electronics TODAY INTERNATIONAL

DECEMBER 1973 Vol. 3, No. 9.

main features

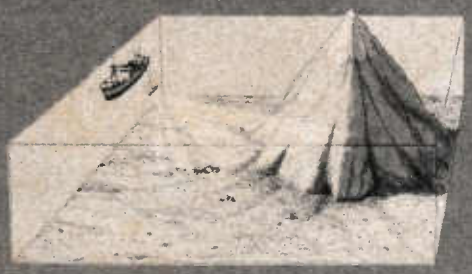
product tests

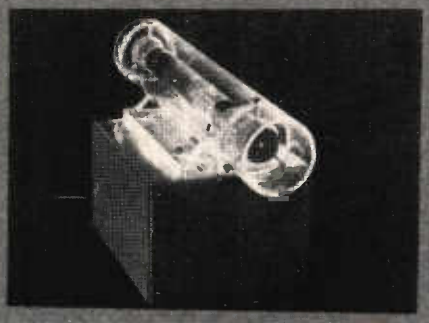
projects

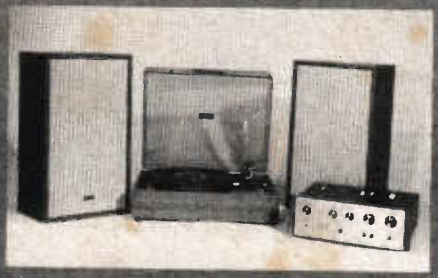
reviews

news & information

COVER: Gas-assisted laser is seen here cutting stainless steel. – Photo courtesy BOC Laser Systems.







COMPUTER CONTEST

FOLLOWING REQUESTS FROM A NUMBER OF PROSPECTIVE ENTRANTS THE CLOSING DATE OF THIS CONTEST HAS NOW BEEN EXTENDED TO DECEMBER 31st 1973.

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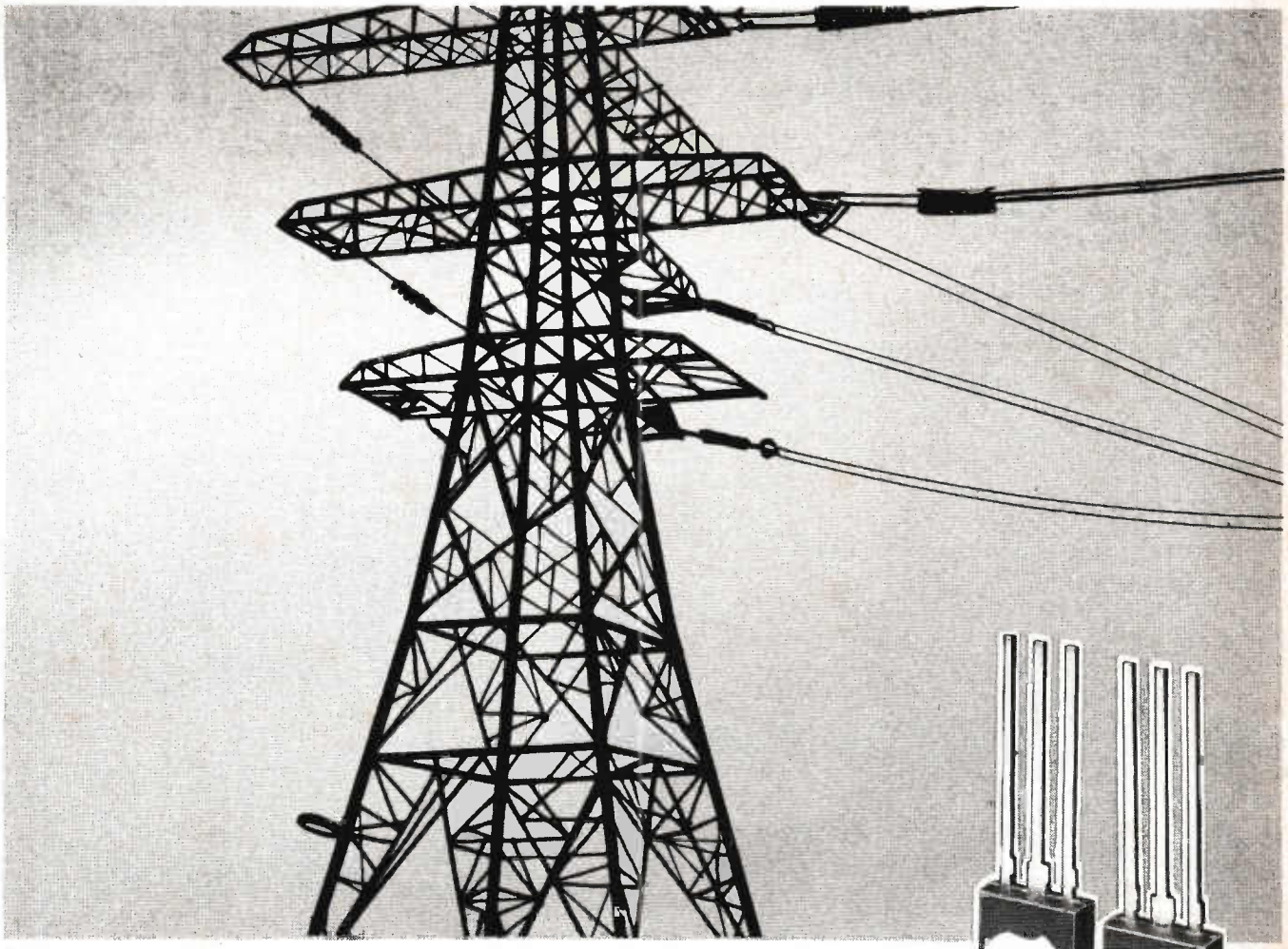
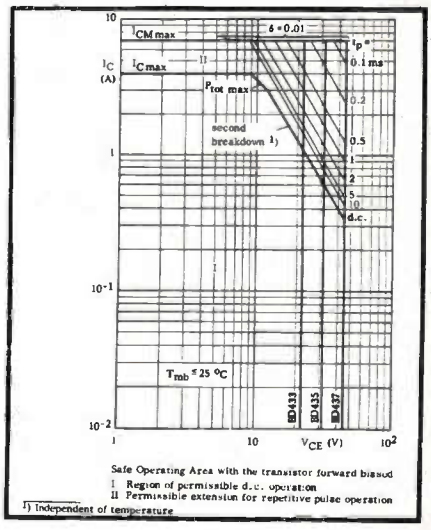


Power problems solved
(in a small package)

Elcoma introduces its new range of flat pack power transistors.

Type No. NPN	PNP	V_{CEO} (V)	I_{CM} (A)	I_C (A)	P_{tot} up to $T_{mb} = 25°C$ (W)	hFE	@ I_C (A)
BD135	BD136	45	1.5	1.0	8*	>25	0.5
BD137	BD138	60	1.5	1.0	8*	>25	0.5
BD139	BD140	80	1.5	1.0	8*	>25	0.5
BD233	BD234	45	6	2	25	>25	1.0
BD235	BD236	60	6	2	25	>25	1.0
BD237	BD238	80	6	2	25	>25	1.0
BD433	BD434	22	7	4	36	>50	2.0
BD435	BD436	32	7	4	36	>50	2.0
BD437	BD438	45	7	4	36	>40	2.0

*up to $T_{mb} = 70°C$



Safe Operating Area with the transistor forward biased
I Region of permissible d.c. operation
II Permissible extension for repetitive pulse operation
1) Independent of temperature

ELCOMA

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$350 HI-FI?

WORLD-WIDE, the fastest growing audio equipment sales are of unitary systems priced at less than the local equivalents of $350.

Probably with this in mind, a number of readers (and equipment manufacturers) have queried our assertion that it is not, generally, possible to buy acceptable hi-fi for *less* than $350.

Perhaps, some of our correspondents suggest, we may be setting our standards at too high a level.

In an attempt to resolve this conflict, we present, in this issue, ten independent reviews of audio systems priced at less than $350.

One of the least expected findings was that, almost without exception, the standard of construction and finish was very high — in many instances putting more expensive equipment to shame.

In some of the units tested, the facilities provided were little short of astonishing. One unit included as standard, a radio tuner, a cassette recorder and two microphones!

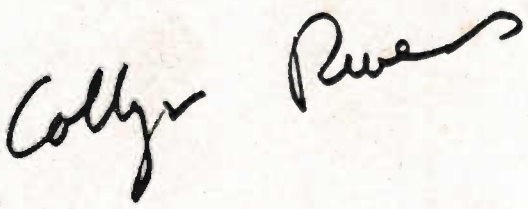
But hi-fi they are not.

Almost without exception, these systems — as sold — would not satisfy a musically discriminating listener — especially if that listener was aware of the considerably improved quality that he could obtain by spending a further fifty or hundred dollars.

We see no reason to modify our earlier statements — that hi-fi *starts* at $350, but we would not for one moment question the value for money that these systems provide.

Nevertheless the commercial success of these units may be due more to their unitary, or 'package deal' concept than their low selling price.

A basic marketing rule is that a product must be easy to buy. Unit audio is — traditional hi-fi is not.



YAMAHA

CA-500 — *The economy answer. No frills just top performance.*

Output power alone doesn't mean much; what counts is how much you can use without distortion. That's where these new Yamaha amps leave all others behind. With amazingly low harmonic distortion, direct-coupling system and FET-type differential amps, the CA-500 and CA-700 porvide full use of their generous output power for performance that betters the most massive system.

Each also features versatility and convenience extras for the most creative stereophile: second phono jack for MC cartridge, double tape monitor/dubbing, one-touch function selectors, high/low filters, dual speaker system selectors and pre-main amp separation. Add to this their compact design, easy operation and amp/speaker protector circuits and you have a pair of the finest stereo amplifiers available.

CA-700 — Outstanding performance, convenience styling.

TECHNICAL SPECIFICATIONS

CA-500 — RMS Power at 1 kHz — 22/22W; CA-700 — 60/60W; Harmonic Distortional 1 kHz — 0.05% at 20W 0.05% at 50W; Power Bandwidth — (distortion 0.5% const. IHF) — 18 ~ 46,000 Hz; 10 ~ 56,000 Hz; Frequency Response — Phono 30 ~ 15,000 Hz ±0.5 dB; 30 ~ 15,000 Hz ±0.5 dB; Aux. Tape PB Rec/Pb, 20 ~ 30,000 Hz + 1 −3 dB; Power Amp section 15 ~ 50,000 Hz + 0 −3 dB; 15 ~ 50,000 Hz + 0.3 dB; Damping factor — 40 at 8Ω 1 kHz; 50 at 8Ω 1 kHz.

SELSOUND HI-FI

The specialists in stereo and four-channel hi-fi systems. For discriminating and budget-minded buyers.

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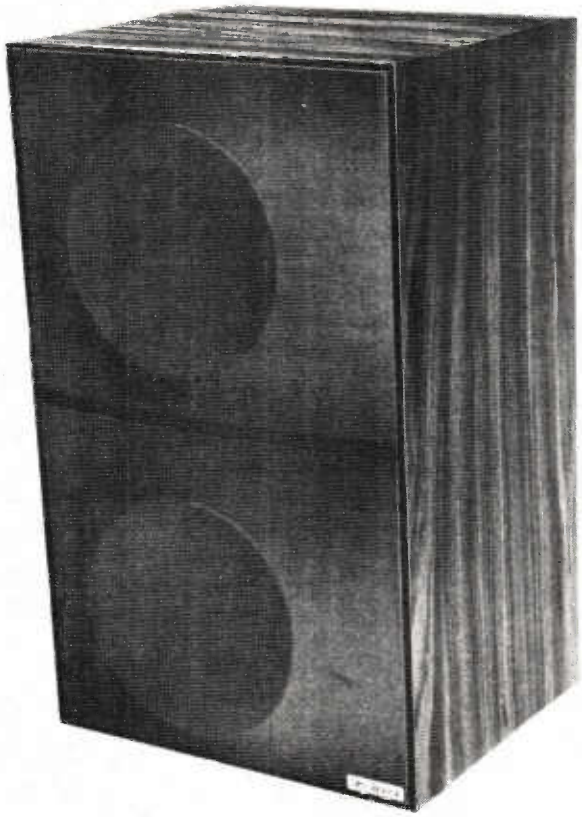
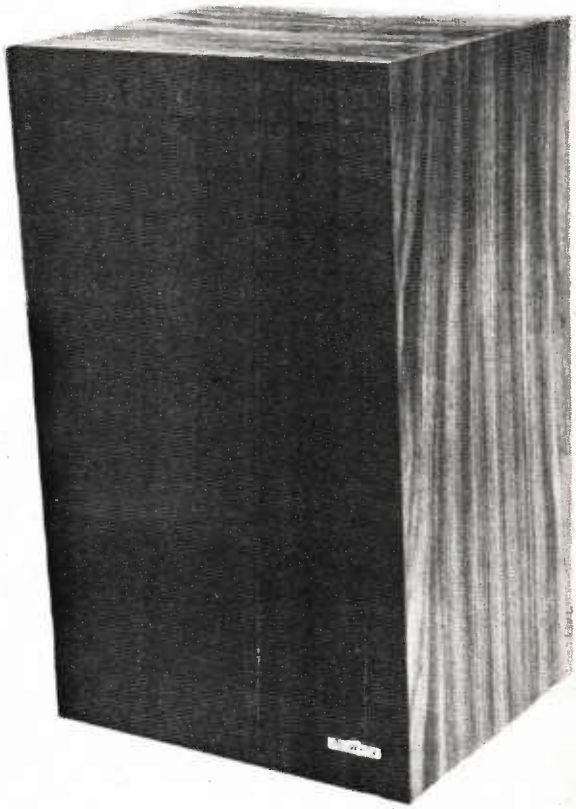
THE MOST TALKED ABOUT SPEAKERS AT THE SYDNEY AND MELBOURNE HI FI SHOWS. AT INCREDIBLE PRICES.



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 T.V. 560-9019.
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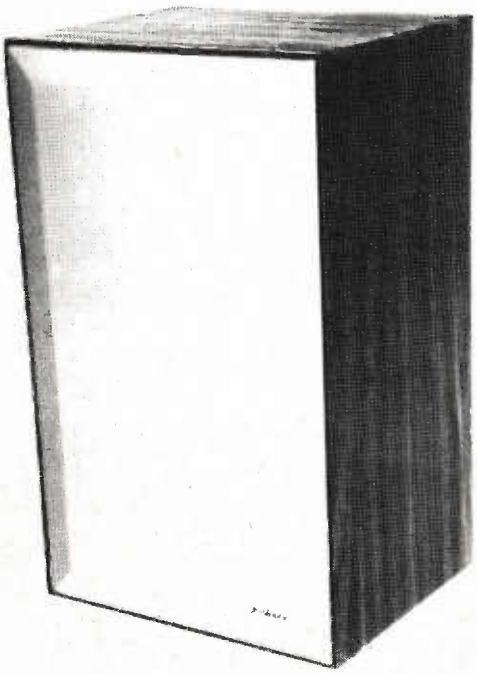
ULTRALINEAR IS HERE

- *DESIGNED FOR THE FUTURE*
- *5 YEARS PARTS AND LABOUR WARRANTY*
- *AUTOMATIC CIRCUIT OVERLOAD BREAKER.*

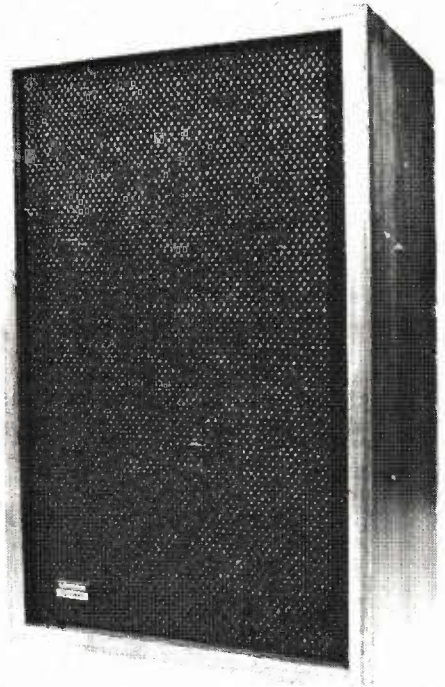
MODEL 100



DRIVERS 12" Twin Cone Woofer.
2½" Super Tweeter.
FREQUENCY RESPONSE 37 Hz to 20,000 Hz.
CROSSOVER FREQUENCIES 2500 Hz
MINIMUM POWER REQUIREMENT 5 Watts RMS
MAXIMUM POWER HANDLING 30 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 $94 EACH

LINEAR SOUND 82



* 1 year parts and labour warranty
* As reviewed in Aust. Hi-Fi Speaker Guide Vol II

DRIVERS 8" Acoustic Suspension Woofer
1½" Pressure Dome Tweeter
FREQUENCY RESPONSE 37 Hz 20,000 Hz
CROSSOVER FREQUENCIES 2300 Hz
MINIMUM POWER REQUIREMENT 3 Watts RMS
MAXIMUM POWER HANDLING 25 Watts RMS
NOMINAL IMPEDANCE 8 Ohms
COLORS AVAILABLE: BROWN
TIMBER WALNUT FINISH
SIZE 21½" H x 13" W x 9¾" D

PRICE $69 EACH

SOLE AUSTRALIAN AGENTS

LINEAR SOUND PTY. LTD.

639 PACIFIC HIGHWAY CHATSWOOD Phone: 412-4352.

LIGHT YEARS AHEAD

introducing the ESS amt 1

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. As an achievement, the ESS amt 1 leaps far forward in the pursuit of acoustic perfection, and it is so clearly superior to all other loudspeaker systems that no previous experience in high fidelity reproduction will have been adequate preparation for this revelation in sound delineation.

Because it uses an entirely new and singular moving system, the Heil Air Motion Transformer produces sound free from even the most subtle forms of distortion, distortion that robs music of its articulation and clarity, thereby creating listener fatigue, pain at high volumes, or coloration in the human voice. All forms of distortion are gone; not only the clipping distortion of high level demands, but the less immediately recognized motional errors that rob brasses of their "sheen," strings of their "guttiness," solo instruments of a natural "ease" and turn an orchestra of individual instruments into a homogenized sonic blur. Every detail of the recorded performance is revealed with a degree of purity never before achieved and completely beyond the ability of all other sound generating devices.

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. It surmounts all the motional and elastic restrictions inherent in conventional transducers and achieves a level of performance that finally approaches theoretical perfection.

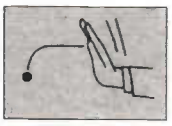
the loudspeaker of the future— the ESS amt 1

Utilizing the newly perfected Heil Air Motion Transformer, developed by noted physicist, Dr. Oskar Heil, and manufactured under exclusive license by ESS, the amt 1 is the most advanced loudspeaker system available today.

The Heil Air Motion Transformer, around which the ESS amt 1 was designed, is a revolutionary new transducer that does not generate sound waves by pushing air with a piston "plunger." As dramatically different from vibrating cones and panels as the rotary is from the reciprocating piston engine, the Heil Air Motion Transformer takes advantage of previously unutilized laws of physics to produce air movement with a technique that approaches the ideal massless generation of sound.

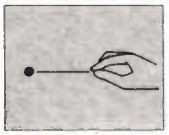
Instead of trying to displace air molecules with the forward-backward motion of a flat or cone surface, the Heil Air Motion Transformer harnesses the power-purchase of a pneumatic "lever" and by applying small squeezing forces over a large surface area produces air movements *five times greater* than 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 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.

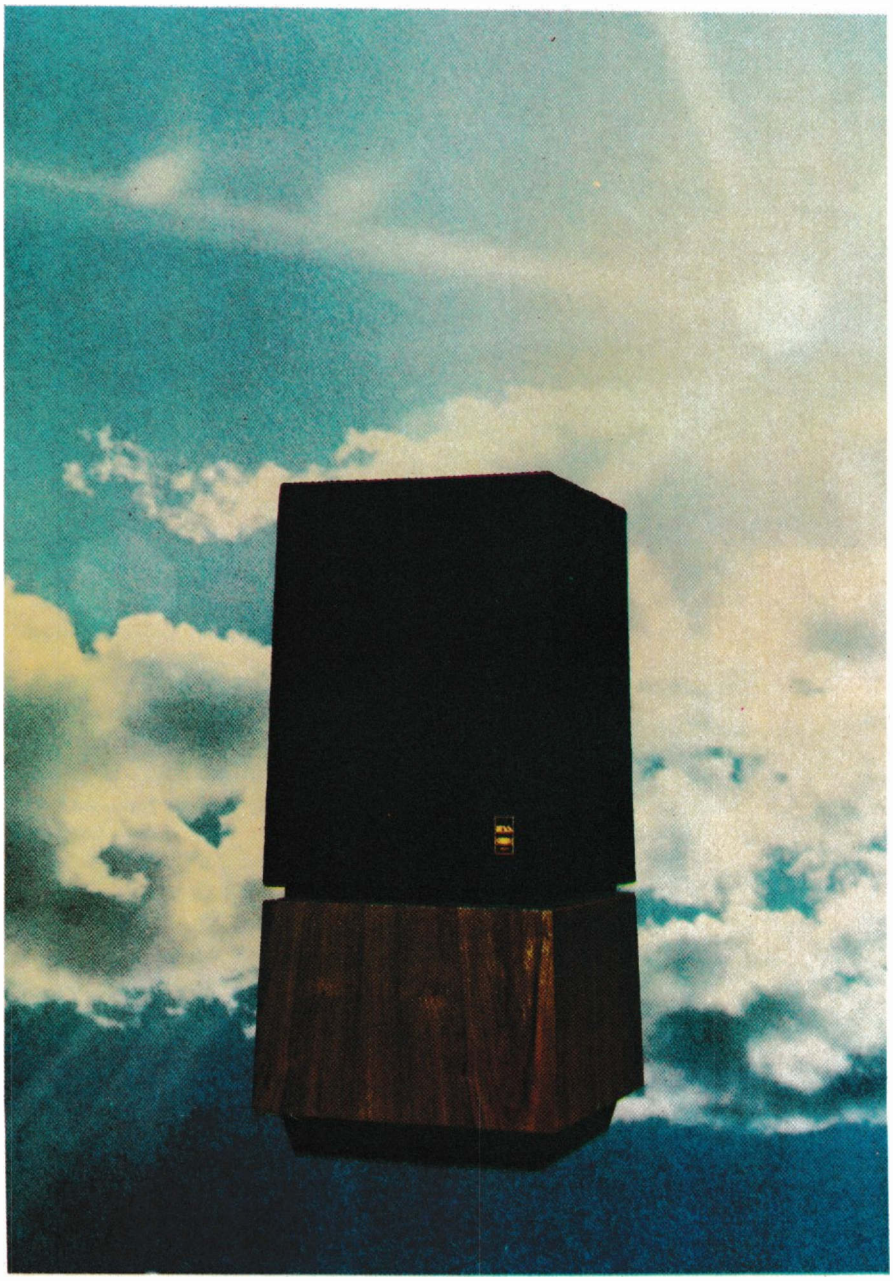
the need for the ESS amt 1

With the stunning improvements in recordings and electronics, the lack of significant improvement in loudspeaker drivers has become more and more apparent. Conventional cones and horn speakers have been produced since the turn-of-the-century, and electrostatics, supposedly new, were produced and sold in Germany in 1923. Listeners felt, and were right in feeling, that there must be a better way to generate sound than to push against air with a conventional "plunger" type loudspeaker motor.

In the conventional paper cone "plunger" speaker, the mass of the moving system is so great that it constantly struggles against its own immense inertia. Just as when starting to push a wheelbarrow full of mushy cement or trying to stop it once it gets rolling, the mass of these devices, at rest or once set in motion, makes precise starting or stopping impossible. As a result even the most compliant of these piston "plunger" speakers blur the sound to an extent now becoming fully realized. More importantly, because of their inability to recover rapidly once set in motion, they clip the tops off transients and thereby rob music of its dynamic range and hence its searing drama. Various attempts to overcome these deficiencies have led to cones at the end of "tubes," cones in sealed boxes, or multiple small cones. None of the "solutions" has had any significant effect in overcoming the inherent problem: too much mass and too little efficiency in transferring kinetic energy from the "plunger" to the air.

Electrostatic and ionic drivers have removed the mass of the moving system as a significant source of error, thus improving transient response through a more rapid recovery, but only at the price of releasing a Pandora's box of other limitations. The electrostatics are unreliable, have poor dispersion, cannot be played at high volumes, are costly, complex, inefficient and place difficult demands on an amplifier. The ionic tweeter has the added drawback of being able to produce only the extreme highs, while being inefficient and temperamental; moreover, it has this interesting feature: it consumes itself over a period of time.

Like the piston engine, the piston cone has endured because, until now, the alternatives have been complex, expensive, and even more inefficient and temperamental. Above all, no alternative has achieved sufficient sonic improvements to warrant the trouble. And yet the existence of these mechanisms even with all their problems and limitations, proves that the public wants greater fidelity in reproduced sound. Fidelity *surpassing* these devices and unhampered by limitations is now available with the revolutionary new ESS amt 1.



ESS amt 1

Stocks are now reaching the better sound shops. Recommended retail price $628 per pair. For further information contact:

ESS Inc., C/o 220 West St. Crows Nest. 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.

Linear Design

BRINGS ON THE NEW

MODEL GST1 TURNTABLE

R.P. $139.00 COMPLETE

"ENTFERNEN SIE DEN DONNER VON DER MUSIK!!"

That's German, and translated it means:- "Remove the Thunder from your music" and that's exactly what you get with the GST-1 Turntable:- No RUMBLE!!
Never have your records sounded so quiet between tracks.

What DO you get? Well, some nice things like:

1. A high torque synchronous motor
2. A neoprene belt drive system
3. A finely balanced 4lb. platter
4. A unique floating suspension to reduce acoustic feedback.
5. A superb transcription tone-arm (see specifications)
6. A Shure M55/E cartridge
7. Magnetic anti-skate adjustment
8. A smooth hydraulic lifting device
9. A handcrafted walnut plinth and lid
10. A two year guarantee.

All this for $139.00. Can it be any good? You bet ya!!.
See the Linear Design Turntable at your nearest HI-FI dealer NOW!!

SPECIFICATIONS

Turntable: Aluminium alloy cast 4lb platter.
Drive: Hysteresis motor via neoprene belt

Wow & Flutter: ±0.05%.
Rumble: Better than 56db.
Speed Deviation: Less than 0.9%
Tone Arm: Static-balance type with lateral balancer, overhang and height adjustment levers. Heavy elements are close to the fulcrum and provides low inertia.
Tracking error: Less than 1 degree.
Stylus Pressure: 1¼ grams (with Shure M55/E).

Arm Lifter: Smooth hydraulic type lift.
Antiskate: Magnetic replusion of direct reading type.

Plinth finish: Oiled walnut only.

DISTRIBUTORS: BJD Electronics Pty. Ltd.

202 Pelham St., Carlton, 3053 Vic. Ph. 347-8255.
190 Willoughby Road, Crows Nest, 2065 N.S.W. Ph. 439-4201

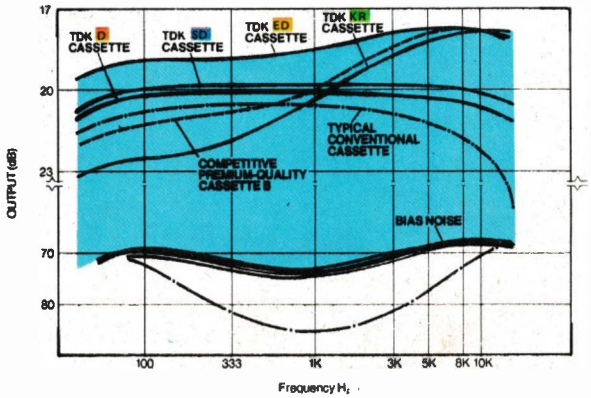
the TDK philosophy

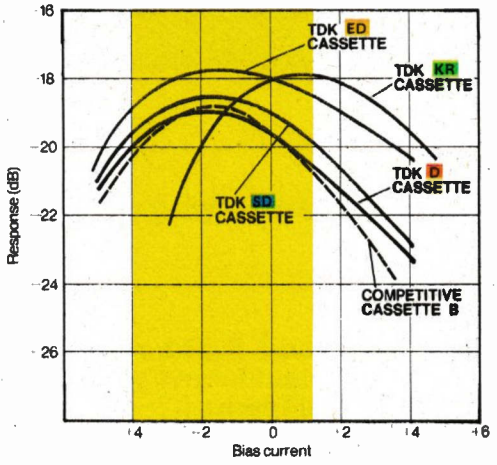
In response to the demands of the ever-increasing number of Cassette hi-fi fans throughout the world, TDK develops its new cassettes under the guidelines provided by the following philosophy:

- to offer cassettes which are capable of capturing and faithfully reproducing the real essence of music.
- to manufacture cassettes with magnetic characteristics compatible with all makes and models of cassette decks and portable recorders.
- to continue research to maintain TDK's leadership in the development of improved magnetic recording tape which exceeds the capabilities of the latest recording and playback equipment.

DYNAMIC FREQUENCY RESPONSE

The frequency response curves of TDK's ED, SD,D-(LN)*and KR cassettes (right). Compare them with a conventional cassette and a well-known competitive high-output tape. Note that chromium-dioxide tape (KR), as well as competitive cassette A, offer great senstivity at high-end frequencies (as does ED), but considerably less sensitivity than the others at frequencies below 1,000 Hz. The curves show that TDK ED cassettes offer the most desirable frequency response, both SD and D-(LN)* cassettes also provide very flat frequency response.





THE IMPORTANCE OF BIAS

The ability of a tape to perform properly over a wide range of bias settings is called its bias tolerance. TDK EXTRA DYNAMIC, SUPER DYNAMIC and DYNAMIC cassettes have a wider tolerance for variations in recorder bias settings than any other cassettes as shown in the diagram. They will perform perfectly on all cassette players, with or without bias selector switches. Many high-quality cassette decks are biased specifically for TDK tape.
DO NOT use TDK KROM-O2 or any other chromium-dioxide cassettes on recorders not equipped with a KRO bias selector switch.

TDK CASSETTES ARE AVAILABLE IN . . .

ED – EXTRA DYNAMIC. The Audiophile Tape, World's Best.
SD – SUPER DYNAMIC. The Professional Quality tape.
***D-(LN). The Dynamic Low-Noise tape – best value.**
ALL SUITABLE FOR EVERY TYPE OF TAPE RECORDER.
KR – CHROME DIOXIDE. The best Special Tape. (Only suitable for special recorders set to "KRO").

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84-86 Nicholson Street, Woolloomooloo 2011. Sydney (02) 357-2444

THIS IS EPI
MICROTOWER

Sensational New loudspeaker system from the USA

EPI MICROTOWER I'S

Yes, the impact is sensational. Superb performance complimented by really beautiful styling, at a price you can afford. Under $100 each.

What is more the Microtower I's are suitable for amplifiers rated from only 5 watts per channel, right up to 50 watts per channel.

They're available in both white and walnut finish to look great in your room. It all adds up to outstanding value, so hear them soon, see them soon, and you'll buy them soon. From you're EPI Dealer.

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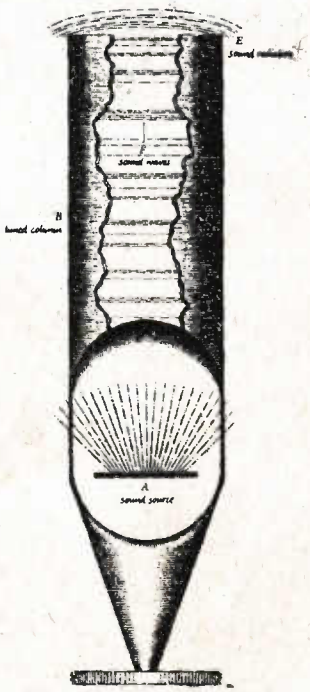
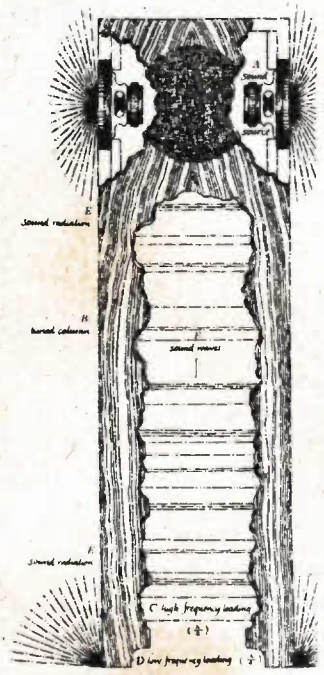
EPI has found a way to produce a big, deep bass sound in a loudspeaker that requires only 4 to 5 watts RMS per channel and costs less than $100.

You're shaking your head. "How could they *possibly* . . . ?"

We did it by eliminating the most expensive part of a speaker: the woofer. And replacing it with a patented process, a remarkable technique for producing tight, accurate bass response down to below 50 Hz; the "Organ Pipe Principle."



The Organ Pipe



The EPI Micro Tower.

Revolutionary is not too strong a word for EPI's new MicroTower.

Instead of the usual configuration of tweeter and woofers, this deceptively simple new kind of speakers uses two full-range 4½" drivers to produce high and mid-range frequencies.

Now, here's where the Organ Pipe Principle comes in:

When an organ pipe is excited by a small flow of air, it radiates sound in all directions.

In much the same way, EPI's MicroTower takes the small vibrations that are produced by low frequency bass notes in the two drivers, and amplifies those vibrations to the proper level, over three octaves of bass response, *within the speaker cabinet itself!*

What this remarkable breakthrough means to the quality of the sound is something remarkable, too:

EPI's MicroTower produces truly omnidirectional sound, or what we prefer to call "Spherical Sound." This means that the MicroTower radiates sound almost equally in all directions, at all frequencies, and with virtually no distortion. (Until now, the only speakers capable of this were EPI's Tower at $2000 per pair and MiniTower at $1000 per pair.)

At under $100 for EPI's MicroTower, just about anybody can afford it. And with its ability to deliver on only 4 or 5 watts RMS per channel, anybody with even the most inexpensive kind of amplifier can now hear bass notes he never heard before.

Within a matter of years, we predict that most component speakers will embody some form of what is now being offered in EPI's MicroTower. But for now, at least, there's only one place it's coming from: Epicure Products Inc., One Charles Street, Newburyport, Massachusetts 01950, USA.

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Our **EPI MARANTZ DUAL SYSTEM** is unique among all systems that can be put to-gether; it is a music system that is right, completely satisfying choice for most people with a demanding interest in both music and sound — at a price far lower than such a system would have cost just a few years ago.
An ambitious claim to be sure. But one which, from experience, we are not afraid to make. Our $479 system will do the following for you:

1. It reproduces the entire frequency range of all music, without distortion, at levels which will comfortably fill your listening room. (Whgerians and rock freak not excluded).
2. It sounds convincing not only on the best recordings but on the majority of recordings of all kinds.
3. It has enough controls and features without making you pay for unnecessary frills. (Theres ample flexability for adding such niceties as a tape deck or additional speakers).
4. Its performance and durability are such that it's highly unlikely you'd want to change any of the components for a very long time.
5. Its fully guaranteed for 3 years.
6. The EPI micro tower loudspeakers have proved true the claim made of them they provide the kind of performance normally associated with speakers costing far more.
7. The Dual automatic manual turntable does its job smoothly and reliably; its heavy platter turns records at a constant speed, quietly. There is a gentle changing mechanism and a convenient cueing control. The Shure cartridge transmits all the sound that is on the record, and at a record saving 1½ grams tracking force. Its excellent high frequency response complements the EPI loudspeakers it comes complete with a diamond stylii.

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The Marzantz 1030 quality that isn't expensive.

The exciting Marantz 1030 console amplifier professional craftsmanship, performance, and engineering excellence rolled into one.

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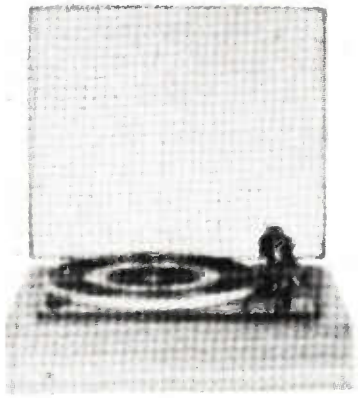
Gold anodized front panel. Quotation from Aust. Hi Fi (AT $199 best value for a long long time).

The price of the individual components is $527 but you can buy the complete system for only $479 installed in your home and guaranteed for 3 years. Come into our store and listen to what we think is the best value in home music systems available today!



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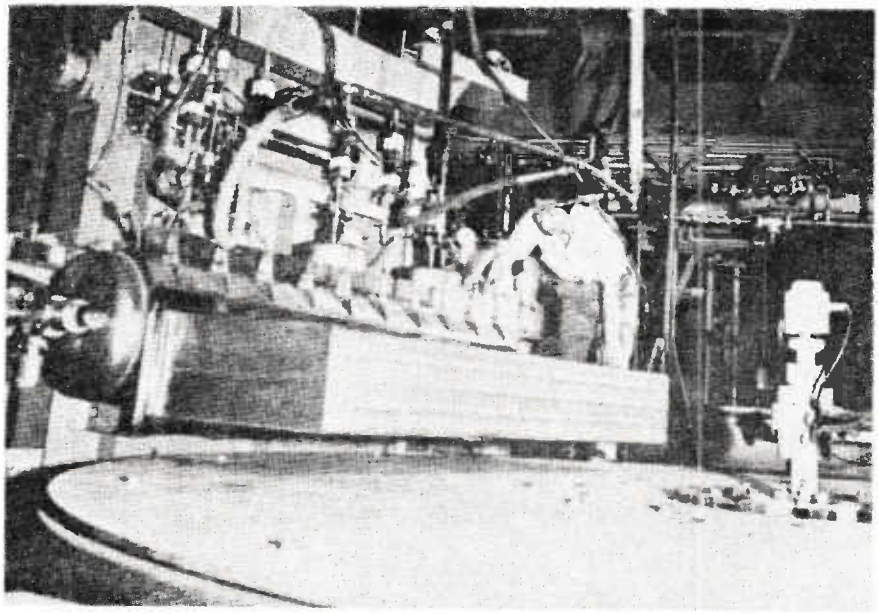
SUPER MAGNET SUSPENDS TRAIN



A prototype of a wing-type super conducting magnet capable of magnetically suspending a 500 km/h (300 mph) super-high speed train has been completed by the Tokyo Shibaura Electric Co. (Toshiba).

The device has been test-manufactured by Toshiba in accordance with the Japan National Railway Corporation's plan to run a 500 km/h super-high speed train between Tokyo and Osaka, Japan's two biggest cities located some 500 km apart, in the 1980s.

The newly-made superconducting electromagnet is 240 mm thick, far less than a conventional electromagnet. This makes it possible to fit the magnet beneath the body of a train like aircraft wings.

The wing-type magnet is inserted into hollow-type ground coils that correspond to rails for a train. This system is called the "Null Flux" track which is characterized by low resistance while a train is speeding.

In completing the prototype, Toshiba has solved economic problems involved in the practical operation of such a super-high speed train.

One of the economic issues is that while the lift power is generated between the car's magnet and the ground magnet, electromagnetic resistance is generated and works against the running of the train. The Null Flux track system minimizes such electromagnetic resistance, making the operation of the train with a small quantity of power feasible. Moreover, the wing shape of the magnet reduces air resistance and gives stability to a running train.

Another economic issue solved is the minimization of heat loss due to adiabetic structure of the device and shielding techniques. The heat loss has been cut down to about 1 W. Thus effective cooling with one kind of refrigerant alone becomes practicable.

SINGLE CHIP AM-FM RADIO

Lester Hogan, president of Fairchild Camera and Instrument Corporation, recently told a US marketing seminar of Fairchild's plans produce a one chip high fidelity AM-FM radio.

Hogan did not disclose technical details of the chip – which is presumably a linear MSI device – but indicated that the device could well take the AM-FM radio market back from the Japanese.

WATCH OUT!

Electronic watches with liquid crystal displays made by the dynamic scattering process are said to be exhibiting a very high failure rate – some watch companies are getting back two out of every three watches that they have made.

Whilst most of the watch manufacturers are claiming that the return rate is less than 10 per cent, this is believed to be based on total shipments rather than numbers sold.

Characteristic failure is disintegration of the dynamic scatter crystal, caused, according to the industry, by ultra-violet radiation when the watches are displayed in shop windows;

This explanation seems improbable in the extreme as the combined filtering effect of the shop window, watch glass and transparent electrodes would virtually eliminate all radiation below 300 nanometres.

A more probable explanation is that there is a 50°C upper temperature limit on most liquid crystal displays of the dynamic scattering type – and this temperature is being exceeded when the watches are displayed in shop windows.

RESTORING SERIAL NUMBERS

NASA's Lewis Research Centre (Cleveland, Ohio, USA) has developed a technique for restoring serial numbers that criminals have removed from metal by filing or grinding.

The method is based on cavitation, the formation of tiny vacuum-like cavities caused by uneven pressure gradients in a liquid.

In practice, the object concerned is immersed in an ultrasonic water-bath. The ultrasonic generator, by creating uneven pressure gradients in the water, causes millions of microscopic cavitation bubbles to strike the surface of the metal with very great force – selectively attacking metal that has been microstructurally altered by the original action of stamping on the serial number.

In some cases the number reappears as a 'ghost' image rather than a 'cleaned out' groove. The technique is said to be cheap and simple to use.

20CM LIQUID CRYSTAL

A small US manufacturer (Transparent Semiconductors, Goleta, California) has developed a 20 cm (8" approx) high alpha-numeric liquid crystal displays.

Prototype quantities should be available early 1974 – price is expected to be US$50 for lots of 1000.

The transmissive dynamic scattering type devices are intended to be back-illuminated and will find applications involving long distance viewing, large audiences, or high ambient light conditions.

PRESSBUTTON PHONE

At the Canadian Electronic Engineering Conference and Exhibition held by the IEEE in Toronto this month, Britain's Pye TMC won the special award for the 'best international product' with their new 'SpheriCall' automatic dialler.

This outstanding achievement was gained in the face of intense competition from leading USA, Japanese and European electronics manufacturers.

The Pye TMC 'SpheriCall', based on MOS-LSI (metal oxide silicon-large scale integration) technology, adds the speed and convenience of pressbutton dialling to an ordinary rotary dial telephone. It has a 'try-again' facility at the press of a button and a memory in which 10 most frequently used numbers can be stored; any of these numbers can then be called automatically by pressing two buttons.

PDP-8 PRICE TO BE SLASHED?

An authoritative source in the USA tells us that the Digital Equipment Corporation may shortly drop prices on the OEM versions of its PDP-8 minicomputer line by as much as 40 per cent.

SKY SPIES IN ARAB/ISRAELI WAR

Five Russian Cosmos 'spy satellites' were launched into orbit between October 6 and October 20.

Soviet military intelligence are believed to have used the satellites to obtain complete information on the Israeli response to 6th Oct Egyptian crossing of the Suez Canal, and subsequent engagements on the Syrian fronts, together with data concerning the movements of the US military forces in the Mediterranean area.

Cosmos satellites of the type used for this operation normally stay in orbit for about 12 days. They are fitted with TV cameras and associated equipment to enable the received data to be stored on tape for subsequent transmission 'on command' to Soviet ground stations. Other information is obtained by photo-reconnaissance cameras mounted in re-entry capsules that are subsequently parachute recovered over Russian territory.

Details of US spy satellites covering the war are harder to obtain, but it is known that an Agena D satellite was launched into orbit from the Vandenberg Air Force Base in California on September 27.

ELECTRONICALLY CONTROLLED TRANSMISSION FOR CARS

A new electronically controlled automatic transmission system for cars has been developed in Britain by Associated Engineering Developments (Cawston House, Cawston, Rugby, Warwickshire, England).

The company has granted an option to Volkswagen to licence the system for use in cars.

Under a specific test programme the suitability of the electronic control equipment for use in Volkswagen vehicles will be examined. BMW are also evaluating one of their 3.0S saloons that has been modified at AED's R & D Centre at Cawston, Warwicks, to accept this new form of transmission control.

The AED system in effect replaces the conventional automatic transmission's familiar but complex hydraulic labyrinth of oilways and valves with an electronic governor or throttle linkage inputs as these are derived electronically to save space and weight. It is extremely flexible in terms of the gear change programmes available to the user and the quality of the change is optimised at all times by precise control of the main hydraulic feed pressure within the gearbox. This technique eliminates 'hard' gear shifts and engine speed run-up during shifts, so prolonging the normal life of gearbox components. Mechanical coupling of the transmission selector lever to the gearbox is no longer necessary, since transmission mode selection is initiated entirely by electrical switching. This feature alone makes the new system very attractive to the car interior designer, insofar as transmission selection can be of conventional 'T' bar form or more conveniently consist of a row of illuminated push-buttons, TV 'touch-plates' or even a single rotary switch.

Several failsafe facilities are incorporated including electronic interlocks to prevent forced changes at excessive speed, and 'fail to top gear' in the event of electrical faults. This means in practice, in the unlikely event of the electronic package malfunctioning, it can simply be un-plugged thus permitting the vehicle to be safely driven home in top gear, whereas a major fault condition on a 'conventional automatic' normally imobilises the vehicle until it has been rectified by a specialist service engineer.

COLOUR PICTURE – PLUS SOUND ON STANDARD TAPE CASSETTES

Japan's Hitachi Ltd have developed a cassette system that records still colour pictures, as well as sound, on standard cassette tapes. Reproduction is via a conventional colour TV set.

The system is intended to record and

news digest

play back colour slides, opaque cards, or still frames of TV images for periods of up to 12 seconds per picture. Sound reproduction is in stereo form.

An Hitachi spokesman said that the system will be commerically available from October 1974. Selling prices are not yet known.

POCKET TV

Britain's Sinclair Radionics are planning to introduce a truly pocket-sized black and white TV set by the middle of next year.

Few details are currently available – except that price (in the UK) will be less than £50.

SPAIN TO USE PAL SYSTEM?

Spain is to introduce colour TV in 1975. Currently the state-owned TV network is conducting test transmissions using the PAL system using experimental PAL colour programmes and equipment purchased from West Germany.

Informal sources say that the Spanish government has already decided to use the PAL system.

SOLAR-POWERED WATCH

A solar-powered watch is now on sale in the USA. Described by its manufacturers (Ness Time, Palo Alto, California USA) as the 'most significant development in watches since the quartz watch', the device sells for around US$500.

Three Bell Laboratories scientists have recently developed a technique for fabricating efficient light-carrying glass fibres from a single material. The new, hair-thin fibres are made with the purest known, commercially available glass.

Normally, glass fibres are fabricated with two different materials – one for a very narrow inner region called the core, and the other for a surrounding outer cladding. Light in transit through a glass fibre is kept in the core region by the outer cladding. Until now, fibres made with differing glass materials may have contained undesired impurities that interfered with the passage of light and caused transmission losses.

The Bell Laboratories scientists, S.E. Miller, E.J. Marcatili, and P. Kaiser devised a way of eliminating the need for two different types of glass without sacrificing the light carrying efficiency of a fibre.

The glass they chose had previously demonstrated a potential for very low transmission loss as an unclad fibre. Using a unique design configuration, the trio fabricated a structure that would automatically form this glass into an optical fibre without the need for using additional materials.

In one design there are three components to the new fibre: a tube, a solid inner rod, and a supporting plate for the rod. All three are made of the same low-loss glass.

The plate bridges the centre of the tube, supporting the glass rod. This configuration is preserved as the assembly is heated and drawn down to the diameter of a human hair.

The solid glass rod becomes the light

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carrying central core of the new fibre. The thin plate provides support without allowing the light to escape. And the tube itself is an overall support and protection for the fibre assembly.

The new fibre has shown light loss of 5dB per kilometre. This would allow signal amplifiers to be placed further apart than in land cable systems now in service. Bell scientists expect the new structure to make it possible to take full advantage of the extremely low-loss light-carrying capabilities of ultra-pure glasses.

THE CHIPS ARE DOWN

Short of being given away with breakfast cereals there seems no lower price limit for electronic calculators.

Industry indications are that the A$29.95 calculator described elsewhere in this issue may seem overpriced in a year's time! Several companies are now believed to be planning units to retail at less than A$13 some time towards the end of 1974.

Pressure from calculator manufacturers is forcing down the prices of the LSI chips that now form the major part of the calculator.

Cal-Tex Semiconductor, for example, are quoting prices as low as US$3.50 for its four-function 12 digit chip, and expect shortly to be quoting US$8 for its engineering chip that incorporates square-root, reciprocal and constant functions.

Another example, showing how prices are falling, is that of Mostek's four function chip which sold at US$30 in 1970, US$18 in 1971, US$8 to US$10 last year – and is now priced under US$5 for large volume sales.

Further reductions in calculator prices may also follow on from Fairchild's recent introduction of the first 'dollar-a-digit' LED arrays. Their new displays are nine digit, nine decimal point devices with inbuild optical magnifiers.

SANYO, GUTHRIE TO PRODUCE COLOUR TV

The Japanese company, Sanyo Electric Co. has established a joint venture in Melbourne with Guthrie Australia Pty Ltd to manufacture colour TV receivers for the Australian market.

To be known as Sanyo Guthrie Ltd, the new company is capitalised at $A250,000 of which Guthrie hold 50 per cent, Sanyo Electric 37.5 per cent, and Sanyo Electric Trading Co 12.5 per cent.

The company has plans to construct a 4500 square metre manufacturing complex at Wodonga by July 1974.

Both 20 inch and 26 inch colour TV sets will be produced – at the rate of 2000 units a month.

PIONEER ESTABLISHES LOCAL SALES SUBSIDIARY

Pioneer Electronic Corporation, Tokyo, Japan, manufacturers of high fidelity audio and stereo equipment, has announced the formation of an Australian subsidiary capitalized at $A100,000.

The new Company, Pioneer Electronics Australia Pty. Ltd., incorporated in Victoria, takes over immediate responsibility for merchandising Pioneer high fidelity and car stereo products through offices in each State of Australia.

Mr. J. Leslie Black has been appointed Managing Director of the new company which began operating on 1st October.

Mr. Black was formerly General Manager of Astronics Australasia Pty. Ltd., a subsidiary of Philips Industries Holdings.

The two other directors are Mr. Y. Ishizuka, President of Pioneer Electronic Corporation, Tokyo and Mr. S. Hayakawa, Managing Director of the same Corporation.

CONCORDE NOISE

Silencing the Concorde's engines to internationally acceptable norms may well be impossible according to a report in the French weekly "Le Canard Enchaine".

The paper – which has a world reputation for publishing secret documents to back up its scoop stories – claims that the reported findings are contained in a document 'Acoustics Memo 21' prepared by the acoustic department of the British Aircraft Corporation.

The British Aircraft Corporation have since admitted that the report exists, but claim that it refers only to the 'spade' silencers fitted to the engines. The silencers, say the Corporation, have not proven to be as effective as had been hoped, but they add, the silencers are only one aspect of the silencing programme.


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good enough....
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WE'RE ALL AT SEA...

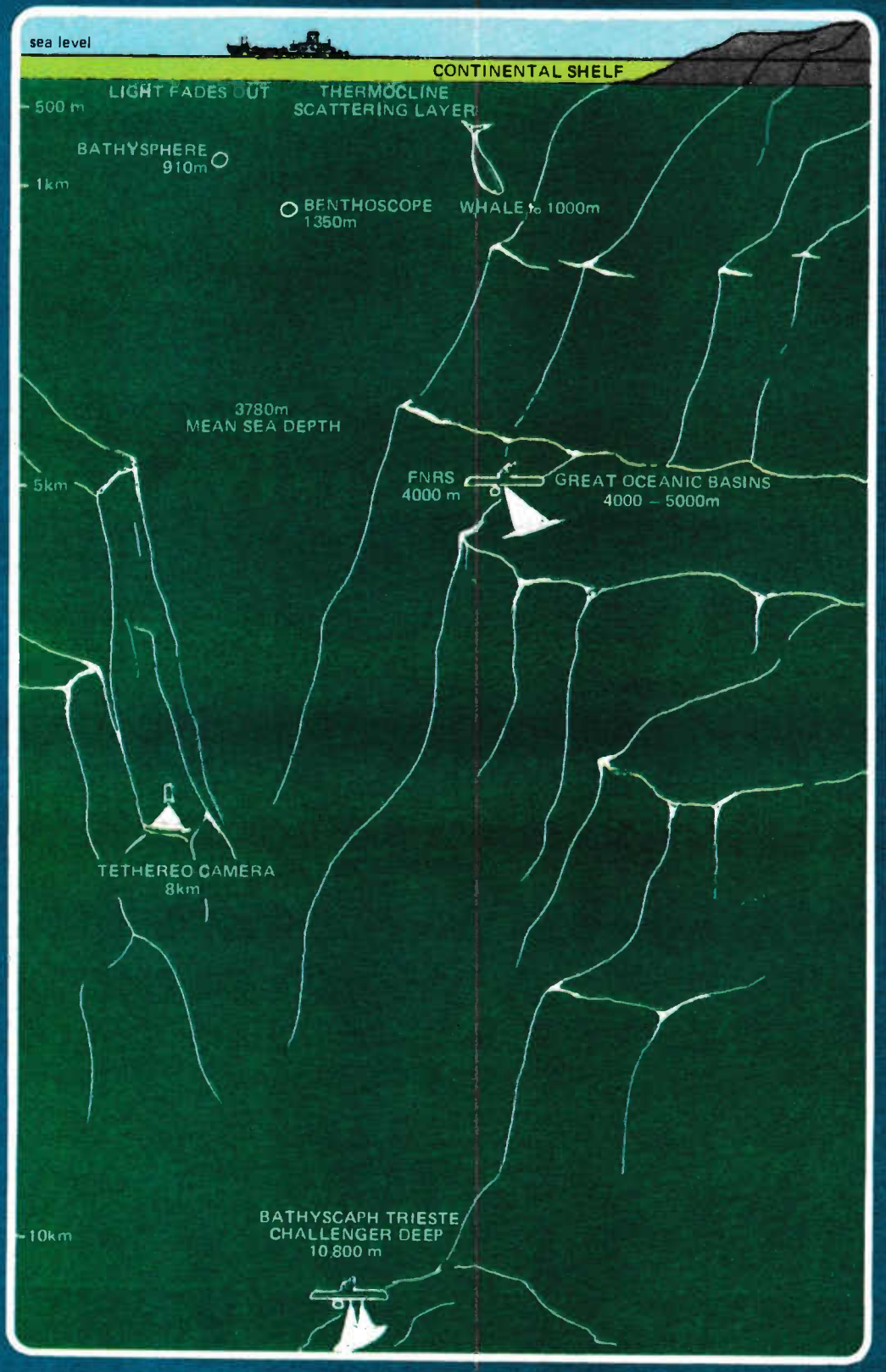


Fig. 1. The oceans are deep, as this diagrammatic cross-section shows.

