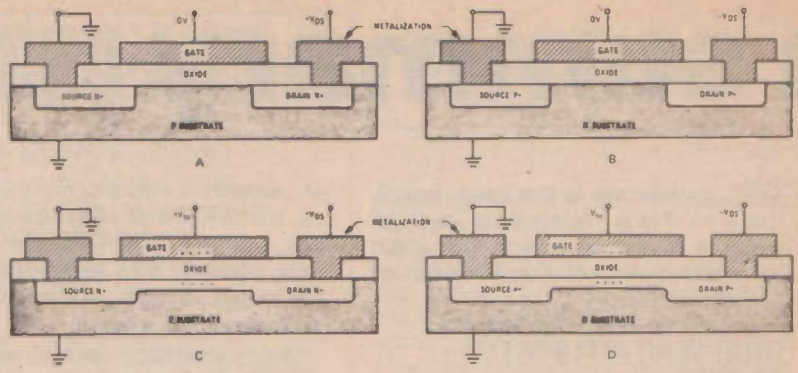


Fig. 6. (A) N-channel MOSFET in the "OFF" condition. (B) P-channel MOSFET in the "OFF" condition. (C) N-channel MOSFET in the "ON" condition. (D) P-channel MOSFET in the "ON" condition.

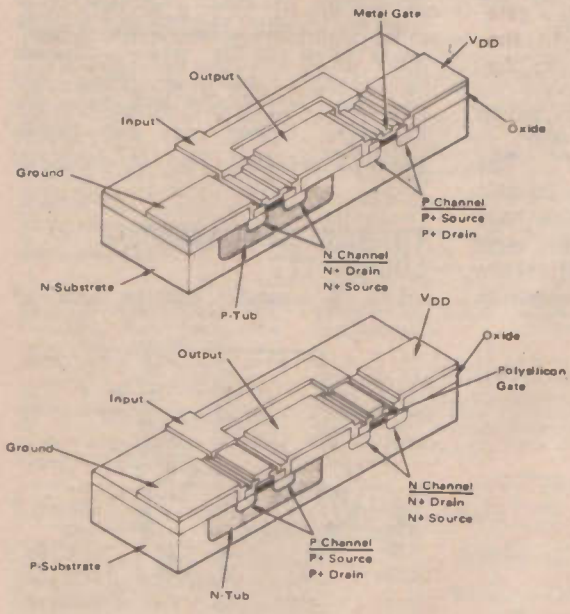


Fig. 7. Two basic processes of CMOS fabrication
(A) The aluminium metal gate process begins with a "P" tub diffusion and an N type substrate. In this tub the N^+ sources and drains are deposited to form the N-channel device of a complementary pair. P^+ sources and drains are located directly in the substrate to form the P-channel device. (b) The silicon gate process differs considerably from the metal gate process. First, an N-type pot, or tub, is used in a P-type substrate. This is exactly opposite to the metal gate arrangement. Secondly, a layer of polysilicon gate oxide replaces metal as the gate electrode. The polysilicon gate layer not only provides for the self alignment of source and drain during production, but, also lowers the switching threshold of the MOS transistors themselves.

4. This differs from the DTL gate primarily in that the input transistors are replaced by one multi-emitter transistor. This is a simple device to produce in integrated form as the emitter area is small with respect to the base area, and in fact up to eight emitters can be connected to the base of a single transistor. This arrangement gives slightly superior performance to that of DTL in that the transistors provide a small gain. But of far greater importance is that input capacitance is reduced because the transistors are fabricated into a far smaller area. Leads are much shorter and have less inductance, and therefore higher speed is possible.

The action of the circuit is as follows: Referring to Fig. 4, grounding any one or more of the emitters of Q1 will turn Q1 on and Q2 off. This in turn, turns Q4 on and Q3 off resulting in a logic"1" output. However, if no input is grounded the reverse will apply, and the output will be at logical zero. As TTL uses a +5 volt supply, the level for logic "1" will be Vcc less Vce (sat) of Q4 plus the forward voltage drop across the diode and the drop across R4. Thus the logic "1" level is of the order of 3.3 volts. In the logic "O" state, the output voltage is Vce (sat) of Q3 and is of the order of 0.6 volts.

The diode in the circuit plays an important role. Firstly assume that Q3 is turned on. The base of Q3 will be Vbe above ground and the collector of Q2 will be Vsat of Q2 plus Vbe of Q3 above ground. Hence there will be a Vbe potential applied between Q4 base and output and Q4 could possibly remain on. The diode is inserted to ensure that Q4 cannot be on at the same time as Q3.

The fan out of TTL is about 10 and the noise immunity is typically one volt. Various manufacturing techniques may be employed to increase speed, such as gold bonding or the incorporation of Schottky diodes on the chip. However TTL is still not fast enough for today's third generation computers.

Considerable care in layout and mechanical design is required because of TTL's relatively high speed coupled with its sensitivity to noise. Additionally, TTL tends to generate switching transients that can cause system problems unless adequately suppressed. Although larger functions may be integrated into one package with TTL than with any previous technology, the degree of integration is not high enough for the reliability and space requirements of the new generation of equipment. The main limitation is the power-dissipation limits of the package and large scale integration must look to other technologies in the future.

EMITTER-COUPLED LOGIC – ECL

ECL is a high speed logic which is sometimes known as current-mode logic, CML. The main difference between this and the other forms of logic discussed previously is that it operates in a linear mode, i.e. it is non-saturating.

The input stage of ECL, see Fig. 5, is a differential amplifier and the logic therefore has higher input impedance than other forms. Additionally emitter

follower type output stages, Q4 and Q5, allow driving 50 ohm transmission lines direct. It's chief advantage is, of course, high speed – 100 MHz or more but it has high power dissipation, is sensitive to noise, suffers speed degradation with capacitive loads and, because of its –5.2 volt (typically Vcc = 1.32V, Vee = –3.2V) supply requirement, is awkward to interface with other logic. Typical logic levels are 400 mV for logical "1" and –400 mV for logical "0".

MOS TECHNOLOGY

All the logic systems previously discussed are based on conventional transistor techniques and are hence known by the collective term "Bipolar" logic. The term bipolar arises because the operation of a conventional transistor depends on the movement of both majority and minority carriers.

There is another major logic technology based on the field-effect transistor (FET) and, in particular, the insulated-gate FET (IGFET), the basic structure of which is shown in Fig. 6.

We are concerned here only with IGFETs. These may be constructed as "N" channel or "P" channel devices and may operate in the 'enhancement' or 'depletion' modes. We will consider firstly the operation of an "N" – channel device. The drain and source regions are N^+ areas in a P-type substrate. Normally there is a high degree of isolation between drain and source – approximately 5000 megohms at 10 volts. When the gate is made positive relative to the substrate, electrons are attracted to the boundary between the silicon and the oxide layer in the region under the gate metallization. If the gate is made sufficiently positive, enough electrons are attracted to the area to reverse the surface conductivity from P to N. This provides a low resistance type-N path from drain to source and the device is turned "on" see Fig. 6c. The gate potential that turns the device on is called Vto.

For P-channel devices, the action is the same but all the polarities are reversed. In other words, when the gate is driven negative relative to the substrate by Vto, there is a low resistance P-channel path from the P-type source to the P-type drain.

In the operation just described, the application of a gate voltage increased channel conduction. Devices such as this where the inversion layer is created or enhanced by the application of a gate voltage of the same polarity as the drain are said to be Enhancement Mode devices.

Similarly, where the conductivity of the inversion layer is depleted (reduced) by the application of a gate voltage of polarity different to the drain, the devices are said to be operating in Depletion Mode.

Type	Symbol (Note 1)	Bias of Drain (Note 2)	Bias of Gate Cut-off Condition	Bias of Gate Conducting Condition
N–Channel Depletion		Positive	Negative	Positive
N–Channel Enhancement		Positive	Zero	Positive
P–Channel Depletion		Negative	Positive	Negative
P–Channel Enhancement		Negative	Zero	Negative.

Table 1. Characteristics of the four basic Field-Effect Transistor structures D = drain, G = gate, S = source. Biases shown are those required for normal operation and are measured with respect to the source.

Most conventional MOS devices are constructed as "P" channel enhancement mode devices and such logic is usually known as PMOS.

A comparison of the various FET types used in logic is given in Table 1.

The electrical characteristics of the MOSFET are:–

(1) Under normal operating conditions with Vg equal to zero, an external drain-source voltage produces a reverse-biased junction between the drain and the substrate. The source-drain resistance is, therefore, very high and any leakage current in the absence of a gate turn-on voltage is only of the order of nanoamperes.

(2) Since there is no dc current path between the gate and any other element of the MOSFET, the dc input resistance of the device is high. Typical dc input currents are of the order of a few picoamperes so the loading effect of the device is negligible. The impedance to ac is governed by the input capacitance, normally a few picofarads, and this places a practical limit on the number of devices that can be driven from a single driver whilst maintaining reasonable speed.

(3) From the structure of a MOSFET it may be seen that all current flow is restricted to the gate area encompassed by the source and drain. Therefore in an integrated circuit incorporating a number of MOSFET devices, no isolation between devices is required. Hence the chip area required for MOS circuits is very small in comparison with equivalent bipolar circuits.

(4) The MOSFET structure requires no critical diffusions or spacing. Hence the MOSFET is an easy device to manufacture in integrated form, much more so than bipolar devices. The yield is therefore high and fabrication costs are low.

The above characteristics make the MOSFET an ideal device for LSI circuits where circuit speed in the low nanosecond range is not required.

CMOS JOINS THE FIELD

A new MOS technology is now challenging TTL for market leadership. Called Complementary Metal-Oxide-Semiconductor logic (CMOS), this latest option is designed to have extremely low power dissipation, making it especially useful

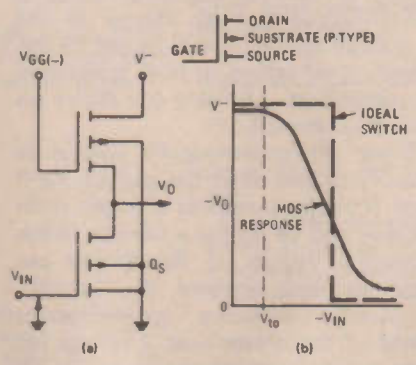


Fig. 8. Typical PMOS inverter circuit using a fixed-bias MOSFET as a load (a) typical transfer characteristics curve of the inverter circuit compared to the response of a perfect switch (b).

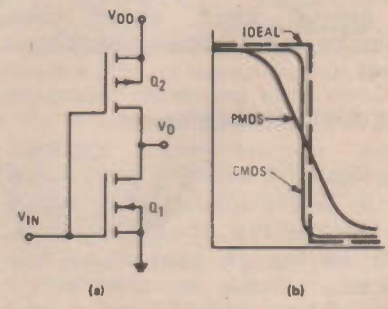
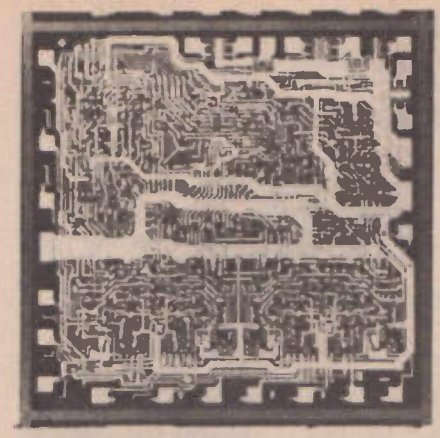


Fig. 9. Typical inverter circuit with P and N-channel MOSFETS connected in complementary symmetry. (a) Characteristic curves. (b) CMOS curve closely approaches ideal switch.



An example of emitter-coupled logic (ECL) large-scale integration (LSI) from Motorola. The device is the MC 10181, a 4 bit Arithmetic Logic Unit/function generator housed in a 24 pin DIL package.

for remote applications where power is scarce. But its other attributes, including high noise immunity, high fan-out, full power-supply logic swings, and the ability to accept a wide range of power supplies will ensure its success in the market place.

One parameter in which CMOS does not distinguish itself is speed. For the time being, therefore, the faster logic families, such as ECL and TTL, are safe from encroachment, at least in applications where high speed is a prime consideration. Moreover, the still limited number of available functions inhibits widespread implementation. Over the long haul, however, CMOS has all the features required to make it a strong competitor.

Some of the features of CMOS are attributable directly to the basic MOS transistor structure while others are the result of, or are enhanced by, the use of MOSFETs in complementary symmetry. For example, the MOS transistor structure inherently has a very high input impedance, thereby eliminating dc fan-out restrictions and providing low power dissipation. The use of CMOS provides an even greater reduction in power dissipation as well as greater speed, greater noise immunity, and full power supply logic swings.

MOS AND CMOS Compared

How complementary operation improves MOS switching performance can be readily appreciated by noting the characteristics of various types of MOS inverters. For example, a simple inverter utilizing an enhancement mode, P-type MOSFET and a load resistance consisting of another MOSFET is shown in Fig. 8. The use of a MOSFET in place of a conventional load resistor is particularly beneficial since a resistor requires far more chip area. Thus, for a given circuit complexity, MOS provides considerable cost savings by increasing the number of cricuits on a wafer.

For an input voltage, V_{in} between ground and V_{to} transistor Q_s is "off", so the output voltage, V_o approaches the V– state, as indicated by the transfer characteristics curve. As the input voltage is made more negative, transistor Q_s begins to conduct as V_{in} reaches V_{to} (threshold voltage), and for further increases of V_{in}, the output voltage is reduced. Note, however, that for a fixed MOSFET load resistance V_o can never reach zero because the resistance of Q_s never reduces to zero, regardless of the value of V_{in}. In fact, its saturation resistance is substantially higher than that of bipolar transistors. Therefore, the total output voltage swing is always less than the supply voltage V–.

When both P-type and N-type field-effect transistors are available, their connection in a complementary configuration, Figure 9, results in far more satisfactory performance. In this type of connection, the signal is applied simultaneously and in phase to both transistors. A little reflection will reveal that when the signal value is zero, the N-channel MOSFET, Q1, is off, while the P-channel device, Q2, is on. Under this condition, the output voltage is very nearly the full supply voltage. When the gate voltage goes high (positive), transistor Q1 is turned on while Q2 is turned off. This causes V_o to go virtually to zero because the current flowing through Q1 is the leakage current of Q2, which is very, very low. (The resistance of a MOSFET in cutoff is approximately 5000 megohms, resulting in a leakage current of less than one nanoampere.)

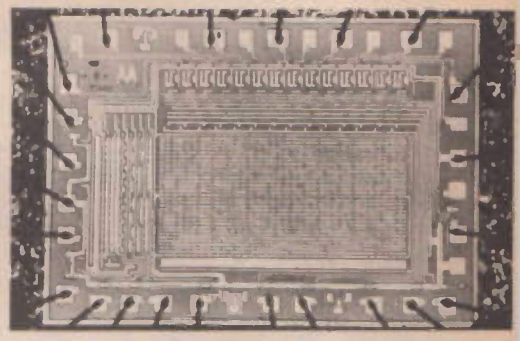
In Fig. 9b the transfer characteristic curve for the complementary circuit is shown in comparison with that of a single-ended circuit. Observe that in addition to a much wider voltage swing, the slope of the complementary circuit curve is much steeper in the transition region. This is caused by the input signal acting on both transistors in opposition – turning one device on and the other off.

Since the power-supply voltage is usually greater than the sum of the P and N device threshold voltages, both devices will be on for a portion of the transition region. If the devices are well matched, however, the "circuit" threshold will be approximately one-half the power supply voltage for any supply used, as shown in Fig.10. The resultant, near ideal, transfer characteristic provides noise immunity approaching one-half the power-supply value.

		POWER DISSIPATION mW/GATE	PROPAGATION DELAY nsec	DC NOISE IMMUNITY ±V	DC LOADING FACTOR	LOGIC SWING V
mWRTL		6.5*/0.5†	27	100	4	1
RTL		19/5	12	100	5	1
DTL		11	30	1000	8	2.8
TTL	54/74	10	13	1000	10	3.3
	500/400	15	10	1000	15	3.3
	2100/2000	22	6	1000	11	3.3
	3100/3000	22	6	1000	10	3.3
HTL		44/13	110	6.5	10	12.5
MECL	1	37	7	250	25	0.8
	2	40	4	250	25	0.85
	3	60	1		HiZ LoZ 70 7	0.9
CMOS		0.0001 DC	50	45% OF V_{DD}	very, very high >500	up4o 20 V, depending on supply V

* Input High † Input Low

Table II. Specifications of main logic families.



The MCM 1131 from Motorola is a preprogrammed character generator used for displays. It stores 64 characters each of 35 bits (5 x 7 dot matrix) in the ASC11 code used by teletype machines. This chip is constructed with metal gate, High Threshold P-channel MOS (PMOS).

CMOS PROCESSING

Complementary circuits have traditionally offered higher performance than single-ended designs, providing that the positive and negative polarity transistors can be well matched. But, whereas high-performance NPN transistors are readily obtained with standard bipolar technology, it has proven quite difficult to produce monolithic PNP devices with equal degrees of logic freedom and performance. Fortunately, the fabrication process for complementary MOS transistors is far less formidable than for complementary bipolar devices, so that CMOS is a practical reality today.

The complementary MOS processing sequence, together with the resulting structure, is shown in Fig. 7. The starting substrate material is lightly doped N-type silicon that serves as the substrate for the P-channel devices. The first process step is to diffuse a lightly doped P-type area or tub that will serve as the substrate for the N-channel devices. This is followed by the N^+ and P^+ source-drain diffusions and lastly by the gate oxidation process. The N^+ and P^+ source-drain diffusions also produce the channel stops shown in the diagram. These

serve to eliminate parasitic leakage paths that might be created by a positive or negative voltage on metalization passing over lightly doped P- or N-type substrate areas.

All of the processing is easily controlled and there are none of the critical diffusion steps (such as base-width adjustments) that are normally encountered in bipolar processing. As a result, processing is readily adaptable to automated techniques.

The complementary operating principles discussed for the inverter are easily adapted to more complex logic circuits, and CMOS has proved to be ideal for the fabrication of LSI devices.

Functionally, the basic capability of these devices is compared with similar specifications of some well known bipolar logic lines in Table 2. In many respects, the performance of CMOS circuits are unmatched. They have:

(1) Standby power in the nanowatt region
(2) High noise immunity, typically close to $\frac{V_{DD}}{2}$
(3) Full power supply logic swings, from 0 to V_{DD}
(4) The ability to operate from a single supply over a wide range of values, (4.5 to 20 volts).

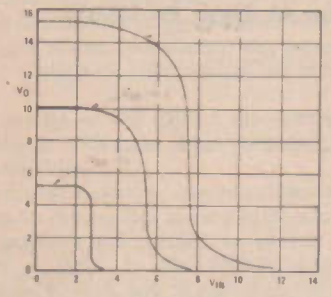


Fig. 10. Transfer curves of Motorola MC2597 dual NAND gate shows nearly symmetrical operation of CMOS for various power supply voltages.

In terms of speed, CMOS devices, when lightly loaded, are comparable with RTL, DTL, and the slower families of TTL. Thus, they are substantially faster than standard PMOS circuits. But, although capable of large dc fan-out to other CMOS circuits, there is a practical ac limitation in that complementary circuit speed is more influenced by current and capacitive loading than are bipolar circuits.

There is little doubt that sales of CMOS will surpass that of TTL by 1975 and supplant it as the logic system in most common use. ●

BIBLIOGRAPHY *"Another logic option for system designers" by Frank Barone, Bernie Schmidt – Motorola.*

Layout of CMOS process masks is considerably enhanced by this coordinate digitizer machine. It is a convenient, efficient method for converting the designer's signal routing plan into data that a computer can understand and follow.

CMOS Logic of the seventies

All indications point to CMOS as the successor of TTL. This report by Jim Wiggins, Marketing Manager Motorola Semiconductor Products (Australia).

COMPLIMENTARY Metal Oxide Semiconductor Logic (CMOS) Technology will emerge as the major logic within the next few years.

Already it has undergone its trial period, with sales of off-the-shelf products rising at an exponential rate. The initial metal-over-silicon process has been supplemented with a laboratory proven silicon-gate technique that will soon add an impressive new low power dimension to available off-the shelf products.

Already several manufacturers have announced standard product lines of over 40 functions, with others claiming custom capability.

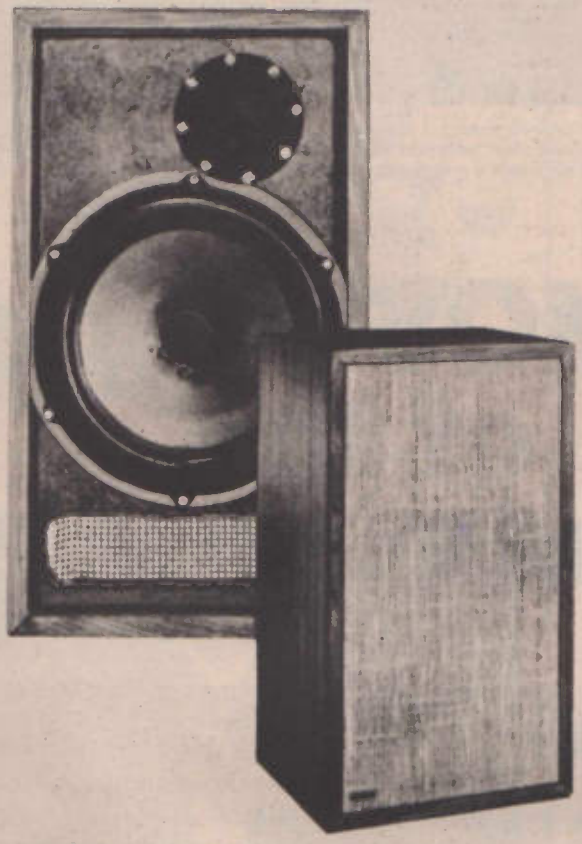
These indications of product maturity, coupled with extensive market research programs that project a potential world market upward of US $200 million within the next half decade, have prompted manufacturers to invest heavily in the CMOS up and coming technology. With strong commitments to research and development and production capacity, manufacturers expect to aid the industry in the early implementation of CMOS products, as well as provide assurance of a steady and reliable source of supply.

Advantages and Features of CMOS

1. The lowest power dissipation of any logic form developed so far, thus lowering cost and permitting battery operation of equipment.
2. Excellent noise immunity that

"...(The Dynaco A-25) has established a new standard of performance in uncolored, natural sound."

THE HI-FI NEWSLETTER (P.O. Box 539, Hialeah, Fla. 33011)



"...you'll have a hard time buying more musical naturalness at any price."

THE STEREOPHILE (Box 49, Elwyn, Pa. 19063)

The critiques from these hobbyist magazines have unusual merit as these publications accept no advertising. Their comparative evaluations are funded solely by the subscriptions of ardent audiophiles.

The A-25's sound quality is a direct consequence of its smooth frequency response, outstanding transient characteristics, and very low distortion. Its aperiodic design (virtually constant impedance over its range) provides an ideal load so any amplifier can deliver more undistorted power (and thus higher sound levels) for a given speaker efficiency.

Uniformity of impedance also makes the A-25 the best choice for adding two new speakers to an existing stereo setup using the Dynaco system* for four-dimensional reproduction. In this way, true "concert hall sound" can be enjoyed with a standard stereo amplifier.

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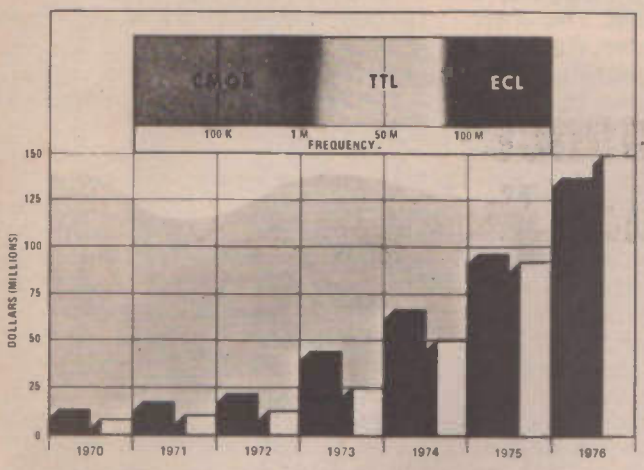
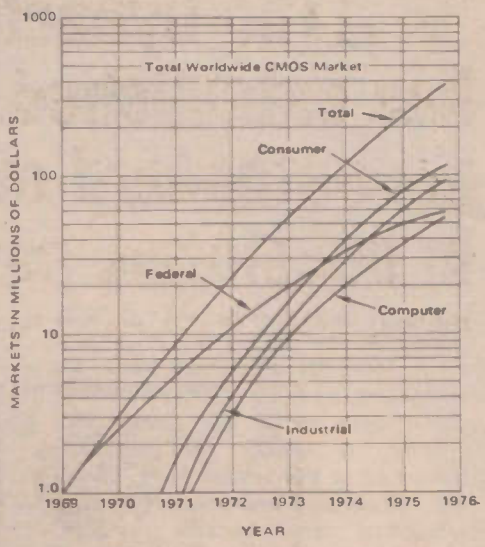


Fig. 1. — The wide dominance of TTL in the digital logic field is being seriously threatened. As seen in the frequency graph at the top of the figure, both CMOS and ECL are pushing into areas previously covered by TTL. In the bar graph portion of the figure the erosion of TTL's market dominance is depicted. Here, within the half decade, both CMOS and ECL market dollars are projected to bypass TTL.

LEGEND
TTL ECL CMOS

Fig. 2. The expected distribution of CMOS devices in the market place.



increases with increased supply voltage immunity of up to 45% of supply voltage is possible.

3. Operation over very wide supply voltage range (1.2 volts to 18 volts). The technique requires only a single positive supply rather than the dual supplies required with some previous MOS.
4. Has packed density greater than bipolar technology, resulting in lower cost MSI and LSI functions.
5. Has lower output impedance than PMOS thus simplifying interfacing with saturated bipolar logic.
6. Generates very low noise and exhibits slow rise and fall times which simplifies system layout design rules.
7. Operates over wide temperature extremes with minimum performance degradation.
8. Very high input impedance results in the highest fanout of any logic form.
9. Logic swing is between power supply and ground.
10. Propogation delay is faster than PMOS and speeds will soon approach those of TTL.

The Economies of CMOS

Complementary MOS logic is a medium-speed logic expected to compete strongly with TTL and DTL families at frequencies up to 25MHz. Although it has a significant number of application advantages over bipolar logic forms, the competitive issue in the area of applications overlap is likely to centre on systems cost. In this category, CMOS is a strong competitor for the following reasons:

1. CMOS power dissipation is normally two to three orders of magnitude lower than the power required to drive bipolar logic. Accordingly, it permits the use of larger chips with greater packing densities, without exceeding the thermal limitations of the package — and without the need for expensive cooling methods. This affinity for large-scale integration is one of its principal cost-saving advantages.
2. CMOS processing is inherently simpler and less critical than TTL and DTL, thus promising higher yields for circuits of equal complexity.

Hence, within the next few years, medium-speed CMOS, in conjunction with high speed ECL, is expected seriously to challenge the overwhelming dominance that has been enjoyed by TTL Logic. (see Fig 1).

But the appeal of CMOS logic is far greater than the mere replacement of bipolar or other forms of MOS circuits. Primarily, it is in the development of new markets for which other forms of logic are not suitable. This is evident from the expected distribution of CMOS sales, which differs substantially from that of bipolar logic among the various markets. The projected distribution shown in Figure 2 indicates Motorola's estimates of the CMOS future on the world scene.

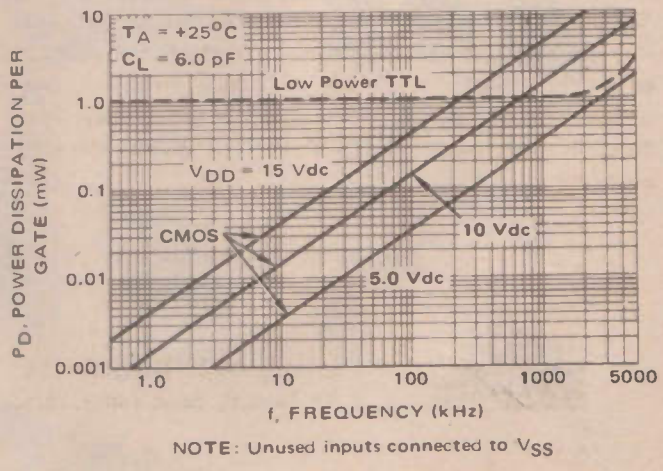
One of the interesting considerations emerging from this graph is the very strong projected penetration of the huge consumer market, where logic circuits have no usage at present. This is primarily due to the large expected use of CMOS in watches and clocks, and in various automotive safety and control devices that are now under active consideration. The consumer market, appliance controls and even the toy market are new areas of applications to be invaded by logic circuits.

In addition to the power saving feature, CMOS offers other advantages that result in low-cost system implementation. These advantages include:

. . . Single power supply operation
. . . Operating voltage ranging from 1 volt, for some silicon-gate circuits, up to 18 volts for standard products.
. . . High noise immunity, (30% of power supply)
. . . Extremely high CMOS to CMOS fanout (50).

(Continued overleaf)

Fig. 3. Comparison of gate-power dissipation for Low Power TTL and CMOS shows superiority of CMOS.



NOTE: Unused inputs connected to V_{SS}

Comparing CMOS with Bipolar Logic

There are several parameters that require discussion when comparing CMOS and TTL. First is the power supply voltage range. CMOS functions are operational over a wide range of power supply voltages. CMOS supply voltages can range from three to 18V, while TTL is generally limited to about 4.75 to 5.25V.

The second significant characteristic is power dissipation. Because of the extremely high off-resistance of MOS transistors, the dc current drain of a complementary MOS inverter approaches zero – as compared to 0.2 milli-ampere for a low power TTL inverter. If CMOS and TTL are compared at the system level, CMOS will out perform low power TTL by a substantial margin, because only parts of the system operate at high speeds at any given time. A CMOS system typically dissipates two to three orders of magnitude less power than low power TTL. (See Figure 3). CMOS transfer characteristics represent a very close approximation to an ideal switch. If multiple devices are stacked in series as shown in Figure 4, the transfer characteristics are shifted slightly, depending upon the number of inputs that are active. In the threshold region, all active devices are turned on slightly, giving a resistive divider effect that reduces device source-to-drain voltage and shifts the effective threshold slightly. This effect is illustrated in Figure 4.

Also note the dotted line that indicates supply current versus gate input voltage, at higher supply voltages the MOS devices are operating at lower impedance levels when switching though threshold, therefore the instantaneous power dissipated is a function of input voltage. This effect contributes to the ac power dissipation of CMOS but is normally small compared to the ac power dissipation caused by the charging and discharging of load capacitors. (Fig. 4 gives a comparison CMOS-TTL gate characteristics.)

CMOS presently has two limitations in comparison to TTL. One is speed of operation. The theoretical maximum frequency of operation of MOSFETS is in excess of 1GHZ,the limiting factor is the parasitic capacitance of junctions and substrate. By eliminating this capacitance, CMOS circuits will be able to operate at speeds near 100MHz and techniques for doing this are presently being developed by the semiconductor industry. Possibilities for solving this problem include silicon on sapphire/spinel, and ion implantation. The second disadvantage is that CMOS output impedance is not as low as that of TTL. This is not a problem on the chip, due to the very high impedance of CMOS, but can be a problem in driving off the chip devices. The lower impedance of silicon gate CMOS and CMOS/bipolar technology will be able effectively to eliminate this problem.

Is 1973 the right year for CMOS?

Complementary metal oxide semiconductor (CMOS) circuits have been available in quantity since 1969. A number of vendors have entered the CMOS field since 1971 resulting in an influx of both new devices and second sources to the marketplace, especially during the last year.

"Is 1973 the right year to go CMOS?" Perhaps rephrased, the question could be put, "Is it now economically feasible to design systems with CMOS integrated circuits?"

Before any system design can be economically implemented with IC's, the proper mix of device types, to construct the system, must be available to the designer. The large variety of TTL functions (over 125 different types), coupled with availability from multiple vendors, created the proper environment for economical system designs using bipolar technology. Is CMOS at that crossroad today so that it too will emerge as an economical digital logic family?

To answer this multi-pronged question, we must first consider how many functions are needed to implement a complete system, and what the cost trade-offs are compared with other approaches. Although each "system" is separate and unique in its device requirements, Motorola has found that a typical digital IC system contains about 16 different device types. Obviously, more than 16 device types are needed to cover a wide range of systems, but how many more? Twenty-five? Thirty? Actual analysis of E.I.A. sales figures shows that over 85% of all TTL sales are concentrated in less than forty device types.

One might conclude then, that since the designer has available today a similar group of over forty CMOS functions, a "proper mix" of CMOS logic devices is available today. In other words, there should be no major design restraints today because of lack of proper CMOS logic functions.

As suggested earlier, the answer to the CMOS design question involves both the availability of the proper devices and the proper economic trade-offs. What are these economic considerations? To answer this question one merely has to examine the virtues of CMOS. What does it

The 1972 McMOS Family

MC14000, 14500 Series

FUNCTION	MC # AL/CL
GATES	
Dual 3-Input NOR plus Inverter	14000
Quad 2-Input NOR	14001
Dual 4-Input NOR	14002
Dual Pair and Inverter	14007
Quad 2-Input NAND	14011
Dual 4-Input NAND	14012
Triple 3-Input NAND	14023
Triple 3-Input NOR	14025
Triple Gate	14501
Expandable AOI	14506
Quad Exclusive OR	14507
Dual 5-Input Majority Logic Gate	14530
BUFFERS	
Hex Inverter/Buffer	14009
Hex Buffer	14010
Strobed Hex Inverter	14502
FLIP-FLOPS	
Dual Type D Flip Flop	14013
Dual JK Flip-Flop	14027
SHIFT REGISTERS	
18-Bit Shift Register	14006
Dual 4-Bit Static Shift Register	14015
8-Bit Static Shift Register	14021
8-Bit Static Bus Register	14034
Dual 64-Bit Static Shift Register	14517

FUNCTION	MC # AL/CL
DECODERS, LATCHES	
BCD/Decimal Binary/Octal Decoder	14028
Dual 4-Bit Latch	14508
BCD-to-7 Segment Latch/Decoder/ Driver	14511
4-Bit Latch, 4-16 Line Decoder-Output Active High	14514
4-Bit Latch, 4-16 Line Decoder-Output Active Low	14515
COUNTERS	
Decade Counter/ Divider	14017
12-Bit Binary Counter	14040
BCD Up/Down Counter	14510
Binary Up/Down Counter	14516
Dual BCD Up Counter	14518
Dual Binary Up Counter	14520
Programmable BCD Divide-by-N 4-Bit Counter	14522
Programmable Binary Divide-by-N 4-Bit	14526

FUNCTION	MC # AL/CL
ARITHMETIC FUNCTIONS	
4-Bit Full Adder	14008
Triple Full Adder (Positive)	14032
Triple Full Adder (Negative)	14038
ALU (7418I Type)	14581
Look Ahead Carry Block	14582
DATA ROUTING FUNCTIONS	
8-Channel Data Selector	14512
4-Bit AND-OR Select	14519
MEMORY	
64-Bit Random Access Read/Write Memory	14505
SPECIAL FUNCTIONS	
Quad Analog Switch/ Quad Multiplexer	14016
BCD Rate Multiplier	14527
Dual Monostable Multivibrator	14528
Dual 4-Channel Analog Data Selector	14529
12-Bit Parity Tree	14531

Table 1. Motorola's line up of standard device functions available at the end of 1972. Many more are promised for release in the current year.

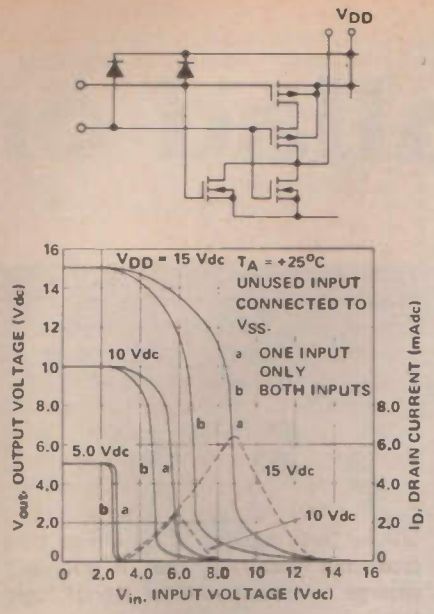


Fig. 4. The schematic of a CMOS two-input NOR gate and typical dc voltage and current transfer characteristics.

offer that is unique? Basically, there are three main advantages to CMOS: ultra low power; very high noise immunity; and wide operating voltage ranges. How then do these attributes create a favorable economic picture for CMOS?

Let's look at system power costs. A typical cost for a commercial system power supply could be $1.00 per watt of delivered power. To understand the significance of this power cost, consider that three MSI bipolar functions consume about one watt, or 33c per function for power supply costs. As CMOS elements only consume microwatts of power (1 watt would power about 50 CMOS devices) the cost per function would be only 2c, a dramatic difference.

A small-system bipolar design using a 5V/15 A supply would as a result cost about $75 for just the power supply alone. The same system using CMOS would probably run on 10V/150mA, which could be implemented with a low cost IC regulator for a few dollars. Where do these "lost" dollars go in a bipolar design?... They are swallowed-up by the cost of large filter capacitors, big heat sinks, hefty 15 or 20A transformers, power-draining cooling fans, and large power transistors. Eliminating these parts highlights another inherent advantage of CMOS – space savings!

Other system savings that help make CMOS an economic reality today are: single-sided PC boards (no need for exotic ground planes); no bypass capacitors (slow rise and fall times); smaller PC boards (more complex functions in CMOS); single power supply operation (CMOS operates at any voltage from 3V to 18V depending upon system need, for instance, 15V for hybrid analog/digital systems); and finally space savings (since CMOS runs cool to the touch it can be packaged in high densities without the need for forced air cooling).

Clearly, there must be both a rapidly growing market for CMOS as well as a number of suppliers building that market. A look at Figure 1 shows recent Motorola CMOS market projections for the coming half-decade.

As for the suppliers in the great CMOS standard product race, the list now includes in addition to Motorola (with 47 devices announced or introduced) RCA, Solid State Scientific, Solitron, Hughes and National. Other major semiconductor vendors have so far limited their CMOS commitment to custom LSI devices. However, they too cannot afford to ignore a potential $210 million dollar market, and may soon be making their product plans known.

The question we started out to answer was, "is 1973 the right year for CMOS?" The overwhelming weight of evidence shows that the right number of complex functions are available today; there are multiple vendors in the business; system economics favor CMOS; and, finally, that the market growth figures all clearly point to 1973 as the pivotal year for CMOS. Thus, 1973 is the right year for new system design with CMOS – "The Logic of the Seventies." ●

Acknowledgements: R.P. Komatz Motorola Semiconductors.

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RIGHT—For the swingers, good sound for any party. The KA-2002 stereo amplifier is compact and good looking outside and all silicon transistorised inside for ear-raising sound performance. Tone controls to suit room acoustic conditions. The KP-2022 stereo turntable has smooth, even turntable rotation with auto-return and auto-cut mechanism to obviate disc or stylus damage . . . with soft-as-a-feather tone-arm action. The KL-2090 bookshelf speakers have remarkable bass response. Can also be wall-mounted vertically or horizontally. Most attractive grille. Altogether a sound setup to please partygoers. $420 approx. RRP.

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Hewlett Packard Calculator -Model 10

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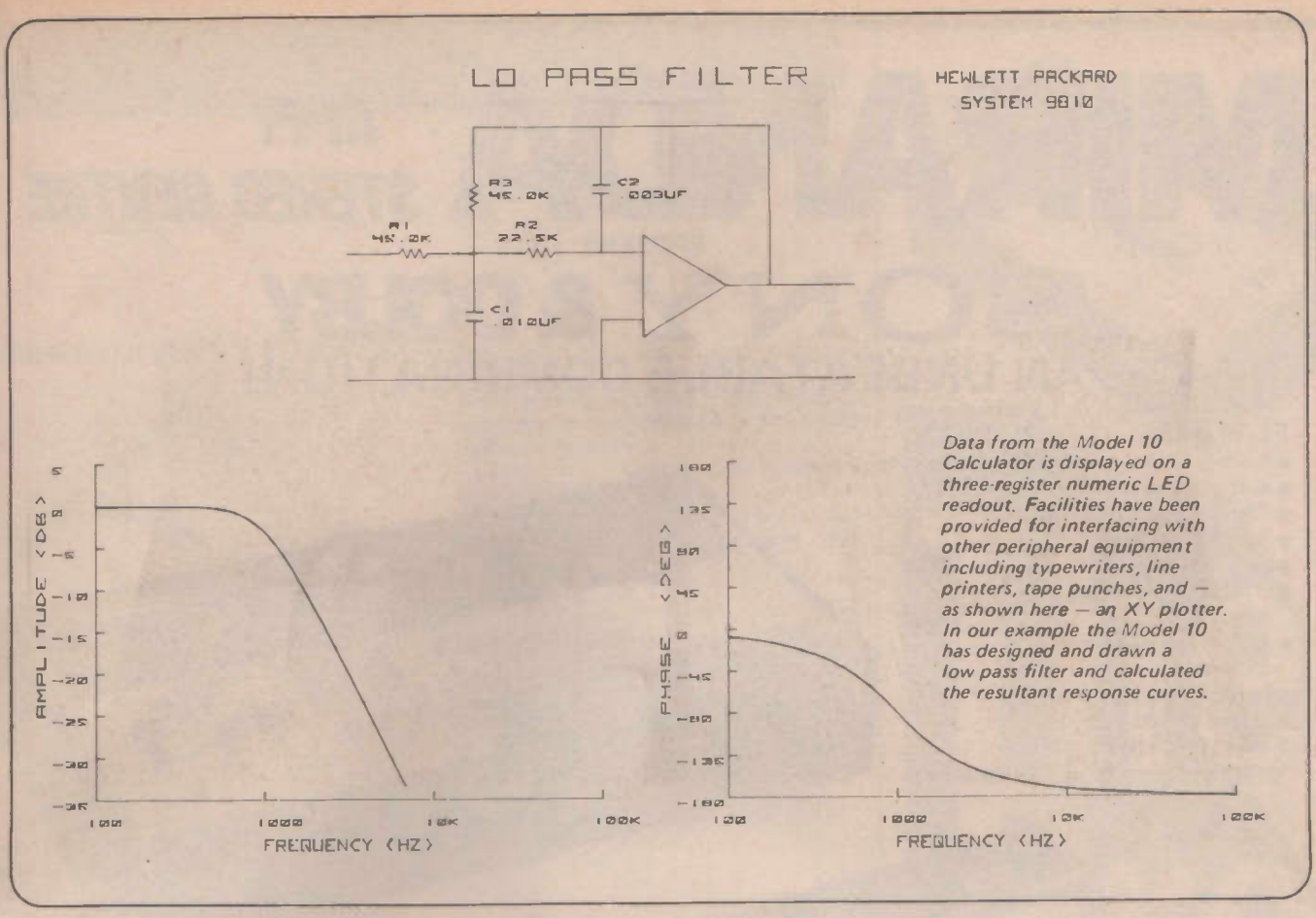
HEWLETT PACKARD started as a very small company. It has since grown to be one of the largest manufacturers of professional electronic equipment in the world. The range of equipment manufactured by Hewlett Packard is vast. It covers everything from voltmeters to specialised processors for engineering, acoustics, biological studies, medicine — in almost every research field in which electronics is used.

The company's philosophy is to supply complete integrated systems (rather than a specialised range of individual instruments) which the user accumulates and fits together.

As systems became more complex and required a computer to control the many functions, Hewlett Packard entered this field also and developed a line of computers and calculators. Again, they concentrated on supplying an integrated system for each purpose. Here, we review one instrument from this line, the 9810 Programmable Calculator, Model 10.

Historically, the early valve computers were monsters which filled a large room. Yet by to-day's



Data from the Model 10 Calculator is displayed on a three-register numeric LED readout. Facilities have been provided for interfacing with other peripheral equipment including typewriters, line printers, tape punches, and — as shown here — an XY plotter. In our example the Model 10 has designed and drawn a low pass filter and calculated the resultant response curves.

standards, these were not particularly powerful. The advent of transistors markedly reduced the size of the machines in two ways. The transistors themselves were far smaller than the valves that they replaced but, even more important, was the increase in packing density brought about by a reduction in power dissipation, for apart from doing away with the heater necessary in thermionic valves, the transistor is a much more efficient switch, consuming and therefore dissipating, far less power when performing its switching function within the computer. But the use of transistors resulted in a machine which was compact but difficult to service, having thousands of resistors, capacitors and transistors crammed into a small space. The huge number of individual soldered joints also told against reliability.

