AUGUST, 1974
60c*

electronics TODAY INTERNATIONAL

Jansen

SPECIAL HI-FI ISSUE

SCOOP TESTS

DUMMY HEAD STEREO

HEIL LOUDSPEAKERS

Registered for posting as a periodical — Category C

The TEAC AS-100. Everything you need in a stereo integrated amplifier.

The people who bring you the most sophisticated open reel and cassette deck equipment on the market do not build less than the best in stereo amplifiers.

Herewith, the AS-100. A stereo integrated amplifier.

This is what it gives you. A flat frequency response beyond the range of audibility. An extremely low harmonic distortion. A very high SN ratio. 30 watts each channel at 8 ohms. And so, unparalleled sound quality.

In order to assure maximum gain, the widest dynamic range, and minimum harmonic/inter-modulation distortion, TEAC's AS-100 employs new computer designed low noise integrated circuits.

Of course, it's completely flexible. Multiple switched inputs allow you to attach 2 turntables, 1 tape deck, a tuner, and 2 further auxiliary inputs. There's a front panel Rec/Play monitor jack. Even 2dB stepped tone controls.

Interested in a truly hard-working, beautifully built amp? One with TEAC quality built in?

It will pay you to investigate the AS-100. It's everything you need in an amp.

TEAC

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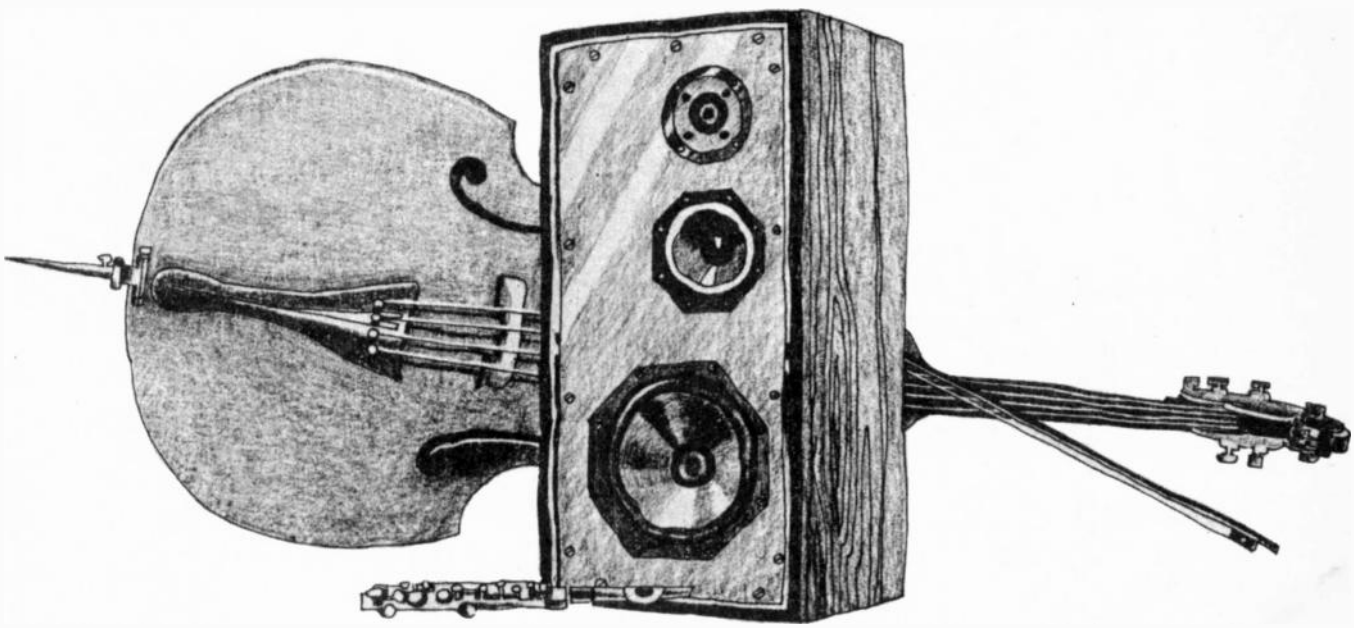
PHILIPS

How can you afford a really good speaker system that has minimal distortion?



Easy...make it yourself!

Building your own speaker system requires no more skill than the average handyman already possesses. The little bit of 'handyman' skill and the Philips range of compatible speaker components could save you up to half the cost of a manufactured system.

The Philips range of Hi Fi speaker components ranges from 1″ dome tweeters through to 12″ woofers, as well as fully assembled two and three way cross over networks. In fact, everything you need to build the system you've always dreamed of. We even have a book that helps you design systems and construct enclosures. So what more do you need except a pair of pliers and a screwdriver?

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A new Hi-Fi magazine

FOR the person who knows little or nothing about hi-fi, choosing equipment can be a traumatic experience. Faced with spending anything from $300 to $3000, he realises he has neither knowledge nor experience of that which he seeks.

He will be overwhelmed with conflicting advice from his friends and confused by a barrage of pseudo-technicalities from hi-fi salesmen, many of whom appear to have totally lost sight of what they are supposed to be selling.

The more determined people eventually find their way to responsible hi-fi retailers — or to one of the growing number of manufacturers' hi-fi demonstration centres.

Somewhere along the way, most prospective hi-fi buyers purchase the specialised hi-fi magazines.

Now their confusion is compounded, for excellent though many of these magazines undoubtedly are, most of them are written specifically for the technically knowledgeable enthusiast — they are not for the novice.

Then there are the 'hi-fi glossies' — in which every single item reviewed is described in glowing superlatives. Marvellous for manufacturers of poor quality goods — but it's a bit rough on those who make things properly — let alone the readers!

So we have come up with a totally new type of hi-fi magazine.

Called Hi-Fi Review, the first issue is due to roll off the presses toward the end of July.

Hi-Fi Review is written specifically for those many thousands of people who are interested in hi-fi but do not have a technical background.

This does not mean to say that it will appeal *only* to the non-technical reader; for although we have taken great care to use primarily non-technical English full data is still included (where relevant) for the lucky few who can understand it.

Hi-Fi Review is people-oriented. It deals with hi-fi in the home *not* hi-fi in the laboratory. It tells you in down-to-earth language just how well an amplifier performs — whether or not it will suit your requirements and whether it does what its maker says it should do.

It is in essence a magazine that people can read, understand, enjoy — and *believe*.

news digest

'75 SOUNDS FANTASTIC

The first ever Hi-Fi exhibition to be sponsored by the Australian hi-fi industry themselves starts August 13 at Sydney's Centrepoint building.

The exhibition, is called '75 Sounds Fantastic.

Realising that technical terms and explanations scare off a large percentage of potential customers, exhibitors are concentrating on the simplicity and beauty of today's high quality sound gear.

Most of the world's leading manufacturers will be showing their wares – and new to Australian exhibitions – a sound theatre will be set up enabling visitors to hear for themselves some of the world's finest hi-fi equipment.

Radio 2GB will conduct a major promotion in conjunction with the exhibition. Prizes in an associated contest will be substantial. Radio celebrity Jeremy Cordeaux will broadcast his midday session from the exhibition.

'75 Sounds Fantastic is supported by:–

ELECTRONICS TODAY INTERNATIONAL
HI-FI REVIEW
AUDIO TRADER
ELECTRONICS NEWS
ELECTRONICS AUSTRALIA.

Electronics Today, together with our associated publications Hi-Fi Review and Audio Trader will have a stand at the exhibition.

The date – August 13-17.

The place – Exhibition level, Centrepoint, cnr. Pitt and Market Sts., Sydney. Don't miss it!

SECRETARIES – 1984.

Or sooner if this 'integrated office' by designer Luigi Colani goes into mass-production.

The 'office' combines chair, desk, computer terminal/type – writer, Telex machine, microfilm reader and information inputs via micro-wave intercom.

ETI's secretary, when shown this new item, showed a singular lack of interest!

DIGITAL WATCHES

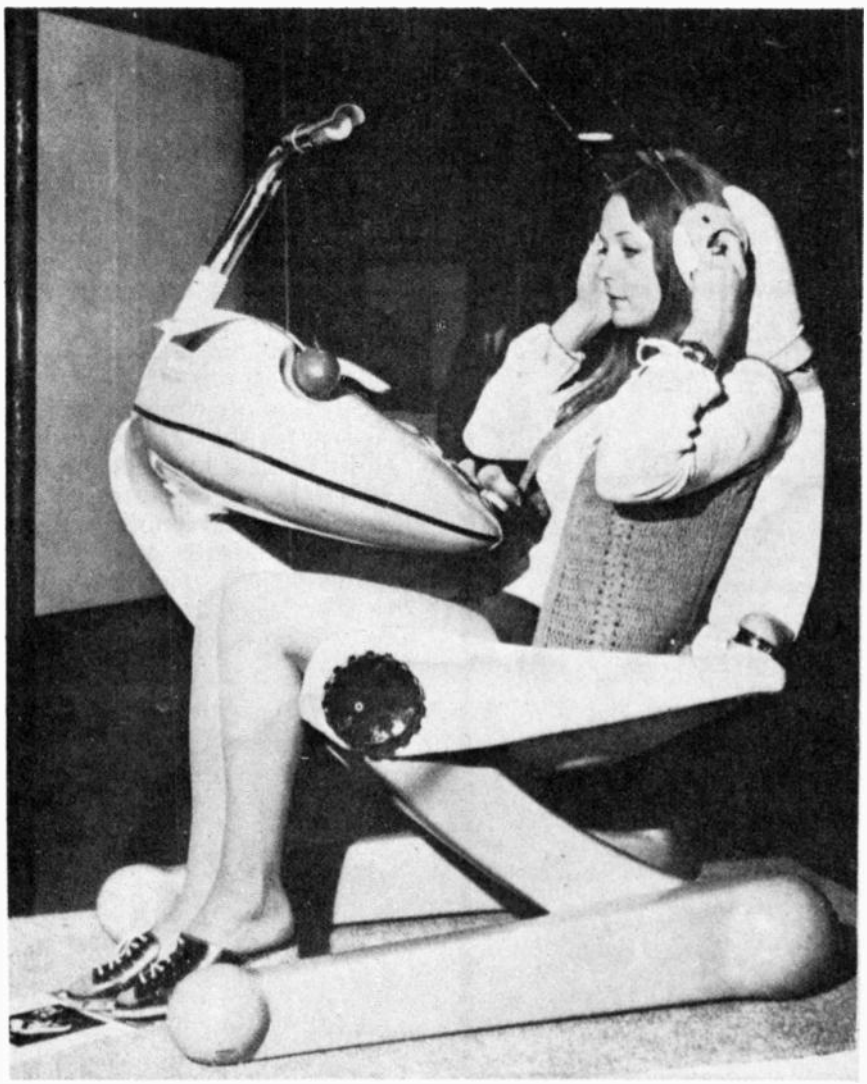
The first under-$100 digital watch is now on sale in the USA. The watch is made by Princeton Material Science, a New Jersey company part-owned by Sprague.

In other digital watch moves, Timex are planning to sell their version at $85 – it is in fact being test-marketed in several areas at that price. Novus, National Semiconductor's consumer products division, are about to launch a digital watch later this year at what a company spokesman called a 'very competitive price', whilst Cox Electronics say that they will launch a $99 liquid crystal model later this year.

Currently, digital watches from companies such as Bulova, Time Computer, Microma etc, sell for $200 upward.

At present 90 per cent of all watches sell for less than the equivalent of $50. Present indications are that digital electronic watches will break that price barrier within the next two years.

(All prices in this news item are in US dollars – about 0.65 of the Australian dollar).



AWA COLOUR TV

AWA's range of colour television receivers will go on sale throughout Australia during August.

Mr. John E. Bailey, joint managing director of AWA-Thorn Consumer Products Pty. Ltd., said he was confident the AWA range would capture the biggest share of the Australian colour television receiver market. Mr. Bailey was speaking after a satellite colour television Press conference to launch the range, at which the Minister for the Media (Senator McClelland) and a panel of Australian editors spoke with TV personality, David Frost, in London.

The conference was the first satellite television press conference held in Australia, the first endorsement by David Frost of a commercial product and the first time a "commercial" has been transmitted by satellite from London to Australia in colour.

Mr. Bailey said prices of 26-inch and 22-inch sets, which would be the first models marketed, would be between approximately $750 and $950 – about eight weeks' average pay compared with the ten weeks' pay needed to buy black and white sets in the early days of Australian television.

AWA recently entered into a joint venture agreement with the giant Thorn Electrical Industries Ltd., of the United Kingdom, the world's largest manufacturers of PAL (phase alternating line) colour television receivers.

The Australian Government, together with the Australian Post Office and Broadcasting Control Board, has chosen the PAL system as the most efficient and the most suited to Australian conditions.

All AWA-Thorn receivers will incorporate the latest developments in the PAL system.

They will be manufactured at a new factory which has been built at Rydalmere, near Sydney, especially for colour set production.

AWA Deep Image colour television receivers will be technologically ahead of most sets available around the world, Mr. Bailey said. They will have a 110 degree picture tube, allowing a slimmer cabinet line, solid state integrated circuits and precision static toroid yoke – a computer-designed electro magnet which controls the direction and alignment of the colour electron beams in the picture tube more efficiently than the usual standard deflection yokes.

Full colour transmission in Australia will begin on March 1, 1975, but colour test patterns will begin on October 7 and limited outside telecasts soon afterwards.

FALLING CALCULATOR PRICES REDUCE SALES

Sales of pocket calculators are falling far short of manufacturer's expectations.

Tired of seeing calculator prices reduced drastically immediately after purchase at a higher price, consumers appear to have decided – en masse – to postpone purchasing.

One US sales organisation say that sales have fallen to about 50 per cent of last year's.

Another distributor told our reporter that his sales have fallen from $40,000 per month last year to $11,000 for the past two months. The distributor said that the manufacturer's policies are putting customers in an impossible position. They clearly want to buy, he said, but don't. They wait until next week for the price to drop.

A similar malaise is beginning to hit scientific calculators too. Bowman's MX 100 for instance has been slashed from US$180 last November to a current low of US$120.

MOLECULE – ULTIMATE MICROCIRCUIT

What must surely be the ultimate in micro-miniature circuitry was proposed recently by Avi Aviram of IBM and Mark Ratner of New York University.

Speaking at a meeting of the American Physical Society last month, the two researchers outlined a technique for designing individual molecules as functioning electronic devices. Presented to the conference was a blueprint for constructing a hypothetical rectifier in molecular form – along with quantum mechanical evidence of the scheme's feasibility!

ELECTRONIC GEARBOX FOR TRUCKS

Britain's Ferranti organization and the Ford Motor Company have jointly developed a semi-automatic transmission system using an electronically-controlled gearbox.

Unlike most automatic transmissions, the new system more or less takes over the actions of a driver changing gears manually.

In use the driver simply selects the desired gear. The automatic device then disengages the clutch, brings the engine to the correct operating speed, changes gear and then re-engages the clutch.

Intended primarily for trucks, the new system is said to cost less than half the normal price of a conventional fully-automatic transmission.

At present the control unit uses integrated circuits – some 300 in fact. Later units will utilise Ferranti's CDI (collector-diffusion-isolation) technology. It will then, say Ferranti, consist of three 40-pin dual-in-line packages housed in a small case and weighing less than three kilograms. In this final version the chips will contain about 12 op amps, 1200 gates and a 400-bit read-only pre-programmed for any number or combination of gear ratios.

LASER WEAPON CONFIRMED

The long-rumoured laser-gun now seems to be for real. The US Navy have just confirmed previously unofficial reports that they are just about to undertake sea trials of a ship-borne anti-missile laser weapon. As the project is totally classified no other details can be published.

COMPONENT SHORTAGE EASES

Although electrolytic capacitors and zener diodes are still in very short supply, the previous world-wide component shortage seems to be diminishing.

news digest

The lead time for resistors (in the USA and Europe) is down to 14 weeks or so — a welcome change from the 52 weeks plus that was being quoted until recently.

Integrated circuits are now generally available virtually ex-stock — particularly digital ICs.

The reason for the sudden improvement is largely due to a falling demand for finished products, especially for automobiles, radios and TV sets. As a result equipment manufacturers are less anxious to maintain large stocks of components.

NIXON'S TAPES

When it was revealed that President Nixon had bugged his own office — tape recording everything that was said in there — his tape records became an important part of the evidence in the Watergate investigation.

To find out whether or not the tapes had been 'edited' in any way, a panel of six experts was nominated jointly by the White House and the Watergate special prosecutor.

The panel of experts found that one tape — one of the most critical — had apparently been overdubbed by an 18½ minute-long 'buzz'.

From there on the investigation became virtually a scientific detective story.

Firstly the tape was 'developed' using a magnetic fluid. Acting in much the same way as do iron filings in a magnetic field, the magnetic fluid revealed the shape of the otherwise invisible marks left by the tape recorder's record and erase heads, when these heads are switched on or off they leave marks on a recording tape which are almost as distinctive and individual as fingerprint marks).

Another test analysed the content of the superimposed 'buzz' and found that it consisted of 60 Hz, 180 Hz, 360 Hz signals — in other words it was in some way related to the 60 Hz mains voltage used in the USA.

Using these and other tests, the panel concluded that it was virtually impossible for the tape to have been edited accidentally. All evidence pointed to a deliberate attempt to erase speech — but in a surprisingly clumsy way.

Although the investigating panel's conclusions were unanimous, experts for the defense challenged the conclusion that the erasures were deliberate.

Pointing out that the original tape had been transcribed using a Uher 5000 recorder, defense attorney, Charles S. Rhyne said that "the Uher 5000 is, according to tape recorder users, the worst, or one of the worst, tape recorders made. It has a history of constant malfunctions."

Rhyne went on to point out that not only did Exhibit 60 (the Uher 5000 , used for the transcription) fail during the panel's test period, but so did another brand new Uher 5000 bought by the panel for further investigation.

The experts also studied the 60 Hz hum in the background of further sections of a tape containing speech. They came to the remarkable conclusion that although the speech had been recorded by a Sony 800B machine it was not one of the machines that the panel tested. In other words, contrary to instructions the Secret Service did not hand over all their machines for investigation by the panel!

MORE FAX . . . ALMOST

An American FM station, WGLO (106.7 MHz) at Fort Landerdale (Florida) has received permission from the U.S. Federal Communications Commission to transmit a visual sub-carrier. The new broadcast service, which will require a special converter (to be supplied on a rental basis by the station), will print out on a standard TV screen such data as airline schedules, local news and stockmarket quotations.

Many U.S. FM stations broadcast subsidiary services via sub-carrier but WGLO will be the first in at least a couple decades to broadcast anything even approaching facsimile.

As luck would have it, WGLO will probably have an international audience. Within their coverage area are the wealthy Binimi (Bahamas) residential and tourist developments.

$10 COMPUTER BY 1980?

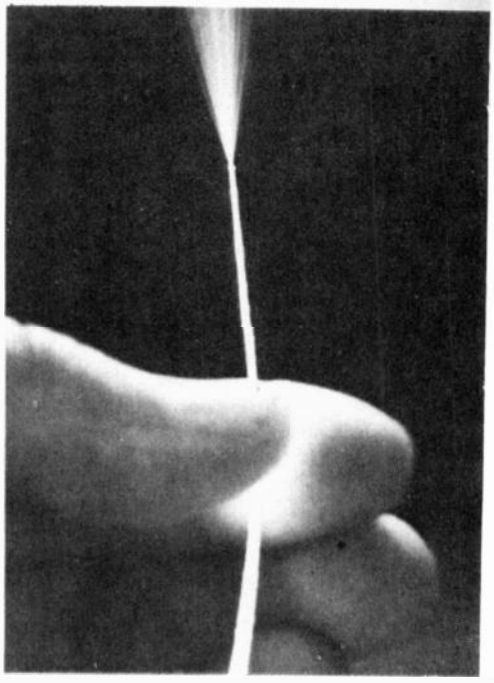
Before 1980 general-purpose microcomputer complete with central processor and internal working memory will be available on a single chip for a cost of between $1.00 and $10.00. Magnetic bubble technology is expected to bring the cost of memory from the present one cent a bit to one tenth of a cent per bit.

These and other similar predictions were made by L.S. Coles and J.M. Tenenbaum of Stanford Research Institute, and O.Firschein and M.A. Fischler of Lockheed Research at New York's recent IEEE Intercon.

In their paper entitled 'Forecasting and assessing the impact of artificial intelligence on society', the authors considered the social implications of 21 postulated commercial products based on artificial intelligence technology.

One of their most startling forecasts is that of single chip computers capable of handling 20 million instructions per second with an internal 65,000 bit memory selling for less than US$1.00! This say the authors, should eventuate before the end of this century.

NEW LOW-LOSS LIGHT FIBRE



Like water from a hose, light pours out of the end of this nearly one kilometre length of light fibre.

A dramatic reduction in the transmission light loss through glass fibre was announced six months ago by the US Bell Telephone Company.

Now, even further improvements have been made.

The achievement may hasten the time when light pulses, in addition to electrical and radio signals, will transmit voice, data and video signals through telephone network. Communications systems using light would have a much greater signal-carrying capacity, with potentially less cost and less dependence on scarce natural resources, than existing transmission facilities.

Light sent through the hair-thin fibres, made by a new process at Bell Labs, loses only about one fifth of its intensity over a distance of a kilometre. In ordinary glass of the sort used in window panes, such a reduction of intensity would occur in less than a centimetre, (the amount of light loss is directly related to the presence of residual impurities and imperfections in the glass fibres).

In long-distance optical communica-

tions systems of the future, low light loss is especially valuable because it cuts down the number of amplifying stations needed to boost the signal along the way.

Another important feature of optical fibre performance is also improved in the new Bell Labs process. This feature has to do with the smearing of light pulses by dispersion.

Dispersion is caused by the fact that some light within each pulse travels in a zig-zag path during its passage along the fibre, thus travelling slightly farther (and taking longer) than other light that travels in a more direct path. As a result the pulse signal may spread out, and may eventually merge with another of the closely spaces pulses, thus lowering the information-carrying capacity of the fibre.

Dispersion can be reduced by varying the composition of the fibre radially to produce a graded index of refraction. This causes the light following a zig-zag path to travel slightly faster than the direct light so that all of a given pulse arrives at its destination at more nearly the same time.

Both performance factors important in glass fibres — low light loss and low dispersion — can be more precisely controlled in the new fabrication process devised by Bell Labs scientists.

A low-loss fibre useful in communications has long been a goal of scientists at Bell Labs and other industrial laboratories. The Corning Glass Works, with whom the Bell Labs scientists have been comparing results, has also reported successes in producing fibres through a different though related process, with losses closely approaching those of the Bell Labs fibre.

First results of the Bell Labs scientists' work have been published in a current (May-June) Bell System Technical Journal article entitled "Optical Waveguides with Very Low Losses." Authors are William G. French, John B. MacChesney, Paul B. O'Connor and G. William Tasker. Further results were presented at the International Glass Congress, Kyoto, Japan (July 8-12, 1974).

RADIO TRANSMITTERS MAY CAUSE EXPLOSIONS

An operating radio transmitter can induce power into any structure that can act as receiving antenna.

If the receiving 'antenna' is of the appropriate length and conductivity, sufficient energy may be induced for sparks to be generated between the 'antenna' and adjoining surfaces or between surfaces which are normally in contact but may become separated.

It is for this reason that notices are often displayed near blasting sites asking drivers to switch off their radio transmitters.

A new British standard, BS 4992 covers the whole problem of RF initiated detonation. Known as the 'Guide to protection against ignition and detonation initiated by radio frequency radiation', BS 4992 contains a most invaluable amount of information about this generally little understood subject.

(BSI Sales Dept, 101, Pentonville Rd, London, N1 9ND).

SPECIAL IC OFFER

As expected, our special IC offer was grossly over-subscribed, in fact our entire stock sold out within three days!

We are currently trying to obtain further supplies, but at present we are not very hopeful of success.

If we cannot obtain further supplies, we will try to obtain another type with basically similar characteristics — if anything it will have a higher specification.

Assuming that we are successful, this new type (together with full circuit details etc) will be supplied against outstanding orders. If any readers receiving this different type are not totally happy with our suggested arrangements we will return their payment in full, together with postage.

PURCHASE PRICE IS ONLY HALF COLOUR TV COST

The actual purchase price of a colour TV set accounts for only 53 percent of its actual cost over its useful life — according to a report issued by the Massachusetts Institute of Technology.

Servicing costs account for 35 per cent of the total, and electrical power required to run it adds an a surprising 12 per cent more, (the calculations assume a useful lifespan of 10 years).

Conclusion of the report is that a set selling for US$400 will in fact cost about US$800 to run but in fact the cost will be very much higher than this, for the calculations do not take any account of inflation over the ten year period. Taking inflation into account, industry observers suggest a true total cost of US$1400 is realistic.

SODIUM SULPHIDE BATTERIES

The formation of a company which will be devoted to the development and commercial exploitation of the sodium sulphur battery has been announced by Britain's Electricity Council and Chloride Group Limited. It will be known as Chloride Silent Power Limited.

The possibility of using a sodium sulphur battery — which makes use of relatively cheap and abundant materials — has been known for many years, in fact a prototype was shown by Ford Motor Company, who own the patent rights, at their Dearborn research laboratories in the USA in 1968. But the problems associated with its conversion from an interesting laboratory project to a commercial product have been very considerable.

Positive research on the sodium sulphur battery by the Electricity Council began in 1967 at the Electricity Council Research Centre. This research has been encouragingly successful and ECRC have produced prototype sodium sulphur batteries using beta alumina tubes as the material for the solid electrolyte. These have been successfully used to power a 1000 kg Bedford van in London and in performance tests on the roads of Cheshire.

The objectives of the joint operation will be:

(a) to engage in development work over at least a four year period to produce commercially viable pre-production sodium sulphur batteries

news digest

for electric bus and commercial vehicle applications;

(b) to develop specifications for the machinery required for bulk battery manufacture;

(c) thereafter to licence interested manufacturers to produce sodium sulphur batteries.

It is expected that the cost of the four year development period will be about £2 million of which the Electricity Council and Chloride will each contribute half.

If the development period is successful Chloride and the Electricity Council will consider how best to make the battery available. It is not expected that batteries will be commercially available for some years.

The sodium sulphur battery which is being developed by the new company could revolutionize urban transport. If the problems associated with its development can be overcome it will treble the range of existing battery powered buses and very considerably extend the number of light commercial vehicle applications which can benefit from pollution free battery power.

AN APOLOGY

An industrial strike hit us part way through printing last month's issue of this magazine.

The issue was finally printed on machinery that was not really suitable for the task.

As a consequence the reproduction on some pages (particularly of pictures) was well below our usual standard.

We apologise to readers and advertisers for the generally poor standard of that issue — but trust that they will agree with our belief that it was better to have a sub-standard issue than none at all.

WALL-HUNG TV

In Japan, Sony have released some details of a prototype flat-screen colour TV set using gas-discharge matrix panels operating from dc.

The display panels are less than ten millimetres thick and about 150 mm across. Purpose of the project say Sony, is to produce picture-shaped colour TV sets with one metre screens.

SONAB INTO COMMUNICATIONS

Known world-wide for their high quality hi-fi equipment, Sweden's Sonab organisation have now expanded into the mobile communications business.

The company has taken over Sweden's AGA mobile communications division (as from July 1st), thus giving Sonab about half Sweden's land-communication business plus an entry into aviation systems.

Sonab's sales last year were approximately A$7 million — the amalgamation with AGA is expected to double that figure in the first year of operation.

DICK SMITH JUMPS AGAIN

Relatively few business men deliberately seek to establish themselves as mildly crazy.

Not so Dick Smith, of Dick Smith Electronics, who, over the past few years has cultivated the belief that he is a 'nut'.

A recent press release from his organisation shows Dick travelling to work on his latest means of transport — a powered pogo stick.

NEW CHIP FOR COLOUR TV

An MOS chip containing all the circuitry for remote control, tuning and display of a colour TV receiver has been developed by Mostek. The device — already planned for use in 1975 US Magnavox receivers — will initially be housed in a 40-pin ceramic package.

NEW SQ CIRCUIT ENHANCES SEPARATION

A breadboard prototype of a 'separation enhancement' system, shown at the recent Consumer Electronics Show (Chicago) provided almost total separation of SQ matrix signals.

Developed by a company called Tate Ltd, the circuit is added to four-channel amplifiers after the normal decoder. The monolithic device then provides channel sound separation far beyond the most advanced full logic systems heard so far.

We understand that the company will market the circuit as a single-chip IC primarily to original equipment manufacturers.

Meanwhile, Fairchild have announced that they will soon be producing a full range of normal SQ integrated circuits for world-wide distribution.

A PECK OF TROUBLE

After decades of experience, the engineers and researchers at Austral Standard Cables Pty. Ltd. perhaps could be excused for believing they had overcome almost every conceivable environmental challenge.

The sad truth, however, is that the ASC people recently have been given the bird.

Over the years they successfully wrestled with the problems of cable moisture permeation, submarine cable protection, electrical interference, assorted "gremlin-inspired" technical difficulties . . . and termite attacks.

The termites were licked when ASC engineers applied the greasy pole principle. They introducted nylon-sheathed cable. To termites, the surface is so slippery that they cannot "latch on" long enough to take a bite.

Nature, however, is able to provide pests in infinitely greater variety than can engineers produce protective covering for cables!

Inevitably, another menace emerged. This time the parrot . . . in its challenging Westralian thousands.

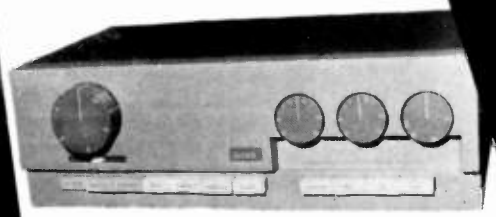
These "iron beaks" have been pecking through integral bearer (IBC) cables at Mt. Newman (W.A.), causing shorts and interference within the mining company's domestic communications network.

ASC's "think tank" in Melbourne doesn't claim to have a quick-remedy for the problem but has suggested that brass tape may stop the birds (nylon probably wouldn't be hard enough).

If that doesn't stop the parrots, ASC's engineering services department may be in for some overtime. (Our Editor suggest the result be marketed as 'polly-final').

Meantime, a CSIRO spokesman recently warned that a termite four or five times bigger (and proportionately more destructive) than the normal pest is about to confront settlements in the country's ever-expanding north-western sector . . . ●

DUAL 1229



QUAD 303

SONY TC 161-SD

KENT HI-FI IS ON THE MOVE

ALTEC 604E
Studio Monitor

KENWOOD 404

REVOX D77
Mk III SAE
PREAMP

KENT HI-FI's DOCTRINE OF CUSTOMER ASSISTANCE

Michael White

In just a few short years, Kent Hi-Fi has grown from a small one-man company to one of Australia's largest and most respected audio retailers.

But, like many a company before them, they created a demand for their services that quickly outstripped the capacity of their premises.

Now they have moved. To a near-3000 square foot showroom just 100 yards further along Kent Street — still in the heart of Sydney.

What is the reason for Kent Hi-Fi's success? How come that despite the almost incredible congestion of their earlier premises — likened once to Hong Kong harbour during the Chinese New Year — they managed to retain an atmosphere where the customer could receive courteous and knowledgable attention — and where he could still feel relaxed?

In reality the answer lies in the fine talent of each member of the company's staff — all of whom were previous clients of Kent Hi-Fi!

Peter Derz

Tony Martin

They are all people who are not just in the audio game for a job. They are people who genuinely like what they are doing.

And that helps quite a lot.

The staff make a real effort to ascertain the client's needs. They make the client's problems *their* problems. And ensure that the client really does obtain the optimum equipment for his expenditure — and his needs.

Now, Kent Hi-Fi have premises that complement the ability of their staff.

Here at 410 Kent Street, the accent is on performance.

As you move through the door you see what is the most comprehensive range of cassettes, cartridges, tapes and accessories in NSW. Here there are 15 or more brands of cassettes alone — and the full manufacturer's range in each brand.

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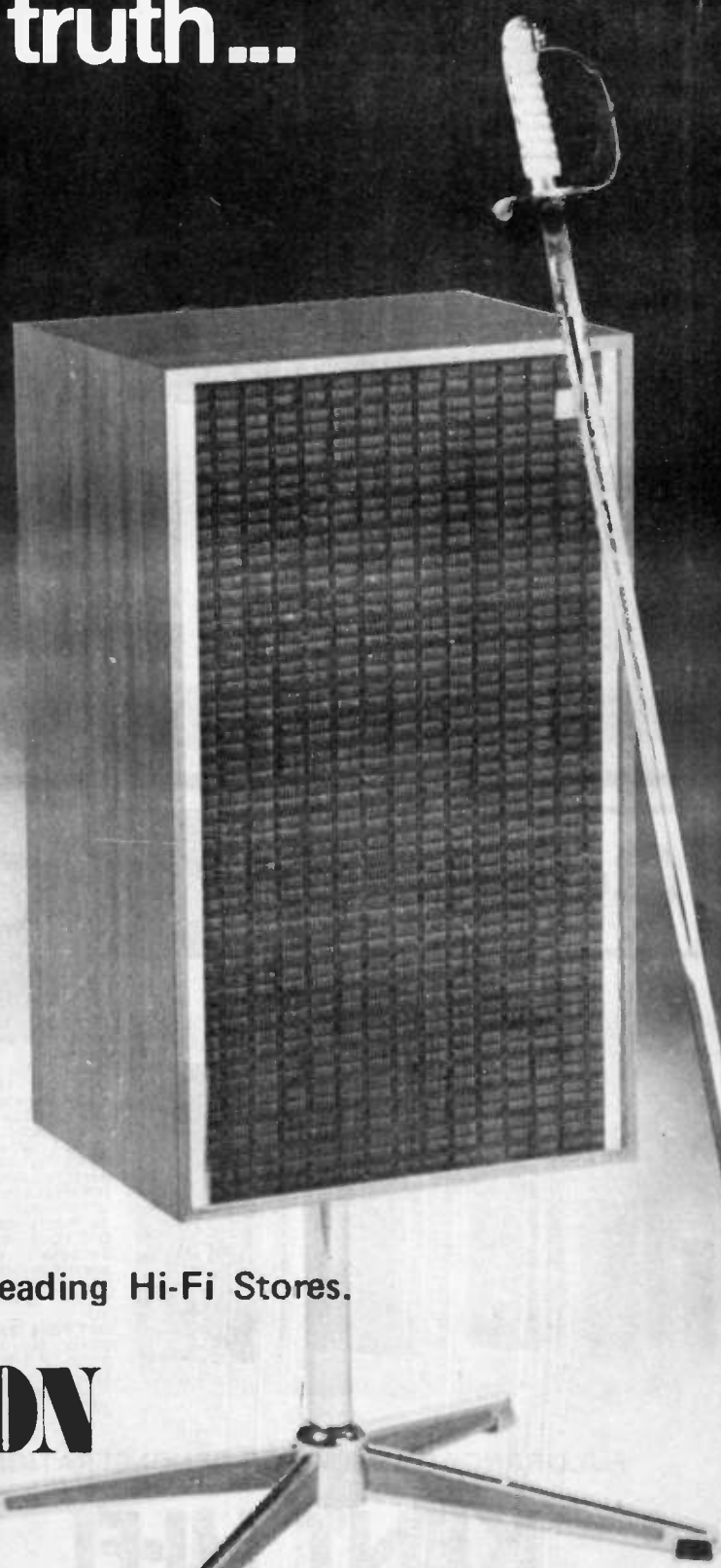

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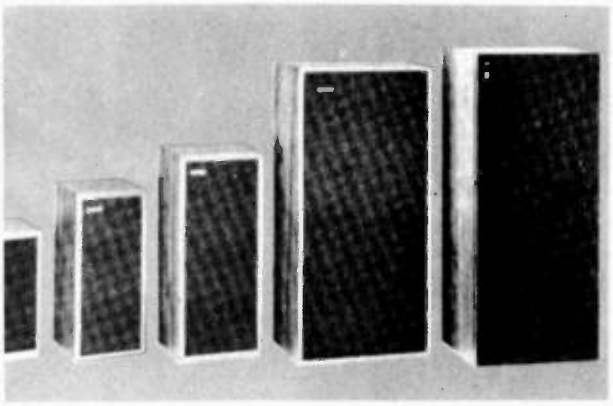

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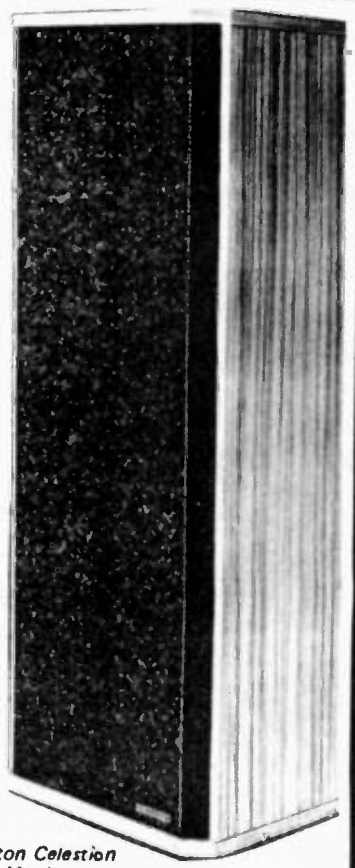

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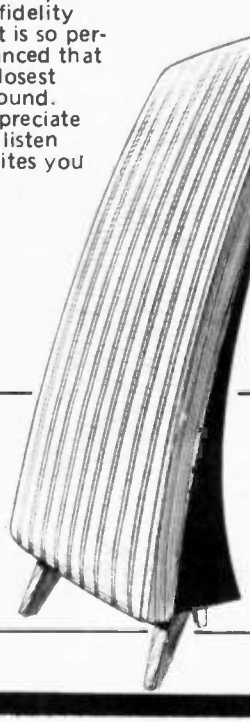

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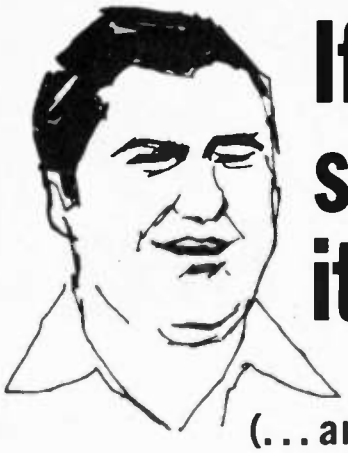

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Transmission line speakers are now very much in the news. Basically they consist of a large enclosure housing one or more labyrinth-loaded speaker drive enclosures. The labyrinth is carefully packed with specially graded fibre or woollen material.

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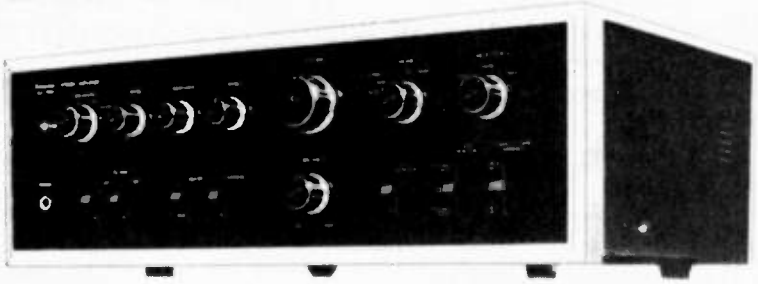

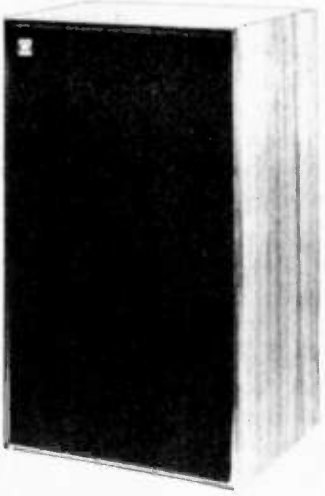

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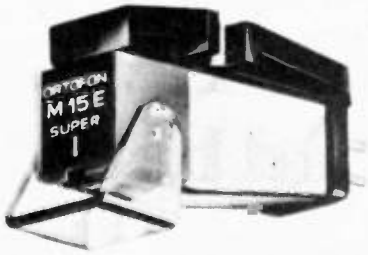

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MANUFACTURER	NUMBER OF MONITORS USED IN U.S. STUDIOS
Altec	514
JBL	256
EV	77
KLH	35
AR	29
Tannoy	28

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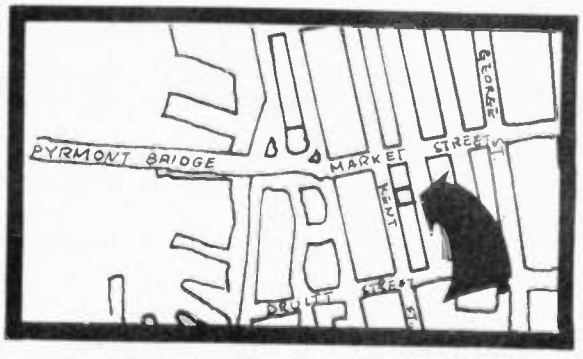

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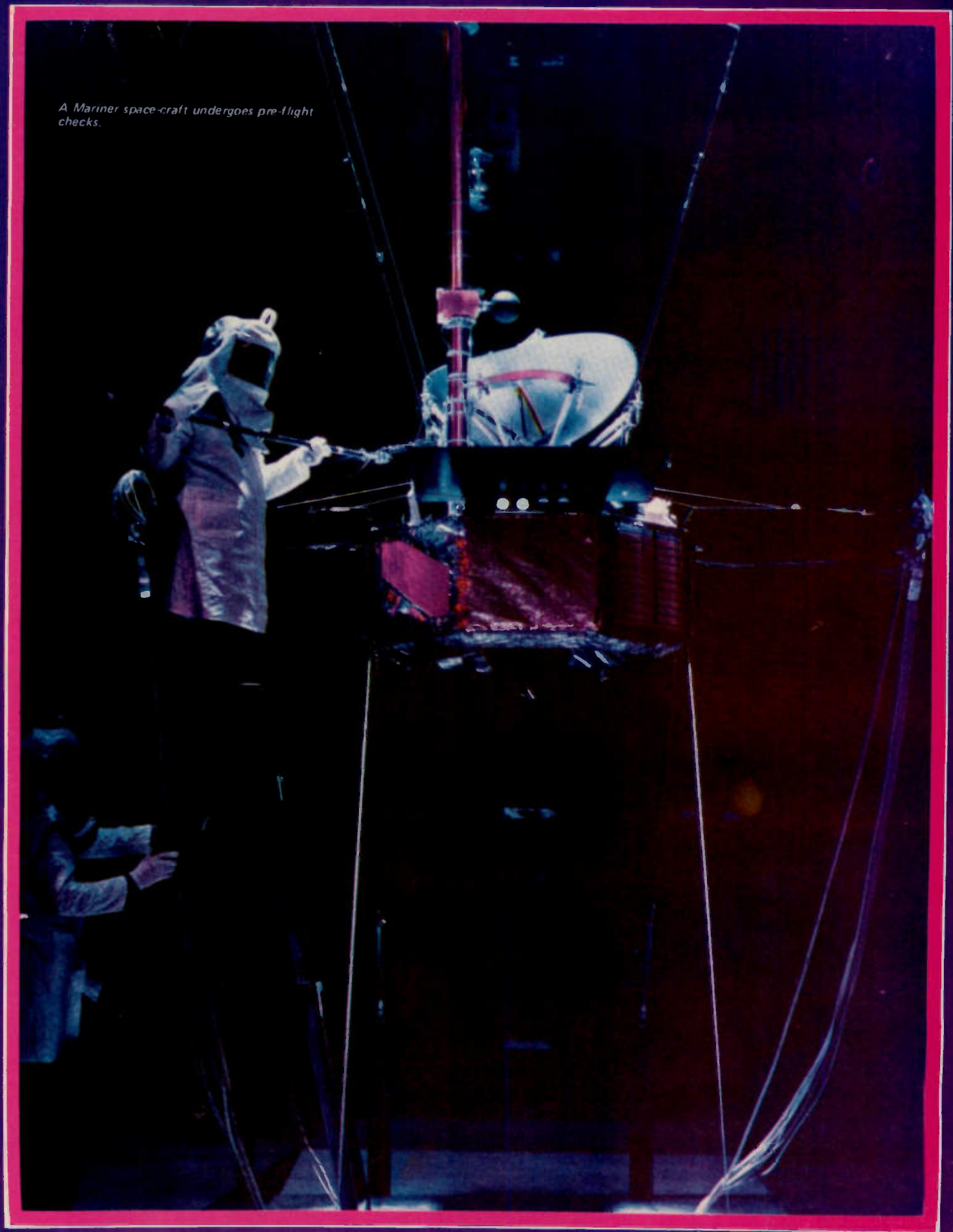
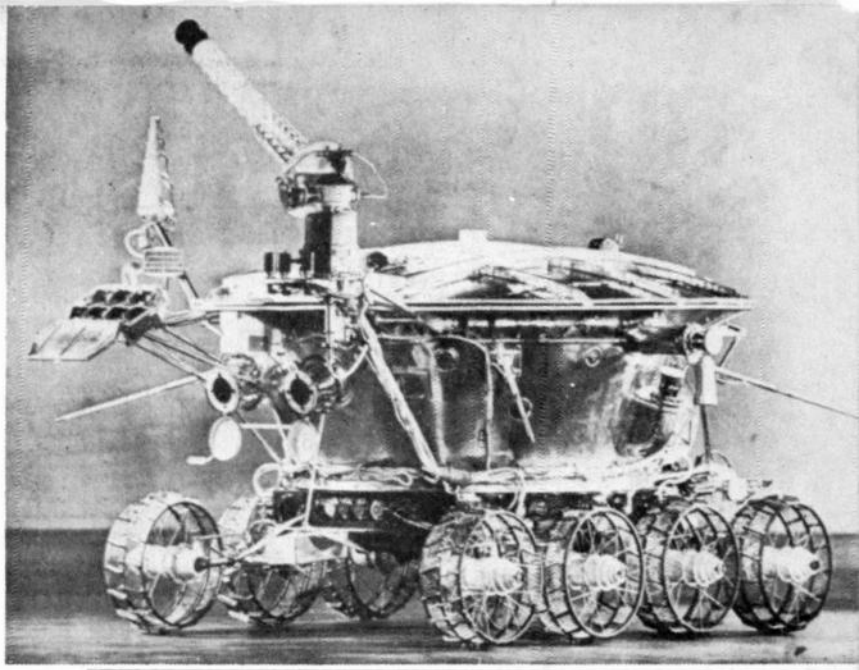


A Mariner space-craft undergoes pre-flight checks.

ROBOTS IN SPACE



The automatic self- mobile vehicle Lunokhod 1, used in early USSR lunar mission.

Why send man into space — thinking machines may be better and cheaper.

THE placing of man on the Moon, and the follow-up exploratory trips, including the use of an auxiliary man-carrying lunar vehicle, were magnificent demonstrations of what technology can achieve.

But superb as the achievements were, it is questionable whether *manned* landings at those early exploratory stages were justified for other than chauvinistic reasons.

The addition of the crew and their intricate life-support systems added immensely to the already complex vehicle and instrumentation payloads and necessitated larger boosters for the rocket systems.

Apart from that there was the hazard to the crew during a mission — and the necessity to abort a mission in the event of a life-support malfunction or other similar accident.

Because of these factors NASA commissioned the Martin Marietta Aerospace Division to study the application of adaptive systems for the exploration of the solar system.

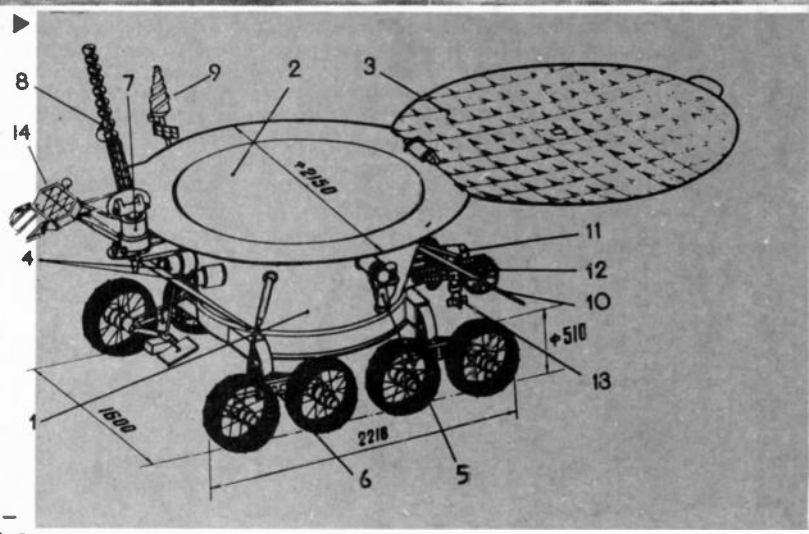
The development of adaptive systems is an exciting new technology aimed at simulating human intelligence using machines that can learn, think and make decisions.

NASA's interest has been to examine this field of artificial intelligence, and to identify practical applications for unmanned spacecraft which will be used for solar system exploration in the 1980s.

The study was in two parts.

The first was a quick look at a large number of possible solar system missions extending to 1990. The objective was to examine the benefits and feasibilities of adaptive features on these missions, and to determine which missions would benefit the most from further study of adaptibility.

The second, and larger part of the project was directed to three Mars missions. The first an improved version of the Viking lander. The others adding respectively, a small tethered rover and a medium-sized rover with a range of one kilometre.



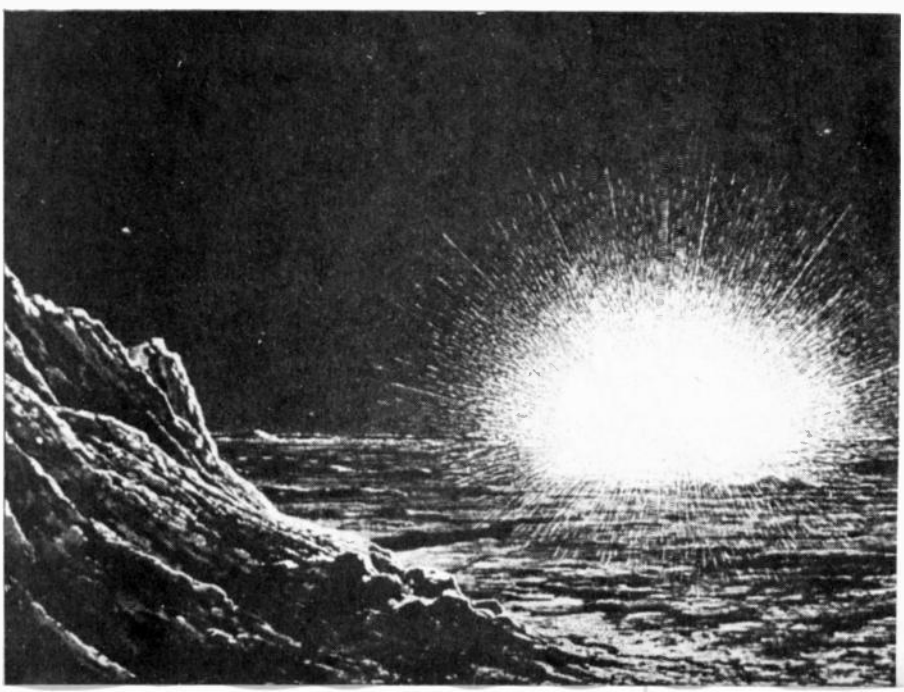
A detailed diagram of Lunokhod 1. 1 — Hermetically sealed instrument compartment. 2 — Cooling radiator. 3 — Polar battery. 4 — Portholes for TV cameras. 5 — Telephotocameras. 6 — Chassis wheel unit. 7 — Pencil-beam antenna drive. 8 — Pencil-beam antenna. 9 — Low positioned antenna. 10 — Polyrod antenna. 11 — Isotype source of thermal power. 12 — Ninth wheel. 13 — Device for defining physical-mechanical surface properties. 14 — Angular optical reflector.

ADAPTIVE SPACECRAFT AND SYSTEMS

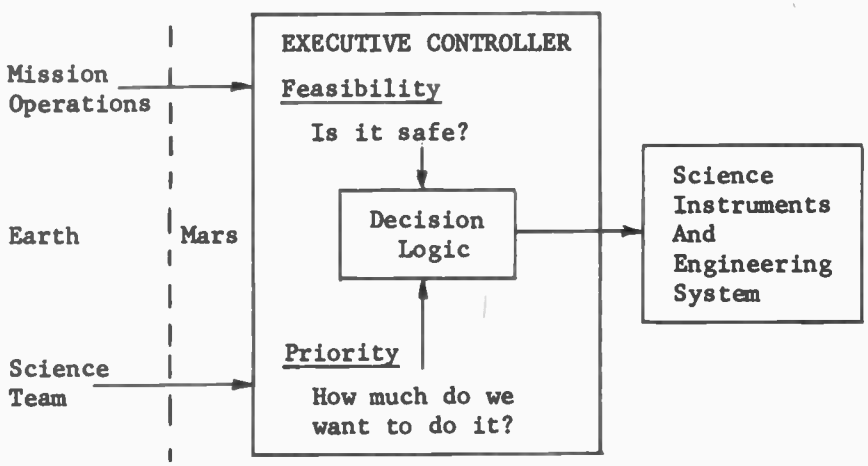
If an unmanned spacecraft can be made to adjust or *adapt* to the environment, to make decisions about what it measures and how it uses and reports the data, it can become a much more powerful tool for the science community in unlocking the secrets of the solar system.