But where are we?

In recent years man has taken to the seas as never before. In this article Dr Sydenham discusses position-location on the sea surface. A following article will deal with sub-surface measurements.

THERE is hardly a square metre of land surface that has not been seen by man — even parts of the distant Moon have been visited. Yet, compared with our knowledge of the land, the seas remain virtually unknown to us: oceanography is a relatively new science. Starting around 1850, scientific enquiry into the oceans soon gained ground and today exploitation of the seas is a multimillion dollar industry. The first study of note was the voyage of the Challenger (1873-1876) in which 150 000 km of ocean was charted and sampled. This wealth of fact finally dispelled the popular notion that the oceans were all of immense depth and lifeless.

Movement into the depths, however, was inhibited because of the existence of several significant barriers. Firstly, it was possible to estimate their position in those days, with precision, only if close to land — there are no distinguishable marks on the surface of the sea as there are along a coastline.

Under the surface of the sea the problems multiply rapidly — see Fig. 1.

The pressure increase demands that the unprotected diver be given time for his physiological functions to adjust; natural light fades rapidly; hostile sea creatures may be present: disturbed mud and silt masks the artificial light. In all, it is only certain kinds of people who dare venture there without the comfort of a submersible chamber.

THE NEED TO EXPLORE THE UNDER SEA

About 70% of the Earth's surface is covered by seas — a mere 700.10^6 km^2. To many it is an ocean of salt water, but it is becoming increasingly obvious that it abounds with food, minerals and energy. Oceanographers suggest the fish catch could be as high as 10^{14} tonnes a year. We do not, as yet, come anywhere close to this size of yield: fishermen need to know where the fish are in order to catch them.

As the known deposits of economic minerals on land are worked out, the price rises. It has now reached a point where it is economical instead to look for, and win, minerals from the sea-floor. For example, diamonds are now literally sucked from the sea bottom.

Getting away to a slow start off the coast of South Africa in the 1930's, diamond dredging was eventually shown to be an economic operation. One dredge extracted a one carat diamond per 250 kg of spoil moved — by comparison, on land the ratio is around 50 10^6 kg per carat. However, when operating dredges it is vital to know their position accurately in order to dredge the floor in a systematic manner.

Diamonds are not the only sea-floor wealth; tin, gold, sulphur, iron, organite sands and phosphorites are also available. Manganese nodules, growing by chemical action at a millimetre per thousand years, exist as dark lumps lying on the sand surface with densities reaching as high as 30 kg per square metre.

There can hardly be a person who has not heard of the seabed oil and gas wells. Offshore drilling, a practice developed extensively in the last decade had its start back in the 1930's. Today huge platforms, supported on legs that go to the floor, or float at depth, are now in place in many oceans and seas. This is big business; financial returns being such that incredibly expensive and sophisticated procedures have been justified to aid the drilling and control of wells. Accurate position control is essential for the rig, for it must not drift away when the drilling-string is drilling a well.

Whenever man seeks wealth it is necessary for him to lay claim to his patch of territory — the problems of undersea claimstaking and the definition and policing of international water boundaries are still not adequately solved — there are no distinguishable surface marks and no easy way to provide a fence that is stable in location.

Budgets of the wealthier countries, earmarked for oceanographic research, have been on the increase this decade. Private industry spends as much as governments in the race to exploit the cream of the ocean resources. In the U.S.A. for instance, research funds run to $\$5.10^8$ p.a.

A large part of these monies goes to fundamental research. Programmes such as the deep dry-dive experiments

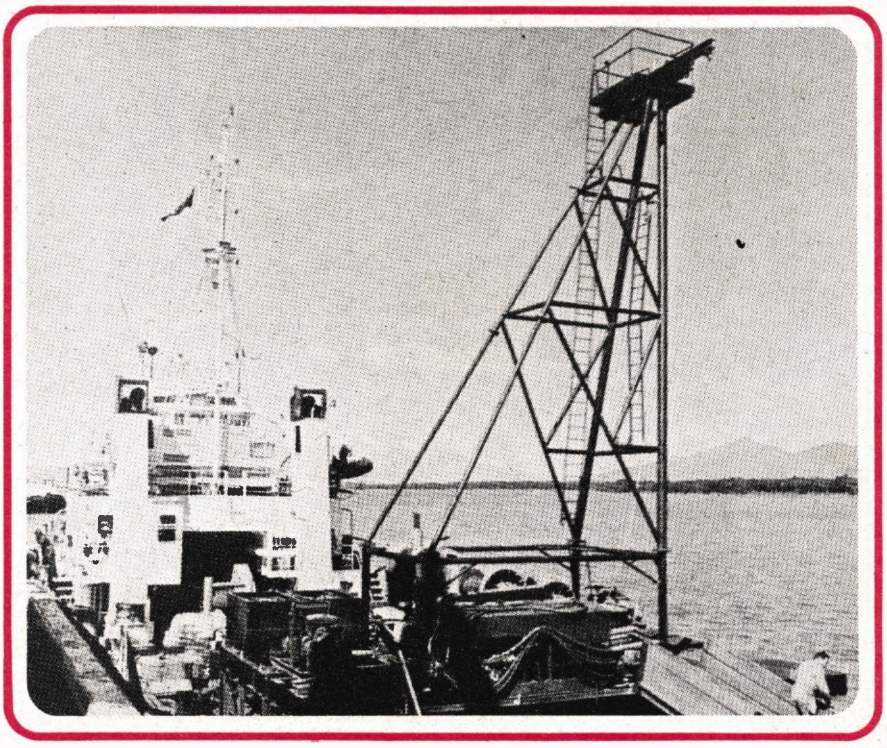


Fig. 2. Survey vessel equipped for marine site investigation.

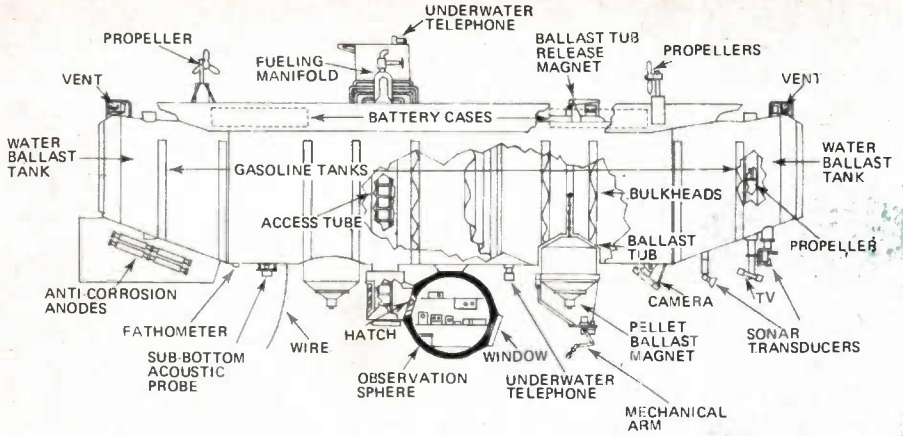


Fig. 3. Trieste – a submersible that has taken man to the deepest depths – bristles with underwater sensing devices.

(the diver undergoes the test in a compression chamber in the laboratory – an equivalent depth of some 500 m has been reached in this way by an unprotected man) and the testing of the now numerous unmanned and manned submersibles – the Trieste (a cross section shown in Fig. 3.) is the best known example – holding the deepest dive record of more than 10 km in the Challenger Deep (at that depth the pressure rises to around 12 kg per mm^2.) Not everyone wishes to go that deep – there is more urgent work in more moderate depths. In all such studies depth and position information is a vital part of the programme.

It goes without saying that the military also need to know the location of submarines, both of their country and of others.

Many submersibles are operated by remote control from a surface mother ship – sea floor crawlers seeking minerals, fish nets that automatically close when a shoal passes into the net, exploration devices and deep-sea rescue modules come to mind. In order to manipulate these devices it is necessary to build in sensors that will monitor depth and relative position so that control can be effected.

We start this survey with a look at the means available for position fixing at a point on the surface of the sea.

MEASUREMENTS ON THE SEA SURFACE

The long-standing position-location problem is that of continuously monitoring the position of a ship in order that it can make way in safety on an efficient course. Another important need is that of avoiding collisions between vessels navigating the recognized shipping lanes. In relatively recent times another class of need has arisen – that of holding a constant position over the sea bed, for example, whilst drilling the sea bed with a floating drill-rig.

USING THE STARS AND SUN

Before the advent of radio-location methods the only means of accurately establishing position away from land was to sight the stars at night, or the sun by day, using a sextant and an accurate clock. Between these checks navigation is achieved by using the magnetic compass bearing and ship's speed to establish up-dated data. The obvious problem is how to overcome the effects of cloud that often cover the stars or sun when a sight is needed.

Total automation of this procedure became a reality in the 1960's when the U.S. space programme developed guidance systems for spacecraft based on electro-optical star trackers. There is, however, little real need for this degree of sophistication in sea navigation as other methods exist that are more reliable and not prone to problems of cloud masking. The use of low-light-level optical sensors does, in fact now permit celestial tracking systems to be used through clouds, but the cost is unwarranted in normal sea navigation.

RADIO-LOCATION

Radio transmission of signals was first demonstrated in 1864 using a pair of kites separated by 30 km. By the 1920's, radio was an established routine feature of everyday life in its communications role, but its value as a direction finder was only just being explored. In 1930 Meint Harms, a German, filed a little known patent describing a method now commonly known as hyperbolic navigation. The patent wording suggests that it was already common knowledge at that time that position could be crudely estimated from a knowledge of the directional signal strengths from transmitters. These methods used amplitude measurements and were, therefore, not very accurate because of the varying transmission attenuations. The patent preamble hints at the hyperbolic method, in so much as it recognises that sectional areas exist in space wherein the received signals from two distant transmitters would pass through minimum and maximum signal strengths. Harms' contribution was to suggest that the two distant transmitters should be locked in phase so that phase differences at a receiver could be used to obtain precision position-location.

It is now agreed that this patent foreshadowed the now commonly used Decca system. Harms, like many an inventor beyond his time, tried to interest many notable companies in the idea – Lorenz, Telefunken and others rejected his idea as unworkable. Today the credit for the first routinely-working hyperbolic location system goes to Dippy for the development of a pulsed system and to O'Brien and Schwartz for the CW method.

For a constant frequency transmission the distance travelled for a given number of cycles is fixed – if these were known, distance would be known (in fact, some methods of surveying do use this procedure). When a second beam is also received from another direction the phase difference between them defines position along an hyperbolic curve – not a point in space. With two fixed base stations one can plot a family of hyperbolic curves that represent phase differences ranging from zero to many cycles. If the sum of the phases is plotted in a similar way another set of curves is created – these are ellipses and they run at right angles to the phase-difference curves. If, therefore, both difference and sum are known, position can be defined with respect to the base line. It is, however, not as simple a matter to measure phase-sum as it is to obtain differences, so another procedure is used that avoids the need to take the sum. It makes use of a third base station taking two phase-difference measurements – one hyperbolic net is superimposed over another but at a different angle. This concept is shown in Fig. 4. With this is is possible to locate which small region, or which curve intersection, the receiver is at.

The British designed Decca Sea-Fix system, shown in Fig. 4 uses transmission of 1 W operating at 2000 kHz: position can be located to within 2 m in 37 km distances. It is a coastal system providing little aid for out at sea. Its North American equivalent is Shoran, in the main.

The current controversial Omega system also uses this hyperbolic principle – its salient features are that the transmission is in the 10 kHz region providing a signal over distances spanning the Earth, and that it can also penetrate down into the seas and oceans enabling a submerged vessel to

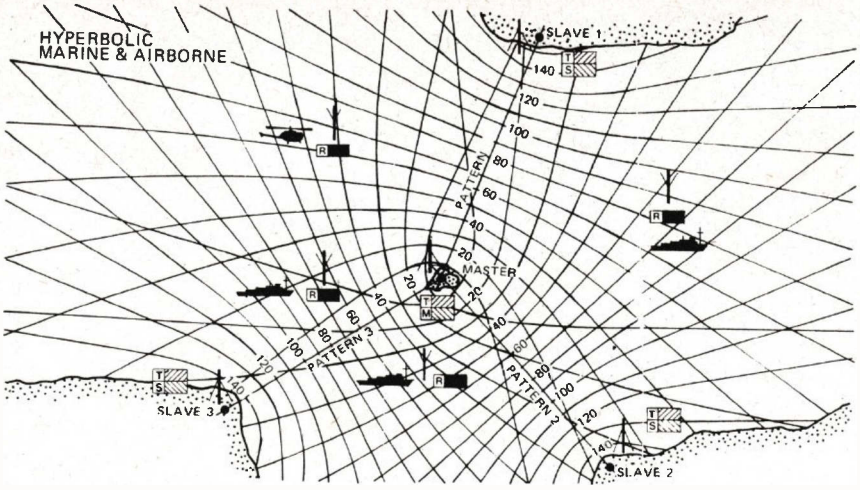


Fig. 4. Ships can locate position by comparing the phase — differences of phase-locked transmissions received from different locations, hyperbolic radio location.

navigate without surfacing. Only eight stations are needed to give global coverage.

A little later than the Harms' patent, in the 1940's, radar became reality making use of the timed flight of a pulse of radio carrier (radio waves travel a metre in three nanoseconds) to give a measure of distance using a single point transmitter/receiver to send and receive the reflected echo. This meant that a more direct method could be used to locate position, as range, distance and bearing suffice to define location. An alternative and more commonly adopted method uses trilateration — two radar stations, placed a known distance apart, each measure range (only) to the target. As the three side lengths of the triangle formed are known, position is known. An extra station, as shown in Fig. 5, overcomes fading and other communication loss defects.

When positioned away from the base stations the system can be used in reverse measuring distance to known bases from a common point. In the HIRAN equipment a pulse of radar energy is sent out from the vessel to base units called transponders; these only transmit a return pulse when a signal is received. An interrogator unit calculates distances and, as we shall see later, can provide control signals for steering. Automatic allowance is made for the fact that the transponders may not be at the same elevation as the vessel.

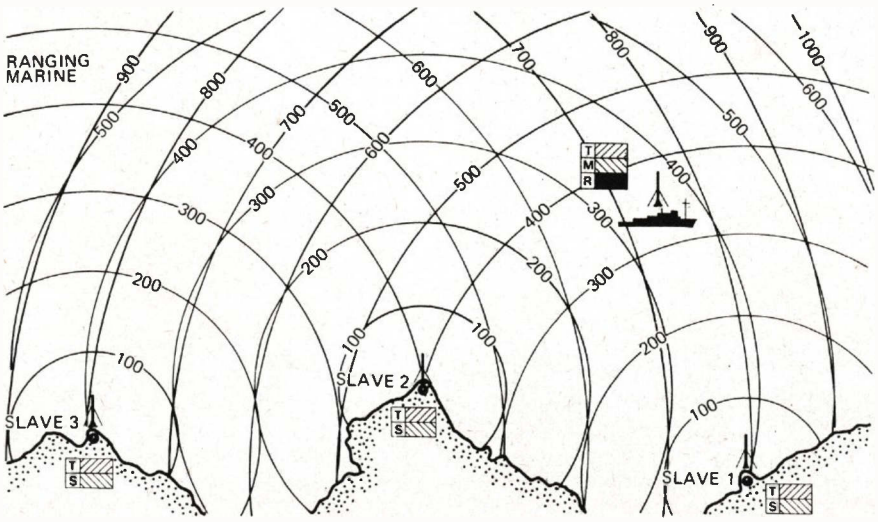
A more advanced system SHIRAN (S-Band HIRAN) operates over 450 nautical miles using 20 W transmission to plot position to within 13 m. The French Trident II method operates on 270 MHz achieving similar precision.

The advantage of trilateration is that it gives greater precision, but is said to be less flexible than the hyperbolic method. It is, however, ultimately limited in precision by the finite pulse rise-times. Yet another system is the Cubic Corporation Autotape for short ranges — it can resolve to 0.01 m, even when travelling at 200 knots in an aircraft.

If the energy is transmitted into a very narrow beam — as in laser radiation — it would be feasible to measure position using one distance and an angle. Laser light-houses have recently been invented to aid navigation, operating in the normal way as a rotating and flashing light source. Perhaps we may see them developed to yield position information at the receiving end. For example, the laser beam can be modulated and detected to give distance between the vessel and the light-house. Angle is then needed. This could be achieved by superimposing another modulation frequency onto the beam that varies with respect to the azimuth bearing of the rotating output beam — giving angle as the instantaneous frequency measured at the receiver.

The latest addition to the numerous variations of the above concepts makes use of satellites to act as precisely placed radio beacons in the sky. Whereas these satellites have enabled geodetic surveyors to improve our knowledge of the Earth's shape and the accuracy of the world mapping grids, there has been justifiable comment that ocean liners do not need such accuracy. (The QE2 has satellite navigation fitted). There is, however, a definite case for its use in marine hydrographic surveys where utmost precision is valuable.

Fig. 5. Ships may also locate position using time of flight radar to obtain two or more distances to known position transmitters, trilateral or ranging radio location.



INERTIAL NAVIGATION

A mass suspended in space resists forces attempting to move it; continuous double integration of the accelerations experienced by the mass gives a measure of distance travelled. It is also necessary to use a second device that keeps the mass orientated the same way in space so that the distances obtained are meaningful — this is usually achieved with a gyroscope. For fast-moving vehicles, such as aircraft, this method can provide reasonable position accuracy, for inaccuracy is a function of the time interval between readings. Generally, therefore, in sea application its use is restricted to fine manoeuvring such as in turning. It also plays an important part in the automation of roll stabilisation of ships, gyro's providing the control signals that operate the angle of attack of the correcting fins. The distinct advantage of inertial methods is that a remote station is not needed.

DOPPLER NAVIGATION

If the velocity of the vessel is integrated with respect to time,

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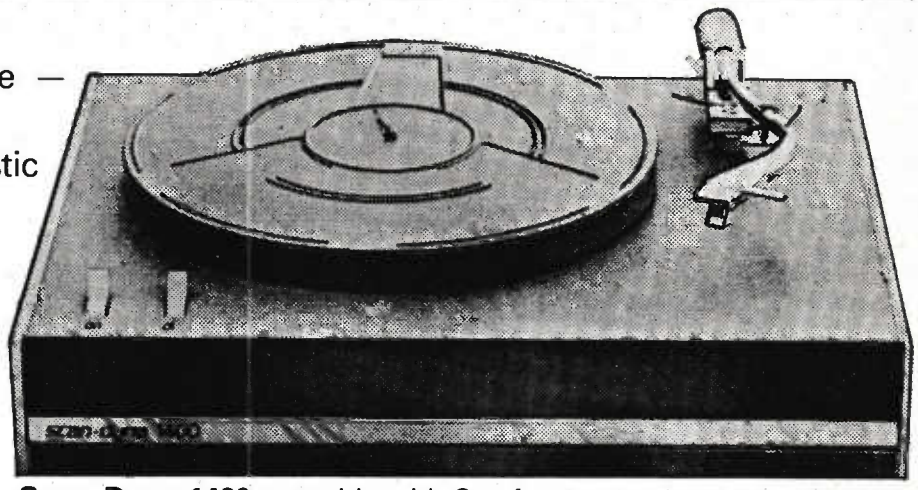

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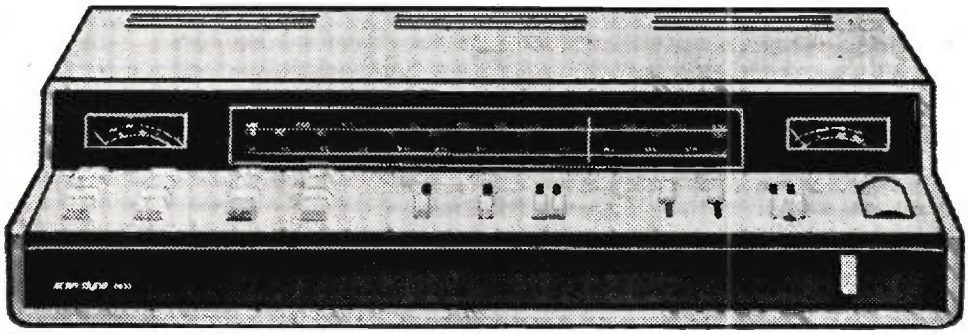

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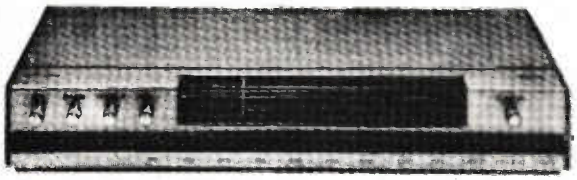

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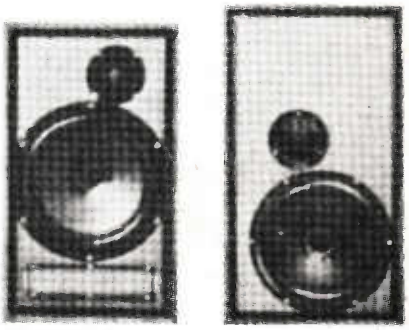

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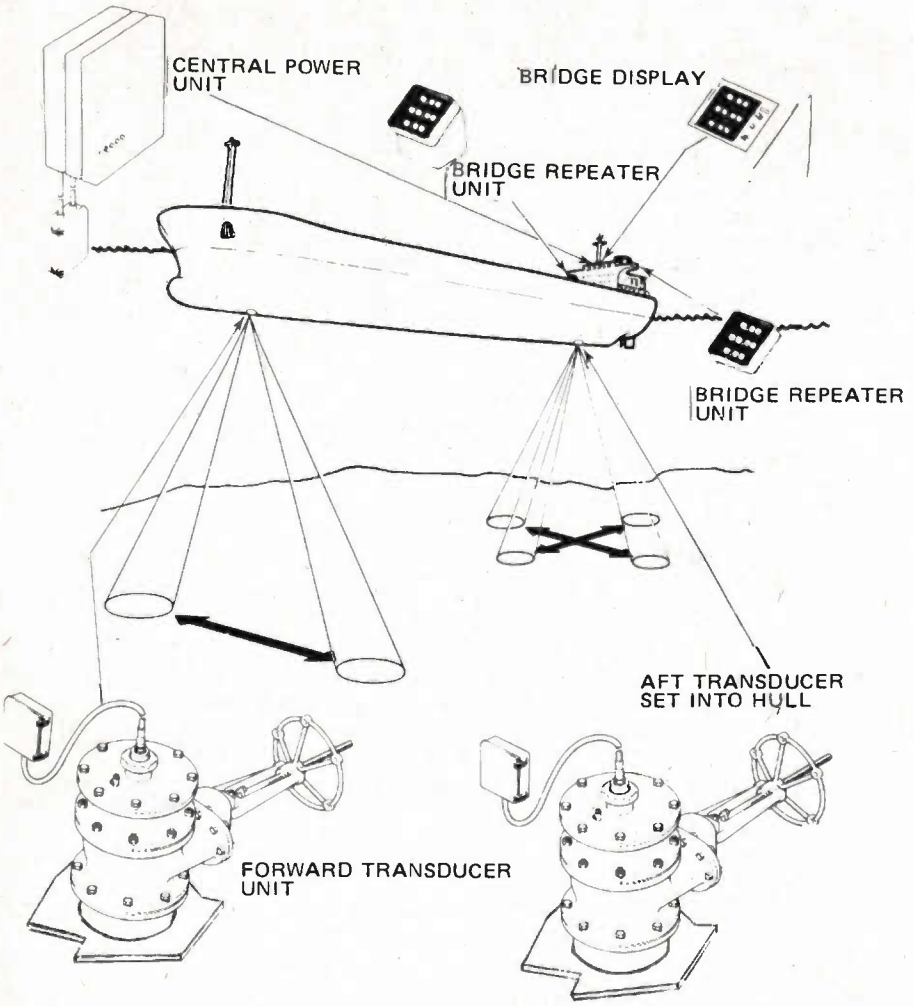

Fig. 6. Diagrammatic explanation of doppler soner used to give true speeds of ships, and the units needed in a Thompson-CSF installation.

distance is obtained. Performed in two directions, position on a plane surface can be defined. The doppler method makes use of the phenomenon in which a reflected, alternating-intensity energy wave has its frequency shifted by an amount proportional to the relative velocity between the vessel and the fixed surface.

No complicated base station is needed, any reflecting surface sufficing to return some of the transmitted radiation. Sea water surface, land or sea-bed are sufficiently good reflectors for this purpose. Doppler radar has been in use for many years but like inertial methods lacks the large scale precision afforded by radio-location methods. It does, however, give high definition over comparatively short distances.

As seems to be the case in this field of position measurement at sea, we can look to the airborne situation to see how things will develop in at-sea measurements. For example, in 1964 the moon-shot programme started design of doppler-radar landing control for the touch-down on the Moon. By about 1970 the same idea had been applied to the berthing of ships. In the Marinex 1973 exhibition, held in London, Marconi Marine exhibited a speed of approach system developed to assist the docking of ships, especially super-tankers. The all-up weight of some loaded tankers is now greater than 500 000 tonnes – even a slight bump into the wharf could be disastrous. There is usually no suitable reflective surface ahead of the ship so docking sonars use the doppler effect of acoustic waves reflected from the dock bottom as shown in Fig. 6. There are transducers at both ends of the ship to enable its orientation to be monitored as well as its velocity. With units like this the ship's speed can be measured to as low as 5 mm per second. The term fine-grained navigation has been coined for such applications.

Another doppler system of interest because of its implications on the future trends of marine instrumentation is the Raytheon airborne doppler using a 5 W, frequency stabilised, CO^2 laser. The laser beam, modulated at 100 kHz is sent to the ground and a reflection received back at the moving aircraft. The resulting doppler difference, as a frequency, gives a measure of actual ground speed.

A recent report reveals that a powerful laser has been used to obtain airspeed of an aircraft using the doppler method facing forward instead of downwind. The aerosols in the air backscatter the forward-projected laser beam providing a return signal that is frequency shifted with respect to the transmitted beam.

REMOTE SENSING

Whilst on the subject of position location of objects on the sea and aircraft, it is appropriate to include the use of the air-borne thermal scanners. These can detect (using the heat radiation emitted) the presence of surface ships at night and in fog, not only where they are at the time of detection but also where they were for periods up to hours beforehand. The heated water-wake of a ship remains after it has passed. Deeply deployed atomic submarines are not immune to

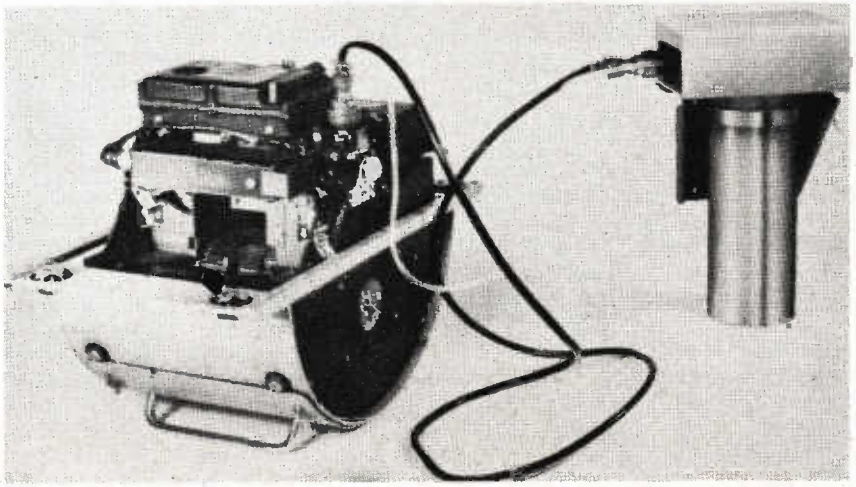

Fig. 7. Airborne thermal scanners such as this can be used to locate relative positions of objects at sea even when not visible to the eye.

this form of detection — their power-sources must be cooled and this produces a heat patch on the surface.

The thermal scanner, as the name implies, scans a high-sensitivity infrared detector across the surface of the sea. The signal strength (related to thermal emission of the sea surface) is used to control the intensity of a visual glow producing a graded black and white trace that portrays the thermal amplitude as a visual equivalent. As the plane flies forward the lines add parallel to each other, in sequence, to form a frame in the reconstructed output display. Commercial scanners, such as the Hawker Siddeley unit shown in Fig. 7, have sensitivities of about 0.1 K. This is adequate to see effects such as the flow-streams of fresh water entering sea water and the position of ships at night. Military scanners probably have a temperature resolution of 1 mK, and no doubt, there are satellites orbiting above us that are taking high sensitivity pictures of the oceans in an attempt to plot the deployment of submarines.

LASER DEFINED LANES

Ships approaching a harbour, dredges working along a channel, laying of submarine cables and similar tasks need straight line guidance. Laser beams can fill this need at low cost. The marine channel light shown in Fig. 8 (designed originally in Australia and marketed by Decca) consists of a laser head that has two output beams emerging nearly parallel to each other. The two beams are shaped in cross section in order that the two overlap in between their axes. One beam is mechanically switched with 0.5 s on and 1.5 s off, the other has 1.5 s on and 0.5 s off. When navigating up this dual beam, toward the laser unit, it appears to the eye as a steady central spot if right on line, or as 0.5 s or 1.5 s flashing signal depending on which way the path has erred. Another method using a laser beam rocks the beam from side to side with a nodding mirror to achieve the same purpose but without the use of two emergent beams. These laser lanes exist out to 20 km at night and 10 km by day. With the currently guaranteed laser life of 18 months this is a cheap and effective form of guidance.

To complete this survey of surface measurements we must include collision avoidance devices.

COLLISION AVOIDANCE

Another measurement need coming to prominence is that of providing ships with a highly reliable estimate of the position of other vessels in close proximity. The man on watch is fast proving to be unreliable, as the sea-lanes fill with traffic. Collisions are ever on the increase. Figures from the U.S. Coastguard suggest that about 200 collisions each year occur because of inadequate collision warnings.

LAD (Lookout Assessment Device) was proposed by Sperry Marine 1970 — it makes use of either a radar or acoustic ranging methods. Details of LAD are given in Fig. 9. Of the many alternatives available, Sperry designers felt that radar was the only truly useful method on all counts. Collision warning radars need to be different from normal marine radars insomuch as they must be ultra-reliable in a continuous operation mode and the false alarm rate must not be too high — one per watch is felt to be the design criteria sought.

Again we can look to the air to see what might happen at sea. Collision of aircraft is a far more serious problem because of the usually disastrous consequences. Aviation law already insists on the use of powerful red or white Xenon strobed lights on aircraft. Vigilaire (by Lora Aircraft Systems) uses silicon photo-conductive sensors to detect infrared radiation from these lamps. It provides a display in the aircraft cockpit that shows which sector the other aircraft is in. Advanced systems incorporate altitude measurements to ascertain if the other aircraft is at the same height and, therefore, a potential threat.

Infrared sensing of ships, from ships, is a developing military skill — the thermal signature of ships enables them to be identified in the dark. It would seem reasonable to expect infrared proximity detectors to be applied to marine collision detection in the near future.

Later we will look at the ways and means by which many of these position location methods are applied to control the course and position of vessels.

We will also consider the devices that have been invented accurately to locate a position beneath the waves. ●

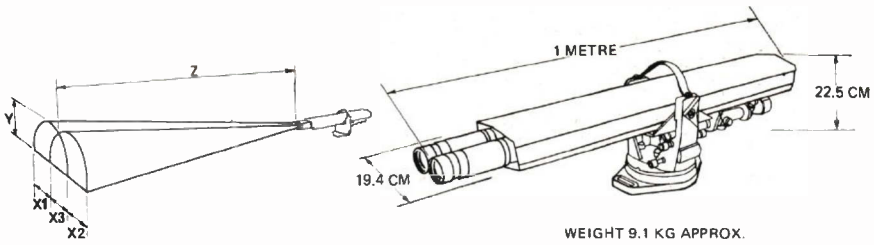

Fig. 8. The marine channel light uses two overlapping laser beams that flash alternately to define shipping guidance along a defined line.

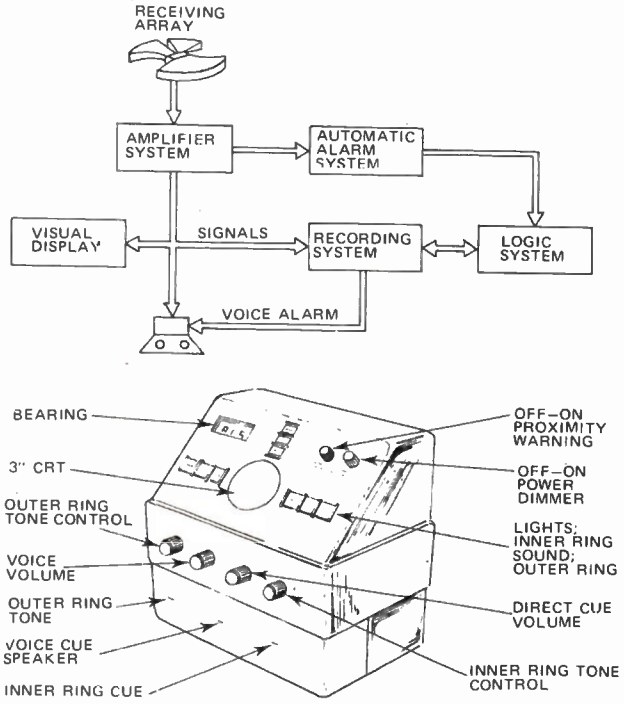

Fig. 9. Schematic of the prototype LAD collision warning system.

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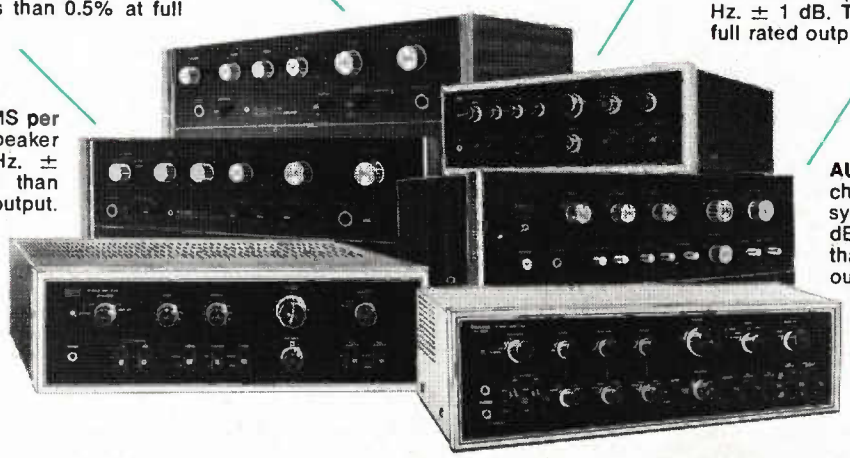

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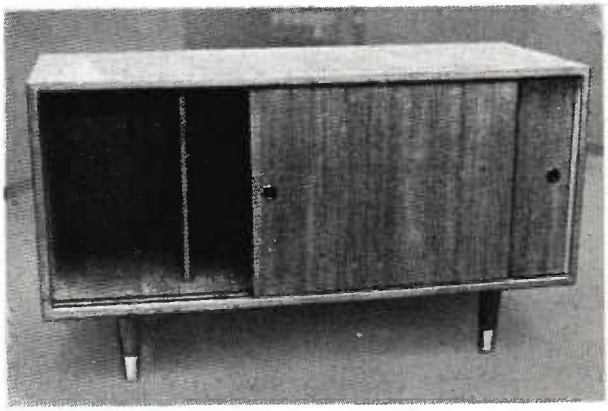

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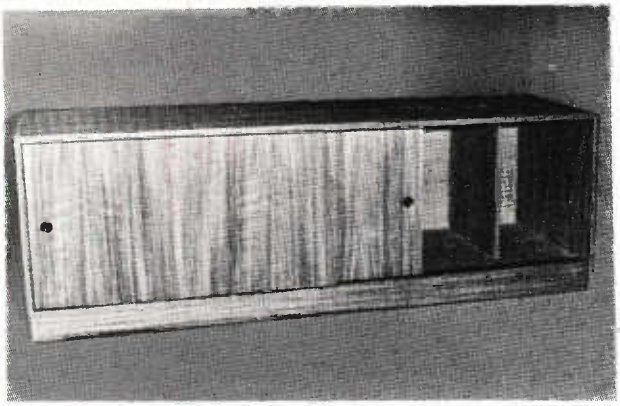

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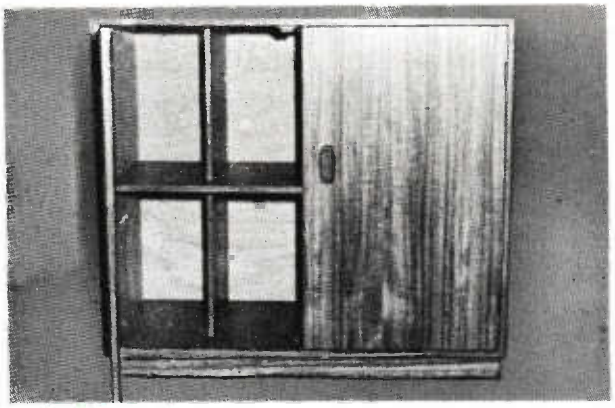

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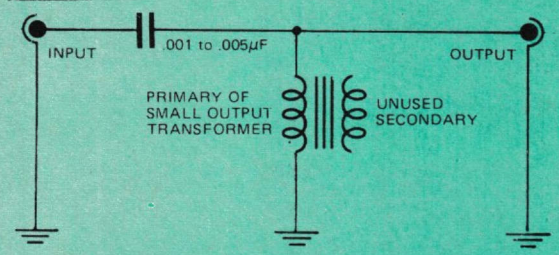
by Terry Mendoza B. Sc. (Hons).

Fig. 1 Hum Filter (see text)



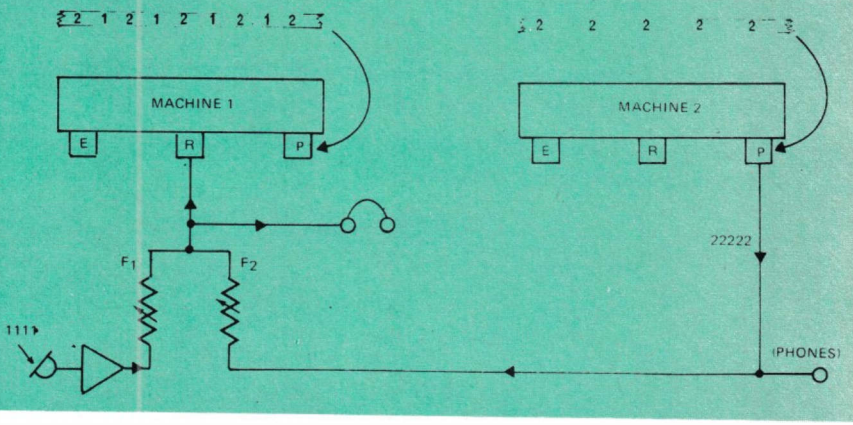


Fig. 2 Simple multi-track set up. Machine 2 plays backing which is combined with new material (via mic) on machine 1.

AS the name implies, multi-track is the technique of combining multiple separate recordings into one composite master.

Its most critical application is in the production of multi-instrumental music, but it may also be applied to documentary creation or drama presentation.

At its simplest, multi-track recording may be utilised purely on grounds of economy — if the recordist is a musician results can be obtained by combining both roles, if the recordist is *not* musically blessed, then at least one musician will be required. It is a great deal easier to find one violinist and re-record him six times than it is to find a willing six-piece violin section.

But having said that, it should be stressed that multi-track music should aim to do *more* than just produce the impression of a number of musicians, where only one had played in reality.

The first problem encountered in multi-track work is maintaining adequate quality. The process involves the copying of signals from one tape track to another in combination with further signals. Immaculate planning is essential, maximising the signal qualities by minimising the number of layers. Another major difficulty is the achievement of the optimal instrumental balance; perfection here depends on careful listening and plenty of practice.

Let us consider the stages in making a piece of multi-track music before going on to consider the many additional techniques that can be used to add sparkle to the finished product.

THE SCORE

The arrangement and instrumentation are the first things to consider once a tune has been selected. The instruments and any incidental sounds should be in keeping with the mood of the piece; for example, a highly reverberated bass saxophone for a sinister piece and a jangle piano for a comedy one. Most people will initially find it easier to work to a full score; once written it is subdivided, say into bass line, rhythm, melody, counter-melody and 'twiddly bits'. Always bear in mind that *change sustains interest*. combinations of instruments, lead 'voices', musical key and tempo.

RECORDING QUALITY

Clean, demagnetised heads are, as always, essential. The earliest recorded tracks undergo most quality loss, hence one should always work from the least important (or least quality-conscious) instrument, usually rhythm or drums. The last track normally carries the lead. Melody lines offer the advantage of immunity to extraneous noise, but may be just as susceptible to hiss or mains hum. Where the lowest fundamental pitch of an instrument is above 100 Hz, a simple inductive high-pass filter may be inserted between the instrument and the recorder. Mains hum is most obtrusive when 'double speed' technique is used (replaying a track at twice the speed it was originally recorded), as this raises the pitch an octave, taking the hum well into the audible spectrum. If a filter, such as the one illustrated, (see Fig. 1) is used, it should be noted that the waveform will be affected.

MULTI-TRACK PROCEDURE

A simple set-up is illustrated in Fig. 2. The first track is laid down on machine 1, in the example being considered, this will be a drum track, made by playing different-sized cardboard boxes. It must be recorded at the maximum possible gain just below distortion level and, most important, the timing must be *very* exact. Any timing error on the original recording will throw the rest of the instrument timings out and synchronized playing will be difficult or impossible. Let us suppose we only record six bars of straight 'box rhythm', without any linking 'middle-8' or introductory drumming. A manageable number of bars are accurately cut from the tape and joined to make a continous rhythm loop, as detailed in the first part of this series.

The existence of very small speed differences between recorders must be acknowledged and, generally, tracks recorded on a particular machine must be replayed on that same one to avoid

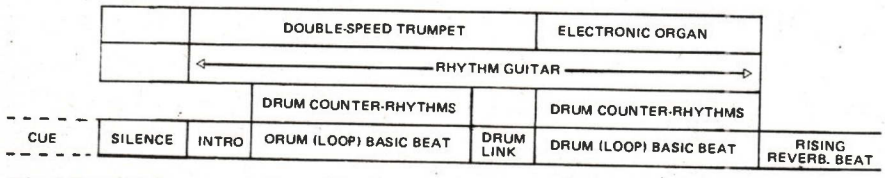


Fig. 3 Graphical representation of final composite master as discussed in the text.

the slight but unwanted pitch change that would otherwise occur. Luckily though, the 'box rhythm' does not have pitch values of any consequence, so the loop can be transferred to machine 2. Monitoring the loop over headphones, *without* feeding it onto the first recorder, a synchronized one beat to the bar is recorded via microphone, leading to a linking passage, still keeping in strict time with the loop. The same goes for an introductory drum passage. Using the same techniques, two bars of cue drumming followed by one bar silence are recorded prior to the true introductory drum passage. Eventually this dummy cue passage will be cut off once the tape is complete, but it serves to enable all the instruments to be fully synchronized from the first bar of the introduction.

The rhythm loop is then fed onto machine 1, via fader 2, ensuring that maximum gain is being utilised. If desired, a more complex rhythm can be recorded simultaneously on machine 1 by opening fader 1 and, using headphones, playing along with the loop replay from machine 2, and balancing the recording levels F1 and F2 against each other. The tape on machine 1 can now be edited to give, in the correct order: cue drumming, one silence, introductory drumming, 'x' bars of composite drumming, linking drumming and 'y' bars of composite drumming.

The chord accompaniment can now be recorded. The introduction of pitch gives the added difficulty that all instruments must be tuned to the same scale. When using a 'fixed tuned' instrument (a vibraphone is one example), the rest of the instruments should be tuned to the fixed one, using it as a reference. Let us assume that an electric guitar is to provide the chord rhythm. A fresh tape is laced up on machine 2 and the set-up patched so that machine 1 plays back the completed percussion track and this is mixed with the electric guitar signal, possibly through the hum-filter. The electric guitar is set to give maximum gain compatible with least abberation of quality and, monitoring the recording inputs of machine 2, the percussion/guitar levels adjusted to give the best balance at the highest undistorted modulation possible.

Fig. 4, 24 channel multitrack recorder utilising two-inch wide tape (manufactured by 3M)

Monitoring can be carried out over loudspeakers as microphones are not being used; it is recommended that the loudest possible monitor signal levels are used to permit the detection of any less obtrusive flaws in the signal. Once the guitar has been tuned, 30 seconds or more of chromatic 'A' are recorded on the fresh tape — to be used as a tuning reference on later occasions. A few rehearsals at playing along with the taped percussion will be necessary before laying down the next copy on machine 2. Thus the new tape will consist of a tuning period followed by cue drumming and finally the percussion/rhythm track proper. We shall confine ourselves to two lead instruments in this initial experiment, one playing up to the drum link and the other playing the remainder.

At the moment the composite tape is on machine 2, and must be left there due to the pitch considerations already discussed, so the set-up must be juggled around to replay on machine 1 and record on machine 2. Although two lead instruments are to be featured, intelligent planning can permit the exercise to be conducted as only one overall copy.

The overdub of the first lead instrument is carried out normally up to just past the drum link. Machine 1 is then stopped as the first instrument will not be playing in the latter half of the tune. The composite tape on

Fig. 5 Self sync circuit (only one channel illustrated)

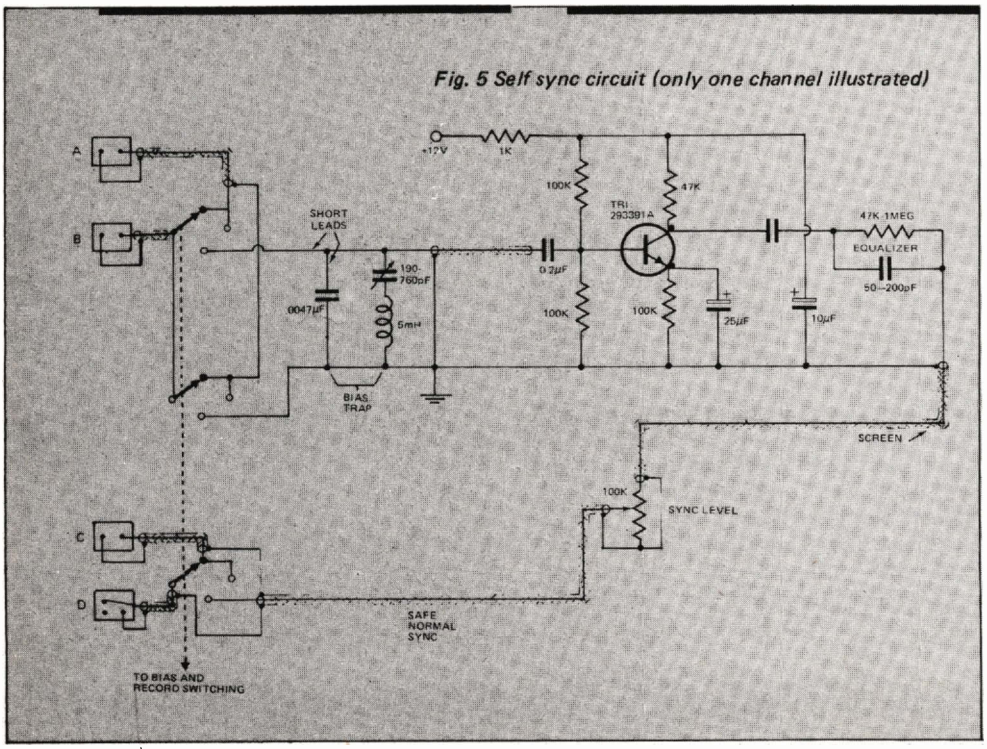
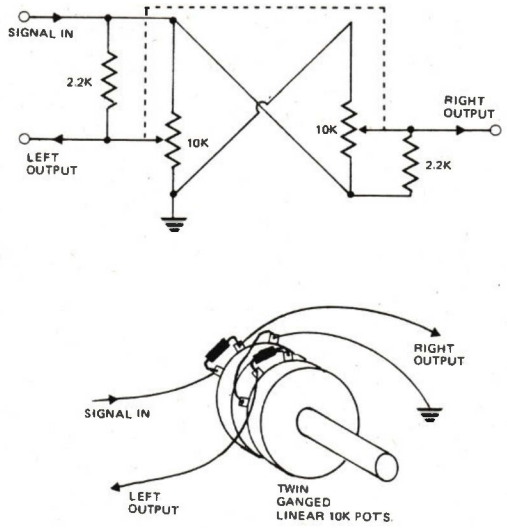


Fig. 6 Economic pan-pot arrangement



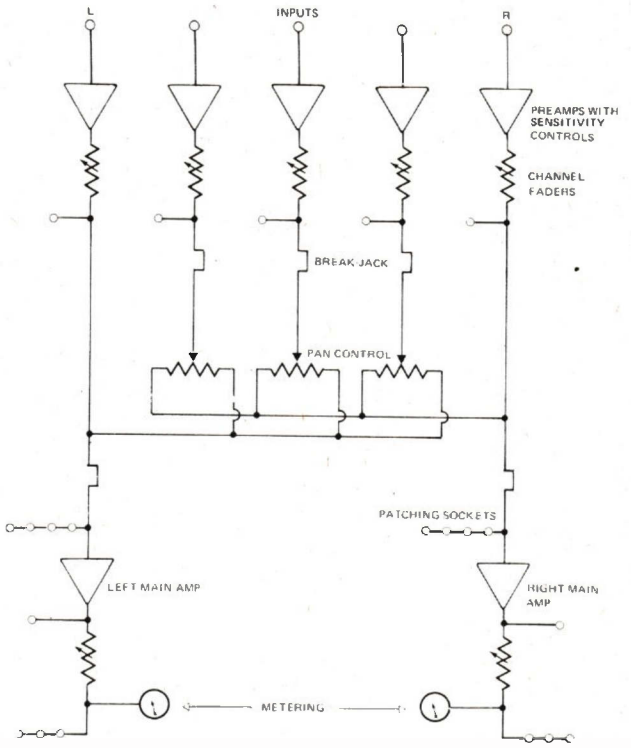


Fig. 7 Simple multi-track mixer design – great flexibility is due to the use of break-jacks and patching sockets.

machine 2 is run back to a short way before the drum link and the second lead instrument rigged up and balanced. Setting machine 1 to record again the second lead instrument is playing along with the backing to the end of the tune. The tape on machine 1 now has two completed halves of a tune. It is now quite simple to splice them together using the drum link from the first half of the recording to allow the ambience of the initial lead instrument to die away.

TRICK EFFECTS

Trick effects are a prerequisite for success in the multi-track process. Let us assume one of the lead instruments is a trumpet. The trumpet can monitor his backing track via headphones or alternatively, a *soft* talk-back loudspeaker. If the replay and recording machine speeds are both dropped one speed during this overdub, reversion to the original speed will raise the trumpet pitch one octave and halve its characteristic attack and decay times giving an ethereal reedy effect. It also can enable the trumpeter to provide an extremely rapid counter-melody if required, due to the doubling of the replay speed.

We now wish to put a memorable ending to our tune which at present just tails off after the second lead passage. Returning to the original rhythm loop, the first beat of a bar is cut off and spliced into the middle of a long length of leader tape. This single sound is replayed on machine 2 and recorded on machine 1 whilst simultaneously feeding the signal from the replay head of machine 1 back into the recording channel. This results in the well-known tape-echo effect. The signal will build up to instability if the feedback level is too high, instead of dying away after half a dozen or so repetitions. Trial and error will eventually give the new recording of the single beat a long echo-decay time (to save time it may be an idea to loop the leader and keep re-recording the effect until satisfied).

The newly-recorded effect is now copied yet again, this time removing the power from the capstan motor on the recording machine the instant before dubbing so that although the dubbing still takes place the recording machine tape-drive will be continuously slowing down. This latest copy will consist of a reverberated beat, the pitch and rapidity of which will rapidly rise until it disappears from the audible spectrum. This effect can now be spliced onto the composite master at the end of the tune and at the position where the first beat of a new bar would have occurred.

It is evident that quality may be maintained over periods where less instrumentation is needed,by splicing in passages from earlier takes; during passages where 'everything is playing' background hiss will not be noticeable anyway.

When all else fails, one neat trick is to cover the hiss by overdubbing a final track of rolling cymbal and snare-brush.

To avoid bringing up hiss, any fades or quieter passages should be made so on the last practicable dub.

Although double-speed has been mentioned earlier, half-speed is just as valid a technique, i.e. doubling record and replay speeds whilst adding an extra voice. It is a difficult proposition however, as one has to synchronise with the extremely rapid (double-speed) tempo and the result, though it is one octave lower tends not to be very accurate. The principal use of half-speed is with the acoustic electronic dubbing link for 'cavern' reverberation, as detailed in Part 1 (see p.39).

EQUIPMENT POSSIBILITIES

The foregoing description has

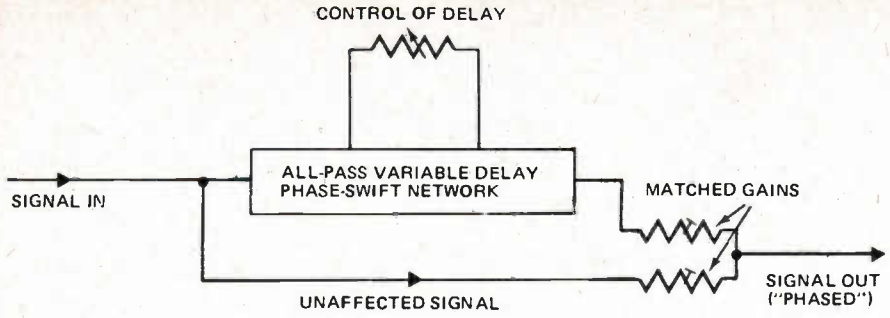


Fig. 8 Block diagram of electronic phasing system

assumed the use of two mono recorders, so it should be stated that virtually the same capabilities may exist on a versatile 3-head stereo recorder.

All professional multi-channel tape recorders are equipped with self-sync. facility, that is to say previously recorded material may be monitored through the recording head so new tracks being laid down are in synchronisation with the existing ones. Hence only after sixteen or even twenty four tracks have been laid down, will one copy be necessary – to provide the final stereo master – and quality will naturally be at a premium. Fig 4 illustrates a recorder of this type.