INTEGRATED CIRCUITS

With the appearance of the integrated circuit, then medium scale integration (M.S.I.), and finally large scale integration (L.S.I.), literally thousands of components were formed on a single semiconductor chip. This led to a dramatic reduction in the size of equipment, a big improvement in reliability and a greater ease of servicing. It also led to better performance as the sheer physical delay in propagating electrical signals around a bulky rack of discrete components had become a significant part of the operation time. It is now feasible to measure operation times of individual components in nanoseconds (10^{-9} seconds). For comparison the velocity of light is approximately one foot per nanosecond, and signals travel in cables at around 70% of this rate.

The basic principles of MOS/LSI (metal-oxide semiconductor/large scale integration) are fairly well established and common to many components manufacturers. In 1969, MOS components represented only 3% of the total sales of digital electronics. In 1971 the total number of sales increased to 25%. The growth rate is due to the dramatic simplifications which these components can make to the manufacture of a computer or other digital equipment. A typical single chip integrated circuit may contain the equivalent of about 5000 transistors. These may be combined to form a 5120 bit random access memory or a 4480 bit read-only memory. And chips such as these cost but a fraction of the many transistors otherwise required.

The dramatic reduction in size, complexity, and price of integrated circuitry has produced a bewildering array of equipment, from huge "number crunching" computers, to pocket sized electronic calculating machines and many instruments which fall between these extremes, including the programmable calculator.

This is a device which, in earlier years, would have been regarded as a computer. As well as the normal arithmetic operations of addition, subtraction, multiplication and division, it has the ability to perform logic operations, that is, to make decisions. In addition, it is able to store a set of instructions on program which it will execute on command whenever the operator provides a new piece of data input.

The size of the instrument has made it possible to take the computer to the job, rather than the other way around — an important consideration to engineers and surveyors. This type of instrument is ideal for their requirements to manipulate relatively

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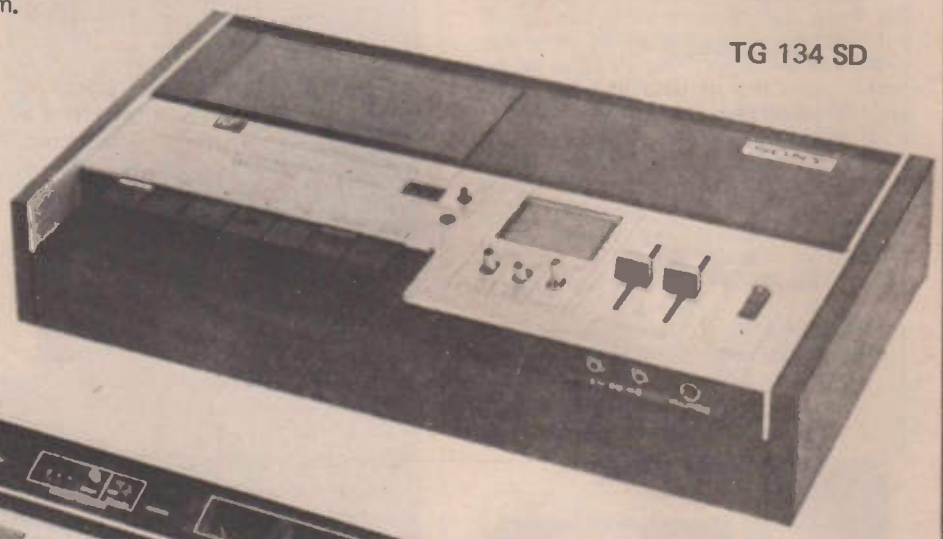

TG 134 SD

TC 161 SD

FEATURES:
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Hewlett Packard Calculator -Model 10

small quantities of data in a complex manner. For this reason many of the Hewlett Packard Model 10 programmable calculators finish up on the tailgate of Land Rovers, rather than in the air conditioned environment which has been the traditional home of the conventional computer.

TOUGH TESTING

When testing any instrument or piece of equipment we have always felt that it is just as necessary to use the equipment the way it is intended to be used, as it is to test it for its compliance with specifications. With this in mind, we decided to put the Model 10 submitted for review through some arduous testing. We tried it out in one of the toughest working environments available anywhere in the world. This was on the Gove Peninsula in Arnhem land in Australia's Northern Territory. The ambient operating temperature averages between 85°F and 90°F during the day and 65°F to 80°F at night the whole year round, while the humidity is consistently in the region above 80%. The air contains abundant quantities of fine dust which has the ability to penetrate almost anything.

We thought that these were severe enough operating conditions, but found that, in addition, there were two other hazards to contend with. The first was transportation by the local airline, which resulted in the virtual destruction of the very well designed cardboard box in which the calculator was packed. This was achieved by the airline staff dropping it on one corner. The second problem was that the local power supply had a 20% fluctuation in voltage and suffered from large transients – which resulted in blown fuses on many of the other pieces of electronic equipment which we used. We felt that such a combination of arduous conditions could not be found in many places in which a calculator may be used. It is a credit to its careful design and rugged construction that the Model 10 did not seem to be aware of these minor distractions and did not miss a beat throughout the job.

We took the computer with us to simplify the manual computations associated with a long series of measurements involved in a dynamic balancing operating. Each set of measurements required the computation of 27 vectors (magnitudes and angles). Such a job would be typical of the uses to which a programmable calculator would be put. While the computations could have been performed on a normal calculator, the probability of performing the entire set of computations correctly would be very small (particularly after a long working day in such heat).

If the computer is programmed under more normal conditions, and the program checked on a couple of trail computations which have known solutions, then it may be assumed that correct solutions will be given to the actual problems to be solved. This may not always be so, but when it is not it is usually due to a mathematical problem resulting from insufficient or incorrect data. The time required to perform these computations on a programmable calculator is in the order of 30 seconds; whereas, by hand on the same calculator, without the programming, it may take as long as one hour. In our case it took six hours to write and fully "debug" the program from the time we first opened the programming manual, so that the break even point comes after about six computations. On the project for which we used the computer the same type of computation was performed some 50 times. Thus, without the aid of the calculator, the same computations would have taken over 50 hours, and the accuracy of the results could not have been guaranteed. The saving in computation time was tremendous. The message was obvious.

The Hewlett Packard Model 10 calculator uses some very advanced hardware and novel design concepts to provide an extremely flexible performance. We could not determine from the Hewlett Packard handbook which integrated circuits were used. Although many of the I.C.s are commercially available from Motorola and several other well known manufacturers, the original part numbers have been replaced by Hewlett Packard part numbers.

The manufacturer's service handbook does not provide a great deal of information. Apparently this is deliberate and is done for a number of reasons. The first, and most obvious, is to stop the copying of the design by others. The second, is that the reliability of the electronics is such that the average machine will probably never need repair. The third reason is that repair of these circuits is very difficult, since one inadvertent discharge of static electricity (from clothing, or some other source) is sufficient to destroy many of the components on the integrated circuit boards. Because of this, Hewlett Packard do not intend that these boards should be repaired outside their workshops.

DESIGN CONCEPT

In concept the Hewlett Packard Model 10 calculator is divided into four logical sections controlled by the keyboard. These sections are, the Central Processing Unit, the Read Write Memory, the Main Read Only Memory (ROM) and the Input Output R.O.M.

The keyboard is divided into four blocks. The one on the right is the programming block, instructing the machine on what operations to perform. It includes IF statements, flagging, subrouting and input output instructions. The next block is the numerical block used for input of data and performing some calculation operations. The third is the data control block which guides the data into the correct storage registers. The fourth block contains keys whose function changes according to the requirements of the user.

The layout of the keyboard has been given careful consideration and contributes to the ease of programming and operation of the Model 10.

As in a general purpose computer, the Central Processing Unit is the controller and processor, performing

Hewlett Packard Calculator -Model 10

	9810A
Language	Reverse Polish
Keyboard	Key per function
ROM size (bytes)	5K to 11K
RWM size (bytes) Available to user	908 to 2924
I/O structure	General
User definable Keys or functions	Optional— single key subroutine
Recording device	Card with Cassette optional
Display	3 register numeric LED
Primary Printer	Optional 16 column alpha-numeric

Model 10 brief specifications

in order the operations in the program stored in memory.

The Read Write Memory is the main store of the computer. It contains all data and program steps entered by the user. With desk top computers it is usually the Read Write Memory which limits the effectiveness of the computer. The Hewlett Packard Model 10 offers a choice of three different sizes of Read Write Memory, allowing 500, 1012 or 2036 program steps and 51 or 111 data registers.

The Read Only Memories provide the directions for performing more complex mathematical operations in the form of microprogramming which is written into the ROM during construction. This enables the user to carry out operations such as logarithm, exponential etc. with a single key stroke as easily as an add or a multiply. The ROM is organized into two parts. The major part is integral with the machine and provides microprogrammed instructions for all the built-in keys, both for programming and some mathematical operations.

A unique Hewlett Packard feature is the Plug-in ROM and keyboard template. Using this approach a single set of keys can be re-defined to perform different operations simply by changing the ROM. To help the operator keep track of the different meanings for the keys, a template labelling all the key operations goes with each ROM.

There are currently available three plug-in Read Only Memories. These are:- the Mathematics ROM, Statistics ROM and the User Definable ROM.

The Mathematics ROM contains functions such as Polar to Rectangular conversion, sin x, cos x, tan x, x^y in x, e^x, set degrees, set radians, $\log_o$ x, 10^x degrees/minutes/seconds to decimal degrees, factorial x and roundoff. There is also a user definable function available which allows the user a function subroutine available with a single key stroke.

The Statistics ROM offers most functions which are commonly required for statistical computations. It also has a key which allows the removal of erroneous data.

The third ROM available is the User Definable ROM. This has nine User Definable functions of a type similar to that available on the Mathematics ROM. It also has several other interesting functions. One is a Protect function which enables the user-defined subroutes to be protected against over-writing with other programs. Two other very useful functions available are "insert" and "delete" functions. These functions enable programs to be corrected without completely reprogramming the machine. This is achieved by inserting "Continue" statements where new statements are to go, in the case of "Insert" statements or by simply removing a statement and reducing all the statement numbers by one in the case of the "Delete" statement.

The input output Read Only Memories are used for decoding the output of the computer to allow it to correspond with the outside world. A different decoder is needed for each of the peripherals used with the machine.

The range of peripherals available for use with the Model 10 is quite large. Two of these that can be mounted with the calculator are the standard magnetic card reader and line printer with a 15 character per line capability. If the standard printer is required for alpha-numberic output rather than straight numerical output, it is necessary to use the Alpha Printer ROM. This redefines the keyboard in letters and symbols for neat and storable outputs.

Other inputs available are:- paper tape, optical cards and magnetic tape. Outputs include graphical plotter, type-writer, paper tape and magnetic tape.

When considering such a powerful machine, it is reasonable to compare it with the range of mini-computers. The advantage of the programmable calculator is that it is easier to use, as programming consists of a set of calculator type steps, rather than a special programming language. There is no complicated start-up procedure to load an executive whose need will be to program and to look after the details of running the machine. It can accept data input from a variety of sources and output the results in a convenient way, either for further processing on magnetic or paper tape, or for final use as lists of figures, or as plotted curves or charts.

With such facilities available why buy a mini-computer? Briefly, the answer is — that one obtains even more power. The calculator, using serial rather than parallel arithmetic, is considerably slower. In addition, although the range of peripherals is wide it reaches a limit eventually. But there is a considerable range of applications where a choice between a programmable calculator and a mini-computer must be made. The Model 10 programmable calculator proves to be quite competitive with the mini-computer range provided the data rate is not too high and only a few output peripherals are required. ●

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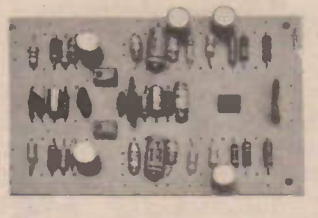

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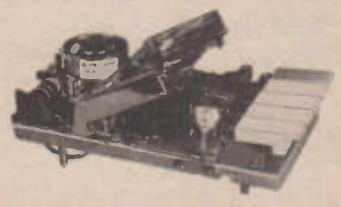

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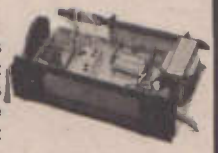

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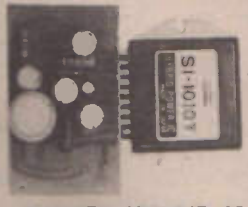

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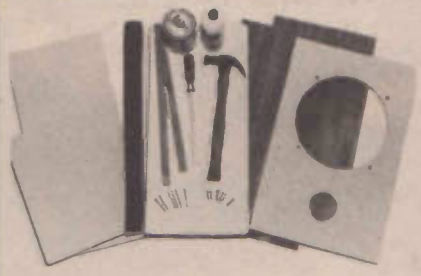
SPEAKER KITS



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This useful wide-band signal injector is ideal for fault-finding in audio and RF circuits VHF. The kit is housed in a clear perspex probe housing and includes batteries. The output is a square wave signal at approx 3KHZ with harmonics extending to TV frequencies. Price $4.50 plus 25c post.

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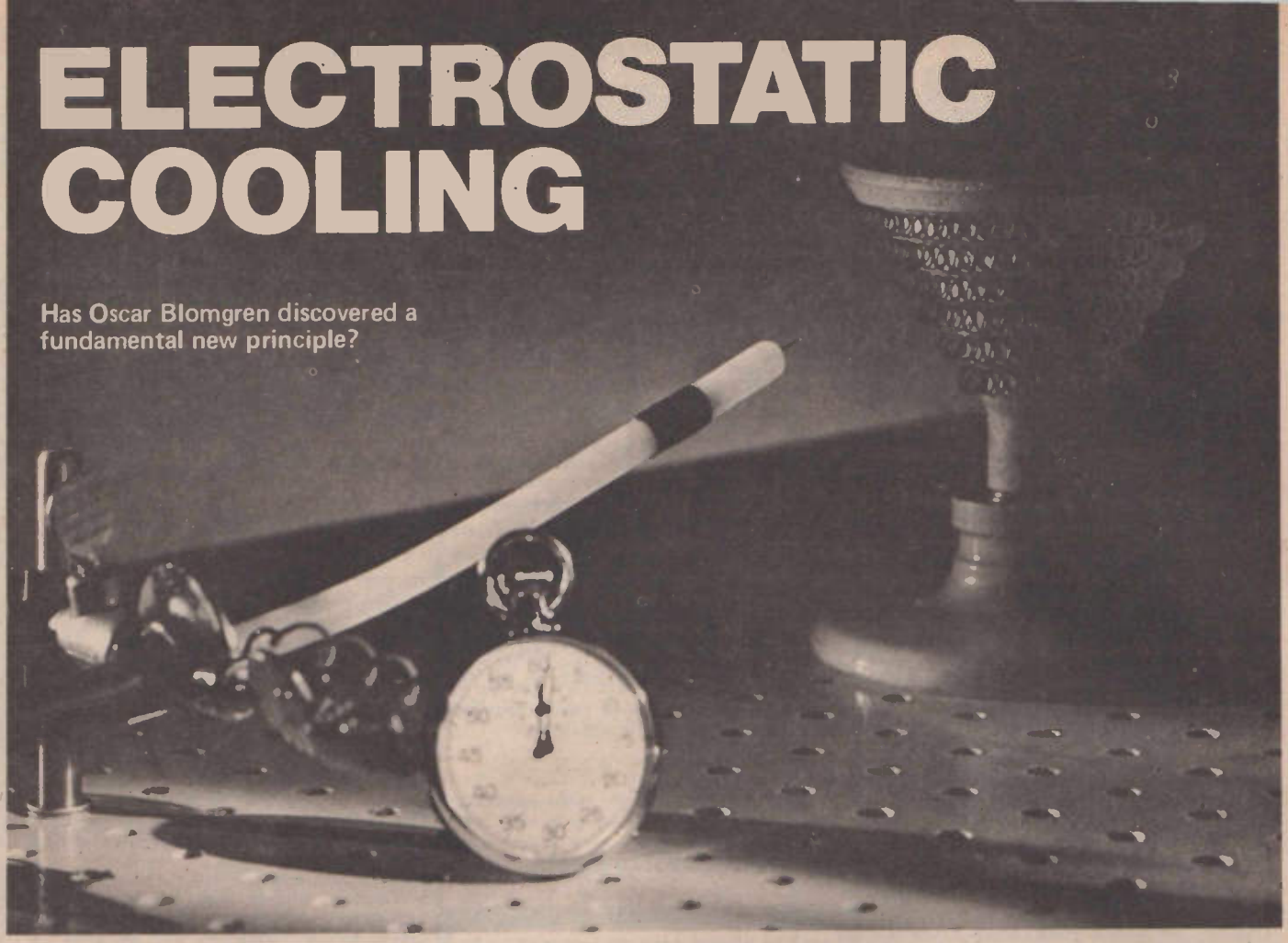
This probe appeared in Electronics Australia and uses an SN7400 and two LED's giving a visual indication of the logic state of any point in a circuit using digital IC's. The kit is housed in a clear plastic housing and includes P.C. board and instructions. A simple project to build in one evening. Our special price $7.50 Plus 25c post.

ELECTROSTATIC COOLING

Has Oscar Blomgren discovered a fundamental new principle?



LIKE philosophy, science has many examples of workable conclusions arrived at by what are later found to be the wrong reasons.

Oscar Blomgren's discovery of electrostatic cooling may well be the ultimate extension of this phenomonen – for here is a workable concept for which there are no really satisfactory explanations at all!

What Blomgren appears to have discovered is a new fundamental principle. In essence, his discovery is that heat may be removed from hot objects by the effect of a non-arcing ionic corona discharge from the negative ends of high voltage probes.

The technique is as simple as it is effective – the equipment required is merely a thin probe connected to an electrostatic generator, (even a basic van de Graaf generator may be used to demonstrate the effect). The probe is simply pointed at the (earthed) object to be cooled.

Cooling is rapid – a red hot sheet of metal may be reduced in temperature by several hundred degrees in a second or two – a Kleenex tissue prevented from igniting whilst suspended directly over a lighted gas jet.

Blomgren says that the precise mechanism of the effect is not understood. One explanation appears to be that a thin boundary layer of air clings to heated surfaces, and this boundary layer acts as an insulating barrier, inhibiting the rate at which adjacent cooler air can carry away the heat.

By creating an electrostatic field, vortex columns are created that 'pull in' cooler air from regions *beyond* the normal boundary layer. The swirling, turbulent air currents thus produced apparantly enable the heat transfer rate to be enormously increased.

Only a small amount of power is required to reduce temperatures through hundreds of degrees. In one experiment, a 1000 watt electric heating element was reduced from 1675°F to 975°F in less than two seconds using a 30 kV, 200 uA (six volts) discharge.

Independent Investigation

A thorough and independent investigation of the phenomonen has been carried out by Dr. K.G. Kibler, senior research scientist at General Dynamics' research laboratories at Fort Worth, Texas.

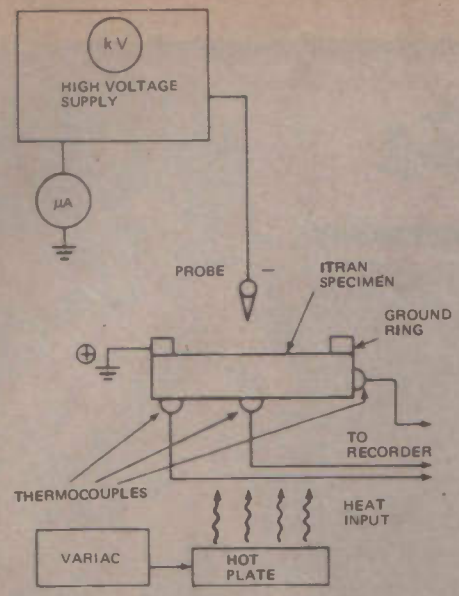
Dr. Kibler is quoted as agreeing with Oscar Blomgren's explanation of how the phenomonen works, but qualifies it by stating that the effect is highly dependent on the individual situation. It is almost impossible to make generalisations or formulate any laws – at least at this stage of experimentation.

Many of Dr. Kibler's experiments have been to assess the prospects of electrostatic cooling in high power CO_2 lasers. A major problem in development of such lasers is heat generated in the optical elements through which the beam must pass. The heat generated can be of such magnitude that the optical elements may be distorted or even destroyed.

Fan or blower cooling is often used but is not really satisfactory because of the physical size of the units required. Hence the interest in electrostatic cooling.

A humber of experiments were conducted with germanium and Irtran 2 (a polycrystaline zinc-sulphide window produced by Eastman Kodak). Both germanium and Irtran 2, because of their long wavelength transmission characteristics are widely used in infra-red lasers. Dr. Kibler states that electrostatic cooling was 'effective' for both materials.

Figure 1 shows a typical experiment in which flat cylindrical Irtran



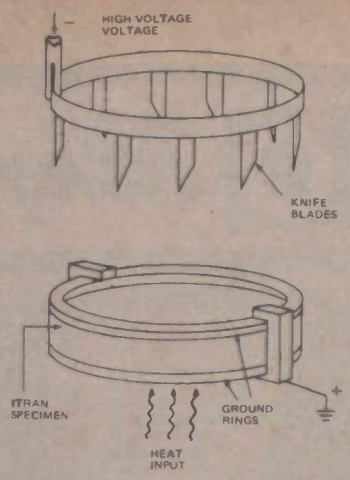


Fig. 1. Data on electrostatic cooling of laser optical elements was provided by this basic test setup.

Fig. 2. Best electrostatic cooling of the Irtran window was obtained as shown above.

specimens were placed horizontally over a hot plate and surrounded by heat insulating bricks. The Irtran specimen was heated and then maintained at a constant 270°F. When the probe was energized – at 25 kV – the temperature of the speciment was reduced to 130°F.

Further experiments showed that it was possible to shape the electrostatic field by shaping the probes, or as shown in Fig. 2, by using an array of probes.

All probe configurations tried by Dr. Kibler lowered the temperature of the Irtran specimen, but by various amounts. Maximum cooling effect was in fact achieved by the method shown in Fig. 2.

For any given probe, cooling appears to depend upon the ionic current flow. In most experiments no cooling was apparant until a current of about 10 uA – saturation was reached in most cases at currents of about 60 uA. (Fig. 3).

Electrostatic cooling is fast becoming more than merely a laboratory curiosity. A number of manufacturers are using the technique (for which Blomgren has practically airtight patents) in commercial applications.

One large European company has been using electrostatic cooling at its plant in Switzerland since early this year and now intends to extend it to its operations in Austria and Germany.

In the USA, the Inland Steel Co has entered a licencing arrangement to work on applications in the steel industry. The Bundy Corporation (tubing manufacturers) has also signed a licencing agreement.

Again in the USA, Cleveland Hard Facing Inc. has found that electrostatic cooling eliminated problems previously encountered in coating delicate parts with certain alloys. The failure rate was reduced from 50% to virtually zero.

General Dynamics is currently believed to be investigating the use of electrostatic cooling for integrated circuit boards and other electronic components.

Electrostatic fields are also being investigated in welding. Blomgren's company Interprobe Inc. (1539 Morrow Ave, North Chicago, Ill. 60064) has found that when an electrostatic field is applied during certain welding operations metallurgical effects take place. These changes include control of grain size and hydrogen content, and virtual elimination of inclusions and voids.

At present it is not clear if the improved metallurgical qualities are due to more effective cooling of the weld – or whether perhaps the electrostatic field contributes to crystal orientation of growth. ●

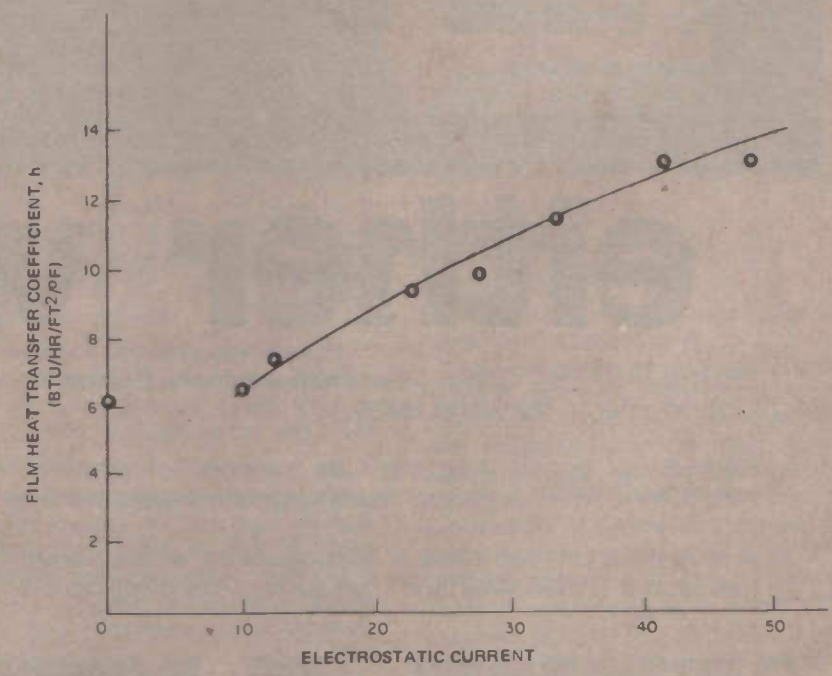


Fig. 3. Electrostatic cooling depends strongly on the current flow. Here, cooling of an Irtran-2 element with a needle probe begins at 10 μA.

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SPEAKER COMPETITION -results

THE Electronics Today Speaker Competition, announced in the December 1972 and January 1973 issues, invited readers to list, in their preferred order of sequence, a list of salient points to be considered when choosing loudspeakers.

The list of salient features is reproduced on this page.

Initial selection of finalists was made by a panel of five judges amongst whom were our Editorial Director and our acoustical consultant Louis A. Challis. Each judge made his own quite independent selection of point order — all five selections were surprisingly similar and their averaged result is reproduced, right (Table 1 — column 'A').

Our selection procedure commenced by including as finalists all entrants who had either of the following selections.

1/ Low distortion
2/ Smooth frequency response
3/ Superior transient response
4/ Wide frequency response

or,

1/ Low distortion
2/ Smooth frequency response
3/ Superior transient response
4/ Wide frequency response

This initial selection reduced the number of eligible entrants from about 1000 down to 300 or so.

Our next step was to prepare a Gaussian distribution of our remaining 300 entries in order to ascertain their average order of preference. The results of this distribution are shown as column 'B' in Table 1 — and as may be seen these are very close indeed to our own averaged choice.

The averaged results from our finalists — together with our judges' individual listings were then again averaged resulting in the order shown in Table 1 — column 'C'.

No single entrant submitted precisely this order, but one entrant was very close indeed — in fact it was exactly as the finalists' averaged results! He is Mr. Reece Anstey of Woodlands, West Australia whose winning entry is reproduced, right. (Also as column 'D' in Table 1).

Congratulations to you, Mr. Anstey! You have won our first prize of a pair of Rectilinear Mk. XII loudspeakers.

Second prize goes to Mr. T. Robin of Mont Albert Road, Canterbury, Victoria. Mr. Robin wins $50 worth of Memorex recording tape — third prize of $25 worth of Memorex tape goes to Mr. Michael Batty of Bexley, NSW.

All prizes in this competition were donated by Leroya Industries — to whom we extend our sincere appreciation.

It is an interesting affirmation of the generally high standard of ethics prevailing within the hi-fi industry in Australia that Leroya — a commercial organization with a vested interest in selling Rectilinear speakers — agreed to supply them to us knowing that we would not only be publishing a complete breakdown of the factors that readers felt important in choosing a pair of speakers — but that we would also publish a totally independent review of the Rectilinear speakers in the very same issue.

This review appears immediately following this article. It is interesting

COMMENT

LOW DISTORTION

Practically every audio authority agrees that the pleasure obtainable from listening to program material for any length of time is almost directly related to the lack or otherwise of distortion. Even quite minor distortion, of which the untrained ear may not even be consciously aware, will cause listener fatigue.

SMOOTH FREQUENCY RESPONSE

This is essential. Minor drop-off of bass or treble may to some extent be correctable by suitable setting of amplifier tone controls — but there is no way in the world one can easily compensate for those peaks or dips that the Americans so aptly call "glitches'.

SUPERIOR TRANSIENT RESPONSE

Essential feature if the speaker is faithfully to reproduce those instruments characterized by a sharp leading edge to their acoustic waveforms. These include tympani, stringed instruments, triangles, etc.

WIDE FREQUENCY RESPONSE

To some extent this parameter is associated with transient response in so far that it is virtually impossible to have good transient response unless the speaker has a wide frequency response. The opposite situation is not necessarily true.

Nevertheless the bass response of a speaker is ultimately limited by the size (and shape) of the room in which it is placed — and few hi-fi enthusiasts have rooms of sufficient size in which faithfully to reproduce frequencies much under 60Hz.

WIDE POLAR RESPONSE

The extent to which sound is distributed around the main axis of a speaker is called its 'polar response'. It is particularly important that a speaker is designed to ensure wide dispersion of the higher frequencies, for these are directional by nature.

A speaker lacking wide polar response has the limitation that high frequency program material will only be heard when one is sitting more or less directly in line with the speaker — unless the room has sufficient diffusion to compensate for the directional effects.

POWER HANDLING CAPACITY

For realistic reproduction — especially of bass frequencies — a speaker must be capable of handling a considerable amount of power. Short of using horn loaded speakers (which are extremely efficient) there is no way in the world that, for example, the bass register of a pipe organ can be reproduced at realistic volume with

to note that the high efficiency claimed (but not totally achieved) for these speakers is not rated of any great importance by most entrants — nor is the extensive parts and labour guarantee. Nevertheless it is pleasant to have a guarantee that goes beyond the normal twelve months period. ●

Many factors are important when buying loudspeakers — here is how our experts and our readers rate them.

less than 20 to 50 watts. That would be an absolute minimum — ideally at least 100 watts would be desirable (depending of course on speaker efficiency).

HIGH EFFICIENCY

Since the advent of power transistors, high power amplifiers have been commercially available at quite low prices. Hence it is of no real consequence whether a speaker is 0.5% efficient or 5% efficient if an amplifier of sufficient size adequately to drive either type of speaker can be bought for nearly the same price.

It should be born in mind that an inefficient speaker is built that way because input power requirement has been traded off against linearity etc. Speaker efficiency is simply a ratio of acoustical power output against electrical power input. It has nothing to do with sound quality. Naturally there is a lower limit below which efficiency becomes a serious consideration — hence the inclusion of this parameter in our listing.

PARTS AND LABOUR WARRANTY

The minor importance placed on this item by our judges and most of our entrants is an excellent commendation for the hi-fi industry and its products. In our experience loudspeakers rarely fail — if they do there is equally rarely any dispute about responsibility.

TABLE 1

PARAMETERS	A	B	C	D
High efficiency	8	7	8	7
Low distortion	1	1	1	1
Wide frequency response	3	3	3	3
Smooth frequency response	2	2	2	2
Wide polar response	5	5	5	5
Attractive appearance	9	9	9	9
Reasonable size	10	10	10	10
High power capability	6	6	6	6
Parts & labour warranty	11	11	11	11
Moderate price	7	8	7	8
Superior transient response	4	4	4	4

Mark your order of preference in the boxes, i.e. 1 for first choice, 2 for second choice, etc.

7 High efficiency
11 Low distortion
3 Wide frequency response
2 Smooth frequency response
5 Wide polar response
9 Attractive appearance
10 Reasonable size
6 High power handling capacity
11 Parts and labour warranty
8 Moderate price
4 Superior transient response

Explain in thirty words or less the reasons for your order of preference.

One to four are the important high fidelity criteria. Five to seven determine the purpose for which the speaker is used. Eight to ten determine the market. Eleven should follow.

ENTRY COUPON

ELECTRONICS TODAY INTERNATIONAL SPEAKER COMPETITION

21 Bathurst Street, Sydney, N.S.W. 2000

Herewith, please find my entry for your Speaker Competition. I have read the rules of the contest and agree to abide by the judges' decision.

SIGNED Reece Anstey DATE 22-1-73

NAME (block letters) REECE ANSTEY

ADDRESS 79 WOODLANDS ST, WOODLANDS, W.A. 6018

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Closing date for the Speaker Competition is January 31st, 1973.

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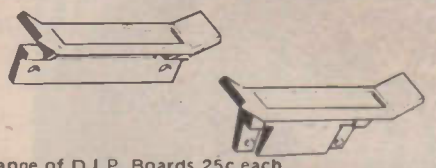
Handles to match to fit on either Card in Black, White, Signal Red, Sky Blue, Pea Green & Yellow. Pt. No. 10037 Clip on. Price: 50c ea +10c post.



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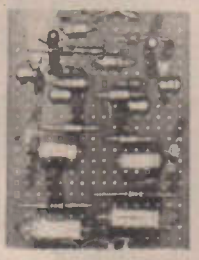

KIt consists of all necessary components and instructions to construct this Unit which is designed to operate with the 'VORTEX' Stereo Cassette Deck. Technical Data: 2 channel amplifier internally equallised to accept signals from tape heads and converts it to feed any amplifier system. Max. output 200m/V. Freq. response 25Hz. Power requirements are 18 volts at 6m/a., which can be supplied by 2 x 9v batts. Complete kit of parts $6.25 plus 25c post.

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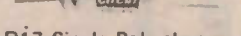

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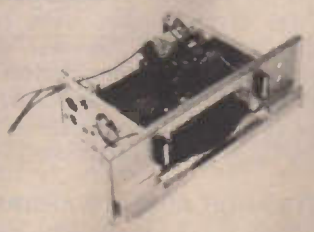

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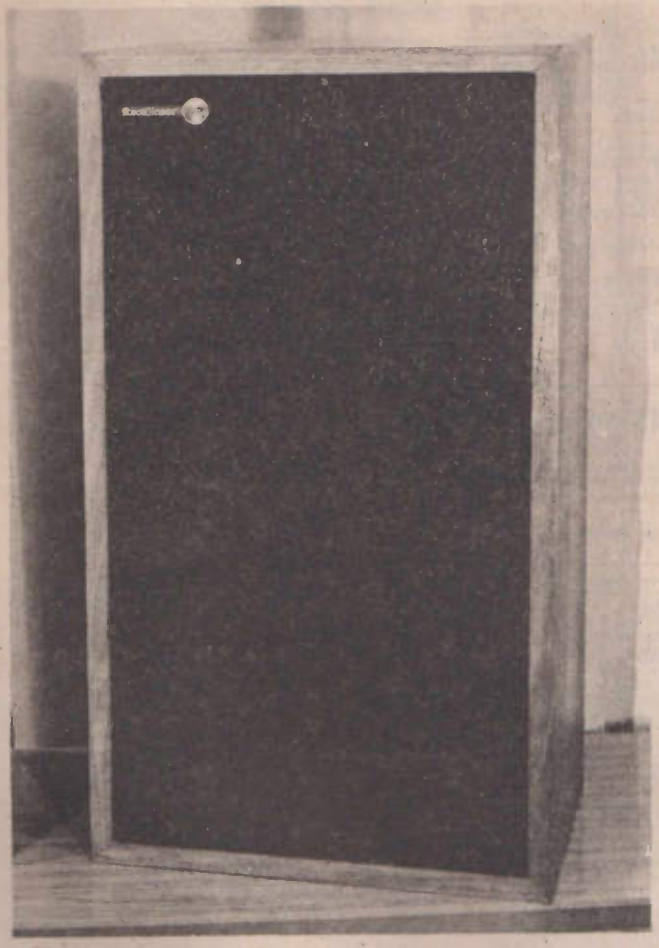

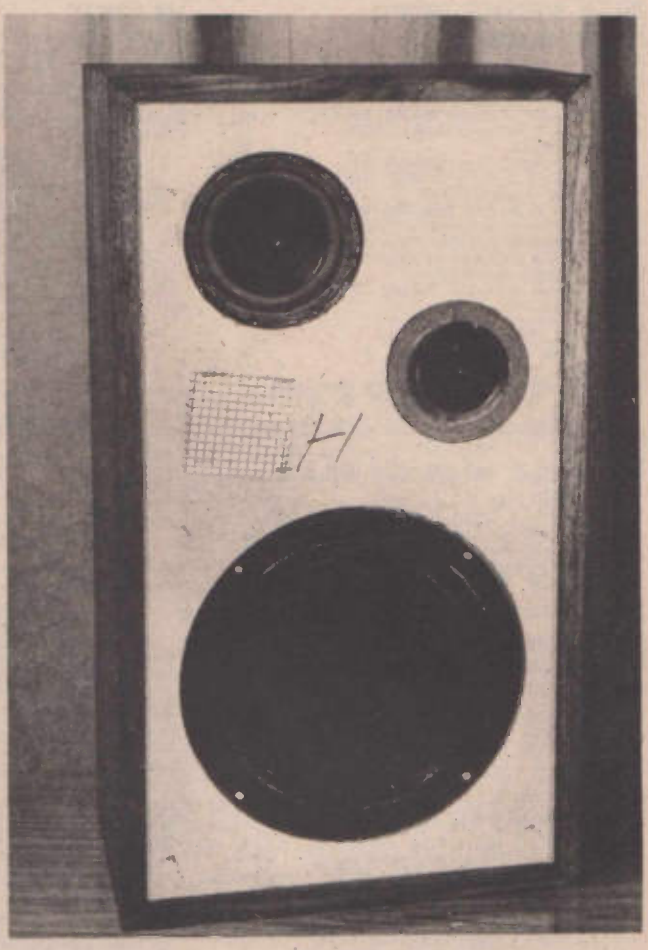

electronics TODAY INTERNATIONAL
product test

Recommended selling price $199 (after April 1st 1973).

IN manufacturing the Rectilinear Mark XII loudspeaker the manufacturer's stated intentions were to produce a 'bookshelf' speaker having a reasonably smooth frequency response, low distortion, and high sensitivity to enable it to perform well with low to medium power amplifiers.

Our tests show that these intentions have been met with the exception of electro-acoustic efficiency, which was relatively low for a vented enclosure.

To obtain their goals, Rectilinear have used a three-way speaker system in a vented enclosure. The speakers consist of a ten inch woofer, a five inch twin-cone mid range speaker, and a three inch tweeter.

The woofer has a number of unusual characteristics one of which is a very large voice coil (two inches in diameter). This is visible through the transparent centre piece of the speaker cone. Another feature of the woofer is a very light but rigid pressed metal speaker frame.

The magnet assembly of the woofer, measuring 4" x 3" x 2", consists of a large 'U' shaped magnet with an 1-7/8" diameter centre pole piece. This

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8H21	Dual JK flip flop (HS 60 MC)	1.10
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8292	Decade counter (low power)	0.90
8251	BCD to decimal decoder	1.75
7480	Gated full adder	0.50
7413	Dual 4 input NAND Schmidt triggers	1.75
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This family of logic offers medium speed combined with a greater noise margin than is available from either DTL or TTL logic. Power requirements are the same as TTL/DTL (single 5 volt supply).

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LU334	Dual 4 input expandable NAND	0.30
LU356	Dual 4 input expandable driver	0.30
LU370	Triple 3 input NOR	0.30
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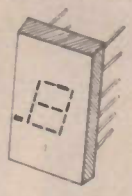
LED DISPLAY

The MAN1 is a seven segment diffused planar GaAsP light emitting diode array. It is mounted on a dual in line 14-pin substrate and then encapsulated in clear epoxy for protection. It is capable of displaying all digits and nine distinct letters.

FEATURES:



- High brightness, typically 350ft-L @ 20ma.
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"UTILOGIC" SPECIAL

Ten (10) pieces of LU321 dual JK flip flops and four pages of application information describing ripple counters (3 to 10) and divide by 12 up/down binary and decade counters, shift registers and self-correcting ring counters.

Complete package only $3.60

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Ten (10) 741 fully compensated operational amplifiers with data sheet and two (2) pages of application notes covering the basic circuits for op-amps.

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8 pin DIL Only 35c each
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LM309K—5 volt regulator

This TO-3 device is a complete regulator on a chip. The 309 is virtually blowout proof, it is designed to shut itself off with overload of current drain or over temperature operation. Input voltage (DC) can range from 10 to 30 volts and the output will be five volts (tolerance is worst case TTL requirement) at current of up to one ampere.

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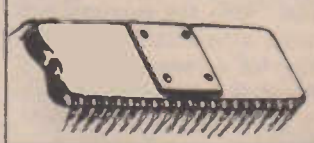
LSI—CALCULATOR ON A CHIP

This 40 pin DIP device contains a complete 12 (twelve) digit calculator, Add, Subtract, Multiply, and Divide. Outputs are multiplexed 7 segment MOS levels. Input is BCD MOS levels. External clock is required. Complete data is provided with chip (includes schematic for a complete calculator).

Complete with data $9.95



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COUNTER DISPLAY KIT—CD-2

This kit provides a highly sophisticated display section module for clocks, counter or other numerical display needs.

The RCA DR-2010 Numitron display tube supplied with this kit is an incandescent seven segment display tube. The .6" high number can be read at a distance of thirty feet. RCA specs. provide a minimum life for this tube of 100,000 hours (about 11 years of normal use).

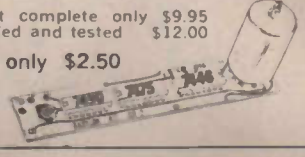
A 7490 decade counter IC is used to give typical count rates of up to thirty MHz. A 7475 is used to store the BCD information during the counting period to ensure a non-blinking display. Stored BCD data from the 7475 is decoded using a 7447 seven segment decoder driver. The 7447 accomplishes blanking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

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

Circuit board is .8" wide and 4¾" long. A single 5 volt power source powers both the IC's and the display tube.

CD-2 kit complete only $9.95
Assembled and tested $12.00

Board only $2.50

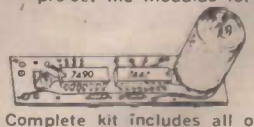


RCA DR2010 Numitron digital display tube. This incandescent five volt seven segment device provides a .6" high numeral which can be seen at a distance of 30 feet. The tube has a standard nine pin base (solderable) and a left-hand decimal point. Each $5.00
SPECIAL 5 for $20

UNIVERSAL COUNTER DISPLAY KIT CD-3

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

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



CD-3 board only $2.25
IC's 7490, 7447 2.75
RCA DR2010 tube 5.00

Complete kit includes all of the above plus 5 programming parts, instructions and Molex pins for IC's. Only $8.95

The MAN3M is a seven segment diffused planar gallium arsenide phosphide readout. It is capable of displaying 10 digits and 9 distinct letters and is encapsulated in a high contrast red epoxy package.

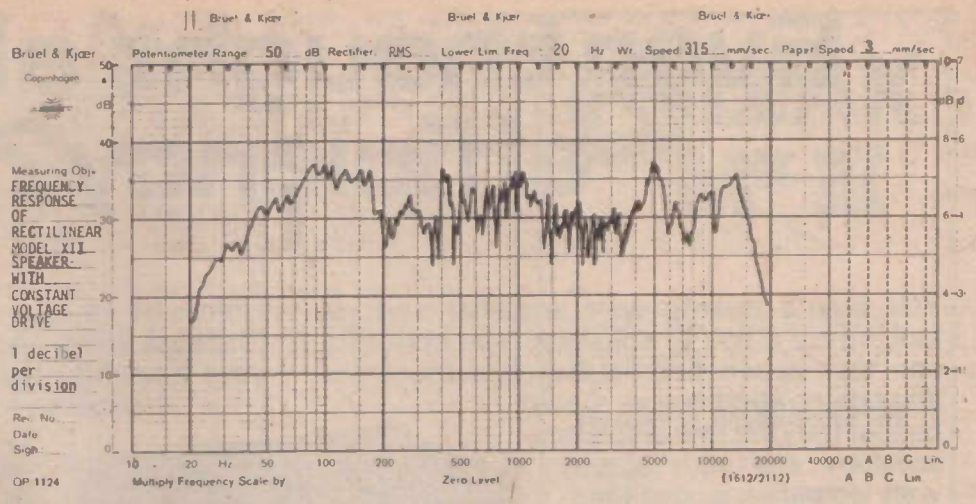
- 0.127" high led 7 segment display.
- Bright red 400 ft-L at 10ma per segment.
- Compatible with standard digital IC's.
- Compact spacing 5 digits per inch.

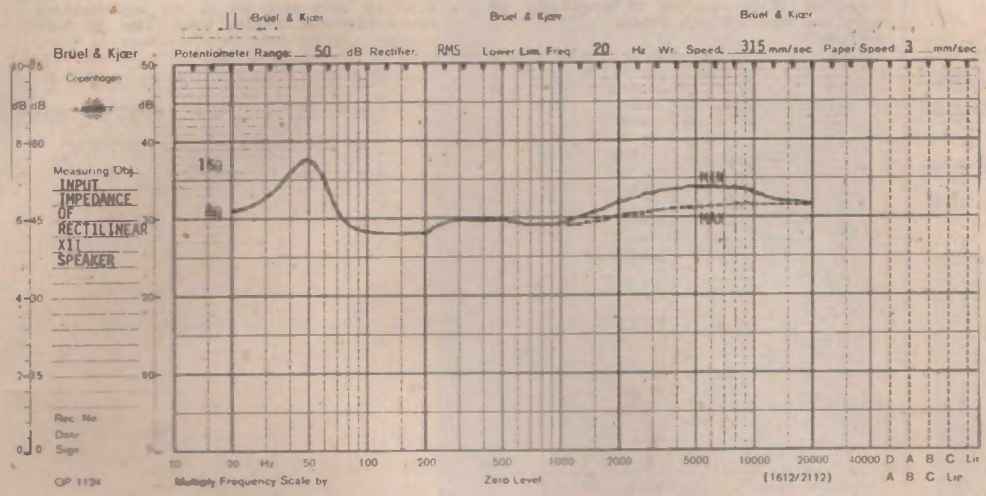
$3.00 each. Ten or more $2.50

Babylon Electronics Inc.

