Jonsen

MARCH, 1974
60c*

electronics TODAY INTERNATIONAL

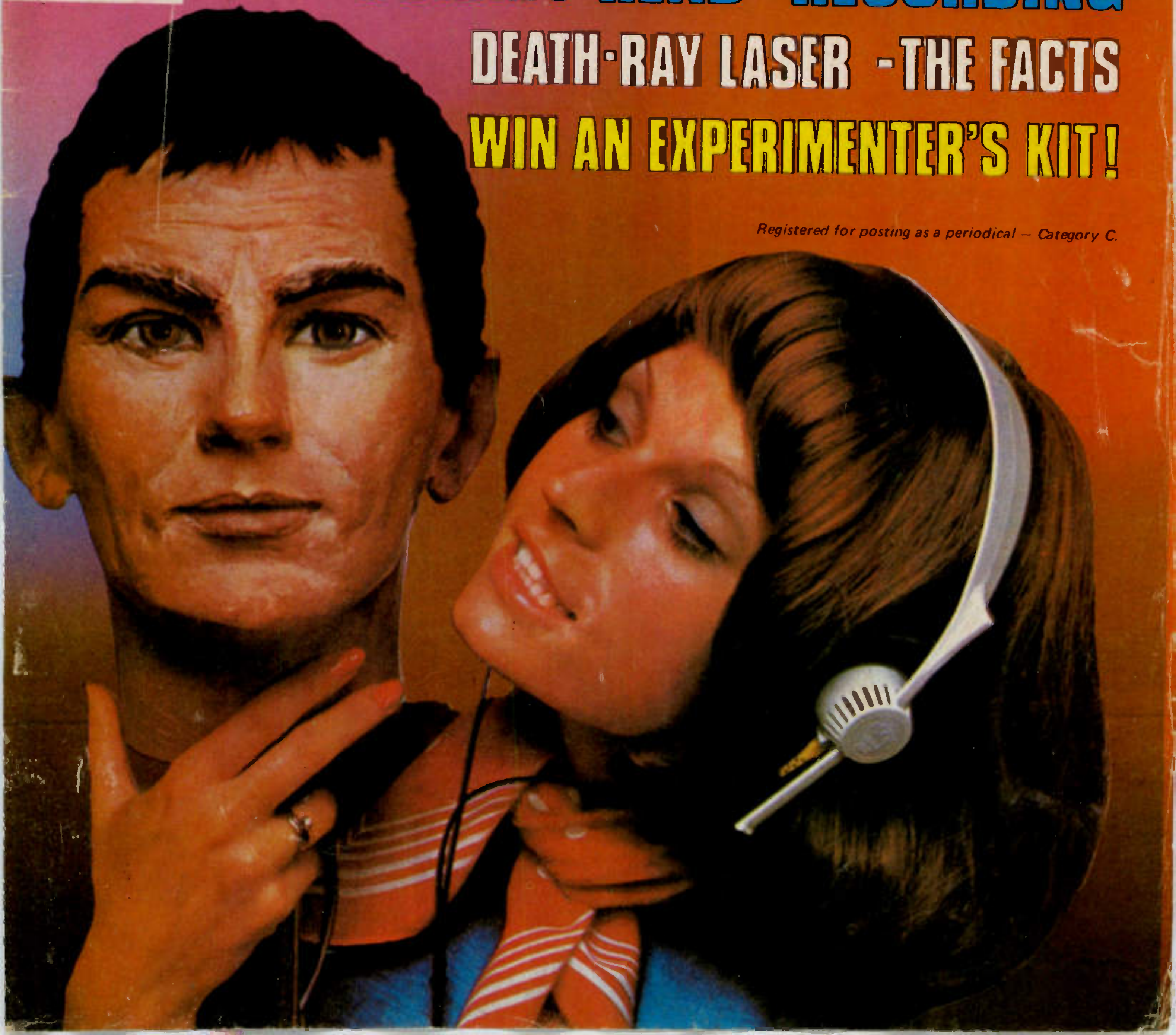
HI-FI

'DUMMY HEAD' RECORDING

DEATH-RAY LASER - THE FACTS

WIN AN EXPERIMENTER'S KIT!

Registered for posting as a periodical — Category C.



You wouldn't buy the wrong pair of shoes for your feet.

A-3300

So why buy the wrong tape deck for your home?

It can happen. There are so many to choose from. Each has its own way of enticing you.

Yet the TEAC A-3300 stereo tape deck stands out. It has everything a serious amateur would want, plus many features that even the professionals love.

It accepts the big 10½ inch reels. So when you give your next party, you'll have uninterrupted music for many hours. Instead of having to change tapes all the time.

Your own recording technique will improve also. Because the A-3300 has TEAC's unique Edi-Q, an electrical record pause control. It eliminates the clicks and snaps that can occur when you pause and then restart. The professionals use it. Now you can also.

You'll especially appreciate the front panel bias switch for the proper selection of bias current and recording equalization. It's an important feature; it gives you the most enjoyment from the new low noise/high output tapes, as well as regular tapes.

Attach TEAC's AN-180 to the deck. It's our Dolby* Noise Reduction Unit. You'll enjoy sound perfection because the Dolby eliminates unwanted tape hiss and noise. Music never sounded so good.

We invite you to take the step and bring this TEAC package of sound into your home.

Notice how well it fits.

TEAC
The sound of perfection

AN-180

AUSTRALIAN DISTRIBUTORS: Australian Musical Industries P/L., 155 Gladstone St., South Melbourne. Vic., 3205. Phone: 69 5888 — 619 Pacific H'way., St. Leonards, N.S.W., 2065. Phone: 439 6966 — Arena Distributors, 273 Hay St., East Perth. Phone: 25 9993 — Sth. Aust. Truscott Electronics Pty. Ltd., Hindmarsh Square, Adelaide. Phone: 23 3024. Miltons Department Stores Ltd., P.O. Box 146, Norfolk Island. OCEANIC DISTRIBUTORS: New Zealand: Direct Imports (N.Z.) Ltd., 590W Southampton Street, Hastings. Phone: 89 184 — Fiji: D. Jeevan & Sons, 87 Cumming Street, (G.P.O. Box 148), Suva. Phone: 22710 — New Guinea: Paul Mow & Co., Box 449, Lae. Phone: 2953.

• 'DOLBY' is a trademark of Dolby Laboratories, Inc.

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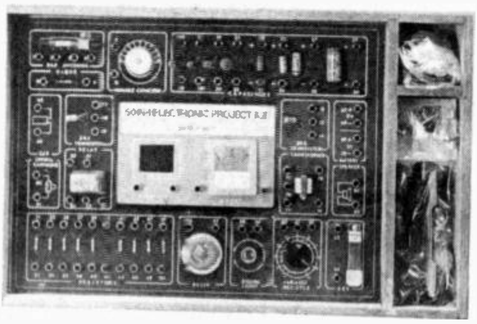

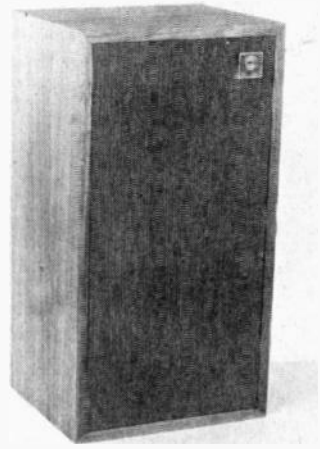

COVER: This dummy head is used by Sennheiser to produce revolutionary new recordings – report on News Digest pages, this issue.

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Four-channel Follies

DESPITE extensive promotion, four-channel sound has not been the overwhelming success that many expected.

Obviously this situation is partially due to uncertainty as to which of the competing systems will be accepted as the industry standard.

But apart from this there are many hi-fi enthusiasts who feel that four-channel sound, in its present form, does not add a great deal to their listening pleasure.

In this issue, two of our contributors — each highly respected in his own field — discuss why this is so.

Interestingly, both agree that much of the problem is due to the recording industry's present practice of re-arranging their existing four-channel master tapes — that just happened to be their studio standard — and marketing the result as four-channel sound.

Even worse has been their attempt to justify their musical gymnastics by describing the 'new musical experience' as part of the course of the evolution of music. A truly nonsensical act.

We believe that surround-sound is here to stay. It may well be achieved within the format of one of the presently competing systems. But if it is, there will probably be major changes in the manner in which recordings are made.

It is reliably reported that several companies are actively developing totally new recording techniques that take full advantage of the considerable but currently unrealised potentiai of both matrix and discrete equipment. Some of these developments may well be revealed later this year.

In the meantime it is ironic that by far the most convincing demonstration of four-channel sound we have ever heard was via conventional stereo headphones reproducing Sennheiser's extraordinary binaural record — described elsewhere in this issue.

The experience was quite uncanny — it being possible subjectively to locate sound sources with apparent precision, not only front and rear — but within the vertical plane as well.

Sennheiser's binaural record is intended solely for reproduction through headphones. However Professor Sennheiser told the Editor of our associated audio trade magazine, whilst she was in Germany last month, that his company's experiments may eventually lead to a whole new concept of equipment and recording techniques.

It seems as if 1974 will be an interesting year!

Collyn Rivers

ROTEL®

goes 1 better!

Since Rotel introduced its RA 210, RA 310, RA 610 to the Australian market, the acceptance has been remarkable and the praise lavish from those who really know a topline amplifier when they use one.
Now Rotel launches its new range of even more sophisticated models, easily identified by simply adding a "1" to the numbers above! Read all about this fantastic new Rotel range with second to none value, more quality, lower distortion!

RA211

Frequency response 20-75,000 Hz. 12 watts RMS per channel. 50 watts total music power (IHF). All solid state electronics, all silicon output transistors. Pushbutton controls for power, speaker system 1, speaker system 2, loudness and tape monitor. Headphone jack, facilities for magnetic and ceramic cartridges, tuner, tape recorder, auxiliary equipment. In handsome timber cabinet.

RA311

A solid state integrated amplifier that lets you enjoy a new world of genuine high fidelity sound! Advanced solid state electronics, low-noise silicon output transistors, 22 watts RMS per channel at 8 ohms, 90 watts total music power (IHF). Frequency response, 15-90,000 Hz distortion 0.1% at 1 kHz. Facilities for magnetic and ceramic cartridges, radio tuner, two tape recorders, and auxiliary input. Tape dubbing from tape 1 to tape 2, 4-channel matrix speaker switch for simulated 4-channel surround effect. High and low filter, loudness, and 1 and 2 speaker system switches. Housed in handsome timber cabinet.

RA611

140 watts total music power (IHF), 35 watts at 8 ohms, RMS. Frequency response 5-100,000 Hz, distortion 0.1%. Generates an amazingly transparent sound. Professional tape dubbing facilities from tape 1 to tape 2 or reverse, facilities for two turntables (magnetic), tuner, two tape recorders, and two auxiliary inputs. Three AC outlets, tone control defeat, muting, high and low filter switches. Individual bass and treble controls for each channel. Slider controls for balance, bass and treble.

See also the potent RA 1210, 160 watt RMS (4 ohm) amplifier with twin power.

HEAR THE NEW ROTEL "1 BETTER" RANGE AT

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Telephone: 21 3623

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Telephone: 23 3599

TAS Audio Services, 44 Wilson St., Burnie 7320
Telephone: 31 2390

VIC Encel Electronics Pty. Ltd., 431 Bridge Rd., Richmond 3121
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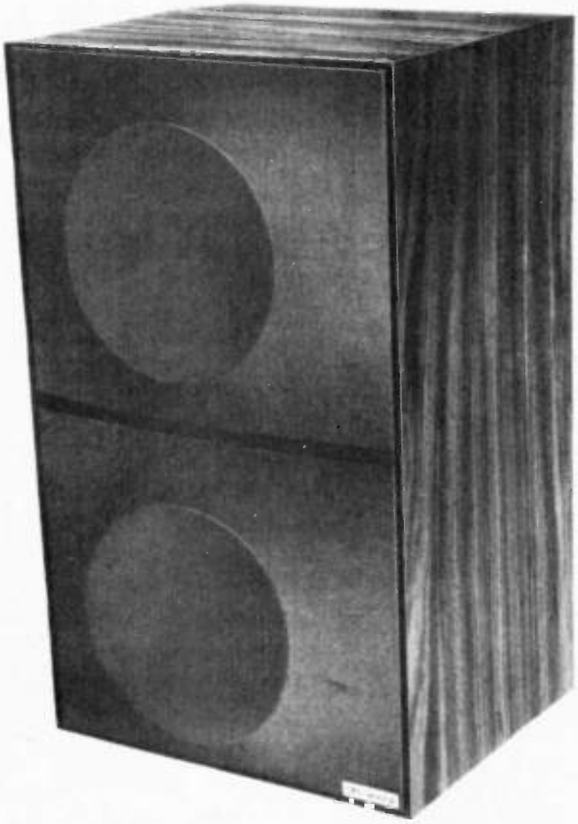
ULTRALINEAR IS HERE

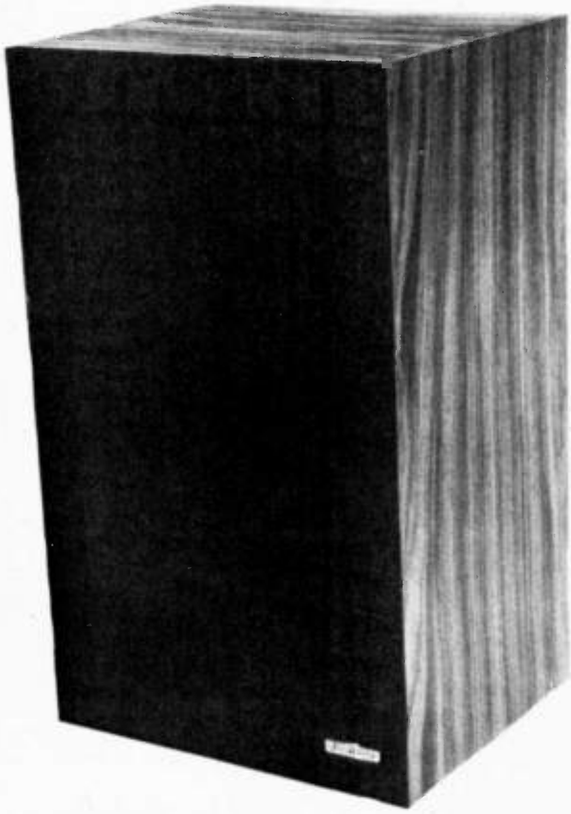
THE MOST TALKED ABOUT SPEAKERS AT THE SYDNEY AND MELBOURNE HI FI SHOWS. AT INCREDIBLE PRICES.



MODEL 200

DRIVERS 12" Air Suspension Woofer.
5" Sealed Midrange.
2½" Super Tweeter.
FREQUENCY RESPONSE 28Hz to 20,000 Hz
CROSSOVER FREQUENCIES 1500 Hz and 4000 Hz
MINIMUM POWER REQUIREMENT 10 watts RMS-
MAXIMUM POWER HANDLING 60 watts RMS
NOMINAL IMPEDANCE 8 Ohms
COLORS AVAILABLE: RED, BLUE, BLACK, BROWN, TIMBER WALNUT FINISH
SIZE: 24 3/8" H x 14½" W x 12" D

PRICE $139 EACH

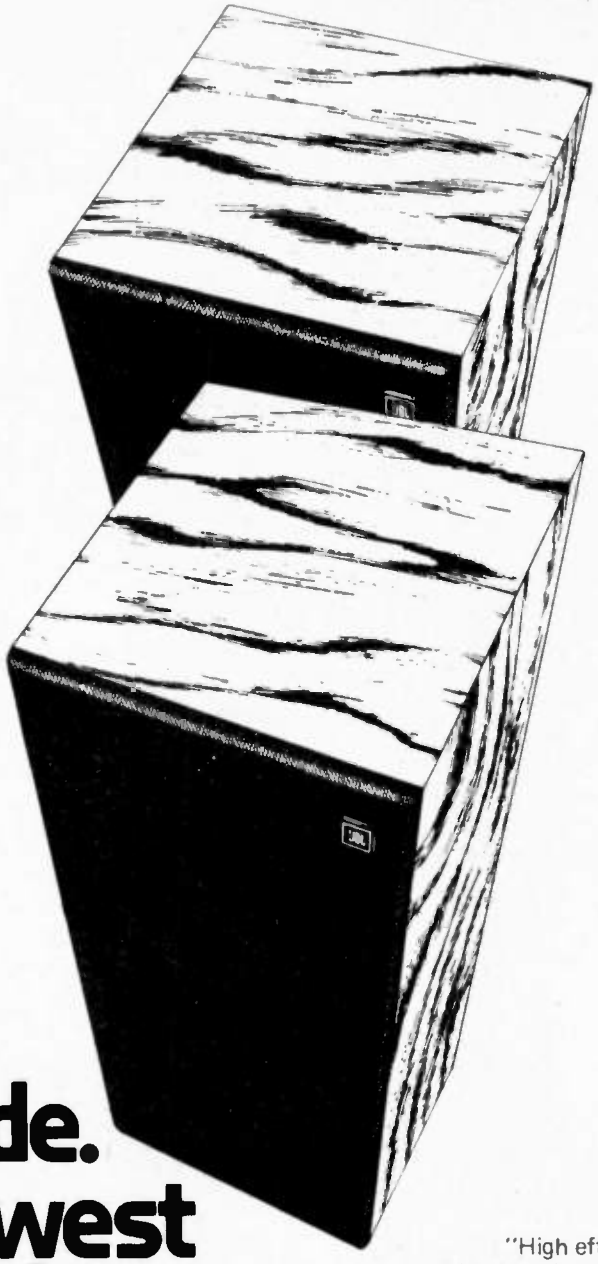


MODEL 150

DRIVERS 12" Air Suspension Woofer.
2½" Super Tweeter.
FREQUENCY RESPONSE 32 Hz to 20,000 Hz
CROSSOVER FREQUENCIES 2500 Hz
MINIMUM POWER REQUIREMENT 5 Watts RMS
MAXIMUM POWER HANDLING 40 Watts RMS
NOMINAL IMPEDANCE 8 Ohms
COLORS AVAILABLE: ORANGE, CHARCOAL
TIMBER WALNUT FINISH
SIZE: 24 3/8" H x 14½" W x 12" D

PRICE $119 EACH

AVAILABLE FROM
SYDNEY: Autel Systems Pty. Ltd., 412-4377; Dyna Stero, 51-7071; S.G.Everets, 602-7859; Appollo Hi-Fi 560-9019.
NEWCASTLE: Hi-Fi; Taree Photographics; CANBERRA: Pacific Stereo. MELBOURNE: Radio Parts; S.A. Sound Spectrum; TAS: Belcanto Audio; W.A. Arener Distributors; BRISBANE: Tel Air.

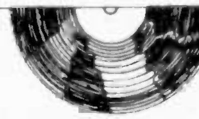


Decade. JBL's newest loudspeaker.

(The price has been strategically placed in a later paragraph of this advertisement. We can't have you running into your JBL dealer's because of "price." That's not even the right reason.)

Some of us think Decade is the best two-way sound system we've ever made. If you'll forgive a few buzz words, we'll tell you why:

"Definition." That's a loudspeaker's capacity for letting the listener hear each part, every part of a whole sound. JBL's Decade has almost perfect definition.



What makes JBL loudspeakers so different from the rest?

Well, we grew up on the other side of the sound tracks, in the music business, making loudspeakers for recording engineers, professional musicians – people who listen to music for a living.

Would it impress you to know that the top professional recording studios like Warner Brothers and Capitol and Elektra and MGM use JBL loudspeakers to record, play back, mix down and master their music? It's true.

"High efficiency". Very important. Most loudspeakers are low efficiency speakers they need a big amplifier to give you back a big sound. Not JBL. The big sound is built in, and a little amplifier goes a long way.

"$189". That means if you've been saving up for a JBL loudspeaker, stop.

Come hear JBL's new Decade. Except for the price it sounds expensive.

JBL

James B. Lansing Sound Inc. 3249 Casitas Avenue, Los Angeles 90039. High fidelity loudspeakers from $189 to $4,000.

Distributed in Australia by JERVIS AUSTRALIA PTY LTD. **P.O. Box 6 Brookvale, NSW.**

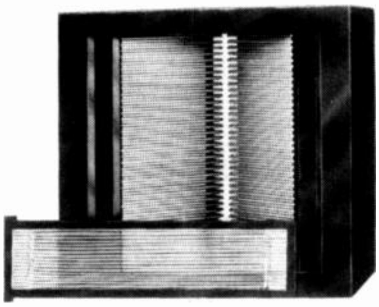
LIGHT YEA

Threadbare though the word "revolution" has become, the ESS amt 1 loudspeaker marks a revolution in high fidelity reproduction through its incorporation of the Heil Air Motion Transformer, developed and perfected by Dr Oskar Heil, of Heil Scientific Laboratories, Inc., over the last four and one half years. This exciting new device gives the ESS amt 1 the first authentically new approach to sound generation in fifty years.

By utilizing the Heil Air Motion Transformer the ESS amt 1 breaks completely with sound generating principles that stretch back, unchanged, to the earliest acoustic phonographs. From turn-of-the-century "talking machines" through today's most sophisticated component systems, the air pressures you hear as sound have been created by the direct push of a diaphragm surface moving forward and backward to get air motion. As the diaphragm surface works directly against the air its movement must be as great, and as rapid, as the required air movement — and this holds true for cones, electrostatic panels, piezoelectric crystals, traveling wave transducers and even ionized air devices that have an ionized cloud moving "forward and backward" just like a paper cone.

The Heil Air Motion Transformer, used as the mid and high frequency reproducer in the ESS amt 1, departs dramatically from this traditional concept of sound reproduction. By squeezing air instead of pushing it, it effectively creates *fives times* more air movement than the direct push of an equivalent flat surface and accelerates transducer design light years ahead. The Heil Air Motion Transformer has no "piston" surface, no voice coil, no elastic suspension devices, no significant mass, no "forward-backward" motion, no resonances, and is so light and simple that it carries a lifetime warranty.

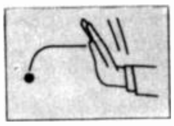
Instead of trying to displace air molecules with the forward-backward motion of a flat or cone surface, the Heil Air Motion Transformer harnesses the power-purchase of a pneumatic "lever" and by applying small squeezing forces over a large surface area produces air movements *five times greater* than an equivalent "pushing" piston surface. And whereas the energy applied to a piston driver is used to push a cone that pushes the air, the Heil Air Motion Transformer squeezes air *directly*. As a



The Heil Air Motion Transformer — The loudspeaker of the future.

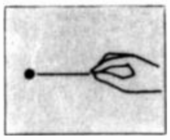
result of this greater more direct and near massless transfer of energy, the Heil Air Motion Transformer approaches instantaneous acceleration for flawless transients, has no "cone breakup" to create coloration, and shows distortion figures as fine as modern electronics to recreate the sharpest of images, the cleanest of attacks and the highest harmonics with a clarity and immediacy never before experienced.

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 imput 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.

The ESS amt 1 combines the amazing Heil Air Motion Transformer with a newly developed ten inch woofer which has an oversize, deep-drawn frame assembly and a powerful magnet to permit exceptional excursions at the highest possible acceleration. The woofer is critically designed for clean, impactful low frequency response and exciting transient capabilities that precisely complement the open articulation of the Heil Air Motion Transformer. The ESS amt 1 triumphs over time and space by recreating in all its past, distant grandeur, every nuance of the original performance. Nothing we say, or can say, will adequately prepare you for the ESS amt 1's incredible new aural freedom, clean, clear and airy as light.

RS AHEAD

The AMT-1 is available from the following leading capital city retailers. Distribution will be expanded as and when stock permits.

N.S.W.

AUTEL SYSTEMS PTY. LTD., 639 Pacific Highway, Chatswood, Sydney, 2067. Phone: 412 4377

CONVOY TECHNOCENTRE, Cnr. Plunkett & MacLean Sts., Woolloomooloo, Sydney, 2011. Phone: 357 2444

INSTROL HI-FI CENTRE, 91a York Street, Sydney, 2000. Phone: 29 4258

KENT HI-FI PTY. LTD., 432 Kent Street, Sydney, 2000. Phone: 29 2743, 29 6973

VIC.

DOUGLAS TRADING, 185-191 Bourke Street, Melbourne, 3000. Phone: 63 9321

INSTROL HI-FI (VIC.) PTY. LTD., 375 Lonsdale Street, Melbourne, 3000. Phone: 67 5831

SOUTHERN SOUND PTY. LTD., 963 Nepean Highway, Moorabbin, Melbourne, 3189. Phone: 97 7245

and also at:

337 La Trobe Street, Melbourne, 3000. Phone: 67 7869

QLD.

STEREO SUPPLIES, 95 Turbot Street, Brisbane, 4000. Phone: 21 3623

S.A.

NO DEALER YET APPOINTED

W.A.

ALBERT'S HI-FI CENTRE PTY. LTD., 282 Hay Street, Perth, 6000. Phone: 21 9902, 21 5004

PERTH HI-FI CENTRE, 396 Murray Street, Perth, 6000. Phone: 22 4409

LESLIE LEONARD HI-FI, Shop U8, Upper Level, City Arcade, Hay Street, Perth, 6000. Phone: 22 3243

TAS.

NO DEALER YET APPOINTED

ESS amt 1

Recommended retail price $628.00 per pair. See any of the dealers listed for a demonstration of the AMT-1 or for further information contact

ESS Inc., ET2, c/o 220 West St., Crows Nest, N.S.W. 2065. Ph. 43 3228

Heil Air Motion Transformer is the registered trademark for ESS loudspeaker systems incorporating design principles invented by Dr. Oskar Heil and licensed exclusively to ESS Inc.

news digest

COLOUR TV TRANSMITTERS

Six colour television transmitters have been ordered by the Australian Post Office from Amalgamated Wireless (Australasia) Ltd. for the Australian Broadcasting Commission.

The transmitters, which will be used as three parallel pairs at sites in Sydney, Canberra and Hobart, will be installed this year and will be ready for the colour service when it begins in March, 1975.

Of the latest design, they are being manufactured at AWA's North Ryde works. They incorporate the Marconi RF drive unit which provides low-level intermediate frequency modulation and shaping of the vestigial sideband characteristics required for television.

In effect, this means that compared with transmitters of an earlier generation in which the band width of a television signal was controlled at high level by use of expensive coaxial feeders and a large signal size, the same effect is produced with the new equipment at a low level and with low voltages. The result is achieved, therefore, more simply, more economically, and more accurately.

Most Australian television stations today are still using their original monochrome transmitters. Some will doubtless continue to do so for some years to come, making the necessary conversion to upgrade them to radiate high-quality colour, but there will be an increasing number installing the most modern types.

Many organisations operate their transmitters unattended, but the stability of performance of transmitters designed 10 years ago is not sufficient. to allow unattended operation for more than a week at the most. Frequently a daily visit is necessary to check performance and to perform regular maintenance.

In the past decade there has been a progressive improvement in performance stability. Modern transmitters can be left unattended for two-month periods allowing the staff to concentrate on programme requirements in the studio. In addition, modern transmitters settle down much more quickly than earlier models after switch-on, normally reaching guaranteed performance in five minutes and levelling off within 30 minutes. This greatly reduces "waiting time" and means that the standby transmitter can be left completely unpowered.

NS CALCULATOR NOW $27.50

National Semiconductor has reduced the price on its NS Electronics Model 600 6-digit pocket calculator to $27.50 from $29.95 and at the same time announced a 9-digit calculator to retail at $32.50.

Geoff Drury, Manager of NS Electronics' system division, said the NS900 would be available for delivery within two weeks.

Drury said the NS900 is the second in a family of consumer electronic products that will be manufactured and sold by NS Electronics. Both machines add, subtract, multiply and divide, and can do automatic addition, subtraction and squaring. Both also have a fixed two-place decimal. The NS600 goes to six-digit figures while the NS900 has nine digits life. An optional AC adapter will also be available for both models.

The NS600 has reached five-figure production rates and is being sold in stores throughout Australia and the United States.

From a zero production level in September of this year, NS Electronics has become the fourth largest personal calculator manufacturer in the United States.

AUDIO AMPLIFIER HYBRIDS FOR CARS

SGS-Ates Semiconductor has recently won a 100 000 piece order from Chrysler Motors (in the USA) for their 10 W and 25 W hybrid audio amplifier modules. These will be used in Chrysler's car radios.

Similar components are already being supplied by SGS-Ates to Magnavox, Delco, Automatic Radio and Zenith.

Indicative of the way in which prices are falling, of relatively large modules such as these, is that the contract price for the TCA 940 10 W module is said to be around US$2 for 100 000 lots.

FIJI PHONE LINK

GTE Australia have been awarded a major contract for a 600 voice-channel micro-wave link between Viti Levu and Vanua Leva the two main islands in the Fiji archipelago.

The system is expected to be operational by the end of 1974.

UK AUDIO SALES INCREASE

Despite a fall in TV sales of an estimated 50% (compared with 1972 levels), sales of audio systems in the UK *soared* by 50% between January and November 1973.

Sales of domestic radios also rose — by some six per cent.

ESP NOW A SERIOUS DISCIPLINE

Evidence is growing that extra-sensory perception (ESP) has a solid scientific basis.

At one time few engineers or scientists would be openly prepared to admit an interest – for fear of public ridicule. But ESP suddenly became academically respectable when the US space agency NASA conducted an experiment with an astronaut in space.

"We know that the effect is not electrical or magnetic," says Professor John Mihalasky, head of the Parapsychology Communication Project at Newark College of Engineering. "But because we don't know how it works it doesn't mean that we cannot use it." Mihalasky cites our present use of electricity as an example. "We still don't understand that entirely but few would dispute that we know a fair bit about its use."

Perhaps the final seal of respectability is given by the IEEE.

A complete session of the IEEE Intercon this month will be devoted to the phenomenon. It has been organised by J.A. Raper currently manager of advanced circuits and control at G.E.'s Defence Electronics Division.

A SHATTERING ABILITY

Legend has it that the great singer Caruso was able to shatter a glass with his unaided voice.

Subsequent attempts by other singers to replicate the act have been unsuccessful.

However at the recent Audio Engineering Society convention held in the USA, Peter Tappan of Bolt, Beranek and Newman, described a series of experiments that were successful.

A goblet was placed in front of a 100 watt loudspeaker that was mounted on an enclosure in such a way that the sound energy was concentrated into a beam 5 cm diamter.

Two singers were able to shatter goblets at audio power levels ranging from 142 to 148 dB by producing vibrato-free notes at the goblet's resonant frequencies.

Although amplification was used to generate the power levels required, the singers demonstrated that they could in fact generate sound levels up to 140 dB without amplification.

As it is very probable that Caruso could generate much higher sound levels than average singers it seems quite probable that his reported capability to shatter glasses is based on fact.

SENNHEISER DUMMY HEAD STEREO RECORD

During her recent European trip, Wendy Roy, Editor of our associated trade journal 'Audio Trader' visited the Sennheiser factory in West Germany. Germany.

Whilst there, she was shown a new recording technique developed by Professor Sennheiser.

Professor Sennheiser uses an actual dummy head to make the recordings. A tiny recording microphone is placed in each ear thus picking up sound virtually as would a human listener.

The theory behind the apparently simple technique is that the shape of the head – and particularly the pinna (the external part of the ear), has a far greater effect on subjective hearing response than had ever been realised previously. Only by recording in a manner approaching that of normal hearing would anything like a realistic sound be produced.

Wendy was able to persuade Professor Sennheiser to let her bring a few demonstration records back with her to Australia.

The record content is basically that of a speaker who moves around a room in which the listener is 'placed' centrally. It is possible accurately to 'locate' the speaker in all parts of the room whether in front of or behind the listener.

At one point in the record the speaker positions himself about three inches above one's skull and then slowly moves sideways to whisper in first the right and then the left ear.

The effect is absolutely uncanny. Spatial location is almost absolute in both planes.

Having heard this record firsthand one must very seriously question the future of four-channel sound – at least in its present form.

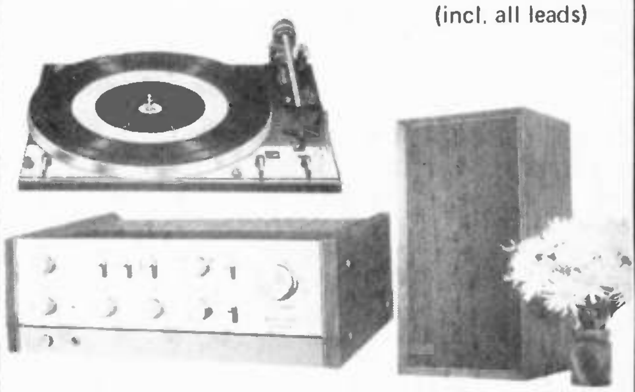
4 TOP QUALITY SYSTEMS TO CHOOSE FROM

Dual 1214 Turntable
Kenwood 4002A Amplifier
Wharfedale Meltons Speakers.

$445 (incl. all leads)

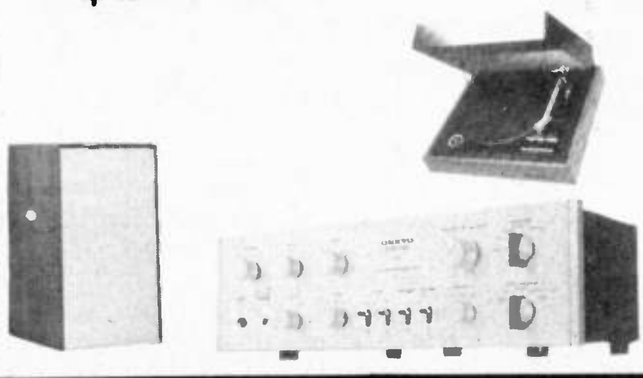
Dual 1216 turntable or belt drive turntable (with Shure 75E cartridge)
Kenwood 4004 amplifier
Altec Lansing Coronas speakers

$599
(incl. all leads)



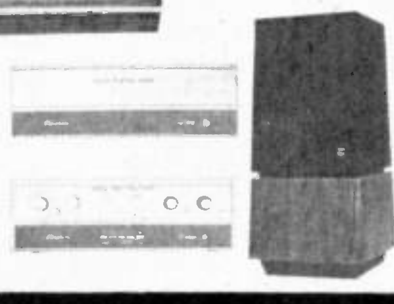
New Garrard S86 SB turntable belt/drive (with Shure 91 ED cartridge)
Onkyo 733 amplifier
Transmission line speakers (built from KEF B129, B110, T27)

$799 (incl. all leads)



Thorens TD 160 turntable (with Ortofon MF 15E, or Shure V15 III cartridge)
Crown IC 150 preamplifier
Crown ID 150 amplifier
The new ESS AMT 1 loudspeaker

$1599
(incl. all leads)



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ELECTRONIC IGNITION FOR FORD

Texas Instruments and Raytheon Semiconductor are competing for a contract from Ford Motor Co for electronic ignition systems.

Raytheon have been awarded US$100,000 for the development work involved – Texas, on the other hand – are using their own funds to pay for the research involved.

The development contract calls for 100 working systems capable of passing the requirements of the USA's Environmental Protection Agency.

The system is being studied by Ford as a possible alternative to catalytic filters for pollution control.

PAL SYSTEM FOR CHINA

The probability that China will adopt the West German PAL colour TV standard is increasing.

Peking's broadcasting service has now commenced experimental PAL transmission.

Chinese TV experts visited Germany last year to study the PAL system and have followed this up by purchasing considerable quantities of colour TV studio equipment.

ROOM TEMPERATURE SUPERCONDUCTORS?

A report from K. Antonowicz from Poland's Nicolas Copernicus University, published in Nature (Vol 247, February 8 1974), indicates that superconductivity may well be possible at room temperatures rather than being limited to cryogenic temperatures as previously believed.

The paper describes anomalous behaviour of aluminium-carbon-aluminium sandwiches.

TANDY AUTHORIZED TO SELL ALLIED RADIO STORES

The US Justice Dept has now authorized Tandy to sell 27 of its stores to Shaak Electronics of Minneapolis.

This follows a suit by the Dept's Anti-Trust Division calling for Tandy to relinquish 37 of its then-recently acquired Allied Radio stores.

The remaining 10 stores concerned will continue to be operated by Tandy until the expiration of their leases, unless otherwise sold or closed down.

The 27 stores to be taken over reported total sales in 1973 fiscal year of US$7.1 million.

COMPUTER DETERMINES WORLD YACHTING CHAMPION

The results of the 12th World OK Yachting Championship held last week at Holdfast Bay, near Adelaide, were processed by a Digital Equipment PDP-11 computer. Sailed in Australia for the first time, the event attracted the largest contingent of overseas entrants ever to visit Australia for a world yachting championship. Of a total of 65 competitors, 40 came from Belgium, Canada, Denmark, Finland, France, Japan, New Zealand, Sweden, United Kingdom and the U.S.A.

Torbun Andrup of Denmark won the world championship, which was contested over seven races at Holdfast Bay. The Holfast Bay Yacht Club which organised the event had a DECwriter teleprinter terminal installed in the clubhouse, connected by land line to a Digital Equipment PDP-11 time-sharing computer at the South Australian Institute of Technology. Although the scoring system was complicated, the computer enabled the progress of the contest to be calculated and printed out rapidly after each race.

ELECTRONIC WATCH SALES

In their current marketing report, the authorative American journal 'Quantum Science' predicts that, once the semi-conductor industry sorts out its supply problems, electronic watch production will skyrocket.

Quantum, predicting that the average retail price will fall below US$50 by 1976, believes that sales will climb from the 1973 total of approximately 180 000 to 950 000 in 1974 and on to a staggering 115 million by 1980.

As percentages this is a climb from 0.09% of the total watch market last year, to 38.2% by the end of this decade.

A further prediction is that the 1980 design will feature a 4 MHz crystal oscillator, single chip silicon on saphire (SOS) CMOS LSI circuitry, and a multiplexed, low-voltage field-effect liquid crystal display. Power supply will probably be a three volt lithium cell lasting for at least 24 months.

SIR LIONEL HOOKE

Sir Lionel Hooke, Chairman of Amalgamated Wireless (Australasia) Ltd, died on Sunday morning after a short illness.

Born at Brighton (Victoria) on December 31, 1895 and educated at Brighton Grammar School, Sir Lionel was the pioneer of the Australian electronics industry and a contemporary of Marconi, Sarnoff and Fisk. His death marks the end of an era, for he was the last Australian to have been continuously involved with radio over six decades, bridging the gulf between spark telegraphy and space age electronics.

When AWA was established in 1913, Lionel Hooke joined the small staff of the company which he was ultimately destined to lead. Soon afterwards, he was selected to accompany Sir Ernest Shackleton's Imperial Antarctic Expedition to the South Pole as a wireless operator and for nearly two years he served in both the "Aurora" and the land parties at the Ross Sea base. When the "Aurora" returned to New Zealand, Lionel Hooke was commissioned in the Royal Naval Volunteer Reserve as deck officer on submarine chasers. After completing a course at Greenwich Naval College, he was appointed to command armed rescue patrol tugs in the Irish Sea. Later, he became a pilot in the Royal Naval Air Service, serving in aeroplanes and airships.

Upon returning to Australia in 1919, he became AWA's Melbourne Manager. He organised Australia's first demonstration of broadcasting to Federal Parliament in October, 1920, when a programme was transmitted from his Middle Brighton home over a distance of 12 miles to a large audience in the Queen's Hall of the then Federal Parliament House in Spring Street, Melbourne.

When in 1922 control of Australia's coastal wireless stations and those in Papua New Guinea passed from the Commonwealth Government to AWA, Lionel Hooke was responsible for the reorganisation and re-equipment of the service. Subsequently, he conducted many wireless telephone demonstrations and took the initiative in the installation of the first mobile police wireless in Australia, production of telephone and telegraph equipment and the establishment of wireless communication between Australia, England and U.S.A.

He was transferred to Sydney in 1925 as Assistant Manager, at a time when entertainment broadcasting was gaining popularity and the Company was active in the development and production of transmitting and receiving equipment.

In 1926, as Deputy General Manager, Lionel Hooke took part in the protracted negotiations and experiments which preceded the inauguration on April 8, 1927 of the Beam Wireless service between England and Australia, the longest direct telegraphic service in the world at that time.

Later, he was associated with the introduction of Australia's first global short wave broadcasts, the Beam Wireless Picturegram service and the erection of our first aircraft navigation beacons.

He spent some time overseas studying electronic developments in England, Europe and America and arranging for the exchange of technical information between AWA and overseas companies. He was responsible for the establishment of Amalgamated Wireless Valve Company.

With the outbreak of World War II, he had the task of guiding and supervising the conversion of AWA's manufacturing operations from a peace-time to a wartime footing. The Company produced equipment ranging from highly specialised aircraft instruments to artillery fuses, radio communication and navigational equipment for the Australian and Allied forces, as well as making four million valves of more than 100 types. At the peak, five thousand men and women were engaged in wartime production and $26 million worth of equipment was manufactured. Shortly before the war ended he became Managing Director and began the re-organisation of the Company which for six years had been on a total war footing. He organised resumption of civilian goods production and the first post-war domestic receivers were made before the close of 1945.

Early in his term as Managing Director, an Empire Telecommunications Conference in London decided to amalgamate the Commonwealth cable and radio services and to transfer them to public ownership. The Overseas Telecommunications Commission (Australia) was created and over many months Lionel Hooke negotiated with the Commonwealth Government regarding compensation and other details. Finally it was agreed that the Commonwealth would take over AWA's overseas telecommunication assets and business, AWA retaining manufacturing, broadcasting, servicing activities, patents and also shares in subsidiary companies. The Commonwealth retained its proportionate shareholding in the Company until 1951.

Notwithstanding AWA's substantial loss of revenue from the Beam Wireless service which the Company had operated for two decades, Hooke was able to report that the 1947 financial year constituted a peacetime record.

He was knighted in 1957 and became Chairman of AWA in 1962.

The late Sir Lionel Hooke was also Chairman of Amalgamated Wireless Valve Co. Pty Ltd, a Director of the Australian Gas Light Company, Email Limited, United Telecasters Sydney Limited. He was Chairman of the Electronics and Telecommunications Industry Advisory Committee and had been a member of the Senate of the University of Sydney for ten years.

He is survived by Lady Hooke and his son, John, Managing Director of AWA.

A memorial service was held in St James Church, King Street, Sydney, on Friday February 22.

AUSTRALIAN WEAPON DEVELOPMENT

The Australian Department of Supply is actively planning two new weapons systems forthe RAAF and RAN.

First of these, code-named Mulloka is an advanced sonar system for intended to provide firing information for anti-submarine work.

The new equipment is designed to eliminate a number of limitations in the existing British and American systems.

High speed signal processing and correlation techniques are believed to be used.

A pilot model of the Mulloka system has been developed by the Weapons Research Establishment at Salisbury, SA and plans are underway for the equipment to be produced in Australia.

The second item is a bomb that scatters a number of smaller explosive 'bomblets' as it strikes the ground.

Latest reports on Barra, an advanced highly sensitive sonic detection buoy used in conjunction with an airborne data processing system, is that development is now well ahead.

AWA now have a $2 million contract for initial development of this latter project. Other companies involved in the Barra project include the Commonwealth Aircraft Corporation, Plessey, Cable makers, and Electronic Systems.

EMERGENCY MEDICAL SYSTEM USES NASA TECHNOLOGY

A compact, 18 kg medical unit — containing essential equipment to help meet a victim's diagnostic and therapeutic needs at the scene of an emergency — including two-way voice and telemetry communications — has been developed by SCI Systems, Inc., Houston, based in part on technology derived from NASA's manned space flight program.

Called Telecare, the ambulance-stored unit permits trained emergency medical technicians to administer prompt, professional care under radio supervision of a physician who may be miles away in a hospital emergency room, or even in his office.

It is during the first critical minutes after arrival of a rescue squad at the scene of an emergency that quick, accurate diagnosis and therapy prescribed by a physician can be instrumental in saving a patient's life — particularly cases involving heart attacks, shock or drowning.

The overall concept of the system brings together six major elements to cope with medical emergencies: trained personnel, diagnostic and therapeutic equipment for use in the field, communications, vehicles, physicians and hospital facilities.

The Telecare unit is a key component of the total system. Despite its suitcase-size it contains the following equipment — brought together for the first time in a single portable package:

- A respiratory resuscitation system,
- A 15-minute osygen supply contained in a lightweight canister developed from space technology,
- A electrocardiogram display and telemetry system,
- A defibrillator for external heart stimulation,
- A semi-automatic indirect blood pressure measurement system using a special microphone placed beneath a hand-inflated cuff, similar to the blood pressure device used in the Skylab program,
- A basic pharmaceutical pack.

Optional equipment can include an electroencephalogram, to permit remote observation and detection of brain waves stemming from technology first devised for the Skylab sleep analyzer, and a strip chart recorder and tape recorders.

WHEY-OUT?

Those who still hold that the moon is made of green cheese will be cheered by a report in the latest New Scientist.

The journal reports that seismic tests of lunar material has shown that sound waves travel through the material at perplexingly slower rates than through terrestrial material of a similar nature.

Researchers at Columbia University's Lamont-Doherty Geological Observatory compared the sound-conducting properties of two lunar rocks with a wide variety of cheeses.

And they found that Norwegian goat cheese conveyed sound at exactly the same speed as one of the rocks.

The findings are not so far regarded as definitive.

USSR EXHIBIT

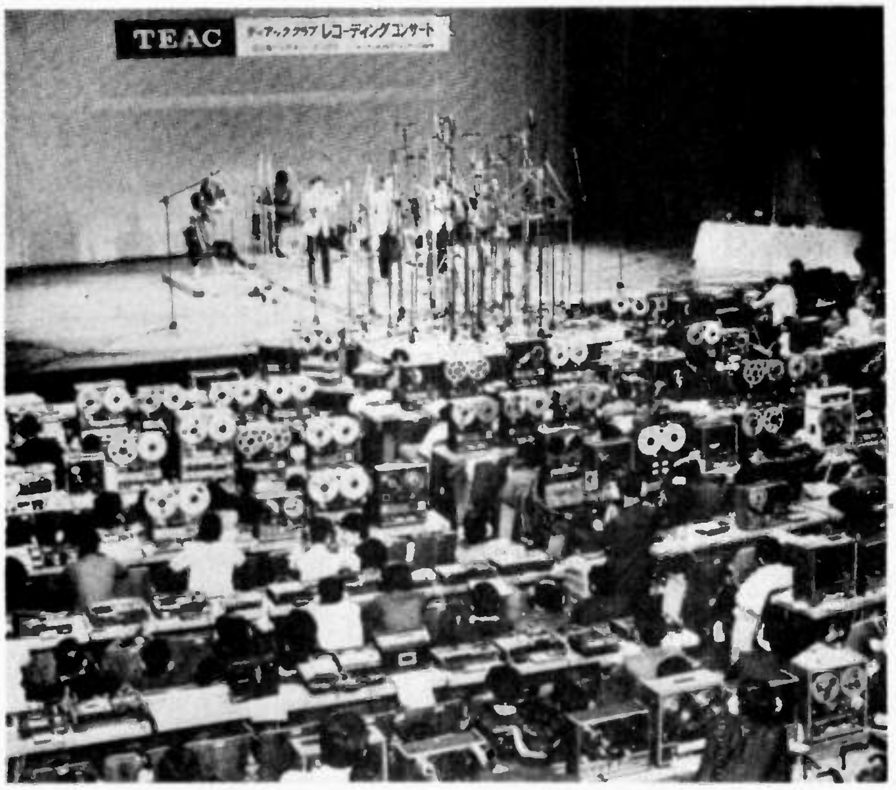
For the first time ever, the USSR will have an exhibit at an American engineering exhibition.

The Soviet Union's V/O Electronorgtechnika Agency have booked space at this year's IEEE Intercon in New York.

Among goods to be shown will be control equipment, computers, data devices, semiconductors and components.

news digest

TAPING EN-MASSE



This incredible collection of tape recorders belong to Japanese enthusiasts attending a 'concert' put on by TEAC.

The TEAC organisation arrange a number of such live concerts. The company supplies the hall, orchestra, chairs, cabling etc. Recording enthusiasts bring along their own microphones, recorders etc.

A seminar on live recording techniques precedes each concert.

ELECTRONIC SIGHT AND SOUND

A project is underway at the University of Southampton's Institute of Sound and Vibration to assess the possibility of implanting electrodes into the inner ear of those people whose auditory nerve is still functioning but whose cochlea is damaged.

Some work of this type has already been carried out in the USA — but so far the implants have only been effective for low frequency sound.

The studies at Southampton will include multiple electrode implantation in a hope that a full frequency range may be covered.

An even more ambitious programme by Dobelle and Mladejovsky of the University of Utah, and Girvan of the University of Western Ontario attempts to implant electrodes directly into the brain of blind people. These electrodes would then be coupled to a miniature TV camera.

Experiments have actually been successfully performed on two blind volunteers.

In one experiment the team implanted a 64 element array next to right occipital lobe of the brain. Then using a computer-controlled simulator the research team mapped out the relative positions of phosphene (sensations of light flashes) responses in relation to the 8x8 array).

After considerable work the patient was able to 'see' and recognise simple patterns and letters which he could then draw accurately. ●

Seen at a recent overseas computer conference — a piano, labelled — 'on-line note retrieval system'.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LASERS AT WORK

Is the laser death-ray a reality? Here, Dr. Sydenham discusses this, and innumerable other possible uses of laser engineering — ranging from communications to fusion research.

IN a previous article we covered the many applications where the availability of the laser radiation source has enabled new and improved methods to be devised for *measuring* many variables. In those applications few needed to make use of the full *power* capability available from the various laser designs. This time we will be considering uses that are not concerned with measurement. We start with a discussion of applications using the heating power provided by focussed laser radiation to cut, weld, or vaporise materials.

CUTTING AND WELDING WITH LASER RADIATION

The first essential requirement needed of a thermal cutting process is that the energy density within the cut reaches limits high enough to melt or vaporize the material. Power available, even from the comparatively smaller laser unit, is sufficient to melt most materials provided the power is well-focussed (see the discussion on laser safety!). For example, a 200 W peak-power pulse (from a He-Ne pulsed laser of 180 cm length) of 500 ns duration when focussed down to 10 μm diameter has a peak incident power density of about 10^8 Wcm^2 This is sufficient to melt small volumes of tungsten — which has the high melting point of 3370°C. Figure 1 shows an experimental arrangement that does this.

A second important requirement for thermal cutting is that the wavelength of the source is such that the material to be cut or heated absorbs the radiation. If it is too transparent the energy passes through, producing little temperature rise. Similarly, the surface must not be excessively reflective at the wavelength involved. A useful property of the focussed beam is that the power density is raised mainly in the region of the focal point. Heating occurs in a localised spot enabling cuts to be made to specific depths, not necessarily passing right through the material.

In the high-power applications (continuous ratings of kilowatts of output) it is advantageous to force oxygen or air into the cut to clear it and to enhance the cutting speed.

A third factor to be considered is the thermal conductivity of the material. It is vital that the heat sinking rate is less than the heat input rate if the localised temperature is to be raised to a vaporizing point. This means that highly conductive materials of high melting point (such as metals) cannot be cut to the same depths as poor thermal conductors having low melting or vaporizing points. To cut thick stainless steel or titanium requires the largest continuous power that can be practically devised.

