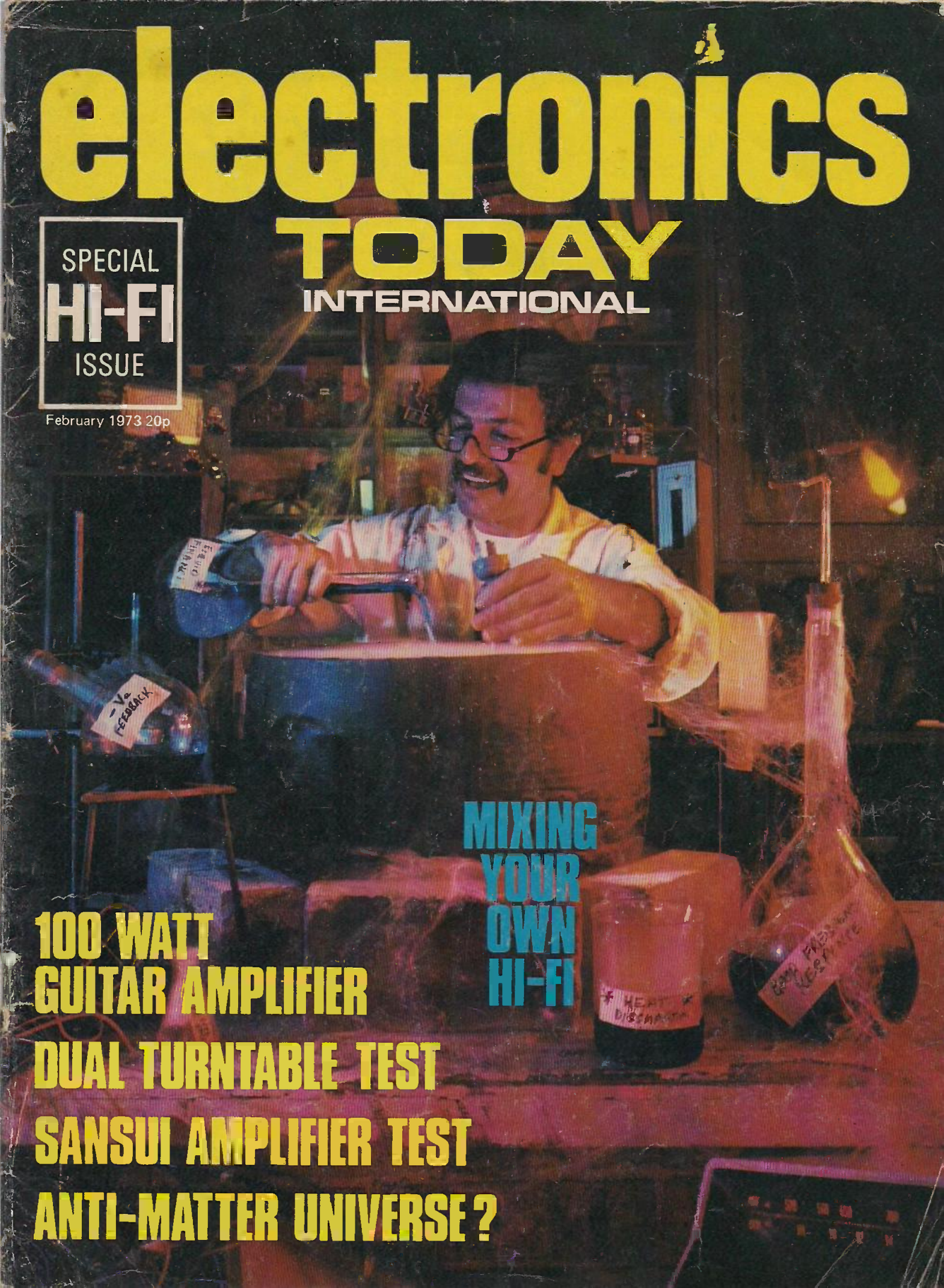
electronics TODAY INTERNATIONAL

SPECIAL HI-FI ISSUE

February 1973 20p



electronics TODAY INTERNATIONAL

FEBRUARY 1973 VOL 2 No 2

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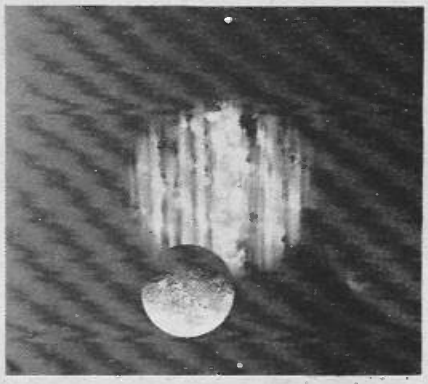
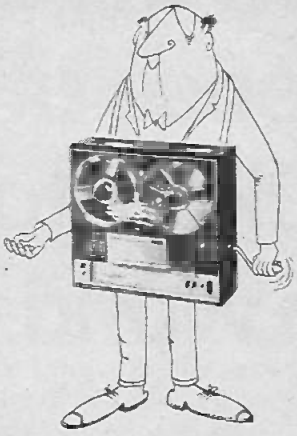
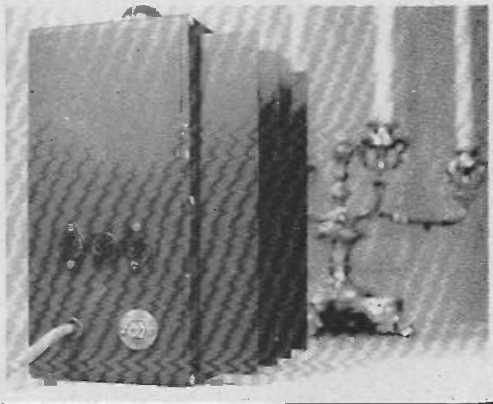
COVER: Our resident alchemist illustrates one way of obtaining hi-fi. A more reliable method is described in this month's main feature story – page 20. (Cover pix, and that featuring Sonab's OA-5 speaker and ELAC 1000T Quadrasound tuner/amplifier on page 20, were taken by Kim Ryrie).







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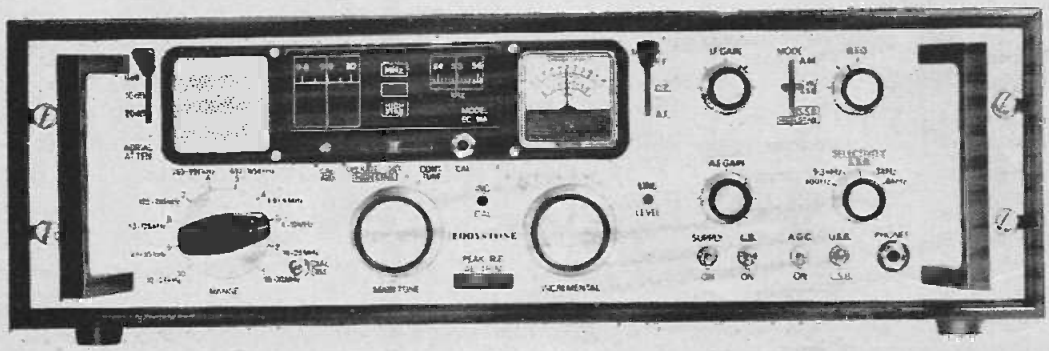

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Professional high-stability receiver series for a wide variety of applications. The standard version can be used as a self-contained F.S.K. terminal, or as a dual-diversity terminal with common oscillator control. Variants are available for Lincompex terminal use, for specialized network monitoring surveillance and for marine applications.

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Editor, British Edition

Alex Mellon
Advertisement Manager
British Edition

Sid Gladwin
Production Manager
British Edition

the costly computer

A few years ago a large road transport company looked at its accounting and shipping departments and decided to investigate buying a computer.

They were told that a computer would not only reduce the staff required but would provide printouts of a vast quantity of data and statistics previously unobtainable. As a result of this a £100,000 computer was installed.

After nine months of operation it was found that the same number of staff were required to service input/output data and that a lack of knowledge of the road-transport business by system programmers had resulted in a gigantic foul up of the whole operation. The managing director in very expressive language wished they had never seen a computer.

Now at last someone from within the computer industry has spoken out strongly against indiscriminate sale of excess computer capability into companies who would possibly be better off without a computer at all.

Mr Bryan Mills at the opening of Computer 72 at Olympia said:-

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

A more detailed account of Bryan Mills speech is given in the News Digest section of this journal. Keep up the good work Bryan.

news digest

COMPUTER CHIEF WARNS CITY

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

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

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

'And I feel it is pertinent to make this point very strongly today on the opening of Computer 72 here at Olympia. This is purely a trade show for the computer industry. If businessmen believe they will learn something from it, they are only fooling themselves. A businessman wants his problems solved — all he will find at Olympia is a confusing display of techniques and hardware'.

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

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

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

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

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

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

ADVANCED CAR TELEPHONE WITH MINI-COMPUTER

The first, and so far only car telephone equipment to use digital frequency synthesis, an advanced technique developed for use in communication between space ships and military purposes, was recently introduced by the Danish firm AP Radiotelefon, of Copenhagen.

Compact in size compared to all competitive equipment, the company's AP 749 provides full duplex operation, as in normal telephone conversation, and requires the use of only one aerial. The AP 749 contains its own mini-computer, making it possible for the equipment to use 49 channels, which can be expanded to 120 channels with the addition of a suitable switchgear. Output is 25 watt broadcast effect.

Because of the extensive use of compact elements, the entire unit can be mounted under the instrument board of practically any car. The control panel forms the front of the cassette unit and takes up no more space than an average transistor radio. An added advantage to the buyer is the company's one-year full guarantee, which covers the materials and labour costs.

Further details may be obtained from AP Radiotelefon, Hjørnagervej 18-20, DK-2650 Hvidovre, Denmark.

From Denmark Review of the Ministry of Foreign Affairs, Copenhagen.

CLASSROOM FIREPOWER

A training system to teach Royal Navy electronic engineers how to set up, maintain and repair the control system for Vickers 4.5in Mark 8 naval gun has been delivered by Marconi Radar Systems Limited, a GEC-Marconi Electronics company, to the Royal Navy Training Establishment at HMS Collingwood.

This is the first such system of its kind to be installed anywhere. It consists of the new Marconi gun control system for the 4.5in Mark 8 gun (background cabinets), which

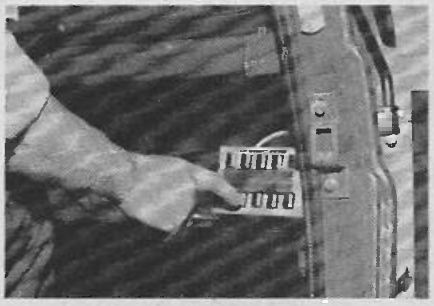
employs static amplifiers. Instead of controlling the gun mounting, it drives a configuration of springs, weights and clutches, (shown in foreground), simulating the effect of the gun on the control system. These reproduce physically, the resonances and backlashes which would normally be present in the gun mounting, and enable the trainee to quickly establish the correct setting up procedure and gauge the effects of his adjustments, both instrumentally and audibly.

ROAD TRANSPORT SECURITY SYSTEMS

A new range of vehicle security systems and devices providing unprecedented protection against highjacking and the theft of vehicles or their loads has been introduced by AFA-Minerva (EMI) Ltd, Twickenham, Middlesex, Britain's leading fire and security organisation. Known as the 'Talisman' range, it features unique, fully-automatic electronic systems and other vehicle protection equipment in a series of products designed to protect all types of vehicles — from cars to heavy articulated lorries.

Believed to be the most comprehensive and advanced of its type available in Europe, the 'Talisman' range has been developed to combat the three key factors contributing to present soaring theft losses from road transport operations — inadequate vehicle protection systems, human error, and collusion.

To foil thieves, the 'Talisman' range provides progressive levels of protection, including devices which greatly strengthen a vehicle's resistance to forced entry, fully-automatic alarm systems, and devices which completely immobilise the vehicle's engine. Any combination of these 'Talisman' products may be selected to provide



the required level of protection.

Several unique immobilisation/alarm systems are available. These are automatically armed when the vehicle's engine is stopped, so avoiding the need for any action on the driver's part and eliminating the risk of human error. An additional feature is an electronic coded push button switch unit which may be independent of all other ignition and power circuits, which causes the engine to be immobilised and the alarm to sound should any attempt be made to bypass the unit, or to start the vehicle without first setting up the correct code.

Other unique features are a delayed-action anti-highjack system, designed to give protection for the driver, and a system which warns of attempts to uncouple a trailer from its tractor unit. The principle of this latter system is also used to prevent trailers, parked alone, from being stolen.

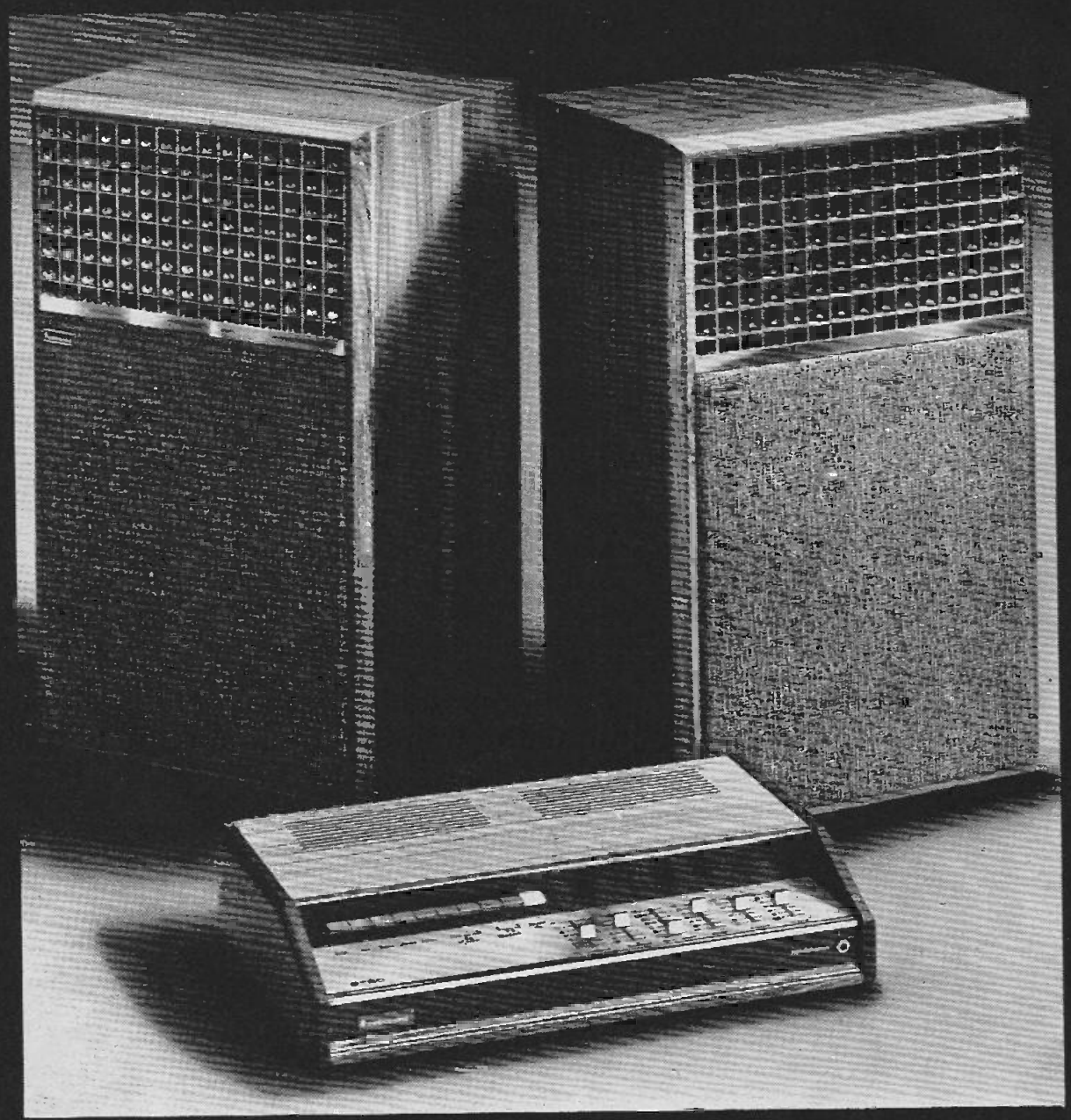
In addition to these solid-state protection systems, the range includes more conventional equipment such as steering column locks, close mesh grilles for partitions and windows, and high security locks to protect doors, roller shutters and car boots.

The Talisman range also features a new form of safe for securing within the boot of a car. Tailored to fit most popular cars, this specially shaped, heavy gauge compartment gives higher protection and far more space for carrying goods than conventional designs of boot safes.

Amongst the many innovations and features of the AFA-Minerva Talisman range are: waterproof door alarm switches; monitored wiring; elimination of false alarms caused by

(Continued on page 10)

Our philosophy is basically sound



The better the electronics the better the reproduction.

It takes a lot of talent to build Metrosound audio equipment – electronic know how, superb engineering.

Metrosound know that the circuitry has to be right to ensure that what you hear is as near pure sound as anybody can make it.

Take the ST60 Integrated Stereo Amplifier – output 30 watts RMS per channel. Designed to satisfy the most exacting Hi-Fi enthusiast. From the low profile advanced styling to the most sophisticated electronic circuitry it's a marvellous piece of equipment.

6 Studio sliders and 10 tab switches provide superb control for your listening including three switched variable filters, middle boost and cut control. Tuner, tape and auxiliary outputs are provided.

To take advantage of the performance of the ST60, Metrosound's big Duplex 25 speakers are absolutely right. Combining dual speakers, a long throw cone and a radically new electrostatic unit, and handling up to 25 watts, they sound as good as they look. The electrostatic unit is mounted behind a specially designed high frequency dispersion grill and the cone is fronted by an acoustically transparent woven vinyl cloth.

For smaller budgets there is also the Duplex 15, handles less power but still combines the cone and electrostatic units.

Metrosound systems are at your favourite Hi-Fi dealer – marvellous sound at a truly economical price.

Here are the specifications

ST60 Stereo Amplifier
Power output :
30 watts R.M.S. per channel.
Frequency response :
20-50,000 Hz ±2db.
Distortion : Less than 0.08% at full rated output.
Hum and noise :
65db on magnetic phono input.
All other inputs better than −70db.
Dimensions :
$20\frac{1}{8}$" wide × $3\frac{3}{8}$" high × $12\frac{1}{2}$" deep.
Price : **£70.00**

Duplex 25 Loudspeaker
Maximum power handling capacity : 25 watts.
Nominal impedance : 8 ohms.
Frequency response : 40-18,000 Hz.
Crossover frequency : 2.5 kHz.
Dimensions :
$16\frac{1}{2}$" wide × $27\frac{1}{2}$" high × 12" deep.
Weight : 40 lb.
Price : **£52.00** each.

Duplex 15 Loudspeaker
Maximum power handling capacity : 15 watts.
Nominal impedance : 8 ohms.
Frequency response : 45-17,000 Hz.
Crossover frequency : 2.5 kHz.
Dimensions :
$18\frac{1}{4}$" wide × $18\frac{1}{4}$" high × $8\frac{1}{2}$" deep.
Weight : 20 lb.
Price : **£36.00** each.

Metrosound Audio Products Ltd., Audio Works, Dept. E.T.I. Cartersfield Road, Waltham Abbey, Essex EN9 1JF.
Tel : Waltham Cross 31933.

metrosound

Metrosound dedicated to better listening

news digest

(Continued from page 7)

vehicle vibration; and fool-proof electronic switches. A facility for large vehicles, such as articulated lorries, enables them to be reversed with the cab door open without triggering off the security alarm. The automatic vehicle immobiliser schemes incorporate a facility to warn of low engine oil pressure which may be caused by an engine fault or lack of lubricant.

CANADA'S OWN SATELLITE

Anik, an Eskimo word meaning brother, is Canada's new communications satellite which was launched from Cape Kennedy aboard a new Delta rocket on November 9.
Anik is shown at Hughes Aircraft Company in EL Segundo, California,

where the 1,200 pound satellite was built for Telesat Canada. A Hughes technician turns the see-through 60-inch parabolic antenna, which is covered with fine gold metal mesh to reduce solar pressure when the satellite is in synchronous orbit, 22,300 miles over the Equator. The new satellite, the first of three spacecraft built by Hughes and two Canadian sub-contractors, Spar Aerospace Products and Northern Electric Company, will provide Canada with 12 channels of high quality colour TV or as many as 5,000 telephone circuits from the US border to the high Arctic and from the Atlantic to the Pacific oceans.

BIG BANG COMPUTER?

A £40,000 computer has been installed by the Ministry of Defence's Explosives Research and Development Establishment at Waltham Abbey,

Essex, to help research into solid fuels for ammunition and rockets.

The computer, a Scottish-built Honeywell Model 316 'mini', is pictured undergoing final pre-delivery check-out at the company's Hemel Hempstead, Herts engineering centre.

It has been designed to gather measurements of the pressure resulting from the combustion of solid fuels inside either a closed vessel (for gun applications) or a small rocket motor. Up to 500 separate measurements can be handled by the system, covering propellant 'burn' times ranging from 2 milliseconds to 100 seconds.

NEW OPPORTUNITIES FOR BLIND

Keyboards are turning into springboards of opportunity for thousands of blind people who once considered themselves handicapped, but who now regard themselves merely as 'competitively inconvenienced'. Through a talking computer, linked to a telephone line, the blind can now proofread printed copy, 'look up' spelling of highly technical words, prepare payrolls, check inventories and process invoices.

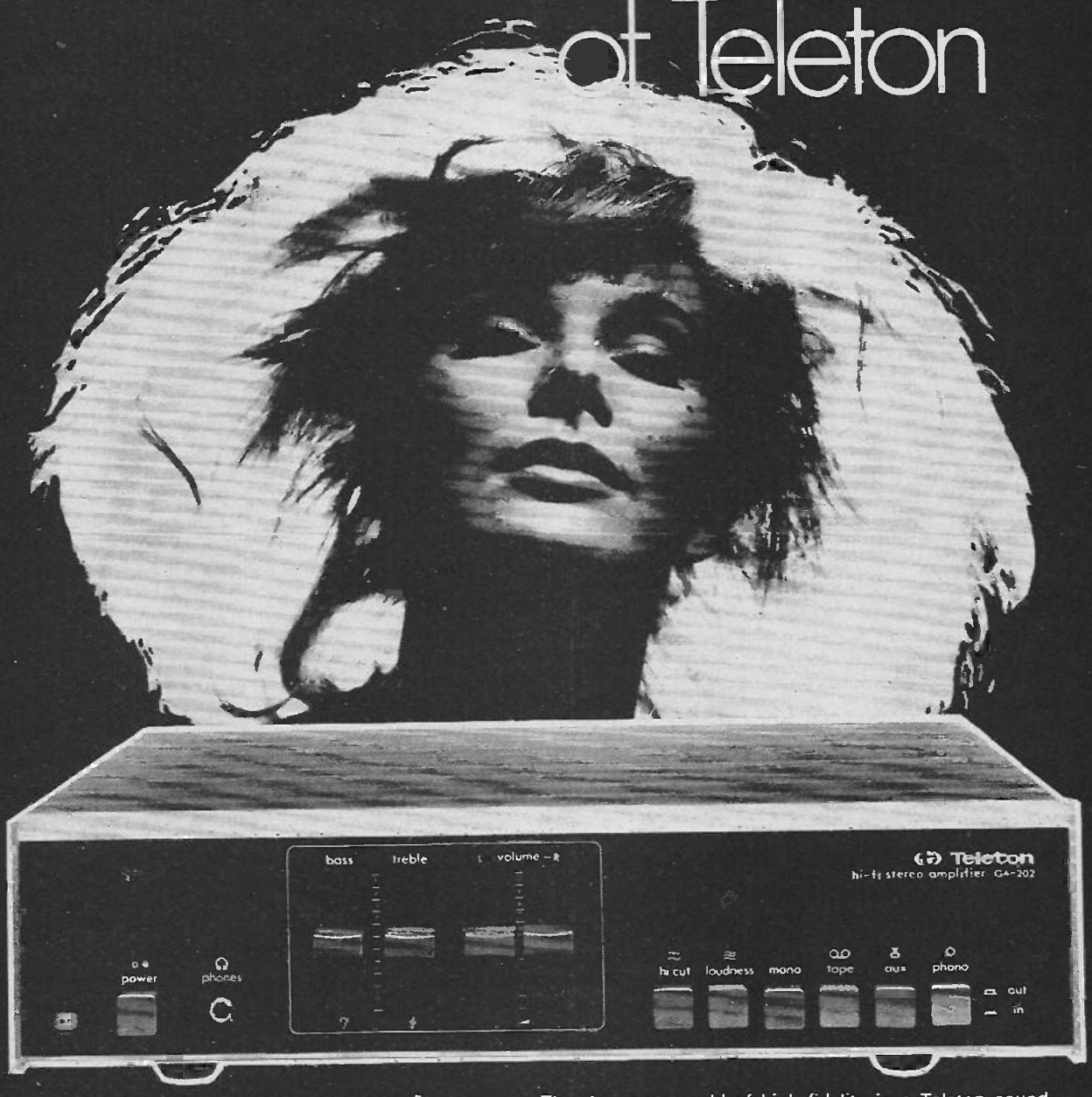
A blind former MIT researcher, Dr Kenneth Ingham, is responsible for the talking computer, a device that may prove to be the most significant aid for the blind since Braille printing. Ingham directed a team of researchers at MIT's Research Laboratory of Electronics that recently developed the Audio-Response-Time-Shared (ARTS) system. Through regular telephone lines ARTS ties together a computer with a variety of input, buffer and output devices. The standard input device is a solid state alpha-numeric keyboard manufactured by the Micro Switch & Keyboard Group of Honeywell. The soul of the system is the speech unit developed by American Systems,Inc. that permits everything typed to be played back as audible letters, symbols, or entire words.

As the blind user presses a key on the keyboard, information is transmitted to the computer through the speech unit. The pressed keys generate sounds that the computer can 'recognise', and the computer then responds to the typist *in voice,* either in individual letters, numbers and symbols or in complete words, messages or computations, depending on the programming. The typist hears precisely what has been typed, or the results of indicated commands or computations, in words and sentences. The typist may correct mistakes immediately or wait until the program is completed. Corrected statements may be inserted by issuing simple commands and typing the changes. When satisfied, the programmer may then tell the computer to print out a copy of the work for sighted associates.

According to Ingham, who is also president of American Systems, Inc, it takes only a few hours to acquaint blind persons already familiar with standard typewriters with the ARTS technique. ARTS makes available an audible form of the common computer program language known as FORTRAN, as well as talking desk calculators, copy editors, library retrieval devices and a talking data assembler. Special vocabulary banks will be available, Ingham said, for special occupations such as medical or legal secretaries.