Post Office Box J, Carmichael, California. 95 608 U.S.A.

RECTILINEAR MK XII LOUDSPEAKERS





provides relatively high electro-mechanical efficiency and allows a diaphragm movement of 7/8".

Yet another unusual characteristic of the woofer is the very low free-air resonance — of a mere 17 Hz, (generally, woofers used in vented enclosures have their natural resonance in the audible range).

The mid-range speaker is a twin-cone unit. It is apparently glued into place in the front mounting panel and is enclosed at the rear by a five inch diameter by five inches long plastic cover, filled with a multicoloured damping material.

The middle cone in this twin-cone unit is quite large — two inches in diameter.

A three inch tweeter is also mounted in the front panel. This unit has a conventional diaphragm with a domed centre.

The crossover network consists of an 'H' type iron-cored choke, an air cored inductor, two capacitors, two large resistors and two wire-wound potentiometers for mid-range and high frequency level adjustment.

The two potentiometers are mounted on a large terminal panel recessed into the rear of the speaker. This panel is also fitted with two screwed input terminals marked "common" and "input".

HOW THEY SOUNDED

The subjective 'A-B' test proved very interesting, because the Rectilinears had a response similar to our own JBL Studio Monitors, even to the slight colouration characteristic of these units. The main differences were the Rectilinear's lower power handling capacity and slightly earlier bass roll off.

The slight colouration resulted in an apparent crispness in their response to all program material. This was particularly noticeable on orchestral records such as the CBS record S2BR220302 entitled "The Tchaikovsky Ballet Album". This record contains some complex orchestral peices and these were produced with exceptional clarity and realism, and the Rectilinear's crisp response partly compensated for the loss of high frequency content due to the normal living room furnishings which tend to attenuate the high frequency components.

The piano in particular is one instrument which many speakers are unable truly to reproduce. Generally they muffle the striking of the notes due to inadequate transient response. The RCA record Nilsson Schmilsson has considerable piano backing, and here the Rectilinears showed good transient response resulting in exceptional realism. This record also has some of the best and lowest frequency content that we have ever heard produced by a bass guitar, and it was only on these passages that we noticed a slight loss of bass and a resonance in one of the speakers sent in for review. The other speaker had no noticeable resonance.

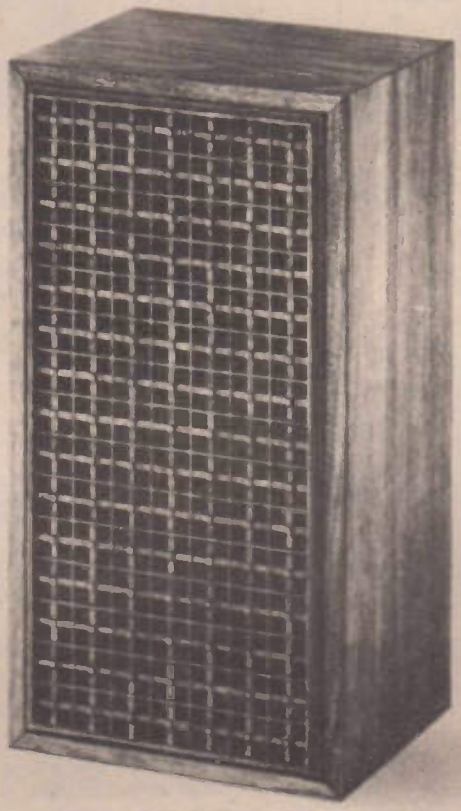
MEASURED PERFORMANCE

The measured frequency response was quite good being within ± 6dB from 30 Hz to 17 kHz, and 9dB down at 22Hz and 18 kHz. The polar response was exceptionally good up to

Ever thought about efficiency?

You buy a twenty watt amplifier and go looking for a pair of speakers. You choose a pair that sound fine in the showroom but disappointing at home. Could be that they are low efficiency speakers and your twenty watt amplifier is overloading and distorting on the loud bits.
So you trade your twenty watt amplifier for a forty watt job . . . and you blow your speakers.
You're caught between the devil and the deep blue sea.

Unless of course you buy Rectilinear . . . . The high efficiency loudspeakers that flatter your amplifier because they don't make it work so hard.



Put 10 watts in and they sound fine. Put 40 watts in and they sound fine. Put 100 watts into the big ones and they still sound fine.
For once you're free of the low efficiency devil, and the low-power-handling deep blue sea.

Investigate Rectilinear—the problem solver.

Solve the money problem too—they start at $139.
(that's the $139 model XI above)

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N.S.W. Sydney Hi-Fi Centre, 83 York St., Sydney, N.S.W. 2000.

S.A. Sound Spectrum, 33 Regents Arcade, Adelaide, S.A. 5000

LER 025

RECTILINEAR MK XII LOUDSPEAKERS

approximately 8 kHz. Above this frequency response dropped off approximately 6dB at 60° off-axis from the tweeter.

Harmonic distortion was also very reasonable being only 3% at 100Hz with 5 watts input. This resulted in no noticeable distortion even at relatively loud levels in the average lounge room.

In terms of the performance specification supplied with the speaker, they compared reasonably well. The frequency response resembled the printed one supplied by Rectilinear, with the exception that Rectilinear's was done with a very long averaging time to smooth out the peaks and drop outs.

A considerable amount of information was supplied with the speaker including the intriguing comment that the speakers were "bookshelf units". Nearly every speaker manufacturer in America uses this definition for any speaker with a volume less than three cubic feet. This is in contradiction to our own definition of a bookshelf speaker, and most European manufacturers' definition, which is generally limited to a unit having dimensions not exceeding 15 x 12 x 9 inches. (American bookshelves are bigger? — Ed.)

The technical information supplied was very comprehensive even including second, third and fourth harmonic distortion measurements for fourteen different frequencies between 30 Hz and 15 kHz.

The installation instructions gave wiring details (in American terminology), and commented on correct phasing of the speakers. Other subjects discussed included speaker placement, adjustments for level controls, warranty and guarantee, and information on correct redress should there by any apparent damage. The five year customer warranty covers the speaker against defective material and faulty workmanship.

The Rectilinear XII Speaker system, although having a rather plain external appearance, would readily match in with most lounge room decors, and has a well balanced set of performance parameters resulting in a very pleasing and clean sound. ●

MEASURED PERFORMANCE OF RECTILINEAR MODEL XII SPEAKER SERIAL NO 204068

Frequency Response	30Hz to 17kHz ±6dB		
Total Harmonic Distortion	100Hz	1kHz	6.3kHz
1 watt	2%	0.6%	0.7%
5 watts	3%	1%	0.7%
Electro-acoustic Efficiency (at 1kHz)	0.5%		
Cross-over Frequencies	350Hz and 11kHz		
Woofer Resonance			
In free air	17Hz		
In enclosure	50Hz		
Measured Impedance	100Hz	1kHz	
	6.5Ω	7Ω	
Enclosure Volume	1.3 cubic feet		
Dimensions	25" high x 14" side x 10¾" deep		
Weight	36lb		

LUX

World's most renowned amplifiers— The ultimate musical experience!

For sheet professionalism in amplifiers, look to Lux! As the world's longest-established manufacturer of amplifiers, the company's manufacturing policy accounts for the quality of sound. It first makes the amplifier to its own standards of quality, then puts a price on it. Fifty years of establishment, experience and reputation enable Lux to present units which make apparent the mystery and softness of every musical instrument. This is ultimate hi-fidelity.

SQ700X

27 transistors, 2 silicone varisters, 4 silicone diodes. Main amp section adopts a fully complementary direct coupled output with differential amplification. RMS power 25/25 watts, distortion less than 0.1%, frequency response 10 – 50,000Hz – 1dB. Other famous Lux models include: 505X, 507X, 202.

NEW! LUX LX 77 HIGH QUALITY SPEAKERS

Finally released after many years of extensive development, the Lux LX 77 3-way speaker system features the exclusive ring diaphragm tweeter which eliminates break-up vibration within the audible range. Dome-type midrange features hemispheric diaphragm for even, wide dispersion. Long voice-coil woofer eliminates non-linear distortion in the low frequency range. Constant impedance attenuator level controls for high and mid-range, are fitted on the front panel, permitting settings to suit your individual listening requirements. Frequency response 30—22,000Hz. Beautifully finished timber cabinets, 26" x 15" x 12".

Speakers: 12" high compliance woofer, 1.6" dome type mid-range, 1.3" ring type tweeter. Crossover frequency 700, 8000Hz, 12dB/oct. 60 watts 80ohm.

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INTERDYN

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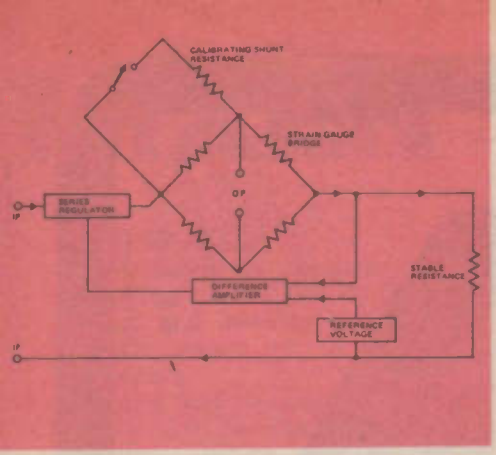

IMPROVING BRIDGE MEASUREMENTS

IN the course of making measurements of the pressure and thrust characteristics of rocket motors, using electrical resistance strain-gauge transducers the Australian Weapons Research Establishment, has developed a power supply with potential application of precision transducer measurements in other fields.

The WRE measuring equipment uses strain-gauges in a Wheatstone Bridge configuration. The conventional circuit has the disadvantage that the output voltage varies with the input voltage supplied to the bridge, for precision measurements the transducer must therefore be recalibrated in relation to the local supply voltage each time it is moved to a new site.

In the WRE development, a miniature high-stability current generator is used to control the stability of the bridge supply (as shown in the schematic diagram). The novel feature is that by making the generator an integral part of the transducer, the output from the bridge becomes independent of supply voltage for variations of up to ± 10% from nominal. Transducers can thus be calibrated at a central station and operated at other sites without the need for a constant supply voltage. In addition, the circuit improves linearity and decreases temperature sensitivity.

Transducers have been constructed which have maintained their accuracy and stability within ± 0.2% for more than a year.

Self-checking capability between calibration has been provided, as shown in the schematic diagram. Operation of a relay-type switch, incorporated in the transducer body, connects a calibrating shunt resistance across one arm of the bridge and allows the stability of the transducer circuit to be checked.

For further information contact Mr J.R. Mapletoft, Propulsion and Marine Physics Division. Weapons Research Establishment, Box 2151, G.P.O. Adelaide. South Australia.

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We don't charge you for the quality.

The Apan BFU-121 is the first fully automatic turntable in Australia. Built of precision parts, the Apan BFU-121 boasts perfect record tracing from its static balance tone arm; excellent dynamic balance from the aluminium diecast turntable; quiet, positive, constant speed 4-pole synchronous motor; feather-touch cue-control lever; removable head shell; all for around $125 – ready to operate with no extra costs.

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A.C.T.: Sonny Cohen & Son, 20 Isa St., Fyshwick
TAS: W. & G. Genders Pty. Ltd., Launceston, Burnie, Hobart
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COMPUTERIZE-AND BE DAMNED?

"If you were me, Oi wouldn't be dooin it" is the punch line to a well-known Irish joke – and could also be the advice from management with some experience of computerizing their company activities – when they choose to be honest with themselves – and us.

CASE 1: Towards the end of 1971, a package holiday and travel firm with international operations sacked its computer, saved itself $180,000 a year and achieved greater efficiency with half the staff. The most charitable comment from its managing director was "Perhaps using a computer could be profitable when we expand to double our present operations"; he had, then, 150,000 bookings a year!

Case 2: Early in 1970, a large firm in the UK domestic appliance sector computerized its extensive spare-parts inventory and desptach system. Two years later, after having spent nearly $200,000 on staff and equipment, they courageously hired two veteran organization and methods experts with only a nodding acquaintance with the mysteries of the computer.

Their two months of intensive study resulted in suspension of all computerization with almost over-night increase of productive work output and continuing cost savings.

Case 3: 'Management Practice' recently reported how a (US) company boosted its profits by taking a good hard look at its computerized inventory control.

What have all these three case histories in common with the laboratory engineer who was persuaded to buy a digital multimeter (measuring to 0.1% and with a number of other facilities) when all he really needed was an Avo Model 8 for continuity testing and simple voltage indications? Simply that, for a given function or set of functions to be carried out, there almost always exists a valid operational form which runs contrary to the oft-heard argument that complex-looking operations require complex-looking systems or equipment.

It is frightening to find that we are slowly but remorselessly being conditioned to using systems, procedures and equipments which are far too elaborate, involved and over-accurate for the problems we need to solve.

Sigma 9 System at Cybernet Time Sharing Ltd. (Rank Xerox).

REAL PROBLEMS

Returning to the computer case-histories, the tour operator found the system was cumbersome and slow, especially in dealing with clients' alterations to intineraries and bookings. A mass of information was potentially available, as the programmers and computer staff claimed, but nothing really worthwhile was *readily* available. Overheads, with staff, kept doubling every two years and eating into profits – while the promised 'golden day' – when all you had to do was press a button and get all the answers to a wide range of really important questions – seemed just as far away as ever.

A real hard look revealed that the staff were doing twice as much work as before the computer arrived, but 75% of their work was in feeding information to the seemingly bottomless funnel of the 'computer room'.

Yet with just one more assistant at certain key booking offices and a revised information-transfer system between the offices (using conventional phone, telex and postal services), the firm found that they could restore the sort of service they used to provide – even allowing for the 100% increase in orders in the intervening 'computerized' period.

The appliance firm with spare-part inventory and order despatch difficulties, had real problems which had nothing to do with computerizing itself. The store-clerk, for example, was spending just as much (if not more) time in preparing information for the computer boys as he originally did in keeping a simple card index.

The difference with computerization was that, if he was asked how many IF strips he had in stock, he could no longer thumb a card index and give the answer, but had to 'input' the computer which had the information in its invisible secret archives and whose current program could not be interrupted till who knows when.

The firm's real problem was that the

The John Bowers Story

EVERY century there has been the growth of new crafts. Inevitably a superior craftsman in his field emerges and his name becomes a by-word. One can immediately think of Chippendale and his furniture; Stradavarius and his violins; Earnest Rolls and his motor cars. Now, John Bowers of Bowers & Wilkins (B & W) has already achieved a remarkable reputation for his B & W Monitor Speakers.

Unfortunately, craftsmen do not turn out their products in mass-produced quantities. For this reason it has not been easy to obtain adequate supplies of B & W speakers, but recently with the opening of a small but modern factory, B & W have managed to turn out more speakers but still up to the same individual crafted specifications that have made them famous throughout the world.

Of course, there are countries where B & W speakers are not sold, but Australia has recently received a limited number of these unique

The B & W Model 70 Electrostatic Monitor Speaker described by experts as ... "perfection". $985 pair.

speakers, which have received the most enthusiastic reception from the experienced Hi-Fi listener.

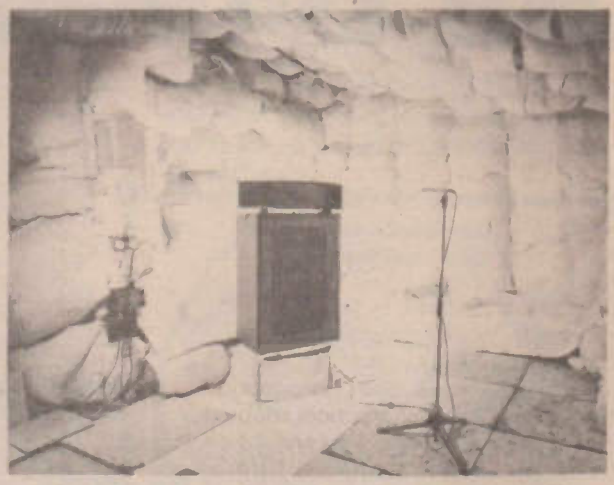
The most interesting of all B & W speakers is the DM70 model, Electrostatic. This speaker is a unique hybrid speaker using the immense advantages of electrostatic reproduction from 70 cycles upwards, and the great mechanical efficiency of a conventional base-pump type of bass unit for the lower frequencies.

The electrostatic unit consists of a semi-circular array of 11 transducers in a free standing form. It is necessary to hear this speaker to believe that such realism is possible.

Typical remarks from music critics writing in world famous publications such as the Gramaphone are, "approaching the ideal everyone is seeking . . . perfection!"

In Vogue magazine there appears an illustration of Lord Snowdon's "workshop" together with an article on the things he treasures most in his own home. In the article he comments about these things such as old Victorian mugs and objects, a jump clock, "which I re-housed in a big brass casing allowing the pendulum to be exposed", a Japanese paper flower and the B & W new electrostatic speakers "which probably give the finest sound there is", . . .

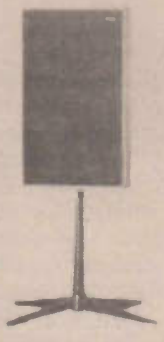
The Model 70 illustrated here is one of the pair illustrated in Vogue and it has resulted in world wide acclaim for this new Speaker design concept. As well as White, it is available in Teak or Walnut finish and it blends in with almost any furnishing. The size of this speaker for such performance is relatively small. The box itself without stand is only 25" wide, 20" high and 15" deep.



A speaker is born! This is the prototype for the Model 70 Electrostatic undergoing tests in John Bower's Anechoic Chamber.

For those who find the model 70 electrostatic monitor speaker a little beyond their budget, the just released model DM2, entirely new Monitor loud speakers from John Bowers, fills a very important place in Hi-Fi reproduction.

This speaker has been several years in its development and it has much of the sound of the B & W 70 electrostatics. The bass response is obtained in a very small box by a rear loading of the bass unit (Patt. APP.) by means of a B & W developed eighth wave acoustic line that also reduces harmonic and dopler distortion compared to the conventional loading. A wide dispersion dome type high-frequency unit carries the frequency response to 30 Hkz with Butterworth third order high and low bass filters in the crossover network. The third speaker is a 1½" lower range tweeter which helps to produce the extremely smooth and level response plot on B & K test equipment.



The B & W DM2 on stand. Monitor speaker realism at a moderate price. $498 pair.

Response plots are supplied with every B & W speaker so that you know the actual performance of the speaker in the test chamber before it leaves the factory.

For those people who are sincere in their High Fidelity listening and require a speaker to give them reproduction that is very close to the original sound with the acoustics of the original recording chamber, then B & W is the speaker that they must have. John Bowers in his demonstrations at Audio Shows throughout Europe has amazed audiences by inviting them to clap with the recorded clapping at the end of the performance. It has been most noticeable that the clap from the audience and the clapping from the speaker blends perfectly — true realism. He then invites the audience to clap with the same applause at the end of his test record with any other speaker in the Audio Fair and the difference is quite conclusive. There is a wide degree of colouration in almost all speaker systems except the B & W Monitor type. To people who have an untrained ear, and used to "tinkle-tinkle-boom-boom", B & W speakers may at first seem a little basic, but so would a live performance. The "real thing" in music does not have the rose tinted colouration that is mistaken for High-Fidelity sound by many people.

You owe to yourself to seek out your nearest B & W stockist who will arrange a demonstration of these fine B & W speakers. I have never enjoyed introducing a product more than I have with the B & W range of Monitor speakers. I am only sorry that there have been so many occasions that we have been out of stock. To those who have been disappointed, I now say and hope we will be able to supply you with your full requirements. Please write for further information

Yours sincerely,

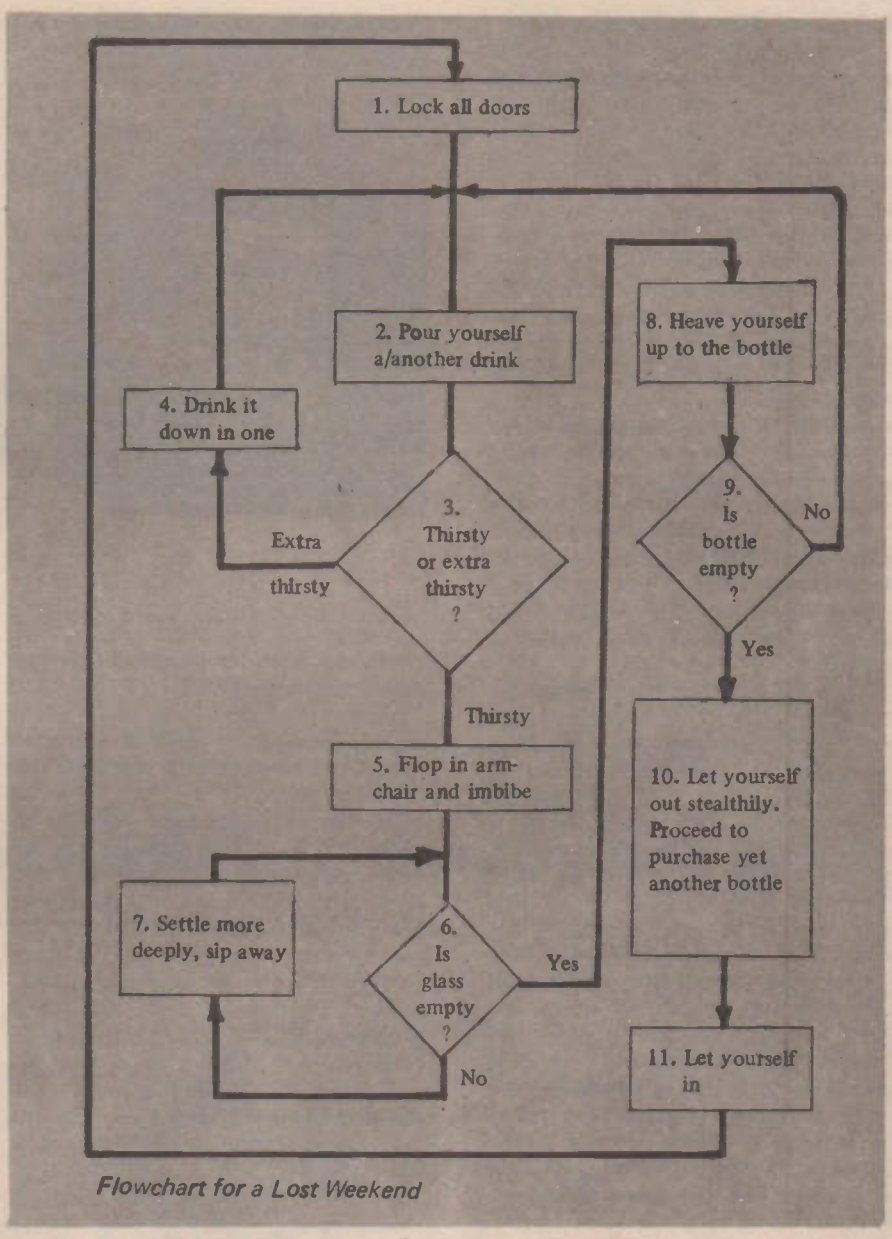
Malcolm Goldfinch

Malcolm Goldfinch,
Managing Director,
Convoy International Pty. Ltd.

manual procedures for stock control, ordering and despatching had fundamental deficiencies which resulted in frequent and inevitable bottle-necks and which computerization could not have taken care of. On the contrary, the computerization (expectably, in hindsight) emphasised these administrative and procedural faults, for the simple reason that the programmers and data-processing experts (who knew nothing about the firm's commercial or engineering peculiarities) took their information from the day-to-day practices adopted in the company when they arrived on the scene. Once certain simple (and, as it proved, very effective) administrative and managerial 'base-rock' practices were introduced, bottlenecks vanished and, with it, the need for a computer.

The American company's real difficulty was that the computerized inventory control system was designed by data processing experts — to whom the computer was the centre-piece on which to hang an inventory control system. They did not appreciate vital commercial aspects of inventory control such as EOQ (Economic Order Quantity) or ELS (Economic Lot Size). By including fixed-elements in the cost of ordering inventories — instead of using just the variable factors — they created an unnecessary wasteful excess of 20% or so in the overall inventory levels; far too much was being ordered and stocked. And, in their textbook approach to data processing, they did not allow for the familiar Pareto law that 80% of value is often accounted for by 20% of the items.

By putting every one of the company's 12,000 and odd inventory items subject to computerized procedures, preparing the input to the monster involved far too much time and effort and cost. Just as much work was involved for a three-cent nut and bolt as for a $5,000 item, and the scheduling of high-value items was literally lost in the mass of low-value item information.



Flowchart for a Lost Weekend

SCEPTICISM

The 'Management' columnist in a national (UK) newspaper reports that, according to reliable management consultants, only one in five of computer installations is earning its keep.

It is fast becoming accepted practice for board chairmen to insist "Yes, we think our £50 million in computerizing was well spent" — and the scepticism with which such remarks are greeted in the profession also grows as tales of woe from users of EDP seem never ending.

The real truth, if one digs into some cases, is that things are bad when the computer is installed (not surprising since, in the views of many managements ill-informed in computer applications, the computer was looked upon as the panacea to end all ills) and, when the computer is installed, things really get worse and the promised panacea recedes further and farther away.

When a computer expert like Brian Rothery writes a book called 'The Myth of the Computer' and (as journalists say) "reveals all", the time seems ripe for a second look at the situation by a by-stander not involved in selling or buying business computers.

SOME LESSONS

Some lessons have been painfully learned in the last decade, of misguided over-selling by computer salesmen, and equally misinformed acquiescence by ill-prepared managements.

Centralisation of corporate activities, especially in the accounting and similar data recording and retrieval sectors, does not always pay. For an

organisation with subsidiary centres of activity scattered miles apart, centralisation of record-keeping at the head-office makes it virtually impossible for the centres' chief executives to assess, rapidly and continually, the profitability of their day-to-day operations and short-term plans. The records are elsewhere, and, by the time they are collected, collated, processed and fed back to the centre in a form useful to the centre-manager, it is too late to do anything about falling profit curves or drain of cash-flow.

The imminent collapse of a famous ship-yard (in UK) was evident to its operational managers six months before head-office tumbled to the inevitable conclusion that they had to cease operations, yet it took six months for the centralized accounting system to digest the inputs from various sources and spell out the result.

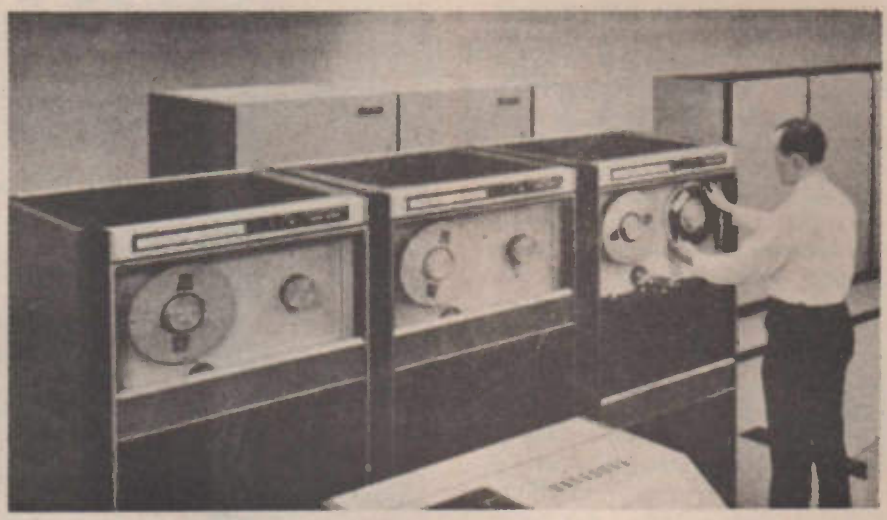
Before mechanisation is installed, be it simple-manual or computerized, the system of handling the work-load should first be examined thoroughly and the procedures clearly delineated.

How much of a manager's or even a clerk's operation is based on intuition matured through experience or sheer man-made common-sense is perhaps not realised. Machines are fundamentally incapable of anything but systematic work and cannot cope with such aspects of the operation. Hence the frequent tales of computerized accounting sending household electricity or telephone bills for amounts astronomic even for a medium-sized business concern. In the old days of manual billing, a clerk would have spotted this discrepancy and queried it before it went farther into the system.

Computer consultants privately concede that most companies would find that, if they merely get their existing methods and systems better organized and made efficient before putting it all on computer, they would find that they could cancel the order for a computer – and be better off.

And the few who really still need a computer will be better advised to get their objectives clear, viz., what information, and to what detail, they want computerization to provide. One management expert asserts that few computers provide real information – and almost all provide just a mass of meaningless and unusable data.

As Brian Rothery indicates in his book, the result is that the only real benefit from the computer is payment of dividends to its manufacturers and programming bureaux.



Identification and clear understanding of what is expected from computerization is not easy, but it is necessary.

The same computer cannot be expected to process information for day-to-day operational activities, and simultaneously act as a source of vital decision-making information for the management; the former involves systematic work, the latter operational research techniques with their own problems of modelling and forecasting. Handling of input data by the computer, its programming and problem-solving approaches for the two requirements are simply poles apart.

In surveying just what various managements were trying to achieve from computerization and how far they have succeeded, it is clear that working out wages for staff or providing information for management decision-making can often by done by cheaper and prompter means than with a computer; the sort of activities most suitable for a computer are the tedious repetitive tasks like sales statistics, stock control, order processing and mathematical calculations for scientific and research work.

In addition to pre-defining what work output is wanted from the computer, managements should also ask "Why?"

Is it to save staff, reduce time lag between input and output of data, reduce errors or expand the scope of data coverage?

This is probably the sort of area where insufficeint analysis and inexact costing of existing methods and systems make it impossible to assess the saving which would result from computerization.

An international airline's experience carries another lesson, viz., never get a computer or EDP specialist to install the system for you. He may be an expert in information processing by electronic machines but he must be made to report to a manager who knows the business in which the company is engaged in, understands what the company's commercial objectives are and can direct EDP activities to the overall interests of the company.

By applying to the computer staff the same controls of operational justification that any other productive worker in the company is subject to – and fighting to enforce it against the tide of pseudo-technical jargon sure to be bandied about – managements can be more certain that, sooner or later, the computer staff will see themselves as managers serving to further the company's interests – rather than EDP experts furthering computer technology – or themselves.

Lastly, once the system is installed, it should be monitored frequently. Business conditions change – and, with it, the real results to be achieved by the computer. Many systems which have started off with a specific job to do, have continued doing it when it is no longer an immediate need – merely because managers did not apply capability criteria to continually update job requirements. ●

MATCHING COMPATIBLE STEREO... THANKS TO WHARFEDALE

True. You can get yourself into a lot of strife if you buy stereo components from seven different manufacturers and an equal number of hi-fi dealers. And matching stereo equipment is a job for an audio expert.

To save you the trouble (*and the unnecessary expense*) Wharfedale's engineers have designed an electronically balanced range of fully compatible stereo equipment. With Wharfedale's experience and *"know-how"* how can you go wrong? After all, Wharfedale have been marketing high fidelity equipment for a longer time than any other *recognised* manufacturer! For over forty years!

In the new Wharfedale range you will find:—

- **THE LINTON STEREO AMPLIFIER**
- **THE LINTON TURNTABLE**
- **THE DC9 CASSETTE RECORDER**
- **MODEL DD-1 STEREO HEADPHONES**
- **YOUR CHOICE OF NO LESS THAN EIGHT HIGH QUALITY SPEAKER SYSTEMS RANGING FROM 20 TO 40 WATTS DIN RATING.**

See and hear the Wharfedale range at your nearest Bleakley Gray franchised dealer. *Listen carefully and critically.* You can depend on Wharfedale quality *absolutely*.

Bleakley Gray Corporation Pty. Limited.

Australian National Distributors:

INTERSTATE REPRESENTATIVES:
N.T.: Pfitzner's Music House, Smith Street, Darwin. Tel. 3801.
Tas.: K. W. McCulloch Pty. Ltd., 57 George Street, Launceston. Tel. 2 5322.

Head Office: 28 Elizabeth St., Melbourne, Vic. Tel. 63 8101*. Telex: 31904
Sydney Office: 177 Salisbury Rd., Camperdown, N.S.W. Tel. 519 5555*
Canberra Office: 25 Molonglo Mall, Fyshwick, A.C.T. Tel. 95 2144*
Adelaide Office: 301 South Terrace, Adelaide, S.A. Tel. 23 6219
Brisbane Office: 3 Prospect St., Bowen Hills, Qld. Tel. 52 7333
Perth Office: 27 Oxford St., Leederville, W.A. Tel. 81 4988

BG—WFR—1272

Featuring the Broadway .201 SEAS speaker systems, the Rota amplifier [illegible] watts RMS per channel), the high quality Garrard Player with magnetic cartridge, base and cover, and you have unbeatable value at the list price of $313.00; let alone at the special Instrol price of ..... $229.00.

Complete Hi-Fi Catalogue.....50c

Please send me your complete full-colour hi-fi catalogue and price list containing full details of hi-fi systems and separate hi-fi components. I enclose herewith postage stamps or money order to the value of 50 cents. I understand that the 50 cents will be refunded on my first purchase.

NAME: .....

ADDRESS: .....

..... Postcode: .....

INSTROL HI-FI

Featuring the Rotel 310 amplifier (15 watts RMS per channel), the now famous Magnavox 8-30 Speaker Systems, the Garrard SP-25 Player, base and cover, and the smooth response of the ADC magnetic cartridge. This is value plus at ..... $299.00.

INSTROL FOR QUALITY SOU HO

Instrol System 229

Instrol System 229

J.B.L
System
799

This system features JBL Lancer 77 speakers at $299.00 ea. and a LUX 708 professional 50 watt amplifier at $228.00, thus totalling $826.00. Instrol now have reduced this to $799.00 including FREE OF CHARGE the JH belt-drive turntable, featuring the Sansui tone-arm ADC 220XE, acoustically sprung base and hinged cover. Special System Offer ..... $799.00.

YOUR HI-FI
ME
ND SYSTEMS

SPECIAL BONUS OFFER!

These systems will be sent FREIGHT FREE by passenger rail to any city or town in N.S.W., Victoria, Queensland or South Australia.

DOUBLE WARRANTY

Every system is not only covered by the manufacturers warranty but also by Instrol's own full guarantee.

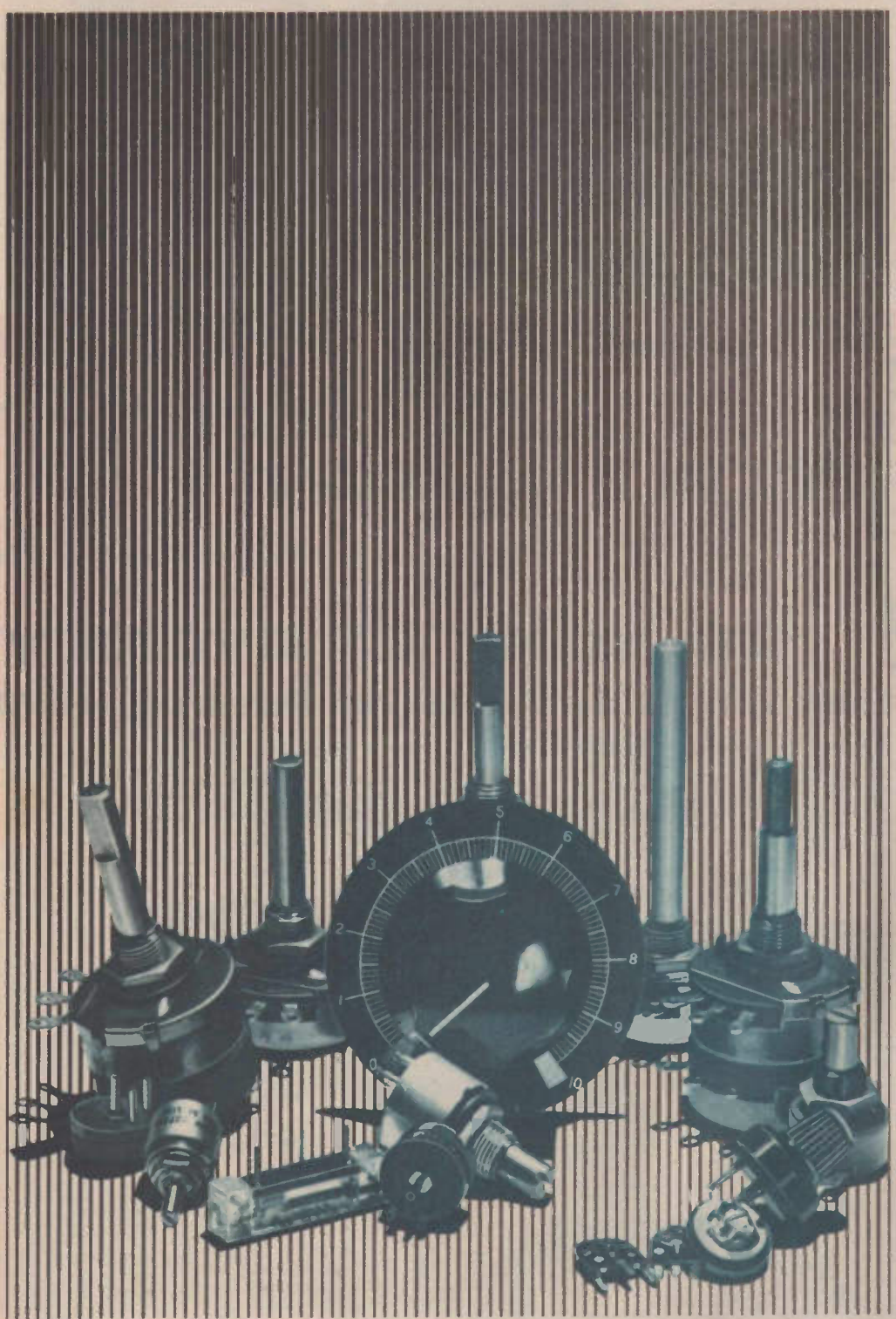
91a YORK ST. SYDNEY

(between King & Market Sts.) 29 4258

Never before have the omnidirectional Sonab V1 speakers been available in a quality system at such an attractive price. They are backed by a 5 year warranty and come in the largest range of colours of any speakers in the world. The Rotel 310 amplifier, JH belt-drive turntable combination and ADC magnetic cartridge complete this system. All for only ... $419.00.

Sonab
System
419

PLESSEY PROFESSIONAL CONTROLS



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

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

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

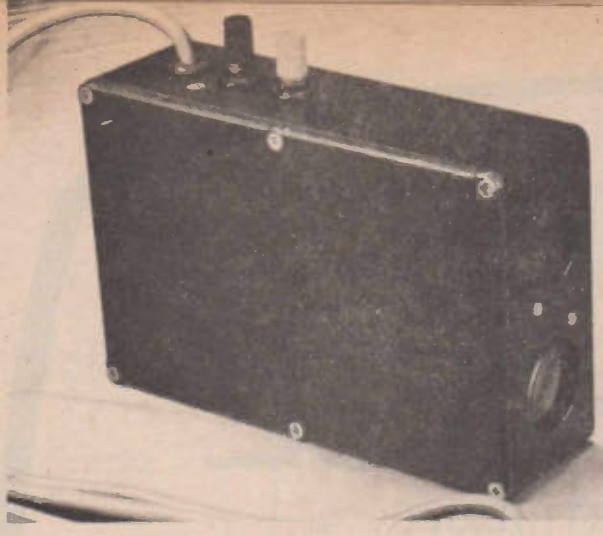
Plessey potentiometer tracks consist of a phenolic moulding loaded with carefully controlled proportions of conducting carbon filler providing superior power dissipation and temperature coefficient characteristics compared to carbon film types.

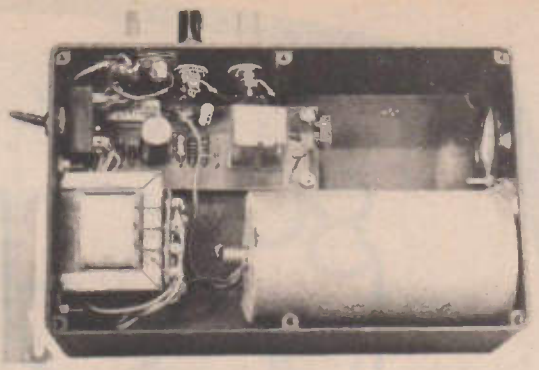
A standardised range is available ex stock. Literature is available on request to the Professional Components Division.

PLESSEY
Ducon

Plessey Ducon Pty. Limited
Box 2, Villawood, N.S.W. 2163
Telephone 720133. Telex 20384
Henderson (N.Z.) 64 189

AD53





DOOR MONITOR

Build this simple unit to monitor entrance ways — or build it just for fun. Either way it is a good beginner's project.

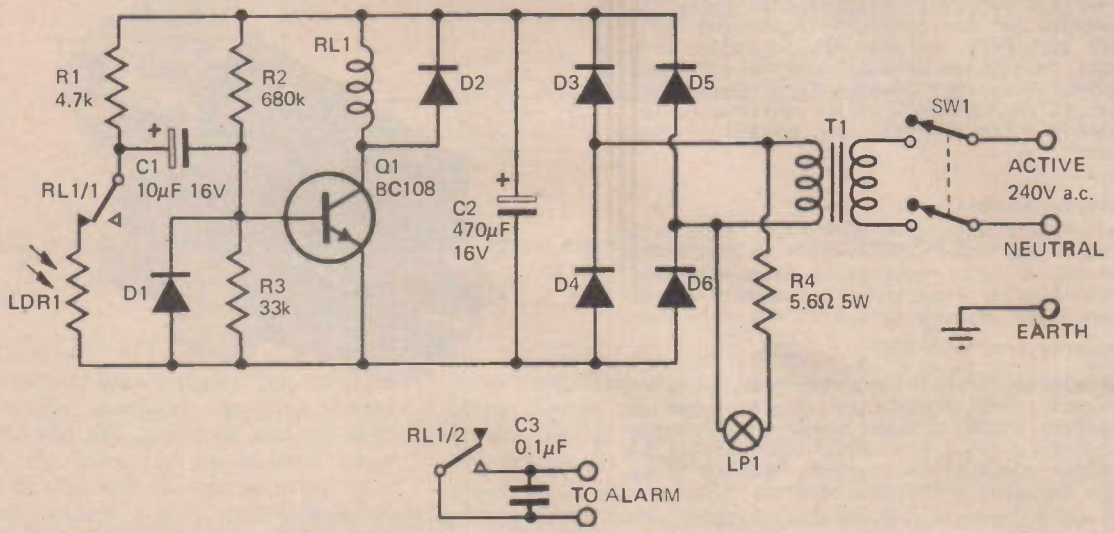


Fig. 1. Circuit diagram of complete unit.

UNITS such as this are used by shop keepers to draw attention to a customer requiring service. They do so by ringing an alarm bell or buzzer when a light beam across the shop entrance is broken.

One disadvantage of most single transistor units is that the alarm continues to sound while ever the beam is broken.

Our unit maintains the simple single — transistor operation whilst limiting the alarm duration to half a second.

Many other applications are possible such as non-contact object counting, liquid-level control, or by using ambient light sensing only, day/night switching.

It must be stressed however that the unit is not intended for use as a burglar alarm. Light beam units are too easily fooled to be of use in such applications.

Reliable operation will be obtained over 10 to 15 feet when using a

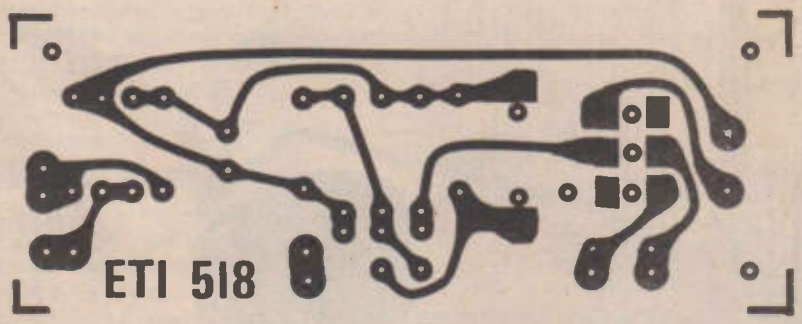


Fig. 2. Foil pattern of printed circuit board (full size).