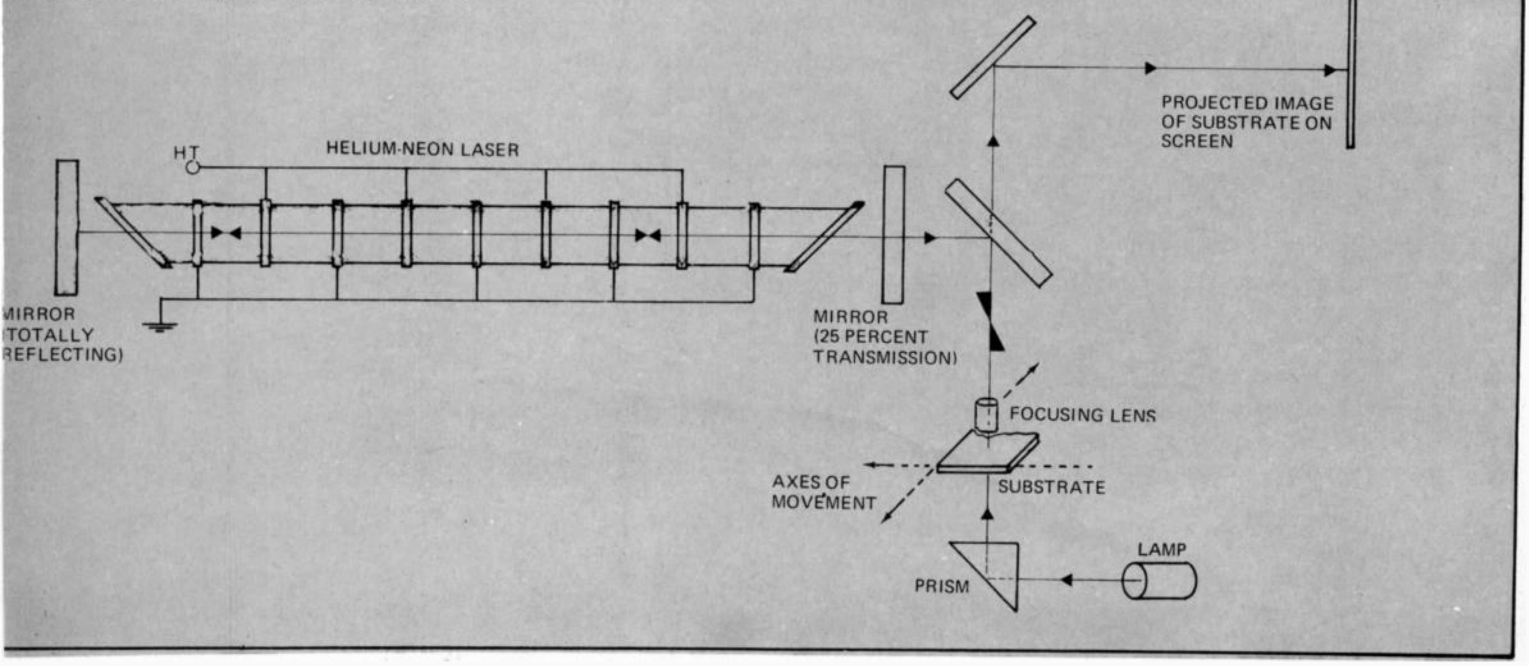
The advantages offered by laser cutting are firstly, that the cut can be made extremely finely with good definition — down to as little as 10 μm wide in thin-film substrate work or to 400 μm wide when cutting 50 mm thick softwood. Secondly, the power is instantly available — the job can be set ready and power applied at the flick of a switch. Automatically controlled cutters can provide a stitched cut as easily as they can contour. A third advantage over alternative methods is that the cutting point is quite remote from the lens focussing the radiation. This enables the cutting spot to be used inside crevices and even through the transparent covers of components. Resistors and valves have been trimmed and welded internally in this way.

As there are no larger cutting forces the task of guiding the head with precision is simplified — light controlled guidance arrangements can be used.

Another valuable feature is that the actual cut can be viewed — usually by inserting a 45° mirror into the path of the beam — so that it can be seen directly. This is shown in Fig. 1.

Laser cutting and welding can be used in virtually any environment — in air, vacuum or controlled gas — that is,

Fig. 1. Micromachining with a pulsed He-Ne laser.



LASERS AT WORK

of course, unless the process uses auxiliary gas.

All these advantages give the impression that laser methods are the answer to all cutting and welding problems. So why do we not see them used more often?

The answer is simple. At this stage of our technology such methods are more expensive than the traditional means. Further, in heavy applications, the power source is excessively large — a CO_2 unit delivering around a kilowatt of continuous power is still about desk size. There are, however, many applications where only the laser has been able to fulfil the need and the steady development being maintained at present will no doubt decrease the cost and size to a point where the laser becomes increasingly more competitive.

Cutting, welding and vaporizing applications now run to an extensive list. They include welding the edges of relay cans and the ends of miniature thermocouples; cutting around the insulation on cables prior to stripping; drilling holes in ceramics, hard steel and babies' teats; cutting contoured slots in plywood ready for the insertion of knife dies; cutting cloth in the tailoring trade; cutting carpet; trimming titanium heat-shield cones and marking paper in a laser writing head.

In the medical world the laser provides a self-cauterizing scalpel, a means to reattach retinas by stitch welding, and a way to burn away tissue defects on a selective basis.

Other recent interests include research into its use to shear sheep (the lanoline in wool is highly selective at certain wavelengths), and, believe it or not, a sincere report talks about the severing of the closure muscle in oysters — called oyster-shucking in the U.S.A. From Italy come reports of a grant providing for a laser that will be used to burn away the black dirt from marble statues that need cleaning.

Let us now look at four areas from the list of heating uses, namely, the trimming of resistors, industrial cutting, the military death-ray and fusion research.

TRIMMING RESISTORS

A number of industrial applications call for the removal of small amounts of material in controlled quantities; one case being the trimming of thick-film resistors.

Thick-film hybrid methods are used in circuits where silicon integrated devices cannot provide high power, high operating frequency or tightly toleranced components. They consist of (as shown in Fig. 2), a suitable film laid onto a ceramic substrate by screen printing. The normal run of production tolerance provided by these screen printed and fired resistors is not adequate and adjustment is subsequently needed to the resistance value.

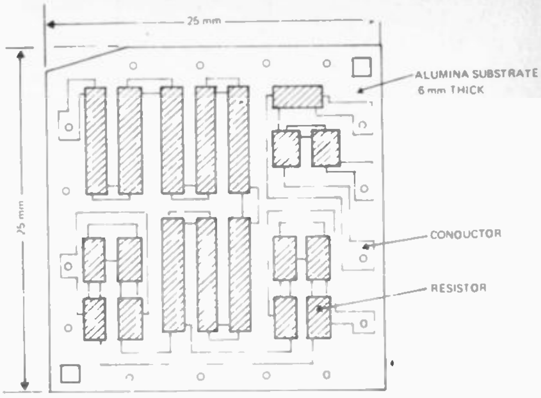


Fig. 2. Thick-film resistor layout.

The conventional method of trimming uses an air abrasive jet to steadily increase the resistance value as material is removed. This method has some short-comings, not the least being the incompatible presence of abrasive in the clean-room. It is also liable to damage discrete components already formed on the chip.

Laser trimming has become the accepted method for performing this task. It has greater precision and is a cleaner process.

The complete trimming system comprises a laser source, an optical system, a controlled movement x-y

Fig. 3. Comparison of various cutting sources.

Property	Ruby or similar solid-state laser		Yttrium-aluminium-garnet laser		Carbon-dioxide laser		Pulsed He-Ne laser
	Pulsed						
Mode of operation	Normal	Q switched	Continuous	Q switched	Continuous	Q switched	Pulsed
Power or mean power in pulse	20kW	1 MW	1W	1kW	50W	1kW	200W (2 m x 2.5 cm tube)
	(8 cm x 1 cm rod)		(7 cm x 1 cm rod)		(per metre of tube)		
Output wavelength	0.7 μm		1.06 μm		10.6 μm		1.15 μm
Pulse length	0.5 ms	1 μs	–	200 ns	–	1 μs	1 μs
Pulse-repetition rate	50 pulse/s, elaborate cooling 1 pulse/min, no cooling		–	400 pulse/s	–	1000 pulse/s	1000 pulse/s
Energy-conversion efficiency	<1%		10-22%		10-20%		1%
Beam divergence	~0.2%		~0.04°		~0.2°		~0.01°
Focal length of suitable lens (n.a. ~ 1)	1-2 cm		1-2 cm		5 cm (must be transparent at 10 μm, e.g. Go)		5 cm
Focal-spot size with above lens	50-100 μm		5-10 μm		50-200 μm		10 μm
Peak power density in focus	10MW/cm^2	1GW/cm^2	–	10GW/cm^2	1MW/cm	20MW/cm^2	1GW/cm^2

co-ordinate table to hold the substrate, a resistance-monitoring unit, and a visual display unit.

The trimmer uses a solid-state neodymium-doped YAG pulsed source providing radiation at 1.06 μm wavelength. Various optical elements focus the beam onto the substrate and provide a viewing channel displaying the substrate on a television monitor as an enlarged image. The optimum trimming conditions occur with 20 nS pulses of 10 MJ-energy being used at 50 per second. The table moves the resistor at 250 $\mu m.s^{-1}$. The focussed power density is 5000 $MW.cm^2$.

In use, the resistor is measured to ascertain its actual value. Trimming then commences by producing a cut across the width of the material to rapidly increase the value. This is then followed by a longer cut along the rectangular shape that provides the final value in a more controlled manner.

The same type of apparatus can be used to scribe (that is, cut a groove) across ceramics and semiconductor materials in readiness for a fracture break. Holes can also be provided. The above instrument drills 200 μm diameter holes in a 1.5 mm thick ceramics in 120 seconds. It is, in fact, a micromachining tool.

A number of laser sources can be used for such applications. The table given in Fig. 3 lists typical properties of seven alternatives. The list is not extensive — many more exist with the list growing larger each day. We will now look at the use of the CO_2 laser in more detail in its role of industrial cutting.

HIGH POWER INDUSTRIAL CUTTING

To date, the highest continuous power output of any laser source is obtained with the CO_2 laser which provides radiation at a wavelength of 10.6 μm (in the infrared region).

As output power increases with length — at roughly 50 W per metre of cavity — large powers are produced at the expense of compactness. Early models used a long straight tube with lengths often reaching hundreds of metres. Obviously this arrangement has limited use in industry and new designs typically consist of folded paths and zig-zag arrangements that reduce the packaged length down to around 3 m. For example, the Coherent Radiation unit shown in Fig. 4 has two 2.5 m lengths folded once; it provides 250 W of continuous output. A recently released Ferranti unit of 450 W has a number of tubes arranged in a zig-zag manner around a cylindrical centreline. State-of-the-art commercial units can provide 1 kW for a volume of around 2 m^3, thereby providing some measure of portability.

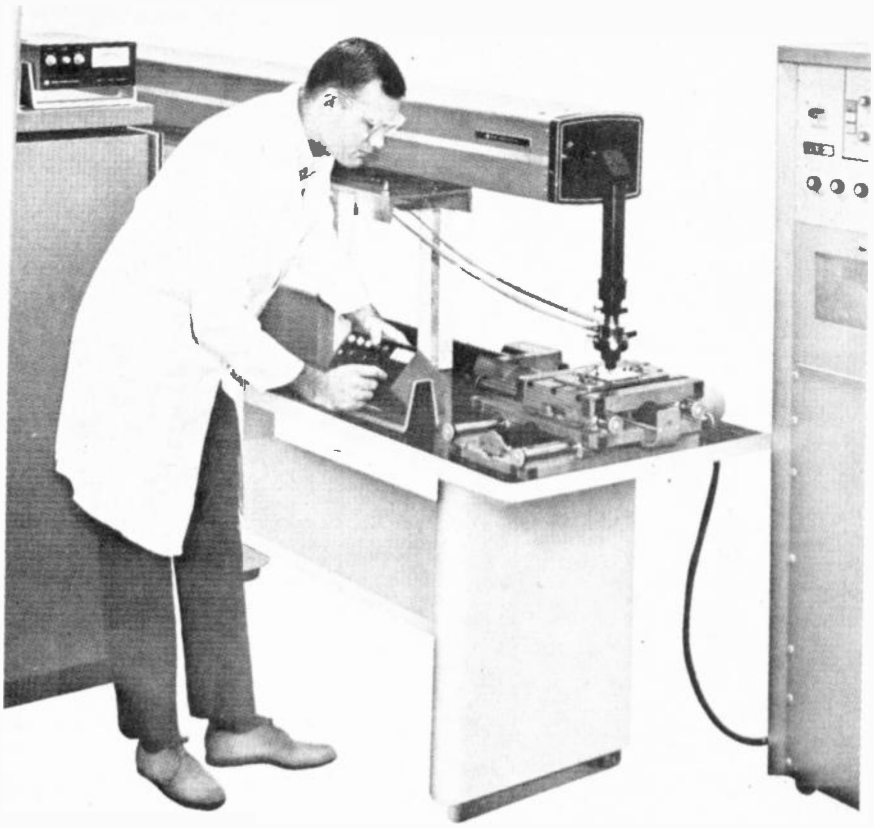


Fig. 4. 250W CO_2 laser cutting unit.

The British Oxygen Company (BOC) in conjunction with Murex have been developing laser cutting systems for several years now and have published many useful tables. Figure 5 lists the potential uses. They have also investigated the use of a gas jet (to clear the vapour and protect the lens from sputtering) with the CO_2 radiation. The jet provides a cleaner start to the cut edge. Figure 6 lists the characteristics of the cutting of material ranging from steel to wood. Slicing of confectionery and other similarly sticky pliable compounds is also suggested.

Cutting rate varies with thickness and type of material. Figure 7 shows that a 350W unit can cut 20 mm thick plywood at 450 $mm.min^{-1}$ or 2 mm thick stainless-steel sheet. As BOC point out, laser methods are not yet able to cut slabs of steel but they can produce intricate shapes in glass plate!

In the BOC-Murex Falcon cutting machine (shown in Fig. 8) the laser is run continuously, the energy being dumped into a calorimeter (used to monitor the power) when not needed by reflecting it witha 45^o mirror. Gold coated optics are used to reflect CO_2 radiation — 10.6 μm radiation is not absorbed or transmitted in gold films.

Application	Material
Line and Profile Cutting	Metals, plastics, glass, ceramics, textiles, composites wood
Welding	Metals, plastics, composites
Scribing	Ceramics
Perforating	Metals, ceramics, plastics
Melting	Refractory materials, metals, non-metals
Machining operations	Metals, plastics
Drying	Metals, plastics
Surface finishing	Metals, plastics

Fig. 5. Actual and potential thermal uses of lasers.

Material	Thickness mm	Gas	Speed mm/min.
Mild Steel	0.5	Air	635
Stainless Steel	0.5	Oxygen	2600
Titanium	0.6	Air	200
Zirconium	0.25	Air	915
Carborundum (Sintered)	1.6	Air	760
Asbestos Cement	6.3	Air	25
Glass (Soda-Lime-Silica)	4.0	Air	100
	1.6	Air	380
	0.2	Air	5000
Perspex	25.0	Air	100
	10.0	Air	200
	4.6	Air	635
Nylon	0.8	Air	5000
P.T.F.E.	0.8	Air	6100
G.R.P.	2.4	Air	635
Leather	3.2	Air	635
Wood-Deal	50.0	Air	100
Oak	18.0	Air	200
Teak	25.0	Air	75

Fig. 6. Characteristics of cutting using a gas-jet CO_2 laser of 200W output.

The Falcon system development began in 1968 when a carton manufacturer in Scotland requested BOC to explore ways and means to cut deep narrow slots in plywood. Cartons are made by cutting the flattened shape out with thin steel strips set into plyboard. Some of these knives cut, others compress the board, forming a crease. A finished steel rule die, as it is called, is a plywood sheet having shapes projecting as knives. The die is pressed into the cardboard. Gaskets and upholstery materials are cut in the same way.

A photo-electric line-following unit traces over the art work causing the underside mounted cutting head to produce the same profile slot through the wood. Shaped knives are then pressed into the 0.7 mm wide grooves. The Falcon unit uses a 4 m long 400 W Co_2 laser.

The economics of the system are worth quoting. Traditional methods involved many man-hours of tedious fret-sawing — a multiple die for small boxes could well have 500 identical shapes on the die, each with intricate curves and cuts. It takes about 30 hours of skilled labour to prepare a 35 mm film-box die board: with the Falcon unit only five hours of unskilled labour is needed. Half of this latter time is devoted to preparing the mask. If a repeat job is needed the laser method needs only two more hours — the conventional method needs the full 30 hours again. The running cost per hour is about a third of the unskilled labour rate, so the machine soon repays its capital expenditure.

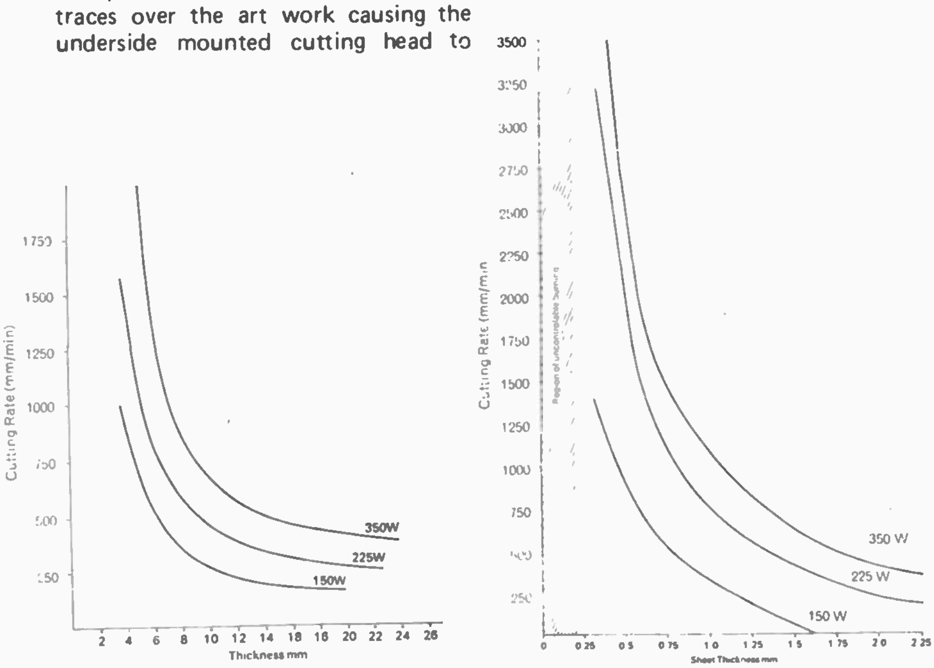


Fig. 7. Cutting rate versus thickness curves for wood and stainless-steel.

LASER WEAPONS

In the previous part we spoke of laser guided or 'smart' bombs, that used the guidance properties of a laser beam. Laser lethal weapons are another field to themselves.

As far back as 1959 such potential was recognised — even before a laser was built. In 1961 the U.S.A. started the ball rolling with a $2 x 10^6 fund. By 1968, gas dynamic lasers, such as the CO_2 system, enabled the concept to be advanced more effectively. In 1971 the Kirkland testing laboratories were completed including a weapons firing test range. Reports somehow gleaned by 'New Scientist' reporters suggested 60 kW continuous, ultra narrow beams were igniting wooden targets at 4 km distances — this unit was designated XLD-1. Spending on high energy lasers now runs to $90 x 10^6 p.a. in the USA. It is anyone's guess how much Russia spends on the same line of research.

What is not heard about is the immense size of the units and the problems of providing the input power. Even at efficiencies of 30% there is a need for short period capability of several megawatts! Rocket motors have been suggested as the source. Missile and satellite melting systems are also being researched. It is virtually impossible to sort fact from fiction — one certainly cannot call any idea an impossibility.

Reports released in 1972 were very promising but recent releases indicate the death ray concept is not quite what it seems, for the high power beam (New Scientist, 26th July, 1973) can be greatly nullified by a number of atmospheric mechanisms. Firstly, the target surface will vaporize producing a dispersing action. Secondly, the air path becomes heated forming a defocusing gas lens — called thermal blooming. Finally, the air may break down into plasma along the path. Already ways are being devised to reduce the effect of such weapons — dumping the exhaust gases along with an additive could well protect the rear aspect of a plane or missile.

Although not military in application

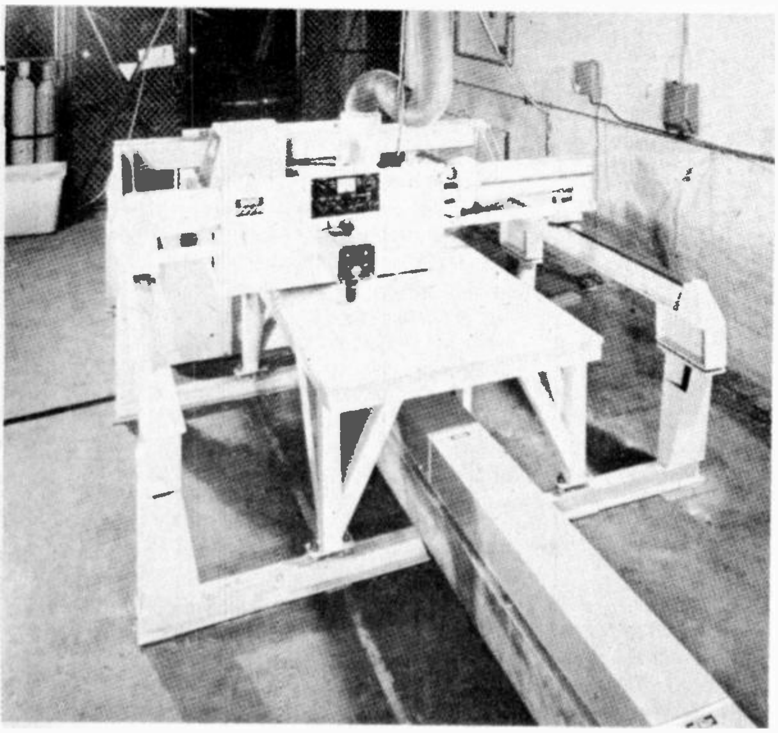


Fig. 8. The BOC Falcon cutting machine.

there is already a call for a 'death ray' in peaceful use. Fire protection authorities in Tasmania are investigating ways to start fires in controlled burn off situations. Speed is the essence, for the whole area should ideally be ignited simultaneously. Hopes are that an aircraft or ground vehicle can start the fires as fast as the vehicle travels.

Closely allied to the 'death ray' is the rule of research aimed at producing atomic reactions using extreme laser powers.

FUSION RESEARCH

Atomic fusion results when the nuclei of light atoms combine to form less nuclei of a heavier atom: the process releases energy. Fusion is the basis of the generation of the energy contained in stars. For example, four hydrogen atoms can be made to combine to form an atom of helium releasing energy corresponding to the lost mass. Fission is the opposite to fusion: a heavy atom is split to provide lighter nuclei. In the hydrogen bomb both reactions take place, fusion being the result of the enormous temperatures generated in the process.

Due to the immense charge fields the nuclei of matter cannot normally be placed close enough together to cause fusion. If energy provided as heat makes the atoms travel faster it enhances the chance of fusion. Calculations suggest temperatures of 10^8 degrees C are needed to cause fusion by this method. Initial research concentrated on the use of plasmas (charged particles of matter that can have immense temperatures) for these can be contained (without vessels that would melt) by using magnetic field "bottles".

The recent trend has been to explore the use of giant laser powers as a means to raise the temperature of a minute volume of the "fuel" to a point where fusion could take place. So far, no one has succeeded but the method holds great hope as a way to provide highly-controlled fusion reactions on a small and useful scale.

There we will have to leave power applications — a class of useage of laser radiation that will undoubtedly be on the increase as time proceeds.

Development of a device is usually prompted by a need for reduction in the price of a commodity. The laser was no exception, for it seems, looking back into the literature of the 1960s, that the promise of extensive bandwidth in communication channels had a lot to do with initial interest in lasers. It is often the way in technological advancement that the initial impetus falls by the wayside with other uses coming to the fore as time proceeds. The laser is an example of this phenomenon, for communication uses are now one of the less publicised fields of application.

COMMUNICATIONS

It was not surprising to see that scientists and engineers of the 1960's saw laser light as a communication tool. The laser grew out of the earlier built microwave (Maser) version. The previous article included a snippet from A.L. Schawlow's Bell Laboratories Record report where he told of the first uses of the Maiman laser as a communication link. Schawlow then saw the laser as a source of extremely high-frequency and coherent radiation capable of extending radio techniques.

The potential of a coherent visible radiation beam that is tightly controlled in its beam spread is that it offers a basic frequency range of virtually dc to 10^{14} Hz. Microwave by contrast has a bandwidth 10 000 times narrower. Further more, the laser beam can potentially be spatially multiplexed, stacking channels as modulation, in many different directions across the beam cross-section. A single laser beam might be able to transmit 10^9 voice channels or 10^6 TV channels.

Initial research difficulties were concerned with finding ways to modulate the information onto the laser carrier. Then came the realisation that transmission losses were an even larger factor to overcome if the potential were to be realised. (A description of a Siemens development was given in E.T.I, February, 1973). To date, laser communications research is idling along — the effort is still being expanded, but research has long reached a state of diminishing returns.

In its simplest form, the laser communication path could be used directly through the air. However, water vapour and other gases in the atmosphere selectively absorb radiation. Windows, where certain wavelengths can pass, do exist in a clear atmosphere, (see Fig. 9) but fog and other particles can cause significant loss of signal — bad fog can attenuate the beam at 200 dB.km^{-1}.

A large part of the various groups' efforts has been devoted to the transmission of laser beams in a controlled environment. Pipes with refocusing lenses, bending mirrors and even reflective insides have been studied as a means to overcome the loss problems. Better results were obtained — 57 dB.km^{-1} for a 2 cm diameter aluminium, internally coated, pipe. Refocusing and guidance using gas lenses (gas flowing in the pipe is heated to form a varying density profile that forms a quick optical lens) achieved slightly less loss but nowhere near enough improvement could be obtained to make the system economic.

Next came fibre-optic principles — solid glass fibres coated with a material of different refractive index or fibre quartz tubing filled with tetrachloroethylene. Losses in fibres are as low as 2·4 dB.km^{-1}, provided the radiation wavelength matches the transmission characteristics of the fibre system.

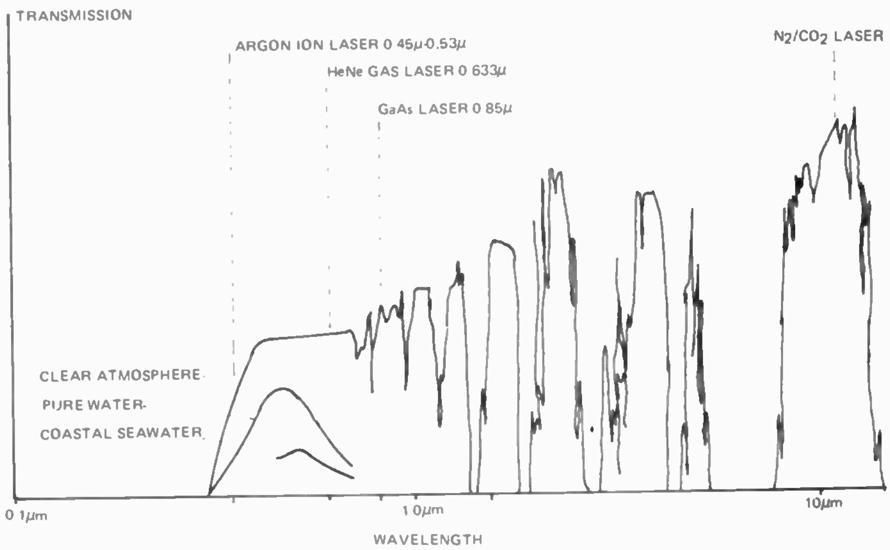


Fig. 9 Transmission of EM radiation.

Having largely overcome the transmission problem the next move is to engineer methods of coupling typical sources to the fibres. Work in progress at the Australian Post Office research laboratories is concerned with the use of GaAs solid-state lamps and detectors.

To obtain the best from GaAs sources and detectors, early units needed cooling to liquid nitrogen temperatures. Today we have efficient room-temperature devices instead.

Clearly then it will still be a while before cables containing fibre optic channels will be installed across the world — maybe never, for who knows what new method could be discovered.

Many laser data links have been built. Police in the USA have a short distance handheld telephone link, television pictures have been transmitted over distances of miles. Gemini 7 used (in 1966) a GaAs voice-channel to send signals back to earth. Satellite communications and improved bandwidth microwave systems have, however, increased the capability of conventional methods. The incentive to push optical communication research has undoubtedly been heavily dampened by these improvements, and by the slow path to success of almost every aspect of development of the basic laser into an economical communication system.

To conclude this review we will look at the advances that have already or soon might be seen in computing, in teaching and entertainment.

COMPUTING

It seems no matter how much storage is provided in a computer system it never quite satisfies the need. There is an eternal quest for higher capacity, faster access methods. A present law of data storage is that capacity goes down if the speed goes up. For example, core storage can provide megabit storage with access times of 1 μs; tape, on the other hand, can provide a thousand times more capacity but with access time measured in minutes. Optical methods could give the best of both worlds at a realistically low cost. A comparison is given in Fig. 10.

The optical method to be used should eventually be holography (see the previous article for a description of this). There are a number of reasons for this — readout can be made without precision imaging systems; dust and other 'noise' only alters the *amplitude* not the *existence* of a data bit in the hologram; no moving parts are needed; the storage density is considerably greater than with any other media; access time is around a microsecond and 3-D information and colour can also be stored. Bell Laboratories can, to date, store 4×10^6 bits with access in 6 μs. Future hopes are 10^8 bits with access in 1 μs.

The basic procedure makes use of a volume of individual holograms. The 1 mm diameter holograms used by Bell Laboratories can store 10^4 bits each. There are 1024 of these minute photographic films. Illumination from a laser projects a reconstructed image of each hologram onto an array of 64 IC chips which each contain 64 photodetectors. Hitachi have also reported a similar development — it was described in ETI October 1972.

TEACHING

The laws of diffraction and interference have been known for centuries and many experiments have been devised to demonstrate them as part of educational programmes.

Until the advent of laser sources these experiments used either white light (in special ways) or coherent light produced from discharge lamps. Interferometry and diffraction effects are much more clearly demonstrated using laser radiation. Diffraction around a fine wire or through a grating can be demonstrated in daylight to an audience of hundreds. Anyone who has had to align an interferometer using a discharge lamp source and a laser will know which is the easiest to do. The laser wins every time.

Lasers have improved the efficiency of the teaching of optical laws, enabling students to progress to a higher level of understanding in the same amount of time.

ENTERTAINMENT

Manufacturers are always on the lookout for consumer products, for the large turnover can mean big profits, nevertheless for all the use of lasers, no company, as yet, has marketed one in a successful consumer product.

It seems the first use of lasers in the home could well be in entertainment. As far back as 1969, RCA released details of prerecorded holographic 'tapes' in which colour programme material is stored. These are read out with a laser that reconstructs the image onto a cheap television camera whose output is displayed on the home television set — and all this was to sell for $400. More recently Philips released details of a laser-read video disk (ETI, November 1972). We await a definite release of such products.

Holographic television that replaces our current flat pictures is also a strong starter for the future. So far its use is limited by the need to transmit about 20 000 times more data — the hologram, after all, represents 3D information, a film only two. This development will only come as part of normal transmission when data links wider bandwidth become available.

It seems that cineholography is also not going to be a starter (that is, seeing 3D films in the theatre) for there appears to be no way to reconstruct images of adequate size without holograms of comparable size. Films would have to be many metres across to do this — it would certainly beat Todd AO and other wide films, but the cost does not justify research at

Fig. 10 Comparison of computer memory alternatives.

MEMORY TAPE	TAPE	DISK	DRUM	CORE	SEMI-CONDUCTOR	OPTICAL
CAPACITY	10^{10} bits	10^8 bits	10^7 – 10^8 bits	10^6 bits	10^5 bits	$10^9 – 10^{12}$ bits
ACCESS TIME	100 sec	300 msec	10 msec	1 μsec	100 nsec	1 μsec
COST	10^{-5} ¢ bit	5×10^{-2} ¢ bit	10^{-2} ¢ bit	2 ¢ bit	20 ¢/bit	$10^{-3} – 10^{-4}$ ¢/bit

"DO NOT LOOK INTO THE LASER"

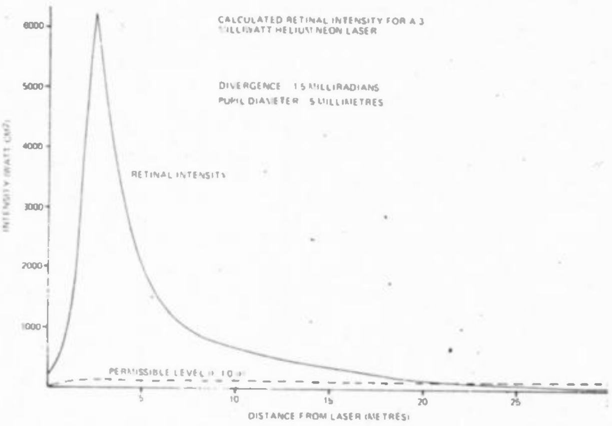
It would be unforgivable to present a review of laser applications without a discussion of the safety aspects of their use.

Lasers are potentially dangerous, especially when large powers are involved, because the radiation intensity is much greater than that provided by conventional radiation sources.

As time passes, the safety criteria vary, but it is generally agreed that all but the smallest sources could cause eye damage by burning the retina. A normal cheap C.W. laser will produce around 3 mW. Figure 11 shows the calculated intensity that this puny source will provide on the retina — it is not so small, by any standards! Note how small the permissible level for continuous exposure is. It is not until the beam is viewed directly from at least a 20 m distance that damage will not occur.

Where possible, lasers should either be enclosed or provided with a beam broadening telescope to reduce the power density. The safest practice is *never to look into a laser beam emanating from the laser* — no matter how small the power is.

Care must be taken to avoid specular reflections — they reflect beams equally as intense as the source.



Where lasers are in use, notices should be displayed to this effect. Be sure to instruct those who could come in contact with the devices that they can be dangerous.

Especially secure precautions are needed where high power systems are used — the slightest flash of an invisible CO_2 laser will bum a hole in the retina.

Like all tools, the laser must be treated with respect.

our present state-of-the-art.

In 1970 a Siemens-built stage laser was used to produce a twisting, twirling effect. (Illustrated on page 16, ETI January 1974). Since the early 1960s, Zenith Radio have been working on acousto-optical systems using laser to produce Son et Lumerie effects — more detail is given in ETI November, 1971.

It is clear the laser is here to stay. One can predict that in the years to come we, or generations following, will be using laser knives in the kitchen, have holographic videophones, take amateur holographic photos, use laser headlights on cars — at different wavelengths for each direction of travel to overcome glare — you can add your own to the list. Nothing is far-fetched; it is merely a matter of economics and social pressures that decide the commodities we obtain.

FURTHER READING

Laser technology is moving so fast that early reviews must be used with caution. The literature contains thousands of articles, so the task of presenting an adequate list is difficult — our own two articles condense over two hundred papers! The following should prove useful.

"Laser applications" Conference by Ian Clunies Ross Memorial Foundation, National Science Centre, Melbourne, October, 1973. (A particularly well balanced and recent overview of applications.)

"Lasers and the Mechanical Engineer" Symposium by Inst. Mech. Engns. London, November, 1968. (Provides breadth but now is dated.)

"Laser Focus" — all issues of this journal are devoted to lasers.

"Review of Laser Microwelding and Micromachining" — K.G. Nichols, Proc. IEE, 116, 12 December, 1969.

"BOC Laser Systems: CO_2 Laser Applications — TC1025" — available BOC, London, U.K.

"CO_2 Applications" — available Coherent Radiation, Palo Alto, U.S.A. ●

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G3 905 5 Pin Din Plug to 6.5mm Stereo Line Connector 2m.

G3- 906 3 Pin Din Plug to 3 Pin Din Plug 2m.

G3- 908 5 Pin Din Plug to 1 3.5mm Plug 2m.

G3- 907 5 Pin Din Plug to 2 Alligator Clips 2m.

G3- 909 2 RCA Plugs to 6.5mm Stereo Line Connector 2m.

G3- 910 4 RCA Plugs to 4 RCA Plugs 2m.

G3- 911 RCA Plug to RCA Plug 2m.

G3- 912 RCA Plug to RCA Connector 2m.

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G3- 914 RCA Plug to 3.5mm Plug 2m.

G3- 915 3.5mm Plug to 3.5mm Plug 2m.

G3- 916 3.5mm Plug to 2 Alligator Clips 2m.

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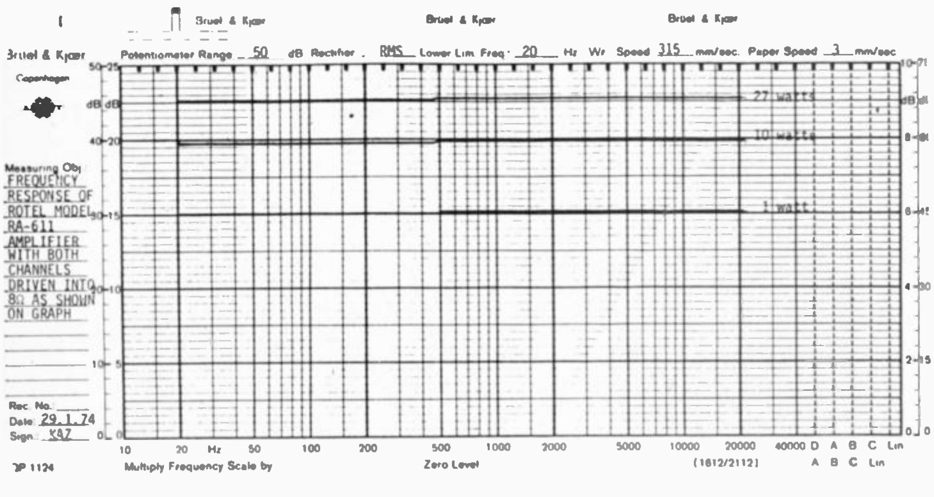

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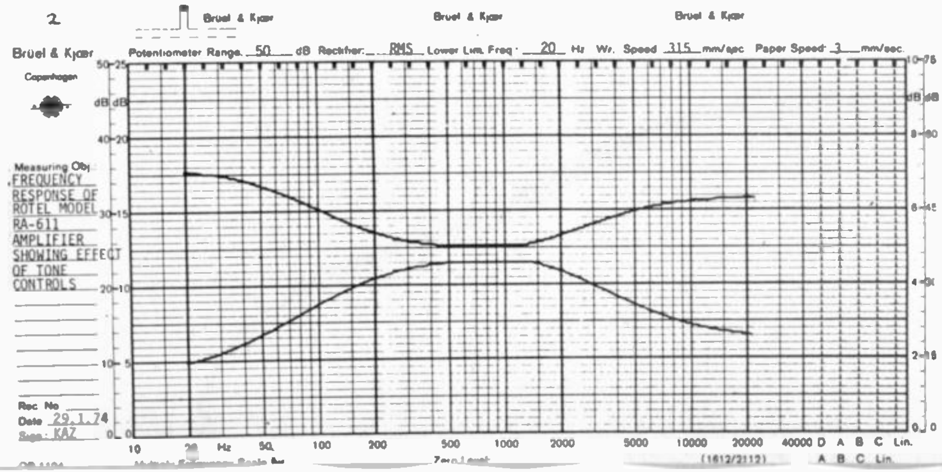


ROTEL amplifiers have achieved a deserved popularity, offering as they do, particularly good performance at a modest price.

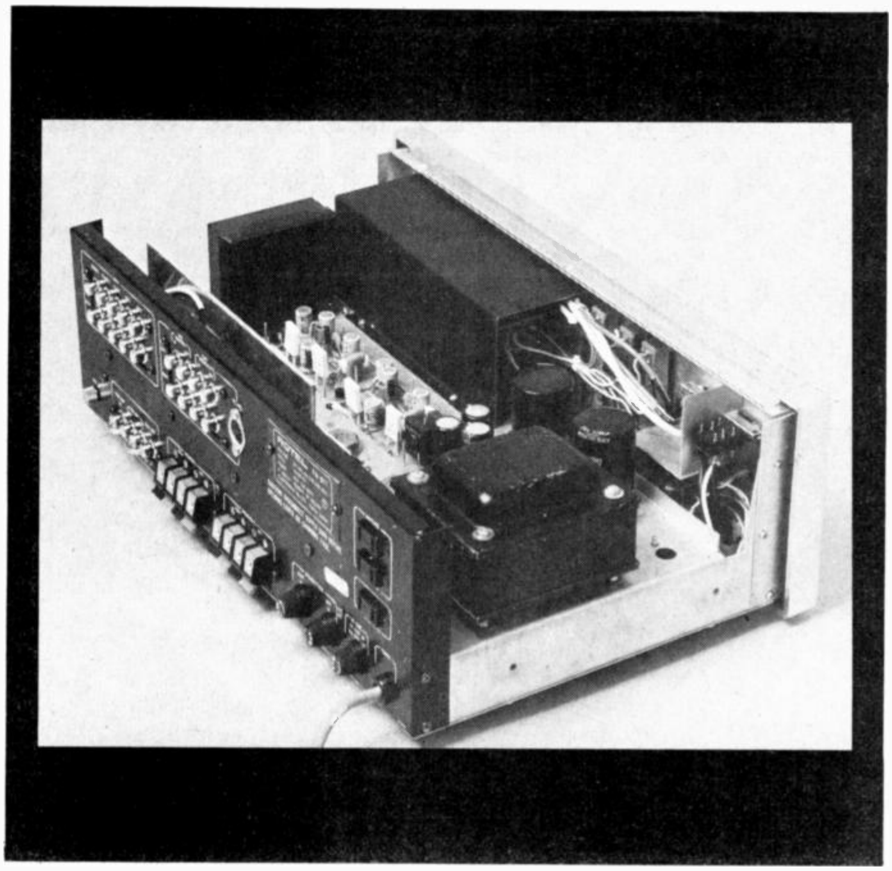
The Rotel RA611 is no exception.

It develops 27 watts per channel, with both channels driven, and has more than acceptable distortion figures.

Frontal appearance of the RA611 is business-like but the two large black artificial louvres which flank both sides of the satin aluminium front panel make the amplifier look smaller than it really is.

The amplifier controls are arranged in three levels:—

Across the top are push buttons for power, low frequency filter, and high frequency filter. To the right of these are two pairs of slider controls for the bass and treble, and to the right of these again are a tone defeat button which disconnects the tone controls, a mono-stereo button, a loudness control, and a muting switch which provides a 20 dB drop in signal level. On the extreme right hand side of the amplifier is a very large (5 cm) volume control knob. This knob consists of a polished aluminium rear section and a 3.8 cm black front. With a knob with



these dimensions and colour there can be no confusing the volume control from the rest!

Below the power switch is a small green bezel light and below this a standard tip ring and sleeve socket headphone connector.

Across the bottom of the amplifier, to the right of the headphone socket, is a speaker selector switch which selects Off, Speaker System 1, Speaker 1 and 2, and Speaker System 2.

To the right of the tone controls is a monitor selector. This is one of the most unusual, yet practical, features that we have seen incorporated in an amplifier for the serious audiophile. It allows selection of Channel 1 on to Channel 2, Channel 1 alone to play, Source (which allows all inputs to be amplified in the normal manner), Channel 2 to play, and Channel 2 to be played into Channel 1.

Next to this control is the input selector for Phono 1, Phone 2, Tuner, Auxiliary input 1, and Auxiliary input 2. To the right of this, and immediately below the large volume control, is a slider control for channel balance adjustment.

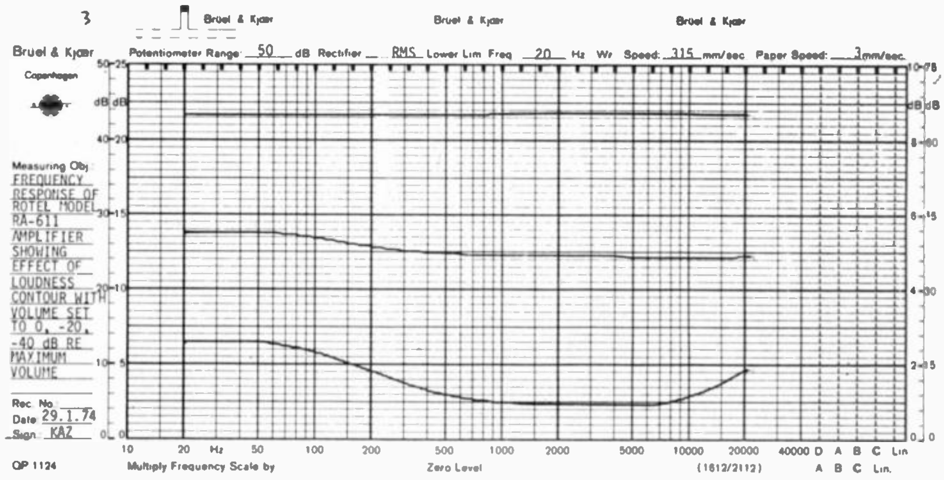
The amplifier casing is constructed from well veneered teak plywood with a moderately large black expanded aluminium grill for heat sink cooling near the rear.

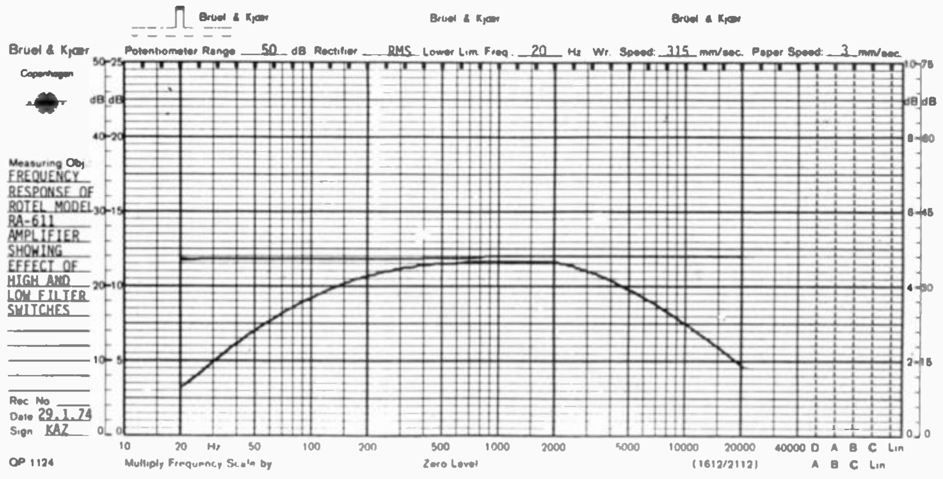
The rear panel provides extremely comprehensive inputs including quick release speaker terminals with fully captive connections together with speaker fuses, mains fuses, and switched and unswitched mains power output connections. The main connections are afforded by 22 RCA type coaxial sockets whilst the ubiquitous DIN plug is there for tape recorder connections.

INTERNAL CONSTRUCTION

The inside of the amplifier is very well constructed. The preamplifier card is well-screened, the phono preamplifier is fully enclosed and shielded, and the main transistors are mounted on a large aluminium heat sink constructed from 12 gauge aluminium which apparently performs its task quite well. Temperature rise at the grill was a modest 25°C after two hours continuous running with both channels driven.

The general construction of the unit





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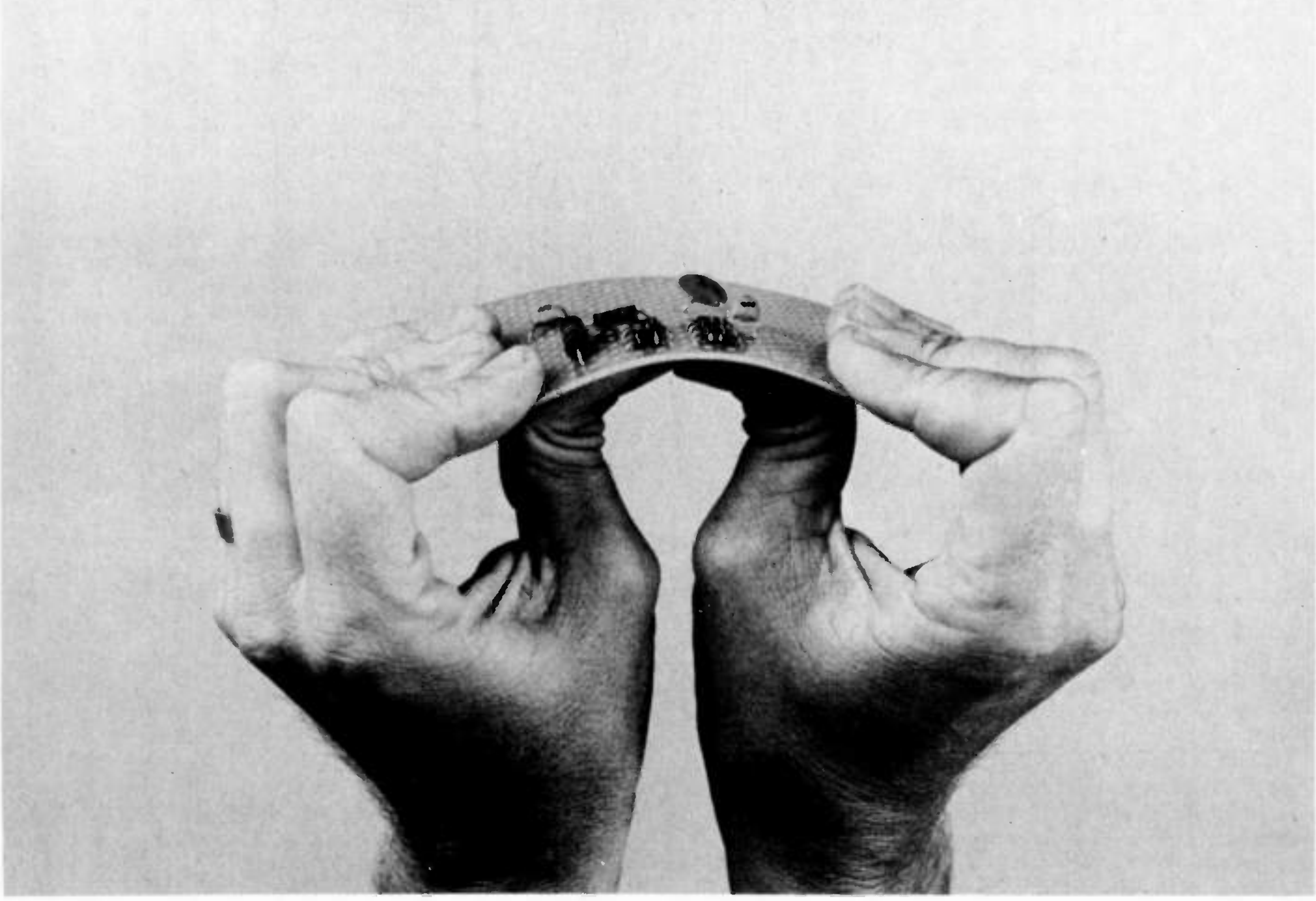

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MEASURED PERFORMANCE OF ROTEL MODEL RA611
SERIAL NO: 47059

Power Output — 27 watts (rms) in 8Ω+ 8Ω loads (both channels driven)

Frequency Response

at rated output 20 – 20 000 Hz
at 1 watt output 20 – 20 000 Hz
at 10 watt output 20 – 20 000 Hz
} ±½ dB

Channel Separation at Rated Output

100 Hz	– 30 dB
1 kHz	– 30 dB

Hum and Noise with Respect to Rated Power

(Volume control at	–73 dB unweighted
maximum gain)	–85 dB A weighted

Input Sensitivities for Rated Output

Input	Voltage	Impedance
Auxiliary 1	125 mV	40 kΩ
Auxiliary 2	125 mV	40 kΩ
Tuner	125 mV	40 kΩ
Mag. Pick-up	2 mV	77 kΩ
Monitor 1	190 mV	47 kΩ
Monitor 2	190 mV	47 kΩ
Main Amp.	600 mV	33 kΩ

Total Harmonic Distortion
(At Rated Output
both Channels driven)

100 Hz	1 kHz	6.3 kHz
0.1%	0.125%	0.31%

Intermodulation Distortion — 0.5%

Tone Controls

Bass:	9.5 dB boost at 50 Hz
	10.5 dB cut at 50 Hz
Treble:	7.5 dB boost at 10 kHz
	9.5 dB cut at 10 kHz

Loudness Control
(at –40 dB re 0 dB
maximum volume control
setting)
+8 dB at 50 Hz. and +1 dB at 10 kHz.