The 33-year-old Ingham is living proof of his conviction that handicapped persons desire, instead of sympathy, to be judged solely on production in the 'competitive environment'. Ingham, a graduate of Boston University and the University of Paris, also holds master's and doctoral degrees from Brandeis University, He has been blind since the

Awaken to the sound of Teleton



Join the procession in Aida. Smell 1812 gunsmoke. Shiver on Bare Mountain. *Awaken to the sound of Teleton.*

There's a new world of high fidelity in a Teleton sound system, with the GA 202 amplifier at its heart to bring you new standards of purity, new heights of quality in the faithful reproduction of the world's greatest music.

The Teleton GA 202 combines all the latest advances in hi-fi technology—calibrated slider controls for bass, treble and channel volume, hi-cut filter, loudness contour, headphone socket, tape and auxiliary inputs, to give you 16 watts per channel (RMS) at under one per cent distortion, 30-30,000 Hz—the soaring choruses and the whispers of a cathedral inside an elegant walnut and brushed aluminium cabinet.

Listen to the Teleton GA 202—your ears have been asleep. Price £50 recommended retail.

Teleton
Sound Sense

Teleton Electro (U.K.) Co. Ltd.,
Teleton House, Waterhouse Lane,
Chelmsford CM1 3DW.
Tel : Chelmsford 62442.

news digest

age of 16, when he lost both his sight and his left hand in a laboratory explosion. He taught electrical engineering at MIT for six years before being asked to head up a group of students and researchers that developed the ARTS apparatus.

'We designed the ARTS system to be plug-compatible with any standard computer. Through keyboards our clients can link into ARTS from offices, libraries or homes.... wherever a telephone line is found. We do not wish to re-invent the world, we just wish to connect it', says Ingham.

For further information write The Protestant Guild for the Blind, Inc, attention Dr Kenneth R Ingham, Director, ARTS Service Bureau, 456 Belmont Street, Watertown, Massachusetts 02172, USA.

KEYLESS LOCKS

A new range of electronic combination locks that eliminate the use of keys or plastic cards was put on display at a British company's stand at the recent International Security Exhibition and Conference held in London. The Data-lock 2000 (seen here) is part of this range which is ideally suited to areas where access is restricted and where keys may not be carried on the person, such as banks, stores, code rooms, operations and control rooms. The Data-lock code box is in the secure area, while outside there is just a waterproof finger-plate with press button figures. Operation of the correct combination, which has been pre-set inside, will activate an electric lock allowing access to the secure area. If there is any error in touching the figures an alarm sounds, and this alarm can only be switched off internally or by pressing the correct four-figure combination. The code box has an in-built battery that is constantly float-charged from the mains so that should the main supply at any time be cut off the battery will take over the operation of the whole system. Also, as an additional security, if anybody tampers with the finger-plate by trying to cut the wire an alarm will sound. A special high security electric lock completes the system. Manufacturers are J. Donne Holdings Ltd., Canberra House, 312-319 Regent Street, London W1R 57B.

SUPERCONDUCTORS LOSING THEIR COOL

Practical application of superconductivity to power transmission lines, electric motors and generators, electric railways etc has been held back by the very high cost of the refrigeration required.

But now, scientists at RCA's Princeton Laboratories have produced superconductivity in niobium gallium conductors at 20.3 Kelvin. Not only does the two-element material become superconducting at a relatively 'high' temperature, thus resulting a reduction in cooling costs of at least 75% – but it also can be superconducting in far more intense magnetic fields than existing superconductors.

AUDIO-VISUAL PROJECTION SYSTEM

New in Britain is a unique form of portable audio-visual aid – a miniature sound filmstrip projection system providing recorded commentary with each filmstrip slide presented automatically and continuously on its built-in screen, with student response facilities if required. Marketed exclusively by AVID Electronics Ltd, Ascot, Berkshire, this highly successful American device is known as the 'Beacon' and is designed as a self-teaching aid in education and training, as a sales or marketing demonstrator and as a reference source for general applications.

The self-contained 'Beacon' is offered in several versions starting from £86.00 and is said to represent the most cost effective form of fully automatic audio-visual presentation

available in the UK. Designed for use even in strong ambient lighting, the Beacon overcomes the limitations of conventional portable slide projection equipment which previously have not been able to offer fully automatic synchronised sound and filmstrip operation.

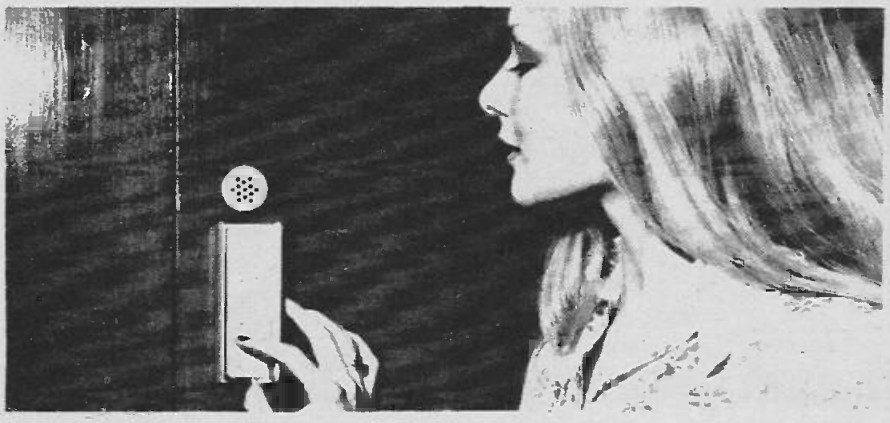
With the growth in educational correspondence courses, this new audio-visual aid is particularly suited for home studies. Lessons previously supplied to students in written form, can be presented more effectively as pre-recorded programme packages on film and cassette which are easily distributed by mail.

Occupying a space slightly larger than a standard telephone, the Beacon comprises a motorised back projection unit mounted permanently on top of a small cassette tape recorder. The projection unit uses 35mm filmstrip, containing up to 120 frames, which is loaded simply and easily into the unit.

A standard compact cassette tape contains up to 60 minutes recorded commentary and also the pre-programmed electronic pulses which automatically change the film slides in perfect synchronisation with the commentary. The sound commentary or pulsing cannot be erased accidently.

Once film and cassette are loaded and the mains power switched on, the only operation required is to press the 'start' button on the recorder unit. The projector then operates automatically and continuously, although the programme can be interrupted at any time and operated manually.

The Beacon is available in three versions each measuring 10" long 6" wide and 13" high and weighing less than 10lb. The series commences with FS200 Beacon equipped with 3" x 4" daylight viewing screen and is priced at £86.00. The FS250 model offers a larger picture format on a 4¼" x 5½" screen and costs £95.00.

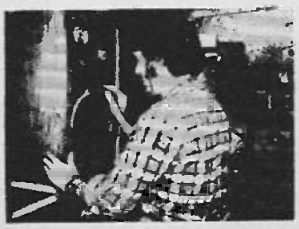


Acoustic Research comes to England

For many years Acoustic Research have designed and manufactured high fidelity equipment for the American public. The firm's preeminence in America, and recently on the continent of Europe, has been based on the efforts of AR's engineers to create equipment capable of reproducing music with the greatest possible accuracy, so that the work of composer, performer, and recording engineer could be presented with the highest degree of precision possible.

AR have approached this challenge from the point of view that this accuracy can be measured objectively, and that the design of high fidelity components can best be accomplished through the application of scientific methods in their testing and evaluation. This approach led to the establishment at AR of an unusually

rigorous programme of production testing – of individual drivers and completed loudspeaker systems, as well as their turntable and electronic products. The extremely close tolerances established by AR's quality control cause a significant number to be rejected – but they also make it possible for AR to offer a unique guarantee on both workmanship and performance: five years



for loudspeakers, three for turntables, and two years for electronics.

A measure of the success of this approach is the number of celebrated musicians who have chosen AR components for use in their homes. A high fidelity system can receive no greater compliment than to be chosen by musicians of the stature of Karl Böhm, Herbert von Karajan, or Dietrich Fischer-

Dieskau for listening to their own recordings.

Now, Acoustic Research have established their own offices and loudspeaker production and test facilities in England. This means two very important things to the British enthusiast. First, the very same quality of design, construction, and performance that has characterised AR's worldwide reputation since 1954 will now be available in an audio product made in England. The same test procedures used in America will be used here. And, the same guarantee will be offered on workmanship and performance.

And, second, AR's new U.K. facilities, coupled with rapid international expansion, make possible drastic and immediate price reductions on all AR products. AR products are available only from selected hi fi dealers. Write for more information.

Acoustic Research International

High Street
Houghton Regis, Beds.
Phone:
Dunstable (05 82) 60 31 51

Recommended Retail Prices

Product	Old price	New price
AR-3a speaker	£ 178.00	£ 100.00
AR-2a[x] speaker	98.00	59.50
AR-6 speaker	68.00	39.90
AR-4[x] speaker	45.00	32.00
AR-7 speaker	New Model	52.00/pair
AR turntable	74.00	41.90
AR amplifier	174.00	110.00

Prices include purchase tax where applicable.

AR
You can see the difference

Searching for the Antiworld

An investigation of alternatives for half the universe

by Mort La Brecque

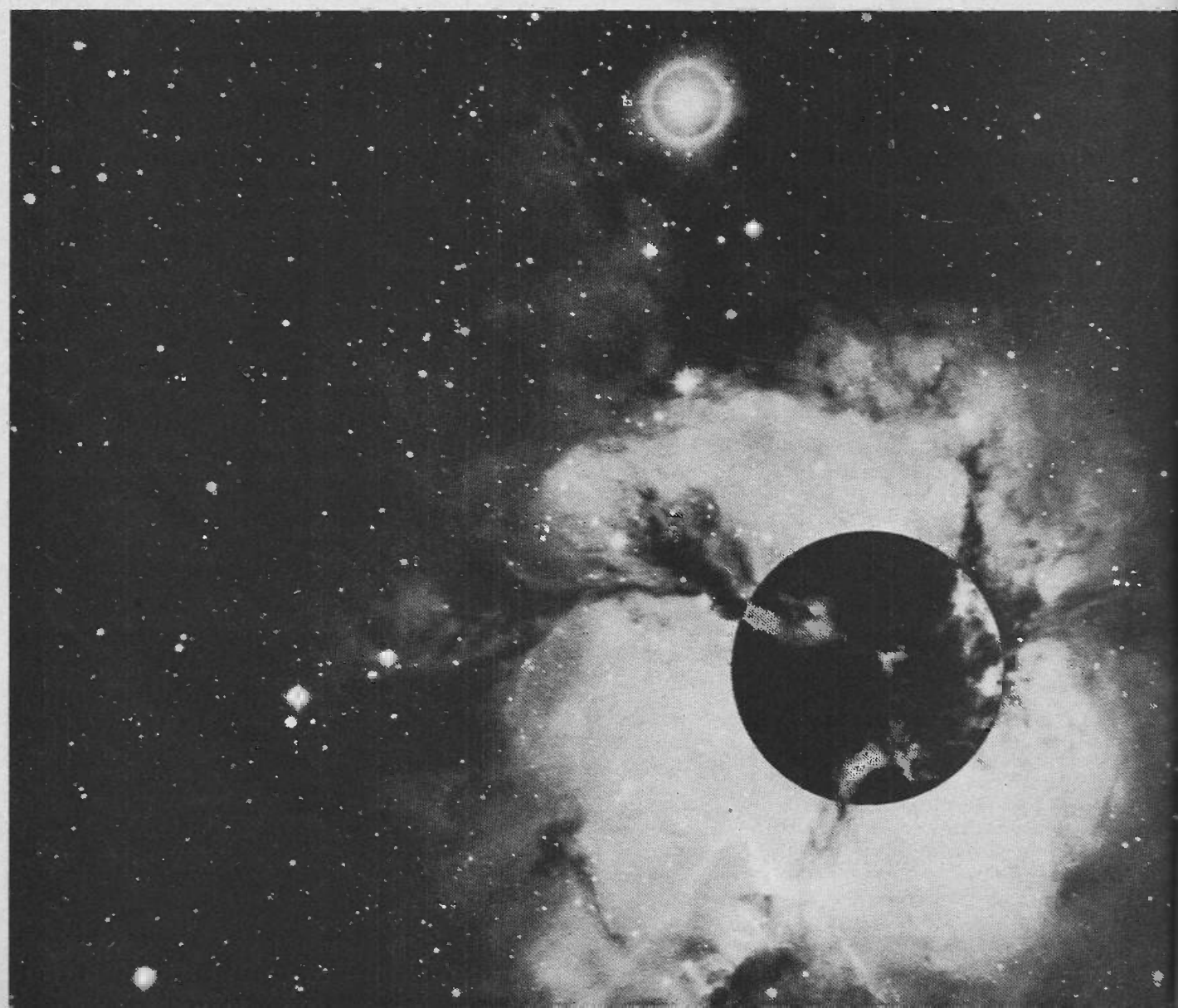
DURING the 17th century, Gottfried Leibniz contended that this is the best of all possible worlds because God chose it out of an infinity of possible worlds for that very reason. Avant garde twentieth century physicists find such cosmological chauvinism as untenable as Voltaire did, for rather different reasons: they believe that existence could be at least as desirable in many of the infinite number of possible worlds – and perhaps is.

Within *our* world, cosmologists have not abandoned Leibniz' philosophical system: he proposed a harmonious hierarchical structure, in which even the smallest unit reflected the whole in microcosm. Over 200 years later, physicists seek an understanding of the Universe-at-large in the submicroscopic physical world. Current issues of interpretation in particle physics lead to very different cosmologies; cosmological theory may be firmly established only after clarification of these issues – and an advanced understanding of elementary particles.

OFFSPRING OF THEORETICAL MARRIAGE

Paul Dirac accomplished one of the major feats of modern theoretical physics in 1928 by demonstrating that Einstein's special relativity could be combined with quantum mechanics to describe particles. As might be expected, the consequences were profound For every kind of particle, Dirac predicted the existence of an antiparticle, with equal mass but opposite electromagnetic and quantum properties.

Thus, for the negatively charged electron, there is the positively charged positron. In 1932, astronomer C.D. Anderson detected positrons in cloud chamber photographs of cosmic rays, confirming Dirac's prediction. Subsequent laboratory energy acceleration experiments have verified



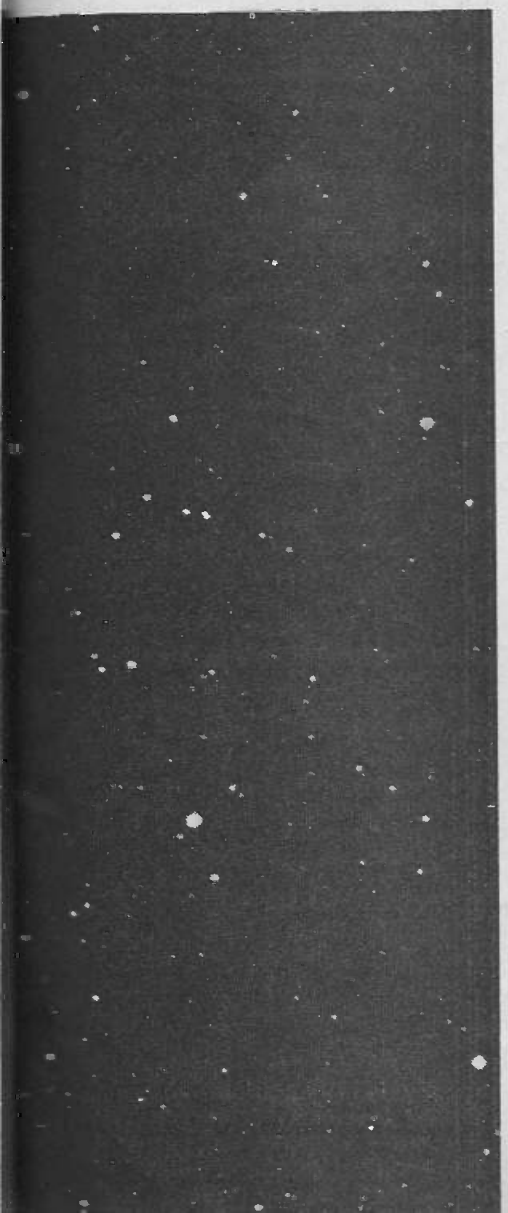
the existence of antiparticles for all known particles except those, like the photon and the neutral pion, which are their own antiparticles.

A VERY SHORT LIFE

Following conventional logic, physical objects should be composed of equal parts matter and antimatter, but this is not the case. Very little antimatter exists, at least within our solar system. Astrophysical observations indicate that, like Earth, the Sun and planets are composed only of matter: although antiparticles are created when high-energy light photons interact with matter, they have an extremely short life of picoseconds.

Dirac also predicted that if a particle collides with its antiparticle – a certainty in the crowded, fast-moving world of the very small – they annihilate each other, simply popping out of existence with either a trail of energy or of less massive particles left behind.

Laboratory confirmation of this prediction indicates a mechanism for the disposal of antimatter, and carries another implication: matter and antimatter cannot coexist at very close spatial proximity without fatal radioactive consequences for physical objects. A homogenous mixture of particles and antiparticles would result in a universe full of the energy of annihilation, but without any life.



THE BEAUTY OF SYMMETRY

While they accept this notion, some theoreticians believe that it raises troubling questions; their feelings are based on intuitive aesthetics as much as on careful observations. The scientific philosophers of antiquity proceeded from the assumption that natural principles are both simple and beautiful; heavenly bodies, for example, were perfect spheres moving in perfect circles. Although modern science has shown that such assumptions are simply naive, and that nature tolerates violent discordance as easily as sweet harmony, symmetry principles remain very attractive. Why should nature favor plus over minus, matter over antimatter?

During the last twenty years, it has been demonstrated that the symmetry laws of physics *are* violated – but only under special circumstances and very, very weakly even then: nature ordinarily obeys the dictum of symmetry. Thus, a number of physicists feel justified in asking whether matter and antimatter exist in equal quantities, if not in our solar system, then in the Universe.

Because matter and antimatter appear to obey symmetry principles in accelerator experiments, the crucial issue is whether the Universe began with equal amounts of matter and antimatter. Theoreticians proposing a charge-symmetric Universe all assume charge-symmetric initial conditions. Their theories differ in explaining the presumed matter-antimatter separation. In one theory, matter and antimatter are eventually grouped in different solar systems within each galaxy; in a second, they are contained inside or expelled outside galactic cores. And a third theory suggests a less homogenous but not less symmetric arrangement of separate-but-equal antimatter galaxies.*

A SYMMETRICAL COSMOLOGY

In 1963, Hannes Alfven, Royal Institute of Technology, Stockholm, proposed with O. Klein a cosmological theory explicitly based on the concept of symmetry.

The Universe begins as a thin gas cloud diffusely filled with equal numbers of protons, antiprotons, electrons and positrons. As the cloud contracts under its own gravitational attraction, particle-antiparticle annihilation occurs; the resulting radiation acts as a brake, reversing collapse into the presently observed expansion of the Universe.

A Leidenfrost effect – a process similar to electrolysis – in the primeval magnetic field, separates matter and antimatter, and limits annihilation during galaxy formation. Because the effect is on a very small scale, matter and antimatter bundles are not separated very far from each other. Thus, each galaxy contains equal amounts of matter and antimatter, distributed as discrete solar systems; although our solar system is made of matter, Alpha Centauri, our nearest neighbor, could well be composed of antimatter, according to Alfven-Klein cosmology.

HEART OF ANTIMATTER

Fred Hoyle, formerly of the Insitute of Theoretical Astronomy, Cambridge University, also suggests that matter and antimatter may coexist within the same galaxy, but in a much different arrangement. Rather than solar systems made either of matter or antimatter, Hoyle says "we could have particles distributed in stars and interstellar gas, and antiparticles condensed as a compact nucleus at the galactic centre." (*Nature*, Nov. 1, 1969) Hoyle assumes that both particles and antiparticles are created in the condensed nucleus of our Milky Way Galaxy, but particles are expelled while antiparticles are retained; their roles could be interchanged, however, in other galaxies.

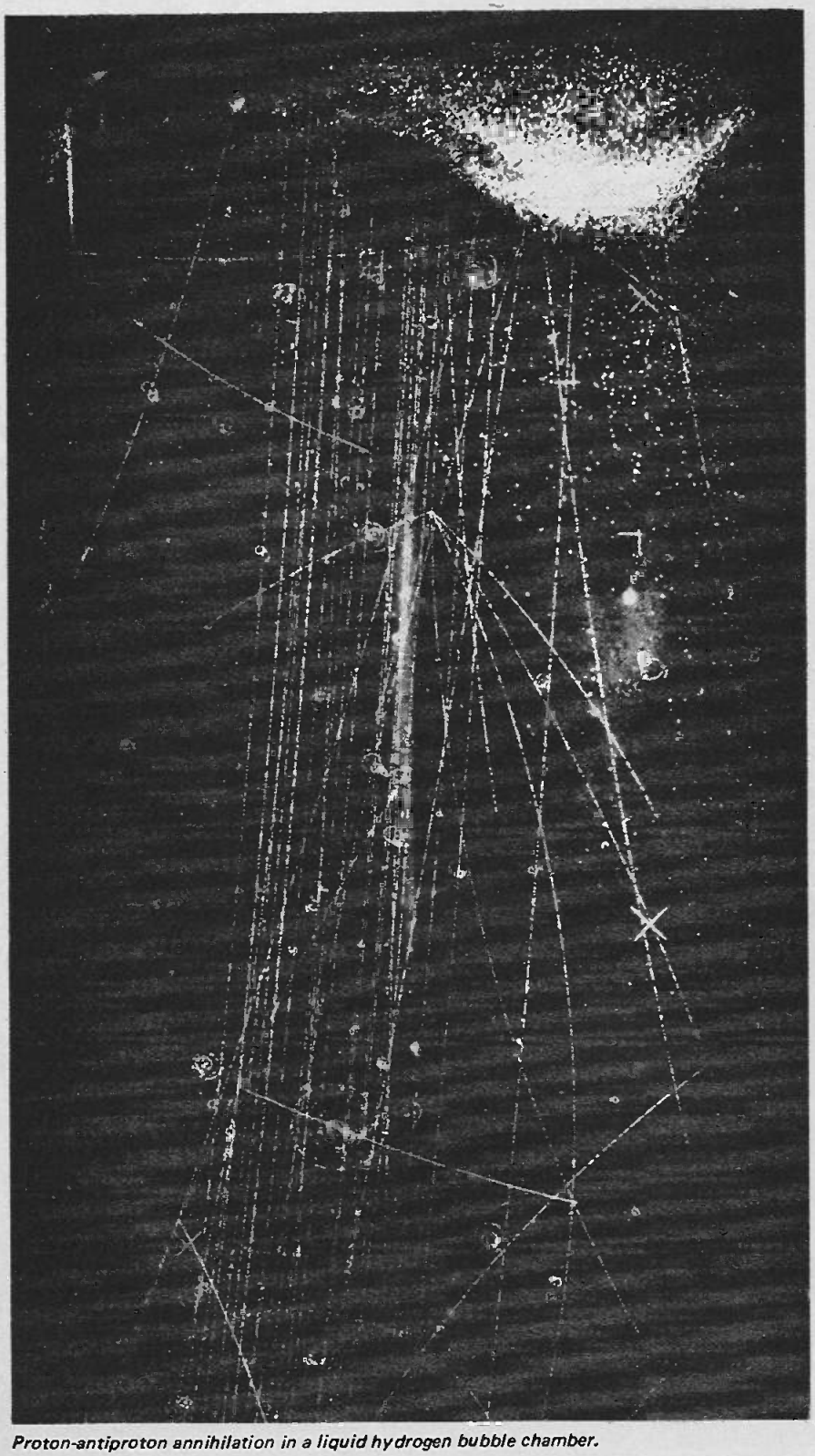
Hoyle acknowledges an obvious flaw in his argument: gravitational masses of galactic nuclei are usually at least an order of magnitude less than the total mass of surrounding stars, suggesting that the model does not produce equal amounts of matter and antimatter in each galaxy. He offers two ways out of this difficulty. The nucleus might fragment through explosions, the fragments showering out into

*Physics is not the only discipline to raise questions of symmetry: biologists have an analogous situation in "left-and-right-handed" amino acids. Laboratory preparation of asymmetrical amino acids always produces an equal amount of levorotary crystalline compounds which rotate light rays to the left – and dextrorotary ones. All known forms of life are composed almost entirely of levorotary amino acids; such a structure has been considered a requirement for identification of extraterrestrial life in meteorite studies. But as physicists speculate about the existence of cosmological antimatter, biologists do not rule out the possibility of carbon-based life, elsewhere in the Universe, composed entirely of dextrorotary amino acids.

Searching for the Antiworld

interglactic space, or the nucleus might radiate part of its mass as gravity waves.

But Hoyle has perhaps a more difficult obstacle to overcome. His model shares another similarity with Alfven's: it is consonant only with a problematic cosmology, in this case Hoyle's own Steady State theory, which calls for the continuous creation of matter and the infinite expansion of the Universe. Most theoreticians find that Big Bang cosmology — with a creation time of picoseconds and a finite expansion of the Universe — fits astronomical observations better.



Proton-antiproton annihilation in a liquid hydrogen bubble chamber.

AN ARTIFACT OF CREATION?

A model of cosmological antimatter compatible with — in fact, dependent on — Big Bang is offered by R. Omnes, Laboratoire de Physique Theorique et Hautes Energies, Universite Paris-Sud. Omnes agrees with most theoreticians that the recent discovery of a 3°K background radiation suffusing the Universe revealed an artifact of that colossal explosion. Ten to twenty billion years ago, time began, according to Big Bang adherents; in the first fraction of a second, the known Universe extended just the distance of a small solar system. Omnes says it contained only thermal radiation then, which must have generated plentiful and equal amounts of matter and antimatter.

He contends that at the extraordinarily high initial temperature — 3×10^{12}°K — particles and antiparticles effectively repelled each other, first avoiding annihilation and then separating to form proto-galaxies and antigalaxies; these worlds in formation interacted only at their boundaries, the annihilation there generating fluid motions by which matter and antimatter separately coalesced in different regions of space. As the Universe continued to expand, the bubble-like shapes contracted under their own gravitational attraction, precluding any radiation disaster through galaxy-antigalaxy contact.