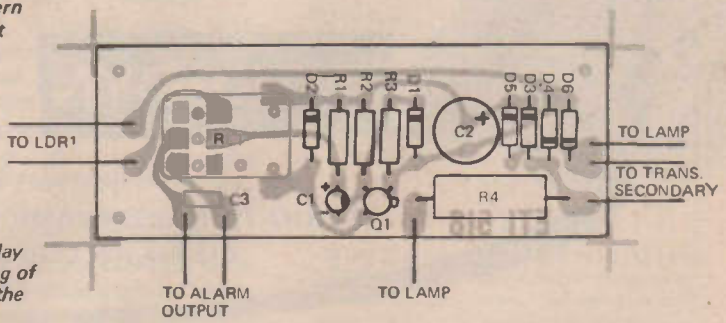


Fig. 3. This overlay shows positioning of components on the board.

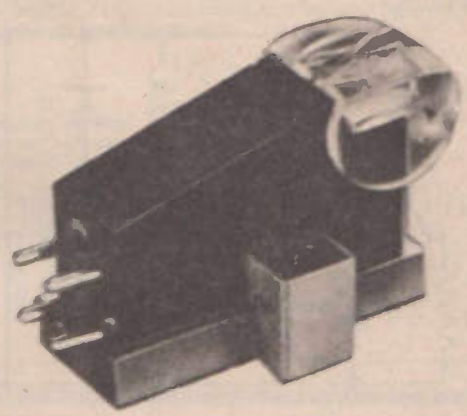
for superb 4 channel reproduction

go for GRACE

F8 SERIES CARTRIDGES

●STEREO ELLIPTICAL ●MATRIX 4 CHANNEL ● 4 CHANNEL DISCRETE

After producing superb cartridges for 20 years, Grace, in conjunction with N.H.K. (Government Sponsored Broadcasting Institute of Japan) continued its search for an even better cartridge. From this collaboration came the Grace F8L, and then the Broadcast Standard Sigma 709 was developed for the commercial broadcasting field. From the Sigma 709, and especially for critical hi-fi enthusiasts, the F8C was developed, and now comes the F8F Shibata 4 channel. "Canadian Stereo Guide" said about Grace: "all in all, the Grace is a very fine cartridge and deserves a place among the handful of top performers".

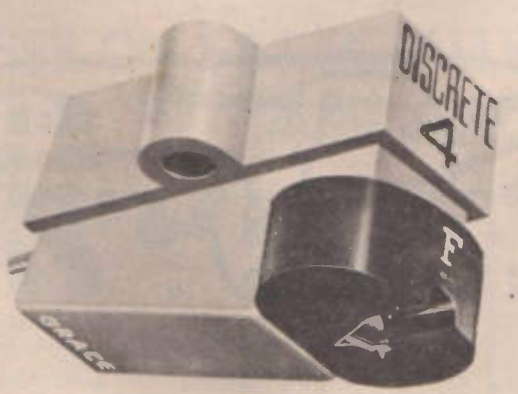


The Grace range includes:

F8C Used with a lightweight high quality low inertia tonearm (e.g. Grace G840F) the F8C gives a new dimension in stereo reproduction. Employs the well-proven Luminal Trace stylus, and tapered magnets ensure a flat response throughout the entire scale.
Frequency range 15-25,000Hz $^{+\ 2.5dB}_{-\ 1dB}$

F8L Flat response, distortion free performance, lifelike and impressive tonal reproduction, ideally suited to laboratory testing of audio equipment or records. Excellent separation even above 10,000Hz gives this cartridge stabilized performance. Luminal Trace stylus, frequency 20-20,000Hz ±2dB

Note: The new 4 channel stylii can be used in existing Grace cartridges.



F8F MATRICAL FLUX CARTRIDGE FOR 4 CHANNEL

Specially developed for reproducing Discrete 4-channel records, the F8F is a wide range cartridge with its own specially developed Shibata stylus. Through the special use of lightweight materials, the cantilever has been reduced in mass to about half that of other cartridges, for improved frequency response, and reduced mechanical impedance, resulting in high compliance. Net result: considerably reduced wear on both stylus and records. Frequency range 10-50kHz. Also available as F8E with elliptical stylus in place of the Shibata, for Matric 4-channel records, and regular 2-channel records. Frequency range 10-50kHz. For best results, use the F8F and F8E cartridges with the Grace G707 Quadmaster arm.

Look for Grace cartridges and tonearms at:

N.S.W.	M. & G. Hoskins Pty. Ltd. 37 Castle St., Blakehurst 2221.
Q'LD.	Stereo Supplies, 100 Turbot St., Brisbane 4000.
S.A.	Challenge Hi-Fi Stereo, 6 Gays Arcade, Adelaide 5000.
TAS.	Audio Services, 72 Wilson St., Burnie 7320.
VIC.	Encel Electronics Pty. Ltd. 431 Bridge Rd., Richmond 3121.
W.A.	Albert TV & Hi-Fi, 282 Hay St., Perth 6000.

INTERDYN

Sole Australian distributors:

INTERNATIONAL DYNAMICS (AGENCIES) PTY. LTD.

P.O. Box 205, Cheltenham, Vic. 3192.

mirror, or from 20 to 30 feet between lens and sensing unit.

The layout of the unit may be varied, quite readily, to suit individual requirements (and the focal length of the lenses used). The unit described here has both the transmitter (globe) and the receiver (LDR) in the same box and uses a mirror to return the beam. However it may be built into two separate units if required.

Almost any converging lens would do, however in a unit of practical physical size there are limits to the diameter and focal length which can be used. We recommend a lens of from 1 to 1½" diameter having a focal length of between 2" and 4". Suitable lenses are sold as magnifying glasses by most optical suppliers and are available from about 50c each. Even cheap plastic lenses as sold by chain stores will do at a pinch.

If the LDR and the globe are in the same box the globe must be shielded to prevent unwanted light falling on the LDR. We used a length of cardboard tube to provide both shielding and support for the globe. (see photograph) The length of the tube should be such that the beam projected is approximately parallel. That is, the tube should be as long as the focal length of the lens.

Assemble components on the printed circuit board as shown in Fig. 3. Make sure that the orientation of the transistor and the polarities of the diodes and capacitors are correct. In our prototype the LDR was mounted on two stiff pieces of copper wire inserted into the printed circuit board. This allows the LDR position to be adjusted for best beam alignment and focus. However differing layouts may require some support for the LDR, or, it may need to be connected by flying leads.

PARTS LIST ETI 518

R1 Resistor 4.7k ohm ½W 5%
R2 " 680k ohm " "
R3 " 33k ohm " "
R4 " 5.6 ohm 5W 5%
C1 Capacitor 10μF 16V Tantalum
C2 " 470μF 16V Electrolytic (PC mounting)
C3 Capacitor 0.1μF 100V Polyester
D1-D2 Diodes 1N914 or similar
D3-D6 " EM401 or similar
Q1 Transistor BC108
RL1 Relay 180 ohm. 2 C/O contacts, miniature type VP2
T1 Transformer A&R type 5579 6.3V 600 mA (or similar)
LDR1 Light Dependent Resistor ORP12 or Philips 2322 600 95001.
SW1 2 Pole 240V power switch MSP type 625 or similar.
LP1 Globe 5.5V to 6.5V at 300mA to 500mA.
Metal Box 4½" x 7¼" x 2" (Die cast)
2 Lenses 1¼" Diameter, Focal length between 2" and 4"
2 Terminals for alarm output
3 core flex and plug
PC Board ETI 518.

Using the Unit

Fit the main unit to one door jam about three feet above floor level, and ensure that it is approximately level. Switch on the unit and note where the light beam falls on the opposite door-jam (a piece of white paper may help to find the beam). Locate a mirror in this spot and adjust the plane of the mirror so that the light beam is returned to the receiving lens.

Take the cover off the unit and position the detector (LDR) for best alignment and for best focus. Note, however, that a position slightly away from focus is better if this provides illumination of the entire LDR surface. The alarm contacts may be used in conjunction with a separate supply and alarm, or may use the supply from transformer T1 providing not more than half an amp is required.

The unit is now ready for operation and apart from its door-minding utility, will provide much fun for children — young or old.

HOW IT WORKS

The sensing element is a light-dependent resistor (LDR) which has a resistance of less than 1k ohm when the beam of light is falling on it. When this beam is interrupted the resistance goes up to more than 10k ohm, the maximum resistance depending on the ambient light level.

Referring to the circuit diagram, Fig. 1, transistor Q1 is biased such that its base-emitter voltage is about 0.3 volt. This is not enough to turn the transistor on, and hence the relay is not energised. With the LDR illuminated, the positive end of C1 is at about two volts. When the beam is broken this voltage will rise rapidly and the resultant change is transferred, by C1, to the base of Q1 turning it on and energising the relay. Contacts of RL1 disconnect the LDR and hence the relay latches on for a time determined by the charging of C1 via R1. The value of C1 has been chosen to provide a half-second alarm-contact closure.

When the relay drops out the LDR is reconnected and the circuit resets itself. If the beam is still broken, the LDR resistance will be high, C1 cannot discharge and the relay will remain open until the beam is remade and broken again.

The power supply is a conventional full wave bridge rectifier and capacitive filter which supplies a nominal 9 volt dc from the 7 volt ac output of the transformer. A resistor in series with the globe, reduces the lamp supply to about 4.5 volts, which increases lamp life considerably, without reducing the light output to any great extent.

Protecting reed relays

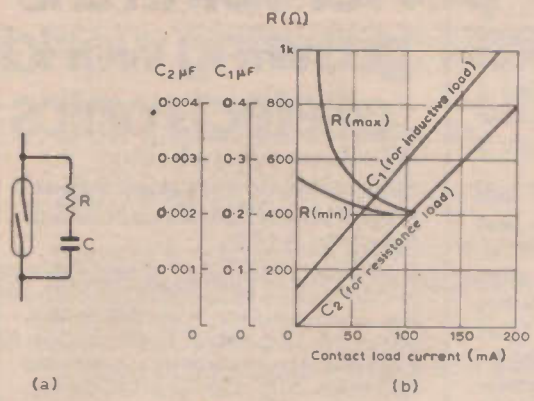


FIG. 1

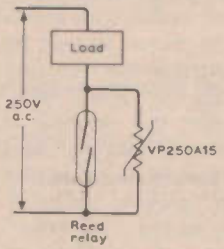


FIG 2

Protecting reed switch contacts using an RC network or a varistor

(Extracted from notes published by Elliot Relays)

SEALED contact reed relays provide the designer with a versatile means of interrupting current flow. They are inherently reliable and can be actuated in a wide variety of ways. In common with all contact switches, however, life can be substantially reduced unless action is taken to protect the contacts from excessive current or voltage surges.

Experience has shown that contact failure is often due to transient overloads of which the designer may be unaware. It is good engineering practice to connect a series CR network across the contacts to prolong contact life as shown in Figure 1 (a). Such a network will protect the contacts against damage which may otherwise occur when the current through resistive or inductive loads is interrupted. Figure 1 (b) gives the values of both C and R for various currents and loads.

The low cold resistance of incandescent lamps and the low initial impedance of capacitive loads cause very high currents to flow when the controlling relay contacts close. To protect the contacts under these conditions a limiter should be connected in series with the load; i.e., thermistor or choke.

Another way of protecting mains-switching contacts against transients, and preventing the transients reaching other equipment via the mains wiring, is to use a varistor. A varistor normally has a very high impedance. When the voltage across it reaches a certain critical value it reverts to a low impedance condition thereby effectively suppressing voltage transients. A suitable circuit is given in Figure 2.

DICK SMITH & STAFF — SUPER VALUES

CIRCUIT BOARDS — pre-tinned

The "Rolls Royce" of circuit boards are now available from Dick Smith — give your equipment that professional look — all boards are heavy duty and most are fully pre-tinned to prevent oxidation marks and to make soldering easier.

72/ G7	Guitar Amp.	1.50
72/ SA9	Amplifier	1.50
72/ S10	Scaler	1.60
72/ 10	IC Probe	.95
72/ S11	4 Channel Converter	1.50
72/ SA10	Playmaster 136	1.90
ET025	Super Stereo	1.90
ET026	Tape Slide Sync.	1.50
ET029	Tuner	1.45
	IC Power Supply	2.50
ET033	Int. audio system	2.60
ET034	Int. audio system	2.60
ET111	Power Supply	1.50
ET1413	100W AMP	2.20

TANGENT KITSETS

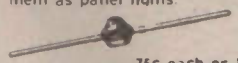
2 Transistor Radio kit. A most popular kit at a most reasonable price — requires no aerial, complete with "easy to build" instructions — all you require is a soldering iron. Ours took only 30 mins to build. Pre-wound aerial coil and crystal earpiece supplied or can be used with any small amplifier (such as below) to operate a speaker — $5.70 plus battery 53c.

A 4.5 watt RMS (6 watts peak) amplifier, features excellent fidelity and extremely low distortion (less than .5% at 1 watt), easy to build. Supplied complete with comprehensive instructions. Suggested uses are—
(1) Stereo amp
(2) Baby alarm
(3) Amp for 2 tran. radio
(4) Intercom
(5) Thing-a-me-bob.
Requires approx. 12 to 18 volts DC.
AMP KIT — $8.70 incl. P.&P.
Fully built & tested: $9.50.

Power supply for above — pre-built, will operate two of above amplifiers or useful for many other things, 240v to 13.8 volt D.C. at 1 amp — $9.00
CALL IN AND SEE THESE UNITS OPERATING.

LIGHT EMITTING DIODE

Miniature M50 Red — the same price as miniature filament bulbs — at this price wire them into logic circuits as status indicators, build low cost counters or use them as panel lights.



75c each or 10 for $6.50

CM70 DM401. A top quality microphone with attractive looks and rugged design. Supplied complete with stand, mounting adaptor and inbuilt "on-off" switch. Dimensions 6" long by 1½" diameter.

CM70 Crystal	$5.80
DM401 Dynamic	$8.00
P P	.50

GO SOLID STATE

VHF POWER TRANSISTORS 30 watts at 12.6 volts — **FANTASTIC OFFER TO AMATEURS — $9.85.**
These transistors manufactured by "Solid State Scientific" are exactly as currently being used by Australia's largest VHF mobile radio manufacturers. They are virtually indestructible (they withstand severe V.S.W.R.) and are guaranteed to give in excess of 30 watts at 144 mcs on 12.6 volts (more at 13.8 volts!) Supplied complete with data sheet, test, circuit and layout diagram.

FEATURES:
- Withstand severe V.S.W.R.
- Low inductance stripline package.
- All leads electrically isolated from stud.
- Greater than 4.4 db power gain

TYPE 2N 5591-$9.85 plus 50c p&p.

DRIVER TRANSISTORS AVAILABLE.
Complete with data sheet and suggested circuit and layout diagram.
2N 5590 (15 watts) $7.75
2N 5589 (7 watts) $6.50 p&p 50c
The complete set of three transistors are available as a special package offer for $22.50 plus p&p 50c.
Data sheets available separately 10c plus 20c p&p.

144 MC'S P.C. BOARD SPECIAL
Now available — tinned fibre glass boards with full layout details and instructions to make each output stage (7, 15 or 30 watts).
Prices for each board are $1.50 each or supplied as complete 300 MW (IN) to 30 watt (OUT) board for $4.20. P/P 20c.

BASE & COVER

Uncut plinth finished in high quality hand rubbed teak will take almost any turntable. Supplied complete with clear perspex cover.

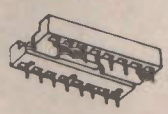
Tremendous value at $16.50
P P $1.00

I.C. SOCKETS

Protect your valuable IC's by not soldering them into circuit — plug them in! High quality McMurdo

14 pin D.I.L. Sockets	80c
16 pin D.I.L. Sockets	90c
8 pin gold plated round socket	$1.30

Inc. P P.



PARTS FOR RECENT PROJECTS

Signetics 555 TIMER I.C.	$2.35
SIGNETICS NE 561B Phase lock Loop I.C.	$9.56

P & P 20c.

SUPER KITS

Dick Smith "Super Kits" are very special as they have been selected by him for "V.I.P." treatment. At least one of each Kit has been built by Dick Smith or his staff and is on display at the electronics centre. Other features are:

1. Expensive pre-tinned "silver" boards.
2. Full copies of constructional articles included.
3. Any changes in circuits, addendums etc are included — saves checking following issues.
4. Most kits contain "extras" at no cost. These extras have been added where Dick Smith thinks they may be more reliable or where he feels the constructor may have difficulty in purchasing them.

DIGITAL LOGIC TRAINER. E.A. MARCH '73
The complete kit including metalwork, patch leads, front panel and construction details to build this logic trainer
$82.00. P P 50c.
All separate parts are available — write for our quote.

100 Watt AMP (E.T. DEC. '72)
The complete kit to build this enormously powerful quality amp. Extras include deluxe pre-tinned circuit board, silicon grease, a can of heat absorbing spray paint and full construction details. New Low price $65.00 p&p $1.00.

SEPARATE PARTS FOR ABOVE KIT:

Metalwork including pre-drilled heat sinks	$14.50 P&P 50c
PF 3577 transformer	$10.60 P&P $1.50
ET.1413 circuit board	$2.20

STEREO 24 ADAPTOR (E.A. Nov. '72)
We have recently built this inexpensive unit and find it quite amazing (call in and have a listen if you can). Complete kit including special board and instructions $5.75 P&P 50c.

PLAYMASTER 136 AMP (E.A. DEC '72)
Good value for money with special transistor offer from Fairchild. Complete kit (less "special offer" transistors) including attractive front panel, pre-tinned boards and silicon grease for transistor mounting. 26 watts RMS

Output	$55.60 P&P $1.00
Metalwork only	$8.00 P&P 50c
Panel only	$2.50
Board 72 SA10	$1.90
BC108B	55c
BC109C	55c

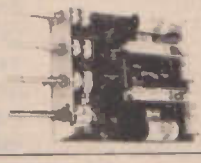
Call in and see these completed "Super kits" and always remember if Dick Smith can build it — ANYONE CAN!!

PLESSEY 3 & 3 AMPLIFIER KIT

Thoroughly recommended, this high quality stereo amplifier utilises the well known Plessey SL.403D IC's. It is supplied complete in an attractive display pack and includes all components other than the power transformer. The instructions supplied are very explicit, in fact, a person who can solder but has had no previous electronic experience could easily build this amp. Our staff member, Ian Smith (age 16) built his in less than two hours. The complete unit is now operating in our Sound Room for all to see and listen to.
Also included are full details of a suitable speaker enclosure, a silk screened board, and all controls. The cost of the separate parts are a lot more than the total kit price —

Plessey AT 102 amp	$27.50 $1.00 p&p
Transformer to suit	$6.66 .75 p&p.

BSR fully automatic
G11-105 Turntable (ceramic cartridge)
$29.64 $1.50 p&p.



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WE ONLY STOCK BRAND NEW COMPONENTS. WE DO NOT STOCK OR SELL SECOND HAND PARTS, COMPUTER BOARDS, DISPOSALS EQUIPMENT, ETC.
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POLLUTION-

its measuremen

This, the twelfth article in Dr. Sydenham's series on transducers in measurement in control, discusses pollution in its many aspects.

HARDLY a day passes without some mention of pollution, either in conversation or in the news media. Although much continues to be written on the harm being wrought on the Earth's ecological systems, its human inhabitants and to its resources, very little is ever said about the measurement problem itself.

Before pollution can be controlled, it must be detected, and that implies the need to measure. Some forms of pollution are obvious – litter that will not degenerate fast enough, thick smog, oil slicks, but many forms of pollution are insidious, going undetected until it is too late to take corrective action.

It is not the purpose here to further add to the literature on the problems resulting from pollution, but to provide a brief survey of some of the instruments used in the two main areas – the contamination of air and water.

CLASSES OF POLLUTION

Although we will not be covering all classes of pollution it is appropriate to mention them to put the discussion in perspective. One classification proposed uses five headings – air, water, land, noise and radioactivity. The first two are our main concern but as the last is also an important area of objective measurement it will be included.

Another way to regard the problems is by identifying the nuisance at source. Pollution is not a study of all contaminants but more of those of known annoyance to humans. In this way pollution divides into chemical impurities (lead, cadmium, oil, organochloride compounds, mercury, cyanide, sulphur and nitrogen compounds and hydrocarbons), biological waste and growth (sewage disposal and population excesses), radiation and ecological imbalance (wasteland deserts, loss of the natural insect and animal population control, disappearance of vital species) and noise (acoustic noise produced by transport machines, industrial processes). There are others of a more

t and control

subjective nature – litter, loss of clear view and the existence of unsightly buildings, but the task of measuring these is most difficult for it is hard to define and qualify standards of allowable nuisance level.

AWARENESS OF POLLUTION

The settling and subsequent growth of cities began many thousands of years ago and this process naturally concentrated the elements of pollution. Fires, human waste and rubbish are concentrated geographically, and unless controls exist, the freely available air and fresh water soon become spoilt.

The Romans recorded their displeasure of the air of Ancient Rome. In 1273 the British instituted a not very successful smoke reduction programme: the penalties were harsh, however, for it seems a man was hanged for burning soft coal. London has been regarded the worst example of city filth for centuries. In Hogarth's time, 18th century London was much like his etching "Gin Lane" (shown in Fig. 1). In the 19th century Parliament often rose prematurely to escape the stench of the River Thames. But now London is one of the cleanest cities and has shown what can be done to eliminate pollution.

Plagues were common throughout Europe, annihilating as many as 65% of the European population in early times. There is little doubt that this was the result of throwing all refuse and sewage into the street. Tudor houses had the outward projecting upper storeys to assist this practice!

It was not until the 20th century that a real awareness of pollution appeared. In Australia a Smoke Abatement Act was introduced in 1902. An Alkali Act was introduced in Britain in 1906. But to have Acts and to use them are different things, and it was not until the 1950's that improvement became evident. The British legislated a Clean Air Act in 1956; Australia's was instituted in the 60's.

Motor vehicles have added to the problem enormously, providing air-borne carbon monoxide, solid

"Gin Lane" – a famous etching by William Hogarth shows the highly polluted nature of life in London in the late 18th Century.

hydrocarbons and lead in great quantities. In 1972 Australians consumed 7 x 10^6 tons of fuel. Estimates for 1970 show that some 5 x 10^6 tons of carbon monoxide were liberated along with 0.5 x 10^6 tons of hydrocarbons. In the United States, (see Fig. 2), and Japan, the problem is even greater. The new, seemingly unrealistic, Congress Act to reduce vehicle emission is forcing design changes at the source of pollution. In this way the user pays the penalty – it is not passed on to others.

It has recently been estimated by the Scientific Instrument Research Association (SIRA) that there will be an expansion of the market for pollution monitoring systems and devices from a current $600m to $3,000m in 1980. There certainly is room for improvement; for instance, few instruments exist that are within the price range of small companies and the domestic home. At present the accurate detection of most serious pollutants requires the use of a number of different, highly expensive instruments.

POLLUTION OF AIR

Let us now consider the contaminants of air and water. It will then be possible to study some of the transducers in use.

Air becomes contaminated mainly by man-made combustion processes. Fossil fuels (coal, oil and now natural gas) release gases and particles when the chemical process of burning takes place. The degree of harmful emission depends much upon the quality of the combustion process.

The main unwanted gases produced are carbon monoxide, carbon dioxide and sulphur dioxide. The first is physiologically dangerous for it can induce a deep fatal sleep without obvious signs. In lesser doses it produces severe drowsiness. It is, however, relatively easy to measure, especially at the exhaust of a vehicle.

Carbon dioxide, although not as harmful of life directly (as long as oxygen exists), does appear to have a far-reaching effect on the globe as a whole. This gas ends up in the upper atmosphere at an increasing concentration of some 0.7 parts per million ppm each year. Calculations indicate that a doubling up of the current concentration of around 300 ppm will reduce the heat loss of the Earth but not the Solar heat gain. This could, it is suggested, result in an increase in ambient temperature of a degreee or so and that might melt much of the icecaps. Depending upon which school of thought you belong to, this will mean either disaster by flooding or merely an increase in plant life that will compensate for the increase of energy gain.

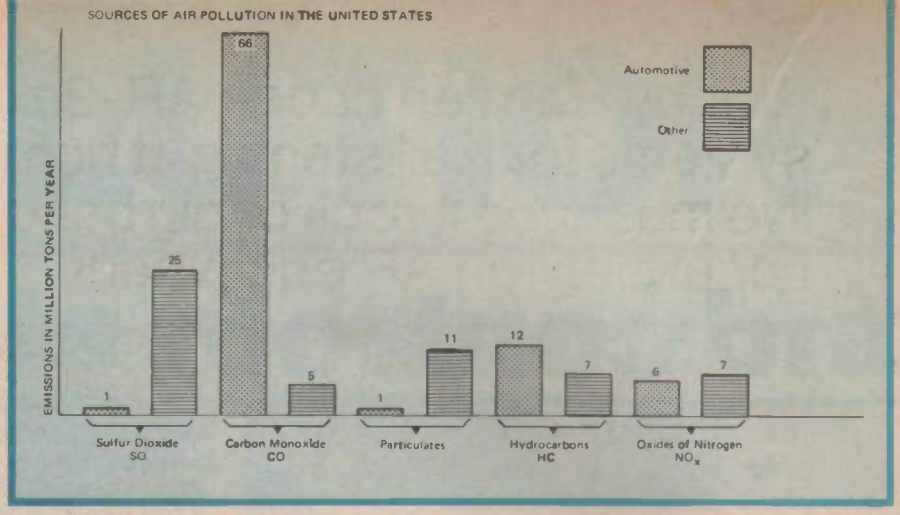

Fig. 2. A recent estimate of the quantity of air contaminants in the U.S.A.

Sulphur dioxide in the air oxidises to produce sulphuric acid.

Rainwater is made into dilute acid when it falls near an industrial chimney emitting the gas).

There are many other gases that pollute the atmosphere and waters – for more complete summaries refer to the reading list given.

Combustion also produces particulate matter ranging in size from 10 micrometers in diameter upward. Smog, smoke, haze and fog are predominantly made of particles, but not always, for optical dispersion effects can produce with gas alone the brown colours seen. Although not regarded as a pollutant in the same sense, pollen grains producing hayfever provide a similar measurement problem, for the grains are minute but powerfully annoying.

Measurement of contaminants in air, therefore, involves in the main, the determination of small quantities of gas impurities and the size and distribution of suspended particles.

POLLUTION OF WATER

In many areas of high density dwelling and industry there is a shortage of clean fresh water – 4,000 x 10^6 gallons are used each day by British industry. To say fresh water is our life blood is no overstatement, for it seems all processes require it in one way or another. Power stations require immense quantities for cooling purposes, and to charge the boilers, (salt water is often used). Paper making needs it when making pulp. It takes 44 gallons to produce a glass of beer, 100,000 gallons to make a car. In most processes it is used only as a transport medium to wash away impurities. Such discharges are termed industrial effluents.

Nature has provided a natural purification process in water courses, and this action can handle a small amount of contamination bacterialogically.

The evaporation rain cycle is invaluable. It is, therefore, reasonable to allow a very limited amount of suitably treated effluent to go into rivers and the sea, but the natural processes must not be overloaded or the whole action ceases. However, the convenience of discharging effluent into a rapidly moving river has enticed too many people to pass their waste on to others.

The main contaminants in water come from industrial waste, sewage, and from chemicals carried from the water-shed areas by rainfall drainage. There is an identifiable water cycle, (see Fig. 3); in it the various contamination courses are interrelated.

In the 19th century, it was a sport to set light to methane discharged from some English canals! It is the absence of dissolved oxygen that is paramount in a water course, for bacteria need at least 2 ppm to convert organic carbon and nitrogen compounds into less harmful chemicals. The Biochemical Oxygen Demand (BOD) is a test designed to find the oxygen need of an effluent. It is arbitrary in nature but does provide, along with other tests such as the Chemical Oxygen Demand (COD) and Permanganate Value (PV), a measure of the degree of pollution.

Some chemicals can be most harmful, even in minute concentrations. Mercury, cadmium and lead are well-known poisons of the human metabolism, entering either through fresh water or sea-water paths. Mercury entering sea-water is concentrated in the bodies of many fish – tuna and shark have often been banned for human consumption for this reason.

Cadmium is a recently declared danger. In 1971 the reason was found why hundreds of Japanese women were suffering from bone decay leading to painful death. It was established that industrial effluent from a factory up-stream contained cadmium. This entered their bones via water irrigation used for the rice they ate.

Continued on page 69

Woody Herman chose AR-2ax speaker systems for his listening at home. The sound of live music, be it rock or big band, is reproduced accurately on AR equipment.

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The name of each winner will appear in this column in the month after.

So here is the first ELAC PUZZLE

At a recent meeting of the Back Scratchers Union, a motion was put to those members present to decide if the members should strike for shorter hours and more pay. The vote was taken on the basis that those in favour would remain standing, those against would sit. After the count had been taken, the Chairman announced "The motion has been carried by a majority equal to exactly a quarter of the opposition". (Loud cheers). "Just a moment" shouted a man from the back – "some of us down here can't sit down because there aren't enough chairs". The Chairman then decided that those who had wanted to sit down could raise their hands. A dozen hands were counted and the Chairman ruled that the motion had been defeated by a majority of one. (Hisses and consternation).

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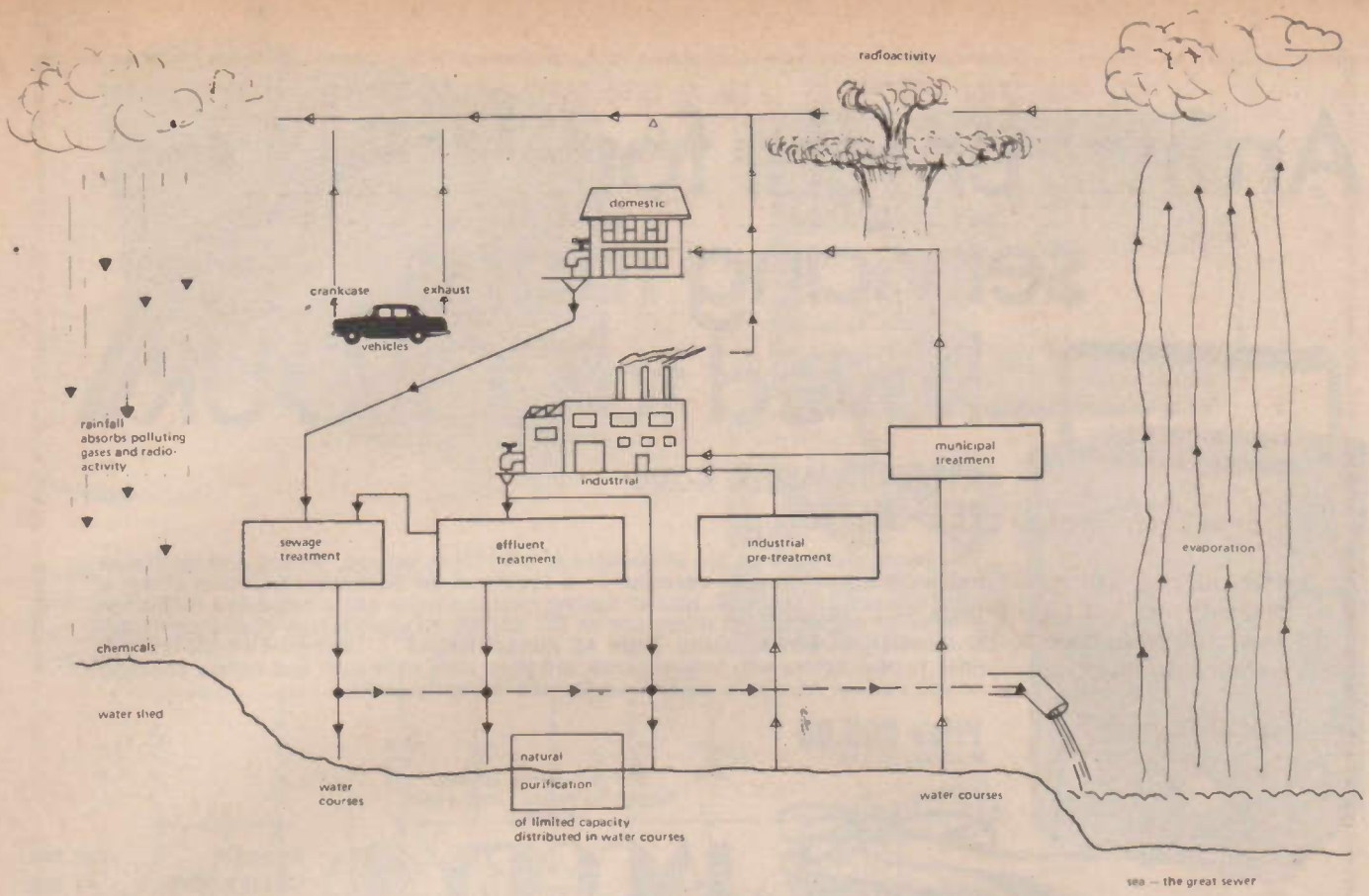

Fig. 3. Water is naturally recycled on a global basis. This basic diagram shows how pollutants enter and to some extent how they are purified.

Control of water pollution, therefore, also involves the need to measure chemical impurity levels, dissolved gas quantities and, as with air, the nature of particulates. Large solids also need consideration but their measurement is more straight forward.

Transducers needed for pollution measurement and control are, therefore, devices for measuring chemical parameters – acidity, ion concentration, specific gas content and composition, and particles. Radioactivity contamination is common to both air and water and will be covered later.

CHEMICAL ANALYSIS INSTRUMENTS

The simplest way to monitor unwanted chemical composition in a gas or liquid is to carry out conventional laboratory tests on samples. Special kits are sold to standardise the procedure. Some enable tests to be made on the spot by virtue of visible colour changes that can be matched against a chart.

Another simple way is to suspend treated paper (litmus for instance) in the fluid stream. The gas analyser in Fig. 4 is a relic used at the turn of the century to test for ammonia and sulphur dioxide in town gas.

Whilst there are cases where these inexpensive methods are satisfactory for spot checks, the need is often for a faster response and a continuous output signal that can be used to actuate control. Such instruments are almost always sophisticated and, therefore, costly. Space does not permit a complete study but those described are the commonly used instruments. Each has application in chemical analysis in general – there is nothing about chemical pollution that gives it a different need to normal analytical practices.

MASS SPECTROMETER

When a gas (which consists of atoms, or molecules made of atoms) is subjected to thermal agitation, some of it will be split into separate atoms with differing electron charges. If positively charged it is called a cation, if negative an anion. In 1907, J. J. Thompson reported a method for separating out different ions into separate locations where an individual measure of each can be made. This instrument, called a mass spectrometer is shown diagrammatically in Fig. 5. It can be used to monitor gas composition as a continuous process.

The example chosen is used in the iron and steel industry to monitor – on line – waste gas composition from blast, oxygen and electric-arc furnaces.

The gases to be studied are sampled

Fig. 4. This elegant coal-gas monitor of the 1900's has two treated papers hanging in front of the gas stream. The sampled gas passes through to be burnt at the top.

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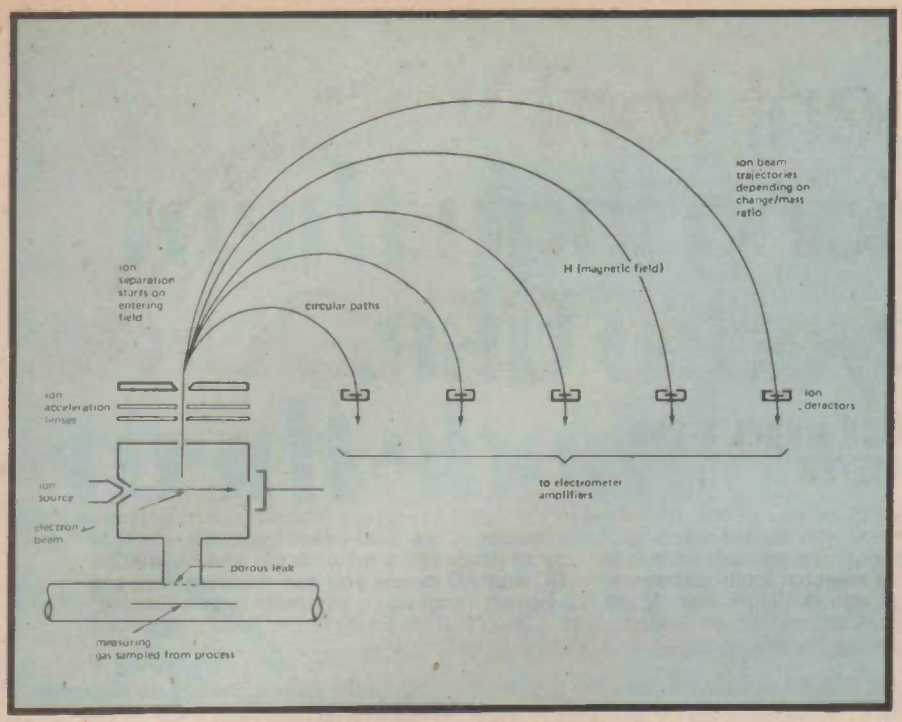

Fig. 5. In the mass spectrometer, ionised gas atoms and molecules are separated into groups depending on their electron-charge/mass ratio.

by bleeding some from the process. They are then pumped past the ionising chamber. An ion source ionises the gas mixture and ions are accelerated by electron lenses to follow the same initial path. Upon entering the magnetic field zone they take up circular paths of radius depending upon their charge/mass ratio. Finally they impinge on ion detectors that produce current proportional to charge. In this way the gas is separated into its constituent parts and a spectrum is formed in space (hence the name spectrometer). Detectors, if placed correctly, will sense specific ions only. Process control mass spectrometers are available commercially.

A chance of ambiguity exists, for there are a number of combinations of charges and masses that produce the same charge/mass ratio even though the element is different. Other tests may be necessary to reduce the risk of error. This is a common difficulty with most analysers, especially when the number of constituent gases rises.

The mass spectrometer is extremely versatile being able to detect any chemical substance that can be ionised. In the steel works example, it is used to measure nitrogen, carbon monoxide, hydrogen, oxygen, carbon dioxide, and water vapour. Other uses have been to analyse the smell of the land after rainfall, the odour of packed apples — it is the best general purpose sniffer available, (the biological sense of smell is however, more sensitive). Well designed instruments can distinguish separate ions having charge mass ratios differing by as little as one part in 10,000.

OPTICAL SPECTROMETERS

In this spectrum-based measuring device, it is the dispersion of electro-magnetic radiation into the various wavelengths (colours if in the visible region) that is used, not the deflection of ions. A sample of gas under study is heated or excited by forming an electric discharge, as shown in Fig. 6. A collimator unit provides an essentially parallel beam of the resulting radiation, as though the source were at infinity. This beam is dispersed into its 'colours' which spread out around the output area. Dispersion is achieved with either a prism, or as in many instruments, with a grating having ruled surface grooves at a pitch appropriate to the wavelengths of interest. Gratings of both transmission and reflection type are used. The output optics see a defined field of view that can be observed manually or with suitably placed photo-detectors (ranging from relatively insensitive photo-cells to photo-multipliers). The intensity of the radiation seen at the various angular positions provides a unique set of data for a given gas. Rotation is usually achieved by slowly scanning the dispersion element keeping the output stage fixed. Spectrographs using photo-detectors are known as spectrophotometers. Spectra (the radiation bands and lines) produced by a source including the gas to be analysed are obtained as emission in this type of spectrometer.

Black body radiation (see the earlier discussion on temperature) produces an emission spectrum that is continuously graded from colour to colour. In contrast, radiation from gases, contains one or more sharply defined lines at precisely known wavelengths. This is explained by quantum theory which shows that energy will be emitted at certain wavelengths only. Knowledge of the prism or grating and the geometry of the instrument enables the line set for particular gases to be determined and hence the analysis of the sample placed in the source.

Many adaptions of the spectrometer principle exist. In the spectro-photofluorometer shown in Fig. 7, identification of chemical compositions is by virtue of fluorescent and phosphorescent characteristics of compounds. The molecules of the sample are excited by ultraviolet or visible radiation producing luminescence that radiates at longer wavelengths — the energy is transformed in wavelength. It is claimed that the sensitivity of this fluorometry technique exceeds normal spectrophotometry by several thousand times: parts in 10^{12} sensitivity is often obtained. A lot depends upon the substance being analysed, of course.

In the absorption technique, use is made of the property of a gas to absorb radiation, an effect that depends upon the wavelength of the radiation supplied and composition of the sample. The atomic absorption flame spectrophotometer shown in Fig. 8. became generally accepted reality in the 1960's after a decade of research at the CSIRO. Originally it was considered that emission spectra monitoring was the better way because the gas produced large amplitude signals. Overall, however, absorption monitoring is superior. The gas (or liquid) to be analysed is fed into a flame, through which radiation from special spectral-line lamps is passed. Study of the spectrum of the energy leaving the flame provides wavelength — amplitude relationships that are again unique to each gas. The reason for the superiority of absorption is that the source, being spectrally pure, enables a better overall signal-to-noise ratio to be obtained — in the emission method the detection signals include many unwanted emission lines that cannot be eliminated in the same way.

In spectrometers each gas is defined by its lines and their positions. Often they are not sharply defined and, further, the spectra may be very similar. One way to increase the certainty of resolution is to feed the scan signal obtained into a powerful

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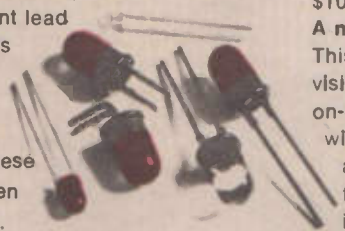

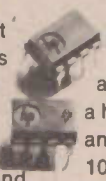

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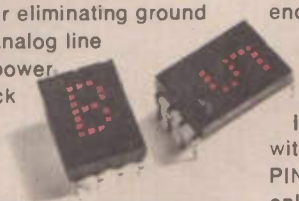

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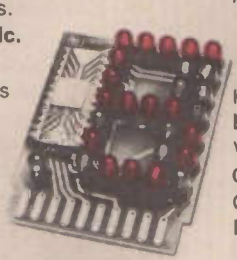

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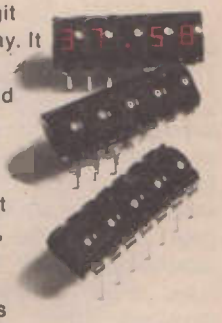

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digital computer and use correlation techniques (described earlier in flow measurement) to test the unknown with a standard spectrum. The use of a computer is, however, expensive. A more economical method uses a mask in the spectrometer exit slit that has a transmission-versus-position characteristic of the standard spectrum being sought. The unknown spectrum is vibrated across the slit and the total transmission of energy through both the mask and the exit slit is an optical correlation of the two. The amplitude of the signal with position of the mask provides a test of the match of the two spectra. The set-up used in a production correlation spectrophotometer is shown in Fig. 9.

The non-dispersive infared analyser, NDIR for short, is commonly used in air pollution measurements. Its principle is based on the selective absorption of gases but no dispersive element is involved, that is, no spectrum is formed. A heated wire provides broad-band infared energy which is split into two identical power beams, see Fig. 10. They are mechanically shuttered to first pass one beam, then the other at about 1Hz frequency. In the reference path, a transparent cell is inserted that is filled with a known non-absorbing gas at the infared wavelengths provided. In the other path the cell is filled with the sample gas. Both beams then impinge onto a common detector cell, also filled with gas. If the sample cell contains gas that absorbs energy the detector cell will be heated slightly less in one half of the cycle than in the other. This produces a cyclic heating effect that manifests itself as pressure changes in the detector. A microdisplacement transducer — capacitance perhaps, monitors the minute vibrations of a diaphragm mounted on the cell. Synchronous detection, derived from the chopper supply, enhances the signal-to-noise ratio. The fluctuations are rectified and converted to dc indicating the degree of absorption as the amplitude of the final output signal. Filter cells are used to reduce the risk of ambiguous operation by removing unwanted wavelengths before the radiation enters the sampling cell. The method is fast to respond having a response time of the order of seconds.

An NDIR instrument can detect carbon dioxide down to concentrations of 10 ppm but the pressure of carbon monoxide, water or methane can introduce considerable error. It can also be used to detect sulphur dioxide down to 2 ppm but again if water and carbon dioxide are present the results are invalid.