Dimensions — 260 x 130 x 425 mm

Weight — 8.5 kg

and its wiring is neat and the designers have taken some care in the fitting of many of the components to preclude long term problems, taking such precautions as tinning the printed circuit board where components are screw connected to the circuit.

MEASURED PERFORMANCE

We proceeded to test the main parameters of the amplifier and it was quite pleasing to find that *all* the performance measurements exceeded the manufacturer's specification.

Maximum power output was 27 watts into eight ohms with both channels driven. This is very good performance at 0.15% total harmonic distortion.

Frequency response at rated output of 25 watts was 20 Hz to 20 kHz ±0.5 dB. This is now virtually an industry standard.

Channel separation at rated output was 30 dB. This is lower than many other amplifiers — but is realistic and totally adequate. (In fact it is good to see that Rotel, throughout this unit, have provided performance characteristics that are down to earth. All parameters are just a little bit better than necessary — but not so much better that the customer is paying needlessly for a technical excellence that is meaningless outside a research laboratory — Ed).

Hum and noise, with respect to rated power output, was –73 dB unweighted and –85 dB ('A' scale) weighted.

Input sensitivities were all particularly good, with the magnetic input having 2 mV sensitivity.

The tone controls offer a slightly lower range of adjustment than we have become used to, providing 9.5 dB boost at 50 Hz and 7 dB boost at 10 kHz — this is just acceptable.

The loudness control provides 8 dB boost at 50 Hz and 1 dB boost at 10 kHz with both channels driven.

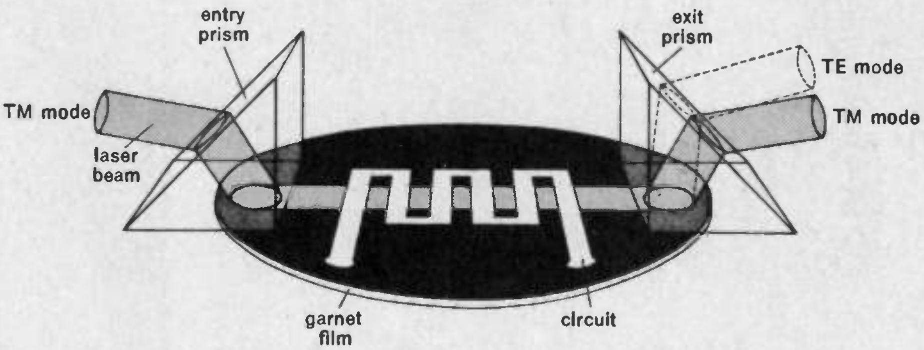
Perhaps our only real gripe about this amplifier is the choice of the anti-log potentiometer used in the volume control circuit. This characteristic results in little control until the volume knob is nearly fully clockwise. This is a little disconcerting at first.

In summary — Rotel's RA611 amplifier has very good performance. It is also more flexible in its facilities than many more run of the mill units.

At its (recommended) selling price of $199 it is an exceptionally good buy●

New switch may be used to modulate light in laser communication systems.

THIN FILM LASER SWITCH



Path of a laser beam through the thin film switch

A NEW light switch for use with lasers has been devised by Bell Telephone Laboratories (BTL) scientists.

The magnetically-controlled switch, which can modulate light passing through a thin, single-crystal garnet film, may some day be the heart of a miniature circuit in an optical communications system. Scientists have been seeking such a switch as part of a system that would permit them to transmit large amounts of information over light beams.

The light switch measures about 19mm across in its present experimental form, but could be miniaturized further to meet the prism requirements of an optical communcations system.

The switch consists of a yttrium-gallium-scandium-iron garnet film, about 2.5 micrometres thick. The film is grown, on a gadolinium-gallium -garnet substrate, and it serves as a waveguide for the light waves. Two types of light waves can propagate in this film. One type has magnetic transverse fields or so-called TM modes. The other types has electric transverse (or TE) fields.

Two prisms are positioned, one at either end of the garnet crystal wafer. One prism serves to guide the beam from an external laser into the film. The second "exit" prism guides the laser beam out of the film. This technique for coupling an external laser beam into an optical circuit was advanced by Dr. Tien and his colleagues in 1969. The exit prism, which is made of a bi-refringent material, has an additional property in that it guides the laser beam out of the film in one direction for the TM type of lightwave and in another direction for the TE type of lightwaves.

A tiny serpentine-shaped electronic circuit, made by conventional integrated circuit techniques, is applied to the surface of the garnet wafer, overlapping the path followed by the laser beam through the garnet film. In the experiment, the light wave is fed into the film by the "input" prism in a TM mode. When a current is passed through the serpentine circuit, a small magnetic field, in the order of 2×10^{-5} tesla is created. When the magnetic field is present, the light wave is converted from the YM mode to the TE mode because of the magnetic-optic property of the film. The exit prism guides the TE and the TM light waves out of the film in two different directions. The light beam can be switched back and forth by turning the induction current, and thus the magnetic field, on and off in the circuit.

By switching or modulating the light in a precisely controlled pattern, information could be coded into the light beam. The beam could then be transmitted through a glass fibre to a distant receiving station where the information would be retrieved by a light detector.

In an eventual optical system, the input prism may not be needed, since the light wave may be generated in the film by a thin-film laser. The exit prism also would be replaced by a thin-film polarizer and a film-fibre coupler. The modulator or switch would thus be extremely simple, involving only a magnetic film and a tiny electric circuit. Because of the serpentine structure, the inductance of the circuit is less than 0.1 microhenry. In the experiment, less than 100 mW of electrical power was used to modulate the light from a 1.15 micrometre helium-neon laser at a modulation frequency of 80 mHz. ●

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Sony unveils its new TC-129 tape deck as a perfect companion to the immensely popular TC-134SD deck! Both have Sony's precisely engineered Ferrite and Ferrite head for fully extended frequency response, excellent signal-to-noise ratio and up to 200 times the life of conventional heads. Both have tape selector switch for optimum adaption from conventional tapes to CrO_2 tapes such as Sony's chromium dioxide cassette tape. Both have manual control stereo recording sliding-type recording volume controls for each channel and dual motor for easy balance control. Both have instant stop mechanism with locking pause control. Both have mechanical/auto stop which automatically shuts the tape transport off when the tape reaches its end. Each has 3-digit tape counter with reset button; headphone jack to accept 8-ohm impedance; microphone jack for MIC/LINE; REC/PB connector. Both are superbly styled. Then what's the difference—apart from their physical layout? Frequency response on the TC-129 is 40Hz-12000Hz with normal tape. 40Hz-14000Hz with CrO_2 tape. On the TC-134SD it's 30Hz-15000Hz normal tape, 30Hz-17000Hz with CrO_2 tape. The TC-129 has its own hinged detachable dust cover. The 134SD has the famous Dolby system to extend response and reduce tape hiss. Both are fantastic value. The choice is yours.

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CREATIVE AUDIO PART 6

A practical guide to creating and producing your own sound.

MUSIC is composed of a series of events occuring in a definite relationship to a time scale, and many devices have been designed for automatic or semi-automatic sequence generation.

These include switching mixers – passive devices fed from a diversity of prepared sound sources, to ring generators in which trigger pulses shock a sequence of resonant circuits into brief oscillation. This latter category includes the rhythm machines that organists use to accompany their playing.

Digital circuitry is well suited to sequential control, and various memory systems have been devised to encode and store voltage levels for interfacing with voltage control systems; at its simplest it can provide a pseudo-random sequence of voltage levels used at low frequency as a control source, at higher frequencies functioning as a white noise source or chromatic generator (band width limited white noise).

At the other end of this scale, whole computer programmes have been devised for electronic music generation, and to this end a number of bigger studios have custom-built computers, notably the R.C.A. system.

The Oramic sound-system to be discussed later also belongs in this category.

SWITCH/MIXERS

Before solid-state switching had become commonplace, the B.B.C. Radiophonic Workshop had found a great necessity for some form of multiple input switching mixer.

The B.B.C. devised one unit based on capacitance control in the form of a motor-driven rotary air-vane variable capacitor. It sequentially scans the 16 input sockets at a preset rate, noiselessly fading each up in turn for the required duration.

There are many ways in which an electronically-switched sequencer may be designed, the simplest being the previously described ring generator. The duration of each output pulse becomes controllable if a ring of one-shot multivibrators is substituted for the ring generator and if each output pulse is fed to its own envelope generator, more than one parameter may be programmed into the sequence. For instance the envelope generator may be used to provide a voltage output to a voltage-controlled oscillator, governing its pitch, as well as performing amplitude control. The circuits illustrated in Figs. 1 and 2 designed by Ehle, first appeared in "dB", March 1969. It is, in essence, a twelve-channel ring sequencing device, with provision for external trigger. When the switch is at 'interrupt' a single 12-event sequence occurs. The start button is pressed to insert a pulse into the ring generator and, by pressing this button more than once, it is possible to generate highly complex sound patterns, as the multiple pulses follow each other round the ring.

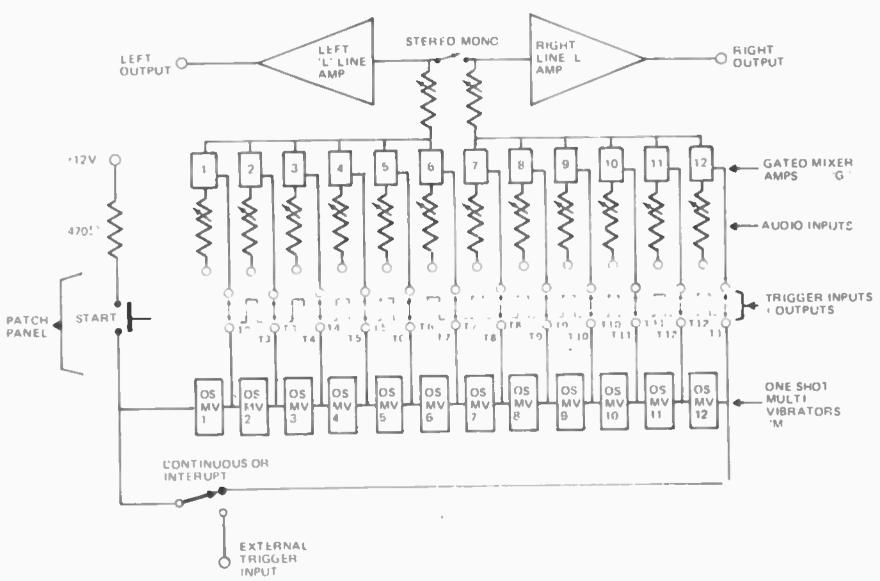


Fig. 1. Twelve channel switching mixer (designed by Ehle).

DRUM SIMULATING DEVICES

A variety of percussive sounds may be obtained with variations on a simple twin-T oscillator of the type illustrated in Fig. 3. The table is given as a guide to the frequency determining and envelope shaping components. Further details can be found in the paper "Electronic Percussion Instruments" by C. Muller, Electronics Worlds, February 1967.

The rhythmic pulses necessary to control a set of circuits of this kind could be obtained from the output of a multivibrator and dividing chain. Alternatively, they could be derived from a ring counter, or even electromechanically – this could be based on a gramophone-type turntable with raised studs which trip microswitches fixed on arms above the turntable (Fig. 4).

The drawback with the automated rhythm devices just described, is that they are unresponsive – once set to give a particular tempo, they are unable to compensate for human variation, the outcome being that the musician struggles to regulate his tempo to that of his machine.

R.A. Hoare of New Zealand has, explored the possibility of a system which could continuously adjust itself to the tempo of the musician (Figs. 5 and 6).

The musician taps his foot on a microswitch as he plays, each tap causing a linear ramp voltage to reach its maximum and return to zero. The maximum voltage is stored in an operational amplifier 'memory', throughout the succeeding period.

A series of potentiometers are used to set selected fractions of this stored maximum, each one feeding a leg of its own comparator, the other leg fed by the currently rising ramp. When any comparator's potentiometer-selected selected fraction of the 'memory' voltage is reached by the rising ramp, that comparator switches to give the required pulse, which can be sent to a drum effects circuit of the type illustrated.

The device always bases its tempo on the preceding period. A rough estimate of the correct rise time is necessary to give a suitable maximum voltage without 'bottoming' the operational amplifier.

In the illustration, switch 2 should be closed first, setting the maximum, followed rapidly by switch 1 which

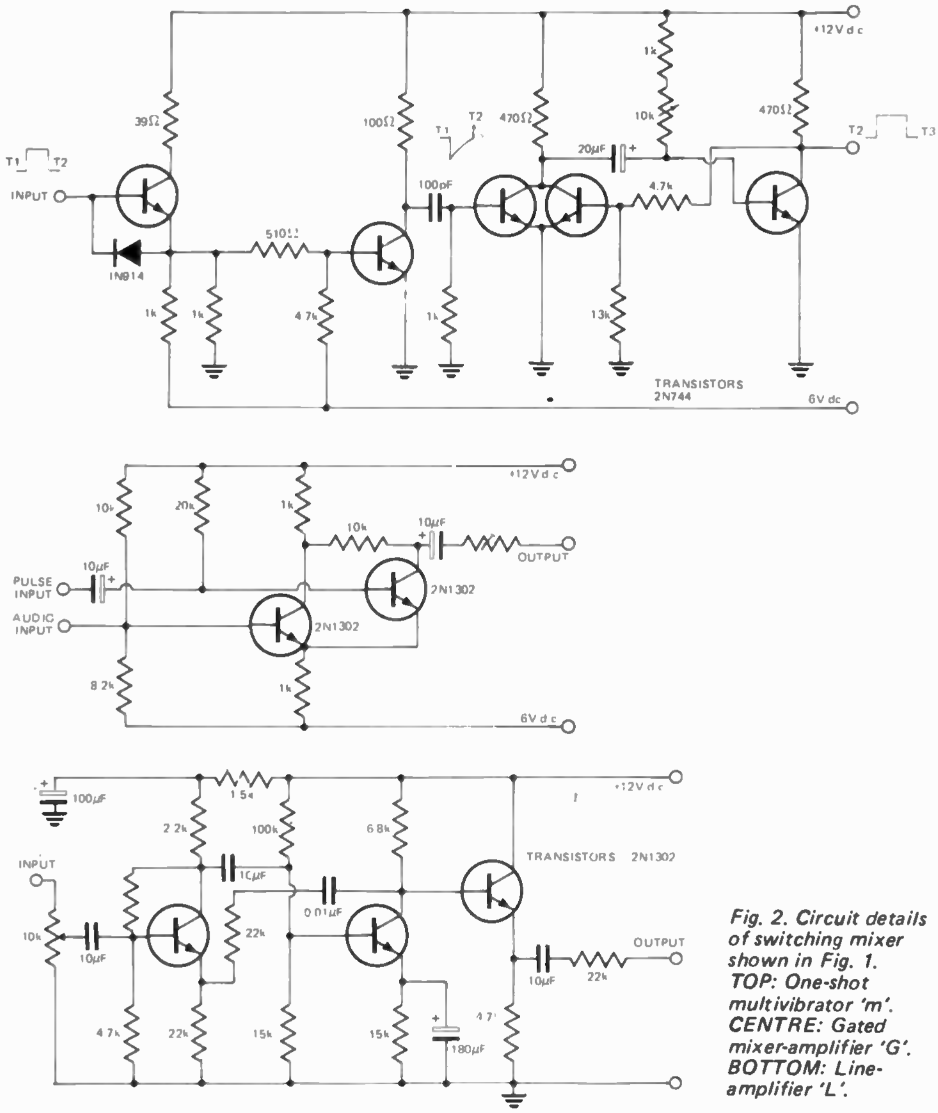
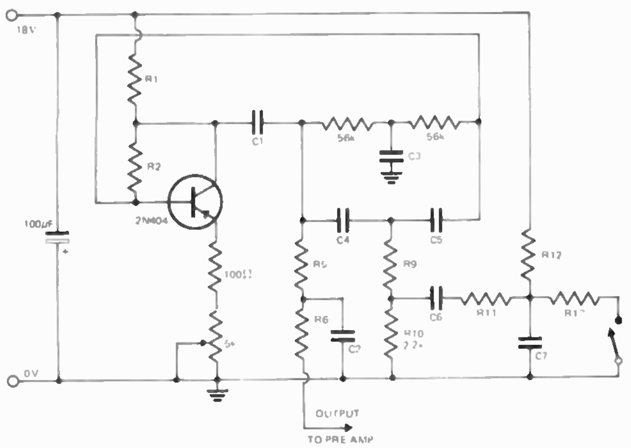


Fig. 2. Circuit details of switching mixer shown in Fig. 1. TOP: One-shot multivibrator 'm'. CENTRE: Gated mixer-amplifier 'G'. BOTTOM: Line-amplifier 'L'.



	ORUM	TOM TOM	BONGO	BLOCKS
R5	22K	82K	82K	330K
R6	10K	82K	82K	not used
R9	2 7K	6 8K	6 8K	6 8K
R11	82K	22K	27K	not used
R12	1M	0 56M	1M	1M
R13	2 7K	2 7K	2 7K	6 8K
C1	0 1	0 047	0 047	0 047
C2	0 1	0 01	0 01	not used
C3	0 1	0 047	0 033	0 01
C4	0.1	0.027	0 015	0 0033
C5	0.1	0.027	0.015	0 0033
C7	0 1	0.1	0.01	0 1

all ½ watt 10%

Fig. 3. Twin-T circuit for percussion effects.

zero's the ramp. This could be accomplished by constructing a pedal with switching derived from a double key-switch, as used in an electric organ, one contact being slightly bent back to achieve the requisite delay. Another possibility is to feed a dc voltage, switched via a single microswitch, to a pair of relay coils, one of which is slugged, (Fig. 7).

The best method would be some form of digital logic to generate a pair of pulses; these could be interfaced directly with transistor or FET switches.

DIGITAL LOGIC SEQUENCE GENERATION

The Triadex "Muse" is a commercially available 'automatic' melody composer consisting of a sophisticated array of digital shift-registers. It has two banks of linear multiposition switches, one bank controlling rhythm, and the other pitch. In addition to the information indicated by the position of the switches, a visual readout of the programme is also shown by a line of LED indicators.

The type of short digital shift-register to be described can be programmed to produce a wide variety of binary words, with the minimum of logic hardware.

The output is in the form of a serial stream of different voltage levels. These are fed to a voltage controlled oscillator to transform voltage variations to frequency variations. The output is taken to a loudspeaker.

The output from the simplified generator illustrated in Fig.8, although assymetric in one period, is perfectly symetrical from period to period. At higher clocking rates the audio frequency output resembles random noise, but more detailed examination will reveal the true periodic nature of this waveform, which is thus termed 'pseudo-noise'. It has a very high harmonic content and, due to the unit delay of events in the sequence, it is easy to filter by direct digital methods — the complete hardware consisting of a dozen on-off switches. Many thousands of waveforms may be generated with this simple register, a few of these are illustrated in Fig.9.

This type of register has not as yet achieved much popularity in the field of synthesizer design, but could easily form the basis of a versatile tone-generating module. A keyboard potential divider arrangement would give the desired incremental voltage changes, which could control the frequency of a voltage controlled square wave clock generator. Drastic tonal changes could now be accomplished simply by flicking the

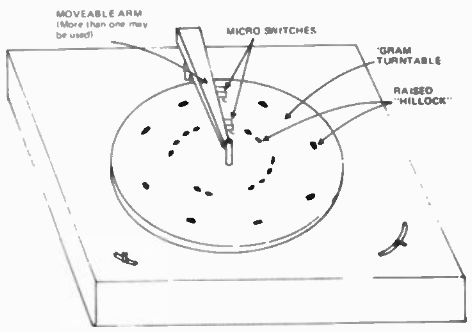


Fig. 4. Electro-mechanical rythm generator.

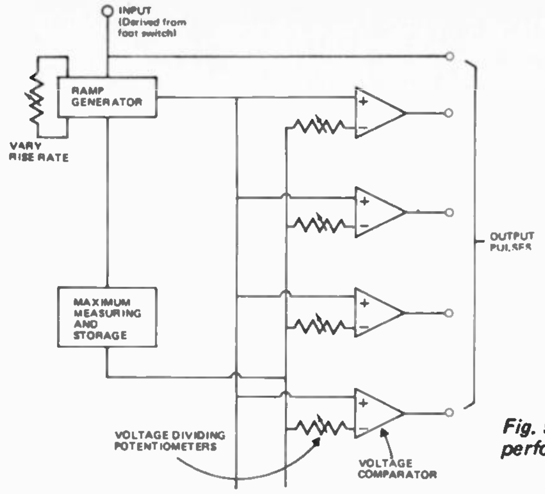


Fig. 5. Rythm generator with 'live performance' control capability.

various switches which make up the digital filter.

This topic has been covered in depth by Burhans in his paper "Pseudo Noise Timbre Generators", Journal of the Audio Engineering Society, April 1972, Vol. 20 No.3. He includes a computer print-out and full explanation which clarifies the action of the filter switches, and discusses the potential of such a generator in a low-cost music synthesizer apparatus.

THE R.C.A. SYNTHESIZER

This is a complete electronic music studio which uses a punched paper roll to control two independent channels, each specifying five parameters — frequency (fine tune) octave, timbre, envelope (specified as growth, duration and decay) and volume. The method of control is similar to that employed by the old steam organ, except that the sensing is done directly by a 'key frame' of microswitches, and not indirectly by keys actuated by air pulsing through the holes. A second similarity with the steam organ is size — the R.C.A. synthesizer occupies ten 2-metre racks with its multitude of tuning-fork oscillator banks, frequency dividers, relays and amplitude controllers.

Despite its versatile range of parameters it is restricted, in that once the paper roll has been punched, it is not easy to juggle parameters around independently.

THE ORAMIC SOUND SYSTEM

Music played on a conventional acoustic instrument is endowed with various qualities absent from music played on, for example, a laboratory sine wave generator, these are the qualities of inexactitude — subtle wandering of pitch, quaver and vibrato; variations in the number of overtones present from moment to moment and continual amplitude changes. In addition there will be the different types of operating noises discussed earlier in the series.

Daphne Oram has developed and patented a method to enable enough control over electronic music, to allow the composer to add whatever degree of 'humanising' influence he wishes.

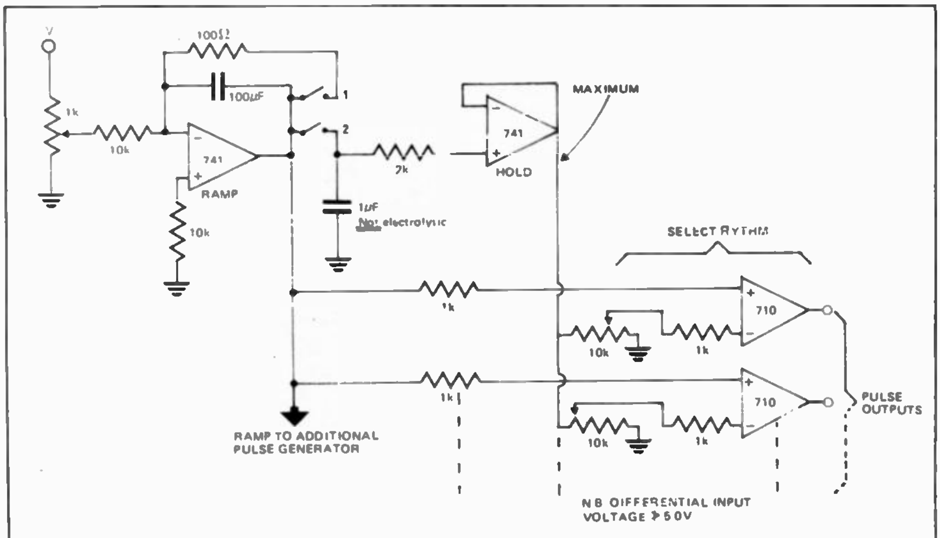
The system is completely graphical, each parameter being drawn free-hand by the composer in Indian ink on 35 mm. transparent film. There are nine film 'tracks' which are synchronously pulled along by a sprocketed roller. Each is scanned photoelectrically, some to derive digital, and the rest analogue, information.

Two tracks, corresponding to 'open string' positions, control the pitch, digitally assisted by a third transposition track which can be equated with the fret positions on a guitar. Another digital track controls the rest of the studio equipment as well as timbre selection.

One analogue track only is used for pitch, providing a realistic vibrato, the rest of the analogue tracks controlling the volume (envelope) of four different timbres. The timbres are composed in the same graphic manner, but as waveforms are periodic, only one cycle needs to be drawn, and this is repetitively scanned to give the signal.

It is an easy matter to alter the time relationship or quality of one parameter with respect to the others, as the timbre, envelope and pitch are composed on separate films.

The mixture of the four envelope signals is taken to one track of a multi-track recorder, with part of the signal feeding a final amplitude control track routed to a reverberation room



Switch 2 is closed first to set maximum, switch 1 is closed immediately after to zero ramp.

Fig. 6. Experimental circuit for rythm generator having 'live performance' control.

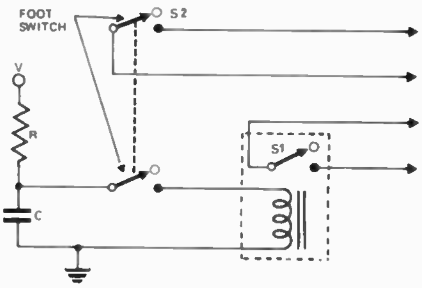
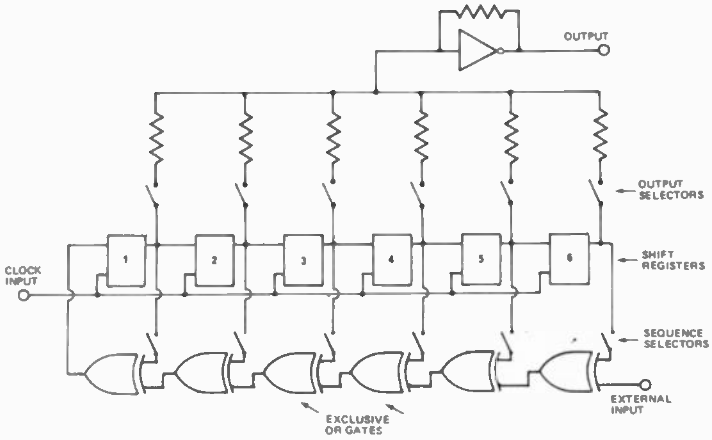
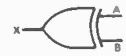


Fig. 7. Using a slugged relay to give the required time differential for circuit shown in Fig. 6.





INPUT		OUTPUT
A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

Fig. 8. LEFT: Pseudo-noise generator circuit RIGHT: Truth table of EX-OR gate.

to allow control over reverberation amplitude as well.

SYNTHESIZERS

A glut of voltage controlled synthesizer designs have arisen since Dr. Robert Moog's first synthesizer went into production in the mid-1960's. Very briefly, these devices operate by converting each control parameter to a linear voltage variation; in many cases this means interfacing a logarithmic or exponential convertor circuit before the actual control input, because our sense of hearing responds linearly to exponential changes of loudness, frequency and so on. Doubling the voltage with such a converter in circuit will double the loudness, or raise the frequency one octave.

The advantage of such a system is that one control voltage may be used to influence any number of devices in tandem, which will track together in synchronisation with control voltage changes. Long runs of cable may be freely interposed between the device and its control apparatus which can be a voltage generator (oscillator) or some form of potential divider — keyboard, ribbon controller or 'joystick'.

New synthesizer designs, including Electronics Today's version are opting for matrix patching between modules to obviate the spider's web of jack-leads which characterise the Moog systems (with the exception of the live performance Mini-Moog which utilises switched pre-patching).

The British E.M.S. 'A.K.S' a matrix patching system, has provision for plug-in pre-patched blocks, but this is no great advantage in live performance as, when going from one patch to the next, alteration of all the control settings is also necessary.

Instead of a matrix system, the A.R.P. 2600 synthesizer (Fig. 10) routes its signal and controls via a bank of multi-way switches wired in to a busbar arrangement.

Many synthesizers provide their own particular 'one-off' facilities — in addition to the complement of oscillators, amplitude controllers and filters.

The Mini-Moog (Fig. 11) has a high accuracy 440 Hz (standard A) generator for tuning purposes.

Moog also make a ribbon controller, which is a resistive strip with an extended conductor suspended above its length; it is played by bringing the conductor into contact with the strip Hawaiian guitar fashion.

The A.R.P. Odyssey (Fig. 12) although monophonic in the strict sense of the word, can route two keyboard voltages simultaneously to separate oscillators. This takes it at least one step nearer to polyphony.

Joystick control is common to the whole of the E.M.S. (and also the Electronics Today) range, and allows independent control over two parameters — one by forwards-backwards movement and the other by side-to-side operation. A conversion suitable for the constructor has been described in a Wireless World design published last year.

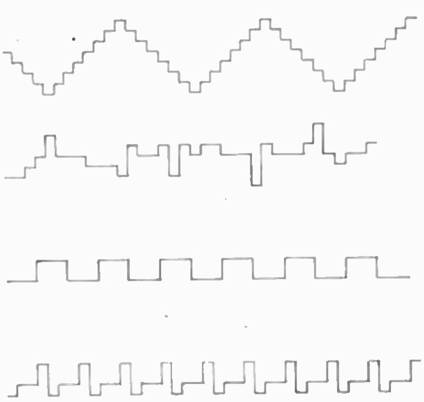


Fig. 9. These are just a few of the many waveforms that can be produced by the circuit shown in Fig. 8

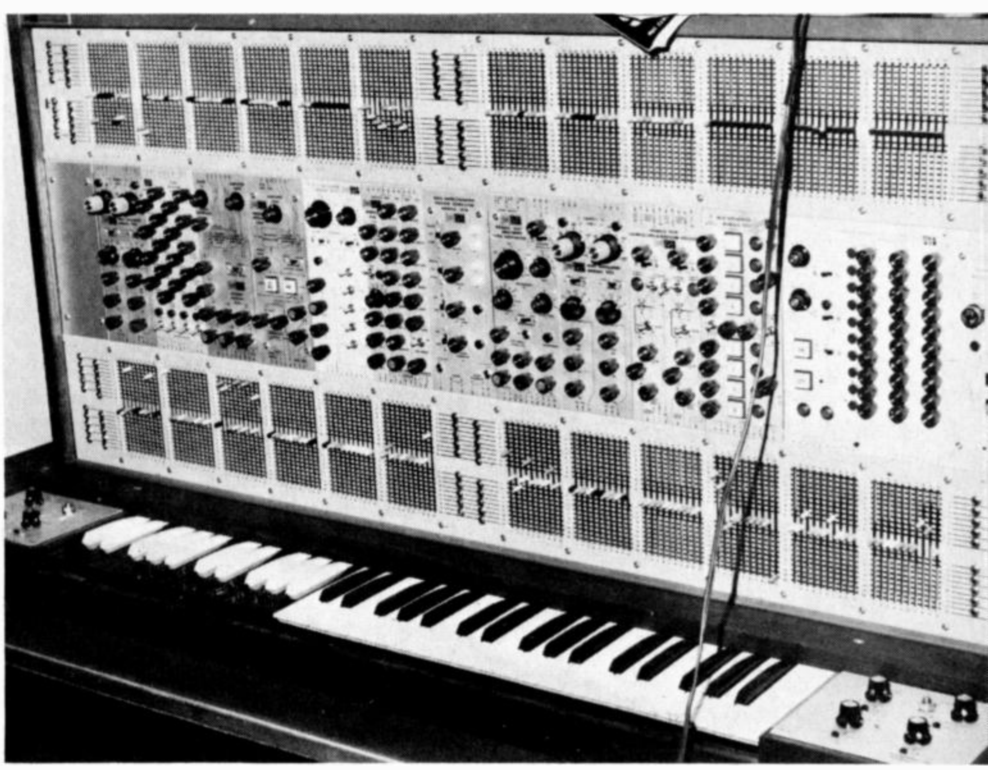


Fig. 10. ARP 2600 Synthesizer.

Fig. 11. Mini-Moog synthesizer.

One fascinating, if temperamental, device is the E.M.S. pitch to voltage convertor. It detects the fundamental pitch of a signal derived from a microphone or other source, even if this occupies only 10% of the total sound level, and locks on to it. After passing through the sophisticated analogue filtering stage, the period of the fundamental is measured and converted into a proportional voltage suitable for control functions. A track and hold buffer ensures spurious outputs don't occur whilst the signal is dying away. Period measurement is used as opposed to counting zero-crossings in unit time, as it produces results far more rapidly.

Both A.R.P. and Moog synthesizers incorporate modest voltage sequencers, occupying a number of layers; the outputs are routed to chosen devices and the control at each sequence step is proportional to the setting of the potentiometer. In order to set up a small melody, the painstaking operation of tuning each potentiometer is necessary.

E.M.S. have chosen the alternative of a digital memory bank for their sequencer. The major model, available free-standing (Fig. 13) or integrated in the Synthi 100, records 256 events in six simultaneous layers, each layer of which may control a different parameter.

The memory may be programmed from the keyboard and, once a layer has been registered, there are many possibilities — the voltage pattern can be routed to control another device, the memory can be made to repeat a certain section many times over, or play it forwards or backwards with a tempo variable over a 1000 : 1 range.

Mistakes can be 'edited' from the memory, layers can be re-written, and if desired the clocking speed controlled from signals recorded on one track of a multi-track recorder.

Their briefcase synthesizer, the A.K.S., has a rather more limited one-layer 256 event memory; this is programmed from an integral keyboard which, based on capacitive control, has no moving parts (Fig. 14). It too offers a wide range of recording/replay speeds.

This brings us to the final area, the use of the full-size computer for electronic music realisation.

COMPUTERS

In the early days the computer was used for the actual production of the tone, i.e. feeding its digital message directly to a loudspeaker. This is tedious, time-consuming and expensive for the composer, as each parameter of every tone has to be completely specified.

On the other hand, although the voltage controlled synthesizer has boundless possibilities, it responds markedly to minute variations of its control settings, and once a particular sound has been devised, it may be difficult to regain with accuracy on a future occasion.

In Britain, Dr. Peter Zinovieff has pioneered the idea of a computerised studio, in which the computer works through an interface which transfers the digital information to voltage levels compatible with the voltage-controlled analogue devices.

His studio, a picture of which accompanied the first article in this series, consists of the E.M.S. Synthi 100 synthesizer, analogue-to-digital and digital-to-analogue converters, PDP.8 Processer, 4 K. Core, 32 K. Disc and Teletype.

Programs can be run through which will tune the oscillators and carry out frequency measurements and similar tasks, relieving the composer of the bulk of the 'setting up'.

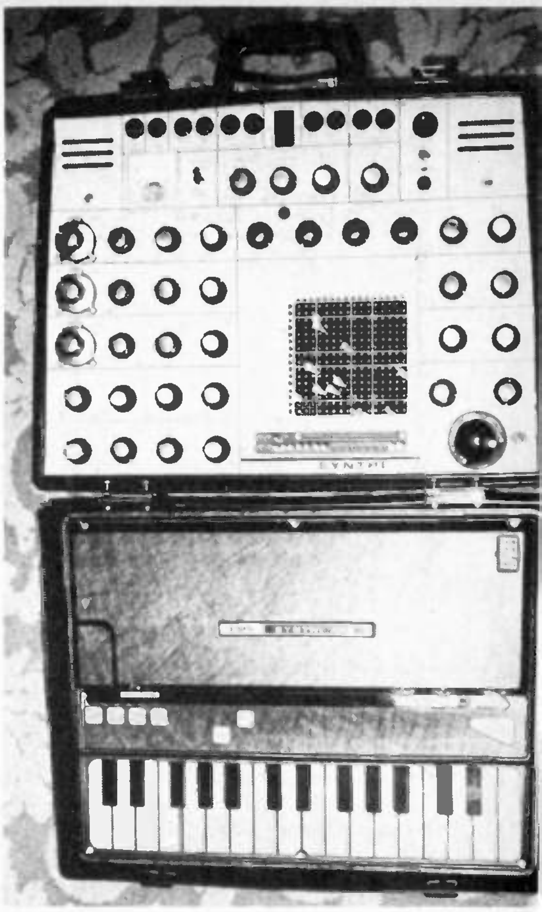
Zinovieff's digital interface has 4 six-bit analogue-to-digital converters, and 64 six-bit digital-to-analogue converters, to allow the computer to control all the devices in the Synthi 100. There are also 4 ten-bit controls to permit glissando effects without audible stepping.

The composer may use the system in a number of ways, guided by a generalised program called Musys. It can be used as a giant sequencer to examine, store, modify as necessary and replay events registered by the Synthi.

Musical scores may be devised and typed directly on to the Teletype in a

Fig. 12. ARP Odyssey synthesizer can route two keyboard voltages simultaneously to separate oscillators.

Fig. 13. (LEFT) EMS' sequencer has inbuilt digital memory bank. ◀

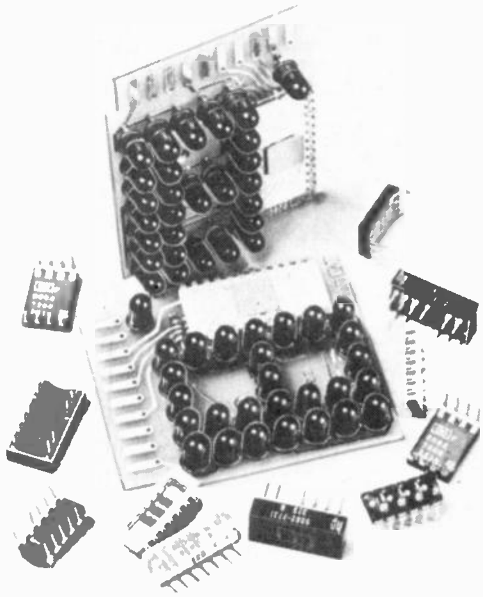


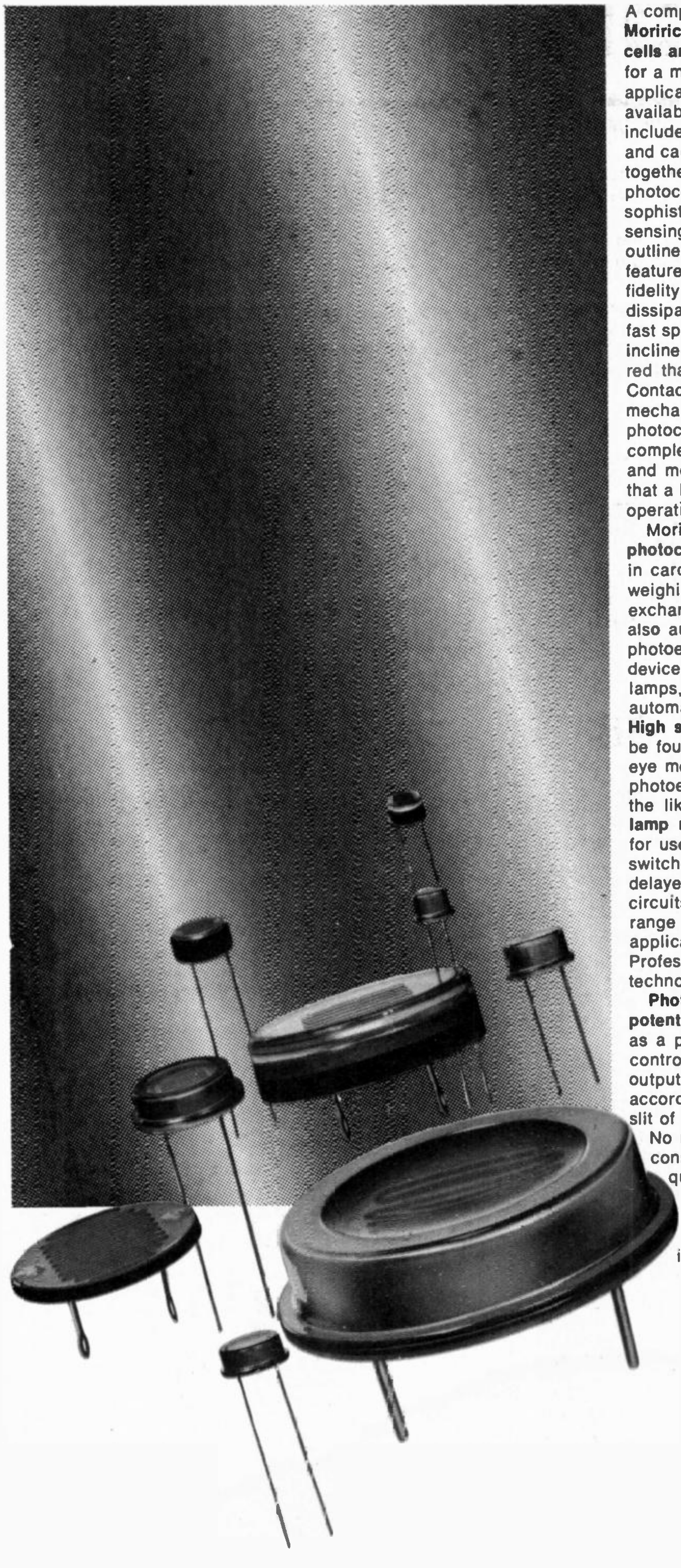
▶ *Fig. 14. (RIGHT) AKS 'briefcase' synthesizer has inbuilt one-layer 256 event memory.*

number of ways. They may be in the form of letter/number instructions i.e. 02.15, E3.5, F7.30. This example would route oscillator 2 through envelope 3 and filter 7 with settings of oscillator frequency 15, envelope attack 5, and so on.

The program also allows the composer to specify groups and arrangements of sounds by collective terms, a glissando as GLISS and a crescendo as CRESC. Musical 'chores' such as transposition and repetition are easily carried out. In common with the integral sequencer of the Synthi, the PDP8 clocking signals may be derived externally, for instance from one track of a multi-track tape.

In conclusion, it is evident from the foregoing that this is one activity in which technology and art occupy common ground. It may appear that this feature has had little in common with the other topics in the series, but one should remember that the common denominator is *tape* — every device mentioned is inevitably involved with the tape recording process at some stage in electronic music realisation. ●





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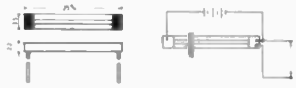
Photentiomatic (photo-potentiometer). Functions as a potentiometer controlled by light in which output voltage changes according to shifting a slit of admitting light.

No mechanical contact construction results in quiet, long-life operation. It offers excellent resolution and high convertible ratio from input to output voltage.

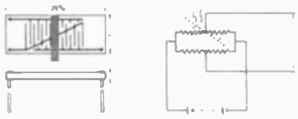
Photobridge (displacement detector for servo mechanisms). Designed for use in displacement detector circuitry in which element resistance is controlled by the relative position of a light admitting slit. Amongst its features are simple adjustment of the light beam and setting point, minimal effect from temperature and light level differences, extended service life and no mechanical noise.

Selenium photovoltaic cells are also available in disc or rectangular form. They are of humidity proofed construction, withstand mechanical vibration and are shortcircuit resistant. Typical applications include use in light meters and colour meters.

Photentiomatic



Photobridge



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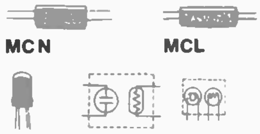

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FOUR-CHANNEL PSYCHO-ACOUSTICS

— is 'three plus one' the answer, asks Dr. Farrimond, Reader in Psychology, University of Waikato, Hamilton New Zealand.

THERE has been in general a lukewarm reception to quadraphonic sound.

Probably this has been due to three factors. Firstly, the uncertainty as to which system will prevail. Secondly, many listeners have not been convinced that there has been sufficient gain in realism to justify purchasing what is virtually a second stereo system. Thirdly is the tendency of some recording companies to indulge in audio gymnastics — combined with an attempt to justify the "new musical experience" as part of the course of evolution of music.

It has always been possible to perform music by locating musicians in the four corners of the concert hall, but it is debatable whether audiences like sounds coming from sources which they cannot see except by turning around.

Psychologically there is a correspondence between the 180° visual field and hearing. Unlike most mammals, Man does not have the ability to rotate his ears so as to locate sounds arriving from a 360° arc, consequently we focus on sound sources which are outside our visual field by turning our heads. The tendency is a strong one and appears to be innate, Wertheimer (1961) has shown that even one-hour old infants attempt to turn towards the source of a sound.

. . . if we are to feel comfortable when listening to recorded music then the important sounds should be at the front and easily locatable with perhaps only the ambient effects being reproduced at the rear . . .

This suggests that if we are to feel comfortable when listening to recorded music then the important sounds should be at the front and easily locatable with perhaps only the ambient effects being reproduced at the rear of the listening area to simulate concert-hall spaciousness.

INAPPROPRIATE TECHNIQUE

It is axiomatic that the closer a recording can approach to reproducing the same sound pressure level variations at the ear of the listener that he would experience in a concert hall, then the more realistic will be the effect. Attempts to create a *different* musical world simply in order to use a new recording technique are questionable, except for music written especially for surround-sound effects. The technique is simply not appropriate for most conventional music.

For loudspeaker listening, the problem of reproducing the correct sound pressure fluctuations at the ears of the listener is more complex than for headphone listening. Loudspeakers must duplicate the *gradients* of acoustic energy in the listening area if the sound is to be accepted as like the original; consequently head movements should not destroy the illusion.

Recording for headphone listening is easier, since in this case it is relatively simple to produce sound pressure level changes which are virtually identical to those which could be detected in the recording studio, substituting microphones for two human ears.

In this case, head movements constitute no threat, since the headphone-wearer takes his listening environment with him. However, headphone listening can only produce a *static* auditory field, that is, one which remains uniform even though the listener moves his head. In this respect, therefore, the situation is artificial.

KALEIDOSCOPIC SUMMATION

In real life, this condition is not encountered, and it seems probable that loudspeakers could provide a more convincing sound panorama if used in the correct way. It should be noted that even though we only use two eyes and ears in sampling our environment, the processes of learning to see and learning to hear depend upon a kaleidoscopic summation of impressions which the brain stores and interprets. The build-up of three-dimensional visual ability depends upon numerous perceptions of objects as viewed from a multiplicity of different angles.

The same holds true but to a lesser extent for the auditory modality. It implies that movement of the listener's head relative to the sound source is an essential element in the establishment of auditory perception. The corollary to this is, that if we are to reproduce a realistic sound image, then the principles which were involved in the development of our auditory abilities should not be violated, otherwise the sound will be heard as unlike the real thing.

The aim of reproducing realistic sound by means of loudspeakers, should be to provide a sound pressure level field in which head movements bring about changes in sound intensity and directionality similar to those which would exist in real-life conditions.

The aim of reproducing realistic sound by means of loudspeakers, therefore, should be to provide a sound pressure level *field* in which head movements bring about changes in sound intensity and directionality similar to those which would exist under real-life conditions. This cannot be accomplished using only two speakers, nor can changing gradients in response to head-movement be duplicated using headphones, although appropriate recording techniques can give an accurate sound image as if from *one position* in the recording studio. It would appear that the establishment of equivalent sound pressure level gradients should therefore be aimed for in the further development of audio techniques and the technology of quadraphony provides an opportunity for producing this closer approximation to reality.

REDUCING HAAS EFFECT

If the frontal sound source of the conventional stereo system could be stabilized and improved by using one of the channels of quadraphony to provide a discrete sound source, then this would help to minimise one of the bugbears of stereophonic listening, that is, Haas effect, in which lateral displacements of the listener's head cause a broadening and shifting of the sound image in the direction of the movement.

Attempts have been made in the past to provide a sound-source between the speakers of a stereo pair. For example, David Haffler (1970) used an additional speaker in this way and fed it with the combined signals from left and right channels. (He also used out-of-phase signal components to feed a speaker providing ambience effects.) However, in this case, the central frontally-located speaker does not carry discrete signals.

A closer approach to realism could be achieved by using one of the discrete quadraphonic channels to provide a central sound source, whilst the remaining fourth channel could relay ambience information from a rear-mounted speaker. In the reproduction of a piano concerto, for example, the centre speaker would relay mainly piano information, along with the sounds from centrally-located instruments in the background, and the left and right speakers would provide the sounds from the remaining instruments of the orchestra from their correct positions.

A closer approach to realism could be achieved by using one of the discrete quadraphonic channels to provide a central sound source, whilst the remaining fourth channel could relay ambience information from a rear-mounted speaker.

The adoption of a "three plus one" discrete system such as this, would mean that not only would Haas effect diminish, so that if the listener moved to left or right, the piano would remain in the centre, but also a further advantage would be that for music recorded from conventionally grouped instruments, each loudspeaker would only need to handle something under one-third of the total information as compared with half for conventional stereo or slightly less than half for a quadraphonic system.

Of course the recording technique for the "three plus one" approach would need to be tailored accordingly. The aim would be to duplicate, via the three speakers, the wave-fronts which were produced in the recording studio at three equivalent directional microphones (or groups of microphones) placed in such as way as to take in one third of the sound-stage to which they were presented. This would result in the production of a lateral distribution of sound which would maintain its directional properties far better than can a conventional stereophonic or quadraphonic system. In the case of stereo it has been suggested by John Crabbe (1973), that "skewing" sound distribution, by using careful speaker design, would reduce the unwanted effects brought about by lateral head displacements. That is, the left-hand speaker could be made to give an increasing intensity of sound from left to centre, whilst the right-hand speaker could be made to produce a skewed and increasing intensity distribution from right to centre. In this way, manipulation of time and intensity would assist in stabilizing the stereo image so that lateral movements would not be so disruptive as they are with conventional "properly-adjusted" stereo. In the case of a four-speaker surround-sound system, skewing the sound distribution for the two speakers at the front could also be accomplished, but an attempt to compensate for fore and aft movements of the listener by varying energy distribution in a static fashion, would not work. It could be done only by means of a monitoring device which would give positional information to the amplifiers, so controlling their output depending upon the position of the (one) listener. This is impracticable, but I mention it for the benefit of lonely electronics wizards who may like to experiment and who don't mind not sharing their recorded musical experiences with another person!