A CRITICAL TEMPERATURE

Omnes' theory of distinct antimatter galaxies rests largely on the critical assumption that particles and antiparticles do not annihilate each other at the very high initial temperatures of a Big Bang. Since such temperatures are unavailable in the laboratory, Omnes relied on extension of theoretical knowledge to formulate his proposal. Dr. Gary Steigman of Cambridge's Institute of Theoretical Astronomy says that Omnes' conclusion "is in contradiction with experiments on nucleon-antinucleon scattering," adding that "for the range of applicability of this theory, nucleons do not repel antinucleons, they attract [and annihilate] them." (*Nature,* Nov. 1, 1969)

However, Omnes believes he has reason to be confident. He states that other theoreticians encourage his research, particularly because coalescence and boundary annihilation relate two basic cosmological questions: the observed size of galaxies and the 3°K background radiation. At a recent meeting of the American Physical

Searching for the Antiworld

Society, Dr. Omnes said his theory presents "rather good answers to several basic questions," although he conceded that "a decisive test of the actual existence of antimatter is still to be found."

SIGNALLING THE ANTIWORLD

The recent Conference on Communication with Extraterrestrial Intelligence urged that a serious program be undertaken to make radio contact with civilizations in nearby galaxies. If such a program were successful, Earth-based physicists might be able to determine whether these civilizations are anticivilizations (from our point of view) simply through a dialogue with possible antiphysicists: comparing results of a particular experiment conducted in the respective high energy accelerators. Charge-parity violation in K^0 meson decay indicates a convention for signs of nuclei charge – and whether the civilization is predominantly matter or antimatter.

Until the probably distant day of interplanetary talk shows, we will have to rely on more indirect methods of testing the proposed theories; these methods were discussed at "Astronomy from a Space Platform," a symposium held at the annual AAAS meeting and arranged by George W. Morgenthaler, Martin Marietta Corporation.

Noting the growing apathy with which people regard research programs of no apparent social relevance, Dr. Morgenthaler contended that such astronomical studies as the search for antimatter are "an integral part of the culture of mankind in the same category as art, music and literature. Astronomy . . . will help man understand his solar system, his Earth home and his evolutionary future."

INTERSTELLAR MESSENGERS

The medium through which the antimatter message will be transmitted is interstellar. Cosmic rays, elementary particles which may be accelerated by stars in their last stages of life – during supernova explosions, for example – travel through interstellar space at near light speeds; their energy levels reach an incredible 10^7 billion electron volts – and perhaps higher.

Dr. Andrew Buffington of the Space Sciences Laboratory, University of California at Berkeley, told the Symposium that "measurements of the isotope and momentum distributions for charged cosmic rays are of great interest in understanding their source . . . We cannot directly determine, using [optical astronomy], whether even our nearest neighboring star is made of the same kind of matter as we and *our* solar system, or if it is composed of the antimatter observed in accelerator experiments. The only practical way to find out would be to analyze an actual sample of material from the region near the neighboring star to see if the material has annihilation properties or reversed electric charge convention."

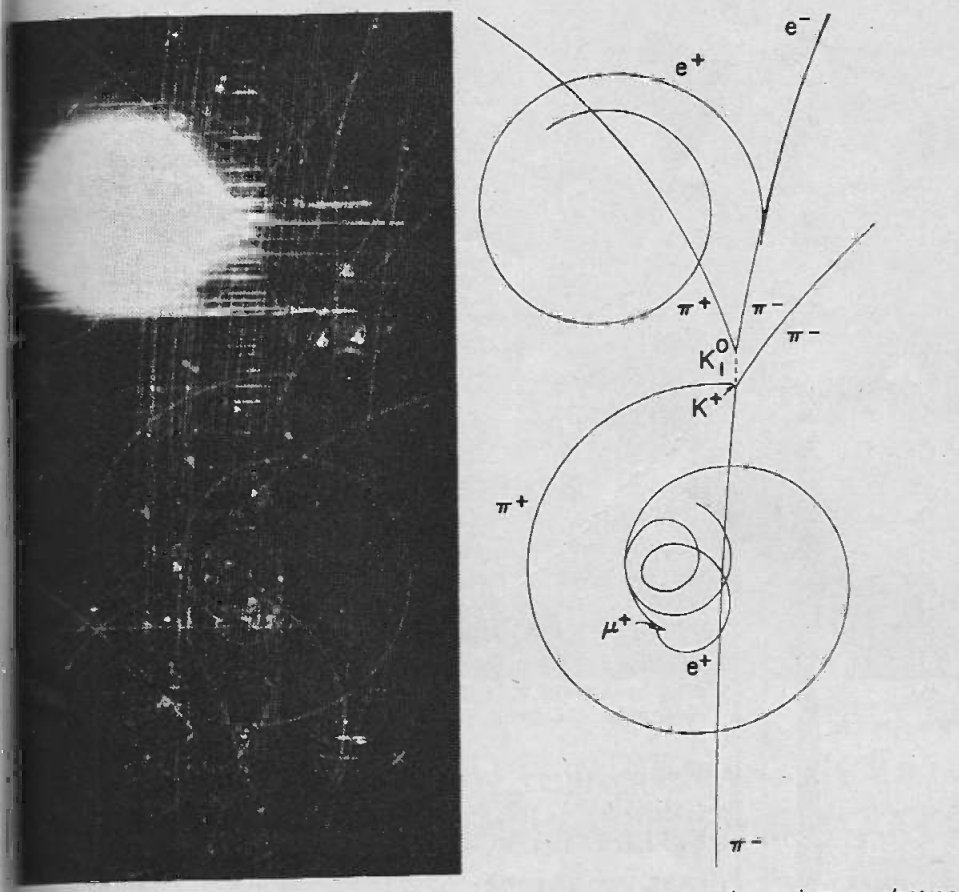
Astronomers will acquire their samples of material from outside the solar system – cosmic ray electrons, positrons, stripped nuclei and protons – with the High Energy Astronomical Observatory (HEAO): a series of four Earth-orbiting satellites designed to carry large, heavy instruments for interstellar X-ray, gamma ray and high energy particle astronomy without an interfering atmosphere. (Cosmic ray particles interact with atmospheric atoms to produce mesons and secondary particles.)

First in the series of experiment packages, HEAO-A is scheduled for launch by NASA in 1975. This flight, and other missions following in the late 1970s, will develop a branch of astrophysics begun during the last decade: high energy particle astronomy – a technical grouping of experiments similar to those used at large accelerators for investigating the properties of elementary particles. Because of advances in space satellite technology, many techniques for measuring accelerator particles can now be applied to cosmic ray particle measurement.

COOLING DOWN COSMIC RAYS

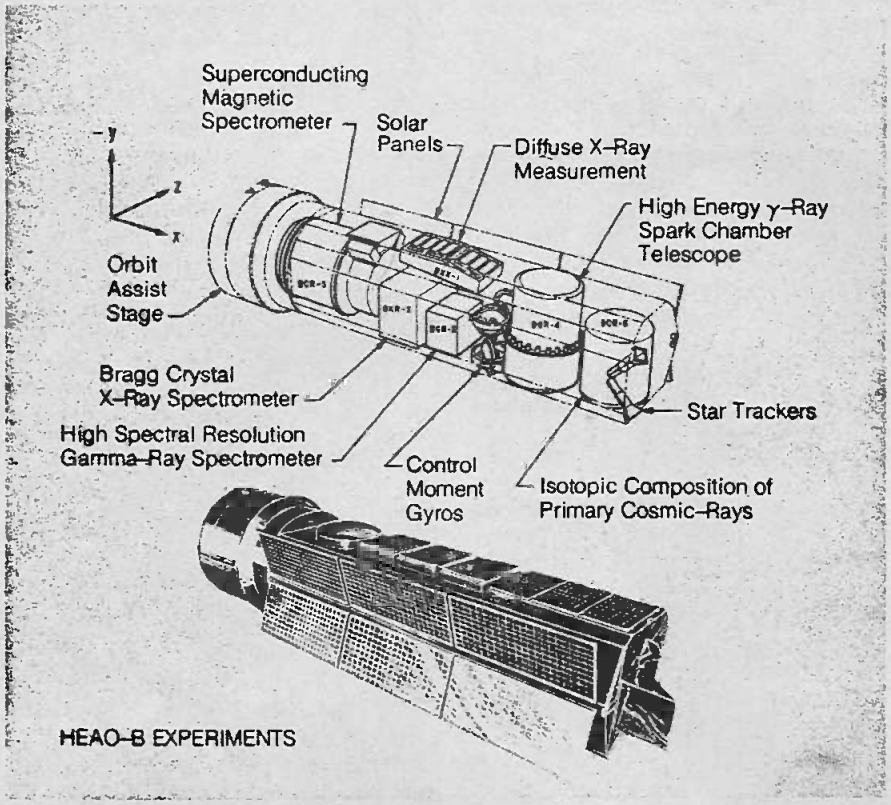
For example, a superconducting magnetic spectrometer, conceived by Dr. Luis Alvarez of the University of California at Berkeley, will search for antimatter on HEAO-B; the instrument is basically a large, super-cooled superconducting magnet, which deflects cosmic rays, with two precision spark chambers at each end to measure their deflection. A spectrometer capable of more critical measurements is proposed by Dr. Buffington for later missions; it uses liquid Xenon proportional counters as trigger, charge identifier and spatial detector.

"The magnet coil is cooled with a liquid helium refrigerator assembly, which also maintains the liquid Xenon in the proportional chamers. When an incident particle with appropriate



Simultaneous creation of matter and antimatter: gamma ray decays into an electron (e−) – positron (e^+) pair.

Searching for the Antiworld



HEAO-B EXPERIMENTS

charge passes through the three chambers, the electronics read out the position data and make a preliminary analysis. If the event appears to be an antimatter candidate, the accurate coordinates and other information are recorded on magnetic tape for more careful analysis elsewhere."

These experiments may not be able to determine which, if any, of the proposed antimatter theories is correct; random interstellar magnetic fields mix cosmic rays from many sources over a period of millions of years before they reach the Earth. Unlike optical astronomy, high energy astronomy cannot identify a given particle with a specific galactic or extragalactic source. However, the mix of particles carries sufficient information about the general nature of the sources and galactic structure to test the existence of galactic antimatter with assurance.

BACKWARD IN TIME

If HEAO discovers significant antimatter events in cosmic rays, it will support a charge-symmetric cosmology; if not, the findings will strengthen the arguments of many physicists, perhaps a majority, for an asymmetrically-charged, matter-dominated Universe.

In 1949, Nobelist, R.P. Fevnmann proposed that, mathematically, antiparticles could be regarded either as oppositely charged particles or as objects moving backwards in time while particles move forward. Some researchers relate the uniform expansion of the Universe – an object moving in one direction in time – with a corresponding time asymmetry of particle motion. Because symmetrical arrangements are not always the most beautiful, a Universe made predominantly of matter need not be rejected on aesthetic grounds, they say.

But whether the day is won by the matter-dominant camp or by those who believe in the equality of matter and antimatter, scientists have always accepted the equivalence of truth and beauty. *A285* ●

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HI-FI an initiate's guide

Specifically for the newcomer to hi-fi, this feature article by Collyn Rivers tells how to spend your money to the best advantage.

FOR the person knowing little or nothing about hi-fi, buying equipment can be a traumatic experience – for he is faced with spending anything between £100 and £1,000 without knowledge or prior experience of that which he seeks.

He will be overwhelmed with conflicting advice from his friends, and a barrage of pseudo-technicalities from that (fortunately) small segment of the hi-fi retail trade who appear totally to have lost sight of what they are selling.

Fortunately the more determined purchasers eventually find their way to responsible hi-fi retailers – or one of the growing number of manufacturers' hi-fi demonstration centres – and receive expert advice and guidance on their proposed expenditure.

Even so a surprisingly large number seek advice from magazines such as ours – often as many as thirty or forty a week. But all we can do is to offer general advice. Only in very exceptional cases can we suggest specific makes of equipment.

The purpose of this article is to provide guidelines for such people. It is specifically intended for those who know little or nothing about hi-fi except that they want to listen to well-reproduced sound.

WHAT IS HI-FI?

In essence, hi-fi is a term used to describe equipment capable of reproducing pre-recorded sounds with as much faithfulness to the original sounds as the current level of technology generally permits.

The only generally recognised hi-fi standard is the German DIN 45,500. Used throughout Europe – but rarely outside it – DIN 45,500 defines the minimum level of performance considered acceptable for hi-fi equipment.

This standard covers a wide range of parameters, including power output and distortion, and is administered on a go, no-go basis. Equipment either meets it or not. If it does, then it is described as meeting the requirements of DIN 45,500 and this fact will be prominently featured in the manufacturers' sales literature.

A substantial segment of the audio industry considers the minimum level of performance laid down by DIN 45,500 to be too low, but for many purchasers seeking to spend as little as possible, this standard provides at least some protection.

DIN 45,500 is not officially recognised in Britain – nor are there any alternatives – nevertheless if one is considering purchasing low-priced hi-fi gear of Continental origin it is worth while checking whether or not it meets this standard.

HOW MANY CHANNELS

The earliest audio equipment was monophonic. A single microphone picked up the original sound, which was then recorded and subsequently replayed via a single loudspeaker. Even when headphones were used, identical sound was reproduced by each earpiece.

No matter how good the equipment, monophonic sound always seems 'dead' by comparison with an original performance. This is because at an original performance there are loudness and time interval differences between the sounds arriving at each ear, and the brain, by analysing these differences, provides spatial information about the hall, the orchestra and the audience. It is this mechanism that enables us to pinpoint positions of various members of the orchestra – even with one's eyes closed.

This spatial information is totally lacking with monophonic reproduction.

Two-channel reproduction (stereo) uses two microphones and two independent recording and reproduction systems in an attempt to preserve the loudness and time interval differences that the listener would experience were he to be at the original performance. In this way an impression of the width of the original sound stage, and of the positioning of the various members of the orchestra will to some extent be recreated in the home.

Another, and to many people an unexpected advantage of stereo sound, is that it partially recreates the 'ambience' (acoustical atmosphere) of the concert hall.

The latest arrival on the hi-fi scene is four-channel – or quadraphonic – equipment. Here, four separate recording and reproducing systems are used, and the resultant sound is heard through loudspeakers which are placed in each of the four corners of the listening area.

The result is similar to stereo, only more so.

Four-channel gear will be described in greater detail later in this article.

COMPLETE SYSTEMS

A stereo system is in effect two virtually independent monophonic systems, but with most components assembled within common housings.

The first stage is either a stereo record player or stereo tape deck. Whichever is used, the output from the device consists of two independent sound signal channels – corresponding to the sounds that each ear would have separately heard at the original performance.

As the energy levels of the two signal channels are too weak to drive loudspeakers directly, an amplifier is used to increase their power level.

Two loudspeakers are used – generally placed along one wall of the listening room – each is driven by the appropriate amplifier channel.

RECORDS OR TAPE

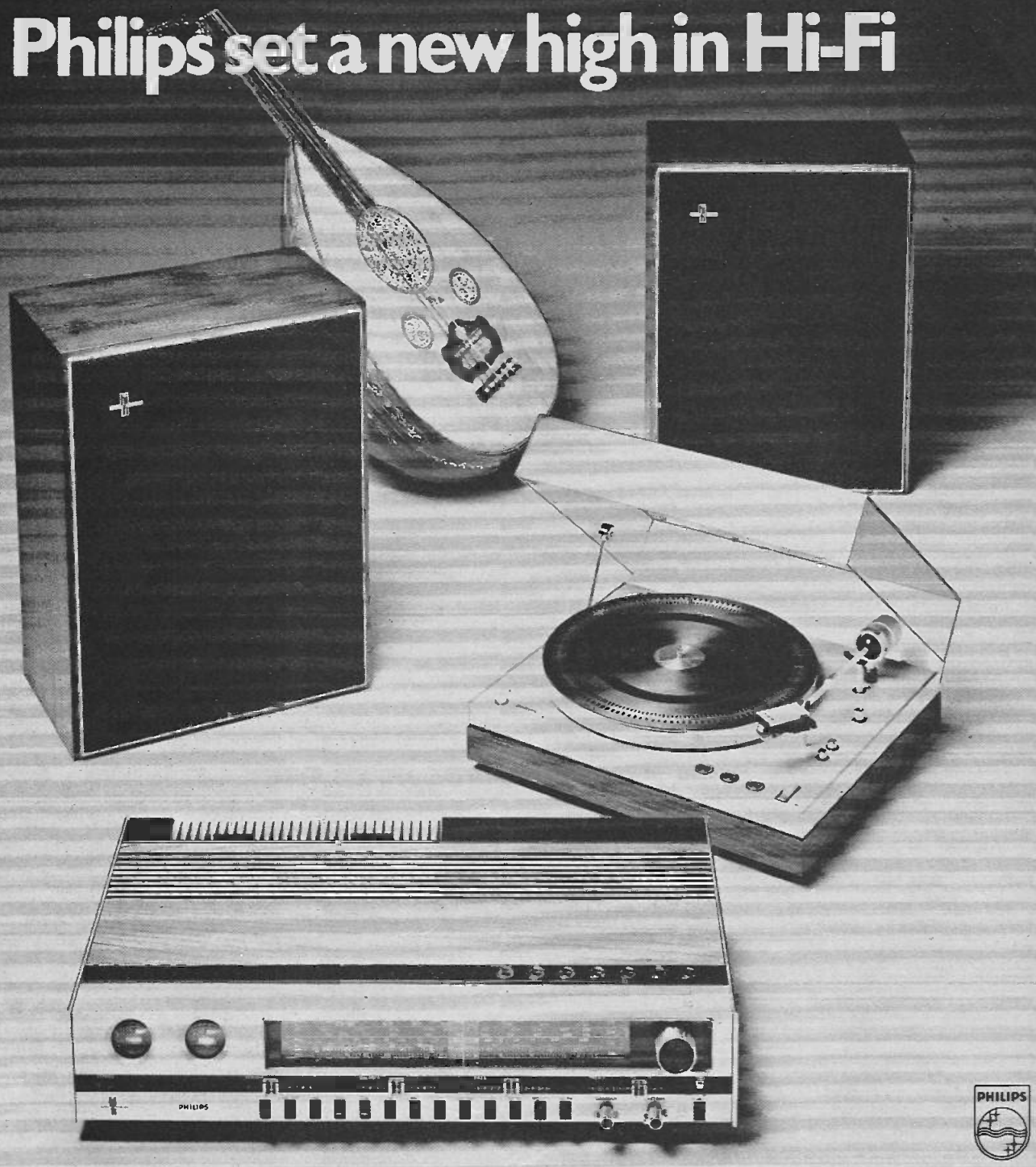
For many years the traditional method of recording and reproducing programme material has been the gramophone record, and until quite recently would have been the almost automatic choice of most hi-fi enthusiasts.

It is of course true that the tape recorder has been with us for a long time, but, in non-cassette form it is an unwieldy format for those whose main interest is to listen to material rather than to *record* it.

The cassette tape recorder has changed all that, and in its latest form

(Continued on page 23)

Philips set a new high in Hi-Fi



Philips have used advanced technology to develop one of the world's finest integrated audio systems.

It is based on the very sophisticated Philips RH720 tuner-amplifier, which offers a high power output of 2 x 30 watts sine wave, every facility for the precise control of sound, and beautifully clear reception on long, medium, short and VHF/FM wavebands, including FM stereo.

You can select any of six preselected FM stations instantly by just laying a finger on any of six controls that are sensitive to the touch. They make ordinary pushbuttons seem clumsy. There's a switch to silence inter-station noise when tuning on FM, and another for Automatic Frequency Control to ensure stable FM reception. Variable bandwidth on AM gives a wider range of tones where reception conditions allow, or increases even further the tuner's remarkable ability to separate crowded stations. You can connect two pairs of loudspeaker enclosures, perhaps in separate rooms, selecting either pair for stereo, or all four in one room for Philips STEREO-4 surround-sound.

The GA212 'electronic' record deck sets new high standards in record reproduction, with touch-sensitive speed selectors, photo-electronic switch-off, strobe for precise speed adjustment, electronic brain to keep speed constant during play, SUPER M magneto-dynamic cartridge, and many other top-quality features.

The RH405 enclosures each have three loudspeakers ... for low, middle and high notes independently ... giving beautiful full-frequency reproduction.

For a free 36-page Audio Guide, write to Philips Electrical Limited, Dept SP, Century House, Shaftesbury Avenue, London WC2H 8AS.

PHILIPS

We want you to have the best.

(Continued from page 21)

HI-FI

it is a serious rival to the traditional record player — with the added capability of being able to record programme material.

The tape cassette works on the same principle as the original reel-to-reel tape recorder — i.e. the tape is wound from one bobbin to another — but now it is fully enclosed within a small rectangular package that plugs into the cassette recorder in a quick and simple way.

Cassettes are classified by numbers related to their running time in minutes. Thus a C60 cassette runs for 60 minutes (30 minutes each side), a C90 for 90 minutes (45 minutes each side) etc.

At present the maximum tape length generally available is C180 — providing a total of three hours playing time.

The quality of reproduction obtainable from a cassette recorder is closely related to its price. At present for any given level of reproduction it is a more expensive sound reproducer than the disc record player. The gap closes as price increases and the very best cassette recorders offer performance very close (but not yet quite equal) to the best record playing systems. When comparing prices of record players and cassette decks one must bear in mind that a cassette deck can (generally) also be used to make recordings as well as reproduce them.

A problem common to all cassette players is random noise. This is generated by the tape at all times and can be annoying during quiet passages in the programme material.

One method devised to overcome this, is the Dolby Noise Reduction System. The Dolby system involves a special recording technique in which quiet passages are automatically raised in volume. Special Dolby circuitry incorporated within the cassette recorder then restores these passages to their original level — the overall effect being a substantial reduction in tape noise.

Conventional tape cassettes use an iron oxide based tape and these are useable in all types of cassette recorders.

Chromium dioxide based tapes are also available. Generally, these chromium dioxide tapes (often abbreviated to Cr02) are capable of better performance than the iron oxide variety but should only be used in cassette recorders specifically designed for their use. (There are also some highly specialised iron oxide based tapes claimed to have equal performance).

Some cassette recorders are built as self-contained units and do not require a separate amplifier. However these inbuilt amplifiers have a very low power output, and are rarely capable of driving loudspeakers at the sound levels desirable for true hi-fi reproduction.

A few cassette tape decks without recording facilities are currently available. They are suitable for playing pre-recorded cassettes only. But the majority of cassette units can be used for recording material directly from radios, record players, microphones, etc.

A headphone jack socket is usually provided to enable the user to monitor the material being recorded.

For top quality hi-fi reproduction one must use a machine with inbuilt Dolby (or similar) noise reduction system, and designed to be used with a high performance iron oxide or chromium dioxide tape. At the time of writing, machines of this sort cost from around £100 upwards.

Quite satisfactory hi-fi performance may also be obtained from machines without the Dolby system, but do not expect a great deal from machines costing much less than £60. Table I shows typical performance figures for three cassette players.

RECORD PLAYERS

Despite the challenge now being offered by the cassette player, the long playing record and record player are far from dead, and at present a top quality record playing system is still marginally superior to a top quality cassette tape system.

Record players can be divided into two main groupings: manual or automatic. Manual units can accommodate only one record at a time, and will probably — but not necessarily — be fitted with an automatic mechanism to stop the turntable and raise the needle at the end of the record.

Automatic players on the other hand, accommodate a stack of records, and these are changed automatically in sequence.

At one time, automatic record players were unpopular with hi-fi enthusiasts, as the lowering mechanism was liable to cause record damage. This is no longer a problem with any good quality unit, though some of the cheaper mass-produced record players are still suspect in this regard.

The turntable may be driven from the motor either by a rubber wheel pressing against the turntable rim, or by a belt. Both mechanisms have their good and bad points — the important thing is to choose a well engineered device — regardless of the design approach taken by its maker.

Some record players use very heavy turntables — to reduce short term speed fluctuations, others use light turntables and inherently smooth running motors to obtain the same result.

As with the drive mechanisms, both approaches have good and bad points. A heavy turntable will reduce fluctuations, but the increased load on the bearings tends to introduce a low pitched 'rumble' which may be reproduced through the loudspeakers. The lighter table will be less likely to 'rumble' but may have minor speed fluctuations unless the drive motor is speed controlled. But of the two best record players that we have ever used — one had a very heavy turntable — the other had a very light one!

The minimum price for a reasonably good quality record player is around £30. Really good ones cost £50 upwards and truly excellent ones around £120.

A record player is a fairly straightforward piece of engineering and whilst some are obviously better value for money than others, one would be very unfortunate to choose a bad example if one keeps above our suggested minimum price.

PHONO-CARTRIDGES

Generally a phono-cartridge will be supplied with the record player — however with top quality record players one may be offered a choice of cartridges.

There are two main types of cartridges. These are classified by their operating principle. Cheapest are the ceramic types in which the moving stylus applies varying pressure to a ceramic material. When squeezed, this material generates a voltage roughly proportional to the applied pressure.

A top quality ceramic cartridge produces quite acceptable sound — in

Table 1

Cassette Tape Recorders

Parameter	£40	£55	£100	Comments
Frequency Response (±3dB)	50Hz-9kHz	30Hz-11kHz	30Hz-14kHz	Wider the better
Wow and Flutter	Less than 0.5%	Less than 0.2%	Less than 0.1%	As above.
Distortion	Less than 5%	Less than 3%	Less than 2%	The lower the better
Signal/Noise ratio	+ 40dB	+ 45dB	+ 50dB	Higher the better

fact they are used by the million in low and medium quality record players. But at the present time this type of cartridge cannot compete with the higher quality magnetic cartridges. Nor does it pretend to.

Magnetic cartridges operate by causing the moving stylus to generate small electrical signals in coils placed near a small magnet attached to the moving stylus. Other magnetic cartridges utilize a magnet located close to the stylus and this causes magnetic energy to be coupled to the stylus and thence to the coils.

The weight imposed by the cartridge stylus upon the record is called the tracking weight. For good quality stylii this will be between half a gram and three or four grams. Within reason the lower the tracking weight the better, but if the weight is less than two or three grams, further decreases in tracking weight have little advantage. In fact a record is more likely to be damaged by the stylus jumping around due to underloading than by excess loading.