The principle used can also be worked in the ultraviolet range of the

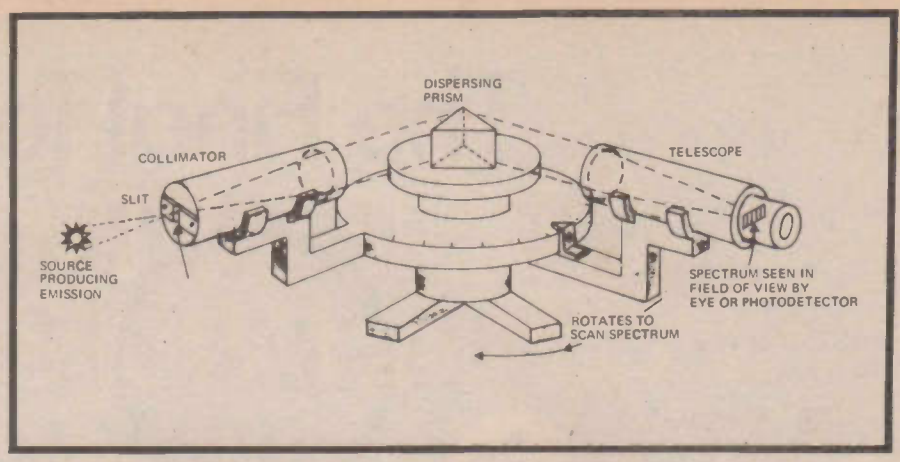


Fig. 6. In the optical spectrometer radiation from a gaseous source is dispersed to form a spectrum of lines and bands unique to each element.

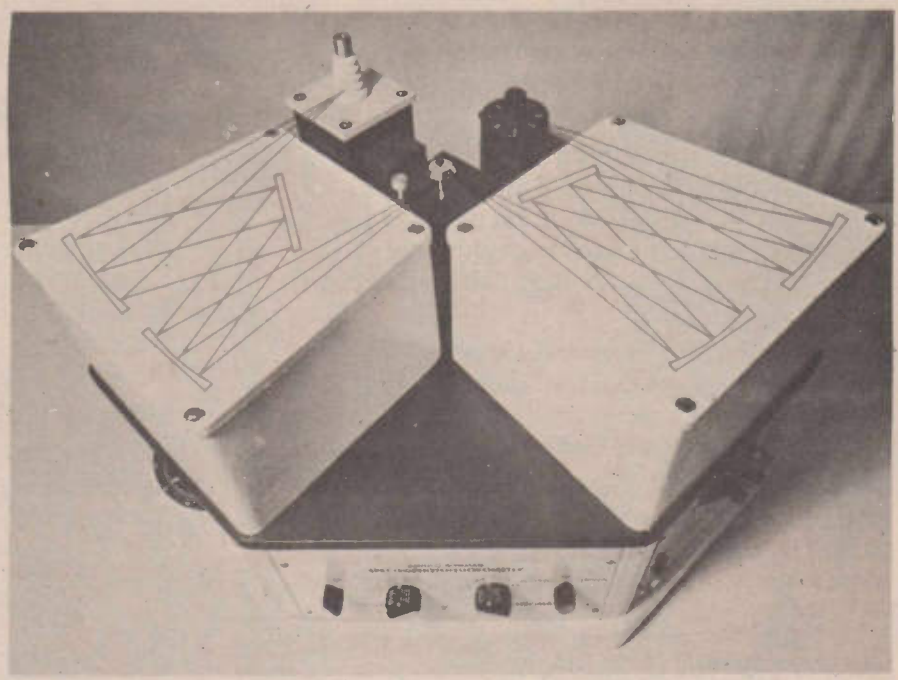
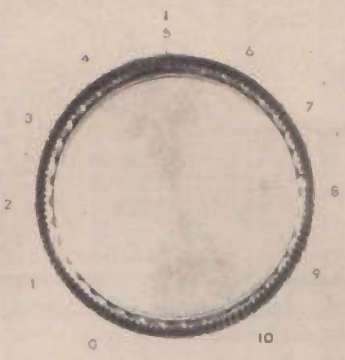


Fig. 7. The Aminco-Bowman spectrophotofluorometer. Lines superimposed show the optical paths of the excitation grating monochromator (on the left) that illuminates the sample placed in the centre and the emission dispersing grating monochromator (on the right) that is used to analyse the spectrum of the luminescence. The source is a Xenon lamp and the detector, a photo-multiplier of appropriate wavelength sensitivity.

Fig. 8. The Australian designed atomic-absorption flame spectrophotometer.

The Final Test



BASF offer you these alternatives:

1. Spend an hour in our research laboratories, and with the aid of a frequency analyser, a spectrograph, a two-co-ordinate plotter, a level recording set and two men in white coats we will prove how much better BASF LH tape is than normal tape or even typical low-noise tape.

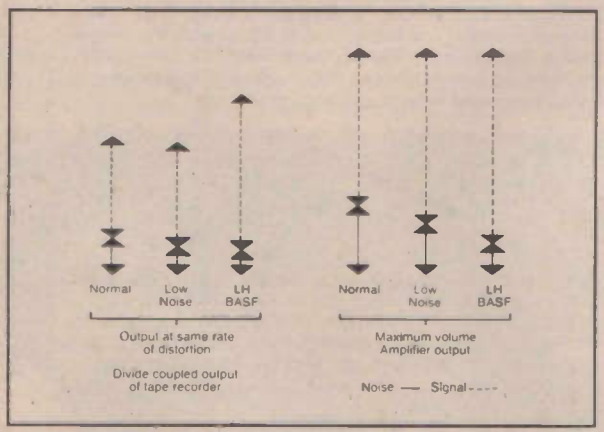
2. Spend five minutes with your hand on the volume control of your own tape recorder. Listen to a recording on normal or typical low-noise tape. Listen to the same thing on BASF LH tape. Twiddle the knob up and down to your heart's content.

With BASF LH tape: low noise-high output. That means that the 'noise' part of the signal on the tape is a much smaller proportion of the total output signal.

So even when you turn the volume up to maximum, although you're increasing the 'noise' by the same amount, there's less 'noise' to increase.

With the other tape, well, just listen.

Now look at these diagrams.



Note first that the BASF LH tape has a greater dynamic range than the normal or low-noise tape.

And secondly to get the same volume output as for the BASF LH you have to increase volume setting on the normal or low-noise tape, which at the same time (of course) increases the output of noise.

Now here are a few facts and figures for those of you who know what they mean. (There aren't many of us about.)

BASF LH TAPE

Sensitivity:	0dB
Frequency response:	0dB
Maximum recording level:	+9dB
Signal-to-noise ratio (dynamic):	60dB
Print-through:	51dB
Erasure:	>70dB

The measuring method corresponds to DIN standard 45512, sheet 2.

You may see what seem to be better figures quoted for other tapes. If you do—ask the manufacturer to what standards he's referring and what measuring method he's using then he'll climb down.

Still baffled?

Send the coupon for Heinz Ritter's 126-page book 'Tape Questions—Tape Answers'. It tells you everything you'll ever want to know about tape recording.

You can't spare $1.25? Then send the coupon back for the complete BASF price list and all the figures that prove every word we've said.

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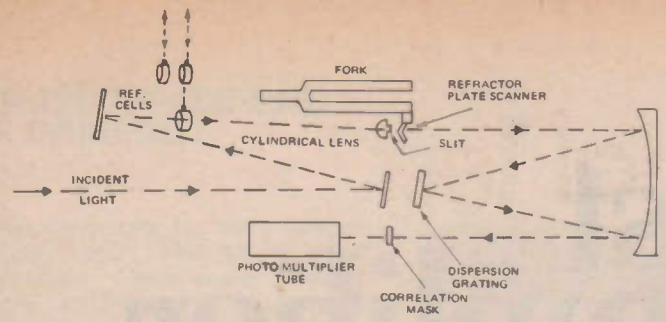

Fig. 9. Use of a mask to perform optical correlation of the spectrum of a vapour.

spectrum if a suitable source (tungsten lamp) and detector are used. Its main air pollution application has been for the detection of nitrogen dioxide from 5 ppm to 200 ppm concentrations.

To be continued next month . . .

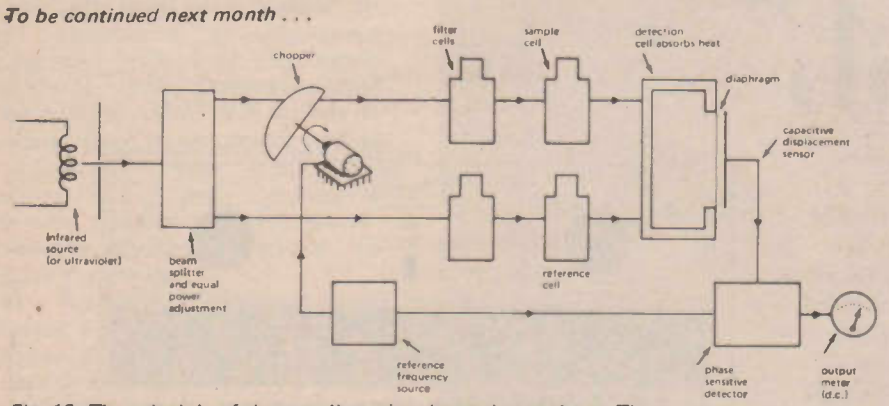

Fig. 10. The principle of the non-dispersive absorption analyser. The source is either in the infared (the NDIR instrument) or in the ultraviolet region.

READING LIST

"Continuous gas analysers . . ." Simpson, C. C., *Inst. of Instrumentation and Control.* Australia. Symposium on the "Advance of process instrumentation" Sydney, 1971.

"A Survey of measurement and control of pollutants" Garrod, D. J., *Trans. Inst. Meas. Control*, London, 1971, 4, 253-262.

"Where there's muck there's brass" Conway, A. *New Scientist*, 1972, 54, 376-378.

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"Air pollution" Gilpin, A., Univ Queensland Press, St. Lucia, 1971 (An international coverage).

"Specification for gas analysers" Verdin, A. *Trans. Inst. Meas. Control*, London, 1971, 4, 44-46.

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"The unclean sky" Bathan L. J., Anchor Books New York, 1966.

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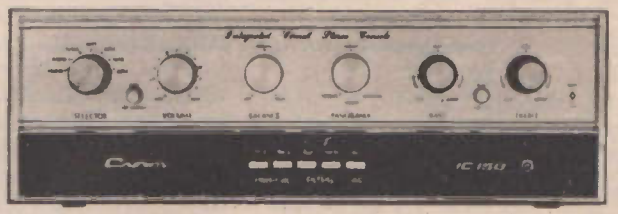

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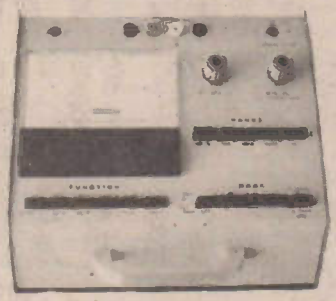

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MASTER

Assembly and operation of the power supply — overload indicator and metering circuits, and final assembly details are provided in this third article in the series.

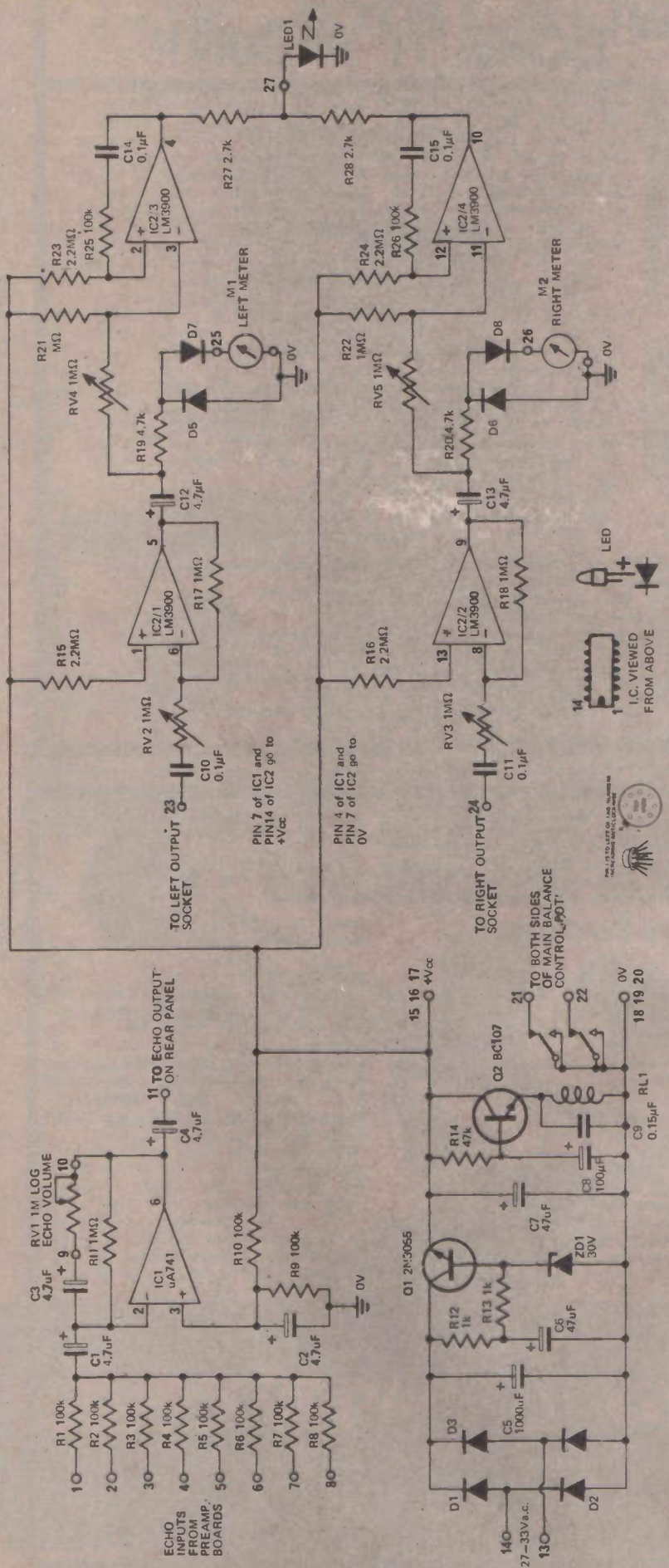


Fig. 1. Circuit diagram of power supply and metering board

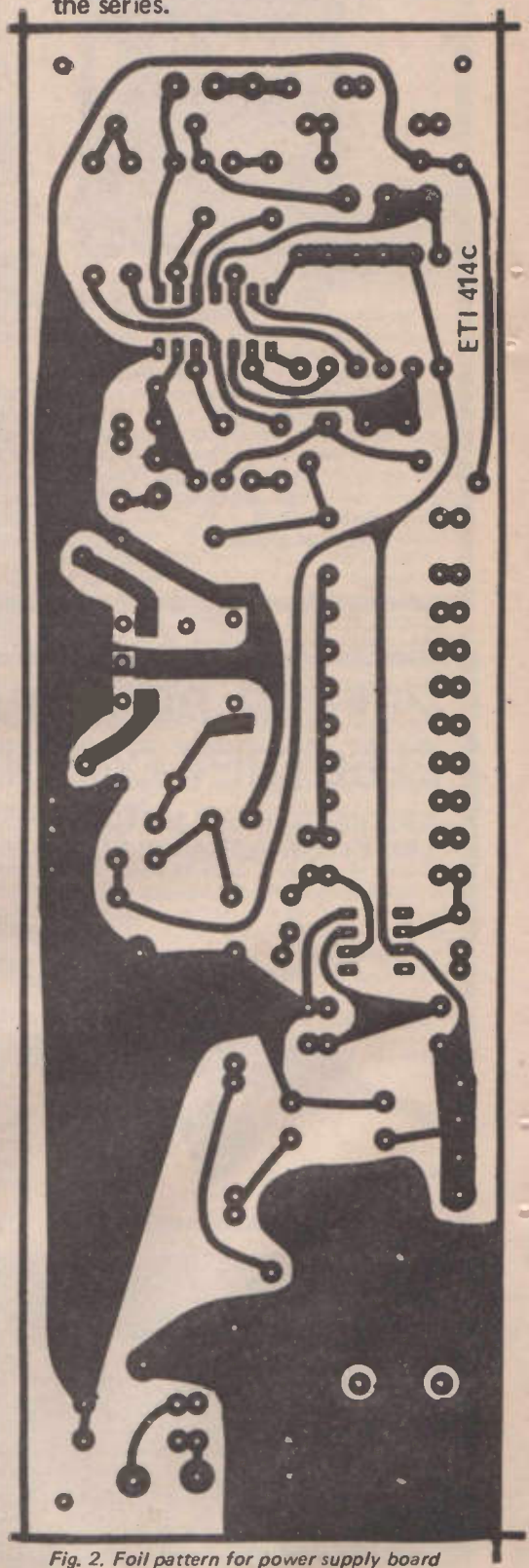


Fig. 2. Foil pattern for power supply board

MIXER

MASTER MIXER

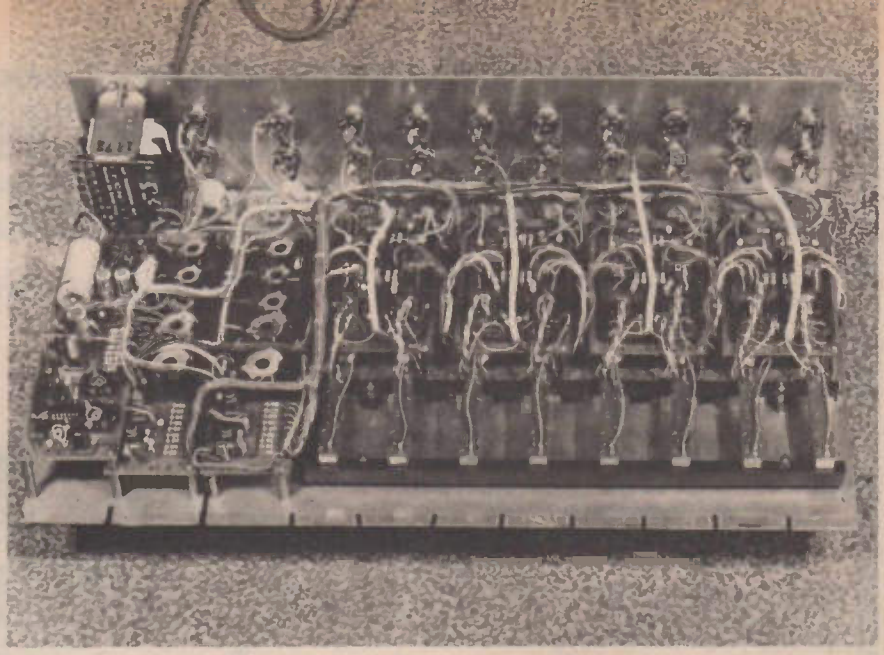
THIS month we complete the last remaining board – that for the power supply and metering circuitry, and provide details of all wood and metalwork.

In the final instalment next month details will be given of how the circuitry can be modified and/or operating techniques devised to suit users' individual requirements.

CONSTRUCTION

Begin by assembling components to the power supply board in accordance with the component overlay (Fig. 3).

Ensure that IC's and tantalum capacitors are fitted to the board with correct orientation (refer to insets on circuit diagram. Use care, when soldering, to avoid heat damage to components – especially IC's. Use a



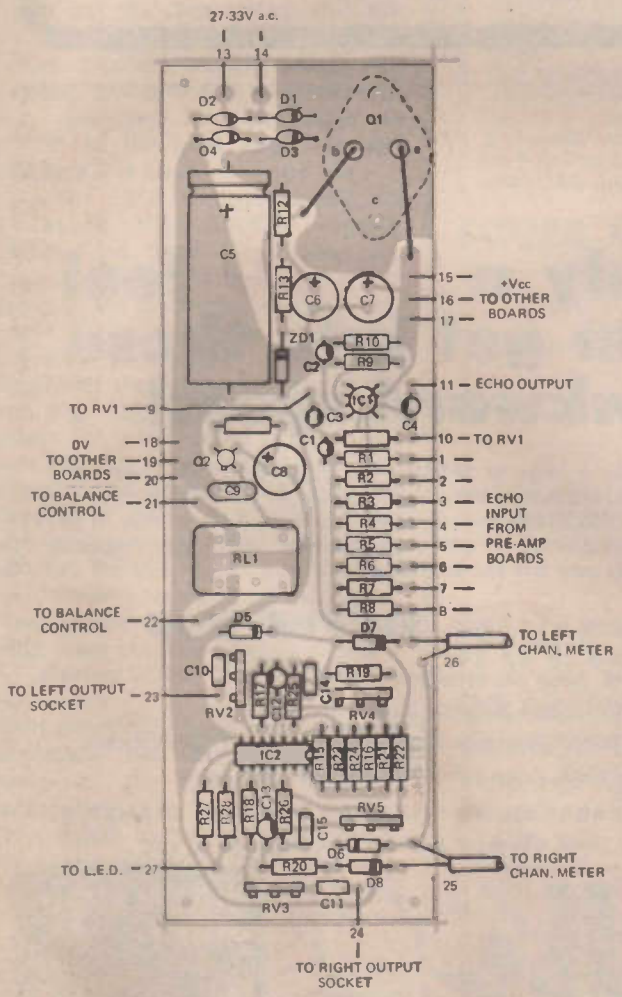


Fig. 3. Component overlay of power supply board.

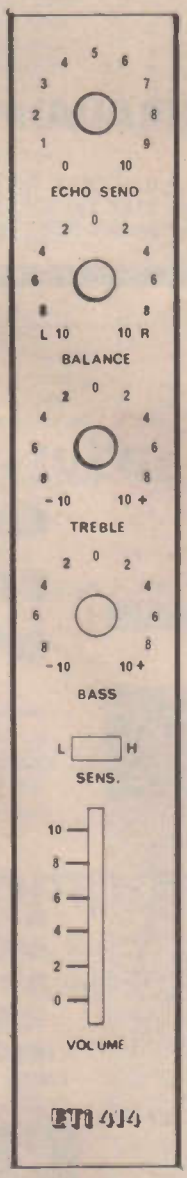


Fig. 4. Escutcheon for preamplifier (actual size 12" x 1¾").

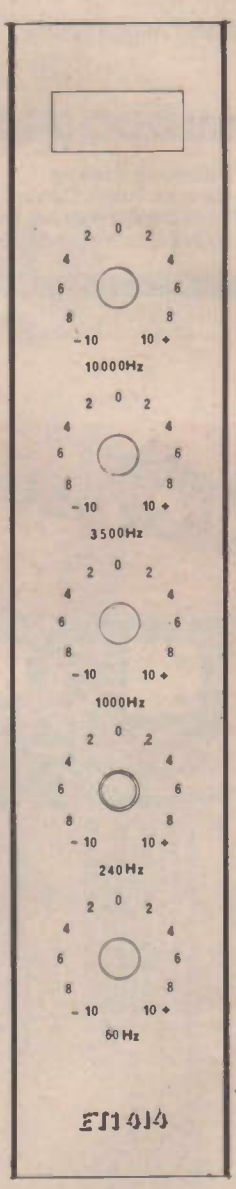


Fig. 5. Equalizer panel escutcheon (actual size 12" x 2¼")

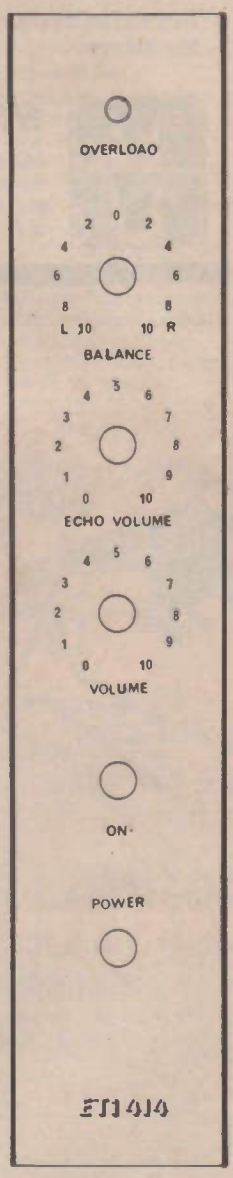


Fig. 6. Main control panel escutcheon. (actual size to be 12" x 2¼").

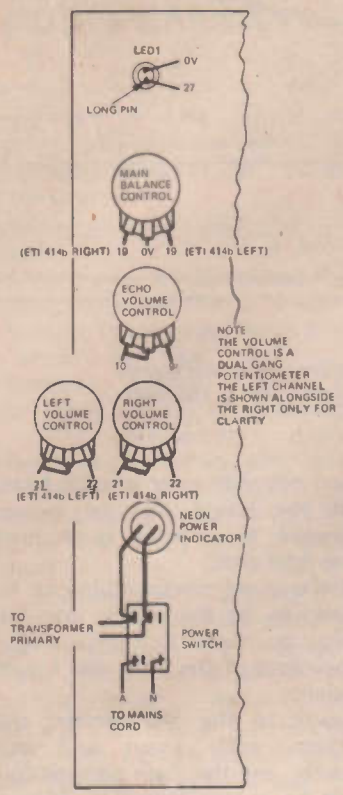


Fig. 7. Wiring to rear of main control panel.

light-weight, low-wattage soldering iron and work quickly.

Printed circuit boards purchased from kitset suppliers may be varnished with resin or similar. Clean off the varnish where the 2N3055 regulator transistor is mounted, to allow electrical contact. Silicon grease should be used between the copper pattern and the transistor to aid heat transfer.

The pins of the relay are inserted into the holes provided in the board and bent to make contact with the copper tracks before soldering. We inserted pins to allow connection of the positive and negative supply leads which have to be routed to the various other boards.

There are three pins for positive leads and three for negative leads. Two leads connect to each positive pin (six leads total). The common leads from the four preamplifier boards and the two main mixer boards, are soldered to lugs secured between each respective board and one of its mounting pillars. Two of these leads are terminated at each negative pin on the power supply board.

By referring to the metalwork drawings and the photograph of the unit, boards and other components

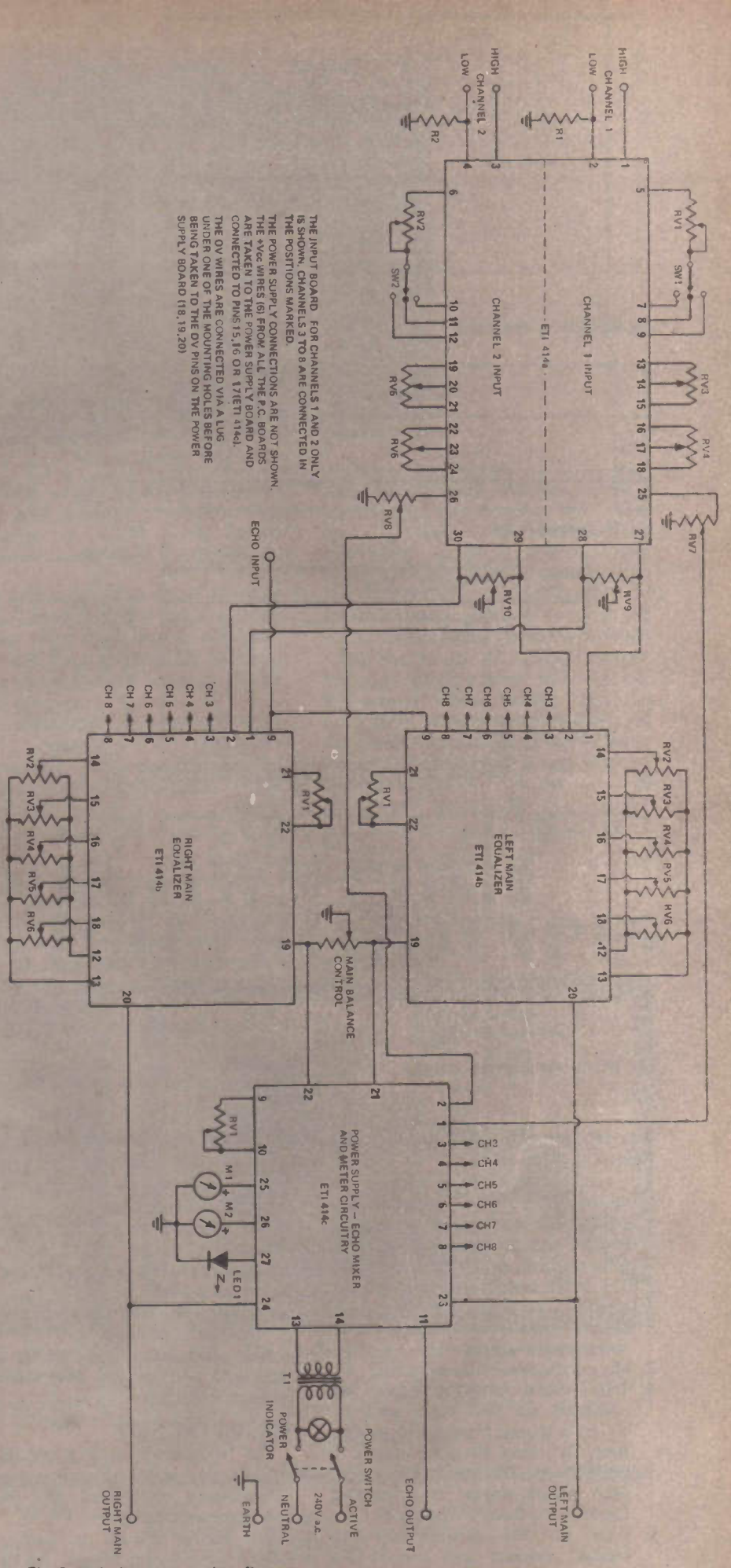


Fig. 8. Main interconnection diagram.

Fig. 9a. Cabinet baseboard.

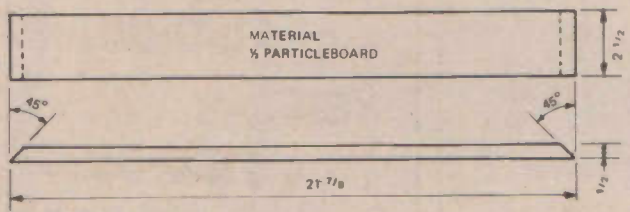


Fig. 9b. Cabinet front

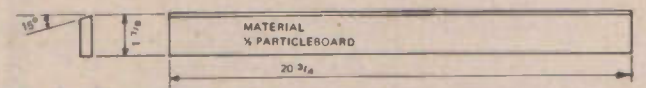


Fig. 9c. Front panel support

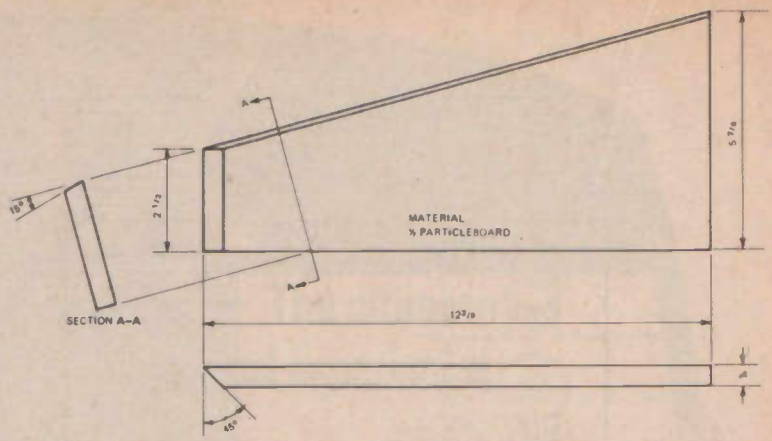


Fig. 9d. Cabinet sides — two required. Note that boards should be mirror image of each other, that is, chamfers should have opposite slope.

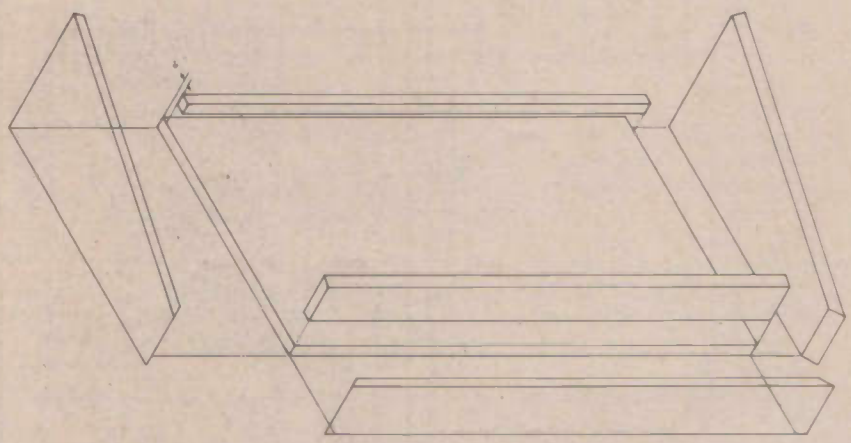


Fig. 10. Cabinet assembly details.

may be mounted to the panel in the following order.

1: Each preamplifier board is mounted on three 1" long threaded pillars. The main mixer – equaliser boards each employ four of these pillars which should be secured to the front panel with countersunk screws.
2: Mount the VU meters, with countersunk screws.
3: Mount the sensitivity switches.
4: The slide potentiometers are mounted on two rails, each of which is spaced from the chassis by four, ¾" long threaded pillars – eight in all. Ensure that pin 1 of each potentiometer is orientated towards the front of the panel.
5: Glue on the escutchions with contact cement and mount the rotary potentiometers, switches and indicator lights.

Note: Two of the escutchions will have to be drilled to allow the front panel to be secured (see the metalwork diagram).

6: Mount the input jacks on the rear of the panel.
7: Mount the transformer and the printed circuit boards.

This completes the front panel assembly and we can now make the interconnections.

WIRING THE UNIT

The interboard wiring should be carried out with reference to the underchassis photograph and to the interconnection diagram, Fig. 8.

All wiring should preferably be colour coded and should be routed down one side only of each board so that the board may be swung-up, sideways, if servicing is required at some later date.

Use one mil plastic tubing, or lacing twine, to tie the wiring into looms. This, as well as improving the appearance of the unit, also facilitates servicing.

Leads to the VU meters, output sockets, echo input and output sockets, and the main balance control must be in shielded cable. These and, as far as possible, all other wiring should be kept well clear of the mains transformer to prevent hum pickup.

WOODWORK

Cut the five pieces shown in Fig. 9 from ½ inch particle board, note that the two pieces cut as per Fig. 9d are mirror images of each other. Veneer the inside surfaces of the two sides (Fig.9d) and the front strip (Fig. 9b).

Assemble the box as per Fig. 10. Screws or nails should be used to hold the panels together while the glue sets. Take care to ensure that the sides are square to the base, otherwise the metal panel may not fit in place. In fact it is a good idea to use the panel as an assembly guide. The support piece (Fig. 9c) is assembled with the short side to the front. The rear panel support is merely a half inch square piece of timber, positioned 3/8 inches from the rear edge of the base (Fig. 10).

When the glue is set, the box can be sanded and all visible outside surfaces veneered, before final sanding and finishing operations are carried out. The inside of the box should be lined with "Alfoil", and this earthed to the metal chassis. If the Alfoil goes over the rear panel support, the metal panel will make contact with it and no other connection need be used.

TESTS AND ADJUSTMENTS

Before initially switching on, remove from the power supply board the +Vcc

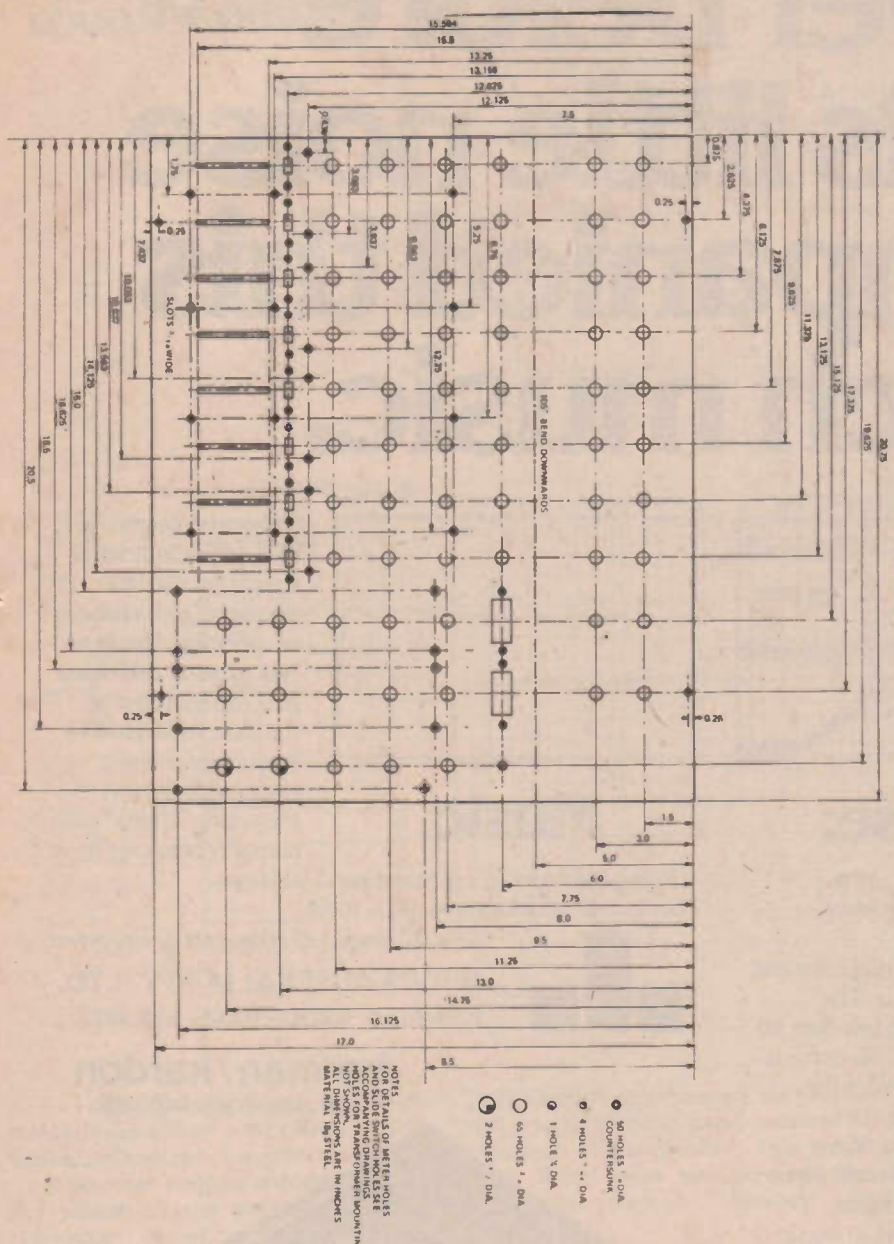


Fig. 11a. Drilling details of front panel.

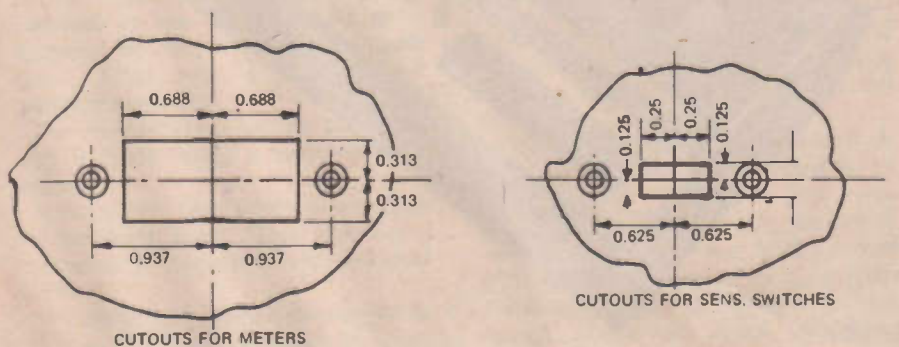


Fig. 11b. Cutouts for meters and sensitivity switches.

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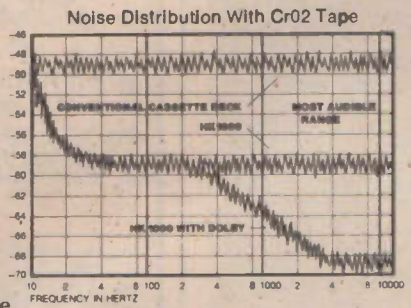
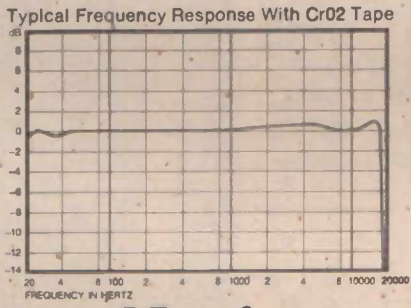


Noise.



Music.

If you're sophisticated enough to be reading this magazine, you're probably familiar with the two main characteristics of cassette decks: hiss and nonlinear frequency response.

Which should make you thoroughly unfamiliar with the performance capabilities of our new HK-1000. As the charts indicate, it behaves more like reel-to-reel than a cassette deck:

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Because of a new low in noise and a new wide in frequency, the HK-1000 brings you a new clarity in music.

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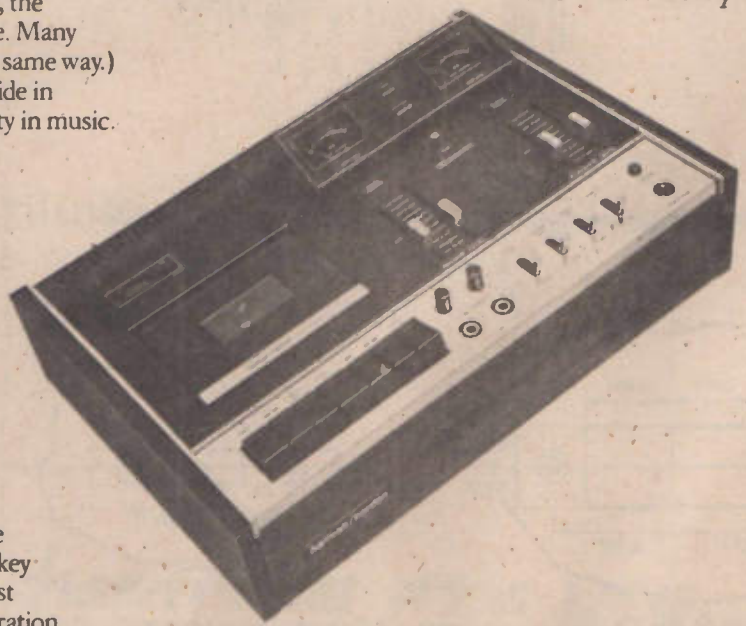

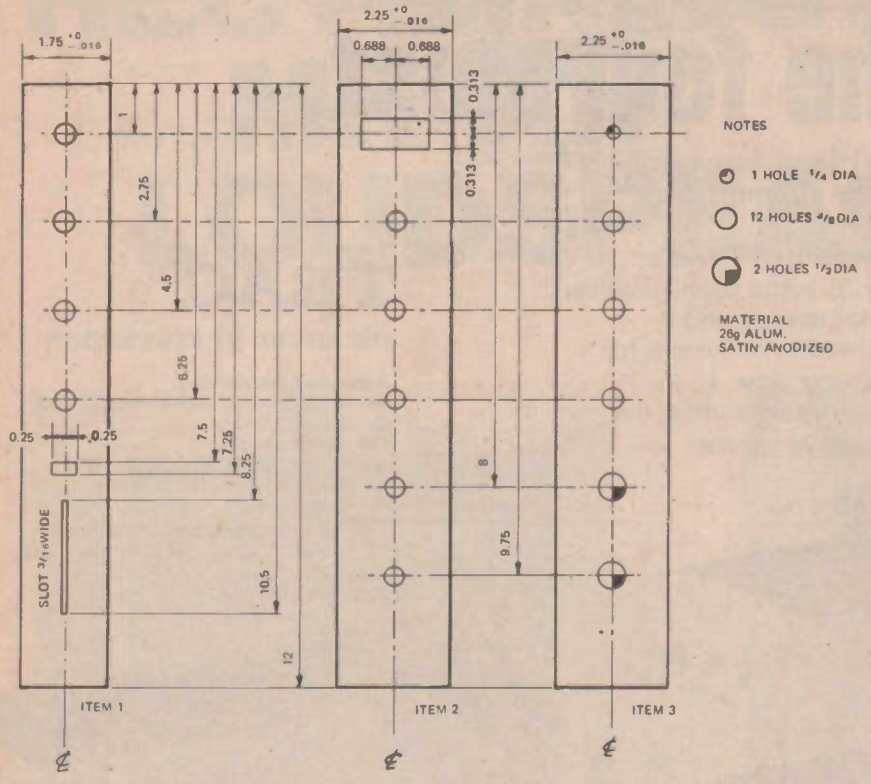

Fig. 12. Drilling details — Item 1: preamplifier panel. Item 2: equalizer panel. Item 3: main control panel.