HEADPHONES ALSO

Theoretically, since we have only two ears, it seems at first sight that it should be possible to duplicate life-like sounds by reproducing at the ears the same variations in sound pressure level which would occur at the concert hall. This automatically suggests the use of headphones, but as already stated, the effect will be a static one as though the head of the listener were clamped immovably in the concert hall. Head movements, with consequent selective focussing of attention upon one instrument or groups of instruments, are not possible in the case of headphone listening.

But there is no reason why the proposed "three plus one" system should not be adaptable for headphone listening as well as for loudspeaker listening, (nor would it be necessary to have a central bone-conduction third headphone!) The signal from the centre channel could be fed equally to left and right earphones in order to produce a central sound image in combination with the discrete left and right information. Much to the sorrow of headphone enthusiasts there have been few recordings made specifically for the headphone listener, although when these needs are taken into consideration and recordings are made specifically for headphones, then the results are said to be extremely realistic. (See report on Sennheiser record elsewhere in this issue). The technique "transports" the listener's head (in effect) to the position occupied by the microphones during recording. In the case of loudspeakers the situation for stereo reproduction is in many ways less satisfactory than for headphone listening, since to achieve stability, the listener must stay on a line equidistant from the two loudspeakers. The impression that a sound comes from between the two speakers is purely illusory and requires that both speakers produce identical signals. Any movement of the listener's head towards one of the speakers will destroy the illusion and the sound image of the centrally-located piano will move towards the nearer (and now apparently louder) loudspeaker.

Stereophonic listening has similarities to the Phi phenomenon in vision where if two lights a short distance apart flash on and off alternately at a particular rate, then the light appears to move from one side to the other and back again. This depends upon the ability of the brain to interpret the rate of alternate flashing as a "movement" from one side to the other. However, the observer cannot attend to what is happening between the two lights since there is nothing there.

The limitation of stereophonic listening is that the illusion of a centre-stage sound source is easily destroyed, since there is no stable sound source which can preserve directionality in the presence of movement of the listener from a central position.

HOW MANY SPEAKERS?

Ideally for maximum realism, each musical instrument should be represented by its own discrete channel and loudspeaker, but the psychological determinant of how many loudspeakers should be used for the reproduction of music is the sound-resolving acuity of the listener. For example, what is the smallest angular separation between sound sources which can be resolved by a listener? (This is a problem on which some work is being carried out by the writer). The other determinant of the number of loudspeakers which can be used is the limitation due to physical size. Few living rooms would conveniently house more than three Quad or Amcron electrostatic speakers in line abreast. (Nor one imagines would they be allowed to!) This would be particularly so in the case of the excellent double Quad speakers

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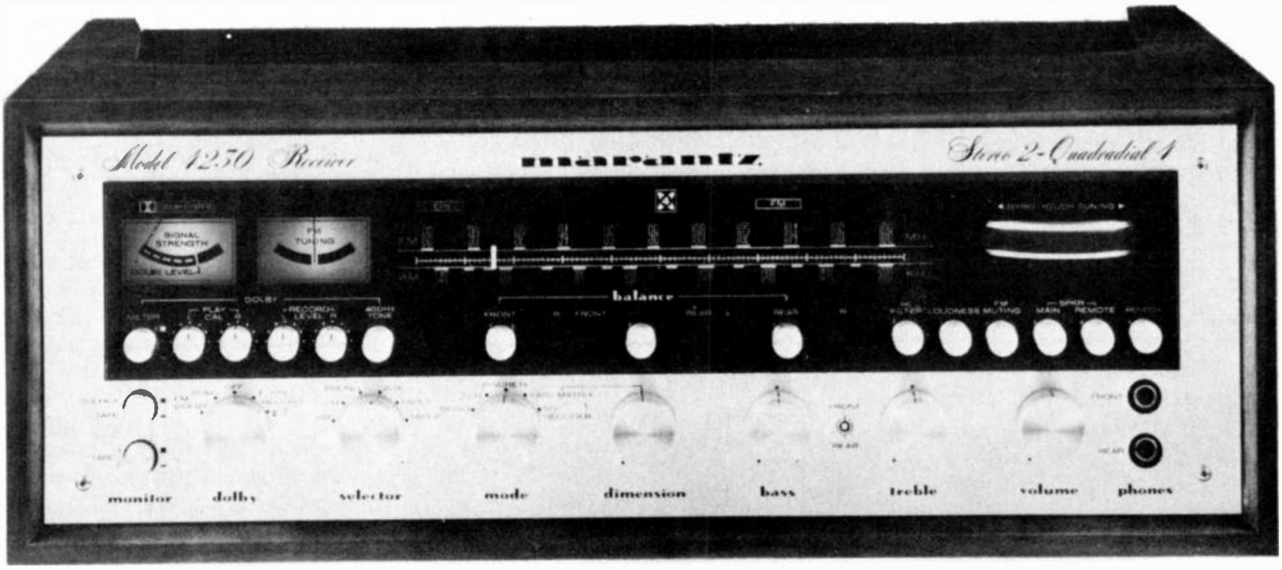

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FOUR-CHANNEL PSYCHO-ACOUSTICS

constructed by "The Radio People" in Hong Kong. (Any traveller to that part of the world is recommended to give these parallel Quad pairs an audition!)

It is difficult to generalise about the number of speakers which would be required to duplicate all the spatial characteristics of, for example, a symphony orchestra, since the ability to locate with any degree of accuracy, the source of a particular sound depends upon a large number of factors. The accuracy of localization of sounds varies with frequency (*Stevens & Newman 1934, 1936).* High frequencies are more easily localized than low frequencies since high frequency sounds tend to be propagated in narrow beams unless steps are taken to avoid this. Low frequency sounds tend to be propagated in an omnidirectional fashion and so their source of origin is more difficult to locate. Transients also have properties which make it possible to determine their source more easily than that of a steady tone. There are possibly several reasons for this, one of which may be that transients tend to have a high frequency content which may aid localization for the reason previously stated. This extended high frequency content of cymbal transients can be shown by playing a stereo record through a CD-4 demodulator, for example the cymbal clashes on the Decca test record SKLM 4861 cause the "Radar" pilot light to be activated, indicating that the frequencies extend up to that of the CD-4 carrier signal. (Some distortion is produced when this occurs so that stereo records should not normally be played via a demodulator in the CD-4 mode).

... the ear apparently responds to high intensity spikes by generating a range of frequencies rather than a narrow band. In other words the ear 'generates' additional information which may aid in localization.

A property of the auditory system, which may also assist in localization of transients, is that it reacts maximally to abrupt changes in energy level. The high contrast feature of transients may in addition make them less easily obscured by reflected or standing waves of about the same frequency. Transients tend also to be of high amplitude and the ear apparently responds to high intensity spikes by generating a *range* of frequencies rather than a narrow band. In other words the ear "generates" additional information which may aid in localization. Hendrickson (1973) states that: "work with single units of the auditory nerve has shown that they respond to a single or narrow band of frequencies at *threshold* intensities and to an increasing range of frequencies as intensity is increased".

THREE IN LINE

Some or possibly all of these properties assist in the auditory localization of sounds, and from a practical point of view, the accuracy of sound reproduction provided by three speakers arranged in line represents a reasonable compromise between convenience and effectiveness.

To summarise, there is a possible argument for the modification of recording and playback techniques in the case of quadraphonic sound to give a three discrete-channel frontal sound source and one discrete rear channel for ambience. The argument stresses the need to duplicate sound pressure level *gradients* in the case of loudspeaker listening so as to stabilize the auditory image and give an improved sense of directionality. An additional advantage would be a reduction in the information load which the frontally-located speakers would carry.

... quadrophony will stand or fall upon its ability to bring a greater degree of realism to the reproduction of music.

Quadraphony will stand or fall upon its ability to bring a greater degree of realism to the reproduction of music. The race for supremacy between rival quadraphonic systems may eventually be decided not by parameters such as decibels of channel separation, but by the utilization of the system in a way which will persuade music-lovers that there is a significant gain in realism.

Possibly the proposed "three plus one echo" system may convince them that there is an audible advantage over stereo or the present quadraphonic "two plus two echoes" system. ●

4 channel decoders

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The SQ disc, as produced by CBS, the EMI Group of Companies and others, is fully compatible with all existing home, broadcast or studio equipment in terms of it ability to reproduce fine fidelity, two channel stereo with full dynamic range (RIAA Equalization Curve) on any standard stereo unit. To play it in four channel, one needs an SQ Decoder, four channels of amplification plus four speakers. No special record player is required.

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ETI 3-74

AMBISONIC SOUND

Terry Mendoza reports

'three plus one' — or just plain three.

THE history of sound reproduction has been punctuated by a series of advances, each attempting to bring the fidelity nearer to that of the original performance.

The first systems were monophonic. They could approximate the sound but with no directional information.

Then, directional content, covering a sector (between 30° and 90°) in front of the listener, was achieved by imprinting two channels of information onto the record groove. Recording technique permitting, realistic 'instrument placement' was now possible. However, the results were a poor copy of the original. The recorded ambience lacked the 'surrounding' quality of the original performance, which existed above and to the rear of the concert goer. Not just in the sector ahead of him.

The answer was to register enough extra signal information which was related, but not identical, to the information carried by the original two channels, so that fill-in speakers could be placed to the rear of the listener. 'Quadrophony' was hailed as the means by which this most realistic reproduction could be achieved.

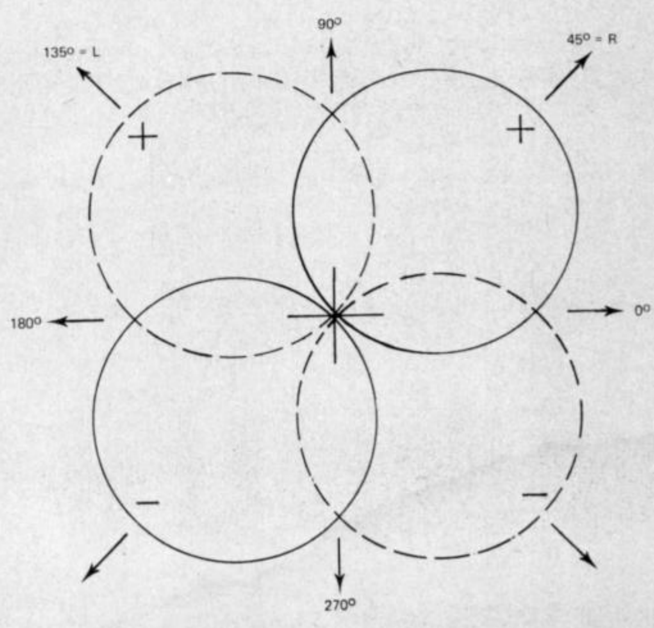
AN ERRONEOUS CONCEPT

But at this point the industry confused the public with an erroneous concept of what the use of 'quadrophony' should actually be. It should not have been for the re-creation of the four-channel master tapes that just happened to be the current studio standard, but to re-create the stage before i.e. the original performances.

Secondly, the conventional so-called 'matrixed' disc could just as correctly be termed a 'mixed' disc, for no matter how elaborately it has been mixed down, it will only contain *two* channels of information. But these two channels can be connected (if desired) to a multiplicity of speakers, and in numerous ways, so that each speaker produces an individual, but not completely independent, output.

Despite what has been said regarding matrixing, it *is* possible to derive unambiguous directional information to locate a source anywhere over the whole listening sphere from suitably encoded material on a two-channel disc.

Unfortunately this system is not being correctly used by the record companies. They have found that they can get more mileage from their four-channel masters by blending between adjacent tracks — in the same way that a stereo pan-pot positions sound between speakers. This pair-blending results in the listener receiving the subjective impression of being in the centre of the orchestra, but does not re-create the original ambience which should surely be the point of the exercise.



Directivity in Blumlein microphone arrangement (after Fellgett).

FOUR CHANNELS UNNECESSARY

In practice, four discrete channels are unnecessary. In most cases identical results could be achieved using only three information channels. Indeed a realistic panoramic plot is only possible on a four-channel pair-blending system if the microphones used have a perfect sinusoidal polar response over 180° and a zero response over the other 180° — as yet no such mikes exist!

Conventional stereo broadcasting utilises a sub-carrier with double sidebands, hence there is sufficient band-width here to provide a third information channel derived by the phase modulation of the sub-carrier. Now the information channels on a conventional disc need not only be regarded as 'left side groove modulation' translating into left channel, and 'right side' into right channel, but they may also be thought of in terms of lateral modulation providing a monophonic signal and vertical ('hill and dale') modulation determining stereo difference. Considered in this fashion a 'third channel' disc principle could follow from the earlier example of three-channel FM transmissions.

AMBISONIC REPRODUCTION

Ambisonic reproduction, that is re-creating the ambience of the original recording situation with associated directionality, can be sub-divided into periphonic and pantophonic systems, the former concerning a complete sphere of information, the latter relating to a horizontal circle (of which stereo can be regarded as forming one quadrant) Pantophonic reproduction does not distinguish vertical directionality, but still achieves remarkable realism.

All reproduction systems must relate back to the original microphone placement and mix-down. Surprisingly, the Blumlein configuration which was one of the earliest of stereophonic microphone arrangements, is tailor-made for pantophonic purposes — it consists of two matched mutually-perpendicular figure-of-eight microphones. When considered for this application, its two basic drawbacks are phasing difficulties when ultimately fed to loudspeakers, and a 180° ambiguity, i.e. a sound could be in front and to the left of the listener, or behind and to his right. Adding a pressure microphone to the Blumlein arrangement provides a phase reference which removes ambiguity; the outcome is a feasible arrangement whereby realistic 360° pantophonic sound can be conveyed via three information channels. This, as has been discussed earlier, could already be compatible with FM transmissions and, subject to certain limitations, could be applied to a two channel disc.

In conclusion, four-channel sound now suffers from the situation where an existing means was adapted towards a dubious end. With the possibility of far greater realism offered by ambisonic sound, the means are now being re-assessed.

Nevertheless, the adaptation of any ambisonic system will still allow the option of pan-potting multi-channel inputs around the panorama. The problem will be to disuade the record companies from re-processing their four-channel masters and developing instead the new record art-form necessary to use ambisonics to best advantage.

REFERENCES: FELLGETT, P.: 'Ambisonic Reproduction of Sound', Electronics & Power 15th November 1973.

FELLGETT, P.: 'Directional Information in Reproduced Sound', Wireless World, September 1972.

GERZON, M.: 'Experimental Tetrahedral Recording', Studio Sound, Aug., Sept. & Oct. 1971. ●

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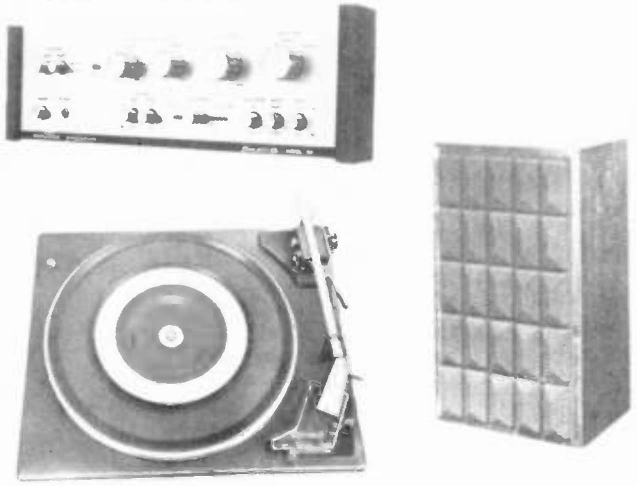

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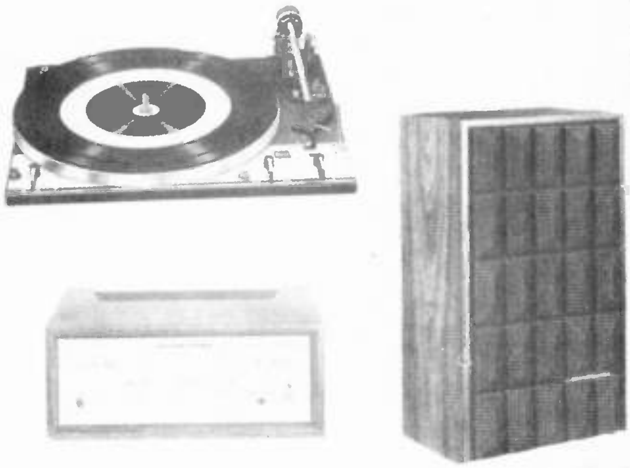

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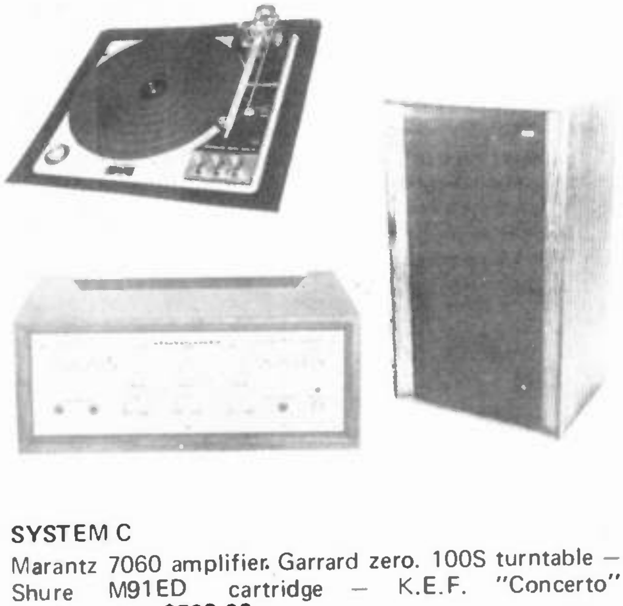

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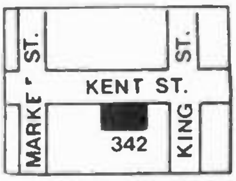


WIN A MULTIMETER CONTEST —RESULTS

CONGRATULATIONS to all entrants for the generally high standard of submission.

Over 40% of all entrants had the correct answers — so final judging had very much to be based on the summary and interpretation of results.

The most outstanding entry was from 15½ year old Richard Kurzeja of Yokine, Western Australia. Part of Richard's entry is reproduced on this page. Nothing need be added to his excellent summary of the problem.

Congratulations Richard, and to our other four winners!

There were very many others who only barely missed out. Thank you for trying.

ETI MULTIMETER CONTEST, JANUARY 1974

HERE IS RICHARD KURZEJA'S WINNING ENTRY.

BEFORE METER IS CONNECTED

RESISTOR	Voltage across	Current thru	Power dissipated
R1	100v	0.5 mA	50 mW
R2	100v	0.5 mA	50 mW

AFTER METER IS CONNECTED

RESISTOR	Voltage across	Current thru	Power dissipated
R1	190.9v	0.954 mA	182 mW
R2	9.09v	0.045 mA	0.413 mW
Rm	9.09v	0.909 mA	8.264 mW
Rc	9.09v	0.954 mA	8.677 mW

Before the meter was connected, 100 volts appeared across both resistors.

When the meter was connected, the voltage across R2 dropped to less than one-tenth of its undisturbed value.

Another change caused by applying the multimeter was a rise in the power dissipated in R1, to approximately 182 mW. This was almost 1½ times R1's power rating of 1/8 watt (125 mW), so that R1 would have overheated and may have destroyed itself.

The results would have been more accurate had the user begun his measurements on a much higher scale, say 500 volts dc. Then the resistance of the meter would have been 500 000 ohms. The meter would then have indicated about 83 volts dc, about one-sixth of full scale, and may have been difficult to read accurately. A 20 000 ohms per volt multimeter on a 100 volts dc range would have read about 95 volts dc (or on the 500 volts dc range, 99 volts). These figures show the advantages of a higher sensitivity meter, and the possible dangers when using a low sensitivity multimeter.

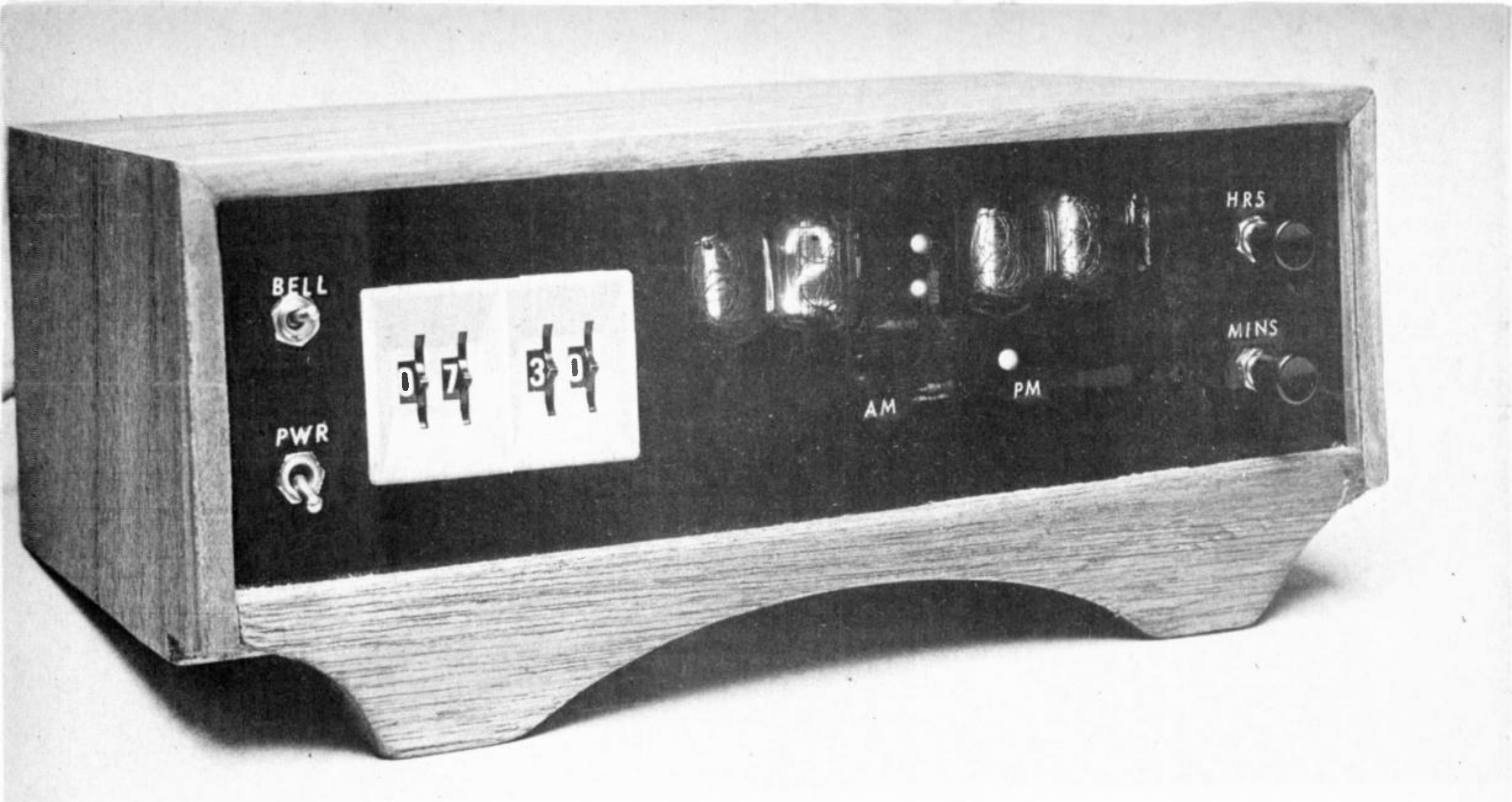
Our youngest winning entrant (and very nearly our youngest entrant as well).

Ian Wright, aged 13, Wembley Downs, W.A.

Patricia Rebula, aged 16, North Geelong, Vic.

Alan Beildeck, aged 15, Kew, Vic.

Michael Pitt, aged 16, Roseville N.S.W.



This method of assembly may be varied to suit individual needs.

ETI PROJECT 521B

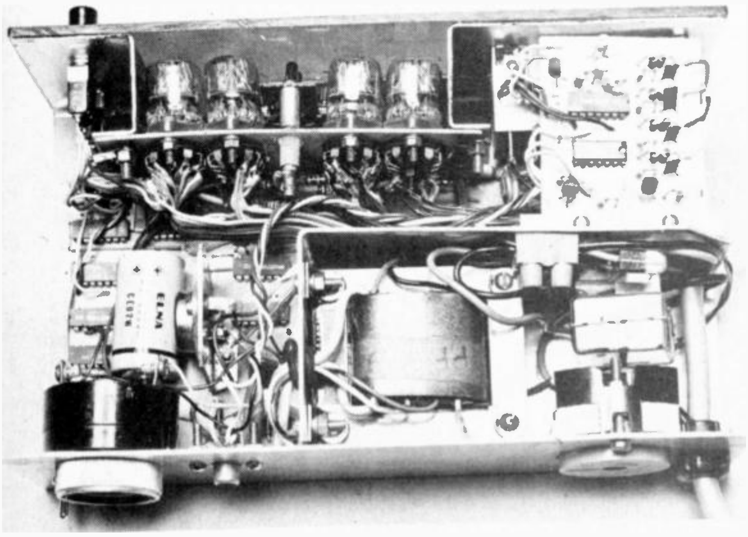
DIGITAL ALARM CLOCK

Alarm and other facilities may be added to improve the basic ETI 521 digital clock.

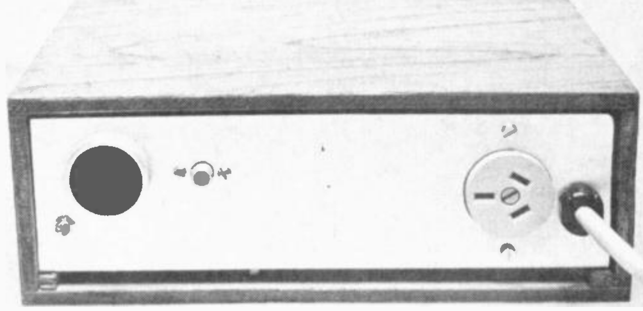
SINCE details of ETI's 521 Digital Clock were published in our July 1973 issue, many people have asked how alarm facilities may be incorporated. This article describes a comprehensive alarm system modification as well as improved time setting facilities — and AM-PM indicators for the clock when used in the '12 hour' mode.

A new chassis and case will be required if the alarm facility is to be built in. For our unit we extended the chassis originally specified by 50 mm on the left hand side to accommodate the alarm thumbwheel switches and mode switches. This extension also allows room for the installation of the alarm board and alarm relay.

Interior of the clock illustrates method of construction.



Rear of the clock showing Sonalert, oscillator output and set/run switch on the left and power outlet socket on the right.



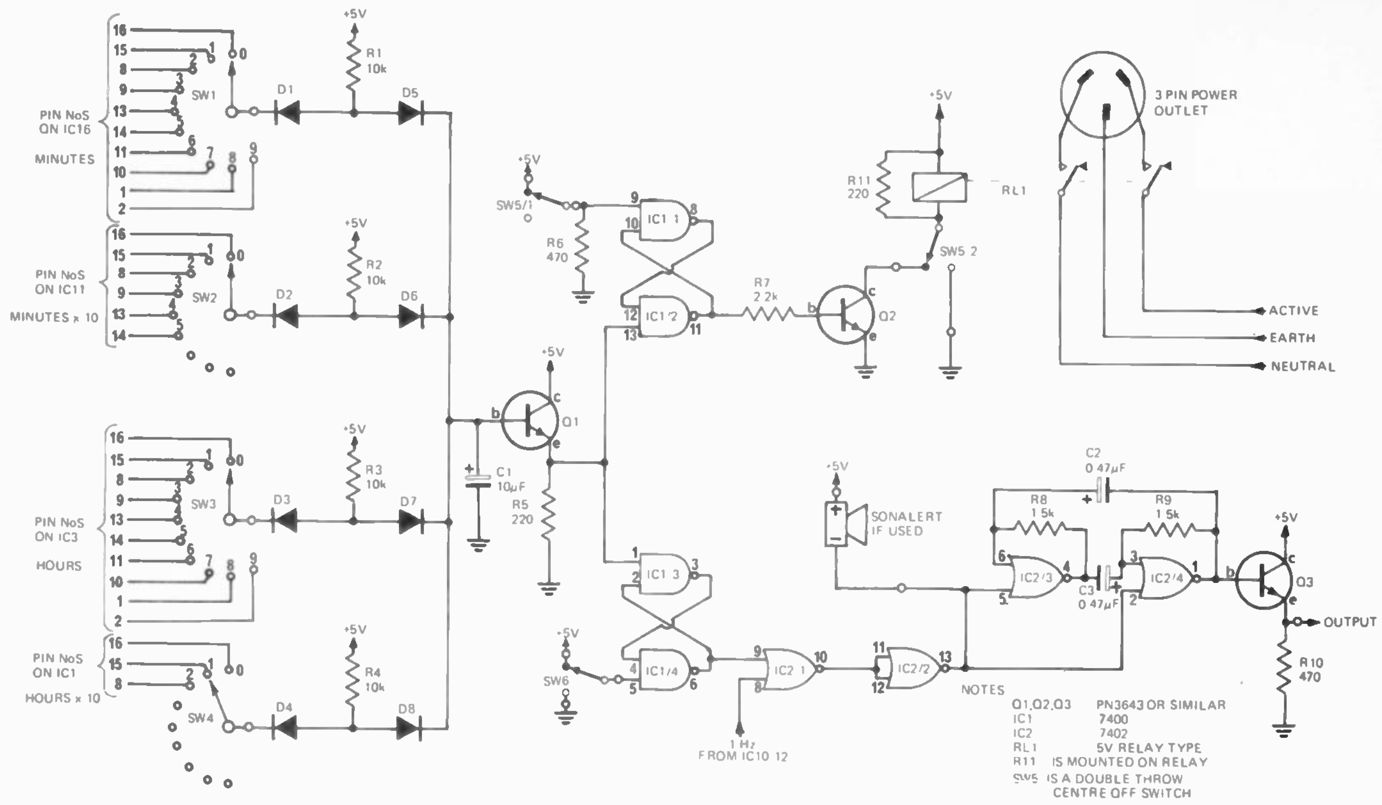


Fig.1. Circuit diagram of the complete alarm facility. Note that SW5 has three positions – Power Outlet On, Off, and Power Alarm On.

Note from the photographs that we mounted the power transformer on an aluminium bracket which also acts as a shield between the mains components and wiring, and the logic board. Note also the Sonalert mounted on the right-hand rear panel.

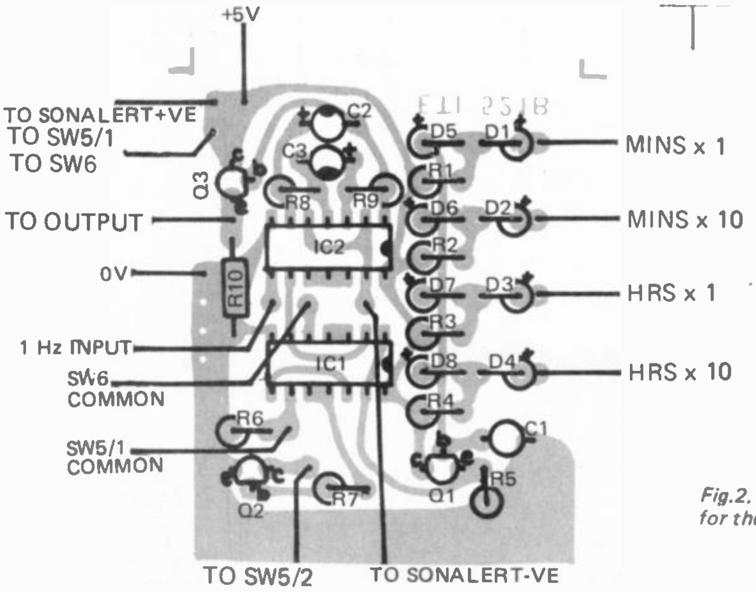
The appearance of the clock was improved by fitting a red perspex panel over the whole front of the clock, all front panel metalwork having been painted matt black. The complete clock was then assembled into a teak-veneered wooden case.

This mode of assembly may not suit everyone but may readily be varied to suit individual needs. Because of this, metal work and woodwork drawings have not been provided.

ALARM FACILITIES

The alarm circuit will operate with both the 12 or 24 hour clock versions. In the latter case there is no ambiguity between AM and PM alarms but there is in the 12 hour version. The conventional mechanical alarm clock also suffers from this ambiguity which rarely if ever, causes problems, hence it is felt to be of little importance.

A four-pole ten-position McMurdo thumbwheel switch is used to select the alarm time. The minutes switch could be omitted but the minutes facility can be useful and the extra cost is minimal – it is nice to get an alarm exactly at 7.00PM, for example, when a specific TV programme is due to start.



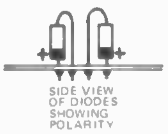


Fig.2. Component overlay for the alarm board.

PARTS LIST – ETI 521B

Alarm circuit				
R1,2,3,4	Resistor	10 k	¼ watt	5%
R5,11	"	220Ω	"	"
R6,10	"	470Ω	"	"
R7	"	2.2 k	"	"
R8,R9	"	1.5 k	"	"
C1	Capacitor	10μF 10 volt electrolytic		
C2,3	"	0.47μF 10 volt tag or electrolytic		
IC1	Integrated Circuit	7400		
IC2	" "	7402		
Q1,2,3	Transistor	PN3643 or similar		
D1-8	Diode	EM401 or similar		
RL1	Relay	Siemens type V23154-D0715-F104		
	Relay Base	Siemens type V23154-Z1005		
	Retaining clip	Siemens type V23154-Z1021		
SW1 to SW4	Thumbwheel switch assembly	McMurdo type 3008-41-08		
SW5	Switch	mini toggle DPDT (centre off) C&K7203		
SW6	"	mini toggle SPDT C&K7101		
PC board		ETI 521B		
As required – Sonalert, 3-pin chassis-mounting power socket, RCA socket.				
Set-Run Switch				
SW3	Switch	mini toggle SPDT C&K 7101		
R.8,R9,R10	Resistor	1 k	¼ watt	5%
AM-PM Indicator				
R11	Resistor	120Ω	¼ watt	5%
R12,R13	"	470Ω	"	"
R14	"	150Ω	"	"
Q1,Q2	Transistor	BC108 or similar		
D7	Diode	IN914 or similar		
LED 3,4	Light-emitting Diode	4403,FLV110,MV5025 or RL2		

DIGITAL ALARM CLOCK

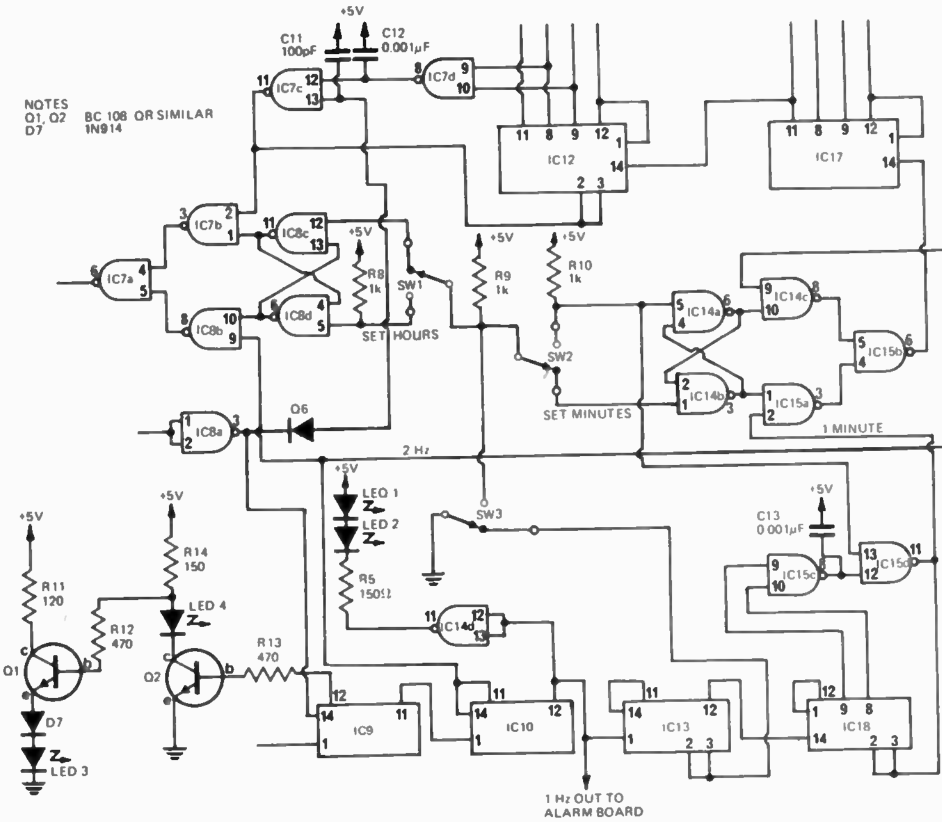


Fig. 3. Modified circuit diagram incorporating AM/PM indication and improved time setting facilities. Part only of complete circuit shown.

Two entirely separate alarm channels are provided. The first, which we have called the BELL circuit, may be used to drive a Sonalert gated at 1 Hz, or, may be used to provide an oscillator output. The oscillator output is also gated at 1 Hz and may be used to drive a 15 ohm speaker direct, or an amplifier if you want to wake the neighbours.

The second alarm channel switches a back-panel mounted, three-pin outlet socket. This may be used to switch on a bedside lamp, a radio or boil the coffee (etc). Note that wiring regulations require both active and neutral be broken, and hence, a double-pole relay is mandatory for safety reasons. The control switch provides, ALARM ON, OFF or MANUAL ON conditions for the power outlet.

The two alarm modes may be used separately or in conjunction with each other.

TIME SETTING

1. Hold-Run Switch

The hold-run switch disables the front panel time-setting push buttons in the RUN position and the clock runs normally. When set to the HOLD position, the push buttons are enabled, and the 'seconds' counters 1C13 and 18 are set (and held) at zero. Thus the clock remains set to the desired time until the switch is set to RUN at the appropriate radio or telephone time pip. The clock, when set to run, will thus start timing to the exact second, even though seconds are not displayed.

2. Setting Rate

The clock, as previously described, incremented the 'hour' or 'minute' counters at a rate of 1 Hz when in the set mode. With this system it can take, in some cases, almost a minute to set the desired time. For those who find this annoying, a small modification has been included to allow a 2 Hz set rate. This increased rate has a slight disadvantage in that it is difficult to increment by only one minute. This is because the button must be pushed and released entirely within a half second interval. However in practice this is rarely of concern as setting is only required after the clock has been switched off.

AM-PM

Although not an essential feature, some people have expressed an interest in a circuit to indicate AM or PM on a 12 hour clock. This has been added by means of two transistor-driven LED indicators. This circuitry may well be built onto a piece of matrix board together with the two flashing-LED 'seconds' indicators if required.

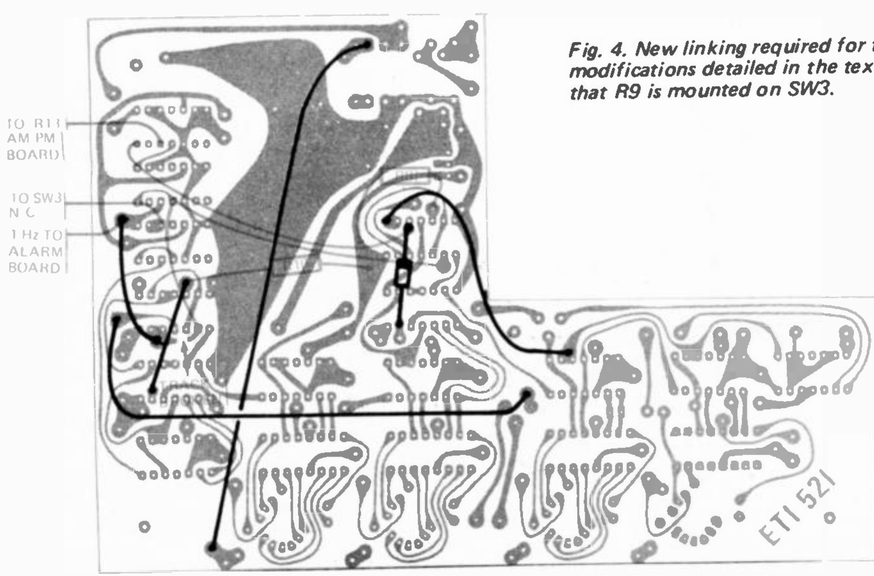


Fig. 4. New linking required for the modifications detailed in the text. Note that R9 is mounted on SW3.

CONSTRUCTION

Alarm

Assemble components on the printed-circuit board in accordance with the circuit diagram. Fig. 1, and the alarm component overlay Fig. 2.

The 'common' outputs of the thumbwheel time-select switches SW1-SW4 are taken to D1-D4 respectively. The inputs to SW1-SW4 are taken direct by wires from the pins on the decoder ICs as detailed in Fig. 1. The resistor R11 is mounted directly across the relay coil contacts and the +5 volt supply for the coil taken direct from the LM309 regulator. Take particular care when wiring ac to the relay base to provide adequate separation and insulation to the pins to prevent short circuits.

HOW IT WORKS

ALARM

The decoder ICs, IC1, 3, 11 and 16 provide a decimal output from a four line BCD input. The appropriate decimal pin is at '0' volts when that decimal is decoded. Thus referring to Fig. 1, and IC16 in particular, if '4 minutes is being displayed pin 13 of IC16 will be at zero and all other outputs will be high. If SW1 is set to position 4 the zero at pin 13 of the IC will, via D1, pull the junction of D1 and D5 down to zero. If SW1 is at any other setting the junction of D1 and D5 will be at +5 volts and transistor Q1 will be turned on. Only when the clock time matches the setting of all four switches will the base of Q1 fall to zero – turning off Q1.

Gates IC1/1 and IC1/2 form an RS flip flop which, providing SW5/1 is set to +5V and Q1 is OFF, will provide 5 volts at IC1/2 pin 11 turning on Q2 and energising the relay.

As the alarm state is stored, it will remain on once triggered until SW5 is switched OFF. If SW5 is switched to its alternate ON position, the relay is switched on independently energising the power output socket.

A second store IC1/3 and IC1/4 operates independently when enabled by SW6. The alarm state is switched at 1 Hz by IC2/1, inverted by IC2/2 and thence may drive a Sonalert direct, or the oscillator formed by IC2/3 and IC2/4 the output of which is buffered by Q3.

AM-PM INDICATION

The 'reset hours to one' pulse at IC8a pin 3 is taken to pin 14 of IC9. This pin is the input to a previously unused divide by two stage in IC9 thus the output at pin 12 of IC9 will be alternately on for 12 hours and off for 12 hours. This signal drives Q1 and Q2 such that LEDs 3 and 4 are switched alternately providing an AM-PM indication. Diode D7 is used to ensure that Q1 can be switched OFF.

Hold-Run Switch

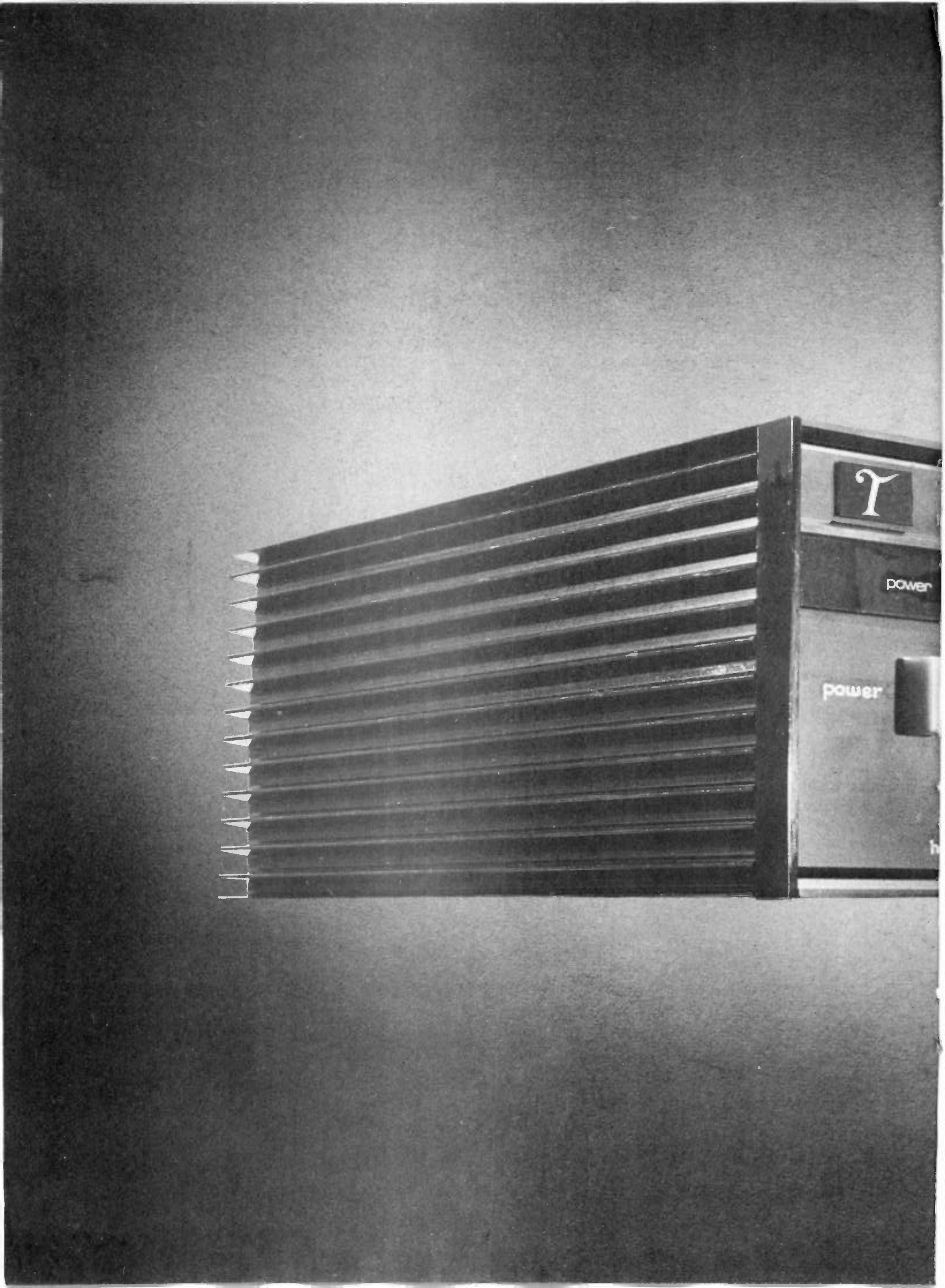
Remove the existing link between pins 2 and 3 of IC13 and pin 1 of IC1. Disconnect the earth wires from the common terminal of both time setting switches (SW1 & SW2). These two wires are joined and taken to the normally open contact of the SET/HOLD switch SW3, and the common of SW3 taken to zero volts. The normally closed contact of SW3 is then wired to pins 2 and 3 of IC13. Resistors R8, 9 and 10 are added to prevent triggering of the clock by spurious pulses, R8 and R10 are fitted as shown on the overlay and R9 is fitted from SW3 direct to +5 volts.

AM-PM Facility

Firstly link pin 3 of IC8 to pin 14 of IC9. Then construct the circuit consisting of Q1, Q2 and associated components onto a small piece of matrix board on which we suggest you also instal the 'seconds' indicators, LED1 and LED2. Input to R13 is then taken from pin 12 of IC9.

2 Hz Time Setting

Break the printed-circuit board track between pin 9 and pins 12 and 13 of IC14. Instal a link between pin 9 of IC14 and pin 11 of IC10. Also link pin 9 of IC8 to pin 11 of IC10. ●


power
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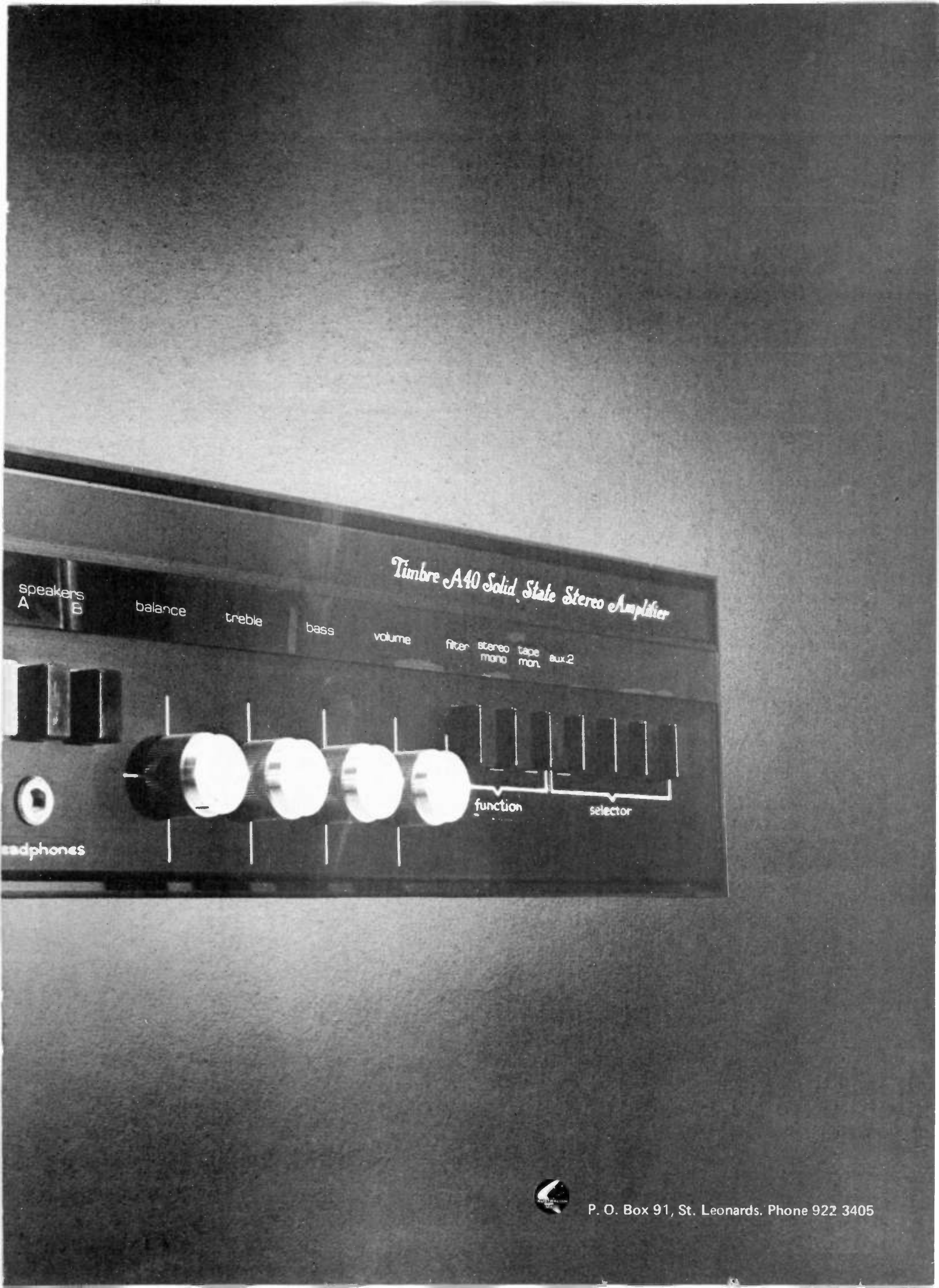
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The Timbre A40 amplifier has been designed using discrete operational amplifiers to give low distortion, flat frequency response and easily controlled gain.