In terms of sophistication, an adaptive system can be extremely simple or as complex as a chess playing machine that learns from its mistakes.

Sunrise as seen from Mercury's terminator.



ROBOTS IN SPACE



Typical control system. On-board executive controller monitors data relating to robot's environment, ie, internal and external temperatures, power availability, wind speed, terrain, instrumentation condition etc, it then compares this against stored data relating to mission priority and desirability and then decides whether or not mission should proceed. The robot's decisions can at any time be overridden or modified by earth-based mission operating centre.

At the bottom scale of sophistication are such devices as thermostats – "if the temperature is above X degrees, turn off heater" or "if the seismometer output exceeds Y, increase sampling rate".

In more complex situations, as for example cloud photography – "search sky with optical sensor, if patches of unusual brightness encountered, point camera in direction and make repeated pictures till clouds disappear or data banks are full".

A rock presents a ,more subtle problem as a target for taking pictures. It is generally neither uniformly darker nor lighter than the background.

The problem can be simplified if the photographing position can be chosen so that the sun strikes from the side, making a highlight and a shadow. For example the surface of the Moon yields much more optical detail when viewed from Earth during a period other than when the Moon is full. The shadows produced when the sunlight strikes the surface at an angle bring out crater detail not seen when light 'normal' to the surface illuminates the scene. On this basis a program for rock recognition has been written and tested. It requires about 200 words of computer memory.

These examples broadly define the function of an adaptive system. In effect the goal is for "thinking" machines to perform the many tasks hitherto achievable only by carrying the best computer-man.

It is accepted that landing man on any extra-terrestial body is the best way of obtaining optimum acquisition of data. However, the extended periods of time involved on such journeys, the necessity of carrying life support systems and the capability of ensuring safe return after such an excursion, require pre-research and proving exercises that are financially prohibitive and wasteful of time.

The "robot" as a primary explorer is a more generally satisfactory alternative.

Table 1 details twenty proposed space missions, commencing in 1979 and culminating in 1988. Listed are possible destinations, payloads, launch systems and propellant methods. Also suitable launch dates and trip durations.

The launching dates are particularly important as missions will also be used for observing comets passing close to our solar system (in the eighties). Correct timing would place vehicles at optimal observational positions at time of "fly-by" of the comets. Similarly the planetary exploration probes have launch "time windows" which allow for the shortest trajectory or for the "assist" of the gravitational pull of some other celestial body to deflect the spacecraft in the direction of its final goal.

It is also interesting to note that new propulsion systems including Nuclear Electric Propulsion (NEP) and Solar Electric Propulsion (SEP) are suggested.

	Science Payload kg	Launch/ Injection System	Spacecraft Propellant	Trajectory Type	Launch Date	Trip Time, Years
Mercury Orbiter	127	Shuttle/Centaur	Space Storable	Venus#	1980	1.83
Venus Orbiter	1036	Shuttle/Centaur	Space Storable	Direct	1983	0.43
Venus Probe	200	Shuttle/Centaur	Space Storable	Direct	1983	0.43
Venus Balloon	244	Shuttle/Centaur	Space Storable	Direct	1983	0.43
Venus Lander	180	Shuttle/Centaur	Space Storable	Direct	1983	0.43
Mars Orbiter	2771	Shuttle/Centaur	Space Storable	Direct	1988	0.58
Mars Lander	600	Shuttle/Centaur	Space Storable	Direct	1988	0.58
Mars Lander/Rover	300	Shuttle/Centaur	Space Storable	Direct	1988	0.58
Halley Flyby	458	Shuttle/Centaur/ HE Burner II	Monopropellant	Direct	1984	1.17
Encke Flyby	1287	Shuttle/Centaur	Monopropellant	Direct	1980	0.22
Encke Rendezvous	415	Shuttle/Centaur	NEP	Direct	1982	1.4
Vesta Rendezvous	111	Shuttle/Centaur	Space Storable	Mars#	1986	1.69
Jupiter Orbiter	248	Shuttle/Centaur HE Burner II	Space Storable	Direct	1980	3.33
Jupiter Probe/Flyby	76/371	Shuttle/Centaur HE Burner II	Monopropellant	Mars#	1982	3.56
Saturn Orbiter	97	Shuttle/Centaur HE Burner II	Space Storable	Direct	1986	4.90
Saturn Probe/Flyby	30/165	Shuttle/Centaur HE Burner II	Monopropellant	Jupiter#	1979	3.17
Uranus Orbiter	361	Shuttle/Centaur	NEP	Direct	1982	5.80
Uranus Probe/Flyby	342/97	Shuttle/Centaur SEP	Monopropellant	Saturn#	1982	7.23
Neptune Orbiter	341	Shuttle/Centaur NEP	NEP	Direct	1982	11.6
Neptune Probe/Flyby	342/51	Shuttle/Centaur SEP	Monopropellant	Saturn, Uranus#	1982	11.6

#Gravity Assist NEP = Nuclear Electric Propulsion SEP = Solar Electric Propulsion

Table 1. Table shows proposed missions for future solar system exploration. Note possible use of nuclear electric and solar electric propulsion in 1982.

MARS MISSION – ADVANCED LANDER – ROVER CONCEPTS

Three concepts for the Mars missions are envisaged: an advanced lander, advanced lander with small rover,

advanced lander with medium rover. Each has a different impact on the Viking '75 lander design and different degrees of adaptability, versatility and sophistication. Engineering aspects of each concept were evaluated in sufficient detail to indicate their required adaptive functions and to work out suitable systems that would be reasonable extrapolations of the Viking '75 system.

Figure 1 shows a proposed model for the advanced lander concept.

Not shown on the drawing are a wet chemistry experiment that can detect optically active amino acids, and a life detection system that monitors the gas over a soil sample for changes in composition that indicate metabolism.

The added rover (tethered) will be carried in available space as shown. A wide range of capabilities can be incorporated into such a rover concept (Fig. 2). It can gather samples within a 100 metre radius of the lander and receives its commands and its power from the lander via an "umbillical" cable. It can pick up samples, make a preliminary analysis with its X-ray fluorescence spectrometer, reject samples that are like ones already collected and return interesting samples to the lander for detailed analysis.

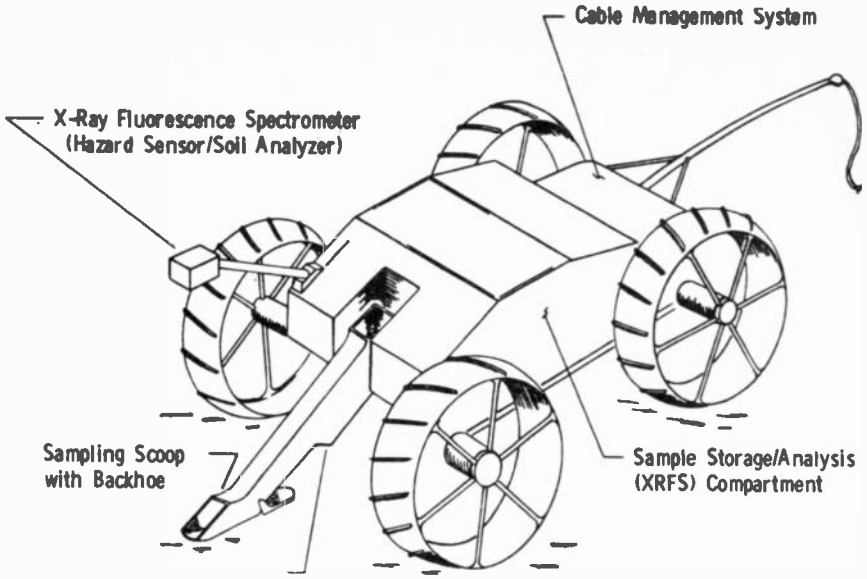


Fig.2. Tethered rover associated with advanced lander.

A more advanced free-roaming rover with a range of 1 km is envisaged for following missions. Figure 3 shows various suggested configurations and the accompanying table outlines the science payload carried.

Stereo imagery would use facsimile cameras about half the size of those used on Viking '75.

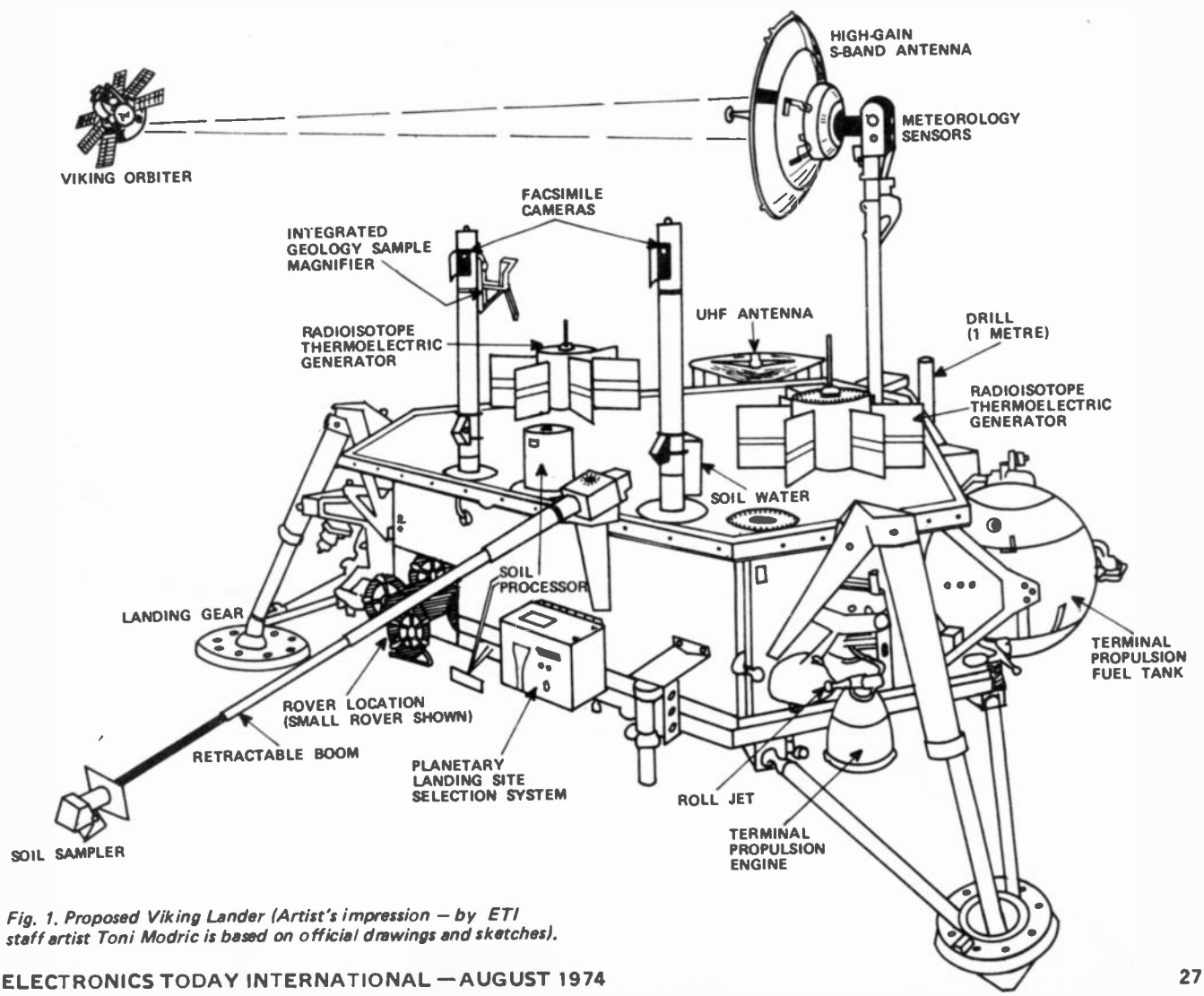


Fig. 1. Proposed Viking Lander (Artist's impression – by ETI staff artist Toni Modric is based on official drawings and sketches).

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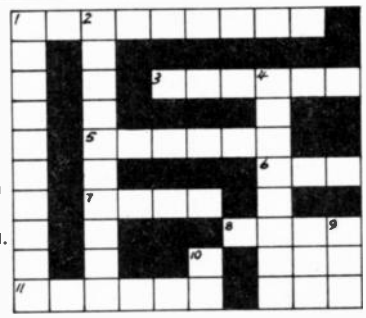
SIMPLY COMPLETE AND RETURN THIS CROSS-WORD ENTRY FORM WITH YOUR COMMENTS – IT COULD BE YOUR FREE PASS TO PARADISE.

CLUES ACROSS:

1. Opposite of Manual.
3. This Hi Fi Company could send you on a Noumea Holiday.
5. An Amplifier control that accentuates stringed instruments.
6. Abbreviation for an input socket.
7. The Deepest sound.
8. A basic part of tapes or fishing rods.
11. Sansui offer a complete Hi-Fi . . . . . .

CLUES DOWN:

1. These Sansui components are both solid state and integrated.
2. A place for your records to revolve (plural).
4. They produce the sound and enhance your room.
9. Sansui amplifiers have this Degree of noise level.
10. The new modulation code which is incorporated in Sansui Stereo Tuners.



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ROBOTS IN SPACE

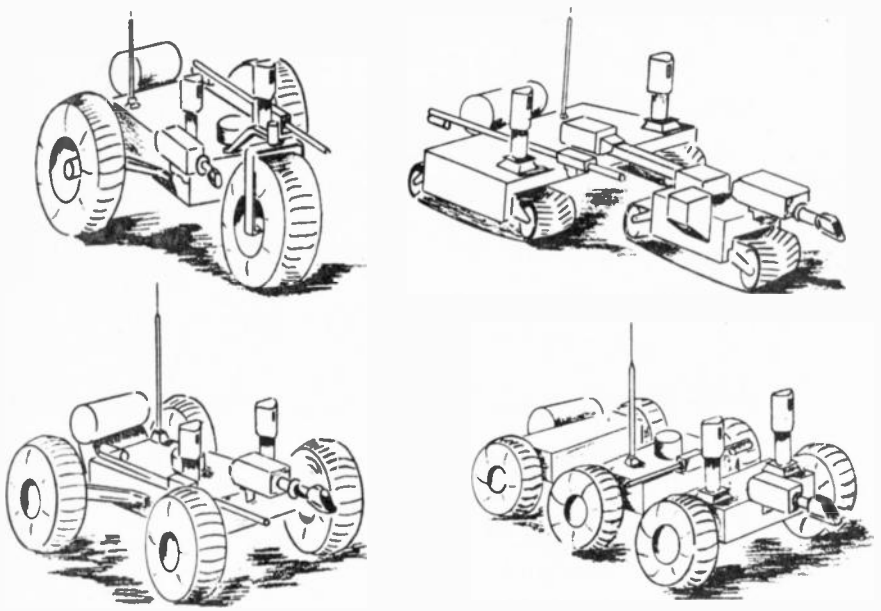

Fig. 3. Configurations proposed for NASA's advanced free-roaming rover.

"Sieves" would provide initial screening of samples for inorganic and organic content. Samplers would be half the size of the Viking '75 one, also a rotary-percussive 1 m drill would be carried. Mechanisms for storing samples and transferring them to the lander would complete this payload.

The major reason for the rover is to be able to manipulate the Martian surface and go part way toward bridging the gap between a passive observer and a geologist on the scene with hands, feet and hammer.

ADAPTIVE REACTIONS – THEIR PRIMARY GOALS

The purpose of this study has not been to put scientific judgment into a computer. Rather, it is to give the scientists a tool that enables them to automate some simple decisions so that they can be made on the lander or rover and carried out promptly enough to do some good. The fundamental philosophy is then to put the adaptive system under as direct control as possible of the scientific teams in order to make modifications quickly and easily.

A further principle to be followed on any mission of long enough duration is to start with a minimum of autonomy and increase it as confidence is gained. The typical actions after a successful landing would be to initially exercise the systems to verify their conditions. The rover would be deployed and traction measured on the Martian soil. At this stage few decisions would be made on Mars.

As confidence increases, more decisions would be made by the on-board controller. Thus fixed action schedules and measurements would be reduced and more flexible ones, based on priorities, phased-in.

These priorities would be determined in part by "on-site" detections of transients and other unusual phenomena which would replace less valuable activities.

Finally when the region close to the lander will have been thoroughly explored, the rover can be sent on long excursions, even out of communications range, since the chance of finding something new will be worth the risk of losing the rover.

This by no means indicates that it is proposed to turn the lander and rover loose with a large bag of untried tricks, but rather to ease into adaptability and to tailor the criteria, thresholds, and logic according to experience gained and the actual conditions at the planet surface.

By applying the adaptive system in such a manner and exploiting the flexibility great advances in adaptability can be made in a singe mission, which, if it had been attempted to *forsee* how the system would react, would have resulted in a long series of missions for the same progress. ●

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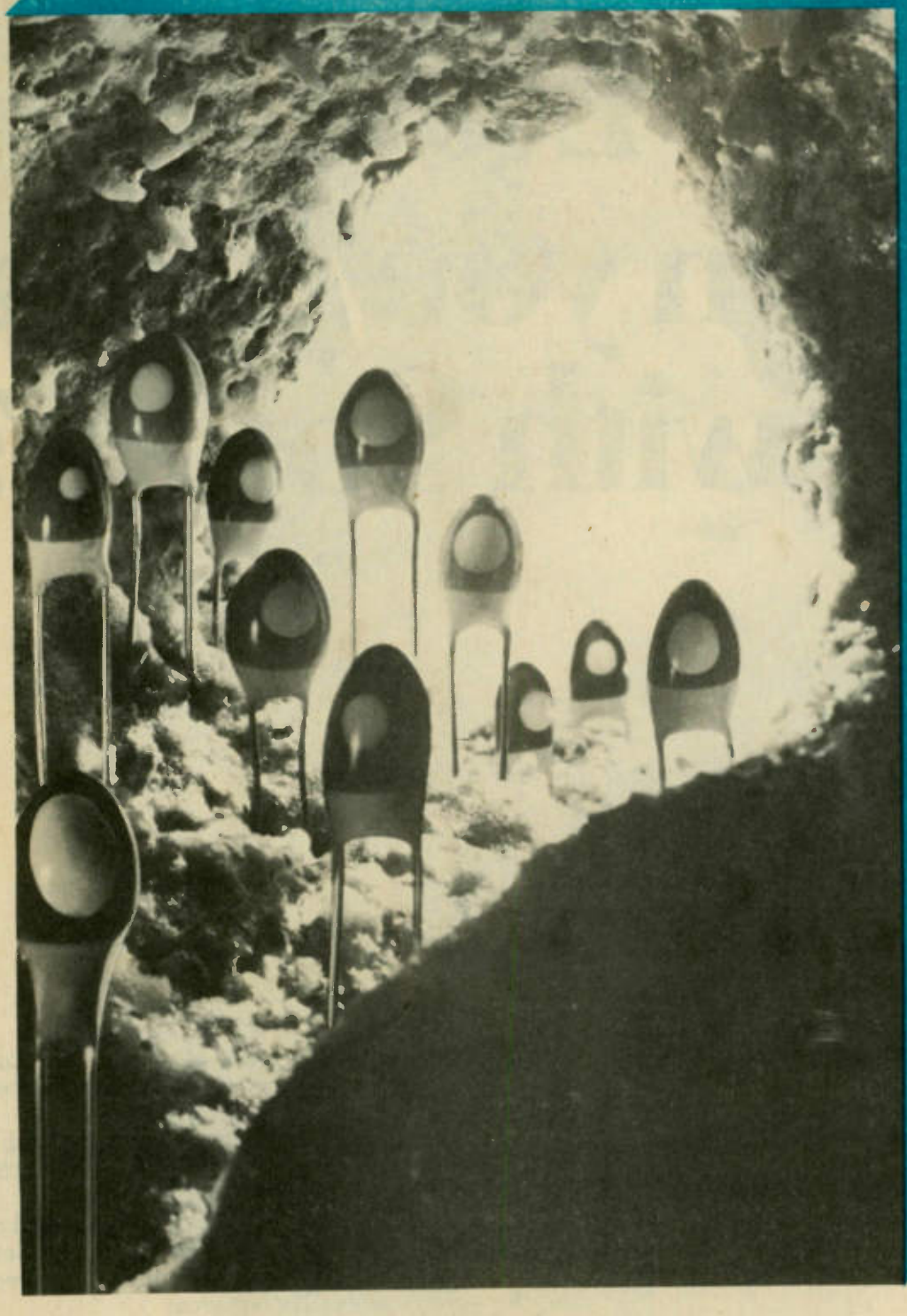
Features include relative low cost, small size, long term stability, long life, proven reliability and quality appearance.

They are fitted with uni-directional leads and are particularly suitable for printed circuit board application. The series is available in seven different case sizes.



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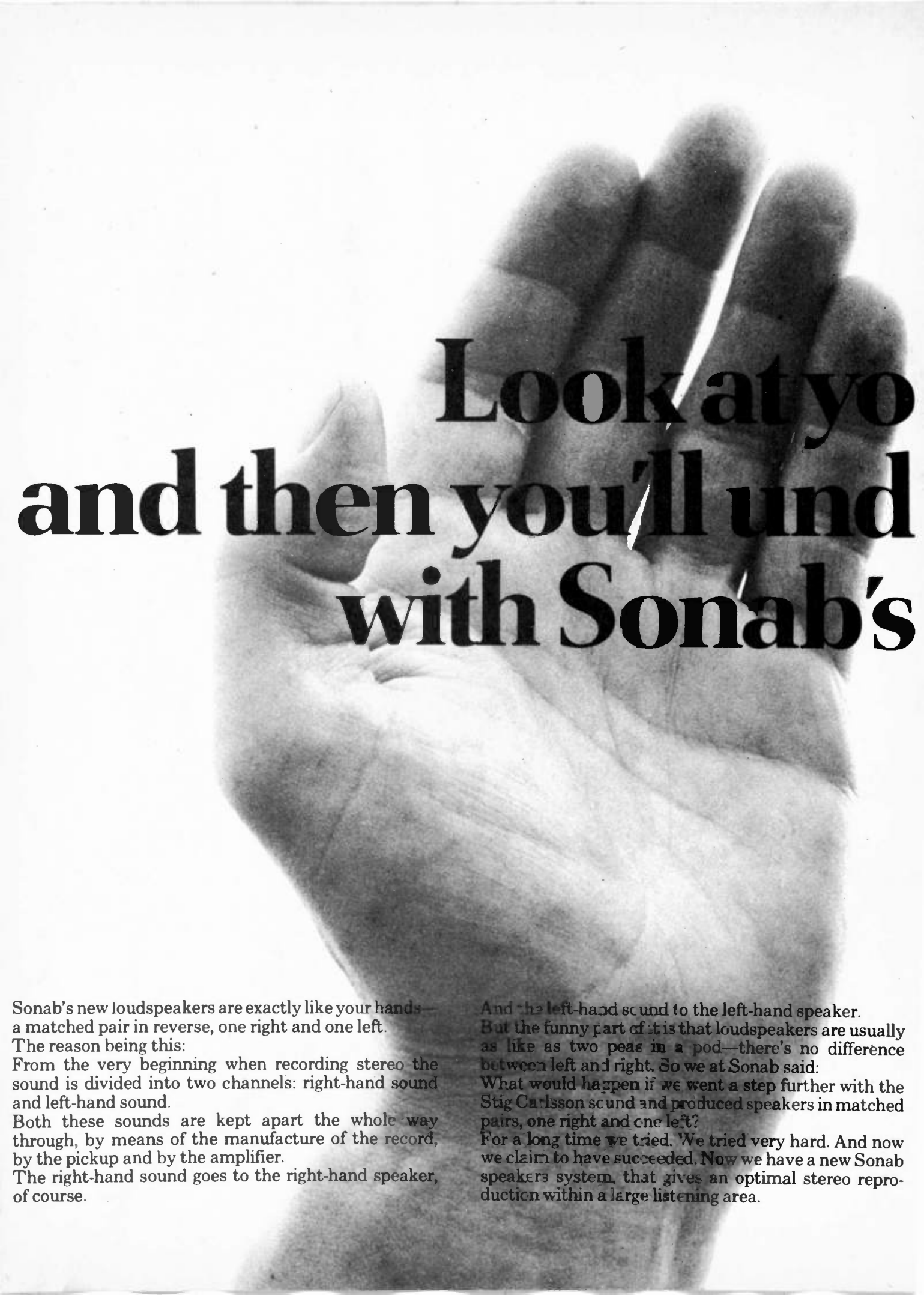

Look at yo
and then you'll und
with Sonab's

Sonab's new loudspeakers are exactly like your hands—a matched pair in reverse, one right and one left.
The reason being this:
From the very beginning when recording stereo the sound is divided into two channels: right-hand sound and left-hand sound.
Both these sounds are kept apart the whole way through, by means of the manufacture of the record, by the pickup and by the amplifier.
The right-hand sound goes to the right-hand speaker, of course.

And the left-hand sound to the left-hand speaker.
But the funny part of it is that loudspeakers are usually as like as two peas in a pod—there's no difference between left and right. So we at Sonab said:
What would happen if we went a step further with the Stig Carlsson sound and produced speakers in matched pairs, one right and one left?
For a long time we tried. We tried very hard. And now we claim to have succeeded. Now we have a new Sonab speakers system, that gives an optimal stereo reproduction within a large listening area.

ur hands erstand what's new new speakers

Speakers made from the very beginning in matched pairs, to remain so for the whole of their lives. If you are curious about the sound, then we would just say this: There are 26 different letters in the alphabet which can be used to describe the sound from the new Sonab speakers.
And there are about 20.000 auditory cells in the ear which you can use to listen and judge for yourself. Do just that. Go to your dealer. Listen.

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Claimed by the manufacturers to be 'virtually indestructible', Empire Scientific Corporation's Jupiter 650011 loudspeaker can be located virtually anywhere – indoors or out. The drive units are claimed to be wind, rain and sun proof!

Editorial Director, Collyn Rivers surveys the scene

UNLESS something really dramatic happens between now and December 31, nineteen-seventy-four will be the year of the cassette player.

For this year, for the first time ever, we are able to say that we have reviewed a cassette machine that can compete on open terms with open-reel machines and the gramophone record format.

The machine, the Nakamichi 1000, costs the earth! But so do the open-reel machines that it trounces.

On a more down to earth level, machines such as the TEAC A-450, the Harmon Kardon HK 1000 and the Pioneer CT 5151 to name just three of several, have performance so close to better quality gramophone records as to be virtually indistinguishable.

Until very recently it seemed improbable that the cassette players and cassettes would make really deep inroads into the gramophone record market — let alone ever replace it. Now we are not so sure.

Cassette tapes have improved enormously; when used with a suitable recorder, virtually all premium tapes can now handle the complete audio spectrum. Many have a response extending beyond it.

The widespread adoption of the Dolby Noise Reduction system has ensured that tape hiss can be reduced to a level where it is about the same as from an average to good quality gramophone record.

Pre-recorded cassettes are also improving in quality. Most are still churned out on cheap low performance tape, but several recording companies, in particular DGM, are now producing pre-recorded cassettes on good quality material using Dolby processing.

There is still a marketing battle between proponents of ferric oxide tapes and chromium dioxide tapes.

The use of these two types of compounds would not matter particularly were it not that cassette recorders must have control circuitry to optimize the bias and equalization characteristics for each type of tape.

But the tape industry is about to release a new generation of high-energy tape formulations that combine the two hithertoo competing materials.

Pioneered initially by Sony, the ferri-chrome combinations optimize performance by taking advantage of ferric oxide's particular advantages for 'lows' — and of chromium oxide's advantages for the 'highs'.

The 3M company, who until very recently were strong advocates of ferric-based tapes, have now signed an agreement with DuPont to manufacture a ferri-chrome tape cassette (which 3M launched at the US Consumer Electronics Show.

Japan's Fuji Film Company — in cooperation with the Japanese National Broadcasting Co — has developed a single layer ferri-chrome tape which it will offer to other manufacturers. Maxell are also developing a ferri-chrome tape.

Other tape manufacturers including BASF, TDK, Ampex and Capitol are known to be preparing to release new products shortly.

Although it is far from certain that all tape manufacturers will settle for the new combined formulation, there are indications that chromium dioxide may be on its way out.

In a recent press statement, George Johnson, President of Audio Magnetics, said "the recent development in the field of ferri-chrome is a return to the ferrite fold on the part of certain manufacturers who have realized that chromium technology has reached a plateau."

Despite their involvement in the chrome field, Ampex agree with Audio Magnetics. Ampex National Sales Manager Shad Helmstetter is quoted as saying, "Chrome is not where the high-end customer is going to be — not where he is now for that matter".

A contrary view is expressed by BASF. A company spokesman (in America) said that in BASF's opinion, chromium dioxide is the ultimate in recording — it is the high end of the market. Significantly though, BASF is currently putting a lot of effort into promoting its new SK low noise, high output ferrite cassettes and recently released a new high energy ferrite tape.

Statistics are not readily available for estimating the sales of tape cassettes in Australia, however in Europe, the tape industry's association quote European pre-recorded tape sales at 9.8 million cassettes (and 5.7 million cartridges) worth approximately A$50 million. The total of 17.5 million units is nearly twice the previous year's.

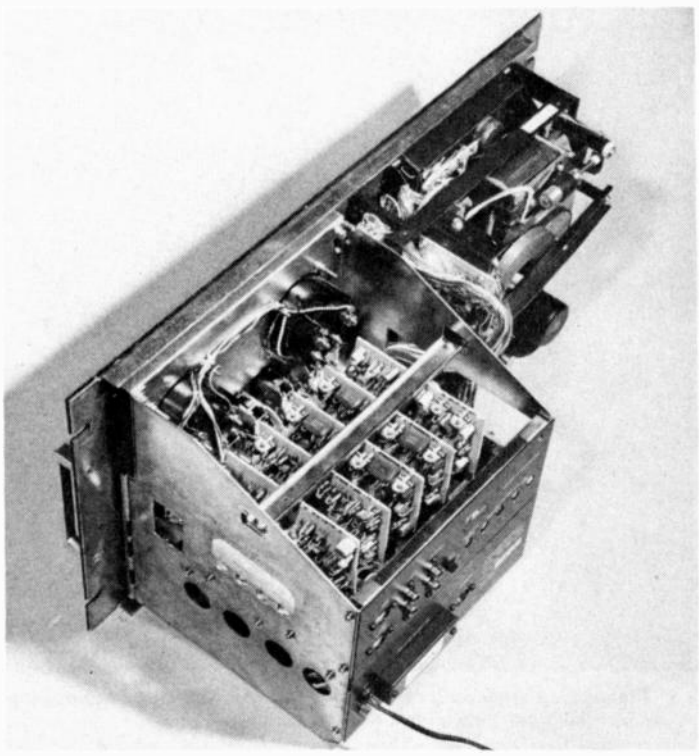
There is a strong swing away from the cartridge format and it is our opinion that cartridges will eventually be used only for automobile systems. Even there, cassette players are making big inroads into the market.

A possible rival to the cassette machine is a new system called Mavica which has just been released by the Sony Corporation.

Intended at present for video replay, the system is based on a flat chromium oxide card 160mm by 220mm. This provides 10 minutes playback in colour, plus stereo sound.

The blank cards cost only a few cents each (in volume) and recording is virtually a mass-duplicating process similar in many ways to printing — except that the programme material is transferred thermally.

It is not yet clear whether Sony



Inside the Nakamichi 1000 cassette recorder.

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intend to market an audio-only version of the Mavica system. From initial reports it seems ideally suited for hi-fi sound reproduction – especially as the method of replicating recordings is so cheap and simple.

RECORD QUALITY

Nineteen-seventy-four seems also to be shaping up as the year when record quality hit an all-time low.

One pressing I heard recently could only have been made by a Serbian fishmongers' co-op during a low point in a five year plan.

Or by a manufacturer so cynical about quality control that the mind boggles. (Two further pressings of the same recording were just as bad).

Our June editorial, criticizing record quality, brought squeals of rage and anguish from a number of local record manufacturers.

Several told us that their quality was better than ever. Others said that they had received no customer complaints.

Overseas manufacturers are rather more realistic, accepting that present-day quality *is* bad.

One major British record manufacturer has admitted this publically – stating ominously that quality could even become worse. Oddly, we had a letter from the Australian subsidiary of *that company* claiming that there was no quality problem at all!

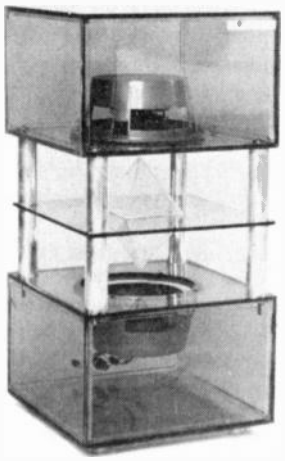
The cause of the decreasing quality seems to be the world shortage of vinyl. This has resulted in record manufacturers relaxing their quality control in order to obtain more saleable records per batch of raw material.

A further cause is that several manufacturers are now recycling their rejects. At first this seems commendable. It becomes less so when one realizes that they recycle the whole record. Paper labels, glue and all! Great for the signal/noise ratio!

The infuriating thing is that there does not seem to be any positive correlation between quality and price. As one of our readers pointed out last month, one often finds that the $1.99 specials are far superior to the full price efforts.

One company (Phase Linear) has a partial solution to the poor signal/noise ratio problem.

Phase Linear have developed an absolutely fascinating pre-amplifier with an auto-correlator built in. This device has sophisticated circuitry that can tell the difference between noise (which is of a basically random nature) and programme material (which has a recognisable pattern – or harmonic structure).



Space-age speaker, seen at a recent London hi-fi exhibition. (manufacturer is A.P. Selmin Ltd).

Having determined which bits of the total signal are programme and which are noise, the auto-correlator automatically filters out the noise.

We have heard the device in operation. With most programme material it is extra-ordinarily effective. Even a dreadfully noisy record was 'magically' quietened.

There are some probably insoluble problems with this technique – it cannot for instance cope with synthesized white noise – which is random by definition. Nor can it cope very successfully with hand clapping – although that might be a blessing in disguise!

Auto-correlation is not a new technique. It has in fact been used for years – especially in space communications where it successfully extracts minute signals which are often below the level of noise.

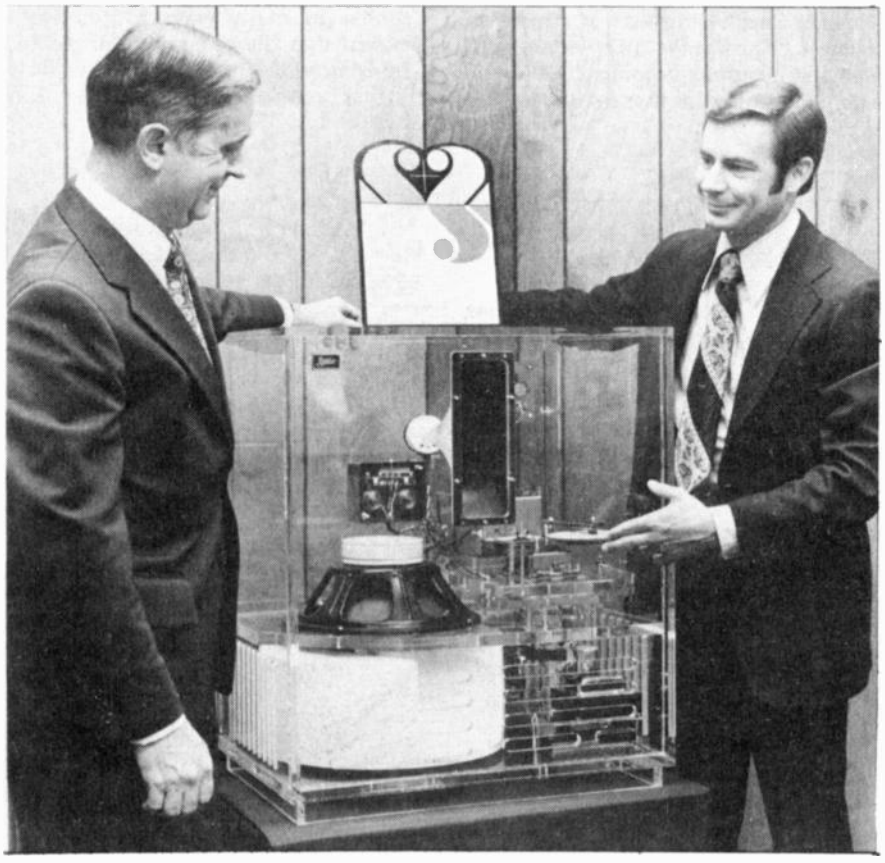
Although not new it is still an expensive technique and it is unlikely that it will be widely adopted unless one of our enterprising IC manufacturers produces a chip with the auto-correlator function included.

FOUR-CHANNEL FOUL-UP

The four-channel scene remains much as it was this time last year. We seem no closer to one agreed system, and even the matrix protagonists have yet to agree on one universal matrix format.

It's bad news, and the public have every reason to treat the sorry scene with caution.

One possible solution is a new format developed jointly by Nippon Columbia



The rotating baffle under the bass driver in Leslie's Plus 2 enclosure causes sound to 'sweep' the room, thus eliminating standing waves.

and Dr. Duane Coopa of the University of Illinois.

Nippon Columbia's President, Takami Shobochi, told us that the system is completely universal — not only can it handle both discrete and matrix recordings without the need for switching — but it is completely compatible in both stereo and mono modes as well.

Currently, UD-4 is just an engineering concept. Prototype units are currently being demonstrated to interested manufacturers but no commercial units are yet on sale. Nevertheless, according to Nippon Columbia's Record Division at least, there is a strong possibility that the system will be on sale by the end of this year.

Elsewhere in this issue our review of the Sennheiser Dummy Head recording system describes how a two-channel recording played back through perfectly ordinary two-channel headphones can provide almost total spatial location.

The effect is quite uncanny — if it could ever be adapted so that speakers could be used instead of headphones one could probably forget the whole existing four-channel scene.

In Britain, two academics and a leading loudspeaker manufacturer are developing their new concept of surround sound — which they have called Ambisonics. The technique has been described extensively in recent issues of ETI.

So far practical demonstrations have been disappointing, mainly it is claimed, because the venues chosen have been unsuitable for the new system.

As patent applications are still pending, not a great deal of technical information has been released, but it is significant that several major US and Japanese companies are now said to be investigating the whole ambisonic technique.

On the four-channel broadcasting scene, it now seems virtually certain that the US Federal Communications Commission will sooner or later lay down a standard for *discrete* four-channel FM broadcasting.

Certainly, GE, Zenith, RCA, Nippon Columbia, and Lou Dorrin all have discrete systems under evaluation by the (US) National Quadrasonic Evaluation Committee.

Matrixed four-channel recordings are broadcast by a number of stations around the USA, but station managements are naturally reluctant to spend a great deal of money on equipment that will soon be technically obsolete.

There are now strong indications that the previous objection to broadcasting discrete four-channel, i.e. that of the great bandwidth required — has been overcome. It is probable that the US will end up using one of the five currently competing discrete systems, and techniques will be devised for processing matrix material so that it can be transmitted via the discrete broadcasting link.

As yet we do not know which (if any) four-channel format is being discussed for our own FM system. If and when Australia has four-channel broadcasting (and your editor can think of many more things that are of greater urgency) then we believe that the discrete system should be used. Our reason for this is simply that a discrete broadcasting link can handle both discrete *and* suitably processed matrixed material without degrading separation. A matrix-type link can only handle discrete material by reducing that material's channel separation to matrix proportions.

Just as we were closing for press, our European correspondent sent us details of a revolutionary new cassette system from BASF.

Designated 'Unisette', the new cassette is totally different from the standard Philips' designed unit. It uses ¼" tape of recording studio quality and has been designed for use at 1.7/8"/sec, 3.3/4"/sec, or 7.1/2"/sec.

BASF are saying very little about the new cassette — except that it will negotiate licencing arrangements in a similar fashion to those laid down by Philips.

However 'informed sources' tell us that the cassette is quite large (about the size of a paperback book), has no moving parts — in the sense that it relies upon the hardware for all transports, and can compete in every way with open-reel tapes of any quality.

WATTS RMS NOW OFFICIAL

Like the contenders in the GREAT AMERICAN HORSEPOWER RACE, US and Japanese amplifier manufacturers have now largely ceased their practice of seemingly multiplying their product's power output by the last two digits of their telephone number.

Soon, in the USA at least, manufacturers will have no choice anyway because the US Federal Trade Commission has now set strict new rules for audio power claims.

Legislation, effective November 4 this year, specifies that amplifier power output *must* be quoted as *continuous* power capability — to be expressed in that technically dubious but colloquially accepted unit, the 'watt rms'.

Other specifications, such as peak power or music power may still be used, but must be based on recognised industry standards — and must be subservient to the main power output disclosure.

There is of course a strong argument for disclosing both figures — for in assessing amplifier performance it is necessary to know the amplifier's

Expect to see an increasing emphasis on clean, compact styling. This all-white/black stereo system by Miida combines good looks with good sound. The clean, classic white lines of the cabinetry complement any modern room decor. The receiver includes AM/FM stereo and a built-in 8-track tape player.

HI-FI-1974

ability to handle peak transients as well as continuous high levels.

BIG MUTHERS

The trend to ever more powerful amplifiers continues, and now there are at least ten domestic models available with outputs of 20 watts and more. There is even one monster that puts out 2 kW!

Whilst power such as this is not needed for driving low-priced speakers — in fact such speakers could not withstand the electrical onslaught for more than a second or two — there is a growing trend toward large speakers of very low efficiency.

Transmission-line enclosures are a typical example. Speakers such as these really *do* need a lot of power if they are to operate satisfactorily.

It is also our opinion, having listened to a very large number of amplifier/speaker combinations, that virtually *all* speakers sound cleaner and firmer when driven by amplifiers of thirty five or fifty watts rating than by the more generally used twenty five watt units.

We stress that there is not a great deal of difference in maximum sound output. In fact as the ear has a vaguely logarithmic response to sound pressure levels it would be necessary to go from twenty five to two hundred and fifty watts even to double the subjective sound levels. The difference is rather one of quality — and it is a *big* difference.

UNIT AUDIO

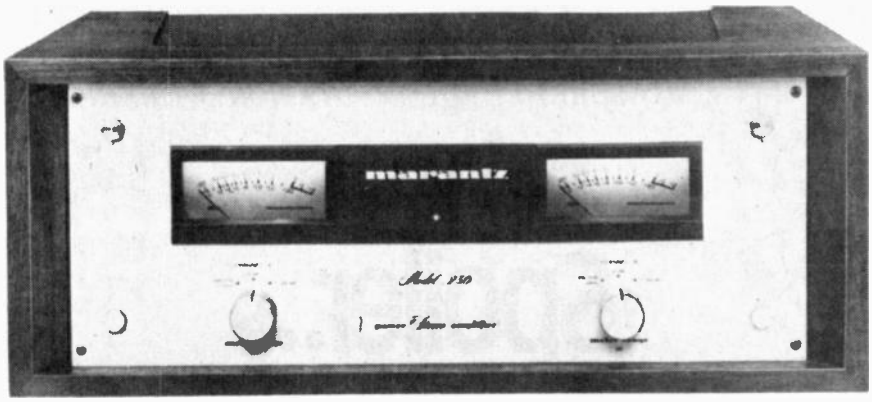
One of the fundamental tenets of marketing is that the thing that you are trying to sell must be easy to buy.

Hi-fi generally isn't. In fact until recently, a novice getting into hi-fi for the first time was often so confused by the multiplicity of non and semi-understood choices that he would as often as not give it away and buy some musical furniture from a chain-store.

The Pioneer Corporation are largely responsible for changing this situation.

Realizing that they must make their products easy for novices to buy, they introduced their Prelude 500 system: a package deal of turntable, amplifier and speakers. Low priced, easy to buy and easy to instal, it opened up the market for literally thousands of people.

Other manufacturers have of course been producing such package deals for years — the difference between their and Pioneer's approach was that of marketing. Pioneer did it on a large scale. And it worked.



Two hundred and fifty watts continuous power per channel! Big amplifiers like this Marantz model 250 really are needed to drive many of today's power-hungry loudspeaker systems.

Now there are dozens of such systems. It is a good healthy trend because it is the *only* way that hi-fi will be sold to the mass market.

WHAT OF THE FUTURE?

Apart from the recent development of truly hi-fi quality cassette recorders, and a few loudspeakers, hi-fi development still consists largely of refining and polishing what went before.

With rare exceptions, speaker drive units are still made very much as they were forty years ago. Cone materials and magnets have been improved and performance is substantially better than was obtainable from the early units — but improvements in loudspeaker performance owe more to developments in enclosure design than drive unit design.

Small modern loudspeakers are dramatically better than they were fifteen years ago, but size apart, Paul Klipsch's horn-loaded speakers, designed in the late nineteen-forties, (and largely unchanged ever since) have still to be seriously out-performed.

Much the same is true of electrostatic speakers. It is now nearly twenty years since P.J. Walker's dramatic demonstration of the full-range Quad ESL at London's Waldorf Hotel.

Yet here again few other speakers can equal the Quad's performance even today. Let alone surpass it.

In fact many authorities believe that the Quad electrostatic speaker is still *the* top unit — at all but high sound levels, which are not any electrostatic's best point.

Amplifier design has improved to the point where a good example closely approaches the ideal of a piece of straight wire having adjustable gain.

In some areas, particularly that of distortion, several amplifiers have been 'over-developed' — to the point where buyers are paying for 'improvements' that could only be detected by physical measurements.

Not all the improvements have filtered through to the cheaper low-powered models — but even there, amplifiers are probably the strongest link in the hi-fi chain.

Turntables and cartridges too have improved and performance of the top models has now reached the stage where their limitation is the quality of the programme material.

We expect to see progressive refinements of programme material and of loudspeakers for some years to come. Eventually though we believe that there will be a complete change in the technology employed.

The change, we believe, will be to a totally digital technology.

Such a technology would have been unthinkable even three years ago — because of the enormous complexity and sheer quantity of operating elements. Literally thousands of transistors would be required.

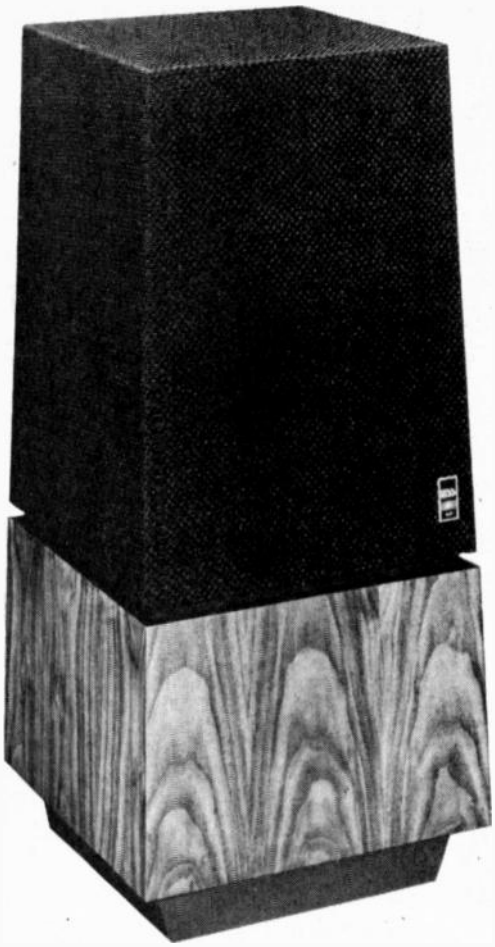
But solid-state technology has now advanced to the point where thousands of transistors and associated components can be formed on a single chip — making feasible many applications that were hithertoo totally impossible.

The adoption of digital technology would virtually eliminate any problems of noise — either from programme material or generated within the reproducing equipment.

It would open the way to a totally new concept in loudspeaker design. These would become a bank of innumerable tiny transducers — driven in various ways and combinations — but capable of reproducing original sounds in a way that can never be even approached by present-day speaker systems.

Sounds way out?

Maybe it is, but in the past few weeks we have discussed this possible trend with four of the world's leading audio equipment engineers — all were *actively* investigating similar approaches. ●



eti PRODUCT TEST

Fundamentally new loudspeaker system has outstanding performance

Heil air-motion transformer loudspeaker system

Recommended retail price $628

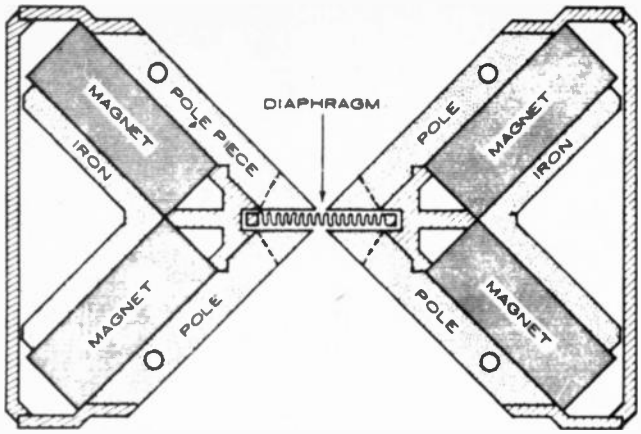
THE ESS amt 1 is the first *new* speaker system to be released for many years. It has evoked more controversy than any speaker since the Bose 901, which, whilst not being revolutionary as a speaker, was nonetheless revolutionary as a concept.

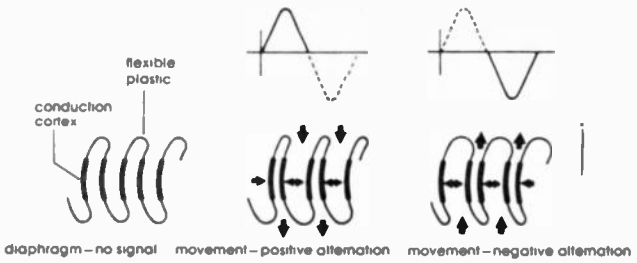
Unlike the Bose, the amt 1 uses an entirely new type of mid-range/tweeter drive element, totally different from any other speaker before. This driver is the brainchild of Dr. Oskar Heil (who invented the field effect transistor). It is called the "Heil Air Motion Transformer".

The diaphragm of the Heil driver is a 0.5mm thick polyethylene membrane covered on both sides by a parallel grid of electrically conductive strips. This element or membrane is folded back and forth to form pleats and is then located in a plastic frame approximately 120mm x 50mm. The

MEASURED PERFORMANCE OF ESS amt 1 SPEAKER SERIAL NO: D17339

Frequency Response	±7 dB	40Hz – 20 kHz	
Total Harmonic Distortion (for 90 dB at 2 metres on axis)	100 Hz 2%	1 kHz 0.6%	6.3 kHz 1%
Electro-Acoustic Efficiency at 1 kHz (for 90 dB at 2 metres on axis)	3.2 watts input 0.8%		
Cross-over Frequency		600 Hz	
Measured Impedance	100 Hz 7Ω	1 kHz 10Ω	6.3 kHz 10Ω
Weight		21.3 kg	
Dimensions	787 x 367 x 367 mm		





Left: The Heil driver unit as seen from above.
Above: Electrical audio signals cause the accordian-like pleats to open or close (depending on the polarity of the signal).

complete element is then inserted between two large magnetic pole pieces so that it lies within the linear flux region of the 3 kg. ceramic magnet.

When an electrical audio signal flows through the conducting strips, they move so that the spacing between the individual folds of the diaghragm vary.

Alternate pairs of pleats move closer together causing an inhalation and expiration of air on opposite sides of the diaphragm.

During the reverse half-cycle of the electrical input waveform, the pleats move in the opposite direction thus generating the second half-cycle of the audio waveform.