PARTS LIST FOR POWER SUPPLY BOARD ETI 414

R1	Resistor	100k	½W	5%
R2	"	100k	"	"
R3	"	100k	"	"
R4	"	100k	"	"
R5	"	100k	"	"
R6	"	100k	"	"
R7	"	100k	"	"
R8	"	100k	"	"
R9	"	100k	"	"
R10	"	100k	"	"
R11	"	1M	"	"
R12	"	1k	"	"
R13	"	1k	"	"
R14	"	47k	"	"
R15	"	2.2M	"	"
R16	"	2.2M	"	"
R17	"	1M	"	"
R18	"	1M	"	"
R19	"	4.7k	"	"
R20	"	4.7k	"	"
R21	"	1M	"	"
R22	"	1M	"	"
R23	"	2.2M	"	"
R24	"	2.2M	"	"
R25	"	100k	"	"
R26	"	100k	"	"
R27	"	2.7k	"	"
R28	"	2.7k	"	"

RV1	Potentiometer	1 Meg Log
RV2	"	1 Meg Trim type
RV3	"	1 Meg " "
RV4	"	1 Meg " "
RV5	"	1 Meg " "
C1	Capacitor	4.7µF 35V "TAG" Tantalum
C2	"	4.7µF 35V "TAG" Tantalum
C3	"	4.7µF 35V "TAG" Tantalum
C4	"	4.7µF 35V "TAG" Tantalum
C5	"	1000µF 50V Electrolytic Pigtail leads
C6	"	47µF 50V Electrolytic PCB mounting
C7	"	47µF 50V Electrolytic PCB mounting
C8	"	100µF 50V Electrolytic PCB mounting
C9	"	0.15µF 100V Polyester
C10	"	0.1µF 100V "
C11	"	0.1µF 100V "
C12	"	4.7µF 35V "TAG" Tantalum
C13	"	4.7µF 35V "TAG" Tantalum
C14	"	0.1µF 100V Polyester
C15	"	0.1µF 100V "
D1-D4		Diodes PA2121, EM401, or similar
D5-D8		" 1N914
LED1		NSL5023
ZD1		Zener Diode BZY88C30
IC1		Integrated Circuit LM307, µA741 (metal can or minidip)
IC2		Integrated Circuit LM3900 (National Semiconductor)
Q1		Transistor 2N3055
Q2		" BC107

PC board ETI 414c

Level indicator edge meters 400µA 410ohms, type PV31 or similar (two required).
Brass spacers, ½" by 1/8" clearance hole (three required).
Brass spacers, 1", tapped 1/8" (two required).
Phone jacks 6.5mm (two required).

Transformer 240V primary 27-33V secondary —200mA.
Power switch type MSP625 dpdt (or similar).
Neon indicator 240V (chassis mounting).
Three-core flex and plug, nuts, bolts, etc.
Relay 1250 ohm, miniature type VP2, two change-over contacts.

(See last month's issue for special semi-conductor offer).

wires leading to the preamplifier and mixer boards making sure they cannot touch other circuitry. Rotate the trim potentiometers to their mid position and switch on. Check the voltage between the Vcc and OV terminals. This should be between 27 and 32 volts. If not, there is a fault in the supply which should be located before proceeding further.

Using an oscillator, feed a signal into the output socket of the left channel. An indication should be visible on the left hand meter. Set the input level to that required to drive the power amplifier to full output (1V for the ETI 413 amp.), and adjust RV2 to give full scale deflection. Now adjust RV4 to the point where the LED just stops flashing. Now repeat the process for the right channel, adjusting RV3 for full scale deflection and RV5 for LED indication. This completes the metering circuit calibration.

Now connect the equalizer boards and one of the preamplifier boards. This preamplifier can be checked either with an oscillator or a microphone. Check that the gain increases when the sensitivity switch is moved to the right, also that the tone controls give maximum boost when moved clockwise. Make sure that the balance control operates correctly and the wires going to the mixers have not been crossed.

Add the other preamplifiers one at a time testing each as above. When all the above procedure is complete the unit is ready for operation.

Continued on page 87

TEAC's new multi-track decks are the fourmost.

TEAC was the first to introduce four-channel decks, long before any others were around. Now we introduce the incomparable A-3340: destined to be the fourmost.

A proven pro, this deck combines the best features of TEAC's forerunners. At first glance, you're struck by its audio sophistication. It's professional 10½" deck with 15 and 7½ ips speeds, and it delivers "four-in-hand" versatility. TEAC's Simul-Sync system for recording individual instruments separately at any time, all in perfect sync. Added to its "one-man-band" recording ability, the 3340 records superb four-channel stereo, as well as regular two-channel stereo and ¼-track mono.

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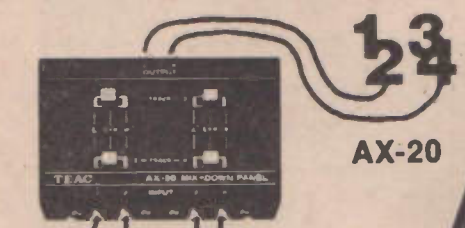


With the optional AX-20 mixdown panel. Simul-Sync recording can be dubbed down to two-channel stereo or mono demos

If you prefer slightly less four-channel sophistication, take a look at our new A-2340. It's like the A-3340 but with 7½ and 3¾ ips speeds, and takes 7-inch reels.
If you want the fourmost, you owe yourself the best—a TEAC A-2340 or A-3340.

If you'd like to know more, write to us for the TEAC Catalogue, price list and franchised dealer list.

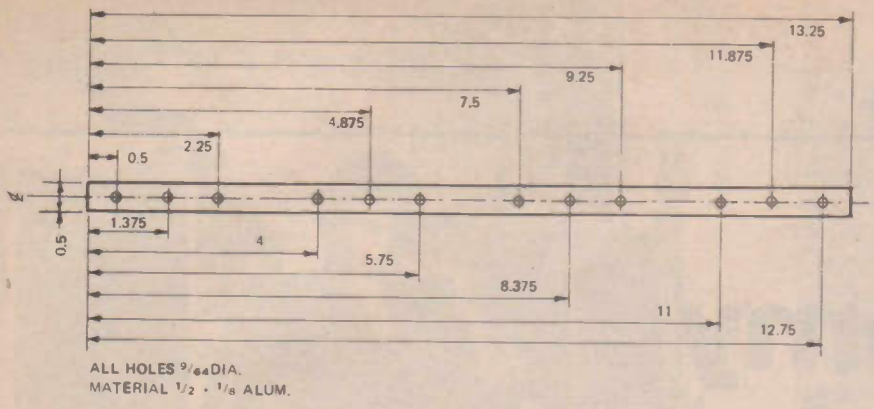


Fig. 13. Slide potentiometer support bars (two required)

HOW IT WORKS

MASTER MIXER POWER SUPPLY

The power supply is of conventional design. Any transformer which will supply 27 to 33 volts at 200mA will suffice. The regulator employs a 2N3055 as a series regulator, and by virtue of the 30V zener diode between the transistor base and the negative rail, maintains the output voltage at approximately 29.5 volts.

At switch-on Vcc rises immediately but the output of the unit is shorted out by relay RLI for approximately four seconds while C8 charges exponentially via R14. Transistor Q2 is simply an emitter follower driving relay RLI. The voltage at its emitter is approximately 0.5 volts less than that on capacitor C7. After approximately four seconds the voltage across the relay rises sufficiently to activate it, removing the short from the output.

This prevents accidental damage to power amplifiers due to switching transients or other warm-up anomalies.

ECHO MIXER

The echo mixer is straight forward. As indicated earlier there are eight separate inputs. These receive signals from the input channel echo-send controls. The gain of the echo amplifier is controlled by RVI which varies the negative feedback. The output goes to the echo output socket on the rear panel. From here it is intended to pass through an echo tape, reverberation unit, or similar type of device before returning to the unit and being split equally to provide an input to each main mixer stage.

METERING CIRCUITS

The metering and overload indicator circuits employ a quad-amplifier IC type LM3900 from National Semiconductor. This package accommodates four independent, internally compensated amplifiers which are designed to operate from a single power supply voltage and to provide a large output voltage swing. Each amplifier makes use of a "current mirror" to provide the non-inverting input.

Unlike a normal operational amplifier, the two inputs are current driven, not voltage. This means that when used as an amplifier the output tries to balance the current in the two inputs. Therefore an initial bias is required. This is provided by R15. For the amplifier to be balanced, an equal current must flow in R17. This sets the quiescent output voltage to approx. 15V.

The ac voltage gain is equal to R17/RV2 where RV2 is the preset value of RV2. The meter is driven by R19 and rectified by D5 and D7.

The second stage (IC2/3) is a comparator-monostable. Both inputs of this amplifier are biased from the supply rail although the current is higher into the negative input. Since this is outside the linear region the output is almost at 0V. When in use current is being added and subtracted to the current into the negative input.

If enough current is subtracted, such that it is less than the current into the positive input, the output of the IC will go high. Due to the positive feedback of R25 and C14 the IC will stay in the high state for approximately 0.1sec, even if the initiating signal has ceased. The overload light LED1 is on while either monostable (IC2/3 or IC2/4) is high.

If the output is continuously high the light will flash rapidly.

Two of these amplifiers are employed in each of the metering indicator circuits. A variable resistor in series with the input to the first amplifier allows zero VU to be adjusted for outputs in the range of 100mV to 3V.

If a single transient exceeds a preset level the indicator light will flash for approx 100 ms. This will allow the "transient" to be seen and thus act as a warning. On a continuous overload the light will flash rapidly. With the ETI413 amplifier this level should be approx IV rms.

Radio astronomy for amateurs

PART IX In this, the concluding article in the series, Roger Harrison answers a number of readers' queries — and describes how the completed system may be used.

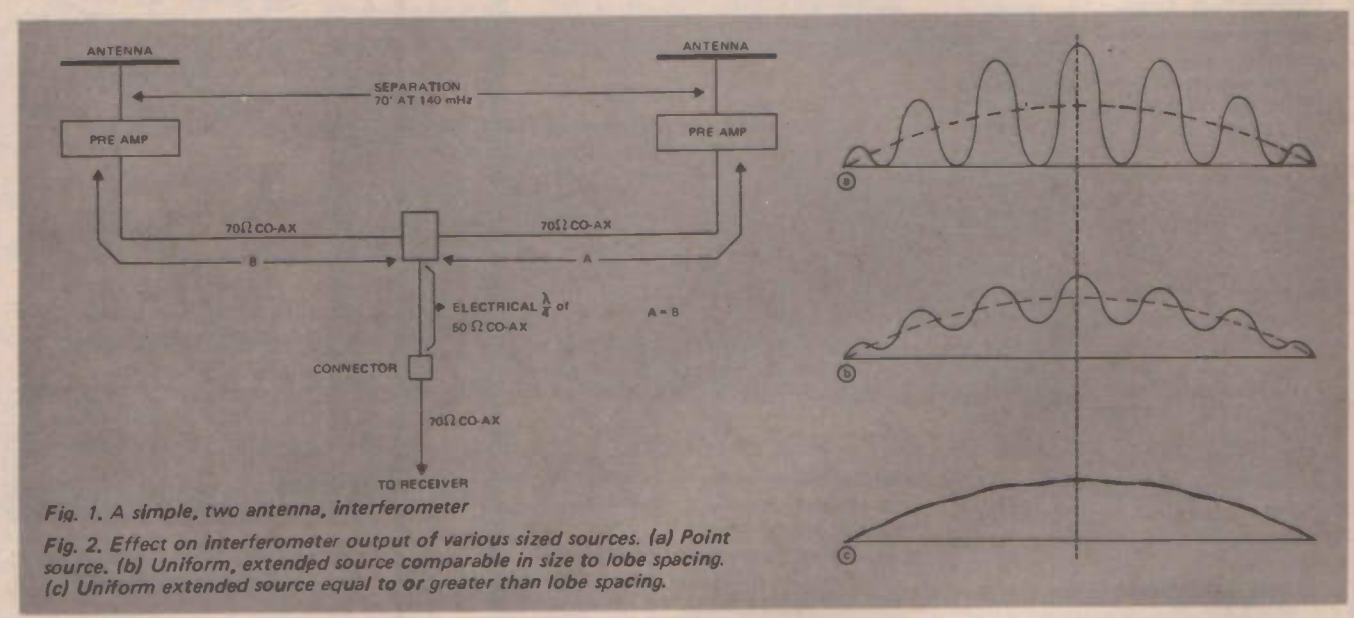


Fig. 1. A simple, two antenna, interferometer

Fig. 2. Effect on interferometer output of various sized sources. (a) Point source. (b) Uniform, extended source comparable in size to lobe spacing. (c) Uniform extended source equal to or greater than lobe spacing.

VARIOUS interferometers were discussed and outlined in Part 3 of this series (ETI, Feb. 1972). A number of readers have expressed interest in constructing such an instrument — complex interferometers are beyond the scope of this series, but here are details of a simple two-aerial system.

All that is necessary is to construct a second antenna array, duplicating the one you have (or intend to use) and couple them together as shown in Fig. 1. Pre-amplifiers will be necessary at the antenna so as to overcome the losses introduced by the long runs of coaxial cable.

Separation of the antennae should be eight to ten wavelengths or more, although initially, five wavelengths would be satisfactory to test the system. At 140MHz, ten wavelengths is exactly 70ft. Don't forget that this separation is measured centre-to-centre of the antenna arrays.

The two antennae should be set up on an East-West baseline. This is best done using a map of your local area that shows true North and Magnetic North. Using a magnetic compass, and allowing for the magnetic declination, determine true East and West with respect to your property and locate the antennae accordingly.

The coaxial cable marked A and B on Fig. 1 must be equal in length as far as possible. A variation of ½" (at most) is allowable. This includes connectors. If the two antennae are designed and constructed to match 70 ohms then a simple linear transformer of 50 ohm coaxial cable (as shown in Fig. 1) will transform the impedance back to 70 ohms to match the receiver input and feed line. All the cables should be run so that no strain is placed on them.

To use the interferometer, the antennae should be aimed such that they face the zenith or at a fixed elevation from the horizon. Each antenna should be parallel and aligned with the baseline or at right angles to it, depending on antenna type used. A suggested elevation (to begin with) would be 30° above the horizon. The narrowest part of the antenna beam should run N-S.

RESOLVING POWER

The ability of an interferometer to distinguish two sources, or resolve a

small source, depends on the distance between the antennae (as this determines the width of the lobes or fringes) and the width of the fringes.

The effect of various sources on a simple interferometer is shown in Fig. 2.

The fringe width of this simple interferometer can be obtained from the following formula:—

$$\text{Fringe width} = \frac{57.3^\circ}{2D \text{ (in wavelengths)}}$$

This gives a value half the spacing between the first null points, which is equal to the width of the fringes. Thus, in the above case, with a spacing of ten wavelengths, the spacing of the fringes (or null points) is 5.73°, the fringe width is 2.86°.

When using the interferometer, an appropriate chart speed should be used. The earth revolves at about one degree of arc every four minutes. Thus, for the above case, it would take 23 minutes to pass from one null to the next. A chart speed of ½" to 1" per hour would be excellent under these circumstances. For wider spacings, slower chart speeds should be used.

THE PHASE SWITCHED INTERFEROMETER

A brief description of this type of interferometer was covered in the third part of this series (ETI, Feb 1972). Briefly reiterating, the phase-switched interferometer varies the electrical separation between the two antennae at a fast rate (typically 300H to 1kHz) such that the nulls and peaks produced by the antennae reverse positions (or phase) at the same rate. Receiver detection is synchronised with the switching rate. It is primarily used for detecting small sources.

The simplest means of using this technique is to switch an electrical half wavelength of transmission line in and out of one of the antenna feed lines. A solid state switch using diodes (having the appropriate characteristics) is preferred to mechanical switching. Suitable detectors are described in some of the references I have mentioned previously. (Wireless World, Aug, 1972 has an article on phase sensitive detectors.) The detector should be preceeded by a selective amplifier tuned to the switch frequency.

THE ROTATING LOBE INTERFEROMETER

Also described in Part 3, this technique employs quite simple circuitry. Cost is increased over a simple radiometer or interferometer as two complete receiving systems, but with a common local oscillator, are used. The phase difference between the two signal paths from separate antennae, is varied by varying the phase of the local oscillator of one receiver with respect to the other. This could readily be achieved using a varicap diode driven by an appropriate function generator. However, the phase stability of each separate receiver, and of the local oscillator itself has to be of a high order, otherwise errors are generated in the system. Suitable test equipment to measure the phase stability and align the system would have to be available.

THE RYLE AND VONBERG RADIOMETER

The simple radiometer is limited in its ultimate sensitivity by the inherent gain and phase stability of the simple TRF or superhet circuitry. In Part 3 I discussed the Dicke comparison system and the Ryle and Vonberg systems, both of which improve the sensitivity of a radiometer by removing the dependence of the sensitivity of the system on the phase and gain stability. This is achieved by comparing the input with a reference

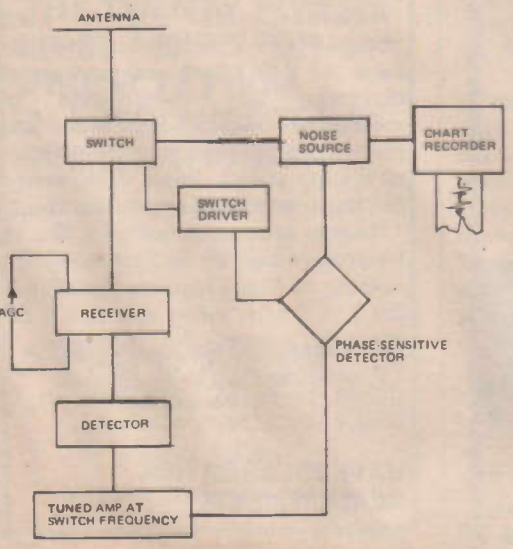


Fig. 3. The Ryle-and-Vonberg radiometer system.

noise source. The Ryle and Vonberg system is the most sensitive and only slightly more difficult to construct in practice. A block diagram is shown in Fig. 3.

It is beyond the scope of this article to describe the complete construction but here are a few suggestions to assist those who wish to tackle development themselves.

The switch should use solid-state techniques. PIN diodes would be excellent in this application as would hot carrier diodes. The noise source could be solid state but the temperature-limited thermionic diodes (described previously) would be better. The receiver is nothing special and could use straightforward TRF or superhet techniques. The complete receiver (except the front end, perhaps, at VHF) could use some of the newly released IC's (i.e. Plessey SL600 series). The tuned amplifier could readily use a cheap op-amp. IC such as the LM301 or uA709.

The phase-sensitive detector I have mentioned previously. The article in "Wireless World", August 1972 describes a solid-state p.s.d. which would be eminently suited to this application. The output would be used to drive a dc-amp/regulator which varies the current supplied to the filament of the noise source; assuming the use of the thermionic diode variety.

The anode current of the noise diode then drives the chart recorder as it is directly proportional to the noise output of the diode. As can be seen, the whole system forms a servo-loop such that the noise source output is made to equal the noise input of the receiver.

The switch and the phase-sensitive detector, should be driven from a multivibrator at a convenient frequency. Avoid multiples of the mains frequency, as this can cause troubles with hum pickup. A frequency between 300Hz and 1kHz is often used in practice.

THE RADIO SPECTROMETER

These instruments generally operate in the upper UHF to SHF range, beginning at about 1000 mHz or 1GHz. Low noise receiving techniques become increasingly difficult in this region. However, high gain antennae are readily constructed and details of suitable antennae were published in "The Victorian VHFer" for August and September 1972. This magazine is published by the VHF Group of the Victorian Division of the Wireless Institute of Australia.

Basically, the radio spectrometer or spectrograph takes two forms. The swept frequency type and the multichannel type. These were described briefly in Part 3 also and I refer to Figs 27 and 28 in that article.

The swept frequency type employs straightforward techniques. The receiver itself could be of the Ryle and Vonberg type having the local oscillator swept over a suitable frequency range. The local oscillator could simply be a suitable oscillator having its frequency varied by mechanically driving a capacitor with a motor — or driving a varicap diode with a ramp or stairstep generator. Alternatively, a frequency synthesizer could be used.

A fairly fast recording speed is necessary, the speed of which must have some known relationship to the rate of change of frequency. Frequency markers at suitable intervals would be well worth including. The rate of change of frequency must be considerably less than the integration time employed at the detector, else spectral lines will be removed by the integrator. Consequent to these requirements, the stability of the local oscillator must be quite high. A frequency synthesizer or phase-locked local oscillator is thus preferred.

The multichannel radio spectrograph employs a wideband receiver followed by a bank of filters and detectors. This is actually a more complex technique than the swept frequency type as the gain and phase stability of the system must be very good if accurate measurements are to be made. Wideband receivers at the frequencies used for these observations present relatively few difficulties. It is the multiple filters that provide the problems.

However, for short term observations, a simple receiver and bank of LC filters and appropriate detectors will demonstrate the techniques involved and show what results can be expected. Observations of the sun using a simple instrument of this type produces interesting results.

If the system is centred on the hydrogen line at 1420 MHz and a number of filters spaced every 500kHz for 1 or 2 MHz either side (i.e. 5 or 9 channels respectively) differences in the output levels of each channel should be noted, depending on the cosmic source being observed.

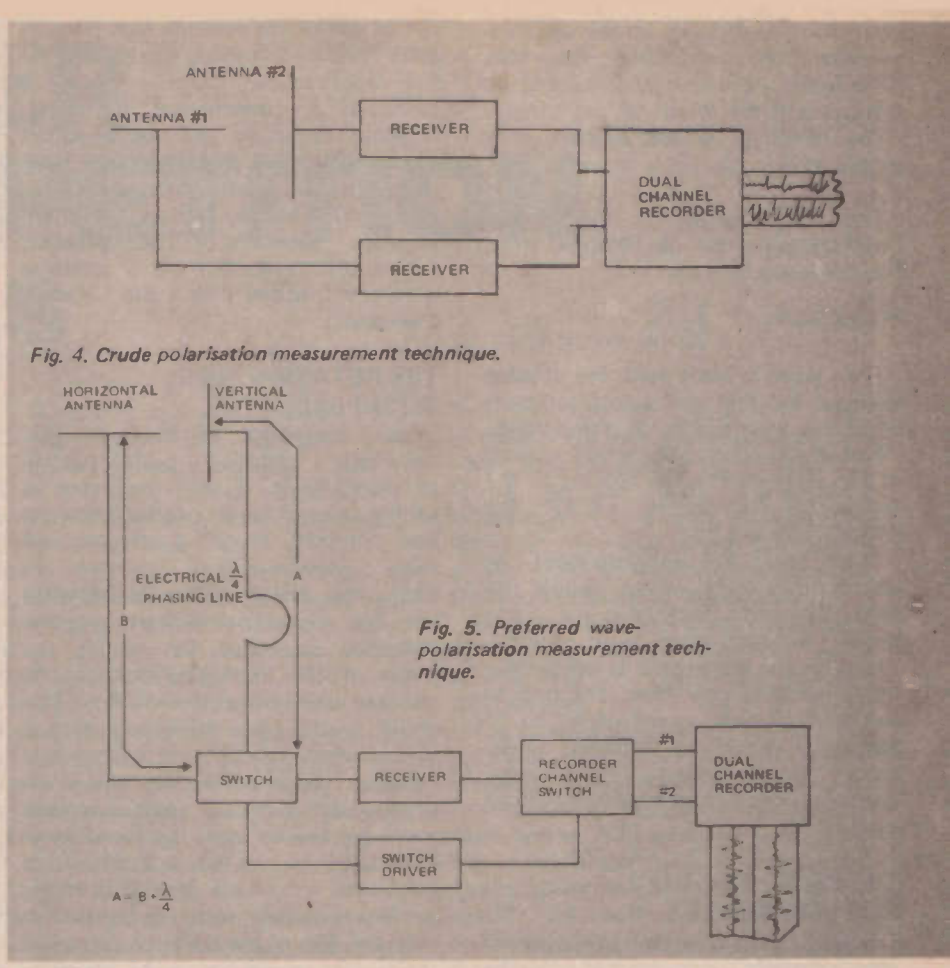
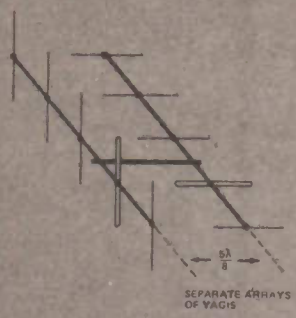


Fig. 4. Crude polarisation measurement technique.

Fig. 5. Preferred wave-polarisation measurement technique.

WAVE POLARISATION MEASUREMENTS

Cosmic noise radiation is not



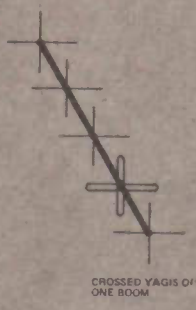


Fig. 6. Antenna arrangements for wave-polarisation measurements.

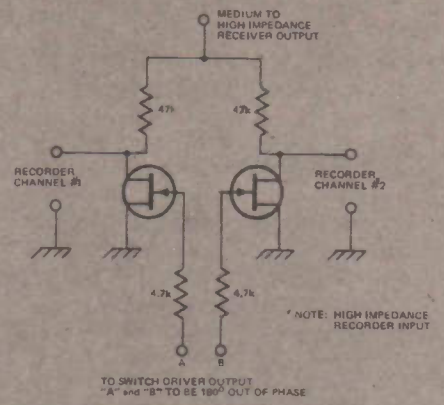
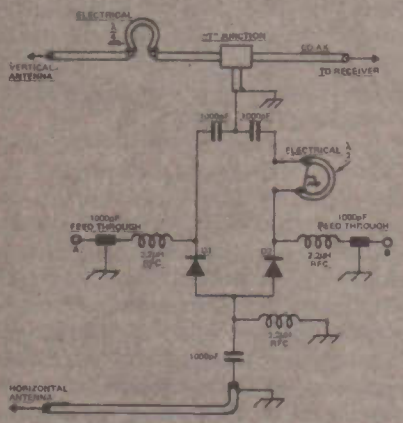


Fig. 8. Recorder channel switching.



A & B to switch driver, 180° out of phase, square wave.

Note: Mount in weather-proof box. All leads as short as possible. Use coax connectors for all cable connections. Alternatively, wire all together and encapsulate.

Fig. 7. Antenna switch for polarisation measurements.

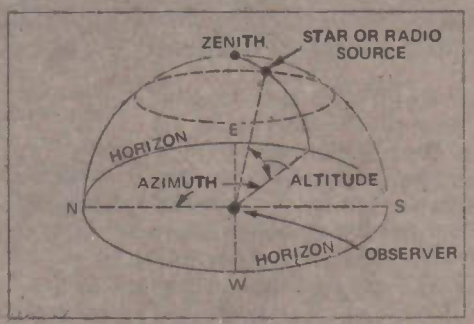


Fig. 9. Illustrating the meaning of the terms Azimuth and Altitude.

necessarily linearly polarised. Apart from this, radiations from some noise sources undergo wave-polarisation under certain conditions. Noise radiations from the sun undergo polarisation changes with varying activity associated with sunspots and flares. Measurements of polarisation changes of solar noise can readily be undertaken with only simple changes necessary to the equipment already outlined for use at 140MHz.

There are two methods of going about this. The first involves using two separate receiving setups, on the same frequency, with antennae placed such that they receive separately polarised components of the solar emissions. I do not recommend this system (illustrated in Fig 4.) as the phase and gain stability must be very good for both systems. Results yielded are also limited.

The second system, shown in the block diagram of Fig. 5 is the better one. Two, linearly polarised antennae, such as a Yagi array are mounted at right angles, either 5/8 wavelength apart, or with the elements on the same boom, are employed as the antenna (See Fig. 6) They are fed separately, 90° out of phase. This is accomplished using an extra electrical quaterwavelength of line as shown in Fig. 5. The aerial switch changes the polarisation of the antenna from left-circular to right-circular at a fast rate, usually between 300 Hz and 1kHz. A switch changes the receiver output from one channel to the other of the output recorder, in synchronism with the antenna switch. The integration time of the receiver detector is sufficiently long to remove the effects of the switching. The receiver is straightforward and can employ any of the techniques mentioned previously.

A circuit of a suitable antenna switch is shown in Fig. 7. The diodes, D1 and D2 can be germanium types such as the OA9 or perhaps, better still, hot carrier diodes.

A circuit for channel switching the receiver output to the dual channel recorder is shown in Fig. 8. Any common, general-purpose FET will suit. If a low impedance receiver output/recorder input is used, suitable transistors can be used with appropriate component value changes.

Instead of the dual-channel recorder shown, two similar chart recorders can be used. However, comparison of the records is more difficult.

If the polarisation changes during the observation period, the peaks of radiation will be displaced with respect to each other.

Instead of the Yagi antennae suggested, two helical antennae could be used. One set for right hand circular polarisation, the other for left-hand. Switching between the two antennae would then be necessary.

ASTRONOMICAL TERMS AND CO-ORDINATES

The position of a celestial object can be defined in several ways.

There are three co-ordinate systems in use in radio astronomy to define the position of objects: viz. the *Altitude and Azimuth* are specified at a particular place and time on the earth; *Right Ascension and Declination* or *Equatorial Co-ordinates*, defines a point with respect to the earth's celestial axis; and the *Galactic Latitude and Longitude.* Practically speaking, the first two are easier to use and are most common in popular literature relating to radio astronomy. I recommend you buy a basic text on astronomy if you wish to gain a

thorough understanding of the systems described. I will describe the *Altitude-Azimuth* and *Right Ascension and Declination* systems of co-ordinates briefly to familiarise you with the subject.

THE ALTITUDE-ASIMUTH SYSTEM

A diagram illustrating this system is shown in Fig. 9.

The term AZIMUTH is the angular distance, in degrees, measured around a horizontal circle which coincides with the visible horizon. By convention it is measured geographical North, clockwise, through East, South West, back to North. Thus, East is at 90° South at 180° and West at 270°. North is either 0° or 360°. In the figure shown, for example, the azimuth might be read as "Azimuth 110°".

The term ALTITUDE is the angular distance from the horizon up to the position of the object observed and is usually specified in degrees. The plane defined by the zenith, the observer and the object, will intersect the plane of the horizon circle at an angle, with respect to the North reference of the horizon circle, which defines the azimuth.

The Alt-Azimuth system is sometimes called the horizon system of co-ordinates.

Antenna systems are often constructed to be steerable in these co-ordinates (in engineering terms also referred to elevation-azimuth). It is a simple system, as only two axis are involved. The object of interest also has to be specified at a particular time for the alt-azimuth co-ordinates given. The time specified is either given in *Greenwich Mean Time* (GMT) with corrections, or in *Sidereal Time*. I will explain Sidereal Time shortly.

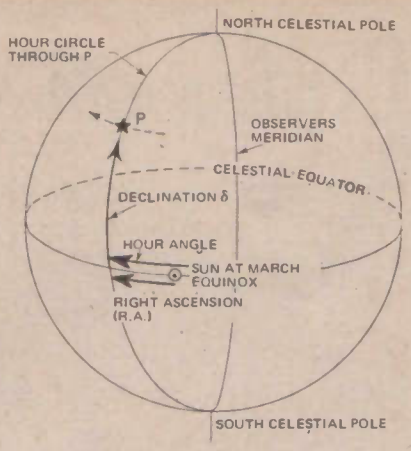


Fig. 10. Equatorial co-ordinates of a point P in the sky. The essential concepts include declination, hour angle, and right ascension. The first angle is usually specified in degrees, etc., and the latter two in units of sidereal time. The reference system undergoes slow changes of the order of a degree per century, owing to precession.

THE EQUATORIAL CO-OROINATE SYSTEM

The concepts of right ascension and declination are illustrated in Fig. 10.

The 'hour circle' corresponds to a geographic meridian, the plane of which passes through P. The "hour angle" is the angle between the observer's meridian plane and the plane of the hour circle passing through P. The "Right ascension" (often designated R.A. or a Greek Letter 'alpha') corresponds to the geographic longitude. Note that the celestial "Greenwich Meridian" or zero longitude, passes through the sun at the March Equinox at a right angle. "Declination" corresponds to geographic latitude and is often designated by the Greek letter 'delta'.

Declination is specified in angular measure whereas hour angle and right ascension are expressed in units of sidereal time.

SIDEREAL TIME

Sidereal Time differs from ordinary astronomical time by an acceleration of 10 seconds each hour or about four minutes per day. Time in these units is reckoned from tables in a nautical almanac; being taken from the entry of the first point of ARIES which occurs between 21st and 23rd March each year. Zero hour right ascension is thus defined. This is the autumnal equinox in the southern hemisphere and the vernal equinox in the northern hemisphere.

Table 1 summarises sidereal time for noon G.M.T. for each day of the year. It is only approximate but errors are not significant within the limits of the systems described. Any source will be within the beam of the antenna if the values given are used.

To obtain local sidereal time, simply add the appropriate number of hours for your meridian; i.e. Sydney is very close to 150° East longitude which is 10 hours advanced on G.M.T. Thus for local noon sidereal time, simply add 10 hours to the values given. For other times of day, add or subtract, the appropriate number of hours (depending on whether the local time is before or after noon) to the local sidereal noon time.

MAKING OBSERVATIONS

It is essential to keep a log of operations. Preferably, two logs should be kept — one detailing modifications, faults etc. — and the other giving relevant details of the observations being performed. e.g. date/time, calibration levels and results, weather conditions, control settings, antenna position, source being observed, type of observation (i.e. polarisation, interferometer) etc.

(Continued on page 94)

TABLE I

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1840	2043	2237	0039	0237	0440	0638	0840	1042	1241	1443	1641
2	1844	2046	2241	0043	0241	0443	0642	0844	1046	1244	1447	1645
3	1848	2050	2245	0047	0245	0447	0646	0848	1050	1248	1451	1649
4	1852	2054	2249	0051	0249	0451	0650	0852	1054	1252	1455	1653
5	1856	2058	2253	0055	0253	0455	0654	0856	1958	1256	1459	1657
6	1900	2102	2257	0059	0257	0459	0658	0900	1102	1300	1502	1701
7	1904	2106	2300	0103	0301	0503	0701	0904	1106	1304	1506	1705
8	1908	2110	2304	0107	0305	0507	0705	0907	1110	1308	1500	1709
9	1912	2114	2308	0111	0309	0511	0709	0912	1114	1312	1514	1713
10	1916	2118	2312	0115	0313	0515	0713	0916	1118	1326	1518	1717
11	1920	2122	2316	1118	0317	0519	0717	0919	1122	1320	1522	1720
12	1924	2126	2320	0122	0321	0523	0723	0923	1126	1324	1526	1724
13	1928	2130	2324	0126	0325	0527	0725	0927	1130	1328	1530	1728
14	1932	2134	2328	0130	0329	0531	0729	0931	1134	1332	1534	1732
15	1935	2138	2332	0134	0333	0535	0733	0935	1137	1336	1538	1736
16	1939	2142	2336	0138	0336	0539	0737	0939	1141	1340	1542	1740
17	1943	2146	2340	0142	0340	0543	0741	0943	1145	1344	1546	1744
18	1947	2150	2344	0146	0344	0547	0745	0947	1149	1348	1550	1748
19	1951	2153	2348	0150	0348	0551	0749	0951	1143	1352	1554	1752
20	1955	2157	2352	0154	0352	0554	0753	0955	1157	1355	1558	1756
21	1959	2201	2356	0158	0356	0558	0757	0959	1201	1359	1602	1800
22	2003	2205	2400	0202	0400	0602	0801	1003	1205	1403	1606	1804
23	2007	2209	0004	0206	0404	0606	0805	1007	1209	1407	1610	1808
24	2011	2213	0008	0210	0408	0610	0809	1011	1213	1411	1613	1812
25	2015	2217	0011	0214	0412	0614	0812	1015	1217	1415	1617	1816
26	2019	2221	0015	0217	0416	0618	0816	1019	1221	1419	1621	1820
27	2023	2225	0019	0222	0420	0622	0820	1023	1225	1423	1625	1824
28	2027	2229	0023	0226	0424	0626	0824	1027	1229	1427	1629	1828
29	2031	2233	0027	0229	0428	0630	0828	1030	1233	1431	1633	1831
30	2035		0031	0233	0432	0634	0832	1034	1237	1435	1637	1835
31	2039		0035		0436		0836	1038		1439		1839

Approximate sidereal time for noon GMT for each day of the year. To obtain local sidereal time, add the appropriate number of tours for your meridian — i.e. for Sydney (close to 150° East) add 10 hours to value given.

TABLE II

Name or Designation	Right Ascension		Declination		Remarks
	hours	minutes	degrees	minutes	
Andromeda	00	40	40°	50'	
Bootes	14	10	51°	30'	
Cassiopea	00	22	64°	15'	
Cassiopea	23	21	58°	35'	Supernova Galactic Nebulosity
Cygnus	19	58	40°	35'	Colliding Galaxies
Cygnus	20	22	40°		Extended Source
Centaurus	12	22	-42°	37'	
Crater	11	38	-15°	02'	
Gemini	06	13	22°	38'	
Crab Nebula	05	30	22°		
Hydra	09	16	-12°		
Puppis	08	20	-42°	30'	Galactic Nebulosity
Taurus	05	35	22°	04'	Crab Nebula
Ursa Major	09	51	69°		
Vela	10	10	42°	30'	
Virgo	12	28	12°	41'	

This is a short list of radio-active sources.

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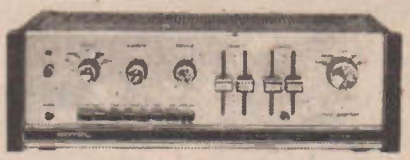

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TRACKING THE SOURCE

There are two ways of mounting and rotating an antenna if it is desired to observe a single object, for the example the sun.

The first is to use an azimuth-altitude mount for the antenna. This method has the drawback that, to enable such a system to keep the antenna pointed at a fixed source, while the earth rotates, both axis need to be driven. For short term observations, this can be done manually, using a table of azimuth and altitude of the object being observed, for the time of the observations. For observations lasting more than one or two hours, correcting the azimuth and elevation angles at short intervals becomes tedious.

A better system is the "polar" or "equatorial" mount. In this system only one axis has to be moved, or rotated, to account for the rotation of the earth. Optical telescopes employ this mounting method.

A diagram is shown in Fig. 11. The main axis is parallel to the earth's axis of rotation. The angle this axis makes with the horizontal is equal to the latitude of the observer's station. Thus, for a station located at 32° south latitude, this angle (angle A in Fig. 11) will be 32°. The angle that the axis of the main antenna lobe makes with the equatorial axis can be varied such that the antenna can be aimed at a particular declination. This system is particularly useful with the astronomical co-ordinates of right ascension and declination. To compensate for the earth's rotation, the equatorial axis is driven in the direction OPPOSITE to the rotation of the earth at an angular rate equal to the earth's rotation. This is derived from sidereal time and is a little more than 15°/ordinary hour.

In the southern hemisphere, the altitude of the equatorial axis is reckoned NORTHWARDS. The opposite applies to the northern hemisphere.

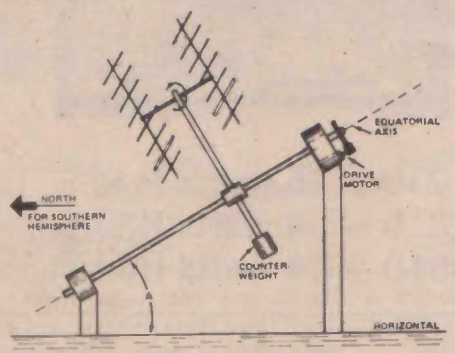


Fig. 11. Polar or equatorial mount.

Make a number of trial observations with each new technique to familiarize yourself with the equipment, the methods involved and the expected results.

A list of strong sources is given in Table 2.

It is useful and extremely instructive to make a radio map of the sky. The method employed involves two things:

(a) A suitable scanning program
(b) Appropriate changes in altitude or declination

The altitude or declination settings will depend on the vertical beam width of the antenna used.

A number of scans will be necessary. In the case of a drift radiometer or interferometer, this involves leaving the antenna altitude set at the same position for several days. This allows for effects of the ionosphere to be taken into account. Usually, a scan of four to six days at each altitude setting is sufficient. The procedure is thus outlined:—

(a) Set the altitude to the appropriate angle, depending on vertical beamwidth.
(b) Record the runs each day.
(c) Carefully log appropriate details.
(d) Do calibrations AT LEAST every eight to twelve hours.
(e) Compare records, side by side, or by overlaying them with a strong light underneath.

Make careful notes of any unusual features. It should be possible to sort out interference from cosmic sources.

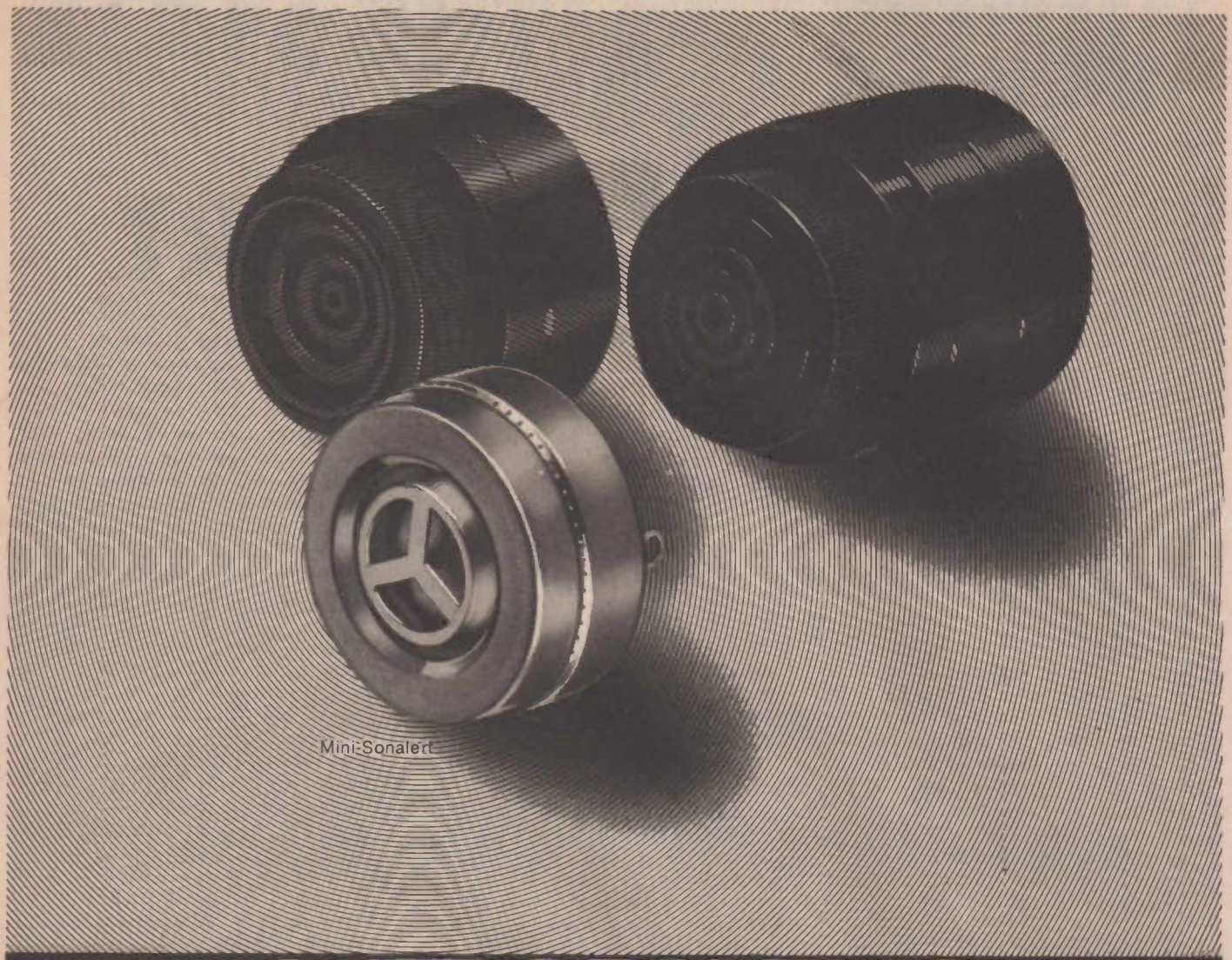
A month or six weeks of such observations should yield a reasonable set of data from which a map can be compiled. Make appropriate corrections, according to the calibration data, where necessary.

Maps are usually drawn using the co-ordinates of galactic latitude and longitude. Converting right ascension and declination, or equatorial co-ordinates, to galactic co-ordinates is best done using tables. Modern tables can be found in many texts on astronomy.

This, the last article in this series, concludes this feature on Radio Astronomy. I trust that you obtain as much enjoyment from your pursuits as I have — who knows — perhaps you may be able to make some contribution towards this fascinating "new" science.

Roger Harrison
VK2ZTB

Watch out for another fascinating new series — written specifically for the radio amateur/experimentor by Roger Harrison — starting in Electronics Today International very soon.



INTRODUCING MINI-SONALERT

Mini-Sonalert is the latest addition to the Mallory range of electronic audible signalling devices.

It is compact, lightweight and highly versatile, consumes less current than a normal indicator light and can be used to complement visual signals. The Mini-Sonalert employs the same solid state circuitry as the larger SC628 and SC628P models, also illustrated, to ensure maximum efficiency, lowest current requirements and highest reliability.

Instant, positive and penetrating audible warnings are emitted, making this miniature device ideally suited for use in fault alarms for computers, fire signals, instruments, medical electronics, appliances, communications, telephone signals and protection equipment.