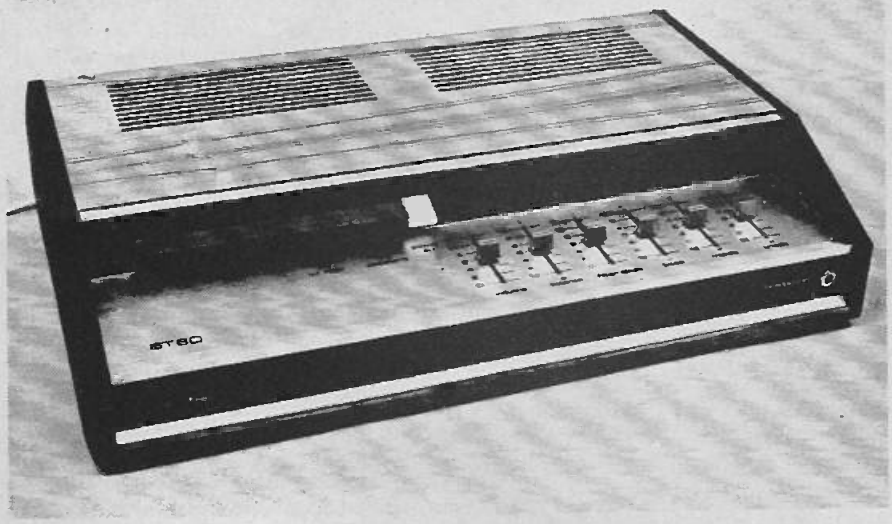
Cartridges vary considerably in price, but as with nearly all hi-fi gear, quality is closely related to price.

Ceramic cartridges range from £1 or so, up to £7; magnetic cartridges from a low of £3 to really superb units costing around £40. As a rough guide a cartridge should cost around a third of the price of the record player with which it is used.

Table II shows typical specifications for three different turntables.

Table II

TURNTABLES Parameter	£30	£50	£120	Comments
Wow and Flutter (rms)	Less than 0.2%	Less than 0.1%	Less than 0.05%	Lower the better but not significant below 0.05%
Signal/Noise Ratio	+ 40dB	+ 50dB	+ 58dB	Higher the better



Shape of things to come? Metrosound's latest Model ST60 amplifier.

RADIO TUNERS

Radio tuners for the Hi-Fi enthusiast are available in a variety of shapes, sizes and prices. They may be FM, FM/AM or multiflex FM/AM. Tuners offering the MW (medium wave) and LW (long wave) AM bands only are not built for high fidelity equipment, in this country, as FM offers much better fidelity. However, any existing AM radio can be modified to enable it to be connected to an amplifier. The sound quality will not be truly Hi-Fi but will be better than most initiates realize.

A tuner may be purchased as a separate item of equipment, or it may be incorporated into the main amplifier and the system is then known as a tuner amplifier. Which system you choose is largely a matter of personal choice. On the one hand the combined unit will reduce the number of pieces of equipment by one, but on the other hand may cost more than you can afford to pay out in one lump. In addition if it is required to update the amplifier to a more powerful version, the tuner must go too if in a combined unit.

Tuners range in price from around £40 to about £110 depending to a large extent on the finish of the front panel and the housing. If a tuner without stereo multiplex decoding has already been purchased, a separate decoder may be bought for around £9. If purchasing a unit offering FM/AM and stereo decoding in the one package. Note that the cost of a tuner is not incorporated in our previously mentioned apportioning guide and should be added as a separate item.

Tuner amplifiers vary widely in price from about £70, up to about £250 but as a basic rule choose the amplifier you need first and then see what is available in a combined unit. The amplifier must take precedence in your choice.

AMPLIFIERS

An amplifier is used to increase the power level of the relatively weak signal from the record player or cassette player — to a level adequate to drive a pair of loudspeakers. It will also have controls enabling one, selectively, to increase or decrease treble and bass frequency response.

In recent years a second class of amplifier has become increasingly popular. This is the tuner-amplifier, and, as its name implies, is a combination of power amplifier and radio tuner. Radio tuners will be discussed in greater detail later in this article.

The selling price of an amplifier is determined by its power output, its ability to amplify signals without introducing distortion, the level of noise that it develops internally, its suitability for use with other equipment such as microphones, tape recorders, extra turntables etc, and of course its quality of manufacture and after-sales service.

Table III shows typical specifications for three amplifiers in different price brackets. Note that for distortion, below 1% is good, below 0.5% is excellent. Anything below 0.1% is gilding the lily.

Amplifier noise may be checked in the dealer's showroom by turning the volume control fully up with the record player switched off, or preferably, disconnected. With a good amplifier only a very faint hiss should be heard with one's ear close to the speakers.

HOW MUCH POWER

Perhaps the biggest problem facing the inexperienced hi-fi buyer is determining how powerful an amplifier he needs. Power output is measured in watts — often abbreviated to 'W'. It seems simple enough but isn't, for the hi-fi industry has an incredible practice of determining, and quoting, this output in at least six widely different ways. As a result, one and the same amplifier may be described as having an output from 10W to 60W depending entirely upon which measurement system has been used.

HI-FI

AMPLIFIERS	TABLE III			
Parameter	£30	£70	£150	Comments
Power Output	18W	30W	60W	Price should be between £2 and £3 channel watt
Total Harmonic Distortion (at 1kHz)	Less than 0.75%	Less than 0.5%	Less than 0.25%	Insignificant below 0.1%
Frequency Response (20Hz-20kHz)	±3dB	±1dB	±0.5dB	Generally adequate with modern amplifiers
Hum & Noise (with respect to rated power)	- 50dB	- 60dB	- 70dB	Higher the number the better.

Output may be quoted in watts (rms), watts (continuous power), watts (peak), watts (peak-to-peak), watts (music power), watts (IHF), etc.

Only two ratings are meaningful for comparing one amplifier with another. These are watts (rms), and watts (continuous power). The former expression is technically dubious but has gained understanding and acceptance by common usage. Both terms are effectively interchangeable. Thus 10W rms is much the same as 10W continuous power. (From here on in this article, when we use the word watt, the rms (or continuous power) rating method is applied.

As we stated above, the price of an amplifier is closely related to its power output, and will usually be somewhere between £2 and £3 per watt. If the price is much less than this, it is a safe bet that the power output is not being quoted in watts (rms). If the price is substantially higher than £4 a watt, it is either a unit of superlative quality — or it is overpriced.

Just how many watts you require from the amplifier depends on a number of factors, these include room size, loudspeaker efficiency, and just how loud you like your music.

Rather than introduce a mass of complicated mathematics we have prepared a simple graph — Fig. 1 which shows average power requirements for rooms of various sizes and for two different types of speaker. (The differing power requirements of speakers are explained later in this article).

As our graph shows, most listening requirements will be satisfied by amplifiers rated between 20W and 100W — and thus costing between £40 and £300. If in doubt err on the side of too *much* power, because bass response will be lacking if there is too little. It is important also to realize that, due to the ear's logarithmic response to sound levels, doubling amplifier power will not result in twice the apparent loudness. In fact it will only just be noticeable. To double apparent loudness one must increase power by no less than ten times. Hence minor differences in amplifier power are quite insignificant as far as loudness is concerned — over the mid-range part of the audio frequency spectrum at least.

Amplifiers have now been developed to the point where they are closer to the ultimate attainable performance than any other item in the hi-fi chain. As a result — and providing power output is adequate — there is little audible difference between amplifiers of broadly similar specifications. These are probably the easiest items of hi-fi equipment to choose, for within the price range quoted previously, we have yet to see any bad ones!

LOUDSPEAKERS

Speakers are individualistic animals, and there are clearly audible differences between speakers of similar specifications and prices.

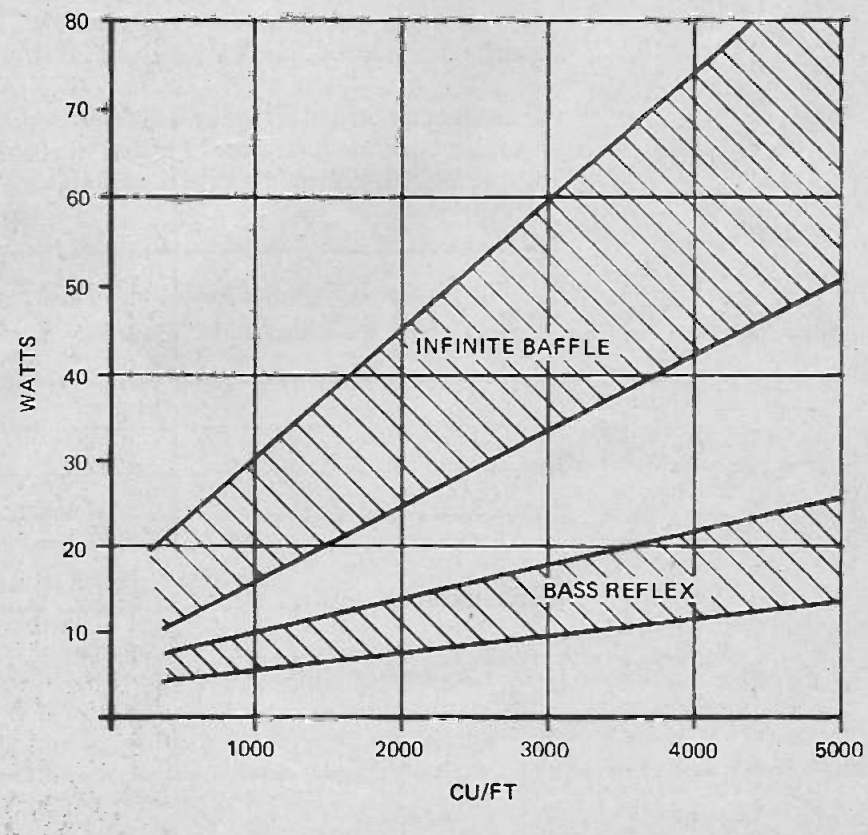
Contrary to general belief, there is no relationship between the number of speaker drive units in any given enclosure and the resultant sound quality. One of the best units currently available uses nine drive units, one of the worst uses eight. It is significant, that with rare exceptions, most really good speakers have only two or three drivers. (The term 'two-way' is often used to describe speaker enclosures using two drive units; 'three-way' for those with three — etc.)

A figure sometimes quoted by speaker manufacturers and salesmen is that for overall efficiency. This is quoted as a ratio of the electrical power input *to* the speaker (from the amplifier) and the acoustical power output *from* the speaker. The result is quoted as a percentage. Thus a speaker requiring 50W input for 1W output is 2% efficient.

There are enormous differences in efficiencies, from as low as 0.1% to as

(Continued on page 28)

Approximate amplifier power requirements for various size rooms.



Meanwhile, let's tell you about Rotel.

In the past couple of years, the name Rotel has come to mean the best value-for-money hi-fi equipment available.

And we intend to keep it that way.

So we've made the range bigger and better than ever.

There are two new amplifiers – the RA 810 (40W per channel at 8 ohms) and the RA 1210 (60W per channel at 8 ohms). Two new receivers – the RX 600A (30W per channel at 8 ohms) and the RX 800 (40W per channel at 8 ohms). And, for the first time, a 4 channel FM/AM receiver, the RX-154A, that will perform any 4 channel activity.

What's more, all the other models in the range have been brought right up to date.

So now Rotel offer you an outstanding range of amplifiers, tuners, receivers and headphones to suit every hi-fi need.

And every model is designed to give you the finest balance of quality and value.

To show that we mean what we say about value, let's just tell you that a well-known hi-fi writer took us to task last year about the value offered by one of our machines. We checked the facts. He was right. We improved our model.

That's how serious we are about keeping our reputation for value.

The whole of the Rotel range is spelled out in detail in a leaflet that's yours in return for this coupon. Send off for it now. And don't forget that you can hear Rotel right now at your Rotel dealer.

To: Rotel, Rank Audio Products, P.O. Box 70, Great West Road, Brentford, Middlesex TW8 9HR.

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Address _____

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Please send me the Rotel range leaflet. ETI2

Rotel equipment is made in Japan and Taiwan by Roland Electronics Ltd., and is distributed and serviced in the UK exclusively by Rank AudioProducts, P.O. Box 70 Great West Road, Brentford, Middlesex TW8 9HR. Telephone: 01-568 9222

(Continued from page 25)

high as 50% – depending almost entirely upon the physical size of the speaker and the design approach used by the manufacturer.

Two types of speakers are commonly used. One, the infinite baffle type, consists of an enclosure that is totally sealed except for the speaker drive units. Bookshelf speakers are usually made like this. They have very low efficiency – from 0.2% to 1% or so. Most of them have a very good bass response if driven by an amplifier of adequate size, at least 20W is required – many need even more.

The second commonly used type of speaker is the bass-reflex cabinet. Generally larger than the infinite baffle speaker, they can easily be recognised (if the speaker grille is removed) as they have a circular or rectangular cut-out usually, but not necessarily in the front panel – venting to atmosphere. They are more efficient than the infinite baffle type of enclosure – 2% to 5% is typical. Because of this they do not require such a large amount of power to drive them.

Do remember when choosing speakers that the efficiency provides no indication whatever of that speaker's quality, merely of the power required to drive it.

Magazines such as Electronics Today International publish tests of various makes and types of loudspeakers. Apart from publishing actual measurements of the speakers' performance, most journals also attempt to describe the quality and type of sound produced. An indication of relative value for money is included – at least in our magazine it is!

But no matter how much one reads about speakers, one can only make a final choice by listening to them.

Visit a reputable hi-fi dealer and ask him to demonstrate speakers in the price range that you have in mind. Don't try to compare more than three speakers in one day and always listen to the speakers at about the same sound level because the louder of any two speakers will nearly always appear to have the better response.

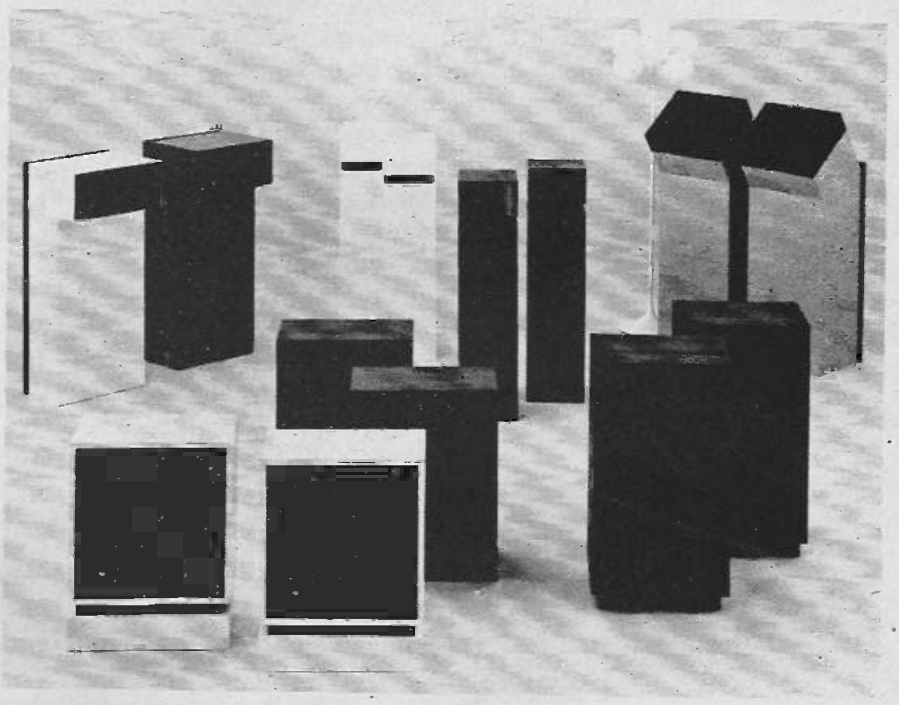
Some hi-fi demonstration rooms have very odd acoustic characteristics, and speakers may not necessarily sound the same in your home as they do in the showroom. If at all possible try to arrange for a demonstration of your final choice of speakers at home – many dealers will oblige if you are a genuine buyer.

As we stressed throughout this article there is a positive correlation between the price and the standard of performance of most hi-fi equipment. This is true also of speakers – but possibly to a lesser extent than the remainder of the equipment, and it is well worth while listening to a number of different types and makes before making a final decision.

In general the more expensive speakers – ie £50 upwards – have greater power handling capability, better bass response and less colouration than cheaper units. (Colouration sounds like speaking through cupped hands).

But good speakers demand an equally high standard of performance from the associated amplifier, record player and stylus, and if these items are not up to standard, the high quality speakers will merely highlight deficiencies elsewhere. A later section of this article explains how to balance the equipment so that this does not happen.

Latest amplifier from Marantz has 120 watts output per channel.



Omni-directional speakers from JBL.

FOUR CHANNEL EQUIPMENT

There are several, currently non-compatible, systems for reproducing four-channel sound. Some use four-track tape recordings (and a special tape recorder), others use specially produced 'four-track' records, whilst yet another class of systems synthesize four-channel sound from normal two-channel recordings.

Four-channel sound usually sounds quite awful in a dealer's showroom – but can be very effective in the home. It seems to need 'dead' surroundings to be truly effective.

At present the market is in a state of confusion, four-channel equipment of several different types is commercially available but there is as yet no internationally recognised standard

(Continued on page 30)

There's no such thing as the perfect Hi-fi system.

That's why we made the 810.

There is no one Hi-fi system which is perfect for everybody.

Rooms, like wallets, are different sizes. And musical reproduction requirements vary.

So we've made the ultra-flexible, supremely compatible, highest quality turntable.

The BSR McDonald 810.

For the man who wants to choose separate amplifier and speakers to build up his own perfect Hi-fi system.

It costs £44·25. It's a transcription unit weighing 16½ lbs. The diecast turntable alone is 6¾ lbs. – solid and dynamically balanced.

A pitch control gives accurate turntable speed, using stroboscopic centre plate.

The low mass aluminium pick-up arm is gimballed for virtually friction free movement in all planes.

It has a slide-in cartridge holder, minimum tracking pressure of ½ gramme and decoupled one piece counter-balance.

Its 4-pole dynamically balanced synchronous motor compensates for any fluctuation in mains voltage or record load.

There's hydraulically actuated viscous cueing on manual and automatic, and a unique anti-skate device.

The 810 is a two-speed player, 45 or 33⅓ – all that's needed on a modern turntable.

It operates by featherweight push-button for start/stop and selection of record size.

A rigid smoke-tinted styrene dust cover and a polished wooden plinth are available as extras.

For a preview just return the coupon, or ask to see and hear the deck at your local dealer.

BSR Limited, McDonald Division, Monarch Works, Cradley Heath, Warley, Worcs.
Tel: Cradley Heath 69272.

Please send me your illustrated brochures of the complete range of turntables.

Name_____

Address _____

_____

ETI1

It's a sound start

BSR McDONALD

(Continued from page 28)

HI-FI

defining even basic formats. As a result, programme material recorded for any one system is not necessarily playable on any of the others.

The cheapest way to obtain a rough idea of what four-channel sounds like is to use the system described in Electronics Today, July 1972. This requires just a few feet of wire and two extra speakers and synthesizes four-channel from standard stereo material.

WHAT IT COSTS

It has been suggested that one can relate the price one pays for hi-fi gear against motor cars. This comment is quite valid.

For example a basic Escort or Mini is the motoring equivalent of about £100 spent on hi-fi. Good value for money if one accepts some limitations of performance.

£120 to £180 buys the hi-fi equivalent of a basic Marina or Cortina – sufficient power for most situations – some performance limitations but reasonably good quality.

£200 to £300 puts you in the Volvo 144, Peugot 504, Rover 2000 class – and this expenditure probably provides the optimum in terms of value for money.

There are still substantial improvements to be found up to the £500 mark and you are now in the Mercedes 250 range.

Above £500 to £750, increments in performance are there, but less obviously. This is the realm of the Mercedes 600, and is for the connoisseur or the very rich.

HOW TO APPORTION THE MONEY

It is essential to apportion the money so that all items are of roughly equal quality. This is where many people go wrong and end up with a brilliant pair of speakers and an inadequately powered amplifier, or an excellent turntable and a lousy cartridge.

There is one practically infallible way of ensuring that everything is well balanced. This is to decide how much you can allocate, and then apportion somewhere between 40% and 60% for the two speakers, and split the remainder more or less equally between the amplifier and record player.

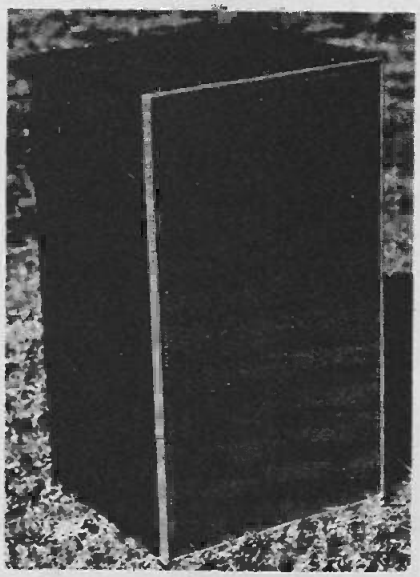
Bear in mind that speaker efficiency will affect the exact amount spent on the amplifier. The higher the speaker efficiency, the lower the power required to drive them, and as the amplifier cost is directly related to power output, less money need be spent on the amplifier if high efficiency speakers are used.

Having apportioned the money, check Fig 1 that your various allocations will enable you to buy sufficient power for your needs.

If you are buying a tuner amplifier, calculate as if it were a straightforward amplifier, and then add somewhere between £20 to £40 to the price. Much the same applies if one has a cassette player in mind, in this case add between £20 to £40 to the amount which would otherwise have been spent on the record player – but spend it all on the cassette unit instead.

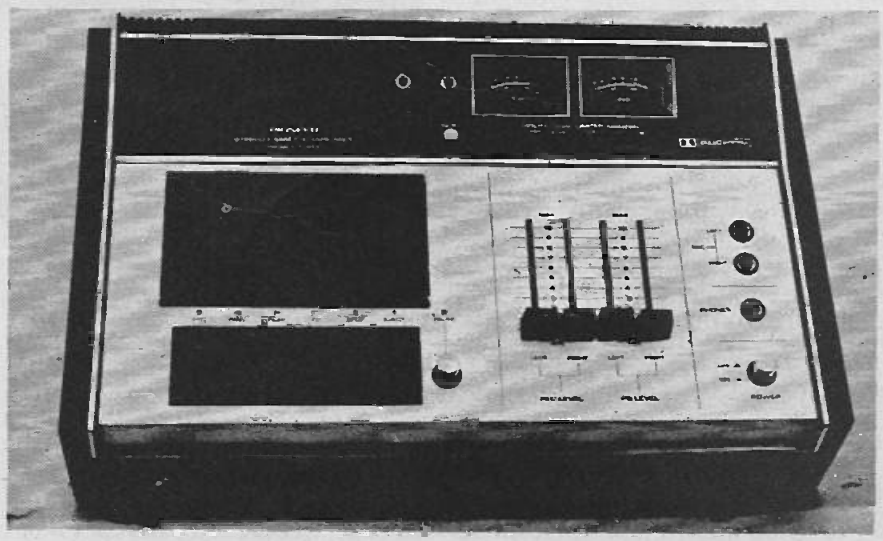
As one goes up in price, it may be necessary to vary the percentages slightly, spending just a little more on speakers and amplifier, and a shade less on the record player. In this league the record player will probably be offered with a choice of cartridges. Here one should spend just over two-thirds (of the record player's allocation) or the player itself, and the remaining one third or so on the cartridge.

We must emphasize that the allocation we have suggested is just a rough guide. There may well be combinations of units, falling outside these guide lines, that will still be well matched. But if you do allocate your money as indicated you are very unlikely to go wrong.



Leak equipment is well known and respected. Photograph shows Leak 250 loudspeaker.

Hi-fi speakers do not have to be heavy as these 15 watt Denton units from Wharfedale prove.



Typical of the new generation cassette recorders is this unit from Pioneer. Machines such as this have performance very close to top quality record playing systems. (A review of this machine will be published in ETI very soon.)

HI-FI

Here are a few examples to illustrate the general principle.

EXAMPLE A

You have allocated £160 – therefore you have about £40 to spend on each of the four items (you need two speakers remember!)

Minimum price for a reasonable amplifier is about £2 a Watt – thus for your money you can afford a 20W amplifier.

You have an average sized listening room and Fig 1 shows that 20W is about the right amount of power.

All is well – and you should have no difficulty in assembling a well balanced outfit.

EXAMPLE B

Here you have the same amount to spend as in example A, but you have a very large listening room.

Figure 1 indicates that you need at least 40W if you are intending to use low efficiency speakers.

Here it is necessary either to just spend more money – or to settle for a 20W amplifier and restrict one's choice of speaker enclosures to the more efficient bass reflex type.

EXAMPLE C

You can afford £200 but would prefer to use a cassette player instead of records.

Deduct between £20 and £40 from your total allocation of £200. This leaves £160 which you should apportion in the ratio described above. To the amount that you would normally have used for the record player add the £20 – £40, so that you now have between £60 and £80 to spend on the cassette player, £40 for the amplifier, and £40 for each of the two speakers.

WHERE TO BUY IT

We very strongly advise you to buy your gear from an established hi-fi dealer unless you know exactly what you need and can service the equipment yourself.

Good hi-fi dealers can be recognised by the quality of the agencies that they hold. If these include several top names then it is a safe bet that they are reputable businesses prepared to back up their sales with service.

These days, no one sells at the recommended retail price, but be careful of any deal which offers you more than about 25% discount. Big discounts can only be given by reducing, or deleting, after sales service. The cost of providing this service is built in to the recommended price so make sure that it is still available before buying.

INSTALLING HI-FI

With present day equipment, installation is a straightforward procedure and can be completed by practically anyone within an hour or two. Nearly all manufacturers provide detailed explanatory literature – others leave rather more to be explained by the dealer.

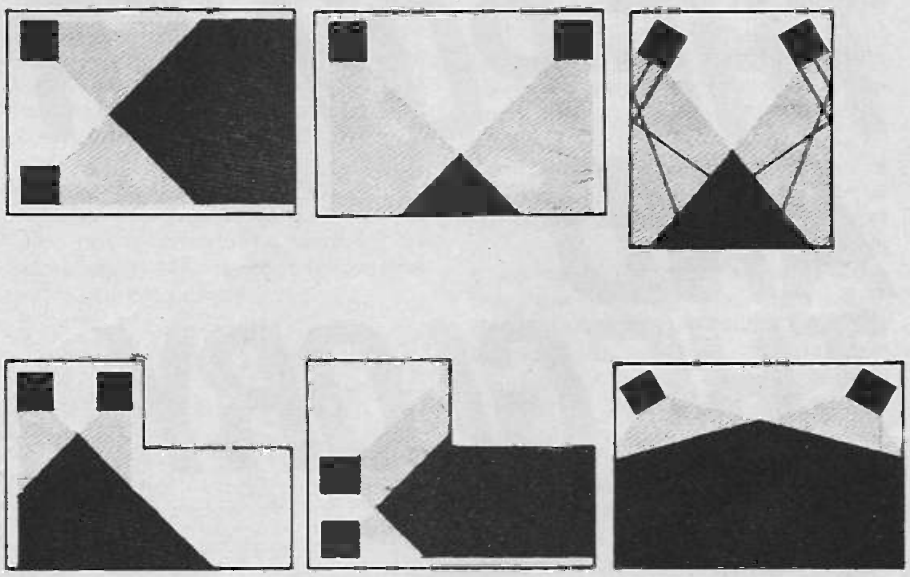


Fig. 2 Suggested speaker placings

But the procedure is not difficult and you can almost certainly rely on your dealer for assistance if you run into any problems. Many dealers will even install the complete equipment if required.