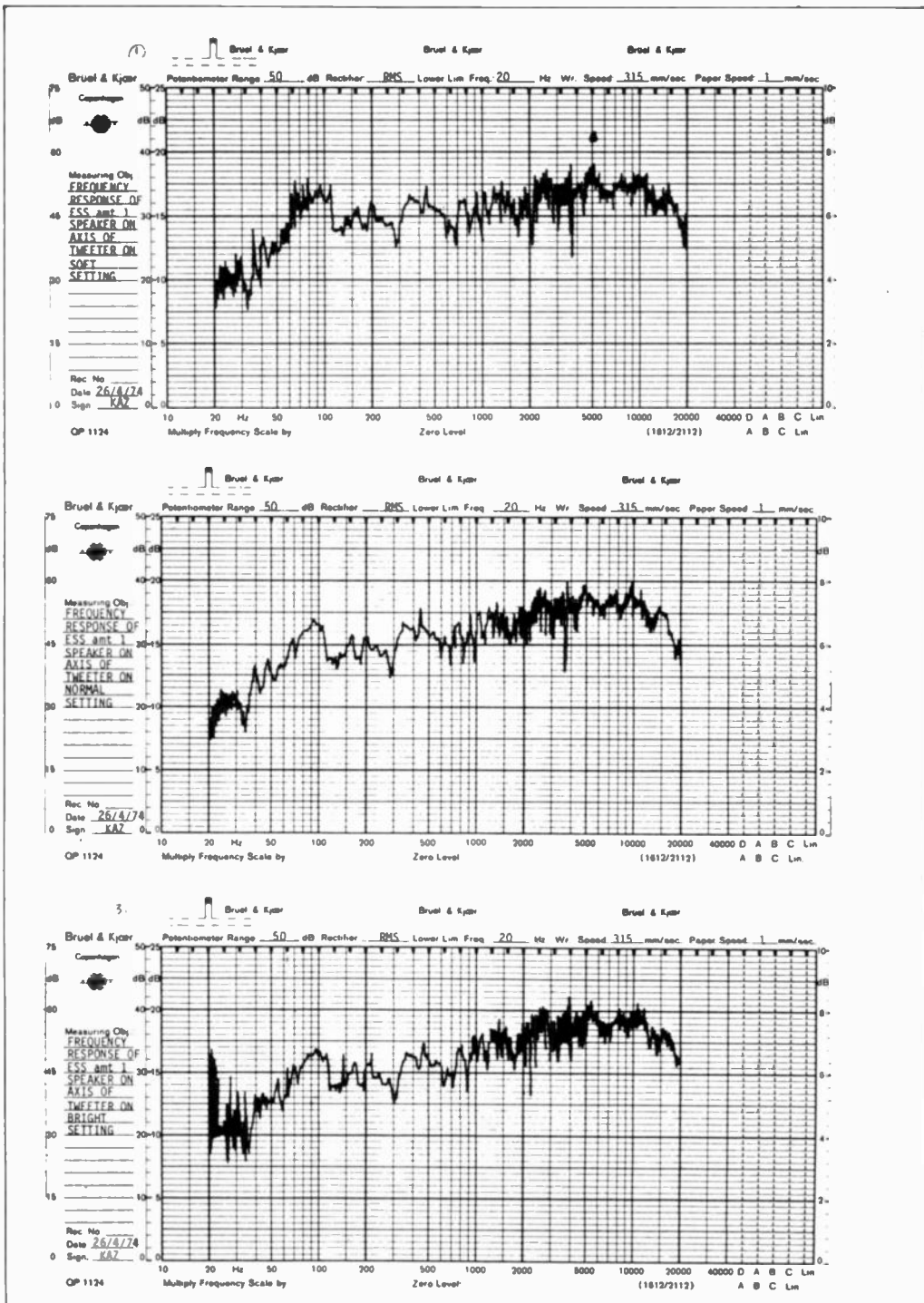
As Fig 1 shows, only a very small motion of the conducting strips and the plastic elements is required to produce a substantial air motion and it is because of this that Dr. Heil has called the drive unit an "Air Motion Transformer".

The major attributes of this system are reasonable efficiency, effective element cooling because of the large surface area and intimate contact with air which is inhaled and expelled repeatedly by the motion of the element, and a reasonably low mass for the element itself (which obviates some of the problems of inertia characteristic of conventional acoustical driving elements).

The current Heil driver covers the frequency range from 600 Hz to well beyond the upper limits of audibility (20 kHz plus).

This wide range enabled ESS to produce a loudspeaker utilizing a single Heil unit for the entire mid-range and treble registers – and a conventional low frequency driver operating in the linear piston range, where its performance can be optimised.

The ESS amt 1 stands 787 mm high with a base dimension of 367 mm tapering to 330 mm at the top. More than half of the 'enclosure' is a lightweight frame with a black cloth covering which conceals both the Heil



Heil air-motion transformer loudspeaker system

driver and the 250 mm low frequency driver.

The concept which resulted in the unit's appearance was essentially a pragmatic one, for the Heil driver, which is mounted on the top, has essentially 360° of horizontal dispersion at low frequencies in the horizontal plane, and a reasonable degree of horizontal dispersion at higher frequencies. The vertical dispersion of the Heil driver is not as good as is its lateral dispersion and this limitation has been seized upon by the system's many antagonists as a severe limitation. Whilst the criticism is plausible and reasonably accurate, the restricted vertical dispersion is not that serious — and the argument has a 'sour grapes' taste to it!

The low frequency driver is cunningly mounted in the top of the enclosure immediately below the Heil driver. It is a conventional cone loudspeaker with special edge treatment, mounted in a vented enclosure with the actual venting port located in the very base of the unit. The cloth cover cleverly hides this speaker and provides an overall attractive and distinguished air for what may well have otherwise been a nasty looking piece of furniture. (With the covers removed, the enclosures have an uncanny likeness to Dr Who's Daleks.)

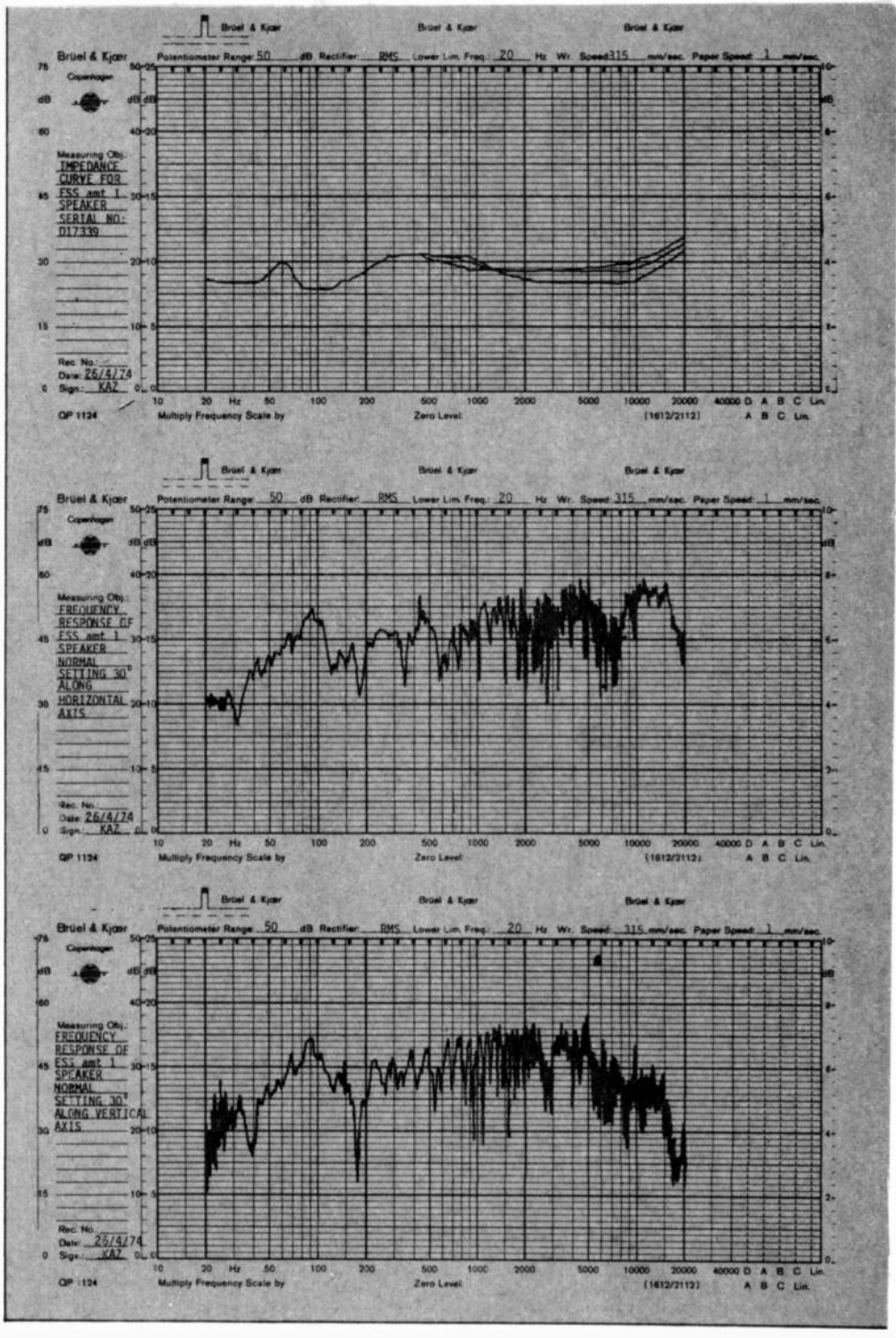
HOW THEY SOUNDED

Our first experience with the ESS amt 1's was some six months ago when we were invited to hear one of the first pairs available, installed in a private home in conditions which were almost ideal. The listening room was well shaped with adequate diffusion and absorption. The speakers were raised on two small stands approximately 200 mm high, and the seating was positioned so that listeners were at the optimum height for the Heil drivers.

The results were, to say the least, superlative but we were unable to do run A-B tests with other speakers which, is the only way to discriminate between superlative recorded material and the attributes of the speaker system itself.

We had to wait another month before we were able to get our hands on a set of these speakers and conduct our own subjective evaluations and the equally important laboratory measurements.

Our first series of tests were subjective A-B comparisons with a series of monitoring loudspeakers



which we retain for just this purpose. These speakers, have in their own right, excellent attributes in terms of above-average frequency response extending right down to the lowest frequencies, excellent power handling capacity, low distortion, and most important, known colouration.

The most outstanding thing we noticed as we proceeded with our subjective evaluation was the amt 1's very low colouration and the fidelity and clarity that they provided on recorded material with high level transients. This intrigued us, for whilst other (US) reviewers had commented on the clarity of the speakers, only one had commented on their transient performance.

In order to evaluate this aspect of their performance, Electronics Today's development laboratory designed and built a special tone burst generator. Unlike commercial tone burst generators, this one is capable of being adjusted to have the onset of the tone burst commence at zero crossover rather than somewhere in the middle of a half cycle. In addition, the number of cycles within the tone burst and the pulse repetition frequency (PRF) are directly controllable to provide an extremely flexible and reproducible test signal.

Using this system, together with a special 12.7 mm microphone (Bruel & Kjaer type 4134S), and a pre-amplifier feeding directly to the input of an oscilloscope, we ran a series of tone burst tests on the amt 1 under anechoic conditions. The driving signal was horrendous. We drove the amt 1

from a 700 watt Phase Linear amplifier so as to produce average steady state levels of up to 96dB at 1 metre on axis with duty cycles up to 1:8 and input frequencies lying in the range 1 kHz to 16 kHz.

No other speakers to which are applied this signal could cope without producing the most distorted wave-form imaginable, whilst much to our surprise the amt 1 produced a fairly faithful rendition under even the worst of the signals that we could generate, — in excess of 400 watts peak into the loudspeaker.

Our next series of tests were more conventional, being a standard free field frequency response measurement on axis and at various angles to the main axis. These highlighted the remarkably smooth frequency response and confirmed the validity of most of the claims made by the manufacturers concerning the flat frequency response.

It was interesting to note that the low frequency roll-off was not as good as we would have desired and bore out our initial observation that the low frequency end was not as good as the rest of the system.

The total harmonic distortion was measured at constant input level at two metres on axis. The distortion levels are comparable to other high quality speakers, varying from 0.6% at 1 kHz to 2% at 100 Hz.

We next measured the electro-acoustic efficiency of the speaker, and whilst the efficiency is relatively good at 0.8%, it is certainly not the 3% that an overseas reviewer would have us believe. This in itself is of no great consequence for with amplifiers of 35 watts to 700 watts readily available, electro-acoustic efficiency has long ceased to be the primary parameter to consider when purchasing a loudspeaker.

The impedance curve is particularly flat, it does not exceed a 2:1 ratio in the main range of interest. The excursions do exceed those claimed in the manufacturer's literature, but the high frequency rise in the range 10 kHz to 20 kHz is smooth and quite acceptable — substantially better than that provided by a number of electrostatic speakers which we have measured and evaluated during the past year.

The last and most important parameter which we examined was the polar plot of the Heil unit in the vertical plane.

It is here and here alone that we believe antagonists of this speaker system can find any real substance and grounds for their criticisms, for our measurements showed quite clearly that the vertical dispersion of the Heil unit is substantially inferior to that which it offers in the lateral plane.

Nevertheless, in an average listening room which is *medium to live* this problem will not manifest itself unless the listener is positioned so as to make the angle between the horizontal plane of the Heil driver and himself greater than 20° or if he positions himself so that the included angle between himself and the Heil driver in both the horizontal and vertical plane is greater than 20°. In this rare condition it is possible for the directional performance of the system to produce a condition which results in a substantial loss of high frequency performance above approximately 12 kHz.

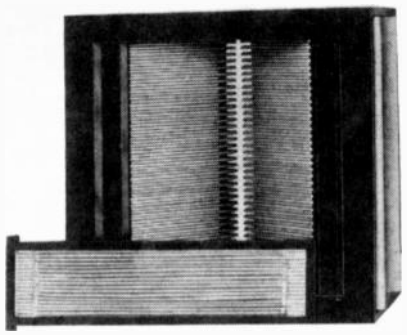
Before we returned these speakers, we ran a comprehensive subjective evaluation to determine their performance on the most difficult passages of recorded material that we had available. The results were highly gratifying for here was a speaker system that in almost every department with the exception of one, was able to provide superlative performance equal or better than any other system we had ever evaluated.

The lack of colouration was exceptional. There are a number of possible reasons for this. Most significant is undoubtedly that put forward by several delegates at the April 1974 Meeting of Technical Committee 29 of the International Electro-Technical Commission in Moscow). Their theory which is starting to gain widespread acceptance is that the flatter the phase response of a speaker system in the range 50 Hz to 10 kHz, the better and more natural that speaker system will sound.

It is interesting to note that the Heil speaker has an almost flat phase response and the cross-over network used, whilst not of the minimum phase-error type, is nonetheless a reasonably good one.

These two factors alone tend to support our belief that a good loudspeaker system does not need multiple drive units and associated cross-over networks (the Japanese trend) but rather a small number of high quality transducers carefully chosen on the basis of performance, not appearance.

The amt 1, in our opinion, is an exceptionally good speaker system. It comes with a lifetime guarantee to the original owner (for the Air Motion Transformer unit) and a five year warranty for the rest of the system. Naturally, as with any new device, it has limitations as well as attributes, and being the first of what we believe will be a long line of acoustical drivers, we have every reason to expect that future generations of the Heil drivers will obviate the limitations which currently raise criticism.



The 'air motion transformer' with diaphragm removed.

Meanwhile, the amt 1's attributes far outweigh its limitations. Whilst not perfection itself, it is such a long way along that path compared with the majority of conventional speakers that we say categorically that it has to be heard to be believed. ●

MANUFACTURERS COMMENTS

Thank you for the opportunity of replying to your most comprehensive and gratifying review.

Taking last things first, that is, your comments regarding vertical dispersion. The ESS amt-1 speaker instruction leaflet describes a simple adjustment to lift the pattern of vertical dispersion, should exceptional circumstances make this change desirable.

The Heil driver in the amt-1 is most certainly the forebear of a long line of exciting applications of the Air Motion Transformer principle. The inevitable question arising from the review is "when will a Heil woofer be available to match the exceptional performance of the existing mid-range/treble unit?" We can only report that the Heil woofer is in the final design stage and, hopefully, the completed system will be available early in 1975.

The full-range Heil system (the amt-2) will, of course, be more expensive than the current systems which use conventional bass drivers with the AMT mid-range/tweeter. Production of lower priced "combination" speakers will therefore continue, and expand.

Currently, the carefully loaded bass driver in the amt-1, and the multiple bass array in the larger amt-3, give exceptionally clean, tight, "boom-less" bass. We believe that these two speakers are at least equal in bass performance to any other speaker in their price range, and that at $628 and $898 a pair, respectively, the overall performance of both is unmatched.

Paul T. Jones
Managing Director
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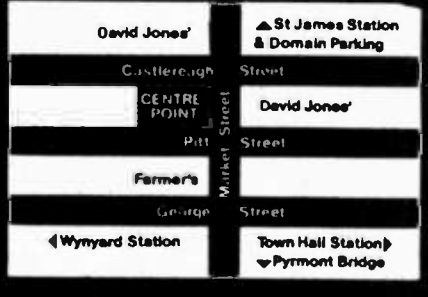

What Quad Terms REALLY mean

A light-hearted glossary by Michael Gerzon and Hugh Ford

THERE HAS been considerable confusion and misunderstanding as to what various technical terms used in connection with quadraphonic sound actually *mean*. The following glossary is an attempt to define the meanings normally given to various commonly-used words and phrases in this field.

AMBIENCE. A sort of muddiness added to sounds to make them less clear.

COINCIDENT MICROPHONES. An arrangement of directional microphones which are spaced apart by more than five wavelengths of the highest audio frequency.

COMPATIBILITY. A property of quadraphonic systems that ensures centre-back sounds are not reproduced in mono and that stereo reproduction gives either narrow or lopsided images.

CONCERT-HALL RECORDINGS. A type of recording in which all sounds appear to be in the middle of an echo plate.

CONSUMER. The technical term for an animal used for laboratory experiments in quadraphonics.

DISCREET SYSTEM. The same as a discrete system.

DISCRETE SYSTEM. (1) Any four channel system that uses four channels. (2) A system that uses four mutually related and interdependent channels. (3) The opposite of a discreet system.

FOUR-CHANNEL SOUND. A recording containing only one dimension (a circle) of sound.

4. (1) A symbol meaning two.
(2) The Japanese word for death.

LOGIC. A method of doing the impossible in an unsystematic manner.

MATRIX. Any system that achieves full discreteness by cheating. Also known as a four-channel system.

MONO. A system of recording sounds from all directions, capable of producing an illusion of spaciousness and depth.

PHASE MATRIX. A system of reproduction using four loudspeakers in which sound positions are determined entirely by the amplitudes of the sounds from the four loudspeakers.

QUAD. Any modern sound reproduction equipment not made by the Acoustical Manufacturing Company Ltd.

QUAD POT. A method of not positioning sounds very well.

QUADRAPHONY, QUADRASONICS, QUADROPHONY. Any system of recording originating on eight or 16 tracks, transmitted through two disc channels, and reproduced through 12 loudspeakers (including woofers, midrange units and tweeters). Note the curious use of Quadri or Quadru roots.

QUADRAPHONIC HEADPHONES. Stereo headphones that cost twice as much.

QUADRAPHONIC SEAT. The only position in a room from which it is not domestically practical to listen.

READY FOR QUADRAPHONICS. Ready for stereo.

SEPARATION. The meaning of this term depends on the laws of logic, which vary from moment to moment.

SHIBATA STYLUS. A method of determining how much dust has collected at the bottom of your records' grooves.

SIDE SOUND POSITIONS. This term has no meaning.

SQUARE SPEAKER LAYOUT. A type of speaker layout that does not fit into domestic listening rooms.

STEREO. An obsolescent term meaning a hi-fi system in which two speakers are missing.

SUBCARRIER MODULATION. (1) A spluttering sound on discs audible to your wife and children. (2) A method once proposed to prevent anyone from taping discs.

SURROUND RECORDINGS. A type of recording in which all sounds seem to be in the middle of your head.

TETRAHEDRAL REPRODUCTION. A system in which one of the loudspeakers is positioned so as to endanger the listener's life.

ULTIMATE IN SOUND RECORDING. Any system not yet including any height information.

VARIABLE MATRIX. A method of making matrix recordings discrete, which uses the fact that you can't tell that a sound is coming from a given direction if it is coming from the opposite direction.

VIDEODISC. A method of obtaining hexadecaphony on gramophone records.

ALL SOLID STATE. Seized controls and cross threaded screws included.

CONSTRUCTED WITH MILITARY GRADE COMPONENTS. Made in 1936.

DESIGNED TO MEET STANDARD 1234. We would like to meet standard 1234 and its half the price of the competition who succeed.

DISTORTION IS ELIMINATED BY . . . You'll be lucky if you can find the fundamental.

ELECTRONIC OVERLOAD PROTECTION. I^2R smell.

Specification: Copywriter's imagination.

IT WILL RECEIVE MORE STATIONS THAN BRAND X. Image rejection and selectivity are zero.

LOW DISTORTION AT EVERY SAGE (SIC) Wireless World P48 (Dec 1937). The dictionary says: distortion, a twisting or writhing motion. Sage, a wise man. The mind boggles.

NOTE THE SMOOTH LOUDSPEAKER RESPONSE CURVE. They took at least a week fiddling the pen speed for this one.

SIGNAL-TO-NOISE RATIO OF 156 dB. It only measured 50 dB unweighted but using a 3 Hz bandpass filter this figure can sometimes be met.

SOLID STATE CIRCUITRY. High distortion.

TESTED WITH THE WORLD FAMOUS BRUEL & KJOER EQUIPMENT (SIC). A five year old might make a better job of the spelling but it looks good.

THIS EQUIPMENT USES AN INTEGRATED CIRCUIT TOO EXPENSIVE FOR OTHER MANUFACTURERS TO USE . . . NASA lost a bomb putting them on the government surplus market at 3c each.

USING THE LATEST COMPUTER TECHNIQUES FOR ADVANCED DESIGN. A mathematical muddle.

WITH VU METERS FOR ACCURATE LEVEL CONTROL. We thought we'd put VU on the scale when we printed our trade mark.

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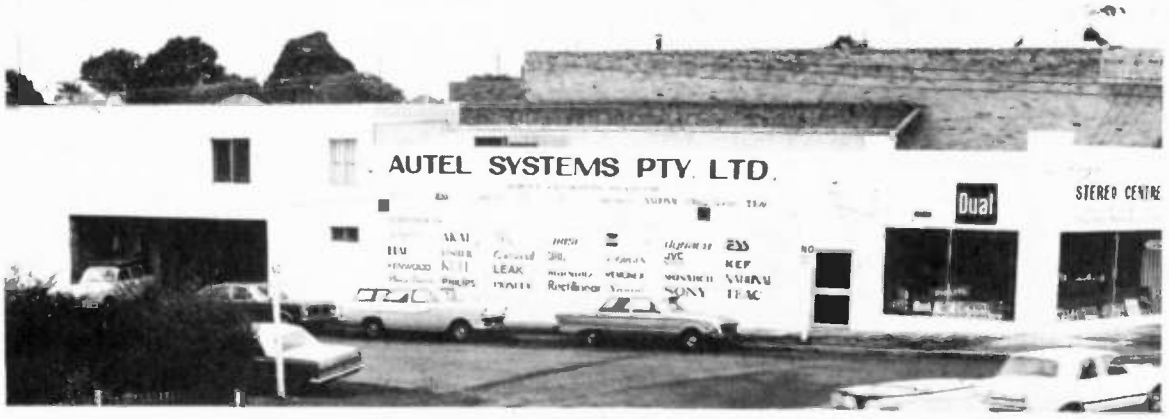

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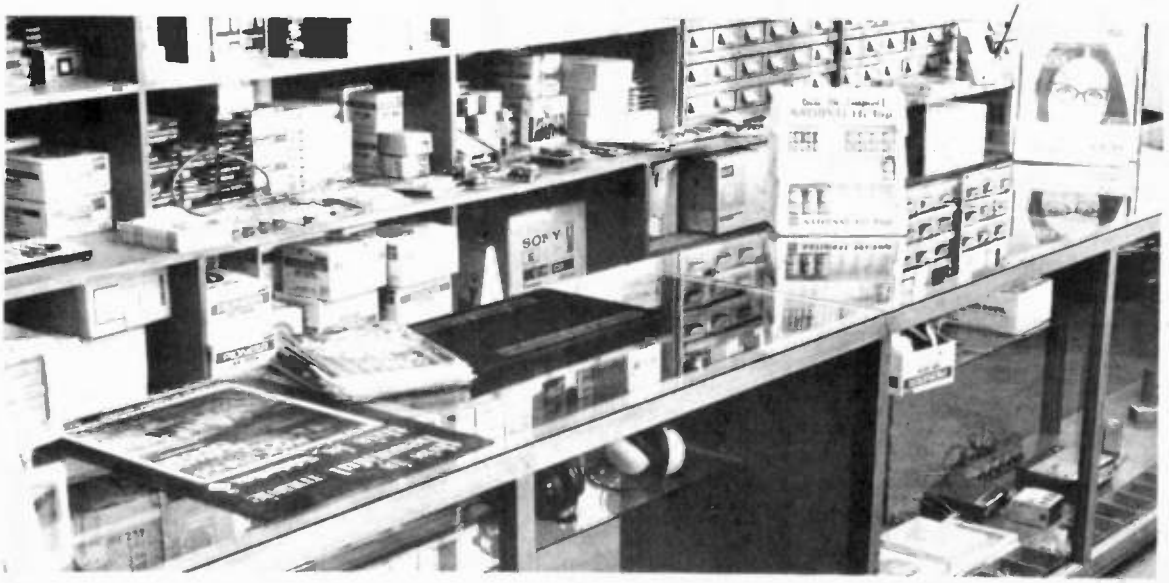

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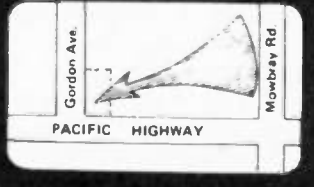

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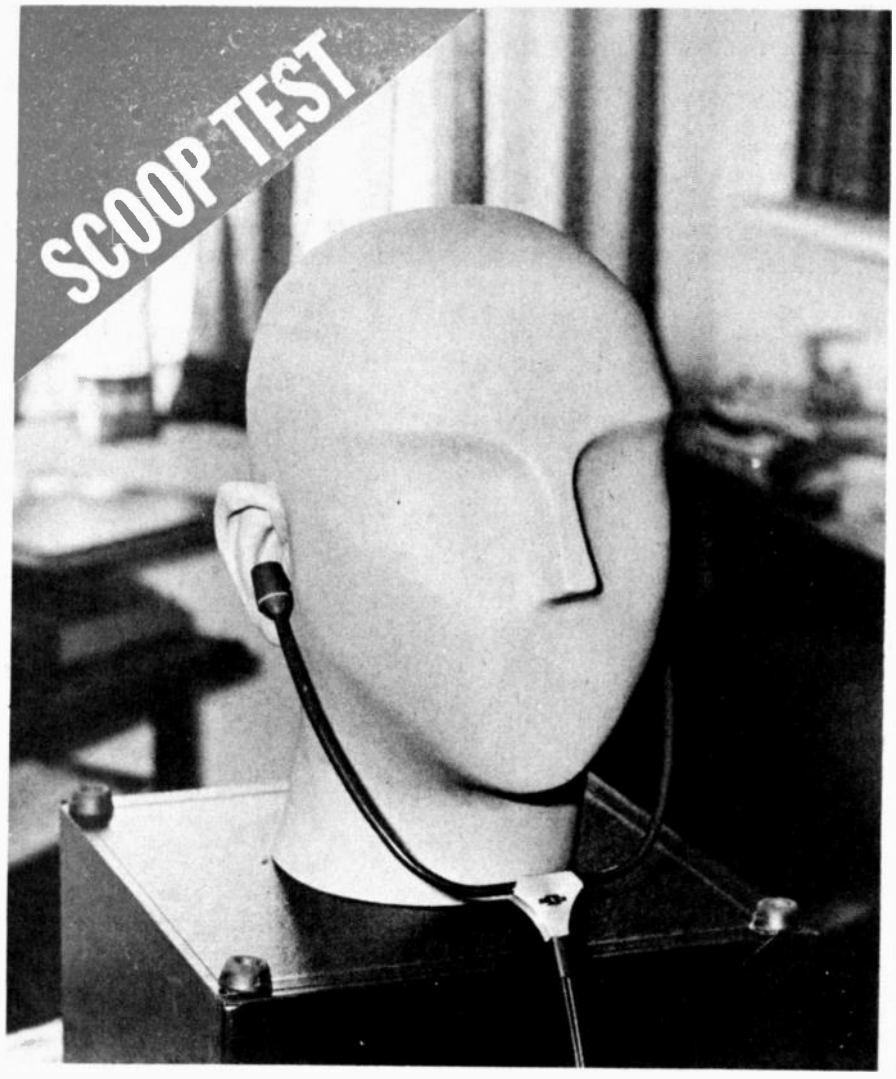


◀ *The Dummy Head with microphone assembly in position. Recordings may be made either by using the Head as shown here — or by wearing the microphones oneself.*

DUMMY HEAD STEREO

We review Sennheiser's fascinating new technique

SOUND recording and reproducing has come a very long way since Edison — nearly ninety years ago. Yet no matter how good the microphones, recording apparatus or playback equipment there is still something missing.

What is missing is an impression of the spatial and temporal characteristics of the original performance.

Four-channel sound was, supposedly, going to fill this gap. But it hasn't.

Perhaps it is missing out because the recording techniques are inadequate — perhaps because the record manufacturers are concerned primarily with gimmicky effects. But whatever the reason, four-channel sound has so far fallen short of earlier expectations.

A NEW TECHNIQUE

Late last year we heard that researchers at Berlin's Heinrich Hertz Institute had developed a new recording technique which was capable of providing full spatial and temporal information — JUST USING TWO CHANNELS.

In effect the German researchers had gone back to nature. They had imitated all parts of the human head essential to the listening process. For instance the shape and softness of the external part of the ear plays an important part. So they made a model of the complete mid-ear and inner-ear, then installed condenser microphones where the human eardrum registers sound pressures.

Recommended retail price approx. $167

Subsequent to our learning of this development, the editor of our associated journal 'Audio Trader' visited the Sennheiser company in West Germany. There she discovered that Sennheiser was proposing to make a commercial version of the dummy head and triaxial microphone at a price low enough to enable the equipment to be sold on the domestic market.

At the same time, Sennheiser were producing a small sample record demonstrating the effect of this new equipment.

We described this record in our March 1974 issue. It is a gem, demonstrating technical innovation of an advanced order. We said then that the effect was quite uncanny and closer to reality than any other technique which we had previously observed, (an opinion we have not changed in any way since).

It was, then, with eager anticipation that we accepted an offer to evaluate the Triaxial Microphone and Dummy Head — which incidentally is not a quarter as good looking as the one shown on Sennheiser's promotional literature. (In fact I'd hate to come across it accidentally in the dark — ED!).

The Dummy Head is a replica of an 'average' person's head. It is moulded from a soft muddy-grey plastic material and is normally used mounted on the top of its carrying case — which, although rectangular, is said to provide similar acoustic properties to that of the human torso.

The Triaxial Stereo Microphone (MKE2002) consists of two miniature microphone capsules mounted on the ends of two spiggots and a plastic yoke. This assembly clips into the outer ear cavity of the Dummy Head — or the recordist himself.

The lightweight cords from the yoke assembly terminate in a small battery-operated preamplifier (which fits conveniently into the recordist's pocket if he is wearing the microphone assembly himself).

Both yoke and microphone capsule adaptors are light and quite comfortable to wear.

The preamplifier has a miniature light which can be illuminated when

the preamplifier is switched on. It acts also as a battery condition indicator, dimming rapidly when the battery requires changing. Apart from switching on the power supply and following normal recording procedures, no additional or complex techniques are required.

A three-metre long cord from the preamplifier terminates in a 5-pin DIN plug. This plugs directly into most European tape recorders directly — however some tape recorders do not have this facility and an adaptor will then be required.

Our first experiments consisted of recording three people who were moving around whilst dictating data in our office.

The results were, to say the least, exciting. The quality was good and the spatial effects uncanningly real.

On replay using a set of HD 424 headphones, it was readily possible to localise and point out, with the eyes closed, where the other two speakers were, whilst there was no doubt that the speech of the person wearing the headphones was right between one's ears, i.e. in the middle of one's own head. Every twist and turn of either the wearer's head, or movement of the people close by was readily discernible.

We repeated the same exercise on live music and the same uncanny realism persisted. People speaking *behind* our seated position could be pin-pointed with almost total accuracy.

As far as this extraordinary ability to locate the sound source is concerned — whether in front of, behind, or even above the recordist (or Dummy Head) our overall impression of the recording was that it is the closest we have ever heard to our own perceived response.

This does not mean to say though that the reproduced sound is an exact replica of the original. It isn't, for reasons that we could not pinpoint until we started instrument measurements.

Our first test was to measure the frequency response of the two microphone capsules when dis-associated from the Dummy Head, (i.e. a free-field plot). We did this with a 12.5 mm Bruel and Kjaer 4134S Reference Pressure Microphone located centrally between them.

This measurement (Fig 1) shows a number of minor peaks and bumps but these are early reflections from our not totally anechoic environment. They are not non-linearities in the Sennheiser capsules. The true response is within 3 dB from 40 Hz to 18 kHz. That is, as flat as one could wish for.

However in use, the trixial microphone assembly is used in conjunction with an artificial (or human) head. This results in a reflection component from the side of the head and the shape of the ears. It is also evident that the ear's cavity absorption effect also affects the frequency linearity of the microphones.

That this was indeed so was proved when we repeated our measurements with the triaxial microphone in position on the dummy head. The results, shown in Fig 2, are not nearly as flat, as the free-air results. In fact there are excursions of the order of ±10dB — particularly at frequencies above 2000 Hz. This is still quite acceptable for amateur recording purposes — indeed we expect that it is actually *necessary* in order to provide the frequency discrimination required for the stereo effect. However this non-linear response may be a serious drawback for professional users.

Sennheiser say that their system is as good as a professional Dummy Head with implanted microphones. We cannot accept this premise and believe that prospective users seeking high precision would be better advised to spend the extra thousand dollars and go for the professional models.

For amateur use though, the Sennheiser head and microphones are a revelation. They have an added advantage that one can use one's own head in order to produce one's own personal binaural recordings.

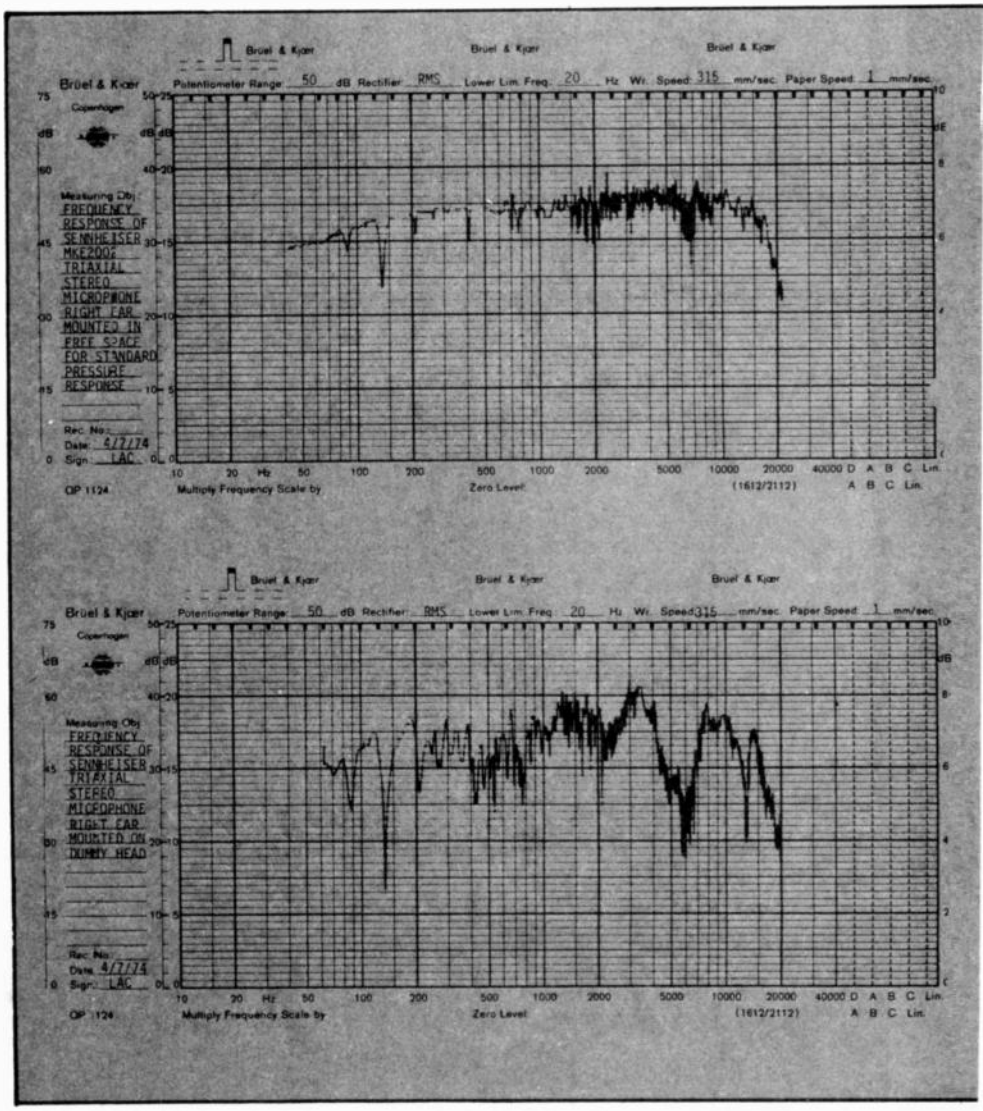
The recorded sound is coloured compared with the original signal — but not badly.

But no matter whether the recording is made via the Head, or one's own ears, the recorded sound, especially if replayed via 'open-air' headphones, is as big an advance as was the change from mono to stereo reproduction. Despite minor colouration, reproduced sound has a naturalness never before experienced.

Above all, the Sennheiser system causes one to question very seriously indeed the future of four-channel sound.

For compared with *any* four-channel sound systems that we have yet heard — this essentially two-channel system leaves them for dead.

And that is a very carefully considered statement. ●



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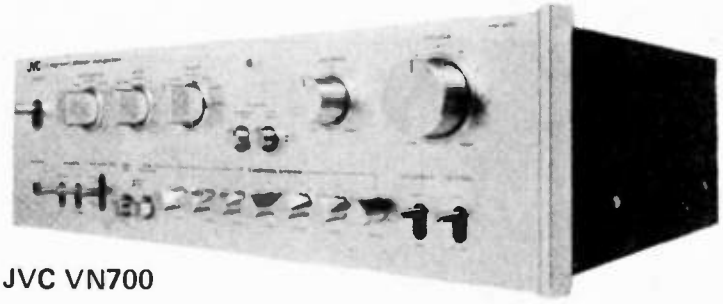

JVC VN700

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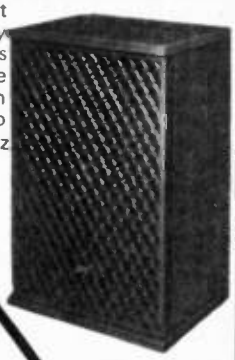

JVC SK12

"4-channel ready"

A look at this precision component will tell you its different, but a closer look will prove it. Notice how the TH universal tonearm houses a 4/2-channel compatible cartridge. And how the turntable's 4-pole synchronous motor and belt-drive system combine to give it the precision required for reproducing discrete 4-channel stereo records: wow and flutter of less than 0.1% WRMS and an S/N ratio of better than 5-db. In addition, auto-stop-return mechanics with anti-skating device and cueing lever. In fact, all that's required to convert the SRP-87 to immediate discrete 4-channel status is JVC's 4DD-5 demodulator and stylus (4DT 10X).

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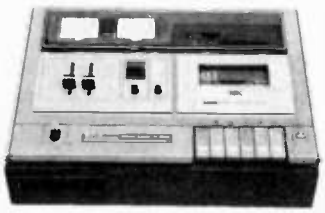
JVC 1667 V



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DIN CONNECTORS

Many amplifiers and tape recorders of European or Japanese origin are equipped with DIN connectors. The pin connections for these connectors are standardized in accordance with IEC* recommendations which are given here.

Most equipment will be wired to this convention. The type numbers given are those designated by the IEC and may be different to those assigned by individual manufacturers.

*International Electrotechnical Commission.

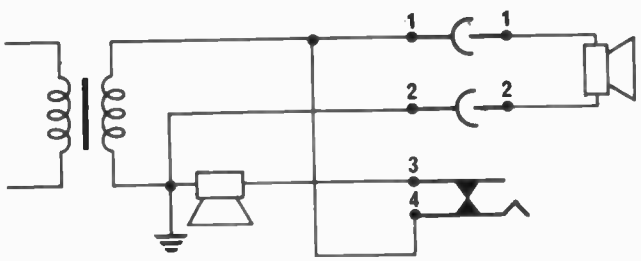

Fig.1a. Example of using the type 05 connector inserted in position A. Both speakers are operational.

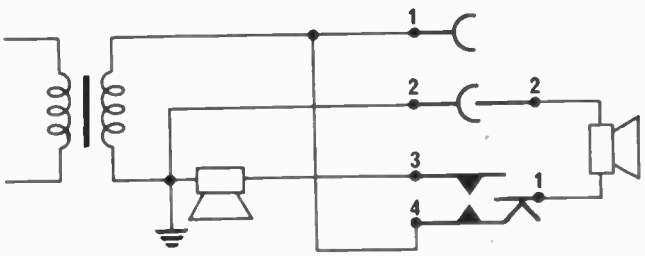

Fig.1b. With the connector reversed, in position B, the internal speaker is disconnected.

Notes 1. – The numbering of the contacts is shown as seen on the mating face of the connector.

2. – The same connectors are used for monaural and stereophonic systems.

3. – Normally, it is recommended to connect the shell of the plug to terminal 2 of the connector to ensure that the screen is earthed.

4. – The pin connector Type 05 can be inserted in a socket connector type 08 in either of the two positions A or B. The switch is actuated by the short round pin 1, when the pin connector is inserted in position B.

TABLE 1

Contact arrangement See Note 1	IEC Type designation/* Pin connector	IEC Type designation/* Socket connector	Application		Connections 1	2	3	4	5
	01	02	Microphone	Monaural system (balanced)	Hot lead	Screening; earth	Return lead		
				Monaural system (unbalanced)	Hot lead				
	03	04	Microphone	Stereophonic system (balanced)	Hot lead of left-hand channel		Return lead of left-hand channel	Hot lead of right-hand channel	Return lead of right-hand channel
				Stereophonic system (unbalanced)	Hot lead of left-hand channel			Hot lead of right-hand channel	
			Record player	Monaural system			Hot lead		Connected to 3
			See Note 2	Stereophonic system			Hot lead of left-hand channel		Hot lead of right-hand channel
			Tape recorder	Monaural system	Input signal		Output signal	Connected to 1	Connected to 3
			See Note 2	Stereophonic system	Input signal of left-hand channel	See Note 3	Output signal of left-hand channel	Input signal of right-hand channel	Output signal of right-hand channel
	06	07 09	Low impedance loudspeaker	Loudspeakers	Hot lead	Return lead			
		08 See Note 4		Loudspeakers					
	05 See Note 4			Loudspeaker with or without switch					

* all connectors have the prefix 130-91EC

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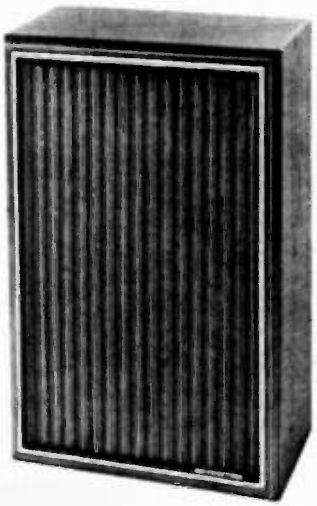

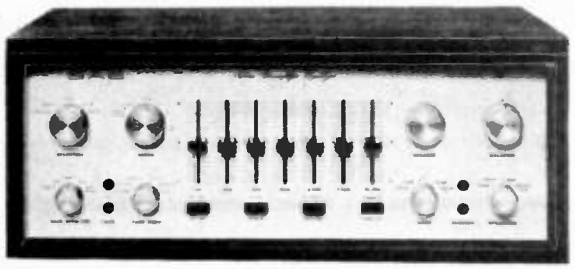

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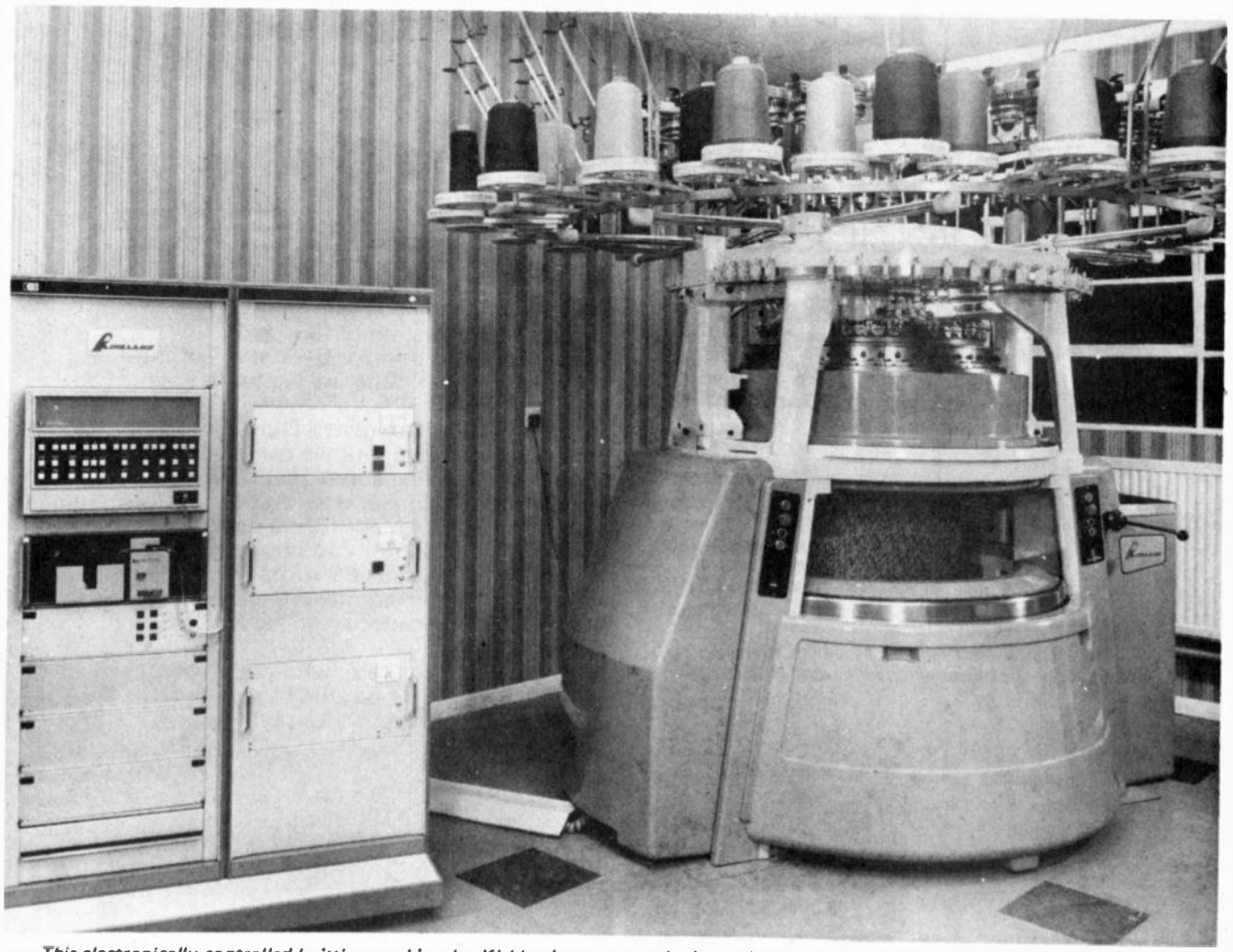
LER057

KNITTING - 1974

The centuries-old knitting machine has been coupled to a mini-computer to gain versatile control over the production of complicated fabric patterns. Here Dr. Sydenham describes this latest step in the highly competitive textile trade.



This electronically-controlled knitting machine by Kirkland, represents the latest developments in machine design and philosophy.

The popularity of knitted stockings was probably the original reason for the invention of the knitting machine. As early as 1527, the French industrial community had formed a stocking-knitters' guild. In early times it was a woman's natural lot to be an accomplished knitter as this extract from an early poem portrays:

"She sayde, as herr whytte hondes whyte hosen were knyttinge,
Whatte pleasure ytt ys to be married."

In 1497 a Professor at Aberdeen recorded that Scots often wore stockings from the knee upward to fill in the space between the then fashionable cloth hose and the short balloon-like breeches. History also tells us that Henry VIII appeared in new-fangled stockings in 1510: the garments were:—

"powdered with castels and sheafes of arrows of fine ducket gold."

Obviously, such fine silk stockings were only used for grand occasions in the 16th century for their manufacture took many hours of dainty hand knitting to produce.

KNITTING is a manufacturing method whereby a single continuous thread is used to gradually produce material or a garment. It differs from weaving which uses separate threads laid into each in a perpendicular manner. Both processes can be used to produce fabrics, ranging from delicate to heavy dense; each has its merits. Historically the two processes have developed side by side. Both originated many hundreds of years ago.

We do not usually give much thought to the production of knitteds by quantity manufacturers. When we watch the ladies knitting away, stitching plain after pearl into complicated ribbing patterns, the process looks as though it would be difficult to duplicate mechanically. The weaving machine seems simpler to design. But history records that

automatic knitting machines are about as old as automatic weaving looms.

THE INCREDIBLE BUNDLE OF BITS AND PIECES – A KNITTING MACHINE

The first accredited automatic knitting machine – a very complicated mechanism that did away with hand knitting for bulk manufacture was in routine operation in 1589.

It seems that mention of such a device was made in a state of the art report made to Cromwell some fifty years after its invention. This report was presented by petitioners seeking to establish a guild. The knitting frame described in the petition was made by the reverend William Lee who came from a town near Nottingham (most of British commercial knitting is still produced here). Lee's machine could be used to knit at a rate at least one hundred times faster than an experienced hand knitter and it had: *"2000 pieces of smith, joiners and turners work . . . it far excels in the ingenuity, curiosity and subtility of the instruments of manufacture in use in any known part of the world".*

This may sound like a rather proud designer's idea of his own invention but the words were written many years later. Seeing is believing; a knitting frame, Fig. 1, still exists today in the Science Museum in London. Bearing in mind that the machine originated nearly four hundred years ago, one cannot fail to be impressed by the design and its execution.

A contemporary historian claimed Lee invented the knitter to allow his young country girl-friend to spend more time with him and less at her knitting. Suffering the setback many inventors experience he was despised in Britain. He subsequently went to France but his patron, Henry IV of France, was assassinated shortly after his arrival and Lee finally died in Paris . . . "in great distress".

Early in the 17th century the Venetians obtained (by devious means, for loom owners realised their potential worth) a stocking loom, but local pressure from traditionalists forced its demise because it was seriously upsetting the economics of the other knitters – an 'oh so familiar' story of progress.

The new looms spread, as was inevitable, and by 1696 they were in common use. In 1670 there were 700 looms in use in Britain. By 1714 the records show 9000 and by 1753 the number was up to 14 000.

Each year the designs became more sophisticated. In 1758 a patent was granted for the first ribbed stocking knitter. Many notable engineers of the time tried their hand at designs: Marc Isambard Brunel built a knitting machine in 1816; Whitworth lodged a patent for a straight material knitter in 1846. By this time textile machines were rapidly being converted to steam power and in 1835 stocking frames using a rotary motion were often steam driven. (This sounds somewhat incongruous today – a steam driven knitting machine!). Cotton and silken hosiery manufacture was big business by 1850 – 3 510 000 dozen stockings a year consumed 4 584 000 lbs of cotton, 140 000 lbs of silk and 6 318 000 lbs of wool: 73 000 people were employed in the British trade in mid-Victorian times.

Most of these early looms, however, generally produced a plain knit only. There were no coloured patterns and highly fancy stitching schemes to create interesting textures. Just when the automatics were invented is hard to discover but by the early 1900's machines existed that used a pre-set mechanical data store to program the knitting action of coloured, patterned fabrics.

Today's machines are more complex again and more precisely constructed. The many hundreds of pieces of wire, called needles, that guide the thread are about half the thickness of a paper clip and they clear each other by only 100 μm. Each needle has to last at least 300 000 000 operations. A typical bulk fabric machine churns out large-diameter double jersey at 50 000 km a week.

WHAT WAS THE FIRST PRE-PROGRAMMED MACHINE?

The concept of punched tape or punched card control of a machine process is more or less accepted as a modern concept. Those trained in digital computing will, however, usually put forth that the first use was much earlier. The jacquard system (after a Frenchman of that name) of controlling a weaving loom was introduced in 1810 and used punched "tape". The "tape" was in the form of a durable paper belt, perforated in set positions across each row which controlled the action of the multi-colour weaving machines – rather like a very large version of today's eight hole tape. Silk pictures (Stevengraphs are the most famous products) of incredibly intricate detail were made on fine machines in Victorian times. However, the jacquard system was more normally used for the production of heavier clothing fabric. Modern looms still use this principle to control the pattern.

Further delving into industrial history reveals the existence of an even earlier controlled loom – Falcon's loom of 1728 also used punched hole control. There is also claim to a paper tape unit three years before this (by Bouchon) but the truth of this appears to be in doubt.