Five Mini-Sonalert models are available in operating voltages ranging from 1 to 30 VDC whilst corresponding current requirements range from 4 to 16 mA.

Sound output is from 60 to 70 db @ 25°C at a frequency of 3,500 Hz ± 500 Hz (depending on model and applied voltage).

All models are available ex stock.

Literature is available on request to the Professional Components Division.

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AMATEUR RADIO

Roger Harrison VK2ZTB

THE STATE OF THE ART

THE variety of interests that absorb amateurs is extraordinary. The amateur licence permits an enormous amount of latitude in this respect. Some highly successful research programmes by individual amateurs and small groups have made real contributions to the advancement of the state of the art of communications.

Back in the 1920's and 1930's it was Ross Hull, an Australian amateur – living in America – who researched tropospheric VHF propagation and was the first to explain the theory of air mass boundary bending of VHF radio waves. Propagation tests in the HF spectrum during the same era, involving large groups of amateurs in many countries, helped map out the vagaries of the ionosphere.

Research work is still carried out by amateurs throughout the world. In Great Britain R. A. Ham FRAS, a member of the British Astronomical Association and the Radio Society of Great Britain has constructed his own observatory for studying the relation between various natural phenonema and propagation on both VHF and HF. Ham's private observatory has facilities for monitoring a variety of VHF beacons for auroral, meteor scatter, tropospheric scatter and ducting, and sporadic E propagation. He has two radio telescopes, one on 95MHz and one on 136MHz, making daily observations of solar noise. Various propagation events are preceded by solar noise bursts from flares and sunspots which eject complex particles that take up to 40 hours to reach the earth.

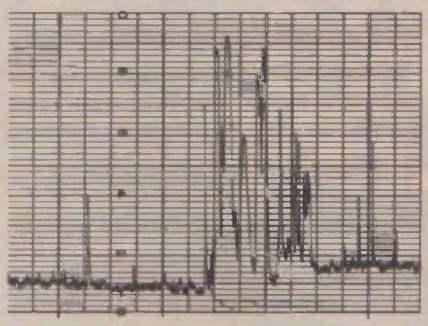
In the field of research into the aurora, northern hemisphere amateurs are well situated. VHF radio waves can be reflected from an auroral "curtain" and thus can be used to provide data on the event. In March 1970 a very active aurora occurred in the northern hemisphere. Many amateurs were able to communicate on VHF by reflecting their signals off the curtain. The beam headings and reports from many amateurs and observations from R. A. Ham provided valuable data for specialist scientific papers written about this event.

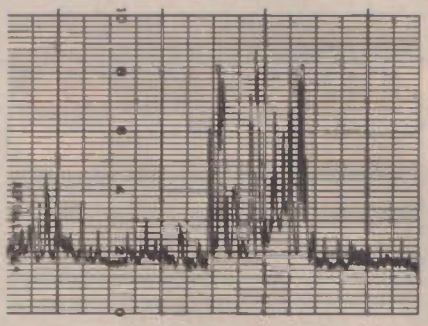
In America a very active small group is the Crawford Hill VHF club who have been making investigations into the communications aspects and problems of moonbounce, or EME communications. They have published an excellent series of reports – the only thing of its kind – not only applicable to EME work but to low noise weak signal UHF communications in general. The reports contain a wealth of practical information on what really are state of the art techniques. Some reports were reprinted in "The Victorian VHFer" last year. Copies should be available from M. Goode, VK3BDL, 92 Mont Albert Road, Canterbury, 3126 Vic.

State of the art techniques are becoming more commonly used by home constructors, particularly at UHF. Designs and articles on up to date techniques appear quite regularly in the "underground" amateur literature. It is becoming increasingly easier to build equipment capable of a high standard of performance – many avenues of choice are open.

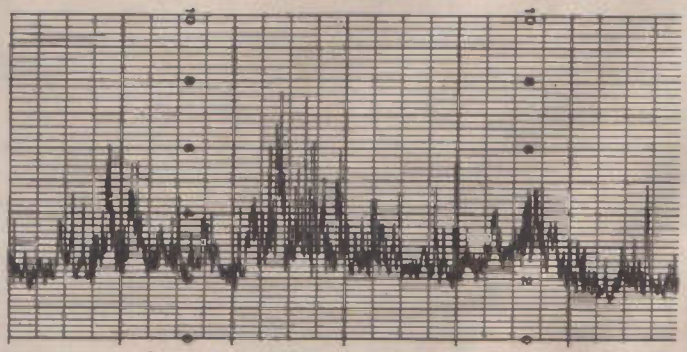
To close off I would like to mention an historic event in Australian amateur history. In the second last week of February, Ron Wilkinson, VK3AKC worked W2NFA, the Crawford Hill VHF Club on 1296MHz moonbounce. Ron gave a report of 559 and received 539. The transmission mode was CW. Ron is located in Geelong in Victoria and the Crawford Hill VHF Club is located in New Jersey, USA. This is the first time that 1296MHz moonbounce has been achieved by an Australian amateur. Ron has spent some two years working towards this singularly fine achievement. Congratulations Ron. ●

Recordings made by Mr. R. A. Ham





Typical individual solar burst – recorded at two frequencies, TOP: 95 MHz, LOWER: 136 MHz duration – two minutes.



A 12 minute recording showing a typical solar noise storm. Frequency of recording was 136 MHz.

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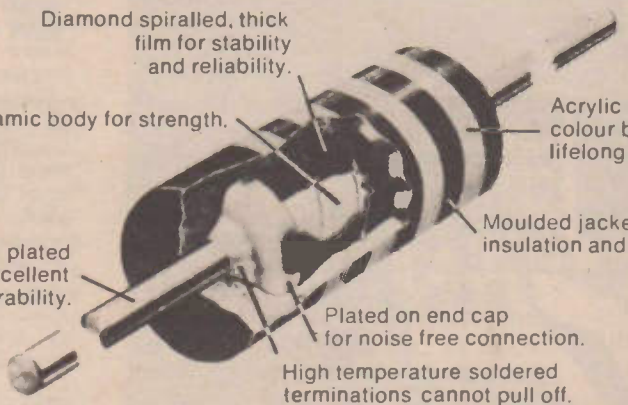

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LOGIC TEST UNIT

The Log 36 unit, developed by Siemens, is used for testing the logic functions of printed-circuit boards and integrated circuits. The unit is said to make it easier and simpler to trace faults at the commissioning stage or when carrying out repairs on equipment or plant. The predetermined function of a logic circuit between its input and output signals can be quickly and reliably checked. Dynamic measurements are also possible on externally connected peripheral recorders.

The input bit patterns are programmed via bounce-free signal switches and the logic states of the outputs are displayed on a panel by glow lamps. The input signals are connected to the input pins of the test specimen and the output signals to the lamp panel by means of jumpers. 31 and 54-pin printed-circuit boards and integrated circuits can be plugged directly into the socket receptacles of the test unit, but adapters are required for non-standard printed-circuit boards.

The supply voltage for the test specimen is obtained from a stabilised and short-circuit-proof power supply unit having a fixed output voltage of 5 V or a variable output voltage of 4.5 to 5.5 V. Other operating voltages can be supplied from an external source.

Whereas printed-circuit boards can only be tested functionally with the Log 36 unit, it is possible to locate the source of fault, e.g. a defective IC package within a printed-circuit board, by using a TTL test probe (internal resistance approx. 40kΩ) to trace a faulty signal path within the circuit. The signal state is displayed by three coloured rings which light up in the head of the test probe.

Further details from Siemens Aktiengesellschaft, Presseabteilung, D-8520 Erlangen 2, Postfach 325, Federal Republic of Germany.

SELECTIVE LEVEL AND VOLTAGE METER

As a rule, the lowest magnitude of oscillation which has to be dealt with in electrical instrumentation engineering is 16 2/3Hz, the frequency of the fundamental wave of a traction current. Despite this, the measuring range of the selective level and voltage meter developed by Siemens, which goes up to 60kHz, starts at 10Hz. With the new analyzer D 2040 it is therefore possible to investigate acoustic and mechanical oscillations below the threshold of audibility. The analyzer D 2040 is said to be tunable from 10Hz through 60kHz without band switching, and all the functions of the instrument can be remote controlled

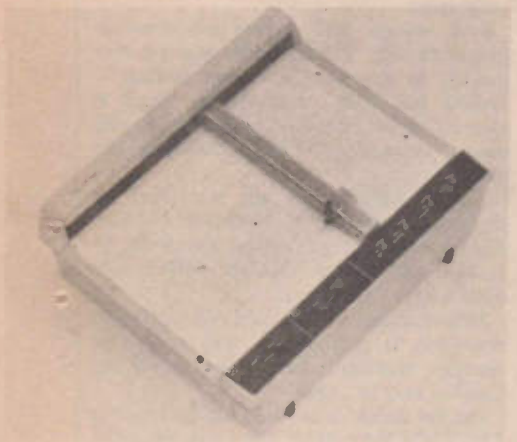
The analyzer D 2040 operates as a superheterodyne receiver, the frequency resolution claimed throughout the entire measuring range of 10Hz to 60kHz is 1Hz. The frequency is set with this resolution and accuracy by a built-in, digitally operating frequency meter. The attenuation of signals which lie only 25Hz above or below the centre frequency of the filter is 60dB, so that for example a 15.05kHz signal can be distinguished from a 15kHz signal. The high selectivity of this narrow-band filter permits the analyzer D 2040 to be used for Fourier analysis as well as for level and voltage measurement. The bandwidth of the receiver can then be switched from 8 to 80Hz, which also applies to the analyzer when used as an active, continuously-tunable filter.

This new measuring device is also designed for determining the spectral density of frequency mixtures and for measuring distortion and mixture products. If the input frequency has to be measured with greater accuracy than the filter width permits, the analyzer can be switched to automatic phase control (APC). When this is done, an oscillator is automatically synchronized. All the switch functions, such as level, input impedance and filter bandwidth, can be remote controlled, and it is also possible to externally influence the frequency setting.

The range of application of the analyzer can be extended even further by using a vibration pickup, which converts mechanical vibrations into electrical values, or a standard microphone, for space and sound analysis. The measuring range extending down to 10Hz permits an investigation of physical vibrations in connection with stability tests and the like with a wide range of possibilities. Acoustic analysis is possible even in the case of frequencies below the threshold of audibility.

Further details from nearest Siemens Office or Siemens Aktiengesellschaft, Presseabteilung, D-8520 Erlangen 2, Postfach 325, Federal Republic of Germany.

HIGH-SPEED OEM X-Y RECORDER



High performance characteristics, notably very fast pen acceleration, are available in a new 11-inch by 17-inch OEM x-y recorder from Hewlett-Packard.

An acceleration of 3000 in/sec^2 on the Y axis and 2000 in/sec^2 on the X axis, coupled with comparable deceleration, results in low overshoot, even though the slewing speed is a relatively fast 30 in/sec. This is an increase in acceleration over the recently introduced Model 7040A of four times on the X axis and three times on the Y axis, and the slewing speed has been increased 50 per cent.

Among the standard options available with the Model 7041A are: basic front-panel controls, English or metric scaling, a virtually limitless choice of calibrated X and Y ranges, a wide range of sweep rates, TTL logic controls, rear connectors, and retransmitting potentiometers.

Standard features include: Autogrip, an electrostatic paper holddown system with no moving parts; long-life, coated slide wires; positive feedback at the pen tip and a recording mechanism that can be driven off scale without noise or damage.

Further details from: Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, Vic 3146.

HOW TO MAKE ACCURATE LOW-RESISTANCE MEASUREMENTS

A new single-page applications bulletin from Hewlett-Packard describes methods for making rapid measurements of resistance in the range from 0.001 to 1 ohm with accuracies of 0.6% or better. Both direct ratio and comparative ratio measurement methods are described. Measurements made using the four-terminal ratio capability of the Hewlett-Packard Model 3450A/B Digital Voltmeter are claimed to be faster than those made with hand operated resistance bridges generally found in standards laboratories. Thus, the use of the automatic DVM provides a means of rapid production testing and calibration, as well as providing the laboratory technician a fast means of comparing working standards with primary resistance standards.

Bulletin L-2 "Accurate Low Resistance Measurements" is available free of charge. Write for your copy to Hewlett-Packard Australia Pty Ltd, 22-26 Weir Street, Glen Iris, Vic 3146.

PRECISION POWER SUPPLIES

Four new high-accuracy dc power supplies introduced by Hewlett-Packard are designed for use as low-cost calibrators, working voltage standards, systems reference supplies or general use laboratory supplies.

Two of the supplies, Models 6114A and 6115A, use four-digit pushbutton switches for rapid and accurate voltage setting. Output voltage accuracy is 0.025% + 1 millivolt; resolution is 200 microvolts. The other two supplies, Models 6104A and 6105A, are designed for uses where the primary application involves remote control. Operating characteristics of all four of these supplies are claimed to be one to two orders of magnitude better than typical laboratory supplies in the same price range.

Models 6104A and 6114A cover the voltage range 0 to 20V, up to 2A and 20 to 40V up to 1A without manual switching. Models 6105A and 6115A cover the voltage range 0 to 50V up to 0.8A and 50 to 100V up to 0.4A. A front-panel current control sets current to any desired value from zero to the maximum current rating. Thus the power supply can be operated as a constant current source with a claimed 0.01% current

regulation. A front-panel LED indicator lights when the present output current or the maximum rated output current for the supply is reached.

Overvoltage protection (a crowbar) is standard on all four models and is adjustable down to 0.5V. The crowbar can be remotely triggered or can itself trigger other crowbars. Crowbar operation is indicated by a front-panel light.

Warmup from a cold start to the output voltage accuracy specification is stated to require less than five minutes. Because of this fast warmup time, these supplies are well suited for use as portable standards or calibrators.

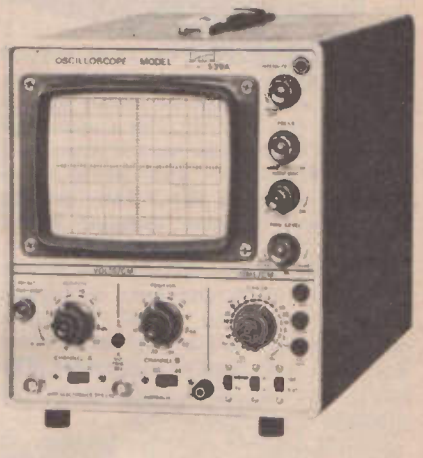
Both voltage and current are remotely programmable. These supplies respond very quickly to new output voltage settings – typical full load programming speed is claimed to be 30 milliseconds over the full output range (a 1.3V per millisecond slew rate).

Voltage and current are monitored on front-panel meters. The Models 6114A and 6115A have a single meter, switchable to voltage or current. Models 6104A and 6105A have two meters.

Auto-tracking, auto-parallel and auto-series operation is possible, as well as remote sensing. Modular construction makes the supplies easy to service.

Further details from: Hewlett-Packard Pty Ltd, 22-26 Weir Street, Glen Iris, Vic 3146.

BWD 539 OSCILLOSCOPE



The following refinements have now been incorporated in the Model 539A BWD Oscilloscope (reviewed in Electronics Today International – November 1972):

Typical bandwidth is now dc to 12MHz-3dB, and rise time is now 30μ sec for both channels, over the sensitivity range 10mV to 50V/cm.

The amplifier response is now flat within 5% over the entire colour video bandwidth. The active sync. separation together with precision triggering enables every waveform applicable to colour T.V. signals to be displayed with complete stability.

Further details from: BWD Electronics Pty Ltd, 331-333 Burke Rd, Gardiner, Vic 3146.

CASSETTE POOLER

Digital Cassette recording is now used by many industries in a wide variety of system applications. The data recorded on the cassette in the majority of these cases

needs to be converted to a medium suitable for entry into a large computer system.

Racal-Thermionic now offer a solution to this problem by the introduction of a cassette pooler which reads the data from the cassette and re-formats it to computer compatible magnetic tape.

Based upon the T7000 computer compatible tape transport, data formatter and buffer store, the pooler system will, accept industrial compatible tape and pool cassettes at the rate of approximately one complete cassette every seventy seconds. Data may be recorded back to the cassette for the use in applications where two-way data transfer is required.

Further details from Tape Recorders Pty Ltd., 47 Talavera Road, North Ryde, 2113.

CROUZET MICROMOTORS AND GEAR BOXES

Relays Pty Ltd, are now handling a large range of Crouzet synchronous micrometers and gearboxes. These motors are available for 240V and 115V 50 Hz and 60 Hz supplies.

The gear boxes 30 cmN (3 cm Kgm) are strong and reliable and are easily mounted and are available without output speeds ranging between 60 rpm and one revolution in 24 hours.

Crouzet Micromotors and Gear Boxes catalogue reference type 82.334 and 82.344 are suitable for timers and industrial or domestic equipment. The dimensional limits for motor and gear box complete are 38.3 mm (1.55") thick and 47 mm (1.85") wide x 65.5 mm (2.6") high.

Further details form: Relays Pty Ltd, Valetta Bldg, Campbell St, Artarmon NSW.

PROGRAMMED CONTROL UNITS FOR INDUSTRIAL PROCESSES

A range of programmed control equipment has been developed by Lee-Dickens Ltd – a UK company – to fill the gap between complex computer-based installations and simple, fixed programming devices. It is particularly suitable for processes involving rapid changes of program – for example, automobile engineering, testing and research of lubricating oils and fuels, and exhaust pollution studies.

Control data are presented on eight-hole punched tape that can be prepared on standard teletypesetting machines. Operators need have no previous programming experience, so that data can be prepared and verified by existing staff.

The equipment is designed on the 'building block' principle enabling large or small systems to be assembled easily. Main part of each system is its tape reader unit, which includes the control logic and power supplies. A typical system would consist of this unit and up to 26 output devices or controllers.

A comprehensive range of peripheral equipment is available, suitable for use in food processing, engine testing, metal finishing, chemical plant and other applications. All are housed in standard DIN-sized instrument cases for panel mounting and unplug from the front for easy servicing.

High-immunity logic is utilised and unplug from the front for easy servicing.

A 'sound' position for the right man...

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Sales Manager (N.S.W.)

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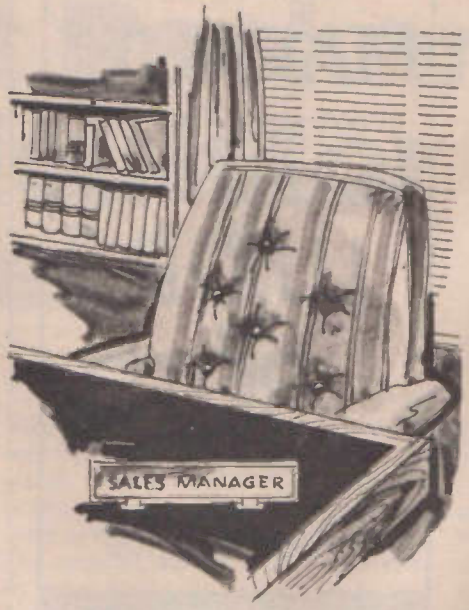

Ferrograph, Memorex, Rectilinear, Stanton and Pentagon all have exciting new products for 1973.

LEROYA INDUSTRIES PTY. LTD., Australia's fastest growing audio wholesalers, are opening a Sydney sales office to service educational authorities, radio and T.V. stations, recording studios, government departments and audio retailers. This is a unique opportunity for an enthusiastic, competent, and trustworthy man to get in on the ground floor and sell some of the world's finest equipment in N.S.W.

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LER 034

environments. All logic connections are fed to the peripherals by multi-way plugs and sockets. A major feature of the design is the system's ability to interface easily with process control equipment.

Further details from: GEC-Elliott Automation, 373 Horsley Road, Milperra, N.S.W. 2214. Also branch in Vic.

NEW RANGE OF ANALOG TAPE RECORDERS

Called SYSTEM 6300, a new range of analog instrumentation tape recorders has been released by Electrodata Associates Pty Ltd. for use in a wide variety of applications. All models in the range are built from common modules so that recording systems can be assembled to suit particular customer requirements. Alternatively, three standard models are available offering 4, 7 and 14 channel operation on ¼, ½ and 1 inch tape.

The fully modular nature of System 6300 enables system costs to be kept to a minimum since no unwanted capability need be purchased. Systems can be updated by adding or changing modules after initial purchase to suit new projects. The servicing ease of fully modular systems is of course a further advantage of System 6300.

This new recording range offers a 64:1 speed range as standard, together with a choice of recording techniques including FM, DR, multiplex and digital to suit a wide variety of applications from long term medical monitoring to fast transient examination.

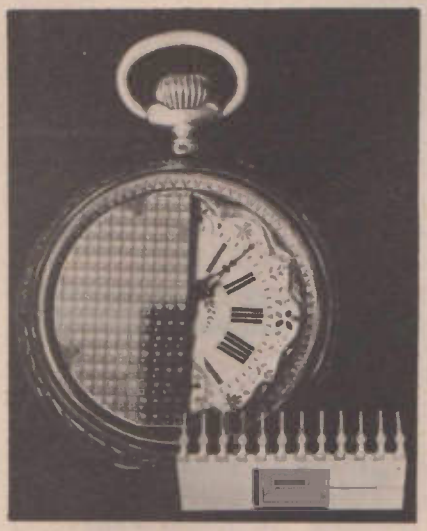
The problem of supplying after-sales technical support, so necessary with sophisticated tape systems is overcome since System 6300 recorders are designed and manufactured in Australia. In addition to support offices throughout Australia, the system designers are readily available to answer the most difficult application problems. Custom engineering is also possible to adapt systems to meet particular customer requirements.

In short System 6300 offers the purchaser a completely versatile, Australian made, modular recording system adaptable to suit his every need, both now and in the future.

Further details from: Electrodata Associates Pty Ltd, 18 Coward St, Mascot, NSW 2020.

COMPONENT NEWS

NOVEL SEMICONDUCTOR STORE RETAINS INFORMATION EVEN AFTER DISCONNECTION OF SUPPLY VOLTAGE



A semiconductor store which can be re-programmed has been developed by Siemens. The module G192 has non-volatile storage facilities, i.e. information is retained even after disconnection of the supply voltage. This characteristic could previously only be obtained with toroidal-core stores. With the mains disconnected, storage times of several months have been measured.

The principle of the store is based on the storing of charges on the insulator of an MOS field-effect transistor. The insulation layer consists of a silicon oxide layer and an adjacent nitride layer, the charge carriers being stored on the interface between the two layers. These charges shift the threshold voltage of the transistor without, however, altering the structure of the semiconductor. This means that information can be written in and erased as often as required. Information is retrieved by applying to a gate a voltage of the appropriate value so that the transistor is then either conducting or cut-off, depending on the stored information. Pulses of +35V and −35V with a length of approx. 50 to 100 μs are required to write in and erase information. The read-out speed is approximately that of normal MOS stores.

The module G 192 is organised on a word basis, in the form of eight words, each of four bits. The information is fed in and read out in parallel. Inputs and outputs are not decoded.

Further details from: Siemens Industries Limited, Melbourne, Sydney, Brisbane, Perth and Newcastle.

DICK SMITH 1973

The second edition of Dick Smith's Electronics Components catalogue for 1973 is now available.

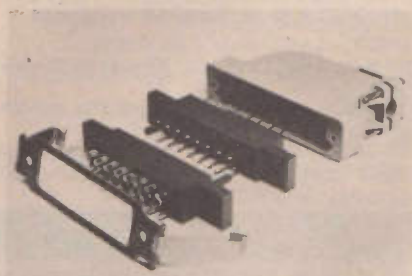
It contains details and prices of a full range of components and equipment for amateur and professional, which are available by mail order.

The catalogue priced at 50 cents is available from:– Dick Smith (Wholesale) Company, 160-2 Pacific Highway, Gore Hill 2065. NSW.

KIT-SETS OPENS IN MELBOURNE

Kit-Sets Aust. Pty. Ltd. have opened their newest retail outlet in Melbourne. Centrally located in the modern air conditioned Richmond Shopping Centre (close to all modes of transport), the new branch incorporates a spacious walk through self-service Dept. for electronic components with a well stocked Hi-Fi centre. Adequate parking for 500 cars is available. Kit-Sets have taken space on the gallery floor utilizing the best facilities and location in this, the newest shopping centre at Richmond.

LOW COST RACK AND PANEL CONNECTOR



Now manufactured by McMurdo (Australia) Pty. Limited, electronic hardware manufacturer, is a connector ideal for rack and panel connection.

The "Multipol" connector is available in three standard versions; 8, 16 and 23 way, with the pins either tintillate or gold plated.

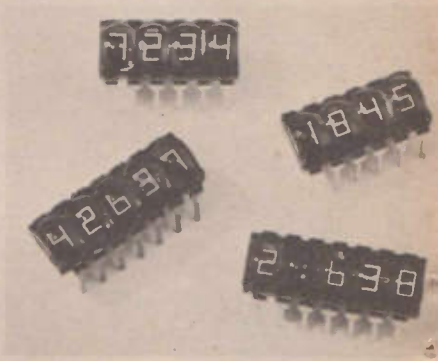
The cable retaining clamp located at the top of the cover is designed for either tap or side entry of cable and a snap-on latch arrangement is also provided to prevent the connector being accidentally dislodged.

Simple polarisation of the connectors is achieved with integrally moulded locator pins.

The "Multipol" connectors are suitable for use by all sections of industry including; electronic equipment manufacturers, broadcasting, television and communications industries.

Further details from: McMurdo (Australia) Pty. Limited, 17-21 Carinish Road, Clayton, 3168.

COMPACT LED DISPLAY



A series of small, end-stackable solid-state displays is now available in three, four and five-digit clusters from Hewlett-Packard. They are used for numeric displays of three or more digits in miniature, battery-powered devices, such as hand-held calculators, or portable instruments where power and space is limited.

These new Model 5082-7400 series are seven-segment monolithic displays 0.11 inches high. Built-in magnification increases apparent luminous intensity, thus reducing power requirements. Options include either the standard right-hand decimal point, or a centred decimal point where good legibility in a multicluster display is desired.

Packages are standard 12 (3 and 4 digits) or 14 (5 digits) pin DIP consisting of a plastic encapsulated lead frame with integral moulded lenses. They are designed to be plugged into DIP sockets or soldered into PC boards. Lead frame construction enables use of standard DIP insertion tools. The shoulders of the lead frame pins areintentionally raised above the bottom of the package so that the display can be tilt mounted up to 20° from the PC board.

For improved contrast, a red dye is incorporated in the plastic to filter out all visible light except the 655 nanometre wavelength emitted by the display. In addition, portions of the lead frame are darkened to reduce reflections.

Since a minimum of 12 pins is required per package, the three-digit clusters come in four-digit packages, with one digit blank. Three digits are thus available in two configurations: flush left and flush right.

These displays are designed for strobed operation and are IC compatible. The decimal point in the Models 5082-7412 through 5082-7415 is located in the lower right of the digit for conventional driving schemes. The Models 5082-7402 through 5082-7405 contain a centrally-located decimal point which is activated in place of a digit.

Further details from: Hewlett-Packard Australia Pty. Ltd. 22-26 Weir Street, Glen Iris, Victoria 3146.

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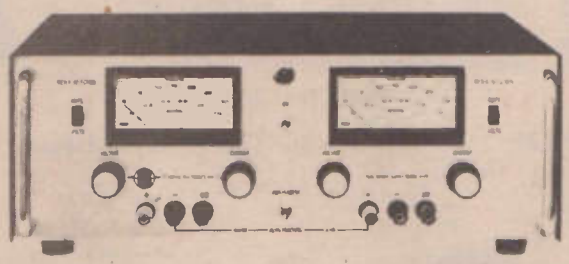

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63 HUME STREET, CROWS NEST, N.S.W. 2065. Telephone: 43-0326.

R.F.1548C

AUDIO NEWS

TARTAN TAPE?

More than 300 Sydney metropolitan retailers attended an unusual presentation last month when the 3M Australia's Magnetic Product Division launched its range of Scotch cassettes.

Highlight of the presentation was an unveiling of two giant sized cassette containers that opened to reveal the cassettes pictured above.

The cassette on the right is the Scotch High Energy model and, according to 3M's press release will run for either 60 or 90 minutes – on both sides.

High Energy cassettes, the press release continues, will give a big impetus to the rapidly increasing popularity of cassette recording!

The cassettes are claimed to provide better playback, and to provide a three to six decibel improvement in signal/noise performance. It is also stated that they are fully compatible – however our reporter states that one cassette proved to be only partly compatible.

Scotch High Energy cassettes have special inbuilt features to reduce distortion and to minimize wow and flutter. They are said to be coated with a special substance to improve high frequency response.

The Low Noise cassette (seen on the right) is claimed to be very sensitive. She is stated to have a dramatically improved signal/noise ratio and to be the ultimate in reliability.

CARTRIDGE TAPE EXCHANGE CLUB

Owners of 8-track car stereo units or home units can now belong to what is claimed to be Australia's most comprehensive tape lending library.

The idea of a tape exchange club for motorists was formulated by Les Baker, Technical Director of Sound House, 12 months ago in association with selected Golden Fleece Service Stations.

This enabled motorists with cartridge or cassette players in their cars to exchange tapes for $1 a time.

The scheme was started off with a library of a little under 1,000 tapes. There are now some 9,000 tapes throughout Victoria, N.S.W. and Queensland, and the numbers are increasing all the time.

Membership of the club costs only $4 per annum. Each member purchases one pre-recorded tape of his choice which can be exchanged at any time convenient to the member. There is no limit as to how long each member keeps a tape.

The service is shortly being extended to S.A. and W.A.

Membership application forms can be gained from selected Golden Fleece Service Stations, or from the Tape Exchange Club Headquarters in each state. For further information write direct to

Sound House Pty. Ltd.,
14 Beatty Avenue,
Armadale VIC 3143

DOLBY LATEST

The following consumer equipment with the Dolby B Noise Reduction System is currently available in various hifi markets of the world:

CASSETTE DECKS

Advent	Model 201
	Model 202
AGS	DS 200
Akai	GXC 46D
	GXC 38D
	GXC 65D
Allied/Radio Shack	SCT-6
Alpha by Highgate	CD 3000
Bell & Howell	Design 1700
Beltek	M1150
Bigston	BSD 200 AS
Concord/Benjamin	Mark IX
	Mark 7
	Studio Z
Craig	2712
	3507
Crown	CTD-270
Denon/Nippon Columbia	TRC 728
Fisher	RC 80B
	SR 110
Harmon-Kardon	CAD 5
	HK 1000
Heathkit	AD 1530
Hitachi	TQR 2000D
Kenwood/Trio	KX 700
Lafayette	RK D40
Marlux	M5000
Nakamichi	Studio Zeta
	SLX
National/Panasonic	RP 969
TEAC	AN 60
	AN 80
	AN 180
	AN 300
National/Panasonic/Technics	
	RS 276 US
	RS 263 US
	RS 279 US
	RS 271 US
	RS 277 US
Otari	MX 500
Pioneer	CT 4040
	CT 4141
Rank-Wharfedale	DC-9
Sansui	SC-700
Sanyo/Otto	RD 4250
	RD 4300
	RD 4350
	RD 4600
	RD 4765
Sharp	RTX 3000
Sony	TC-134 SD
	TC-161 SD
	TC-161 SD
	TC-131 SD
Tandberg	TCD 300
TEAC	A250
	A350
	A450
Teleton	CD 100
Toshiba	PT 490
	PT 470
Wollensak	4760
	4765
	4780
Yamaha/Nippon Gakki	TB 700

NOISE REDUCTION UNITS

Advent	Model 100
Advocate	Model 101
Alpha	DB 6
Concord	DBA 10
Kellar	KDB1
	KDB2
	KDB3
Lamb	220
	420
Lasky's	NRU
Teleton	SNR 100D

OPEN-REEL TAPE RECORDERS

Akai	GX-225D
	GX-285D
Ferrograph	Series Seven
Hitachi	TRQ 7000 D
KLH	Model 41
Revox	A77

TURNERS AND RECEIVERS

Akai	AA 901D
Harmon-Kardon	Citation 14

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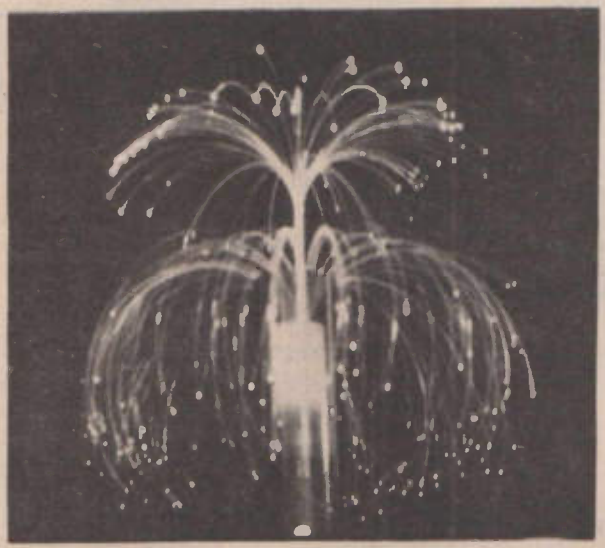

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OP1030	10 mil	mono-fiber	180 feet	$ 2.99
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OP2008	20 mil	mono-fiber	48 feet	$ 2.99
OP2016	20 mil	mono-fiber	96 feet	$ 5.49
OP3003	30 mil	mono-fiber	18 feet	$ 3.23
OP3006	30 mil	mono-fiber	36 feet	$ 5.75
OP4503	45 mil	mono-fiber	18 feet	$ 4.31
OP4506	45 mil	mono-fiber	36 feet	$ 8.27
OP7076	.087 mil	light guide 7 x .017	6 feet	$ 2.75
OP7193	.120 mil	light guide 19 x .017	3 feet	$ 2.75
OP7196	.120 mil	light guide 19 x .017	6 feet	$ 4.67
OP7373	.152 mil	light guide 37 x .017	3 feet	$ 3.35
OP7376	.152 mil	light guide 37 x .017	6 feet	$ 5.87
OP8020	2 low heat light bulbs 3 watt 6.5 volt			$ .71
OP8000	4 channel light head			$ 3.35
OP8030	Eyelet Assortment			$ .95
OP8050	Adhesive end-treat compound			$ 2.99
OP8060	Fiber Optic manual			$ .83
OP8070	Fiber Optic starter kit			$10.63

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TRIO

MODEL CO-1303

This is an all solid state, 75 mm oscilloscope with outstanding performance features — vertical sensitivity of 20 mV/cm, frequency response from DC to 1 MHz — despite its small size and ease of operation. Lightweight and portable, it will prove to be a very handy and reliable instrument in electronic equipment assembly centers, school classrooms and amateur radio stations for a wide range of scope applications.

SPECIAL FEATURES

1. Vertical sensitivity of 20 mV/cm, wideband frequency response from DC to 1 MHz.
2. DC vertical and horizontal amplifiers for wide versatility make possible slow sweep speeds of less than 1 Hz.
3. All solid state construction for compact, lightweight portability.
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PARAMETERS

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Type 8900A

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BOOK REVIEWS

REVIEWERS: Brian Chapman, Jan Vernon

AN INTRODUCTION TO INDUSTRIAL CYBERNETICS AND INSTRUMENTATION. By O.G. Pamley-Evans. Published 1968 by Emmott & Company Limited Manchester. Review copy supplied by publisher. Hard cover, 223 pages 8½" x 5½". Australian price $5.95.

Industrial process control is a most fascinating technology, embracing as it does key features of many disciplines including chemistry, physics, mechanics, instrumentation and electronics. And, as process control is at the heart of any automated plant, whether producing car engines or toothpaste, instrumentation technicians and engineers can be sure of a stable future.

The present volume could not hope to deal exhaustively with every aspect of process control and does not pretend to. It does, quite successfully, give an overall concept of process control and is primarily intended for the technician undertaking a first course.

The text covers the field in a comprehensive, although necessarily brief manner, is well written and would be of value to anyone requiring background training in the subject. – B.C.

TRANSISTOR CIRCUIT DESIGN TABLES By D.S. Taylor. Published 1971 by Butterworth & Co. Ltd. Review copy supplied by publisher. Hard covers, 120 pages 8½" x 5½". Australian price $5.40

This valuable little book contains a set of eight design tables which enable the rapid design of semi-conductor networks containing up to two transistors and their associated RC networks.

The tables are:–

1. Parallel resistance and series capacitance
2. Potential dividers
3. Time constants
4. Capacitor and inductor reactances
5. Common emitter amplifier stages

6 & 7. Transistor astable and monostable circuits

8. Schmitt trigger circuits

Each table is preceded by a section which provides design criteria and helpful hints appropriate to the circuitry described.

The book should be invaluable to those in instrumentation and similar fields, who constantly require to design small interface circuitry. Due to component tolerances and differing transistor characteristics not being taken into account, the tables must be considered to provide a rough guide only. But this is more than adequate for the breadboard stage. – B.C.

ALTERNATIVE PINK PAGES, Written and Published by Philomena Horan and Stephen Wall. P.O. Box 8, Surry Hills, 96 pages. Price $1 ($1.20 including postage). Our copy purchased from Angus and Robertson.

A certain book-reviewer once reviewed the Sydney Telephone Directory. It was a short review, that could be paraphrased as "Not much of a plot but a rich and varied cast of characters".

Our thanks to that legendary book-reviewer, for without that story in mind we might not have thought of reviewing the "Alternative Pink Pages".

It's considerably thinner than the conventional Pink Pages but then the Alternative Pink Pages is not meant to meet the needs of everyone. It's mainly for people who "cannot live happily within the mainstream Australian culture".

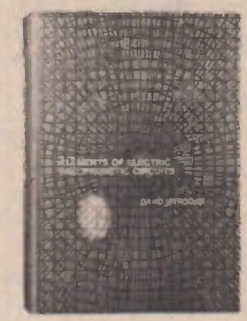
There's all sorts of information – how to find cheap building materials, cheap food, how to find a commune, addresses of consumer groups, ecology people, cheap entertainment, legal aid, astrology classes, urban action groups, yoga and meditation.

The publishers say, "There are alternatives to 9 to 5 jobs, beerdrinking, hire purchase, Valium, forced leisure, suburban living and Spanish furniture". This is what the book is about, an attempt to list what's available as an alternative to our conventional jobs, schooling, life-style and entertainment.

I'm not sure that I have a clear concept of "Mainstream Australian culture". Perhaps I'm not quite in the mainstream myself because I'm interested in the recycling idea and the Alternative Pink Pages gives several places and suggestions for recycling cans, glass and paper. And if I were furnishing a house I'd definitely investigate some of the junk shops listed, instead of getting involved in the new furniture and appliances on hire purchase business.

This is the first issue of the Alternative Pink Pages. The publishers want people to tell them of their experiences with the various services listed in the book, and to suggest any useful services which should be included. The next issue is due this winter.

Even if you are quite firmly and happily established in "mainstream Australian culture" you may still find the Alternative Pink Pages interesting just for the picture it gives of a way of life that some of us rarely make contact with. – J.V.



ELEMENTS OF ELECTRIC AND MAGNETIC CIRCUITS by David Vitrogan. Published 1971 by Holt, Rinehart and Winston Inc. Hard covers, 620 pages 9¼" x 6¼". Review Copy supplied by Holt, Rinehart and Winston (Aust) Pty. Ltd. Australian price $13.65.

This text is designed to provide the basic concepts of electric and magnetic circuit theory for students of electrical engineering.

The electrical section of the text opens with the fundamental concepts and laws of electrical circuits, application of Kirchoff's laws, circuit simplification, network theorems and the transmission of electrical power.

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RECORDINGS classical

REVIEWER: John Araneta

SHOSTAKOVICH – Symphony No. 15 Maxim Shostakovich, Radio-Sym. Orch of the USSR Ariola – Eurodisc 85301 MK

I confess I do not know what to make of this latest symphony of Shostakovich. Personally, I rather think the symphonies following the Tenth have been variable to say the least, and I would not except those supposedly moving protest works nos. 13 and 14 from such a judgement. such a judgement. Critics in the Soviet Union have been rather generous in their estimates of the present work, and it is of course a ready axiom in the minds of most westerners that this fact need not and usually does not convey anything objective about the work in question. By contrast, most western critics have been harsh: this symphony has been labelled banal (very little Shostakovich isn't), over-blown (ditto), and even fashionable (of late a word rarely used in the case of Shostakovich).

Most critics have especially taken exception to the use here of quotation (i.e. from *William Tell, Die Walkure),* an acceptable enough device in more up-to-date music but not so it seems in music as tonal as this. Musical quotation is not exactly a device new to Shostakovich but while it seems to me that critics are quite prepared to grant the ironic use of quotation, it is often forgotten that the use of such device in Shostakovich is only too effective when it is rendered in an almost painfully obvious and banal fashion.

The two fast movements following the Largo in the Sixth Symphony are never properly appreciated because few western critics can take them for what they are: deliberately obvious, vulgar music. The irony intended may not be of the Anglo-Saxon type, but it is not for that reason less ironic. But devices such as quotation can be easily misunderstood not just because critics are unwilling to accept the deliberately vulgar use they are often subjected to but there also seems a rather curious reluctance to accept Shostakovich the "symphonist" for what he really is, that is to say, a programmatic composer.

Most Shostakovich symphonies contain, it seems to me, some programme or other, which as the old saying goes need not also be readily explicable. The point is that devices in Shostakovich are programatically intentioned and understood in that context, such devices as quotation and deliberate vulgarity can be more readily accepted. This is not to say that the use of such devices in Shostakovich have a ready-made excuse for whatever happens. I would be the last to deny that the use of banality and quotation in the Seventh Symphony is a complete disaster.

Here in the Fifteenth, I just cannot be sure. This symphony is not as over-blown as everyone has made it out to be, and a very bitter work it almost certainly is. Not to be compared with a work like the Tenth Symphony, this Fifteenth may be closer in stature to the Twelfth, a work which in my opinion is a far better musical work than either the Thirteenth or Fourteenth. Performance by the composer's son sounds authentic enough and exciting, though I do wish Russian brasses would learn to play in tune. Good sound. – J.A.A.

RACHMANINOV – The 4 Piano Concertos Rhapsody Vladimir Ashkenazy (piano), Andre Previn (cond.), London Sym. 3 DECCA SZLF 6565/7

This year's Rachmaninov centenary should hardly come up with any startling novelties, so well has the composer's music been served on records in the last few years. An opera has already been released in America and I, for one, would really like to hear a new, good but idiomatic recording of the Op. 37 Vespers. Otherwise there will probably be more recordings of the concertos and the solo piano music, and why not? I suppose this often very difficult music is as good a test as any in the literature.

But if every new release comes to me like this, my initial reaction should be simple and to the point. Why must new, import, Decca pressings be afflicted with what seems to be the now perennial swish and hiss? An examination of three other (sealed) sets reveal unremarkably the same results. So the recordings get better, the pressings are correspondingly worse. In all fairness, I should say that the Decca label is not the only company at the moment with this problem but the rather marked deterioration in quality in just the last year or so makes me express myself strongly. Is it some liquid on the records, the plastic, both, what?

What about the performance? Ashkenazy's readings of concertos 1,2,4 and the Rhapsody allow me to admit here we have virtuoso playing of a high order. But for all the enthusiasm of these performances, and Previn eloquently seconds Ashkenazy's ideas, nevertheless I feel a curious lack of real identification with the music. What bothers me most of all, is the astonishing way in which rubato is utilized in these performances. While I will not say that I cherish the composer's own recordings of these works above anyone else's, I am always amazed at how discreet his rubato could be. Ashkenazy/Previn are by contrast unashamedly vulgar. Surely no one has to feel each time "it's coming". I also do find distressing the fact that neither pianist nor conductor is especially decided as to whether they want a straight-forward or mannered approach. Nevertheless, it is in general quite possible to enjoy these performances and they are certainly among the better available.

Perhaps the only real failure in the collection is the Third Concerto. There is a consistent tendency on the part of Ashkenazy to overstate, and slow-down his phrasing. The results do not make for pretentiousness; this reading sounds clumsy and in this concerto Previn, of course, has little choice but to follow Ashkenazy. Of all the concertos, this work is the most difficult and a comparison with how the composer handled the cadenzas and the while of the third movement is instructive. Not only is the composer's sense of phrase preferable, but he seem to have been one of the few with the technique to make the third movement flow. – J.A.A.

MOZART – Ballet Music for "Le petits riens," K. Anh. 10. 4 overtures: Il Re Pastore, K.208 Lucio silla, K.135 La Finta Semplice, K.51 Der Schauspieldirektor, K.486 Neville Marriner, Academy of St. Martin-in-the-Fields HMV ASD-2834

If you are not one of those who just will not listen to any Mozart below a certain Kochel number, then this record should be fun. The ballet music for "Les petits riens" may not even be all Mozart, who cares when the performance here is such a delight? The opera overtures on the reverse side are tantalizing in that I now find it interesting to speculate what a Mozart opera would be like with the Academy. Pure champagne, and why not? – J.A.A.