All the interconnecting leads will be supplied and it is simply a matter of plugging these leads into the right places.

It is probable that the speaker leads supplied will not be long enough. These may be replaced by standard two-core lighting flex.

Speaker 'phasing' is important. This will almost certainly be explained in the instructions supplied with the speaker enclosures. If it is not, then ask the dealer to tell you how to do it – or even to come along and check it for you.

The record player should be level in both planes. Check that it is, with a spirit level.

An adjustment will probably be provided for setting the tracking weight of the record player tone arm. Again, instructions will be provided with the unit and adjusting to the correct weight is a simple matter.

Transistor amplifiers do not generate much heat and as long as you do not actually cover them up, it is only necessary seriously to consider ventilation on bigger units (of 30W and over).

The length of the signal leads between the record player and the amplifier is fairly critical and affects high frequency response. If the leads are too long don't cut them – just coil them up. If too short, then move the amplifier closer to the turntable.

The two speakers should be placed about eight to ten feet apart, and for most types, raised so that the tweeters are between 3'6" and 4'6" above floor level. Figure 2 shows a number of suggested speaker placings.

Locating the speakers in the corners of the room will increase the bass output – moving them away from the corners will reduce it. Try several different speaker placings before making a final decision. ●

Hi-fi equipment specifically named or shown in this article has been included solely to illustrate certain points. The inclusion of any item should not be taken as an endorsement of quality, nor as any recommendation to purchase. Nor should it be assumed that other equipment – that has not been included – is in any way inferior.

THE POWER AND THE GLORY

electronics TODAY INTERNATIONAL product test

We test the McIntosh C26 Preamplifier and MC2105 105 watt power amplifier.

AMERICANS make things bigger, better and more powerful, than practically everyone else.

A good example of this is the McIntosh MC2105 amplifier and matching C26 preamplifier, for here is a stereo amplifier system that can deliver a cool 105 Watts, *average continuous power* from each channel into 4, 8 or 16 ohm loads, and provides superlative performance with apparent ease.

The McIntosh preamplifier is packed in three heavy cardboard cartons — inside one another — providing more than adequate protection.

Having unpacked the unit one cannot help but be impressed by the unusual appearance. A large black glass panel stretches right across the front of the unit and this carries markings that are gold coloured when the unit is switched off, but which change to green when power is applied.

Each end of the front panel is finished by a chromed metal strip. All control knobs on the front panel are machined from solid aluminium and these are finished with a high lustre on the front face and have a knurled edge. The position of each knob is indicated by a slot neatly cut in its edge. The input selector switch, which is located in the top right hand corner, has six positions. These are:—

Auxiliary
Tape 2
Tape 1
Tuner
Phono 1
Phono 2

A selector switch, that provides every conceivable operating mode, is located adjacent to the input selector and has seven positions. These are, by clockwise rotation:—

1. Left channel input to left and right channel outputs
2. Right channel input to left and right channel outputs
3. Stereo reverse
4. Stereo normal
5. Mono, which adds the left and right inputs and feeds the combined signal to both output channels.
6. Left plus right input to left channel output only.
7. Left plus right input to right

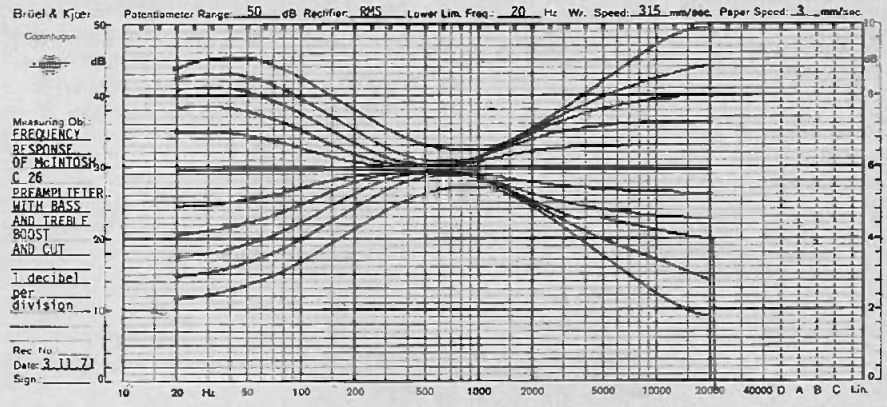
channel output only.

A set of six "push on" "push off" buttons are located below the input and mode selector knobs. These select Tape 1 or Tape 2 Monitoring, Low Pass and High Pass Filters, and Main and Remote Speakers. When all speakers are switched off, two 16Ω, 10W dummy load resistors are switched across the outputs. The make and model identifications of the preamplifier together with a red illuminated "power on" indicator strip and the volume control are located in the top right section of the front panel.

The volume control was the only part of the preamplifier, that in our opinion did not reflect the same level of thought and effort evident in the rest of the unit. This control doubled as an on-off power switch (at the fully anticlockwise position) and this could result in excessive wear of the potentiometer. Ideally, an additional "push on" "push off" button could have been included with the six buttons on the left hand side for switching the power on and off, or, alternatively, a pull to operate control potentiometer could have been used.

The bottom half of the right hand side contains the following controls:

a) A loudness control which is variable and independent of the volume control.

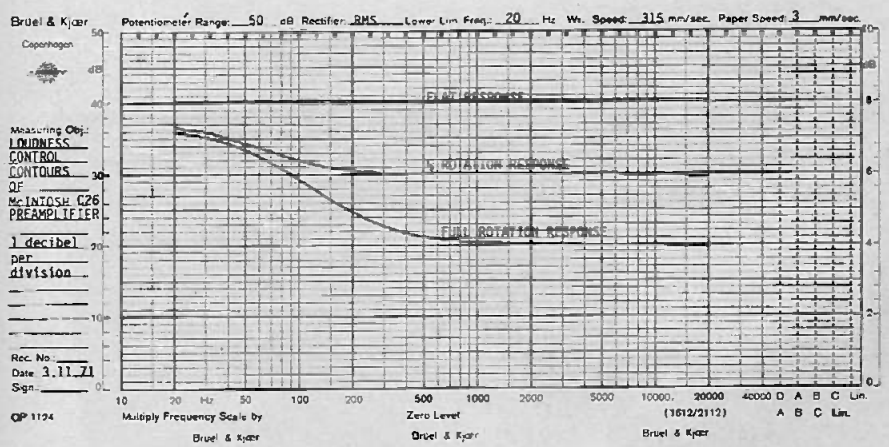


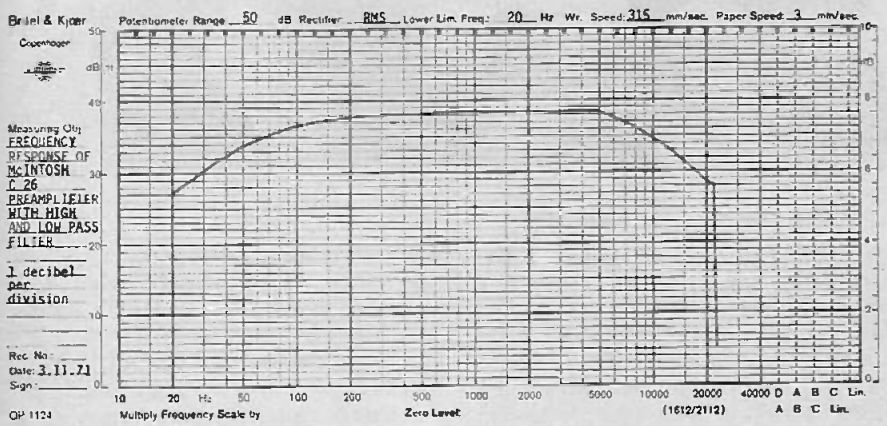
b) A balance control.

c) Dual concentric bass control knobs with five boost and five cut positions.

d) Dual concentric treble control knobs with five boost and five cut positions.

A ring tip and sleeve socket for headphones is located on the front panel between the push buttons and the loudness control knob. Two additional controls are located on a recessed panel in the top of the unit. One provides 180° phase shifting of the left channel, should the speakers be wired out of phase. The second is an independent volume control for the centre channel output.





Adjustment of the loudness control was rather time consuming for as you moved the loudness control from the "flat" position to the "maximum" position you reduced the volume of the mid range and high range components rather than boosting the bass end as is the normal practice. Because of this arrangement it was easier to adjust the bass and treble controls rather than to adjust the loudness control, correct the volume control, then readjust the loudness control and so on, to obtain the desired combination of control settings.

The preamplifier is supplied with mounting brackets which incorporate the PANLOC mounting system developed by McIntosh. This system consists of quick release buttons located on the front panel of the preamplifier, allowing the unit to be slid out of its case, thus providing access to the phase and centre channel controls. In this position an engraved aluminium panel is revealed. This carries a block diagram of the preamplifier circuitry and performance specifications.

THE CONSTRUCTION

The back panel of the preamplifier contains all the input and output terminals. These consist of three sets of four spring-loaded terminals, one set for the power amplifier input, one set for the main speaker output and one set for the remote speaker output. (The speaker outputs are wired back to the preamplifier from the main amplifier unit) Six pairs of R.C.A. type coaxial sockets are provided for the following inputs; Auxiliary, Tape 2, Tape 1, Tuner, Phono 1 and Phono 2. Four pairs of R.C.A. type coaxial sockets are provided for Tape 1 and Tape 2 outputs and for two main amplifier outputs. A single R.C.A. type socket is provided for the centre channel output. Four 2-pin power sockets, one switched, three unswitched, are provided to energize auxiliary equipment.

THE POWER AND THE GLORY

The internal layout and metal work is exceptional. All components and printed circuit boards are mounted on a heavily chromed plated mounting panel. The main circuitry is contained on three printed-circuit boards horizontally mounted at the left hand end. The smallest board contains the power supply and centre channel circuitry. The other two boards contain the preamplifiers for each channel. These two boards have been laid out with all components laid parallel to an edge or an end of the board. The only difference between the two boards is an additional capacitor and resistor on the left channel preamplifier board, which are used to shift the output signal 180°. Each circuit board has its own serial number stamped on it and quality control markings can be seen at various places on each board.

All transistors are colour coded in addition to the normal type numbers and are soldered onto pins located on the printed circuit boards. This arrangement minimises the chances of overheating the transistors during soldering and simplifies the removal of any transistor for replacement if required. The circuit utilizes emitter-follower configurations with negative feedback to reduce noise and distortion.

The power transformer is fully enclosed in a metal housing to provide maximum shielding. All wiring is fully colour coded and made up in harnesses, shielded where necessary. All the wiring terminations on the boards are also made via stand-off pins.

The preamplifier is supplied with a 16 page glossy "Owners Manual", a Service Information leaflet and an "If You're in a Hurry" card. The "owners Manual" covers the following topics:–

Guarantee
Installation
How to connect (graphically illustrated)
What the controls do
Listening to your stereo system
Performance limits and charts
Technical description and block diagram.

The service information manual includes

a) Detailed circuit diagrams with voltage levels and component details.
b) Printed circuit board layouts
c) Component parts lists with manufacturer's part numbers.

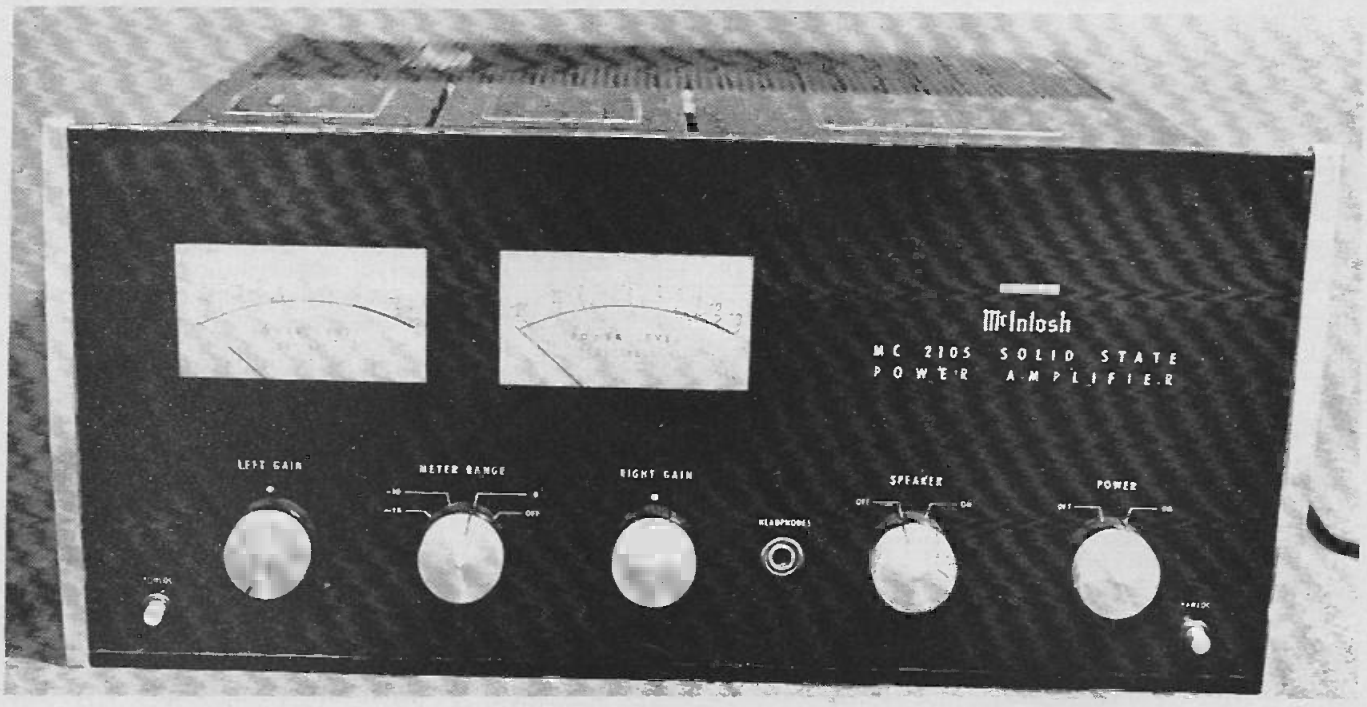
The "If You're in a Hurry" card gives concise instructions for external connections and for operating the various controls.

The McIntosh Guarantee, we believe, is unique for any preamplifier or amplifier, and states that, "should the performance of these units exceed the published performance limits specified, during the first three years from date of purchase, then McIntosh will restore the unit to its original performance free of charge, with the exception of transport costs". The recognized Australian distributors are service agencies.

Our laboratory tests showed that the measured performance was equal to, or better than, the manufacturer's performance limits in all parameters.

The total harmonic distortion was considerably better than the stated limits, being 0.04%.

The frequency response rose less than ½dB from 20Hz to 25Hz, and was then flat from 25Hz to 20kHz.



THE McIntosh MC2105 solid state power amplifier is very similar in appearance to the preamplifier. The external finish is identical, with a black glass front panel with chromed trims at each end and machined aluminium knobs.

The front panel contains two large illuminated power-level meters in the top left hand corner. These are balanced by the make and model identification in the top right hand corner. Five aluminium knobs arranged across the bottom of the front panel provide the following facilities – from left to right:–

a) Left channel gain control.
b) Meter range switch with four positions, namely OFF, -20dB, -10dB & 0dB.
c) Right channel gain control.
d) Speaker "on-off" rotary switch.
e) Power "on-off" rotary switch.

A ring tip and sleeve headphone

MEASURED PERFORMANCE McINTOSH MODEL C26 SOLID STATE STEREO PREAMPLIFIER SERIAL NO. 5031.

Frequency Response
20Hz to 20 kHz $^{+0}_{-½}$ dB

Total Harmonic Distortion

100Hz	0.04%
1kHz	0.04%
6.3kHz	0.04%

Hum & Noise with Respect to Rated Power
Auxiliary Input 89dB
Phono Input 75dB

Bass Control
15dB boost at 50Hz
16dB cut at 50Hz

Treble Control
17dB boost at 10kHz
18dB cut at 10kHz

Loudness Control
Maximum of 14dB boost at 50Hz

High Pass Filter
4dB cut at 10kHz

Low Pass Filter
5dB cut at 50Hz

Channel Separation at Rated Output
Auxiliary Input 42dB
Phono Input 39dB

Input Sensitivity for Rated Output

Input	Input Level	Main Output Level	Tape Output Level
Auxiliary	0.25V	2.7V	0.25V
Tape 1	0.25V	2.7V	0.25V
Tape 2	0.25V	2.7V	0.25V
Tuner	0.25V	2.7V	0.25V
Phono 1	2 mV	2.7V	0.25V
Phono 2	2 mV	2.7V	0.25V

Dimensions 5-7/16" high, 16" wide, 13" deep
Weight 17lb.

socket is located between the right channel gain control and the speaker "on-off" rotary switch. Two push buttons, one in each corner at the bottom are the quick release buttons for the PAN LOC mounting system. This is the same system as that used in the preamplifier. Two R.C.A. coaxial signal input sockets, and two speaker output terminal strips are located on the mirror finished chrome-plated back panel that is part of the main mounting board. The speaker output terminal strips have four terminals marked: common, 4 ohm, 8 ohm and 16 ohm respectively. These outputs are fed back to the preamplifier "power amplifier" input terminals, so that all functions can be controlled at the preamplifier once the gain controls on the power amplifier have been set. The speakers are then connected to the speaker terminals on the preamplifier.

The internal layout of the power amplifier is finished to the same degree of quality as the preamplifier. The power transformer, measuring 4½" x 4½" x 7", is fully shielded in a metal housing and is mounted adjacent to the two line-output autotransformers which are also enclosed in metal housings. The three transformers are mounted in line directly behind the front panel.

The rear section of the amplifier contains four very large heatsinks on which the main driver and power transistors are mounted, two vertically mounted plug-in printed circuit boards, and two 39,000 μF capacitors. The two printed circuit boards are assembled with the same degree of detail and quality control which we observed on the preamplifier boards.

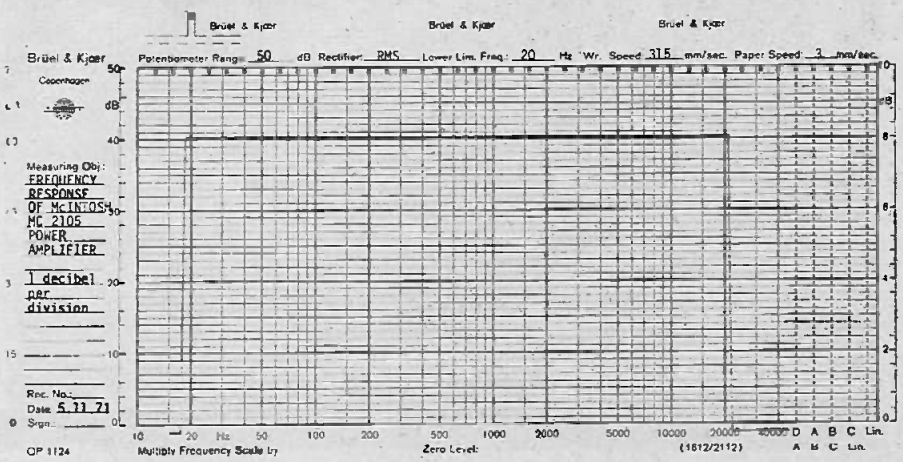
The construction of the autotransformers is quite intriguing; they are bifilar and pentafilar wound, or in general terms – scramble wound – to minimise the distortion inherent in standard transformer construction. The construction of the laminations is typical of the effort put into the transformer's design. These are tape wound and then cut and lapped optically flat. Once the windings are wound on, the laminations are then sealed together with a controlled air gap so that the desired response characteristics of the transformer are produced. This attention to details is necessary to maintain the very low distortion figures claimed (and achieved) by McIntosh.

The meter circuitry is an unusual innovation, it accelerates the movement of the meter when responding to a transient signal, thus compensating for the inertia characteristics of the meter, and then provides a slower decay so that the peak level may be more adequately determined. The manufacturers claim a peak reading accuracy within 2% of the true value. We found, during our tests, that impulses of 200 milliseconds duration, or greater, gave a true reading on the meter at the 0dB level, and impulses less than 100 milliseconds duration gave errors greater than 10% (ie – ½dB).

The unit came complete with an Owner's Manual, a Service Information leaflet and an "If You're in a Hurry" card, with similar information to that detailed for the preamplifier.

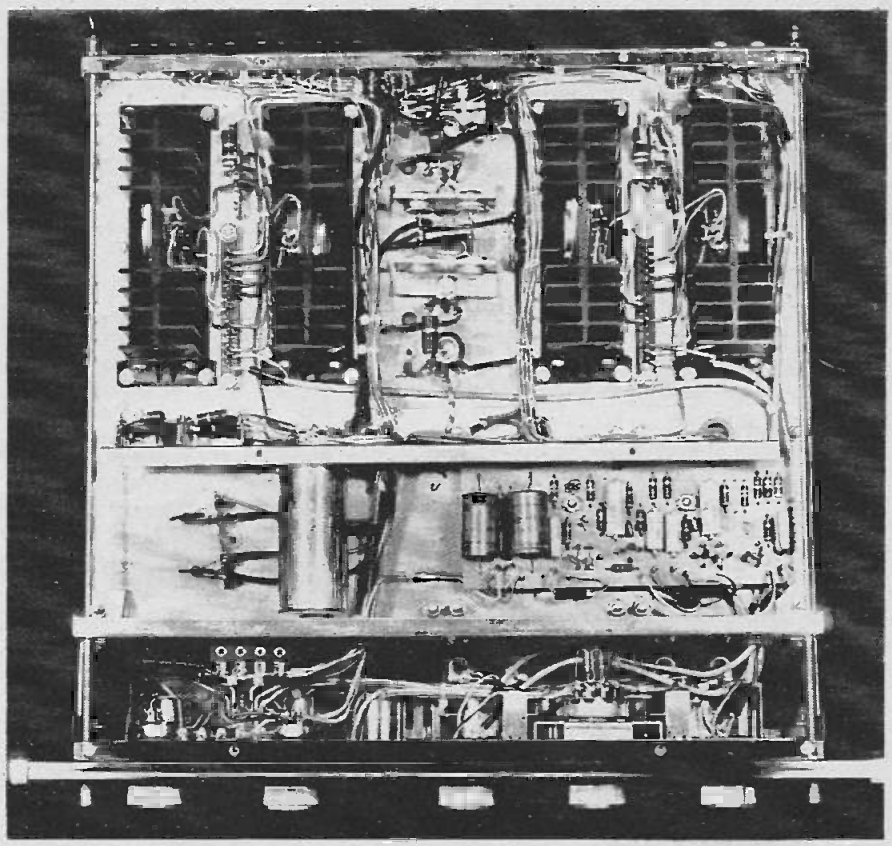
MEASURED PERFORMANCE

The measured performance of this amplifier can only be described as exceptional. At rated output of 105 watts per channel the frequency response was flat from 20Hz to 20 kHz ±0.1dB. With such a high output rating we were surprised when after two hours operation with one channel operating at 105 Watts and one at 250 Watts (that's right – 250 Watts), the temperature rise did not exceed 80°F



This graph shows the extraordinarily flat frequency response of the McIntosh Power Amplifier.

THE POWER AND THE GLORY



above a 70°F room temperature on the overloaded channel heatsinks. At rated output the temperature rise of the heatsinks was only just noticeable.

Total harmonic distortion was particularly low, especially for an amplifier with transformers in the output stages, and above 40Hz was considerably lower than the limits stated by the manufacturer.

The left channel power level meter was sticking around the 0dB graduation, thus making it impossible to determine its calibration accuracy. However, we may assume that the calibration of the right channel power level meter is indicative of the order of accuracy to be expected. The calibration accuracy of this meter was better than 0.3dB over the graduated range, and its associated attenuator within ±0.2dB for the -10dB and -20dB range. With the meter range setting at -20dB the unit delivered ½ Watt when the meter indicated 0dB. At the -10dB meter range setting the output was 5 Watts at 0dB, and at 0dB meter range setting the output was 50 Watts at 0dB. A +3dB meter indication at 0dB range setting corresponded to a power output of 100 Watts.

The Power amplifier is designed with adequate controls so that it may be used on its own, driven by any suitable programme source (500mV at 50KΩ impedance.)

The McIntosh amplifier is the best amplifier we have ever tested – at S1626 for the two units, it is also one of the most expensive amplifier systems that we have ever seen.

During subjective testing we found it impossible to use its full power capability, for our test speakers (50 Watt continuous rating JBL monitors) could not handle the power, nor could we withstand the sound levels created. Whilst most manufacturers of high powered amplifiers claim that the average home can easily use – or will benefit from such reserve power – we have always found the speakers to be the limiting factor with high level transients or sustained signals.