Falcon's loom (a working unit exists in the Science Museum) uses thick cards (more like boards) with 20 holes across and four rows down. These cards, by the absence or presence of holes, give the instructions that decide the appropriate partings for the threads, ready for the next throw of the shuttle. Each card has the data for a row of weave. This machine, like Lee's knitter, is also a complex masterpiece of craft and ingenuity.

The jacquard system was eventually applied to knitting machines and is still used today – the rather fragile tape data store has been replaced by more robust steel equivalents such as steel tapes, pattern wheels, drums and discs. A control arbor of one manufacturer's method is shown in Fig. 2; teeth have been selectively cropped to suit the needs of the pattern.

Until about four years ago machines could be broadly classified as those with no variable program ability (for simple texture, one-colour cloth) and those that incorporated a mechanical form of pre-programming. Mechanically, machines still resemble earlier designs. A pre-1940's design of a basic circular knitting machine is shown in Fig. 3. The yarns feed up and

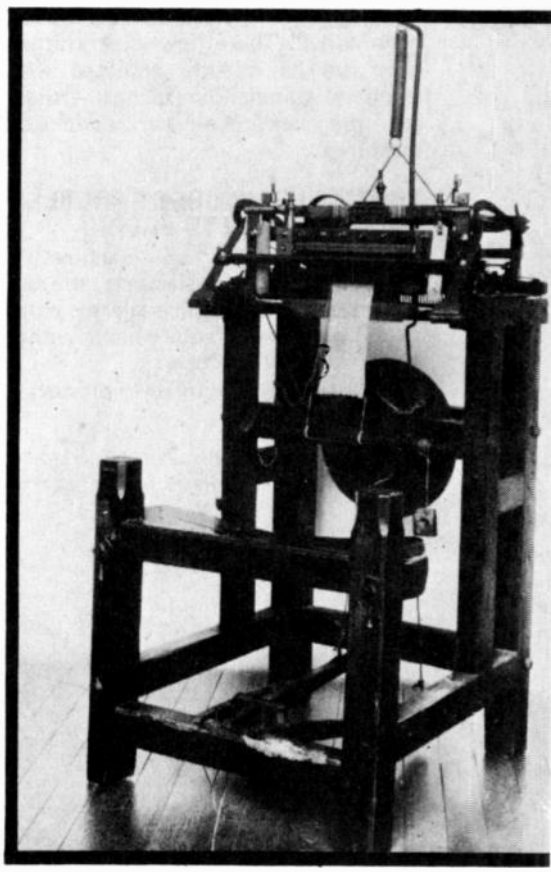


Fig. 1. The first knitting machine – after the design of Rev. Lee (1589) (Courtesy Science Museum London).

KNITTING - 1974

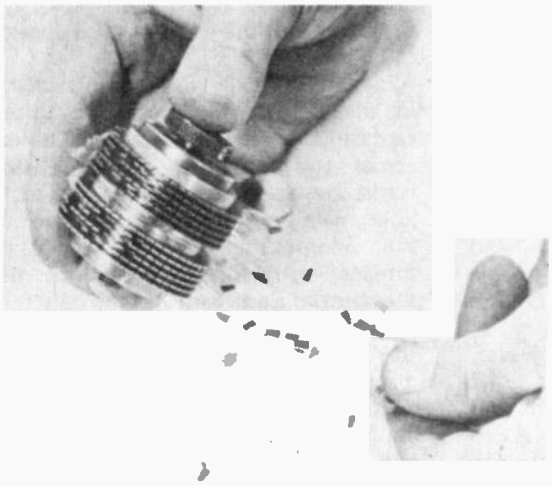


Fig. 2. Cropped-discs assembled on an arbor are used by one manufacturer to control the pattern produced by a knitting machine.

Fig. 3. Knitting machines looked like this forty years ago.

over tensioning and guidance heads then down into the centre of the circular knitting head. The knitted material is pulled off with the roller seen underneath the main frame. The mechanism is powered by an electric motor.

Materials, such as cheese-cloth, are used as a flattened circular belt of material; jersey fabric is usually cut open to form a single flat width from which garments are fashioned by the normal tailoring methods. Machines that knit shapes are another breed – here we are mainly concerned with continuous material production.

Today, a third class of machine has been added. There now exist knitters that can be directly actuated with electrical commanding signals – these are the new computer controlled machines.

THE MANUFACTURER'S PROBLEM – FROM DESIGN TO FABRIC

Whichever type of machine is available to the manufacturer, the aim is the same – to produce saleable cloth to the customer's requirements within a competitive time-scale.

The work flow required to produce a patterned fabric is shown in Fig. 4; it consists of several sequential stages. Firstly, the artist/designer prepares a coloured drawing of the design in conjunction with the customer. This is then edited into a form suitable for knitting production. The designer must allow for the modular stitches which preclude a perfectly smooth pattern because of their discrete nature.

Next the now quantized stitch pattern layout is transferred into permanent machine instructions – the control arbor, for instance. Finally, the machine is run for a test period to verify that the cloth is correct. If the product is acceptable, the run is commenced; if not, it is back to an earlier part of the process to modify the data.

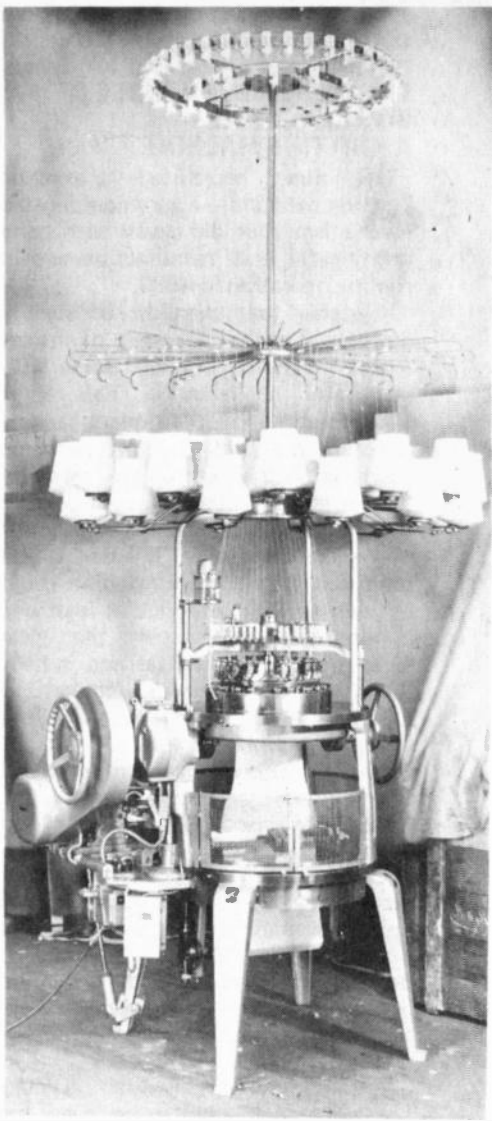
From the manufacturer's point of view any method of speeding-up part of this process without increasing the product price is a worthwhile investment for the knitting machines can then be better utilized and the customer gets the assignment sooner.

SOME UNSOLVED PROBLEMS

Mechanical automatics lack the highly desirable ability to produce a short run of fabric at a reasonable cost. Often the manufacturer needs to show the prospective customer an actual sample, to provide a special fabric for an important yet limited requirement occasion (Fig. 5 shows a coat of arms design recently made by Kirklands of Leicester), or to cater for specialised needs of clubs or societies who desire special uniforms, curtains or what have you. The production of special intricate designs for such small markets is very expensive as the whole process must be invoked including the manufacture of the steel data medium.

Consideration of the work-flow diagram of Fig. 4 shows that certain parts cannot be eliminated – the human interaction is vital as the desired effect is often highly subjective.

There are, however, two significant bottle-necks in the process. They occur in the editing and permanent data preparation stage and in machine control. Modern developments have concentrated on these parts of the process making use of the now



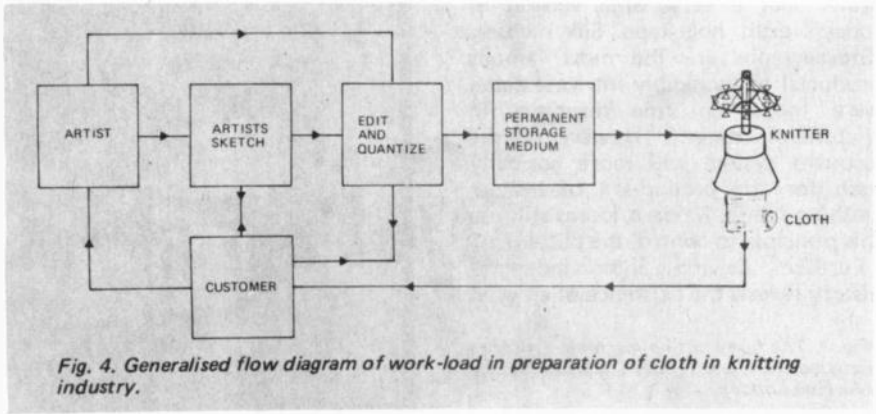


Fig. 4. Generalised flow diagram of work-load in preparation of cloth in knitting industry.

extensive computing and commanding power of the relatively inexpensive mini-computer. Abut ten knitting machine manufacturers are currently working on these problems.

THE DATA PREPARATION STAGE

Commonly used equipments require the operator to instruct the data storage medium about the colour of each stitch at each position. With around 10 000 or more stitches to a complex pattern cycle (try counting the stitches in the coat of arms of Fig. 5) this can be an extremely slow and tedious task.

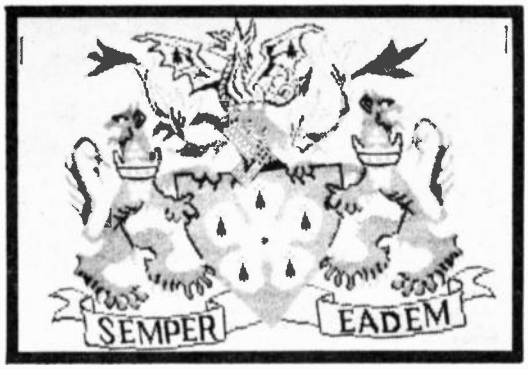
Latest equipments, such as the Kirkland "Time-saver" system (that this article is based upon) use automatic scanners. The "Time-saver" system, shown in Fig. 6, is based on a wide-bed Calcomp plotter (extreme right) and a Hewlett-Packard, model 2100A, mini-computer (seen in the top right of the central console).

The artist's hand-drawn design, which can be nearly a metre in width and of any length, is placed on the scanner feed rollers. A custom-built optical reading head (designed by Barr and Stroud) moves across the pattern recording colour and positional data. The reading head scans over its separate colour differentiating channels using optical filters to decide the colour at each point. Up to six colours can be accommodated but in the knitting trade it is rare to use more than three — blue, red and yellow along with the shades white and black. The designer invariably produces the drawings as discrete coloured areas — continuous colour toning is not relevant in this application.

During the scanning process, which takes place at around 45 stitches per second (a 10 000 face stitch pattern is scanned in four minutes) the collected data is stored up in the computer. Whilst this is happening the data can be used to reconstruct the design on a high quality multi-colour visual display unit (vdu for short). The monitor used is more than a straight adaptation of a commercial colour television monitor for better resolution and less distortion are needed. This part of the Kirkland system was designed in conjunction with Sarek Controls.

The computer can also be used to repeat the basic pattern cycle on the vdu, see Fig. 7, thus enabling the operator to see whether the pattern repeats correctly — the top of the pattern may not join exactly with the bottom of that above. It also enables the designer to look for unexpected unpleasantries. The computer can also provide a number of standard background patterns such as bird's eye, herringbone, vertical stripes etc and several overlying patterns can be merged into a common form of data.

Fig. 5. This coat of arms (for Leicester) was produced on an electronically controlled knitting machine system to commemorate the era when computer control became practice.



At some stage it is usual for the designer to require interaction with the data as the vdu may show up features which need editing.

An interesting problem arises in direct automated data acceptance from continuous line drawings. If the original has continuous smooth curves that are not already squared-off into discrete stitches the computer must make decisions about the allotment of a stitch: the simplest criteria is to provide a full stitch when the original edge overlaps more than 50% of the reference-grid squares and no stitch for less. Fig. 8 illustrates what happens to Mickey Mouse when he is quantized in this way. Some edges have become ragged and unpleasing to the eye. The designer needs to decide the compromise needed between the true shape desired and the degree of fuzziness that can be allowed.

It is a moot point in the trade whether it is better to produce a very carefully drawn original on squared paper, in a digitized form or to feed in a rough sketch then edit the display afterwards. It appears to be false economy to use computer editing. The drawings to be prepared are usually within the skills of most colourists and colourists cost less than computer time.

The facility does exist in the computerized method for editing if needed. A roving spot is moved across the vdu pattern. When the operator has the spot in the required position, commands can be given, via the tele-typewriter, to delete or add stitches as necessary. A similar process can be used to remove areas and move areas around at will.

Another way to view the appearance of the final cloth is to use the scanner unit as a plotter. This is achieved within seconds by changing the reading head to a multi-colour head. The plotter can then be used to provide a hard copy of the design for storage or for sending to the customer. In this way the need to actually knit samples of fabric is largely avoided.

PUTTING THE DATA TO WORK

Once the pattern has been verified and accepted the next task is to convert it to the appropriate means of control for the machine in use. If mechanical control this means mechanical production; if electrical, direct use of the tapes.

Mechanical — the control tape is used

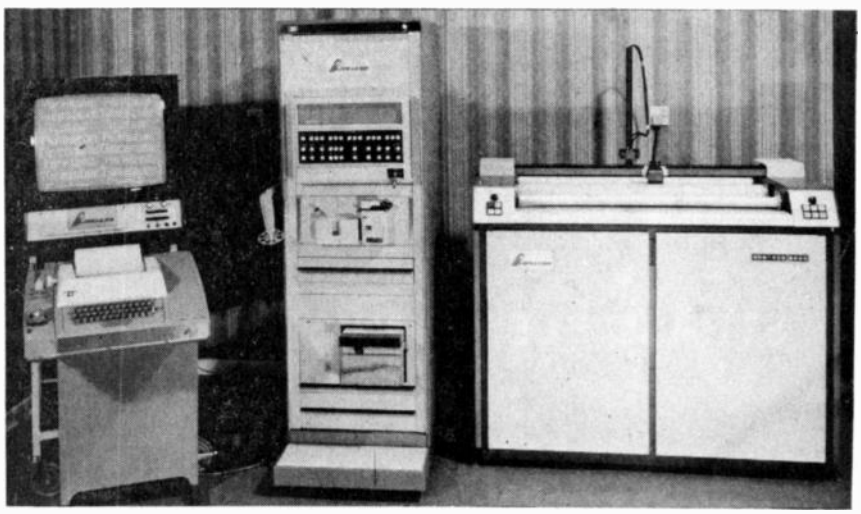


Fig. 6. Time saver pattern data preparation system.

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to operate a special-purpose machine like that of Kirkland's shown in Fig. 9. In this arrangement the discs to be cropped are loaded onto standardised arbors that fit onto the cropping heads, (seen on the left-hand side of the unit of Fig. 9). Data on the punched tape decide which teeth are plucked out and which are not. The arbors then go to the knitting machine for the start of the fabric run.

Electronic — in many cases the customer wishes to see a short length of fabric or, alternatively, the run requirement may be short. Here the tape can be used immediately to control knitters that have direct electrical input controls. The illustration on page shows the complete electronically controlled knitting machine. The console houses the Hewlett-Packard mini-computer and the tape reader. The unit interfaces with the many electro-magnetically actuated needles of this special knitting machine. Rather than use entirely computer-based instructions on a continuous basis the actuators have an inbuilt facility to hold the positions given them thus releasing the computer. There is also provision in this machine for the use of permanent magnets as permanent pattern storage — they will be used to hold the actuators.

The computer linked machine is not intended as a replacement for the mechanical automatic. The latter is more economic when rapid pattern change is not needed. It does, however, offer a new dimension in the marketing of knitteds.

It is not hard to envisage a facility of the near future whereby the customer is able to enter a "knitteds-to-order" shop, design a pattern with the help of the resident designer and after a short wait, leave the store with the finished cloth. ●

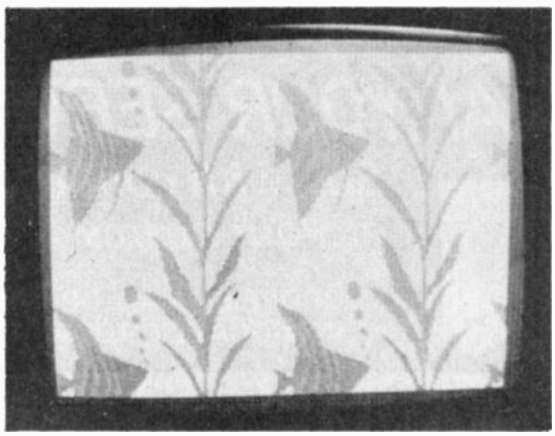

Fig. 7. The designer needs only to produce one cycle of the pattern — the computer-based colour display repeats it to provide a view of the complete pattern.

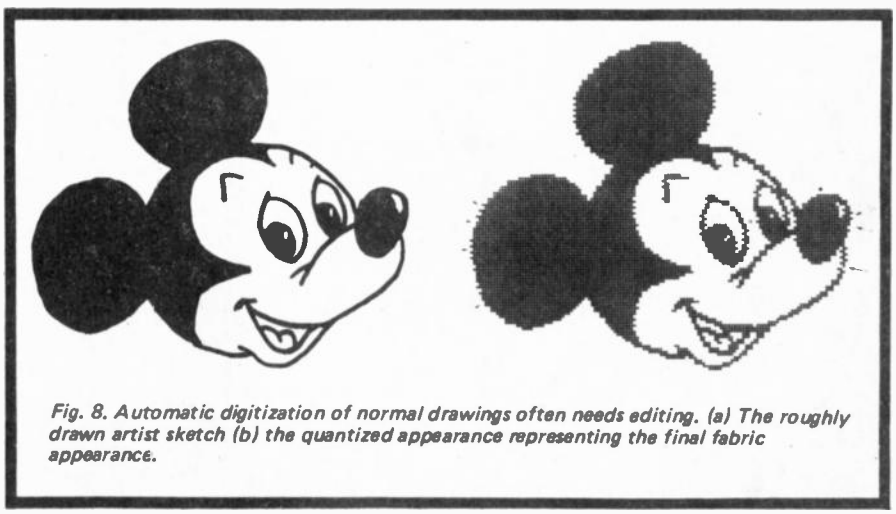

Fig. 8. Automatic digitization of normal drawings often needs editing. (a) The roughly drawn artist sketch (b) the quantized appearance representing the final fabric appearance.

Fig. 9. "Discomatic" produces cropped discs from paper tape control.

Further reading:

"Electronics in knitting", F. Carrotte. Hosiery Trade Journal, July 1973.

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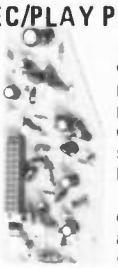

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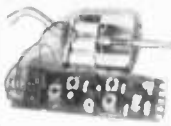

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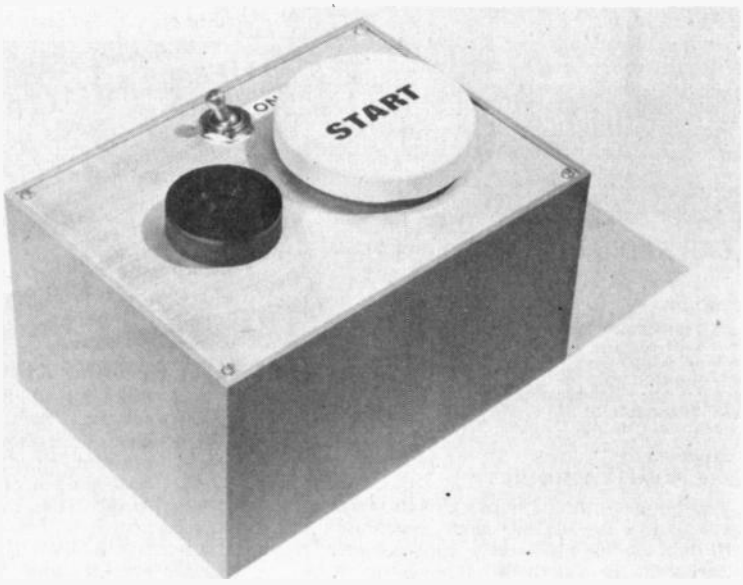
PROJECT 526 THE PRINTIMER



an A.J. Lowe design

Improve your photo print quality with this simple design.

ONE OF the major causes of poor quality in enlarging black and white photographs is lack of consistency in print-development time.

Many photographers think that they can get away with making enlargements without exposure test strips by pulling the print out of the developer when it looks about right. The PRINTIMER should teach them better 'manners' and help them produce better prints.

The unit described in this article gives an alarm a fixed time after pushing the start button. Once the timer is set at the development time you believe is right for you, whether that is 1½ minutes, three minutes, or anywhere between, consistent development times will be obtained giving consistency of results. Poor prints are then the result of wrong exposure, not a combination of wrong exposure *and* wrong development.

WHAT IT DOES

As can be seen from Fig. 1, the timer has an on/off switch and a start button as its only visible controls. It can be turned on, and left on, for the whole of a darkroom session as the current drawn is very low. Once an exposed photo paper has been truly dunked in the developer, the start button is touched, and (say) two minutes later, a Sonalert alarm beeps for a few seconds to indicate the expiry of the chosen development time. The device is ready for immediate re-use. It saves all the problem of watching a clock while development is taking place. The start button, which has been made super large, costs nothing and can't be missed in the darkroom. It can be operated with an arm or wrist by those darkroom workers who like having their fingers wet all the time.

Other uses for this device are as an egg timer, or even as a timer for quiz shows where a contestant must answer in a particular time. It could also be used as an STD telephone-call timer to remind you of the passage of time. Although it is basically a preset timer

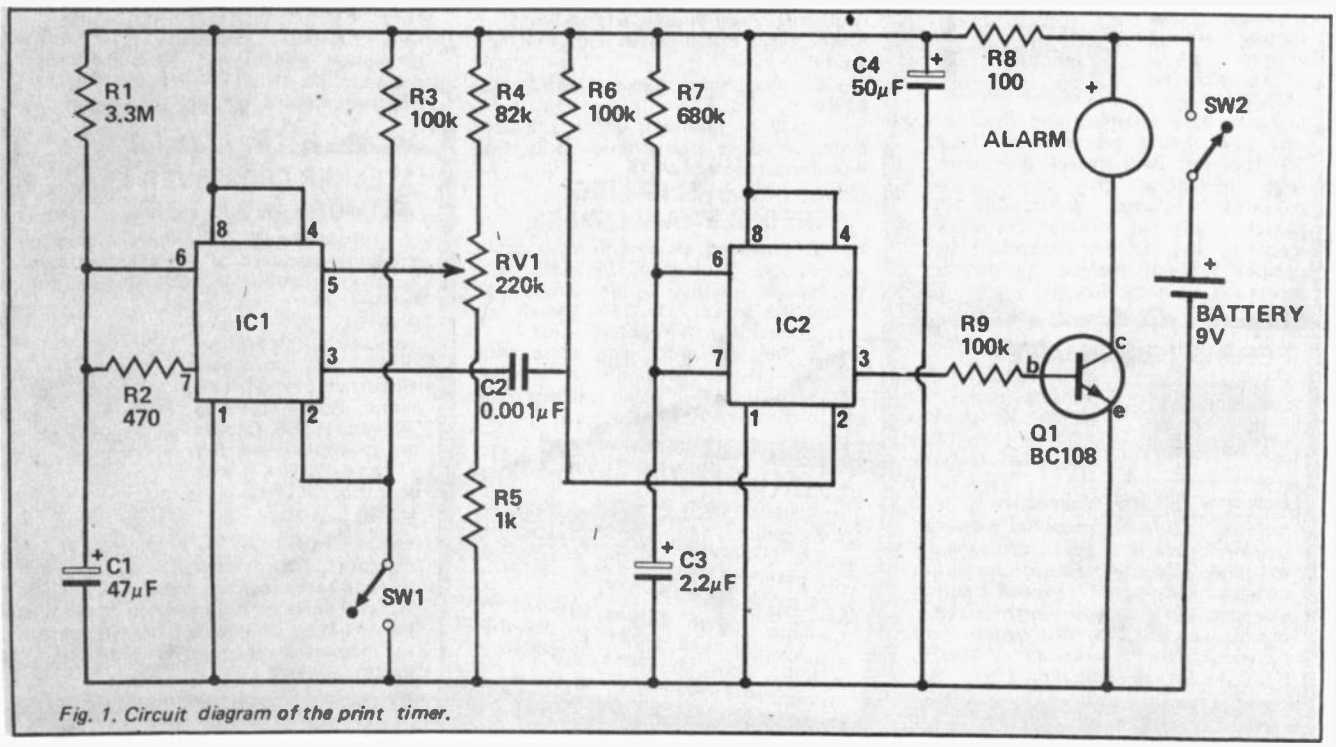


Fig. 1. Circuit diagram of the print timer.

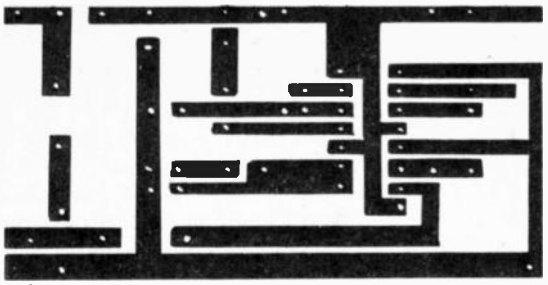


Fig. 2. Printed circuit board (full size).

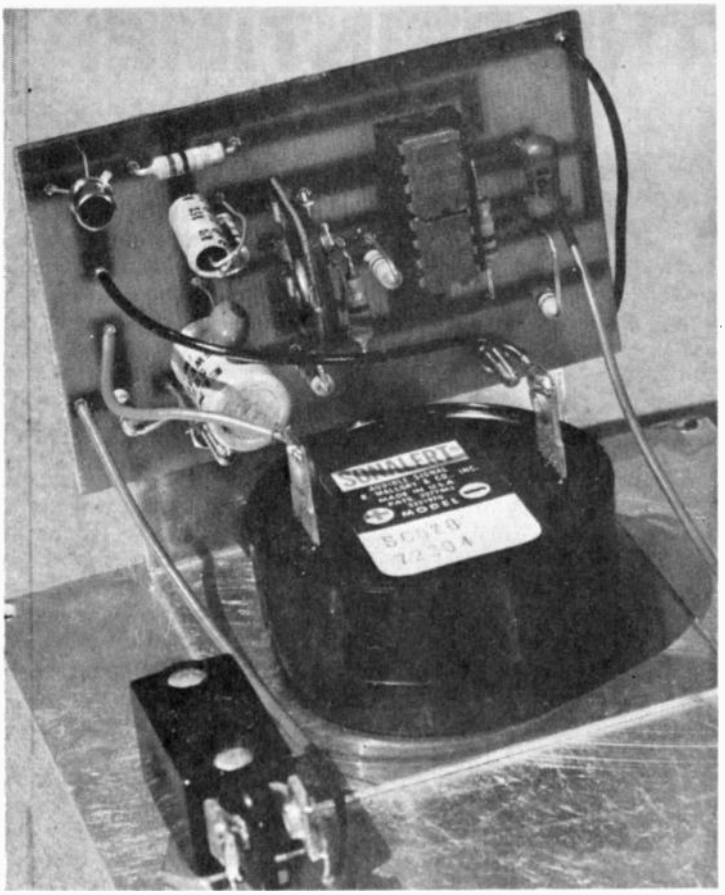


Fig. 3. The printed circuit board is mounted on an aluminium bracket which, in turn, is secured to the front panel by means of the Sonalert.

HOW IT WORKS

The timer uses two NE555V IC timers as shown in the circuit diagram Fig. 1.

Integrated circuit IC1 is the main timer – its time of operation being determined by the values of R1, C1 and the preset pot RV1. When the start button, S1 is pressed, terminal 2 of IC1 is connected momentarily to the negative rail. This sends the output of IC1 (terminal 3) high.

At the preset time, terminal 3 goes low, and so applies a negative going pulse to terminal 2 of IC2 which is the second NE555V timer. Terminal 3 of IC2 goes high, turning on the BC108 transistor Q1, thus allowing current to flow through the Sonalert. After the Sonalert has sounded for a couple of seconds or so, as determined by the values of the timing components of IC2 (R7 and C3), terminal 3 of IC2 goes low again, and the Sonalert is turned off.

The fact that terminal 3 of IC1 is low (in the quiescent state of the device) does not cause IC2 to restart as a negative going pulse is required to do that.

Resistor R8 and capacitor C4 stabilise the supply to the ICs so that they are not affected by pulses produced when the Sonalert switches off and on.

PARTS LIST

R1	Resistor	3.3 megohms	¼W
R2	"	470 ohms	"
R3,R6,R9	"	100k	"
R4	Resistor	82k	"
R5	"	1k	"
R7	"	680k	"
R8	"	100 ohms	"

RV1 Preset potentiometer 220k

C1 Capacitor electrolytic 47µF 6.3 volt tantalum
C2 Capacitor .001µF ceramic
C3 Capacitor electrolytic 2.2µF 25 volt
C4 " " 50µF 25 volt

IC1 IC2 Integrated circuit timers NE 555V

Q1 Transistor BC 108

Alarm Sonalert type SC628, or Morganite type MB-12

S1 Push button switch — see text.

S2 Toggle switch on/off

Battery 9 volt

Case, p.c. board, aluminium for bracket etc.

it could be made readily adjustable, as described later.

CONSTRUCTION

The timer was built into a plastic case measuring 140 x 100 x 75 mm with the works mounted on a printed circuit board 70 x 47 mm. The printed circuit board is mounted on an aluminium bracket, which in turn is secured to the front by the Sonalert as shown in Fig. 3. The arrangement shown leaves enough room in the case for a 9 volt Eveready battery, type No 276-P, which will last a very long time.

There is nothing critical about the layout, and those who prefer Veroboard or matrix board construction can easily work out their own layouts.

The copper side of the printed circuit board used in the prototype is shown full size in Fig. 2, and the layout of components on it is shown Fig. 4.

Both ICs are mounted in one 16 pin DIP socket with their notches nearer the positive rail. Note that pin 5 of IC2 is not used and so the bottom right hand corner pin of the IC socket may simply be run through a hole in the board or cut off.

Polarity of electrolytic capacitors C1 C3 and C4 must be observed, as must the polarity of the Sonalert.

The large 60 mm diameter push button marked START is a gift from your friendly jam manufacturer – it's the screw cap off one of his jars. The 'spring' of the push button (developed after much experimenting) is a disc of plastic foam about 3 mm thicker than the depth of the cap, and about

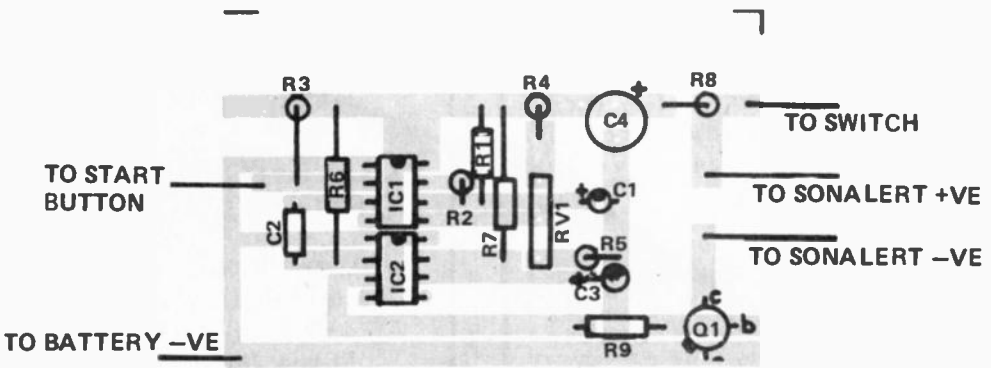
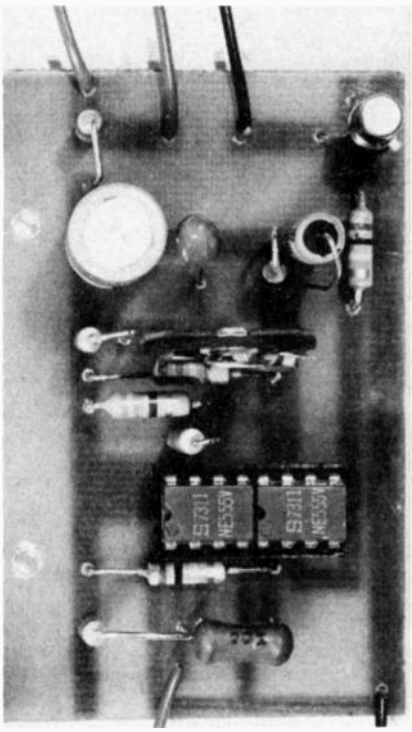


Fig. 4. Component overlay.

THE PRINTIMER



The completed print timer.

20 mm less in diameter.

First solder a flexible lead to the inside of the screw cap — out near the rim. Then paint the cap white if it carries some brand name.

Next carefully remove the paint from the lower edge of the rim of the cap by rubbing it on a piece of emery cloth. The edge of the cap must be clean all round because this is the surface which makes contact with the aluminium panel, and it must 'make' wherever the button is touched. Glue the plastic foam 'spring' centrally, to the inside of the cap. When it is set the push button is ready for mounting on the panel. Its position should be determined and then a hole drilled obliquely through the panel at some point below the cap, but clear of the foam-plastic spring. Thread the lead (soldered to the cap) through the hole, and position the cap so that the lead does not cause any restraint to pressing the cap.

When all is in position the bottom side of the plastic foam may be glued to the front panel. You now have a first class push button, far bigger than any you could buy.

Note that the battery negative lead is connected to the panel by means of a suitable tag on the printed-circuit board mounting bolt. From there the negative lead goes to the printed-circuit board itself.

The battery should be anchored inside the box by a suitably shaped aluminium bracket.

ADJUSTMENT

With the component values shown the timer range is from about ½ to 3½ minutes. Component tolerances could affect these figures, but timing is not sensitive to battery voltage variations. The actual time delay before the Sonalert sounds is set by the preset pot RV1. This should be adjusted to the time of development you intend to use.

Those who want to have an adjustable timer, for other purposes, could bring out leads from the printed-circuit board and substitute a panel mounted potentiometer for the preset pot RV1. ●

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WIN A SOLDERING IRON!

Spot the deliberate errors in Des Troyer's power supply circuit

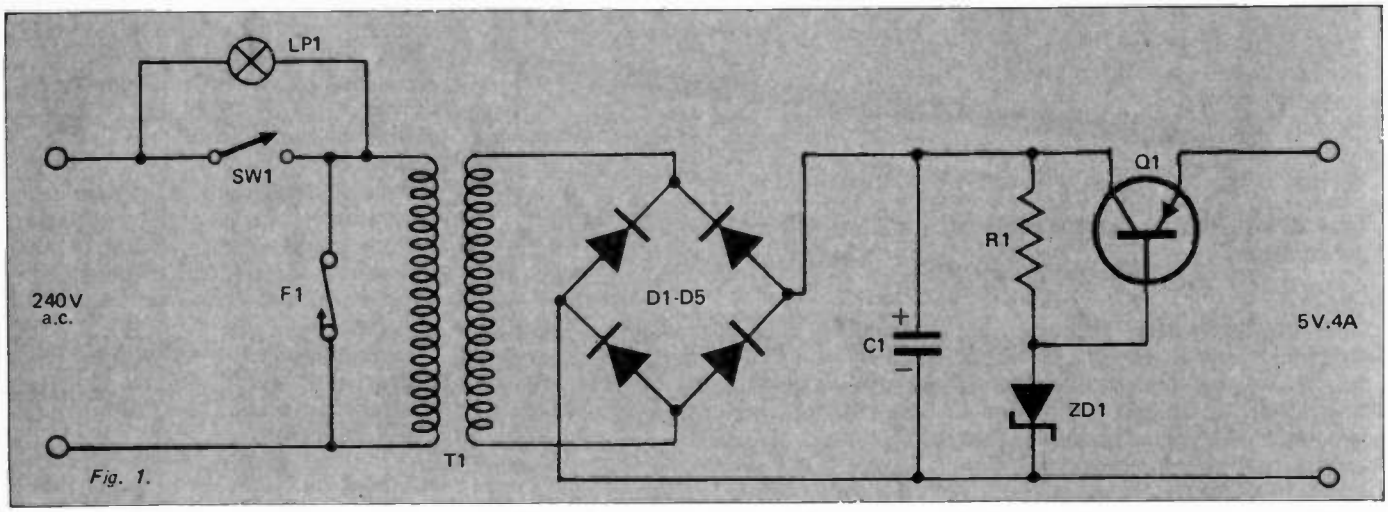


Fig. 1.

A LITTLE knowledge can be a dangerous thing. This old saying is certainly true of electronics, for the power supply (Fig. 1), as designed by Des Troyer, obviously contains quite a few errors.

He assures us that it is designed to supply a constant 5 volts at currents up to 4 amps with less than 1 volt PP ripple. As our readers can see, his design will not only not work but, is positively unsafe.

Whilst some of his errors are only in drawing or typography, there are other fundamental errors which any proficient hobbyist will immediately spot — or will he?

There are Adcola soldering irons waiting for the 12 best accounts of Des Troyer's errors. The Adcola irons are the M70 model which are specially designed for use on transistor, miniature and micro-miniature electronics and instrument work. They operate direct from 240 volt ac, are quick heating, efficient and reliable.

Winners will be notified by mail and results will be published in the earliest possible issue.

Please be absolutely sure that you include your name and address, in BLOCK LETTERS, with your entry.

DES TROYER'S PARTS LIST

R1 — Resistor 560 ohm ¼ watt
C1 — Capacitor 200pF 16 volt electrolytic
Q1 — Transistor 2N3055
D1-D4 — Diode type IN914 or similar
ZD1 — Zener diode 4.4 volt 400 MW
T1 — Transformer power 240 V to 15 V at 2 amps
F1 — Fuse 10 amp
LP1 Neon indicator.

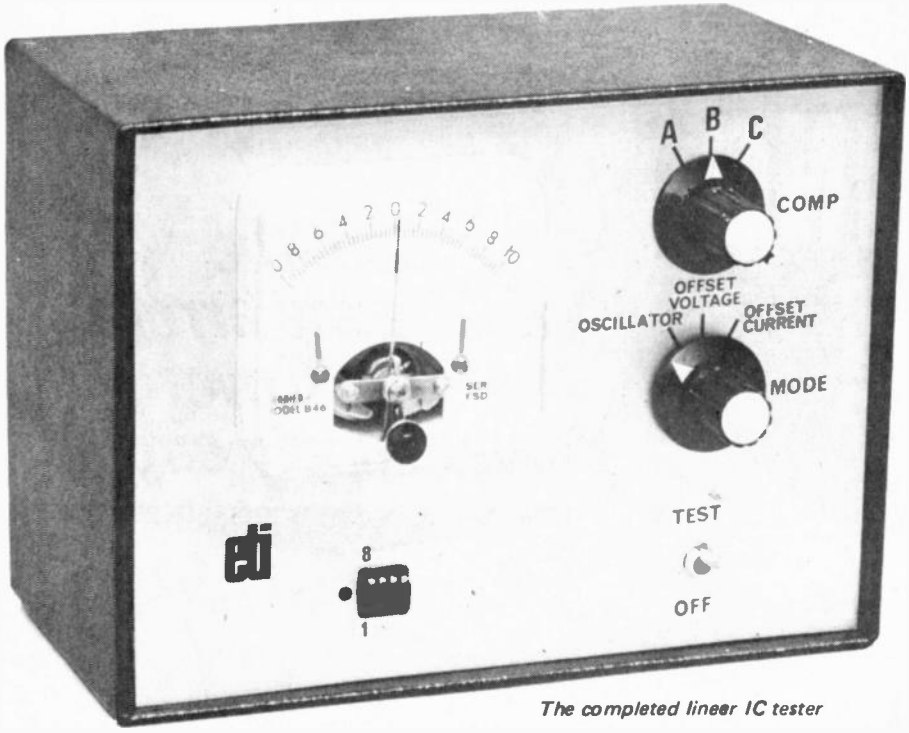
Des Troyer has clearly made many errors — readers may nevertheless assume that the voltage rating of T1 is correct.

THIS IS NOT A CONSTRUCTIONAL PROJECT. BEGINNERS ARE WARNED NOT TO ATTEMPT TO BUILD THIS CIRCUIT AS IT CONTAINS DELIBERATE ERRORS.

Entries must be addressed to:—
Adcola Contest, Electronics Today International, 15-17 Boundary St., Rushcutters Bay, NSW 2011.
CLOSING DATE:— Monday 26th August 1974.

THE ADCOLA M70 SOLDERING IRONS TO BE AWARDED AS PRIZES IN THIS CONTEST HAVE BEEN DONATED BY KITSETS AUSTRALIA PTY LTD.

LINEAR IC TESTER



The completed linear IC tester

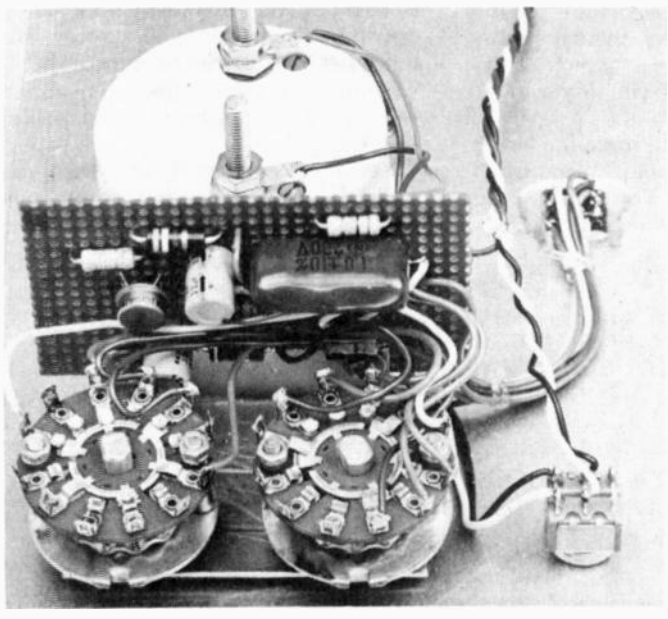
Test all commonly available operational amplifiers for three vital parameters.

LINEAR integrated circuits are available today at prices little higher than those of discrete transistors. As they offer far better performance parameters, and greater versatility than transistors they are being used in new designs in ever increasing numbers.

Most linear ICs are now built into a standard 8-pin, dual-in-line plastic pack, have the same pin connections and very similar characteristics. Hence as the only real difference is in the associated frequency compensation network, a universal, linear – IC tester is quite a feasible proposition.

The tester, described here provides a quick check of vital operating parameters. Checks are provided for offset voltage (max ±10mV), offset current (max ± 1000 nA) and of operation in an actual circuit configuation.

It is a most valuable instrument; saving an experimenter time that would otherwise be spent tracing down faulty ICs.



Showing the internal construction of the tester. Note that matrix board hold the majority of the components.

PROJECT 115

CONSTRUCTION

We chose to mount our circuitry on a small piece of matrix board, rather than a printed circuit board, as there are relatively few components used.

Make sure that IC1 is orientated correctly (note pins 1, 5 and 8 are not used). The wires from the compensation switch (SW2) should be as short as possible in order to minimise the chance of unstable operation.

The test socket should be glued into place (taking care not to get glue down the pins) and, after the wires to the socket are soldered on, these should also be held to the panel with glue or a metal clamp.

The wires to the socket must be supported in some way, as detailed above, to prevent the rather fragile pins breaking off.

HOW TO USE

The parameters of commonly-available ICs are detailed in Table 1. An IC on test should not exceed these figures. Those that do exceed these values may not operate correctly in some circuits and should be discarded.

To test an IC, plug it into the test socket making sure that it is orientated correctly. Select the appropriate equalization as detailed in column 4 of Table 1 and switch the unit on. Select 'OSCILLATOR' mode and observe that the meter should sweep up and down the scale at about 1 Hz.

Now switch to 'OFFSET VOLTAGE' mode and read the meter which is calibrated at 10 mV full scale deflection.

Next switch to 'OFFSET CURRENT'. In this mode the meter is calibrated at 1000 nA (1 microamp) full scale deflection.

Discard any IC that does not oscillate or has excessive offset current or voltage.

TABLE 1

TYPE	MAX OFFSET CURRENT	MAX OFFSET VOLTAGE	COMPENSATION
301	50 nA	±7.5 mV	C
307	50 nA	±7.5 mV	A
308	1 nA	±7.5 mV	C
709	500 nA	±7.5 mV	B
741	200 nA	±6 mV	A
748	200 nA	±6 mV	C
777	20 nA	±5 mV	C
1456	30 nA	±12 mV	A

PARTS LIST ETI 115

R1,2	Resistor	100	5% ½W
R3,5	"	2.2M	" "
R4	"	1 M	" "
R6	"	22 k	" "
R7	"	1.5 k	" "
R8	"	3.9 k	" "
R9	"	33 k	" "
R10	"	150 k	" "
C1	Capacitor	1μF polyester	
C2	"	0.0047μF polyester	
C3	"	33pF ceramic	
C4	"	220pF "	
C5,6	"	10μF 16V electrolytic	

IC1 integrated circuit μA741

M1 meter 0.5 mA — 0 — 0.5 mA Ferrier Instruments model B46 or similar

SW1 Switch 2 pole, 3 position rotary

SW2 " 2 pole, 3 position rotary

SW3 " 2 pole on-off toggle.

Metal box approx. 150 x 180 x 90mm. (Aust. Trans 70-50-40) or similar.
2 x 9V battery (type 216 or similar).

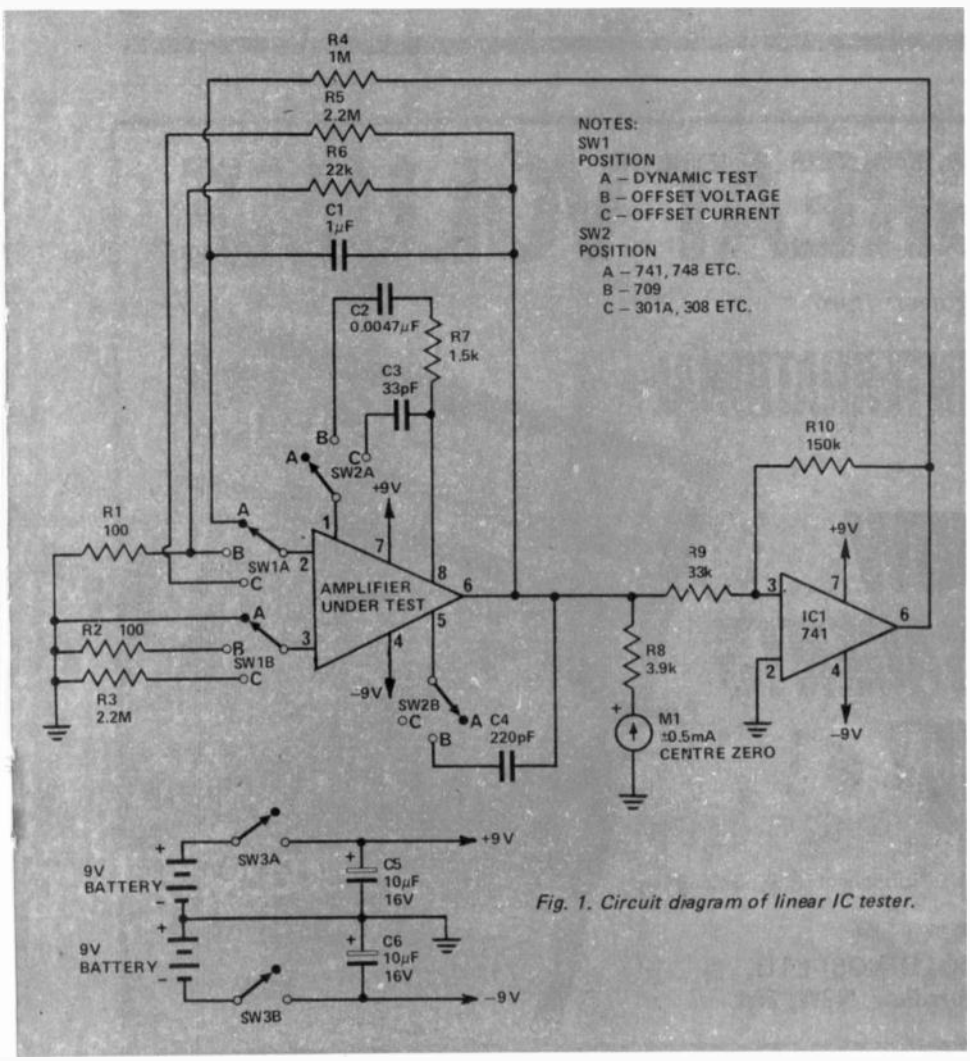


Fig. 1. Circuit diagram of linear IC tester.

HOW IT WORKS – ETI 115

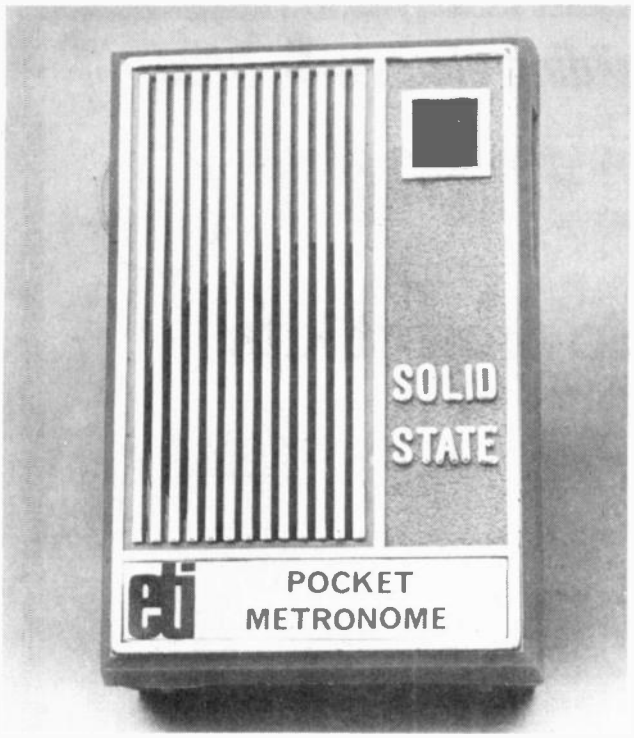
Centre-zero meter M1, via resistor R8, indicates the output voltage from the IC under test. The frequency compensation components for the particular IC under test are selected by SW2, and the test mode is selected by SW1.

In position "C", of SW1, a 2.2 megohm resistor is connected from the output (pin 6) of the IC under test to the inverting input (pin 2), and a 2.2 megohm resistor from the non-inverting input (pin 3) to ground. Current is drawn by both pin 2 and pin 3 of the IC and, if these currents are equal, the output voltage will be zero. Any difference in input currents will therefore be indicated as an output voltage on meter M1.

In position B the resistor from pin 6 to pin 2 is reduced to 22k and a 100 ohm resistor, R1, is connected from pin 2 to ground. This results in the IC having a voltage gain of 220. Resistor R2 is also made 100 Ω so that offset current does not affect the operation in this mode. Hence the IC will now amplify any offset voltage between pin 2 and pin3 (that is, it is operating in the linear mode) by 220 and the meter deflection will be proportional to the offset voltage.

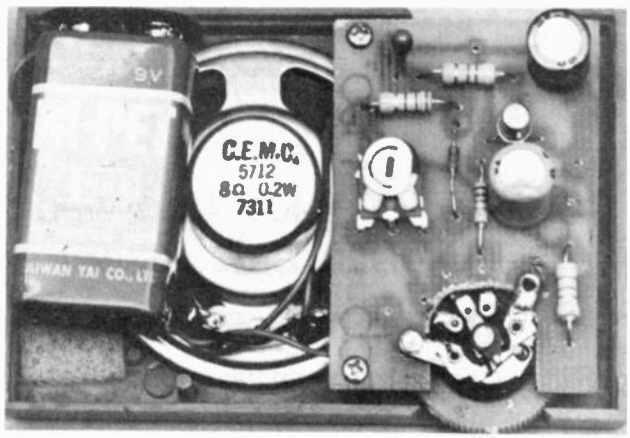
If either offset voltage or offset current are excessive the meter will read off scale and the IC should be discarded.

In mode A the IC is connected as a triangular wave oscillator having an operating frequency of 1Hz. Integrated circuit IC1 is connected as a Schmitt trigger where the output of the Schmitt goes high if its input drops below -1.5 volts, and will go low if the input exceeds 1.5 volts. The output of IC1 is taken, via a 1 megohm resistor, to the input of the IC under test and the output of the Test IC becomes the input of the Schmitt trigger. An integrating capacitor, C1, is connected across the IC under test. The effect of this is to cause the output of the test IC to rise at 7 volts per second until +1.5 volts is reached. At this point the Schmitt operates and the output of the test IC now commences to fall at the same rate. When -1.5 volts is reached the direction reverses again and the cycle repeats. Thus we have an oscillator with a frequency low enough to be followed by the output meter as an indication of correct operation.