The tone controls are of the Baxandall type with the frequency determining elements in the feed back loop.

The power amplifier is a fully complementary output design using current drive to all stages after the basic two transistor gain section. This is achieved by use of a current source load for the class A driver transistor and boot strapped load into this class A driver. The class B output transistors run without standing current giving very good thermal stability.

Attention has been paid to stability into reactive loads and, together with the very low distortion figures obtained gives a sound quality of exceptional standard.

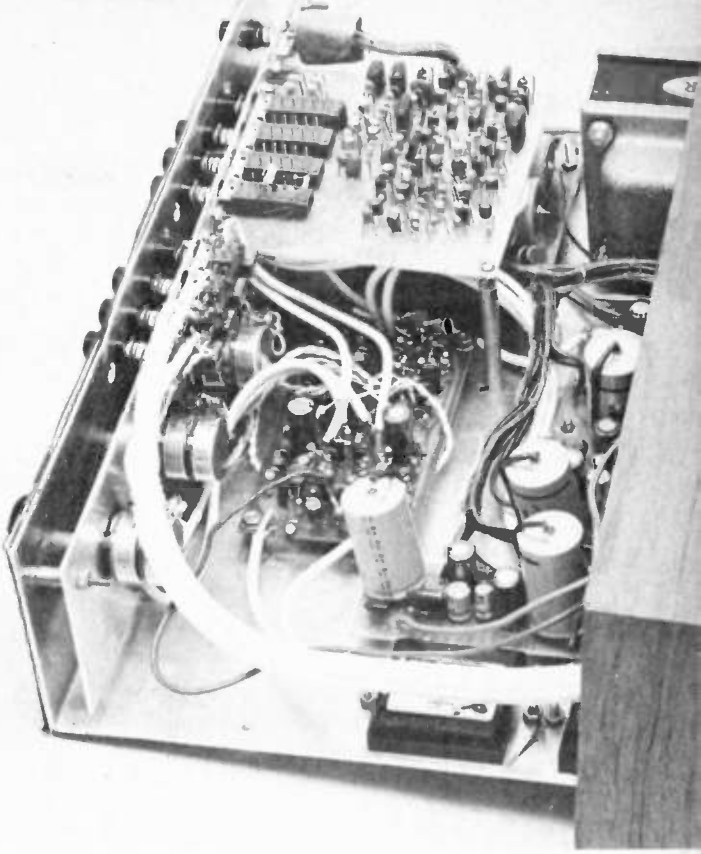
Specifications

Power Output: R.M.S.	40 watts per channel into an 8 ohm load both channels driven.
Frequency Response:	20 Hz to 20 kHz ±1 dB.
Total Harmonic Distortion:–	Better than .1% (20 Hz to 20 kHz)
Intermodulation Distortion:–	Better than .1%
Hum & Noise:–	Phono 65 dB. Tape 65 dB. Tuner 80 dB. Aux 80 dB.
Sensitivity:–	Phono 3mV. Tuner 200mV. Aux 1 200mV. Aux 2 500mV.
Scratch Filter:–	6 dB. at 12 kHz. 12 dB. at 20 kHz.
Tone Controls:–	Treble ± 15 dB at 10 kHz. Bass ± 15 dB. at 100 Hz.

eti PROJECT 420E

Alternative decoder offers same performance as IC version.

DISCRETE SQ DECODER



This photo shows the ETI 420 amplifier with the discrete decoder fitted. Note the supporting spacer at the rear of the board. ▶

THE ETI 420 4-channel amplifier, published in the January 1974 issue, has achieved instant popularity. Unfortunately the special SQ decoder IC is in very short supply and there are unlikely to be more stocks until late this year.

To overcome this problem we have developed a new decoder board which is a direct replacement of the existing one, but uses transistors to replace the IC. The decoder may of course also be used for building your own four-channel amplifier.

Obviously the printed circuit board is larger and the circuit more complex, but cost is approximately the same and assembly is simple.

The specification of the amplifier, incorporating the discrete SQ decoder, is virtually the same, with the exception that the SQ decoder phase shift is now 90° ±10° from 30 Hz to 20 kHz, rather than from 100 Hz to 10 kHz as with the IC.

CONSTRUCTION

The construction is straightforward. The usual precautions should be taken with all polarized components, transistors and capacitors etc, with regard to polarity. Assembly of the board should be performed in accordance with Fig. 3. Note that the switch should be pressed fully home on the board and the contacts soldered to the tracks where applicable.

INSTALLATION

The board is mounted in exactly the same manner as the IC version, with the exception that a long spacer (56 mm) should be used to support the

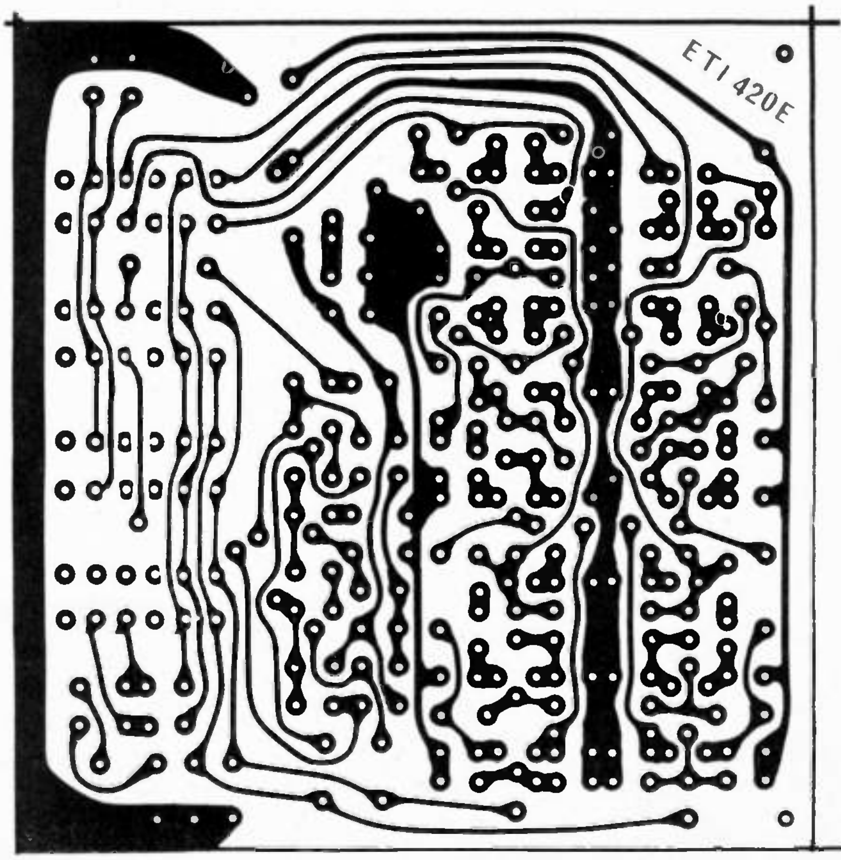


Fig.1. Printed circuit board for the decoder (full size). ▶

DISCRETE SQ DECODER

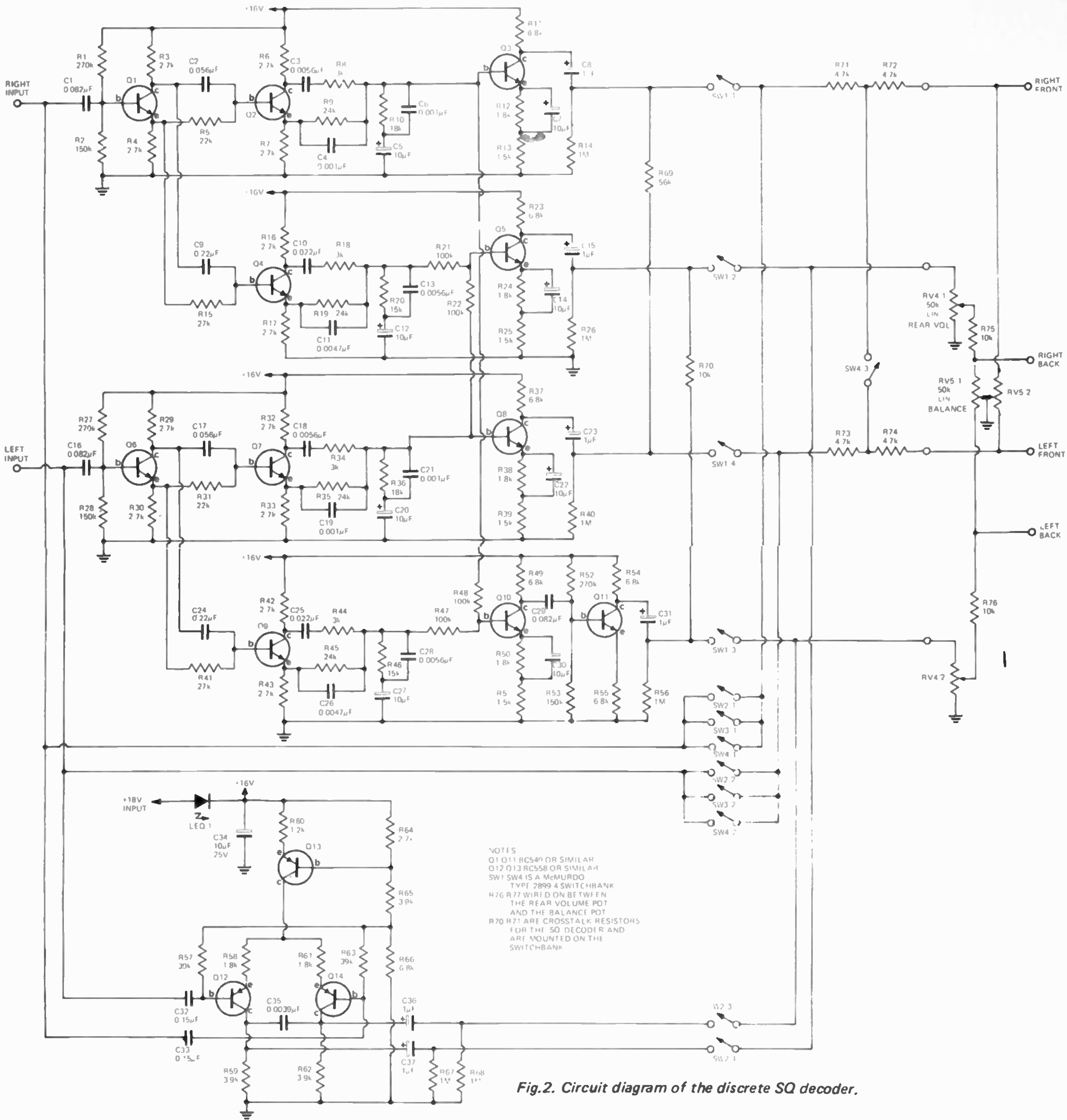


Fig.2. Circuit diagram of the discrete SQ decoder.

PARTS LIST – DECODER BOARD

R1,27,52	Resistor	270 k	½W	or ¼W	5%
R2,28,53	"	150 k	"	"	"
R3,4,6,7,16,17,29,30,32	"	2.7 k	"	"	"
R33,42,43,64	"	2.7 k	"	"	"
R5,31	"	22 k	"	"	"
R8,18,34,44	"	3 k	"	"	"
R9,19,35,45	"	24 k	"	"	"
R10,36,	"	18 k	"	"	"
R11,23,37,49,54,55,66	"	6.8 k	"	"	"
R12,24,38,50,58,61	"	1.8 k	"	"	"
R13,25,39,51	"	1.5 k	"	"	"
R14,26,40,56,67,68	"	1 M	"	"	"
R15,41	"	27 k	"	"	"
R20,46	"	15 k	"	"	"
R21,22,47,48	"	100 k	"	"	"
R57,63	"	39 k	"	"	"
R59,62,65	"	3.9 k	"	"	"
R60	"	1.2 k	"	"	"
R69	"	56 k	"	"	"
R70,75,76	"	10 k	"	"	"
R71,72,73,74	"	4.7 k	"	"	"

RV4,5	Potentiometer 50 k dual lin rotary
C1,16,29	Capacitor 0.082μF Polyester
C2,17	" 0.056μF "
C3,13,18,28	" 0.0056μF "
C4,6,19,21	" 0.001μF "
C5,7,12,14,	Capacitor 10μF 10V electrolytic PC mounting
C20,22,27,30	" 10μF 10V electrolytic PC mounting
C8,15,23,31,36,37	Capacitor 1μF 16V tag tantalum
C9,24	" 0.22μF Polyester
C10,25	" 0.022μF "
C11,26,	" 0.0047μF "
C32,33	" 0.15μF "
C34	Capacitor 10μF 25V electrolytic PC mounting
C35	" 0.0039μF Polyester
Q1-Q11	Transistors BC109, BC549 or similar
Q12-14	" BC178, BC558 "
LED1	light emitting diode McMurdo type 3240-01-02 or similar
PC board	ETI 420E
SW1,2,3,4	switchbank McMurdo type 2899-4

HOW IT WORKS

To decode SQ matrixed material, the left and right input signals must each be split into two signals with a constant 90° phase shift between each pair, regardless of frequency.

Although a simple integrator will provide the 90° phase shift it does not provide a constant amplitude (–6 dB/octave). A more complex network is thus required.

Basically, each input is split into two components at 180°. Each is then phase shifted by two slightly different networks in series. When referred to the input, the output phase continually changes with frequency (maximum shift 540° at 20 kHz). However when one output is referred to the other there is a constant phase shift of 90° ±10° between 30 Hz and 20 kHz.

In detail, the right channel input is buffered by Q1 which provides two, 180° out of phase, signals. A phase shift varying between 0° and 180° (90° at 130 Hz) is provided by C2 and R5 and this signal is then buffered by Q2. Additional phase shifting is provided by C3, C4, C6, R8, R9 and R10 to provide a total of 540° shift at 20 kHz. This network has a loss, constant with frequency, of 10 dB.

The values of the phase shift components are critical – stated values *must* be used. The resulting output of the above network is referred to as Rϕ°.

The output of Q1 also feeds a second network (Q4 etc), having different phase shift components, the output of which lags the first network by 90°. This output is known as the R (ϕ–90°).

The left channel input receives the same treatment and produces corresponding Lϕ° and L(ϕ–90°) outputs.

The Rϕ° and Lϕ° outputs are buffered by Q3 and Q8 respectively and amplified to compensate for the 10 dB loss in the phase shifting networks.

The right-back output is now produced by mixing equal proportions of R (ϕ–90°) and Lϕ°. These are mixed by R21 and R22 and then buffered and amplified by Q5.

Similarly the left-back output consists of equal proportions of L(ϕ-90°) and Rϕ°. These are mixed by R47 and R48 and then buffered and amplified by Q10. This output, as required by the SQ coding, is then phase shifted 180° by Q11.

Some crosstalk between left and right channels is recommended and R69 provides 10% mixing of left and right front channels, whilst R70 provides 40% mixing of the rear channels. These two resistors are mounted on the switch bank.

Except for component numbering, the ambience mode is as described last month.

rear right hand corner of the board. We used two 25 mm spacers and one 6 mm to do the job, but a piece of rod drilled and tapped both ends would be better if you have one, or can make one.

Wiring to the board differs slightly from the IC version in the following respects:—

1. The positions of left and right input channel wiring is reversed to that previously used.

2. The position of left and right back output channels is reversed.

3. The position of left and right front outputs are reversed.

Check these points on the overlay to make sure all wiring is the correct way round.

4. Mono switching is done, on-the-board, hence wires 13 and 14 from the preamplifier are not required. ●

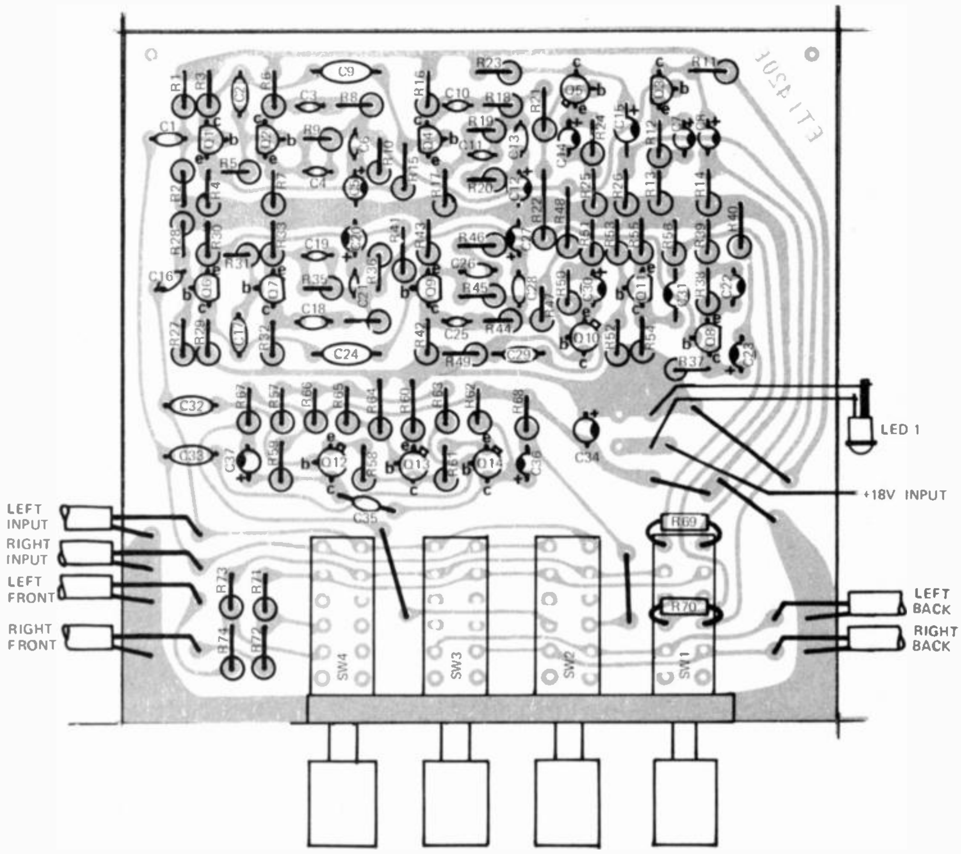
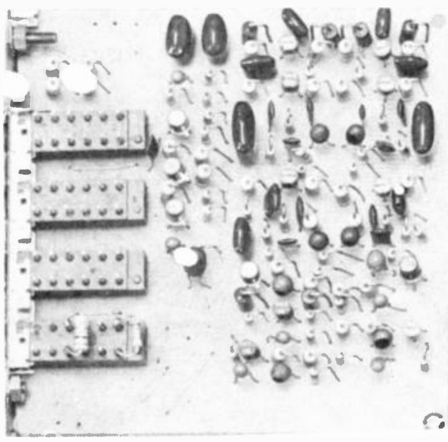


Fig.3. Component overlay.



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SONAB System 429

INTERNATIONAL MUSIC SYNTHESIZERS

The Voltage Controlled Filter module has a 100:1 control range.

eti 3600/4600

THIS month we describe the operation and construction of the Voltage Controlled Filters (VCF). These filters have more than a two decade range and provide switchable lowpass, highpass and bandpass modes of operation, all with a 12 dB per octave slope.

The operation of this filter is covered by Provisional Patent (Aust) 3651.

CONSTRUCTION

The method of assembly is similar to that used for most of the other modules. A small aluminium bracket is used to hold the printed circuit board and associated switches and potentiometers.

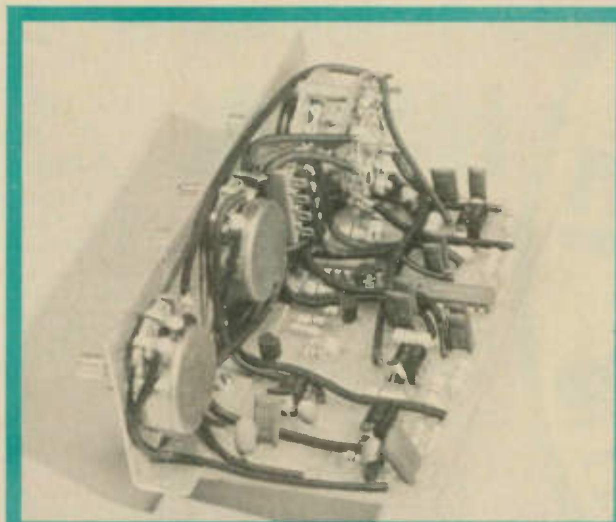
When assembling the components to the printed circuit board the usual care must be taken with the orientation of

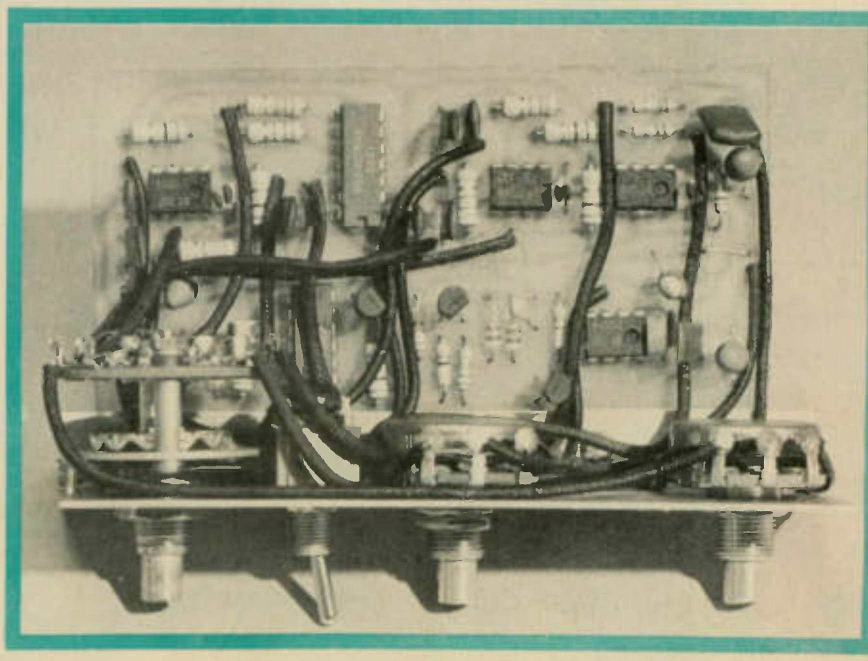
PARTS LIST V.C.F.

R1	Resistor	220 k	¼W	5%
R2	"	22k	"	"
R3	"	680Ω	"	"
R4	"	6.8 k	"	"
R5	"	39Ω	"	"
R6	"	330Ω	"	"
R7,8,14	"	1.2 k		
R17,	"	1.2 k		
R9	"	200 k	"	"
R10	"	150 k	"	"
R11	"	100 k	"	'
R7,8,14	"	10 k		
R15,18,19	"	10 k		
R20	"	3.3 k	"	"
RV1	Potentiometer	100 k log rotary		
RV2	"	25 k lin rotary		
C1,5,10,15	Capacitor	33pF ceramic		
C2	"	470pF "		
C3	"	47pF "		
C4	"	0.082μF polyester		
C6,8,11,13	"	0.022μF polyester		
C7,9,12,14	"	0.0047μF polyester		
C16,17,18,20	"	10μF 20V tag tantalum or pc electrolytic		
C19	"	0.01μF polyester		
Q1,3	Transistor	PN3638 or similar		
Q2	"	PN3643 "		

IC1,3,4,5 integrated circuit LM301A
IC2 integrated circuit SCL4001AL **
IC6 integrated circuit SCL4016AL *

** MUST be Solid State Scientific.
* Prefix and suffix varies from manufacturer to manufacturer.
D1-D3 diode IN914
SW1 3 pole 3-position rotary switch
SW2 4-pole 2-position toggle switch C & K type 7401 or similar
PC Board ETI 601 h
metal bracket to Fig. 3.





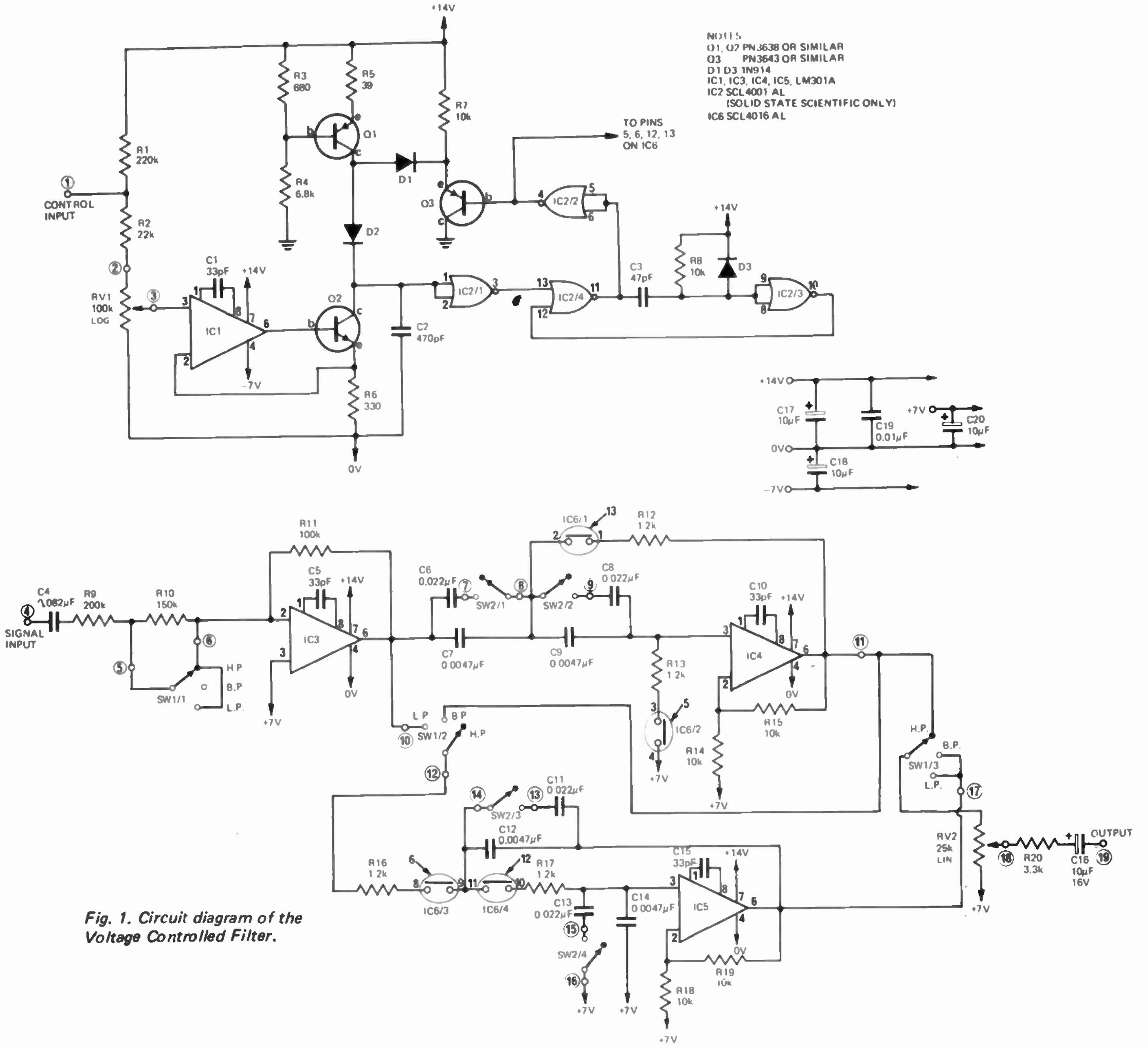
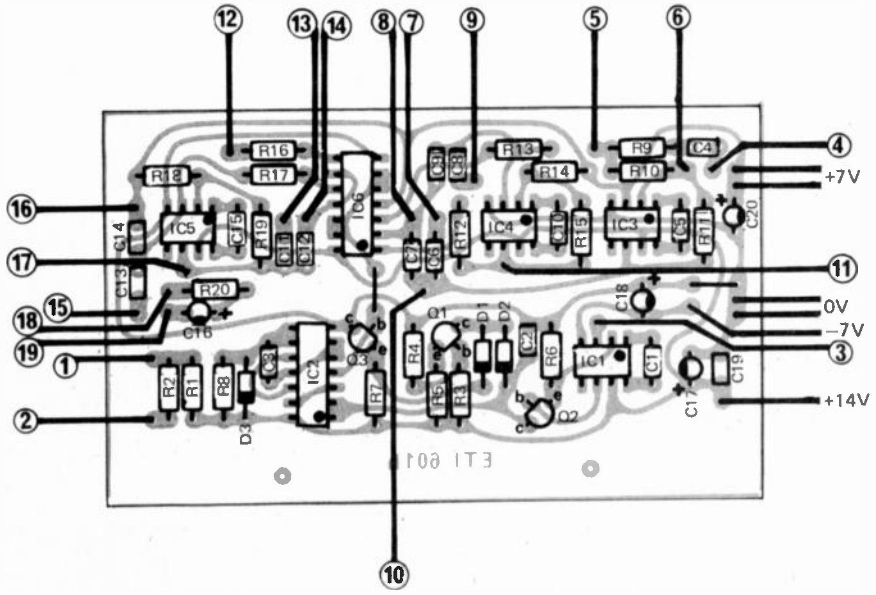


Fig. 1. Circuit diagram of the Voltage Controlled Filter.



◀ *Fig. 2. Component overlay of VCF.*

SPECIFICATION

MODES	low pass high pass band pass	
SLOPES	12 dB/octave	
Q	bandpass	1.5
CONTROL RANGE	> 100 : 1	
FREQUENCY RANGE (Nominal)		
Low range	20 Hz –	2 kHz
High range	100 Hz –	10 kHz
INPUT VOLTAGE RANGE		
Time control at maximum.	30 mV – 5 V	

NOTE: Low end of range is limited by the chopping frequency dropping below 20 kHz thus becoming audible. High end of range is limited by the maximum obtainable oscillator frequency. (> 2MHz).

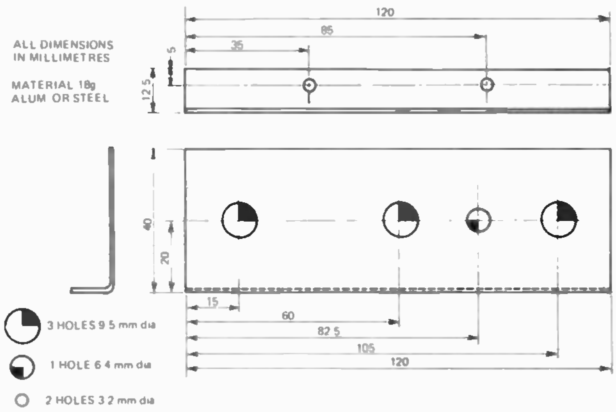


Fig. 3. VCF mounting bracket.

polarized components. Assemble the components to the board in accordance with the overlay Fig. 2, using sockets for the CMOS ICs at least. Note that IC2 MUST be a SCL4001AL as made by Solid State Scientific. Although this component is made under the same number by other companies, the Solid State Scientific version is much faster and has a much narrower linear region. If another brand is substituted the oscillator may work over a restricted range, or worse still may not work at all.

Wiring from the printed circuit board to switches and potentiometers is as shown in Fig. 4.

See also Errata column – page 79. ●

HOW IT WORKS

The voltage Controlled Filter consists of four main sections:

1. The Buffer Amplifier.
2. A High Pass Filter.
3. A Low Pass Filter.
4. A Voltage/Frequency Converter.

The buffer amplifier, IC3, is used to provide a high input impedance (greater than 200 k) and a level shift. In the low pass and high pass modes the gain is approximately –6 dB and in the bandpass mode –11 dB. The reason for this will become obvious as we proceed. Note, that although we have called this circuit an amplifier, the output is in fact less than the input.

If, for the moment, the CMOS ICs (which are analogue switches) are considered to be ON (IC6, 4016), it may be seen that the highpass (IC4) and lowpass (IC5) filters are normal 2-pole active types. They have a gain of 6 dB (which accounts for the 6 dB loss in the buffer) and have a 1 dB rise just before cutoff frequency is reached.

In the bandpass mode the two filters are connected in series and the resultant overall gain is 11 dB, hence the 11 dB cut in the buffer-amp in this mode.

Thus it can be seen that by selecting buffer gains the overall gain is held at unity in all modes.

Note that the supply rails are +14 volts and zero. Thus the 'common' line, as used internally in the unit, is +7 volts.

To vary cutoff frequency, either the resistive or capacitive arms of the filter must be altered. To select the HIGH or LOW range (10 kHz or 2 kHz nominal upper limit) we change the capacitive arms. For voltage control we use special circuitry to change the resistive arms as follows:

If a resistor is switched in and out of circuit at a variable rate, and for a fixed duration, the effective resistance will be equal to Rx TOTAL TIME/ON TIME. A voltage-controlled oscillator is used to switch the resistive arms of the filter on for a period of 200 nanoseconds and off for a time which is made variable. Take for example R12 (1.2 k) which is switched by IC6/1 (CMOS IC has a resistance of about 300Ω when on). If IC6/1 is switched at 1 MHz the effective resistance will be

$$\frac{(1200 + 300) \times 10^{-6}}{200 \times 10^{-9}} = 7500\Omega$$

If the oscillator frequency is reduced to 100 kHz the effective resistance will be 75 k, since the cutoff frequency of the filter is proportional to resistance, and the resistance is proportional to chopping frequency. If now the chopping frequency is made proportional to input voltage, it can be seen that cutoff frequency will be proportional to input voltage.

The voltage-to-frequency converter used does in fact have a linear relationship from about 10 kHz to 3.5 MHz. Frequencies below 20 kHz however should not be used, as the chopping frequency will become audible.

A variable constant-current source is provided by IC1 and Q2, where the base-emitter voltage of Q2 is compensated by taking feedback from the emitter of Q2 to IC1. A further constant current source is provided by Q1. The current from Q1 can flow either via Q3 to ground (output of IC2/2), or through Q2 as well as into C2. The current provided by Q1 is higher than the maximum available through Q2 and thus C2 will be charged by a constant current (when IC2/2 is high) the value of which is determined by the input voltage.

The voltage on C2 is passed to the input of IC2/1 such that if this voltage is above approximately 7 volts the output of IC2/1 will be low (0V) whereas if the input voltage is less than 7 volts the output will be high (+14V).

A monostable having a pulse duration of 200 nanoseconds is formed by IC2/3 and IC2/4. If the input at pin 13 of IC2/4 goes high a negative going 200 nanoseconds wide, pulse occurs at pin 11 and is inverted by IC2/2. This positive pulse will turn off Q3 allowing the current from Q1 to charge C2. The voltage across C2 will rise about 3V in the 200 nanoseconds, and will go above the 7V level causing IC2/1 output to go low. Capacitor C2 will now be discharged by the current through Q2 until C2 voltage falls below the 7V level, retriggering the monostable, thus generating another 200 nanosecond pulse.

The repetition rate of the pulse is determined by the current through Q2 and hence is proportional to the input voltage. The 200 nanosecond pulse thus derived is used to turn on the CMOS switches in the active filters.

The input voltage to IC1 is variable by means of RV1 which thus acts as a 'tune' control. Resistor R1 provides a static voltage across RV1 which allows the filter to be tuned to a fixed frequency in the absence of a control input.

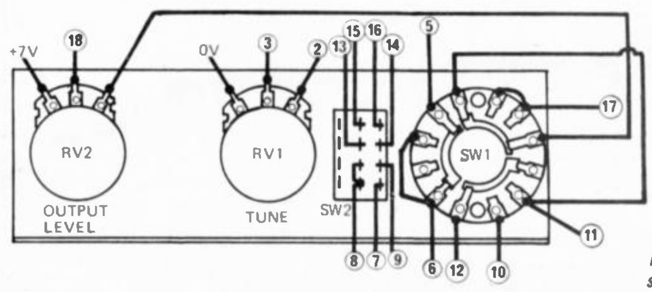


Fig. 4. Wiring diagram for switches potentiometres.

WHAT IS IT?

IT'S NOT A CHINESE CREMATIONAL URN. NOR IS IT AN EARLY VERSION OF DR. STRANGELOVE'S BOMB. OR EVEN A DEVICE FOR THROTTLING CAST-BRONZE FROGS.

SO WHAT IS IT? A YEAR'S FREE SUBSCRIPTION TO THE FIRST READER WHO COMES UP WITH THE RIGHT – OR EVEN AN APPROXIMATE – ANSWER.

HINT – IT'S A SCIENTIFIC INSTRUMENT. IT'S MADE OF BRONZE IT'S ABOUT TWO METRES IN DIAMETER.

ANSWER IN NEXT MONTH'S ISSUE

ERRATA

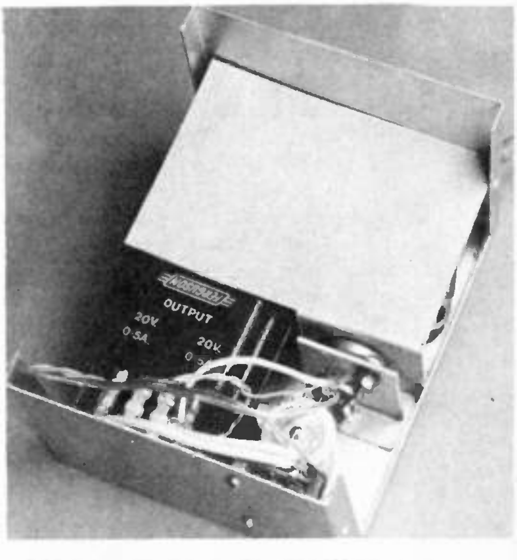
MUSIC SYNTHESIZER ETI 3600/4600
NOVEMBER 1973, page 84, Fig. 8. Corrections 42 and 37 should be reversed.
DECEMBER 1973, page 79. In the parts list for the mixer Q1,Q21,Q41,Q61, and Q81 should be BC558 or BC178. Q2, Q22, Q42, Q62, Q88 should be BC548 or BC108. (The two lines were inadvertently transposed).

KILL THAT GHOST ETI 216.
FEBRUARY 1974, page 91, Fig. 2. Potentiometer RV1 should be relabelled RV1/2. Potentiometer RV2 should be relabelled RV3/4. The potentiometers are correctly shown in the circuit diagram.

NICKEL-CADMIUM BATTERY CHARGER ETI 519.
FEBRUARY 1974, pages 65, 66. There is a possible safety hazard in this project. As shown in Fig. 4, the mains power cable is bent around and terminated in a two-way connecting block.

If the cable were to break at the point where it enters the connector there is a possibility of it swinging around and contacting the case of the power transistor Q1.

Constructors are advised to insert an insulating separator as shown in our revised unit. This separator must be securely fixed in postiion. Alternatively a metal separator may be used – in which case it must be securely earthed.



We are grateful to Neville Wright of the Electricity Authority for bringing this possible danger to our notice. ●

ELECTRONICS -it's easy! PART 5

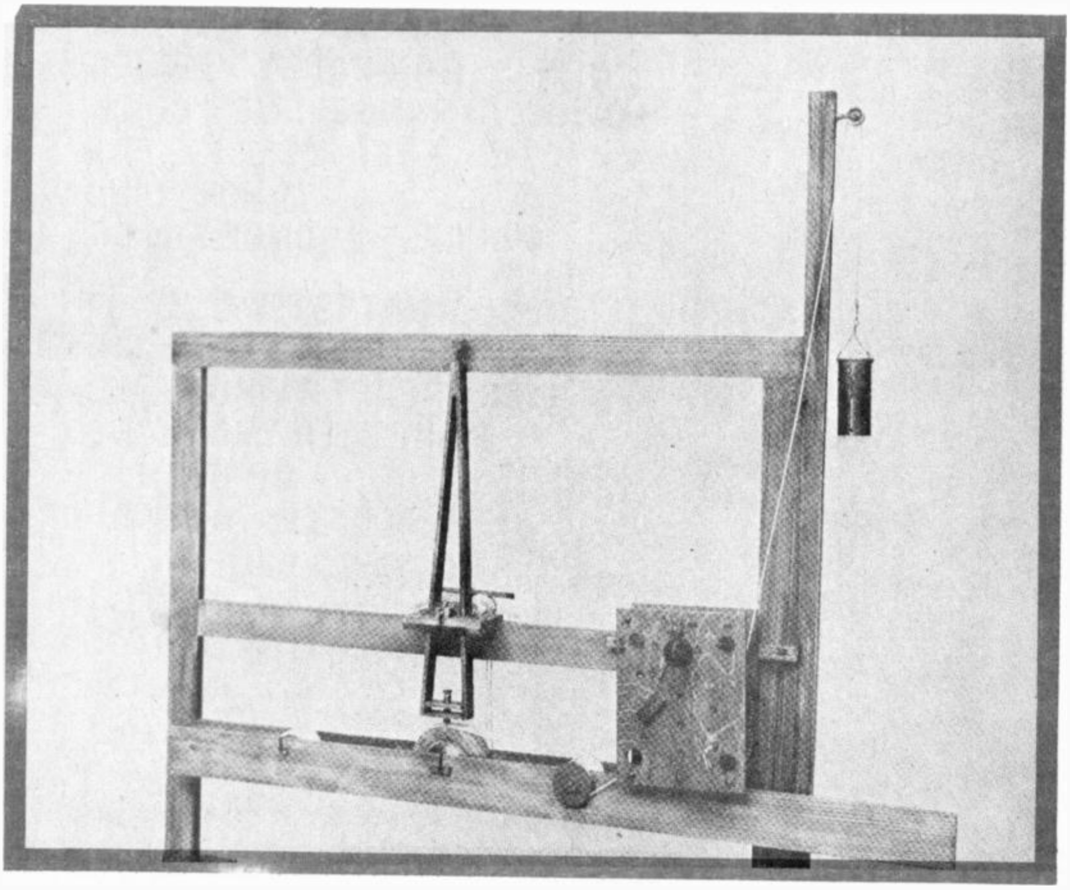


Fig. 1. The receiving terminal of Morse's first telegraph. The falling weight drives the paper strip past the triangular shaped pencil holder. Current received by the coils halfway up this holder cause the beam to deflect making a mark on the trace.

This article in our continuing series, explains how electronics is used in communication systems.

ELECTRICAL methods of sending information have existed on the Earth since the dawn of creatures, for the nervous system, that is so fundamental to life, is based on information transfer by the use of electric currents!

So there is nothing new to the electrical communication systems — but it is only in the past 140 years that man has made use of the principle in his inventions.

The Ancient Greeks knew a little about electricity . . . Thales of Miletus wrote about charged amber, . . . but it was not until recent times that its existence in living creatures was discovered.

In 1791, Luigi Galvani reported his observations (his wife's in actuality) of the effect of applying electricity to frogs' legs, hinting in his writings that electricity exists in tissues. It is very doubtful that Galvani saw the inherent implication that it acted as the means of communication between sensors and muscles.

Forty years passed by, and then, around 1830, a doctor named Jackson was demonstrating how a coil of wire wound around a piece of soft iron caused it to become magnetic, doing it more as entertainment than as a scientific demonstration.

Watching on was Samuel Morse, a well-known portrait painter of the time. He saw the 'trick' as the basis of a method for transmitting intelligence between people located remotely from each other. He visualized electricity, transduced from an invisible current to a visible movement thus enabling messages to be sent using invisible electrons. He was thinking of the telegraph as we know it now.

In Morse's time communication had remained little changed since time immemorial. But the tempo of life was rapidly quickening demanding more speed in communication.

Forms of telegraph existed . . . shuttered light beams, semaphore flags . . . but they lacked speed and versatility.

For several years, Morse developed methods for sending code along a wire circuit using an electro-magnet to deflect a pencil resting on the paper thus producing a scribed line on a moving paper strip (Fig. 1). The method was limited, however, to short distances (devices were not very efficient in those days and most of the power available was wasted as heat) and this drove him to think how he could regenerate the signal). Eventually Morse devised the relay: the electrical input signal, providing enough power to operate the armature, closes the next circuit via contacts and so on. The relay is a simple type of power amplifier, for the power output can be many times the power input.

Eventually Morse devised a system of transmitting information using a code in which combinations of short and long dc pulses were used to represent letters and symbols.

The dc pulses were transmitted along telegraph wires and if the distance between the receiver and sender was very long — intermediate relays were used.

Relays (described in Part 2 of this series) consist basically of a solenoid, which, when energized by an electric current, cause one or more pairs of contacts to close.

As used by Morse, the transmitted signal was used to energize the relay solenoid — this caused the associated contacts to close — which in turn provided the necessary switching for the next stage.

A whole series of such relays were used if necessary to enable the data to be transmitted over thousands of miles.

So much for the telegraph and the use of switched dc currents for information transfer. Let us now look at the early developments in the use of ac currents for this purpose.

In 1887, the son of a Hamburg lawyer, Heinrich Hertz (Fig. 2), wrote in his diary that he had discovered what we now call radio-waves. (Do not bother to search for an explanation of what these *are* for no one knows . . . we do know, however, what they can *do* and how to use them to our advantage). These time-varying oscillations pass through space without the need for wires, being in fact, just a small part of the electromagnetic spectrum we mentioned in a previous part of this series.

Hertz' discovery started the still-continuing search to find ways to generate and sense waves across the entire electromagnetic spectrum. It is said that Hertz thought there was little use for his discovery! The unit for frequency . . . the Hertz . . . is named after this scientist . . . whose pioneering work opened up new vistas in our capability.

Hertzian waves, as they were called at first, could only be detected visually to begin with . . . as minute sparks across the receiving coil's terminals. By 1890 Edouard Branly, in Paris, had devised a technique that could use the waves to operate a relay. It relied on the fusing together of metal filings when they were placed in a field produced by the waves. As the filings joined up they closed an electrical circuit. The method was very crude, and most inconvenient, for the filings had to be shaken apart after each bit of information. It was, however, the start of many experiments that were to eventually lead to the development of radio communication as we know it today.

Fig. 2. A contemporary etching of Heinrich Hertz.

Marconi is generally credited with the first successful radio broadcast but some historians give that credit to the Dane, Johannes Sorensen, who is said to have signalled a ship from the shore even before Hertz reported his findings (in 1866).

Also predating Marconi, was the Russian engineer A.S. Popov, who on 7 May, 1895, demonstrated the possibility of sending messages over the air.

Popov was also the first man to establish a practical regular radio link — between the island of Kuutsalo, near Kotka, and the island of Suursaaren. This link was put into service on Feb 4, 1900, and was used regularly until April, 1900. During 8 days, 440 official telegrams were transmitted.

In 1897, Marconi, helped by several others, succeeded in transmitting lengthy messages over a distance of 7 km between Lavernock Point in Wales to the Island of Flatholme situated in the middle of the Bristol Channel. His success was immediately met with acceptance (not like Sorensen who was publically ridiculed for suggesting he could communicate without wires).

In 1898 Marconi set up a link between the Royal yacht "Osborne" and Queen Victoria's residence on the Isle of Wight.

For many years to follow, the main use of electronics was for communication purposes. The large economic gains that were available using electronic techniques were responsible for the rapid progress that took place in the electronic discipline.

Telegraphy is a simple but efficient way to send information . . . the electrical contact is closed and opened in a certain time sequence to form a code . . . the Morse code for instance. This contact sets the current flowing in the transmission medium, thereby carrying information. At the receiver the signal is used to close another contact that can either be heard or seen. Today we still use the same concept . . . the telex service, short-wave radio and ship-to-ship links . . . but in general the methods are much more complicated as they incorporate such devices as error detection, multiple channels and automatic output recording.

We will now take a look at the forms of signals that can be used to convey information — leaving the actual circuits used until late in the course when we have developed some mastery of the workings of components and sub-systems.

TWO CLASSES OF SIGNAL — DIGITAL AND ANALOGUE

Let us go back to a simple direct current circuit, as shown in Fig. 3. The person operating the key-switch at the transmitting end can cause the device at the receiving end to operate, thus conveying something to the other person. What he has done, in effect, is to set a current flowing, the magnitude of which is decided by the voltage of the battery supply and the resistance of the indicating device. (The

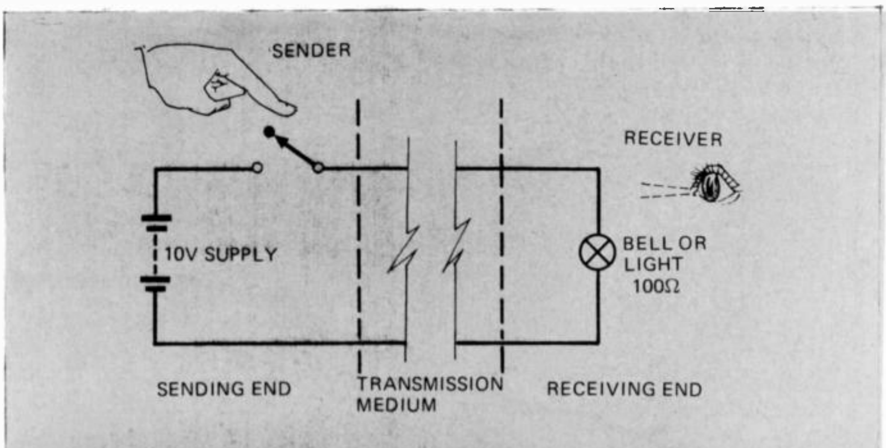


Fig. 3. A simple d.c. signalling circuit using on-off control.

ELECTRONICS-it's easy!

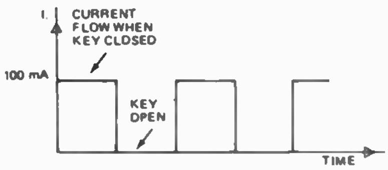


Fig. 4. Amplitude-time graph of current in a switching circuit.

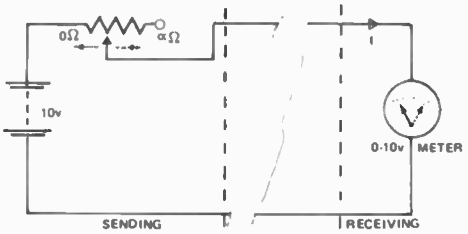


Fig. 5. A simple d.c. signalling circuit using variable current control.

resistance of the cable is assumed to be negligible here, but in practice it must be considered, especially when distances run to many kilometres).

But as shown in Fig. 3, no matter how the switch is closed, it can only provide an ON or OFF action. If the sender repetitively opened and closed the key the current amplitude/time graph would look like that shown in Fig. 4. Note there can be no currents in the circuit between the on and off values.