Figure 5 illustrates a circuit suitable for use with one channel of a stereo recorder (the preamplifier was designed with an input impedance characteristic matching a nominal 3000 ohms at 1000 Hz. The record function is disabled in the 'safe' mode and the other two modes are self-explanatory. The equalizer introduces a complementary high frequency boost to compensate for the high frequency roll-off due to the relatively large record head-gap, in comparison with the much finer replay head-gap. Self-sync'ing on a stereo machine gives the undoubted advantage that two independant tracks can be laid down before the first dub becomes necessary, i.e. when transferring this recoding to a second recorder in combination with a new instrument.

A second stereo deck will allow stereophonic multi-track music to be accomplished, but to achieve a true stereo effect, as opposed to a left/right ping-pong situation, some form of stereo routing is necessary – a 'pan-pot' or panning-potentiometer. The sensation of linear 'aural movement', in common with all our senses, is dependent on the existence of a logarithmic/antilogarithmic relationship between the sound levels reaching our two ears. The pan-pot must mimic this gain relationship; one way is to use a pair of ganged back-to-back log/antilog potentiometers. These tend to be prohibitively expensive as it is very difficult to make such potentiometers track accurately and match well. A far more economical solution is illustrated in Fig. 6; ganged linear potentiometers are utilized with the linear law distorted to a log law (approximately) by a pair of low value load resistors.

MIXING

The simple mixing circuit illustrated in Fig. 2 will be found in all reasonably equipped recorders, mono or stereo. Active mixing is always to be preferred to purely resistive mixing in all types of audio work. An ideal specification of a multi-tracking mixer might run as follows:

Five channels, three with pan-pots to two output groups. two direct channels, one feeding only the right hand side and a similar one for the left; variable equalisation, sensitivity, and feedback for monitoring can be useful on each channel, and break-jacks at each stage of the mixer channels so that limiters/compressors, reverb. units etc. can be patched in at will. (See Fig. 7.

The mixer designs previously published in ETI offer a useful guide to possible circuitry.

HALF TRACK EFFECTS

A whole range of unusual effects are possible when a half-track stereo recorder is used. When there is a narrow spacing between record and replay heads and a high tape speed is chosen, a "parallel wall" single echo can be achieved by simply dubbing from one track to another, then playing the original and the copy (i.e. both tracks) simultaneously. More startling results are obtained by pan-potting the two tracks around the stereo field whilst they are being copied onto a second stereo recorder.

If the spools are swapped over after making a recording 'reverse play' will be obtained – an interesting effect as the attack and decay are transposed. A reversed drum rhythm loses its percussiveness and is transformed into a rhythmic pattern of whooshes; a piano track similarly treated assumes an organ-like attack characteristic.

If a reversed passage is tape echoed and the echoed piece then restored to its rightful direction, the outcome will be the conventional original track with each note *preceded* by a swelling 'echo' of the note – its pre-echo. Softly strummed guitar gives an effect not unlike the flamenco style of playing.

TAPE SPEED

When carrying out a recording with conventional tape-echo, if the tape speed is adjusted by gently pinching the tape as it enters the sound channel, an eerily different sound is obtained due to the varying discord set-up between the music entering the recorder and the pitch of the tape-echo.

An eccentric capstan, produced by building up a layered lump of splicing tape on one side of it, will impart a warble to any tape played or recorded on it – indeed some of the cheapest tape machines seem to have this facility already built-in!

The relationship between replay (or recording) tape speed and pitch has

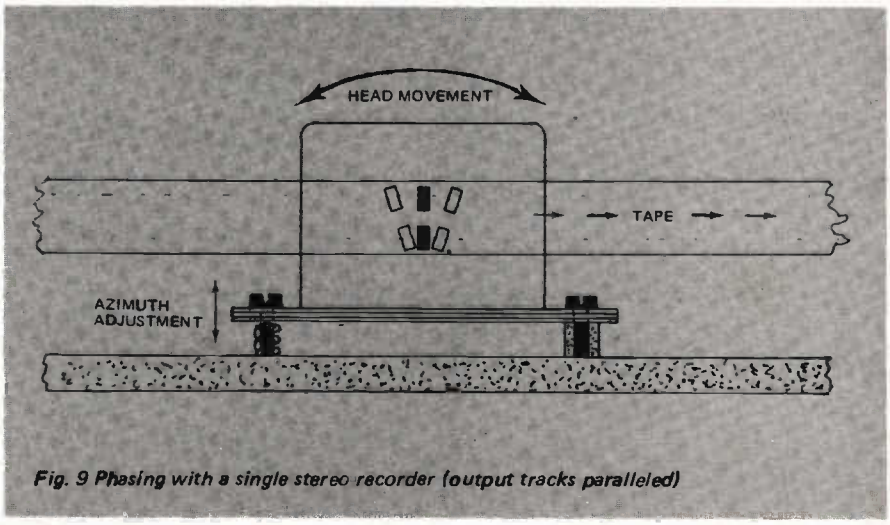


Fig. 9 Phasing with a single stereo recorder (output tracks paralleled)

long been one of the most important tools for music concrete. A single note, or noise replayed at different speeds, will provide a chromatic scale of notes which can be edited to perform any desired melody. The origin of the effect may have been anything from a bedspring to a pneumatic drill! It is usually edited into a loop which can then be played on the variable speed machine.

Tape machines may be modified in one of two ways to suit them to this type of work:

1. Mains synchronous capstan motors may be amenable to powering by an auxiliary unit which is essentially a variable frequency sine wave source (with suitable amplification).
2. Different radii capstan sleeves may be bolted to the main capstan – finely engineered sleeves offer the less drastic alernative but have the drawback that glissando effects are impossible.

EXTENDED LOOP FEEDBACK

Where musicians prefer to ad-lib, instead of working to a full score, this process is most effective. It is based loosely on conventional tape echo which, to recap, is the feeding back of a replay of a newly recorded signal to the record head at a slightly lower level, so that although perpetuated, each repetition is at a lesser magnitude. If the small gap between the record and replay head is now expanded to around five secondsworth of tape, a newly-recorded musical statement will take five seconds to get to its first repetition and re-recording. This gives the musician adequate time to accompany himself on the re-recording and continue the process ad infinitum or until he makes a mistake – when this happens the error crops up every five seconds as well!

The procedure is easier to carry out with two recorders, the first one recording and the second replaying, although it should be feasible on a single 3-head machine if a lengthy loop is taken out between the record and replay heads. In the former case the recorders are spaced the required distance apart, using chair-legs as necessary as additional tape guides. The tape is taken through the first sound channel, thence across the room and through the second sound channel, with the take-up spool placed on the second machine. Head cleanliness is essential and so is very careful setting of the replay and record controls of both machines. If the replay setting is too high the composite tape will get continuously louder until it enters distortion, and if too soft the initial passages will quickly get lost under tape hiss. The fine balance point between the live music being fed to the first machine and the taped accompaniment from the second machine can only be determined by experiment. A useful dodge is to repeat earlier musical statements occasionally as this reinforcement will prevent them becoming fuzzy and indistinct which otherwise results as the number of copies increased.

PHASING

Phasing or skying gained popularity in the 'psychedelic' era and is still with us; it consists of combining a signal with itself, delaying one part by a short variable amount. The frequencies within the signal which have been delayed by ½ wavelength will cancel, and the others will be subject to varying degrees of cancellation or reinforcement, depending on their phase relationships.

Altering the delay between the signal and its time-shifted counterpart affects the phase relationsips and alters the "phasing" sound.

There are legion methods of producing phase, and a few of the commoner ways are outlined below:

(a) Electronically (Fig. 8). a signal is fed to an all pass phase-shift network, the shift being governed by a single potentiometer. The output of the network is suitably attenuated to be combined at equal gain with the untreated signal.

(b) Using a single stereo recorder (Fig. 9) the signal is recorded simultaneously on both tracks. On replay the head is moved in a direction parallel with that of the tape movement, using the azimuth adjustment screw, and the two output channels are combined.

(c) Using a 2-head mono machine (Fig. 10), an additional head is wired in parallel to operate on the unused track, the lower one if it is a half track recorder. The recording is made on a clean tape. During recording or, if preferred, on replay, a loop is induced between the two replay heads using some kind of swinging guide arrangement.

(d) Using one stereo recorder and one other recorder; this method is very effective and requires no special construction, but total success is rarely achieved, and an edited combination of various takes is often the best solution.

The material to be phased, preferably with some sort of cue for signal synchronising is placed on the second recorder and carefully copied onto the lower track of the stereo (first) machine. Both tapes are rewound and the lower track copy routed so that it can be copied onto the upper track in combination with replay of the tape still on the second machine. The levels of both tapes are balanced and the second recorder paused at the cue signal. The stereo recorder is started (lower track playing, and upper track recording) and as the cue from the lower track is heard the second recorder is released. The two tracks will probably be well out of synchronisation (giving a parallel wall echo type effect) and, by slowing down or speeding up the tape on the second machine with a hand respectively placed on feed or take-up spools, synchronisation is gradually achieved. The material goes through its most intense phasing just prior to sync. and jockeying the spools will cause the pitch of the effect to rise and fall.

Whichever technique is adopted, the phasing will be *least* effective with simple, pure tones, and *most* effective with complex harmonic signals i.e. fuzz guitar, cymbal and drum percussion.

To conclude, multi-track is a highly creative art which relies on imaginative scoring, playing and engineering, well maintained equipment and plenty of patient practice.

Next month we shall be looking at documentary compilation. ●

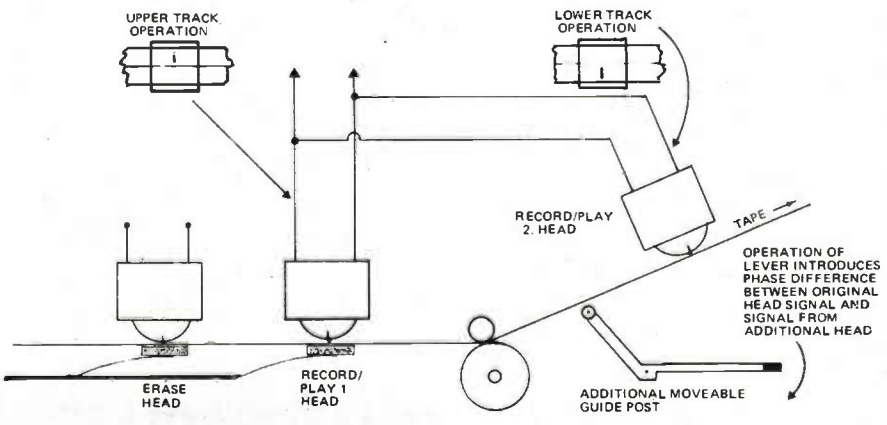


Fig. 10 Phasing system for use with 2 head mono machine

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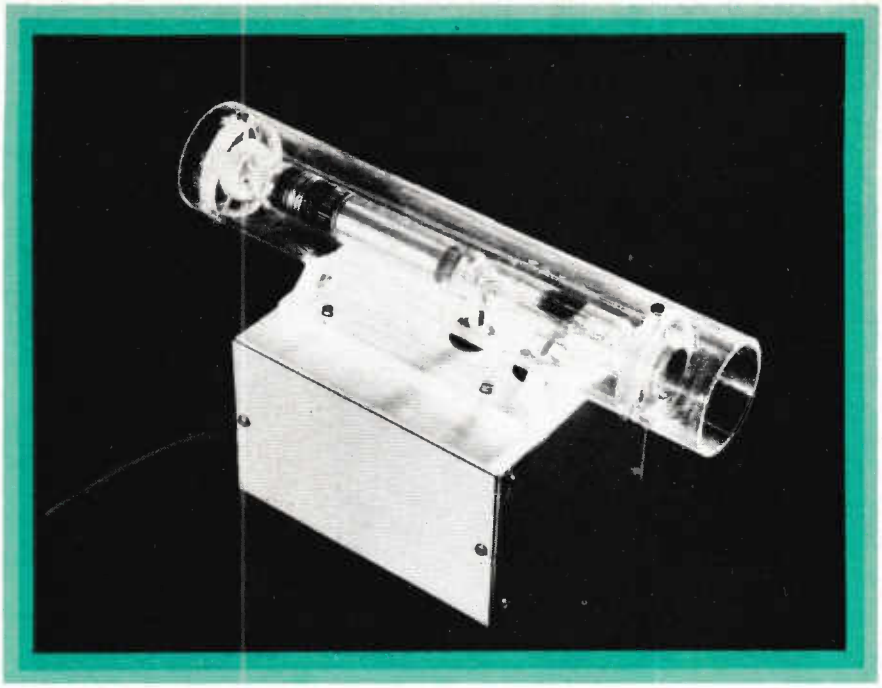

The ETI laser — note the 9.5 mm thick perspex rings mounted within the tube to take the support screws. These rings and the tube mounting base were made from small off-cut of the material which can be obtained from any acrylic supply house.

IN the past ten years, lasers have enabled scientists to know more about physics than the combined efforts of all previous scientific endeavour.

From demonstrations of basic principles, to, 'sawing' up unwanted buildings, providing sight lines for surveyors, to shooting down enemy missiles, applications for lasers are virtually unlimited.

Until recently, lasers have been totally out of the realm of all but the wealthiest amateur experimenter.

But now, simple helium-neon laser tubes are available at surprisingly low cost. It is absolutely practicable for the amateur to build a working laser for well under $100!

The helium-neon laser is simply a 'cold-cathode' type of gas tube with mirrors mounted internally to 'generate' the lasing action, (a full description of the operating principles of this, and other, lasers was published in our June 1973 issue).

To energize the laser, a suitable high voltage power supply must be used. This supply is in fact the major part of this constructional project.

The characteristics required are shown graphically in Fig. 1(a).

Over the range OA, very little current is drawn and no light is given off — this is known as the 'dark discharge' or 'Townsend' discharge region. At point 'A' (5 kV for the CW50, 6 kV for the CW 301) a breakdown occurs and the dark discharge changes to the characteristic orange-coloured, neon-glow discharge i.e. the tube is 'fired'. Region A to B is the region in which this glow discharge continues. However at C, a further breakdown occurs and the glow discharge becomes an arc discharge.

The glow discharge and arc discharge regions are characterised by successively lower voltages and higher currents, i.e. there is a 'negative resistance' characteristic.

The laser tube must be operated at an optimum point that is determined by tube parameters such as gas pressure, discharge length and optical volume in the arc discharge region. For the tube (type CW50) the specified optimum operating point is 1200 volts at 5 to 6 mA. The laser power supply must hence perform the dual role of:—

1. Supplying at least 6 kV at low current to fire the tube, and
2. Supplying 1200 V at 5 mA to 'maintain' the tube.

A suitable circuit, that does just this, is a modified form of the Cockcroft Walton, voltage-multiplier circuit. The basic configuration of this is shown in Fig. 2.

The 'modification' is simply the choice of capacitor values. C_1 is chosen to be quite large (by a factor of 100) with respect to C_2, C_3, and C_4; and C_2, C_3, and C_4 are chosen such that under light loading, as is present before the tube actually 'fires', (i.e. in the 'dark discharge' region,) the circuit does in fact operate as a voltage multiplier but, under the heavier loading of the glow discharge, these capacitors cannot hold the necessary charge for the circuit to continue operating as a voltage multiplier. Since C_1 is larger than these capacitors, and *can* maintain sufficient charge, the circuit now acts as a simple half wave rectifier with D_1 and C_1.

To overcome the negative resistance characteristic of the laser, a ballast resistor is inserted in series with the anode (or cathode) lead to the tube. There is usually an optimum value specified for this resistor, but it is not critical and can be varied to obtain correct tube operating voltage.

A readily available transformer is type PF3124 (Ferguson) which has a secondary voltage of 1325 volts (rms). This, after half-wave rectification, becomes 1870 volts peak and when multiplied provides 7.5 kV which is sufficient to cause the tube to strike (more than 5 kV).

This simple power supply circuit would operate the tube satisfactorily but it can be considerably improved to

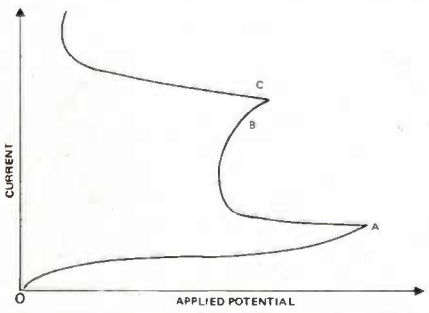

Fig. 1(a). Characteristic V1 curve for a low pressure gas discharge tube.

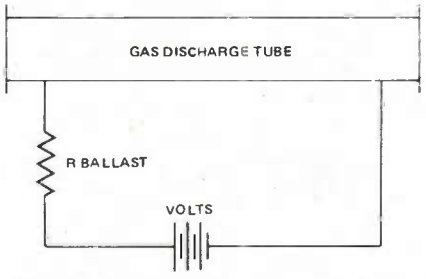

Fig. 1(b). A ballast resistor is required to counteract the 'negative resistance' characteristic of the tube.

PROJECT 524

LASER TUBE DATA		
Model	CW50	CW301
Mode	TEM nm	TEM oo
Beam divergence (milli-radians)	<2.0	<1.0
Beam diameter mm $1/C^2$	2.0	1.0
Trigger volts	5000	6000
Operating volts	1000	1200
Tube length	241 mm	264 mm
Tube diameter	25.4 mm	25.4 mm
Ballast resistor	100 k	70 k

Both tubes produce 0.5 mW at 6328 A at 5–6 mA.

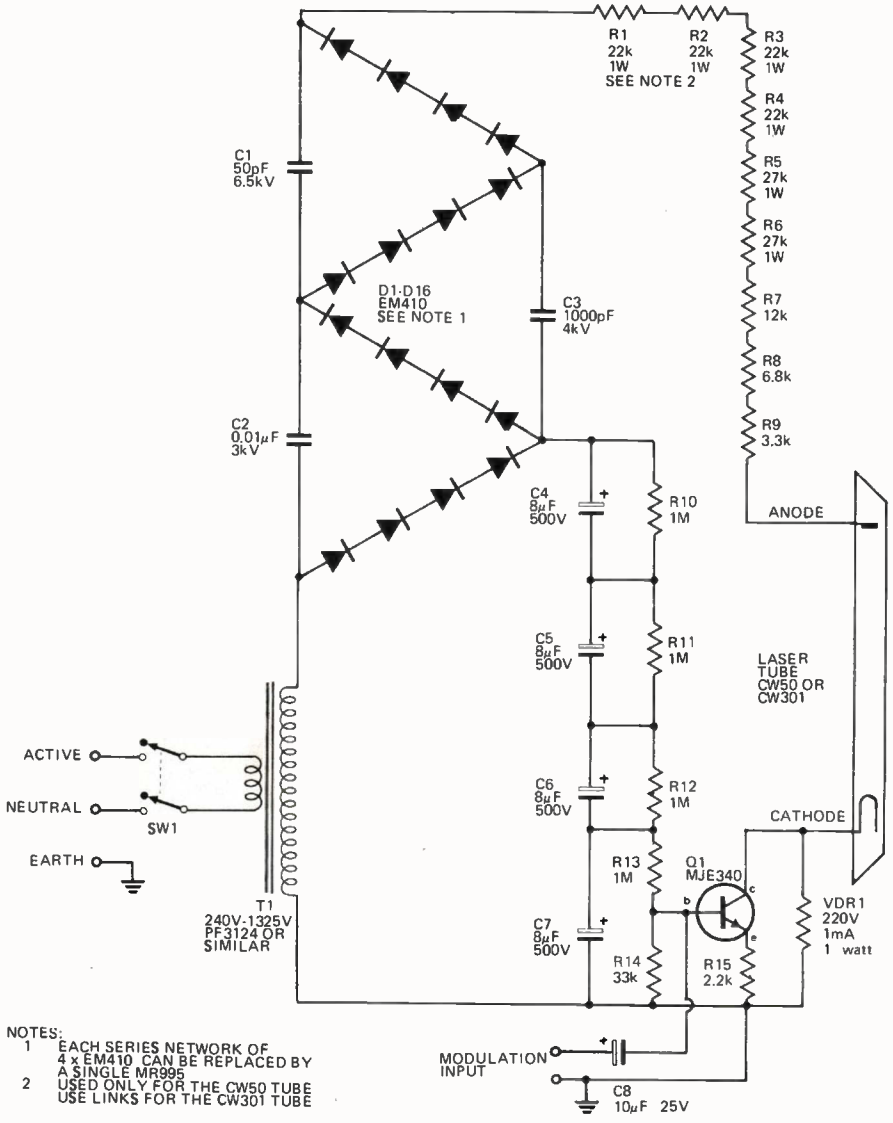

Fig. 3. Circuit diagram of the laser power supply.

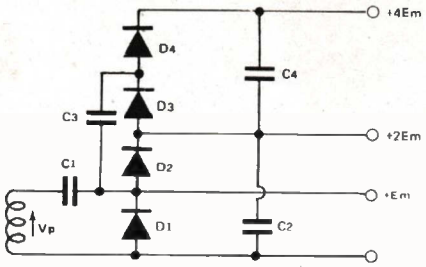

Fig. 2. The basic Cockcroft-Walton voltage quadrupler circuit.

provide better output stability and reduced ripple and quantum noise on the output. This is achieved by maintaining constant tube current by means of a constant current regulator incorporated in the cathode lead. (Transistor Q1).

Varying the current through the laser tube will vary the coherent light output proportionally, and hence, a signal applied to the base of the regulator transistor will cause the laser output to be modulated. The modulation source should not exceed one volt peak (to avoid clipping). The voltage dependent resistor, VDR1, is incorporated to prevent the laser being cut off by over modulation which would result in Q1 being destroyed.

CONSTRUCTION

Mount the components to the PC board in accordance with the component overlay. The board, after the interconnecting wiring is attached, is mounted on 12 mm spacers in one end of the box. The transformer, switch, input jack and mains input cable are fitted to the other end.

The tube itself may be mounted in a variety of ways, as long as there is not a heat source, or heat sink, near the body of the tube. Uneven temperature gradients along or across the tube may cause buckling and consequent minor mirror misalignment.

A good simple method of mounting the tube is to use a three point mounting for the tube at both ends of a piece of aluminium or perspex tubing. The tubing will need to be about 50 mm inside diameter and about 305 mm (12 inches) long. Distance between the mounting points will depend on the type of tube used.

The perspex has the advantages of insulation and transparency so that the tube may be seen (for school demonstrations etc). However the orange glow from the gas discharge may be a nuisance in some experiments. We cemented our perspex mounting tube to a 3/8 perspex base, and drilled holes through the combined base and tube to

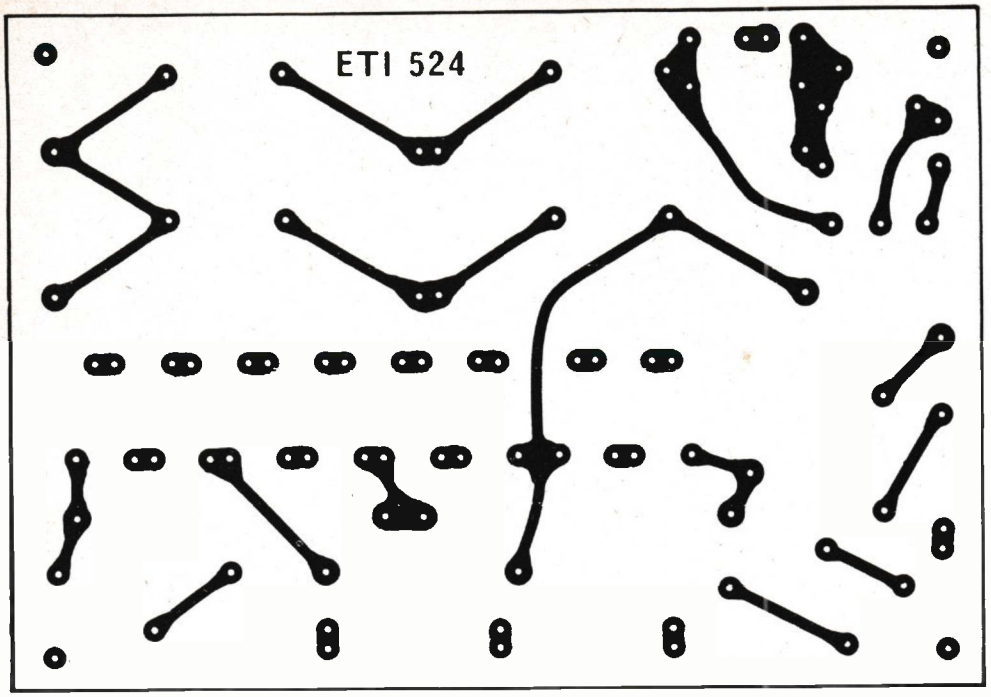

Fig. 4. Printed circuit board layout for the laser power supply.

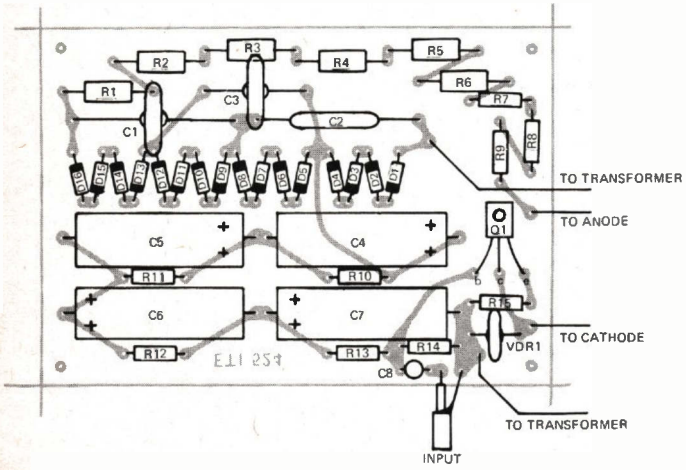

Fig. 5. Component overlay.

accommodate the anode and cathode leads.

The lead from the ballast resistance to the pin connection of the tube should be as short as possible. Connection to the pins must be made with small clips. DO NOT FORCE the clips onto the pins, but use a gentle twisting movement. DO NOT attempt to solder to the pins. The pin-to-glass seals are extremely fragile.

Remember also that the voltage on the tube is 1200 V and the transformer can supply 10 mA – **THIS IS LETHAL** if due care with insulation and layout is not taken.

ADJUSTMENT

When the laser is switched on it will be necessary to adjust the ballast resistance such that 100 volts is obtained across the collector to emitter of Q1. This will also ensure that the tube operates in the correct current range.

THE LASER TUBES

Two tubes may be used in the above circuits without any alterations; types CW50 and CW301. Both of these tubes are ½ to 1 milliwatt, cold-cathode laser tubes. The CW50 tube has a multimode output i.e. several spatial modes propogate in the cavity resulting in a 'multispot' output. The CW301 tube has a single mode output but of course is more expensive. The power supply circuit can also be used with tubes up to 2 mW power output by using a different ballast resistance. Energy Engineering should be consulted for a suitable higher power tube.

When the tube is operating, the mirrors may be adjusted for maximum power output, or rough mode selection, by means of alignment screws at the cathode end of the tube. This procedure must be carried out with care, and *only when necessary*. Take care when handling the tube as it is fragile *and expensive*.

PARTS LIST ETI 524

R1,2,3,4	Resistor	22 k	1 Watt	5%
R5,6	"	27 k	1 Watt	5%
R7	"	12 k	1 Watt	5%
R8	"	6.8 k	1 Watt	5%
R9	"	3.3 k	1 Watt	5%
R10,11,12,13	"	1 M	½ Watt	5%
R14	"	33 k	"	"
R15	"	2.2 k	"	"

VDR1 Voltage dependent resistor 220V, 1 mA, 1 Watt

C1	Capacitor	50 pF	6.5 kV) disc
C2	"	0.01μF	3 kV) cer-
C3	"	1000pF	4 kV) amic
C4,5,6,7	"	8μF	500 V electrolytic
C8	"	10μF	25 V tag or "
D1 to D16	Diode	EM410	1000V (or 4 by MR 995)

Q1 Transistor

Q1 Transistor MJE340

Laser tube type CW50 or CW301, Energy Engineering

T1 Transformer 240V to 1325V Ferguson type PF 3124 or similar

SW1 Switch SPST mains switch

One metal box (see text), input jack socket, 12 inch (304 mm) length of 2 inch (50 mm) ID perspex or aluminium tubing offcut of 3/8 inch (9-10 mm) thick perspex approx 12 inch x 3 inch (304 mm x 76 mm) perspex cement, nuts and bolts etc, rubber grommet, mains flex and mains cable clamp, 4 by ½ inch (12.7 mm) spacers.

Energy Engineering advise us that they have established a free technical advisory service and will gladly answer any questions readers may have regarding lasers.

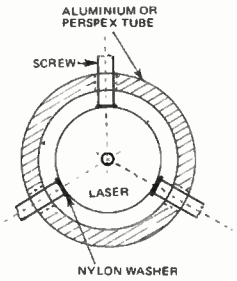

Fig. 6. Proposed method of mounting the laser tube. If perspex tubing is used a reinforcing piece may be required (see photo of laser).

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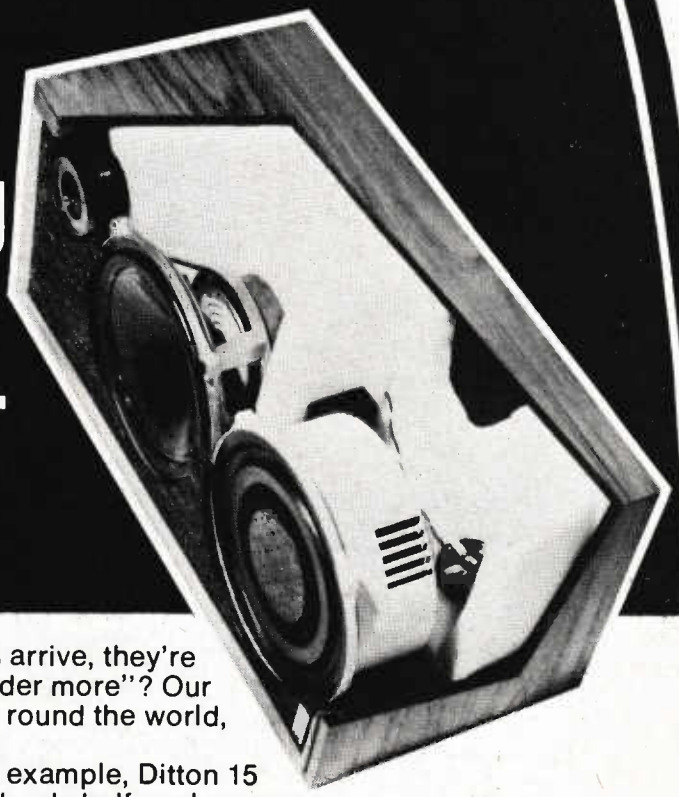

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Simple observations and experiments using the ETI 524 laser.

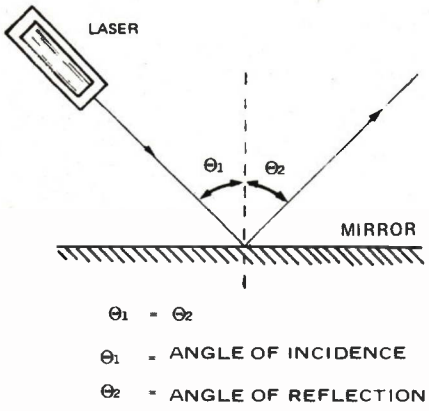
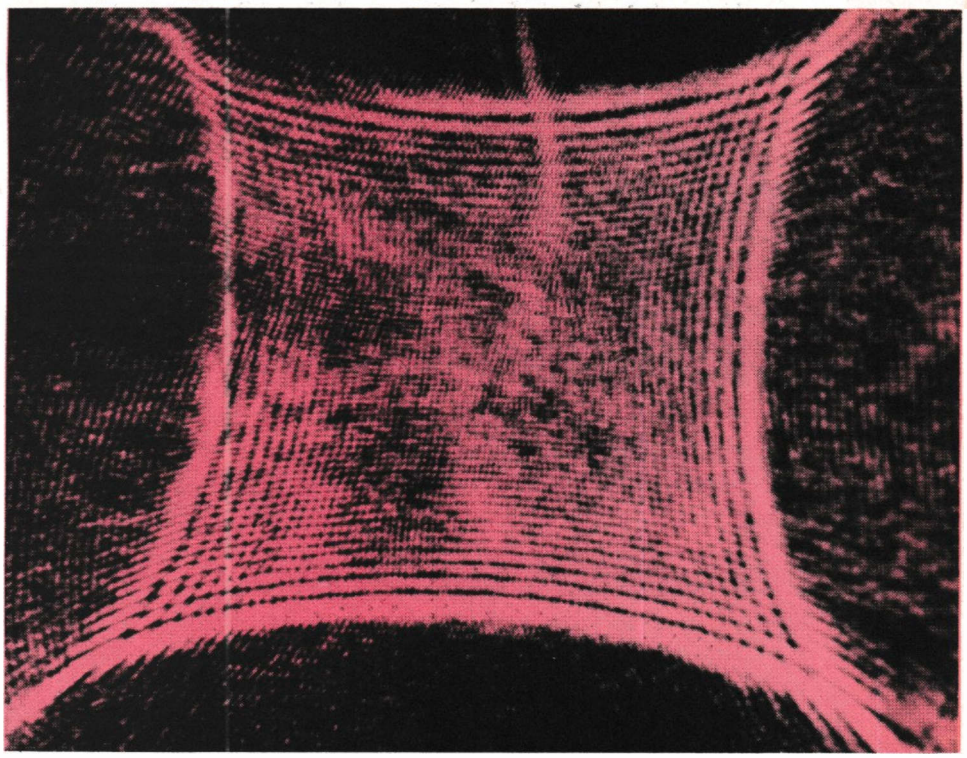


Fig. 1. Technique for measuring the angles of incidence and reflection for a plane mirror.



This interesting pattern was produced by intercepting the beam with bubble glass.

LASER EXPERIMENTS

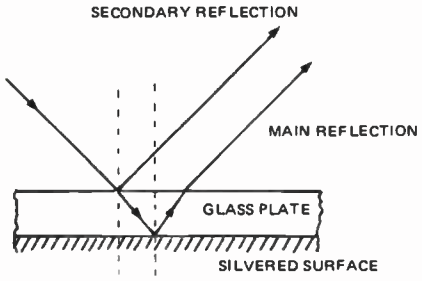


Fig. 2. A secondary reflection from the front of the glass will occur with a back silvered mirror.

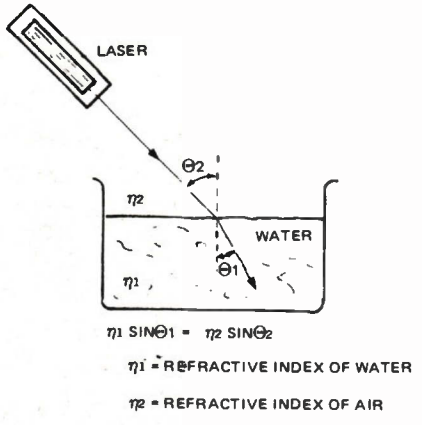


Fig. 3. Procedure for measuring the refractive index of water.

THE helium-neon laser generates an intense, coherent beam of red light at a wavelength of 6328 Å. The laser beam, having little divergence, lends itself to the performance of many experiments which were previously only possible by the use of elaborate and expensive equipment set-ups. In fact, it is said that research using lasers has helped develop in the past ten years more physical theory than all previous, combined endeavour.

In this article we examine, firstly, some of the peculiarities of the laser beam and then, some simple experiments which may be performed with a minimum of ancillary equipment.

SAFETY

Although the 0.5 W to 1 mW output of this laser is not particularly hazardous it is still advisable to take precautions.

Do not look directly into the beam, nor into any specular reflections.

CHARACTERISTICS OF THE LASER BEAM

Scattering

When we first switch on the laser we find that the beam itself cannot be seen, only a spot of intense red light wherever the beam strikes something. The beam may be made visible by blowing smoke or chalk dust into the beam path. The laser beam then becomes visible because of the light being *scattered* by the tiny smoke or chalk particles.

Granulated appearance

If the laser beam is expanded by inserting a lens in the beam path, we find that the enlarged spot has a granular or speckled appearance when it falls onto a diffuse-reflecting surface such as a piece of white paper. That is, the expanded spot seems to be made up of a large number of tiny spots.

The explanation for this is that, although the amplitude of the reflected light is constant over the surface, the phase of the reflected wave, or its polarization (or both), varies randomly from one elemental area to the next over the illuminated screen; hence the radiation from all these elemental areas adds and cancels (depending on phase), in space, to produce a very complex interference pattern.

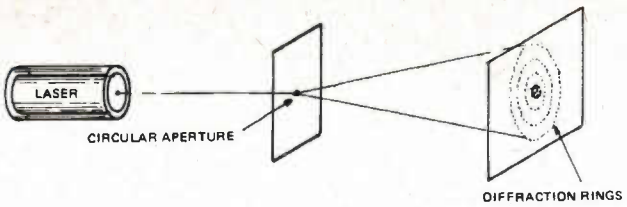
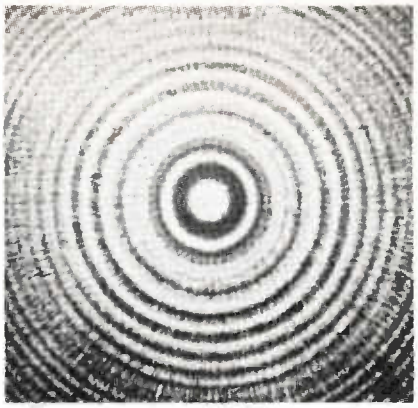
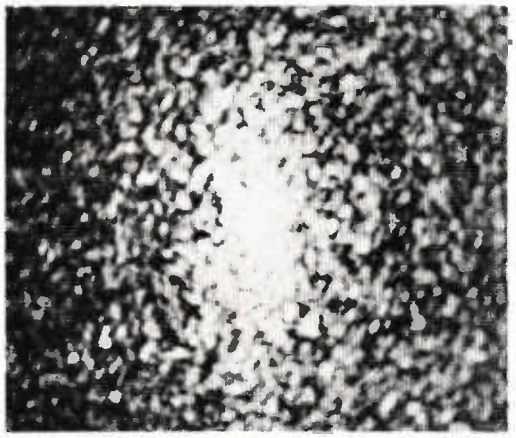


Fig. 4. A tiny hole punched through aluminium foil with the point of a needle will produce a circular diffraction pattern similar to that shown on the right.





Complex pattern of dots produced by passing laser beam through frosted glass.

This granular appearance can be put to very good use in diagnosing nearsighted vision (myopia). With the laser beam held steady, move your head slowly from side to side and then observe whether the spots appear to move in the same direction. If they move *with* the motion of your head (same direction) you have either normal vision or you are farsighted; if they move in the opposite direction, you are nearsighted. For those who wear glasses, try it both with and without your glasses.

If the laser beam is directed onto milk, no specular pattern is observed because milk is a colloidal suspension, and the Brownian motion of the suspended particles causes very rapid variations of the interference pattern similar to that produced by incoherent light.

Colour of the beam

We are struck, at first, by the intense red colour of the beam, but although as said before, this red colour is a single 6328 Å wavelength, *there are other colours present.*

These may be observed by darkening the room and placing colour filters in front of the beam. It will be found that the laser also has fairly strong outputs of *incoherent* light in the blue and green wavelengths. These are due to the non-lasing atomic transitions in the helium and neon gases. We will leave it to you to try various coloured filters and determine which is needed to *transmit* individual colour components of the beam and absorb those not wanted.

Polarization

The laser beam is polarized and the plane of polarization may be determined by passing the beam through a piece of polaroid film (or polaroid sunglasses). By rotating the polaroid, the plane of polarization of your laser will be found.

Further it will be found that this plane of polarization rotates with time. This effect varies from laser to laser due to small differences in manufacture.

LAWS OF GEOMETRICAL OPTICS

The laser may quite readily be used to verify laws of geometric optics. In all these experiments take care that reflected or diffracted laser beams do not enter the eye.

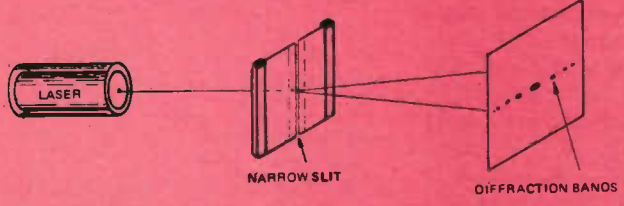
Reflection

One of the first laws of optics is that the angle of incidence is equal to the angle of reflection. This may be verified as follows: reflect the beam off the surface of a mirror as shown in the diagram, make the beam visible with smoke and measure the angles Θ_1 and Θ_2 to the normal (line perpendicular to mirror). It will be observed that Θ_1 equals Θ_2. Additionally it will be seen that the incident ray, the reflected ray, and the normal all lie in the one plane.

If an ordinary plate glass mirror is used in this experiment a second reflected beam may be observed. This is because the mirror is silvered on the back of the plate glass and consequently, you will not only observe the main reflected beam from the silvered surface, but also a secondary, less bright, reflection from the front of the glass.

Refraction

When a ray of light passes obliquely from air to water, air to glass etc., the ray changes direction at the interface, that is, the ray is bent or refracted. This refraction depends on the relative densities of the two media. In glass or



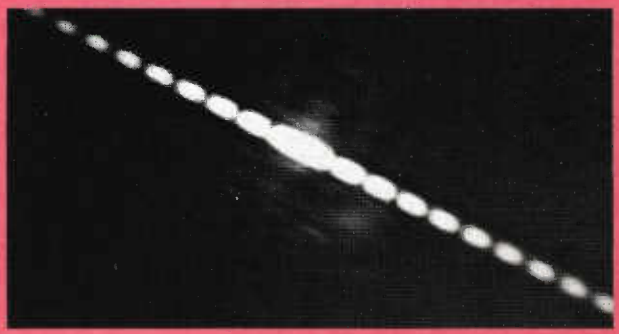


Fig. 5. Two razor blades can be used to make a narrow slit for the production of horizontal diffraction bands (shown right).

LASER EXPERIMENTS

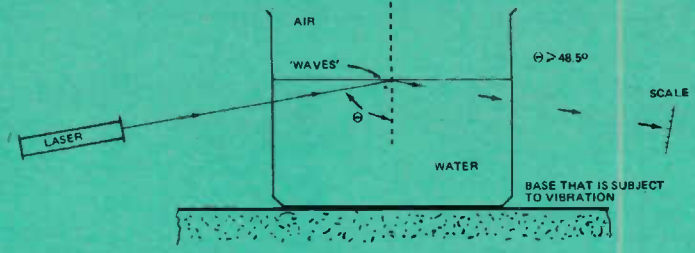


Fig. 6. Method of detecting vibration with a laser.

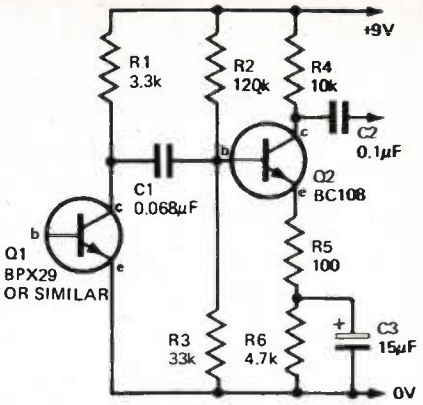


Fig. 7. A suitable detector circuit for optical communications experiments.

water, for example, the velocity of light waves is decreased and the beam is deflected towards the normal. This effect may easily be illustrated by passing the laser beam through a glass of water. If the water is made steaming hot, and a tiny amount of milk or liquid detergent is added to it, both the incident and refracted beams will be visible. (Steam makes the incident beam visible).

LAWS OF PHYSICAL OPTICS

Physical optics is concerned with those phenomena which are characteristic of light itself. The following experiments verify the classical wave theory of light. We cannot treat this subject to any depth but full theory can be found in any standard physics text.

Diffraction

When light waves pass through an aperture, or past the edge of an obstacle, they always spread to some extent into the region which is not directly exposed to the oncoming waves. This phenomenon is called 'diffraction'. To explain this bending of light, Huygens (nearly three centuries ago) proposed the rule that each point on a wave front may be regarded as a new source of waves. This is a very important principle and is basic to the explanation of the diffraction phenomena.

To observe diffraction, simply pass the laser beam through a small circular aperture or a very narrow slit. A small aperture is easily made with a needle point in aluminium foil. A slit may be constructed by bringing two sharp, clean edges, such as those of razor blades, together to form a slit approximately 0.3 mm wide.

An endless variety of diffraction patterns can be formed by passing the laser beam through pieces of broken glass or patterned drinking glasses or hair. These diffraction patterns are formed by imperfections in the glass and sharp edges. Refraction effects are also present and hence the patterns are quite intricate.

OTHER EXPERIMENTS

Vibration detector

By directing the beam into a container of water at an angle greater than the critical angle (the angle for which there is *reflection* off the water-air interface and no refraction through the interface), you can construct a vibration monitor.

Any vibration of the base (such as the floor boards of a house when someone is walking) will be transmitted to the surface of the water as waves which are easily detected by observing movement of the reflected beam. Further, if the container of water and laser are placed on a solid base in the ground (e.g. a heavy concrete block), you now have a sensitive 'earthquake' detector capable of monitoring slight earth tremors.

Observing heat waves

Since temperature has an effect on the density of air, it is possible to observe the shadows of heat waves with a laser. You can readily observe this by holding a burning match or cigarette lighter in the path of the beam after expanding it with a lens.

Experiments in optical communications should be confined within the boundaries of your own property or building. Communication over long distances between buildings etc. is subject to PMG licencing laws and is therefore illegal without a licence.

Optical communications

A simple communications link over distances of up to ½ km (depending on atmospheric conditions) can be established by modulation of the output of the laser and by detecting this modulation with a photo-transistor, or PIN diode, coupled to a suitable amplifier. The circuit of a suitable detector, preamplifier is given in Fig. 7.

An input jack is provided on the laser for a modulation input which should be a maximum of one volt peak. Signal levels greater than this will result in signal clipping.

Much more elaborate systems can of course, be built with extended bandwidth and sensitivity. For transmission over long distances, say up to 1 km, beam collimation and collecting optics are usually necessary.

However, because of the inductive effects of the tube itself, it is difficult to current modulate this type of laser tube much above 500 kHz, and maintain a reasonable power output.

Further experiments using this laser will be described next month. ●

the MASTERPIECE

"Creation of Sound" is greatly affected by the listening room and the stereo system. If the basic system is poor, even a masterful performance will not be worth a snap of the fingers. It is the "MULTIAC" Series Compact Stereo, the masterpiece of ONKYO, which has been perfected through the most stringent technical examination of the amplifier, player and speaker system from every conceivable angle.

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SPEAKER SYSTEM
Type 3 way semi-bass-reflex type. Speakers 12" Woofer [8" Woofer], 4¾" Squawker, Horn-Tweeter. Frequency Response 35~20,000Hz, [40~20,000Hz. Crossover Frequency 500Hz, 9KHz. Impedance 8 ohms.

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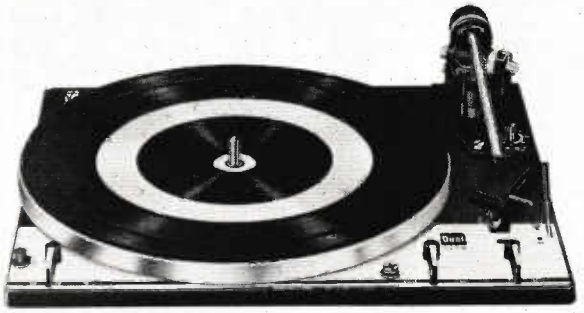
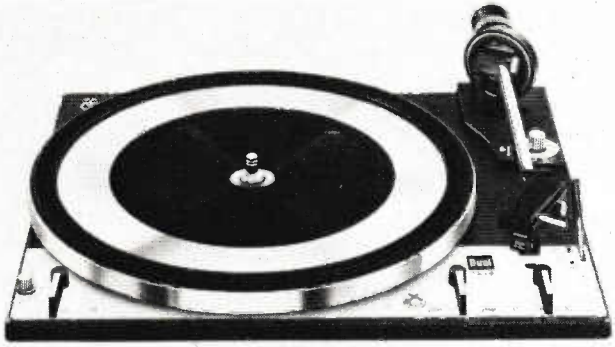
But not necessarily the most expensive one.

DUAL 1214



DUAL 1216



DUAL 1218

DUAL 1229

DUAL 701

Dual

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PACKAGED SOUND -$350 Hi-Fi

We test ten under-$350 unit audio systems.

Whilst preparing these reviews, we found that the selling prices of the various systems tested varied very considerably from shop to shop — sometimes by more than $50.

Because of this we have not followed our usual practice of quoting manufacturer's recommended retail prices.

BEWILDERED by a multiplicity of choices, and confused by a plethora of incomprehensible pseudo-technicalities, many a prospective hi-fi purchaser chooses the easy way out and buys an audio package deal from his local friendly chain store.

In fact people are doing so in ever-increasing numbers, and by far the biggest sales of 'hi-fi' equipment are of this type.

Basically what the purchaser gets for his money is a complete sound system ready to take home and plug in.

Some manufacturers merely supply the customer with selected units – but sold as a 'package deal'. Others actually build the various units comprising the system into some form of cabinet – or carrying case.

Either way, the purchaser does not have to attempt to match up various combinations of record players, amplifiers and loudspeakers. It is done for him by the supplier.

It is very important that this choice of components be made correctly, for the overall performance of a hi-fi system is always limited by the performance of the poorest item. It is essential that no single item be substantially better or worse than any other.

The supplier is in a much better position than most of his customers to assess and match up units to provide optimum value for money.

Suppliers of medium and high priced unit audio systems take very great care to provide an optimum 'mix' of individual units and it is very unusual for a buyer to be sold an unsatisfactory system.

Unfortunately this is less true of low-priced unit audio systems. Here the systems are excellent value for money in the sense that the price of the whole system will usually be substantially less than the price of the individual units sold separately.

But our overall impression of the low priced end of the market is that many of the suppliers are spoiling their products by attempting to market them just a little too cheaply.

Of the ten unit audio systems reviewed in this issue none had loudspeakers really capable of doing justice to the remainder of the system. All systems reviewed would have been substantially improved if the design and/or construction of the loudspeakers had been upgraded.

Certainly it would be possible for the purchaser to upgrade the performance at a later date by buying better speakers – but to some extent this negates the whole point of unit audio.

Nevertheless our overall impression of the units tested was favourable. In our opinion it would be very unlikely that, without specialised knowledge, a prospective purchaser would be able to buy individual units, providing substantially better performance than the better of the systems tested, for less than $350.

Testing the Systems

– Our Reviewer Comments

Each of the systems reviewed was evaluated in terms of standard of construction, basic performance, ability to produce realistic sound levels without excessive distortion, etc. Rather than our normal laboratory tests, the systems were evaluated in a normal living room environment.

Apart from actual listening tests – using high quality records – we measured the frequency response of each system.

This measurement shows how faithfully the system can reproduce a range of sounds at the same relative intensity at which they originally occurred.

An ideal system reproduces all sounds at their *original, relative* intensities. In practice however even the best of systems fall short of this ideal.

In the following reviews the systems have been tested by playing a special test record on which there is a continuous tone that slowly rises in pitch from a very low frequency (20 Hz) right up to a virtually ultrasonic frequency (20 000 Hz). This tone is recorded on the record at constant sound level.

A special microphone, placed in front of the loudspeaker, then picks up this tone. The tone is then fed into a chart recorder where a graph is automatically drawn of amplitude against frequency. The relevant graph is reproduced in each of the reviews.

When studying these graphs, bear in mind that a change of 10 dB is *heard* as a change in sound level of approximately 50 per cent. The frequency range over which the output level does not change by more than 50 per cent is also given in the test results column in each review.

HOW LOUD?

The sound output level of each system is shown in the test result tables. This was measured at distortion levels, that whilst not really acceptable to dedicated hi-fi enthusiasts – would be quite tolerable to the average listener.

Subjectively, sound levels double for an increase of roughly 10 dB. Thus a system producing a sound level of 104 dB will sound about twice as loud as one producing 94 dB. In practice all systems tested had sufficient outputs to produce realistic levels in small to medium sized rooms.

For their intended use, all systems offer reasonable performance – quite a few offer much better performance than we would have expected for the price.

But very few of the systems have really good *total* performance and we imagine that many purchasers will eventually upgrade the speakers to provide the superior performance inherent in the amplifiers and record players supplied.

This observation is true of every system tested. In each case the amplifier – and often the turntable as well – was capable of a higher level of performance than the speaker systems.

It seems a shame that suppliers do not offer intending purchasers the option of a better speaker system than those miniscule devices currently supplied.

PIONEER PRELUDE 500

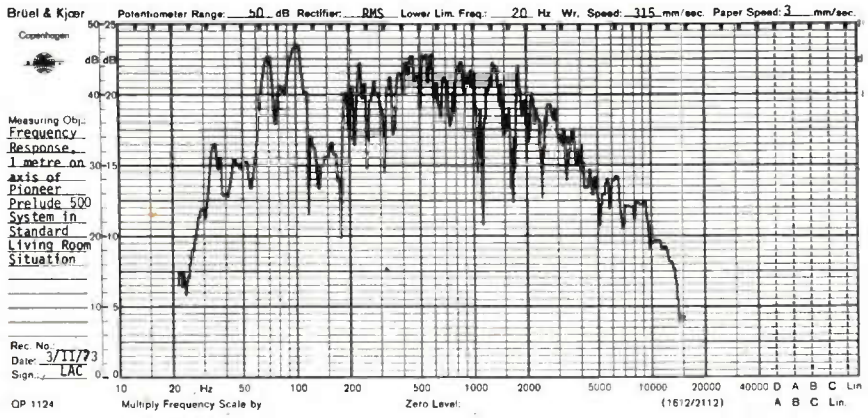
THE Prelude 500 has taken the local market by storm – particularly as it has been deliberately designed for future upgrading. The heart of this system is the well proven SA500 amplifier which, (twin 12 watt in its latest form), is a truly excellent unit with most of the ergonomic design features that one could reasonably ask for.

The SPL100 turntable is a reasonable quality, two-speed belt driven unit featuring low wow and flutter, a reasonable magnetic cartridge, and automatic cut-off and return.

The weakest link of the system is most probably the small SCS11 speaker enclosures. The manufacturers do not deny that these have been sold as the first stepping stone to what they hope will be a long term plan for building a better system.