PROJECT 228

Two simple units provide full timing range



We built our unit into a cheap radio housing.

POCKET METRONOME

AS ANY student of music will know – a metronome is a vital piece of equipment in early lessons. One is so busy remembering where all the fingers go, etc, that timing almost always suffers!

Conventional metronomes are quite bulky devices which seldom, if ever, leave the music room. But here we present the circuit of a simple unit which may be made small enough to fit in a shirt pocket, whilst still offering adjustable timing and a reasonable output level. By virtue of its portability it may be used to provide timing for those who have been expelled from the house, to go and practice somewhere where he won't offend 'music' lovers.

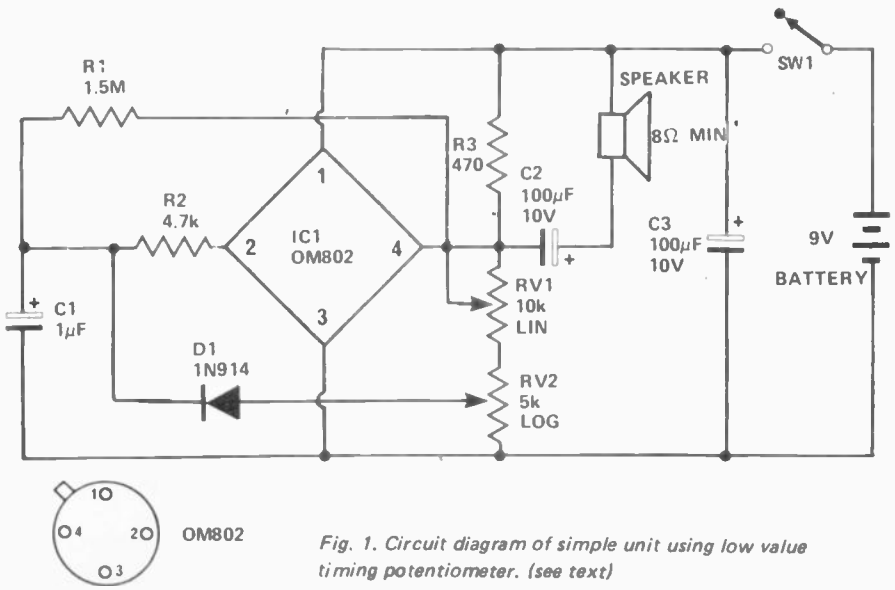


Fig. 1. Circuit diagram of simple unit using low value timing potentiometer. (see text)

CONSTRUCTION

There are very few parts, and the circuit is so simple that it will only take a few minutes to assemble a working unit on matrix or vero-board. We purchased a small radio set for $3.95 and stripped the works out of the case. Thus we now had a case, speaker, potentiometer, battery and battery clips for less than it would have cost us to buy the parts separately! The potentiometer supplied with the radio was a low resistance unit and, if such is the case Fig. 1 should be used. If this approach is not used then the even simpler circuit 2 may be used with a separately purchased 2 megohm potentiometer.

Whilst we don't normally recommend the destruction of perfectly good radio sets, on this occasion it seems to be financially justified, and one could always reassemble the radio after the metronome has served its purpose!

Building the unit into a shirt pocket configuration does have one disadvantage – the smallness of the speaker limits the volume of the tick produced. If this is considered to be too much of a problem then, of course, the unit should be constructed using a larger (12 cm or more) speaker which will be much more efficient.

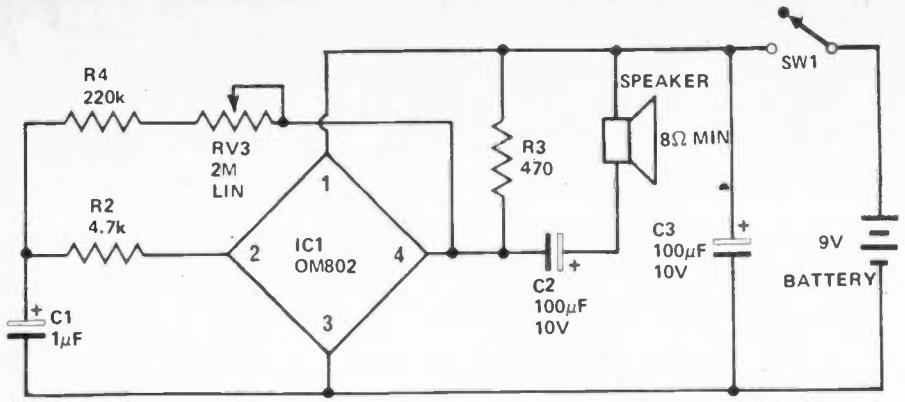


Fig. 2. Circuit diagram of an even simpler unit using a conventional high value potentiometer.

PARTS LIST

*R1	Resistor	1.5M	½W	5%
R2	"	4.7k	"	"
R3	"	470	"	"
**R4	"	220k	"	"
*RV1	Potentiometer	10k	Lin trim	
*RV2	"	5k	Log	
**RV3	"	2M Lin		
*D1	Diode	IN914		
C1	Capacitor	1μF 10V electrolytic		
C2,3	"	100μF 10V electrolytic.		

IC1 Integrated circuit OM802

Speaker 8 ohm or higher

SW1 single pole switch

9V battery type 216 or similar

* not required if circuit 2 is used
**not required if circuit 1 is used

HOW IT WORKS – ETI 228

The OM802 IC acts as a relaxation oscillator where the output at pin 4 is a square wave (although not symmetrical). The output of the IC is coupled to the speaker via a 100μF capacitor C2. The speaker hence receives a short pulse of power (peak 6 watts), producing a sound similar to that of a mechanical metronome, each time the output of the OM802 changes negative. The positive going edge has a slow rise time and does not provide an output.

When the output of the OM802 is high there is virtually no current into pin 2 and hence C1 will charge via R4 and RV3 (circuit 2). When the voltage across C1 reaches approximately 50% of the supply voltage, the output of IC1 goes low, the voltage at pin 2 of IC1 goes low and C1 will be discharged. When the voltage across C1 falls below 1 volt the output of IC1 will go high again and C1 will be recharged. Since RV3 controls the current into C1, it also provides control of the operating frequency.

In some cases it may be desirable to use a low value potentiometer to control operating frequency and in this case circuit 1 should be used. In this circuit RV2 is the main control and the maximum pulse rate is preset by means of RV1. The slowest rate of about 40/min is obtained with RV2 set to minimum (slider at negative rail), that is when C1 is charged via R1 only (1.5 megohm). If RV2 is set at some intermediate position, C1 will charge rapidly to the voltage at RV2 slider via diode D1, and then continue to charge at the slower rate set by R1.

The maximum rate is adjusted by RV1 when RV2 is at maximum-rate position. It was found that best results were obtained with RV2 connected in reverse, ie anticlockwise rotation for maximum rate.

Dick Smith Ele

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System 2 has a 6" Rola or MSP woofer coupled to a Plessey or Philips dome tweeter. Cabinet is a Bass reflex type measuring 17¼" x 10½" x 8½". Handles 20W peak with a response from 50-19000Hz. A great sound for **$42.50** (P&P Road Freight on).

ONLY $42.50

YOU CAN DO IT

System 3 features a great big 12" heavy duty Bass driver and dome tweeter combination. Fully sealed enclosure uses the acoustic suspension principle. Handles 30W rms with a response from 30 to 30,000Hz. Yes a full 2-way, 12" system is yours at a fraction of the normal price for just an hour's fun building it. Terrific value at **$49.90** (P&P Road Freight on).

System 4 as system 3 but has sealed midrange unit also **$57.90** (P&P freight on).

X30 dome tweeters cover 3kHz to 30kHz only **$8.90**.

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AC188	.70	.60
AC187 / 188 Pair	1.40	1.30
AD149 Use OC26		
AD161	1.40	1.30
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AD161 / 162 Pair	2.80	2.60
AF114	.90	.85
AF115	.90	.85
AF116	.90	.85
AF117	.90	.85
AF118	1.40	1.30
ASZ15 (OC28)	3.60	3.40
ASZ16 (OC29)	3.65	3.45
ASZ17 (OC35)	3.60	3.40
ASZ18 (OC36)	3.65	3.45

	1-9	10 up
AY8140	1.50	1.40
AY9140	1.50	1.40
AY8171	1.20	1.10
AY9171	1.20	1.10
AY8149	1.20	1.10
AY9149	1.40	1.20
BC107 (E 5447)	.26	.22
BC108 (BC548)	.25	.22
BC108B	.45	.40
BC109 (BC549)	.25	.22
BC109C	.45	.40
BC147	.45	.40
BC148	.45	.40
BC149	.45	.40
BC157(BC177)	.30	.28
BC158(BC178)	.30	.26
BC159 (BC179)	.30	.26
BC186	.70	.65
BCY70	.70	.65
BCY71	.85	.80
BCY72	.70	.65
BD137	1.70	1.60
BD138	1.75	1.65
BD137 / 138 Pair	3.40	3.20

	1-9	10 up
BD139	1.50	1.45
BD140	1.60	1.55
BD139 / 140	3.10	3.00
BDY20 Use 2N3055		
BF115	.70	.65
BF167	.65	.60
BF173	.85	.80
BF177 (BF336)	1.50	1.40
BF178 (BF336)	1.50	1.40
BF179 (BF337)	1.60	1.50
BF180	1.20	1.10
BF184	.65	.60
BF185	.65	.60
BF194	.50	.45
BF195	.50	.45
BF200	1.25	1.20
BFW10 Use 2N5459		
BFW11	1.45	1.35
BFW61	1.30	1.20
BFY50 (2N3053)	.80	.70
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OC28 (AD149)	1.60	1.40
OC28 Use ASZ15		
OC44	.45	.42
OC45	.45	.42
OC70	.40	.36
OC71	.40	.36
OC72	.45	.42
OC74	.45	.42
OC75	.45	.42
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	1-9	10 up
2N2926	.50	.45
2N3053	.80	.70
2N3054	1.70	1.60
2N3055	1.20	1.00
2N3564	.55	.50
2N3566	.65	.60
2N3567	.65	.60
2N3568	.75	.70
2N3569	.65	.60
2N3638	.45	.40
2N3638A	.55	.50
2N3702	.50	.45
2N3640	.60	.50
2N3641	.45	.40
2N3642	.45	.42
2N3643	.55	.50
2N3644	.45	.40
2N3645	.55	.50
2N4292	.50	.45
40250 Use 2N3054		
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SN7403N	.60	.54	.48
SN7404N	.60	.54	.48
SN7405N	.60	.54	.48
SN7408N	.60	.54	.48
SN7409N	.60	.54	.48
SN7410N	.60	.54	.48
SN7413N	.80	.72	.65
SN7420N	.60	.54	.48
SN7430N	.60	.54	.48
SN7437N	1.20	1.10	1.00
SN7440N	.60	.54	.48
SN7441AN	2.20	2.10	2.00
SN7442N	2.00	1.90	1.80
SN7447N	3.00	2.80	2.60
SN7450N	.60	.54	.48
SN7451N	.60	.54	.48
SN7453N	.60	.54	.48
SN7454N	.60	.54	.48
SN7460N	.60	.54	.48
SN7470N	1.00	.95	.90
SN7472N	1.00	.95	.90
SN7473N	1.20	1.10	1.00
SN7474N	1.20	1.10	1.00
SN7475N	1.50	1.40	1.30
SN7476N	1.20	1.10	1.00
SN7480N	1.80	1.75	1.70
SN7482N	1.90	1.85	1.80
SN7483N	2.45	2.40	2.35
SN7486N	1.20	1.10	1.00
SN7490N	1.25	1.20	1.15
SN7491AN	1.60	1.55	1.50
SN7492N	1.50	1.45	1.40
SN7493N	1.50	1.45	1.40
SN7495N	2.20	2.10	2.00
SN7496N	2.20	2.10	2.00
SN74107N	1.10	1.00	.90
SN74121N	1.20	1.10	1.00
SN74141N	3.20	3.10	3.00
SN74192N	4.00	3.80	3.70
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- D16 2 10A 600 PIV SILICON rectifiers (S425A
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- D19 7 Silicon NPN trans. 2N2369, 500MHz (Code P397)
- D20 3 2N3053 NPN Silicon transistors
- D21 7 BC 107 NPN transistors
- D22 7 NPN transistors 6 x BC108, 3 x BC109
- D23 6 NPN high gain trans. 3 x BC167, 3 x BC168
- D24 4 BCY70 PNP transistors TO-18
- D25 4NPN transistors 2 x BFY51, 2 x BFY52

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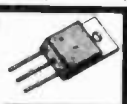
	1-9	10 up
SC141D 6 amp 400V	2.00	1.90
SC146D 10 amp 400V	2.25	2.00



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— brand new — fully tested and guaranteed.

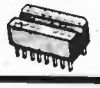
	1-9	10 up
400 MW (BZY88 &ZX79 series)	.35	.32
1.8 / 2.5 Watt (BZX70 series)	.75	.65
10 Watt (Stud BZY93 type)	1.50	1.20

Bargain Discs — for use with Triacs

	1-9	10 up
BR100	.80	.75
ST4	.98	.86

Low Cost D.I.L. I.C. Sockets

	1-9	10 up
8 pin	40	.36
14 pin	.45	.40
16 pin	.50	.45



SIGNAL DIODES

Top quality Philips, S.T.C., Texas etc.

	1-9	10-99	100 up
AA119	.25	.20	.15
BA100	.25	.22	.20
BA102	.60	.55	.50
BA114	.40	.35	.30
OA90	.25	.20	.15
OA91	.25	.20	.15
OA95	.25	.20	.15
OA200	.30	.25	.20
OA202	.30	.28	.20
IN4148 (IN914A)	.15	.13	.10

POWER TRANSISTOR BONANZA!

1-9	10 up
$1.30	$1.25

Coded GP100 brand new TO3 metal case germanium P.N.P. Possible replace OC25, OC28, OC29, OC30, OC35, OC36, ASZ15, ASZ16, ASZ17, ASZ18 and majority of germanium power transistors in OC, AD and NKT range.

Vceo = 50V Vcbo = 80V I.C. = 10 amps

Ptot = 30W hfe = 30-170

SILICON RECTIFIERS — Fabulous Value

1 Amp (Plastic)	1-9	10-99	100
EM4005 / IN4001 50 Volt	.15	.14	.13
EM401 / IN4002 100 Volt	.20	.19	.18
EM404 / IN4004 400 Volt	.22	.21	.20
EM410 / IN4007 1000 Volt	.36	.34	.30
10 Amp (Stud SO10 Case) — A Bargain			
MR110 100 P.I.V.	.90	.85	.80
MR410 400 P.I.V.	1.20	1.10	1.00

Readout Breakthrough

0.3" 7 segment LED readout at below US and UK prices. Definitely brand new and fully guaranteed. Huge purchase sends prices crazy!

DL707 (common anode) $2.75 2.75 for 10up or DL704 (common cathode)

NO120 NIXIE DRIVER TRANSISTOR

Suitable replacement for BSX21 C407 2N1893 etc Vcb — 120V

1-9 **ONLY 60c** 10 up 60c

UT46 UNIJUNCTION TRANSISTOR

Electrically equivalent to 2N2646 etc.

60 CENTS 10 up 50c

ENORMOUSLY RUGGED SCR'S

— Ideal for S.C.R. ignition etc. — TO48 Case.

	1-9	10 up
C164D 400 Volts at 16 Amps	2.75	2.50
C168D 800 Volts at 16 Amps	4.50	4.25

LIGHT EMITTING DIODES

Cheapest in Sydney — Litronix, Texas, Fairchild.

	1-9	10 up
Miniature red	30	.26
Lge with Mtg. red	.45	.40
Medium green	90	.80

SILICON CONTROLLED RECTIFIERS

Bargain prices — all plastic pack G.E.

	1-9	10 up
BRY39	1.60	1.50
C103B 200 Volts at 8A	1.76	1.56
C106Y1 30 Volts at 4A	1.00	0.95
C106D1 400 Volts at 4A	1.50	1.35
C122D 400 Volts at 8A	2.20	2.00
C122E 500 Volts at 8A	2.70	2.50

2N3055

115 Watt Silicon NPN Power — FULLY IMPORTED — best in Australia

$1.20 each

ZN414

10 transistor radio IC from Ferranti. Operates from 1.5V. Power Gain 72 db consumes only 300µA. Frequency range from 150kHz to 3MHz. See Elementary Electronics E.A. May '74. **ONLY $3.95**

BABANI AND BERNARDS BOOKS

BP1	First Book of Transistor Equivalents and Substitutes	$1.00
BP2	Handbook of Radio, TV and Ind Tube and Valve Equivalents	1.00
BP3	Handbook of Tested Transistor Circuits	1.00
BP4	International Handbook of the World's Short Wave, Medium and Long Wave Radio Stations & FM & TV listings	.80
BP6	Engineers and Machinists Reference Tables	.50
BP9	38 Practical Tested Diode Circuits for the Home Constructor	.80
BP11	Practical Transistor Novelty Circuits	1.00
BP14	Second Book of Transistor Equivalents and Substitutes	2.20
129	Universal Gram Motor Speed Indicator	.25
181	Radio, TV and Electronics Data Book	.75
196	AF-RF Reactance Frequency Chart for Constructors	.40
202	Handbook of Integrated Circuits (IC's) Equiv. and Substitutes	2.00
RCC	Resistor Colour Code Disc Calculator	.25

Silicon Bridge Rectifiers

High quality assemblies giving maximum ratings and reliability at minimum cost.

Type	Current	P.I.V.	1-9	10 up
MB1	1.8A	100	1.40	1.20
MB4	1.8A	400	1.80	1.60
MB8	1.8A	800	3.20	3.00
MB10	1.8A	1000	4.20	4.00
PA40	8A	400	6.00	5.75
PA60	8A	600	6.75	6.50
PB40	25A	400	7.20	7.00

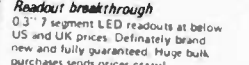
LINEAR INTEGRATED CIRCUITS

TYPE	CASE	DESCRIPTION	1-9	10 up
AWM 1306	TO5	FM Converter	$6.20	$5.80
CA 3028A	TO5	RCA Linear	3.00	2.80
LM 301A (UA 301A)	TO5	High input operational amp.	1.30	1.20
LM 309 (7805)	TO3	5 volt 1 amp regulator	4.20	4.00
LM 308 N	D.I.L.	Operational amp.	4.00	3.60
LM 381	D.I.L.	Dual operational amp	4.50	4.00
LM 709 (see UA709C)				
LM 741 (see UA741C)				
MC 1330P	D.I.L.	Homodyne IC	3.20	3.00
MC 1469R		½ amp voltage regulator	4.75	4.40
NE 555	D.I.L.	Timer IC	2.45	2.20
NE 556	D.I.L.	Dual timer	2.75	2.60
NE 5618	D.I.L.	Phase Lock Loop IC	9.50	8.90
TAA 300	TO5	1 watt audio amp	2.90	2.70
TAA 521 Equiv. 709C				
TAA 840	D.I.L.	AM Radio tuner	3.20	3.00
TBA 221 Equiv. 741C				
TBA 281 Equiv. 723C				
UA 703C	TO5	RF.IF Amp	1.50	1.30
UA 709C (LM709)	TV6 or D.I.L.	General Purpose amp.	1.00	95
UA 723C (LM723)	TO5	Regulator	1.50	1.40
UA 739C	D.I.L.	Dual OP amp. low noise	2.50	2.25
UA 741C	TOE or D.I.L.	Operational amp.	1.20	1.10
OM 802			2.50	2.30

Digital Experimenters Packs

Specially produced for counter enthusiasts etc. Full instructions. TTL 'A' has Datalit 707 plus 7490 plus 7447 to build a single decade counter. Only $6.90.

TTL 'B' as 'A' above but also has 7475 latch to hold readout while counting. Only $7.90. Both come with full instructions and can be cascaded.



Readout breakthrough

0.3" 7 segment LED readouts at below US and UK prices. Definately brand new and fully guaranteed. Huge bulk purchases sends prices crazy!

DL 707 (Common anode) or DL 704 (common cathode). $2.95 each $2.75 10 up.

Special Digital ICs

	1-9	10 up
9001	1.50	1.30
9368	3.20	3.10
95H90 300MHz Decade counter	19.75	19.00

1. Send your order with cheque, money order or postal note. Allow a minimum of 30 cents to cover packing and postage.
2. A minimum order amount of $2.00 applies, so it is better for you to place a few large orders than a lot of little ones (saves you P&P!!)
3. If you wish to receive goods COD, a prepayment of $2.00 must be sent with your order.

ctronics Centre

BUILT THE ETI 422 SUPERKIT 100Wrms AMPLIFIER

Congratulations to Electronics Today on a really great amplifier. We are proud to announce that this project is to receive the Superkit treatment with exclusive fibreglass boards. Just check the spec alongside.

The kit will be available in 3 stages to suit your budget. Compare the finished amplifier with commercial units at twice the price. We have secured the most magnificent TEAK cabinet to house the project which gives the final professional touch. Your friends just won't believe it's home made.

Kit 422A PreAmp consists of the 4208 PCB and all components for the low noise Pre-Amp including fibreglass board $24.50 (P&P $1.00)

Kit 422B Main Amp and Power Supply consists of the ETI 422 Power Board fibreglass) and all electronic components for it and the power supply including transformer. $62.00 P&P $1.50.

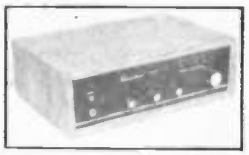
SPECIAL COMPLETE KIT FOR ONLY $118.00 includes all sections ABC above and full instructions (P&P $2.50). On a limited budget. Then get Kits A and B only and supply your own hardware. Special price only $82.50 saves you $4.00. Or fit it in your own cabinet by ordering full kit less cabinet for $113.00. Missed the article? Then send us a stamped self addressed envelope (fullscap) and we will send full details.

Separate components available

ETI420B PreAmp Board (fibreglass) $2.80 ETI422 Amp Board $3.60 2500/50V electros , $1.80 each McMurdo 2900-4 switch $3.60 9504/3577 Transformer $11.75 (P&P 75c) McMurdo 2904/1 switch $1.40 Front Panel $3.50 Chassis $6.90 (P&P 75c) McMurdo phone jack 75c WBF003/3 heatsink $1.90 LED Indicator $1.45 TEAK cabinet $8.00 (P&P 75c) 4 input RCA strip 80c. Back panel $4.50

"BEAT THIS SUPERKIT VALUE" WITH OUR EXCLUSIVE FIBREGLASS BOARDS.

Note: Due to damage complete kits sent by COMET. No P.O. Box addresses please.



SPECIFICATIONS
Power output 50Wrms. Frequency Response ±5dB from 20Hz to 20kHz. Channell separation 45dB. Hum & Noise – 78dB (aux) – 67dB (disc) Input sens. Aux 210mV Disc 2.1mV, Main amp 500mV. Distortion (10W) 0.16% Tone controls ±13dB. Damping factor >70. PCBs in fibreglass throughout. Handsome teak cabinet. Full instructions.

ONLY $118

HIGH SENSITIVITY MULTIMETER SPECIAL

20,000Ω/V
ONLY $10.50

This must be Australia's cheapest 20,000ohm/V multitester having 5 DC, 5 on AC, 2 DC current ranges and 2 resistance ranges. 34μA high sensitivity movement. Easy to read scale. Off position for safety 3% DC accuracy. Normal Retail Price is $17.50, a few discounters have them at $15.00. Please support our bulk purchase (It's in your interest) Only $10.50 Yes ten dollars fifty!! (P&P $1.00).

BEAT THESE LOW SHURE PRICES

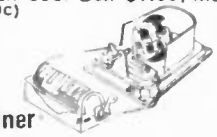
These are the genuine item and represent outstanding value. Call in and hear one — unbeatable sound, at an unbeatable price!

M75 Recommended retail $16.00 Our price only $13.50
M55E Recommended retail $19.00 Our price only $14.99
M91ED Recommended retail $38.00 Our price only $28.00
V15MkIII Recommended retail $80.00 Our price only $69.95

BEGINNERS SPECIALS

Simple Electrical Kit Packs

These are very easy to build real working models. See how the basic principles work in practice. Three to choose from with full instructions and they are extra easy to build. No soldering needed and will give a lot of fun. Electromagnets pack 80c: Bell $1.00; Motor $1.50 (All P & P 30c)



Morse Code Trainer

Produced specially for the forthcoming Novice Licence trainee. Only needs case and battery. All the electronics including a minispeaker and so easy to build $3.75. Key special at only $1.50 extra.

FERRANTI ZN414 MICRORADIO IC KIT

(as featured in Electronics Australia May '74). At last you can build a true miniature radio. IC features a 10 transistor circuit which requires only tuned circuit and 3 parts. 72dB gain. Operates on 1.5V and only 300μA. We've seen one in half a matchbox, can you beat it? No case supplied because you'll want to build it your way.

Minikit still available on special offer at only $6.75 (see article).

HOW THINGS WORK

(subtitled 'The Universal Encyclopaedia of Machines') is a veritable goldmine of information. Packed into 600 pages are the answers to questions that confuse the layman. Over 1000 two colour diagrams tell you why zippers zip, how soap works, what nylon is, why a ship floats and on to synchromesh and automatic transmissions ... rockets and explosives ... cameras, lenses, polaroid etc. Even a basic description of colour TV!

A truly fascinating book to browse through and now in a new updated English edition (the original German book has sold out of every printing). Will keep inquisitive kids quiet and saves Dad the embarrassment of not knowing 'Why?' At only $3.90 it should be on every bookshelf.

NICAD BATTERY SPECIAL

Limited quantity only of Midland Nickel Cadmium rechargeable batteries. Designed for their Walky Talkies to give economy for heavy users. Unaffected by idle periods. Can be recharged up to 100 times or more! Cells are hermetically sealed in high impact plastic case. Ideal replacement for equipment using 8 penlight cells. 12V output and 400mA/hour capacity. Recharge at 40mA. Measures only 5.6cm x 5.6cm x 3cm, weighs 6oz. Fitted with jack socket and 9V transistor battery type connector. Jack supplied with lead and connectors to suit Midland transceivers. Get two — one in use, one on charge. At our price you can afford to!! Normal retail $16.50 NOW ONLY $10.50 or two for $19.99 (P&P 75c)

6-12V INVERTOR

Enables any 12V appliance (radio, recorder etc) to be run off 6V dc. Ideal for owners of older VWs — you can now fit a 12V radio. Built in diecast case. Fully solid state 1.5A max output at 12V dc. Only $29.95 (that's less than the extra you'll pay for a 6V radio) 2 for $50 (P&P $1.00)

New computerised resistor packs

You know the usual resistor packs with 2 or 3 resistors of every value including 33ohms, 18k and 39k that you hardly ever use? Well ours is different. It's based on a Philips computer listing which shows the values that are used the most. So our pack contains 20x1k and only 2x560hms. However there are at least 2 of every value from 220hms. to 470k. A total of 50 different values and over 260. ¼W, 5% carbon film resistors. Normal Value over $8.00. Ideal for service people and hobbyists and only $6.50 (P&P 50c)

ONLY $6.50

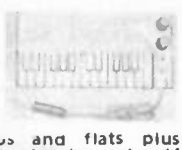
Real Superhet Tuner for only $7.90

Yes here's all the basic parts for a 3 transistor superhet tuner. Printed Circuit, all coils, ferrite bar antenna, tuning gang etc. Covers 530 to 1600kHz (thumbwheel dial included). Measures only 45mm by 135mm, ideal for coverter IF strip (cheaper than parts alone!) Self-oscillating mixer, 2 stage IF amp with agc into diode detector, NPN transistors and operates off 9V. Why fork out $20, this one is only $7.90 (P&P 75c)

100W GUITAR AMP (ETI) features full 100Wrms output. Prepunched heatsinks and silicon grease plus heat dissipating paint. Sturdy metal case. Simplified instructions included. Still only $65.00 (P&P $1.50)

100W PRE-AMP produced in response to numerous enquiries. Two sensitivities to suit mics and guitars, volume, treble and base controls. No case so you can build it into something else. Pretinned boards and full circuits included for $9.50 (P&P 75c)

MONOPHONIC ORGAN



Very popular little kit with 'keyboard' actually on circuit board which is GOLD plated (no excuses for this project looking home made!). Covers 2 octaves including sharps and flats plus tremolo. Uses simple stylus to play notes. If you want to take over from Rolf Harris you'd better get one. Only $13.50 (P&P 75c). Board only $3.50. (All parts for May projects in stock see July ad).

CRYSTAL RADIO. We've seen kits for them at over $6.00. For junior readers (or your kids!) we have a genuine ready made crystal set in case complete with earpiece for only $2.95. Uses ingenious variable permeability tuning arrangement. Worth buying just to rip the parts out. Definitely not rubbish. $2.95 (P&P 50c)

TEXAS SN76023 IC'S for audio amps (see June 74 E.A.) only $2.50 circuit board to suit (E.A.74/SA5) only $4.00 (Both P&P 75c)

DICK SMITH 'EICO' POWER SUPPLY KITS

Almost every project you build needs a 240V ac power supply, so we've put together some bargain kits. They all include full circuits, instructions, transformer, filter capacitors and all semiconductors. Metalwork etc not included.

PS2VA has a 240/12V ct at 150mA transformer and gives 9 or 19V on open circuit. Typical outputs are 6V @ 300mA and 12.6 to 13.6V @ 150mA. Ideal for battery saver or NiCad charger etc, running 9V radios and recorders etc. $4.95.

PS15VA uses the PF2155 multitap transformer to give a wide selection of outputs, e.g. 2 to 22V at no load, 4 to 16V @ 1A, 6.3V @ 1½A and many more $7.25 (P&P 75c)

PS121Reg gives 12V do @ 1A, fully regulated and protected by the popular Fairchild 7805 IC. Ideal for projects requiring protection with good regulation and filtering. $10.25 (P&P $1.00)

PS5Reg As the PS121Reg but gives 5V dc @ 1A for TTL logic projects etc $10.25 (P&P $1.00)

PS122Reg is a completely adjustable, regulated supply for 9 to 12.6V dc @ 2A and uses a 2N3055 regulator transistor. Ideal for running car stereos in the home $19.75 (P&P $1.50)

PS125Reg is fully regulated to give under 2mV ripple at full load. Adjustable from 9 to 13.8V dc @ upto 5A. Ideal for bench supply and operating transistorised 2Way Radios etc. Uses 'C' core tranny, 7231C and 2N3055s. Ideal for Amateurs to run mobiles from mains. $27.50 (P&P $2.50)

DICK SMITH WHOLESALE PTY LTD

P & P 50c or unless stated otherwise

Head Office and Mail Orders to 160-162 Pacific Highway, Gore Hill, NSW 2065
Telephone 439-5311

also at — 361 Hume Highway Bankstown (100yds from Chapel Road) Tel 709-6600

HANDLING CMOS

The Do's and Don'ts

by Vic Yates — Director of MOS Marketing Motorola, Europe

THE one disadvantage of all MOS devices is their susceptibility to damage from inadvertent contact with objects carrying static charges.

Such objects include nylon overalls — often used by operatives in industry, conventional polystyrene foam — used for packing normal semiconductor devices and, of course, the human body. There are, in addition, many other ways in which destructive voltages can be applied.

The CMOS logic family, consisting as it does of networks of p and n-channel insulated gate field effect transistors, can be damaged in the same way if some simple precautions are not taken.

The metal gate electrodes of the MOS devices in the CMOS family are separated from the diffused region by a layer of insulating oxide about 1200 Å thick. A potential difference of 60 V between the gate and any other terminal on the device is sufficient to rupture the oxide layer and render the device unusable. It can be calculated, since the gate capacitance is typically 5 pF, that a static charge of 10^{-12} coulombs will produce a 60 V gate voltage.

Manufacturers of CMOS logic devices incorporate a system of diodes, connected to each gate input terminal, which are designed to protect the oxide layer. These diodes conduct in either the forward direction or operate in the Zener mode to limit the gate voltage and can withstand the full normal operating current of the protected circuit.

In spite of these diodes, Motorola recommend that the following precautions be taken when handling CMOS devices.

In the factory

Personnel handling CMOS devices should wear anti-static clothing. Cotton is ideal. Nylon gloves, finger cots and smocks must not be worn under any circumstances.

Before touching a CMOS device, operatives should first touch an earthed surface to discharge any personal static charges and should avoid dropping CMOS devices — they may fall on a charged surface.

Until actually required for use, the CMOS devices should have all their leads short circuited; they are normally supplied in black conductive plastic foam which protects them.

Assembly

It is good practice to ensure that all leads of a CMOS device are earthed during either conventional or reflow soldering. Printed circuit cards can be plugged into dummy sockets with all pins earthed and conductive adhesive tapes can also be used.

Soldering irons, solder pots and flow soldering equipment should be in good electrical and mechanical condition and must be properly earthed. The same comments apply to automatic insertion equipment and machinery. All work-benchtops should be clad with metal which is at earth potential.

Testing

Test equipment should be checked to ensure that spurious voltage transients do not occur anywhere in the test set-up even when switching the equipment from one operating mode to another.

Never plug-in or unplug a CMOS device or a printed circuit card containing CMOS devices when the power supply is switched on. Ensure that the action of switching on and off power supplies does not generate transients.

Circuit design

Even if all the conditions mentioned above are satisfactorily met, component fatalities can still occur if one or two basic rules are not followed during the equipment design phase.

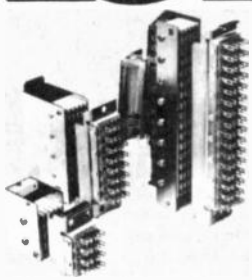
All unused input leads must be connected to ground or to V_{DD} to prevent the input from floating. Floating inputs not only destroy the very real noise immunity benefits to be gained from the use of CMOS, but can also result in the destruction of the device itself. In addition, while the actual supply voltage is not critical large transients on the supply rails must be avoided.

Conclusions

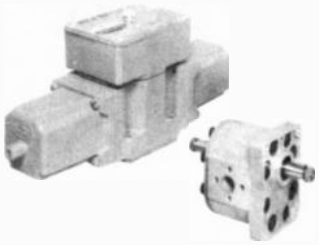
The rules governing the handling of CMOS devices have been outlined; the reader could be forgiven for thinking that CMOS is difficult to use and will 'blow up' at the slightest provocation.

These rules have been developed by us — a manufacturer of CMOS circuits — so that we can say to our customers: follow them and you should have no problems. If the truth be known, the rules could probably be relaxed without danger. We know of CMOS circuits which have been lying about unprotected on development engineers' benches and have been soldered in and out of circuits without damage. However, during the manufacture of equipment, chances cannot be taken. The rules we give are simple straightforward common sense and should not cause any great expense or problem to implement. ●

Australia



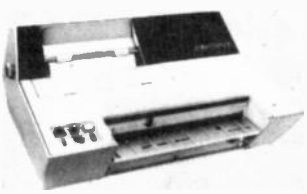
Plessey knife and fork connectors are part of the wide range of multi-circuit connectors marketed by Plessey Australia, Components Division. They are available in standard 20, 40 and 80 way sizes.



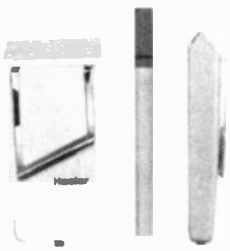
Internationally recognised "RACINE" hydraulic pumps and valves are sold and serviced throughout Australia by Plessey Australia, Telecommunications Division, Meadowbank, NSW.

These NEC solid tantalum capacitors are designed for decoupling, by-pass, blocking and filtering applications in both professional and domestic electronic equipment. They are but one of the extensive range of professional components available from Plessey Australia, Components Division

This Mini Base station is ideal for a wide variety of two-way radio systems and is part of a complete range of mobile communications equipment available from Plessey Australia, Electronics Systems located at Richmond, Vic.

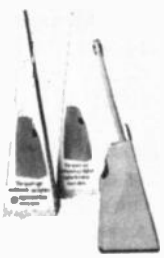


Marketed by Plessey Communication Systems, the Facsimile Remote Copier is a desk-top copier capable of transmitting and receiving over public or private telephone lines, printed, written or graphic material within minutes.

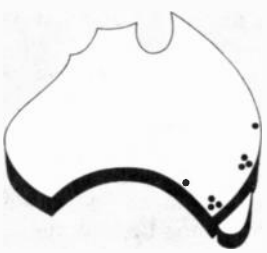


This cigarette pack size radio paging receiver uses the most advanced electronic equipment to maximise efficiency in the location of staff. This inductive loop system is available from Plessey Communication Systems.

Designed and manufactured locally, Plessey hydraulic cylinders and presses are available for a variety of industrial and mobile applications. The cylinder illustrated is just one of the wide range available from Plessey Australia, Telecommunications Division, Meadowbank, NSW



Marketed by Plessey Australia, Components Division the 'Magi-spark' is a compact electronic gas lighter providing a continuous spark suitable for use in kitchens, on boats, caravans and for outdoor stoves and gas barbecues



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

Plessey.

ELECTRONICS IN CRIME

PART 2

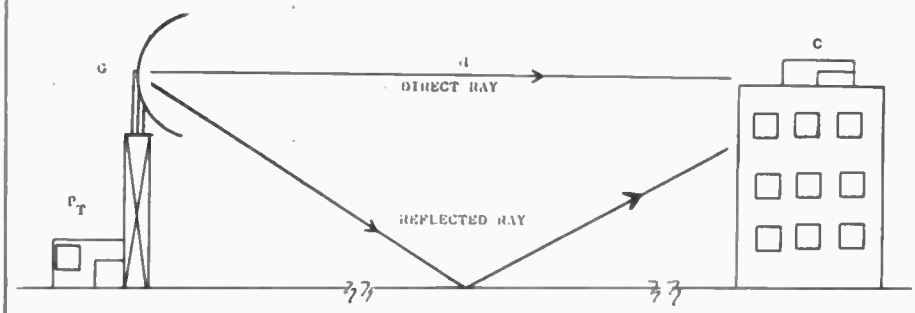


Fig.1. How a radar station can destroy computer data. This is an actual case that was discovered at one of the main international airports in the USA. A computer centre was located 2 km from the airport's long-range radar antenna – which had a power gain of 2500 (34 dB) Peak transmitted power was 3 MW. The electric field at the computer centre (point 'C') was 237 volts/metre – direct ray only. With the addition of the reflected ray, which arrived in-phase with the direct ray, the intensity was 474 volts/metre! This is 54 dB higher than the potential susceptibility level of the computer.

In the war with crime, *both* sides are using increasingly sophisticated techniques. Electronics Today reports –

GEORGE ORWELL'S novel '1984', described a future in which people live under the terror of a totalitarian regime where both the rank and file as well as privileged party members are subject to surveillance, control and whims of 'Big Brother' (an arch-dictator) and his secret police.

While a blaring propaganda machine manipulates the populace, other sinister organisations collate data on individuals and subject them to such meticulous scrutiny, that even their inner-most fears are no longer secret. Privacy is non-existent and both in the home and on the streets the ever present "electronic" eye of "Big Brother" maintains a constant watch. Dissenters to the system are summarily dealt with, and after signing "confessions" disappear into oblivion.

We still have ten years before Orwell's prophesized regime – yet even now there are signs that some of what Orwell feared may eventuate.

Already we are scrutinized – benevolently or otherwise.

Social security organisations collate data on individuals, state security organisations scrutinise their own agents as well as individuals and groups who, they believe, could be prejudicial to the security of the state.

Commercial interests keep dossiers on their personnel. Rival politicians scrutinise each others private lives.

Credit-bureaux keep secret files on customers whilst other government and commercial organisations try to collect all the information they can – with or without the knowledge or consent of the individual. And once this data is stored it is never forgotten.

Closed circuit TVs survey staff and customers alike in department stores, hotels, bars, apartment house lobbies, streets, and banks.

The erosion of privacy of the individual whether by "legal" or criminal means is becoming more commonplace everyday; a more sorry aspect is that the conditioned public is beginning to accept this as a way of life.

Electronic intrusion devices, whether used "legally" or otherwise, constitute the most distasteful and sociologically dangerous misuse of technology.

The aquisition and storage of personal data, whether by government bodies or others, is questionable – both morally and ethically. Despite what the computer companies tell you, such data *is* vulnerable to intrusion by unauthorised persons, and it is a fact that criminal use has and will continue to be made of such data.

COMPUTER SECURITY AND DATA PRIVACY

As more and more information is stored in computer memory systems the danger of intrusion by the "computer criminal" even when elaborate security precautions are taken, ever increases.

It also places the computer itself in danger. Criminals, knowing that their records are stored in such a machine or tapes, may make attempts to destroy them by destroying the machine. More subtle intrusion methods may involve the "writing-in" of a program of commands to eradicate specific data without the knowledge of the authorities.

In the commercial world industrial espionage is commonplace. The industrial spy is a highly specialised professional versed in the latest electronic techniques and the computer presents a most vulnerable target; especially where remote machines necessitate the sending of data over lines. Ironically, whilst frowned upon by legal authorities, no concrete laws exist to stop such malpractices. The industrial spy can blatantly operate with little fear of the law.

The growing awareness of the need for computer security was vividly brought to focus in 1970 in the USA.

There, a militant group of dissidents, aware of the damage that can be done, placed a bomb in the US Army Mathematics Research Centre at the University of Wisconsin. The resultant explosion killed a research employee and destroyed a 1.5 million dollar computer complex and caused a further five to six million dollars damage to the facility. Data which had been collected over 20 years and

represented *1.3 million man-hours* of effort were irretrievably destroyed.

Unfortunately there have been and continue to be further examples of this type of crime underscoring the vulnerability of computer systems.

Dynamiting a computer is nevertheless a crime of the "old school" with chances of apprehension in favour of the police.

COMPUTER vs COMPUTER

A recent case reported from California deals with the theft of information by one computer from another. The spying computer took over a computer services' bureau terminal, having previously obtained the pass code by electronic interception. The only reason that the crime was detected was that the bureau, in accordance with a previously made arrangement, delivered the punched cards to its customer. When the customer denied having ordered these cards they were printed out to discover what error had occurred.

Even more amazing was the sequel to this event when an over-excited sergeant of police mistakenly wrote out a charge under Californian state law indicting the computer with unauthorised acquisition of information from another computer! Perhaps this is a portent of things to come.

A much more serious threat is posed by the "new breed" of criminal: the electronic expert, highly educated with above average intelligence, knowledgable and ingenious as any circuit designer. Because, by virtue of his education, he is capable of commanding a high salary in conventional employment, he plays the game for the highest stakes, and in a manner that makes orthodox police detection methods useless. It is opening up the field for a new kind of police officer – virtually a duplicate of his criminal counterpart but on the right side of the law.

The computer's first characteristic of interest is the "inhuman" speed and scale of its operation. It can perform in a few seconds work that would take thousands of man-hours to do otherwise.

The computer needs only to be criminally instructed by one man to have the criminal capability of thousands.

Computers are becoming more and more sensitive to their electromagnetic environment.

A unit located on the 60th floor of a new New York building was found to give a more than normal number of errors. On investigation it was found by spectral analysis (RF) that two radio towers, a microwave link and an "in house" RF paging system were producing electromagnetic fields of a critical level in the computer room. The resulting interference picked up in the computer circuits resulted in faulty operation.

Having identified the problem, a solid shielded room was built to house the unit and its power supply. Power and signal lines were filtered, and air ducts and other intakes and outlets treated as necessary.

Similar cases of units actually failing in the vicinity of airport radar installations and naval bases have been reported.

This indicates how the computer is vulnerable to both interference or destruction by directed beams of high RF power. Highest susceptibility has been found over a frequency range of 450 MHz to 3000 MHz.

Since the computer circuits themselves radiate power, effective shielding techniques have to be applied to these radiated signals as they can be picked up by surveillance receivers and data extracted.

Within a computer complex, security measures cover both physical security of the computer and the "integrity" of the circuitry and signals. In high security systems routine checks for clandestine transmitters and integrity are made with an EMI/RFI sweep. This, with other suitable equipment measures and locates any electromagnetic interference.

Mini-computers have been designed to provide programmed access to selected areas. Personnel are admitted or locked out from pre-determined areas at pre-selected times based upon their authorization level. A print out and alarm occurs on a security console if any attempt is made to subvert the system. Each controlled area has a card reader installed at the protected point of entry or terminal. Magnetically encoded ID cards enable entry only to authorised persons.

The use of coded cards, keys, combinations and passwords for access to security areas is standard practice. Yet even these are subject to human frailities such as theft, transference, loss and duplication.

Technology is still searching for a "foolproof" system. Some recent innovations utilise hand geometry, fingerprint and voiceprint identification with claimed high reliability.

Where a computer is linked with remote terminals via cable or radio link, susceptibility to intrusion increases considerably.

The sophisticated criminal can lease or purchase equipment to wiretap data lines.

The hard wire tap or a micro-wave receiver introduced into the "link" path enable virtually total acquisition and print-out of data being sent.

Fortunately, such activities can be detected. Microwave systems for example are designed with a "fade margin" which allows for degradation of received power. If an intruding antenna is introduced into the path further deterioration of the signal is apparent – and detectable. Special cables have been developed that are sensitive to any tampering, giving instant alarm, but their high cost precludes their use on other than short distance links.

The most effective method to safeguard data transference is to use crypto-devices. Such devices are available commercially.

Operational data security can only be achieved through the proper evaluation of threats and vulnerabilities to the system. The process is dynamic because of the design changes in computer hardware and the constraints imposed by the operating environment.

A great deal of work is still required to establish secure systems. More active participation at graduate level in

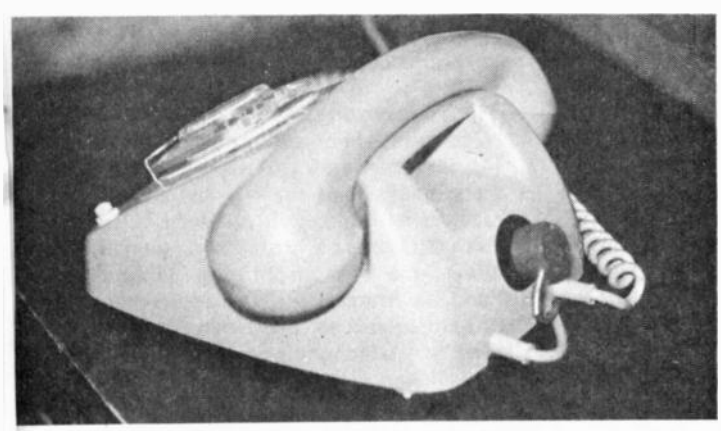


Fig.2. Inductive taps (such as this shown attached to a telephone) are commercially available from many tape recorder manufacturers!

In one of his 1969 Boyer Lectures, Professor Zelman Cowen quoted an American source as saying "there are only nineteen years left until 1984, but American listening devices will meet that deadline easily".

THE LAW AND THE POTENTIAL "BUGSTER" – DON'T!

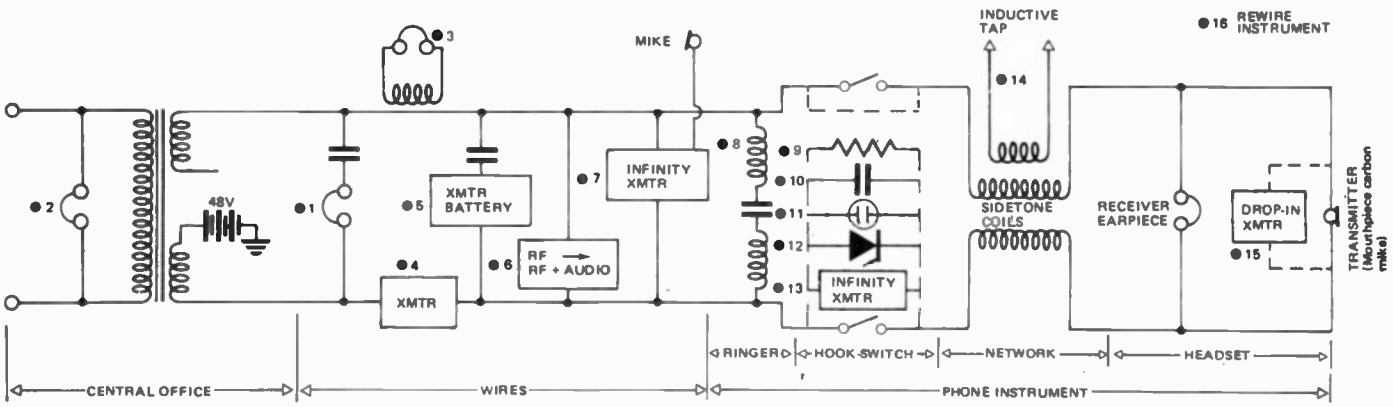
There are laws pertaining both to tampering with the telephone system and felonious intrusion on third party communications. Both carry the most severe penalties, including imprisonment.

If the reader feels tempted to "experiment", either to see if his phone is bugged or try to bug one himself, he is liable to be dealt with to the full extent of the law.

Tampering is very rapidly detectable and the chances of apprehension and subsequent prosecution are very high.

If the presence of a bug is suspected contact the telephone authorities. They will (if they believe it necessary) bring in experts to deal with the matter and apprehend the responsible parties. DON'T TRY TO DO IT YOURSELF.

Fig.3. How telephone systems are bugged, the various numbered points indicate vulnerable points – as explained in the main text.



colleges and universities is also warranted. Formal courses treating operational data security in the depth are required.

BUGGING – AN OLD TECHNOLOGY

Bugging dates back to the introduction of wire telegraphy.

The use of a suitable detector such as a morse sounder, wired across the telegraph line enabled the operator to intercept any messages.

From these early beginnings the "art of intrusion" has evolved into a highly sophisticated exercise in the application of state-of-the-art technology.

The vulnerability of the individual to such practices has been vividly demonstrated in such cases as the recent Watergate affair. The devices used and the methods of their concealment are such, that they can only be detected with elaborate search both directly and with the aid of specialised instruments. Even after careful searching it is hard to ascertain if a place has really been "de-bugged". The "bugs" are in many cases so minute in size and their concealment so ingenious that detection is nigh on impossible. The deliberate placement of "phoney" bugs in easy-to-find places, is also not uncommon to lull the victim into a false sense of security.

Now the introduction of solid-state imaging devices of dramatically smaller size than present video equipment portends the evolution of visual as well as audio-only bugs.

Telephone Bugging

Telephones are particularly vulnerable to bugging.

Most people know that they can be bugged so as to intercept messages – less commonly realised is that they can also be bugged so that they 'listen-in' on conversations within a room, even whilst the receiver is on its rest.

Modern solid-state telephone bugs are small and ingenious. Visual inspection will not always reveal their presence. Other methods must be used to locate them.

Figure 3 shows various ways in which a typical domestic telephone hand-set may be bugged.

The numbers in parenthesis (below) refer to points indicated on this drawing.

Because the law prohibits tampering or bugging only generalised details are shown rather than specific or complete circuits.

Bug detecting services can interfere with the operation of telephone systems, so any such testing is limited to operators who are legally sanctioned by the authorities to do so.

The Phone Tap

A phone tap is some direct or indirect connection to the telephone line that enables an eavesdropper to listen to tape record conversations or signals. (1)

The patch into the telephone system may be made at various places in the telephone network – including the local or central telephone exchange. (2)

Inductive Taps

An inductive tap consists of a pick-up coil, which is sensitive to the magnetic field within the telephone handset. Any voice signals will be picked up by this device and subsequently amplified. Inductive bugs are generally concealed within the telephone receiver and cannot be detected by normal line testing. Only a visual inspection will reveal their presence (3 and 14).

Surprisingly perhaps, inductive taps are sold quite openly by tape recorder manufacturers specifically for taping telephone conversations. (see Fig. 2)

The Transmitting Tap

The series-connected transmitting tap (4) is fairly easy to deal with. An electronic sweep with a surveillance receiver will detect its presence. Since this tap can be installed anywhere along the line from the victim's hand-set transmitter (a replacement drop-in unit) to and including the central telephone exchange, the surveillance receiver must be ultra-sensitive.

The advantages of the transmitting tap is that the listener does not have to have physical access to the phone line once it has been installed. Since the tap obtains its power from the phone line it does not require batteries. It should be noted that this device only transmits when the phone is off the hook and is used to intercept phone conversations only.

The surveillance receiver will detect the presence of this type of bug only if the line is actuated so that the bug transmits. A difference in the off-hook voltage will also be noted at the telephone instrument when compared with the off-hook voltage when no tap is present and therefore a telephone analyser may be used to detect its presence.

A parallel connected transmitter (5) may also be used. This type of bug is battery operated. It does not disturb the line but as it transmits continuously, battery life is very short. It too can be detected with the surveillance receiver.

RF Flooding

This method amounts to flooding the telephone with high level RF energy and retrieving the signal which has been modulated by the carbon microphone inside the telephone handset.

The high level RF energy goes through the hook-switches and the phone does not have to be modified. It is very difficult to use against multi-line sets and is usually used only against single line sets.