We consider that this amplifier system is best suited to professional applications, although – if used with suitable speakers – it will provide perfect performance for the most discerning, well-heeled domestic user.●

MEASURED PERFORMANCE OF McINTOSH MODEL MC2105 – POWER AMPLIFIER SERIAL NO. 4978

Frequency Response
20Hz to 20kHz +0.1dB

Total Harmonic Distortion at Rated Output

40Hz	0.25%
80Hz	0.12%
1kHz	0.17%
6.3kHz	0.16%

At 1 Watt Output

100Hz	0.5%
1kHz	.04%
6.3kHz	less than .03%

Channel Separation

100Hz	67dB
1kHz	50dB
10kHz	40dB

Hum and Noise with Gain Control

At Maximum Setting	–85dB
At Minimum Setting	98dB

Power Output
105 Watts for 0.5V Input

Input Impedance
200k Ohms

Damping Factor
18 to 4 ohms output
13 at 8 ohms output
10 at 16 ohms output

Dimensions 16-3/16" wide x 7-1/8" high x 14½" deep
Weight 65 lbs.
Price £870.20 for the combined units

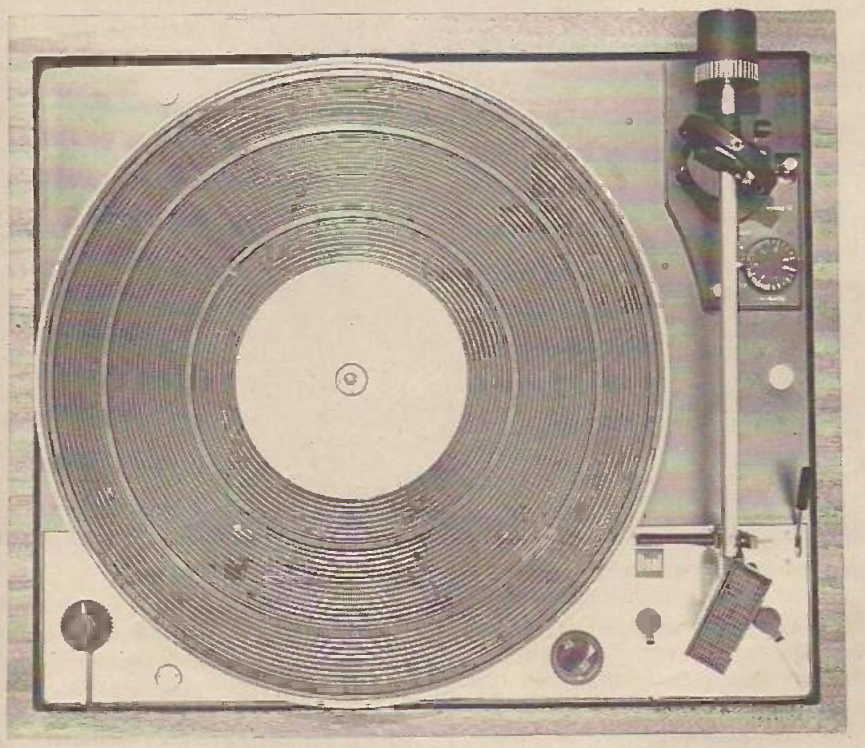
a) Speed control lever with three position, for 33-1/3 rpm, 45 rpm and 78 rpm. Around the lever pivot is a knurled knob for speed adjustment. This knob varies the position of the drive pulley on a tapered motor shaft, thereby changing the turntable speed by a small amount.

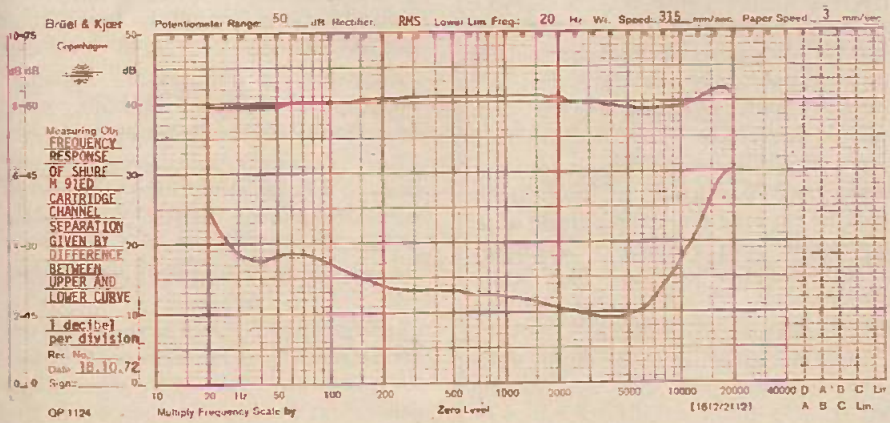
b) Strobe sight lens which can be adjusted to vary the line of sight.

c) Start-stop lever.

d) Record size select lever with three positions, for 7", 10" and 12" records.

A cueing lever is located directly behind the record size select lever. This is very well damped in the raising mode and partially damped in the lowering mode. Two further controls are located at the base of the tone arm pivot and consist of an antiskate adjustment and a lever for raising the gimbal joint to compensate for a multiple stack of records.





The antiskate adjustment consists of a knurled knob with two sets of graduations on it. These graduations consist of a red scale for spherical styli, and a white scale for elliptical styli. The red scale is applicable when the knob is turned anticlockwise and the white scale when the knob is turned clockwise. These scales are graduated from 0 to 3 grams.

Balancing and tracking force adjustments are effected by a main counterweight on the end of the arm and a graduated dial in the centre of the gimbal joint. The counterweight is fitted to a stub shaft which fits into the back of the tone arm shaft. This shaft can be moved in or out to provide a rough balance and locked in place by a screw. Fine balancing is then achieved by screwing the counterweight in or out.

The correct tracking force is obtained by turning a graduated dial at the centre of the gimbal joint to the desired tracking weight. This dial tensions a spring by the required amount to produce the necessary tracking force at the stylus. Due to the design of the gimbal joint this arm can be balanced in all planes and, in theory, could play a record whilst upside down, or at any other angle for that matter. Screw adjustments are also provided for adjusting the height of the stylus tip over the record in the raised position, and for varying the lateral position in the automatic mode so that the stylus drops onto the "run in" groove.

A very practical feature is the tone arm support bridge which extends from the tone arm rest to the edge of the turntable. The tone arm can be rested on this bridge without operating the automatic stop, thereby simplifying the operations necessary for manual usage.

Operation of the turntable is very simple and only requires operation of the stop-start switch once the record size and speed selection is made.

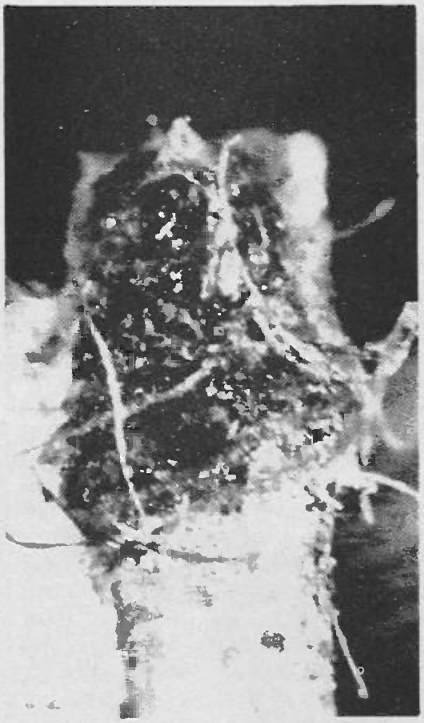
The turntable was supplied with two multi-record spindles, one for conventional records with ¼" diameter centre holes, and one for 45 rpm records with large centres. Another centre was also supplied for playing single 45 rpm records.

To facilitate and simplify the fitting of a cartridge, the cartridge mounting plate can be released from the tone arm headshell by moving a small lever. A gauge is also supplied to assist in

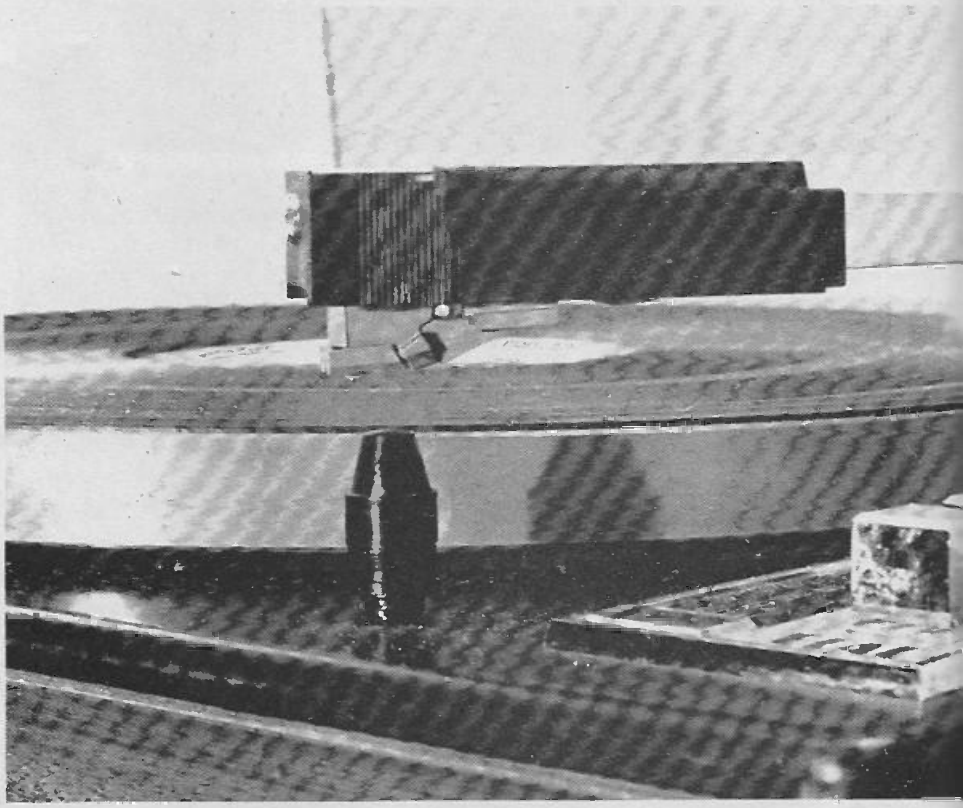
(Continued on page 78)

RECORD WEAR

Do records lose their brilliance after a few playings? Louis Challis reports



Unretouched micro-photograph of stylus after playing just one dirty record!



Elac automatic and record player was used continuously for several hundred hours.

AUDIO folklore has long held that the high frequency content of gramophone records is partially destroyed the first time that they are played.

But as folklore is notorious for wrong conclusions – or at best – the right conclusions for the wrong reasons – the record wear story is one about which we have always had reservations.

Reservations mind you, not disbelief, for we knew for a fact that the most difficult passages of rest records such as the Shure TTR101 are effectively ruined by as little as three to five playings due to the high stylus velocities involved in tracking the high energy high frequency content.

Most records are ruined by poor styli and excessively high tracking weights – but what happens to records played with new styli and low to medium tracking weights?

Would you believe that the high frequency content increases!

For our experiments we chose a number of brand new pressings. These were:– JUST THE BEGINNING, Cherry Pie CPS1000. MOZART KLAVIERKONZERTE, (F MAJOR KV37), Deutsche Grammophon 139 447 SLPM. JOY – THE GREAT COMPOSERS HITS FOR THE '70s, CBS SBR 235509.

The equipment we used for our evaluation consisted of two high quality automatic changers fitted with removable head shells, and capable of being programmed so that they automatically played a 7" band of the records over and over again.

The electrical output from each record player was then fed to the input of a 60dB amplifier, with 47k input impedance, and thence to an audio frequency analyzer which provided one-third octave band analysis on a high speed level recorder. The frequencies analyzed were those falling within the 8kHz and the 16kHz third-octave bandwidth filters.

We started our tests with a 12 micron conical stylus installed in a high quality cartridge tracking at one gram.

According to the folklore the high frequency content should have decreased with repeated playing.

But it didn't! As the record was played repeatedly, the measured output from 8kHz to 16kHz increased!

Actually the explanation is quite simple. The increase in output is caused by distortion of the fundamental program content at lower frequencies and the consequent generation of 'apparent output' at the higher frequencies.

Our second test was run using a medium quality magnetic cartridge fitted with a 12 micron conical stylus tracking at three grams.

The resultant analysis showed after 10 playings the high frequency distortion of the highest level passages had increased by 10% (1dB). In the same time there was only a 5% increase in distortion for program components 10dB below the peak level.

After a further 40 playings the peak level distortion had only increased by another 5%, and by 2% for signals 10dB below the peak levels.

Subjectively however, it was readily possible to to hear the difference between the record used in our second test (after it had been played 50 times), and a brand new record even without making immediate A-B comparisons. And while the low frequency content was hardly affected, the high frequencies exhibited a roughness and lack of clarity that was most pronounced.

Finally we switched to a crystal cartridge fitted with a diamond stylus and tracking at three grams.

The results were much as we could have deduced from our previous tests. Firstly, the rate of increase of distortion was even more marked than with the magnetic cartridge tracking at three grams, but now two other factors became clearly evident.

After the first 12 playings there was an attenuation of approximately 3dB in some of the low level high frequency program material, but this was soon masked by an increase in surface noise which rose almost linearly – typically at the rate of 0.08dB per playing.

It was interesting to note that, although recorded material with high sound levels and fundamental content in the 4kHz to 8kHz range exhibited a significant colouration after many playings, piano music with little fundamental content above 4kHz exhibited only a loss of highs after as many as 120 playings.

The other factor that was noticeable was the increase in surface noise which rose by typically 10dB in the one-third octave band centred on 16kHz.

So separating the facts from the folklore – what are we left with?

1) Cartridges which track properly in the vicinity of one gram (and fitted with a good and clean stylus) cause no significant deterioration of records until at least 10 playings. This deterioration then occurs at the high frequencies above six to eight kHz and is usually inaudible even to the trained ear. But after some 40 playings, this deterioration is apparant, particularly if an A-B test is performed with a new record of the same pressing.
2) If one uses a cartridge tracking at approximately three grams, then the deterioration is more pronounced after ten playings, and there are typical increases of two dB in high frequency distortion.
3) Cartridges tracking at three grams also exhibit a more rapid increase in the level of surface noise.
4) Good bi-radial styli seem to generate far less distortion than do conical styli for a given class of cartridge.

The message seems quite clear.

Provided you keep your records clean, then money spent on good quality cartridges will result not only in better playing now, but also continuing enjoyment for years to come. ●

THE EARLY YEARS

The first Edison cylinder records used a tin foil platten which was clamped onto a mandrel and had an exceedingly short life – of some 6 to 10 playings.

Because of the production problems involved with tin foil, Edison experimented with various waxes for the outer surface of his cylinder recordings. But these were short lived as they gave only 20 to 30 playings with a "low volume" horn, or as few as 10 playings using a large horn to provide the greater acoustic output required for a large room.

Edison even tried metallic soaps for the recording surface, but when in 1902 another company developed celluloid as a viable recording material, Edison developed the famous Edison cylinder which used a celluloid outer sheath on a plaster of paris base. These were technically very advanced for they could provide a frequency response of 150 to 6000 Hz and used a diamond or sapphire stylus with a radius tip to provide long life.

When Columbia Records produced three minute records to counter Edison's two minute records, Edison increased the rotational speed from 120 r.p.m. to 160 r.p.m. and the groove density inch from 200 to 500 per inch. This improved the fidelity and provided a frequency response of 150 to 7000 Hz but the cylinders did not last as long. These cylinders were produced right up to 1929 until superceded by the disc recordings first introduced in the early 1920's.

The best of these early discs were designed to have a "silent surface" and were made from shellac. The material was rather abrasive and caused the styli to wear very rapidly. These laterally cut records originally were designed to rotate at 80 r.p.m. and had a frequency response of approximately 150 to 6000 Hz. The steel stylus which was almost invariably used, lasted for just one playing and then had to be replaced. If it was not replaced then the high frequencies, which were already deficient, were even further attenuated.

The Edison and French Pathe discs and disc reproducers used a "hill and dale" system of recording. The Edison discs used a rotating sapphire stylus system not unlike a ballpoint pen to track from outside to in as on present day recordings. The Pathe system tracked from inside to out to make use of the lower velocities at the centre of the record when played with a steel stylus. This system was used on studio transcription records up to 10 years ago. By this means, when the stylus reached the outside of the record, the higher velocities compensated in part for the loss of high frequencies resulting from the blunting of the stylus.

The Edison discs were very well made and because of the use of a fully profiled stylus were almost indestructible. The earliest examples were 3/8" thick and were made as a multi-layer construction with a bakelite surface and a fibrous filler between a shellac binder at the centre.

These records played at 80 r.p.m. and had no great loss of high frequency right up to about 8 kHz.

Edison used condensor microphones, electronic amplification and electro-magnetic cutting heads to produce what were remarkable examples of recorded material – even by the standards of to-day.

POCKET-SIZE TV CAMERAS

Solid-state TV cameras may become as small as a wrist-watch – Shaun Kannan reports.

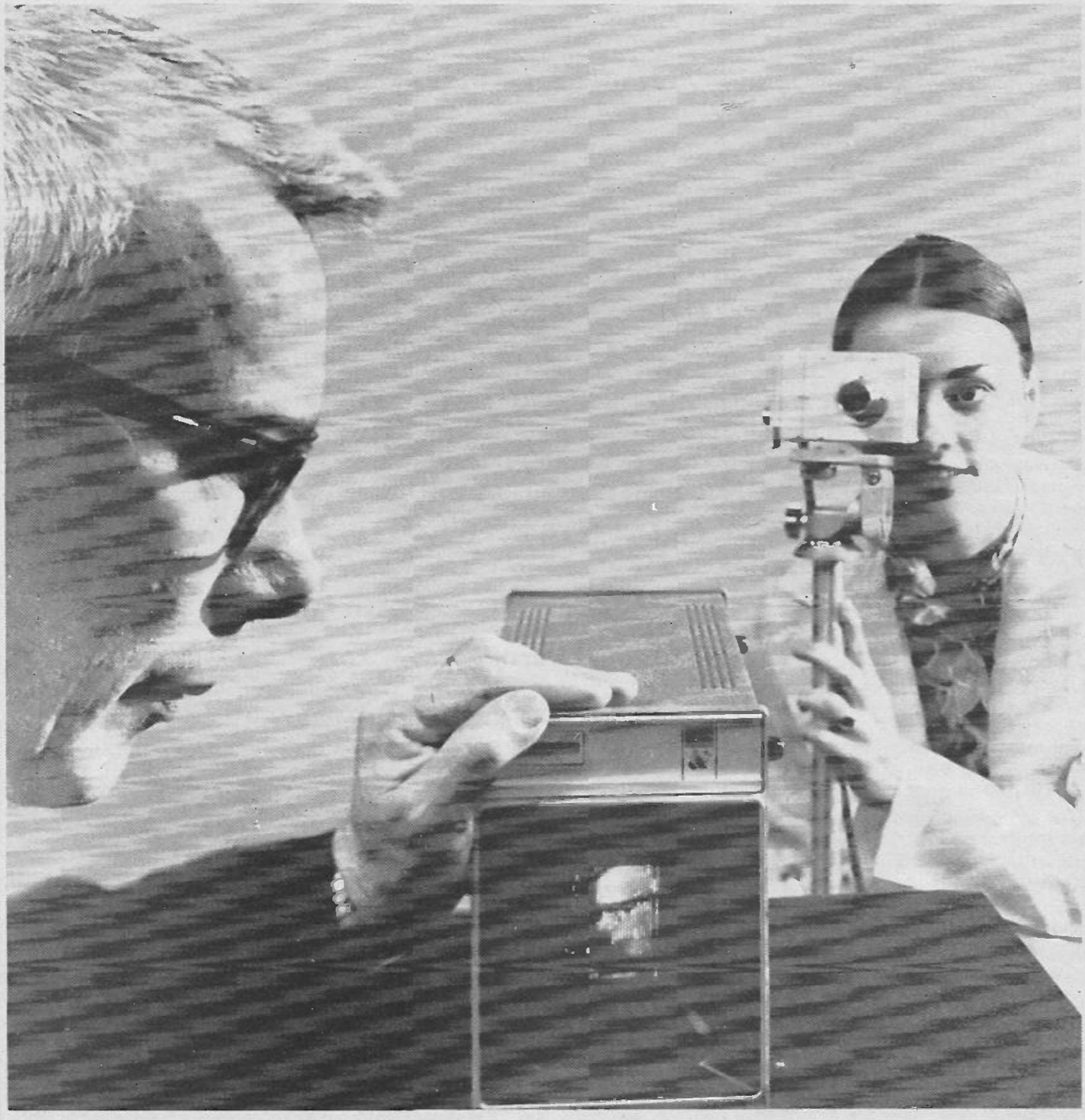


Fig 1 – RCA's experimental video camera in demonstration

Fig 2 – Sample picture from a CCD camera (Bell Labs)

EXPERIMENTAL all-solid-state video cameras as small as a palm-held electric razor have been developed – independently – by RCA and Bell Laboratories.

Both cameras use the basic charge-transfer technology described in our September issue.

The image sensing devices used in these cameras do not need the high voltages, electron beam scanning or vacuum envelopes used in conventional TV cameras.

And, since the cameras have the associated electronics built into the sensor integrated circuit, further developments could result in cameras with sensors and electronics much smaller than the lens itself.

BUCKET BRIGADE DEVICE (BBD)

RCA's camera has a 0.2" sq image sensor on a silicon integrated circuit. The 1408 photo-sensitive elements are arranged in a 32-row matrix with 44 elements in each row. The elements are spaced 0.003" apart. The device can be visualised as rows of isolated-gate FETs with sources and drains connected and with the gates coupled to the drains.

The electrical charges representing bits of stored information are transferred from one element to the next by means of clock pulses that raise the level of each element in the correct sequence – in the same way as a fire-fighting-brigade passes a bucket of water down the line.

On the same chip, the BBD has a 32-stage shift register also operating on the bucket brigade principle. This is used for the vertical scanning and a-line-at-a-time read-out to give the picture signal. Only nine connections are enough to feed control signals to, and take the video signal from, the sensor.

Image resolution is not as good as a conventional TV camera which has nearly 400,000 picture elements but it is sufficient to give a recognisable picture of a foot-square object.

The device uses horizontal transfer scanning. Stored charges from each row are successively transferred into a continously operating output register; see Figs 3 and 4. Each row of sensors is a BB register in which the sources and drains of MOS transistors are revrese-biased to act as photo-diodes. in the in-between-scan 1/60 sec period, the horizontal clock voltages are disconnected from all rows, allowing a charge pattern to be built up on the sensor, corresponding to the image being viewed. The horizontal clock is then re-connected via transmission gates, and the 32-stage BB scan generator switches the gates 'on' sequentially. The charge pattern in each line is transferred to the output register which again is a similar BB and delivers the charge patterns in sequence to an output amplifier also integrated on the same chip.

CHARGE-COUPLED DEVICE (CCD)

Bell's camera has a 4.8x6mm sensor with 13568 light-sensitive elements in a matrix of 128 rows. Bit density is 0.0016" square per element. The operation is essentially as outlined in our May issue but only one 64-row area is used for imaging; the other 64-row area is used for storage and read-out. The imaging (charge accumulation) period of about 1/60 sec is followed by a frame transfer sequence which shifts the charge pattern from the imaging area into the storage area in about 1m sec. While a new frame is being integrated in the imaging area, the image in the storage area is shifted down, one line at a time, so that lines of information enter the horizontal serial register in sequence. The horizontal register then shifts each line of information to an output diode to give the video signal in a serial form.

The frame read-out is completed by the time a new charge pattern is formed in the imaging area, and the storage area is then ready to have the new frame transferred into it. The cycle is repeated 60 times a second.

CHARACTERISTICS

At this admittedly experimental stage, some tentative characteristics for such systems can be formulated.

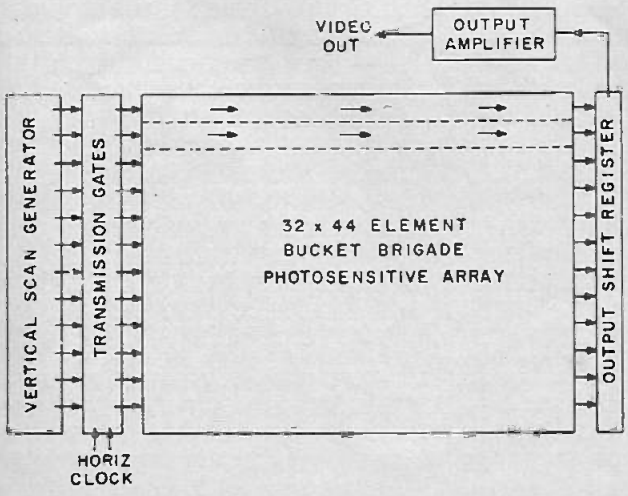
For example, there are two scanning schemes: line-by-line horizontal transfer (HTS) as used by RCA, and vertical transfer with separate store (VTS) as used by Bell. Also there are two charge transfer techniques: the bucket brigade technology used by RCA, and charge coupling as used by Bell. In principle, either VTS or HTS can be used with either method of charge transfer.