Notwithstanding, these speakers provide a commendable performance between 60 Hz and 5 kHz. This performance can be enhanced at the top end through the judicious use of the treble boost control.

It is not particularly easy to provide an extended frequency response with one small speaker covering both ends of the spectrum but the Prelude 500 system does reasonably well and shows in what manner the system can be readily enhanced. ●



PIONEER PRELUDE 500			
TURNTABLE		**AMPLIFIER**	
Type	Player	Radio tuner	No
Drive	Belt	Microphone input	No
Number of Speeds	2	Headphone socket	Yes
Anti-skate	No	Tape record input	Yes
Cartridge type	Magnetic	Tape monitor	Yes
		Separate balance control	No
		Multi-speaker switch	Yes
LOUDSPEAKERS		Rumble filter	No
Type	–	Treble cut filter	No
Dimensions (in mm.)	267x479x194	Loudness control	Yes
ADDITIONAL FEATURES			

TEST RESULTS

Maximum output level: 102 dB.

Frequency response: 60 Hz – 5 kHz.

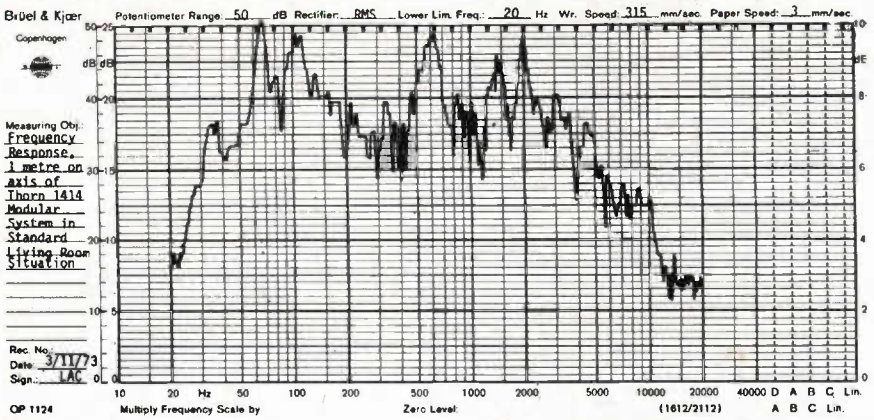
Distortion: Low distortion but cabinet resonances pronounced below 200 Hz.

Standard of workmanship: Very good.

Control layout: Very good.

Comments: Clean but 'peaky' response, treble poor above 5 kHz. Standard of turntable and amplifier would justify better quality speakers. Speakers supplied suffered from cabinet resonances.

THORN 1414



THORN'S 1414 Modular system is typical of the larger modular units. Large speaker enclosures are provided. These give a generally clean sound and a reasonable frequency response.

Thorn have taken a lot of trouble to design a radio tuner system and amplifier offering excellent performance. The frequency response is fair, but not outstanding; the drop in response above 5 kHz is quite pronounced.

Major features are excellent storage space, good ergonomic design, and low distortion at high listening levels. In keeping with most of the other units we felt that an enhanced performance could readily be provided with a slight refinement in the detailed design of the speaker enclosures. ●

THORN 1414			
TURNTABLE		**AMPLIFIER**	
Type	auto changer	Radio tuner	Yes
Drive	Idler	Microphone input	No
Number of Speeds	4	Headphone socket	Yes
Anti-skate	No	Tape record input	Yes
Cartridge type	Ceramic	Tape monitor	No
		Separate balance control	Yes
		Multi-speaker switch	No
LOUDSPEAKERS		Rumble filter	No
Type	–	Treble cut filter	No
Dimensions (in mm.)	433x663x400	Loudness control	No
ADDITIONAL FEATURES			

TEST RESULTS

Maximum output level: 98 dB.
Frequency response: 30 Hz – 6 kHz.
Distortion: Low distortion but some colouration.
Standard of workmanship: Very good.
Control Layout: Very good.
Comments: Fair performance but slight colouration due to speaker enclosure design.

PHILIPS GF90805P

THE GF90805P is an outstanding unit. It has excellent ergonomic design, smart appearance, a high quality cartridge, well damped, hydraulically controlled cueing lever, slider controls, presence control, and two VU meters.

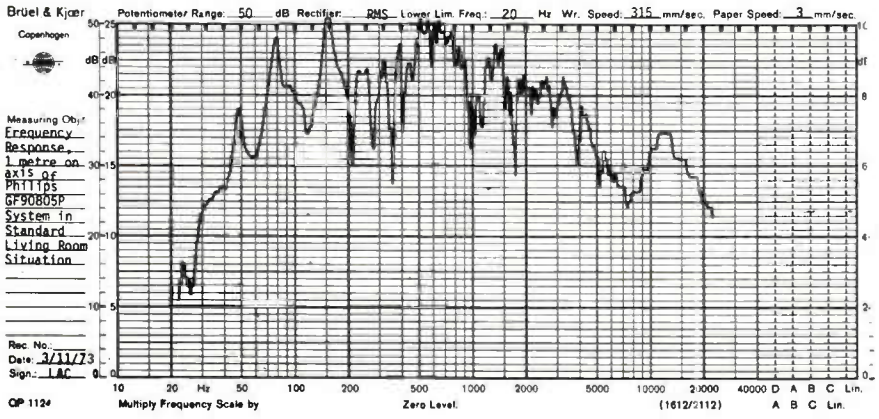
The record player is one of the better models produced by Philips. It offers two speeds, and belt drive.

The medium sized speakers supplied with the unit feature a woofer and two tweeters in each enclosure.

Whilst the unit only provides 6 watts per channel, the overall performance is creditable, but nevertheless could still be upgraded by the addition of larger speakers.

These speakers provide a genuine 50 Hz to 12 kHz performance and whilst the response is not remarkably flat it is nonetheless quite creditable.

This system was the best of those tested and would probably satisfy the great majority of buyers seeking equipment in this price range. ●

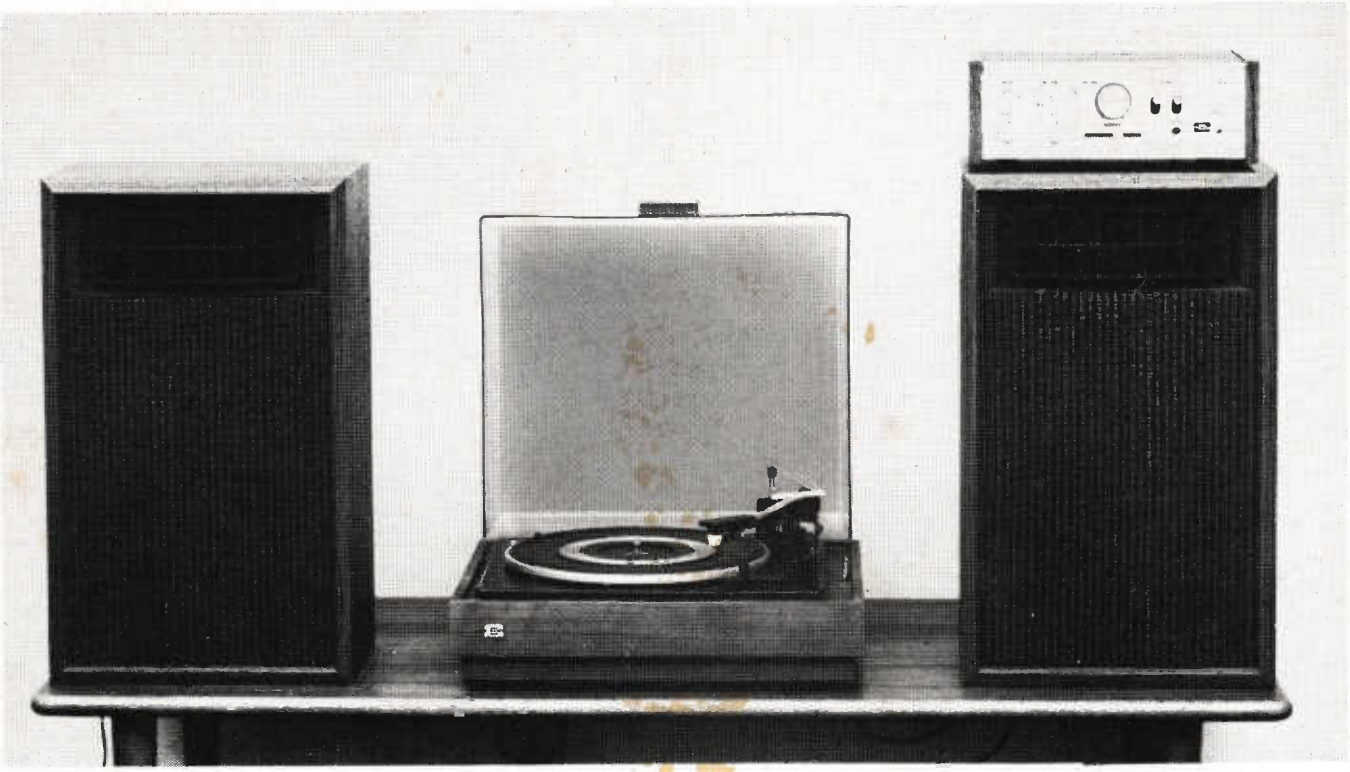


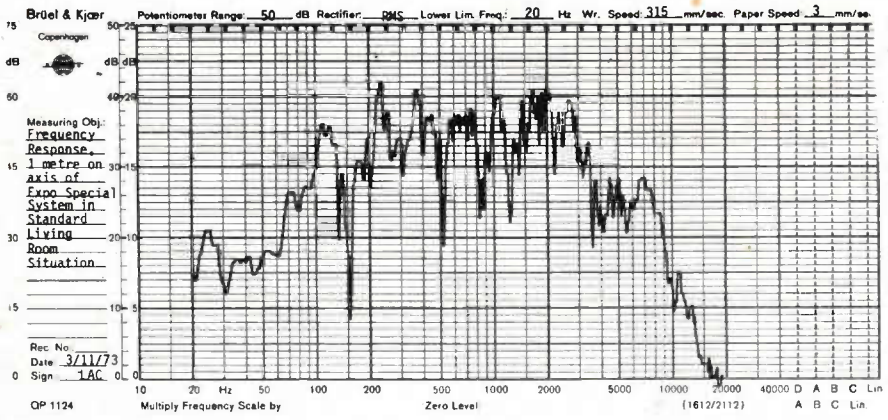
PHILIPS GF90805P			
TURNTABLE		**AMPLIFIER**	
Type	Player	Radio tuner	No
Drive	Belt	Microphone input	Yes
Number of Speeds	2	Headphone socket	Yes
Anti-skate	Yes	Tape record input	Yes
Cartridge type	Magnetic	Tape monitor	No
		Separate balance control	Yes
		Multi-speaker switch	No
LOUDSPEAKERS		Rumble filter	No
Type	Unsealed	Treble cut filter	Yes
Dimensions (in mm.)	265x265x97	Loudness control	Yes
ADDITIONAL FEATURES Slider controls, prescent control, two VU meters, hydraulic cueing lever			

TEST RESULTS

Maximum output level: 92 dB.
Frequency response: 45 – 6 kHz.
Distortion: Moderately low over most of spectrum, but higher than desirable below 160 Hz.
Standard of workmanship: Very good.
Control layout: Very good.
Comments: Maximum output lower than other units tested, but still adequate for small to medium sized rooms. Quite creditable performance generally.

EXPO TA 2200





The Expo Special System is a low cost system featuring a twin 5 watt amplifier, a Garrard Model 40B automatic changer, and speaker boxes of size and performance roughly comparable to those of the more expensive Expo TA 3100.

Distortion is slightly higher but by no means unacceptable – we doubt if many people would be aware of it. Frequency response is reasonably good ± 10 dB from 65 Hz to 9 kHz. If anything it is smoother than that provided by the TA 3100.

Subjectively, the unit is good – it sounds better than it looks! ●

EXPO TA 2200			
TURNTABLE		**AMPLIFIER**	
Type	auto changer	Radio tuner	No
Drive	Idler	Microphone input	No
Number of Speeds	3	Headphone socket	Yes
Anti-skate	No	Tape record input	Yes
Cartridge type	Magnetic	Tape monitor	No
		Separate balance control	Yes
		Multi-speaker switch	No
LOUDSPEAKERS		Rumble filter	Yes
Type	Vented	Treble cut filter	Yes
Dimensions (in mm.)	298x482x201	Loudness control	No
ADDITIONAL FEATURES			

TEST RESULTS

Maximum output level: 97 dB.
Frequency response: 65 Hz – 9 kHz.
Distortion: Moderately high distortion caused by speaker enclosure resonances and design.
Standard of workmanship: Good.
Control layout: Good.
Comments: Good overall response.

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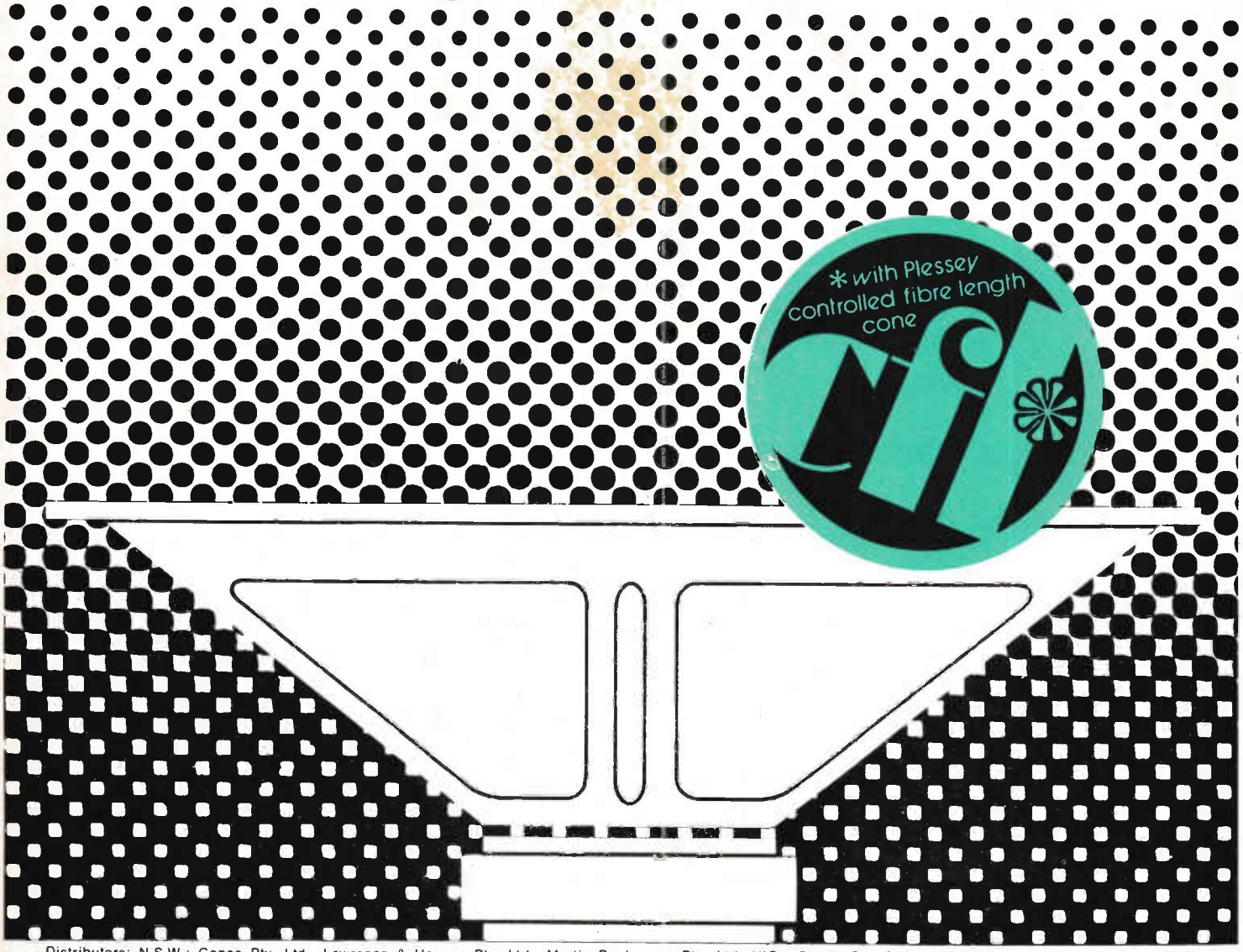

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NATIONAL SG 1010

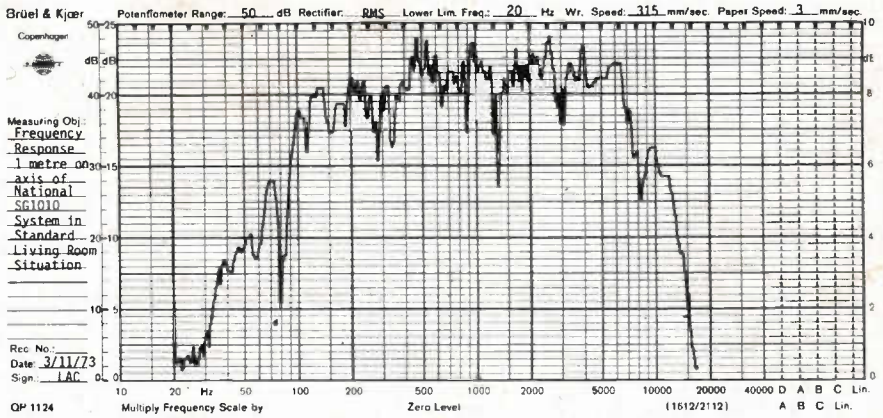
THE Japanese have been renowned for the number of facilities that they can provide in a piece of equipment at a limited price. The National SG1010 is no exception to the rule.

This unit, whilst miniscule in size, offers a multi-band radio, a cassette player, and a small record player. The latter worried us because it alone was out of keeping with the rest of the unit.

The only criticisms that we can reasonably make of the unit concern the type of cartridge and lack of proper adjustment of tracking weight, the degree of wow and flutter that such a small turntable will develop as a result of its low turntable mass, and last but not least, the common criticism that the speakers, if slightly larger, would provide an enhanced low frequency performance.

Whilst the speakers were very small, the system had no difficulty in providing a remarkably clean frequency response between 80 Hz and 10 kHz.

Many people will favour a unit as small as this. It can sit on a bedside table, on a shelf, or even on the kitchen work bench. There is no doubt that this unit will prove to be popular because of the large number of features it offers. But just don't use that turntable too often! ●



NATIONAL SG 1010			
TURNTABLE		**AMPLIFIER**	
Type	Player	Radio tuner	Yes
Drive	Idler	Microphone input	No
Number of Speeds	2	Headphone socket	No
Anti-skate	No	Tape record input	No
Cartridge type	—	Tape monitor	Yes
		Separate balance control	No
		Multi-speaker switch	No
LOUDSPEAKERS		Rumble filter	No
Type	Semi-sealed	Treble cut filter	No
Dimensions (in mm.)	232x360x140	Loudness control	No
ADDITIONAL FEATURES Cassette player/recorder included			

TEST RESULTS

Maximum output level: 100 dB.
Frequency response: 90 Hz – 10 kHz.
Distortion: Very low distortion right across the spectrum.
Standard of workmanship: Very good.
Control layout: Very good.
Comments: Generally good performance but the small record player supplied with this unit will inevitably develop significant wow and flutter. The use of such miniscale turntables may save space and cost but the purchaser usually ends up paying in other ways.

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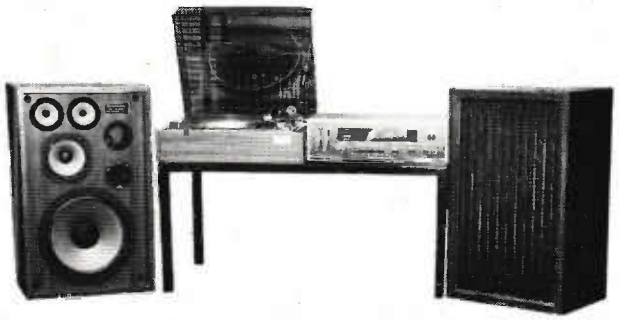
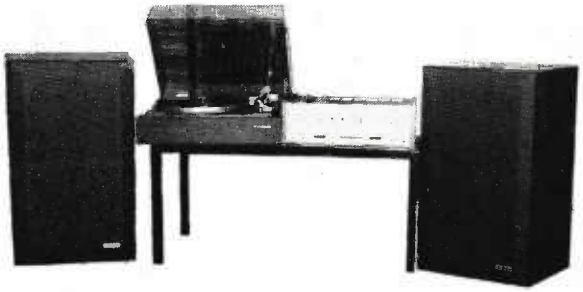


KENWOOD 4090 SPEAKERS – 50 watts 3 way 4 speaker system
SONY 230 TURNTABLE – Auto return
MONARCH GS 22 TUNER AMP – 20 W.R.M.S. per channel 2 years guarantee

$517.00



ULTRA LINEAR 100 LOUDSPEAKERS – 12" 2 way with cutout and 5 years guarantee
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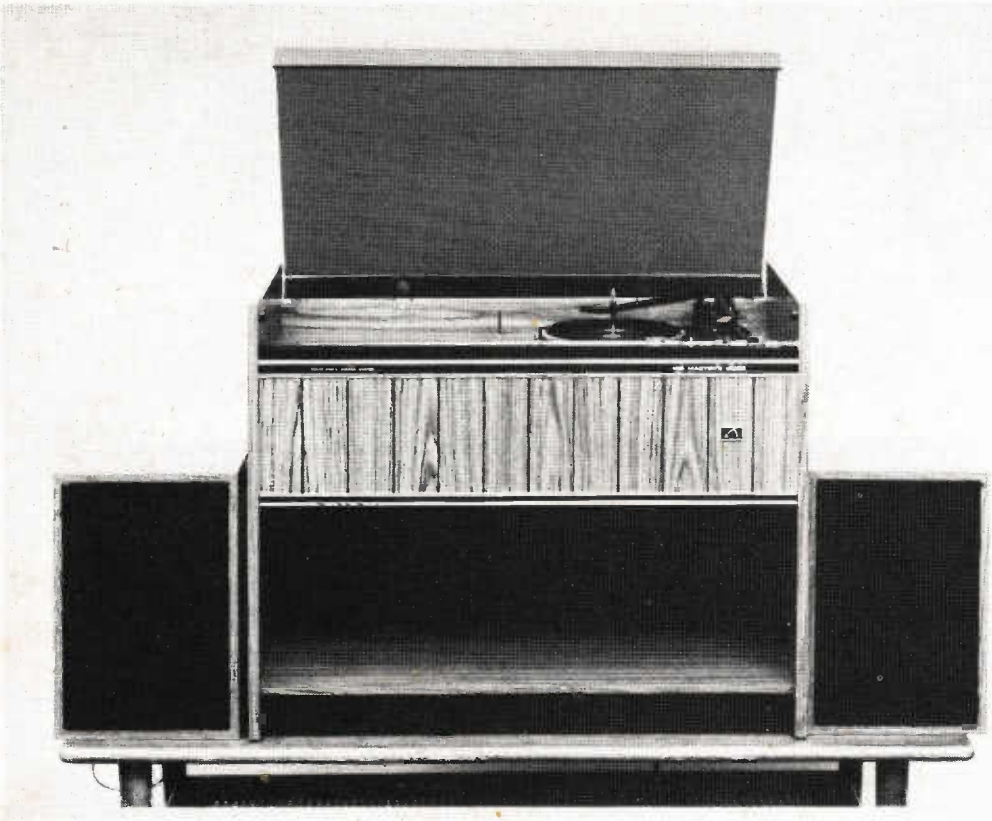
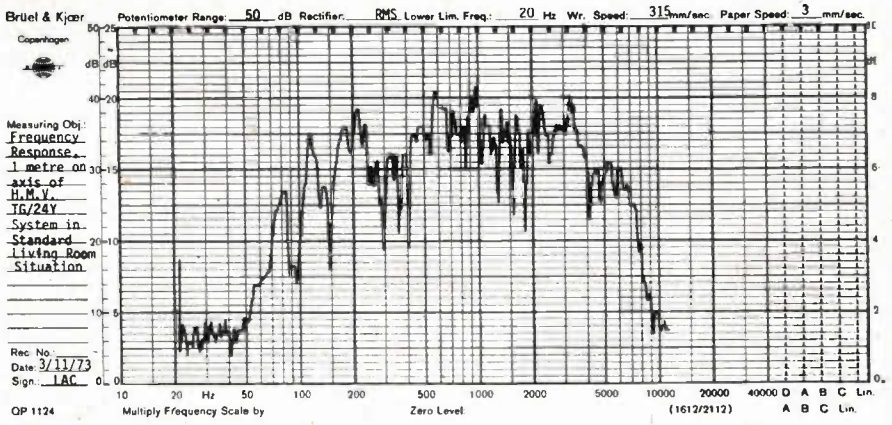
HMV TG/24Y



HMV have always placed emphasis on good finish and longevity. The TG/24Y is very much in this tradition.

The unit incorporates a single band radio tuner with excellent performance. Overall frequency response of the system is quite good, and distortion is acceptably low except at the bass end of the spectrum.

Although the speaker enclosures are unsealed and unlined, the single drive unit used in each unit puts up a quite creditable performance. ●



HMV TG/24Y			
TURNTABLE		**AMPLIFIER**	
Type	auto changer	Radio tuner	Yes
Drive	Idler	Microphone input	No
Number of Speeds	3	Headphone socket	Yes
Anti-skate	No	Tape record input	No
Cartridge type	Ceramic	Tape monitor	No
		Separate balance control	No
		Multi-speaker switch	No
LOUDSPEAKERS		Rumble filter	No
Type	Unsealed	Treble cut filter	No
Dimensions (in mm.)	246x355x230	Loudness control	No
ADDITIONAL FEATURES			

TEST RESULTS

Maximum output level: 96 dB.

Frequency response: 65 Hz – 7 kHz.

Distortion: Moderately low distortion generally but very poor below 200 Hz.

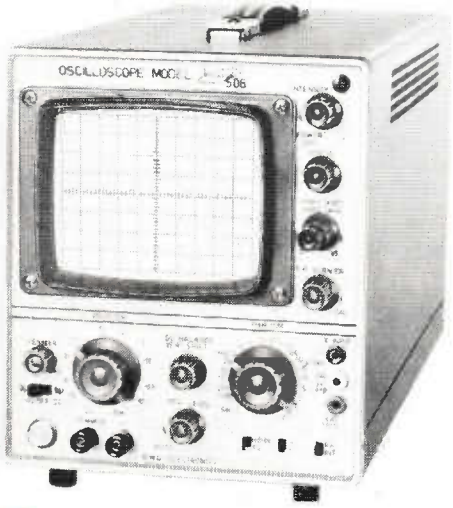
Standard of workmanship: Very good.

Control layout: Very good.

Comments: Fair performance but could be greatly improved by redesign of speaker enclosures.

D.C. TO 15MHz 5mV/cm

b.w.d 506



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b.w.d 509B

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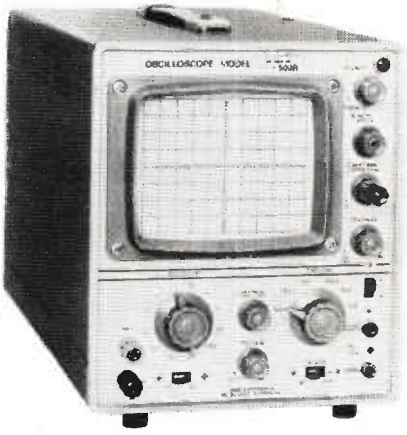
Triggering:	2Hz to 10MHz 1 cm deflection or 1V p-p ext.
Trig. Facilities:	AUTO, Level select, Int and Ext.
Horz. Amplifier:	DC to 1MHz
Sensitivity:	.6V to 6V/cm
Z Modulation:	20V pos. blanks trace at norm inten.



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HMV TJ4X

SOME people believe that a high fidelity system should be a piece of furniture that will grace the floor, provide storage for their records, and provide physical size commensurate with the large sum of money they think they are spending. If this is your criteria then the TJ4X may well be exactly what you have been looking for.

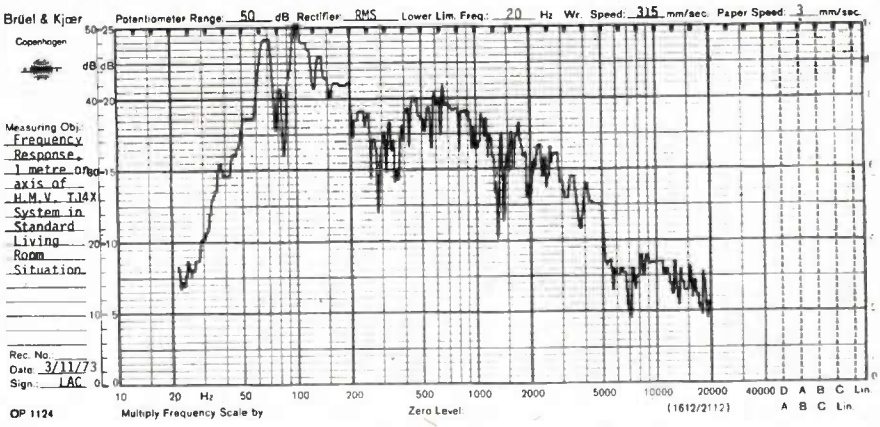
The performance is reasonable but the frequency response is degraded by the lack of frequency linearity provided by the speaker enclosure. This peaks between 60 and 200 Hz as a direct result of the type of rear vented enclosure and lack of damping materials used in its construction. Some people like this sort of sound but frankly we thought it had gone out of fashion many years ago.

A few simple modifications to the design of this enclosure would nevertheless produce the enhanced performance that we know the drive units are capable of providing.

The large amount of record storage provided in the base of the unit is a definite boon for those people who do not have shelves.

The radio tuner provided in this model has good clean sound with a good band-width (estimated 8 kHz). No doubt this tuner will be used as much if not more, as the record player.

Whilst we are critical of the speaker enclosures there is otherwise no doubt but that the unit is well-designed and constructed and should give many years of trouble-free performance. ●



HMV TJ4X			
TURNTABLE		**AMPLIFIER**	
Type	auto changer	Radio tuner	Yes
Drive	Idler	Microphone input	No
Number of Speeds	4	Headphone socket	Yes
Anti-skate	Yes	Tape record input	Yes
Cartridge type	Magnetic	Tape monitor	No
		Separate balance control	Yes
		Multi-speaker switch	No
LOUDSPEAKERS		Rumble filter*	No
Type	Semisealed	Treble cut filter	No
Dimensions (in mm.)	323x563x419	Loudness control	No
ADDITIONAL FEATURES Record storage included			

TEST RESULTS

Maximum output level: 101 dB.

Frequency response: 40 Hz – 5 kHz.

Distortion: Generally low distortion but poor between 80 Hz and 100 Hz due to very pronounced enclosure resonance.

Standard of workmanship: Very good.

Control layout: Very good.

Comments: Fair performance but pronounced boom and poor treble balance resulting from type of speaker enclosure used.

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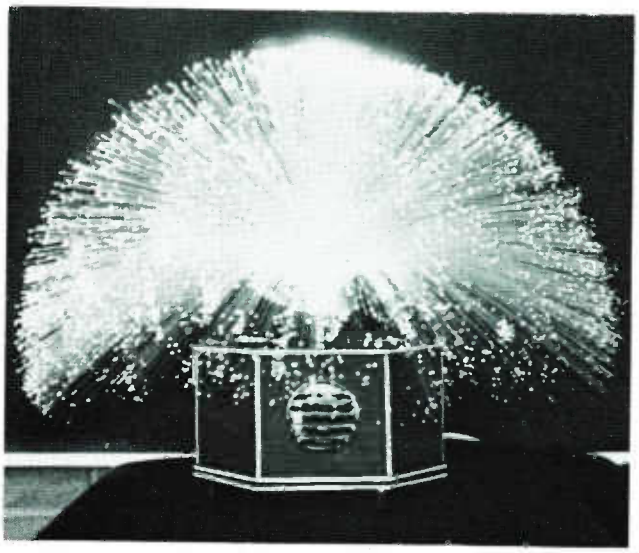
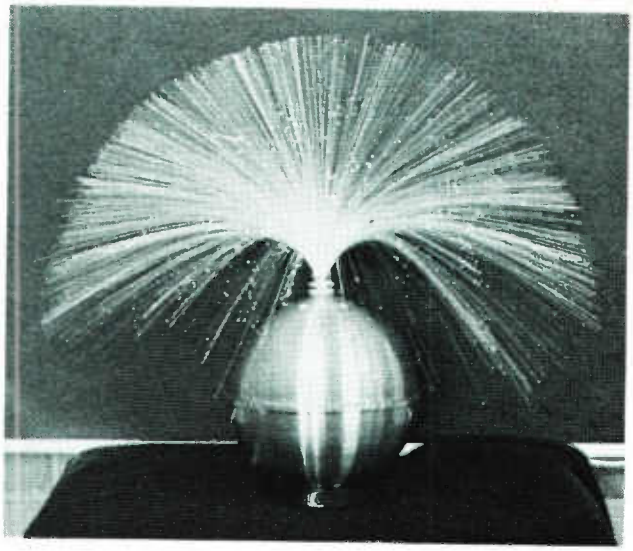
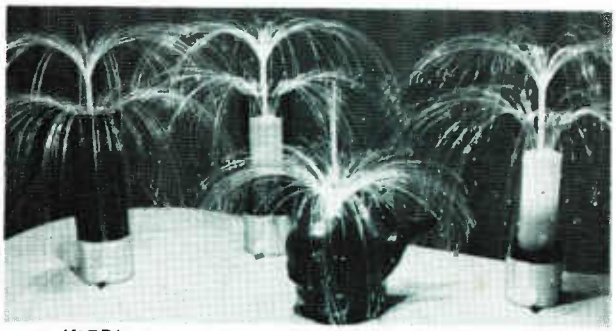
ILLUMINATED FIBRE PRODUCTS have now released 2 new models, that change color automatically so ask for them at your nearest distributor.



KIFP/4 CORALITE a brilliantly strong automatically changing 7 color display lamp that has a 15 m/m fibre glass spray, quartz halogen lamp, electric cooling fan and mounted in an attractive wood-grained hexagonal sided base. Fitted with a special safety thermal overload switch.
Suggested Retail $125.



KIFP/3. STARDUST a beautiful delicate auto changing color lamp – with a 9 m/m glass fibre spray on a 6½" diameter sphere anodised base, red, gold or blue.
Suggested Retail $70.



KIFP/1 KIFP/2

Distributors

NEW GUINEA Hagen Electrics Pty Ltd, P.O. Box 100 Mount Hagen New Guinea, Phone: 521 562.

VICTORIA Radio Parts Group, 562 Spencer St, West Melb. Vic. 3003. Phone: 30 1251.
Dorward Enterprises Pty. Ltd. 56 Levanswell Rd, Moorabbin Vic. 3189. Phone: 95 4633.

QUEENSLAND Ace Plastics (Aust) Pty Ltd, 29 Hayward St. Stafford, Queensland 4053. Phone: 56 3041

SOUTH AUSTRALIA Dependable Electronic Services, 59 Queen Street, Norwood, SA. 5067 Phone 332 1018.

WEST AUSTRALIA Arena Distributors, Romney Building, 273 Hay Street, East Perth WA 6000 Phone 25 9993

KIMBERLEY PLASTICS PTY. LTD.
CNR. SOUTH ROAD & ALEX AVENUE, MOORABBIN, VICTORIA 3189
CABLES: KIMPLAS MELB.

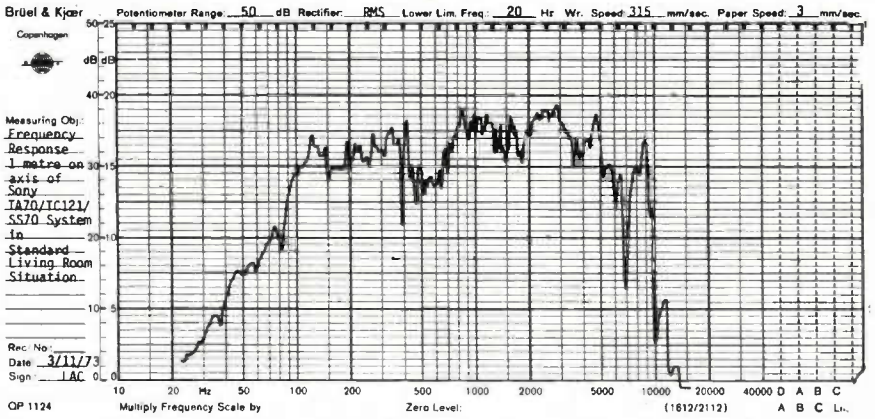
SONY TA70/TC121/SS70

THIS system was different from others tested in that it did not come with its own record player. Instead, it was supplied with the new little Sony TC121 cassette recorder, which has excellent performance considering its low recommended retail price. Likewise the TA70 is a very good amplifier featuring low distortion at power outputs up to 10 watts. Even the speaker's performance belie their size.

Basic system performance is 85 Hz to 10 kHz with the cassette player at -20 VU. There is no doubt that the addition of a record player will make this a really good small modular system.

The cabinet work and overall finish of this system is exemplary and it is clear that the Japanese are placing an even higher important on the appearance of their units than they did in the past.

Subjective evaluation of this system showed it to have reasonably good performance with the exception of noticeable frequency doubling. It would most probably require a significant increase in expenditure to improve the performance of the small speakers used but this is a necessary step if lower distortion is required. ●



SONY TA70/TC121/SS70			
TURNTABLE		**AMPLIFIER**	
Type	Vented	Radio tuner	No
Drive		Microphone input	No
Number of Speeds		Headphone socket	Yes
Anti-skate		Tape record input	Yes
Cartridge type		Tape monitor	Yes
		Separate balance control	Yes
		Multi-speaker switch	Yes
LOUDSPEAKERS		Rumble filter	No
Type		Treble cut filter	Yes
Dimensions (in mm.)	180x260x223	Loudness control	Yes
ADDITIONAL FEATURES	Unit was supplied with cassette recorder rather than turntable, but matching turntable is available.		

TEST RESULTS

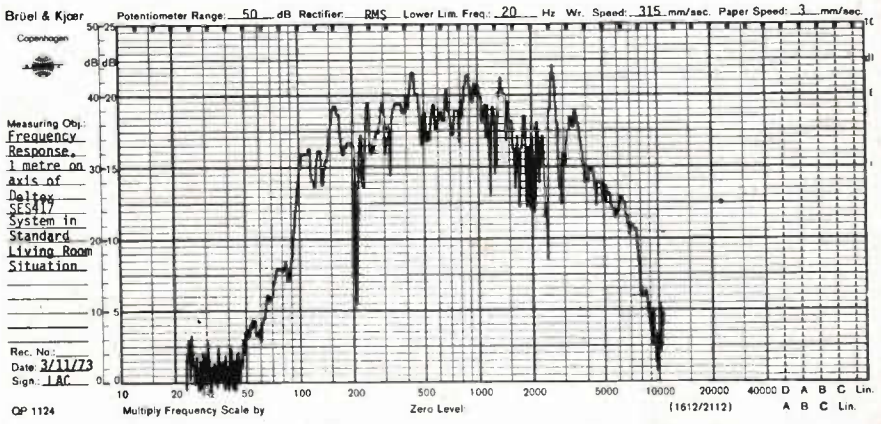
Maximum output level: 103 dB.
Frequency response: 85 Hz – 10 kHz.
Distortion: Moderately low distortion but speakers prone to frequency doubling.
Standard of workmanship: Very good.
Control layout: Very good.
Comments: Reasonably good performance but speakers prone to 'doubling' i.e. producing false notes at multiples of correct frequency.

DELTEX SES 417

THE SES417 provides the maximum possible number of facilities for the price.

It features not only a record player, a multi-band radio tuner, but also a cassette player, a pair of microphones, one with an on-off switch, an FM aerial — and a pair of these typically medium-performance speakers.

As with many of these systems, the total performance suffers primarily as a result of the speaker system which in this case limits the performance to 80 Hz — 6 kHz. This is one system that would undoubtedly benefit from a good pair of speakers even though the performance is acceptable with the existing enclosures. ●



DELTEX SES 417			
TURNTABLE		**AMPLIFIER**	
Type	auto changer	Radio tuner	Yes
Drive	Idler	Microphone input	Yes
Number of Speeds	3	Headphone socket	Yes
Anti-skate	No	Tape record input	Inbuilt
Cartridge type	Ceramic	Tape monitor	No
		Separate balance control	No
		Multi-speaker switch	No
LOUDSPEAKERS		Rumble filter	No
Type	Vented	Treble cut filter	No
Dimensions (in mm.)	222x292x146	Loudness control	No
ADDITIONAL FEATURES Unit includes cassette player/recorder, two microphones, FM antenna			

TEST RESULTS

Maximum output level: 104 dB.
Frequency response: 95 Hz — 8 kHz.
Distortion: Distortion level is quite low right across the spectrum.
Standard of workmanship: Very good.
Control layout: Very good.
Comments: Clean sound but poor bass and treble resulting from small speaker enclosures.

MORE POWER FOR YOUR DOLLAR

DOMINION

STEREO AMPLIFIERS

MODEL KTX-4000V
Size: 13.8" x 7.9" x 4.3"

SPECIFICATIONS:
Output Power:
25W x 25W RMS at 8 ohms
65W x 65W music power

FREQUENCY RANGE:
25 – 40,000 Hz ± 2dB

OUTPUT IMPEDANCE
4 – 16 ohms

DISTORTION (TOTAL HARMONIC)
At 1 watt RMS @ 1 kHz = 0.1%
At 25 Watts RMS @ 1 kHz = 0.1%
At 28 watts RMS @ 1 kHz = 0.5%

POWER SUPPLY
240 volts AC

* $126.86 Tax Inc.

MODEL KTX-2000V
Size: 13.8" x 7.9" x 4.3"

SPECIFICATIONS:
Output Power:
15W x 15W RMS 8 ohms
40W x 40W music power

FREQUENCY RANGE:
25 – 30,000 Hz ± 2dB

OUTPUT IMPEDANCE:
4 – 16 ohms

DISTORTION (TOTAL HARMONIC)
1 watt = 0.14%
14 watts = 0.16%
16 watts = 0.18%

POWER SUPPLY
240 volts AC.

* $105.19 Tax Inc.

MODEL KTX-1200V
Size: 13.8" x 7.9" x 4.3"

SPECIFICATIONS:
Output Power:
6W x 6W RMS at 8 ohms
15W x 15W music power

FREQUENCY RANGE:
40 – 20,000 Hz ± 3dB

OUTPUT IMPEDANCE:
4 – 16 ohms

DISTORTION (TOTAL HARMONIC)
1 watt = 0.2%
5 watt = 0.31%
6 watt = 0.7%

POWER SUPPLY
240 volts AC

* $84.79 Tax Inc.

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M2 MONITOR ACOUSTIC INE SPEAKER

1 a class of its own.
he DM2 is a 3 unit medium size ıonitor loud speaker, employing n acoustic wave line system. lesigned for the professional or ritical home user where extended ow frequency response, exceptional' ıid frequency linearity and high ower handling are required.
ower Handling: suitable for all uality amplifiers with true RMS utput of between 25-60 watts.

B&W
OM70 MONITOR. IMPROVED ELECTROSTATIC SPEAKER

The ultimate in non-compromised sound. The DM70 is a hybrid design employing an exclusive 11 element, wide dispersion electrostatic unit, and a 13" high powered, low distortion, moving coil base unit. Where the ultimate in quality reproduction is desired, there is no compromise . . . only the DM70.
Power Handling: suitable for all quality amplifiers with a true RMS output of between 25-125 watts.

B&W
D5 MONITOR SPEAKER

True sound value.
This is the speaker ideally suited for the person who wants B & W quality in compact size for a small room and at a budget price.
And the D5 is a B & W all the way!
Power Handling: suitable for all quality amplifiers with true RMS output of between 10-25 watts.

B&W
OM4 MONITOR SPEAKER

The mighty mini monitor.
Small in size . . . enormous in sound reproduction, from high to low frequency. This is the sound they said could not be obtained in a speaker of its size!!!
Power Handling: suitable for all quality amplifiers with true RMS output of between 10-30 watts.

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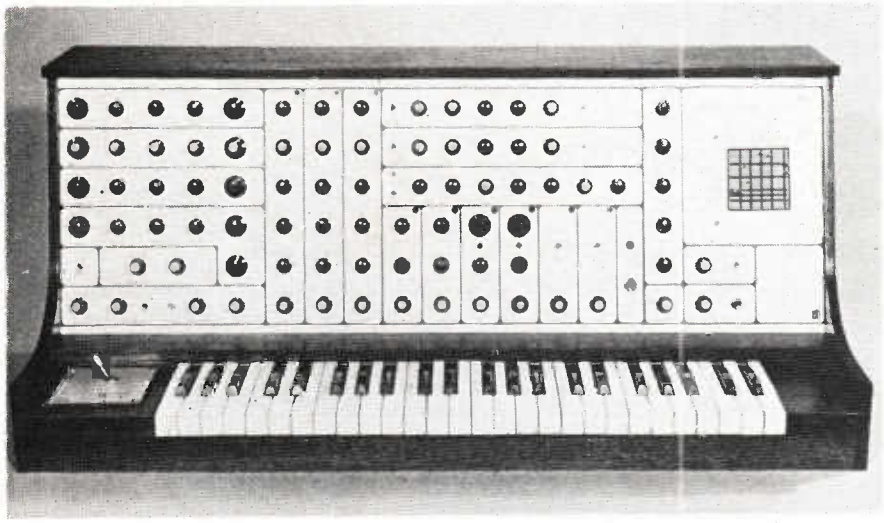
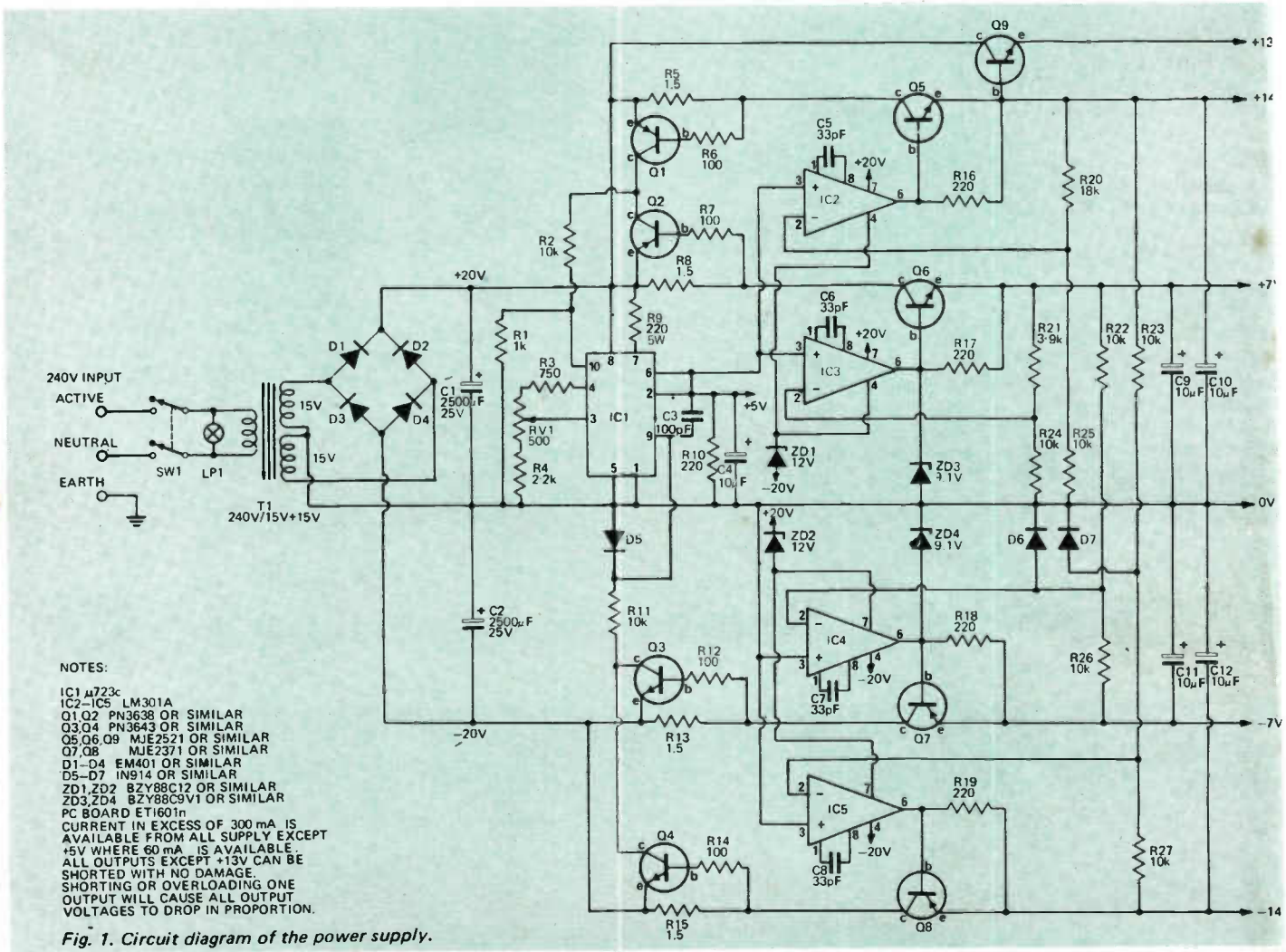
INTERNATIONAL MUSIC SYNTHESIZERS



eti 3600/4600

Constructional details of the mixer, noise generator/controller and main power supply are provided in this, the third article in the series.



NOTES:

IC1 µ723c
IC2–IC5 LM301A
Q1,Q2 PN3638 OR SIMILAR
Q3,Q4 PN3643 OR SIMILAR
Q5,Q6,Q9 MJE2521 OR SIMILAR
Q7,Q8 MJE2371 OR SIMILAR
D1–D4 EM401 OR SIMILAR
D5–D7 IN914 OR SIMILAR
ZD1,ZD2 BZY88C12 OR SIMILAR
ZD3,ZD4 BZY88C9V1 OR SIMILAR
PC BOARD ETI601n
CURRENT IN EXCESS OF 300 mA IS AVAILABLE FROM ALL SUPPLY EXCEPT +5V WHERE 60 mA IS AVAILABLE. ALL OUTPUTS EXCEPT +13V CAN BE SHORTED WITH NO DAMAGE. SHORTING OR OVERLOADING ONE OUTPUT WILL CAUSE ALL OUTPUT VOLTAGES TO DROP IN PROPORTION.

Fig. 1. Circuit diagram of the power supply.

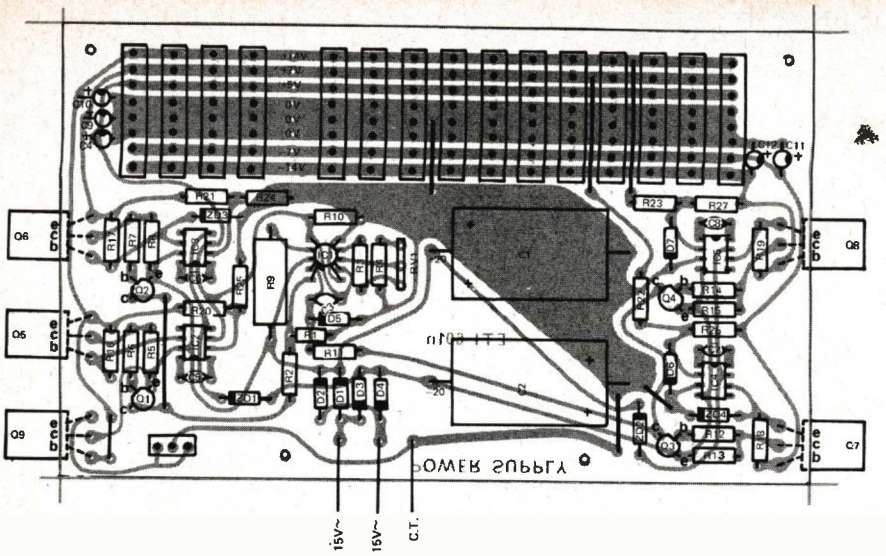
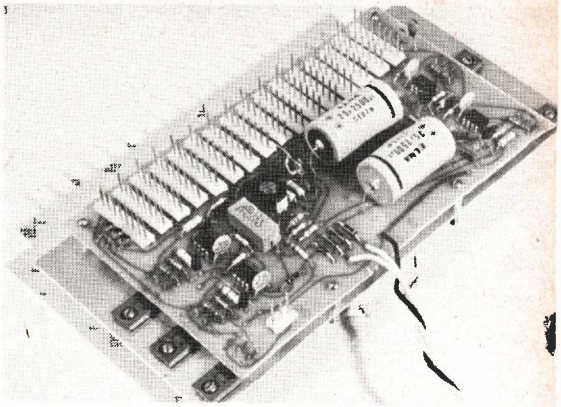


Fig. 2. Component overlay for power supply.



The method of construction of the power supply particularly mounting of the power transistors is shown in this photograph.

MODULES to be described this month are, the mixer, noise generator and controller, and main power supply.

These three modules, together with those described last month enable the partly completed unit to be used to generate quite complex waveforms — and hence, sounds.

CONSTRUCTION

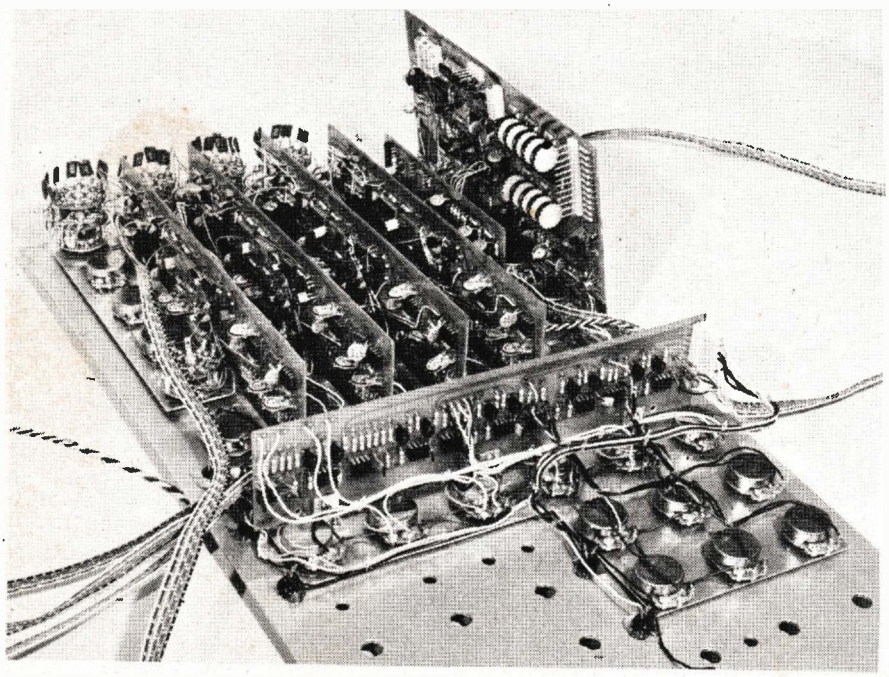
Power Supply

Assemble the PC board with the aid of the component overlay Fig. 2. The power transistors should not be mounted at this time. Check the orientation of all the components especially checking the 723 regulator, the tag on the IC being next to pin 10.