A surveillance receiver or a telephone analyser with a built-in RF detector can be used to spot this device but only whilst it is in use.

The Infinity Transmitter

Another device, and one which has received widespread publicity, is the "infinity transmitter".

This device may be installed inside the phone (7). When the eavesdropper wishes to listen into a *room conversation,* he dials the appropriate phone number and by using a pitch-pipe sends a tone down the line just before the bell rings. This actuates a relay in the handset which in turn immobilizes the bell and also connects the handset microphone directly to the line.

All conversations within the room will now be monitored by the microphone *whilst the handset is still on its rest.* Thus an eavesdropper, merely by ringing his victim's number can monitor conversations in a room thousands of miles away.

The infinity transmitter is not a piece of science-fiction apparatus. Regretably it is only too real and is used in large numbers right now by people on both sides of the law.

External microphones are sometimes used in conjunction with an infinity transmitter (7). The external microphone is hidden wherever required and connected to the control unit via concealed wiring.

Infinity transmitters are located by sweeping the line with a tone generator.

Ringer Mechanisms

In many telephones, the ringer coils will transmit sounds within a room onto the lines. The audio signal can be detected by connecting a low-noise high-gain amplifier across the line.(8)

A telephone analyser can determine if an individual instrument is prone to this effect.

Hot-Miking

Some eavesdroppers rewire telephones so that they are 'hot-on-hook'. This enables the eavesdropper to listen-in to a room conversation whilst the hand-set is on its rest.

Various methods are employed to do this. The "earthy" side of the hookswitch is bridged permanently. Across the other set of terminals of the hookswitch can be wired a resistor (9), capacitor (10), neon bulb (11), or an SCR (12). In the case of the SCR and the neon bulb a voltage pulse (100V) has to be applied to activate the "tap".

Having made a tap in any of the methods listed the infinity transmitter (13) described earlier is used. It is modulated either by the receiving or transmitting element of the handset.

Many variations of these techniques are possible. Tests with a telephone analyser will indicate if "hot-on-hook" problems are present.

Transmitter

This is rather a crude way of tapping a phone but is cheap, quick and effective.(15) The original carbon mouthpiece is removed from the handset and a transmitter dropped in. When the phone is off the hook the tap transmits, using the phone power, as well as allowing normal conversation. This device can be detected during a sweep with the lines actuated, by a physical inspection or with a telephone analyzer.

Re-wiring the Instrument

There are many methods (16) of sending room audio down the lines when the instrument is on hook, simply by re-wiring the instrument. Either the receiver or transmitter elements of the handset maybe used as the microphone. Again, a telephone analyser will detect this type of bugging.

IN THE 'INTERESTS OF SECURITY'

Present day bugs can be completely self-contained "wireless microphones", disguised by housing them in everyday objects such as pens, watches, ornaments etc. They can be placed on the premises by "official" visitors, janitors, cleaners or any person able to gain entry legally or illegally.

In many cases they are "built in" into a building. In the case of hotel security for instance, it has been observed that some American hotels have bugs installed in all rooms. It is the duty of the house detective or security man to scan the rooms at regular intervals in a central listening post to "hear" if anyone is discussing the theft of "hotel towels" and other "valuable property."

In the so-called interest of security there is little control over how far this can be carried.

Even though the law does not accept tape-recorded evidence the potential for blackmail is frightening. This most obnoxious of crimes is also on the increase and it is estimated that in the US alone millions of dollars are paid out annually by victims.

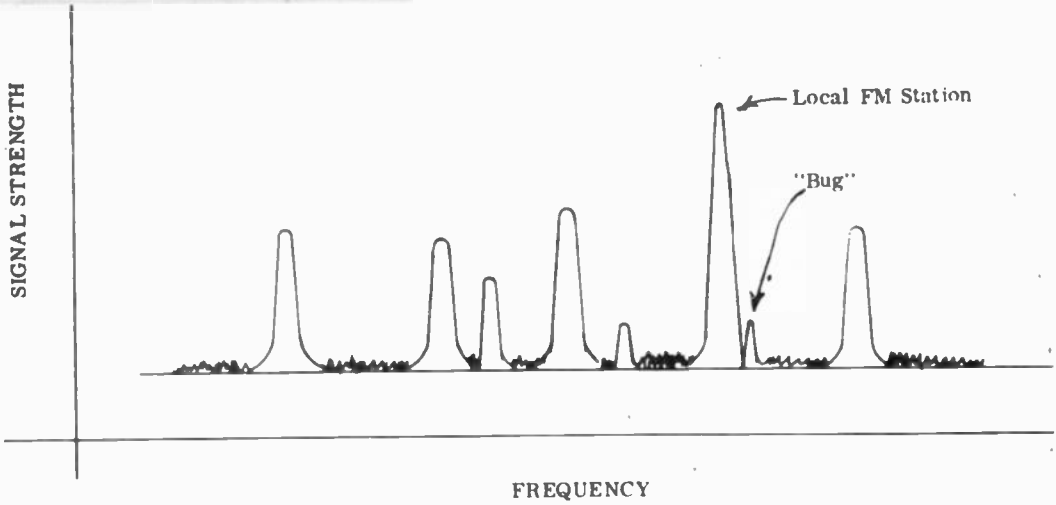
The ingenuity of bug designs knows no bounds. On completion of the US embassy in the Soviet Union during the Stalin era, an elaborately carved eagle representing the American great seal was presented to the US by the Russians. This was erected in one of the conference rooms at the embassy.

For several years afterwards the Russians were able to listen in on conversations from a nearby parked truck. The device fitted into the carving was a passive type bug. A resonant cavity with a diaphragm, the bug could be energised at any time by a narrow beam of RF directed at it from a transmitter located outside the embassy grounds.

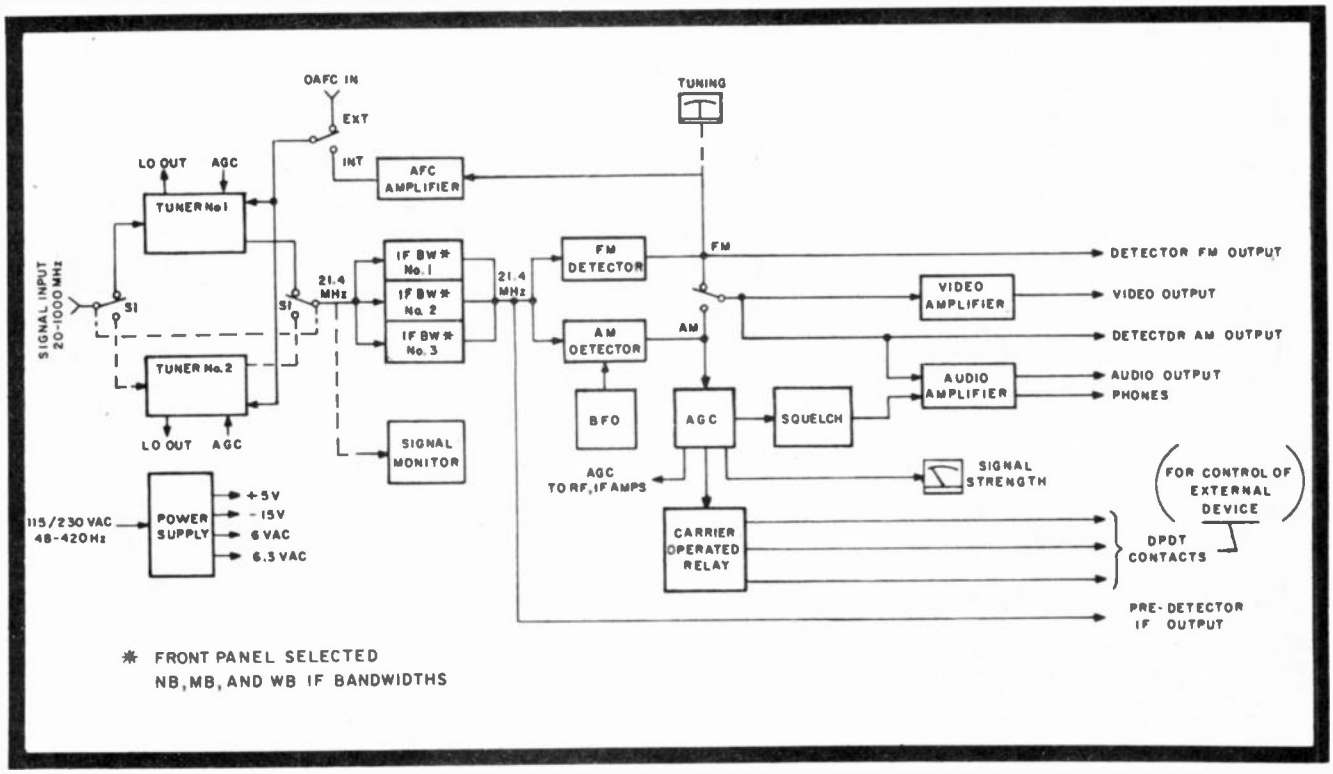
The frequency transmitted was equal to the resonant frequency of the bug. Any sound vibrations affecting the diaphragm would modulate the RF and could be picked up by a receiver tuned to that frequency.

The bug could operate indefinitely since no batteries were required. The approximate year that this type of bug was produced – 1945.

ELECTRONICS IN CRIME



Experienced bugging operators often tune a bug's transmitter frequency so that it is all but 'hidden' by a strong local station.



Block schematic of typical surveillance receiver used for radio bug location.

EQUIPMENT USED IN "LOCATING BUGS"

The "Telephone Analyser"

This unit is specially designed for testing telephone circuits. Both resistive tests and voltage measurements can be made. Any device "tapped-in" will show up either by a voltage anomaly or change in circuit resistance. Recently, RF detectors have been incorporated so that presence of RF on the line can be detected.

DIODE DETECTOR

This can be a field strength meter, grid dip meter or crystal detector. If a transmitter is located in the area a quick sweep with this device can detect it very quickly. Limitations of this device are its frequency range, selectivity (which is very poor so that a bug whose frequency is very close to that of a local radio or TV station is undetectable) and inability to detect carriers using ac power lines.

COMMERCIAL RADIO RECEIVERS AND COMMUNICATIONS RECEIVERS

Commercial receivers built for communications use are not really suitable for bug location. They have too limited a frequency range and whether AM or FM they do not cover that part of the spectrum used for their IF frequency. (i.e. usually 455 kHz or 10.7 MHz). Experienced bugging operators know this and often design their bugs to work on this frequency.

The majority of bugs operate on FM and will not be detected by an AM receiver.

SPECTRUM ANALYSERS

The spectrum analyser displays on a CRT screen a panoramic picture of radio signals over a wide frequency range. Signals appear as narrow spikes or pips if they fall within the instrument's tuning range. (See Fig.). A variable bandwidth facility permits the detection of a bug signal close to a local station.

The receiver parts of the spectrum analyser are generally of a lower sensitivity than a narrow-tuned receiver. This type of bug detector is effective but difficult to use because "ghost" signals generated within the analysers are difficult to distinguish from 'true' signals.

SURVEILLANCE RECEIVERS

Surveillance receivers come in every size, shape and price range. Since the bug can operate on any frequency these receivers can cover a very broad range. Variable selectivity is important and both AM and FM detection is necessary for effectiveness.

Modern bugs have shrunk in size to the point where a wireless transmitter can be fitted inside a button, cuff link or even pill size, to be swallowed by the victim. The latter is a "telemetry" type used for location of personnel.

The telemetry bug is a type that can be attached to a vehicle, package or a person. It emits a continuous signal which can then be followed by direction finding equipment and the geographic location of it continously monitored.

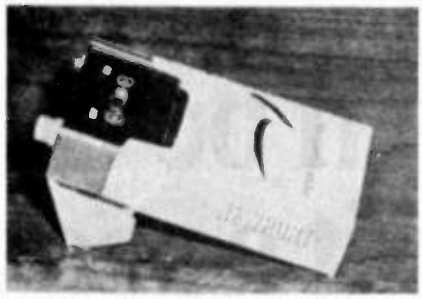
Any wires or cables penetrating into a building are a potential bugging hazard. Apart from the telephone wires, power cables and other household wiring can have audio sent along them and picked up outside the house.

Sound vibrations in the air impinge onto the walls and windows. A laser beam directed at a window will have a reflected component that will be modulated by the sounds inside the room. A simple detector amplifier circuit will extract these sounds.

A microphone stethoscope with high gain amplifier can be pressed against an adjoining wall and conversations on the other side of the wall can be heard.

The situation today is such that any determined effort by one or more methods of bugging a place has a nearly 100 percent chance of success.

The privacy of the individual has little chance of surviving in the future. ●

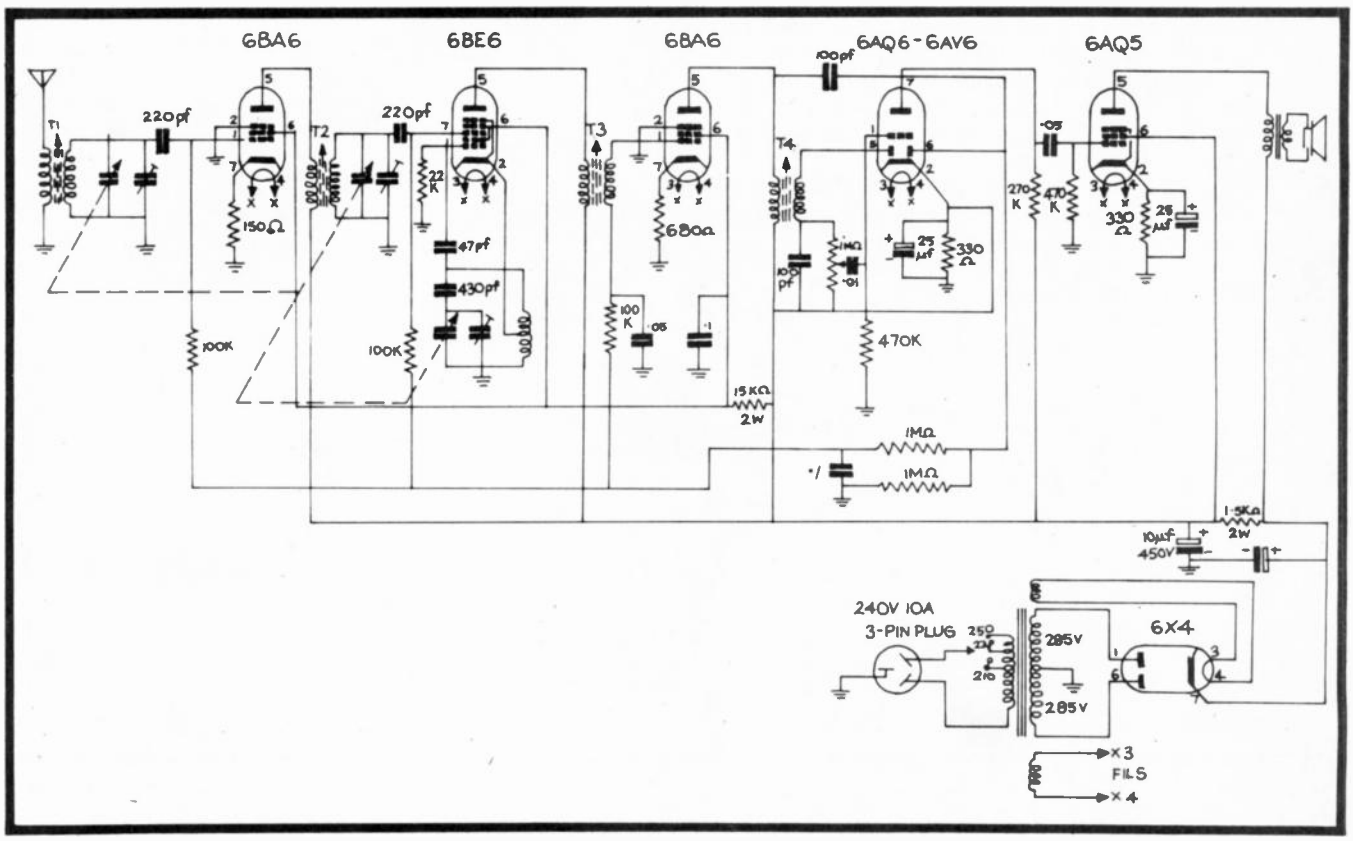


This bug, built into a cigarette packet, has a range of 200 metres.

Telephone insert seen here (centre) is an FM radio transmitter. It monitors all conversations within a room, and broadcasts them over a range of several hundred metres.

This apparently harmless-looking pen is in fact an FM bug. The microphone is in the top half — transmitter, antenna and batteries in the lower half. Capable of operating continuously for three days on one set of batteries, this bug is claimed to have a range exceeding 100 metres.

One year from now you'll be able to read this circuit as easily as the back of a cornflakes packet.



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10G54B	10"	54.0	2"	Bass Guitar	40-60	40-4000	100	100	4 ⅞"
12C10L	12"	10.0	1"	Lead Guitar-Organ	75-95	70-7000	100	25	6"
12E18L	12"	18.0	1 ½"	Lead Guitar-Organ	80-100	80-7000	100	60	6 ½"
12E18B	12"	18.0	1 ½"	Bass Guitar	45-65	50-4000	98	60	6 ½"
12G54L	12"	54.0	2"	Lead Guitar-Organ	70-90	70-7000	102	100	6"
12G54B	12"	54.0	2"	Bass Guitar	30-50	30-4000	100	100	6"
15E28L	15"	28.0	1 ½"	Lead Guitar-Organ	70-90	70-8000	102	60	7 ⅝"
15E28B	15"	28.0	1 ½"	Bass Guitar	35-55	30-4000	98	60	7 ⅝"
15G54L	15"	54.0	2"	Lead Guitar-Organ	70-90	80-8000	107	100	6 ¾"
15G54B	15"	54.0	2"	Bass Guitar	30-50	30-4000	100	100	6 ¾"
18G54B	18"	54.0	2"	Bass Guitar	30-50	20-3000	100	100	7 ⅞"
18K96B	18"	96.0	3"	Bass Guitar	35-45	20-3500	103	125	8"

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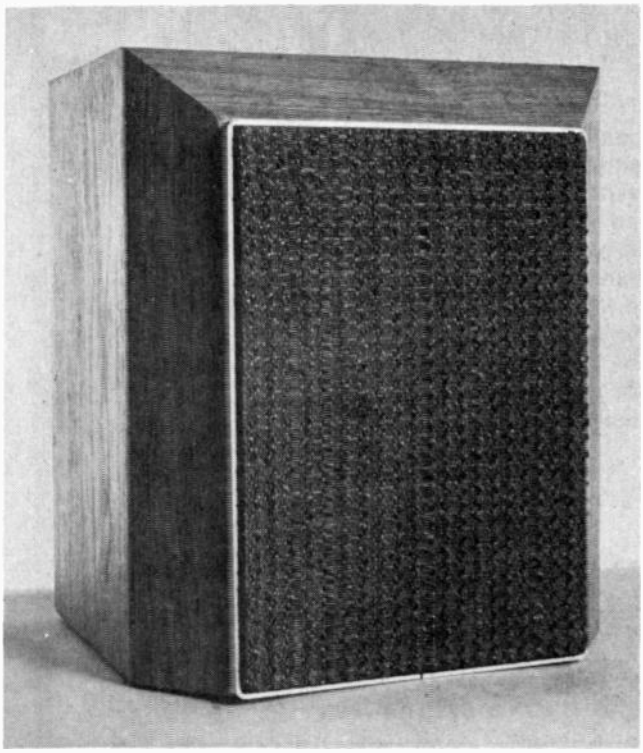

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	1 kHz	1.4%
	6.3 kHz	0.3%
Electro-Acoustic Efficiency* (for 87 dB at 2 metres on axis)	7.5 watts	
Measured Impedance	100 Hz	16 Ω
	1 kHz	11.5Ω
	6.3 kHz	11.5Ω
Cross-over Frequency	1800 Hz	
Dimensions	38 x 32 x 26 cm	
Weight	8.3 kg.	

* A test level of 90 dB at 2 metres on axis could not be obtained without frequency doubling distortion occurring.

TWO papers which have become classics in the literature of loudspeaker design are Olsen's (1951) 'Shape of Speaker Enclosures; and A.N. Thiele's (1961) 'Loudspeakers in Vented Boxes'.

G.L. Industry's unconventional-looking GL-2a speakers owe a very great deal to the design concepts outlined in both these papers. And the concepts have been used to good effect.

The enclosures are rigidly constructed from teak veneered particle board and are both heavy and well made. The front of the enclosures have a complex curvature which must have presented the cabinetmaker with many headaches, and undoubtedly resulted in an increase in cost. The reason for the odd shape is Olsen's contention that tapering the front of an enclosure reduces problems of refraction and diffusion around the front face of that enclosure. The inside of the enclosure is lined with an underfelt type of material.

The GL-2as are sold in pairs. One speaker is designed for the left channel and one for the right channel. Although we have not seen them, GL-2's are also produced for monophonic and monitoring use and these have symmetrical construction, however swapping the left and the right speakers, did not appear to make any subjective change in frequency performance.

The drive units are different in appearance from most others that we have seen in similar sized speakers. Firstly, the woofer is a 165 mm diameter MSP Hi-flux unit. This is a high efficiency unit featuring an unusual diaphragm which is radially ribbed and coated on the back face to provide linear piston operation over an extended frequency range. These drive units feature an injection moulded plastic frame with a Hi-flux Alnico magnet and a 25 mm diameter voice coil.

The tweeter is a 57 mm diameter Peerless cone type unit well proven for its extended frequency response and low distortion.

A simple crossover network keeps the woofer in its linear piston range. This ensures that the unit will not operate at frequencies where the diaphragm breaks up introducing excessive distortion.

The venting part is 50 mm in diameter and approximately 80 mm long. Enclosure volume is 20 litres.

The choice of drive units, say G.L. Industries, was based, not on the external appearance of the enclosures, but on those factors that are significant when seeking optimum performance. These include correct magnetic damping, cone rigidity, and as low a resonant frequency as possible.

The company further claim that the filter cross-over network was selected as an odd order cross-over to reduce phase cancellation of sound waves in the cross-over region.

Thiele, in his now classical paper "Loud Speakers in Vented Boxes" has pointed out that if drive unit parameters and the loud speaker enclosure parameters are treated as primary design functions in the design of a high pass filter network, one can design a loud speaker enclosure which will provide optimal low frequency response without resorting to many of the trial and error techniques which have been a feature of many previous designs. The size of the drive unit contributes to the extent of the audible low frequency components but does not necessarily extend the frequency response downwards nor add to the quality of the sound.

The designers of the GL-2a claim that for a given choice of speaker there is an optimum speaker volume, and that the volume they have chosen is the best possible for the speaker configurations they have used.

HOW THEY PERFORMED

No matter what some of us felt about the appearance of the GL speakers they certainly work quite well – at low to medium listening levels at least. Their low frequency performance is better than we would have expected from an enclosure of this size, and their total response is better than many other speakers of their size.

Both mid-frequencies and highs are clear and bright, but their is some colouration at mid-frequencies at high power levels. Low frequency response (below 100 Hz) could not compare with larger enclosures with more powerful low frequency drivers, nevertheless, the range and quality of the performance was good compared to other small speaker systems.

Free field frequency response tests showed that the overall response of the speaker was excellent. It was within ± 6 dB of the 1000 Hz performance from 50 Hz right through to 20 Hz on axis, and even at 30° to the main axis showed very little real reduction. Distortion on the other hand is rather higher than we would expect from an enclosure of this size.

The impedance curve is exceptionally flat, lying between eight ohms and 20 ohms right across the spectrum. As smooth as one could desire from a two-way system. Nevertheless, although the curve is flat, it is higher than normal and because of this the acoustic power output is lower than most other speakers of this size.

The maximum output before frequency doubling occurs is only 87 dB (at two metres).

Output is adequate for average-sized rooms, but realistic loudness levels cannot be achieved in large rooms.

The GL-2a's are a novel design based almost entirely on a theoretical approach – rather than the aesthetic approach used by many of their competitors.

Potentially, the design is excellent. At present, performance at low levels is very good indeed, frequency response is excellent, but colouration at high power levels is greater than normal.

The drive units chosen are excellent for their normally intended purpose but are not really good enough for these enclosures. Were the drive units to be of higher quality, with better acoustical and physical characteristics, then the performance of these enclosures would probably be quite outstanding. ●

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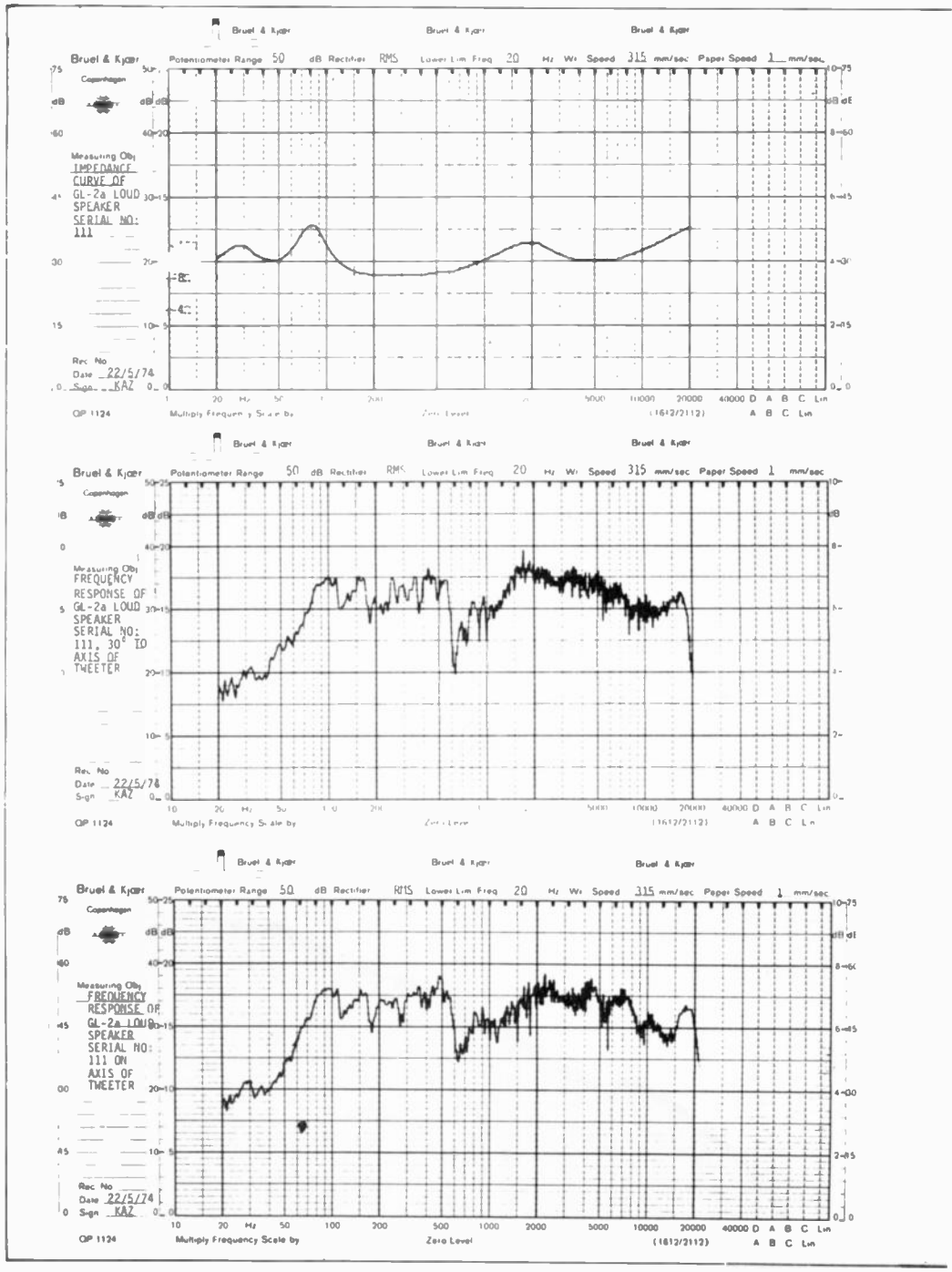

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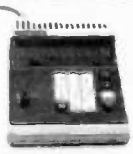

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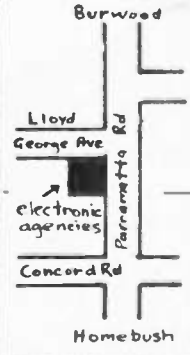

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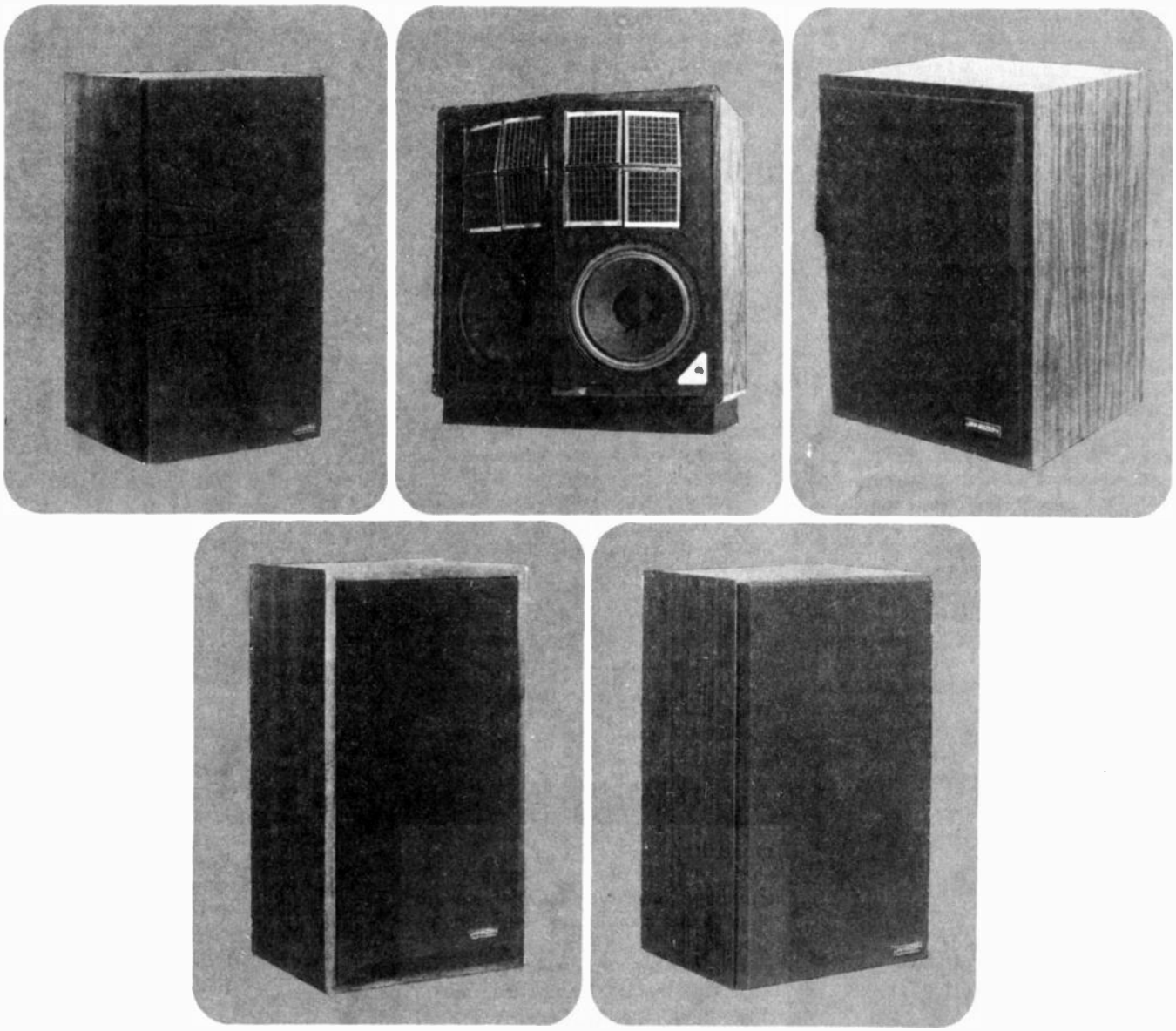

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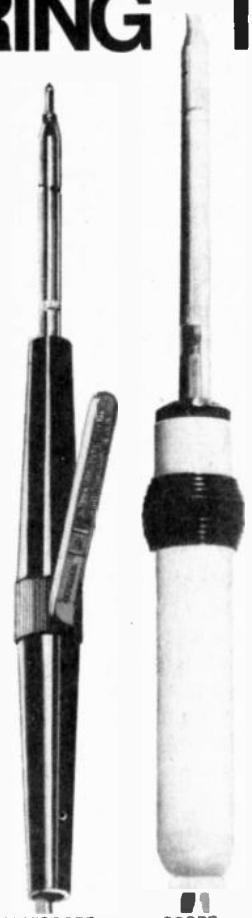

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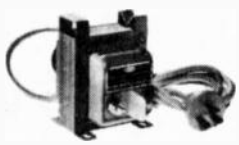

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ELECTRONICS —it's easy!

PART 9

Detection and amplification — how it all started

BY THE LATTER part of the 18th century, scientists understood the many obvious effects of electrostatics. They could generate electric charge at will with their "influence-machines". They could store charge in Leyden jars; could make it go where the experimenter wished it to and they could detect it by watching the leaves diverge in an electroscope or the movement of a pair of pith balls (Fig. 1 and 2).

At the same time, social aspects of existence created a faster pace in commerce and in people's way of life, and this in turn created the need for faster means of communication. The mail coaches, travelling at an average of twelve kilometres per hour (at the best!), were just not up to the growing needs of the time.

Against this background, various men of science investigated how they might use electricity to send signals over long distances.

In 1753 Charles Morrison proposed using electrostatic discharge along cables as a means of communication but it was George Lesage who actually first did this — in 1774. But it was one thing to send charge, another to detect its arrival.

IN SEARCH OF A DETECTOR

In 1810 Sommering (Professor of Anatomy at Kassel in German) built an ingenious detector, Fig. 3, in which a minute electrolytic cell (an electrolyte is an electrically conducting solution) produced gas bubbles when the electricity arrived and decomposed the fluid. Seeing these arrivals was a problem so he devised a finely balanced inverted spoon that was situated over the bubble-tube exit in the manner of a see-saw balance. When the gases were generated they collected under the spoon raising it to tip the balance. This in turn set off a mechanical alarm that could be heard with ease. Notice here, particularly, the need for amplification and how Sommering achieved it. As you can imagine the method was somewhat slow but, no doubt, messages in some form of code could be sent faster than by mail coach. We can estimate the delay time would be about 10 seconds, not hours, or even days as required previously, so it was a big step forward. As transmission distances increased, these experiments also provided increased knowledge about the speed of electricity.

Then came another vital discovery. Oersted, by chance in 1819, noticed that electric current deflected a magnetised compass needle. The science of electro-magnetism thus had its beginnings, and was rapidly seen as a tool to provide new forms of detection. Oersted soon had a rig established (in 1820) to detect arriving currents — the needle-telegraph was born. By this time electricity could also be produced with primary-cell batteries — the voltaic-cell (after Volta who reported his design to the Royal Institution in London in 1800) was more easily used than the electrostatic "influence" generators.

Needle-telegraphs were adopted rapidly and numerous types were invented. Figure 4 shows the simplest design of terminal used in the middle 19th century. Many designs were tried in an effort to speed up the reading procedure, to increase the information rate of the communication link, and to reduce the required skill of the operator. Out of this endeavour we have inherited the inkpen recorder, the Schilling code (whereby a number of channels are used most efficiently without sending unused information), the punched tape concept of data storage, the modern teletype machine and frequency and time-division multiplexing. These pioneers too found the need for amplification as we will explore a little later in this section of our course.

The activity in this prior-electronic era — no thermionic valves or transistors then — can be likened to the pace we see in electronics today.

Innumerable forms of telegraph were devised. Indeed by 1850, a practical French telegraph system was clocked officially at a send/receive rate of 40 words in 4.5 minutes (over 350 km). Subsequent tests showed that the system could operate at six words per second over distances of 2000 km. The first under-sea-cable telegraphy channel — across the English Channel

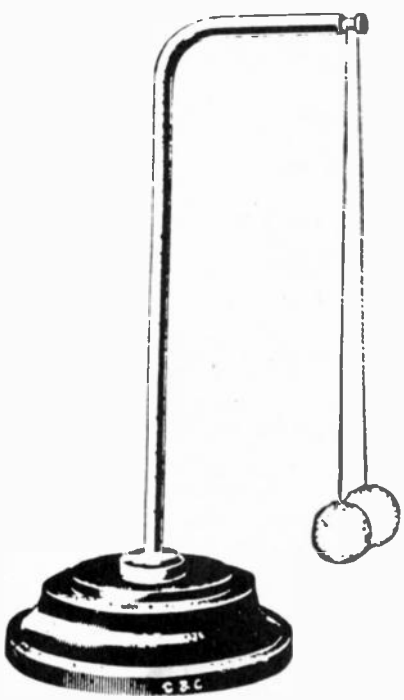


Fig. 1. Pith ball apparatus for detecting charge. If the balls are charged, with the same polarity, they are held apart by the electrostatic field.

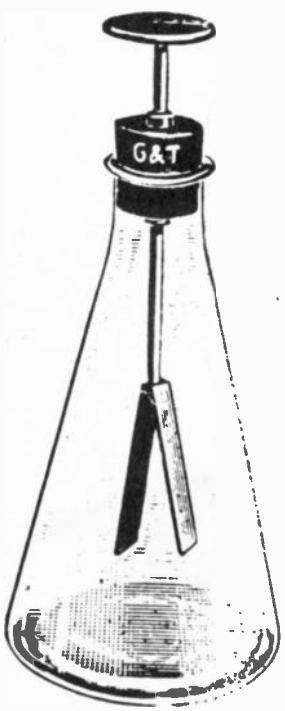


Fig. 2. The gold-leaf electroscope is another charge detector. If the plate at the top of the jar receives charge the gold leaves inside will diverge.

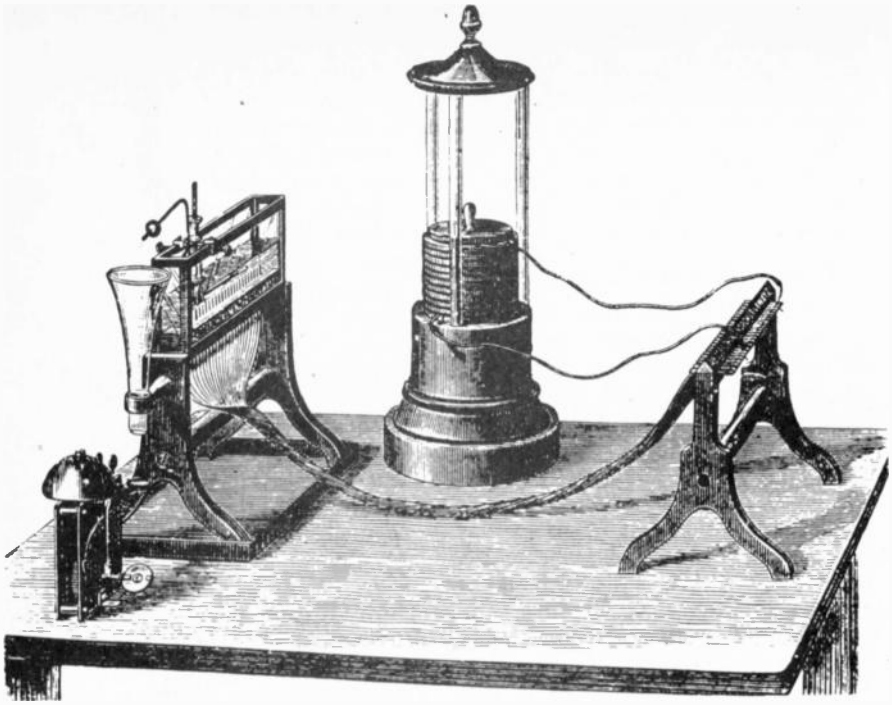


Fig.3. Sommering's 1810 electrolytic detection telegraph. The central voltaic pile provided electric current that was applied to the channel representing the letter to be sent. Current at the receiving end (LHS) produced gas, by electrolytic action; which raised the balanced spoon and caused a lead ball to drop through the funnel onto the bell. It really worked but the problem of finding which channel was in use must have been time consuming.

to France was laid in 1850. It only lasted a few hours but it proved that a submarine cable-link was feasible.

However signals arriving across the (later laid) Atlantic cables were still very poor indeed because of the considerable capacitive effect of the cable. It was like trying to send a square wave signal down a line which was connected to a very large paralleled capacitor – the received pulse was thus badly distorted and the problems of detection were still most severe. A real breakthrough was made when Lord Kelvin, then William Thomson, designed a very sensitive mirror galvanometer by which one could 'see' the arriving code pulses (the moving-coil of this type of meter rotated a mirror which deflected a light spot across a scale – Fig. 5). The use of this instrument enabled the first signals to be exchanged between the U.S.A. and Britain, in 1858.

In the 1880s, Heaviside suggested that loading the cable with added inductance would cancel out the capacitive reactance. This was found to improve performance greatly (remember our related discussion of vector diagrams). Discrete, lump-loading, (that is inductors added at intervals) was used originally but today we add inductance by winding a continuous Mumetal strip around the inner core.

THE BIRTH OF RADIO

By 1900, cable-telegraphy over cables was totally accepted, but by this time another system – radio – was emerging as a contender for speedy communication. It too posed severe detection (and amplification) problems.

In 1886 Hertz made the first practical observations which proved that electro-magnetic radiation did exist. He explored its properties but felt it was of little practical use to mankind! Hertz died in 1894 not knowing what a vast technology he had initiated.

In that same year Marconi, then 20 years old, became interested in the various Hertzian wave phenomena and carried out many experiments using equipment based on other people's designs. Guglielmo Marconi was not an *originator* of ideas, rather an accomplished developer of established technique – he took existing ideas and made them work better and in more useful ways.

Hertz had used arc-discharge to produce high-frequency ac current in his sending aerial, and a minute spark gap across an antenna to see, or detect, its reception.

Later on, Oliver Lodge (in 1894 again) managed to transmit and detect 18 cm wavelength radiation at a 20 metre range (through walls) using an improved detector – which he named the coherer.

In the coherer method of detection E.M. radiation causes metallic filings (the most common type) to change from high resistance to a low resistance. De-cohering was accomplished by a gentle tap with a little hammer. There were many kinds of coherer (see Fig. 6), but Marconi's nickel and silver filings design was

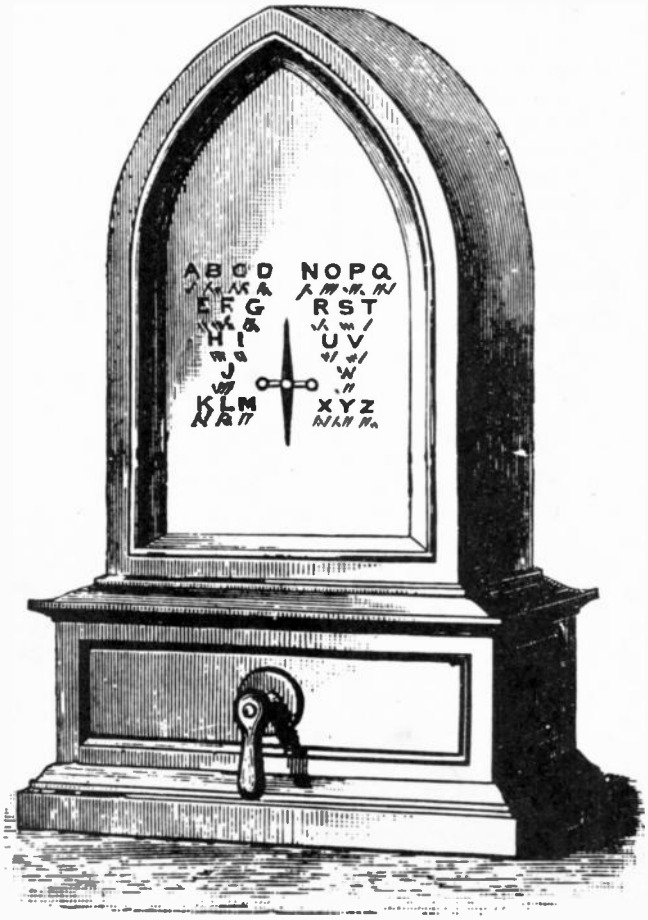


Fig.4. A typical, single-needle, telegraph terminal of the middle 19th century. The handle was turned to the left, or right, causing the needle at both ends to move accordingly. The code sequence of movements decided the letter sent and received.

ELECTRONICS —it's easy!

probably the most sensitive. Improved antenna design increased range to a kilometre and radio telegraphy was started as an alternative to cables which were still proving troublesome across waterways.

The coherer was somewhat limited, it had to be tapped to restore it – (one of Marconi's 1899 detectors incorporated automatic control to provide a restoring tap after a pulse of radiation was detected) – consequently experimenters looked for a better way to 'see' the signals.

Next in line (in 1902) came the magnetic-detector. Compared with the coherer this new device had higher sensitivity, better discrimination against noise and faster overall response and reset time. Its principle (again developed but not invented by Marconi) was based on Rutherford's 1895 discovery that a superimposed high-frequency signal applied to an electro-magnet makes it more sensitive to ac signals. (This principle is still used today in magnetic tape recorders – it is called high-frequency bias.)

The continuous band of the Marconi magnetic detector, shown in Fig. 7, is made of iron wires and was driven as an endless belt by clockwork. In the centre were two horseshoe magnets that provided steady remanent magnetism in the wire as it passed. At the same point were two coaxial coils surrounding the wire; one went to the antenna, the other to headphones. Under normal conditions the wire experienced no change in field strength, just a steady unchanging value, and no voltages were induced in the headphone coil. If, however, a voltage occurred in the antenna coil, this induced a signal in the headphone coil, which then followed the audio frequency, thus reproducing the original audible buzz of each code bit.

The magnetic detector was also investigated by Wilson and Evans in 1897 in an attempt to trigger remote devices – torpedoes, in fact.

THERMIONIC VALVES

Marconi did not play a dominant role in development of the thermionic valves that were soon to replace the magnetic detector. That achievement went to Sir Ambrose Fleming who pioneered the diode or two-element thermionic valve.

In the years closely preceeding 1904, Edison had discovered an effect that he could not explain. His incandescent, carbon-filament lamps blackened with use. To investigate the problem he added a second plate inside the glass envelope (as shown in Fig.8a). He found, to his surprise, that current flowed between the filament and the plate, when the latter was wired to the positive terminal of a battery, but not when reversed. History has it that he did not realise the implications of this finding, but he had in fact constructed the first thermionic valve rectifier. The effect became known as the Edison effect. Ambrose Fleming recognised the useful properties of Edison's device. He went on to improve its performance and apply it to the detection of coded-radio signals. It also enabled analogue, (continuously varying) voice signals to be transmitted and detected with greater simplicity than any then-existing method. At last a really satisfactory rectifier was available.

The valve era of electronics was born. Fleming's diodes (see Fig. 8b) were adopted immediately for weak signal rectification.

But that was not the end of the development for yet another discovery was the rectifying property of a pressure contact made between a crystal, such as galena, and a fine wire. This is, of course, the "cat's whisker" detector mentioned in the previous article in this series. Undoubtedly, this was the forerunner of the point-contact type of semiconducting diode and the junction-diodes of today.

Today, thermionic valves find little place in new designs but they are still used in high-frequency or high-power equipment – we will describe their operation later in this series.

Let us now turn to the second great problem of those days – that of amplification.

AMPLIFICATION

The ability to rectify ac signals into a dc form was a great step toward establishing an electronic discipline. But more significant again was the final break through when a thermionic amplifier valve was devised in 1907. To fully appreciate how useful it is to be able to amplify small signals routinely, we need to look at the methods available to designers before this time.

We have discussed in earlier parts how an electronic system is basically a means of communicating one physical effect of the natural world from one place to another, electronic circuitry providing the most convenient energy transmission medium for most purposes.

Many of the physical effects to be transmitted are too small to be sensed by our normal physiological senses. The need might be to hear the noises of insects, to see the behaviour of biological cells, to hear and see each other when out of normal range or to see minute movements. In each of

ELECTRICS may be said to be the application of electricity to passive components (or electric motors etc) where signal amplification is not necessary (eg an electric drill, house wiring etc).

Electronics, in the broadest sense, covers applications requiring the use of active devices (transistors, vacuum tubes, integrated circuits) for controlled signal amplification, eg, speed control, radio, television etc.

No clear cut definition is possible, however, for a relay amplifies (small signal in coil controls large signal through contacts) and thus may be considered as either an electric, or an electronic device. Further, the humble crystal set contains no active devices, nor source of energy other than that received by the aerial, yet it, is considered part of the electronic discipline.

Nevertheless, our definition is close enough.

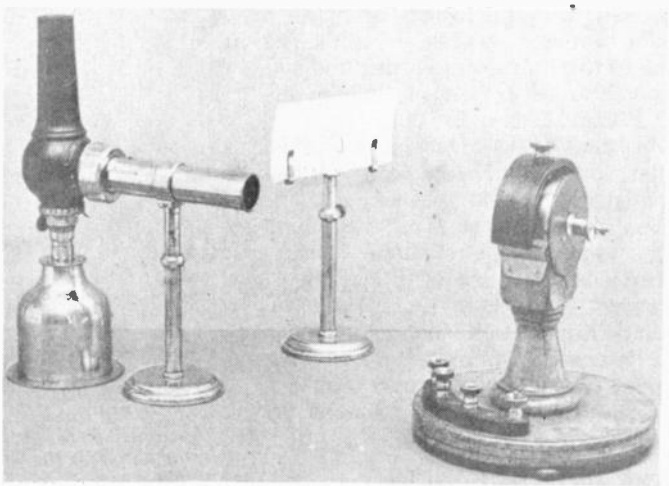


Fig.5. Kelvin's mirror galvonometer (1858). The oil lamp, at left, provided a light beam that was deflected by a mirror mounted on the coil of the galvanometer at right. The deflected beam moved across the calibrated scale at centre.

these, and many other examples, the energy level of the original signal is inadequate to satisfactorily operate our detectors and some mean is needed to amplify the effect. We also refer to this as adding gain to the system. Electrical scientists and engineers prior to 1912 had a tough time, for gain was just not to be had without the application of ingenuity and cunning.

EARLY DEVICES

In 1858 Thomson invented the mirror galvanometer as mentioned above. That provided gain by using the optical lever principle, but it did not provide electrical amplification,for the output form was a displacement, not an electrical quantity.

Mechanical levers were often used to provide increased displacement amplitude. In seismology, minute movements of inertial mass were transformed into considerable deflections of a stylus, by using levers and long arms. Shaw and Laws (around 1900) measured the magneto-strictive length changes of nickel with their 6-lever "electric micrometer": the micrometer screw was turned (see Fig. 11) until a contact was made.

Early designs of gramophones and recorders usually managed with one input or output trumpet but the Columbia quadruple-disc "gramophone" of 1904 had four trumpets to provide enough signal to cope with an audience of 20,000 people. One design of early telephone mouthpiece used two trumpets to couple the speech vibrations to no less than 12 microphone units!

Prior to the discovery of the amplifying valve the dominant electrical gain device was the electro-mechanical relay. We have already met the relay in an early practical exercise. Today their form has little changed from the first unit devised by Wheatstone in 1837, (Fig. 12), it was used to operate a bell.

Today, relays can be made much smaller and with great reliability but the principle remains unchanged.

Relays can only produce digital signals, the contact is either open or closed. Because of this, whilst relays are invaluable in dot-dash type telegraphy, they are useless in voice-telephone work.

Nevertheless, the relay principle played a vital part in early electrical developments for, as well as being able to amplify signal levels, they provided the means of driving equipment — automatic feeds for arc-lamps, clock rewinders, alarm releases, printing telegraphs and step-by-step telephone exchange selector switches. Provided digital operation sufficed, relays could

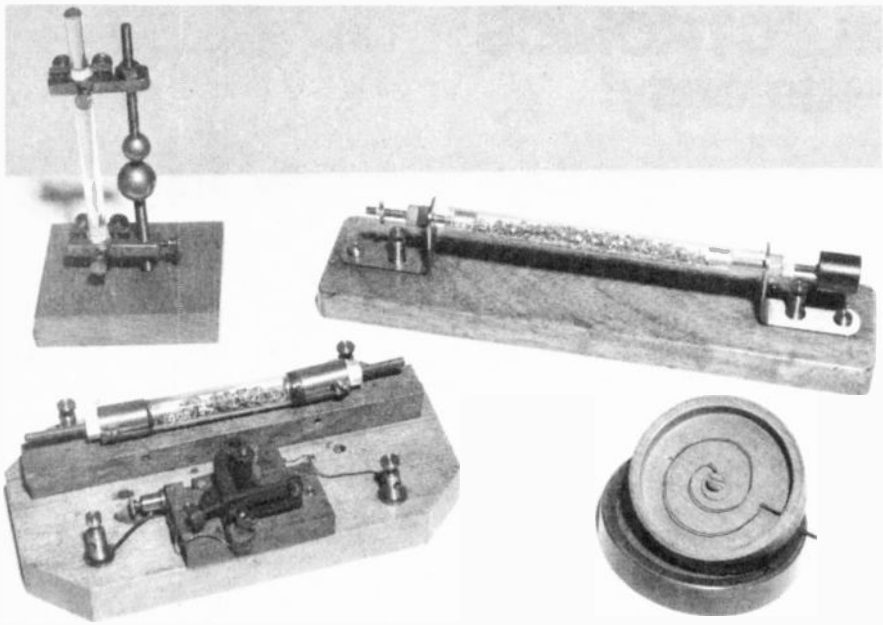


Fig.6. Equipment used by Lodge (1894) to detect electro-magnetic radiation. Two types of coherers, used as detectors, are shown. (top right and bottom left).

easily provide stable gains of a million or more. Brown's signal regenerator of 1899 used a relay, to sense the level of incoming poor-quality pulses from underwater cables, and hence to gate out clean levels thus repeating the original pulse signal.