As this kind of signal has only certain *discrete* values we call it a DIGITAL signal, this word originating from the Latin word for 'finger'. The type of electronic circuit that generates these signals is known as a SWITCHING circuit.

It is convenient here to point out why apparently wasteful resistance is actually so useful in electronics. In the example of Fig. 3. the resistance of the bell or light converts the flowing energy into a useful signalling effect. Without resistance there could be no signal generated at the receiving end. Too little resistance in the device would lead to an enormous current flowing uniformly in the wires; too high a resistance in the device would not provide enough energy to produce the desired indication.

Consider now what happens if we remove the key, replacing it with a variable resistor, as is shown in Fig. 5. Further, at the receiving end we put an indicating volt-meter instead of the bell or light. As the sender varies the *resistance* in the circuit, the current also varies in accordance with Ohms Law. When the variable resistor is set maximum value, (infinity in our example), no current flows, and so the meter registers zero volts. As the resistance is reduced by the sender the current increases, and the meter reading increases accordingly. Finally, at minimum resistance, current reaches the level at which the meter pointer reads full-scale.

Thus the signal varies *smoothly*, without any evidence of the rapid transitions that we saw in the switching circuit (unless the sender produces them by very fast changes of the resistance). This form of signal is called an ANALOGUE signal.

It is not possible to uniquely define how this signal would look as time varies (as we did for the switching case), for this depends entirely on the sender. If, for example, the resistor is varied uniformly from maximum to zero a ramp signal is produced as shown in Fig 6a. It can also be seen that a sinewave can be generated (Fig 6b) if the resistor is first set to give half-voltage and is then moved back and forth with the appropriate time-resistance relationship. The analogue circuit can be used to produce switching action by very rapid movement, but a digital circuit cannot be used to obtain analogue behaviour (at least not without additional additional circuits — as we will see later in the course.

The resistance of the circuit plays a vital part in the production of the analogue signals, especially when the value can be made to vary by some means or other. We will see later that the well-known transistor is really little more than a variable resistor — in which the current passing through it is controlled by another current fed to it in another terminal — much in the same fashion as a policeman controlling traffic flow at an intersection in a one-way street.

The next point to consider is how the two forms of signal (digital and analogue) convey information.

INFORMATION IN DIGITAL SIGNALS

Digital signals can only exist at discrete set levels . . . a desk calendar for instance is essentially a digital device. It either *is* Feb 17th — or it isn't. It shows no intermediate stages, such as Feb 17.75th!

By contrast, a conventional watch or clock is an analogue device, in that the passage of time is indicated as a smooth progression of the hands around a dial.

The most basic electronic device for generating a digital signal is a switch. It is either ON or OFF, there are two, and *only* two, possible states.

There are many other devices and circuits (described later) which have only two unique states, and these are known collectively as Binary (meaning two state) devices.

These binary devices form the basis of digital electronics, the digital computer being the most outstanding example, where many thousands or even millions of binary devices are used in combination to perform amazing tasks.

Let us examine how information may be transmitted with a keyed (switched) system such as shown in Fig. 3. Here the light is either ON or OFF. This means that the sender can only signal one piece (we call it a bit) of information at a time . . . Come when the light goes on, etc., the only information that is actually transmitted is that the key is closed. That is, we must *assign a meaning* to this bit of information.

We can however, send the same signal two or more times in sequence and assign meanings to the individual sequences. We can also make our key

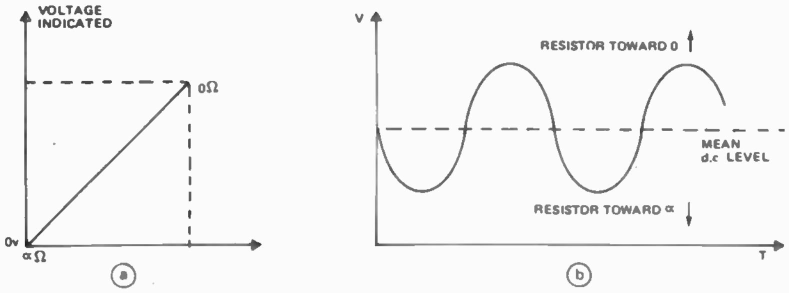


Fig. 6. Circuits with continuously varying current levels are called analogue circuits.
(a) A linear ramp *(b) A sinewave.*

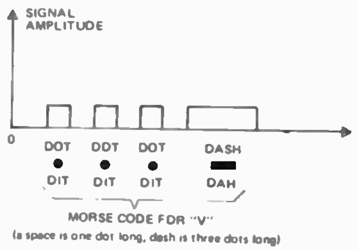


Fig. 7. Amplitude-time graph of Morse code letter V as produced by keying a d.c. circuit.

closures of varying duration.

The first man to construct such an arbitrary code was Samuel Morse in 1837. His code was constructed of agreed sequences of short and long dashes to represent each letter of the alphabet. For example the letter V is represented by dot, dot, dot, dash; its amplitude time graph is illustrated in Fig. 7.

Thus by sending series of such groups we can build up words and hence complete messages in any spoken language. (In computing jargon, each such *group* of bits is called a 'word' even though it may not correspond to any spoken word.)

The Morse code is only one of many possible codes that can be used to transmit information. Many other communication codes are in use, each having unique characteristics most suitable to a particular purpose. Typical examples are the Baudot, ASCII, Selectric and Hollerith codes — to quote just a few in general use.

These codes differ from Morse in that they use groups of pulses (all having the same length) and are based on variations of a fundamental counting system known as the Binary code which we shall now examine.

We normally do all our mathematics (adding, multiplying etc) in a system based on the number 10. For example the number 1285 equals:—

$$\begin{aligned} 1 \times 10^3 &= 1000 \\ +\,2 \times 10^2 &= \;\;200 \\ +\,8 \times 10^1 &= \;\;\;\;80 \\ +\,5 \times 10^0 &= \;\;\;\;\;\;5 \\ &= 1285 \end{aligned}$$

We don't have to count by tens, we can count by two's, eight's, twelve's or any other base number we wish.

Let us now consider how a system with base 2, (a binary system) works.

If we have one switch it has only two possible states — but what happens if we have a second switch? If we let '0' equal switch position OFF, and '1' as switch position ON we can construct a table of the possible combinations as follows.

	4	3	2	1	
SW1				0	0
only				1	1
SW1 +			1	0	2
SW2			1	1	3
SW1 + SW2		1	0	0	4
+SW3		1	0	1	5
		1	1	0	6
		1	1	1	7
SW1 + SW2	1	0	0	0	8
+ SW3 +SW4	1	0	0	1	9
	1	0	1	0	10
	1	0	1	1	11
	1	1	0	0	12
	1	1	0	1	13
	1	1	1	0	14
	1	1	1	1	15

From this we can see that adding a second switch gives us four possible combinations (2^2). Taking this still further, three switches gives us 2^3 = eight combinations, four switches 2^4 = 16 combinations etc. Thus if we were to use six switches a total of $2^6 = 128$ combinations would be possible. We can thus use a group of six bits in a binary code sequence to represent the numbers 0 to 9, all the letters of the alphabet (in both capitals and lower case) plus a number of punctuation marks and other symbols or commands we may wish to transmit.

The length of the code word is thus fixed and the sequential groups of bits (words) are separated by a longer than normal space.

The main differences between the various codes are merely the number of bits in the 'word' and the way in which meanings are assigned to the word.

At first sight these binary codes seem to be a dreadfully slow way to transmit information. But remember electronic switches can open and close millions of times a second, so, in practice, we can send information enormously faster using serial binary codes than can a morse code operator.

Further since all the binary bits are the same length and there is the same number in each we can send each word in parallel.

For example, referring to our table, the figure 8 could be sent on four lines by putting a 'one' on line 4 and 'zeroes' on lines 1, 2 and 3. Thus in this case the transmission rate would be four times faster again. However the use of parallel transmission is impractical (due to the number of lines required) except over short distances, eg, within a computer.

INFORMATION IN ANALOGUE SYSTEMS

Unlike digital signals, that can exist only at discrete levels, the analogue signals can exist at any level between zero and the maximum available.

In theory every minutely different level can be used to represent a specific bit of information, thereby giving us unlimited code capacity at each instant of time. Practice, however, limits the separation between levels that we can reliably detect because Noise (the name given to unwanted disturbing signals) can add or subtract from the signal at each defined level leading us to wrongly interpret the true intended meaning.

In reality then, there is a limited signalling capability in any analogue signal and the capability depends on the level of unwanted signal entering the system. The noisy signal obtained from a temperature measuring thermometer (Fig. 9), illustrates this.

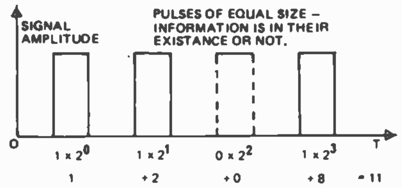


Fig. 8. Sending the number 11 in binary code (digital form of signal).

It tells us how the temperature varied with time but only to a precision limited by the width of the noise superimposed on the record. Within the width of this noise band we cannot say with certainty what the temperature was doing. It may have varied along the mean centre line, it may have varied from the upper to the lower limit or any other way you care to propose. We have no way of knowing what happens when noise swamps the signal.

MODULATION

We saw in Figs. 5 and 6 how the current in the circuit was varied in accordance with the wishes of the operator: (The wiper contact of the resistor was moved with time to accomplish this.) In the parlance of electronics this process is called modulation; the direct current was modulated to produce ac waveforms. The Morse and the binary code are transmitted by modulating a basic dc current.

Looking at the temperature record in Fig. 9 it can be seen that the original signal is modulated by the noise to produce frequencies that probably did not exist in the true temperature signal. Although detrimental in that instance, this process of adding frequencies to others can be used gainfully to transmit information.

If we start with a continuously generated ac signal (instead of the dc case mentioned above) we can modulate the ac waveform in a similar manner by varying its amplitude or its frequency. Let us look at these modulation methods in a little more detail.

Amplitude modulation . . . this is the name given to the process in which the instantaneous amplitude of a constant frequency wavetrain is varied usually in order to convey information. This is shown in Fig. 10.

The original signal is called the CARRIER for it carries the signal

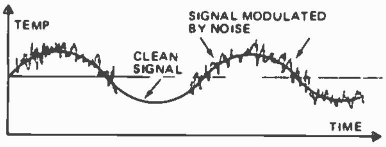


Fig. 9. Resolution of the signal in an analogue circuit is limited by the unwanted noise present with the signal.

information. Amplitude modulation is used extensively in radio transmission, especially the normal broadcasts we are now so familiar with. It is a simple matter to send Morse code over a carrier — the carrier is simply switched on and off to produce short bursts several cycles long. The principle is, however, not confined to radio but finds uses in many other fields of electronics. It is often abbreviated to 'AM'.

Frequency modulation . . . in this type of modulation the amplitude is held constant, and the instantaneous frequency varied instead. The carrier is the same as that for AM to begin with, but after modulation the combined signal has the appearance shown in Fig. 11. (This modulating form is usually known as FM). It is less prone to noise problems than AM but is more expensive to implement, so its use is more restricted than AM systems. No doubt you have heard of FM radio . . . the broadcasting system that uses frequency modulation to transmit the sound signals.

WHY MODULATE AN AC CARRIER?

By now you could well be wondering why we go to all this trouble to modulate an ac signal — it needs a special generator to produce the carrier in the first place and special circuits to recover the signal when received.

Why not use a simple battery-powered dc signal and just vary it with a switch or variable resistor?

To answer this question let us consider the problem of transmitting speech over long distances. As we speak we create pressure waves in the air which another person, reasonably close to us, can detect by means of his pressure sensitive ears — but the distance over which this acoustic communication can take place is strictly limited. How can we transmit a spoken message halfway round the world — or even to the moon?

Of course you know that the means is radio; in a radio transmission we modulate a carrier frequency by the amplitude and frequency of the voice. But how does this technique increase transmission distance? The answer lies in the nature of electromagnetic waves.

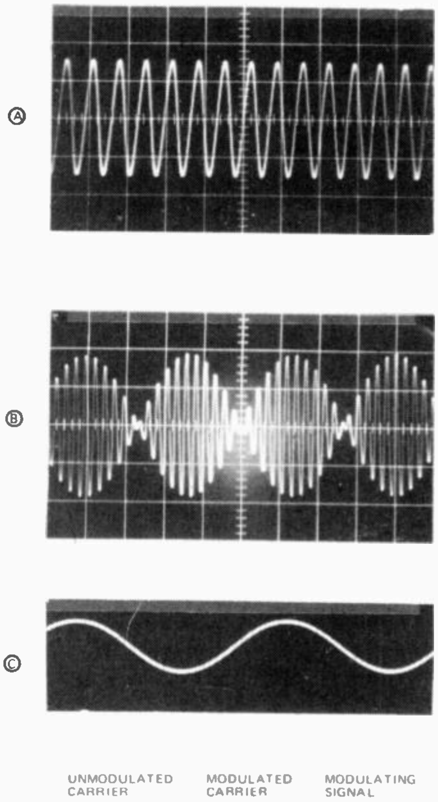


Fig. 10. In amplitude modulation, the amplitude of the a.c. carrier signal is varied, the frequency remaining the same.

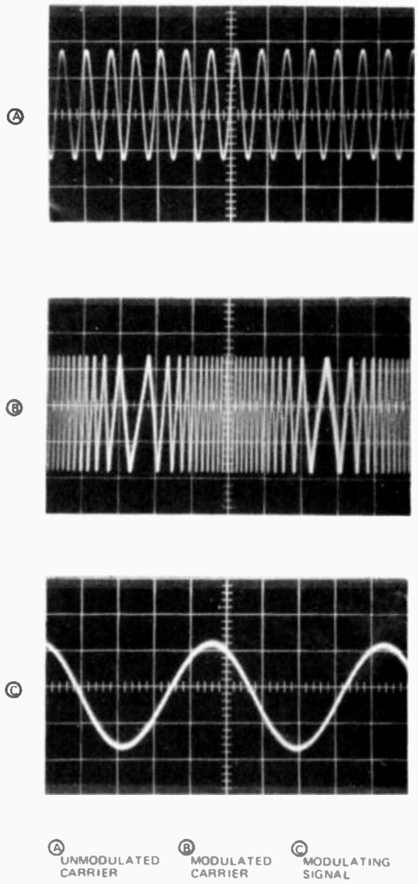


Fig. 11. In frequency modulation, the amplitude of the carrier is held constant, the information signal being used to vary the instantaneous frequency.

ELECTROMAGNETIC WAVES

In a preceding section we told you that when a current flows through a wire there is also an associated magnetic field. In addition where we have two conditions, or charged bodies, insulated from each other and at different potentials, there is an electric field between them.

Thus we can have a magnetic field without an associated electric field and correspondingly an electric field without a magnetic field. However if the fields are *changing it is impossible for either type to exist separately.*

A changing electric-field will produce a magnetic field, and a changing magnetic field will produce an electric field.

This electro-magnetic disturbance, in a similar manner to the ripples caused by a stone thrown into a pond, propogates in all directions.

The remarkable thing about an electromagnetic disturbance is that it propogates at the speed of light and it does not require air, *or any other medium,* for its propagation.

Hence its ability to travel through the vacuum of free space.

As no-one wants to listen to everything that is broadcast, different carrier frequencies are used for different transmission applications.

The carrier frequencies used depend on the specific application, eg, radio, television, amateur radio, radar etc. All use frequencies, appropriate to the type of modulation, in bands allocated by international agreement. Thus AM radio commercial stations use carriers within the range 550 kHz to 1.5 MHz whilst radar may use frequencies in the 1 to 10 GHz region.

In fact communication systems have used electromagnetic radiation with frequencies from 10 kHz for VLF (very low frequency communications with submarines) to light wave frequencies (by using lasers) in the 100 Terahertz region.

Do not confuse low frequency electromagnetic radiation (eg 20 kHz) with audio at the same frequency. They are entirely different phenomena. Audio needs a medium such as air and propogates in air at around 334 metres per second. Also note that the speed varies, with the medium. By contrast electromagnetic radiation at 20 kHz propogates at 300 x 10^6 metres per second and does not require a transmission medium.

At the receiving end, special circuitry is used to then recover the modulation impressed upon it.

MULTIPLEXING

Assume that we wished to send four telephone communications over a wire

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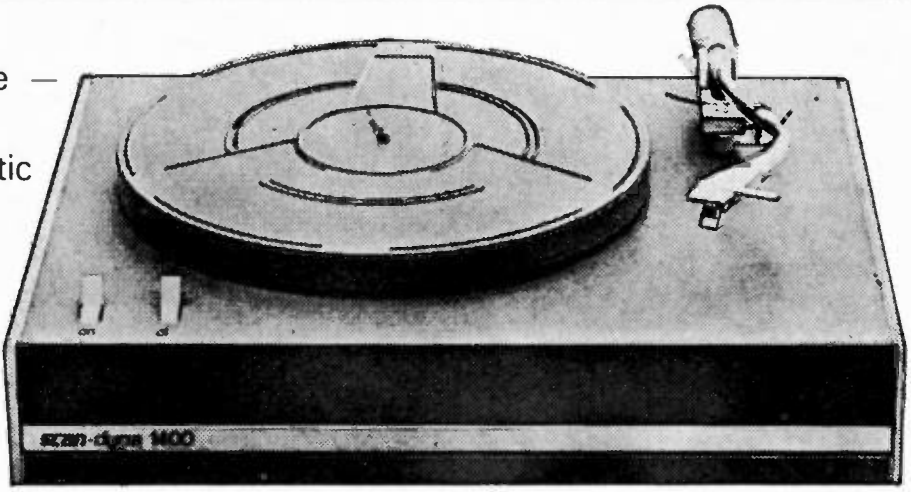
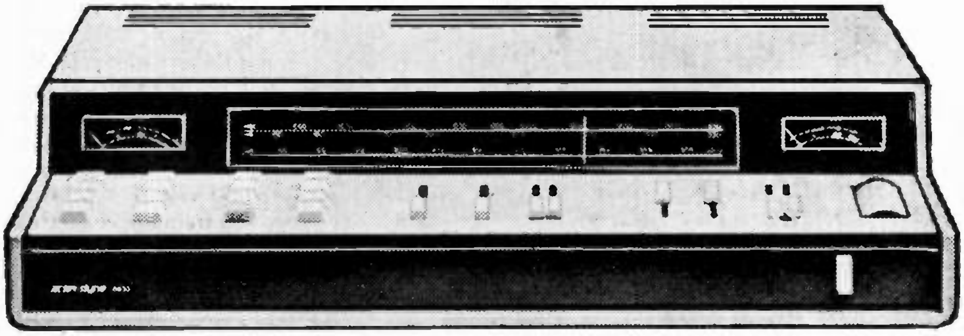
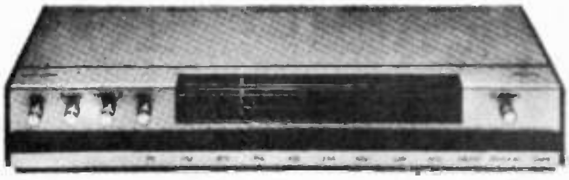


Scan-Dyna 1400 turntable with Ortofon arm and cartridge.

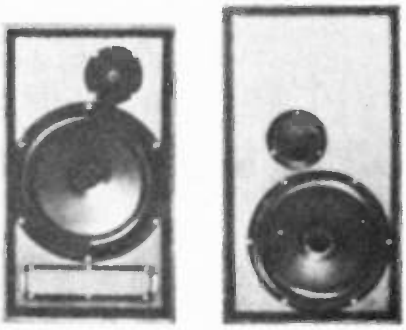


Scan-Dyna 2400 turner-amplifier 2 x 40 wts. rms. 4 ohms.



Scan-Dyna 2000 turner-amplifier 2 x 25 wts. rms. per channel 4 ohms.

Q4
Quad adaptor



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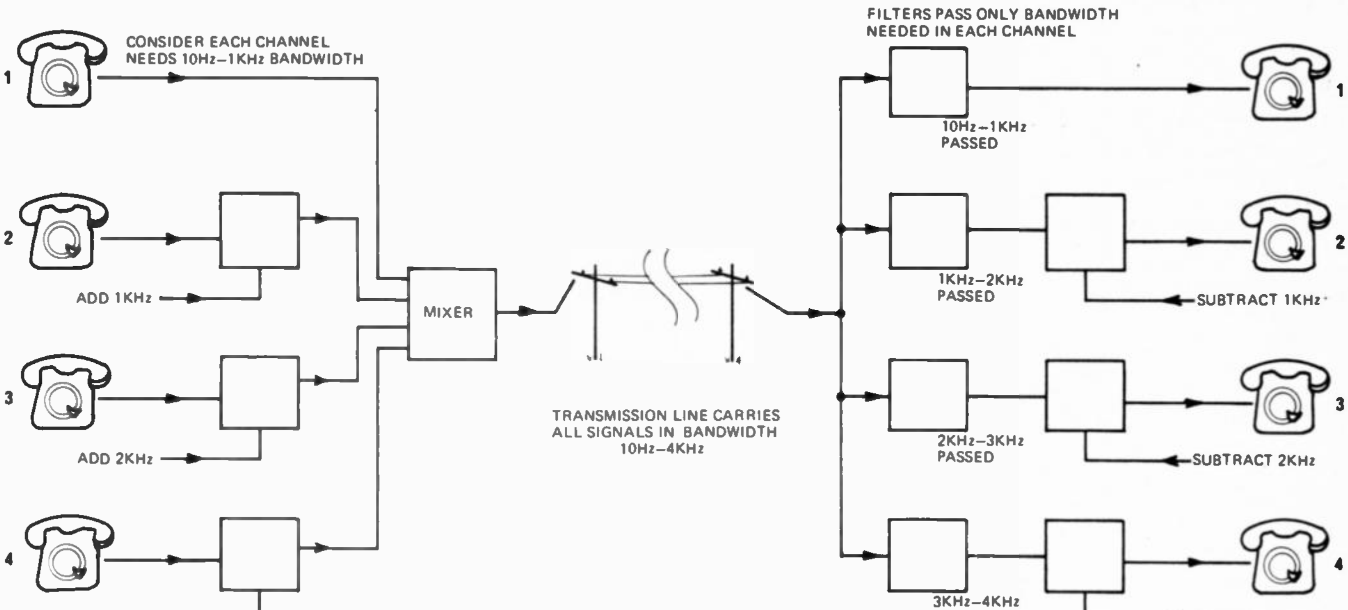

Fig. 12. Frequency multiplexing enables communication channels to be stacked up across the frequency spectrum without interaction between each.

at the same time. The first channel, as shown in Fig. 12, could be sent direct. If we attempted to add the others to the same line the result would be like a party line . . if they all spoke together it could become unintelligible and certainly not private. This is overcome by adding the second voice signal to a carrier frequency just higher than any frequency in the first voice channel. This is done by modulation. The other lines are also modified this way placing each voice channel up at a higher frequency than the channel below. Hence the jargon, stacking the channels, for they are being placed across the frequency spectrum, side by side or on top of each other – however you like to visualize it.

For reasonable intelligibility it is necessary to transmit the frequency components of human speech lying, approximately, between 300 Hz and 3300 Hz, i.e. a range of 3000 Hz. This is known as the required BANDWIDTH.

Thus the signal in the interconnecting telephone lines may contain frequencies ranging from the lowest in the first (unmodulated) channel, to the highest in the (modulated) fourth channel. Each channel – as we have seen – requires a *bandwidth* of approximately 3000 Hz, (and it is desirable to separate channels to some extent to prevent overlapping) so that four voice channels will require a total bandwidth of 12 000 Hz (plus channel separation).

In normal telephone line systems however, the number of channels which can be so multiplexed is strictly limited as the total bandwidth that can be handled by a conventional telephone line is seldom much more than about 12 kHz. (Special cables however can handle thousands of channels multiplexed this way).

Having so multiplexed our separate conversations onto one line, it is obviously necessary to separate them at the other end. That is to *demultiplex* them. This is done by using the special electronic circuits known as filters to select the narrow band of frequencies that constituted each individual carrier. Each channel must then have the modulation recovered from the carrier. This process of demodulation is done for each channel and the recovered audio then fed to the individual telephone subscribers.

Frequency multiplexing is certainly a complicated process for sending information. But it is far less expensive to transmit many information channels this way than it is to keep adding new lines to a global communications system, especially if the lines convey television, or if they run under the sea.

As the electromagnetic frequency spectrum is usable up to at least 10^{14} Hz it will be appreciated that an enormous number of communication channels may be used.

The total frequency spectrum cannot

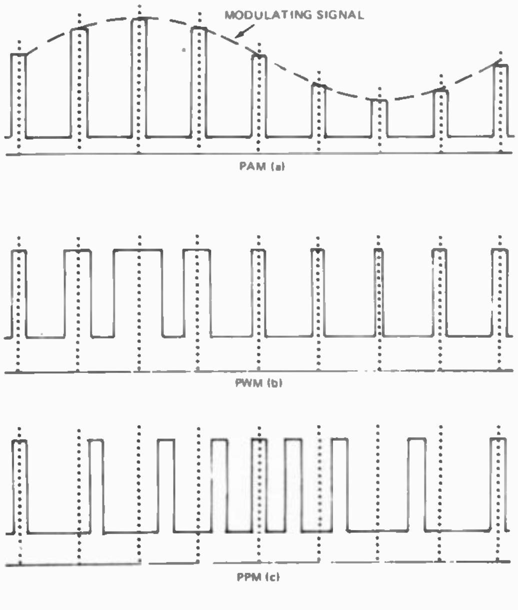

Fig. 13. Modulation of pulse carriers.
(a) Pulse amplitude modulation PAM.
(b) Pulse width modulation PWM.
(c) Pulse position or pulse time modulation PPM or PTM.

be crammed into any one line of course, but hundreds of channels can be multiplexed onto a microwave link. In the future, laser communication systems may allow thousands of TV channels to be transmitted over a single beam of light.

MODULATION IN DIGITAL SYSTEMS

The principle of modulation is not restricted to analogue signal transmission systems, but can also be applied to digital communication links — those that use on-off signals. Again there exist a number of ways by which a basic digital wave-train can be modified to represent signal data that comes in original analogue form.

In our discussion of the transmission of digital codes we saw how a train of pulses could be used to represent all the characters needed for the transmission of messages. In that case, see Fig. 8, the presence, or not, of pulses at certain times indicates the meaning assigned to each data word. It can be seen that the continuously transmitted signal would look like a square-wave train that has pulses missing now and then. This is in fact how signals are sent around inside a digital computer . . . a square-wave train is generated continuously with a generator (called the clock) and the instruction circuits (called logic) decide which pulses are to be there and which are not, depending upon the code value to be sent.

As said before this method of coding may be used for wire or radio communications and in general is known as Pulse Code Modulation — PCM.

Note that the pulses are not always there and each pulse does not carry complete instantaneous information: It takes the addition of several pulse positions to build up the 'word'. Consider now, the case where pulses are continually generated, as before, but where we actually alter some characteristic of each pulse, in a way that is proportional to the analogue input signal to be sent on the data link.

Pulse amplitude modulation (PAM) is one method . . . in this case a square-wave signal has its instantaneous amplitude (of each pulse) varied in accordance with the amplitude of the analogue input signal, as is shown in Fig. 13a.

Pulse width modulation (PWM) is another method . . . the width of each pulse is varied, the height being held constant and the frequency remaining the same, as is illustrated in Fig. 13b.

Pulse position modulation (PPM) . . . also called pulse time modulation (PTM) . . . the remaining available variable is modulated in this. Pulses are identical in height and width but their position is varied within each carrier pulse period. The frequency remains the same, as is shown in Fig. 13c.

The advantage of using pulses to modulate the carrier is mainly that the pulses can be restored (with digital circuits) to their original form as the communication link progresses (in what are called repeaters) thus retaining the quality of the original signal throughout the transmission. This means less errors are sent for in electronic hardware it is possible to maintain timing accuracy far more easily than amplitude accuracy.

Digital modulation methods are used extensively for data transmission in scientific experiments and equipment. One example is the satellite data link (Fig. 14). Digital modulation may also be used in normal voice communications by converting the analogue voice and signals into digital form.

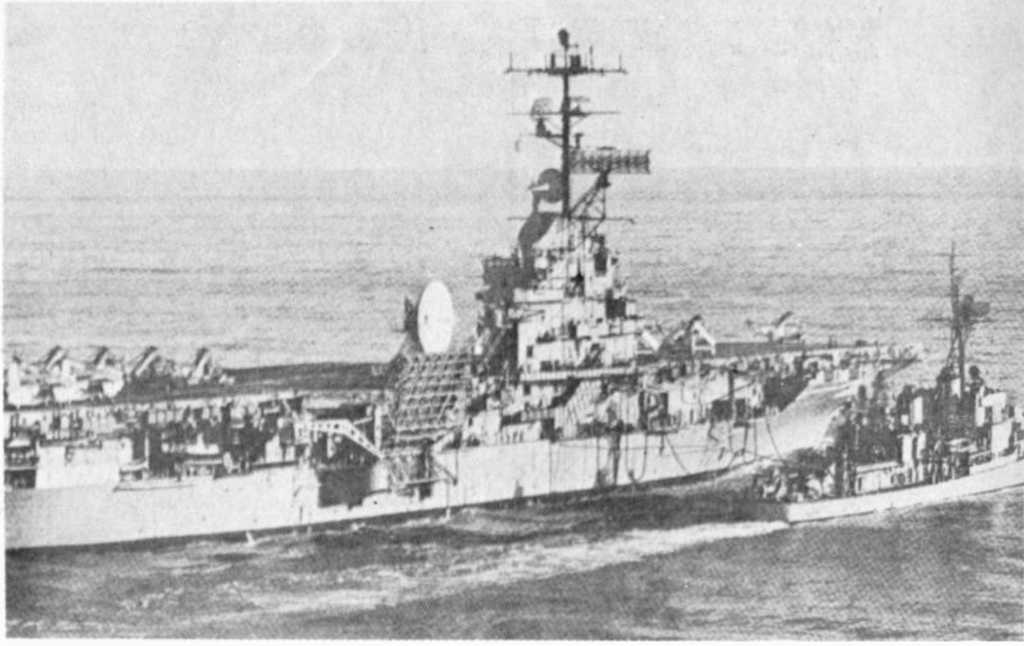

Fig. 14. Communication links sending measurement and control data are known as telemetry systems. In the picture above the round white dish antenna receives data from television cameras in space.

Cost, and the extent to which external unwanted noise is able to upset the system usually decides which method is to be preferred for both analogue and digital systems can convey information. Another factor that may influence the decision is the form of the data when derived, or the form needed on receipt. If already in digital form direct transmission of binary code probably would be preferred to converting it to an analogue equivalent and then back again at the receiving end. (Systems sending data derived from sensors are generally called TELEMETRY systems).

This has been a *systems* introduction to the transmission of data. To understand the design of the black boxes we will need to study many circuits before the operation of the many methods is to be fully comprehended. It has, however, added another significant chapter to the understanding of electronics at the systems level. The principles and terms encountered here are constantly used in electronics. ●

ELECTRONICS — in practice — page 91

ELECTRONICS -in practice

UNDER 17 YEAR OLD'S

EXCITING NEW CONTEST – PAGE 127 THIS ISSUE

THEORY in this issue has been concerned with information transmission – so here are two quite different exercises that will illustrate the concepts.

The first is for those who wish to use the Morse Code, perhaps because they ultimately wish to become one of the world-wide group of radio amateurs, who spend their leisure time building and using radio transmitters and receivers for communication across the globe. A working knowledge of the code also enables you to listen in to the many signals sent in the shortwave band of the radio set.

The first thing that must be done is to learn the dot-dash code sequences used to represent each letter of the alphabet. They are given in Fig. 15. Also given are the accepted codes for punctuation and procedure. When you feel you know the code try yourself out by listening to the signals found as you scan the dial of a good short-wave radio set. Don't be too discouraged at first. It requires much practice to reach the speeds used by trained operators.

Another, and probably better way, to learn morse is to build yourself a code practice rig such as that shown in Fig. 17.

The relay coil (from the earlier experiment on the L.D.R. and resistors) is wired in series with the operator's sending key and also in series with a normally closed contact of the relay. When the key contact is made, the relay closes, pulling the contact open, thus opening the circuit releasing the armature. This closes the contact pulling the relay on . . . and so on. The process continuously produces oscillations causing the relay to become a buzzer.

When the relay oscillates in this manner its electrical coil generates a high ac voltage with each swing of the armature. This voltage is sufficient to produce a loud noise in an earpiece.

The 0.005μF capacitor smooths away the harmful peaks of this generated voltage, safeguarding the earpiece. Components in the filter section can be varied as you please to obtain the sort of sound you desire.

The resistor placed in series with the relay coil is provided to reduce the supply voltage to a safe working level. In this mode of use the relay can be provided with a little more than its normal voltage, for the coil is not energised all of the time. Select the resistor that gives the sound you like.

This circuit gives the ardent enthusiast the chance to practice without disturbing the peace of those around (as would be the case if a normal buzzer were used). If necessary the relay can be put into a sound-proof enclosure.

A	di-dah	S	di-di-dit
B	dah-di-di-dit	T	dah
C	dah-di-dah-dit	U	di-di-dah
D	dah-di-dit	V	di-di-di-dah
E	dit	W	di-dah-dah
F	di-di-dah-dit	X	dah-di-di-dah
G	dah-dah-dit	Y	dah-di-dah-dah
H	di-di-di-dit	Z	dah-dah-di-dit
I	di-dit	1	di-dah-dah-dah-dah
J	di-dah-dah-dah	2	di-di-dah-dah-dah
K	dah-di-dah	3	di-di-di-dah-dah
L	di-dah-di-dit	4	di-di-di-di-dah
M	dah-dah	5	di-di-di-di-dit
N	dah-dit	6	dah-di-di-di-dit
O	dah-dah-dah	7	dah-dah-di-di-dit
P	di-dah-dah-dit	8	dah-dah-dah-di-dit
Q	dah-dah-di-dah	9	dah-dah-dah-dah-dit
R	di-dah-dit	0	dah-dah-dah-dah-dah

Punctuation

Frequently employed in Amateur Radio

Question Mark	di-di-dah-dah-di-dit
Full Stop	di-dah-di-dah-di-dah
Comma*	dah-dah-di-di-dah-dah

*Often used to indicate exclamation mark.

Procedure Signals

Stroke	dah-di-di-dah-dit
Break sign (=)	dah-di-di-di-dah
End of Message (+ or $\overline{AR}$)	di-dah-di-dah-dit
End of Work ($\overline{SK}$)	di-di-di-dah-di-dah
Wait ($\overline{AS}$)	di-dah-di-di-dit
Preliminary call ($\overline{CT}$)	dah-di-dah-di-dah
Error	di-di-di-di-di-di-di-dit
Invitation to transmit (K)	dah-di-dah
KN	dah-di-dah-dah-dit

* * *

One dah should be equal to three di's (dit's).
The space between parts of the same letter should be equal to one di (dit).
The space between two letters should be equal to three di (dit's).
The space between two words should be equal to from five to seven di's (dit's).

Fig. 15. Sound equivalents of the Morse Code for letters, numbers, punctuation and procedure signals.

MODULATION

With a working knowledge of dc and ac circuits, signal waveforms, circuit construction, a few basic components and proper use of the multimeter, it is now quite realistic for us to tackle a more ambitious experiment. This time, then, the aim is to build an entire system for sending signals by amplitude modulation and, with a few changes, by frequency modulation. In building this system you will develop expertise in mechanical construction, use some new components, and at the same time gain direct practical experience with dc and ac signals.

To some, the project may appear formidable but, remember, even the most complicated systems break down into familiar sub-system black-boxes which are each made up of basic components in basic circuits.

This particular project will be in several stages adding more on each month.

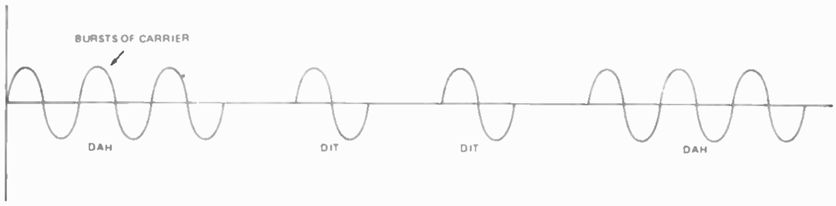

Fig. 16. Morse code sent by radio, travels as bursts of carrier signal. Here is the amplitude-time graph of the letter X.

ELECTRONICS-in practice

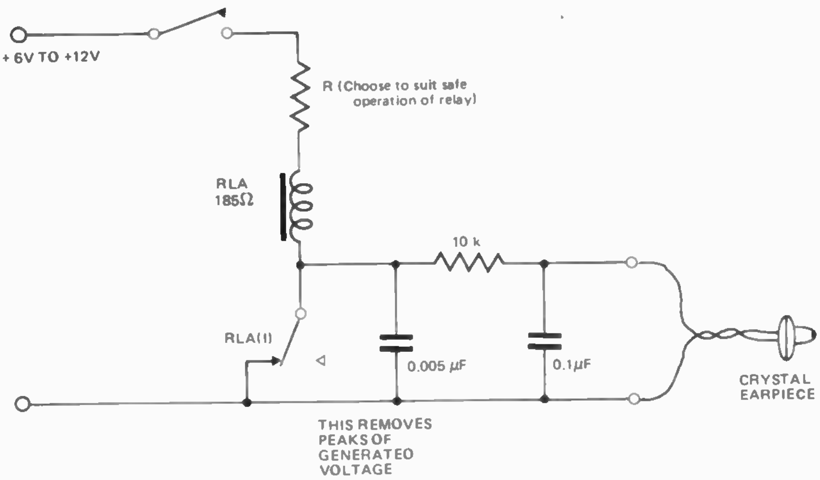

Fig. 17. A simple code practice circuit. The relay acts as a buzzer providing high-voltage ac signals in the earpiece.

SYSTEMS USING AM AND FM TRANSMISSION

To send multiple channels of analogue signal information (that is, the continuously varying kind which can have all values between certain limits) over a common line we have seen that we need to generate an ac carrier signal and then modulate this in some way adding the original signal frequencies to the carrier. The combined signal is then fed into the common transmission line and sent to the receiving terminal where the modulated signal is demodulated in order to recover the original data.

The system diagram, given in Fig. 18, portrays this procedure for AM working. A power supply provides dc energy to a 'box' that uses this power to produce a steady dc signal having constant amplitude and frequency: (the carrier). The amplitude of the carrier is modulated, the basic frequency remaining the same, before being fed to the transmission line. This set of input equipment is repeated for each channel to be sent but with each carrier different from the others. Only one input is shown in detail. Upon receipt at the receiving end the varying amplitude of the carrier is used to produce a dc voltage that is proportional to the amplitude of the input signal at the sending end.

The FM system looks somewhat similar — see Fig. 19. The differences are that the modulating input is now derived by altering the frequency of the carrier, leaving its amplitude constant. Demodulation, in this case, (methods vary considerably) is achieved by deriving pulses of uniform amplitude and width (constant energy, therefore) and with one being generated for each cycle of carrier signal. These are smoothed by an averaging circuit. The more pulses received in a given time the higher the average signal level, hence a varying frequency signal produces a varying demodulated output. In this way the dc output at the receiving end is proportional to the dc input that is modulating the carrier at the sending end.

When we get to building the complete FM stage (in the next part) we will also add a dc channel to the transmission wire to demonstrate how both the light circuit (shown in Fig. 19) and the data circuit will operate over the same line at the same time without interfering with each other. Thus we will clearly demonstrate the concept of frequency multiplexing wherein signal channels are 'stacked'.

This month we detail how to build the generator and modulating devices. In the next article in this series the rest of the two systems will be described. These have been designed to use the components already specified in this course plus a few inexpensive additional parts which, in turn, will find use again as the basis of other circuits later on.

THE LOW-FREQUENCY AC WAVEFORM GENERATOR

In normal transmission systems the carrier frequency signal varies with time at a rate faster than the eye can follow — telephony over open wire trunk lines, for example, operates at kilohertz frequencies; telephony over microwave links is at hundreds of megahertz. Consequently if we attempted to build even the first type of system little could be learnt unless you had an oscilloscope at your disposal to look at the waveforms at various places in the system. To overcome this problem the exercise project described here has been designed to operate with a carrier-frequency of around 1 Hz or less, enabling most of the waveforms to be studied by observing the movements of the pointer on a multimeter. The real system works in a similar manner — but at a far faster rate.

The generator is not made entirely from electronic components but uses mechanical motion cyclically to vary the light intensity falling on a light-dependant-resistor (LDR). The schematic diagram is given in Fig.20.

This method gives us a good opportunity to build a composite device in which mechanical, optical and electronic parts are involved. Many sophisticated instruments use all three disciplines together like this.

The 6 Vdc motor (see Fig.21) is of the type found in cheap electrically driven toys or in model trains. Using a

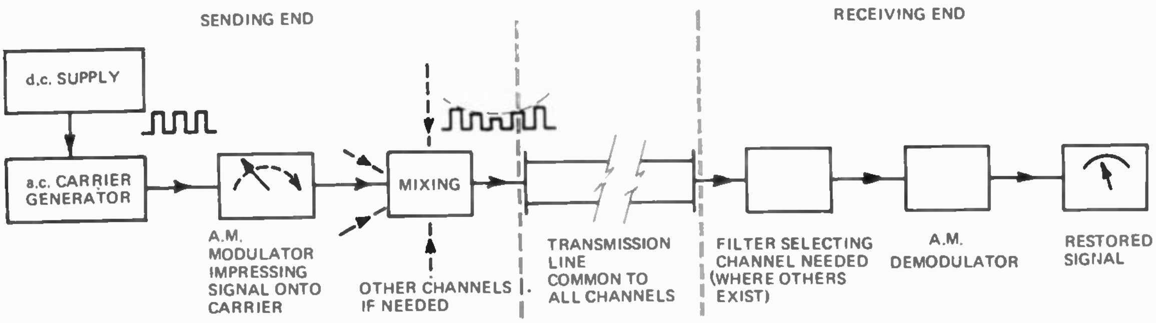

Fig. 18. Block schematic of pulse amplitude modulated communication link.

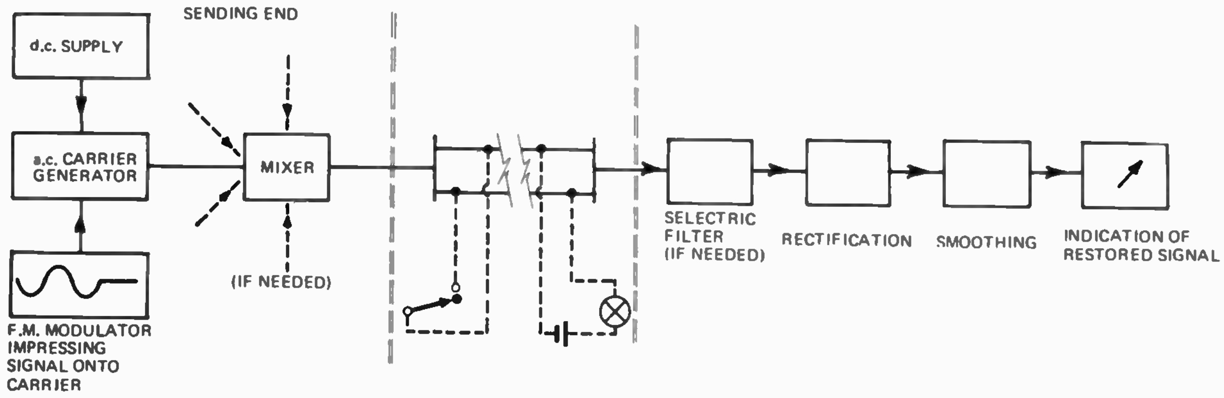

Fig. 19. Block schematic of a pulse frequency modulated link.

rubber band as a belt and a large wheel, the output shaft speed is reduced to rotate at around 10 revs. per second maximum.

Very little precision is needed in the construction — it consists of bent pieces of aluminium or brass strip, tag strips and a suitable wheel. We made the prototype in less than three hours using only elementary hand-tools.

Almost any dc motor will do provided its operating voltage suits the power supply. A resistor can be added in series with smaller voltage motors in order to drop the maximum value applied to the motor.

If you have finished the unregulated power-supply described last month this can be used along with a series dropping resistor.

Pushed onto the shaft is a disk of opaque material (plastic sheet or thick card) cut as shown. This shutters the LDR from the light source as it rotates.

The shape shown will produce square-waves and is usually called a chopper disk. It is the easiest to make. We leave it to you to design other shapes for producing, say, sinewaves, sawtooths, or pulses of higher frequency than the rotational speed of the shaft. (If you drill about 50 holes around the disk and run it at say 10 rps it will generate a 600 Hz signal — this will easily power a loudspeaker, producing a constant tone). The circuits given are designed for use with square-waves.

The speed of the motor, and hence the *frequency* of the signal, is varied by varying the voltage to the motor. Note how the variable resistor is used here as a "potentiometer" giving an output voltage between the wiper and one end which varies smoothly from 0 – 6 V.

The LDR has a 150 Ω resistor in series with it; this enables a voltage swing to be obtained as the light intensity changes — a practical example of how resistors enable voltages to be produced as needed.

By redrawing the LDR and resistor circuit you will see that they form a kind of potentiometer with the mid-point acting as the wiper connection. Ohms law explains why the voltage varies as the LDR changes resistance.

The output of this low-frequency generator is taken from the leads of the LDR and this, in turn, feeds a second potentiometer. By varying the potentiometer the *amplitude* of the carrier is altered from zero to the maximum available (*approximately*) 5V. Hence position of its shaft decides the level of the AM carrier — it is, therefore, our AM modulating signal input. (Although we use a mechanical potentiometer here, the unit could be replaced with, say an LDR and resistor which would enable us to modulate the carrier with the varying intensity of a light input). This potentiometer forms the AM modulating block shown in Fig.18.

If we leave the AM control set to maximum, variations in motor speed will produce frequency modulation of the carrier. The motor speed potentiometer is, therefore, a kind of FM modulator — the FM modulator box shown in Fig.19. As we are using square waves the two cases are more correctly called pulse amplitude modulation (PAM) and pulse frequency modulation (PFM). The working concept remains the same if the chopper disk is cut to produce sine waves.

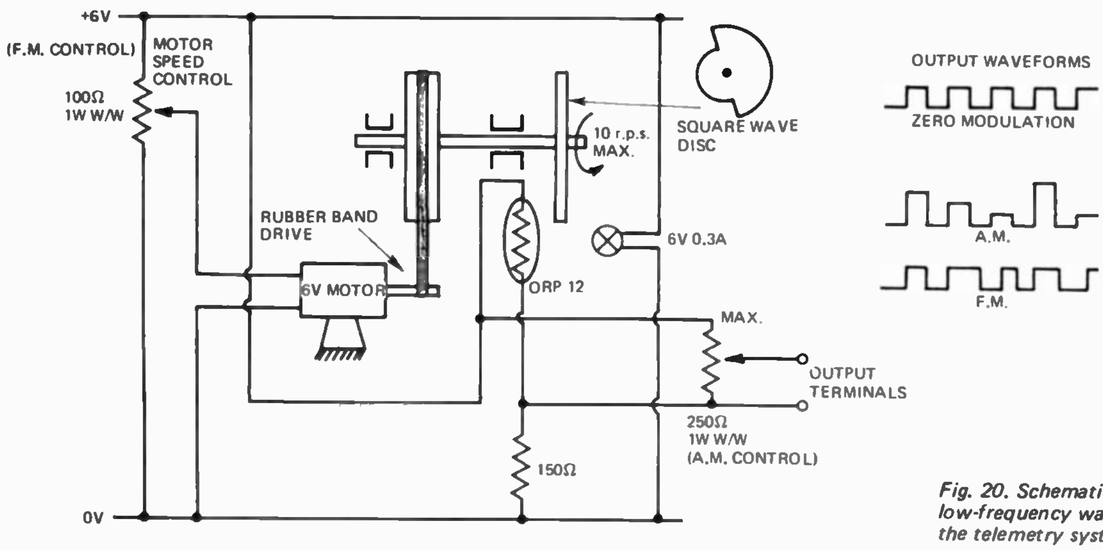

Fig. 20. Schematic layout of the mechanical low-frequency waveform generator used in the telemetry systems discussed.

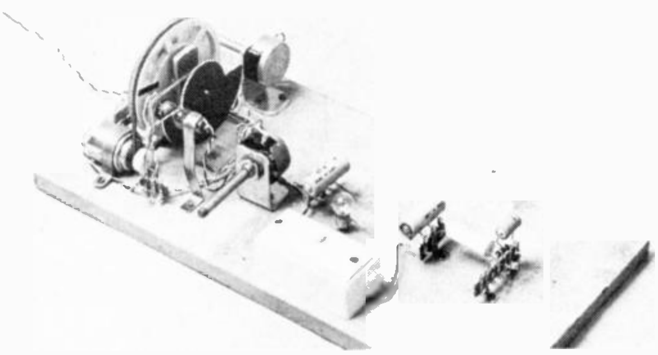

Fig. 21. The generator is simple to build and uses commonly available components.

TESTING THE SYSTEM

Little can go wrong with the generator, the only problem arising might be overheating. If in doubt use your multimeter to check currents, voltages and resistances and from these calculate the watts dissipated ($W = I^2R = EI = E^2/R$). The LDR must not be made to dissipate more than 150 mW. The motors and potentiometers are robust in the sense that they will heat slowly with little risk of rapid burnout. All components in this experiment are robust so there is little chance of failure. Later when we reach a level of using transistors and the like, things are very different. Try to develop a careful approach — "think first — connect the power last" when you are completely satisfied that the design is within safe limits. Once you have the unit running connect the multimeter (set to dc volts) to the output terminals. If the generator is turning at about 1-2 seconds per revolution the meter movement will follow the waveform closely. Next, study the effect on the output of variations in the AM and the FM modulation controls. Note particularly that when the frequency is varied the amplitude remains constant and vice versa.

Most meter units are damped to respond to a full-scale swing in about 1-2 seconds. Consequently waveform frequencies higher than 1 Hz will tend to be averaged — the meter acts as a smoothing energy store. The degree of smoothing increases as the frequency rises.

It will be seen that the ac waveform switches between 0V and +V and is, therefore, not a true ac signal. It 'sits' on a dc level of 0V.

It is possible to observe the frequency changes by listening to the pull-in "clicks" of a relay placed across the output terminals. A lamp circuit can be wired across the relay contacts to enable you to see the varying frequency more clearly than with the multimeter. (The relay specified for previous exercises is satisfactory).

In the next part we will assume the generator is working. We will then add on a dummy transmission line and demodulation circuits for each case. It would be wise to build the generator on one end of a board leaving as much room again for the remainder of the exercise.

YOUR LIBRARY

Much can be learned about components, terminology and parts availability if you have a few of the inexpensive up-to-date catalogues listing electronic equipment. The following are worth having in your collection:

Dick Smith — Electronics Catalogue
Kit-Sets Australia Catalogue
M.S. Components Catalogue
Radio Spares Catalogue (extensive, but not always available). ●

no gimmicky sales talk. just the facts.