The PC board is mounted by ¼ inch spacers onto an aluminium panel Fig. 9 which is also the heatsink for the power transistors. The power transistor leads must be bent apart and up at right angles to pass through the PC board from the underside.

The heatsink should be used as a guide to determine the bending points. Since the transistors are on the under side of the PC board there must be no strain on the joints, otherwise the PC board track may be broken. Mount the transistors, using mica insulators, in position on the heatsink. The transistors may then be soldered to the PC board through the access holes provided. If required the heatsink may then be removed for other work to be carried out.

All assemblies and modules described in this, and last month's, article are used in the larger (4600) model synthesizer. Some of the components are used also in our smaller (3600) unit, but interconnections etc, are changed. Full details of this will be provided later.



The mixer and noise generator modules shown mounted in position.

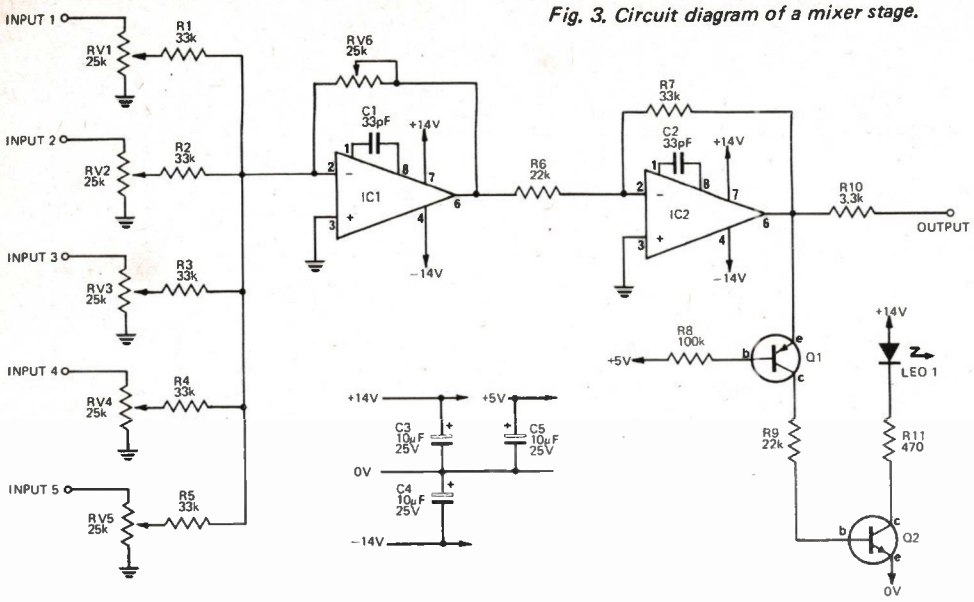
Mixer

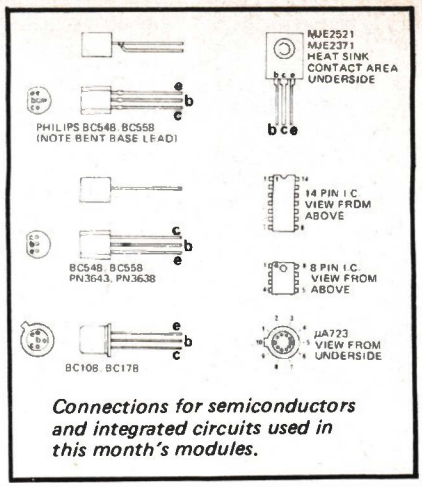
Assemble the PC board with the aid of the component overlay Fig. 4. Check the orientation of ICs and transistors. With the BC548-558 transistors there are two different pin connections used, depending on the manufacturer. National and Fairchild versions are the same and as shown on the overlay, whereas the Philips type is the reverse. The Philips type can be identified by the base (centre) lead, which is bent off centre, away from the flat. To use the National type bend the centre lead towards the flat.

The mechanical assembly is slightly different on this module than that for the oscillators. A metal plate is used to hold all the potentiometers (24) and three small brackets hold the PC board. The LED indicators are mounted on the front panel itself and are connected to the PC board either by soldering, or as recommended, by a plug and socket.

Each oscillator output is fed to three potentiometers on the mixer board. Five pads are provided on the PC board for connecting the common connection of each set of three potentiometers. A pin may also be fitted to each pad so that the oscillator connection may be disconnected if required.

Fig. 3. Circuit diagram of a mixer stage.





Connections for semiconductors and integrated circuits used in this month's modules.

NOTES:

MIXER 1 ONLY SHOWN, MIXERS 2-5 ARE SIMILAR
EXCEPT MIXERS 4 AND 5 HAVE ONLY 2 INPUTS
IC1 AND IC2 LM301A OR SIMILAR
Q1 BC558 OR SIMILAR
Q2 BC548 OR SIMILAR
LEDs NSL 5023 OR SIMILAR
COMPONENT NUMBERS FOR MIXERS 2-5
ARE AS FOLLOWS –
MIXER 2, ADD 20 TO ALL NUMBERS i.e. R5 BECOMES R25
MIXER 3, ADD 40 TO ALL NUMBERS i.e. R5 BECOMES R45
MIXER 4, ADD 60 TO ALL NUMBERS i.e. R5 BECOMES R65
MIXER 5, ADD 80 TO ALL NUMBERS i.e. R5 BECOMES R85

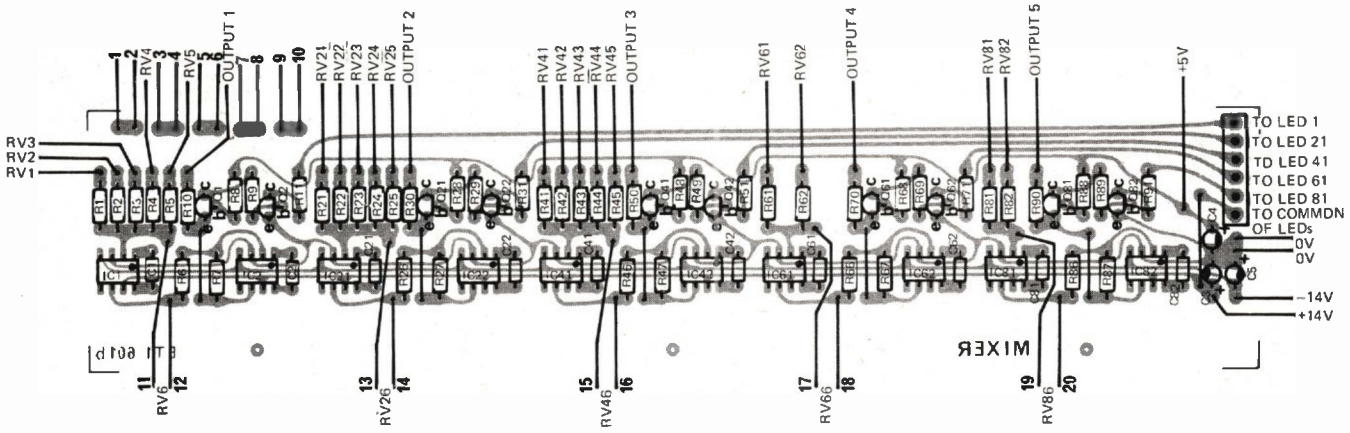


Fig. 4. Component overlay for mixer board.

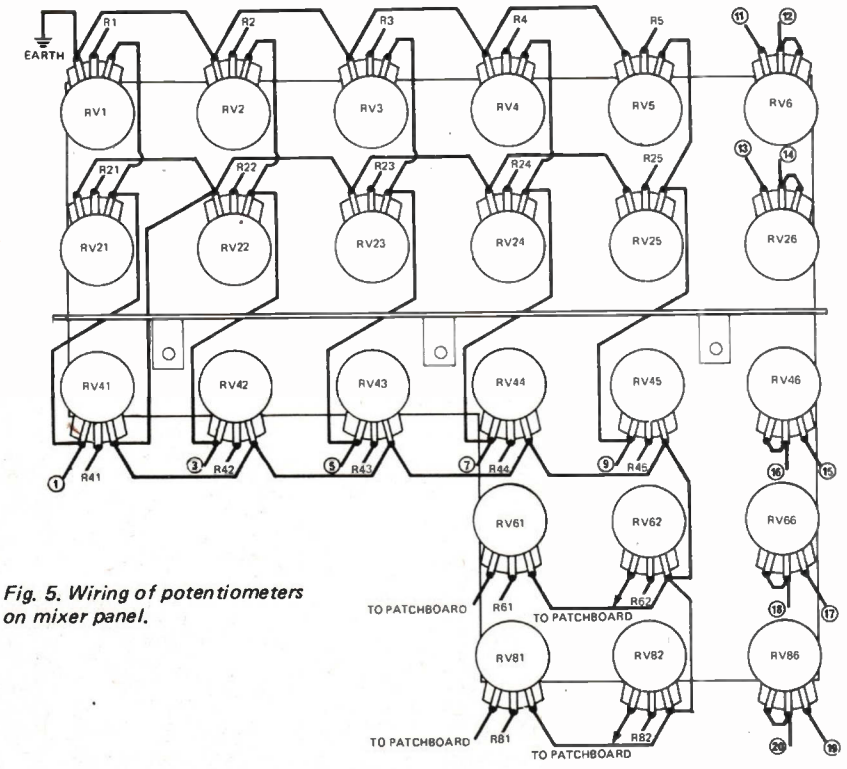


Fig. 5. Wiring of potentiometers on mixer panel.

Noise generator and controller

The construction of the module is very similar to that of the oscillator described last month.

Assemble the PC board with the aid of the component overlay, Fig. 7. It is recommended, that IC sockets are used for the CMOS. Make sure the integrated circuits and electrolytic capacitors are orientated correctly before soldering in place.

The PC board is then mounted on the metal bracket shown in Fig. 12. The bracket goes on the component side of the PC board to prevent any possibility of shorting the copper tracks. The two potentiometers and the switch may now be mounted and wired up. This bracket also holds the additional switch related to oscillator 4 which is wired up as shown in Fig. 8 The interconnection between this switch and that in oscillator 4 can be either by soldered leads or, a plug and socket can be used.

Soldering with power connected should be avoided along with accidental shorting of the outputs. The output can be shorted for a brief

POWER SUPPLY – How it works

The power supply provides regulated outputs of +14V, +7V, +5V, –7V and –14V. The 5V supply can deliver 60 mA and all other outputs 300 mA. An additional output of +13.4V is provided to supply the high current requirement of the headphone output amplifier.

The rectifier and filter is a conventional system supplying ± 20V. The 5V output is derived from a μA723C, voltage regulator (IC1) which has very good temperature and load regulation. The +5 volts is used as the main reference for the other supplies. Current limitation is provided for by R9 which limits the current to about 85 mA. The output is adjustable by RV1 such that exactly 5V can be obtained.

The output of IC1 can be shutdown in either of two modes. A positive current into pin 10 or a negative current out of pin 9 will cause the output voltage to drop to zero. Use of this is made in the overload network of the other supply outputs.

The +7V output is via a series pass transistor, Q6, which is controlled by IC3, a high gain differential amplifier which is used as a comparator. The non-inverting input (positive) of IC3 is connected to the +5V output where, in addition, the inverting (negative) input, is connected via a 5/7 divider R21/24. The result of this connection is that the output will stabilize at +7V. The high gain of IC3 will keep this voltage constant with nominal load and supply voltage changes.

A current sensing resistor, R8, is in series with the collector of Q6. If the voltage across this resistor exceeds 0.6V, the base emitter of Q2 will become forward biased, turning it on. This causes a positive current to flow into pin 10 of IC1 shutting it down. Since the output of the +7V regulator is referred to the +5V output, the +7V supply will also shut down and the output current will be limited to about 400 mA. To prevent over voltage from the +7V supply on switch on, the output is limited by ZD3 to about 8.5 volts.

The –7V supply is similar to the +7V supply, except that the reference voltage is now zero volts, (pin 3) and this is compared to a voltage at the junction of R26 and R22. The voltage will be zero when the output of the –7V is identical to the +7V but of opposite polarity. Diode D6 is used to protect the input of IC4. Overload on this output turns on Q3 which removes current from pin 9 of IC1 shutting it down. This shuts down the +7V supply and since the –7V "tracks" the +7V output, it also will shut down.

The ± 14V supplies are identical to the ±7V supplies except for the sensing resistors R20/25 on the +14V supply.

The +13.4V output is simply an emitter follower on the +14V rail. This supply should not however be shorted since no protection is provided.

MIXER – How it works

The mixer used is quite conventional, using an IC (IC1) to sum the input currents. Individual gain control is provided by RV1-5 and overall gain by RV6. Since the output of this type of mixer is inverted an additional IC is used to reinvert the signal.

Overload indication is provided by Q1, Q2 and LED1. If the output voltage exceeds 5.6V, Q1 becomes forward biased and Q1 and Q2 turn on, illuminating the LED indicator. The base resistor R8 prevents damage to Q1 should the output swing negative. The overload point as indicated by the LED is chosen to protect the inputs of following stages from being overloaded. The mixer itself has an overload point of about 12V.

Mixers 1,2, and 3 are identical whereas mixers 4 and 5, although otherwise identical, have only 2 inputs. The inputs of mixers 1,2, and 3 are wired directly to the outputs of the individual oscillators.

NOISE GENERATOR AND CONTROLLER – How it works

White noise is generated digitally by an 18 bit shift register which is clocked at about 35 kHz. Several feed-back loops around the shift register cause it to generate a psuedo-random bit pattern which closely approximates white noise.

The oscillator uses a quad, dual-input NOR CMOS gate (IC3), and although a NAND or inverter could be used in the circuit, it would not necessarily be a pin for pin replacement. Feedback is taken from the 5th, 9th and 18th stage in the shift register and these outputs are "mixed" by IC2 which is an exclusive OR gate, (see table) the output of which controls the 'D' input of the shift registor. Resistor R1 and capacitor C1 are used to ensure that the system will start.

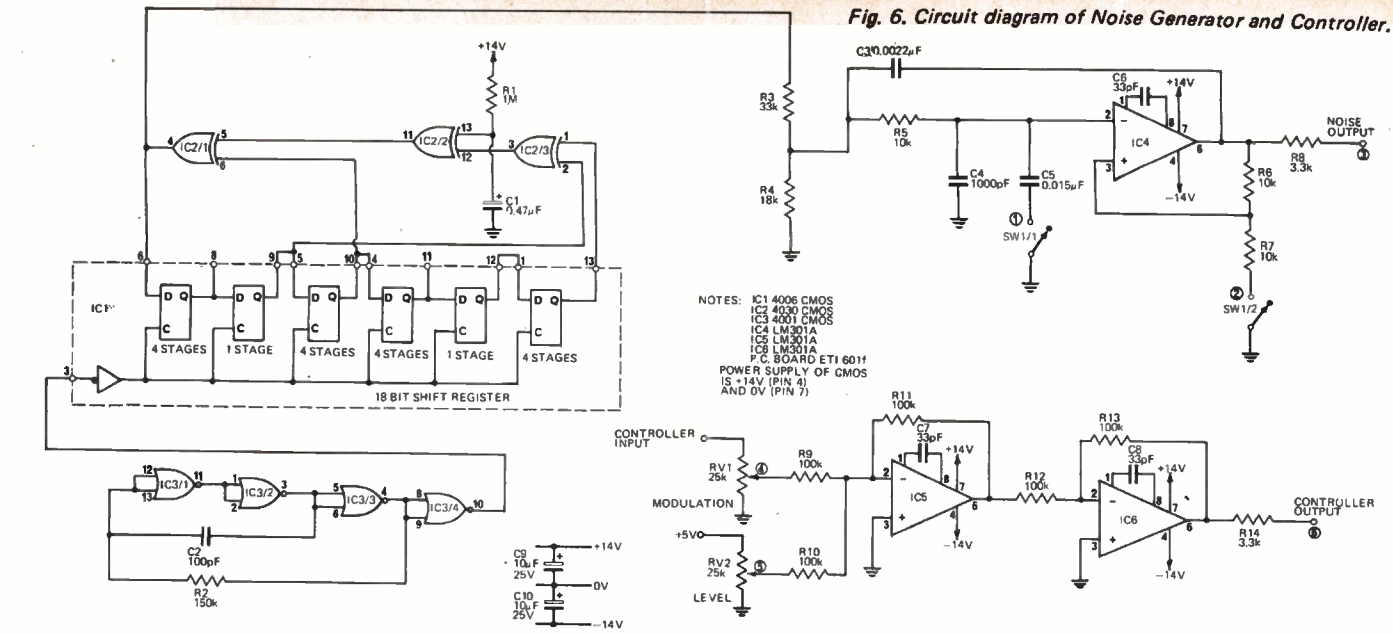
INPUTS		OUTPUTS
A	B	
0	0	0
0	1	1
1	0	1
1	1	0

1 = HIGH LEVEL
0 = LOW LEVEL

The output of IC2/1, as well as being the control for the shift register, is the white noise we require. However, due to some unwanted components above 15 kHz, a low pass filter is used with a 15 kHz cutoff. To give an alternate "PINK" noise output, the filter is changed to cut frequencies above 500Hz with a 6 dB/octave slope. Since the output voltage will fall if some of the spectrum is removed, additional gain is also provided when 'PINK' noise is selected.

The controller is a completely separate function which is used to add a dc component to another signal or control voltage. This is done by mixing, in IC5, a percentage of the input signal and a percentage of a dc voltage. The output of IC5 is negative however, and must be inverted by IC6.

Fig. 6. Circuit diagram of Noise Generator and Controller.



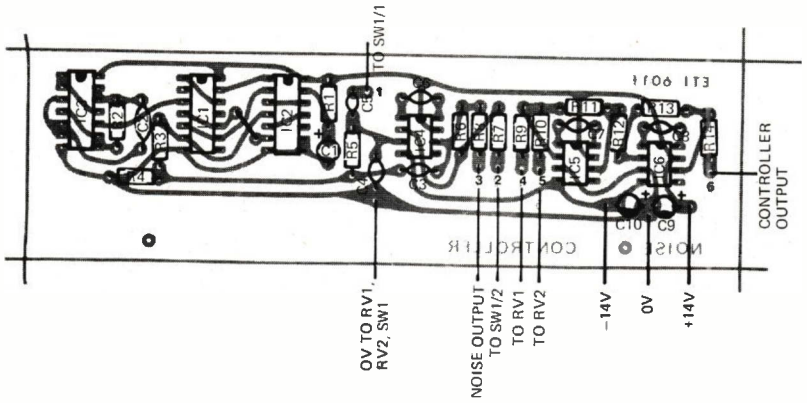


Fig. 7. Component overlay of Noise Generator and Controller.

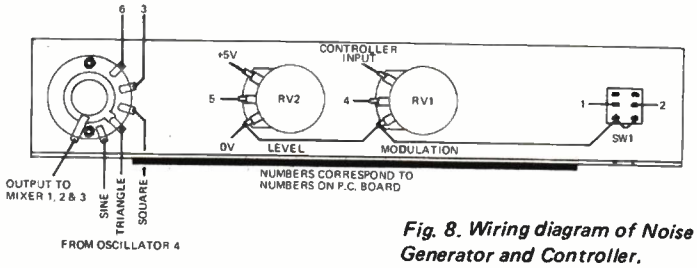
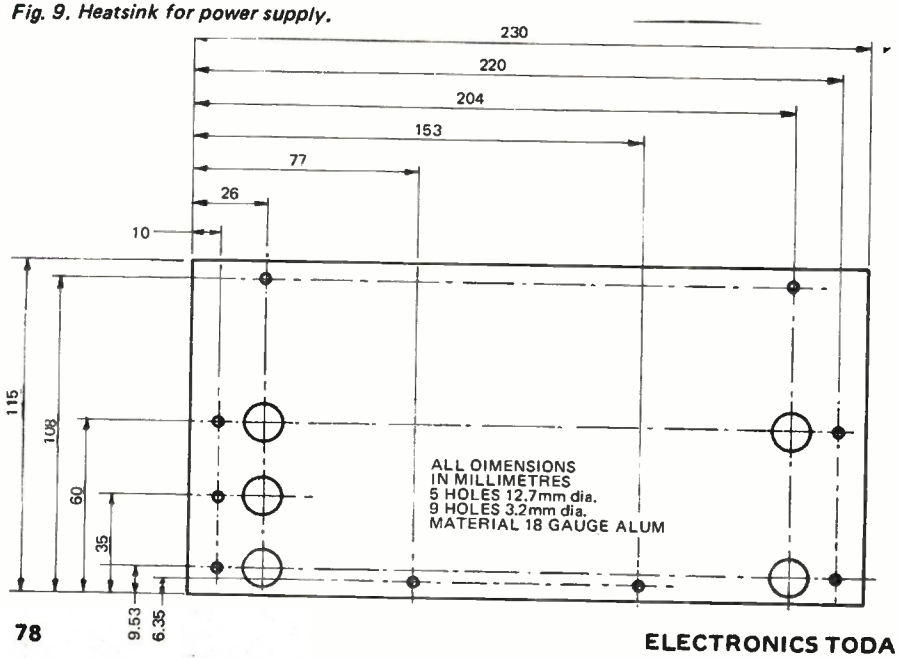


Fig. 8. Wiring diagram of Noise Generator and Controller.

INTERNATIONAL MUSIC SYNTHESIZERS

Fig. 9. Heatsink for power supply.



period without damage however this is not recommended.

The supply voltage to CMOS must never be reversed. This could cause the devices to destroy themselves.

Although the inputs of CMOS are internally protected against static charges, some care is still required in their handling. They should be stored in their aluminium carrier or in conductive plastic. They should be the last components added to the PC boards, preferably using IC sockets.

NEXT MONTH

Next month we will describe the Envelope Control, Transient 1 and Transient 2 modules. It is emphasised again that we are at present describing the larger synthesizer. The changes required for the smaller unit will be detailed later.

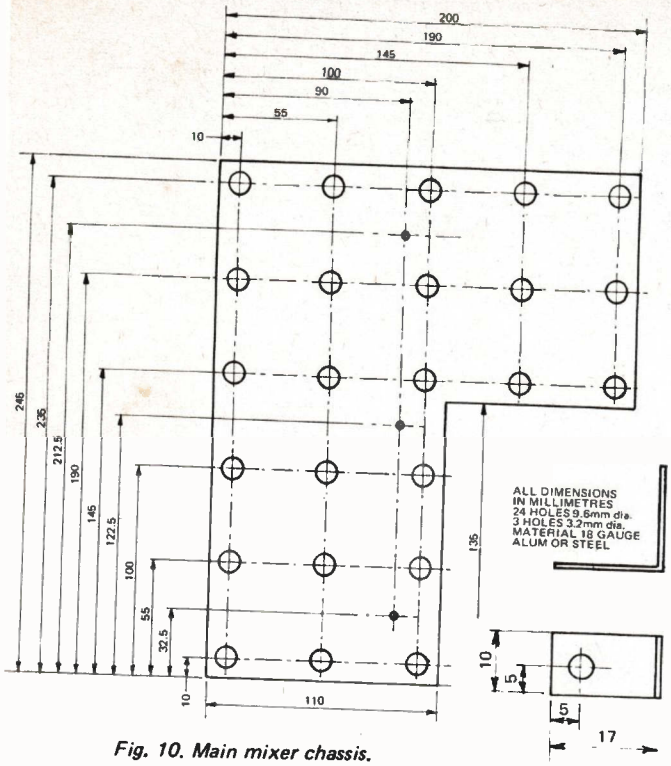


Fig. 10. Main mixer chassis.

ALL DIMENSIONS IN MILLIMETRES

2 HOLES 3.2 mm dia.

MATERIAL 18 GAUGE STTEL OR ALUM.

Fig. 11. Mixer board support bracket (three required).

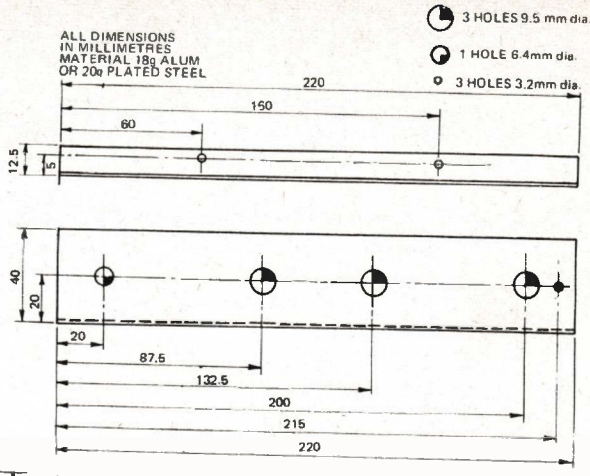


Fig. 12. Noise generator and controller support bracket.

PARTS LIST POWER SUPPLY

R1	Resistor	1k	¼ W	5%
R2,11,22,23, 24,25,26,27	"	10k	"	"
R3	"	750Ω	"	"
R4	"	2.2k	"	"
R5,8,13,15	"	1.5Ω	½ W	"
R6,7,12,14	"	100Ω	¼ W	"
R9	"	220Ω	5 W	"
R10,16,17,18,19	"	220Ω	¼ W	
R20	"	18k		
R21	"	3.9k		
RV1	Potentiometer	500Ω large trim type		
C1,2	Capacitor	2500μF 25 V electrolytic		
C3	"	100pF ceramic		
C4,9,10, 11,12	"	10μF 20V electrolytic P.C. mounting		
C5,6,7,8	"	33pF ceramic		
IC1	Integrated Circuit	μA723C metal can type		
IC2,3,4,5	" "	LM301A minidip		
Q1,Q2	Transistor	PN3638 or similar		
Q3,4	"	PN3643 " "		
Q5,6,9	"	MJE2521 "		
Q7,8	"	MJE2371 "		
D1-D4	Diode	EM401 or similar		
D5,6,7	"	IN914 " "		
ZD1,2	Zener Diode	BZY88C12 "		
ZD3,4	" "	BZY88C9V1 "		

T1 Transformer 240V primary 15 V-0-15 V sec @ .75A or more.
SW1 Toggle Switch DPDT 240 V rated
LP1 240V Neon Indicator
PC board ETI 601 n
Heatsink as per Fig. 9.
T05 heatsink for IC1
4 ¼" spacers
Recommended extras

16 8 pin Utilux plugs type A2402-8
1 3 pin Utilux plug type A2402-3

PARTS LIST MIXER

R1,2,3,4,5,7	Resistor	33k	¼ W	5%
R21,22,23,24, 25,27	"	33k	"	"
R41,42,43,44, 45,47	"	33k	"	"
R61,62,67	"	33k	"	"
R81,82,87	"	33k	"	"
R6,9,26,29,46	"	22k	"	"
R49,66,69,86,89	"	22k	"	"
R8,28,48,68,88	"	100k	"	"
R10,30,50,70,90	"	3.3 k	"	"
R11,31,51,71,91	"	470	"	"
RV1-6	Potentiometer	25k	lin rotary	
RV21-26	"	25k	" "	
RV41-46	"	25k	" "	
RV61,62,66	"	25k	" "	
RV81,82,86	"	25k	" "	
C1,2,21,22,41	Capacitor	33pF ceramic		
C42,61,62,81,82	"	33pF "		
C3,4,5	"	10μF 20 V elect. PC mounting		
IC1, 2,21, 22,41	Integrated Circuit	LM301A minidip		
IC42,61,62, 81,82	" "	" "		
Q1,21,41,61,81	Transistor	BC548, BC108 or similar		
Q2,22,42,62,82	"	BC558, BC178 or similar		

LED 1,21,41,61,81 light emitting diode NSL5023 or similar
PC board ETI 601 b
Metal chassis as per Fig. 10
3 brackets as per Fig. 11
Recommended extras

1 6 pin plug Utilux type A2402-6
1 6 pin socket Utilux type M2139-6
1 8 pin socket Utilux type M2139-8
14 pins Utilux type M2138

PARTS LIST NOISE CONTROLLER

R1	Resistor	1M	¼ W	5%
R2	"	150k		
R3	"	33k		
R4	"	18k		
R5,6,7	"	10k		
R8,14	"	3.3 k		
R9,10,11,12,13	"	100k		
RV1,2	Potentiometer	25k lin rotary		
C1	Capacitor	0.47μF 25V elect. PC mounting		
C2	"	100pF ceramic		
C3	"	0.0022 polyester		
C4	"	0.001 "		
C5	"	0.015 "		
C6,7,8	"	33pF ceramic		
C9.10	"	10μF 20V elect. PC mounting		
IC1	Integrated Circuit	SCL4006AE*CMOS		
IC2	" "	SCL4030AE*CMOS		
IC3	" "	SCL4001AE*CMOS		
IC4,5,6,	" "	LM301A minidip		

*The prefix and suffix of CMOS varies from manufacturer to manufacturer.
SW1 Toggle switch DPDT C & K 7201 or similar

PC board ETI 601 f
Metal bracket as per Fig. 12.
Recommended extras

3 14 pin IC sockets Utilux type M1938-4 or similar
1 8 pin molex socket Utilux type M2139-8
8 pins for above socket Utilux type M2138

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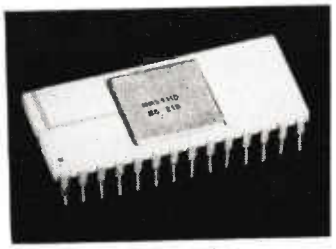

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The Integral Timer — is designed for timing any kind of an event, e.g. sports events, photography, long-distance phone calls or even a 3 minute egg. It will count down from 1 hour in 1 second steps and may be stopped or started at will.

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TYPE	DESCRIPTION	1 — 9	10 +
SN7400	Quad 2 input NAND gate.	85c	60c
SN7401	as SN7400 with open collector.	85c	60c
SN7402	Quad 2 input NOR gate.	85c	60c
SN7404	Hex Invertor	85c	60c
SN7405	Hex Invertor with open collector.	85c	60c
SN7406	Hex Invertor 30 Volts.	$1.80	98c
SN7407	Hex Driver 30 Volts	$1.80	98c
SN7408	Quad 2 input AND gate.	85c	60c
SN7409	Quad 2 input AND, collector O/C	85c	60c
SN7410	Triple 3 input NAND gate.	85c	60c
SN7413	Dual Schmidt Trigger	$1.05	98c
SN7417	Hex Driver 15 Volts	$1.95	98c
SN7420	Dual 4 input NAND gate.	85c	60c
SN7430	8 Input HAND Gate.	85c	60c
SN7437	Quad 2 input NAND Buffer	$1.80	$1.28
SN7440	Dual 4 input NAND Buffer	85c	60c
SN7441	BCD to Decimal Decoder Driver	$2.45	$1.79
SN7442	BCD to Decimal Decoder.	$2.30	$1.44
SN7446	BCD to 7 Segment Decoder Driver 30V.	$3.90	$2.76
SN7447	BCD to 7 Segment Decoder-Driver 15V.	$3.50	$2.24
SN7450	Expandable Dual AND or INVERT Gate.	85c	60c
SN7451	Dual AND or INVERT Gate.	85c	60c
SN7453	Expandable 4 wide AND or INVERT.	85c	60c
SN7454	4 wide 2 input AND or INVERT.	85c	60c
SN7460	Dual 4 Input Expander.	85c	60c
SN7472	J-K Master Slave Flip Flop.	$1.40	94c
SN7473	Dual J-K Master Slave Flip Flop.	$1.35	$1.04
SN7474	Dual D Type Edge-Trig Flip Flop.	$1.35	$1.01
SN7475	Quad Bistable Latch .	$1.75	$1.38
SN7476	SN7473 with Preset and Clear.	$1.30	$1.04
SN7483	4 Bit Binary Full Adder.	$2.45	$2.24
SN7490	Decade Counter.	$1.60	$1.38
SN7493	4 Bit Binary Counter	$1.50	$1.38
SN7496	5 Bit Shift Register.	$1.95	$1.44
SN74121	Monostable Multivibrator	$1.30	98c
SN74151	8 Bit Multiplexer.	$3.90	$2.24
SN74153	Dual 4 line to line Multiplexer	$4.90	$3.34
SN74154	Divide by 16.	$3.90	$2.24
SN74192	Up/Down Decade Counter.	$4.90	$3.68
SN74193	Up/Down Binary Counter.	$4.90	$3.58

LINEAR I.C.'s.

TYPE	DESCRIPTION	Case	1 — 9
LM300H	Voltage Regulator	TO5	$5.75
LM301A	Operational Amplifier	TO5	$1.50
LM301N	Operational Amplifier	DIL 8	$1.35
LM302H	Voltage Follower	TO5	$5.75
LM304H	Neg. Voltage Regulator	TO5	$6.20
LM305AH	Pos. Voltage Regulator	TO5	$4.30
LM307N	Operational Amplifier	DIL 8	$1.50
LM308H	Precision Op Amp.	TO5	$5.25
LM308N	Precision Op. Amp.	DIL 8	$2.90
LM309K	5V Voltage Reg. Pos.	TO3	$4.30
LM310H	Comparator	TO5	$6.20
LM311N	Compator	DIL 8	$3.75
LM320K	Neg. Voltage Regulator	TO3	$7.60
LM321H	Neg. Voltage Regulator.	TO5	$7.60
LM324N	Quad Operational Amplifier	DIL 8	$4.80
LM339N	Quad Compator.	DIL 8	$7.30
LM340K	Pos. Voltage Regulator.	TO3	$4.80
LM370N	AGC/Squelch Amplifier	DIL 14	$5.50
LM371H	RF/IF Amplifier	TO5	$4.20
LM372N	AM IF Strip	DIL 14	$3.75
LM373N	AM/FM/SSB IF Amp/Detector	DIL 14	$5.75
LM380N	Audio Power Amp. 2W.	DIL 14	$2.85
LM381N	Low Noise Stereo Pre-Amp	DIL 14	$5.25
LM565CN	Phase Locked Loop	DIL 14	$6.50
LM709	Operational Amplifier	DIL 14	90c
LM710CN	Comparator	DIL 14	$1.90
LM711CN	Comparator	DIL 14	$1.90
LM723CH	Adjustable Volt. Regulator.	TO5	$1.75
LM741CN	Operational Amplifier	DIL 8	$1.35
LM741CH	Operational Amplifier.	TO5	$1.35
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LM748CN	Operational Amplifier	DIL 8	$1.90
LM1303N	Stereo Pre-Amplifier	DIL 14	$3.10
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LM3900N	Quad Amplifier.	DIL 14	$1.95
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COSMOS

TYPE	DESCRIPTION	1 — 9
MM74COO	CMOS equivalent to 7400	$1.35
MM74CO2	CMOS equivalent to 7402	$1.35
MM74CO4	CMOS equivalent to 7404	$1.95
MM74CO8	CMOS equivalent to 7408	
MM74C10	CMOS equivalent to 7410	$1.35
MM74C13	CMOS equivalent to 7413	
MM74C20	CMOS equivalent to 7420	$1.35
MM74C30	CMOS equivalent to 7430	
MM74C73	CMOS equivalent to 7473	$4.25
MM74C74	CMOS equivalent to 7474	$2.80
MM74C154	CMOS equivalent to 74154	$10.35
MM74C192	CMOS equivalent to 74192	$10.95
MM74C193	CMOS equivalent to 74193	$10.95

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the STEADFAST PERFORMANCE, the UNFLINCHING QUALITY, and the UNPARALLELED CONSTRUCTION

of all Amcron equipment will remain"
(The **AMCRON** Philosophy)

This design philosophy is unique today and is reflected in the comments that follow. High Fidelity magazine said: "If you can afford it, the best is really worth the price" after a searching laboratory test of the Amcron IC 150 pre-amplifier. Their review of its companion, the Amcron D150 power amp said: "In testing the 150, CBS labs. found itself working close to the limits of its test equipment. Every harmonic distortion measurement the lab made — even those for extremely low power output — was below 0.05%. Were the figures ten times as high, we would still consider them to be excellent in most equipment. At half power most of the figures are below 0.02%."

AMCRON D 150 POWER AMPLIFIER is engineered to provide maximum total performance in universal adaptation. Two massive specially designed heat sinks and the entire chassis are utilized to prevent thermal fatigue, the predator of most high power amplifiers. All components of the circuitry must meet the highest criteria for long term performance. After assembly each unit is tested and approved to meet or exceed our guaranteed specifications.
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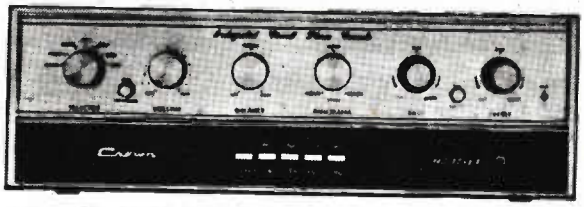

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ELECTRONICS -it's easy! PART 2

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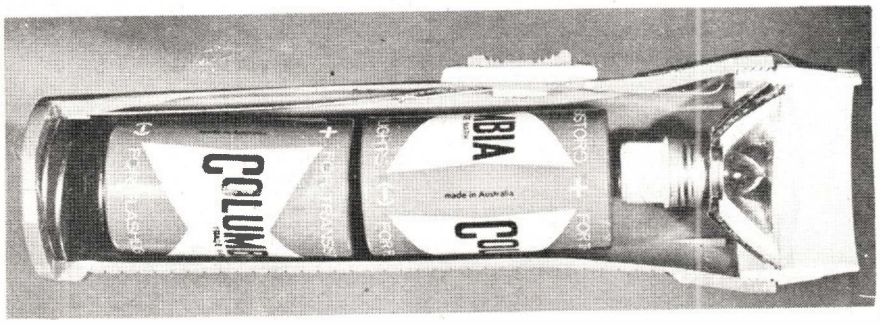


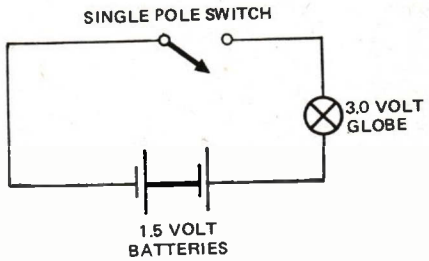


Fig. 1(a) Exploded view of the common hand torch.

Fig. (b). The same torch in its schematic symbol form.

TO UNDERSTAND the operation of the basic components used to build system blocks, and to see how they work together to produce many different functions, we must look at electricity at its most basic level. This lays the foundation for understanding how things operate — and for the design of simple devices.

We are going to start by considering a simple torch — basically a light globe energised by power supplied from a couple of batteries.

Figure 1a shows how the torch is constructed.

It is obviously not very convenient to use actual photographs or detailed drawings of all electronic components — hence a system of representative symbols is used instead. Each symbol represents a component or 'black box'.

Figure 1b shows how the torch would be drawn using these symbols. This method of represenation is called a circuit drawing and is almost invariably used to depict electronic circuits.

Looking at the torch as a 'system', the batteries supply electrical energy to the torch globe where it is converted to visible light energy. The purpose of the connecting wires and switch is to control *when* and *where* this energy conversion process takes place.

The paragraph above explains the purpose and operational requirements of the torch, but does not explain why and how it operates. To understand this we must look at the internal action of the components themselves — getting right at the structure of matter.

THE STRUCTURE OF MATERIAL

Our physical world is made entirely of chemical elements. There are over a hundred different kinds, but each has a basic similarity.

Each element — no matter what it is — is composed of tiny entities called atoms. These in turn consist of even smaller particles called protons and electrons. It is the number of such protons and electrons, and their orientation with respect to each other. that varies from element to element. (There are also a number of other sub-atomic particles making up the structure of the atom. These include neutrons, mesons, etc. These particles play no part in electronic theory and for this reason will not be discussed).

Each atom has a central, very dense part (called the nucleus) that is made up of one or more protons held together as a single unit. Around this, at great speed, whirl one or more electrons, at a radius considerably larger than that of the nucleus. The mass of the electrons is negligible compared to that of the nucleus. Thus our concept of an atom is one of shells of electrons surrounding a tiny nucleus. Normally there are as many protons as there are electrons — but not always, as we shall see later.

As the electrons whirl — at enormous speed — around the central protons, outward forces are generated that, unless balanced in some way, must inevitably cause the electrons to be hurled from their orbits.

A fundamental property of protons and electrons is that each is physically attracted to the other (whilst electrons and protons each repel their own kind). It is this attractive force between the protons and the whirling electrons that (normally) balances the outward force — thus maintaining a stable situation.

This attractive or repulsive effect is known as 'charge' By convention, the charge on an electron is called 'negative', and that on a proton is called 'positive'.

The simplest of the elements is hydrogen. This has just one proton in its nucleus, and one electron in orbit. But just where the electron *is* at any time, is impossible to define, for the orbit changes direction continually.

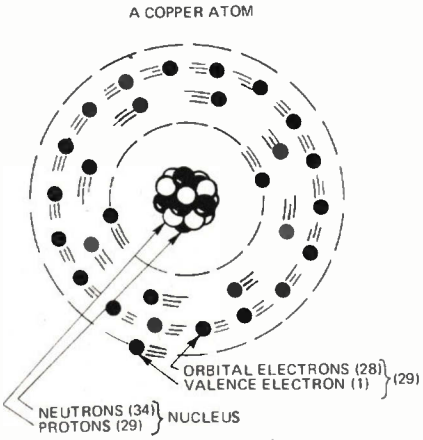


Fig. 2. Representation of a copper atom. Electrons in orbital shells surround a tightly packed central nucleus of neutrons and protons. Neutrons are neutral particles which really are a combination of proton and electron. Together they exhibit neutral charge. The valence electron in the outer shell is the electron which forms molecular bonds and is also the one which may easily be stripped off and become part of an electrical current flow.

Moving up the periodic table (the classification chart listing the chemical elements in order of number of protons) the combinations become increasingly more complex as the number of protons and electrons increase.

Electrons also exist in more than one shell — following certain basic physical laws. An element having many shells is shown in Fig. 2. Normally the charges balance, giving neutral overall charge, but if as can be done, an electron is *removed*, the atom then has a surplus of positive charge and is called a *positive ion.* If an electron is *gained* it is known as a *negative ion.*

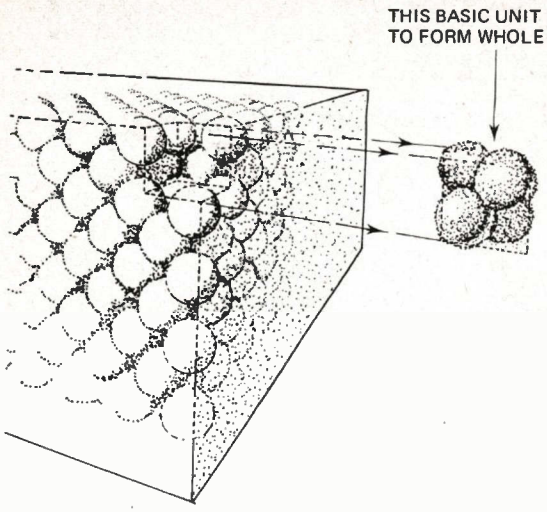


Fig. 3. How atoms join together to form matter.

Like people, atoms rarely exist solely by themselves. They like to form associations with others of the same kind (or other kinds). These combinations of atoms are called molecules and it is large assemblies of molecules, held together by molecular forces, that forms the physical matter of the universe. Water, for example, is formed of molecules each consisting of two hydrogen atoms and one oxygen atom.

CONDUCTORS, RESISTORS AND SEMICONDUCTORS

All matter then is made of atoms arranged in a more or less uniform matrix – as shown in Fig. 3. In some materials a few of the electrons, in the outer shells, are not rigidly attached to any particular nucleus. They make what is called a "sea" of electrons, formed by the free electrons, as depicted in Fig. 4.

Materials in which this occurs to a marked extent are called *conductors* of electricity – for the free electrons can be made to flow around a loop of material if a charge unbalance is produced in some way. The wires in the torch, the filament in the globe and the switch connections are *conductors*. In these, electrons flow easily, although, as we see later, less easily in the filament.

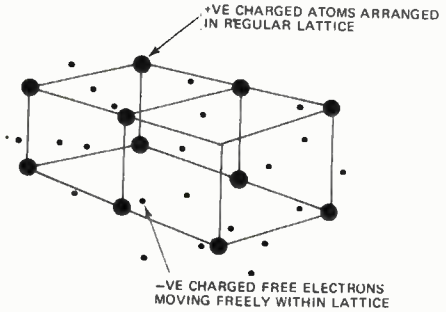


Fig. 4. In a conducting material, numerous electrons are free to move around as portrayed in this simplified picture of a piece of conductor.

In other materials the electrons are tightly bound to the nucleus and there are no free electrons to form the "sea". It is not possible to produce a flow of electrons. These materials are called insulators.

Insulators enable us to isolate electron flow, thus allowing it to occur only when we wish. The coating on the wires and the case of the torch are both insulators. The insulating coating ensures that battery power does not leak away – but is only used to energize the lamp when we want it to.

Air is an excellent insulator, when our torch is switched off, for example, the action of the switch is to separate a pair of contacts. The air gap thus introduced effectively blocks electron flow.

There are no sharp dividing lines between conductors and insulators. At one extreme there are exceptionally good conductors such as silver, copper, and gold. Then there are reasonably good conductors such as steel and brass. At the opposite extreme there are very poor conductors such as rubber, dry wood, plastics, phenolic boards and ceramics. Poor conductors such as these are generally known as insulators.

The filament in the torch globe is a poor conductor of electrons by comparison with the connecting wires and switch contacts. It resists the flow of electrical energy. In so doing, heat is generated – to the extent that if the battery can supply the necessary energy the filament will glow white hot, thus providing light.

There are, as said before, a range of materials whose properties lie somewhere between that of conductors and that of insulators. Some of these materials have other specialised properties – these will be described later in this series.

CURRENT

If two pieces of material, one with an excess of electrons, and one with a

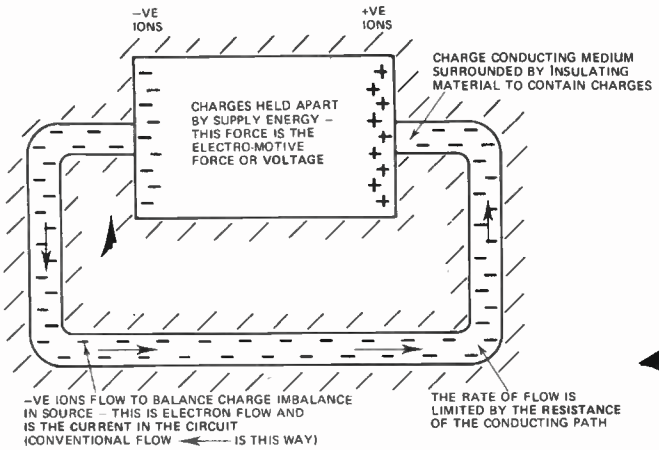


Fig. 5. Current is a flow of charges.

Fig. 6. Prefixes of units used to denote small and large numbers.

tera	T	10^{12}	1,000,000,000,000.0
giga	G	10^{9}	1,000,000,000.0
mega	M	10^{6}	1,000,000.0
kilo	k	10^{3}	1,000.0
milli	m	10^{-3}	0.001
micro	μ	10^{-6}	0.000,001
nano	n	10^{-9}	0.000,000,001
pico	p	10^{-12}	0.000,000,000,001
femto	f	10^{-15}	0.000,000,000,000,001
atto	a	10^{-18}	0.000,000,000,000,000,001
Still used but should be avoided:			
hecto	h	10^{2}	100.0
deca	da	10^{1}	10.0
deci	d	10^{-1}	0.01

For example, 1.85 MΩ = 1.85 10^{6} Ω = 1,850,000 Ω

deficiency of electrons, are joined by a conductor, electrons will flow from the material with an excess of electrons to the material with a deficiency of electrons until the charge on the two pieces of material has been equalised (Fig. 5).

Material with an excess of electrons is known as 'negatively charged' and conversely, material with a deficiency of electrons is known as 'positively charged'. Thus electron flow is from negative to positive.

Early experimenters in electricity knew nothing of atomic theory and, unfortunately for us, arbitarily agreed to accept a direction of current flow that is in fact precisely opposite to that which takes place. This concept is called conventional flow, whilst the later (and correct) concept is called electron flow.

The flow of electrons along a conductor is called an electric current. It is measured in units called amperes, (amps for short), rather than in actual quantities of electrons, because the number of electrons flowing is enormous – even our humble torch would have well over 10^{18} electrons flowing through its components each second! (One ampere = 6.24 x 10^{18} electrons/second).

Currents in electronic circuits are usually much smaller than in power equipment. For example the current flowing in a pocket transistor radio is only a few hundredths of an amp. In an electric heating radiator it is several amps. The current picked up by the aerial of a radio receiver is only a few millionths of an amp.

So that they may be expressed more easily, electrical units are, where necessary, prefixed to indicate a larger or smaller value of the base unit. These standard prefixes are shown in Fig. 6.

VOLTAGE

Current flow is caused by an imbalance of positive and negative charges. This imbalance may be called 'electron pressure'. The greater the difference between the positive and negative charge the greater this electron pressure will be.

The amount of imbalance is called the 'voltage' – the unit of electron pressure being the 'volt'.

Voltage, being akin to pressure, determines the amount of current flow.

Like the unit for current, the volt is also given suitable prefixes to cover the wide variations in magnitude that can occur in electrical phenomena. The voltage level in a radio receiving aerial will be a few microvolts. Lightning strikes may be in megavolts.

In our torch, each battery provides 1.5 volts. When the two batteries are connected together their voltages add to provide 3.0 volts.

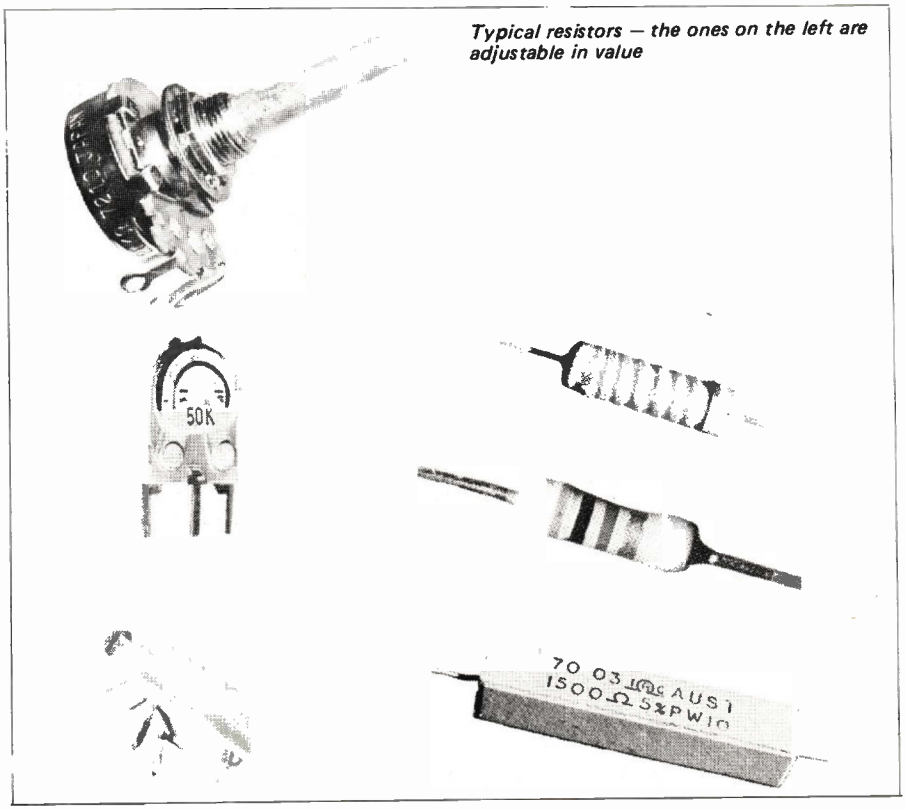
An older term – electro-motive force – is still sometimes used for voltage. Yet another term is voltage potential – or just potential.

RESISTANCE

Electrons inevitably collide with atoms as current flows through any material capable of electrical conduction. These collisions impede the flow of current and cause the material to heat up.

Current flow is also affected by the cross-sectional area of the material, for just like water, more current can flow through a large conductor than a small one.

The combination of these effects –



Typical resistors – the ones on the left are adjustable in value

that cause a material to impede the flow of current – is known as resistance. Resistance is measured in ohms, a unit often represented by the Greek letter Omega (Ω).

In many instances resistance is an undesired effect, for by impeding the flow of current, and thus causing heat to be generated, energy is wasted. The leads connecting a car battery to the starter motor are, for example, made of large sectional area and kept as short as possible in order to reduce this wastage of energy.

But in other applications – especially in the field of electronics – resistance is deliberately used to control current, voltage – or both.

Resistors, manufactured for use in electronic circuits, have either a fixed or an adjustable value. Their values of resistance may vary from fractions of an ohm to billions of ohms. A number of typical resistors are illustrated in Fig. 7, together with the symbol used to represent them in circuit drawings. (The ohmic value of resistors is usually shown in the form of concentric bands of colour – the relevant code is shown in Fig. 8).

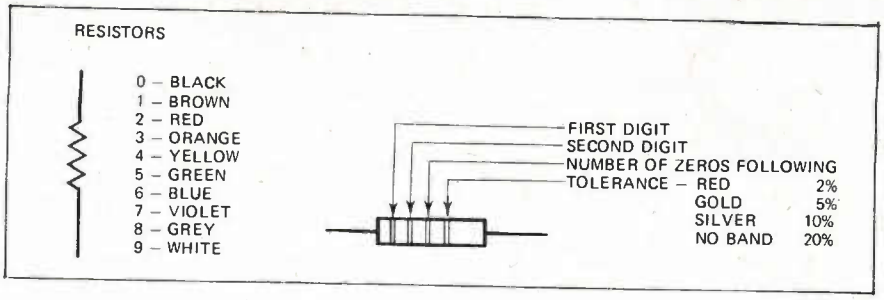
OHMS LAW

We have seen that an increase in voltage will cause an increase in current flow, and that increased resistance will cause a decrease in current flow. Ohm, in the 19th century discovered that there is an exact relationship between voltage, current and resistance.