All manner of methods were tried to obtain amplification of analogue (continuously varying) electrical signals. Probably the most successful before the thermionic valve was Shreeves' electromechanical telephone repeater unit, but it came too late (1910) to help the art. Shreeves' device consisted of a nicely packaged telephone receiver ear-piece mechanism driving a mouthpiece mechanism as a combined single unit. The mouthpiece used a method whereby a dc bias current is modified by the audio-frequency signals of the earpiece. Gain was, thereby, introduced by controlling the rate at which power flowed from the biassing power source into the output circuit. The input energy only had to decide the *rate* of output power flow; it did not have to *provide* it. (This, as was pointed out earlier in the series, is the definition of an amplifier).

THE VALVE AMPLIFIER

In 1907 Lee de Forest conceived the idea of introducing a perforated metal plate, (Fig. 9) between the filament and plate of the Fleming diode valve — this was the first triode valve. They were known as "Audions" and by 1912 were in use as amplifiers.

Their operation is quite straightforward. A voltage of the correct polarity (anode positive) will cause a current to flow between the

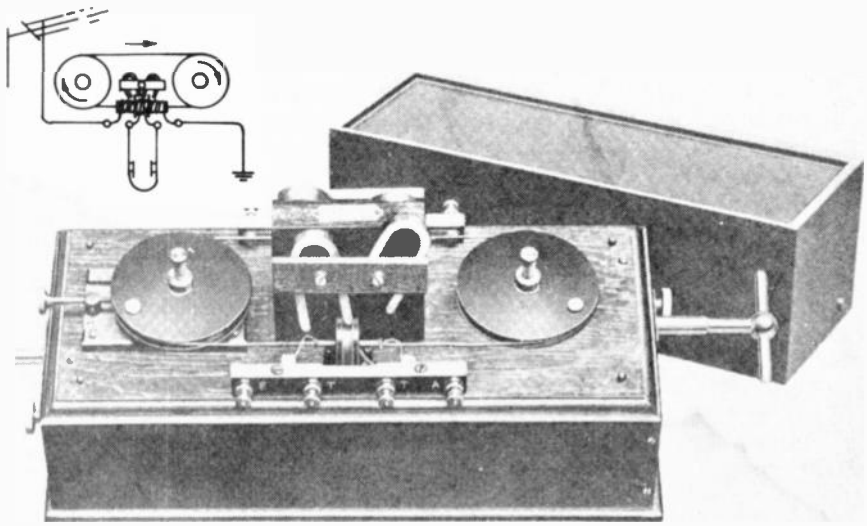


Fig.7. Marconi's magnetic detector of 1902.

ELECTRONICS —it's easy!

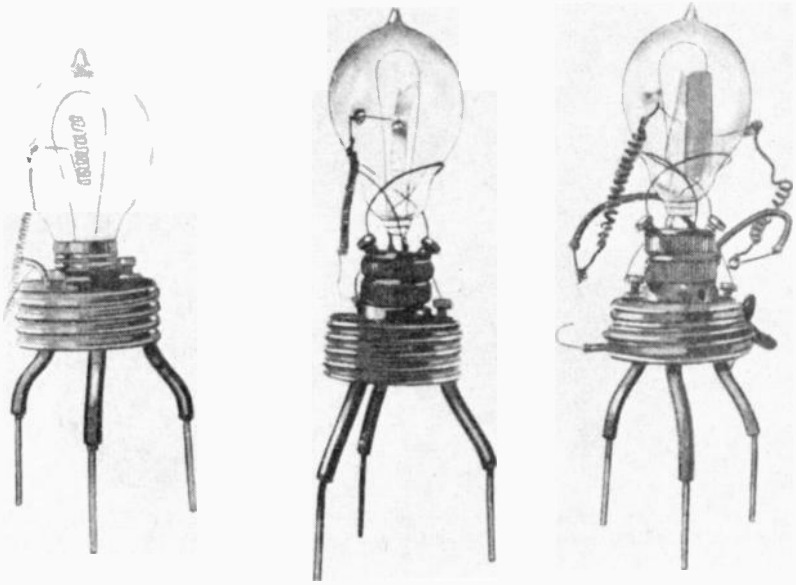


Fig.8a. The Edison effect (b) Three of the actual diode valves used by Fleming in 1904.

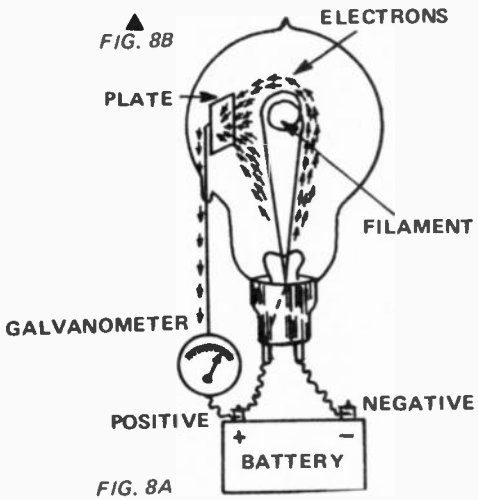


FIG. 8B

FIG. 8A

filament (cathode) and the plate (anode) if the grid is left unconnected. Signals connected to the grid either allow or prevent this action depending upon their polarity and magnitude — as shown in Fig. 9. A small varying signal voltage applied to the grid controls the flow of a large current in the anode circuit, thus obtaining gain (by producing a signal larger than that fed in).

Early "audions" were not particularly good amplifiers but they could be cascaded to provide increasing signal. They were also incapable of carrying much current to begin with. By 1922, however, 5 kW valves had been developed and by 1930, 1000 kW valves existed along with peanut-sized units for radio receiver work.

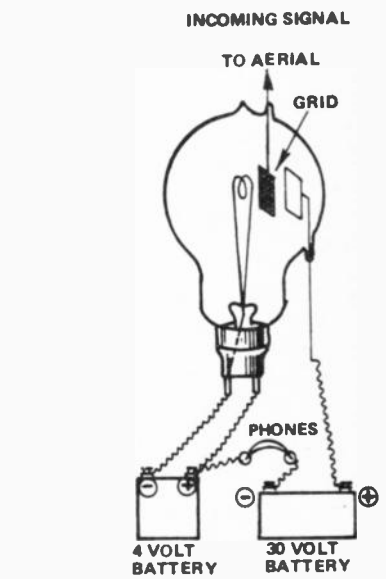
The German designed Loewe multiple-valve receiver of 1930 was especially interesting for it contained, in a single glass envelope, three triodes along with the resistors and capacitors needed for the three gain stages. Perhaps this was the first integrated circuit. The advent of valves gave considerable impetus to the development of electronics for they gave designers a new dimension of freedom. It became reasonably easy to build amplifiers, oscillators, digital circuits (the digital computer), measuring instruments (the first vacuum tube voltmeter was probably that originated at Cambridge University by Mallin in 1922), battery eliminators, successful television — the list is virtually endless.

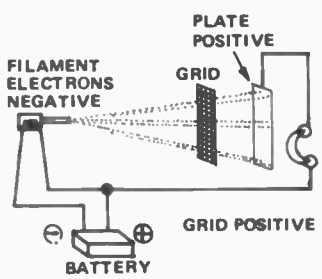
TRANSISTORS

Valve technology continued to improve, but by the early 1950's the shortcomings of valves — excessive size, power dissipation and cost — were becoming an intolerable barrier to further progress. Early digital computers filled many rooms of a building, portable radio sets needed large batteries etc. A new development was needed, and in 1947 the first practical transistor amplifying element was produced to fill the waiting need. The idea had been around for several decades but the necessary production technology had not been available.

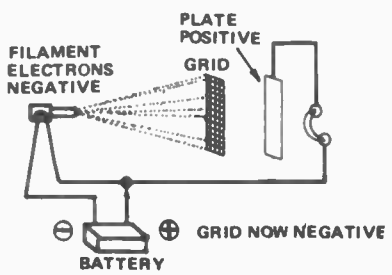
This development initiated the so-called solid-state era that we now enjoy. Today, transistors are used by the hundred and even thousand in modern integrated circuits. We now are truly at a systems level, for electronic designers today think more in terms of the *capability* of given circuit blocks than about how to interconnect separate, discrete elements.

The foundation element of active circuit system blocks is the amplifier. In articles that follow we shall discuss this vital component assembly considering it as a black box that behaves in different ways depending upon how passive components are connected around it. Our study of amplifiers will include a brief introduction to the thermionic valve



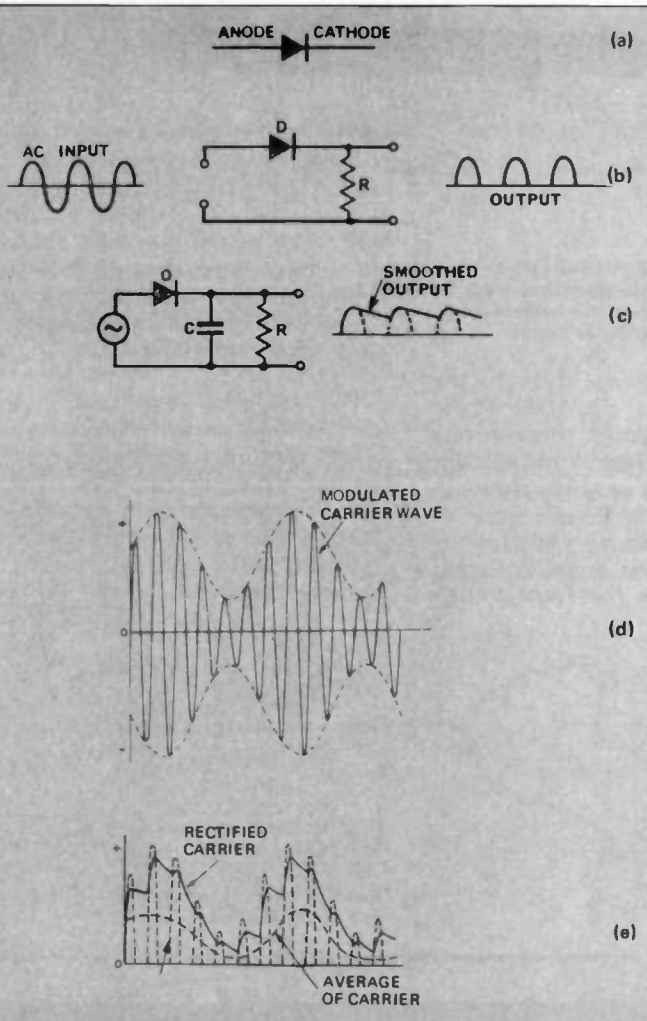


THE BOMBARDMENT OF THE PLATE BY ELECTRONS



SHOWING HOW THE GRID PREVENTS THE ELECTRONS FROM REACHING THE PLATE

Fig.9. The triode value, invented by Lee De Forest, and a schematic of how it works.



RECTIFICATION – THE ONE WAY VALVE

A diode, as we have seen earlier, acts as a one-way valve for current flow. The symbol for a diode is shown in Fig. 10a. The two leads of the diode are named *cathode* and *anode*, and the diode will only conduct when the anode is more positive than the cathode.

One major application of diodes is in the conversion of ac to dc. When sine waves are applied to a diode circuit (Fig.10b), the negative half-cycles will be blocked. The diode will only conduct when the anode of the diode is positive with respect to its cathode. The result will be pulses of current which may then be smoothed into a steady, direct current by the action of a capacitor (Fig. 10c).

This process, of converting ac into dc, is called RECTIFICATION, and a diode constructed for this purpose is called a RECTIFIER.

As most electronic apparatus requires a source of smooth dc power, and as the mains power supply comes to us as ac, the process of the rectification is fundamental to modern electronic systems.

Further, if an ac waveform, modulated as shown in Fig. 10d, is applied to the circuit of Fig. 10c and the time constant of CR is chosen to be much longer than the period of the carrier signal but short compared to the minimum period of the modulation frequency, the circuit of Fig. 10c will effectively demodulate, or detect, the signal thus recovering the original modulation as shown in Fig. 10e, such a circuit is called a DETECTOR circuit.

Diodes may also be used to protect equipment against reversed connection of the power supply, to protect against excessive input voltages and for a whole host of other applications.

amplifier: it will be brief because the technology is now outdated. Nevertheless, it still is used in many measuring instruments and electronic devices and, the principles involved align with those used in solid-state amplifier circuitry. It will also help those trained in valve technology to better appreciate the operation of transistors.

The course will then describe the necessary basics of semiconducting amplifier components without undue explanation of semiconductor theory – that will be left to added reading, for a thorough knowledge of the physics of semiconductors is not necessary for an appreciation of the electronic discipline.

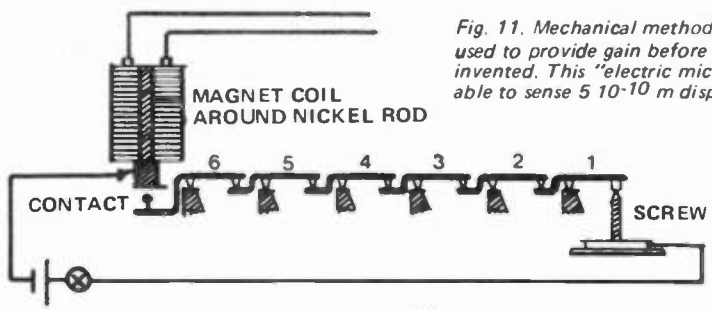


Fig. 11. Mechanical methods were often used to provide gain before valves were invented. This "electric micrometer" was able to sense 5 10^{-10} m displacements.

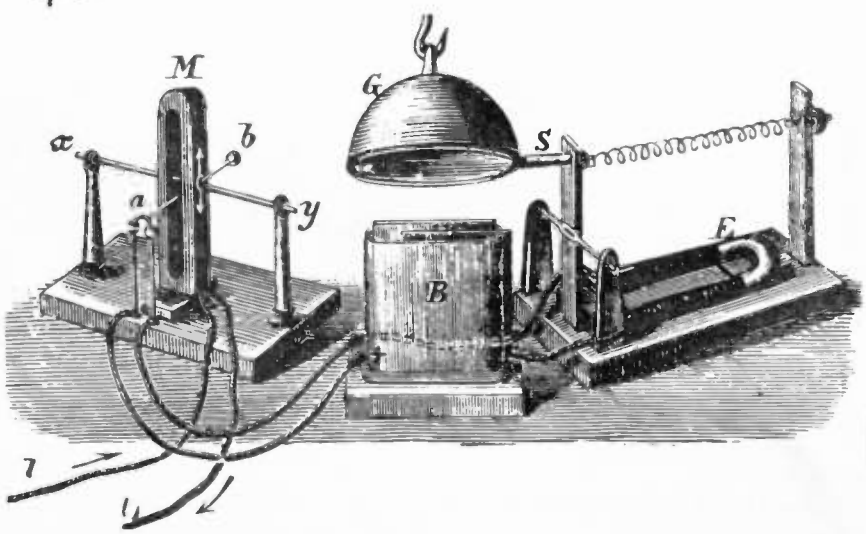


Fig.12. Cooke and Wheatone's relay of 1837 – the first. Current entering the wires on the left caused the compass needle 'ab' in the coil M to rotate making two mercury contacts at a. This in turn operated the bell hammer by means of an electro-magnet (E) and battery (B).

ELECTRONICS—in practice

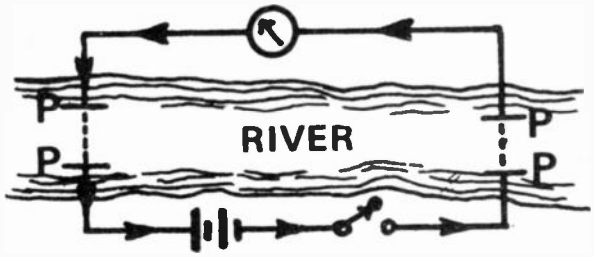


Fig. 13. In 1842 Morse demonstrated wireless electrical communications using the ground as "wires".

ELECTRICITY flows through the ground with ease. In 1842 Morse showed that he could communicate across a river in New York without wires. He used the principle shown in Fig. 13. The plates P were made of copper and were deeply sunk into the mud. He established that the current flowing across the river was proportional to the plate size, and to the distance between the plates on each side. (The current paths do not short out!) Lindsay signalled across the 1.5 km width of the river Tay, Scotland, in 1854 by this means. After this, many attempts were made to bridge larger distances but as the method is very inefficient little came of such effort.

This intriguing technique is easily demonstrated using the circuit of Fig. 14. It uses a buzzer oscillator similar to that shown in Part 5. It is left to you to experiment with plate size and spacing. The idea is not restricted for spanning water only — it works for continuous ground. ●

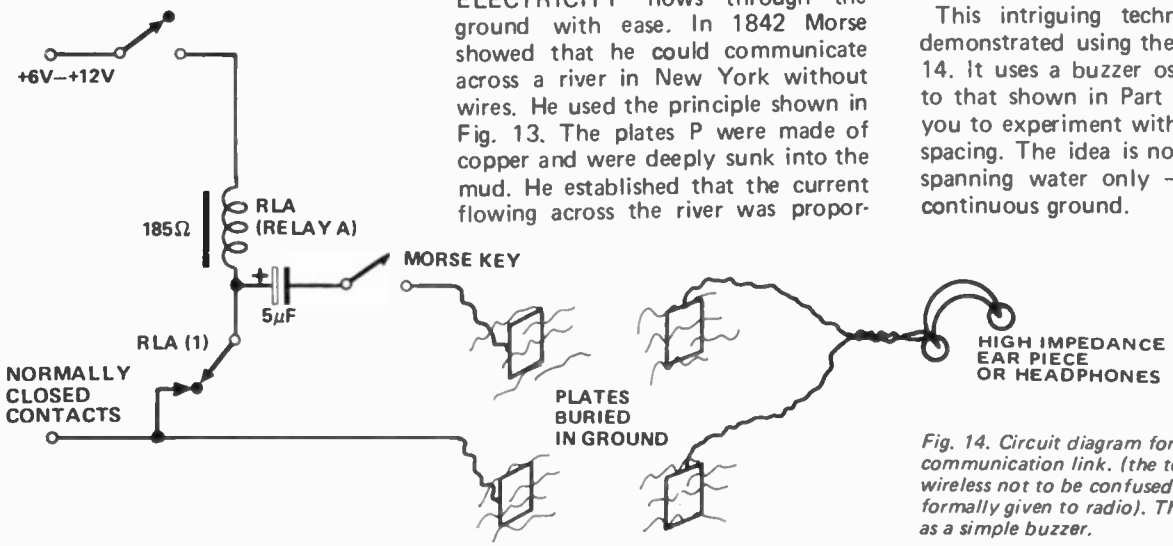


Fig. 14. Circuit diagram for a wireless communication link. (the term wireless not to be confused with the name formally given to radio). The relay acts as a simple buzzer.

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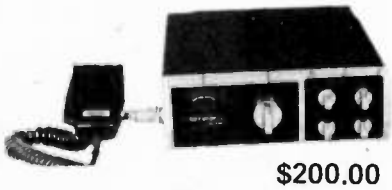

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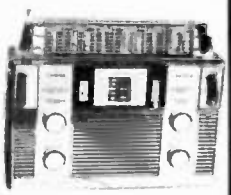

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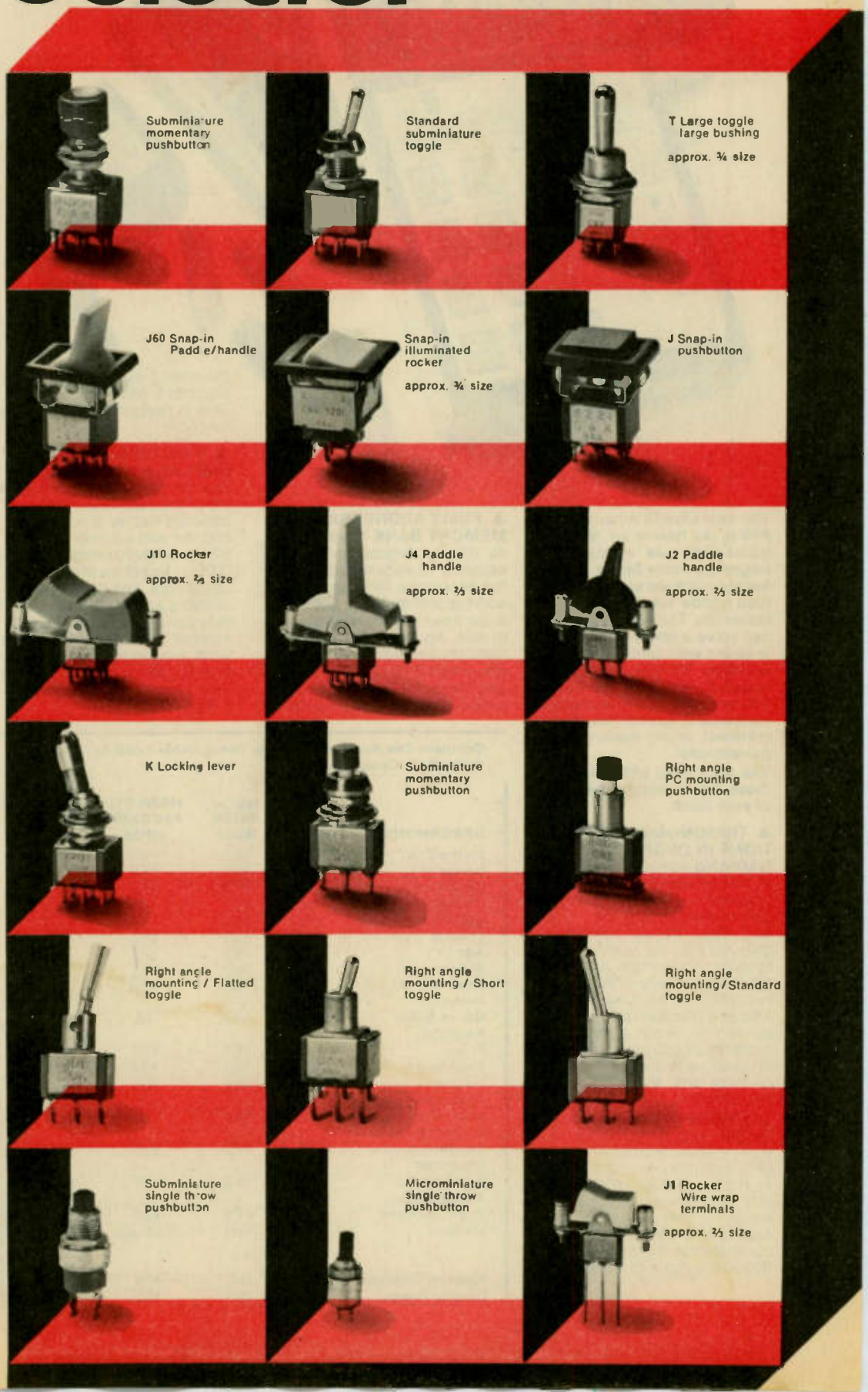

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MELB.: Zephyr Products Pty. Ltd. 56 7231. ADEL.: K. D. Fisher & Co. 223 6294. PERTH: H. J. McQuillan Pty. Ltd. 68 7111. N.Z.: Henderson (N.Z.) 6 4189.

Lloyd's Accumatic™ 999 Pocket Slide-Rule Calculator

$130.00

PLUS SALES TAX IF APPLICABLE
(Students eligible to purchase the E999 sales tax exempt.)

The new Lloyd's Accumatic 999 is like having an "electronic slide-rule" at your fingertips—only *better* because it does even more than a slide-rule! And it's faster too. The Accumatic 999 can solve a complex scientific problem with split-second accuracy. It's really the perfect calculator value for the scientist, engineer, mathematician, accountant, banker, teacher, architect, or *any* math-using professional.

The Accumatic 999 puts all these capabilities in the palm of your hand:

▲ TRIGONOMETRIC FUNCTIONS IN DEGREES OR RADIANS Besides performing all common arithmetic functions (addition, subtraction, multiplication and division), the Accumatic 999 can instantly give you the sine, cosine, or tangent of any angle, as well as the inverse of any of these functions (i e arc sine, etc.) And an exclusive degree/radian conversion switch allows you to compute in radians as well as degrees – a feature unavailable on most other slide-rule calculators

▲ EXPONENTIAL FUNCTIONS Natural logarithms (ln x), natural antilogarithms (e^x), common logarithms (log x), common antilogarithms (10^x), square roots ($\sqrt{x}$), reciprocals ($\frac{1}{x}$), and powers of numbers (x^y) are all easily computed on the Accumatic 999 at the touch of a button.

▲ FULLY ADDRESSABLE MEMORY BANK In addition to its "display" register and its separate "constant" register, the Accumatic 999 has a fully addressable memory bank that is the most advanced available to date An $(m + x^2)$ key automatically squares a number and enters it into memory – very handy for finding the hypotenuse of a right triangle when the other 2 sides are known It also has 5 additional memory keys to perform other memory functions.

▲ EIGHT-DIGIT DIGITRON® DISPLAY A brilliant 8-digit Digitron display is located at the top of the calculator This patented display is actually *brighter* and superior in legibility to the light emitting diodes (LED's) found on many other calculators The display also contains an overflow (error) indicator as well as a negative number (minus) indicator The wrap-around decimal feature enables calculations to proceed even when answers exceed 8-digits

▲ OTHER SPECIAL FUNCTIONS Other important function keys on the Accumatic 999 include Pi (π) key, a multi-purpose Clear (C) key, Data Recovery (DR) key; and Change Sign (+/−) key And in addition to performing basic geometric, trigonometric and logarithmic functions, the Accumatic 999 is capable of executing certain other advanced operations, including quadratic equations, hyperbolic and inverse hyperbolic functions, and polar to rectangular transformations In the field of business and finance, the Accumatic 999 can compute compound interest, present value, and mortgage amortization In statistics mean and standard deviation and chi squared evaluation In electronics charge on a capacitor and admittance problems There's no end to the Accumatic 999's versatility!

▲ AC/DC OPERATION The Accumatic 999 operates off 4 long-life alkaline rechargeable batteries And a combination AC adapter and battery charger lets you save the batteries and run the instrument off 120 volt AC house current when you're near an outlet AC adapter/charger and batteries are included with the unit

Compare The Accumatic 999 To These Other Leading Slide-Rule Calculators!

DESCRIPTION	T.I. SR10	MECH. SLIDE RULE	HEWLETT PACKARD HP35	LLOYD'S E999 SLIDE RULE
Multiply (X)	YES	YES	YES	YES
Divide (÷)	YES	YES	YES	YES
Square (x^2)	YES	YES	YES	YES
Reciprocal ($\frac{1}{x}$)	YES	NO	YES	YES
Square Root ($\sqrt{x}$)	YES	YES	YES	YES
Change Sign (+/−)	YES	NO	YES	YES
Add (+)	YES	NO	YES	YES
Subtract (−)	YES	NO	YES	YES
Scientific ($X10^{xx}$) Notation	YES	NO	YES	NO
No. of Digits Readable	8	3	10	8
Pi (π)	NO	YES	YES	YES
Exponent (x^y)	NO	NO	YES	YES
Natural (Ln x) Logarithm	NO	YES	YES	YES
Natural (e^x) Antilogarithm	NO	YES	YES	YES
Common (Log x) Logarithm	NO	YES	YES	YES
Common (10^x) Antilogarithm	NO	YES	NO	YES
Trig. Functions	NO	YES	YES	YES
Memory	NO	NO	1+Stack	$1 + x \rightarrow m$ 2 $x \rightarrow m$
Radians/Degrees	NO	NO	NO	YES
Display Recall	NO	NO	NO	YES

Send coupon for literature which describes our complete range of Calculators.
From $17.99 onwards.

SOLE AUSTRALIAN DISTRIBUTOR
W.H.K. ELECTRONICS & SCIENTIFIC INSTRUMENTATION
P.O. BOX 147, ST. ALBANS, VIC., 3021, AUSTRALIA.

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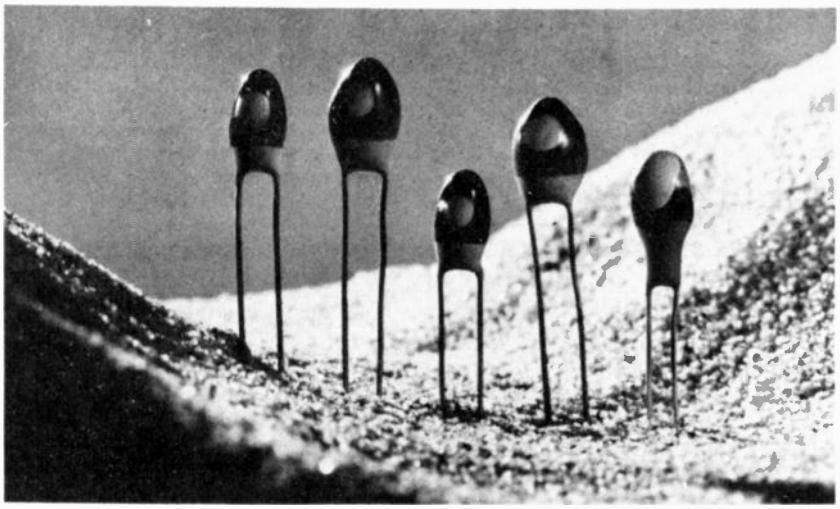
COMPONENT NEWS

SOLID TANTALUM CAPACITORS



These NEC resin-dipped tantalum capacitors available from Plessey Ducon Pty Ltd, are particularly suitable for printed circuit board mounting and are designed for decoupling, by-pass, blocking and filtering applications in both professional and domestic electronic equipment.

Conventional solid tantalum technology is employed in their manufacturer, with tantalum oxide dielectric and sintered anode construction.

They are finally dip-encapsulated in epoxy resin and colour coded.

The capacitors are designed for continuous operation at rated voltage ranging from -55 degrees C to +85 degrees C.

Further details: Professional Components, Plessey Ducon Pty Ltd, Box 2, Villawood, NSW 2163.

PLESSEY ANNOUNCES NEW RANGE OF IMPATT SOURCES

The ATO 240 Series of C.W. Impatt sources from Plessey are a new range of devices covering frequencies from 40-60 GHz, and offering power levels of 25, 50, 100 and 200 mW.

State-of-the-art diodes utilising integral heat sink processing and low parasitic bonding geometry are mounted in specially designed cavities. They are intended for fixed frequency operation, but may be tuned over a bandwidth of 1-2 per cent if required.

These sources offer an economic alternative to equivalent klystrons, with the additional advantages of size and biasing simplicity. Applications include parametric amplifier pump sources, waveguide communications and spectroscopy.

Further details: Professional Components Division, Plessey Ducon Pty. Ltd., Christina Road, Villawood, N.S.W.

ELCOMA CATALOGUE SEMICONDUCTORS 1974

ELCOMA have announced the availability of their 1974 semicondcutor short form catalogue.

Brief data is presented on all types of transistors and diodes presently available for both new design and existing equipment commitment.

The single catalogue is complementary to the more complete data handbook system which is recommended for initial equipment design. The catalogue allows a ready access to the range marketed by ELCOMA with selection charts presented in order of voltage breakdown, and power dissipation. All types are referred to the particular data handbook in which complete data may be found.

The book covers the following range of devices:

Rectifier Diodes and Thyristors
Diodes
Low Frequency and Deflection Transistors
High Frequency and Switching Transistors
Special Semiconductors
Devices for Opto Electronics

The publication is available free of charge to requests on official company letterheads from:

ELCOMA, Electronic Components and Materials, Box 50 PO, Lane Cover, NSW 2066.

IC INSERTION/ EXTRACTION

The hazards associated with the handling of integrated circuits, particularly their extraction from a printed circuit board, have now been overcome with a special hand tool.

Called the 885 PUL-N-SERTIC, the device permits both insertion and extraction – easily, quickly and safely. To insert, the IC is simply placed between the jaws. The pins on one side are lined up with the circuit board holes, and the package is 'rolled' into position, inserting all leads simultaneously.

Possibly its greatest advantage, however, is in desoldering and extraction. The tool is first positioned over the IC, and the side clips are slid down over the base. On melting the solder, a simple squeeze-and-lift movement neatly removes the package. Mechanical damage is avoided, and the tool body acts as a heat sink to prevent thermal damage.

Further details: Royston Electronics Pty Ltd, 22 Firth Street, Doncaster, Vic. 3108.

DIGITAL THUMBWHEEL SWITCH

The Digital company of California have added a new output code to their already extensive range of multi-position thumbwheel switches.

The new code is "Complement of 9's, Complement of BCD". This output code is compatible with the latest generation of IC's that can be driven directly by this switch code.

Digitran has available "Complement of 9's Complement of BCD" as standard output in Series 300, 700, 8000, 28000, and the economy 29000 Series. This code can be made available in any other switch series should demand justify tooling.

Full details of the new Digitran "Complement of 9's Complement of BCD" output switches, together with copies of the Digitran output code chart, are available from the sole Australian agents, British Merchandising Pty Ltd., 49 York Street, Sydney. 2000.

TWO DTL/TTL COMPATIBLE OPTO ISOLATORS IN ONE PACKAGE

A pair of inverting optically-isolated gates, each with a light-emitting diode and a unique integrated detector are now available in a single package. This dual-channel configuration makes higher density packaging possible resulting in more usable board space.

The photons are collected in the detector by a photodiode, then amplified by a high-gain linear amplifier that drives a Schottky clamped open collector output transistor. Delay times of only 50 nanoseconds can be obtained with this high-speed integrated photon detector.

Turn to the next page

BUY STATE OF THE ART SOLID STATE COMPONENTS— Direct from the United States!

All listed prices are in Australian dollars, International Postal Money Orders (please send PO receipt with order for immediate shipment). Banque Chasiers check (preferably in US funds) and rated company cheques (with foreign exchange stamp approval affixed) will be accepted. Due to recent Australian government restrictions we are not able to clear personal checks . . . All goods are new unused surplus and are fully guaranteed. Orders will be shipped within two workdays of receipt of same. All customs forms will be attached. Minimum order amount is $5.00, do not add postage — we pay postage. Surface mail for orders under $10.00 and Air Mail for orders over this amount.

DATA SHEETS ARE PROVIDED FOR EACH ITEM PURCHASED

7400 SERIES TTL

		DIP
7400	Quad 2-input NAND gate	$ .20
7401	Quad 2-input NAND gate	.20
7402	Quad 2-input NOR gate	.22
7404	Hex inverter	.22
7405	Hex inverter*	.20
7406	Hex inverter buffer/driver*	.35
7408	Quad 2-input AND gate	.22
7410	Triple 3-input NAND gate	.20
7420	Dual 4-input NAND gate	.20
7430	8-Input NAND gate	.20
7440	Dual 4-input NAND buffer	.20
7441	BCD-to-decimal decoder/driver	.80
7442	BCD-to-decimal decoder	.80
7447	BCD-to-7 segment decoder/driver	1.00
7448	BCD-to-7 segment decoder/driver	.80
7450	Expandable dual 2-wide 2-input AND-OR-invert gate	.20
7451	Expandable dual 2-wide 2-input AND-OR-invert gate	.20
7472	J-K master-slave flip-flop	.30
7473	Dual J-K master-slave flip-flop	.40
7474	Dual D-type edge-triggered flip-flop	.40
7475	Quadruple bistable latch	.75
7476	Dual J-K master-slave flip-flop with preset and clear	.40
74L78	Dual J-K master-slave flip-flop	.40
7483	4-Bit binary full adder (look ahead carry)	.80
7489	64-Bit read-write memory (RAM)	3.00
7490	Decade counter	.90
7492	Divide-by-12 counter (divide by 2 and divide by 6)	.60
7493	4-Bit binary counter	1.15
7495	4-Bit right-shift left-shift register	.75
74121	Monostable multivibrator	.60
74123	Dual retriggerable monostable multivibrators with clear	1.50
74193	Synchronous 4-bit binary up/down counter with preset inputs	1.00

*With open collector output

LINEARS

NE540	70-Watt power driver amp	$1.00
NE555	Precision timer	1.00
NE560	Phase lock loop DIP	2.00
NE561	Phase lock loop DIP	2.00
NE565	Phase lock loop TO-5	2.00
NE566	Function generator TO-5	2.00
NE567	Tone decoder	2.50
NE5558	Dual 741 op amp MINI DIP	.90
710	Voltage comparator DIP	.60
711	Dual comparator DIP	.25
723	Precision voltage regulator DIP	1.00
741	Op amp TO-5/MINI DIP	.55
747	Dual 741 op amp DIP	1.00
748	Op amp TO-5	1.00
CA3018	2 Isolated transistors and a Darlington-connected transistor pair	.75
CA3045	5 NPN transistor array	.75
CA3026	Dual differential amp	.75
LM100	Positive DC regulator TO-5	.50
LM105	Voltage regulator	1.00
LM302	Op amp voltage follower TO-5	1.25
LM311	Comparator DIP	1.00
LM370	AGC amplifier	1.00
LM703	RF-IF amp epoxy TO-5	.25
LM3900	Quad op amp	2.00
LM1595	4-Quadrant multiplier	1.00

8093-8094	Tri-state quad buffer DIP	$1.00
8850-9601	One-shot multivibrator DIP	1.50
8811	Quad 2-input MOS interface gate 15V open collector DIP	.30

RTL EXPERIMENTER PACKAGE

We purchased a computer using RTL logic. All the ICs are Motorola plastic DIP 700 series. Each board contains 3 or 5 ICs and a gold-plated standard 42-pin finger connector. VCC and ground are connected to all ICs, and a .05 bypass is provided. Each active pin of all ICs on the board go to a pin on the connector.

BOARDS AVAILABLE:

#1	3 MC724P Quad 2-input gate	$1.25
#2	3 MC789P Hex inverter	1.25
#3	3 MC790P Dual J-K flip-flops	1.25
#4	3 MC792P Triple 3-input gate	1.25
#5	5 MC799P Dual buffer	1.25

SOCKETS FOR BOARDS:

Bank of 5 bussed together to take 5 boards - gold-plated wire $2.50

Ten bussed together $4.50

Set of 5 boards and sockets with data and applications $7.95

LSI CALCULATOR ON A CHIP

This 40-pin DIP device contains a complete 12-digit calculator. Adds, subtracts, multiplies, and divides. 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 $7.00
Data only $1.00

SLA-1 OPCOA

Pin compatible with MAN-1.

Large .334" character.

Mounts on .4" centers.

Left-hand decimal point.

$2.00 Each; 10 For $16.00

FAIRCHILD "TRIMPOTS"

Brand new 20 turn precision trimmers. These are prime parts, mostly individually packed in sealed envelopes.

FOLLOWING VALUES IN STOCK:

10 Ohm	1K	50K
20 Ohm	2K	100K
50 Ohm	5K	200K
100 Ohm	10K	250K
200 Ohm	20K	500K
500 Ohm	25K	1 Meg

Each Only 89¢

Ten for $7.50

Please specify P or L (PCB or wire leads). Order NOW, these won't last!

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).

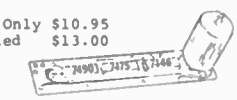
A 7490 decade counter IC is used to give typical count rates of up to thirty MHz. A 7475 is used to store the BCD information during the counting period to ensure a non-blinking display. Stored BCD data from the 7475 is decoded using a 7447 seven-segment decoder driver. The 7447 accomplishes blanking 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 4 3/8" long. A single 5-volt power source powers both the IC's and the display tube.

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

Bcard Only $2.50



RCA DR2010 NUMITRON

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

Each $4.00
SPECIAL 5 for $17.50

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 $9.25

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 worse case TTL requirement) at current of up to one ampere.

Each $1.50 5 for $7.00

Babylon Electronics Inc.

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

Maximum dc and ac circuit isolation between each input and output is maintained while DTL/TTL compatibility is achieved. This new Hewlett-Packard 5082-4364 dual isolator is designed for use in high speed digital applications where common mode signals must be rejected. Some typical applications include its use as a line receiver, and digital programming of floating power supplies, motors and machine control systems. Ground loops between system interfaces such as a computer and peripherals can be eliminated.

Supply voltage required is 5 volts, input current for an eight gate fan-out (13 mA) is 5 milliamperes. Common mode rejection is 20 volts at 1 MHz. Performance specifications are guaranteed over the full 0° to 70°C temperature range.

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

WIDE BEAM LEDS FROM PLESSEY

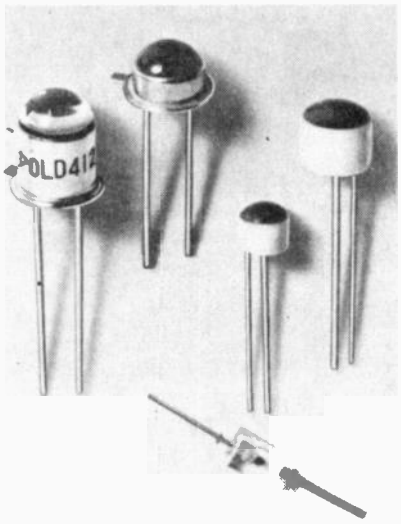
A new range of light emitting diodes from Plessey provide a highly reliable light source with wide beam spread characteristics.

Various types are available to emit red, green, amber, or infrared light depending upon the application.

Applications include their use in punch tape readers, conveyor control, rotation counters, automatic weighing machines, position control and opto-isolators.

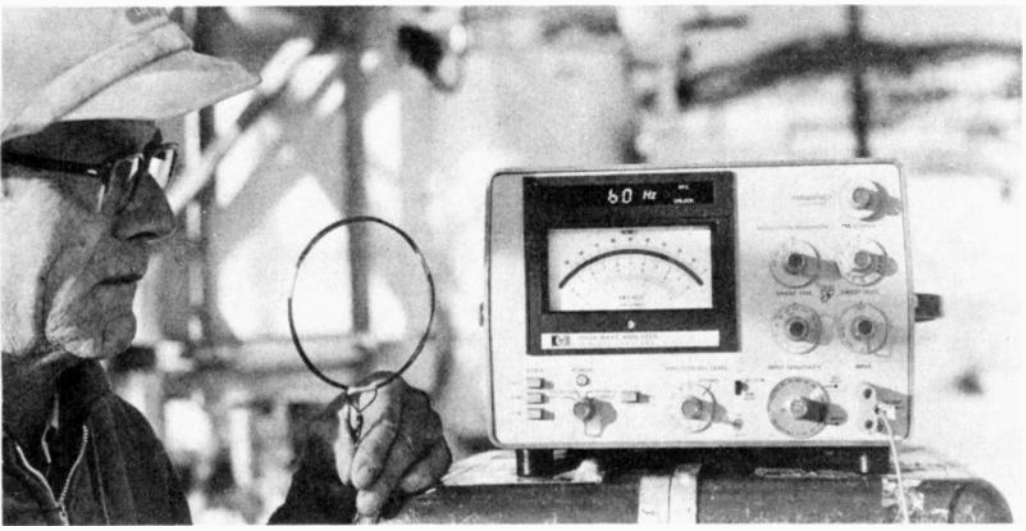
Their response is fast and they can be modulated from dc to several MHz. Power consumption is low and the diodes can operate at low voltage and current levels. All leads are gold plated.

Further details: Professional Components, Plessey Ducon Pty Ltd, Box 2, P.O. Villawood, N.S.W. 2163.



EQUIPMENT NEWS

LOW FREQUENCY WAVE ANALYSER



Accurate single-frequency measurements are fast and easy to make with this new Hewlett-Packard Model 3581A Wave Analyser. A built-in counter displays the tuned frequency unambiguously with 1 Hz resolution on an LED digital readout. Signal amplitude is read on a four-scale analogue meter. Two scales are for log displays of 90 dB and 10 dB (expanded), and the other two are linear with 1 or 3 full scale. Amplitude can be read to better than 0.1 dB on the meter's expanded 6-inch 10 dB scale.

Some uses for the Model 3581A include harmonic analysis, fm and phase noise measurements of high-frequency signals, and analysis of power lines for control signalling and carrier current voice channels. Very low frequency applications include evaluation of sonar devices and low frequency radio transmission systems.

A communications version, Model 3581C, is designed for analysis of telephone voice channels, both single and up to 12 multiplexed. It can also be used to pinpoint interference on data channels, look for spurious tones, and analyse levels of transmitted tones. Specifications of both Model 3581A and 3581C are identical except for modifications to the latter needed to make it compatible with telephone systems.

Further details from: Hewlett Packard Australia Pty. Ltd., 31-51 Joseph St., Blackburn, Vic. 3130.

DIGITAL MULTIMETER HAS ACCURACIES OF A "SUB-STANDARD" INSTRUMENT

A four-digit multimeter which combines automatic ranging with a 100 μV resolution on voltage measurements is a new addition to Philips range of digital voltmeters and multimeters. Combining multimeter facilities with high measuring accuracy, it is intended for use in test and production-work applications requiring accuracy of a "sub-standard" precision.

Covering dc voltages from 0-100 V and ac voltages from 0-500 Vrms in auto-selected ranges the PM 2424 offers a maximum resolution on such measurements of 100μV. On current measurements the range covered is 0-1000 mA in four auto-selected ranges on both ac and dc, while resistance measurements covered are 0-10 megohms in five auto-selected ranges. Maximum resolution on current measurements is 100 nA and on resistance 100 milliohms. Polarity indication is displayed when applicable.

Switching between the instrument's ranges on any parameter is fully automatic, the ranging time being 200 ms/range. Should an overrange condition arise, then all figures light simultaneously to provide a clear indication of overranging.

The PM 2424 has a stated accuracy of ± 0.01% of reading ± 0.01% of scale. The instrument employs a digital method of automatic zeroing before each measurement. This is important in ensuring a high measurement accuracy, particularly at the lower end of all ranges.

Full overload protection is provided on all inputs. The resistance ranges are protected up to 100 V (200 V for maximum 5 seconds). A floating input and its integrating type analogue-to-digital converter give the instrument a high common-mode rejection factor.

The unit is normally supplied in mains operated form and a battery operated option is available. External accessories include dc high voltage probe for voltages to 30 kV. Shunts & current transformers extend existing ranges to 10,30 & 100 A respectively.

Further details: Philips Industries, 95-99 York St., Sydney. N.S.W. 2000.

NEW POTENTIOMETRIC RECORDER

Tecnico Electronics announces the release of a new Rustrak Model 4300 3-channel Potentiometric Recorder manufactured by Recorder Systems Division Gulton Industries Inc.

This recorder is available with a wide variety of signal conditioning modules which enables the basic unit to monitor most electrical parameters as well as temperature.

Further details from: Tecnico Electronics, Premier St., Marrickville, N.S.W. 2204.

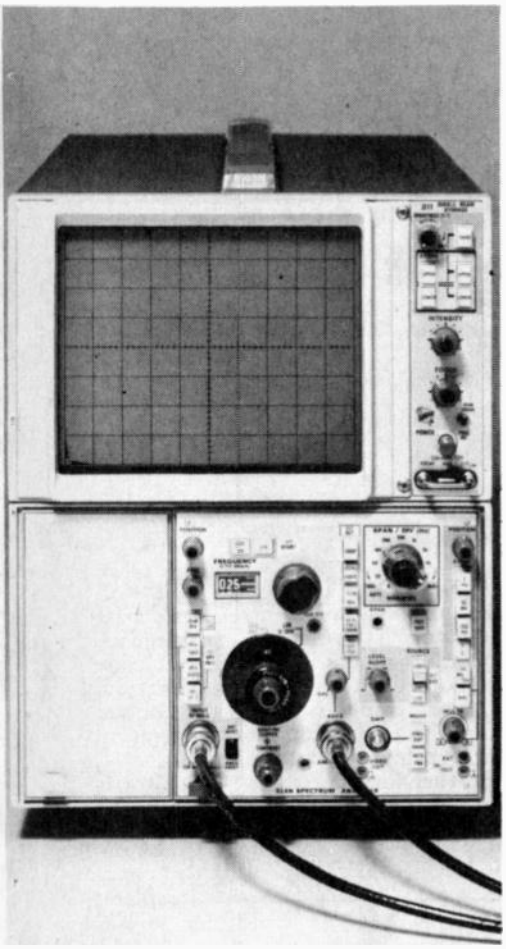
LASER SYSTEM RECOGNISES PRODUCT DEFECTS

The combination of low-cost lasers with reliable solid-state photo-detectors provides an efficient means of measurement or quality control of industrial products under stationary or assembly line conditions. An object or transparency placed in a laser beam produces a diffraction pattern which is characteristic of that object. Variations in dimensions, surface finish or configuration change the pattern in a manner recognisable to an optical readout system. A patented photosensor array performs much of the computation which formerly required a large and expensive digital computer, and allows an accept/reject decision to be made, or a recognition function to be performed with a minimum of computing facilities.

The cost effectiveness of the system has been investigated in applications including measurements of razor blade sharpness, quality control in a button factory, inspection of aerial photographs and recognition of abnormal tissues or cells. Because of the relative insensitivity of the system to variations in positioning of the object, quality control of fast moving objects is entirely feasible.

Further details from: ANAC (Australia) Pty. Ltd., P.O. Box 102, Sutherland, N.S.W. 2232.

TEKTRONIX 5L4N LOW FREQUENCY SPECTRUM ANALYZER



The new 5L4N is a 0-to-100 kHz spectrum analyzer that offers both high performance and economy. Tektronix state that the analyzer has unique features including push-button selection of 50 ohm, 600 ohm or 1 megohm input impedance with calibration appropriate to the selected impedance.

Dynamic range is 80 dB with intemodulation more than 70 dB down from two full-screen signals. A built-in tracking generator is standard in each analyzer. This low-frequency swept-front-end spectrum analyzer operates with any 5000-Series System, using two of the three compartments. Tektronix recommend the 5L4N Spectrum Analyzer with a D11 Storage Display Unit and 5103N mainframe as the optimum system for all applications. Further details: Tektronix (Australia) Pty Ltd., 80 Waterloo Rd., North Ryde, NSW 2113.

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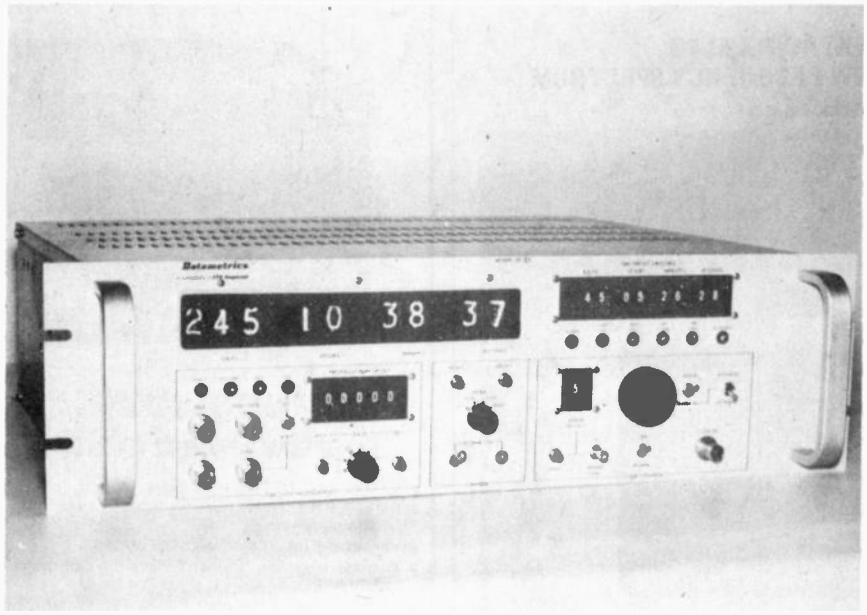
EQUIPMENT NEWS

UNIVERSAL TIME CODE GENERATOR



Datametrics is pleased to announce their Model SP-125 Universal Time Code Generator that is designed to serve as a Master Time Reference for distributing precision time code indices for indexing different recording mediums such as magnetic tape, camera film, and oscillographs.

The Model SP-125 can also be slave synchronized to within a few micro-seconds of an external received IRIG-B time code that is derived from another Master Time Code Generator. The unit has an internal time base oscillator to insure continuous operation in the event of input code drop-out during slave sync operation. It also employs a fail-safe power supply to ensure continuous operation during primary power failure.

Further details from: John Morris Pty. Ltd., 63 Victoria Avenue, Chatswood, N.S.W. 2067.