- High-precision, polished uniform thickness POLYURETHANE BELT provides smooth revolution with minimized wow-flutter (less than 0.175) and high s/n ratio (better than 48dB).
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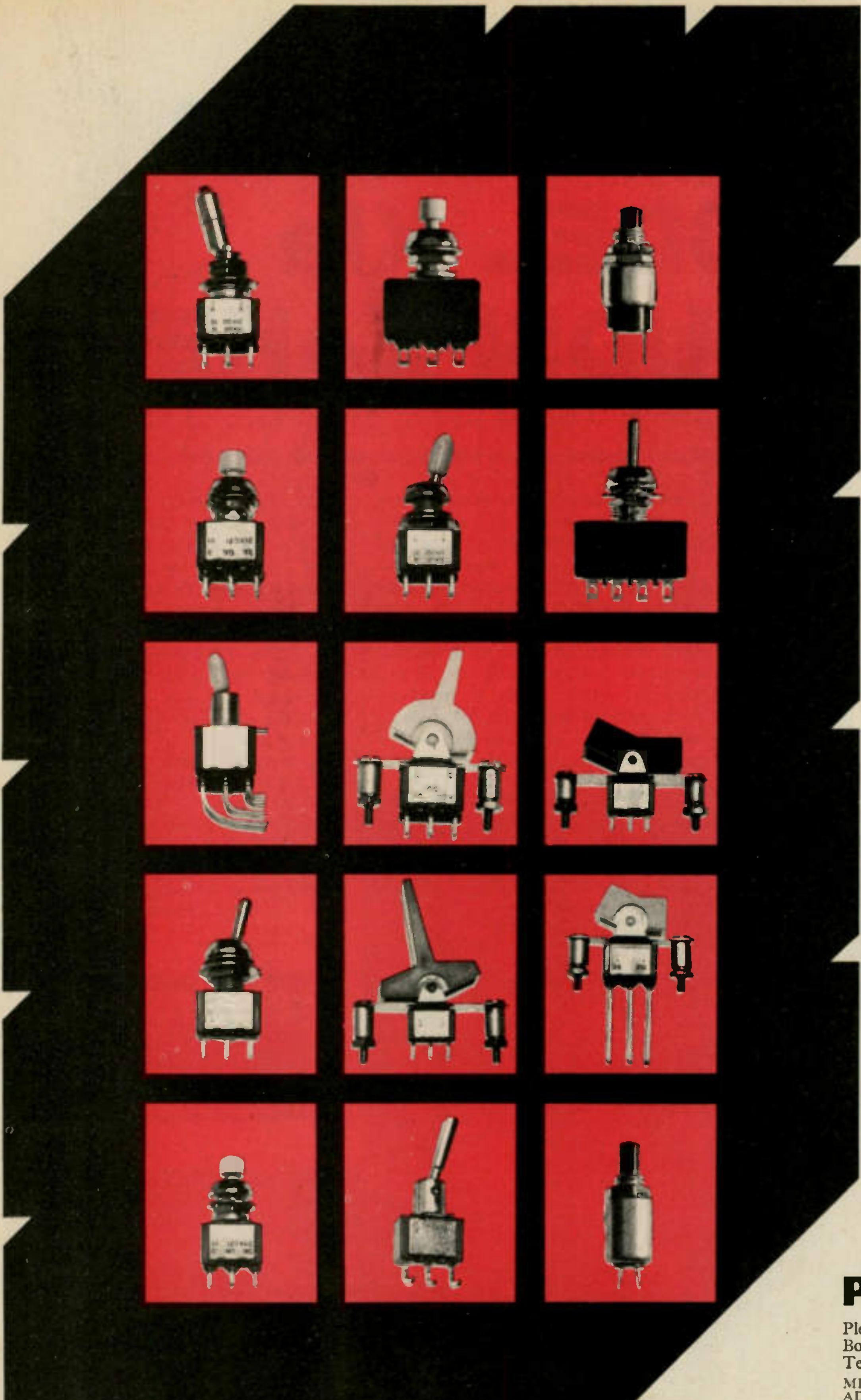
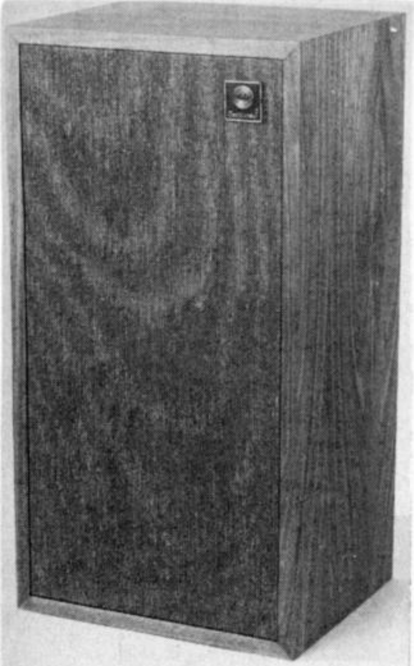




Recommended retail price $122.

RECTILINEAR MODEL XIa LOUDSPEAKERS

Low-price bookshelf speakers from Rectilinear use bass-reflex design.

IN producing the X1a loudspeakers, Rectilinear's aim was to produce budget-priced bookshelf units combining flat frequency response, low distortion, and the utmost simplicity in design in order to keep cost to a minimum.

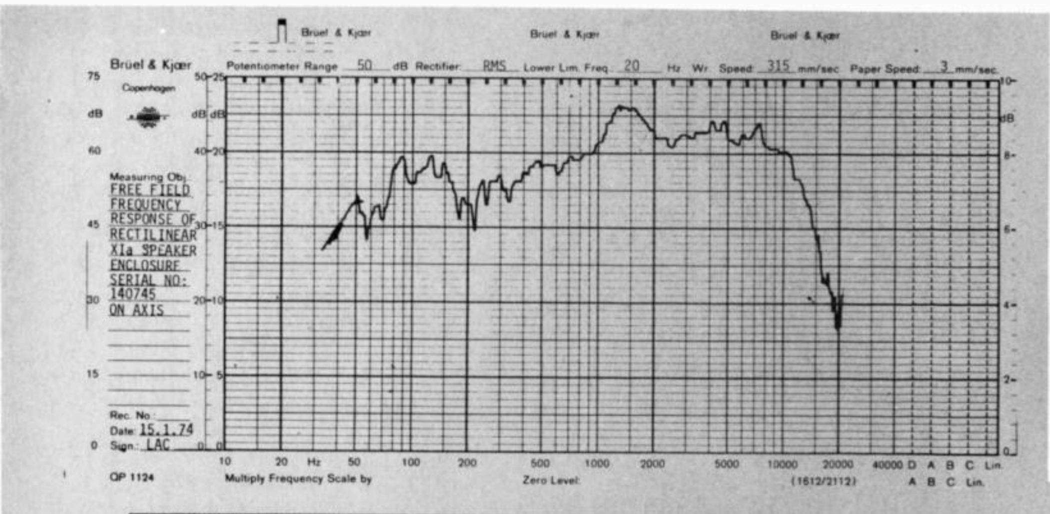
The designers have stated that they have placed particular emphasis on achieving high efficiency without loss of bass response, as well as relatively constant impedance right across the audible spectrum.

These characteristics were considered necessary in order to make the speakers compatible with moderate to low powered radio receivers and amplifiers, for equipment of this type seldom operates satisfactorily with speakers having non-linear impedance.

The Rectilinear XIa is a vented enclosure system using a 25 cm. diameter woofer with a butylized cloth surround and a long throw voice coil. Porting is achieved by a cardboard tube, mounted from the face of the cabinet. The length and diameter has been correctly chosen to provide optimum results.

In order to provide a suitable extended range the woofer voice coil is of large diameter (3.8 cm). This provides a high efficiency response up to 1 kHz. In addition the magnetic path has been made particularly long in order to give good electrical damping and low distortion at high output levels.

Because the upper frequency range of the woofer drops off smoothly at the top end due to its own mechanical impedance characteristics, the Rectilinear Research Corporation have done what all other manufacturers do under similar circumstances. That is to use a simple cross-over network to



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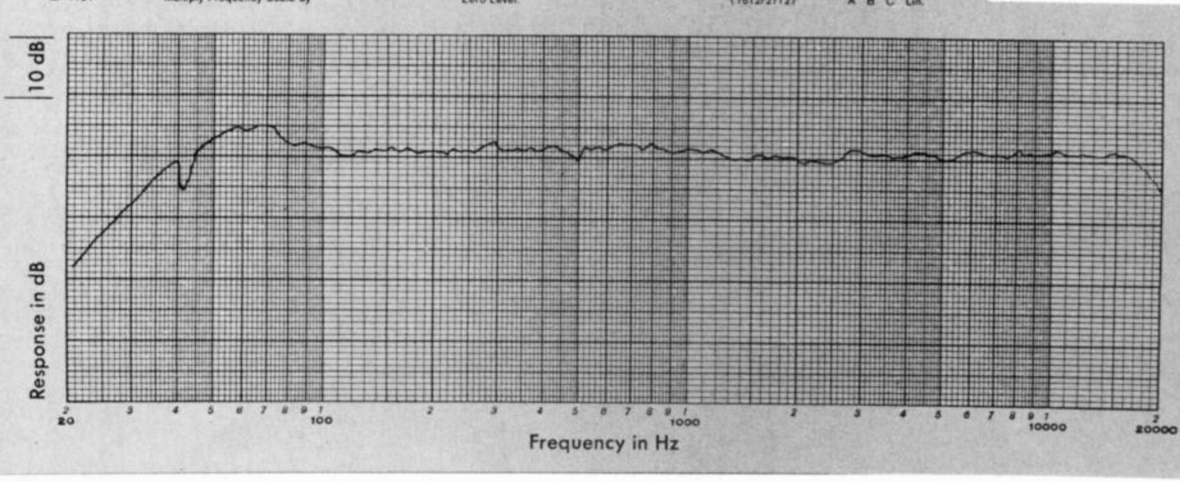


Frequency response graph supplied by Rectilinear.

drive the tweeter (a 8.9 cm unit covering the range from 1 kHz-18 kHz).

This cross-over network consists of a series capacitor and a parallel inductor constituting a quarter-section network with an electrical insertion loss of 6 dB per octave for both the low frequency driver and the tweeter. By making use of the natural attenuation of both the low frequency driver and the high frequency driver an 18 dB per octave actual roll off is claimed, beyond the actual cut off frequency.

In addition, a potentiometer control is fitted next to the speaker terminals on the rear of the enclosure to provide optional broad-band tweeter sensitivity reduction when this is required.

The tweeter voice coil is 1.4 cm diameter and the diaphragm utilises a special light weight cone to extend the output up to the top end of the spectrum. However, whilst the top end of the spectrum is good, the mid band is too uneven and adversely affects results.

The cabinets of the XIa speakers are beautifully finished. They have a veneer of almost perfect oiled walnut using 1.6 cm. thick particle core stock with heavily damped walls and an internal damping of fibreglass (which is very effective). The grill cloth is plain, and unpretentious. An optional plastic fretwork is available at additional cost.

Although the XIa's are billed as bookshelf speakers we feel that the dimensions 58.5 x 31.4 x 26.6 cm. deep are bigger than most book shelves can cope with.

Bass reflex design is used in order to achieve the high efficiency that is claimed (and realized), but unfortunately at the expense of overall linearity in the critical region between 50 Hz and 200 Hz. Our frequency measurements showed that the response is particularly peaky, with 10 dB peaks at 90 Hz and two nulls at 58 Hz and 220 Hz.

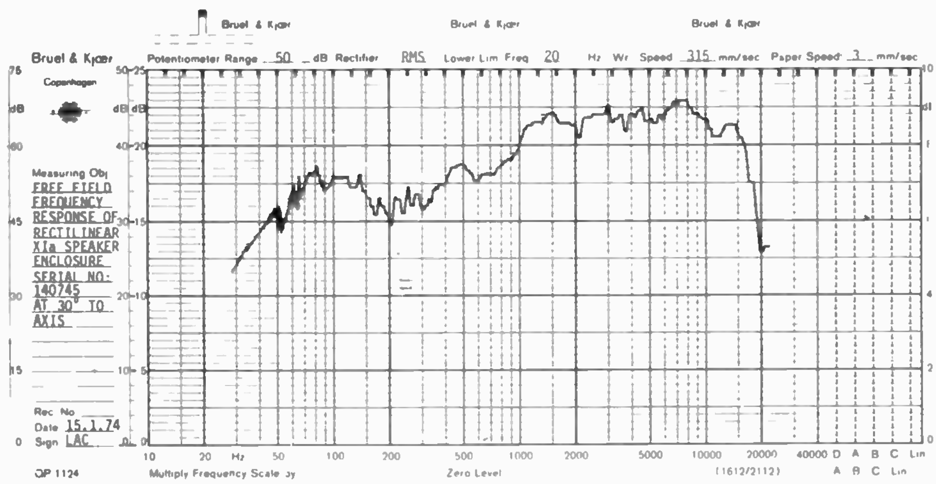
The overall free field performance of the units tested in our laboratory was not nearly as flat as claimed by the manufacturers. The rising response immediately above cross-over frequency was indicative of inadequate balance between the acoustical sensitivities of the woofer and tweeter. This resulted in an effective 10 dB level difference between the two speakers.

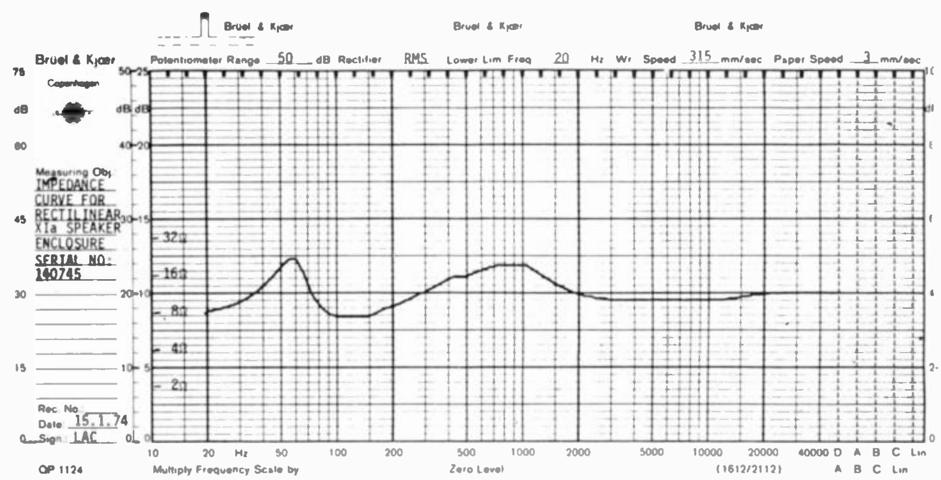
This lack of balance showed itself up very clearly during subjective evaluations where the speakers performed badly both on choral works and straight voice. We tried out a wide selection of records, but on each occasion the results were basically the same with the differential rise between tweeter and woofer dominating the audible response. Using the tweeter control at the rear of the enclosure, improved the situation a little but did not completely overcome the problem. This is basically one of correctly controlling and matching the sensitivities of the woofer and tweeter during assembly.

The impedance characteristics of the unit are reasonably flat, if anything, they are better than indicated in the manufacturer's literature. This results in a quite acceptable impedance curve.

RECTILINEAR
SPEAKER MODEL XIa – SERIAL NO: 140745

Frequency Response on axis	60 Hz to 14 kHz $^{+6}_{-10}$ dB	
Frequency Response 30° to axis	55 Hz to 18 kHz $^{+6}_{-10}$ dB	
	Frequency	Distortion
Total Harmonic Distortion for 90 dB at 2 metres on axis	40 Hz	10%
	63 Hz	2%
	80 Hz	1.1%
	125 Hz	1.1%
	250 Hx	1.1%
	500 Hz	0.6%
Sensitivity for 90 dB at 2 metres on axis	1 watt	
Woofer Resonance	56 Hz	
Measured Impedance	see curve	
Dimensions	585 mm. high 314 mm wide 266 mm deep	





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

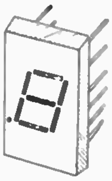
Set of 5 boards and sockets with data and applications $7.95

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).

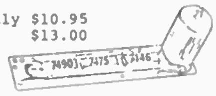
A 7490 decade counter IC is used to give typical count rates of up to thirty MHz. A 7475 is used to store the BCD information during the counting period to ensure a non-blinking display. Stored BCD data from the 7475 is decoded using a 7447 seven-segment decoder driver. The 7447 accomplishes blanking 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

Board 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 4 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.

RECTILINEAR MODEL XIa LOUDSPEAKERS

The distortion characteristics of the XIa are particularly good. With an input power of 1.2 watts, the distortion above 80 Hz is less than 1% and only in the region of 40 Hz to 70 Hz does it rise to 10% and 1% respectively. This is the critical distortion region for these speakers but as there are few records with high output in the region of 40 Hz to 60 Hz this is a small penalty to pay for the otherwise low distortion characteristics of the speaker system at normal signal levels. Distortion above 4 watts increases markedly, and whilst the speakers have a 10 watt rating this cannot be utilised fully without noticeable distortion.

The efficiency of the XIa speaker is quite acceptable if viewed in terms of the drive required at 1 kHz, i.e. 1.0 watts produces 90 dB at 2 metre on axis. Unfortunately the low frequency performance is not nearly up to the same standard. If the overall performance was comparable with that measured at 1 kHz, this would most probably have been the most efficient bookshelf speaker system that we have seen.

Transient response is very good, and the manufacturer's state that this is the result of the simple cross-over network used in the system. This is probably correct, certainly the overall transient response of the speakers with tone burst signals is far better than we would have expected. In fact it is better than many other more expensive speakers that we have recently evaluated.

Mechanically, the speakers are well made, and good quality components are used throughout. This has enabled Rectilinear to give a five-year parts and labour warranty.

Our overall impression of the XIa speakers is that if the tweeters and woofers were more accurately matched these speakers could be particularly good. But the units tested had a regrettable step response in sensitivity between woofer and tweeter that resulted in a subjectively poor sound that we personally disliked. ●

THE MANUFACTURER COMMENTS

Thank you for your review of our Rectilinear XIa loudspeaker system. We appreciate your fairness.

One small point however should be clarified.

The inadequate balance you refer to may be an error on our part. All speaker testing should be done with the tweeter control in the 'normal' position. We should have indicated this. This may account for not only our differences in SPL vs Frequency response, but also for our different impedance curves. The control was designed to aid in compensating for the deleterious effect of the optional fretwork grill — on upper frequencies.

Your comments regarding the low distortion, the very good transient response, efficiency and cabinet work are greatly appreciated.

We enjoy your magazine and find your reviews stimulating and impartial.

Very truly yours,
Stanley Grossman,
President,
Rectilinear Research Corporation.

SENSORS ON by Talus

Fantasy to fact!

SOME years ago a man from Associated Electrical Industries (AEI) in Britain wrote in their house magazine that 'fantasy is the name we give to achievements we cannot comprehend, and fantasy reduces to fact as our knowledge approaches that needed to understand the processes involved.'

Jules Verne wrote of rockets to the Moon, submarines under the oceans and voyages around the world at a time when each was a science fiction subject. Few people today would look at these achievements as fantasy!

Our knowledge of the world around us grows in a manner that can be compared with the growth of a spot of mould . . . a basic fact leads to more facts and these, in turn, lead to others producing a rapidly expanding system which keeps on growing at an ever increasing rate as long as the system is fed.

The expansion of knowledge at the limits of this growth is largely due to the people we call specialists . . . those who study subjects in depth, often with little idea of how their work relates to the whole.

Specialists are invaluable, but if we had only specialists we would soon run into chaos.

Fortunately for us there is another type of person . . . the so-called 'generalist'. His or her role is to sift through the specialists' contributions, picking out previously unrealised basic facts and presenting them in a more efficient educational form . . . the new course, the book, the popular magazine, the lecture, etc. We could say their role in life is to simplify the work of specialists, bringing out the dominant contributions and representing them in a co-ordinated way that is easy to comprehend by the non-specialist.

It is not always possible to identify a person as one or the other. Many people act in both capacities at one time or the other. There is also a very large group of people who are neither . . . they are the spectators of life who merely look-on at those who make advances with an automatic mistrust of anything new or different. Even they, however, have a role to play for they provide the reasons that cause the doers to proceed with caution.

Curiously, at least to my way of thinking, there are many people who decry the generalists, regarding them as self-styled 'experts' who know too little about anything to be able to make sound judgments. The specialist, on the other hand, is often placed on a pedestal (perhaps because they cannot be properly understood by the others who, therefore, give them the benefit of the doubt). In sharp contrast to the generalists, the specialist is often allowed to make judgments about problems more general than his experience has covered . . . the pity is that such statements are usually taken as gospel truth by the masses.

For the truth is that there are specialists and specialists and generalists and generalists . . . the worthwhile generalist is really a specialist at sorting information in an executive manner. We should not condemn either out of hand nor should we accept either without caution. In recent times it has been said that man's greatest problem is not knowing about things but what things to know about, thus showing the roles of each type of approach.

In reality then, an originally complicated concept is eventually presented in an uncomplicated way giving it a more general and less limited useage.

Some of the best examples of this process are to be found in the field of electronics. Take radio. In the late 19th century cartoonists mocked suggestions that people could speak to each other through walls and across water without the need for wires. Today virtually everyone on Earth has seen a radio set. Fantasy has changed to common everyday fact!

Numerous other examples exist. In the 17th century Pascal came close to being burned at the stake for building a simple adding machine. His persecutors said he was working with the Devil for the machine could 'think'. A couple of hundred years later Babbage suffered no such problems as he attempted to get his mechanical calculator to go. Today we are now at the point where school-children will soon be using solid-state calculators as routinely as their fathers used a book of tables and the slide-rule. We still marvel at the achievements made in calculator technology, but that will soon wear off as familiarity removes the last shreds of fantasy from another aspect of advancement.

One wonders what will be the next fantasy to crumble. Evidence is pouring in that suggests we must regard mental telepathy and other psychic phenomena a fact rather than fantasy. One person, at least, seems able to bend and break table-forks by thinking about it. A group working (in Russia) on the recent disappearance of two children in Adelaide has produced amazing facts about places and things situated in Adelaide — without any of the group having ever been in Australia.

Eventually the basic facts will emerge.

They will turn out to be simple in concept for that is the way of knowledge. If they are not simplified they will remain in the realm of fantasy understood by a few and barred from acceptance by the many. ●

jensen

MODEL 2 gives you 2 WAY RELIEF

Here's good news for Hi-Fi buffs!!

Jensen Model 2 — It's an outstanding 2 way speaker system, with a whole lot more performance, features and value.

1. PERFORMANCE: You get one each of Jensen's famous woofers and tweeters. A 8" woofer and a superb 3½" direct radiating tweeter.

2. FEATURES: We use the Flexair suspension system for clarity. A unique crossover for tonal blend. A handsome vinyl covered cabinet. And the best 5 year warranty.

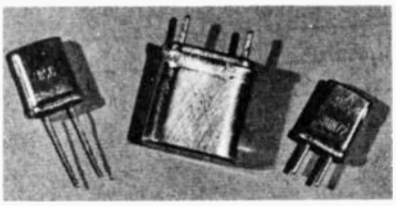
3. VALUE: Total Energy Response design: Jensen's exclusive fuller richer sound. It's the difference you hear when you compare.

$169 per pair

* *SEE YOUR AUDIO DEALER TODAY THEN TAKE TWO JENSEN MODEL 2 SPEAKER SYSTEMS AS DIRECTED YOU'LL FEEL BETTER FAST!!*

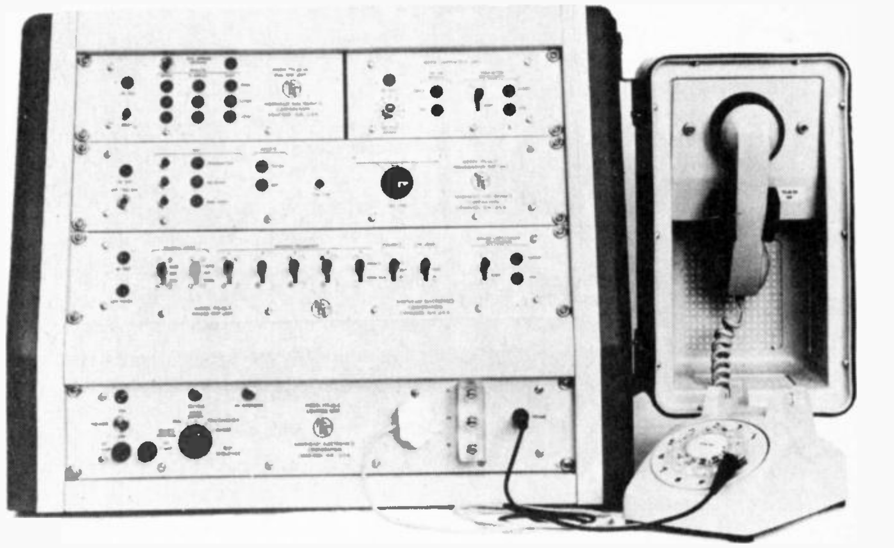
jensen

AUSTRALIAN DISTRIBUTORS:
B.J.D. Electronics Pty. Ltd., 190 Willoughby Road, Crows Nest, 2065 N.S.W. Ph. 439-4201
202 Pelham St., Carlton, 3053 Vic. Ph. 347-8255



EQUIPMENT

SPECIALISED TEST AND MEASURING INSTRUMENTS



Specialised test and measuring instruments manufactured in the U.S.A. by Northeast Electronics Corporation will be marketed by Amalgamated Wireless (Australasia) Ltd.

Northeast Electronics Corporation are major suppliers of instruments to the American telephone industry and their range includes discrete test sets for transmission, level and noise measurement, service analysers, impulse noise counters and signalling test sets.

Testing of data channels and PCM systems are catered for by specialist devices. Fully automatic transmission measurements can be made using centralised access and test systems either computer or card controlled.

A cross licensing, manufacturing agreement has also been negotiated with National Electronics Corporation which includes a free-flowing exchange of engineering expertise and know-how.

Further details from: Amalgamated Wireless (Australasia) Ltd., Engineering Products Division, 422 Lane Cove Road, North Ryde. 2113.

SUPER-REGULATED, HIGH VOLTAGE SUPPLIES

The new Spellman SRM Series of high voltage supplies are super-regulated to 10 ppm (0.001%) line, load and ripple. All models operate from a 28 V dc input. A full range of models from 1.5 kV to 30 kV output, adjustable from zero to full working voltage make these units attractive for many applications. Electron microscopes, lasers, precision P.M. tubes and C.R.Ts, X-ray equipment, electron beam analysers, beam steering are but a few of the applications.

Conversion efficiency is 75% and the unit employs an hf oscillator circuit to enable low ripple to be achieved with small, low storage energy capacitors.

A big feature of the SRM series is the method of construction. Each sub-assembly is pluggable. This permits a quick breakdown of the unit to individual sub-assembly level.

Further details from: ANAC Pty Ltd, P.O. Box 102, Sutherland NSW 2332.

FOR CIRCUIT DESIGNERS

The Arlunya Model PS.101 Power Supply is specifically designed to provide the commonly-used fixed rail voltages required by analogue and digital circuit designers during "bread board" and prototype development. It offers four floating outputs, two of which are switch selectable from 12 to 15 volts, the other two switch selectable from 5 to 6 volts with 1 A simultaneously available from each output.

The four outputs may be operated in series in any combination giving a maximum voltage of 42 V with 1 amp capacity.

A commonly used combination would be one output ±15 V another at 5 V for TTL circuits whilst the other 5 V output is usefully employed for a logic probe ensuring complete isolation from probe to circuit under test.

Further details from: Arlunya Pty. Ltd., P.O. Box 113, Balwyn, Vic. 3103.

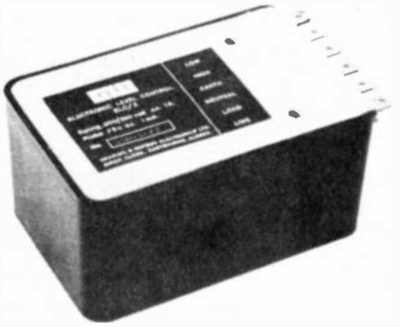
DIGITAL VOM FOR PRODUCTION-LINE USES

The Simpson Model 360 digital volt-ohm-milliammeter, intended primarily for field use, has a 0.84 cm, 3½-digit nonblinking light-emitting-diode display that can be read at 5 metres in daylight.

The instrument includes automatic polarity-selection, a current range to 10 amperes, power from nickel cadmium batteries or ac, and automatic flashing overrange indication, linear to 250 counts beyond maximum. The Model 360 is also equipped with an analogue indicator for scanning nulls and peaks, as well as a front-panel analogue-output jack for interface to other instruments. The 2 kg pound unit includes 29 popular ranges measuring ac/dc voltage, current and resistance, including two "low-power-ohms" ranges at 200 ohms and 2 kilohms.

Further details from: Tecnico Electronics, Premier Street, Marrickville, N.S.W.

LIQUID LEVEL CONTROL



An electronic level detector suitable for controlling the level of liquids where the conductivity varies with level, such as water, milk sewage, etc, has been developed by Gearing and Watson (Electronics) Ltd.

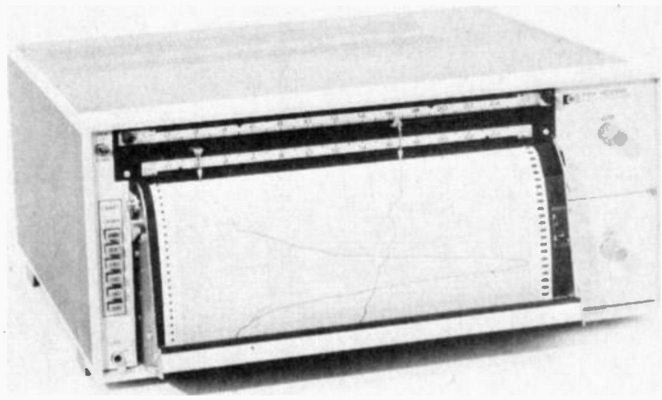
Two level probes may be used so that the level is controlled between the probes; for example a container may be filled to the upper level probe but the level may fall to the lower probe before the control operates to restore the level to the upper probe again. The unit is designed for 'Fill' applications and is available with a reverse action.

The level comparator is an integrated circuit while the load switch is a 'triac' – eliminating contact maintenance. The unit is encapsulated for protection and can operate in high ambient temperatures.

Further details from: British Merchandising Pty Limited, 49 York Street, Sydney.

EQUIPMENT NEWS

STRIP-CHART RECORDERS FOR OEM USE



Designed to allow a user to choose spans, speeds and other options to meet his specific requirements, two new OEM strip-chart recorders offer versatility at reasonable cost.

These single-span 10-inch (25 cm) recorders, the Hewlett-Packard Model 7130A/B (two-pen) and the Model 713A/B (one-pen), can be ordered with one of six available chart speeds from 6 inches (15.2 cm) per minute to 1 inch (2.54 cm) per hour. An option is available with four or eight speeds plus an external input, selected by front-panel push-buttons. Both 50 Hz and 60 Hz mains frequency versions are available.

Easy servicing, important to the OEM, is a feature of the new Models 7130A/B and 7131A/B. Minimum down time is assured by modular construction and plug-in printed-circuit boards. For example, the entire servo-pen assembly can be pulled out of the front of the instrument after removing only two screws.

No clutches or gears are used in the servo system. Instead the pens are driven by a plastic belt. In addition to greater reliability, this simple mechanism operates more quietly than most conventional servo systems. Built-in electronic limiting prevents damage should the pen be driven off scale.

One of six input spans, from 1 mV to 100 V on each channel, can be specified. Input is single-ended and floating, with 1 megohm resistance on all spans.

The chart paper has a 10-inch (25 cm) writing width. It feeds from the top to the bottom over a platen that can be tilted at one of three angles. This facilitates both viewing and chart notations.

There is no restriction on allowable source resistance. Normal mode rejection at mains frequency is more than 40 dB while common mode rejection is more than 120 dB at dc and more than 90 dB at mains frequency. Response time is less than 0.5 sec, overshoot is less than 2% of full scale, accuracy is ±0.2% of full scale and linearity is ±0.1% of full scale. The left hand zero is standard and adjustable ±1 full scale. A right hand soft or hard zero is available as an option at no charge.

Additional options include remote controls for chart speed change, chart on-off, pen lift and event markers, retransmitting potentiometer; limit switches, rack slides and mounting brackets and a rear control connector.

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

VERSATILE INFRA-RED GAUGES

By utilising techniques pioneered in infra-red astronomical observations, a British firm (Infrared Engineering Ltd) has developed a range of gauges for on-line industrial measurements in a wide variety of applications and conditions.

Infra-red absorption and reflection measurements are used to compute the concentration, weight or thickness of individual substances. Very small signals can be translated into useful industrial measurements and the instruments are insensitive to ambient light, heat and vibration.

Gauges can easily be integrated into existing production lines since the sensing head need not be closer than 8-10 in. (205-255 mm) to the material being measured.

The manutacturers not only supply standard gauges but will design and produce any specific control system to operate from the readings of the infra-red instruments.

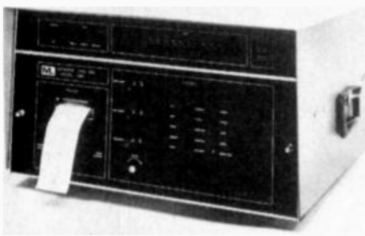
Standard gauges can measure moisture contents from 0.1 per cent to 60 per cent in static or moving paper or textile webs, and in foodstuffs and a wide range of organic and non-organic materials. They are particularly useful in ceramic production as, unlike other instruments, they are unaffected by moisture impurity or by compaction of the sample under test.

In plastics processing, standard gauges are used to measure film thickness while custom-built devices can simultaneously gauge the layers making up a laminate. Coating weights of a wide range of materials can be measured including most hot-melt adhesives and solvent-based coatings – often while still wet.

The gauge system with its high optical luminosity and powerful signal processing circuits is particularly suitable for 'in situ' gas analysis over open paths as it avoids the problems often associated with normal instrument cells.

Further details from: Tosco P/L, P.O. Box 245, Hawthorn, Vic. 3122.

BATTERY OPERATED FIELD DATA LOGGER



Monitor Laboratories Model 9100 is a small, portable, battery operated data acquisition system. It is suited for field use in environmental, meteorological and geophysical applications.

A crystal time base digital clock provides year, day, hour, minute and second information, plus 90 switch selectable scan interval times from 0.01 sec. to nine days, which is complemented by a wide range of precision scanning speeds for Fourier data analysis.

Using a built in 12 bit A/D converter with preamplifier it can scan up to 64 analogue inputs with system speeds from 1 to 10 000 channels per second, depending upon the method of switching selected, i.e. via relay, FET or CMOS options and the output recorder used. (Continued on page 112)

SCOPE

SOLDERING IRONS

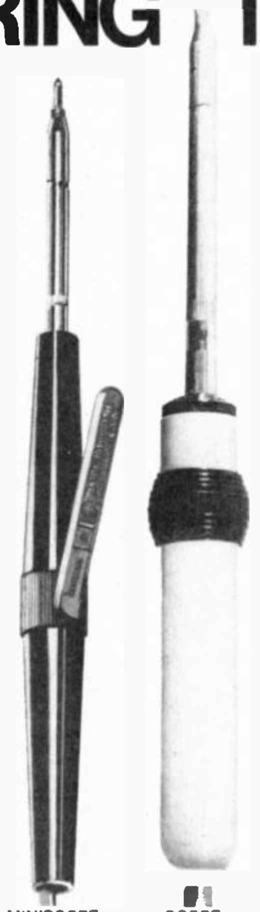
Buy a SCOPE and join the club of satisfied users—you need not keep it a secret, others don't. That's why SCOPE is known at all the best places—in the tool kit, on the bench, in the boot, on the kitchen table, in the garage, on the service truck, in the engine room, even on the roof . . . Wherever SCOPE goes it gives you the best service—and a host of satisfied users will agree *it is the FASTEST, the EASIEST, the SAFEST . . . THE BEST.*

ECONOMICAL
Consumes current only whilst in use. Scope performs all the functions of other irons from 40 to 150 Watts. (Miniscope—up to 75 Watts).

FAST
Fast heating due to the unique replaceable carbon element. Only 5 to 6 seconds' initial heating up time from cold, then practically instantaneous.

VERSATILE
Copes with all soldering jobs—from miniature components to large solder lugs. Temperature control at your finger tips. Heat only when, where and as much as needed.

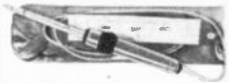
SAFE
Low voltage operation. Scope irons operate from 2.5V to 6V.
For your complete protection and the satisfactory operation of your Scope iron, demand and use THE ***natronic*** TRANSFORMER which incorporates a specially designed ELECTROSTATIC SHIELD.
It is the only transformer approved by SCOPE Laboratories.



MINISCOPE SCOPE

SPARE PARTS
No expensive resistance wire heating elements to replace. Maintenance without special tools. Spare tips, carbon elements and other parts readily available from your Scope Distributor.
Scope products are available from all major electrical wholesalers and Hardware Stores throughout Australia and from H. W. Clarke, Wellington and Auckland, New Zealand.

The Scope is yours to have and to maintain easily. It's an Australian made.



CONVENIENT
Ideal for those almost inaccessible spots. No burning of adjacent insulation.

LIGHT WEIGHT
Scope weighs only 3½ oz.
Miniscope 1¾ oz.

All irons are supplied complete with a spare tip and two elements.
Modern two-tone styling, together with a strong stainless steel barrel is a feature of the De-Luxe Iron, which comes in a handy re-usable plastic pouch. The Standard economy version, with black handle and mild steel barrel, is supplied in a cardboard fibre pack.

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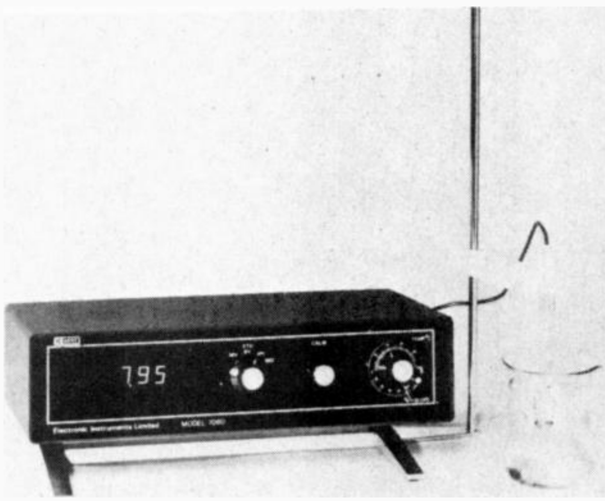
EQUIPMENT NEWS

In addition, digital data inputs are available as well as warm up outputs to turn on external sensors prior to a system scan.

A wide range of battery operated peripherals is available for use with this data acquisition system.

Further details from: Arlunya Pty. Ltd., P.O. Box 113, Balwyn, Vic. 3103.

NEW LABORATORY pH/mV INSTRUMENT HAS DIGITAL READOUT



A new laboratory pH and mV instrument has been introduced by Electronic Instruments Limited, the George Kent Group Company specialising in analytical instrumentation.

The new instrument, known as the E.I.L. Model 7060, adds a digital readout instrument to the already extensive E.I.L. 70-Series range. It can be used to measure pH, redox (O.R.P.) and millivolts or can be used with ion-selective electrodes. The pH range of the Model 7060 is from 0.00 to 13.99 pH and the millivolt range is from −1999 to +1999 mV; the automatic sign indication feature of the instrument obviates necessity for polarity switching.

With an input impedance of 10^{13} ohms and a drift less than 100 uV/degrees C, a relative accuracy of better than ±0.01 pH, ±0.1 mV or 0.1% of reading (whichever is greater) can be attained.

The front panel controls include a mode switch for pH, stand-by and relative pH measurements; a calibration (asymmetry potential) control; a temperature compensation adjustment (0 to 100°C) and a slope indicator (80 to 100% Nernst slope). The rear panel controls include isopotential point adjustment (pH 6 to 8 nominal) and a strip chart recorder output span control.

Rear panel connectors include the inputs for the measuring and reference of electrodes as well as a strip chart output strip chart recorder output, a BCD output, an ATC probe input and a Karl Fischer polarising current output (1-10µA).

Further details from: Kent Instruments (Australia) Pty Ltd, 70-78 Box Road, Caringbah, NSW 2229.

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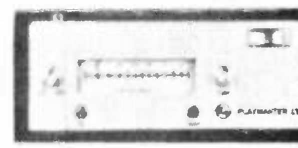

This newly designed high quality solid state broadcast Tuner offers wide band width, high sensitivity, excellent selectivity and S/N ratio. The unit is an excellent hi-fi programme source and is fitted with all necessary control facilities. See Electronics Australia December '72 for details.

SPECIAL KIT PRICE $62.00

Reg. P/Post $2.00, Optional teak cabinet $6.00 (Post 75c)

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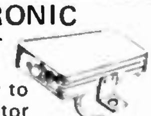

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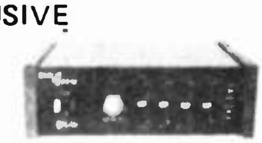

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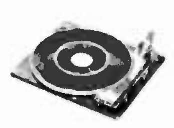

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Woody Herman chose AR-2ax speaker systems for his listening at home. The sound of live music, be it rock or big band, is reproduced accurately on AR equipment.

The accuracy with which AR speaker systems reproduce music serves as a valuable tool for many notable musicians. Among the most notable is Woody Herman, whose big bands have long enjoyed great success. His secret seems to be an ability to stay in tune with the evolution of musical styles, as is documented by the Herd's latest recordings. In spite of a schedule of more than 200 concerts every year, Mr. Herman can sometimes relax in the seclusion of his Hollywood home. Here, he listens to a high fidelity system consisting of an AR receiver, AR turntable with Shure V-15 type II cartridge, and a pair of AR-2ax speaker systems.

The low frequency speaker cone of the AR-2ax uses a newly developed material and process of manufacture which makes its absorption of high frequencies very high, suppressing a form of colouration frequently found in conventional cones its size. The circular suspension ring around the cone is also of a new material, silent and highly stable. The voice coil is a new high temperature design, triple insulated and wound on a former of Du Pont Nomex. The mid range speaker is a small, high dispersion cone type. The high frequency unit is the same miniature hemi-spherical device as is used in the AR5 and AR3a and is the best high frequency speaker we know how to make.

The workmanship and performance in normal use of AR products are guaranteed from the date of purchase; 5 years for speaker systems, 3 years for turntables, 2 years for electronics. These guarantees cover parts, repair labour and freight costs to and from the factory or nearest authorised service station. New packaging if needed is also free.

The AR catalogue and complete technical data on any AR product are available free upon request.

AR-2ax recommended retail price $469

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BOOK REVIEWS

REVIEWER: Brian Chapman

F.M. RADIO SERVICING HANDBOOK 2ND EDITION By Gordon J. King. Published by Newnes-Butterworth 1970. Hard covers, 206 pages 155 x 255 mm. Price $10.

The great FM debate in Australia continues. At present it seems most likely that ultimately we will do the sensible thing and align ourselves with the rest of the world and the 88-108 MHz VHF band, (rather than the previously decided upon, non-standard, UHF system).

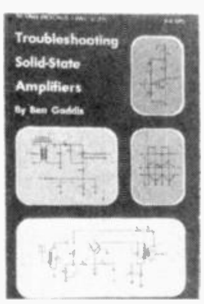
If such is the case, this text book will be most suitable for the technician or experimenter. It describes the FM system, lucidly, from basic principles and with negligible mathematics. The various discrete sections of FM receivers are covered in detail, adequately supported by circuit diagrams of various receivers in common use throughout the world.

FM stereo transmission and reception is also covered in detail and although such a system is not as yet planned in Australia, it undoubtedly will be introduced as soon as possible after the basic FM system is on the way.

A section on the alignment of FM receivers is provided together with one on common faults encountered and servicing methods.

Finally equipment specifications are discussed in glossary form with particular reference to the German DIN 45-500 standard which seeks to establish minimum requirements for hi-fi equipment.

Although the book is a little old, it is doubtful whether there has been one published more recently, that is more suited to the needs of the serviceman. – B.C.



TROUBLE SHOOTING SOLID-STATE AMPLIFIERS by Ben Gaddis. Published by TAB Books 1973. Soft covers, 256 pages 135 x 215 mm. Australian recommended price $6.15.

This is the second in a series of three books designed to cover the entire field of fault-finding in solid state circuitry.

All three books describe the basic theory of the various amplifier circuitry used and then describes methods of determining which component is at fault in any particular circuit.

The book is entirely non-mathematical, even to the extent of not giving, in a lot of cases, typical values and voltages to be found in a certain type of circuit. For example, nowhere in the book does it tell you the typical base-emitter voltages required to turn on either germanium, or silicon transistors. This piece of information is one of the most basic facts in servicing amplifiers, especially those where compound transistor circuitry is encountered.

Coverage of the field is adequate, and explanations are given for all the normally encountered circuits. The book would be adequate for a beginning technician but of little use to anyone wishing to progress to a more proficient level. – B.C.

MINICOMPUTERS FOR ENGINEERS OR SCIENTISTS. By Granino A. Korn. Published by McGraw Hill Book Company. Hard covers, 303 pages 225 x 150 mm. Price $17.75. Available late March.

It is debatable whether historians of the future will (in keeping with the iron/steam age tradition) refer to our era as the 'atomic age' or the 'computer age'.

Most likely 'computer age' will be the term used, for post World War II technology would not have been possible but for the tremendous capability provided by computers. Indeed the development of the atom bomb would not have been possible without the aid of a first generation computer.

Early computers had little computational power, were slow, and were of massive proportions. But their ability to crunch numbers thousands of times faster than any previous means, ensured their rapid acceptance by science and industry.

Development of the computational art has been extremely rapid and, as part of that development, a separate class of machines known as minicomputers has been evolved. These computers, although physically small, are considerably more powerful than first-generation, full-scale computers.

In fact approximately one half of all computers now used in the United States are minicomputers, and as they become ever cheaper and more powerful, they are finding more and more applications in industry as well as science and engineering.

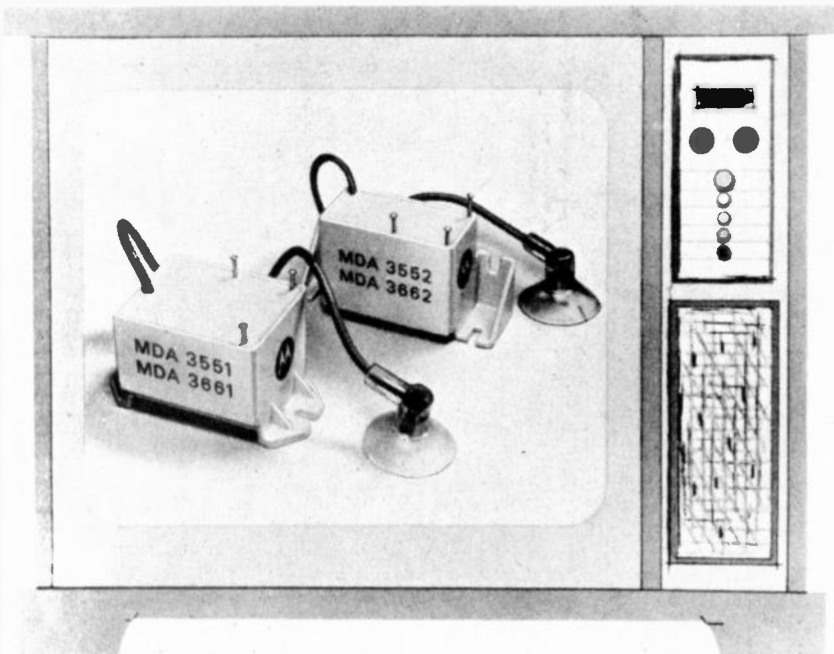
But there are so many different varieties and makes of machines available, that the task of selection is difficult for those unfamiliar with computer techniques. Moreover the engineer or scientist, or other potential industrial user, is unlikely to have such familiarity. Obviously, they need to know what these little machines are capable of, and how to use them to best advantage, *before* selecting a system for the particular application.

Hence the need for a book such as this – it is a complete coverage of minicomputers considered as research and development tools. How to assess them, how to use them – in fact all you need to know about minicomputers, programming, peripherals and applications.

The book is well written, by an acknowledged expert in the field, and provides a clear and concise treatment of the subject, together with some very useful tables in the appendix. The conciseness and clarity of the text will be much appreciated by busy people who seek to find rapid insight into minicomputer applications in engineering, scientific research, control and instrumentation. – B.C. ●

component news

HIGH VOLTAGE CRT/TV TRIPLER ASSEMBLIES



A new series of 30 kV rectifier assemblies has been introduced by Motorola Semiconductor Products Division. The assembly series meets the industry trend toward the use of voltage multipliers in CRT and TV horizontal deflection applications for computer graphic display terminals, television receivers, and industrial security/process video monitors.

Designated the MDA3551/2 and MDA3661/2, the new tripler series provide approximately 50% lower leakage as compared with similar tripler devices. Average forward output current is 3 mA at 25 kV with excellent voltage regulation under changing load current conditions. The assembly fill and case is self-extinguishing and arc-tracking resistant. Individual rectifiers within an assembly will avalanche prior to dielectric breakdown of fill and case materials. Custom assembly options available include special anode connector with custom type/lead length and internal bleeder/equalizer resistors.

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

SMOKE DETECTOR

Motorola Semiconductor Products Division has announced a new depletion-enhancement mode (Type B) N-channel MOSFET — the MFE824. The new silicon device is intended for use in highly sensitive smoke detection applications.

A significant device parameter is the very low reverse gate current (I_{GSS}) figure of 1.0 pico-ampere maximum at a V_{GS} of 10 volts dc. In effect, the device exhibits 1.0 pA maximum gate current leakage when the drain is short circuited to the source.

Typical operational temperature range for the device is −65 to +200°C. The unit is available in the standard TO-18 package and can dissipate 300 mW of power at 25°C. Maximum drain current I_D is 30 mA with a maximum drain source voltage V_{DS} of 20 volts.

REED SWITCH FOR INDUCTIVE LOADS

The CTC-500 is a tungsten contact pressurised changeover reed switch ideally suited to switch inductive loads. The maximum contact rating is 20 VA and the breakdown voltage is 1000 volts minimum.

Typical applications are reed relays, proximity switches for machine control and fluid level float switches. The switch is available in an ampere-turn band of 70-110 AT.

Further details from: NS Electronics Pty Ltd., Cnr Stud Rd & Mountain H'Way Bayswater 3153.

HIGH FLUX SOLAR CELL

At present the high cost of photovoltaic solar cells prohibits their use in the large scale generation of electricity from sunlight.

However, the Plessey Company's Allen Clark Research Centre has now shown that suitably designed gallium arsenide/gallium aluminion arsenide heterostructure junction semiconductor solar cells can be operated at light intensities of 2000 times full sunlight, to produce specific outputs between 20 and 40 W per square centimetre, whereas with silicon cells the maximum usable sunlight concentration is about 10 times.

This high concentration is possible because the (GA,Al)As material is relatively transparent to sunlight so that the surface layer over the junction can be much thicker than is the case with silicon, giving a lower electrical resistance and allowing much higher power to be generated.