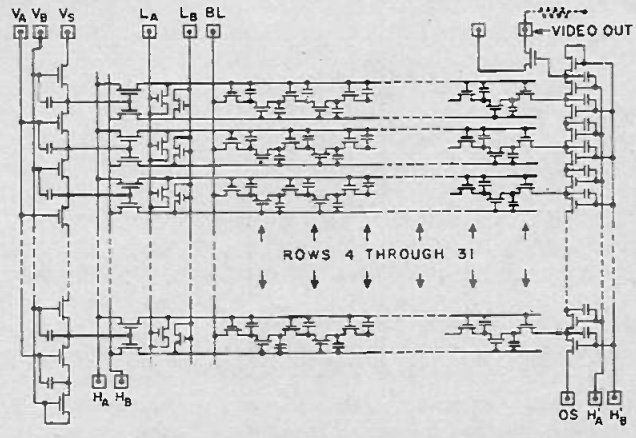
Both systems of scanning and both systems of charge transfer are capable

(Continued on page 76)

Fig 3 – Block diagram of a BBD charge-transfer sensor

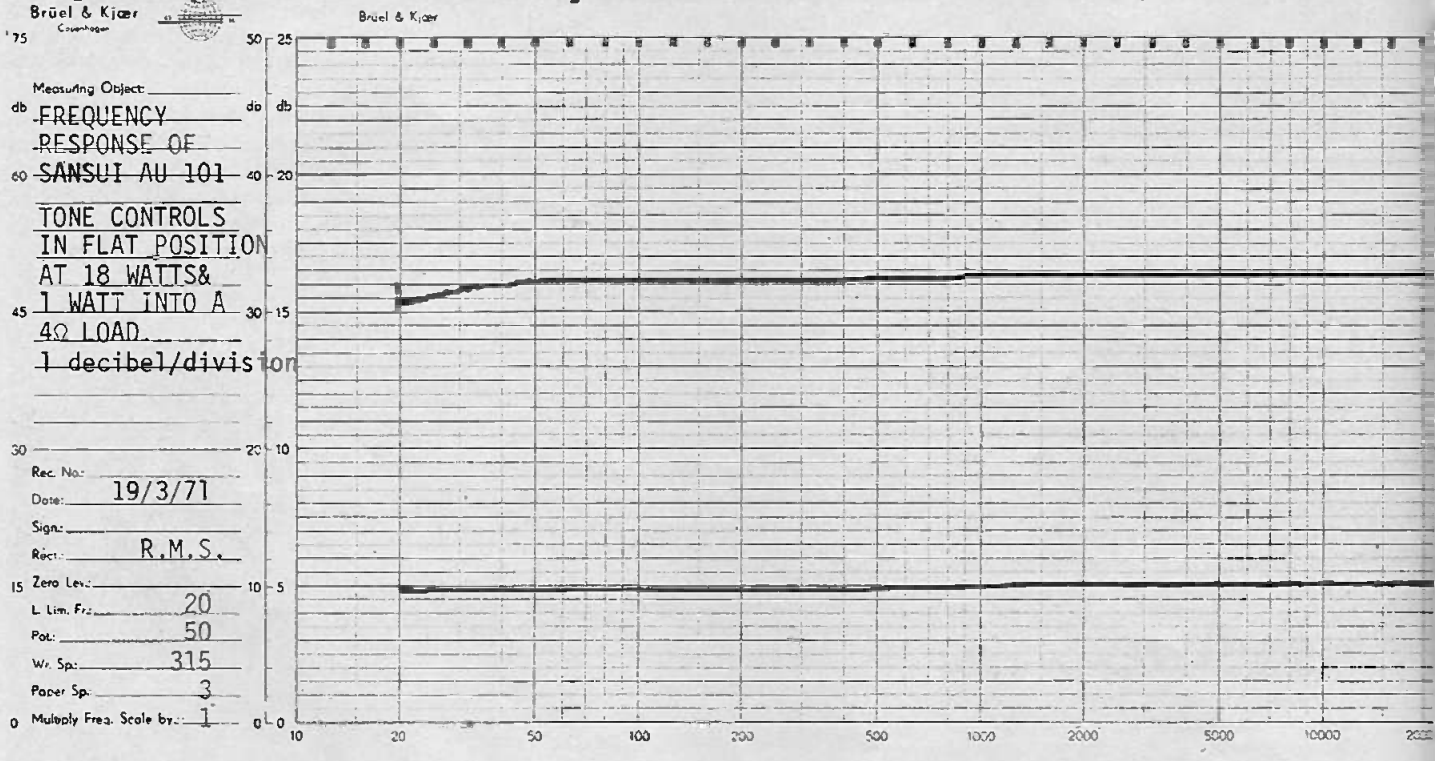
Fig 4 – Circuit Diagram for the BBD sensor (To aid clarity, the two photo-diodes associated with each element are not shown)

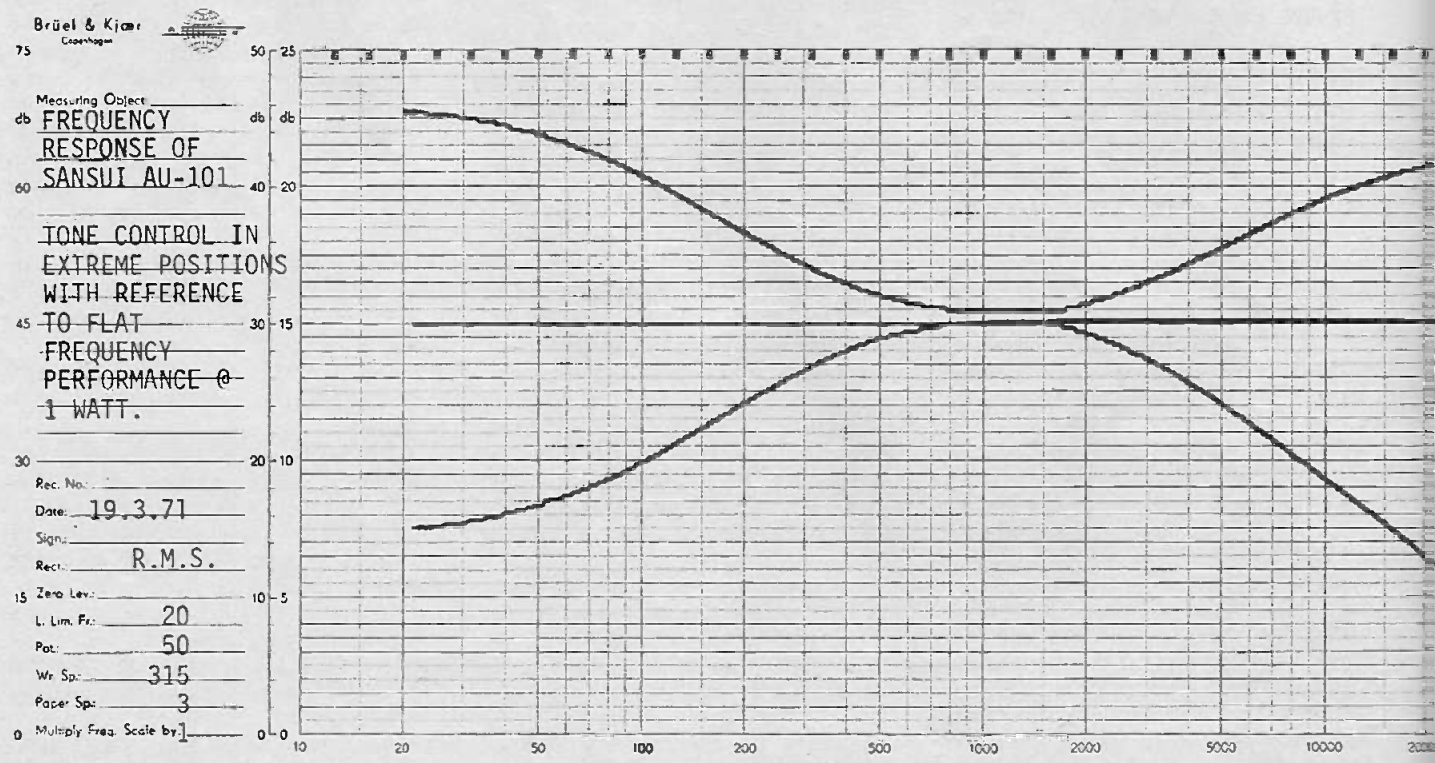




SURPRISE

Performance of Sansui AU-101 stereo amplifier belies its low price





PACKET

electronics TODAY INTERNATIONAL
product test

There is an old saying that looks can be deceiving, and the Sansui AU-101 amplifier is a fine example of how one can be caught out. Having been told that this amplifier is the cheapest of the manufacturer's range, we made the mistake of thinking that the performance would be poor in comparison to the rest of the range.

Sansui are currently one of the best-known Japanese hi-fi manufacturers, and the release of the AU-101 marks a departure from what we have previously regarded as their forte – namely, the manufacture of expensive equipment.

The AU-101, which came packed in a simple cardboard carton, is what can only be described as a 'no frills' amplifier. The case is matt-black painted steel, with veneered wooden ends and black anodised aluminium face. The bright anodised aluminium knobs for the six main controls of power, bass, treble, balance, volume and microphone and auxiliary selector, are set in a row in the upper half of the panel, whilst the minor controls for speakers on/off, loudness control and tape monitor are effected by black aluminium levers placed in a row below.

The other facilities provided are a headphone plug, a microphone plug, and a tape monitor playback DIN plug. The rear panel contains R.C.A. plugs for phone (magnetic only) auxiliary input, and record and playback plugs for a tape recorder or tape deck.

The speaker outputs are provided by large, well-spaced screw terminals with slots large enough for a five-cent piece. The only other facilities are one switched and one unswitched American (or Japanese) type mains outlet, a fuse, and the mains voltage selector for 100, 117, 220 and 240 volts ac. The mains cord is two metres long and comes fitted with a 3-pin plug.

The inside of the amplifier is an eye-opener, for the circuitry boards used are so small that it makes one wonder why such a large case is necessary. However, there is method in this madness, for this has obviously been done to facilitate stacking of multiple units of the same basic dimensions, such as the QS1 Quadphonic Synthesizer and other units in the Sansui range.

The circuitry is neat. All the transistors, apart from those in the output stage, are silicon planar. The preamplifier stages are mounted on a printed circuit directly under the main controls. This is a logical and practical step, for with such high gains (70 dB) poor layout would easily result in instability even at ultrasonic frequencies. The main amplifiers have a single-ended push/pull configuration, using 5 N.P.N. transistors and one P.N.P. capacitively coupled to the speaker.

The main amplifier and its associated heat-sink is placed on the bottom of the chassis and provided with a demountable cover underneath for rapid access to the underside of the printed circuit. This seemingly simple step will save up to an hour or more in a fault-finding exercise.

Amplifier thermal stability is well provided for by two compensation bias diodes mechanically clamped to the output transistor heat sinks. Finally, overload protection is effected

(Continued on page 75)

Lasky's are serious about Akai, how serious are you?

Unless you are a fanatic, muzzling your dog to achieve the ultimate in listening pleasure is not really necessary – what is of prime importance is to make sure that you have the right equipment to listen to in the first place, equipment that won't make "odd" noises of its own! In fact, high fidelity equipment that will reproduce exactly and with absolute fidelity, the most subtle sounds captured in to-days disc and tape recordings and FM stereo broadcasts.

That is where we at Lasky's can help you, because with our vast selection of equipment and our experienced sales staff at your disposal you can choose exactly the system or unit to suit your individual requirement and budget. AND you can't go wrong by choosing Akai.

The complete 1973 range of Akai – stereo reel-to-reel, cassette and 8 track cartridge tape recorders (some incorporating radio receivers as well), amplifiers, receivers, speakers and headphones – is gathered together for you to see, hear and compare in the ideal surroundings of our showrooms at 42-45 Tottenham Court Road, W1 – the "Sound Centre of the World". Akai's own experts will be on hand every day during February (Monday to Friday 12pm – 6pm) to demonstrate the capabilities of this outstanding equipment.

We are serious about Akai quality and value and we are sure you will be when you have seen and heard for yourself.

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FEBRUARY IS AKAI MONTH AT LASKY'S

If you are unable to pay us a visit we shall be pleased to send you full illustrated information on Akai high fidelity equipment together with a copy of Lasky's 1973 Audio-Tronic Catalogue.

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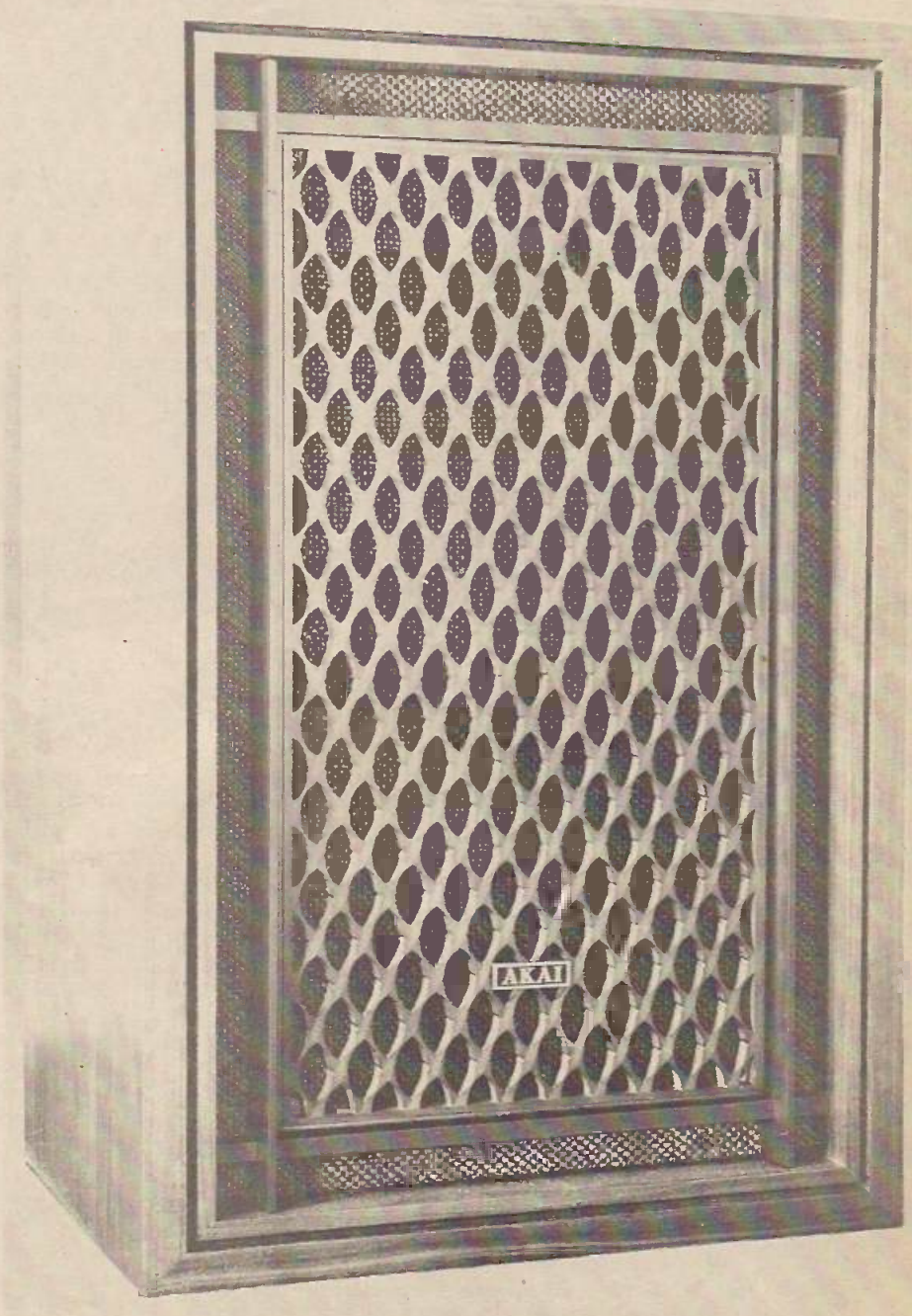
AKAI LOUDSPEAKER TYPE SW 155

Akai's SW155 speakers have a fine appearance and combine reasonable performance with low distortion.



THE Akai SW155 speakers are one of the more recent types of speakers which are designed with striking front grilles. They are designed to be an additional piece of furniture with an emphasis on the quality of external finish. The dark grille cloth of these speakers is deeply recessed – to approximately 1½" – and covered with a heavy carved timber grille. This deeply recessed front considerably reduces the available internal volume (by about 200 cubic inches).

The striking appearance of these speakers may limit to a minor extent their use in some rooms. The main box is constructed from 1" thick veneered plywood which also forms the heavy timber surround to the front panel. The enclosure is of the vented design and has a third bonded fibre lining, which provides some internal damping.

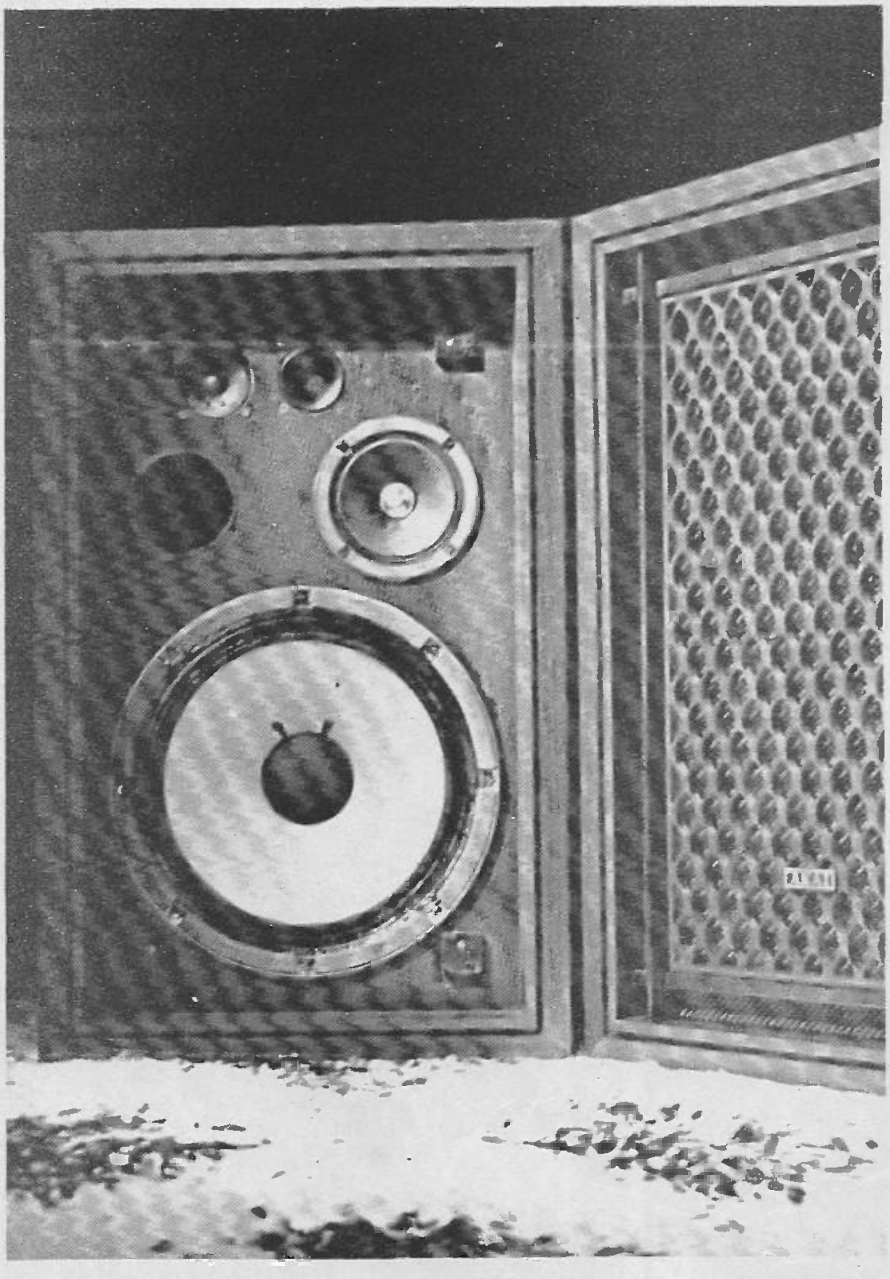
The speaker complement consists of four units:–

The largest speaker is a 12" woofer having a 6 ohm impedance and 25 Watt nominal rating, with a magnet measuring 4¾" diameter by 5/8" deep.

The next speaker is a 5" midrange unit, L.C. coupled, with an 8 ohm wire wound potentiometer wired in parallel.

electronics TODAY INTERNATIONAL
product test

AKAI LOUDSPEAKER TYPE SW 155



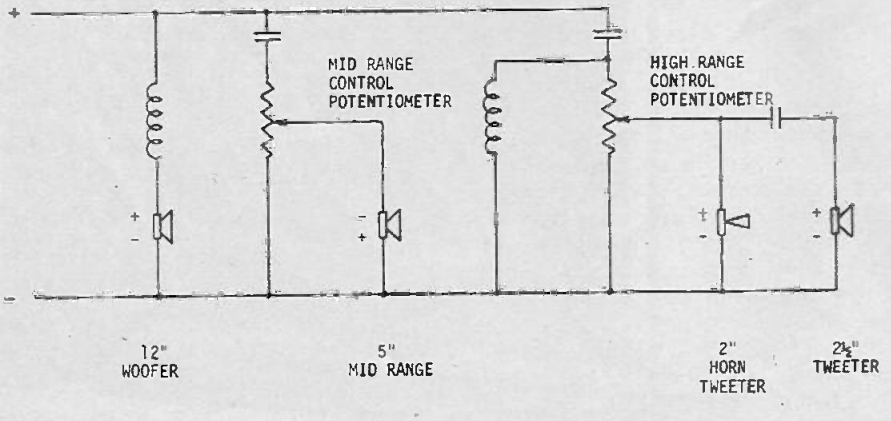


Fig. 1. Akai's method of interconnecting the various drive units provides an unusually large range of mid-range and treble attenuation.

The midrange speaker rather surprisingly, has a 3 Watt nominal rating and an 8 ohm impedance with a magnet assembly measuring 2¾" diameter x 3/8" deep. This speaker operates in the range between 1200Hz and 5000Hz at which point the 2" Horn type tweeter takes over via a second L.C. crossover network and another 8 ohm wire wound potentiometer.

The 2" horn type tweeter has a 1¾" diameter by 3/8" deep magnet assembly: this is relatively large for a tweeter.

The final speaker in the network is a conventional design 2½" cone-type tweeter capacity coupled to the 2" horn type tweeter and designed to be effective above 15,000Hz.

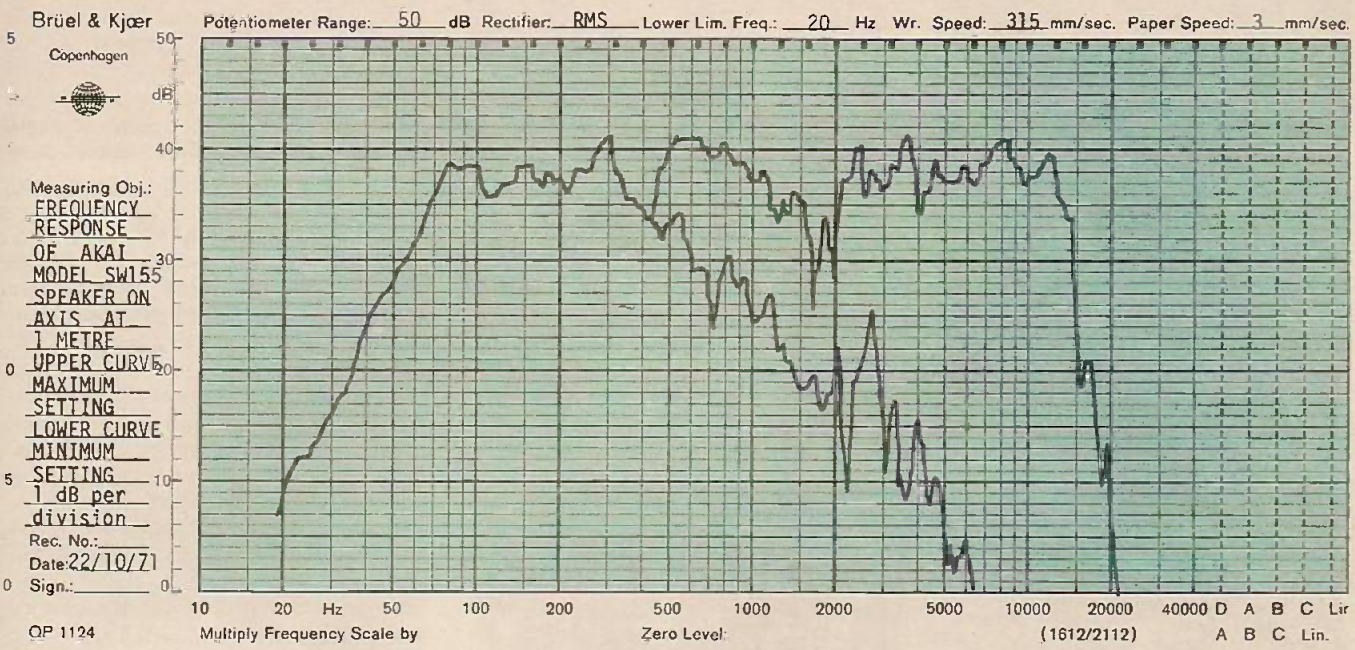
The mid-range and high-range controls are mounted on a recessed panel in the back of the speaker. This recessed panel also contains a pair of spring loaded terminals as well as a practical tip and sleeve jack socket which Akai alone use on loudspeakers. The speaker comes complete with a cable fitted with a tip and sleeve plug each end to facilitate connection of the speakers to an amplifier with similar facilities.

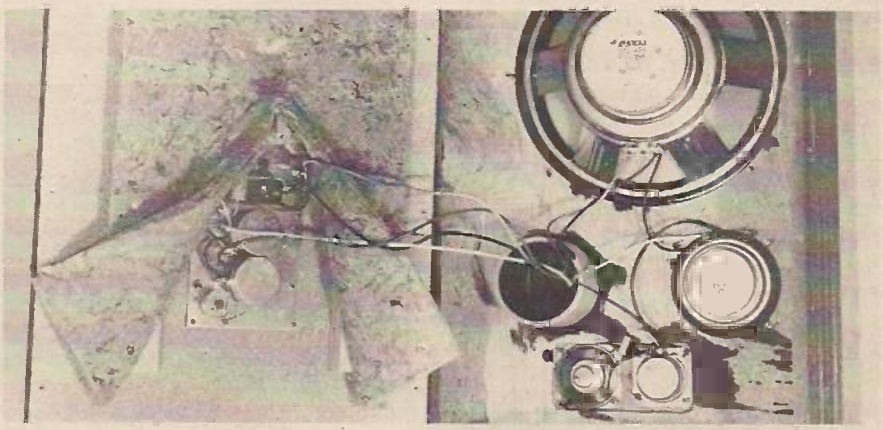
A set of six felt pads with adhesive backing are supplied with each speakers. These pads which are ¾" in diameter by 1/8" thick may be used if one wishes to stand the speakers on the floor.

Subjective A — B tests with our control monitors indicated a loss of low frequency response which could be partially corrected with bass boost. Further subjective tests in the home showed evidence of a very slight colouration and a lack of presence and brilliance with the mid-range and high-range controls set at the normal setting. By adjusting these controls to their maximum positions there was a slight improvement in the presence and brilliance. There was a notable difference in the frequency response between the two speakers.

The mid and high range controls provided some boost and, rather surprisingly, exceptional cut. In fact, with the circuit arrangement used (refer Fig. 1) the minimum settings of the mid-range and high range controls isolated the mid-range speaker and the two tweeters. In most speaker systems we have seen, the potentiometer is connected in series with a fixed resistor thereby limiting the effective range of the potentiometer

An intriguing feature of the speakers





was the wiring of the mid-range speakers which appeared to be intentionally wired up so as to be 180° out of phase with the other speakers. Both speaker units tested were wired in this fashion. The measured frequency response confirmed the lack of low frequency performance with a noticeable roll off below 80 Hz.

The measured crossover frequencies were approximately 1600Hz, 4000Hz and 14,000Hz, which is in close agreement with the catalogued data. The 2½" tweeter had a very low sensitivity as is shown by the sharp drop off above 15 000Hz. But as most people above the age of 25 years (and many below) cannot hear frequencies above 15,000Hz we are confused as to the reason for including the second tweeter.

Between 100Hz and 15,000Hz the response is relatively flat and comparable with most speakers in its price bracket.

A noticeable peak occurs around 100Hz and can be attributed to the vent pipe diameter and length. A slight reduction in diameter of this pipe, or an increase in its length, would optimise its performance and would extend the low frequency responses of the system.