CHARLES RUGGLES: (1) Men and Mountains, (2) Angels.
CHARLES IVES (3) From the Steeples and the Mountains.
AARON COPLAND (4) Quiet City
DANIEL G. MASON (5) String Quartet on Negro Themes in G minor, Op. 19. Lukas Foss, Buffalo Philharmonic Orchestra (in nos. 1–4) Kohon Quartet (in no. 5) TURNABOUT TV-34398.

On this record you get two revolutionaries (Charles Ives & Ruggles), one ex-revolutionary (Aaron Copland), and one always-has-been-will-be conservative (Daniel Gregory Mason). I suppose it is not surprising to have establishment-anti-establishment games on records; it is common enough "live". Actually there might just be only one "real" revolutionary here, he is dead, and I have never been sure of Charles Ives. There can be no doubt about his remarkable anticipation of modern techniques, and there are times when I feel something like the Fourth Symphony is a very fine work indeed. How about some of the songs? Not the *Variations on "America"*, nor the *Fourth of July*. How about the piece here? I do not know. But Charles Ives *was* revolutionary. Charles Ruggles. I have never been able to take to Ruggles. He sounds as if he might be fascinating, if not good. I know Ives said this was "fine strong music" but I feel if you have heard one Ruggles, that is usually quite enough. His music, it is true, is very concentrated, has a great deal of modernisms but it sounds so post-romantic, really. Copland's *Quiet City* is perhaps the only thing here that says things clearly without claptrap. *Quiet City* is a fine piece, despite the fact that much other Copland (Symphony no. 3) now sounds like film music. I was quite prepared to dislike the

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Mason. On Negro Themes! In this day! But it really is quite pleasant.

It is good to see Ruggles finally getting his due on records. The recording on this disc is fine enough. One wishes the performances had more polish. But they are serviceable, and at the very least always adequate. I shall keep this record, until something better comes along, and even if I do not change my mind. – J.A.A.

BRITTEN – THE POET'S ECHO (PUSHKIN)– TCHAIKOVSKY – SIX SONGS, Galina Vishnevskaya (sopran), Mastislav Rostropovich (piano) DECCA SXL-6428.

It is good to have at least half a side of Tchaikovsky songs as finely rendered as these. Strange that with one or two exceptions, Tchaikovsky's songs are not as well known as his other work. The pieces excerpted here are selected (presumably by the soloists) and arranged to evoke the mood of a cycle thus pairing them well with the Britten work on the reverse side. These songs seem to come straight out of *Eugene Onegin*, which is like saying that Vishnevskaya would only be expected to do them well, and she does. I may as well say it now, but the real star of this disc is her husband and the erstwhile cellist, Rostropovich. Such fine and thoughtful playing is rare enough these days and it never ceases to amaze me that the piano is the man's second instrument.

Of equal interest is Britten's Russian cycle *The Poet's Echo* (after Pushkin). Britten has already set French, German, Greek, Italian, Latin and English so well, a formidable array of languages for any composer. One, of course, would not associate him with Russian but here we are, and this cycle (I listened to the Tchaikovsky first) sounds so very Russian and also very Britten. As usual the poems (from Pushkin) are very carefully selected and arranged in a sequence that conjures up a variety of moods all culminating and reflecting their many strains in the marvellous final *Lines Written During A Sleepless Night*, with its nocturnal and clock sounds bringing once more to mind Britten's lifelong and Novalis-like fascination for Night and Sleep. Vishnevskaya and Rostropovich (Britten's dedicatees) evidently love the music. This is a moving and important cycle, important not the least with regard to Russian music. Composed in 1965, I have no doubt that Russian composers have taken this cycle to heart and as evidence I invite anyone to listen to Shostakovich's Fourteenth Symphony with this work and some other Britten in mind and one is bound to find that the Symphony is at times even more embarrassingly Britten than one thought. Translations of the Russian are enclosed, the Tchaikovsky songs by Peggy Cochrane and more skillful versions of the Pushkin by Mr. Peter Pears. Fine Sound. – J.A.A.

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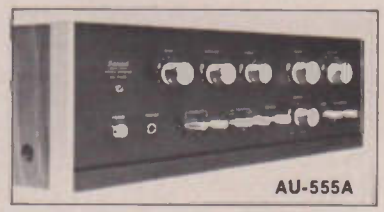
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REVIEWER: Mike Delaney

"WHEATSTRAW SUITE" – The Dillards. W.E.A. Stereo. EKS. 74035.

There's a story here that I think you should know about mainly because "Wheatstraw Suite" is one of the great, undiscovered American albums. It's a background type rave that's really necessary. Honest.

Well, back in 1968, three records were released, all of which started a revolution: "Sweetheart Of The Rodeo" by the Byrds, Dylan's "John Wesley Harding" and "Music From Big Pink" by the Band. Somebody somewhere called the music 'country-rock' because it was country played by rock people. Remember that, it's kind of important.

Anyway, all three albums went down a storm and everybody started flocking to Nashville and/or Memphis because country was the new world – brave at that. The Byrds touched on bluegrass, Dylan took 'em to the prairie and the Band got 'em right up into the mountains. A lot of others did a lot of other things too; but not as obviously effectively. For the next three years almost, every rock group worth its oats was obliged to incorporate a country song into their act. Most of them stuck to Dylan cuts like "I'll By Your Baby Tonight", "Tonight I'll Be Staying Here With you" and/or "You Ain't Going Nowhere"; very few took it any further.

Joe South had a couple of hits; Kris Kristofferson did likewise with things such as "Help Me Make It Through The Night", "Sunday Mornin' Coming Down" and a whole bunch of other, mostly maudlin' torchers; Johnny Cash had a string of them, the biggest being "A Boy Named Sue", and virtually everybody hired pedal steel and mandolin/banjo pickers to make it sound authentic. Generally, though, it wasn't.

Apart from Buffalo Springfield, The Flying Burrito Brothers, Poco and the three mentioned above – groups, group members and friends respectively – nobody did nothing. John Stewart and John Prine did, and recently, Jonathan Edwards, Danny O'Keefe, Kenny Loggins, Ian Matthews, Grateful Dead/New Riders and a couple more did some good things too. But whether it was real country music or just rock 'n' roll with country trimmings is the clincher.

Now, this is where the Dillards come in. All the other great stuff had been recorded by ex or sometime rock 'n' rollers: The Byrds, Dead, Burritos and Band made it just fine; Dylan can do anything anyway. But much of their character, much of their sensibility for rock was held over. None of them played it totally traditional – none outside the Dillards.

Thus comes "Wheatstraw Suite", the first of their seven-or-so albums to be issued in Australia. Originally released back in the winter of '68, this is one of the finest, most melodic, most moving of all the great country records. Don't let that put you off – the 'country' thing. This is a remarkably special and precious record for a number of reasons. More than any other, "Wheatstraw Suite" gets you involved, makes you understand and feel the pathos, energy, values and aesthetics of traditional American music – every situation, emotion; each minute of a whole day. It's almost spiritual, reaching and holding an intensity, a joy in simple things that is always overlooked.

Gram Parsons, late of the Flying Burrito Brothers, had this to say: "We are playing Roots music – music that is simple. It's a form of love music, a binding type of music between peoples. Our music is simply saying, 'Find a way to love'. And it's emotional because all our music takes all our emotions . . . We are involved in music of the spirit, or if you will, Goose Bump Music . . . When the music is honest those bumps are usually the end result. Listen to the simplicity of gospel, country, and blues. That's where we're at."

The reason Parsons left the Burritos is because the goose bumps stopped coming right after their first album, "The Gilded Palace Of Sin". It's kind of the same with the Dillards, but more so. "Wheatstraw Suite" is their finest record – real goose bump music. Music of the spirit. The finest music of the spirit. They haven't done it since. Nobody has.

The thing that makes "Wheatstraw Suite" such a special album is its soul: country is white soul, like blues is black. Parsons explained it just about as precisely as anyone could: "We're playing with white soul, and soul is universal. And the universality of Roots music has stood the test of time . . . We are doing white soul as opposed to black soul. There's a colour chart in soul . . . white, yellow and black. And it's been proven that the boys in South Carolina can't cut the sitar like the boys in Baghdad." This stands for the Dillards probably more in the long run than for any other contemporary Roots band. Their music is honest – an honesty unaffected by rock; more intricate than rock; more the product of people and the way people feel. It's simple music expressing basic emotions. Universal goose bump music.

There's a traditional called "I'll Fly Away" which starts off side one – just voices; five part harmony as pure and as natural as harmony can be. The Byrds and Crosby, Stills & Nash used voices best with rock 'n' roll, but neither has or had the absolute clarity/command of the Dillards. Anyway, what the song does is haunt you. It just sticks and stays: "Some glad morning/When this life is over/I'll fly away/To my home on God's celestial shores/I'll fly away . . . " It's like a hymn – it *is* a hymn.

There's a real down-to-earth passion in what the Dillards do with their music. It's gracious and bright and incredibly alive. Happy too. "Nobody Knows", "Hey Boys", "The Biggest Whatever" are songs that ring so clear and poignant, projecting images rich, earthy and colourful. Images of the land; green plains and white, rolling clouds; sketches of its people and their humour, their subtleties.

They recount Tim Hardin's "Reason To Believe" – hope and sorrow and warmth. Rod Stewart should have had the sense to have left well enough alone. But no. He took it right out of context and made it sound like every other vaguely-countrified American ballad – affected, morbid and consequently boring. He almost lost the melody.

The Dillards do it like it must be done – with reverence. It's a classic love song and one of Hardin's best – one of the best from the last decade.

They get to do a couple of other cuts much the same – as good as, if not better than the versions you've been living with for all these years. There's the Lennon/McCartney "I've Just Seen A Face" and two more well worn traditionals, "She Sang Hymns Out Of Tune" and "Single Saddle". Everybody's ripped off their arrangement to the Beatle tune so you've probably heard it already without knowing. It's simply breathtaking – 1.55 minutes of furious bluegrass; harmonies weaving and hovering and soaring. Even the Beatles don't match it. They don't even come close.

The other two aren't bad either; Roy Rogers (*the* Roy Rogers) used to sing "Single Saddle" in one of his late forties' Mexican-border-down-Rio-way Westerns. I think it's sort of like his theme song. "She Sang Hymns Out of Tune" is one of those old, old pieces that somehow developed into a classic; every obscure and not-so-obscure mix-sixties' folkie has had a go at it with varying degrees of success – most of them awful. Nillson tried his hand too, regrettably.

Everybody tried to make it into something akin to "Mr. Bojangles" – soulful sweet with voices heartfelt, straining and genuine. The trouble is that it's not that kind of song. As with everything the Dillards do, they understand it intuitively and ultimately. The lyrics go something like this: "She sang hymns out of tune/and carried a yellow balloon/Traded her love for a Spanish dubloon/And talked to the people/the people who are . . ." It's kind of spiritual and kind of not – sweet and bitter and whimsical. That's the way it should be done – the way the Dillards do it like a small, involving character sketch.

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POP

"Little Pete" and "Don't You Cry" are really swift, up-tempo tracks – the faster and higher they fly, the more poignant, nagging is the image and attachment. And good music can always be assessed on the depth of the attachments – what you feel is what the song is about. Both songs simply possess you:

Little Pete was just a kid
who lived around the corner of the street.
Levi jeans and jelly beans and a great big smile
for everyone he'd meet.
He read comic books
and distant longing looks
they'd pay him when they passed.
They always looked so peaceful
so they'd ask.
He'd tell them
try to see the things that children see –
an unsophisticated life's a great philosophy . . .'

That's basically the concept behind the music – all their music. The Dillards flawlessly blend gospel and soul. They tell stories, little fables on life, incorporating all the things which matter – all the things which make it easier to touch people. Exultation. Exaltation.

"Listen To The Sound" and "Lemon Chimes" are two of the best songs on the album because they touch the deepest – sure and clear; total. The voices cry out at you – the singer *is* crying. That's another way how you can tell if it's good country. That singer has *got* to cry. And hard. And long.

"Bending The Strings" is a bluegrass instrumental. It's the type of cut that the Byrds tried with "Nashville West" and "Bristol Steam Convention Blues". Poco tried it on "Grand Junction", Dylan tried it on "Nashville Skyline Rag" and the Burritos did it with "Orange Blossom Special". All are good – "Bending The Strings" is just slightly better, more convincing.

"Wheatstraw Suite" is as the title implies – sort of like a suite. It touches the prairies, travels high into the mountains and gets down onto the plains. It meets people and sings about places, describing events, depicting the way people think and react and feel. It's like a cross country adventure avoiding the main roads, hitching instead of driving, sleeping out beneath the stars.

Quite simply, "Wheatstraw Suite" is one of the most amazing and beautiful albums I've ever heard. You may quote me.

"IN SEARCH OF AMELIA EARHART" – Plainsong. W.E.A. Stereo. EKS. 75044.

Basically, Plainsong is episode four in the continuing saga of Ian Matthews – one of England's finest and most underrated singer/songwriters. First it was Fairport Convention for two and a half increasingly successful years, thence Matthews' Southern Comfort through three excellent albums and a monster hit in "Woodstock". *That* "Woodstock". Two solo albums followed – both of which sank without a trace; both of which were really good. He sort of had a hit with his revival of the old Phil Spector/Crystals' "Da Do Ron Ron" – a wee bit strange with Ian crooning 'I met him on a Sunday and his name was Bill.' Fine.

Anyway, with all this behind him, he went on to form Plainsong – a band that's supposed to be Matthews' Southern Comfort volume two minus all those temperament clashes which split the original.

Needless to say, Plainsong is a wonderful group – much more capable and sympathetic than his previous outfits. Matthews gets to do things *his* way; Matthews *needs* to do things his way. The reason Plainsong will probably stick it out is because the other three realise where Southern Comfort went wrong. It's all got to do with a thing called 'creative ego'.

As can be expected with anything Matthews gets to do, the music remains much the same – better and more mellow with each consecutive disc; each consecutive band. But basically the same. Ian's songs seem to command especially well with Plainsong – something they never achieved before except on the first solo album, "If You Saw Thro' My Eyes".

"In Search Of Amelia Earhart" continues where the last Matthews' Southern Comfort album, "Later That Same Year", left off. It's country and it's folk and it's all those blends in between. Plainsong makes it sound a whole lot more interesting and apparent than did the last group, particularly with ballads. That's really important because most of Matthews' songs are low-key and slow: Southern Comfort always used to come across anaemic when they'd do anything outside a light jig. I guess that would've made it tough on Ian.

Plainsong are far superior to Southern Comfort purely because they're more relaxed. They've got greater feel – a warmth and sense of authority that Matthews needs; something he didn't find in the old band. His songs seem to have more substance – depth and colour; the melodies are stronger and the arrangements less vague. His new group knows how to enhance the subtlety of his material, balancing Matthews' constant understatement with a developed sense of melody. They draw his music right out into the open where it belongs. They're more versatile too – which helps.

As a band, they've got taste. Knowing full well that Matthews has got one of the most distinctive and unaffected voices in British rock, they've placed him right out in front of everything, only occasionally bringing back-up harmonies into the picture. But even then, it's short and sharp, just for the sake of a quick change. That's one of the major reasons why Southern Comfort never really sounded the way everybody thought they should: there were too many lead singers none of whom had the chance to establish his own character. Not so Plainsong.

"For The Second Time", "Side Roads", "Call The Tune" and the narrative "True Story Of Amelia Earhart", four of the five Matthews credits, are among the best he's written to date. And that's really saying something for those who aren't familiar with the fine work he's done in the past. The fifth cut, "Even The Guiding Light" sounds a bit like Lindisfarne circa "Nicely Out Of Tune"; it's still good though.

(Continued overleaf)

POP

The rest of the songs are a mixture of traditionals and contemporary standards – Paul Siebel's "Louise", a lilting "I'll Fly Away" and "Yo Yo Man" plus Judy Henske's "Raider". There's a couple more that are just as good, but you can hear them for yourself.

"In Search Of Amelia Earhart" is possibly the most satisfying album since "If You Saw Thro' My Eyes" because it's complete. Matthews worked on detail – each song is different in style from all the rest; each arrangement and each melody realises its full potential. In short, there's not one song less than fine.

Perhaps Plainsong will be the band that'll win Matthews the recognition he so thoroughly deserves. It should've happened earlier because what he's got has been refined into something very much his own; it's rare that you find a musician so knowledgeable, so well versed in the traditions behind both English folk and the American equivalent.

You should hear Ian Matthews.

"CAPTAIN BEYOND" – Captain Beyond. W.E.A. Stereo. BS. 2078.

Captain Beyond don't sound bad – just old. They're playing high energy rock 'n' roll the way it was back in '68-'70 with a bevy of groups the likes of Fat Matress, the original Deep Purple circa "Kentucky Woman" and, to an extent, the earliest Mountain around the time of "Climbing" – their first album as a bona fide band.

With backgrounds in Iron Butterfly, Deep Purple and one of the thousands of bands that Johnny Winter sort of had together for a time, Captain Beyond carries on in the finest rock furioso tradition. Basically, what it all means is fast playing, loud playing and lots of sweat, brimstone, hellfire, seemingly portentous lyrics and overly-long flashbacks of double guitar psychedelia. Riff madness. As I said before, it's not bad – just old.

If Captain Beyond had got themselves together maybe a year or so earlier, what they're doing could've been really effective. As it is, it's interesting – kind of – but rather predictable. Yes, rather.

As a group, they play just fine. It's obvious that they're good musicians – inventive, exciting and fully in command. It really is a shame that they have to paraphrase a style that has been done to death. Heavy rock still evokes the odd shiver of recognition a la Black Sabbath, but that's more from nostalgia than anything else.

"Captain Beyond", the group's first album, does have its merits; though they're not to be found in the actual songs. Larry Reinhardt is a fine guitarist – virtuoso Clapton/Cream style flying in and out and round about, making each cut much more potent than the melody would have you believe; Lee Dorman and Bobby Caldwell make a great rhythm section, pulsating ever onwards in the chunka-chunka-crash-chunka vein. Vocalist Rod Evans hasn't improved that much since he sang Deep Purple's "Hush"/"Kentucky Woman" but, at least, he's louder. He screams longer too.

Sometimes it sounds really pretentious just like the old Iron Butterfly with lyrics all to do with tomorrow's yesterday or today's tomorrow or dancing ever backward into yesterday's dream. You know what I mean – that type of thing we've heard from everybody who outlived the original summer of peace and hidden meaningfulness. Right. Now hands up all those who really thought that "In-A-Gadda-Da-Vida" was letting you into something that you didn't know about already. Ah-ha! Caught you!

Musically, it's good – dated but good. Captain Beyond needs an idea-man to get them a more valid direction and/or identity. I'll wait . . .

"DAVID ELLIOT" – David Elliot. W.E.A. Stereo. SD. 7222.

Almost everything on Elliot's first album is really ordinary. But it still grows on you – sort of. He's not at all original and his songs are just plain and he can't sing for nuts and even when he sounds passable, it's because he's ripping off (a) Elton John, (b) the Bee Gees, and (c) Steve Miller. But, for what it's worth, it still hangs in there and tries to get you hummin'.

As a songwriter, Elliot has no style or personality outside of what he's pinched from the three mentioned above. What he does is enjoyable, not because he himself offers much, but because he can rely on a whole slew of back-up musicians to slap it into shape. His album makes it as much as it can on the ideas of people like Caleb Quaye, B. J. Cole and Roy Temro from the now defunct Hookfoot; Albert Lee from Heads, Hands & Feet; Francis Monkman late of Curved Air; Dave Mattacks from Fairport Convention; Dee Murray and Nigel Olsson from Elton John's band and guitarists Mick Grabham and Tim Renwick. All Elliot seems to do is sing and strum a bit – both of which you could live without.

It's a fairly disorganized album with a character that's thread-bare at the best of times. Side one is devoted to the funkier (faster) things – none of which, excepting "Kid's Stuff", gets off the ground for more than a couple of riffs. The reason this song in particular makes it better than anything else is because Albert Lee plays such a scorching guitar that not even the tired melody gets to screw it up. All he does is rattle off a whole lot of the licks that Clarence White innovated into rock 'n' roll through the last four Byrds albums – kind of electronic Nashville with a pick.

"You Better Move" isn't bad either, it's just that it's built around one of those standard riffs – the type of thing you've heard everywhere else from anybody. And better.

Side two is the big ballad spectacular, starting off with "Dary Mary" – the Steve Miller song, partially re-written in the verse, a couple of extra notes in the chorus. The lyrics are all different too. So is the vocal line. It's still the Steve Miller Band song because that's where all the ideas were taken from.

All the other tracks on the ballad side are fair – easily and instantly forgotten. The only cut that really soars is "Open The Door" – the Elton John/Bee Gees take. It's good because the style is good. Elliot must have sat down and listened real hard to "Madman Across The Water" and then, feeling sufficiently inspired, skipped off a composite with all the same nuances, subtleties, moods retained intact from the original. At least, he can rip off well.

Elliot is dull. "David Elliott" just doesn't.

INPUT GATE

LETTERS FROM OUR READERS

SCIENTIFIC IRRESPONSIBILITY

I found your editorial concerning Project Sanguine (ETI March 1973) very interesting, but I think you should remember that it is politicians not scientists who pervert science for military ends. The task of a scientist is to seek truths – it is not for him to determine or control the uses of his discoveries.

TB. Canberra ACT.

** Then it is about time that scientists woke up to themselves and realized that they are part of the human race. The old catch cry that scientists discover truths and politicians distort them is a gross distortion of reality.*

Consider these facts – which we can fully document – and then read our correspondent's letter again.

Sean McBride, Chairman of Amnesty International – following a year long investigation into the use of torture by government agencies – said, "governments have submitted torture to intellectual analysis and produced progressively more sophisticated methods that make the medieval rack and thumbscrew look like childrens' toys. Science, medicine and technology have combined in the service of government to liquidate dissent by destroying personality".

George Pinet, a lawyer who was in Brazil last year wrote, "Scientific research has made it possible to identify the maximum suffering that the various systems of the body can endure without resulting in death".

At a recent Science Fair in the USA, a youth showed a series of experiments involving surgical operations on pregnant guinea pigs. Alone he removed the womb of a donor animal and made twelve attempts to implant fertile eggs into the wombs of other animals. The youth stated that he had no previous knowledge of surgical or anaesthetic techniques – nor had he even previously seen the internal organs of such animals. This appalling disregard for animal suffering was rewarded by First Prize.

An elite group of some three dozen top US physicists – many of them Nobel Prize winners – attached to the Institute of Defense Analyses, devised the 'electronic battlefield' in Vietnam. Here, unidentified targets were shelled and bombed purely on the indications of acoustic and seismic sensors. If it moved – then it was killed – whether soldier – woman, child or animal. These scientists changed the concept of warfare from a method of obtaining military objectives in a humane a method as possible – to one of killing as many of the enemy as possible.

The US Navy – at its base in San Diego, implant electrodes into the pleasure and pain centres of dolphins' brains to teach them to swim into the vicinity of submarines to provide false acoustic targets – (and are thus killed)

In Vietnam, behavioural scientists have trained this most peaceful of animals to seek out, and spear to death, suspected saboteurs.

At Cambridge (UK) a team of scientists is studying deep diving physiology of dolphins. This work is partially funded by the US military who are researching the ability of deep seals and dolphins to carry weapons.

The father of dolphin study, Dr. John Lilley is so disgusted by the research of his fellow scientists that he has abandoned all further work in this field.

Scientists discovering truths? Collyn Rivers – Editorial Director.

BWD OSCILLOSCOPE

Please accept our thanks for the product test you recently carried out on our Model bwd 509B Oscilloscope. We wish to commend your magazine for the interest it takes in equipment of Australian manufacture. From the comments we have received it is obvious that your articles are widely read and respected, and considered authoritative both by manufacturers and users of electronic equipment.

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HEAVY DUTY 2" POLE (53mm) 15" (381mm) 70-80 HZ 8 ohm	CG15HD	Guitar	60/4,000	37	17,000	220,000	13¾ (350)	14⅝ (370)	6¼ (159)
12" (305mm)	CG12HD super	Guitar	60/5,000	30	14,000	186,000	10¾ (273)	11⅝ (294)	4½ (114)
12" (305 mm) 2" pole (53mm) 30Hz. 8 ohm	CG12 Super	Bass	25/5,000	25	14,000	186,000	10¾ (273	11⅝ (294)	4½ (114)
12" (305 mm) 1½" Pole (38 mm) 30Hz. 8 ohm	CG12	Bass/Mid.	25/9,000	20	14,000	105,000	10¾ (273	11⅝ (294)	4½ (114)
12" (305 mm) 1½" Pole (38 mm) 30Hz. 8 ohm	CG12T	Full	25/15,000	20	14,000	105,000	10¾ (273	11⅝ (294)	4½ (114)
10" (254 mm) 1½" Pole (38 mm) 45 Hz. 8 ohm	CG10	Bass/Mid.	40/10,000	20	14,000	105,000	9⅛ (232)	9⅝ (245)	3⅝ (92)
10" (254 mm) 1½" Pole (38 mm) 45 Hz. 8 ohm	CG10T	Full	40/15,000	20	14,000	105,000	9⅛ (232)	9⅝ (245)	3⅝ (92)
8" (203 mm) 1" Pole (25.4 mm) 55Hz. 8 ohm	CG8	Bass/Mid.	45/10,000	12	14,000	56,000	7 (178)	7⅝ (194)	3⅝ (92)
8" (203 mm) 1" Pole (25.4 mm) 55Hz. 8 ohm	CG8T	Full	45/17,000	12	14,000	56,000	7 (178)	7⅝ (194)	3⅝ (92)
8" (203 mm) 1" Pole (25.4 mm) 55Hz. 8 ohm	CB8	Bass/Mid.	45/10,000	10	12,000	48,000	7 (178)	7⅝ (194)	3⅛ (80)
8" (203 mm) 1" Pole (25.4 mm) 55Hz. 8 ohm	CB8T	Full	45/15,000	10	12,000	48,000	7 (178)	7⅝ (194)	3⅛ (80)
8"	1" Pole	CF8	Bass/Mid.	20/8,000	12	14,000	56,000	7 (178)	7⅝ (194)	4" (107)
4" (107 mm) ⅞" Pole (14.3mm) 8 ohm	CB4	Treble	2,500	SYSTEMS UP TO 25 WATTS	10,000	15,000	3⅝ (92)	4¾ (121)	1⅝ (48)
4" (107 mm) ⅞" Pole (14.3mm) 8 ohm	460TC	Treble	17,000	SYSTEMS UP TO 25 WATTS	6,000	9,000	3⅝ (92)	4¾ (121)	2⅛ (54)
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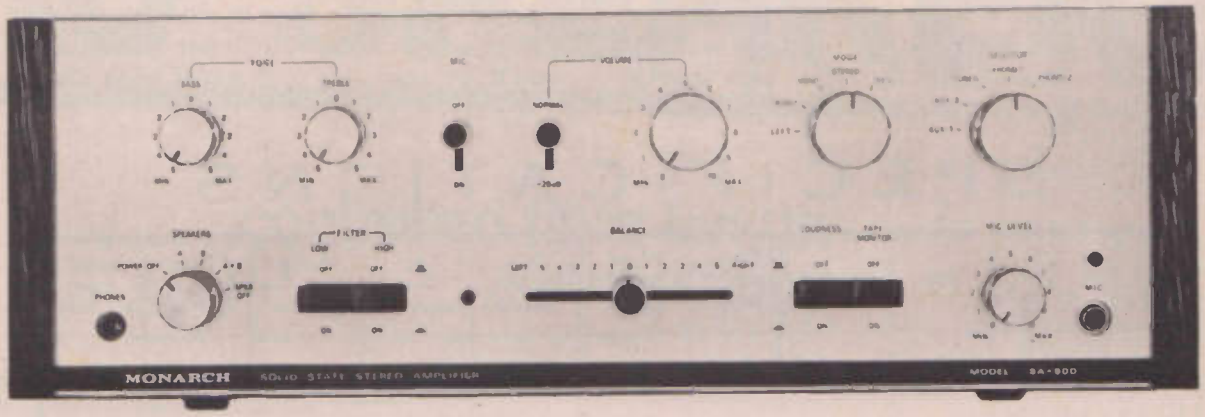

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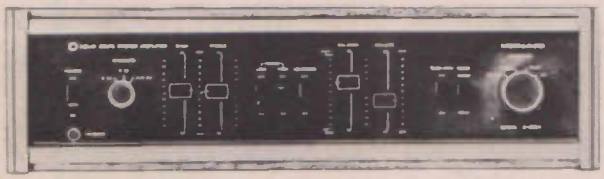

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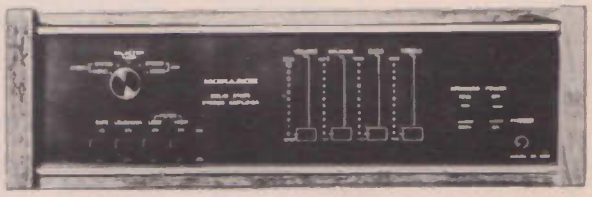

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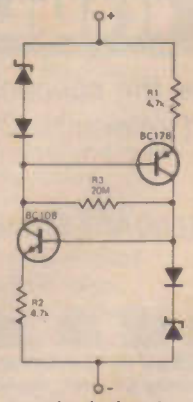
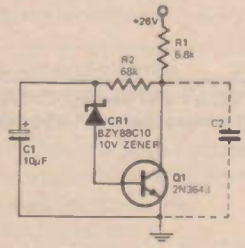


This unique two terminal circuit can be used to define a constant current in the same manner as a Zener diode may be used to define a constant voltage.

The values of R1 and R2 shown are for a current of 1mA. Maximum applied voltage with transistors shown should be limited to 50 volts. Minimum should be at least 8 volts.

NOISE GENERATOR



In this circuit the Zener diode, as well as providing a source of noise, stabilizes the amplifier transistor collector operating point. The gain of the transistor is about 75 and the noise output of the circuit is about 15 volts. Capacitor C2 may be added to filter out high frequency noise – in which case the output drops. For example with C2=0.1µF, the output falls to 0.5 volt.

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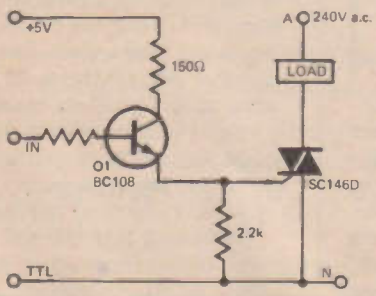

Here is a useful circuit for driven mains operated devices direct from TTL logic circuits. Although it works well, it has the inconvenience that the neutral line is connected to circuit ground.

For inputs other than TTL levels a 10k series resistor may need to be connected between Q1 base and ground to reduce leakage.

Approximately 1mA at 1.4 volts is required to switch Q1 on. If driving from a low impedance, some means of current limiting will also be required.

Submitted by L.W. Brown, Burwood, Victoria.

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(Continued from page 14)

in a person's resistance to earth, as they quickly become moist and relatively conducting; thickness is more important than the material, as there is little difference between wool and nylon socks of the same thickness.

DSL has found that a useful indicator of the hazard from a person is the time taken for a potential on him to decay to half value. They have made a timer to measure the decay, and find that there is practically no hazard if the decay time is less tha The remaining contribution to insulation is the floor material. In hazardous areas such as where inflammable materials are handled, the floor should be relatively conducting. Here too a decay time of 0.1 second is a useful criterion, and this has been related to resistance for quite a wide range of floor covering materials and finishes.

Applying the same principles, DSL has been able to advise the Army of the type of finish to use in buildings where meteorological balloons are filled with hydrogen before being released. The principles could also be applied in industry where a build-up of static electricity may be a hazard.

For further information contact Mr S. A. Lott, Defence Standards Laboratories, P.O. Box 50, Ascot Vale, Vic 3032.

NEW VOLT

Until this month, a group of standard cadmium cells at the CSIRO National Standards Laboratory gave the measure of the volt for Australia. On 1 January a method based on the peculiar quantum behaviour of electricity in a super-conducting junction (the Josephson effect) replaced the standard cells. It was apparent from work done by NSL and a few overseas standards laboratories that a slight uncontrollable drift in the voltage of the cells was taking place. Those same laboratories also demonstrated the superiority of the Josephson method. The volt is now being maintained much more precisely (to 1 part in 10^7) using the stable volt derivable from the Josephson effect.

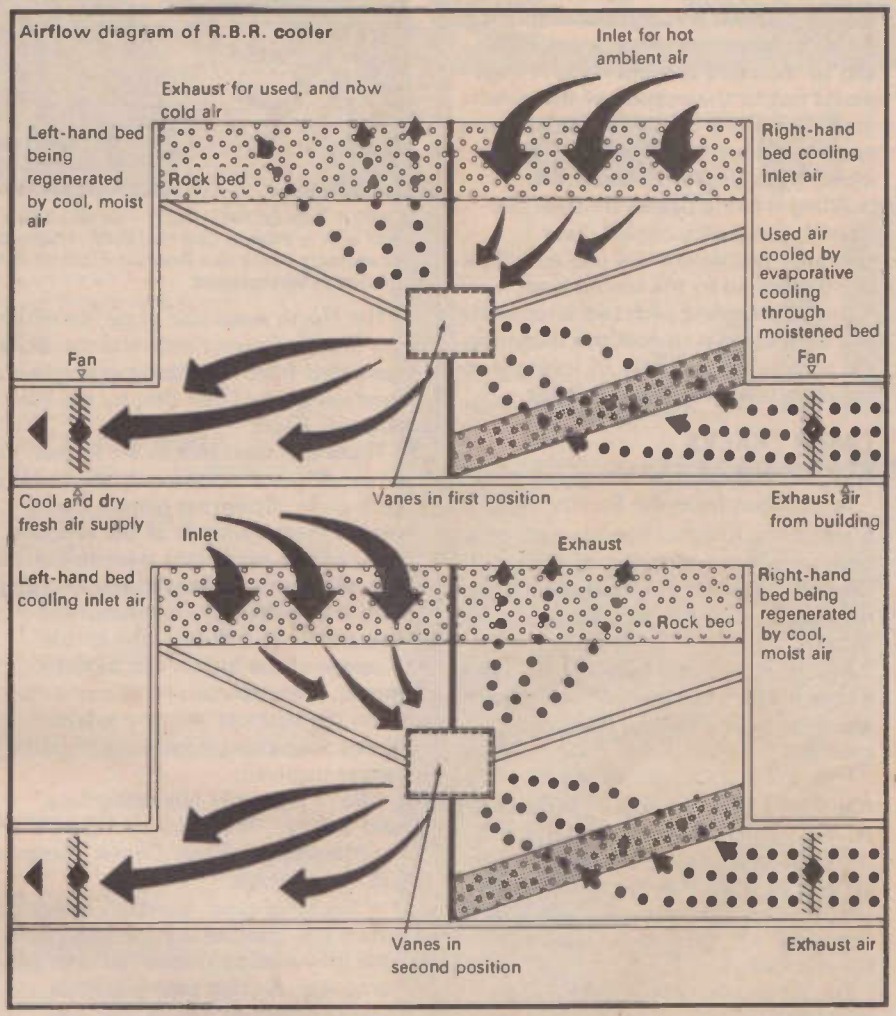
This has been done by an agreement to assign a numerical value for the relation between electric potential (in volts) and frequency (in hertz), as displayed by the Josephson effect.

The value as adopted by the Consultative Committee on Electricity, which is associated with the International Committee of Weights and Measures, is 4.835940 by 10^{14} hertz per volt.

The Josephson effect is named after B. D. Josephson who predicted it in 1962. It was soon confirmed experimentally. The effect is a peculiar quantum phenomenon which gives precise voltage steps in a superconducting junction when it is irradiated by electromagnetic waves, such as microwaves.

The frequency of the radiation determines the size of the voltage step, so that the volt can be determined in terms of frequency, which can be measured far more accurately than any other physical quantity.

SCHOOLS USE ROCK BED AIR CONDITIONER



Over 70 schools in South Australia have been equipped with 250 rock bed regenerative (RBR) air conditioners to provide comfortable working conditions at low cost through both summer and winter.

Some schools have been in areas with day temperatures as high as 43°C and others as low as 7°C. Nevertheless, there has been no difficulty in maintaining temperatures above 20°C in winter and below 29°C in summer. Even under extreme summer heat, the total power cost for cooling a school containing 140 pupils is as low as 60 cents per day.

Simple in operation, RBR units contain highly effective heat exchangers (rock beds) which help to isolate the building thermally, enabling 100% fresh air to be circulated within the building with a very small increase in thermal load. The systems were designed by the CSIRO Division of Mechanical Engineering and are manufactured under licence by RBR Air Conditioning Pty Ltd in New South Wales and Geraldton Building Co. Pty Ltd. in Western Australia.

The RBR system can provide heating, cooling, or circulated air without heating. With this system, it costs virtually no more to cool than to ventilate. It operates on the indirect evaporative cooling principle. Beds of ordinary 5-mm rock screenings 3m by 5 m are used to form both the evaporative cooler and the heat

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exchanger. The cooler bed is 1.5 cm thick while the heat exchanger has two beds, used alternately, each of 13 cm thickness.

The cooler bed is wetted periodically with a water spray, and every five minutes a motor-driven vane reverses the direction of air flow through the heat exchangers. Air from inside the school is drawn through the evaporative beds, where its temperature falls and its moisture content rises. It then passes out to the outside of the building through one of the heat exchangers, cooling the bed in the process. Meanwhile, fresh air from outside the building is being passed through the second, previously cooled, heat exchange bed where it is cooled before being supplied to the schoolroom.

Thus, by cooling each bed alternately and then using it to cool the incoming air, a continuous supply of fresh air at constant temperature is available.

LASER TRACKS SAN ANDREAS FAULT

Technicians from the Bendix Field Engineering Corporation have set up a laser tracking unit in remote Plumas Country, California, to acquire movement data along the San Andreas Fault.

According to team leader Dan Taylor, a laser beam is being used because of its accuracy in pinpointing stationary satellites.

This installation, consisting of a trailer and two buildings housing computers, controls and radar equipment, is one of two stations being used. The other is at Otay Mountain outside of Chula Vista, California. A third laser installation is planned for Guaymas, Mexico this year.

The project, known as SAFE (San Andreas Fault Experiment), is attempting to measure the movement of two great plates of the earth's crust in California.

LASER TRACKING UNIT – Bendix Optical Technician Don Weaver stands in front of a laser unit in Plumas County, Calif., that is being used with satellites to keep track of movements in the San Andreas Fault. It is hoped the information will be useful in predicting earthquakes.

The North American plate, on which the Plumas County laser site stands, is separated from the Pacific plate, the location of the Otay site, by the San Andreas Fault.

These east-west blocks are known to be moving in a north-south direction of each other. Scientists believe that repeated measurements of the slippage will provide important information on the relative movement of the two plates.

By triangulation – measurement from two points to a third – the actual slippage of the blocks can be determined. Simultaneous measurements from the two stations to a satellite allows scientists to compute the distances involved.

"We're primarily recording data," said Taylor. "It is then sent to NASA's Goddard Space Flight Center, Greenbelt, Md. for analysis."

"Goddard sends numbers indicating where the satellite is at certain times. This information is then fed into our computer. A drive tape (satellite locator program) directs the laser beam to tiny reflectable mirrors on the satellite," he added.

"The computer on site keeps track of the number of times the beam hits the mirrors, the amount of time lost between projections, the output of power to the laser and many more facts," said Taylor.

Jim Lacey, a NASA spokesman at Goddard, said, "When this residual data is added to the earthquake data bank at U.S. Geological Survey and Environmental Protection Administration, it will be useful in constructing a mathematical model for possibly predicting earthquake behavior."

Over a five-year span, it is hoped enough information can be gathered to determine the overall movement of the San Andreas Fault.

PARLIAMENT OPENS

"All members of Parliament were invited to go and meet the Governor-general . . . but some Labor MPs . . . declined to do so, having met him before."

Canberra Times,
Wednesday, 28 February

Bi-directional record and playback tape deck
Model A-4070
● 4 Ferrite heads (6 head function) ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .06% at 7½ ips ● F/R 25 to 24,000 Hz at 7½ ips ● S/N ratio 58dB

Make music- not noise

You may not realise it, but until now, even the best tape decks allowed a degree of noise during recording and playback. This may have been all right for conventional tapes, since they were far from perfect.

But with the recent introduction of the low noise/high output tapes, it's no longer permissible.

Which brings us to a new generation of decks by TEAC. And TEAC calls them Superior Sound/Low Noise decks: decks designed to get the most out of the low noise tapes as well as the conventional types.

Five of these new generation decks are described here. If you'd like to know more, write to us and we'll send you further information (catalogue, dealer list and price list) on the unit(s) that interests you.

Stereo Tape Deck
Model A-3300
● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .06% at 7½ ips ● F/R 25 to 24,000 Hz ● S/N Ratio 55dB

Stereo Tape Deck
Model A-1230
● 3 heads-4-head function ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB

Automatic Reverse Stereo Tape Deck
Model A-1250
● 3 heads-4-head function ● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● Triple motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB

Combination Head Stereo Tape Deck
Model A-1030
● Reel size 7" ● Tape speed 3¾ ips and 7½ ips ● One motor mechanism ● Wow and flutter .08% at 7½ ips ● F/R 30 to 22,000 Hz at 7½ ips ● S/N Ratio 55dB ● Auto. Shut-off

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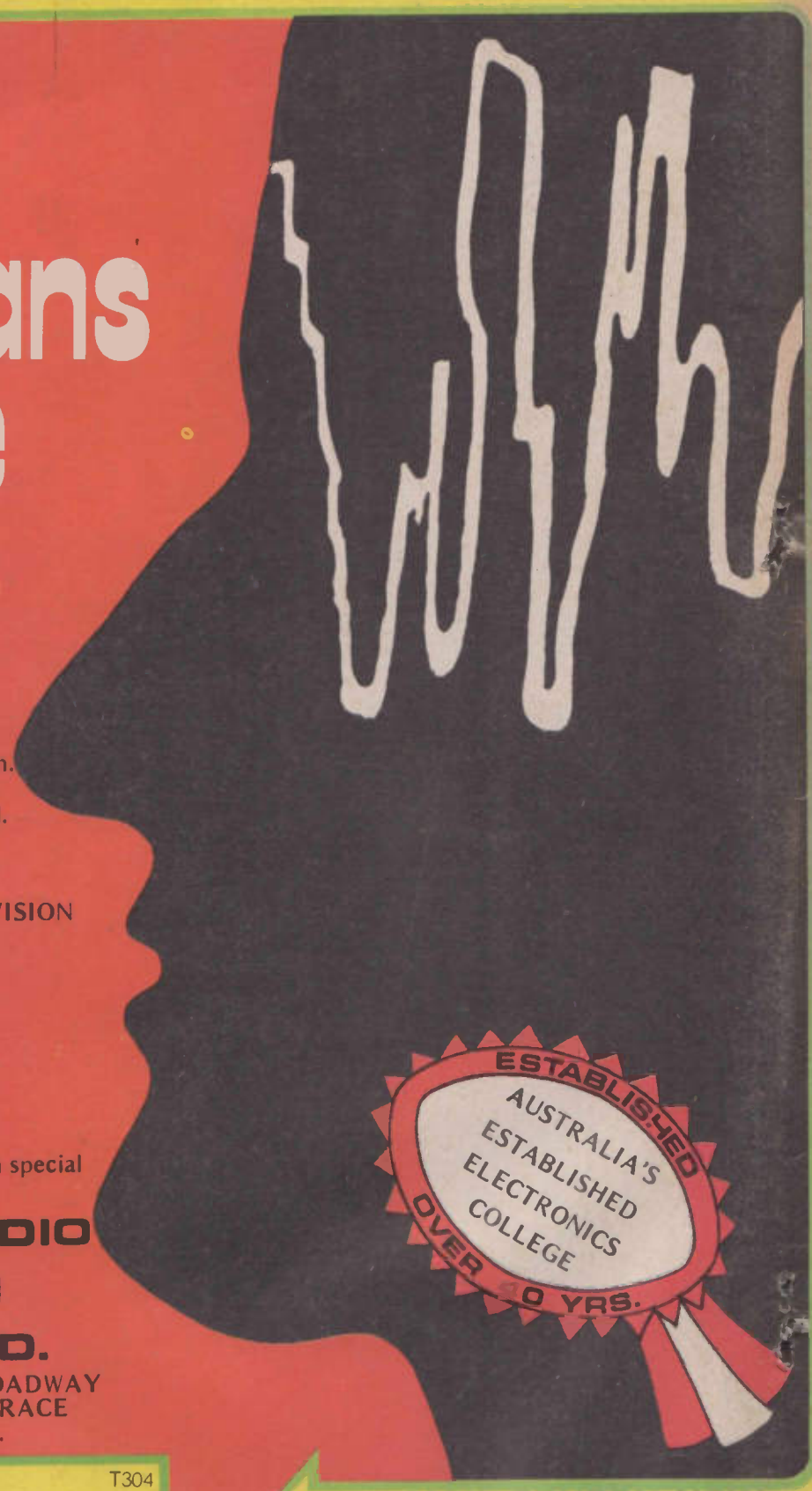

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