This relationship, which has become known as Ohms law is perhaps the most basic and certainly one of the most used laws in the whole of electronics and electrical engineering.

From it the designer can determine just how much resistance is needed to limit current to desired values at

FIG. 8. KNOWING RESISTOR VALUES



READING THE RESISTOR CODE

Resistors are coded with coloured bands to ease the problem of marking such small components.

The numbers corresponding to the ten colours used and the values per position are:

For example, 180 000 ohms is coded with the first digit brown, then grey and finally yellow. The fourth band indicates the tolerance that the value has with respect to the stated value. For example, silver indicates 10% tolerance meaning the 180 000 ohms could vary between 180 000 ±18 000 i.e. 162 000 to 198 000.

These tolerance may seem to reflect poor manufacture but in most circuits they are, in fact, quite satisfactory. Relaxing the tolerance enables the maker to sell them more cheaply.

PREFERRED VALUES

If the maker tried to produce and sell every value of resistance that exists there would be chaos and the costs would be greatly increased. The actual values made, therefore, are limited to a range called the preferred values. These are listed below

The values may seem illogical at first sight, but this is not so. They stem from the fact that the tolerance extremes of a value reach the extremes of adjacent values, thereby covering the whole range without overlap. Values normally available stop in the megohm decade.

Tolerance		
±5%	±10%	±20%
1.0	1.0	1.0
1.1		
1.2	1.2	
1.5	1.5	1.5
1.6		
1.8	1.8	
2.0		
2.2	2.2	2.2
2.4		
2.7	2.7	
3.0		
3.3	3.3	3.3
3.6		
3.9	3.9	
4.3		
4.7	4.7	4.7
5.1		
5.6	5.6	
6.2		
6.8	6.8	6.8
7.5		
8.2		
9.1		

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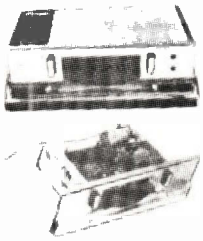

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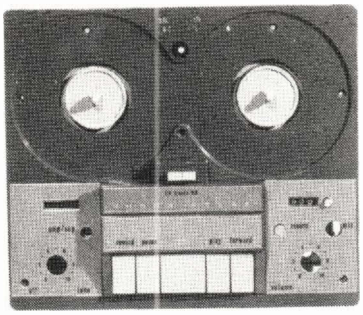

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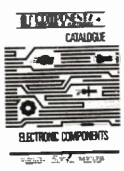

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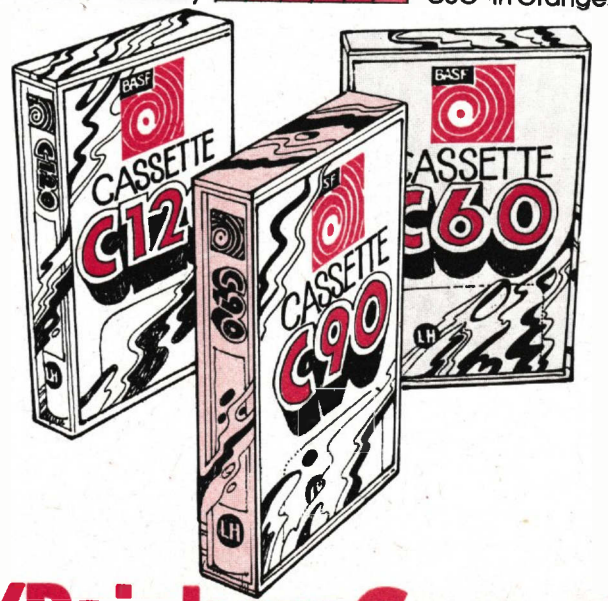

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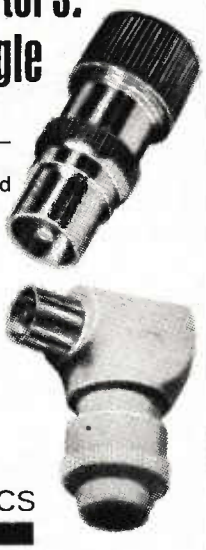

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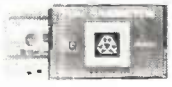

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ELECTRONICS -it's easy!

various voltages, to establish what voltage is needed to perform certain functions, even in the case of our torch, to calculate how much resistance the globe filament must have to be able to produce the desired light.

Ohms law may be expressed as

$$I = \frac{V}{R}$$

where I = current in amps
V = voltage in volts
R = resistance in ohms

That is, the current flowing in a circuit is linearly related to voltage, and also linearly related to the inverse of the resistance.

Thus if we know any two quantities we may calculate the third, eg, we may find the voltage if current and resistance are known by using simple algebra on the formula. This then becomes:—

$$V = IR$$

Similarly, resistance may be found by using the form:—

$$R = \frac{V}{I}$$

For example, the total resistance of a circuit, in which one volt causes one amp to flow, is one ohm. Or if 10 volts is applied across a resistor of 10 ohms — then a current of one amp will flow.

Conductors and insulators are really so-called because of their largely different values of resistance (for materials of the same size and cross-sectional area). There are also certain materials called semiconductors that do not conform to Ohms law — more about these later.

COMBINATIONS OF RESISTORS

We have seen that if we know the total resistance in a circuit, together with the applied voltage — then we can calculate the current flowing. Often however we will find that there are a numer of resistances connected end-to-end (series), or across each other (parallel) — or even mixtures of the two. In such cases it is necessary to work out the 'effective' resistance of the whole circuit.

Resistors in series have a total resistance equal to the sum of each. For example, in Fig. 9 the total resistance is 2050 ohms. Obviously the total must exceed the value of the largest of the resistors — a good check that a decimal place has not been lost.

In our torch, the total resistance is that of the globe plus interconnecting wires and switch contacts. But here the resistance of the wires and contacts is so small (tiny fractions of an ohm) that they do not significantly affect the total and therefore may be ignored.

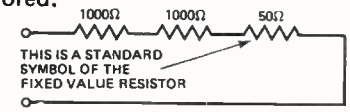


Fig. 9. Resistors connected in series, total resistance is 2050 ohms.

Resistance in parallel are rather more tricky. The rule here is

$$\frac{1}{R\ \text{total}} = \frac{1}{R} + \frac{1}{R_2} + \frac{1}{R_3}$$

where R total = total resistance where R_1, R_2 etc = individual resistors.

Thus the circuit shown in Fig. 10 has a total resistance of 45.45 ohms. (Note that with resistors in parallel the total must *always* be smaller than the value of the smallest resistor.

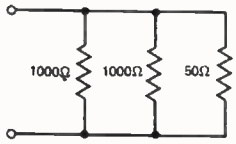


Fig. 10. Resistors connected in parallel. Total resistance is 45.45 ohms.

When a circuit has a combination of series and parallel resistors (Fig. 11 for example), the total resistance can be determined by reducing individual sets in turn. The two parallel 10 ohm resistors reduce to an effective value of 5 ohms. Thus we now have two five ohm resistors in series — equivalent to 10 ohms. Finally we have this effective 10 ohms in parallel with the remaining single five ohms resulting in a final effective value of 3.33 ohms.

POWER RATING OF RESISTORS

When discussing the energy relationships of black boxes we said that some dissipate power — a resistor does this of course, producing heat energy that is lost. It is essential to know just how much heat is dissipated, for overheating could lead to incorrect operation — or even failure if that resistor was not designed to withstand the heat generated.

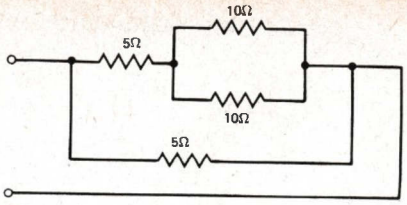
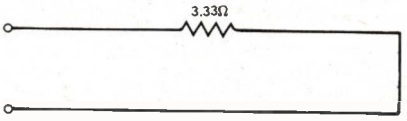


Fig. 11. Combination of series and parallel resistors — their effective resistance is 3.33 ohms — as shown in Fig. 11b.



Power is measured in units called watts. The method of calculating power dissipated in a resistor is

W = VI where W equals power in watts
I equals current in amps
V equals voltage in volts

By substituting the appropriate Ohms Law equation for V or I we obtain two other equations. Thus substituting V = IR we get:—

$W = (IR)\ I = I^2R$.

Similarly substituting $I = \frac{V}{R}$ we get:—

$W = V \cdot V/R = V^2/R$.

Hence if we know any two of the three Ohms Law quantities we can calculate the power dissipated in a resistor as well.

For example, a resistor of 1000 ohms connected to a supply voltage of 10 volts has

$W = 10^2/1000 = 0.1W$ (or 100 mW).

Resistors come in various wattage ratings, either as fixed values or variable for use where the value needs to be adjusted. Ratings range from 1/8 W to 25 W and more. The majority of circuitry uses 1/4 and 1/2 W resistors. A point worth remembering is that the rating quoted is the maximum that the manufacturer recommends. A resistor run at that rating gets quite hot. It is good design to use them to only half the rated value. ●

ELECTRONICS -in practice

THE best way to learn practical skills is to be actually involved with the hardware. Now is the time to start building circuits in order to learn how to solder properly and to become familiar with components.

If you do not already have them you should purchase a small set of the essential handtools. You will need a lightweight soldering iron, a pair of side cutters, long nose pliers, screwdrivers and preferably an electric or hand drill complete with drill bits.

In this first exercise we will use resistors in conjunction with a device called a relay. The complete circuit is given in Fig. 12 and a list of parts needed for the exercises is given to assist you in purchasing the necessary components.

As this is the first encounter with practice the procedure will be carefully detailed.

The 12 V supply can be obtained by using eight 1½ volt torch-cells placed positive to negative to obtain 12 V.

PARTS LIST

1 — 12 V battery or supply and connector.
1 — 12 V lamp (100 mA to 320 mA) and holder.
1 — Miniature relay, Davall 21/2CA, 185Ω, two change-over contacts.
1 — Relay holder socket.
1 — Single pole switch.
10 — ½W, resistors, assorted say, 47,100,470, 1.0k, 1.5k 4.7k, 10k, 100k, 1M.
1 — ORP 12 light dependent resistor (LDR). Hookup wire of assorted colours.
1 — Mounting board 24 holes by 3 inch.

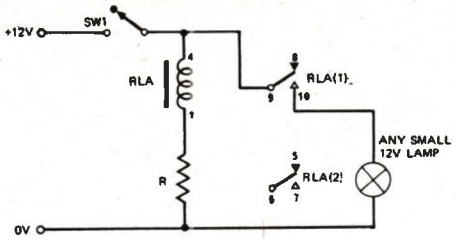
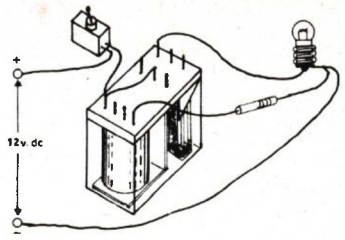


Fig. 12. Basic relay circuit



This sketch shows the actual component connection for the circuit shown in Fig. 12.

Alternatively, a 12V car or motorcycle battery, or a model train supply, will do in this instance.

The relay is a switching device in which the current flowing in the coil magnetizes a soft iron core which pulls down an armature. The armature in turn mechanically actuates a set of contacts. In the relay specified, the operation of the armature and contacts can be seen through the plastic cover. The relay has two sets of contacts. We will use this component to build many simple and interesting devices.

A switch between the circuit and the battery supply is desirable but not essential for operation.

Having now determined the characteristics of our relay we can use another interesting device, the light dependent resistor (LDR), to turn the relay on whenever light falling on the LDR exceeds a certain level.

This device may be wired in place of 'R' in Fig. 12.

Unlike a normal resistor the LDR changes its resistance in accordance with the light intensity falling on its grid-like structure (see Fig. 13a). The relationship between light level and resistance is non-linear and is best expressed by means of a graph, as in Fig. 13b. Such a graph, as it tells us the characteristics of a particular device, is called a *Characteristic Curve.*

We previously determined the resistance necessary to just operate the relay from a 12 volt supply. By finding this value of resistance on the graph we can look across and down, to find the corresponding light intensity necessary to the relay when using an using an LDR type ORP 12.

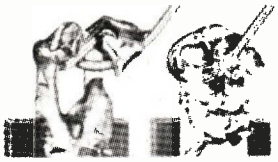
A well lit room is generally around 100 lux and bright sunlight up to 8000 lux or more. The intensity must be

SOLDERING

Good soldering is most important — many of the problems that beginners have with their first projects are due to poor joints. The following hints will aid you to become adept at soldering.

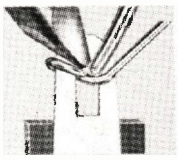
1. Purchase a good quality iron with a wattage rating between 15 and 25 watts.
2. Use only resin-cored solder (60/40 tin-lead content). Do not use acid flux.
3. A new, or worn, iron will need tinning. To do this let the iron get quite hot and file the tip smooth to expose fresh clean copper. Quickly, before the copper has time to discolour, apply resin — cored solder — it should flow all over the tip forming a shiny coating.
4. Keep your soldering iron clean. Wipe it frequently with a damp cloth or sponge.
5. Make sure the connection to be soldered is clean. Wax, frayed insulation, and other foreign substances will result in inferior joints.
6. With older components, or copper wire, it will be necessary to clean and tin the individual components before soldering them together (see 3 above).
7. Attach the wires to be soldered. Do not make more than a half turn in a lead to be soldered — twisting makes subsequent removal difficult.
8. Heat the connection with the iron and apply the solder to the connection. Do not melt solder on the iron and carry it to the joint.
9. Keep the iron on the joint until the solder just commences to flow on the connection. Too little heat results in a high-resistance joint (known as a dry joint) too much causes component damage and evaporates the tin component again causing a poor joint. This step requires practice.
10. Let the solder harden before moving the connection. Then check for a smooth bright joint. A joint that has been moved will have a crystalline appearance, may have a high resistance and will fracture easily.

Good soldering is a matter of practice. If you follow the above hints, it will be only a matter of time till you are making professional joints.

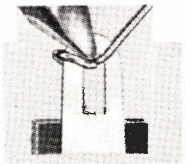


Poor connections look crystalline and grainy, or the solder tends to blob.

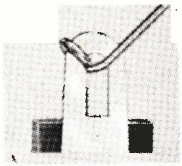
Attach the wire.



Heat both the wire and the connection point.



Apply solder to both the tip and the connection.



Let the connection harden before moving the wire. Then check for a smooth, bright joint.

higher than the amount determined from the graph for reliable operation of the relay.

Just as for an ordinary resistor, the power dissipated in the LDR may be calculated. Note however that this must be done for each light level, and that the power dissipation in the LDR rises rapidly as the light intensity increases.

The coil of the relay specified has a resistance of 185Ω so, if you calculate the current flowing when operated from 12 V, you should get 65 mA. Wire the circuit without the resistor R, and check that the lamp lights when the switch SW1 is closed.

Next, place the resistors, one by one,

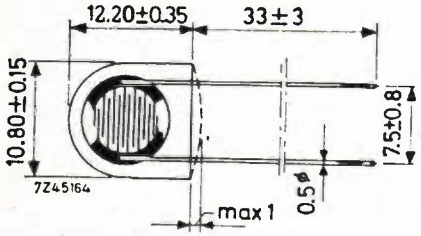


Fig. 13(a). Light dependent resistor (type ORP 12)

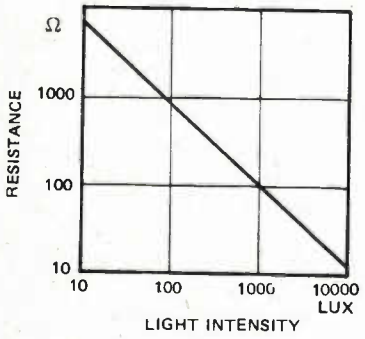
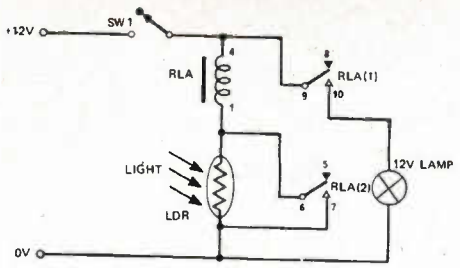


Fig. 13b. Characteristic curve of ORP-12 light dependent resistor.



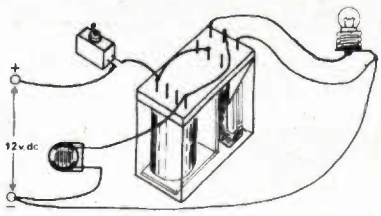


Fig. 14. Replacing resistor R with an LDR (see text), will allow the relay to be operated by a light beam. Relay contacts 6 and 7 are used to hold the relay in once it is operated. Omit connections to these contacts if hold operation is not required.

in series with the relay coil and find the value that just enables the coil to pull in contacts, turning on the lamp. In each case calculate the current flowing through the relay, and the power-rating needed of the resistor. You should be able to do this by referring to the theory given. Having found the value of R, calculate the voltage that just operates the relay (having found the current flowing and knowing the coil resistance, it is a case of applying Ohms Law). Knowing the voltage required, and the current, calculate the power required to operate the relay. Confirm your results by then using the coil resistance rather than the current.

Understanding Ohms law is absolutely essential and tests such as the above will help provide this understanding.

CIRCUIT MOUNTS

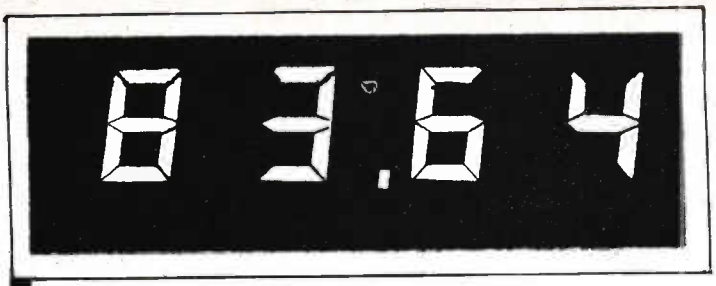
There are many ways to construct circuits. The simplest is to use brass or copper plated nails placed in a piece of dry wood. Although this will suffice, it is better in the long run to use a board made specially for the purpose. As the course proceeds we will discuss various other means.

A good start is to use ready drilled matrix board with hole spacings at 0.25 inches. There are other boards with holes at 0.1 inch centres, but the extra space afforded by 0.25 inch centres makes it easier for beginners. Pins are sold that push into the holes ready to take the components.

The spare contacts on the relay can be used to hold the relay on once it has been operated, even though the light has been removed. This method of operation is called latching. The circuit for this is given in Fig. 14. The normally-opened contacts close when the relay operates, shorting out the LDR. To release the relay operate SW1.

Do not cut the leads of components unless the circuit is to be permanent. Also, do not solder too close to the component body as the heat can damage it.

No doubt you can think of many uses for this light sensitive relay. The contacts can switch currents up to 1 ampere at a voltage up to 100 V. *Do not use it to switch circuits connected to the 240 V mains: it would be lethal.*



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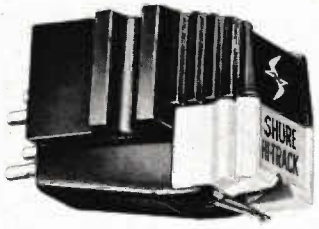

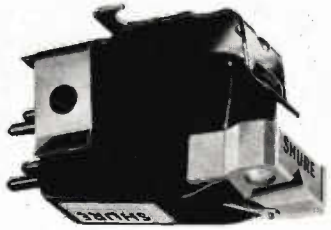

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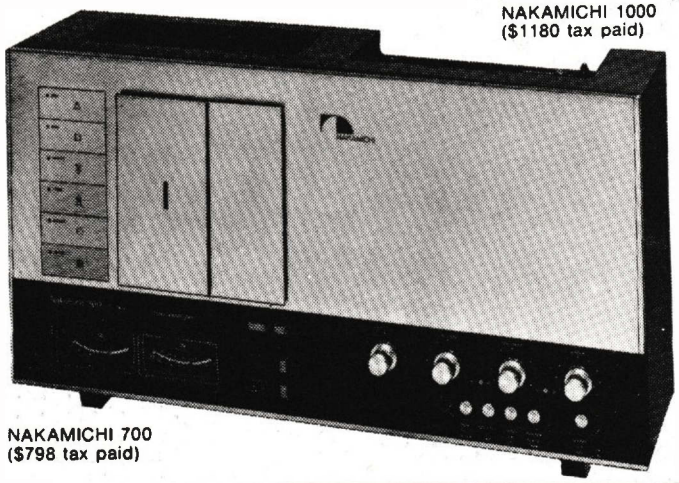

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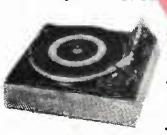

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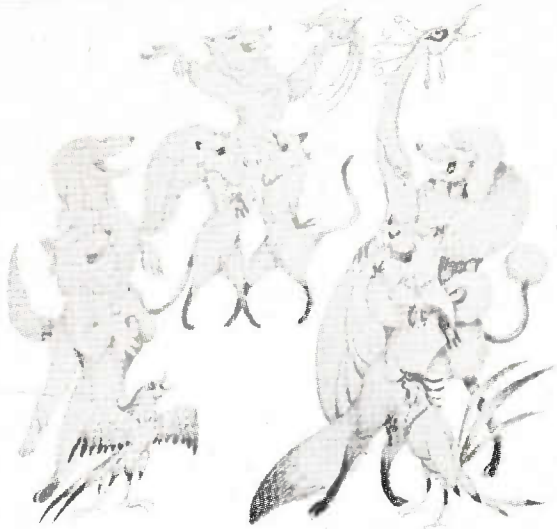

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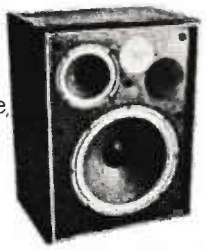

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SENSORS ON

Am I the only one jinxed?—by Talus

SOME months ago I had occasion to make comment about the quality of the service provided by agents who sell us our instrumentation.

I had hoped that that chance to air my views would have pacified my soul but, alas, events have stirred it to boiling again. Here is an account of my chart-recorder experiences which have been in turmoil for over two years now!

It all started with the need to purchase a multi-point dotting recorder — these dot a multi-colour tape onto the paper, switching sequentially over a number of measurement channels. It had to give reliable service with maintenance periods hopefully about a month apart. The instrument finally chosen was made by a well-known company, (but I dare not say the name), who have been making these presumably rugged instruments for use in dirty, hostile industrial situations. I shopped around for the best price — with no success, for each agent gave the same quote — and finally bought, for a mere $500, one that was in stock so that the work could proceed. It arrived, packed in a carton of another product, without documentation. The agents could shed no real light on how to convert it from a thermocouple unit to our need of a millivolt unit, so our troubles had begun. Within a week the channel-recorder indicator cord had broken, jamming the mechanism.

We next found that the expensive, multicolour tape went dry prematurely, failing to provide a mark. It was eventually established that the tape circulating mechanism was not operating. After a year of trying various adjustments, and using many new tapes, we think we have that problem solved, but only after we redesigned the drive gear and the channel indicator mechanism.

A year after that purchase we were in need of a second multi-point recorder, but this time we wanted one with better precision and a wider chart width. As usual, we embarked on that pre-purchase chore of chasing the specifications, the prices, the agents, and the availability. We were after a good deal (and we got it alright — a good deal of trouble!) Five agents sent us quotations, and it seemed that a recorder of the same make as the first was the best buy, as we were offered a discounted price. We were not told it had been used! I could not believe that the first purchase was anything but bad luck — after all the recorder was made by a most revered process-instrument company. So we made our second mistake and bought the discounted unit, subject to viewing it.

It arrived — the recording paper sent was not suited to our request and to my dismay the print wheel had been left wet with ink, corroding one projection right away. The ink-pads were caked with dried ink, and there were only four of the necessary six coloured inks provided. I rationalized the situation — it was reduced in price from its normal cost of a mere $1100, a new wheel was cheap and the pads could be cleaned so, after servicing it, we accepted the delivery and put it to work. (We did have to readjust the multiplexing switch in the process).

Three weeks later it developed one of those mysterious, intermittent faults. Switching the power off cured it each time, so we suspected an electrolytic capacitor in the power supply. The servo did not completely fade, it merely lost its tightness.

It's another long story, but we eventually found that an end-stop safety contact (hidden under a gear wheel) had come adrift — the screws had fallen right out producing the loss of gain that we had experienced when the contact occasionally shorted out. What turning the power off and on had to do with things we never found out — perhaps opening the door to cut the power disturbed it. I'm happy to say that this recorder is now performing well.

By this time I was getting a bit fed up with the agents who sold us both units, so I ordered the new print wheel from another agent, who has the same name as the maker of the recorder. (I mistakenly thought I was getting a little closer to the maker). Would you believe—the printing wheel sent had the wrong number of projections on it?

Before we had taken delivery of recorder number two, or had received the wrong print-wheel, our programme needed yet a third recorder of similar style. This time we knew that we had to make a really sound decision for the unit chosen would be going into a unit eventually needing three recorders that were identical.

Again we looked at the data sheets. Again the best price and model seemed to be from the same stable as the other two. I was, however, obviously reluctant to order, especially from Agent No. 1. The sales pitch by now had improved in that the first model that gave us trouble was replaced with one using a new linear motor, the marking ribbon system was improved using a completely different method to advance the ribbon; the electronics had been replaced with more modern dc techniques. In all, it seemed to be the right buy, so an order was lodged on Agent No. 2, who apparently was a subsidiary of the parent company who made the recorders.

This time to my delight (but only momentarily) recorder No. 3 arrived in a proper carton complete with a guarantee card, and all tied up for safe transport. Aha! I thought, we have found a good reliable and useful agent at last. My dreams were soon shattered! There was no handbook explaining the connections. We specifically had requested this, as we needed to get right into the servo circuits to modify their purpose. (Mind you, I consider the manual as part of the instrument, anyway).

Our Technical Officer set it up, and proceeded to put it through its paces. It was soon found that the servo was not stable — an input excursion from one side to the other set it happily oscillating with a quarter-span amplitude. Again I experienced that sinking feeling. Obviously the agent had done absolutely nothing about checking it prior to delivery. The motor stay-strap had been put on in England (with a special tool), and there it stayed until we took delivery.

I telephoned the sales manager — was this a normal problem? Could he suggest the remedy rather than send it back to them? He said he would look into it, and phone me back (this installation was a $4.00 telephone call

away from the city). I never heard from him again.

In the meantime, in disgust and because of mistrust of the whole world, we redesigned the servo-amplifier, using up-to-date integrated circuits, as they suited our purpose better, and it now goes satisfactorily.

One might think that was the end of the saga. Our next upset occurred when we ordered new ribbons for this third recorder from the same supplier of the recorder – do you know the completely wrong thing arrived!

Having chosen this model as the basis of our triple system design we now await delivery of a second identical unit, buying it from Agent No. 1, who assures us it *will* work and that the other agent is not as good as they. The only consolation is that I have actually seen one in action on an exhibition stand of the agent. Seeing is beleiving – that one worked! I hope, however, that it is not the one we are sent.

One other constant source of annoyance, is the supply of paper for these and our other recorders (we have ten models for different purposes, ranging over seven manufacturers). Not one of the agents involved has ever supplied paper in less than three months, yet they swear black and blue that they always keep a half-dozen rolls in stock of each style ordered originally by purchasers of their recorders. I suspect that do not even bother to import it until my (and your) orders are received.

I find it hard to believe that I am so stupid that I make new problems (you know the stray 1000V or the screw-driver dropped into the circuit that happens with unskilled technicians) yet I seem to continually be confronted with recorder problems. If you have had similar experiences why not tell me – I need reassuring that it is the industry and agents who make and supply the goods that are at fault, and not me that is jinxed.

It is not only the automotive industry that needs improved quality control. It all comes back to the same problem – any instrument not made in Australia is a somewhat foreign being to the agent. You cannot talk to the designer or experienced service-staff, so things are unlikely to improve. We ourselves will, of course, become better and better at designs as we are continually forced to rethink the pros and cons of the workings of imported goods.

Next month I will discuss what the British have done to try and improve the quality of instruments, using the new Instrument Evaluation Centre set up by the Scientific Instrument Research Association. ●

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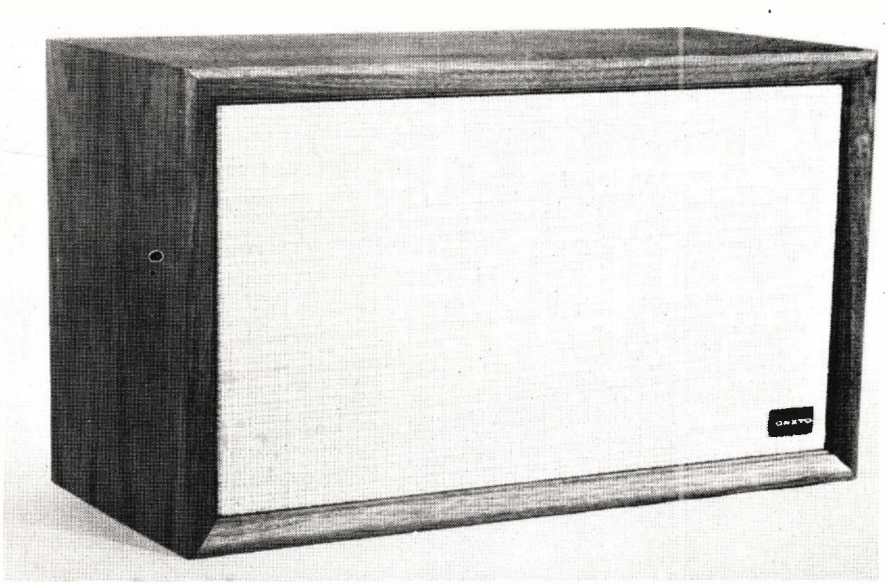
ONKYO MODEL 25 SPEAKERS



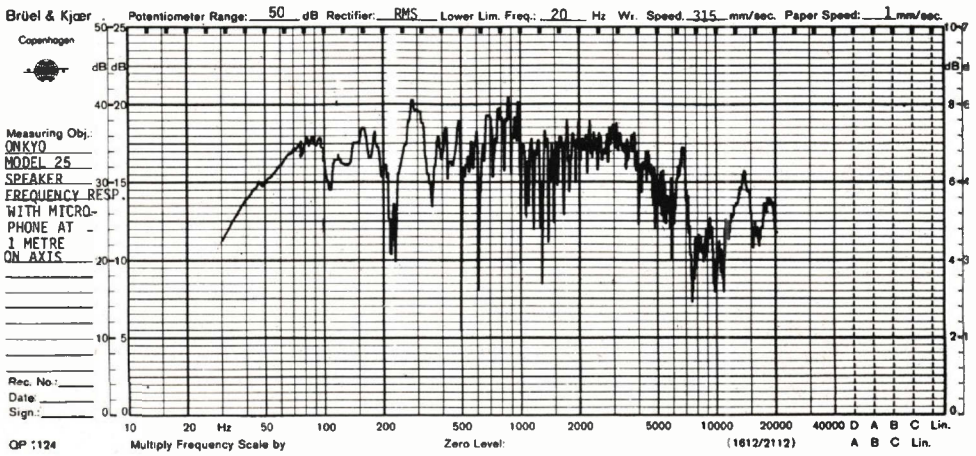
Speakers designed for high power input levels.

ONKYO are one of Japan's largest manufacturers of speakers. They have been producing components for more than thirty-five years, and now have a staff of over 3,600 personnel. Most of their products go directly to the Japanese hi-fidelity market and are used by other high fidelity manufacturers to produce their own systems.

It is only during the past few years that Onkyo have been marketing their own range of speakers, radio receivers and amplifiers, but in this country they are best known for their speakers. These range from miniature super horn tweeters through standard mid-range horns and drivers, domed mid-range and commercial type (350 mm diameter) low frequency drivers. Some of their more advanced systems, including the Scepter Series, are very well received on the American market where the majority of their speaker systems are now marketed.

The Model 25 system falls in the middle of the Onkyo range and is not conventional, for it uses a 35 mm diameter low-frequency driver in an .042 cubic metre (1½ cubic foot) sealed enclosure. This is unusual, and not the best design for good low frequency performance. In fact equally good performance would result from the use of a smaller low frequency driver.

Additionally the use of a 50 mm mid-range and a 25 mm dome tweeter in a fully sealed enclosure is unusual.

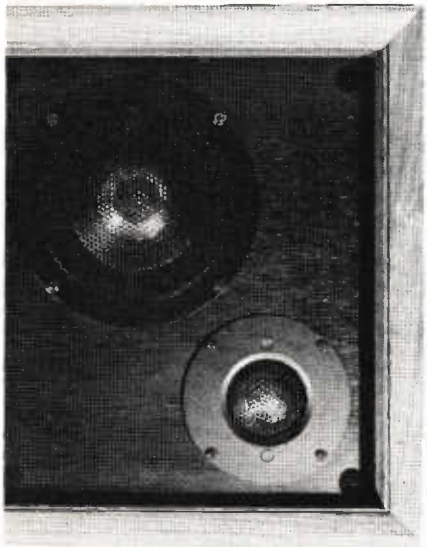


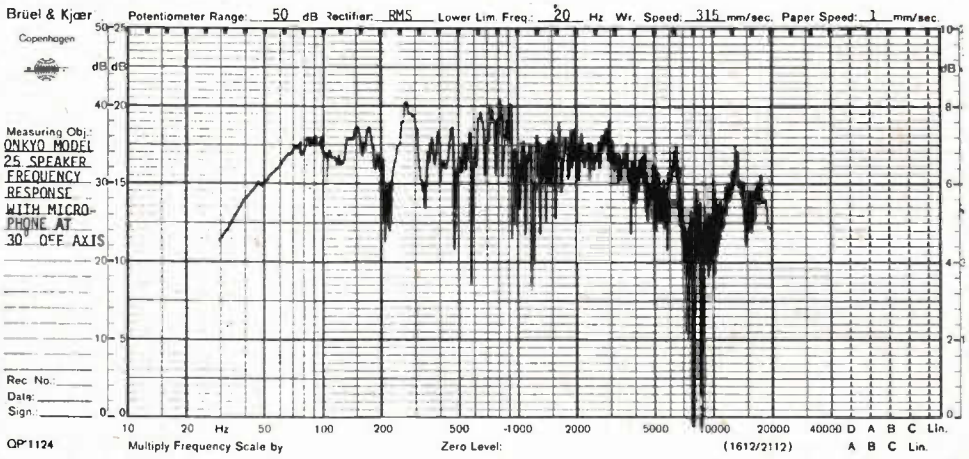
THE WOOFERS

The low frequency driver type W3501A is massive, features a heavy magnet assembly and weighs 4.9 kg. The speaker diaphragm is supported by a flexible neoprene-rubber, roll surround and the centre of the voice coil dome is provided with a 15 mm diameter venting aperture to provide voice coil cooling and pressure equalisation for the fully sealed enclosure.

MEASURED PERFORMANCE OF ONKYO MODEL 25 SPEAKER

Frequency Response	
as per attached level recordings	
Total Harmonic Distortion	
(for 90 dB at 2 metres on axis)	
100 Hz	1%
1 kHz	0.5%
6.3 kHz	0.3%
Electro-Acoustic Efficiency	
(for 90 dB at 2 metres on axis)	5.6 watts
Measured Impedance	
100 Hz	6 ohms
1 kHz	12 ohms
6.3 kHz	5 ohms
Cross-Over Frequencies	
low	700 Hz
high	7 kHz
Weight	23.8 kg
Dimensions	650 mm x 375 mm x 300 mm





MID-RANGE DRIVER

The 50 mm mid-range driver is unusual in several respects. Firstly, it uses a massive 14 mm diameter ferrite magnet, weighing approximately 2.7 kg., and secondly it has provision for acoustical damping through the use of a fibreglass rear cover.

The frequency response of this drive unit is not as flat as it could be. It exhibits noticeable peaks at 3 kHz and 6.5 kHz. It is regrettable that the manufacturers have not used a speaker with a similar response to the DM500 which is a low power version of the type MD 503A actually used.

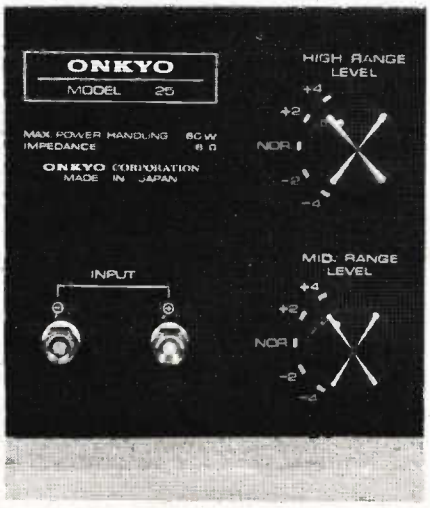
The linearity of the DM500 could have transformed this system by providing a flat mid-range frequency response.

The MD503A is fully repairable and as such presents a new dimension in mid-range speaker elements.

THE TWEETER

The 25 mm dome tweeter TW-301B weighs 0.6 kg. It is well made and is very similar in design to Philips AD0160/T tweeter.

The diaphragms of both the MD-503A and TW-301B are well



ONKYO MODEL 25 SPEAKERS

protected by domed perforated metal covers.

THE ENCLOSURES

The enclosures are very well manufactured from 22 mm and 25 mm thick particle board veneered on both sides. The internal bracing is strong and quite adequate in controlling enclosure resonances. The front of the enclosure has solid wooden edge mouldings and an unprententious buff coloured grill cloth. The overall appearance is plain and most certainly conservative when compared to some of the latest Japanese speaker systems.

CROSSOVERS

The cross-over network is conventional and uses high quality components, in what appears to be a pi network which provides cross-overs at 700 Hz and 7000 Hz. This is mounted on a printed circuit board fixed at the rear of the unit. There are two adjustable potentiometers to set the output level of both the mid-range and high frequency speakers and these are mounted next to the speaker terminals at the rear of the enclosure. Such a facility is convenient where it is desired to try to match the speaker response to the room acoustics and in the case of this speaker is a decided advantage.

SUBJECTIVE EVALUATION

Our first series of tests involved a subjective evaluation of the speakers to determine the extent of colouration. These tests showed that the speakers exhibit a pronounced colouration which we felt detracted from an otherwise apparently good performance. This colouration was quite pronounced on piano pieces and was very noticeable with organs and guitars.

MEASURED PERFORMANCE

The first series of measurements we carried out determined the on-axis frequency response. These showed that the frequency response of the system was non-linear to a pronounced extent in the region between 3 kHz and 7 kHz and to a less extent above 7 kHz.

The tests were repeated with the microphone 30° off axis. This showed that the directionality of the mid-range and tweeters is quite good but that there was no improvement in frequency linearity off axis. The tweeter has a prominent peak at 15 kHz and elsewhere in the spectrum it has a lower output than the other two drivers.

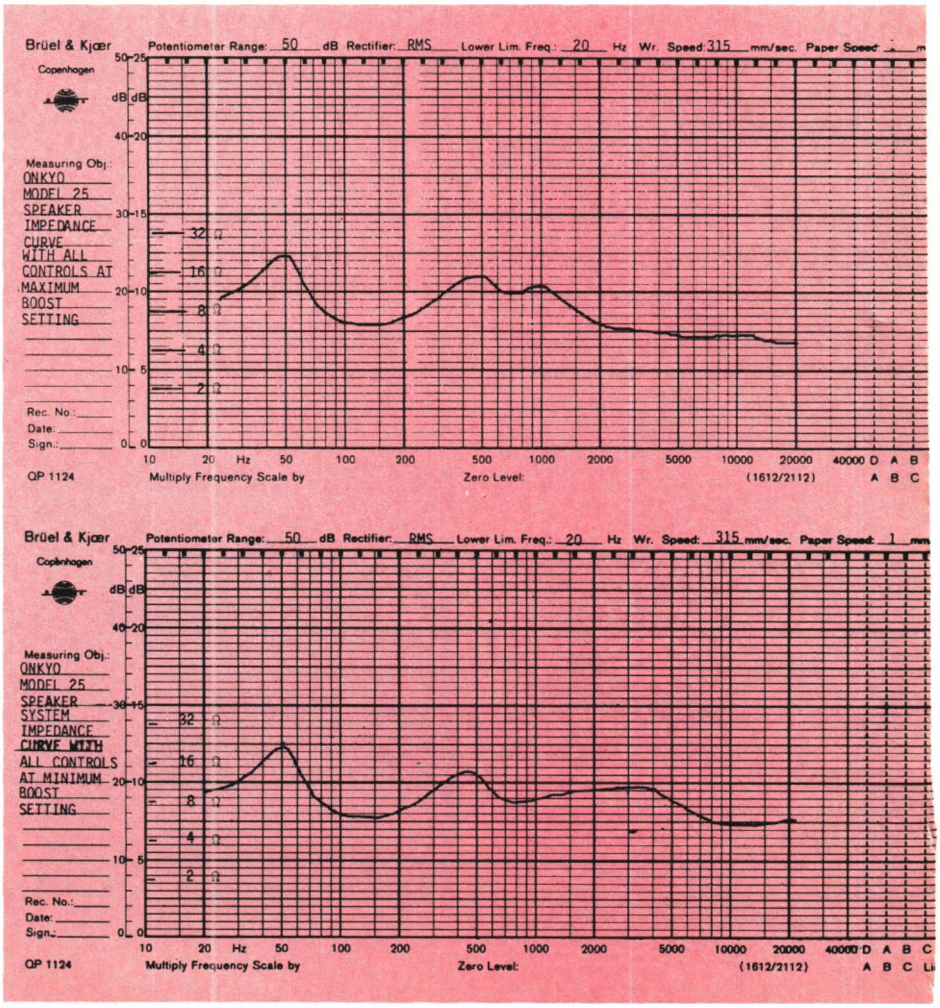
We repeated these measurements with the speaker mounted in our reverberation chamber to determine the total acoustical output of the system. This showed conclusively that acoustical output between 6 kHz and 15 kHz was low. The speaker response was found to exhibit a series of pronounced peaks at 150 Hz, 250 Hz, 500 Hz, 3 kHz, 7 kHz, and 13 kHz.

We next measured the impedance characteristics of the system and found that the low frequency drivers, as mounted in the enclosure, had a resonance of 50 Hz which is in good agreement with the manufacturer's literature. The speakers exhibit a flat impedance characteristic, which means they have little difficulty in coping with very high powers. The distortion characteristics of the Model 25 are remarkably good and distortion components are virtually inaudible when the output level is 96 dB with the microphone at one metre on axis. Under these conditions the total harmonic distortion is below 1% at all frequencies over 100 Hz, and less than ½ per cent at all frequencies above 1000 Hz.

The speakers have no difficulty in coping with a genuine 60 watts of programme content and are relatively untroubled by sine wave power inputs in excess of 30 watts from 20 Hz right up to 20 kHz.

Unlike most other manufacturers Onkyo offer a genuine five year warranty for their speakers. Such a warranty certainly indicates that Onkyo have considerable faith in their products, and are prepared to back this up.

The overall appearance of the Onkyo Model 25 is clean. The speakers are particularly well made and show that Japanese manufacturers are starting to produce speakers designed to provide higher efficiencies, and to be capable of coping with higher powers than many of their European competitors. These are speakers designed for somebody who wants to drive them hard and still achieve an undistorted sound without adding *further* colouration. ●



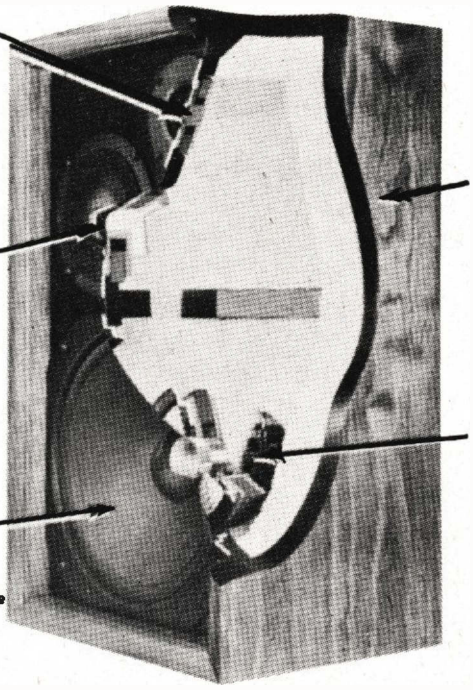
THE INSIDE STORY

OF THE ONKYO 25 SPEAKER SYSTEM:

"An exceptionally well built system with good all round performance"

AUDIO MAGAZINE (USA)

JANUARY 1973



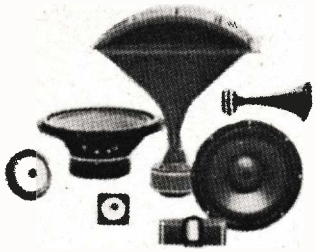
TWEETER
- Thin Diaphragm — 1" dia. Super-Hard Duraluminum
- Magnet — ½ lb. Ferrite
- Frame — Cast Aluminum

MID-RANGE
- Diaphragm — 2" dia. Super-Hard Duraluminum
- Magnet — 2¾ lb. Ferrite
- Cavity Damping — 2" d. Fiberglass

WOOFER
- 14" E.I.A. Diameter
- Molded Non-Press Cone, Ported Dome
- Neoprene Surround
- Cast Aluminum Frame
- 3¼ lb. Ferrite Magnet
- Aluminum Foil Voice Coil Bobbin
- 2" Long-Throw Voice Coil
- Heavy Bolted Construction

CABINET
- ⅞" Flake-Core Walnut
- 1½" Horizontal and Vertical Struts
- ¾" Joint Braces
- Double Thickness Fiberglass Damping Mats
- Removable Front Grille
- Solid Walnut Front Molding

NETWORK
- Integrated Circuit
- P.C. Board Construction
- Large Air Core Chokes
- Mylar Non-Polarized Capacitors
- 12dB per Octave Slope
- Choke Attenuator, 5 position, 2dB per Step, Tweeter and Mid-Range



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AMATEUR RADIO

THE STATE OF THE ART

Roger Harrison VK2ZTB

OSCAR 6 was 12 months old in October. In late October it had completed a little over 5000 orbits (about 85/week) and gives every indication of extending its planned life by a considerable amount. Optimists are calculating orbits to February 1974!

The satellite has had quite an eventful life and established several firsts. The first mobile (i.e.: from a moving terrestrial vehicle), aeronautical mobile and portable (i.e.: portable independant power supplies) contacts through a free access satellite can be rated high among its achievements.

One of the basic aims of Oscar 6 was to demonstrate that relatively simple and inexpensive techniques can be employed for space communications. This basic aim has certainly been demonstrated many times with the thousands of contacts that have been made through the satellite.

The command and stabilisation systems have been thoroughly proven and the on board experiments with 'housekeeping' etc have been of great assistance in planning future designs of satellites of this type. The failure of the 435.1 MHz beacon was somewhat of a blow, but the cause appears to be in the realm of 'an act of God', rather than inadequate design. The power supply system has functioned admirably and the duty cycle – controlled by command from the ground – which determines battery drain by having the translator 'on' at appropriate intervals, rather than continuously, has certainly contributed to the satellite's longevity and usefulness.

Of the five command stations throughout the world, three are in the southern hemisphere, two of these being in Australia; viz: VK3YDB George Long/VK3ZDH Dave Hull in Melbourne and Don VK6HK in Perth. The other southern hemisphere command station is in New Zealand.

A total of almost 60 Australian amateurs has operated through Oscar 6, establishing contact with other countries which include Japan, Hawaii, New Zealand, the Philippines and South Africa.

A more complete resume of the activities associated with Oscar 6 and its achievements will be included in a later issue.

MOONBOUNCE ACTIVITY

On the 6th of October 1973, Ron Wilkinson VK3AKC of Geelong, Vic., worked W2NFA (the Crawford Hill VHF Club) at 0357Z on 1296 MHz via the moon. Signal reports were 549 to Ron and 559 to W2NFA. There was a team operating the station at W2NFA, located at New Jersey; the team comprising Dick Turrin (W2IMU – well known in moonbounce circles), Bob WA2HVA, Tony K2K11 and Roger Abson.

This is the first accredited confirmed Australia – USA contact on 1296 MHz moonbounce and is a world first as well as being a new distance record for moonbounce on this band. Congratulations to Ron VK3AKC and the team at W2NFA for a fine effort. It is all the more a great accomplishment for the fact that Ron operated his equipment entirely unaided on this occasion. His antenna has to be manually aimed and adjusted to track the moon. As can be seen from the resume below, most of his equipment is home constructed.

Equipment: W2NFA Transmitter:– Modified ring amplifier from UPX-4 equipment running six 7289 valves (planar power triodes similar to 2C39, same as 3CX100A5). Power output is 500 watts. Driver is mixture of valve and solid state gear. Receiver:– Transistor preamps using MT4000 transistors into a converter using two type V766 transistors. Antenna:– 18.3 m dia. parabolic dish, circular polarisation on transmit and receive. VK3AKC Transmitter coaxial cavity amplifier using two 3CPX100A5 valves (cavity constructed by Trevor Nevin VK5NC – ex 5ZTN) running approx 160 watts dc input. Two blowers are used, one on the anodes and one on the cathode cavity. Ron now has a permit to run 500 watts.

The final is driven by a 2C39BA, 20 watts out which is in turn driven by a 2C39 tripler, 3 watts out, driven by a BAY96 tripler (144 MHz to 432 MHz). The base rig employs a heterodyne VFO and a QQE06/40 in the output. This is run by remote control. Receiver:– A magnetic latching relay isolates the receiver system input by switching to a 50 ohm load. ($185 worth! – donated; Ron is not rich, merely patient). There follows two cascaded preamps using NEC1336 transistors realising approx. 3.1 dB noise figure and about 12 dB gain.

The 1296 MHz converter is the well-known design by Les VK3ZBJ using one tuned filter ahead of it. The IF is at 144 MHz and an IGL FET converter to 28 MHz completes the line up. All the foregoing is mounted at the feed horn.

Coax to the operating position is used and the receiver is the Rx portion of an FT200 transceiver. A dB level meter and a tape recorder are attached to the output.

Antenna: Homemade 8.5 m dish on an azimuth-elevation mount employing 'armstrong' tracking method. i.e.: it is manually positioned. Ron's wife usually provides the power/coffee/biscuits/ etc.

The feed is circularly polarised, designed by Dick Turrin W2IMU, and is essentially a section of circular waveguide. All homemade.

The coax employed is 7/8" (22.23 mm) dia. type HJ5/50 under 5lb pressure of helium. Loss at 1000 MHz is 1.27 dB/30.5 m, a 12.2 m length is used in Ron's installation. Cost? $98 . . . the type 75AW connectors cost $21.60 each. A piggy bank helps.

General:– Ron can receive about 13 dB (measured) of Sun noise and 2 dB from the earth.

W2NFA reported that Ron's signal was 10 dB above the noise for three minutes of the contact.

Just for interests sake, the path loss on 1296 MHz is 294 dB. All operation was CW (morse).

The moon was not visible throughout the whole period of operation, being obscured by cloud cover.

Ron would like to thank all those who took an interest in the project and gave assistance, particularly to Trevor Nevin VK5NC who built the transmitter PA cavity, Varian Pty Ltd who donated the 3CPX100A5's, the Crawford Hill VHF Club and the US Naval Research Laboratories who provide the computer predictions for the moon position.

(Continued overleaf)

On the 15th Oct. 1973, Ray Naughton VK3ATN worked VE2DFO (Canada) and W6PO (California USA) on 144 MHz moonbounce. Ray's equipment has been described previously. Briefly, he runs 150 watts (CW) to a rhombic antenna array which is semi-fixed (or more correctly – semi-moveable). Ray is returning to more moonbounce work.

On the 16th and 17th Oct. 1973, Chris Skeer, of Hatherleigh S.A., VK5MC worked VE2DFO (Canada) on 144.107 MHz moonbounce and W6PO (California). Reports exchanged both ways were 0 . . . this means 'all copied'. The reporting system for 144 MHz moonbounce (also used on 432 MHz) is:– T (or TANGO) . . . odd letters copied M (or MEXICO) . . . most letters copied O (or OSCAR) . . . all copied.

This is to simplify reporting procedures as many EME stations on 144 MHz can only accommodate fixed antennae, thus there is a limited 'window' during which both stations 'see' the moon and can exchange information. The same system is used on meteor scatter. The window on these occasions was approx. 35 minutes which is rare indeed for stations using fixed antennae. Usually it is 10-12 minutes or less.

On the 17th, Chris also heard KH6NS calling and sent a report of M but no two-way contact was made. An unidentified SSB signal was also heard, the doppler shift causing it to be unreadable.

Equipment: VK5MC Transmitter:– The PA uses a 3CX150 running 150 watts CW and is home built. Receiver:– A FET preamp using a U310 with a noise figure of about 1.3 dB, grounded gate configuration. This is mounted at the antenna. The converter is homemade as is the preamp and feeds into a modified FR100B receiver with a 600 Hz mechanical filter in the IF. Antenna: Two stacked rhombics, the long axis being 208.6 m long! Height is 9.144 m and Chris built a new shack at the feedpoint end of the rhombics to reduce feedline losses. Mohammad came to the mountain. Now that's what I call dedication to system design!

On the weekend of 27th/28th Oct. 1973, Chris copied his own SSB echoes back from the moon. I believe that this is the first time an Australian amateur has achieved this. If anyone can tell me anything different – I would like to hear from them. I have no details of power etc.