D.C. MICROVOLTMETER

The Marconi D.C. Microvoltmeter TF2655 is a versatile, general purpose meter for the measurement of direct voltage from 0.3 microvolts to 1000 volts and direct current from 30 picoamps to 1 milliamp.

It features a high input resistance varying from 5 megohms to 1000 gigaohms for voltage measurement; for current measurement it has a low and constant voltage drop at the fully-floating input terminals.

The indicating meter zero is offset by 10% which allows the TF2655 to function as a null detector for dc bridges and it can also be used as a very stable and linear amplifier with a regulated voltage gain.

Adequate overload protection is included and the zero stability is very good. The instrument is all solid-state, robust and shock-proof and will withstand a wide range of operating temperatures.

Further details: Amalgamated Wirless (Australasia) Ltd., Engineering Products Division, NSW, 422 Lane Cove Road, North Ryde. 2113. •

STOP electrical accidents

Scanelec Safegard

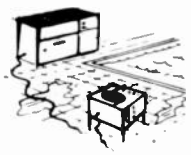
CORE BALANCE EARTH LEAKAGE CIRCUIT BREAKER

Protect your family against electrocution and your home against fire with Scanelec Safegard. If any appliance in your home becomes "live" through a wiring malfunction or deterioration, or if someone accidentally tampers with a live wire Scanelec Safegard cuts off the power *before* a serious accident can occur.
If a wiring fault occurs, despite fuses or ordinary circuit breakers, a fire could start.
Scanelec, cuts the power, stops the fire starting.
A Scanelec Safegard unit can be installed economically on to any switchboard. Don't hesitate and risk death or fire.

Protect your children.

Common causes of electrical accidents with children is inserting a pair of scissors into a power outlet, playing with electrical appliances, cutting power cords etc. A Scanelec Safegard protects against these circumstances and could save your child's life.

Swimming Pool Hazards.



It is now required that new pools with underwater lighting be fitted with a safety device such as a core balance unit. However existing swimming pools need the same protection. Around the pool area are often electric lighting, record players, appliances, electric barbecues etc. All can be dangerous in wet conditions.

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The multiplicity of electric appliances in today's kitchens can be dangerous through cord or appliance faults, putting a knife into a blocked toaster etc. Scanelec can protect against these dangers.

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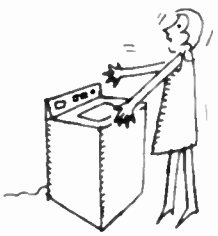

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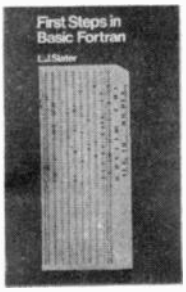
BOOK REVIEWS

Reviewer: Andrew Pozniak.



FIRST STEPS IN BASIC FORTRAN By Lucy J. Slater. Published by Chapman and Hall 1971. Soft covers, 104 pages 215 x 135 mm. Price $2.95.

As is well known, the computer is firmly entrenched in the day-to-day operations of many businesses. But, as well, it is being increasingly used as a learning tool in most tertiary institutional courses. Thus it is now common practice to provide the student with an introductory course in practical computer programming in his first year of tertiary studies.

Such courses are usually designed by the faculty to which the student is attached and, are either related to the particular subject being studied, or, are given as an extra subject of term duration complete with end of term examinations.

The primary aim of such courses is to familiarise the student with the basics of computers and with the acquisition of elementary programming skills. Unfortunately this aim becomes blurred with the introduction into the course of particular subject-related problems which the student has to solve and understand before he can begin to write a program. Also, excessively heavy treatment of such aspects as "WFAF" (Well Formed Arithmetical Formulae) and the use of "stiff" mathematical terminology and other superfluous technicalities, make the acquirement of such skills by the student altogether harder than they should be.

It is therefore a breath of fresh air to find such a publication as this, where unnecessary technicalities are eliminated as far as possible. The result is a good effective text, which is straight to the point and which is written mainly for the non-mathematical student.

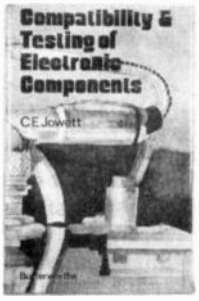
The book begins with a discussion of the various computer functions and elements. It then introduces the student to methods of implementing programmeable arithmetic statements, logic, format, conditional interrogation, and finally use of subroutines and "calling up of functions". And all this quite painlessly!

Many problems are set throughout the text, and these, coupled with suitable practical exercies, should enable any reader to acquire the ability to interface with the machine he wishes to use. The book may leave a lot to be desired as far as the purist is concerned, but there is no doubt that it achieves what it sets out to do, that is, train the non-mathematical student, in the use of computers, as quickly and easily as possible.

The book is not written by a mathematician or computer soft-ware writer, but by an economist who considers the computer merely as a black-box, problem-solving tool. This accounts, very largely, for its clarity and the meticulous step-by-step approach.

Hence, the book is an ideal source of fundamental Fortran programming knowledge for the non-mathematical student. But obviously the student of science-orientated subjects may well require to supplement this text with knowledge of more sophisticated programming techniques.

It should be emphasized that no-one can learn programming from a book alone. One must have access to a computer so that programs may be run and debugged. It is in this latter aspect alone that the book is deficient. No error analysis or debugging procedures are incorporated. — A.P.



"COMPATABILITY AND TESTING OF ELECTRONICS COMPONENTS" by C.E. Jowett. Published by Butterworths 1972. Hard covers. 345 pages 215 by 135mm Australian price $17.50,

As implied in the preface, the purpose of this book is to outline an overall concept of component part life based on thresholds of failure, to identify such failures, and provide an outline of suggested testing methods.

To achieve the aim the various state-of-the-art techniques of testing both active and passive components, and of analysing the causes of failure, are discussed in detail.

Since an in-depth treatment of the tremendous diversity of available methods and criteria would require many volumes similar in size to this one, this book can at best only be purely qualitative, and give only a generalized treatment of the subject.

Althouh there are drawings, graphs and tables distributed throughout the text, their quantity seems rather frugal. This is a distinct failing as visualization of various failure modes is essential for an adequate understanding by the reader. In particular, in the section dealing with the manufacture of thin laminates, there is only one solitary plate showing photomicrographs of typical faults. This, and many other sections, could have been considerably enhanced by the inclusion of suitable photographs.

However, in general, the text should be suitable for the design engineer and technician who seek a better understanding of the failure modes of devices, and assistance in the selection of more reliable devices. A.P.

INPUT GATE

LETTERS FROM OUR READERS

REFLECTED SOUND

In the article "Ambisonic Reproduction of Sound", E.T.I. Volume 4 No 1, the importance of proper spatial acoustic relationships has been discussed.

I feel that this quality can be produced without the necessity of using multi-channels, matrixing etc.

For the last eighteen months I have evaluated, critically, the principles of Professor Stig Carlsson's Sonab speaker design.

I then started from scratch using a modified ETI Magnavox 8-30, with Philips tweeter, design. I initially experimented with only one tweeter, with the bass/midrange oriented according to Carlsson's design principles. Later on I increased the tweeters to four, noting acoustic changes.

I have found that a three dimensional spatial effect is produced. There is horizontal location, vertical location, and front-back location. Sound images are distinct and an absence of the Haas Effect is evidenced.

It seems that this design produces a subjective, spherical sound source, a recognised ideal speaker parameter.

Having demonstrated and listened to four channel high fidelity equipment, I think I have some justification in saying that there exists a speaker design that obviates the necessity of quadraphonic reproduction for a realistic musical experience.

I discovered after eighteen months evaluation that these speakers fullfil the following acoustic parameters.

1. Omnidirectional wave propogation.
2. A three dimensional sound field.
3. An absence of the Haas effect.
4. A direct to reflected energy ratio of 1 in 9 (Bose & Carlsson).
5. A sound source within our 180° visual field, for greatest listening comfort.

I'm quite satisfied with this speaker, seeing no necessity, at present, for more esoteric and pedantic techniques of sound reproduction.

Louis Hissink,
Kambalda West, W.A.

* *Interesting though that Sonab's latest speakers (the OA 12 and OA 14) seem to rely less on reflected sound than do early models.*

BEETHOVEN REVIEW

Congratulations to Tanya Buchdahl for her beautifully written and comprehensive review of Beethoven's piano sonatas published in your July issue.

It must have taken weeks of work to produce, please tell her that it was very much appreciated.

P.V. Messina
Darwin, N.T.

FLAT RESPONSE

Reports on audio amplifiers always stress that the frequency response should be flat. But according to the Encyclopaedia Britannica Vol II, the ear hears different levels at different frequencies. To quote, "generally speaking, two tones of equal energy but different frequency will not seem equally loud; this is true because th ear's sensitivity varies over its range. Sensitivity is greatest for the middle-high tones — those of frequencies from 1000 to 4000 Hz".

Why then don't amplifier manufacturers arrange to suppress the frequency response from 1000 to 4000 Hz so as to make the sound seem flat to the ear instead of making the amplifier response flat so that the ear hears a non-original sound?

The Encyclopaedia also says that the maximum frequency that anyone can hear is around 16 000 Hz. Why then do amplifiers have a response up to fifty or even a hundred thousand Hertz?

Robert Mills,
Hillsdale, NSW

*

As you say, the ear is far more sensitive to mid-range sounds than it is to treble and bass.

Recording equipment on the other hand records all frequencies at roughly equal levels. When the recording is subsequently replayed the ear will then perceive the sound non-linearly — as if it were the original.

Unless the complete sound reproducing chain has a substantially flat response the sound that you hear will be unlike the original.

Amplifiers don't need to have a response beyond the hearing range.

This can readily be proved by wiring a filter in series so that all frequencies above a preset limit are attenuated. But transistor amplifiers respond to 50 kHz plus anyway — so some manufacturers make a selling point out of it!

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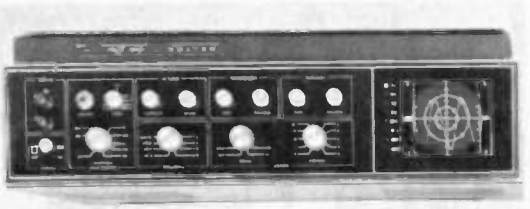

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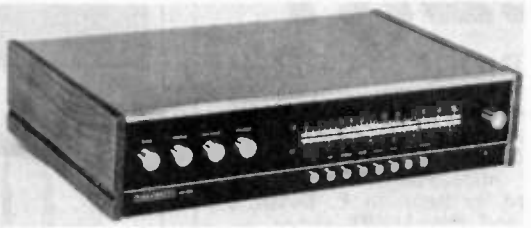

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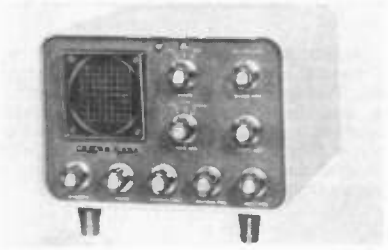

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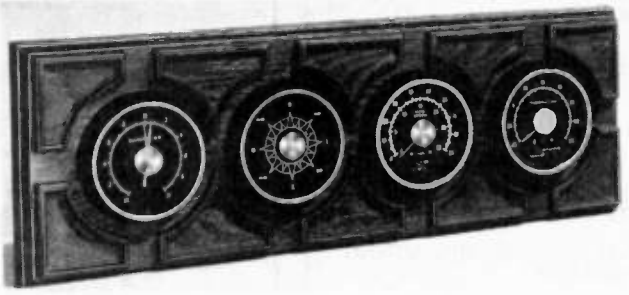

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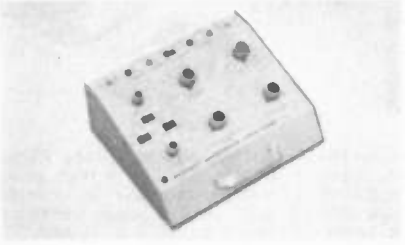

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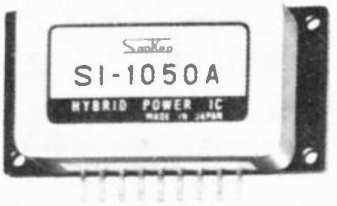

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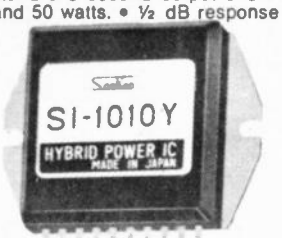

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GREAT BRITISH SOPRANOS: Agnes Nicholls, Miriam Licette, John Cross, Eva Turner, Mary Garden, Maggie Teyte, Isobel Baillie, Elsie Suddaby, Dora Labatte, Gwen Catley. HMV Treasury (mono) HLM-7033 ($4.50).

One of the better historic collections I have heard. This is a selection of 15 items, and a very imaginative one, culled from EMI archives dating back as far as pre-1904, and given the age of some of the originals the sound quality is astoundingly good. The first track is a selection from Weber's Oberon Act II: *Ocean, Thou Mighty Monster*, sung by Agnes Nicholls, a previously unpublished performance dating from 1911, and it is a dashing and unbelievably clear one. Miraim Licette follows with *Mi tradi quell' alma ingrata* from Act II of Don Giovanni, again amazingly clear for 1929, and it shows Miss Licette must have been a Mozart singer of no mean talent. Joan Cross sings two selections, *Willow Song and Ave Maria* from Act IV or Verdi's Otello (recorded 1937), and she sings in a style a little uncommon nowadays – directly. In common with pianistic style, which dictates that the direct approach like that of Backhaus is out of date, the French style has taken over, a rather delicate and sometimes mannered way of playing – so it is good to hear a track such as this one to remind us what real directness is.

The same applies to Dame Maggie Teyte's two performances on the end of this side; *Psyche* by Paladile (1941) and *Ce n'etait pas la meme* chosen from Hahn's Ciboulette, accompanied by Gerald Moore (1946). Eva Turner's *One Fine Day* from *Madam Butterfly* (1933) sounds more like Butterfly's portly mother than the young Japanese girl herself, but for all that the voice is rich and beautiful. The oldest track dates from before 1904; Mary Garden singing her most famous role of Melisande in Debussy's Pelleas and Melisande. She is accompanied at the piano by Claude Debussy himself in *Mes longs cheveux* – mercifully it is only a short track for though one gets a good idea of Miss Garden's fashionably quivering but pretty voice, the sound quality is terrible and the pitch is as bad.

The second side contains four sopranos whose voices are of the light and supple variety. The first is Isobel Baillie (with the LSO under Sargent), not at her best in *Ne' trionfa d'Alessandro . . . . Lusinghe piu care* from Handel's Alessandro, arranged by Sir Henry Wood in the style of a Percy Grainger piece – perhaps 'Handel in the Strained'? The voice is lovely but sounds just a little tired. Not so with Elsie Suddaby, whose voice is very much prettier than her name. Her (1927) *O Sleep! Why dost thou leave me?* whose voice is best tracks on this record – also Handel, from Semele. It is followed by Purcell's *Hark! the echoing air* from Act V of The Fairy Queen. Dora Labette (accompanied by Sir Thomas Beecham at the piano) sings three Delius songs; Cradle Song, The Nightingale and Evening Voices (Twilight Fancies), which are not nearly as forgettable as the rest of his music. She sings them most feelingly, but disconcertingly seems to have retreated a pace or two from the microphone for every note over D in the last song. The record finishes in high style with Adam's variations on *Ah! Vous dirai-je, Maman*, sung in 1949 by Gwen Catley with delightful humour and formidable technique – she tosses off high Ds and even Es apparently without turning a hair.

The timing is generous – just under 53 minutes, and the transfers are excellent. I understand a leaflet containing notes, texts and translations is included, but I haven't seen it. The cover shows an impressive twilight scene; the back cover, however, gives descriptions of non-existent photos of the sopranos (which I suppose appeared on the original English cover) – maybe the sun has set on them. – T.R.B.

MOZART: The Magic Flute. Theo Adam (Sarastro), Peter Schreier (Tamino), Siegfried Vogel (Speaker), Sylvia Geszty (Queen of the Night), Helen Donath (Pamina), Hanne-Lore Kuhse (1st Lady), Gisela Schroeter (2nd Lady), Annelies Burmeister (3rd Lady), Guenther Leib (Papageno), Renate Hoff (Papagena), Harald Neukrich (Monostatos). Rundfunkchor Leipzig; Die Staatskapelle Dresden/Otmar Suitner. Eurodisc 80-584XR (3-record set with notes and libretto in three languages) $18.60.

I wish I had been able to compare this set with any of the other five sets in the British catalogue, but finding one was as easy as finding a giraffe on Bondi Beach. This version in fact is not available in England or (as far as I know) America, nor is it widely advertised here, so it may be quite new to most people – I don't know how recent it is, however, because no production date appears anywhere on it; but judging by its extraordinarily good sound quality I should think no earlier than 1973. Though not the cheapest version available, I think it is worth every cent – it is enchanting. Following hard upon Solti's 1971 set (SET 479-81) which received much praise, the competition is stiff; but from what I remember of a radio broadcast of this set, the two are quite different in approach yet equally acceptable. Solti's version seemed to be striving after nobility of expression, as many of his performances do, which doesn't go amiss in this ablimely allegorical work.

The story itself is idiotic – "famous for its stupidity" is Edward Dent's comment – but the music is quite the opposite. As the Eurodisc notes rather picturesquely put it, "The only fact, we can take for certain, is: Schikaneder/Gieseke's 'Magic Flute' would, at least, long since rot in some archives, if Wolfgang Amadeus Mozart had not become its composer".

Suitner, rather than pursuing the opera's profundity, treats it in a friendlier fashion (as if to prevent the sublime becoming ridiculous by treating it too seriously), and leaves it to the music itself to make the transformation into the work of genius it is.

So Pamina here is a very sweet young thing without the slightest touch of bathos, touchingly innocent in her lament *Ach, ich fuehl's* – Helen Donath is almost ideal as a bewildered young girl lost in the world at large. Peter Schreier's Tamino, I am glad to say, sounds suitably masculine. The Magic Flute is not really the place for 'poofter bastards'; this is an opera where the men are men and the women are proud of it (as the saying goes). Theo Adam (Sarastro) is very impressive; of the comic characters, Renate Hoff and Harald Neukirch are delightful, and Guenther Leib as Papageno, though fractionally a better actor than singer as far as characterization goes, is in the former absolutely first-rate. The three youths are actually sung by clear-toned boys (in common with the Solti set only); the three ladies of the Queen of the Night are rather colourless, but their voices are most beautifully matched.

The part of the Queen of the Night itself, though not at all lengthy, is one of the most difficult of all opera roles and one where reputations can be made (Erna Berger made hers in this part). The more times I hear Sylvia Geszty's performance, the better I like it. Her pitch is absolutely precise, her voice is faultlessly flexible; and given the difficulty of the role sounds remarkably unstrained. Her voice has a metallic, almost harsh edge which she plays up where necessary (especially in speech) and which couldn't be better here – an excellent piece of casting, in fact. She is infinitely preferable to Cristina Deutekom in the Solti version (the only excerpts I have heard), who not only has none of the regal authority of Geszty but produces the strangest sort of warbling sound in the (very) upper register – quite unhuman in a way.

Suitner directs the Dresden State Orchestra so well that it doesn't make its presence felt once – it plays with beautiful clarity and cohesion, and there isn't a note that is in bad taste anywhere. The sound is very clear, almost dry (but no distortion), which

CLASSICAL RECORDINGS

suits this opera well. My only complaint is that there isn't enough directionality – it sounds two-dimensional, at the microphones, instead of three-dimensional and 'stagey'.

Accompanying notes are really classy: two booklets in a type of dust-jacket – the first booklet contains notes of very detailed historical interest in German, French and (rather colourful!) English, plus photos of the cast and many of the contemporary Ramberg engravings; the second is the libretto, well laid out in three languages.

I would point out again that this version shows no great profundity; but as a performance which delights in the opera's fancifulness, is not cowed by its reputation and allegorical connexions, and which shows the exquisite proportions of Mozart's writing, I think this could hardly be bettered. – TRB

THE ELISABETH SCHWARZKOPF SONGBOOK Volume 4. Elisabeth Schwarzkopf (soprano); Geoffrey Parsons, *Gerald Moore (pianos). HMV OASD 2844 (texts and translation enclosed) $6.20.

MOZART: Abendempfindung K.523; Der Zauberer K.472. BRAHMS: Immer leiser wird main Schlummer Op.105/2; Sandmaennchen (No.4 of 'Volkskinderlieder'); Wie Melodien zieht es mir Op.105/1; Der Jaeger Op.95/4; Liebestreu Op.3/1; Staendchen Op.106/1; Vergebliches Staendchen Op.84/4. WOLF*: Im Fruehling; Auf eine Christblume (1). GRIEG: Erstes Begegnen Op.21/1; Zur Rosenzeit Op.48/5; Mit einer Primula veris Op.26/4; Lauf der Welt Op.48/3; R' STRAUSS: Die Nacht Op.10/3; Wiegenliedchen Op.49/3.

Elisabeth Schwarzkopf fans should find this record very enjoyable, but anyone who hasn't any of the earlier Songbook volumes should try one of those rather than this new issue. Sad though it is, Madame Schwarzkopf hasn't very much voice left; but the artistry is as wonderful as it ever was, and it is good to see that she continues to make records while she can – she is an amazing 59 this year. Also, as always, Geoffrey Parsons and Gerald Moore play with impeccable taste (and incidently, the record is produced by Madame Schwarzkopf's husband, Walter Legge).

It is maybe a pity that the two Mozart songs were included at the expense of a couple more Strauss songs; generally her Mozart is as bad as her Strauss is good. The two included here, both of limited pitch range, are not too bad, except that rather broad liberties are taken with the tempo K.523, and in K.472 the voice sounds a bit too knowledgeable for the innocent young thing who should be singing. It seems to be the top of her range that Schwarzkopf is having trouble with; the first of these songs is transposed down a semitone to a range of D#' to E", and the second is transposed down a hefty minor third, to a similar range of D' to E" – hardly high notes for a soprano.

Far more than half the songs here are the slow, contemplative sort, at which Madame Schwarzkopf usually excels, but she puts I feel too much warmth, or thick contemplation, into many of them, and even occasionally in the quicker humorous pieces like the Brahms Op.84/4. Her consonants, too, suffer here and there from woolliness. Some of the songs are magnificent, however, such as the Brahms Op.105/2, and especially some of the lighter, faster pieces, notably Brahms' Staendchen, Grieg's Lauf der Welt, and Strauss' Die Nacht.

Schwarzkopf is, I think quite unsurpassed in Strauss Lieder as these two (too few!) songs bear out. Her recording of the Four Last Songs with the Berlin RPO/Szell (ASD 2888) is justly famous; and the seven songs on ASD 2493 (with the LSO/Szell) are quite indescribably beautiful, but are unfortunately backed with four of Mozart's concert arias sung very indifferently.

This review is more negative than I meant it to be; this record is still a very fine affair, but unfortunately suffers in comparison with other Schwarzkopf performances. As for sound quality, I have heard better – the voice is sometimes too forward in relation to the piano (a fault in the original recording) but I think more care could have been taken in the pressing here because there is some painful distortion towards the end of the first side. – T.R.B.

MOZART: Piano Sonatas for Four Hands. Sonata in F K.497; Five Variations on an Andante in G K.501; *Organ Piece for a Clock* in F minor K.608. Christoph Eschenbach and Justus Frantz (piano). DGG 2530-363 ($6.20).

The first volume of the four-hand sonatas I reviewed a couple of months ago (June ETl), and the comments I made then (including those on the sound, which is exemplary) all apply to this volume. Frantz and Eschenbach play with a delightful clarity and precision, and sound quite obviously as if they are enjoying themselves thoroughly; but I don't think this is enough for the meatier pieces. For that reason I think the Andante and Variations is the most successful piece of this record because it has no particularly great profundity. Here Eschenbach and Frantz sound very fine and it is really amazing how little the problems of hand-tangling and non-synchronization seem to bother them.

The short piece for mechanical organ, despite the seemingly inconducive-to-inspiration nature of the instrument it was composed for, is quite another matter. I don't know whose transcription this is, but I feel sure that it isn't Mozart's. It is quite obviously and characteristically a piece for organ of some description, even mechanical, as is quite plain from even the first few bars. The opening chords sound ridiculous hammered-out percussively – they should be towers of sound, relying on the organ's property of maintaining volume until the keys are released. They would have sounded even more ridiculous on the lightweight pianos of Mozart's time. As it is, Frantz and Eschenbach insist on playing in the currently fashionable French style – minimal pedalling and a lightweight, airy touch, which at least on a modern instrument couldn't be further removed from an organ tone.

This style, however, lends itself quite well to the slow movement of K.497, particularly when it includes as much grace as it does here. Otherwise, the two outer movements suffer from the customary lack of proper depth (particularly the first movement).

It should be interesting to hear how the remaining volumes (if any) sound. I assume there are two more. Though most of the 'heavy' stuff is over with, some of what remains is of considerable stature, and it will also be interesting to see what is included and what is not. Remaining are the duet-sonatas K.357 (a misleadingly early Koechelnumber), K.358, K.381, K.19d, the Fugue K.401, and the Fantasia K.594 (also transcribed from the mechanical organ); and for two pianos, a *Larghetto and Allegro*, a *Grave and Presto* K.Anh.42, and the Fugue K.426 (which Mozart later wisely transcribed for strings and added an Adagio (K.546).

The four-hand and two-piano music of Mozart is very hard to come by elsewhere, and in complete form is only available (not here of course) on L'Oiseau Lyre (four-record set), played by Demus and Badura-Skoda, a set praised by the *Gramophone* fro completeness, but the performances were regarded indifferently. I don't know why this music should be so thin on the ground, for much of it is so good; but I'm afraid that at the moment what there is hasn't really got off the ground. – T.R.B. ●

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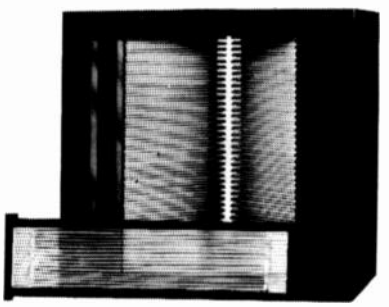
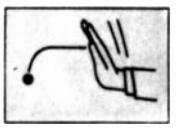


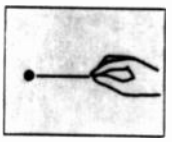
The Heil Air Motion Transformer—The loudspeaker of the future.

To form a picture of the completely new technique by which the Heil Air Motion Transformer generates sound, imagine trying to set a cherry pit, a low mass object (air), into motion with a high mass object, the flat of your hand (cone and voice coil).



This is obviously a technique of low effectiveness because the great mass of your arm and hand relative to the small mass of the cherry pit prevents rapid movement and results in a poor transfer of kinetic energy from your arm to the cherry pit. Result: the pit can never move faster than your hand pushes it. Moreover, when trying to accelerate your hand rapidly and stop it suddenly, the great inertial force created by the mass of your arm results in sluggish starts and overhanging stops. All the dynamic drama of music is removed.

And yet for all its shortcomings, this is the way sound has been reproduced since the acoustic phonograph. Now imagine placing the cherry pit between your fingers and squeezing. The result: high effectiveness in the transfer of kinetic energy from your finger to the cherry pit, great movement of



the cherry pit with a small but powerfully effective lever-like movement of only the tips of your fingers.

This analogy describes the ESS Heil Air Motion Transformer's principle. Sound is squeezed into the air instead of pushed toward it. A light small surface only .5 mil thick and made of a recently perfected plastic having enormously high internal molecular damping is formed into multiple interfacing cavities. The volume of these cavities alters in response to electro-magnetic forces generated by a uniformly distributed conduction cortex and projects sound outward with an almost perfect transfer of kinetic energy. The entire moving system is only two inches by five inches and its mass is effectively equivalent to only *three-quarters of a linear inch* of air across its surface—by contrast a conventional cone mechanism is effectively equivalent to one to three feet of air. This permits the moving system to react exactly with the input signal and results in an incredibly accurate conversion to sound waves, a conversion realized by the listener as vastly superior definition, clarity and spatial proportionality. Music is reproduced to scale with a distinctiveness to each individual timbre that marks the difference between merely satisfactory reproduction and sound as clear as light.

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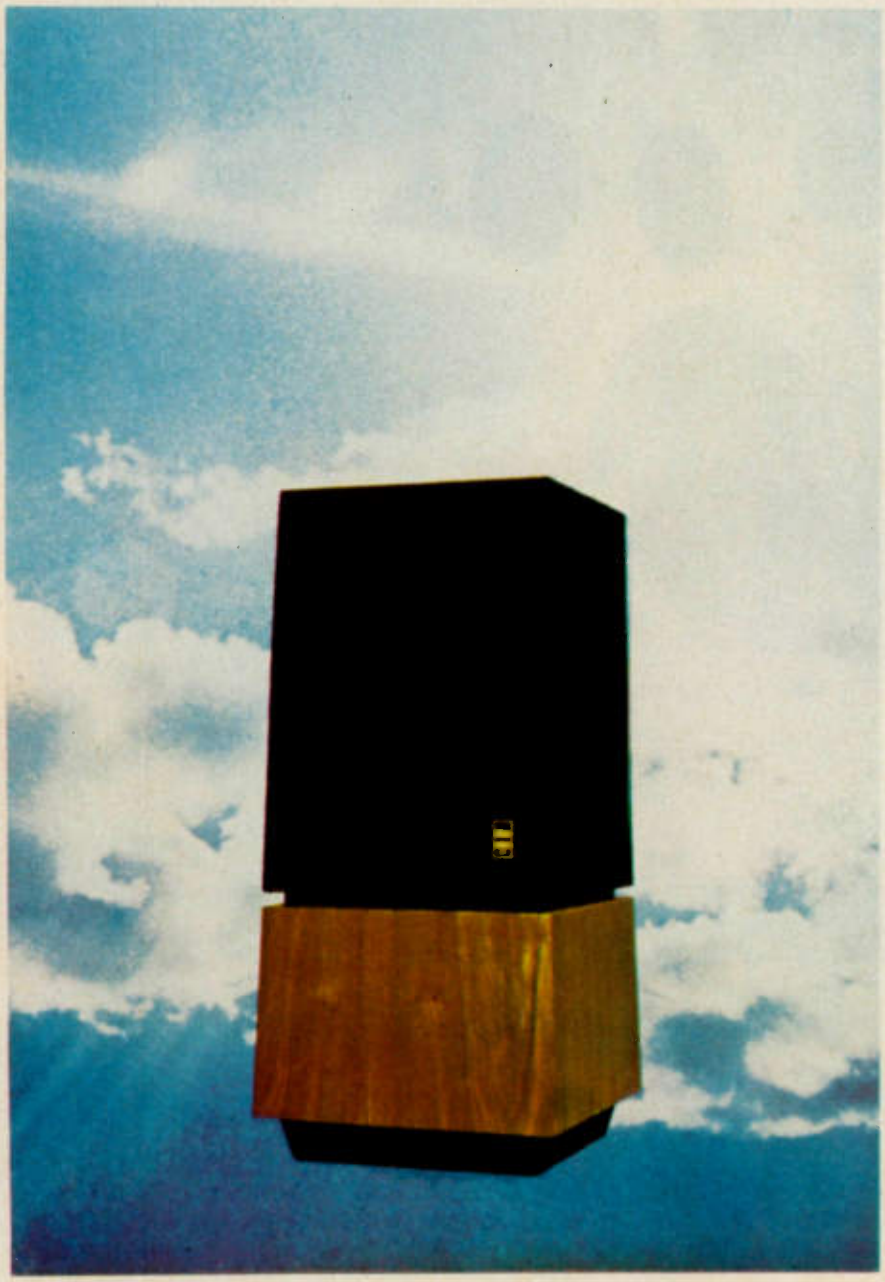

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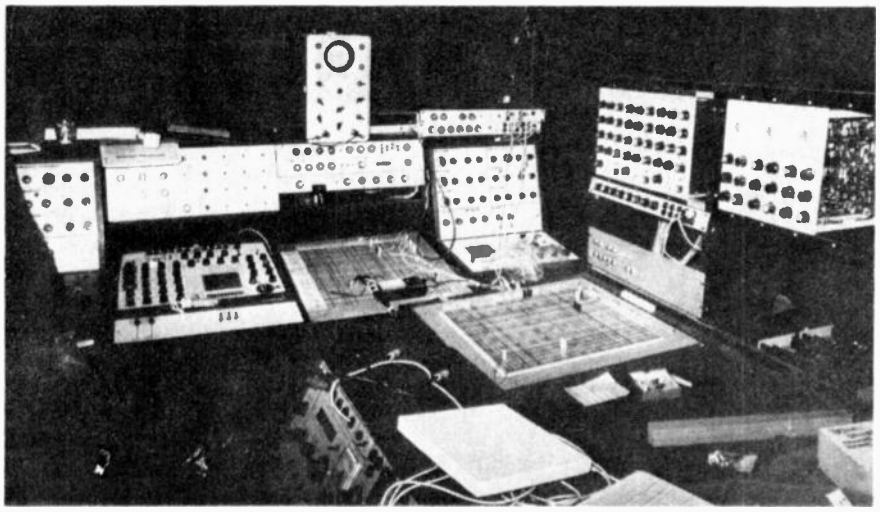


◀ *General view of Studio showing two matrix pin patching boards; on right are envelope shapers and voltage controlled filters. To the right of the oscilloscope is a digital frequency meter, a random voltage generator and a pitch to voltage converter.*

Scott Joplin a la synthesizer — Terry Mendoza reports.

PRODUCE, said the man, an album of synthesized rag-time music.

Scott Joplin '75 as it were.

The challenge was irresistible. Peter Jacobsen, a blind and highly talented pianist, and Trevor Taylor, a percussionist with an abiding interest in electronic music, completed the team.

The requirements of the album were that it should possess the commercial appeal of 'synthesizer sound' whilst interpreting the rag-time idiom in the way in which the composer, Scott Joplin would have approved.

It was obvious that it would not be easy, as the score was originally intended for solo piano, and suitable contrapuntal parts had to be arranged to warrant performance on a synthesizer; Peter had necessarily to work out and remember these parts in his head.

The following equipment was used for the initial sessions:— one EMS 'AKS' keyboard synthesizer; one EMS 'VC23 Synthi' with 'DKI' keyboard; high-speed half-track Ferrograph Series 7; Revox tape deck equipped with sel-sync on one channel; domestic Dolby B processer/de-processer; Leak 30 amplifier and louspeaker system.

The multitrack procedure was utilised for recording each tune, starting with the least significant parts (percussion and bass line), so that the quality was preserved on the more vital melody material.

Keeping the number of track-to-track transferences to a minimum also contributed to maintaining the quality.

Our first stage was to record a bass line on to the upper track of the Revox. The unused synthesizer was set up with a percussive "white-noise envelope" which allowed Trevor to lay the percussive rhythm at this same stage, thus saving one copy. Once recorded, the composite upper track was monitored on sel-sync, i.e. fed through the record head to the monitor circuit, so that the bottom track could be recorded in sync with it. It was immediately apparent that the timing of the initial track had to be impeccable, as every track subsequently laid had to synchronize exactly.

Both synthesizers were basically monophonic — suitable harmonies had to be built up by further layering — it proved impracticable to run oscillators from both synthesizers 'in tandem' via a single keyboard. As well as the first harmony line, the bottom track of the Revox was taken up by a further percussive sound simulating a bass drum.

The two completed Revox tracks, each carrying two sounds, were then fed to the two input channels of the VCS.3, to be further modified and then controlled by the two output pan-pots to give the beginnings of a multi-track stereo image.

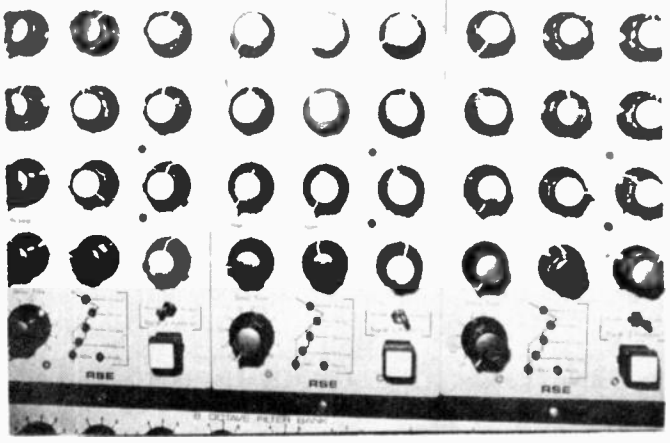
A passive resistive network was lashed up to patch the VCS.3 outputs to the Ferrograph stereo inputs in combination with the output from the other synthesizer. Monitoring the Ferrograph inputs, Peter now added his second part of the harmony.

To lay down the next part, the whole process was adopted in reverse, playing back the composite Ferrograph tape through the resistive mixer and again recording on the Revox.

This 'bouncing' of the tune between machines was continued, adding an extra track each time until three harmony, two melody and one counter-melody line had been added.

For two very trying days we worked to produce two short tunes, after which time we were acutely aware of the limitations of the recording process — and of the synthesizers. Slight frequency response discrepancies between input and output amplifiers were converting what started as crisp, fresh sounds, into muddy ones after they had been copied a few times. The signal-to-noise ratio was 'good', but not really up to professional standard.

On the principle that there is no 'right' or 'wrong' synthesizer sound as there would be if one tried such tricks with conventional orchestral instruments, we pre-emphasised the treble frequencies and Dolby-deprocessed the hissy signal on the penultimate dub. Although the hiss was definitely much reduced, the



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recording as a whole sounded rather lifeless.

The fickleness of the synthesizer tuning caused the most exasperation. The keyboard seemed to suffer a pitch 'warp', so that on each side of the mean value the tune became progressively sharp. To obtain an acceptable chromatic scale, the voltage control was adjusted so that the mid-point of the warp corresponded with the mid-scale of the musical part being played; the playing had to be confined to a ¾-octave spread on each side of this value, entailing drastic re-thinking of the arrangement.

As the oscillators warmed up, tuning drift caused a further problem; we tackled this by switching the equipment on long before the session, and recording a reference tuning signal on the tape at the very start, so that all future copies could be tuned to this note. Just prior to each take the same tuning procedure was repeated, namely getting the correct tuning spread followed by unison and octave zero-beating tuning with the reference tone.

One of our biggest handicaps was the very slight linearity discrepancy in the voltage/pitch function of the various oscillators. When tuned to unison (zero-beating) at a particular frequency, one oscillator would warp relative to the other, resulting in an increasing beat frequency as the keys further from this note were depressed. This effectively limited us to a single oscillator working, which also drastically reduced the scope of tone colours available.

Another treatment denied us was sub-audio frequency modulation, the true 'vibrato' effect, as patching in the sub-audio frequency completely upset the keyboard tuning. This was possibly attributable to a slight off-set de-voltage value for the 'bass line' of the sub-audio control waveform.

An interesting point was the criticality of amplitude settings when using matrix pin-patching of signals; if the amplitude of the original tone generators was too low, the later stages, envelope generators and filters, had to be turned to a high gain introducing unwanted system noise into the sound. Conversely, too high a gain resulted in break-through of the signal through the envelope shaper, but here again this may have been due to the particular synthesizers we were using.

After discussion, we concluded that the creative aspects of the project were being limited by the equipment in use. It was agreed that we should start the project again, this time using a more sophisticated technical set-up.

In actuality our choice of venue was limited to 'Electrophon Music' one of the sole commercial electronic music studios in Britain. Run by Brian Hodgson and Delia Derbyshire, both formerly of the B.B.C. Radiophonic Workship, the studio is housed in one relatively small room. Two of the walls are occupied with various voltage control devices and two 64 x 64 way patch panels. The centre of the room is dominated by a comprehensive 10-channel R.S.E. mixing desk which is routed to a Brennell-Richardson 8-track recorder and three high-speed Revoxes for mastering purposes. One of the Revoxes has been modified to take the vari-speed attachment, to allow tape speed variation on record or replay.

Along the back wall are two Tannoy monitor speakers fed from a Quad power amplifier. Buried well out of the way are two Grampian Reverberation spring units.

The first day's work at the studio was rather bewildering, as we had progressed from a very limited situation to one in which virtually any effect was possible.

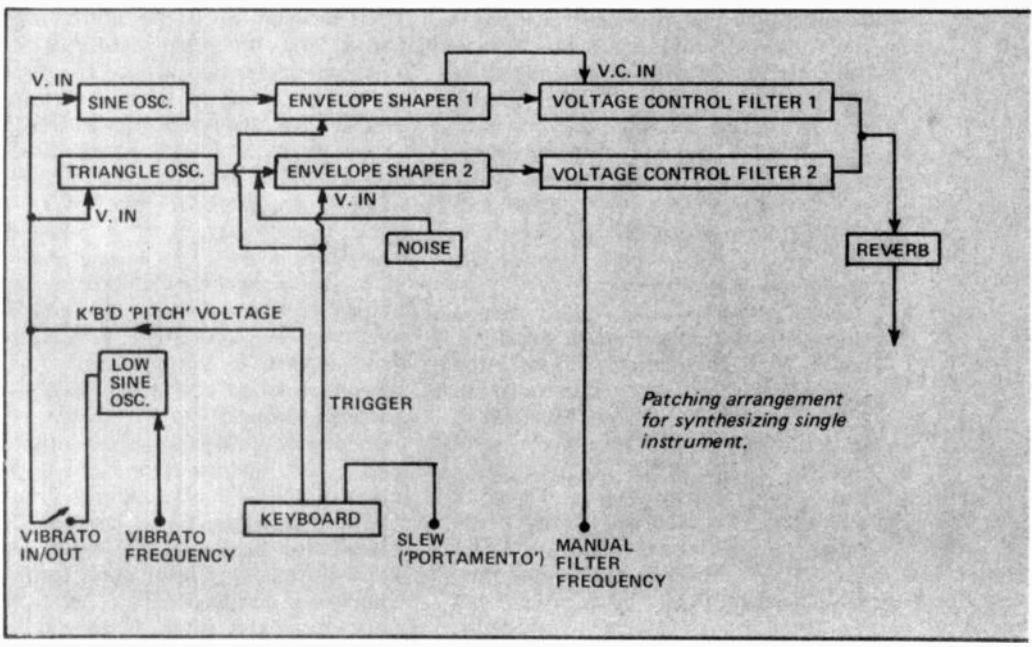
Metering provided some initial difficulty; the signals were mixtures of pure tones which can be audibly deceptive in themselves — a low frequency sine wave may appear to be of small amplitude, when in absolute terms it may be of very high power.

A second concern was the frequency sensitivity of the meters — they may be indicating an overload condition at a level much below tape saturation. The mixer meters had been adjusted to indicate the actual tape saturation levels, and were consulted with more faith than the P.P.M's on the Brennell, which may have also been rather frequency sensitive.

The studio has been calibrated to use the BASF range of professional low-noise high-output tapes, and it is very disconcerting to watch the meters on the mastering Revoxes flicking so much into the red — the mixing desk V.U.s were carrying the true signal levels. Before carrying out a mix-down from the Brennell to the Revoxes, the stereo image was set up as follows:—

A tone was fed into one mixer channel with the associated pan control on the left position. The main output channel controls were adjusted next, so that the left output meter indicated the same reading as the channel from which the tone was being sent. Turning the pan control to the right, the same procedure was adopted. Finally, with the pan control in the mid-position, both output meters indicated the same degree of modulation, after which the Revox level meters were double checked to ensure they were also receiving equal modulation for left and right channels (their input gain controls had been rendered pre-set by the removal of the gain control knobs, thus avoiding accidental re-setting).

A far more sophisticated system of working was now possible. All signals and controls entered at the left side of the matrix boards, leaving at the top. In addition to the normal resistive pin-patching which is common to the EMS range of synthesizers, numerous



Patching arrangement for synthesizing single instrument.

ELECTRONIC RAGS

'open pin' leads were also available, enabling direct patching into the boards, so that occasional ancillary devices, for instance the random voltage generator that I brought along, could easily be routed in.

The keyboard sequencer was the centrepiece of the operation. It has a three-layer memory with controls to vary the analogue voltage increments of the real-time or remembered voltage control signals. The memory position is indicated by a cold cathode readout, and can be 'inched' or clocked through at any speed, forwards or back, and may even have its clock speed externally voltage controlled. For our particular application the memory as used to register a short passage that would be featured at the 'next take', and this voltage sequence used to test the effectiveness of the sound being set up, at the same time avoiding the need for Peter to keep playing the same piece over and over again.

Tuning was much simpler; the oscillators were switched on very early to give them time to stabilise, and one was used solely as a reference signal tuned, using a Heathkit digital frequency meter, to read the keyboard centre F sharp (to our approximation 370 Hz).

This same reference signal was also patched to the X-plates of an oscilloscope with the time-base switched off. The keyboard real-time voltage was patched to a number of the other oscillators, one of which was routed to the Y-plates. The keyboard control voltage output is of the centre-zero type, and the centre note is F sharp, so this key is depressed and the frequency of the oscillator under keyboard control manually tuned until the Lissajous figures on the screen indicated that unison tuning had been achieved, i.e. a static circle or ellipse. In practice one had to be satisfied with a slowly changing ellipse or premature baldness! The next stage was to press the F sharp of the next octave and adjust the keyboard output 'increment size' until a nearly static figure eight Lissajous was again seen.

We had earlier discovered that a single keyboard-controlled oscillator has a limited aesthetic appeal, the requirement being for two or more oscillators to be tracked together in unison, octaves, or some other musical interval, apart. Hence our next stage was to substitute a second keyboard-controlled oscillator for the reference oscillator going into the oscilloscope, roughly tuning the two oscillators aurally by manually altering the frequency of the second oscillator, with the final tuning carried out to minimise Lissajous figure movement.

Once the wave forms had been chosen, tuned to the requisite intervals and amplitudes, they were then routed to the various modifying devices. A vast range of effects were possible, using the R.S.E. custom-built bank of voltage controlled filters and envelope shapers.

It did not take us long to discover, however, that the automatic voltage control effects had to be integrated with fairly complex manual effects, or the results very quickly became tedious. Choice of the 'right' sound was not easy. A sound that seemed lacking in character on its own, was often quite startling in an 'ensemble' when contrasted against stronger sounds. Similarly, we often found very rich individual sounds which had great interest on their own, but which refused to blend or became totally neutral in the mix.

With the complex patching arrangement we were now using, it was difficult to avoid slipping into the patching habits which gave us quickly acceptable results.

The envelope shapers, although extremely versatile, produced many wave forms which were not suited to our purposes. The 'on time' had to be switched to follow the key actions – elongation of this period prevented Peter playing rapid passages, as the decay would not have commenced before the next note was played, blurring the note definition. Similar comments apply to the attack time which had to be kept to an eighth of a second or less for the percussive type of notes demanded by rapid playing.

One problem which we did not solve for a long time was achieving the 'chunky' bass sound needed to propel the tunes along. The ear, being less sensitive to the bass frequencies as against those in the mid-range, would hear the notes as either clicking 'rasps' (with square waves) or muffled 'hum' (with sine wave or top-filtered triangular waves). The answer was to feed two unison oscillators, sine and triangle to one envelope, with a string bass type envelope shape, feeding the same sine wave simultaneously to a second envelope and mixing the two envelope outputs.

On occasion we synthesised a useful bass sound, marred by a slight upper frequency 'tizz''. The solution here was to group the signal through the octave filter bank, and then selectively cut the frequency until the offending component disappeared.

The bass was often filled out by double tracking a typical bass guitar type of sound with a longer 'droning' envelope on another tape track.

The octave filter bank was also a useful tool when we attempted synthesis of conventional instruments, as subtle changes in tonality gave the added control needed for the imitative work.

Timing discrepancies initially caused problems, but working with an 8-track machine we were able to set up one track and record an 'electronic metronome' sound at a suitable tempo. After four or five tracks had been laid in sync with this, a click track was then erased and the newly empty track used for another take.

In the early stages we worked on the basis of a two mix-down procedure, i.e. laying down six tracks, then mixing them in stereo on to tracks 7 and 8, which left the first six available for re-use. Once filled (in sync with 7 and 8) the whole eight tracks could then be mixed down to stereo. We noted that once the second set of tracks were laid, the mix on 7 and 8 was not always exactly as we would have wished, so we adopted a new way of working, based on the fact that most tracks contained material over fairly short periods, i.e. it was uncommon to find signals appearing on all tracks simultaneously. It was possible to drop into record, and with care, to drop out of it again, without leaving any click, so we compiled our first eight tracks, and then once a sound had been set up for the 'ninth' we would work out which track had a suitable gap at the desired time in the tune, using our written tape log. We would then drop the sound in at this point. Thus, by the time we had finished, many of the tracks contained a jigsaw of timbres. One benefit was that quality was maintained by not copying before the mix down, but there was the disadvantage that more juggling of the faders was required.

Reverberation naturally played a large part in the production. We tended to confine it to the melody and percussive parts, keeping the harmony relatively dry, and the bass quite dry. The reverb was passed via a tape delay, to separate it slightly from the original sound and maintain clarity.

Probably the biggest problem was audio fatigue. Listening to pure tones soon tried the ears so that the monitor gain controls were gradually brought up during the day – as each session progressed, it became more difficult to judge an interesting sound from one resembling a cheap reed organ! We tried to counter this by working on it only two days a week. This did help, despite one rather unpleasant by-product of the sessions, which was manifest two days after – a blinding headache due to the auditory strain!

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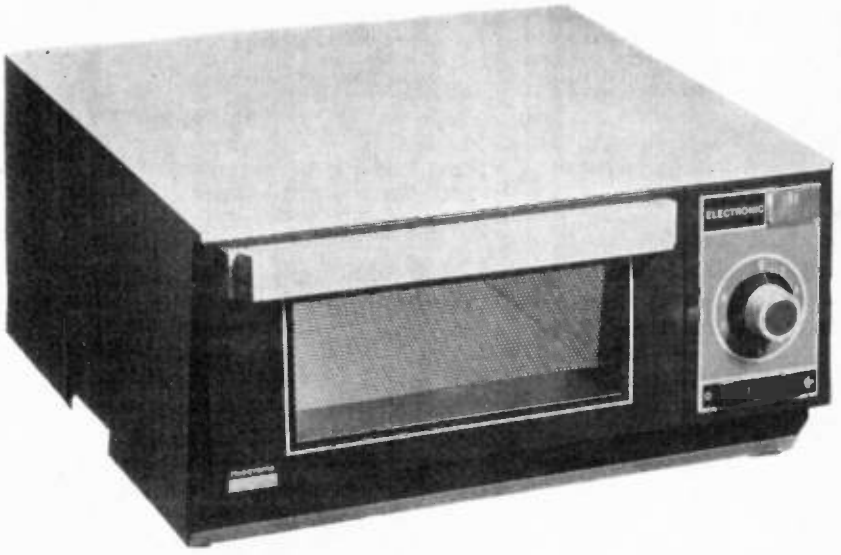

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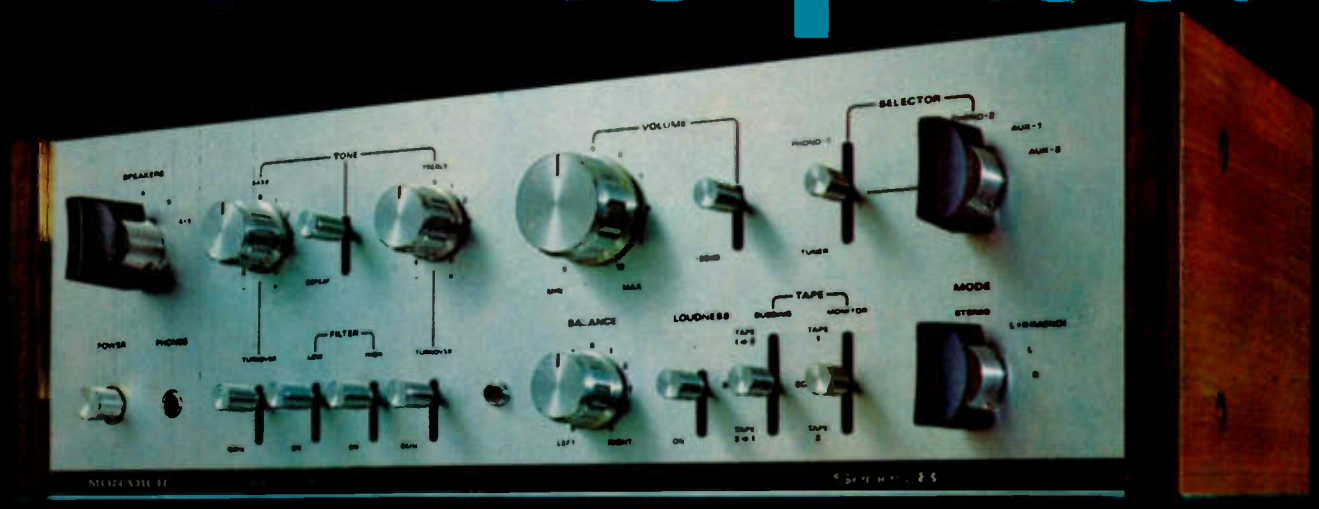

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