Cheap concentrators such as curved mirrors or Fresnel lenses can thus be used to focus the sun's rays onto small area solar cells, thereby greatly reducing the unit cost of the electricity produced.

The optimum working voltage and efficiency of gallium arsenide solar cells increases with light intensity, and at 2000 times full sunlight an efficiency of 24 percent is forecast. Efficiencies approaching this value have already been achieved with non-bloomed and non-optimised cells of this type.

Plessey scientists are at present working with small cells, but it is envisaged that in practical applications cells of normal size – about 2.5 cm square – would be employed.

CUSTOM AND HIGH VOLTAGE CAPACITORS

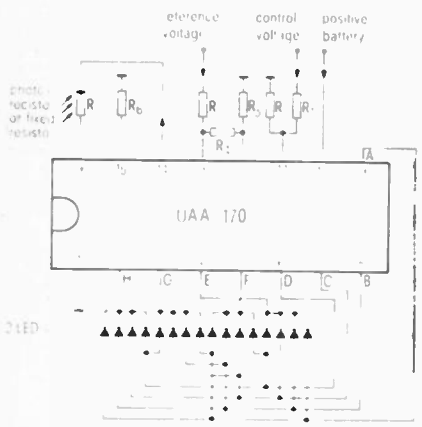
Namco Electronics, recently appointed sole Australian representative for Bycap Incorporated of the U.S.A., now has data available on Bycap's standard range of high voltage capacitors.

These capacitors, designed for bypass, coupling and filtering applications, are available in voltage ratings of 3000 to 150 000 volts dc.

Apart from these standard products, Bycap has wide experience in designing and fabricating custom capacitors for such applications as defibrillators, impulse generators, energy storage banks, radar modulators and power factor correction. Further details from: Namco Electronics, 239 Bay Street, North Brighton, 3186 Vic.

IC FOR OPTOELECTRONIC SCALES

LED Drive with UAA 170



Up to now, light-emitting diodes have been used primarily for digital displays. They are used both as individual points of light for simple yes/no indication and as multiple arrays forming the outlines of figures and characters.

The new Siemens integrated circuit UAA 170 is a driver, which is capable of causing an individual point in a linear LED array to glow, providing analogue indication of a given condition. This newly developed package, for driving up to 16 diodes, is therefore particularly suitable for optoelectronic scales, the scale pointer being represented by the transition from light to dark on the diode array.

The IC operates with a supply voltage of 10 to 18 V (package type DIL 16) and its input is driven by a dc voltage. On the output side, up to 16 LED's can be connected. When the input voltage is varied by about 1 V, the voltage at the output of the circuit changes in such a way that the light emission of one diode is taken over by the next one. Special importance is attached to the fact that the switchover of emission, i.e. the selectivity of the output signal, can be adjusted at any time on the outside of the UAA 170 package from "abrupt" to "very gradual".

The information value of individually driven components can be increased by using a diode array composed of light sources of various colors. Furthermore, two UAA 170 packages can be connected in series, thus making it possible to drive up to 30 LED's.

As its first application, the new circuit has been incorporated in a car radio dial composed of LED's. A further promising application would be a similar arrangement for indicating

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(Dick Smith is the Hi Fi Nut)

1

DSHF3 Hi Fi package. The greatest offer ever. A 100W amplifier. Two 3way, 3speaker systems. A belt drive turntable with magnetic cartridge. The total value here is $527. We've cut it down to **$499** and include **FREE** a cassette player worth **$130.**

2

DSHF4 is the fabulous AWA QX300. Imagine a combined amp and tuner with 58 semiconductors and built in radio tuner. Two handsomely finished speaker cabinets and a transcription turntable. But the big feature is the microphone and mixer — ideal for parties because you can run your own disco!! A really great set up for **$299** and we let you choose a **FREE** record.

3

DSHF2 Hi Fi Package is a 3-piece modular unit. The amplifier and turntable are combined in a low-look polished Teak case. Two twin cone speakers are also included in matching timber cases. Normal retail value is around $225. Dick's price of **$185** saves you **$40** and you get **FREE** can of record cleaner and a choice of record from our vast selection.

4

AC/DC Cassette Recorder Thousands of uses for this handsome little machine. Records voice and music on two track cassettes, plays back pre-recorded tapes. Simple, single master control. With mic and remote control switch for battery or mains operation Terrific value at **$37.50** and we give you **FREE** first cassette.

5

DSHF1 Hi Fi Package consists of top Expo Amplifier, BSR Turntable with bias adjuster, auto cue etc, Base and tinted perspex cover and two AWA loudspeakers. Just plug them together and you have a complete system. Total value of this system is $246. Dick's price saves you $47 at only **$199** PLUS **FREE** headset for private listening enjoyment.

DICK SMITH ELECTRONICS CENTRE

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THE NUT

These are just a few of our popular sellers. Whatever your requirements do yourself the favour of getting us to quote on your system. You must save. We only hold stocks of popular, fast selling lines, but we can get anything you want. In this way we don't have expensive stock and can pass the savings on to you.

COMPONENT NEWS

the position of sliding controls on ultrasonically remote-controlled TV sets. Finally, also under consideration is an electronic clinical thermometer having a linear array of LED's as an analogue indicator and an appropriate driver package.

NEW YELLOW GALLIUM PHOSPHIDE LEDs

A new range of gallium phosphide yellow light-emitting diodes (LEDs) is announced by the Plessey Optoelectronics and Microwave Unit.

These devices, GPL 120, GPL 121 and GPL 122 are high intensity yellow emitters, in plastic packages, designed for direct snap-in panel mounting by means of the plastic grommet provided GPL 100 series.

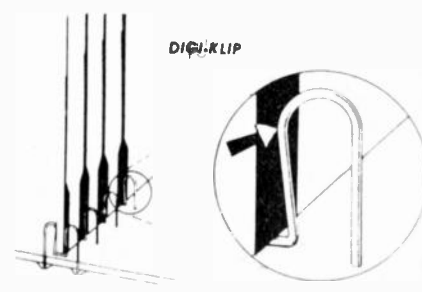
The construction of these devices, with a reflector as an integral part of the package, gives a large emitting surface. With the yellow transparent encapsulation of the GPL 120 and the clear resin of the GPL 122 a high light output is obtained over a 60 deg. polar diagram. The GPL 121 has a yellow diffuse resin for wider viewing angles.

The GPL 120, with its high output of 4.7 m candelas at 20 mA, gives a really bright light which does not cause the eye fatigue effects often experienced by operators using gallium arsenide phosphide red emitters.

Although intended as a panel indicator, the GPL 120 can be pulsed at 1 amp to give higher intensities for communications and film marking application.

Further details from: Plessey Ducon Pty. Ltd., Villawood, N.S.W.

DIGI-KLIP



The Industrial Products Division of Morganite Australia Pty. Limited has announced the availability of an advanced technique in the assembly of printed circuit boards. This technique using the Digi-Klip was developed for and proven successfully in the NASA satellite projects over ten years.

Digi-Klips enable free standing printed circuit boards to be connected without the restrictions of conventional connectors.

Further details from: Morganite Australia Pty Limited, 65 Bourke Rd, Alexandria, NSW.

RECORDINGS classical

REVIEWER: Tanya Buchdahl

COLLECTED DIABELLI VARIATIONS: by Beethoven, Czerny, Liszt, Hummel, Kreutzer, Mozart (son), Moscheles, Archduke Rudolf and others. Rudolf Buchbinder (piano – Steinway fluegel). Telefunken Das Alte Werk SMA-25081T/1-3 (3-record set with notes) $18.60.

This is probably one of the historically most important issues of the decade, and in any case it is the first recording of the Diabelli Variations complete. I wonder how many people actually know that anyone other than Beethoven wrote variations on Diabelli's theme?

In 1819 Anton Diabelli, probably a better businessman than he ever was a composer, sent one of his own waltzes to 51 musical heavies of the day, 'from the excellent Assmayer to the gentleman with a name like a sneeze' – Worzischek – (Tovey), in order that they all write one piano variation each on it, all to be published in a national collection by the 'Vaterlaendische Kuenstlerverein' or Society of Artists of the Fatherland.

Amongst the 51 were musicians never heard of today, and no wonder, judging by their offerings here. Other better-known musicians are Moscheles, Kreutzer, Hummel, a couple of Webers and a couple of Czernys – even Liszt, as a boy of eleven, appears with a surprisingly good variation which shows up quite a few others written by much older men. So many of these variations are just decorations of the original, according to the current principles of improvisation, and thus quite a number sound alike, especially as they are all bound by a basic unimaginativeness and unoriginality. Probably the best variation (Beethoven's excepted, of course) of the remaining 50 was Schubert's, 100% characteristic Schubert; it's a pity he was only allowed one variation, and that was all he did.

All those 50 composers occupy two records; Beethoven occupies the third. Beethoven was in fact highly unimpressed with the waltz to begin with, and as Tovey puts it "his first impulse was doubtless to advise Diabelli with Beethovenish precision to go Elsewhere". Nevertheless, and despite the fact that he was chewing over both the Ninth Symphony and the Missa Solemnis at the time, something in the stubborn and perfunctorily charming theme must have tickled his fancy, and enough so that he not only wrote one variation but thirty-three. When Diabelli finally received the set in 1823 he was disconcerted to put it mildly, but he had the good sense and musicianship to publish them all the same, though in a separate volume; and thus he ensured his immortality, for the set is monumental. Such a recording as this where Beethoven's work is in close proximity with the variations of the other fifty serves as a poignant, and almost chastening, reminder of just how lonely a genius Beethoven was.

As for the recording, Buchbinder plays with much delicacy and clarity, no doubt the attributes which make him such a good accompanist as is the way he is usually known. His account of the Beethoven is very competent, but it is no match for Brendel (on Turnabout) or Barenboim (on Calendar, which disappeared with the label in 1969). The sound quality is good, if a little brittle in the upper register, and not entirely related to the type of instrument used. The lesser variations, however, are only alphabetically separated into bands; as the sides are only about 23' each and the variations run on almost immediately, surely each variation could have been made a separate band and spread out more? The notes provide very useful miniature biographies of Diabelli and the lesser 50, with their portraits – of which four are actually photographs, which may shake your sense of their antiquity a bit (one is Assmayer, straight from the asylum by the look of him – all manic eyeballs, hair, and cranium).

An important set to have, then, and edifying (Beethoven), or diverting (everyone else) in small doses – don't listen straight through all of it, as I did, or you will have Diabelli's immortal theme plaguing you for days, permuted or otherwise. – T.R.B.

HAYDN: Cello Concerto in D, Op. 101; Oboe Concerto in C. Miklos Perenyi (cello), Peter Pongracz (oboe). Orchestra of the Hungarian Radio and Television/Janos Sandor. Hungaroton HLX-90034 ($2.98). Distributed by Avan-Guard.

Did he write it or didn't he?

Both the concerti on this record have been the objects of speculation as to whether Haydn actually wrote them. Though the oboe concerto in C is apparently entered in the thematic catalogue of his works (which Haydn inspected himself) no manuscript is extant, and so until one turns up, the debate stands.

The history of the cello concerto, however, is delightful. Such a concerto also appears in the thematic catalogue; in the early 19th-century an edition was published "according to the author's original manuscript". But in 1838 Gustav Schilling wrote in his 'Encyclopaedie der Tonkunst' that it was actually the work of one Anton Kraft, cellist at the Esterhazy court during Haydn's time there – information which seems to have come from Kraft's son. Why not? – there was no longer any manuscript to disprove it. And in the foreword of a miniature score published earlier this century, Dr Hans Volkmann claimed to have *proved* that it was Kraft's. It certainly convinced even Tovey (see Addendum to Vol. 3 of Essays in Musical Analysis), but then A. Hyatt King remained a Haydn supporter (see his chapter in the Penguin 'The Concerto' Ralph Hill) – Ed.

As it was after all only Kraft's work it seemed to Francois Auguste Gevaert, a Belgian composer, pedagogue and smart-alec extraordinaire, perfectly all right to improve the concerto. So in the 1880s he set to, and as I learn from one delightful cover-note (to Oceania OCS-23, Gendron and the Vienna State Opera Orch. under Sternberg), vintage 1951, his version required additional flutes, clarinets and bassoons; he knocked 38 bars out of the first movement alone (and some of the loveliest, though no doubt such exquisite classicism had no appeal to him); added a bar at the end of the adagio; added a superfluous cadenza; turned the final coda into a bravura display and generally dollied up the solo part! The writer of these same notes (who assumes the work to be Kraft's) rather illogically remarks "assign the concerto to Haydn, and Gevaert's 'reconstruction' takes on the aspect of desecration. Assign it to Kraft, and the revision bestows needed elaboration to a crudely scored composition". Three years later the original manuscript turned up – it *was* Haydn's after all. It seems that the doctored version, without a note being changed, was suddenly a desecration and not an improvement. Surely, a rose by any other name! No use now to claim that such 'primitive' instrumentation could never be Haydn's – but *primitive?* And 'missing that touch of genius.? This is just nonthink – I have yet to find a touch of genius in Beethoven's 'Wellington's Victory', but it doesn't make it any the less Beethoven's work.

Every composer has his off-moments like everyone else, and it's just sheer nonsense to expect composers to 'display their genius' in everything they write. Tovey, it seems, was most disturbed by the Adagio's first two bars of "pure Mozart" than anything else – the first dozen or so bars of Schubert's Fifth Symphony are also pure Mozart, but still Schubert's pure Mozart. In any case, if Kraft could supposedly imitate Haydn, why not Haydn Mozart? A pox on discreditors!

(Continued on page 122)

This Perenyi recording has of course reverted to Haydn's original, and it amazes me that anyone could have found it in his heart to fiddle around with it. It doesn't neex extra flutes, clarinets, bassoons; the oboes and clarinets already there provide the dark sort of tone that is just the right foil for the cello – the flute could hardly be further removed. If not riddled with this elusive quality genius, it is still a delightful and gentle piece of music, and far more so in the original than the revision. That is the way Perenyi plays it; he takes it a little slower than usual (though all 29' 06" is on one side) at a sensuous, gentle speed, and emphasizes the wonderfully soft lyricism which is the real character of the work, not the rather incongruous virtuoisity imposed by Gevaert. Perenyi plays beautifully – I would like to hear what he could do with the Boccherini concerti, and I'd like to hear more of him in general.

In proportion to the quality of the performance, I haven't devoted nearly enough time to the oboe concerto on the other side, but suffice it to say that like the cello concerto it is excellently performed. Pongracz's virtuosity is the principal delight in this work which strikes me as having less of Haydn's genius in it than the other. The orchestra is everywhere sympathetic, and the opening bars on the first side are exquisite sweetness. One very small complaint: Sandor for some reason adopts the disconcerting practice of playing the (Staccato) two-chord perfect cadences scattered throughout the cello concerto's first movement with only the last chord *f* and the first one *p*.

The balance on both sides is remarkably good, far better than I have heard on many full-priced records. Except for isolated pitch wavering, the surfaces are also first-rate, and really almost unbelievably good as it seems that the cello concerto has been transferred from 1967 recording (SLPX-1248) and the oboe concerto from a 1964 recording (LPX-1084). So from the points of view of soloists, orchestra, balance, surface, price and historical accuracy this record could hardly be bettered. – T.R.B.

JAN PIETERSZOON SWEELINCK: Works for Organ. Louis Thiry at the Organ of Notre-Dame-des-Blancs-Manteux. Arion ARN-37178 ($6.20) Distributed by Avan-Guard.

Not everyone's cup of tea, perhaps, but an excellent issue for those who enjoy a modicum of esoterica in their musical diet. This is a joint production by O.R.T.F. and the French Arion label, not very well known in Australia yet. The presentation is as lavish as anyone could desire; there are extensive notes in a booklet stapled inside a flap cover, in French and written by M. Thiry himself, but almost all of it is translated into excellent English. As an extra, the back cover bears a large engraving of the composer.

Sweelinck (1562-1621) was the organist at the Calvinist 'Oude Kerk' in Amsterdam throughout his life, in the time of the great Monteverdi, Vittoria and Frescobaldi. This was the time of international music, a late baroque style characterized by florid virtuosity held in check by the discipline of polyphonic invention. I cannot say I know very much about Sweelinck's music; for all but the most dedicated, Louis Thiry's own notes should be ample introduction; and for the most dedicated, there is a comprehensive if outrageously expensive book just issued by Leiden V.P. and O.U.P. (1973) entitled "Sweelinck's Keyboard Music" by Alan Curtis which seems well worth investigating.

The rather unfamiliar nature of the music wears off surprisingly quickly, especially for those who are accustomed to 'historic organ' anthologies. This record is rather better than the type of anthology which comprises a jumble of composers and seems primarily intended to demonstrate the organ's rather than the composers' abilities – just by presenting the one composer in a representative selection. It is one of the few records I have come across which not only gives an extensive description of the organ's specifications (and it is a beautiful organ– but it makes a concerted effort to explain a relatively unknown composer to the assumed-uninitiated. Thus it is ideal for those who have the Bach *Orgelwerek* and are wondering where to go next, for those who want an intelligent introduction to a "new" composer, and it is of course indispensible for all schools of music. – T.R.B.

PROJECT KITS

Having read your recent article on the "Electronic Project Kit IC 150 in 1", I feel I should let you know of a kit which I think is one of the cheapest and best on the market.

This is the Denshi Board (available in different models). Unlike the 150 in 1, the Denshi is not a game of connecting wires, rather it involves the positioning of components on a board comparable in a way to the common "matrix" board. Metal links are used for connecting components, avoiding both soldering and the "ratsnests" of wires that often evolve with wire links. The components, themselves, are all mounted in small, transparent, plastic boxes with the symbol and value stamped on top. This avoids boxing small components and prying little hands.

Four books came with the project, which contain between them about 100 circuits, the circuits range from very simple — demonstrating electronic fundamentals — up to quite decent four transistor radios.

On fundamentals, the books teach the basic principles of current flow, ohms law, parallel and series connections of resistors, connection of batteries in series and parallel, rectification and basic principles and characteristics of transistors. Each principle has some experiments to demonstrate and verify these principles.

There are 20 resistors from 10 Ω to 1M Ω, seven ceramic capacitors from 5pF to .05 μF, six electrolytics from 10 μF to 50 μF, two signal diodes, two audio transistors 25B33, one R.F. transistor 2SA269, an RF choke, three transformers and all the sundries such as lights, pots, radio-tuner, 70 mm speaker etc.

All projects run off a 9 V battery Eveready type 216. There is no suggestion of running the circuits from the mains. There is however, a circuit for a high voltage generator to light up a neon bulb, but considering the current available it could hardly be called dangerous.

Naturally there are the inevitable transmitter circuits.

With each circuit there is an explanation of what it does and briefly how it works.

A kit like this would provide a very good introduction to electronics for beginners and interest the owner enough to read some texts on electronics.

Usual disclaimer, A.M. Hamilton, Vic. 3300.

PIRATE RADIO

I Disagree with several comments made in Electronics Today International on the subject of pirate radio.

On page 36 certain statements were made which I Believe are false. Such as, (because)

Another point raised by our Correspondent is that many 'Pirate' they do not have time to study for an Amateur licence. May I suggest though that if the time spent pirating was otherwise engaged in studying for the amateur licence. You then go on to say, Many pirates have an erroneous idea of the level of technical knowledge required. It is only barely 'specialised', in fact some of the questions could be answered by high school students doing science as part of their curriculum. As many pirate's do or may get much time to pirate or go pirating They would learn much more from being illegal than sitting down at a desk and studing. As I was in my last year of school I could not spare much time to study for the licence and what time I could get was not enough, of the two sections (Regulations and Theory) in the exam, I only took one but failed (and that was Regulations) and I used to get 'B's in science. I am shore I would have learned much more in the time I waste with Book's, Shore some of the questions could be answered by a High School Student but it is not often these questions come up, you need practical experience to be able to answer some of the questions in the exam. I hope that you will publish my letter in the next edition I will be looking to see what others have to say on this subject.

T.S.

(This letter is published as received.) — Ed.*

A substantial number of letters have been received on this subject. We will publish a representative selection of these letters next month.

ELECTRONICS -it's easy CONTEST No. 2

UNDER 17's
FIVE OF THESE KITS TO BE WON!!

Mykit Series 50 in-1

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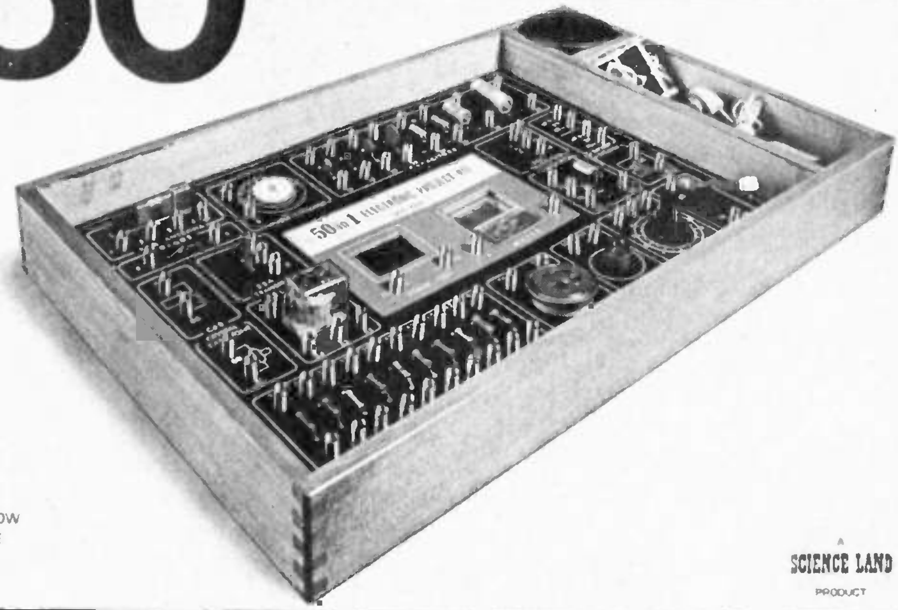

MYKIT SERIES 50-IN-1
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LEARN ELECTRONICS
WITH EACH PRODUCT.

BUILD MAIN PROJECTS: TWO-TRANSISTOR RADIO TELEPHONE TRANSISTOR AMPLIFIER WIRELESS PHONOGRAPH SIGNAL TRACER DIODE TESTER TRANSISTOR TESTER AC BRIDGE ILLUMINOMETER TRANSPARENCY INDICATOR ELECTRONIC ORGAN (LOW FREQUENCY OSCILLATOR) ELECTRONIC METRONOME ELECTRONIC ALARM CLOCK TELEPHONE AMPLIFIER 50 PROJECTS IN ALL

A SCIENCE LAND PRODUCT

Under 17's — here's an opportunity to win a 50 in 1 Experimenter's Electronic Project Kit.

Entrants must answer all 10 of the following questions — the answers to which may be found by studying the current and previous parts of the ELECTRONICS — it's easy series.

Each question should be answered in not more than 30 words.

The five prizes will be awarded to those entrants submitting the clearest and most concise *correct* answers.

1. Explain the difference between active and passive components.
2. What is a binary device?
3. How fast do *electrons* flow in a conductor?
4. What is meant by 'period' in electronics?
5. Explain the meaning of the abbreviation rms.
6. A harmonic — what is it?
7. How many volts in a nanovolt?
8. Explain rectification.
9. What is an LDR?
10. Express your age (in years) in decimal and also in binary numbers.

To encourage our younger readers this contest is limited to boys and girls who are less than 17 years old on the closing date for entries — March 31st, 1974.

Winners will be required to submit proof of age.

Please be absolutely certain that you have included name, address and age, in block letters, with your entry.

Entries must be addressed to:—
Electronics Today International, 15-17 Boundary St., Rushcutters Bay, NSW 2011.

CLOSING DATE: MARCH 31st 1974 (entries post marked March 31st will be accepted).

The five 50:1 Electronic Experimenter's kits to be awarded as prizes in this contest have been donated by Dick Smith Electronics Centre. Thanks Dick!

HIGH-VOLTAGE SWITCHING AMPLIFIER

Opto-coupling provides extreme isolation in 600 volt switching circuit.

THIS amplifier, the circuit of which is shown in Fig. 1, employs opto-couplers to achieve a high degree of isolation between input and output. It produces a ±600 V output swing about the common rail from a ±1.5V input.

The output stage consists of a chain of eight transistors connected in series across the power supply. The voltage across each transistor is held at a maximum of 150 V by a potential divider network consisting of eight 150 k resistors.

Circuit operation is as follows: when input 1 is 1.5 V positive with respect to input 2, the light emitting diode in the upper opto-coupler will produce light, and its associated transistor will turn on. The lower light emitting diode will be reverse biased and its associated transistor is held off. Base current flows in Q10 via the 150 k 2 W resistor and D10 and Q10 therefore turn on.

In turning on, Q10 effectively grounds the base of Q9 and this transistor is held in a non-conducting state. Resistor values are such that transistors Q6 to Q8 also do not turn on under these conditions.

When the transistor in the upper opto-coupler turns on (because of the positive input to the amplifier), it connects the base of Q1 to its emitter, preventing Q1 from conducting. Current can now flow from the +600 supply, through the base emitter junction of Q2, through D2 and to the common line via the chain of resistors. Transistor Q2 turns on and in doing so allows base current to flow in Q3 which then also turns on. In this way, all the transistors Q2 to Q5 conduct and the output swings positive by 600 V minus V_{SAT} for transistors Q2 to Q5.

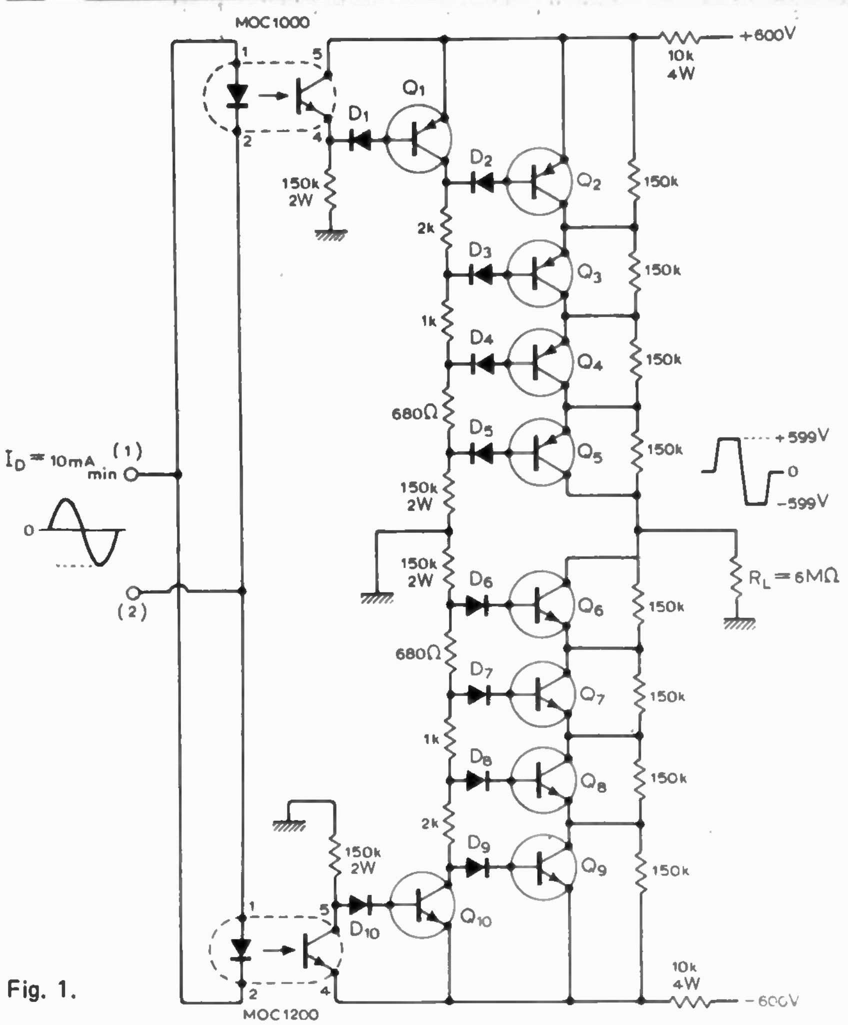


Fig. 1.

A polarity reversal at the input causes the lower light emitting diode to illuminate and the upper light emitting diode to extinguish. Transistor Q1 turns on and causes Q2 to Q5 to turn off.

Transistor Q10 turns off, allowing transistors Q6 to Q9 to turn on, swinging the output to almost 600 V in a negative direction.

The transistors employed in the circuit are low-cost devices which are housed in plastic TO-92 packages.

The opto-coupler performance is such that an isolation between input and output of 1.5 kV is achieved. It is important to note that an input current of at least 10 mA is required to ensure reliable circuit operation.

NON-CONTACT SIZE MEASUREMENT

Unique method uses opto-electronics to measure size.

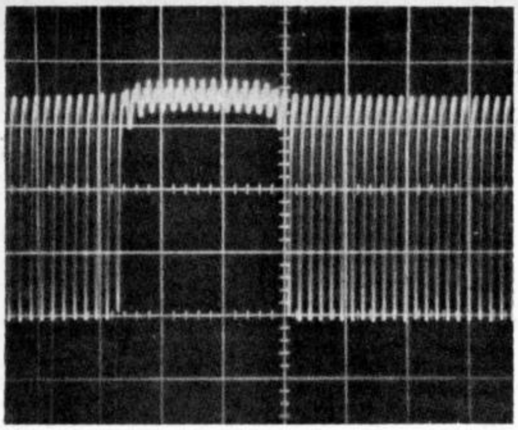
THERE are many occasions when it is necessary to measure the dimensions of an object automatically. One could think of countless applications in industry. The length, width or diameter of objects; the width of slots; the size of holes; the level of liquids in bottles, and the like.

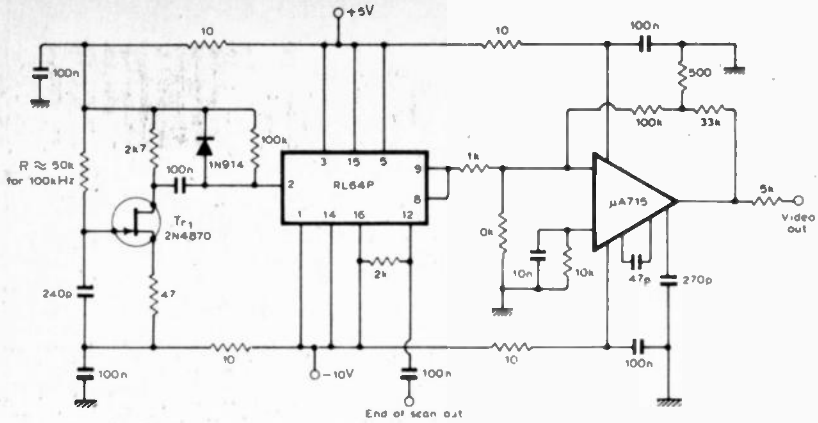
This design note describes how such a system can be designed using only very basic electronic circuitry and simple optics.

The heart of the system is a linear monolithic array of photodiodes. The photo-diodes are formed in a single chip of silicon and are arranged in a line. The distance between diodes is accurately determined during manufacture. A shift register made on the same chip enables each diode in turn to be "addressed' and a signal proportional to the light falling on the addressed diode appears at the output.

The speed at which the diodes are addressed is determined by the rate at which clock pulses are fed to the photo-diode array. Each clock pulse causes the next diode in the line to be addressed. The sequence is started by a start pulse which is followed by a number of clock pulses. These must be at least two greater than the number of the diodes in the array being used. The next scan is then commenced by applying a new start pulse.

In measuring the dimensions of an object, the object's silhouette is arranged to fall on the array of diodes. The number of diodes in the array 'blacked out' by the shadow is proportional to the size of the device. As the speed at which the diodes are





scanned is accurately known (clock pulse rate), the length of time a black signal level occurs is also proportional to the size of the object.

Although the arrays are capable of sensing all levels of grey between black and white, in measuring applications of the sort being discussed it is usually only necessary to differentiate between black and white.

The accuracy of measurements taken in this manner is determined by a number of controllable factors. The clock speed can be accurately set by employing a crystal oscillator. The object is normally focused on the array using lenses. The accuracy achieved will therefore depend on the precision of the optics and the field of view which, in turn, is determined by the focal length of the lens and the distance from the object.

In general terms, if a 64-diode array is used and the field of view is 64 mm, then the resolution will be one millimetre.

A very simple circuit for driving a 64-bit Reticon photo-diode array is shown in the accompanying drawing.

A standard unijunction oscillator (Tr_1) produces the necessary clock pulses for the RL-64P photo-diode array. Each clock pulse causes a signal proportional to the light falling on one photo-diode to appear at the output. In addition, the clock pulses cause each of the diodes to be addressed in turn. A μA 715 op. amp is used as a straightforward amplifier to produce an output signal of about 6 V from diodes saturated with light.

The accompanying photograph shows the output waveform which occurred when the shadow from a piece of wire 30 mils in diameter was allowed to fall on the array. The diameter of the wire can be measured by counting the pulses.

The circuit demonstrates a very simple application of photo-diode arrays; more sophisticated circuitry can be employed in more complex applications. For instance, if the output amplifier is allowed to trigger a monostable with a time constant slightly greater than the clock pulse width, a single output pulse is obtained with a width proportional to the size of the object being measured.

TEMPERATURE SENSOR

Simple, inexpensive circuit has a resolution of 0.15°C.

THERE are many occasions when it is necessary to detect a difference in temperature between one point and another and to take some action should the temperature differential rise beyond some pre-set level. An application that immediately springs to mind is the control of cooling fans in equipment cabinets in response to the difference between the internal temperature of the cabinet and ambient.

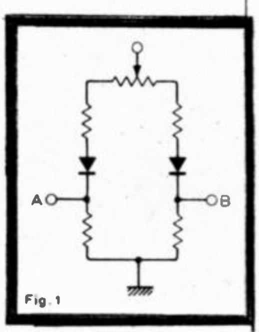
Jim Barnes of Motorola's application laboratories at Phoenix, Arizona, has designed a simple, inexpensive circuit for just this purpose. This has a resolution of about 0.15°C and a differential range of 5.5°C.

In the circuit, temperature measurement is performed by general purpose silicon diodes (IN4001). These exhibit a temperature coefficient of about 2 mV/°C over a very wide temperature range. When two of the diodes are connected in the bridge configuration shown in Figure 1, a voltage appears between terminals A and B which is proportional to the temperature difference between the two diodes. The potentiometer provides a variable offset current giving a temperature offset range of about ± 5.5°C.

The bridge output of 2 mV/°C temperature differential must be amplified before it can perform a power switching function. A standard low-cost MC1741G operational amplifier was chosen for this purpose (see Figure 2) and used open-loop to provide a gain of some 100 000. A temperature differential of 0.15°C will therefore cause the output of the amplifier to swing almost the whole power supply voltage of 26 V.

The output current capability of the MC1741 (5 to 10 mA) is insufficient to drive most power relays, so a buffer transistor (MPS-A20) is included in the circuit for this purpose. A zener diode provides the necessary level shifting between the output of the op-amp and the input of the buffer.

Motorola Semiconductors Ltd.



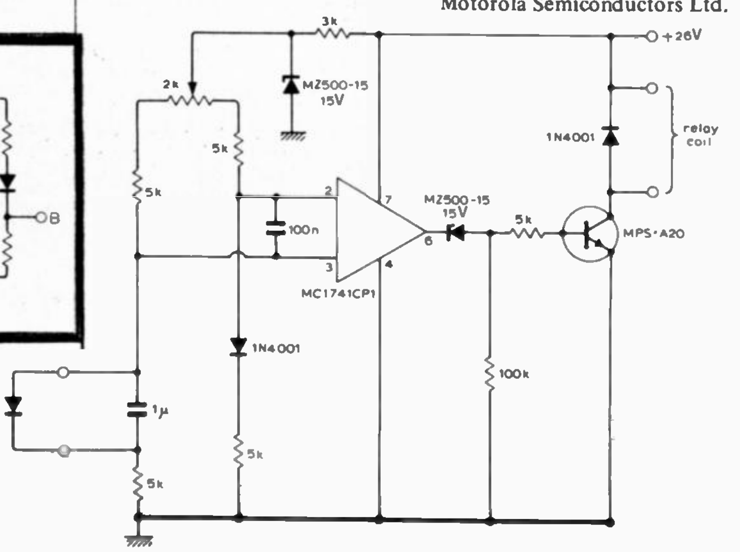
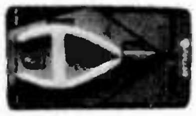


Fig. 2

Dick Smith Electronics Centre

TOOLS



Fuller 7150 series pliers and cutters electronically induction heat treated, coil springs, vinyl cushion grips. Approx 4" long All at $2.50 each 7151 long nose: 7152 diagonal cutters: 7153 needle nose: 7154 cutting snippers: 7155 bent nose: 7156 flat nose **Offset** screwdrivers two blades — Philips or normal (state which) 80c or $1.50 pair.

Table vice makes a good thirdhand. Clamp for fixing to table etc 3" jaw with 1½" opening $6.25 (P&P $2.00).

Abel nibbling tool cuts up to 16 gauge any shape hole. Ideal chassis-bashers weapon $6.45.

Professional stripper. Not from Kings Cross, but a crib of that well known one made in Hong Kong. Plier type action, grips wire, cuts and removes insulation in a single action. Don't be put off by cheap price $4.50.

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Plike pliers, cutters, crimper and stripper. All 4 in 1 for $3.41.

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FREE SOLDER WITH IRONS THIS MONTH

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Mico 10 Watt. A very popular low price, light weight iron for delicate IC work etc 4, 6 or 12V (state which) $5.25. Interchangeable tips available. Transformer to suit $9.00 incorporates rack, indicator and carrying handle (P&P $1.00).

Soldavac $6.95 spare tips $1.60.

Soldapullt is an even bigger sucker $9.95.

Vibroscope etches any metal, runs off 2.5 to 6.3V AC or DC. $5.75.

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ER308 Megaphone

with 16W amplifier having a range of approx 1km. All 5 acre block owners with children need one $52.00 (P&P $1.00).

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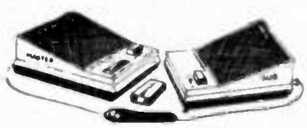
Magnavox 8-30 Systems DSE 8-30A consists of 8-30 and two 3TC tweeters plus crossover for 8 or 15ohms (specify) $25.50 (P&P $2.00) Cabinet kit to manufacturers spec and professionally finished — premitred joints etc, Innerbond and grille cloth $24.50 (P&P $4.00).



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Power Convertor run your tape recorder or radio in the car. Converts 12V down to 9, 7.5 or 6V at ½A max. Plugs into lighter socket $5.00 (Cheaper than the parts alone).

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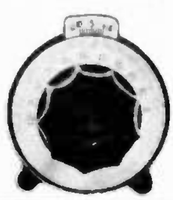
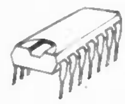


ICs

At time of preparation of this advert 6.1.74 we have ample stocks or expect them by 1.3.74. We are now importing ourselves these guaranteed new devices.



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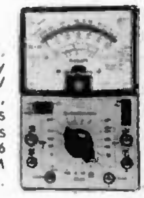
SN7441AN	2.60	SN7495N	2.70
SN7442N	2.45	SN7496N	2.50
SN7447N	3.50	SN74107N	1.50
SN7450N	.90	SN74121N	1.50
SN7451N	.90	SN74141N	5.00
SN7453N	.90	SN74192N	8.50
SN7454N	.90	SN74193N	8.50
SN7460N	.90		

Ultrasonic transducers. In response to fantastic demand we have air expressed further supplies. Range up to 80ft. No licence required. Ideal burglar alarms etc. 40kHz operation (See Feb-March E.A. for circuit or details with your order if required) $5.95 each.



Philips Multimeter 50,000ohm V. Overload protection, Polarity reversing, 20uA movement 0.3V range for transistor circuit tests, 1% precision resistors. 23 ranges DC Volts from 0.3 to 1.2kV, Amps from 30uA to 12A, AC Volts from 6 to 1.2kV, Ohms from 10k to 100M Model SMT 101 $34.50 (P&P $1.00).

Crocodile clips Medium size Red or Black 20 cents. Miniature plastic covered Red or Black 15 cents.

New instruments in stock

Three new Australian designed and manufactured instruments for service use etc. The emphasis is on ingenious circuitry, rather than flashy-looking front panels. As a result we think they are outstanding value. Buy them because you'll use them rather than sit and look at 'em. All ready to use with operating instructions and circuit diagram. (P&P 75c).

Ultralinear Pattern Generator for setting up mono or colour TV. Gives horizontal and vertical bars, cross hatch and dot patterns. Cunning digital circuit allows accurate adjustment without setting instrument up $27.60.

Shorted turns tester is ideal for all high Z trannies including EHTs. Simple LED indication. A bargain at $15.33.

Sure test transistor / diode checker is an extremely simple pass / fail tester for rapid checking of devices including SCRs etc $9.20.

Free Valve Testing. Don't forget to bring your valves in for checking FREE on our Super Mercury Tester. Replacements at TRADE PRICES too.

Car Alarm Stickers. These are overruns from an alarm installation selling at $100. Put one of these stickers on your car window and a potential thief will think you have one of the alarms. It doesn't matter whether you have an alarm or not, so long as the thief thinks you have. Eye-catching in Red, Black and White $1.00 each self adhesive. (P&P free).

The tremendous Ferranti ZN414 Radio IC. Into a TO-18 transistor can they've packed a 10 transistor radio with a power gain of 72db. Operates from 1.5V battery consuming 300uA. Frequency range 150kHz to 3MHz. Earphone radio only requires tuned circuit and 3 other parts. Ex stock $5.90 or complete earpiece radio kit for $9.75 (P&P 50c).

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Have you seen our book ads? We are now stocking McGraw Hill, AARL, SAMS books as well as popular local titles. Also overseas magazines in addition to Electronics Australia and Electronics Today. Get your copies from us then buy the parts right away!

Kits (P & P 75c)

30 Watt 144MHz Amp (Jan 74 E.A.)	$ 37.50
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SPECIAL OFFER TO ALL READERS OF ELECTRONICS TODAY

Mits 908M Electronic slide rule calculator

The MITS 908M adds versatility to the convenience of a hand-held calculator and the result is an eight function machine that fits in a pocket or a brief case. Reliability and accuracy are not sacrificed for size in the 908M. There are two decimal modes, fixed and floating, and leading zeroes are blanked. It employs light-emitting diodes to display an eight-digit readout with sign and error indications. The latest integrated circuitry makes available for four arithmetic functions plus square, square root, reciprocal and percentage in a single key stroke.

If you need more, there's a memory and a simple algebraic entry system. An extra feature, the battery circuit override, gives you time to think about the problem without using up battery time. The display blanks shortly after the last entry, is stored, then returns intact when the [=] key or another function key is pressed.

OPERATING NOTES

Fixed Decimal Point

The calculator operates initially with a floating decimal point but a fixed point can be entered by using the key sequence [·] [=] [N]

Any digit from 0 to 7 can be used for N. For example, a five-place decimal would be entered as follows:

[·] [=] [5]

This value can be changed at any time by repeating this key sequence and using another digit. When the machine is in the fixed point mode, results are rounded off prior to being displayed. Note that only results are displayed in fixed point; entries continue to be displayed in floating point.

The location of the fixed point will be ignored if the result to be displayed contains more significant integer digits than would be allowed by the fixed point. For example, the result 1234567.8 would be displayed even if the fixed point had been set for two or more decimal places.

Memory

The memory register can be used to store intermediate results while you work an involved problem or to store a constant number required frequently in the execution of a series of problems. If an intermediate result is to be stored, press the [M] key immediately after the [=] key depression which brings the result of the calculation to the display.

MITS 908 Calculators possess a MEMORY, also included is a % key, floating and fixed decimal point (0-7 places), which proves the MITS calculators give you the best value for money today. No Electronic Slide Rule Calculator is perfect without a MEMORY which is essential in complex calculations.

PRICE: $75.00 Sales Tax Paid) Including case.
$66.15 Sales Tax Exempt) Plus $1.50 postal charge.

Students are eligible to purchase this calculator Tax Free. Send a stamped self addressed envelope for Sales Tax Exemption Form.
For this special offer only prepaid orders accepted.

SAMPLE PROBLEMS:

1. Reactance $Z = \sqrt{R^2 + X^2}$
   Given R = 16Ω, X = 32Ω

   Key sequence on 908M
   1,6,X²,M,3,2,X²,+,M = $\sqrt{x}$,
   Answer
   35.777087Ω

2. Parallel resistance R_T
   $R_T = \frac{R_1 x R_2}{R_1 + R_2}$
   Given R_1 = 27Ω, R_2 = 220Ω

   2,7,+,2,2,0 =,M,2,7,x,2,2,0,÷,M, =
   24.048582Ω

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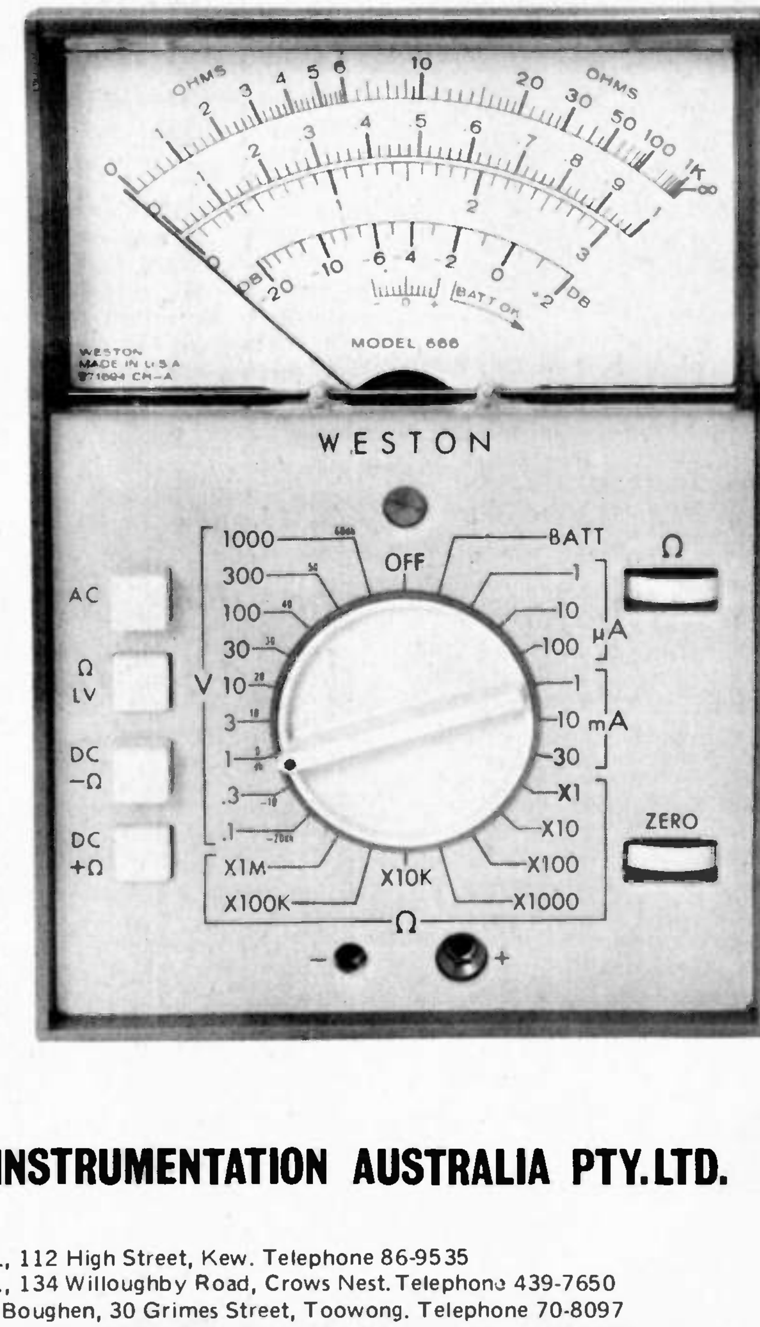

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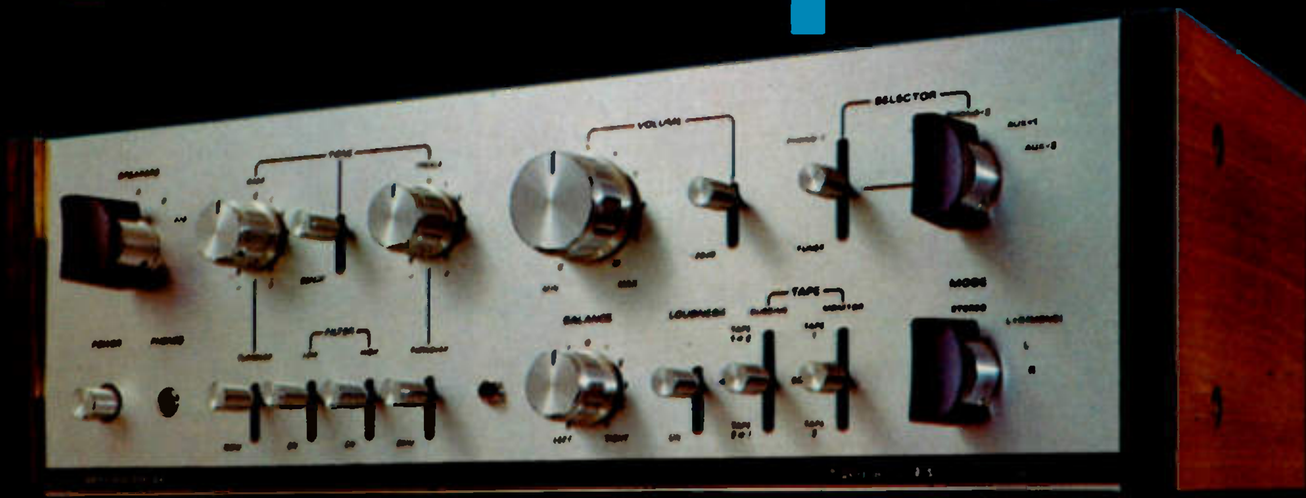
The compliment we like best about the new Monarch Series 8:

"It's no surprise!"



When people already think of one name as the best value for money, they naturally expect every new model to maintain the same high standards — or improve on them. So, Monarch's brilliant new Series 8 amplifiers will come as no great surprise.

No surprise — even though we've created a superb new amplifier, top-of-the-range Monarch 8000 to bring you continuous RMS power of 55 watts per channel at 8 ohms, with distortion of less than 0.1%; even though we've included tape dubbing and turnover controls; even though we've produced a frequency response of 10 Hz to 60,000 Hz; even though we're presenting three other new Monarch amplifiers — the 80, 88 and 800, which feature dramatic improvements in power and efficiency. It's no great surprise — because you *expect* Monarch to be the best . . . And it is, so all Monarch amplifiers remain "kings" on a power-to-performance-to-cost rating.

Try any of them. The prices are as undistorted as the sounds. All with the same beauty of design you expect of top performers. And all have the Monarch two-year guarantee on parts and labour. You know you're getting Monarch quality. Without paying more.

Monarch 8000	—	110 watts RMS
Monarch 800	—	80 watts RMS
Monarch 88	—	48 watts RMS
Monarch 80	—	24 watts RMS

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