I must thank Ron VK3AKC for the above information; I might add that it took some persuading, cajoling etc to prise out of him all the details of his record breaking EME contact! ●

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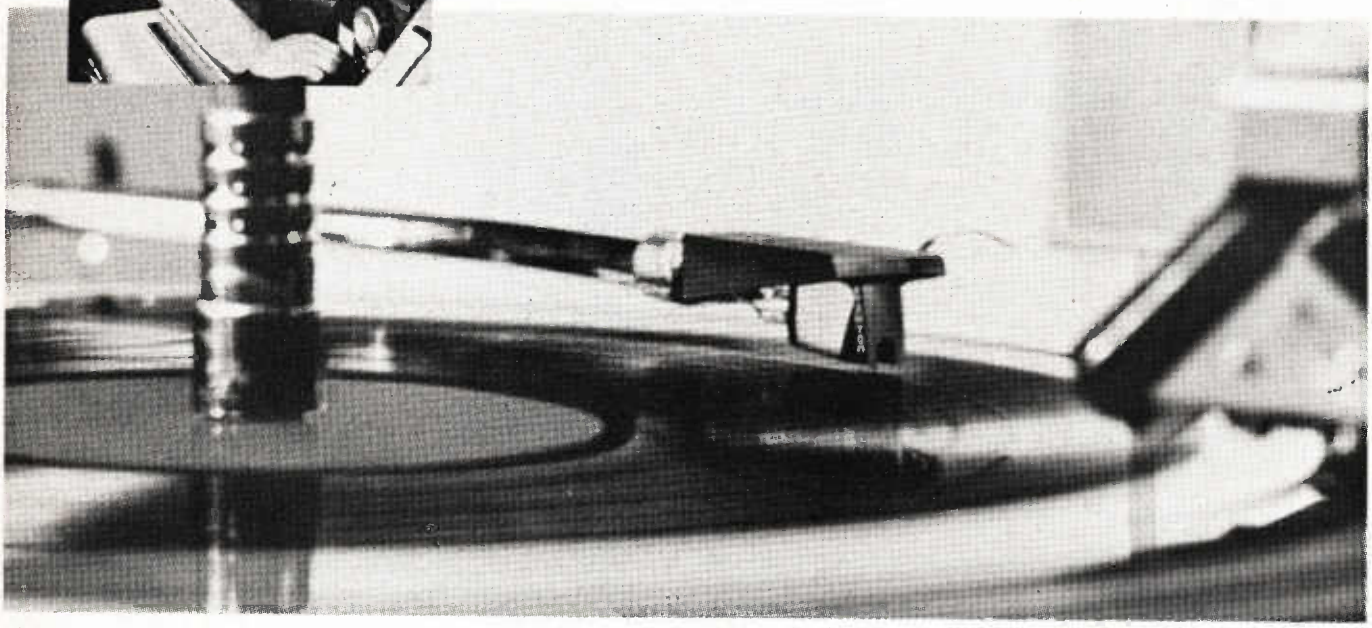

Stanton's 681 Series is the Calibration Standard to recording engineers such as Robert Ludwig.

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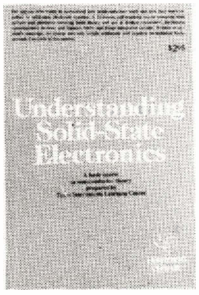
BOOK REVIEWS

REVIEWER: Brian Chapman



UNDERSTANDING SOLID–STATE ELECTRONICS by Texas Instruments Learning Centre 1972. Soft covers 242 pages 215 x 130 mm. Price $2.95.

There must be many thousands of people who wish they had an understanding of electronics but are scared off by the complicated appearance of the subject as presented by many books supposedly written for beginners.

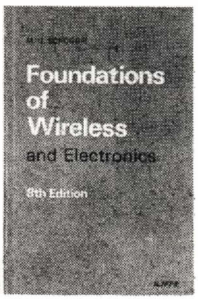
Here is a book which is suitable for anyone who wants to understand how semi-conductors work and how they are used in basic electronic systems.

The book is constructed as a 12 lesson self teaching course in the basic theory of diodes, transistors, thyristers, optoelectronic devices; and bipolar, MOS and linear integrated circuits. Each lesson is prefaced by a glossary of the terms which will be introduced, and is followed by a self-test questionnaire.

The course is written in layman's language, is well illustrated, and almost completely free of any but the most elementary mathematics. It may truly be said that no previous technical background is required at all.

Although the treatment is simple and lucid, it does not skimp on depth of treatment. Hence, having completed this course, the student would not feel that he has gained merely a superficial knowledge of the subject.

No doubt this book is one of the best basic electronic-theory texts available. – B.C.



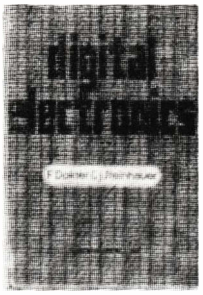
FOUNDATIONS OF WIRELESS AND ELECTRONICS BY M.G. Scroggie 8th Edition. Published by the Butterworth Group 1971. 521 pages 215 x 135 mm. Soft cover edition $6.10, hard covers $10.00

This book is one of the traditional basic texts making its first appearance as long ago as 1936. This eighth edition bears little resemblance to the first and is completely up-to-date, in that it contains transistor and integrated circuit techniques as well as some traditional valve theory. The valve theory may well be considered redundant, but there are still a lot of valves in use, and it serves as a useful comparison for the FET theory given in parallel with that for valves.

The real value of the book lies in the soundness of the basic theory. The coverage is thorough and to a reasonable depth without sacrificing clarity. This particular feature of a clear, conversational and easy to understand text, is what made Mr. Scroggie one of the best technical authors in the field of electronics for almost half a century.

Apart from its value as a standard electronics text, the book could well serve as an example of how a text should be written.

This book, and in fact all Mr. Scroggie's books, are thoroughly recommended to any budding technician. – B.C.



DIGITAL ELECTRONICS by Doktor and Steinhauer. Published by Macmillan 1973. Hard covers, 270 pages 235 x 155 mm. Price $19.95

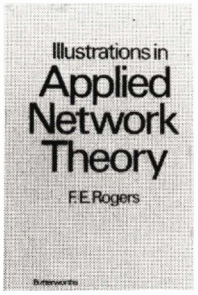
This book is part of the Philip's technical library series, and with its recent publishing date, is right up to the minute in its treatment of digital technology.

The text commences with a discussion of analog and digital techniques, as applied to electronic measurement and data handling, and then covers coding and switching algebra in considerable detail before passing on to a treatment of the realization of basic logical functions by electronic means.

This is followed by the design of the basic logic circuits and then by the various manufacturing methods used to realize these designs. An extensive bibliography at the end of the book provides references for those who wish to pursue individual topics further.

Naturally, the book concentrates on devices of Philips manufacture but this does not affect the validity of the treatment in any way.

The book is suitable for engineers or students requiring a general survey of digital techniques with particular emphasis on logic and coding. – B.C.



ILLUSTRATIONS IN APPLIED NETWORK THEORY by F.E. Rogers. Published by Butterworths 1973. 228 pages 215 x 135 mm. Price $14.50 hard cover, $7.25 soft cover.

A thorough understanding of network theory is vital to any practicing design engineer, yet it can be one of the most uninteresting of subjects, causing many undergraduates to develop a distinct dislike for that section of their course.

The main reason for this is perhaps the lack of relation between the theory, as taught, and the solution of real engineering problems.

This book attempts to overcome the problem by firstly providing a well written, fresh approach to basic network theory, and secondly by providing numerous worked illustrations of typical problems. These illustrations are presented in the form of a question, an interpretation of the problem and a comment on the technique employed. Any limitations of the system used, and points worthy of note in the solution, are discussed in this comment.

Written by a man who specializes in the teaching of network theory, this book should help remove the traditional distaste for the subject. – B.C.

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013, 014 Siren Module Conventional & European (Hee-Haw) with manual or automatic operation. $9.55 + 15% s/tax.

015: Microphone/Guitar pickup preamplifier. Complete with bass, treble, volume controls mounted on printed board, fits against front panel with absolute minimum of wiring. Inputs low Z mic. 0.5mV, pickup 100mV, guitar/high Z mic. 5mV. Outputs 25mV/10 K for mixing and 1V/10 K for driving power amps directly. $12.90 + 15% s/tax.

016: Active mixer module. Mixes up to 6 015's or 020's and drives any auditec power amplifier. $7.95 + 15% s/tax.

018: 50 watt power amplifier module. 60 watts R.M.S. into 4 OHMS, same performance characteristics as 009. $31.95 + 15% s/tax.

020: Microphone/Guitar/pickup preamplifier. Designed for small or large economical mixers. Takes any microphone, guitar pickup or high level input and drives 016 mixer. Bass cut link included for paging systems. $6.70 + 15% s/tax.

021, $7.60 + 15% sales tax, **022** bass & treble module $7.95 + 15% sales tax.

023: Regulated power supply module. Standard 18 volts D.C. @ 100mA max. Powers all auditec Preamplifiers. 220 — 240V 50HZ input, output options from 12 to 27 volts. $12.95 + 15% s/tax.

024: Regulated variable power supply module. Precision power supply 5-25 volts @ 2A max. Line and load regulation better than 0.2%. Fully load protected. $22.00 + 15% s/tax.

025: Stereo magnetic equalising preamp. R.I.A.A. ±1dB. Outputs 1v and 25mV, adjustable. Inputs 2mV/47K. Max. signal handling 170mV, E.N.I. — 125 dBm. $15.90 + s/tax.

028: Stereo 20 watt power amplifier. 20 watts R.M.S. max. per channel at 0.1% T.H.D. Self-contained with power supply and heatsink (not transformer). $35.90 + 27½% s/tax.

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E.T./12/73/

Dick Smith Ele

Dick's New Centre Opens

It is the most advanced store of its kind in Australia. Dick toured the world to see all the very latest ideas in self-selection etc. Discussed methods with similar organisations overseas. Now you can see the result at 162 Pacific Highway, Gore Hill. If you were put off by our old cramped shop alongside you'll want to spend days in our new place. It's enormous and fully air conditioned!! Most of the goods are on self-selection to save your time (and money). We even let you write your own dockets out!!
Counter staff are on hand to advise you. Other innovations include:

FREE valve testing service. Dick has the very first Mercury valve tester installed. Fresh from the USA, this is an automatic Pass/Fail tester you can operate. Just bring the valve in and test it for free. Then we have replacements at TRADE prices. This new service has proved very popular with users of the Telefix calculator ($2.00) since you can service your own TV set for a fraction of the usual cost.
New Demonstration Lab. Right by the entrance is a demonstration room where we will be having displays of interest to everyone (send in your suggestions and suppliers note too). We are trying to arrange for the new ETI Synthesiser to be demonstrated for example, as well as some of the very latest test gear. Watch our ads for advance information on these FREE displays.
Noticeboard. We don't just want to sell you stuff, we want to help you swop yours, ideas etc. So we've installed a noticeboard where you can for a couple of weeks advertise at no charge (naturally we won't be responsible for the outcome and we have a few reservations on what can be put up!!).
Special Hi-Fi area. Our demonstration room will be about the same size as an average room at home so you can get a really good impression of what the gear will sound like. There will also be an area where you can just look and compare.

New streamlined mail order department. This was opened just in time to cope with the avalanche of mail after our new catalogue and the mail dispute at Redfern. Those of you who have tried our new Mail Order Form tell us that it is extremely easy and clear — especially the Back Order section. Such is the volume of our business now that we are finding that your order may take up to a day in our system. (We know this because we log the progress of every order through the system). Other firms may claim to be faster, they just don't handle the same volume!! Next month we'll tell you more about the premises, meantime if you're in Sydney, call in. It's definitely worth a visit (rivals the Opera House some say!!)

Educational kits prove extremely popular at this time of year. All components are reusable so there's hours and hours of fun and no soldering or technical knowledge is needed.
Crystal Radio kit an all time favourite enables local stations to be picked up without battery. Assemble your first radio in under an hour for $4.95 (P&P 30c).
10 in 1 includes a solar battery and enables several radios, signal generator and morse code oscillator etc to be built. 10 projects in all for only $8.95 (P&P 50c).

50 in 1 Solar Energy kit gives 50 experiments using relay, transistor, transformer meter etc. Requires two batteries. With 58 page manual $21.95 (P&P $1.00).
150 in 1 The Ultimate kit (see ET review) A magnificent kit in wooden case with enlarged visualised IC, radio tuner, CdS cell, transformer etc. No soldering so you can build the circuits up over and over again — and some of your own. Beautifully presented in 16" x 8½" x 3½" case at $35.95 (P&P $2.00).

Headphones

Headphones P&P 50c Prices to suit all pockets. Headbands to fit all heads (even big ones). **SA32D** our cheapest with 300mW rating, frequency response from 25 — 18000Hz $5.95.
SH850GX a higher powered model with wider frequency response. Supplied with cord and stereo plug $10.95.
AD38SL ideal for professional users, very comfortable has built-in independent volume and tone controls plus stereo-mono switch. 20-2000Hz response $14.95.
Pioneer SEL20 very compact and light weight. Unique open back design for better sound dispersion. Uses new ultrathin polymer film diaphram $23.15 (P&P $1.00)

Pioneer SE50 really are the b having a 3" cone type element rich bass and a horn tweeter (j like a loudspeaker system). Le and balance controls built in. W worth $46.00 (P&P $1.00).

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New, new Dick has Guaranteed calculators
We are now stocking the "Advance" range of electronic calculators. Don't be put off by the prices — just add $20 to $30 to get the true value. We sold the first trial shipment in two days!!
1200 Ruby has a digit display with 12 digit capacity. Selectable decimal point. Does all the usual calculations including chain multiplying etc. Runs from 9V transistor battery. Bright easy to read LED display. We save you around $10 at our ridiculous price of only $59.
8012 Grantham is a desk top job with floating decimal. Operates from 240V with constant key, overfl indication, leading zero, suppress and 8 digit display $79.00.
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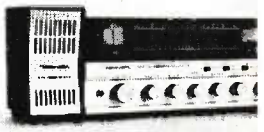
Note all these calculators are av able on our normal money b guarantee terms. Why not try one our expense for 7 days. ALSO TH HAVE FULL 3 MONTH AU TRALIAN WORKMANSH GUARANTEE. Send now you ca go wrong!!

New Realistic with FET Front End at old price
Has over 30 semiconductors, tunes in SW CW SSB/AM Broadcast etc right from 600kHz to 30MHz. Operates from 12V — use one in your car! Variable BFO, Cascade RF stage. 240V ac operation or batteries. Recommended at $225 (P&P $3.00).



STOP PRESS. Digital counter, E.A.Dec Complete kit inc. crystal, case and readouts. 20MHz $116 (P&P $2.00) With Prescaler giving 200MHz capability $135 (P&P $2.00)

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of RIAA curve from
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) is typically -68dB.
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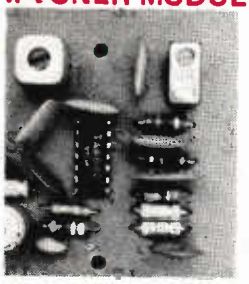

specifications:
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Output 750 mV into
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le only (needs ferrite rod
apacitor) $13.20
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eight extra).

Holiday time is ideal for knocking up a kit (they also make ideal presents). Here we list our most popular. First the Dick Smith "Superkits." These have been specially selected for the VIP treatment. Prototypes have been built and evaluated and we include comments and suggestions for improvement over original specs. You also receive reprints of articles and corrections. Most have flow-soldered P.C. Boards and extras that we think will help you to get a Super finish.

Playmaster 136 Amplifier. Without doubt the most popular amplifier kit we have ever handled. Compares favourably with commercial units. Has expensive brushed aluminium panel. We also include silicon grease to improve thermal conditions in output transistors. Less Fairchild Special offer transistors $55.60 (including translstors $65.00) Both P&P $1.00.

ETI 100W Amplifier features full 100W RMS output. Prepunched heatsinks and silicon grease plus heat dissipating paint. Sturdy metal case. Ideal for guitar enthusiasts. Simplified instructions included $65.00 complete (P&P $1.50).

100W Pre-Amp Kit. Produced in response to numerous enquiries to complement the above amp. Two sensitivities for mics and guitars, volume treble and bass controls. No case since most users build it into something else. Pretinned boards full circuits included for $9.50 (P&P 50c).

Kits

Varilight Dimmer. Handles up to 1000W gives professional light dimming at a fraction of the cost. Includes 8A triac and posh Clipsal flush mounting plate $6.90 or electronic components only in short-form kit at $4.90 (Both P&P 50c).

Digital Logic Trainer. Learn all about digital with this beaut kit. Many sold to tech colleges, industry etc. Contains 6 JK flip flops, 2 and 3 input gates, inverters, buffers and 4-input Schmitt. These are supplemented by a dual range clock, level setting switches and LED readout. Our kit uses best components available including a handsome silk-screened panel $82.00 (P&P $1.00).

Musicolour. Watch the coloured lights dance to the sound of your favourite music. Filtered bands of audio are used to trigger the lights. Complete kit includes anodised front panel and explicit instructions $52.00 (P&P $1.00).

30Watt R. F. Kit has proved popular with Amateurs. Available in 3 stages which together give 30 Watt out from 300mW in at 144MHz from a 12.6V supply. Get the complete kit (for advanced constructors) for $37.50 saving you $5.00 on stage prices.

Dick's Decision Maker. Helps you make difficult decisions just by pushing a button. Ingenious little circuit using transistor switching and LED lamps. Supplied with silver label and tough plastic case to fit your pocket. Only from us at $8.75.

Electronics Australia and Electronics Today Kits.
These kits use the same high standard components as our Superkits but are presented without added refinements. We use no reject or inferior parts, manufacturers seconds etc. We are too anxious to preserve our reputation!!

Playmaster 131 Tuner (E.A. Feb 71) still very popular uses TAA840 IC and is supplied with handsome matt black scale card. $23.50.

Signal Generator (E.T. June 71) gives sine and square wave output in range 15Hz to 150kHz. Case included $24.50.

Transistor Tester is very easy to build with our 3" movement. Looks professional with de-luxe satin panel, diecast case etc. $14.50.

Mic Pre-Amp. (E.A. March 72) suits all mics, has adjustable Bass response to improve performance. Another easy one at $3.30.

LED Indicator (E.A. March 72). Ideal for checking audio signals. Used by many groups to check out mixers, amps etc. $3.10.

20W P.A. Amp (E.A. June 72) uses the TA20C module, has mixing inputs and gives 20W RMS supplied with engraved front panel and case. Ideal guitar practice amp $57.00.

Reverb Unit (E.T. 25 Top Projects) as featured in our catalogue. Improves sound of most instruments enhancing natural decay of sound. Complete with Plessey Spring Unit $36.00.

Signal Injector (E.A. June 73). Almost as useful as a screwdriver. Uses 2 transistors and will do AF and RF work. Essential piece of basic test gear. Complete with handsome probe case $6.25.

Stereo 2-4 Adaptor. The easiest way to sample 4-channel is this simple decoder from Nov 72 E.A. Knock one up for only $5.75.

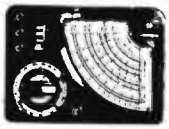
Sperry Digital Clock Kit (E.A. Sept '73) Based on the Sperry Gas readout and National integrated circuit, this kit provides full 24 hour mains operation. All parts are included in the kit except the metalwork (we thought you'd prefer to make your own). Full kit $49.00 Special Sperry/National offer of readout. IC and transistors only $28.75 (Both P&P 50c).

Headphone Adaptor (E.A. Aug '73) provides two sets of headphone outputs or speakers or both to be operated simultaneously. Separate left and right control from this very versatile unit. Full circuit details included etc. $18.95.

TEST EQUIPMENT

A wide range of multimeters from beginner's models right through to the professional FET instrument.

DSE-2 is an ideal first multitester having a sensitivity of 20,000ohm per volt. 17 ranges cover AC and DC volts, amps. Resistance and useful capacitance ranges. Complete with test leads at $12.50 (P&P $1.00).



Jayem 100K is a high sensitivity (100,000ohm / volt) instrument with 51 ranges and accurate to ±3% .5" movement is easy to read and the carrying handle acts as a stand. Diode protection and built-in magnetic shield. Very popular at $39.50 (P&P $1.00).

Jayem L-55 FET VOM has a constant 10Meg input impedance. Has 27 ranges. Battery operated and supplied in handsome vinyl carrying case. 2x probe included to double d.c. voltage ranges and input impedance. $43.50 (P&P 75c).

E-Z Hooks the most tenacious test prod we know. Fast safe and trouble-free. Two types — XL-1 is extra long for birdsnesters, beryllium copper, gold-plated contacts recommended at $1.55. X-100W is a shorter version for general test use 86 cents.

X-100W

Car Burglar Alarm (E.A. Sept 73). Protects everything on your car except the driver. Yes even roof racks. Ideal for beginners, $17.95.

It's not just a price list. In fact you could hardly call it a catalogue. 64 pages jam-packed with information. 20 pages of data alone. Just check some of the contents:

- **P25,26,27 Inside circuits and connections of 43 popular digital ICs.**
- **P26,29,30 Descriptions, circuits, applications of 6 popular Linear ICs.**
- **P50,51,52 Test gear to enable you to build a full scale lab.**
- **P48,49 Tools and more tools. All the things you can't get, we've got on this spread.**

Simply send 30cents to cover Post and Packing and we'll send you the 50cent catalogue, plus 50c vouchers by return. Remember it's a 64 page catalogue with over 20 pages of information, specs etc. Send now to avoid disappointment.

Dick please send me your Free catalogue. I enclose 30 cents towards post and packing.

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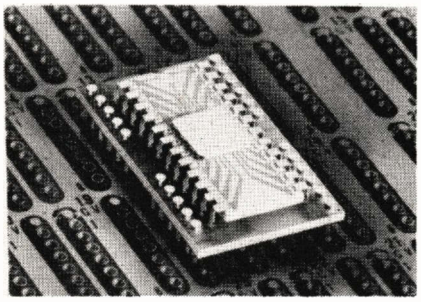
COMPONENT NEWS

LSI ADAPTOR



A new LSI adaptor designed to accept LSI DIP's has been introduced by Augat Inc. Augat is a leading manufacturer of integrated circuit interconnection products.

The LSI adaptor plug provides extreme flexibility by accepting 24, 28, 36 and 40 pin LSI devices, and adapting them to 14 and 16 pin I.C. patterns for any of Augat's P, W and R packaging panels. The LSI DIP's are soldered into the adaptor which plugs into the packaging panel.

The glass epoxy adaptor plug is designed to eliminate error in production. Plugs are keyed at one end for identification of pin 1 and pins are located to prevent improper installation.

Further details from Total Electronics, P.O. Box 103, North Brighton, Victoria.

D-MOS NEWS FROM SIGNETICS

Tecnico Electronics have announced the introduction of nine new D-MOS Devices from Signetics Corporation. These devices are silicon insulated – gate, field-effect transistors of the n-channel enhancement mode type. They are fabricated by a new principle which gives superior high frequency performance up to 2 GHz.

A special diode (connected between the gate and the source) is said to bypass any voltage transients. Thus the gate is protected against damage in all normal handling and operating situations.

Applications for these devices include UHF, VHF, general purpose RF and analog and digital switching.

A free 28 page booklet on the Signetics D-MOS range is available from Tecnico Electronics –

Sydney: P.O. Box 12, Marrickville, N.S.W. 2204.

Melbourne: P.O. Box 180, Northcote, Vic. 3070.

DC GAS DISCHARGE DISPLAY WITH INHERENT MEMORY

A new dc gas discharge (plasma) matrix display panel with inherent memory, the first of this type to be commercially available, has been developed by the Special Components Department of Ferranti Limited. This new display is claimed to be at least three times (and more typically ten times) as bright as any comparable flat pack display system.

The plasma display panel is intended for use as a visual display for both alphanumeric and graphical information. Since the panel is dc operated, and therefore lighted for 100% of the display time the risk of flicker is completely eliminated.

Due to the matrix form of the panel a direct binary input can be used without the need of a digital-to-analog conversion system. This coupled with the high brightness and rugged construction of the panel make it ideal for use in a wide range of applications including computer display systems. The small size of panel only 22mm thick and high brightness available, are suited to use in high illumination environments such as offices and public places.

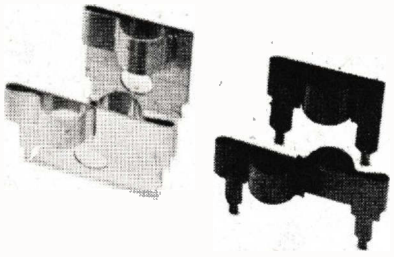
A thick film printing process is used in the manufacture of the matrix panel, making it possible to change the cell spacing. Panels with higher resolution and alternative colours will be available in the near future.

Each panel comprises a series of common anode lines run at right angles to a series of common cathode lines with a neon gas cell at each intersection. A maintaining voltage is applied to the panel and by using appropriate voltage pulses on the anode and cathode lines each cell can be selectively lit or erased.

The panels are available as separate components or complete with a small electronic drive unit. If required, a complete display system can be built up and supplied to a customer's own requirements. This new development enables Ferranti to cover the whole range of displays from a single LED dice to a complex 2080 character CRT display system.

Further details from: Ferranti Limited, Special Components Department, Gem Mill, Chadderton, Oldham, Lancashire. UK.

HEAT DISSIPATORS FOR T092 TRANSISTORS



Following the recent announcement of local manufacture of T092 style transistors, McMurdo (Australia) Pty. Ltd. are now marketing a range of heat dissipators specifically designed for use with these transistor styles.

Three types are available, a universal free-standing series, a printed circuit mount series and a fan-top series.

The first and second are shown in the illustration, and are, as can be seen, available for single or double mounting of devices.

Plain brass or black anodised finish can be ordered according to the user's requirement.

Up to 33% increase in disssipation is claimed to be achievable through the use of these TO92 style heat dissipators.

Further details from: McMurdo (Australia) Pty. Limited, P.O. Box 321, Clayton, Vic. 3168.

SANKEN DISTRIBUTOR

The Sanken Electric Company Limited of Japan, a leading manufacturer of hybrid audio amplifiers and semi-conductors, has appointed Tristate Electronics Pty. Ltd. exclusive Australian agents for their range of products. Stocks of the more popular devices are available from Tristate Electronics or their authorised distributors in all states. Additional information may be obtained by writing direct to Tristate Electronics Pty. Ltd. at their office situated at 2 Sarah Street, Mascot, N.S.W.

HIGH-SPEED MOS DUAL CLOCK DRIVER

Designed for driving highly capacitive loads in an MOS system, the new dual-clock driver circuit MM10026C is available from distributors and warehouse stocks. This high speed clock driver is capable of 20-nanosecond transition time with a 1000-picofarad load, and is able to produce, it is said, an output driving current of ±1.5 amperes with a 20 volt swing. Pulse repetition rates from 5 to 10 megahertz are possible depending on loading.

The MMH0026C may be driven from TTL and DTL gates and the output voltage levels are compatible with all PMOS and some NMOS devices. Power consumption in the MOS "O" or high output voltage state is only 2.0 milliwatts. The high output drive capability permits the clock driver to interface with a wide variety of logic and memory circuits.

Available from stock the MMH0026C is packaged in metal, ceramic and Mini-DIP plastic, all rated for operation from 0 to 85°C.

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

KITSET CATALOG

Kitsets Australia Pty Ltd have just released a well printed and illustrated, 80 page catalog of their complete 1973-1974 range.

It contains details and prices of kitsets, components, Hi-Fi equipment, tools and test equipment available from any of the company's interstate branches.

Price of the catalog is just 65 cents and it may be obtained by calling at any of the branches as detailed in the Kitsets advertisement elsewhere in this magazine, or by writing to:

Kitsets Australia Pty. Ltd., P.O. Box 176, Dee Why, NSW 2099.

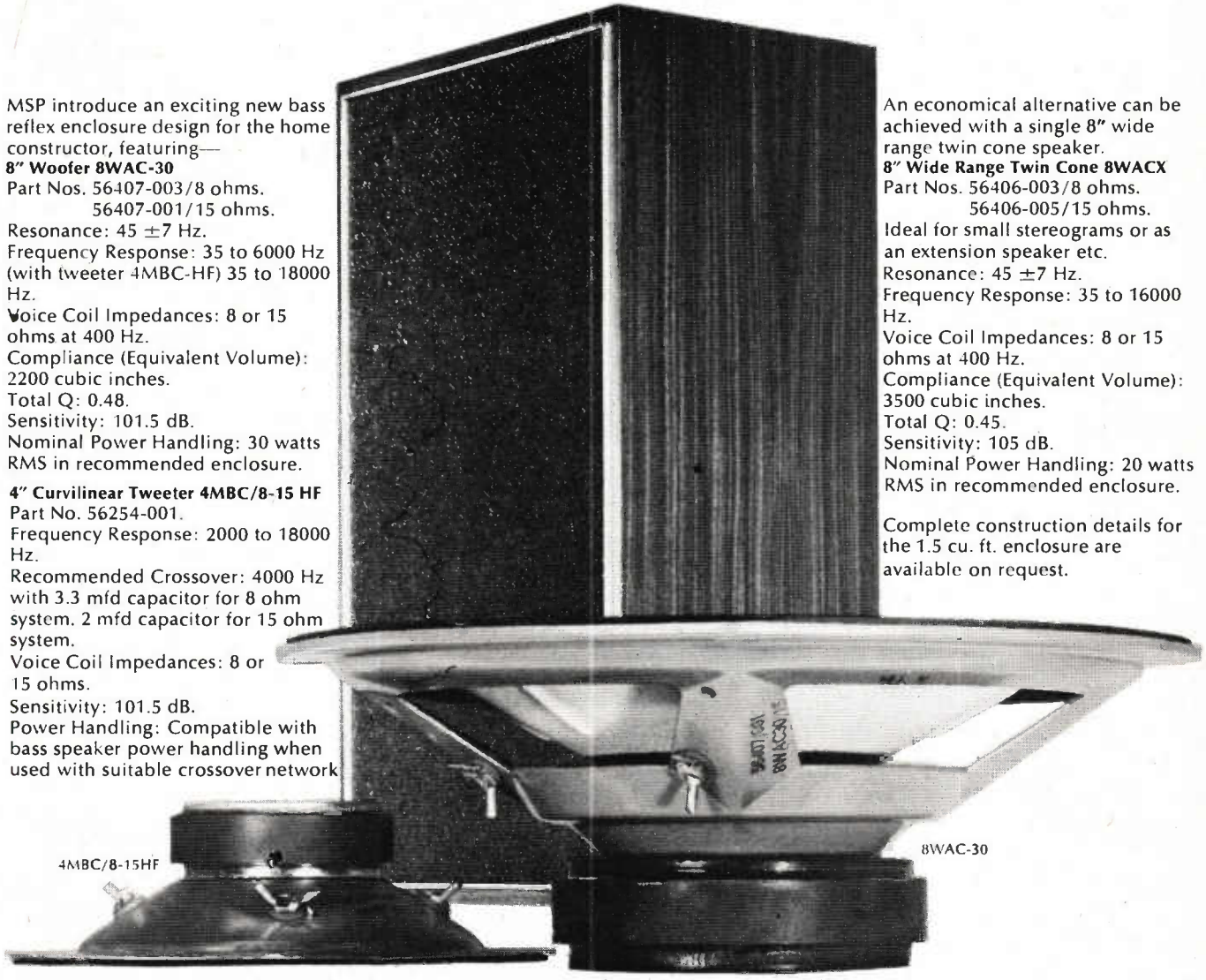
powered High Fidelity

1.5 CUBIC FOOT SPEAKER SYSTEM — 30 WATTS

MSP introduce an exciting new bass reflex enclosure design for the home constructor, featuring—

8" Woofer 8WAC-30
Part Nos. 56407-003/8 ohms.
56407-001/15 ohms.
Resonance: 45 ±7 Hz.
Frequency Response: 35 to 6000 Hz (with tweeter 4MBC-HF) 35 to 18000 Hz.
Voice Coil Impedances: 8 or 15 ohms at 400 Hz.
Compliance (Equivalent Volume): 2200 cubic inches.
Total Q: 0.48.
Sensitivity: 101.5 dB.
Nominal Power Handling: 30 watts RMS in recommended enclosure.

4" Curvilinear Tweeter 4MBC/8-15 HF
Part No. 56254-001.
Frequency Response: 2000 to 18000 Hz.
Recommended Crossover: 4000 Hz with 3.3 mfd capacitor for 8 ohm system. 2 mfd capacitor for 15 ohm system.
Voice Coil Impedances: 8 or 15 ohms.
Sensitivity: 101.5 dB.
Power Handling: Compatible with bass speaker power handling when used with suitable crossover network



An economical alternative can be achieved with a single 8" wide range twin cone speaker.

8" Wide Range Twin Cone 8WACX
Part Nos. 56406-003/8 ohms.
56406-005/15 ohms.
Ideal for small stereograms or as an extension speaker etc.
Resonance: 45 ±7 Hz.
Frequency Response: 35 to 16000 Hz.
Voice Coil Impedances: 8 or 15 ohms at 400 Hz.
Compliance (Equivalent Volume): 3500 cubic inches.
Total Q: 0.45.
Sensitivity: 105 dB.
Nominal Power Handling: 20 watts RMS in recommended enclosure.

Complete construction details for the 1.5 cu. ft. enclosure are available on request.

MANUFACTURERS SPECIAL PRODUCTS
554 Parramatta Road, Ashfield, N.S.W. 2131. Phone 7975757.

N.S.W. George Brown & Co. Pty. Ltd., 5195855. **VIC.** AWA Ltd., 679161. **QLD.** Chandler Pty. Ltd., 310341. **S.A.** Newton McLaren Ltd., 510111. AWA Ltd., 722366. Gerard & Goodman Pty. Ltd., 232222. **W.A.** AWA Ltd., 286400. **TAS.** AWA Ltd., 343836. AWA Ltd., 315466.

A.D. 30

THE NEW CORAL STAGE 7 SPEAKERS OFFER A WIDER RANGE OF SEATING POSITIONS.

Sharing stereo can be a problem. That old familiar hangup of a triangular arrangement for listener and speakers doesn't leave much room for family appreciation, far less showing it off to a crowd.

Unless you're a solitary, you should hear what the Coral Stage Series can do to improve matters.

The Coral Stage Series has something you don't find on other speakers. A metal whirligig which is a wide-focus acoustic lens. It spreads the sound from the mid-range, the tweeter and the super tweeter speakers, so that you hear the same quality of reproduction in all parts of the room.

This means that you can hear the full stereophonic or quadrophonic effect wherever you choose to sit. Consequently entertaining is that much easier.

Instead of designing your room round the speaker system, you can now fit the system into your room. So long as there are no obstacles to absorb the sound, you should hear everything perfectly.

'Everything' from the largest of the Coral Stage Series, the Stage 7, is 25–20,000 Hz. The 12" woofer uses a hollow-formed cone of Coral's special chemical fibre pulp. It is mounted in a beautifully finished polished walnut baffle, flat on both sides to eliminate acoustic bounce. Above it, the mid-range and tweeters stand proud of a toning fabric-covered panel.

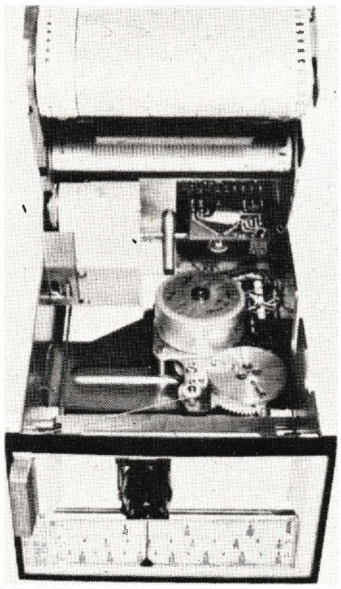
You'd think we meant those speakers to be seen, the care we've taken with the construction. And indeed, we have given you the opportunity to display them. The speaker grille lifts off very simply.

Unlike some speakers we could mention, Coral have nothing to hide.

Sole Australian Distributors: Genac Pty. Ltd., 153 Sturt St., South Melbourne, Vic. 443 Concord Rd., Rhodes, N.S.W. 81–97 Flinders St., Adelaide, S.A. 50–54 Lt. Edward St., Brisbane, Q'ld. 46 Milligan St., Perth, W.A. Cnr. Ingham Rd. & Echlin St., Townsville, Q'ld. Homecrafts, 199 Collins St., Hobart, Tas.

EQUIPMENT NEWS

SIX-CHANNEL POINT RECORDER



A new six-channel multi-point chart recorder has been announced by Philips. The instrument has been designed as an addition to the Process Control System (PCS) range of equipment, but it can also be used equally well as a recorder in its own right.

The recorder incorporates many new features and a great deal of thought has been given to eliminating known weak points. A new inductive displacement pick-up replaces old fashioned slide-wires and sliding contacts; the channel selector switch is based on a printed circuit board which cuts out numerous wires and eliminates contact failure; a ratchet drive wheel system positions the system when it is driven to either extent of its travel. The print function is performed by a disposable printing head fitted with six coloured fibre tips.

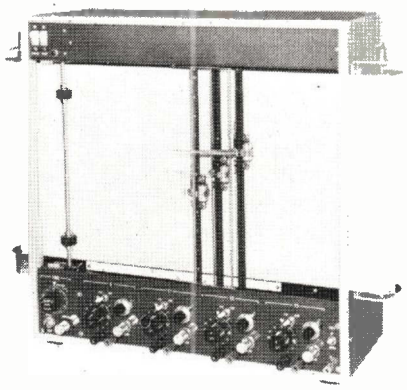
Input signals from all transducers which provide a current voltage or resistance variation are all acceptable and plug-in modules automatically condition the signal and set the span of each channel, therefore each of the six channels can record a different process parameter if desired.

The records are produced on a 100 mm wide chart which is driven by a synchronous motor. A choice of two chart speeds can be selected by means of a lever, and three gear-box ratios are available to give chart speeds of 20 to 120 mm per hour (standard) 10 to 60 mm per hour or 60 to 360 mm per hour. The chart drive mechanism swings away from the main chassis to facilitate easy chart renewal. With a standard chart speed of 20 mm per hour, eight hours of recording can be obtained.

The chassis can be withdrawn from the case and locks into the half withdrawn position to enable past-record inspection, chart replacement, chart-drive speed change, continuous single channel monitoring selection and any electrical or mechanical adjustments to be made. In this half-withdrawn position the recorder remains functional.

The recorders are housed in strong sheet metal cases which are suitable for flush panel mounting. Overall dimensions are 96 x 144 mm (front); 450 mm (depth). All electrical connections are made to terminal blocks mounted on the rear of the case.

3 CHANNEL X–Y, T RECORDER



The Riken Denshi Model D-73B is a three-pen X-Y recorder, having three unrelated Y inputs, and one common X input. In addition by engaging the chart drive transmission, paper may be drawn from the supply reel, to pass under the pens, resulting in a recording of the three Y signals against time. This chart drive type of time base makes it possible to record for long periods, and ensures a high degree of accuracy for the time axis.

Smooth accurate recordings are said to be assured, in the D-73B, through the use of a noise rejection circuit, which protects against common mode, and normal mode noise.

A solid state chopper circuit accepts the dc difference voltage, between the input signal, and the pen position signal, converting it into a precise square wave.

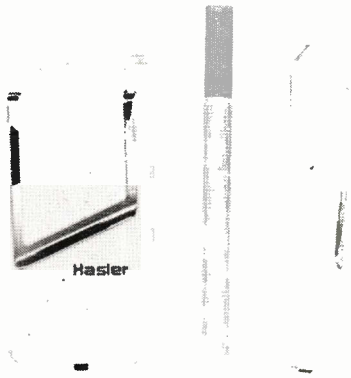
Each of the recorder input channels, X, Y, Y_2 and Y_3 offers an 11 – step attenuator, which assures the user a known calibrated sensitivity. In addition, a continuous vernier adjustment may be switched in, to adjust the recorder sensitivity to any intermediate value, permitting calibration in direct engineering units.

A 10 speed gear transmission makes instantly available speeds from 75 mm/hr to as high as 480 mm/hr.

The Model D-73B may be operated in either a horizontal, or a vertical position and rack mount kit is available for mounting in any standard 19 inch rack.

Further details from: John Morris Pty. Ltd., 63 Victoria Ave., Chatswood N.S.W. 2067.

INTERFERENCE FREE RADIO PAGING



Radio paging has gained wide acceptance as an important aid to internal plant, office or warehouse communications.

Plessey Communications Systems has been active in this field since radio paging equipment became available and is now concentrating on the Hasler inductive loop system which has a number of distinctive operating advantages.

Hasler inductive loop systems can be installed in city buildings without interference to similar systems in closely adjacent buildings. Even systems on separate floors of the same building can operate efficiently with absolutely no interference between the adjoining systems.

Unlike free radiating VHF equipment, the inductive loop system controls the paging signal within a required area.

The system is flexible and reliable. A miniature receiver smaller and flatter than a cigarette packet, emits a discreet yet distinctive "beep" signal. Only the person required is alerted and other staff are undisturbed. The system can be built up from one to hundreds of receivers to meet any requirement.

Further details from:Plessey Communications Systems, 87 Racecourse Rd, Nth Melbourne, Vic.

VERSATILE FUNCTION GENERATOR

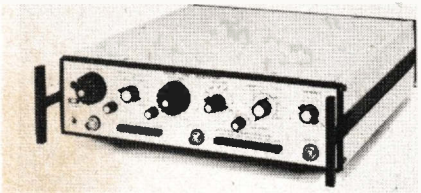
An addition to the Exact instrument range, the Model 7260 Function Generator, has been introduced by Exact Electronics Inc., of Hillsboro, Oregon, U.S.A.

This versatile function generator is said to offer new capabilities in pulse, sweep and transmission line testing applications. With its bandwidth of 0.0001Hz to 20 MHz and extremely flat frequency response, it is claimed to be capable of producing high quality waveforms right through its frequency spectrum. The instrument is two complete waveform generators in one, a main generator and a 100 ns to 1000 second ramp/pulse generator. It can produce sine, square, triangle, ramp, pulse and sync

waveforms. Model 7260 produces pulses with widths variable from 25 ns to 1000 s- and repetition rates from 0.0001 Hz to 20 MHz, and it is thus applicable to a wide range of pulse generator require:nents.

Other features are: the ability to control "start" and "stop" frequencies for sweep operation, within a 1000: 1 range with instant frequency reading without external counter; produces sine^2 pulses for broadcast transmission and TV line testing; push-button control of operating modes of both generators; main generator operates in run, gate, burst or sweep modes; can be triggered or gated for single shot and burst operation applications, either internally or externally.

The Model 7260 also offers several choices of dc offset. The operator can select variable



±10 V of dc offset to position the waveform above or below ground. Without the use of an offset, the waveforms are symmetrical about ground with the exception of ramp. When either positive or negative fixed offset is chosen, the Model 7260 automatically halves the amplitude of the waveform. In positive fixed offset, the most negative excursion of the waveform is at ground; in negative fixed offset the most positive excursion is at ground. Offset also can be externally programmed with an analog voltage (VCO, voltage controlled offset input).

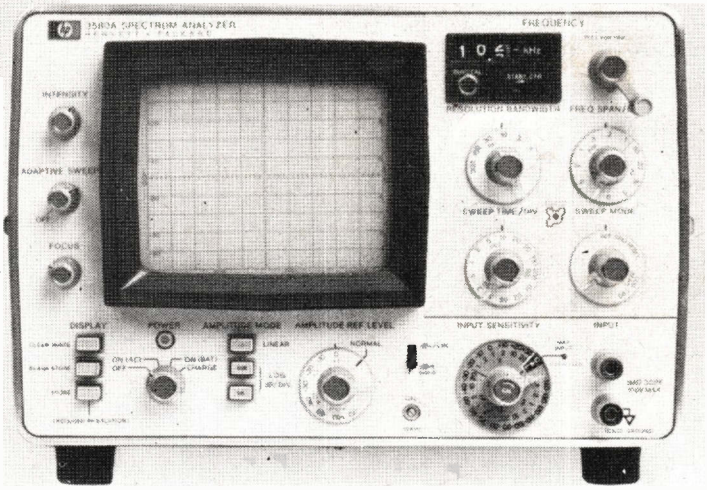
Output voltage is 20 V p-p open circuit or 10 V p-p into 50 ohms. The instrument has a V : F (voltage proportional to frequency) output and 80 dB of attenuation in 10 dB steps, with 20 dB continuously variable. The output can also be floated by removing a ground strap.

A sync input is provided for locking to an external frequency or clock. The instrument has a search mode for manually sweeping the main generator over three decades.

Further details from: Jacoby Mitchell Limited, 215 North Rocks Road, North Rocks, N.S.W. 2151.

5 Hz TO 50 kHz SPECTRUM ANALYSER

A new Hewlett-Packard spectrum analyser, Model 3580A, displays very slow sweeps clearly and steadily using digital storage techniques. A standard, non-storage CRT is used . . . its trace is refreshed at high speed from a digital memory. No display adjustments need be made when sweep speed is changed. The trace is automatically updated at the correct rate, and the intensity and focus controls, once set, need no readjusting. The discrete dots,



characteristic of digital storage displays, are connected with line-generator circuitry so as to form continuous lines. Thus, the display is a sharp, continuous line that looks like an analog display.

If a trace is needed for future reference, a STORE pushbutton on the front panel is pressed and the trace is stored in digital memory. It can be recalled and superimposed on a subsequent trace for comparison.

Sweep times of the Model 3580A can be set from 0.1 to 2000 seconds. To speed analysis of a spectrum, signals below a variable baseline, set by the user, can be automatically swept at high speed. In those parts of the spectrum below the baseline, the instrument sweeps up to 20 times faster. But, when a signal appears above the threshold, the sweep slows to reproduce the full response. Called "adaptive" sweep, this technique speeds analysis. For example, looking at two signals in a 10 kHz sweep, adaptive sweep reduces analysis time from 200 seconds to only 14 seconds.

Some uses for the Model 3580A include analysis of mechanical vibrations, evaluation of mains-related electrical interference and characterisation of audio filters. Other uses could be analysis of voice and data communication channels and evaluating underwater acoustics signals.

To resolve closely spaced signals at low frequencies, the Model 3580A has a minimum bandwidth of 1 Hz. Five additional bandwidths to 300 Hz are selected from the front panel.

Amplitude range in the linear mode is 100 nanovolts to 20 volts full scale; in the logarithmic mode, from −155 dB to +30 dB. Dynamic range is 80 dB. Input sensitivity is 30 nanovolts maximum.

The Model 3580A can be operated either on internal rechargeable batteries (option 001) or mains power. A standard internal 10 kHz pulse provides harmonics every 10 kHz for easy calibration. Option 002 offers balanced and floating input, terminated in 600 or 900 ohms.

Weighing only 35 lbs (15.9 kg) with batteries, the Model 3580A measures 7.83" x 12.8" x 16.9" (199 mm x 325 mm x 430 mm).

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

10 AND 18 COLUMN DIGITAL PRINTERS

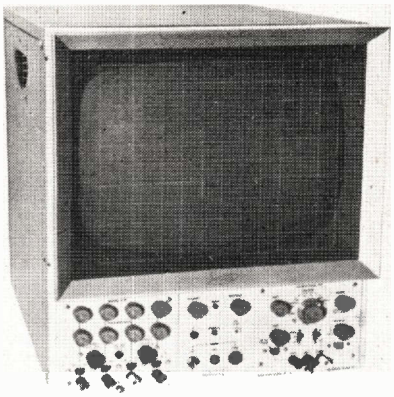
A digital printer designed to log the output of digital voltmeters, counters and other digital devices has been announced by John Fluke Mfg. Co., Inc., Seattle, Washington.

Designated the Model 2010A Digital Printer, the new unit operates at a rate of at least 2.5 lines per second and records in either black or red on fan-fold paper. The ten column unit prints 8 columns of data and 2 columns of functions; the 18 column unit, 16 of data and 2 functions. Data storage is provided which allows the inputs to be removed four microseconds after the print command signal so that a new reading can be made.

Function symbol generation and control of decimal point position circuits enable the printer to easily interface with all Fluke digital instruments and most comparable instruments by other manufacturers.

Standard cables are available to all Fluke digital instruments. Power is 115 V or 230 V, 48 to 440 Hz, 25 VA. The unit is 175 mm high x 202 mm deep x 375 mm wide. Weight is 6.8 kg (15 lbs). Accessories include an input mating connector, power cord, pack of fan-fold paper and roll paper adapter.

Further details from: Elmeasco Instruments Pty., Ltd., P.O. Box 334, Brookvale, N.S.W. 2100.



17" DISPLAY SCOPE

Remote monitoring, large or complex patterns, multiple audience viewing etc. demand a large panoramic screen for satisfactory performance. To accommodate this demand, BWD Electronics Pty. Ltd, have produced a 17" (430 mm) display oscilloscope with six interchangeable plug-in amplifier & time base modules.

The Model 1722, an advanced large screen unit, uses transistors for the plug-in amplifiers X & Y deflection systems. It operates within conservative ratings, a factor which contributes to reliability and operational stability.

Modular design enables this instrument to be provided with front, rear, or remote controls; for either bench or 19" rack mounting. The unit is already being used to display cardiac wave forms in open heart surgery; classroom demonstrations in universities and colleges; and readout from analog computers.

In one of its more unique versions, the controls are top rear mounted and incorporate a rear-facing 3" (76 mm) direct coupled monitor – the ultimate for demonstration and educational situations. The 1722 Series, as with all BWD equipment, is entirely designed and manufactured in Australia.

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

THE 214 DUAL-TRACE STORAGE OSCILLOSCOPE

Tektronix has just added storage to its popular 200-Series line of miniscopes. The new 214 measures 76 x 135 x 241mm and weighs just 6 kg. This hand-held oscilloscope lets you make dual-trace storage measurements anywhere, anytime, with minimum effort.

Costly equipment breakdown in the field demands prompt action. You need to get there with the right tools, find the problem, and solve it. In these emergencies, portable storage oscilloscopes are proving themselves a most valuable tool.

Many applications involve low or random rate signals that are difficult to view. These are easily captured and displayed using the 214 in the storage and single-sweep mode. The 214 writes up to 500 divisons per millisecond in the storage mode, and you

(Continued on page 123)

BETTER THAN BOSE!

That's right. Even though Bose are the most highly reviewed speakers in the industry; even though critics proclaim "Bose is best, big or small, high or low"—now there are two speaker systems better than Bose 901 and Bose 501!

BOSE 901 SERIES TWO

Introducing the Bose 901 Series Two—it's everything that the original 901 was, and more: • Multiplicity of acoustically-coupled full-range drivers • Flat power radiation • Completely new Active Equalizer design, suited to program source variations never available before, and adapted to a much wider range of room environments (even drapes) • and SYNCOM™ II Speaker Computer quality control testing.

BOSE 501 SERIES TWO

Also introducing the new Bose 501 Series Two — the other speaker with direct and reflected sound, and flat power radiation, at a price far lower than you'd expect to pay.

The new 501 Series Two features: • A new tweeter with double the magnet size of the original 501 and four additional components in the crossover network, for improved high frequency response and power handling capability • and 100% selection and matching of the woofers and tweeters with the SYNCOM™ II Computer—the unique computer designed by Bose and put into operation in August 1973 to achieve a new level of speaker performance.

We invite you to challenge us! Compare the Bose 901 Series Two to any other speaker, regardless of size or price; and compare the Bose 501 Series Two to any speaker up to the price of the 901 Series Two. You be the judge. If we have done our homework correctly, the comparison will be interesting and short!

AUSTRALIAN DISTRIBUTORS
WEDDERSPOON
W. C. WEDDERSPOON PTY LTD
193 Clarence Street Sydney 29 6681

BOSE®

Among the finer things of life ...

The world of Micro is a talented team of engineers, skilled sound technicians and expert designers, specialising in the production of turntables that challenge the ultimate in faithful reproduction of original sound.

The Micro 611 turntable is a professional quality, belt-drive turntable with 8 pole hysteresis synchronous motor assuring smooth, constant and stable rotation, with minimised wow-flutter and high signal-to-noise ratio.

The 611 incorporates the MA 101 Mk II static balance type tonearm, with adjustable, perfect antiskating device, direct reading stylus pressure gauge and oil damped arm lifter.

The Micro Range includes: MR 611, MR 111, MR 211, MR 311 turntable/base/cover. MB 300, MB 600, MB 800S turntables only.

Micro cartridges: M 2100/6, M 2100/E, VF 3100/7, VF 3100/E, broadcast-station-standard VF 3200/E and MC 4 100/E moving coil. Also MA 101 Mk II 4-channel arm, and Micro electrostatic headphones.

MICRO

MR 611

SOLE AUSTRALIAN DISTRIBUTOR

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INTERNATIONAL DYNAMICS
(Agencies) Pty. Ltd.
P.O. Box 205 Cheltenham, Vic. 3192

Hear Micro at:
• N.S.W. M & G HOSKINS PTY. LTD., 37 Castle St., Blakehurst 2221 – Telephone 546-1464. • Q'LD: STEREO SUPPLIES, 95 Turbot St., Brisbane 4000 – Telephone 21-3623. • S.A. CHALLENGE HI-FI STEREO, 6 Gays Arcade, Adelaide 5000 – Telephone 23-2203. • TAS. AUDIO SERVICES, 44 Wilson St, Burnie 7320 – Telephone 31-2300. • VIC. ENCEL ELECTRONICS PTY. LTD., 431 Bridge Rd., Richmond 3121 – Telephone 43-3762. • W.A. ALBERT TV & Hi-FI, 282 Hay St., Perth 6000 – Telephone 21-5004.

EQUIPMENT NEWS

(Continued from page 120)

:an view the stored event for up to an hour. The double-insulated plastic case of the 214 lets you make safer, elevated measurements. And, the rugged case insures hat the scope will take the rough treatment :xpected of portable instruments.

Many operator conveniences are built into his miniature oscilloscope. The dual 1 MΩ signal probes are colour-matched vith the vertical deflection controls to prevent measurement error. Deflection controls are designed to clearly show horizontal and vertical deflection factors. Trigger level and slope selection are implified to one rotary control. An auto rigger mode automatically triggers the cope on the signal it receives or provides a right reference trace with no signal applied.

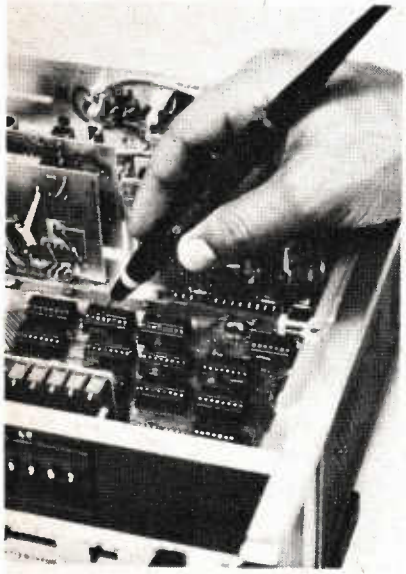
Turning the trigger control from the AUTO position permits selection of any combination of trigger slope and trigger level.

Bandwidth of the 214 is 500 kHz with vertical deflection factors from 1 mV/div to 50 V/div. Calibrated sweep speeds range from 5 μs/div to 500 ms/div.

Rechargeable internal batteries provide up to 5 hours of nonstorage operation and up to 3-1/2 hours in the storage mode. The batteries are protected from deep discharge, by special circuits which automatically turn off the scope when the batteries drop to a predetermined voltage level.

Further details from: Tektronix Australia Pty. Limited, 80 Waterloo Road, North Ryde, 2113.

HIGH-LEVEL LOGIC PROBE



The newest logic probe form Hewlett–Packard is said to do for high-level logic circuits everything the earlier versions did for lower levels. For circuits in the 2-to-25 volt range the pen-size probe indicates logic states (high, low and bad) and pulses. It brings new speed and convenience, it is claimed, to troubleshooting HTL, HiNIL, MOS, relay and discrete-component circuitry.

The new probe (HP Model 10525H) detects digital information and displays it by means of a band of light near the probe tip. When the light is on, bright and steady, the probe is touching a point in logic high state, i.e. over 9.5 V. Light off means a low state, below 2.5 V. Inputs between the logic thresholds, or open circuits, make the light burn at half brightness. A single pulse, even as short as 100 ns, produces a .05-second response: low-going pulses make it blink momentarily on. Pulse trains up to rates higher than 5 MHz cause the light to blink at 10 Hz.

All these functions are performed with negligible circuit loading – the probe's input resistance is above 20 k ohms both for logic highs and lows.

Power for the probe may be anywhere from 12 to 25 volts dc; the power input is protected against damage for voltages from +40 to -400. The probe tip can even be plugged momentarily into a power main without damage; it is protected against inadvertent probing up to ± 70 V continuous, or ± 200 V intermittent.

The device is completely repairable and carries a full one-year warranty.

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

RECORDINGS classical

REVIEWER: John Araneta

BIZET CARMEN – Soloists, Chorus & Orchestra of the Metropolitan. Leonard Bernstein (conductor) 3– DGG 2740 101.

Carmen is not as most performances on stage or records would have it, a tired and now dated opera. None of the recorded performances available give us a perfect picture of what this opera can be about. Certain recordings give us marvellous orchestral playing, Beecham for HMV and Karajan on RCA. The approach of each conductor in these particular instances emphasizes rather different aspects of the score. Both certainly give us the richness of the orchestral score but Beecham insistent on the grace and subtleties of the music does often neglect the quality of strong, dramatic realism which probably made this music so startling in the early years of its history; Karajan on the other hand presents a more powerful interpretation but there is perhaps too much of the grand opera in his style which not only neglects the more intimate qualities of the music but like the Beecham, stark realism is also neglected.

Other recordings have as their chief virtue, a strong presentation of the central role of the opera. Callas for the HMV set conducted by Pretre, presents to my mind the most exciting dramatic performance of Carmen on records. She is the only interpreter on records who does not elect a grand opera interpretation of the role however powerful that may be, (ie. Leontyne Price on RCA); or, an almost self-consciously subtle portrayal of Carmen (ie. de los Angeles on HMV). Carmen is a gypsy and that is exactly what Callas comes up with. Her voice is often coarse and this fact does turn a number of listeners away from an appreciation of her dramatic success in the role. In short, Carmen, on records and on stage, is often a difficult problem of casting, we always tend to get voice and the wrong dramatic interpretation or accurate theatrical presentation and a corresponding less than adequate vocal performance.

The opera presents further problems as well and these problems are reflected in the variable casting we get on records of the other roles of the work. Bizet may have departed a great deal from the French grand opera tradition but casting in his opera presents as serious a problem here as in those now largely neglected operas. In every single recording we meet with serious instances of miscasting: none of the Don Joses are completely satisfying from either a vocal or dramatic point of view; Micaela is yet another problem; still another is the quality to be expected from Escamillo; ensemble in this very ensemble opera is also largely neglected owing largely to the fact that the very minor roles of the opera are often given to less than enthusiastic singers who may also not be actors. All these problems may in the abstract reflect standard difficulties one may encounter in any opera but the point is that in the case of *Carmen*, certainly one of the most recorded and performed operas in the repertory, success has always been a highly qualified matter.

There are other problems to be sure, the French language, and which version of the opera to use. My own view is that while idiomatic French is highly important, French productions and French singers often tend to emphasize the qualities we tend to associate with the word "Gallic" and Carmen is not a typical Gallic product. It is neither French in the aristocratic or bourgeois sense and the work has more kinship to the stark realistic literary works of French nineteenth century art and literature. We tend to forget this and it is not surprising *Carmen* has become the stalest of operas in the repertory.

What in fact is *Carmen* supposed to represent in opera history? And related to this matter is the all-important question of which version of the opera to use in performance. To my mind, the original opera-comique version with spoken dialogue is to be preferred because the dialogue highlights the realism in the music (if delivered in the proper fashion) and also since Guiraud's recitatives sound so time-wasting in that they are not only often mediocre but they also interrupt the flow of the drama. It is unfortunate that the only version to approximate the original version to date, the Fruhbeck directed recording again for HMV, not only presents serious miscasting but it is also the least exciting performance on records.

Every new recording of *Carmen* presents us with different aspects potential in the score. I admit to being quite prepared for at least another qualified success if at all and from another different point of view. Well, this version is certainly different from anything to date and while it is not the perfect *Carmen*, I am still amazed how in this performance the opera can excite and hold interest from beginning to end. Let us dispense with the more obviously important shortcoming in this performance. The French here is not idiomatic but at least the delivery here is not ultra-refined and I am quite willing to accept undernourished French when so many of the other aspects of the work are delivered in such a stirring manner. Bernstein does not use the complete original version, but here at least the dialogue is always delivered dramatically and with the relationship of the dialogue to the set pieces very much in mind.

The success of this recording is mainly due to the conducting of Leonard Bernstein. From beginning to end, Bernstein extracts excitement from every passage of the score, even those usually dreary transitional sections of the work. In no other performance do I get the feeling the score has been rediscovered anew: the troublesome French brass and wind writing that often sounds flat or vulgar comes off with the proper balance. Bernstein adopts a very realistic interpretation of the work which never seems to stop: the incredible continuity and drive he achieves in the final sections of the opera must be heard to be believed and the power he gets from the music may not be Gallic, but almost for the first time I can understand what made *Carmen* so unsettling and gripping the first time. His tempos can often be slower than usual but nothing really detracts from the compelling whole we get of the work.

Marilyn Horne's Carmen is opulently sung and there is a tremendous dramatic vigour to her interpretation. Her Carmen may not be the perfect gypsy of Callas but is nevertheless highly successful. James McCracken's Don Jose is not ideal, some of the upper register of his voice cannot cope with the music and he resorts to falsetto but otherwise his singing is often splendid and his Don Jose is flesh and blood without the vulgarity of Corelli or the pitch problems of Vickers. Escamillo (Tom Krause) is not as immediately compelling dramatically but I have the feeling there is much more to his interpretations of the role than at once meets the eye. At any rate his singing is on a very high level. Micaela (Adriana Maliponte) is perhaps the least successful characterization here but this may not be the singer's fault. It is a slight yet very difficult role to gauge and in any case the singing is more than competent. All the minor roles are delivered with verve and enthusiasm. I cannot as a matter of fact compare the achievement here with any other.

The ensemble work is nothing less than excellent and it is never tiresome. The orchestra plays magnificently and Bernstein certainly gets those choruses moving. The boys sound like urchins as they should be. The producers have seen fit to add some bullring cries at the end of the work which are delivered with right timing and also dramatically place the final scene. I have heard that the original recording sessions began with some confusion as to the dates of sessions and the consequent confusion which arises from such things. If so it is all to the good for DGG has come up with a realistic and vivid sound I do not usually associate with them. Not perhaps then the ideal *Carmen* possible but certainly the version to live with for a long time. – J.A.

WAGNER – PARSIFAL. Soloists, Vienna St. Op. Chorus, Vienna Boys Choir, Vienna Philharmonic Orch., Georg Solti (Cond.). DECCA SET-550/4.

So much of *Parsifal* is variable, one finds a deeply moving and interesting passage only to have this interrupted by stretches of thin vocal and orchestral writing. Perhaps also in no other opera of Wagner is the use of leitmotifs so indicative of a poverty of invention. The banalities in the score are often incredible, as for instance, the marchlike writing for chorus of grail knights which easily destroys something as

remarkable as the Transformation Scene. I must confess too that the fake religiosity of the work can make me quite ill. The very spiritual approach of most conductors to this score hardly helps matters since this is not a religious work at all. Rite you may call it but not religion.

An antiseptic approach will not do either, and I do think the Boulez recording is a bit clear-cut to suit this music. For once, conductor Solti here has elected to treat this score as passionately as though it were Tristan, which makes one all the more wish that Solti's own recording of *Tristan* had been like this. There is little of the vulgarity that often marred Solti's rendition of the Ring cycle here. Instead I am in fact quite surprised by the care with which Solti phrases the music, taking his time as much as Knappertsbusch ever did but never neglecting the undeniable glow of the sound and the very passionate drama of the music. There is little doubt that Solti is very much becoming the true romantic interpreter one only usually sensed in his past interpretations. The orchestra responds magnificently to his direction and what a sound they make. Everyone talks of the splendour and "inner-lighted" quality of this score but no recording has made us hear it until now. Perhaps this is because this is the first studio recording of *Parsifal* to be made and a greater care for orchestral balance has been possible. Not that this performance sounds like a studio product. *Parsifal* is hardly my favourite opera but for once I felt it possible to listen to all of the work without reflecting that perhaps seeing it makes some difference.

Solti's cast is the strongest on record, in my opinion, and one will not find elsewhere such consistently fine singing from everyone involved. Perhaps the finest performance *and* characterization here is Christa Ludwig's Kundry. The portrayal is humane, never vulgar, and intense. The singing is quite simply superb. The other most striking interpretation is Fischer-Dieskau's Amfortas. For once, the suffering of Wagner's maimed king is not spelled out but it is very much in evidence. It is an extremely subtle and compassionate portrayal. In the rather thankless task of Gurnemanz, Gottlob Frick does a great deal by intelligent delivery of the text and acting to minimise much of the dullness in Wagner's writing for this role. A look at the cast with such luxuries as Lucia Popp and Kiri Te Kanawa among the Flower Maidens gives one an indication of the splendours of this set. Rene Kollo's voice in Parsifal is not always to my taste, it is at times rather hard in timbre but he does make for a convincing and youthful sounding Parsifal.

Recording is magnificent but the pressings as usual leave something to be desired. It really is a pity that as recording techniques seem to get better, quality control over pressing seems to get worse. However, this is very much in my opinion the finest Parsifal available on records and the only recorded performance which makes sense of the structure of the work. Everything moves plausibly towards the great climax in Act II which is the crux of the plot, and everything else after is not just, for once, an unending epilogue that does not quite resolve matters.

– J.A.

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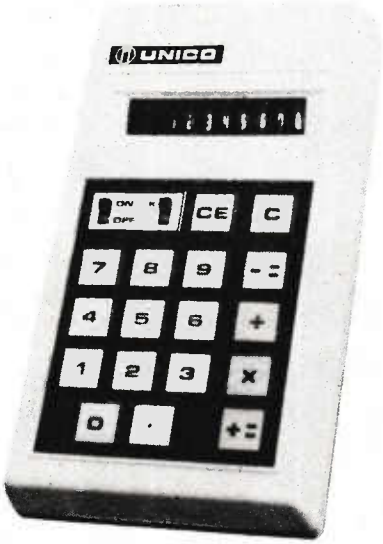

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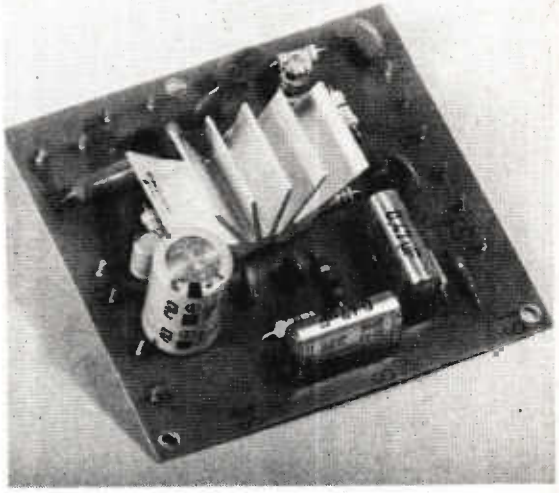

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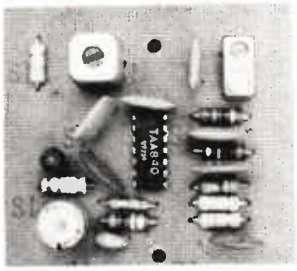

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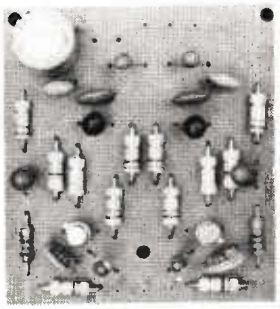

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RECORDINGS POP

REVIEWER: Mike Delaney

Groupie-ing about with Marc Bolan

— Michael Delaney

"Great Hits" – T. Rex. E.M.I./T. Rex Wax Co. Stereo.BLN.5003.; "Bolan Boogie" – T. Rex. Phonogram/Cube. Stereo.2326.012.

A tour rave and sort-of-review: Groupie-ing about with Marc Bolan.

Right from the start, Bolan under-estimated his audience – force fed them plasticon when they needed their meat prime cut, pressure cooked and fat free; wielded the phallus predictably, unremarkably for two solid hours of non-stop ego overkill – ADORE ME – 'my lips are like lightnin'/girls melt in the heat'. He preened, posed, pouted and ponced about relentlessly; skulked, bumped, ground it around inevitably, killing any chance the band may have had to get down.

Briefly, the first T. Rex Sydney gig was dire: a complete sell out with cock power up the front; utter disbelief, *boredom* from the fifth row back. Bolan was very nearly unforgiveable – arrogant, detached, painfully conceited, demanding instant and sustained *frenzy* through his presence alone; hardly concerned (it seemed) with his music in the least.

"Twentieth Century Boy", "Telegram Sam", "Hot Love", "Jeepster", "Chariot Choogle" – cranked up, wanked off dry, dangled interminably and then deteriorated, hanging on and on like a bad smell. "Get It On", the supposed climax, with Bolan ravaging/raping/rorting a substitute guitar cheapo, came off as exciting as a dud orgasm – twice as messy.

Essentially, the T. Rex opening gig was depressing, myth-shattering.

Adelaide, Melbourne and Brisbane reacted infinitely better, as did Bolan. A really bad thing to start a tour in the biggest potential market, Sydney, particularly since the second show (Sunday night) was mostly amazing. A-M-A-Z-I-N-G! But to an audience of less than 3,000 stunned mullets who could bearly raise enough steam to get themselves home.

Of all the gigs, the second Sydney show was by far the best – musically. T. Rex simply *rocked*. Bolan got *down* – no pouncing, no persona pyro-technics, minimal arrogance. What we got was *the* electric warrior, the full punch drunk English street punk – mean, vengeful, out for blood: "So what *do* you want then . . . to sit on my face! Well, baby, you can *slide* on it."

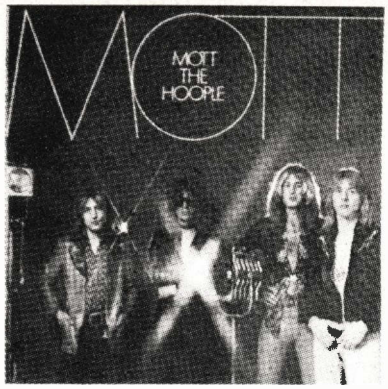
Straight into "Twentieth Century Boy" – instant berserkus. And he *meant* it, a total sonic energy assault; gut muscle rippling, flexing, pulping. "Chariot Choogle" and "Buick Mackane", both cuts from "The Slider", hard on quick as a flash – stalking, soaring from extension through riff to solo, retreating right back only to build over again through "Jeepster", "Telegram Sam" and "Get It On" – harder, dirtier, gouging out chords, hurling them whip lash against the amps till *everything* S-C-R-E-A-M-E-D.

Bolan, guitar-picker, supported these swift, sweeping solo wirings through every song – sounding out images, tones, textures; riding rough shot on the clockwork band mechanicals, spoon feeding riff/rhythms back to the group individually, shifting gears, accelerating up and over the bed rock effortlessly.

Sydney heard one of the world's premier rock 'n' roll bands on Sunday, mainly because the boopers stayed away. (Thereby removing the scream machine which Bolan ego trips for, from and by).

"Great Hits" represents T. Rex phase two, relatively close in style to the band Australia hated to love/loved to hate: "Solid Gold Easy Action", "Twentieth Century Boy", "Telegram Sam", "The Groover", "Children Of The Revolution", "Metal Guru" plus a host of single 'B' sides just as effective as the Bolan hits – "Thunderwing", "Lady", "Sunken Rags", "Jitterbug Love" and "Born To Boogie". Two album cuts are also included – "The Slider" title track and "Shock Rock" from "Tanx", the most recent T. Rex outing. An excellent package – heavy electric rock 'n' roll.

"Bolan Boogie", issued over 18 months ago, ties in the first four episode of T. Rextasy – "Ride A White Swan", "Hot Love", "Get It On", "Jeepster"; several T. Rex 'B. sides of similar vintage – "Woodland Rock", "Summertime Blues", "Raw Ramp", "The King Of The Mountain Cometh"; three Tyrannosaurus Rex cuts, two from "A Beard Of Stars" ("Fist Heart Mighty Dawn Dart", "By The Light Of The Magical Moon") and "She Was Born To Be My Unicorn" from "Unicorn". "Beltane Walk", "Jewel" and "Dove", all from the "T. Rex" album (recently re-issued as a Phonogram $2.95 budget) are also featured. A fine insight to the percussive acoustic based boogie band that brought hysteria, presentation and quality back to the singles market.



"Mott" – Mott The Hoople. C.B.S. SBP. 234395.

In effect, Mott The Hoople's essential character has always been slight, largely and obviously eclectic, hardly individual. Prior to their chart success with the Bowie-induced "All The Young Dudes" hit single/album, they worked through four unimpressive Island/Festival releases, each an erratic, directionless blend of predatory hard-rock, muscular 12-bar boogie a la early Free, and nondescript Dylan-esque ballads – none of which worked consistently.

With "Mott", their second Columbia set, Hoople shape up still very much in the wake of Bowie's earlier ambi-sexual sado-machismo punk persona ("Violence", "Hymn For The Dudes", "I Wish I Was Your Mother"), liberally spiced with post Chuck Berry 12-bar Americanisms ("All The Way From Memphis", "Drivin' Sister", "I'm A Cadillac", "Hona-loochie Boogie") and a markedly noticeable Roxy Music vocal/brass affectation sustained throughout.

More dynamic, affirmative in mood, varied in tempo and arrangement, animated in delivery, "Mott" is their most polished set to date. Ian Hunter, Hoople's main man, at last seems to be coming to terms with his role in the Lou Reed Millenium – blitzkreig rock 'n' roll aimed at the veins of teenage wasteland. If the shoe fits . . .

Other highly recommended hit compilations.

"Sladest" – Slade. Phonogram/Polydor.

Includes "Coz I Luv You", "Take Me Bak 'Ome", "Mama Weer All Crazee Now", "Cum On Feel The Noize", "Skweeze Me Pleeze Me", "Get Down & Get With It", "Look Wot You Dun".

"Janis Joplin's Greatest Hits" – Janis Joplin. C.B.S. Stereo. SBP.234339.

Includes "Piece Of My Heart", "Me & Bobby McGee", "Move Over", "Summertime", "Try (Just A Little Bit Harder)".

"The Best Of Peter & Gordon" – Peter & Gordon. E.M.I./Columbia. (BUDGET) Stereo. SOEX 10004. – $2.99

Includes "A World Without Love", "Nobody I Know", "Woman", "Lady Godiva", "The Knight In Rusty Armour", "I Don't Want To See You Again".

"More Creedence Gold" – Creedence Clearwater Revival. Stereo. L.34910.

Includes "Hey Tonight", "Sweet Hitch-Hiker", "Lookin' Out My Back Door", "Who'll Stop The Rain", "Up Around The Bend", "Lodi", "Good Golly Miss Molly", "I Put A Spell On You".

Six-digit calculator for the consumer market sells at $29.95!

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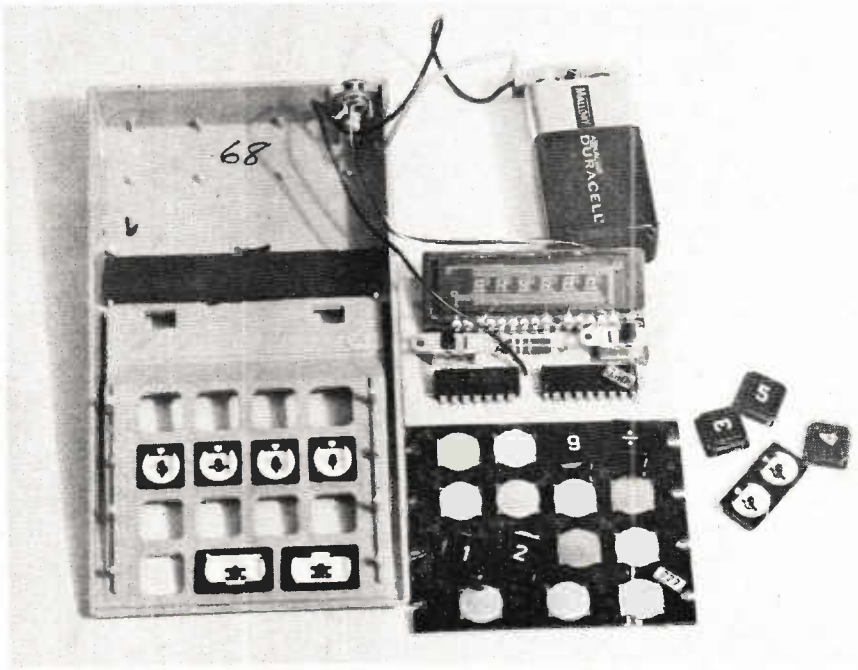
It can't help but be an instant success and we understand that National Semiconductor plans in the future to bring out calculators with greater capability, even perhaps up to scientific notation and transcendental functions. It will be interesting to see if similar price reductions can be made in these top of the line units.



This picture of the dissassembled calculator shows the incredible simplicity of the design. There are only nine electronic components (including the batteries) in the entire machine.

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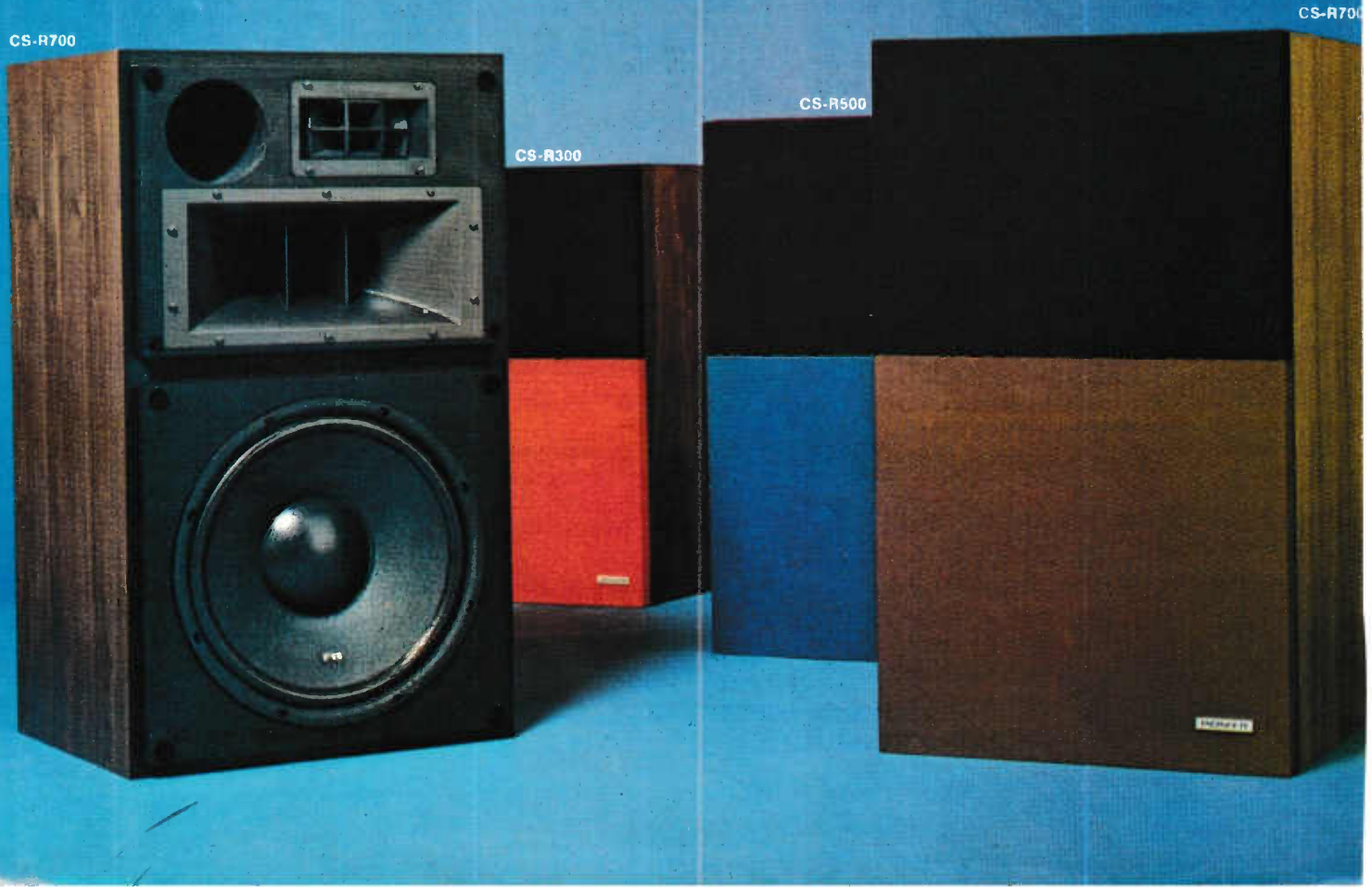
	Speakers	Maximum Input Power	Crossovers	Dimensions
CS-R700	12" woofer, midrange horn, multicell horn super tweeter	75 watts	750 Hz, 14,000 Hz	15" × 26" × 13⅜"
CS-R500	10" woofer, 5" midrange, horn tweeter	60 watts	800 Hz, 5,200 Hz	13¾" × 24" × 12⅛"
CS-R300	10" woofer, horn tweeter	40 watts	6,300 Hz	13" × 22½" × 11"

PIONEER®



DOUGLAS
SELLS SOUND FOR LESS!

AKAI GXC 46-D
HI-FI cassette stereo tape deck

Styled right, performs superbly. With the inclusion of the famous GX Head focused-field recording system and two other top systems, Dolby Noise Reduction and Akai Automatic Distortion Reduction systems, the sound of this brand new cassette machine belies the notion that natural clear sound reproduction can only be achieved with an open reel unit. Check the features and then listen. Amazing Hi-Fi response: 30-18,000Hz at 58dB S/N (with Dolby). You'll be glad you did.

New Tariff Reduction Brings New Lower Price
NOW ONLY
$255

**POST YOUR CHEQUE OR ORDER TODAY!*

DOUGLAS TRADING for HI-FI SOUND

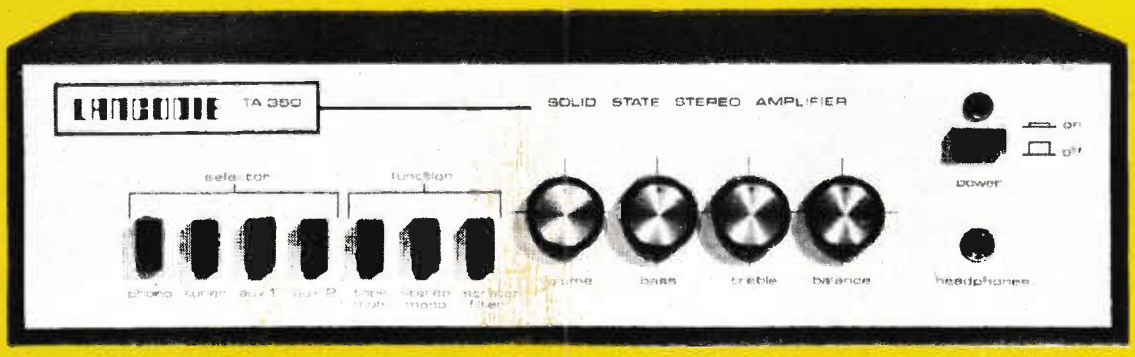
185-191 BOURKE STREET, MELBOURNE – PHONE 63 9321
Complete range of fabulous Memorex tapes and Jensen Hi-Fi speakers

Ludwig..

(he would have approved)

Van Beethoven a creative genius of music.

LANCODIE only reproduces this genius. It can be enjoyed by you, by following an easily understood, and informative assembly leaflet with a readily accessible kit of parts and components arranged in their natural working order. Don't show LUDWIG the discourtesy by expecting his best from anything less than equipment of the finest of quality ■ ■ ■



POWER OUTPUT :	35 Watts R.M.S. per channel at 8 ohms (both channels driven)
DISTORTION :	Less than 0·05% total harmonic Less than 0·05% I.M.
FREQUENCY RESPONSE :	20 Hz to 20 KHz ± 0·1 db

$150

Stable and ring free output into reactive loads up to 0·5 μf.

■ ■ TA 350 the finest of quality.

quality coupled with simplicity——

LANCODIE

Send MAIL ORDER to:- LANCODIE P.O. Box 91, St. Leonards N.S.W. 2065. Tel: 42-6571

The price of $150 includes package & post C.O.D 70¢ extra.

LANCODIE products are available at ELECTRONIC KITS & ACCESSORIES

24 Darcy St., Parramatta, N.S.W. 2150. Tel. 635 9491 • 186 Queen St., St. Marys, N.S.W. 2760. Tel. 623 0346.

INPUT GATE

LETTERS FROM OUR READERS

DIGITIME MODIFICATIONS

I have been looking for digi-clock designs and your 'Digitime' project is one of the best I have seen. Could this circuit be adapted to use solid state LED's such as GaAsP LED's (advert. P134 ETI July '73). Could it be adapted to run on battery power (making use perhaps of a crystal oscillator)? And could an alarm be built into the clock?

R.M. Sandringham
Vic. 3191

The Digitime circuit may be used to drive an LED display if the correct decoder is used – decoder type will depend upon the characteristics of the display chosen.

In its present form the current consumption is too high for battery operation.

An alarm modification will be described shortly.

CLERICAL CALCULATOR

Clerical work in business offices includes making time sheets, adding up man-hours etc. This can be a little tricky, for instance, public servants work from 8 am to 4.36 pm. Adding or multiplying a number of such odd times can be puzzling when using conventional calculators.

There is clearly a need for a calculator that "carries over" when the units exceed '59'. Then, pay clerks would find man-hours summaries a breeze, whereas even with decimal notation, such sums are far from straight-forward. This facility would be useful for those people who calculate in degrees and minutes, also.

C.A.F. Red Hill, Qld. 4059

MUSIC SYNTHESIZER

I am very interested in your music synthesizer project and expect to use many of the component modules in my electronic music studio.

In particular I am seeking a variable contour dc voltage generator – i.e. an envelope shaper that does not just have a linear attack and decay waveform, but a choice of (say) exponential, logarithmic or quadratic wave shapes on both attack and decay.

C.E.V. Menora, W.A. 6050.

The envelope shaper used in our synthesizer has facilities for both exponential and linear attack and decay. Details of this module are planned for publication in our January issue.

MICROWAVE OVENS

We commend you on your article on microwave ovens – it is a step in removing the 'black magic' image of these devices.

In your article you quote that it is desirable to protect the magnetron against no load operation, however in modern ovens such as the Husqvarna, the oven can be run indefinitely without load, also the stand-by current of a 700 watt microwave power is 25 watts only. The heater supply is removed when the anode is switched on. Of further interest is the fact that a modern magnetron has a life of around 10 years average use.

Mr. Reg Geary,
Managing Director.
Supaspede Microwave Oven
Mfg. Co. Ltd.
Footscray, Vic. 3011.

TOO MANY ADVTS?

I am writing to express my concern at the poor quality of the September issue of "Electronics Today International".

In that issue of 168 pages there were approximately 70 full pages of advertisements. This does not include the twenty odd pages of "catalogue" included. If they are included in the calculation then a massive 54% of the magazine was devoted to full page advertisements.

R.C.N. Armidale, NSW 2350.

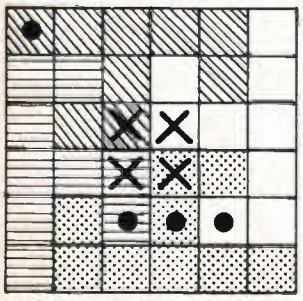
In each issue, ETI carries between 62 and 70 (occasionally 75) editorial pages, and by and large this is the highest editorial content of any consumer electronics publication worldwide.

Unlike many other publications, if our advertising content increases – as indeed it has substantially this year, then we increase the total number of pages in that issue accordingly.

ELAC PUZZLE COMPETITION

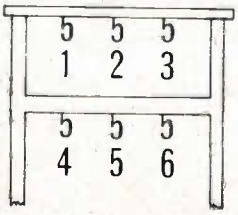
PRIZE – AN ELAC STS.244-17 Cartridge
Awarded to first correct entry opened on publishing date of next issue of Electronics Today International

SOLUTION TO PUZZLE NO. 7



The first correct entry opened was sent in by C.H. Tam St, Marks College James Cook University Queensland, 4811. Congratulations to C.J. Tam and ELAC STS.244-17 cartridge has been awarded.

You can see that a single lamp hung on any one of the hooks could only mean the same thing – that two lamps hung on the upper hooks 1 and 2 could not be distinguished from two on 4 and 5.



Two red lamps on 1 and 5 could be distinguished from two on 1 and 6. Two on 1 and 2 would be different from two on 1 and 3. Remembering the variations of colour as well as position, what is the greatest number of signals that could be sent.

PUZZLE NO. 9

Two spies on opposite sides of the Berlin wall contrive a method of signalling by night. They each arrange in their respective windows a stand, like our illustration, and each possess three lamps which can show either white, red or green light. They construct a code in which every different signal means a sentence.

Post your entries to
ELAC PUZZLE COMPETITION No. 9
P.O. Box 150 CROWS NEST, N.S.W. 2065

Permit No. T/C 4108

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.

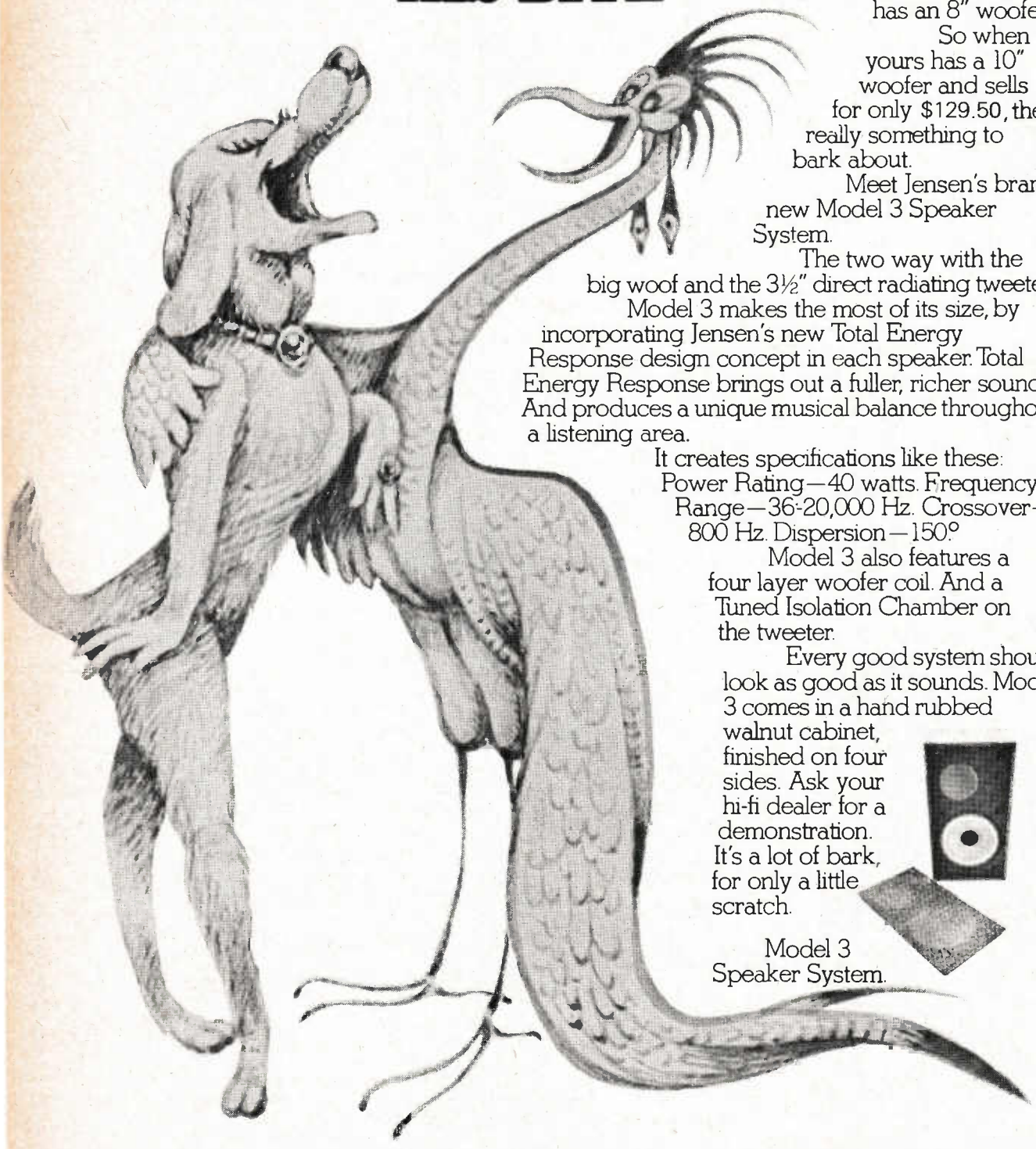
$169 per pair

* *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

HIS BARK IS BIGGER THAN HIS BITE



Any two way system worth its keep has an 8" woofer. So when yours has a 10" woofer and sells for only $129.50, there's really something to bark about.

Meet Jensen's brand new Model 3 Speaker System.

The two way with the big woof and the 3½" direct radiating tweeter. Model 3 makes the most of its size, by incorporating Jensen's new Total Energy Response design concept in each speaker. Total Energy Response brings out a fuller, richer sound. And produces a unique musical balance throughout a listening area.

It creates specifications like these: Power Rating—40 watts. Frequency Range—36-20,000 Hz. Crossover—800 Hz. Dispersion—150°

Model 3 also features a four layer woofer coil. And a Tuned Isolation Chamber on the tweeter.

Every good system should look as good as it sounds. Model 3 comes in a hand rubbed walnut cabinet, finished on four sides. Ask your hi-fi dealer for a demonstration. It's a lot of bark, for only a little scratch.

Model 3 Speaker System.

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

HAM RADIO SUPPLIES

MAIL ORDER SPECIALISTS

323 Elizabeth Street, Melbourne (2 doors from Little Lonsdale Street)

MIDLAND

MODEL 13-700 TRANSISTOR 2-CHANNEL CALL SIGNAL TRANSCEIVER

CIRCUIT: 1 Watt, 2-Channel Solid State Transceiver, 12 Transistors, 1-Diode, 1-Thermistor.
RECEIVING FREQUENCY: 2-Channels available, Channel 11 (27.240 MHz) Crystals Factory Installed in Number One Position.
RECEIVING SYSTEM: Crystal Controlled, super-hetrodyne System with Tuned RF Stage.
INTERMEDIATE FREQ: 455 kHz.
TRANSMIT SECTION: Crystal Controlled Oscillator foloowed by RF Amplifier.
MODULATION SYSTEM: Push-Pull High Level Class "B".
RF INPUT POWER: 1 Watt.
FREQUENCY TOLERANCE: ±0.005%.
RECEIVER SENSITIVITY: 1uV or better at 10 dB S/N.
SPEAKER/MICrophone: 2¼" PM Dynamic, 8-ohm.
ACCESSORY JACKS: AC, Earphone and charge.
POWER SOURCE: 12V DC (8 x 1.5V "AA" cells) **$39.95** each P.P. ($1.00 or **$79.00** a Pair BE EARLY.

5 WATT UNITS

MIDLAND model 13-869 5 Watt 23-channel crystal controlled, frequency synthesized 27 MHz transceivers, all crystals included, 12 to 13.8V DC operation, noise limiter, S-Meter, with mobile bracket, dual-conversion receiver with P.T.T. microphone, all for only. **$95.50** P.P. $2.00.

MIDLAND model 13-894 5 Watt AM-SSB combination transceivers. 27 MHz all 23 channels crystals provided. 12 to 13.8 V DC operation, noise blanker, selectable sideband switch, clarifier, squelch control, S-Meter, mobile bracket with P.T.T. microphone, containing 29 transistors, 3 FET's. one IC and 53 diodes, all for only **$185** P.P. $2.00

NEW RELEASE

MODEL NC-310
DE-LUXE 1 WATT 3 CHANNEL C.B. TRANSCEIVER
- **WITH CALL SYSTEM**
- **EXTERNAL AERIAL CONNECTION**

Housed in a rugged die-cast case, the NC-310 comprises a fully miniaturized transmitter and receiver, both crystal controlled for precise, dependable operation. This unit employs a sensitive superheterodyne receiver circuit with one stage of RF and two stages of IF and three stages of transmitter which uses rugged silicon transistors.
Other receiver features include: an efficient squelch circuit which silences the receiver when no signals are being received, Push-pull audio for high output and undistorted sound and AGC (Automatic Gain Control) to prevent overloading on strong signals and to maintain uniform sound output. For increased selectivity, a 455KHz Ceramic filter is employed.
This unit has a built-in calling device, which allows you to receive and transmit a call signal. The function of the calling device can be tested by pressing both Push-to-Talk switch and tone call switch simultaneously. This transceiver has also a battery checker for your convenience.

Also available on 27.880 MHz $6.00 Extra

SPECIFICATIONS, NC-310

Transistors:13
Channel Number: 3, 27.24 OMHz Citz. Band
Transmitter Frequency Tolerance: ±0.005%
RF Input Power: 1 Watt
Tone Call Frequency: 2000Hz
Receiver Type: Superheterodyne
Receiver Sensitivity: 0.7μV at 10dB S/N
Selectivity: 45dB at ±10KHz
IF Frequency: 455KHz
Audio Output: 500mW to External Speaker Jack
Power Supply: 8 UM-3 (penlite battery)
Current Drain: Transmitter: 120-220mA
Receiver: 20-130mA.

Price $50 per unit or $99.00 pair.

ELECTRONIC KITS FOR BEGINNERS

Mykit Series 150 in 1

Mykit Series 10 in 1

Popular imported electronic kits, no soldering, easy to assemble, battery operated, safe, suit all ages — children and adults, board type construction with easy to follow instructions that make them ideal gifts.

CRYSTAL RADIO KIT No. 28207, tunes AM broadcast band, simple 1 hour construction, no batteries, ideal for beginner, post and pack. **$4.95** 30c p.p.
AM TUNER AMPLIFIER KIT No. 28241, build your own 3 transistor tuner and amplifier, all parts transistors, tuning gang, transformers, speaker etc. **$13.50** p.p. 75c.
10 PROJECT ELECTRONIC KIT, No. 28202, 10 working projects, SOLAR BATTERY, builds radios, oscillators, signal generators, all solid state. **$8.95** 75c p.p.
15 PROJECT ELECTRONIC KIT No. 1544, learn electronics with each project. Build these, morse code oscillator, radios, alarms, sirens etc. **$11.25** p.p. 50c.
IC-20 20 PROJECT ELECTRONIC KIT, learn about intergrated circuits with this educational kit, 20 working projects including intergrated circuit. **$13.25** p.p.75c.
50 PROJECT KIT No.28201 DELUXE MODEL, 50 working projects, educational entertaining, all solid state, includes everything, nothing to buy, constructed in hardwood case, panel meter, radios, amplifiers, burglar alarms, tachometer, test equipment, good value — **$21.50** p.p. $1.00.
DELUXE 150 ELECTRONIC PROJECT KIT using intergrated circuits. Contains all parts for 150 different working projects including I.C. diode and transistor radio, electronic switches, relays, alarms, test equipment, etc, etc. Very good value, Prices **$34.95** p.p. $2.00.

NEW RELEASES

80/ Project kit build 80 different and sophisticated circuits. Includes mike, speaker etc. **$24.50** p.p. $2.00.
Also delux 200 project kit in stock early December **$45** p.p. $2.00.

GENERAL COVERAGE COMMUNICATION RECEIVERS

"REALISTIC DX150. Solid state (as 4 bands covering 535 kcs to 30 mcs fully transistorised SW/CW/SSB/AM broadcast 240V A.C. or 12V D.C. operation. Product detector for SSB/CW plus fast and slow AVC — variable pitch BFO — illuminated electrical bandspread, fully calibrated for amateur bands, Cascode R.F. stage — ANL for R.F. and A.F. — Zener stabilised — OTL audio — illuminated "S" meter **$220** p.p.
Matching speaker 8 OHM for use with "Realistic" DX150. Price **$14.50** extra p.p. 50c.
"TRIO" 9R59DS. (General coverage.) 4 bands covering 540 kcs, valve type, to 30 Mcs. Two mechanical filters ensure maximum selectivity. Product detector for SSB reception. Large tuning and bandspread dials for accurate tuning. Automatic noise limiter. Calibrated electrical bandspread. "S" meter and B.F.O. 2 microvolts sensitivity for 10 db S/N ratio. Price **$180.** p.p. $2.00.
SP5D. Matching 8 OHM speaker unit for use with Trio Equipment. Price **$15.50** p.p. 50c.
LAFAYETTE HA-600A five-band, bandspread tuning, solid state SSB-AM-CW. **$225** LAYFAYETTE HA-800, solid state, as above but Ham Band Only, SSB-AM-CW. **$220.00** p.p. $3.00.

MODEL OL-64D/P MULTIMETER

20,000 ohms per volt. DC volts: 0.025, 1, 10, 50, 250, 500, 1000 (at 20K o.p.v.), 5000 (at 10K o.p.v.). AV volts: 0-10, 50, 250, 1000 (at 8K o.p.v.). DC current: 50uA, 1mA, 50 mA, 500 mA, 10 amps. Resistance: 0-4K, 400K, 4M, 40 megohms. DB scale — 20 to plus 36 dB. Capacitance: 250pF to 0.02uF. Inductance: 0-5000 H. Size: 5¾ x 4-1/6 x 1¾ in. **Price $19.75** p.p. 50c.

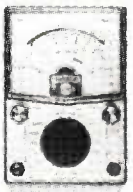
CT-500/). $16.75

Popular, medium-size, mirror scale. Overload-Protected.
AC/V: 10V, 50V, 250V, 500V, 1000 (10,000Ω/V)
DC/V: 2.5V, 10V, 50V, 250V, 500V, 5000V (20,000Ω/V)
DC/A: 50μA, 5mA, 50mA, 500mA.
OHM: 12kΩ, 120kΩ, 1.2MΩ, 12MΩ
db: — 20db to +62db.
Approx. size: 5½" x 3-5/8" x 1¾". p.p. 50c.

A-10/P
$55.00 p.p. $1.00

Giant 6½" Meter. Inbuilt signal injector. Overload Protected.
AC/V: 2.5V, 10V, 50V, 250V, 500V, 1000V, (10,000Ω/V).
DC/V: 0.5V, 2.5V, 10V, 50V, 250V, 500V, 1000V at 30,000Ω/V) **5000V (10,000Ω/V).**
DC/A: 50μA, 1mA, 50mA, 250mA, 1A, 10A.
OHMS: 10kΩ, 100kΩ, 1MΩ, 100MΩ
db: -20 to + 62db
Singal Injector: Blocking oscillator circuit with a 2SA102 transistor.
Approx. size: 6-2/5" x 7-1/5" x 3-3/5".

H10K1 MODEL L-55 FET MULTITESTER



This amazing instrument features a 20 Meg ohm input impedance, 36 ranges from 300 mV full scale to 1200 volts and can measure as low as .2 ohm! Comes complete with probes and carry case. **$42.95** p.p. 75c.

MODEL C1000 $6.95 P.P. 50c

Is the ideal low cost pocket meter.
AC volts: 10V, 50V, 250V, 1000V (1000Ω/V).
DC volts: 10V, 50V, 250V, 1000V, (1000Ω/V)
DC current: 1mA, 100mA
OHMS: 150kΩ
Decibels: -10db to +22dB.
Dimensions: 4¾" x 3-1/8" x 1-1/8" 4¾" x 3-1/8" x 1-1/8"

200-H. $12.50 P.P. 75c

90° quadrant meter. Pocket size.
AC/V: 10V, 50V, 100V, 500V, 1000V (10,000Ω/V).
DC/V: 5V, 25V, 50V, 250V, 500V, 2500V (20,000Ω/V).
DC/A: 50μA, 2.5mA, 250mA
OHM: 60kΩ, 6MΩ
Capacitance: 100pF to .01-μF, .001μF to .1μF.
db: -20db to + 22dB.
Audio Output: 10V, 50V, 120V, 1000V Ac.
Approx. size: 4½" x 3¼" x 1-1/8"

If you're going to steal an idea, steal from the best.

"When the Citation components were in their final design phases we had the rare opportunity to see some of the first engineering prototypes and we have never quite gotten over the dedication and enthusiasm exhibited by the highly qualified engineering team that 'gave birth' to those winners. Small wonder, then, that we were elated to find that the Model 930 receiver is the brain-child of that very team. It abounds in Citation features, many of which one would have thought impossible to incorporate in a receiver at this attractive price. Of course, the Citation 12 boasts more power (60 watt rms per channel), but then again the [Citation 11 preamplifier and the Citation 12 power amplifier] combination retails for a cool $1200.00 or so, as opposed to just under $550.00 for this receiver. The rest of the circuit refinements are there, though, including the twin power supplies (not negative and positive voltages supplied by one power transformer, but actually two complete power supplies including two separate power transformers), super-wide frequency response and power bandwidth, fantastic square wave response and rise time, and conservative and meaningful power ratings that can serve as a model to the rest of the industry. All this plus a superior tuner section make the 930 a receiver that even the died-in-the-wool 'separatists' should take a good look at."

Audio Magazine, June, 1972

IMPORTED AND DISTRIBUTED IN AUSTRALIA BY JERVIS AUSTRALIA PTY LTD
PO BOX 6 BROOKVALE NSW 939 2922

harmon/kardon
The Music Company

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 S5.00, 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

DIGITAL INTEGRATED CIRCUITS (dual in line package)

Signetic TTL (5 volt operation)		
8440	Dual 2/2 and or invert gate	$0.35
8455	Dual 4 input buffer	0.40
8480	Quad 2 input NAND gate	0.40
8H16	Dual 4 input NAND (high speed)	0.35
8H70	Triple 3 input NAND (HS)	0.35
8H80	Quad 2 input NAND (HS)	0.35
8H90	Hex inverter (HS)	0.35
8H21	Dual JK flip flop (HS 60 MC)	1.10
8290	Decade counter (HS 60 MC)	3.15
8292	Decade counter (low power)	0.90
8251	BCD to decimal decoder	1.75
7480	Gated full adder	0.50
7413	Dual 4 input NAND Schmidt triggers	1.75
74181	Arithmetic logic unit	3.50
8260	Arithmetic logic unit	3.15
8261	Fast carry for above	1.35

Send for free brochure listing hundreds of bargains.

Signetic DTL (5 volt operation) dual in line

SP629	Flip flop	$0.35
SP659	Dual 4 input buffer	0.25
SP670	Triple 3 input NAND gate	0.25
SP680	Quad 2 input NAND gate	0.25
SP690	Hex inverter	0.25

Signetic "Utilogic"

This family of logic offers medium speed combined with a greater noise margin than is available from either DTL or TTL logic. Power requirements are the same as TTL/DTL (single 5 volt supply).

"Utilogic" dual in line package

LU300	Dual 3 input expander	$0.30
LU301	Quad 2 input diode expander	0.30
LU305	6 input NAND	0.30
LU306	Dual 3 input NAND	0.35
LU314	7 input NOR	0.35
LU317	Dual 4 input expandable NOR	0.30
LU333	Dual 3 input expandable OR	0.30
LU334	Dual 4 input expandable NAND	0.30
LU356	Dual 4 input expandable driver	0.30
LU370	Triple 3 input NOR	0.30
LU377	Triple 3 input NAND	0.30
LU387	Quad 2 input NAND	0.30

LINEAR INTEGRATED CIRCUITS

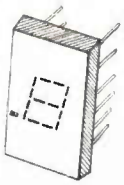
Fairchild and Signetic devices (no choice). Some of this line is not marked but it is fully tested and sold on a money-back guarantee. State first choice on package (TO-5, 8-pin dual in line, or 14-pin DIP—we will not ship flat packs).

NE526	High speed comparator	$1.00
NE565	Phase lock loop	3.50
NE566	Function generator	3.50
NF567	Tone decoder	3.50
709	Popular operational amplifier	0.35
5558	Dual 741 op amp (compensated)	1.00
747	Dual 741 op amp	1.00

LED DISPLAY

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

FEATURES:



- High brightness, typically 350ft.-L @ 20ma.
- Single plane, wide angle viewing, 150°.
- Unobstructed emitting surface.
- Standard 14-pin dual in line package.
- Long operating life, solid state.
- Operates with IC voltage requirements.

ONLY $4.00

"UTILOGIC" SPECIAL

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

Complete package only $3.60

LINEAR SPECIAL

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

EACH $0.65 PACKAGE $6.00

8 pin DIL Only 35c each
$2.75 for ten.

LM309K—5 volt regulator

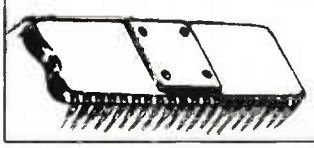
This TO-3 device is a complete regulator on a chip. The 309 is virtually blowout proof, it is designed to shut itself off with overload of current drain or over temperature operation. Input voltage (DC) can range from 10 to 30 volts and the output will be five volts (tolerance is worst case TTL requirement)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

EACH $2.50
FIVE for $10.00

LSI—CALCULATOR ON A CHIP

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

Complete with data $9.95



Data only $1.00

COUNTER DISPLAY KIT—CD-2

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

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

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

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

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

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

Board only $2.50

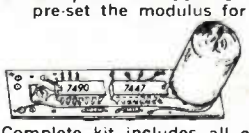
RCA DR2010 Numitron digital display tube. This incandescent five volt seven segment device provides a .6" high numeral which can be seen at a distance of 30 feet. The tube has a standard nine pin base (solderable) and a left-hand decimal point. Each $5.00

SPECIAL 5 for $20

UNIVERSAL COUNTER DISPLAY KIT CD-3

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

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



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

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

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

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

$3.00 each. Ten or more $2.50

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