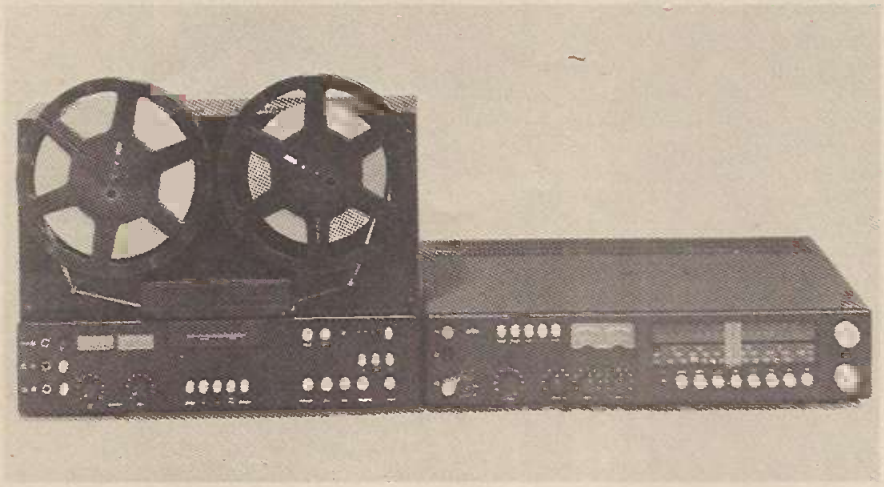
For the housewife who wants a set of speakers to complement her furnishings, and for the husband who wants a reasonable performance with low distortion then the Akai SW155 speakers would fit the bill. ●

Measured Performance of Akai Speaker Type SW155 Serial No. 1555806

Frequency response
50 Hz to 15 kHz± ± 6dB
Harmonic distortion at 10 Watts input
100Hz 0.6%
1kHz 0.27%
Harmonic distortion at 20 Watts input
100Hz 1.0%
1kHz 0.4%
Electroacoustic efficiency
0.7%
Dimensions:
25"H x 16"W x 11¾"D
Weight
39 lbs.
Price
£129 pair

Speaker type SW155 serial No. 1559824 was also used for the subjective tests

AUDIO NEWS



BRAUN HI-FI NOW IN UK

Braun hi-fi is a leader in the German domestic market and, when selected models from this impressive range were launched in mid-November in the UK by Hisonic Limited, Tovil, Maidstone, their representatives made it clear that they would not expect Braun to become a brand leader here.

However, the technical competance of the products, linked to the special Braun design concept, should provide an opportunity for this best of Germanic designs to achieve a significant share of the hi-fi market.

At this initial press and trade presentation Mr Raymond Cooke, Managing Director of Hisonics Limited (and, incidentally, of KEF Electronics Ltd) introduced Mr G Widtskiold, Area Marketing Manager, Mr H Knapp, European Accounts Supervisor, and Mr D Aldred, Braun Product Manager for Domestic Hi-Fi Products. Special reference was made to the co-ordinated aesthetic design of all Braun products, with a physical appearance that is remarkably flexible in blending into different environments.

In the view of Mr Widtskiold, the aesthetic design of high fidelity equipment currently available in this country reflects four basic approaches:

(a) the styling of individual component manufacturers who specialize in just one item of the hi-fi chain, using a design that is intended to be as inoffensive as possible — a rather negative approach;

(b) the Japanese approach stresses the technicality of the product and emphasizes particular features through dials, knobs, etc;

(c) the Scandinavian style of comparatively 'soft and warm' approach; and

(d) the Germanic style which is precise and analytical.

The systems to be made available by Hisonic are the Cockpit 260 Stereo Compact System, which incorporates a stereo amplifier (25W per channel into 4Ω), (FM/AM) radio with stereo decoder, a turntable with two speed motor hydraulically damped cueing device and facilities for tape recorder input and output. The two 4Ω loudspeaker systems are available, types L260 and L420, both bookshelf models. Recommended price: £243.87 (inc PT), without loudspeakers.

The Regie System is the 510 tuner/amplifier, with a 70W into 4Ω amplifier, distortion 0.1% and full facilities for tape, disc and auxiliary inputs and outputs. The complementary PS500 turntable has a 4-speed synchronous motor. Three other loudspeaker systems (bookshelf and freestanding designs) also marketed for this system. The Regie combination, less speakers, is priced at £313.97.

As part of the range, the Braun TG1000 two-track tape recorder is being introduced. Of professional standard, it offers three speeds, 1 7/8, 3¾ and 7½ inches per second, and incorporates an electro-mechanical braking system and photo-electrically controlled tape tension for both reels. Remote control of all functions is possible, and 'off-the-tape' plus 'before-the-tape' monitoring is available. There are three stereo magnetic heads, all metal mirror types in 'V' technology. This is an elegant high performance design which sells for £345.65.

Obviously, at these prices, Braun products will not be handled by dealers concerned with mass marketing techniques. The franchised dealers will concentrate on service and the presentation aspects of these prestige products.

CANNON XLR CONNECTOR DISTRIBUTORS

Public address, recording studios, or anyone seeking reliability in microphone and other connectors will know of the high standard attained by Cannon products. A variety of connectors and sockets, such as, the XLR-3-11C, XLR-3-13, to XLR-3-31, plus microphone cables (twisted or twin, in grey or black), is available from: PSP Electronics Limited, 228 Preston Road, Wembley, Middlesex HA9 8PB.

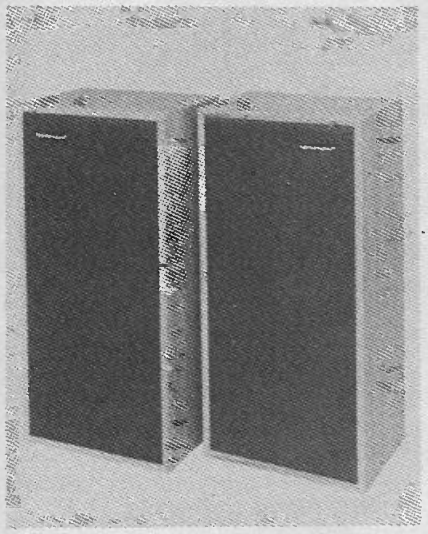
Microphone cable is also available in ten colours from another source: Future Film Developments, 1st floor, 90 Wardour Street, London W1V 3LE. This company also offers at a competitive price a range of American-made connectors (known as Switchcraft) which are fully interchangeable with the Cannon XLR series, RS components, Amphenol Excellite and Qwick types. Full details from these companies.

NEW BRITISH STANDARD FOR RECORD DECKS

The first part of a new standard defining measuring methods for record playing equipment characteristics has been issued by the British Standards Institution. The standard, reference number BS4852, costs £1, plus 20p postage and is available from BSI Sales Branch, 101 Pentonville Road, London N1 9ND. *UK535*●

NEW EAGLE SPEAKER

Eagle International, of Precision Centre, Heather Park Drive, Wembley HA0 1SU, has introduced a new loudspeaker, Model AA20, having a power handling capacity of 15watts rms. This latest Eagle design employs a high



compliance, dual cone combined bass and mid-range speaker, with a separate 3 inch tweeter. The units are housed in a cabinet finished in oiled teak veneers and dark grille cloth. Impedance: 8Ω. Overall dimensions: 23½ x 12 x 9 inch. Price: £28.

COMPACT AUDIO SYSTEM COMPARATOR

A compact audio system comparator that facilitates selection — by push-buttons — of up to five different amplifiers and up to ten pairs of loudspeakers has been introduced by Geoffrey Goodwin Hi-Fi Ltd of Northern House, Station Approach, Hitchin, Herts. Clearly marked self-cancelling press buttons on the front panel provide changeover between units. Two stereo headphone sockets are fitted, and the connections for amplifiers and speakers are by DIN sockets at the rear.

The brushed aluminium case measures 17in wide by 2¼in high by 4in deep. Price is £19.50.

STEREO 'PHONES WITH INBUILT AMPLIFIER

Christened the MIN-STER (derived from 'miniature stereo'), a new stereo headset has a small stereo amplifier fitted inside one headphone casing, powered by two 1.5 volt cells in the other earpiece. This means that the headset can be coupled directly to the pickup output from an ordinary record deck.

Output of the amplifier is 450mW per channel and a frequency range claimed of 20Hz to 17kHz, no tolerances stated. Each 'phone has a separate volume control, removable foam-filled head pads and easily cleaned ear cushions. Six metres of coiled flex, terminating in a plug, are attached.

The unit will be of considerable interest to anyone wishing to listen to records without disturbing neighbours or room companions. The manufacturers are Cowley Instruments Ltd, 381-387 Cowley Road, Oxford OX4 2BU and the units are being distributed direct to dealers. Price, we understand, is around £20.

'LIVING WITH HI-FI'

This is the title of a new book by John Borwick, Technical Editor of *The Gramophone*, written for the hi-fi enthusiast who is primarily concerned with getting the best results from his or her audio system, rather than delving too deeply into the technicalities of high fidelity sound systems.

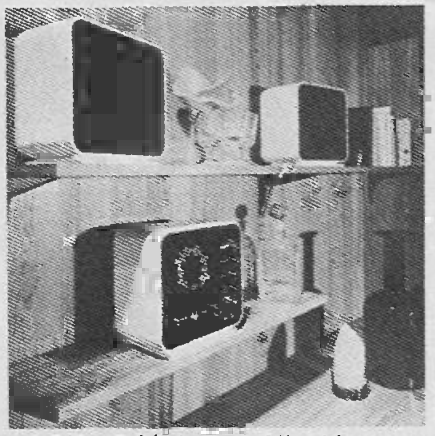
The strength of this text is its up-to-dateness (eg references to 4-channel equipment and the newest Bang & Olufsen Beogram 4000 record deck) allied with clarity of the style. There is no condescension such as one finds in the 'pop' music Press sometimes.

The areas covered include: the sounds of music, hi-fi sources (disc, tape and radio/TV broadcasts), then separate sections on hi-fi hardware — turntable, pickup cartridge, pickup arm, amplifier, loudspeaker/headphones, radio tuner, tape equipment, listening to hi-fi, installing hi-fi, and how to check overall performance. Diagrams or pictures are on almost every one of the 156 pages.

This paperback volume can be purchased for £1.00, including 20p postage and packing, from General Gramophone Publications Limited, 177-179 Kenton Rd, Kenton, Harrow, Mx HA3 0HA.

EAGLE FM MODEL SC-720 STEREO SYSTEM

Admirably suited to the modern living room, the latest Eagle Receiver System comprises a tuner-amplifier and twin loudspeakers, all of which are almost identical in size, namely, 9 3/8



x 9 3/8 x 6 3/8 inches. All cabinets are finished in matt white. Behind the facia of the tuner-amp is an illuminated circular tuning scale, and a tuning indicator that glows when an FM stereo transmission is received.

There are inputs for tape recorder and pickup, and an output socket for stereo headset, a useful adjunct when the listening area is shared with a TV set.

Power output: 5 watts rms per channel into 8Ω FM frequency range: 88-108MHz and AM frequency range: 520-1610kHz. Price: £62.20 complete.

4 CHANNEL CARTRIDGE PLAYER

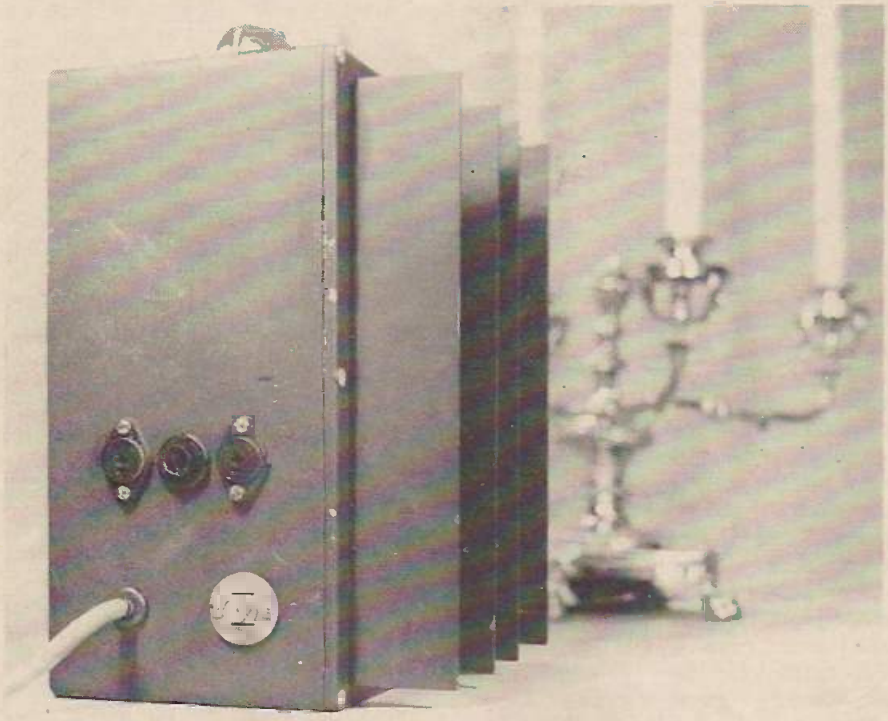
This very compact, attractively styled, quadraphonic cartridge player, is the latest of the comprehensive range of Pioneer tape players to be offered for In-Car Entertainment in this country.

The TP-41 re-creates music from four separate sound tracks giving the 'wrap around' sound as compared with stereo re-creating two separate sound tracks, but it can still be used to play one's collection of stereo cartridges through the four-speaker system.

Several models are available to suit all individual requirements.

Price £82. 09, available from Autocar Electrical Equipment. 1 Chantry Road Industrial Estate, Kempston, Beds. ●

100W GUITAR AMPLIFIER



In the early days of radio one of the standard acceptance tests for shipborne radio apparatus was its ability to withstand a 13 stone radio operator climbing up the equipment rack wearing heavy boots.

Electronic equipment used by pop groups and for public address systems — whilst often built to substantially lower standards — often receives similarly rugged treatment.

For this type of use, the ability to operate reliably despite having spent the previous six hours rolling around in the boot of a car will be of far more importance than a stainless steel facia with a lot of coloured indicator lights and VU meters.

The amplifier described in this project has been specifically designed for just such applications.

It is intended primarily as a guitar amplifier and for public address systems. In the interests of ruggedness it has been put together entirely without frills. It has no tone or volume controls and must be used with a suitable preamplifier.

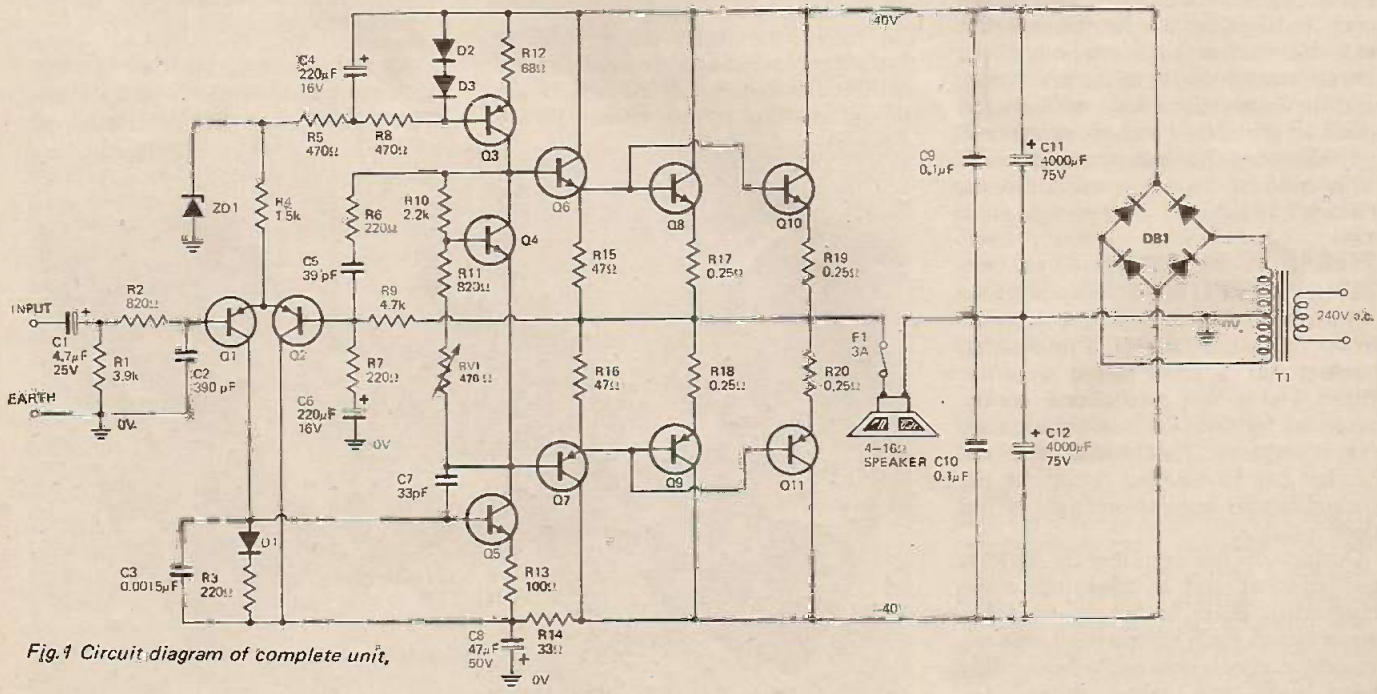


Fig. 1 Circuit diagram of complete unit.

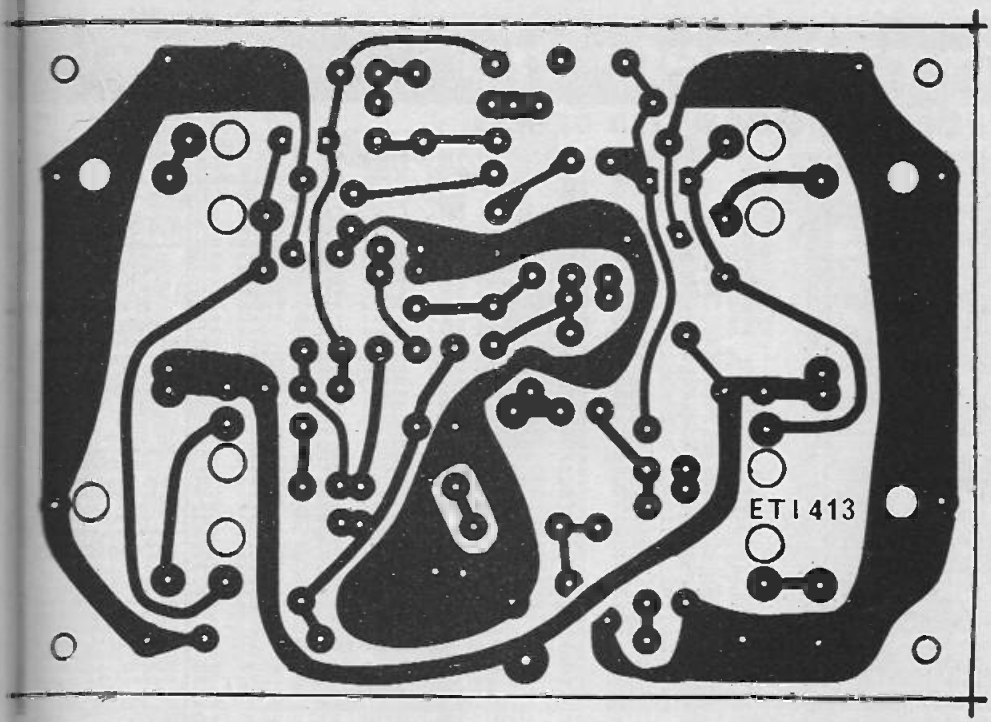


Fig. 2 Foil pattern for printed circuit board (full size).

It is not only rugged mechanically, for it will handle over a hundred watts continuously with a sine-wave input.

Despite the design criteria of ruggedness, the performance specifications put the unit well into the hi-fi area. Frequency response – as the accompanying table shows – is virtually flat from 50 Hz to 20 kHz and total harmonic distortion is less than 0.5% from 0.1W to 80W.

Any number of speakers may be driven from this amplifier providing their combined impedance is equal to or exceeds four ohms.

CONSTRUCTION

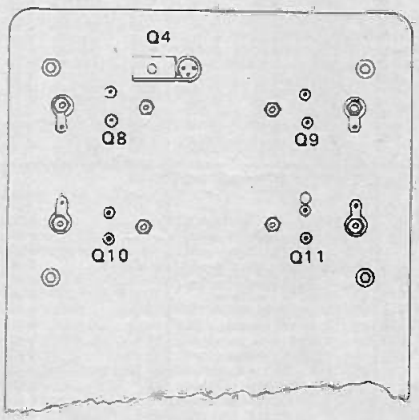
Construction is quite straightforward as most components are mounted on the printed circuit board.

Start by soldering the components on to the printed circuit board according to the layout shown in Fig. 3. Make sure that all capacitors, diodes and transistors are put in the right way round. Metal 'fan' type heatsinks are used on Q3 and Q5. Make sure that these are well away from any other component.

A heatsink is fitted between Q6 and Q7 (Fig. 4) and is insulated by mica washers. Note that the heatsink will be slightly skewed and the transistor slightly twisted so that the heatsink can be bolted on to the 'metal side' of the transistors. Remember that insulating washers must be used.

The printed circuit board will be mounted onto the lid of the die-cast metal box and short connecting leads will be used to connect the board to the output transistors which are mounted on the outside face of this lid.

(Continued on page 56)



Inside view of lid showing position of Q4, Q8, Q9, Q10 and Q11 (See also Fig. 6.)

HOW IT WORKS

The amplifier is of conventional design using a quasi-complementary symmetry, output stage and a differential input stage.

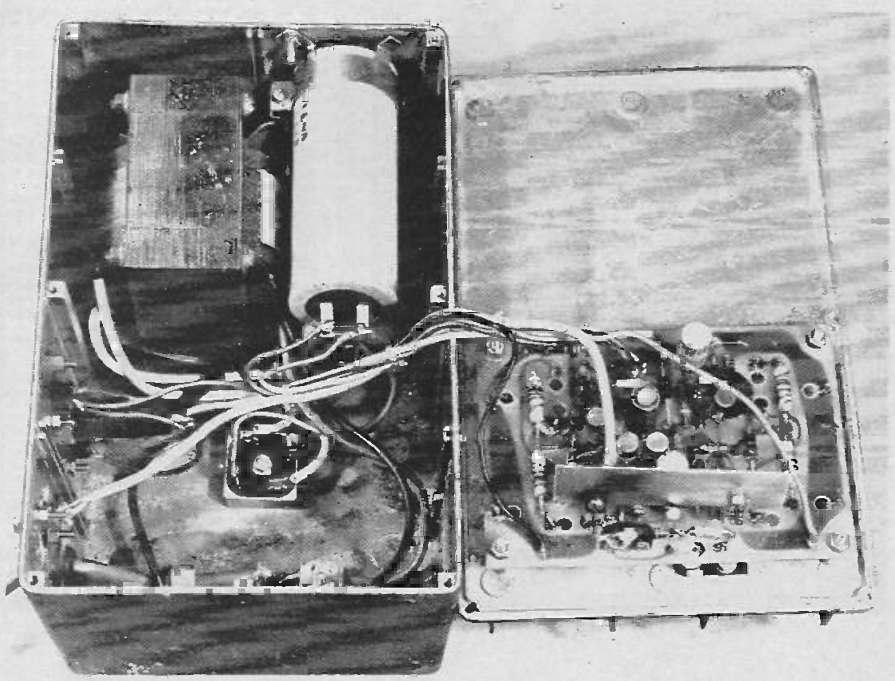
Output transistors are paralleled for greater output capacity – and transistors Q6 and Q7 connected in a Darlington configuration provide current gain.

Q3 is a current regulator supplying approximately 10 mA. This controlled current passes through Q4, thus setting the bias for the output stage, and Q5. The voltage at the collector of Q5 is set by its own base-emitter voltage. Since this transistor is working with an almost constant current in its collector it has a very high voltage gain. This gain is attenuated at high frequencies by C7.

Transistor Q5 is controlled by the differential pair Q1 and Q2. Due to the negative feedback via R7 & R9, the action of Q1 and Q2 is that of an error amplifier. Thus it tries to keep the voltage at its two inputs (the bases of Q1 and Q2) constant. Because of this action, the output voltage is held equal to the input voltage multiplied by (R9+R7)/R7. This gives the amplifier a voltage gain of approximately 22. This gain may be changed by varying the value of R7. An appropriate change must then also be made to C6 as R7/C6 determine the lower –3dB point. The value of R9 should not be altered.

The output bias current – which is necessary to prevent cross-over distortion – is set by RV1.

ETI PROJECT 413



The largest selection

BRAND NEW FULLY GUARANTEED DEVICES

AC107	0·20	AD162	0·83	BC148	0·10	BD137	0·45	BF188	0·40	OC19	0·25	2G371	0·16	2N2219	0·20	2N3054	0·66	2N4059	0·10
AC113	0·20	AD161 &		BC149	0·12	BD138	0·50	BF194	0·12	OC20	0·63	2G371B	0·12	2N2220	0·22	2N3055	0·50	2N4060	0·12
AC115	0·23	AD162 (MP)		BC150	0·18	BD139	0·55	BF195	0·12	OC22	0·38	2G373	0·17	2N2221	0·20	2N3391	0·14	2N4061	0·12
AC117K	0·20		0·55	BC151	0·20	BD140	0·60	BF196	0·14	OC23	0·42	2G374	0·17	2N2222	0·20	2N3391A	0·16	2N4062	0·12
AC122	0·12	ADT140	0·50	BC152	0·17	BD155	0·80	BF197	0·14	OC24	0·56	2G377	0·20	2N2368	0·17	2N3392	0·14	2N4284	0·17
AC125	0·17	AF114	0·24	BC153	0·28	BD175	0·60	BF200	0·45	OC25	0·38	2G378	0·18	2N2369	0·14	2N3393	0·14	2N4285	0·17
AC126	0·17	AF115	0·24	BC154	0·30	BD176	0·80	BF222	0·95	OC26	0·25	2G381	0·16	2N2369A	0·14	2N3394	0·14	2N4286	0·17
AC127	0·17	AF116	0·24	BC157	0·18	BD177	0·65	BF257	0·45	OC28	0·50	2G382	0·18	2N2411	0·24	2N3395	0·17	2N4287	0·17
AC128	0·17	AF117	0·24	BC158	0·12	BD178	0·65	BF258	0·60	OC29	0·50	2G401	0·30	2N2412	0·24	2N3402	0·21	2N4288	0·17
AC132	0·14	AF118	0·25	BC159	0·12	BD179	0·70	BF259	0·85	OC35	0·42	2G414	0·30	2N2646	0·47	2N3403	0·21	2N4289	0·17
AC134	0·14	AF124	0·30	BC160	0·45	BD180	0·70	BF262	0·55	OC36	0·50	2G417	0·25	2N2711	0·21	2N3404	0·28	2N4290	0·17
AC137	0·14	AF125	0·25	BC161	0·50	BD185	0·65	BF263	0·55	OC41	0·20	2N388	0·25	2N2712	0·21	2N3405	0·42	2N4291	0·17
AC141	0·14	AF126	0·28	BC167	0·13	BD186	0·65	BF270	0·35	OC42	0·24	2N388A	0·55	2N2714	0·21	2N3414	0·15	2N4292	0·17
AC141K	0·17	AF127	0·28	BC168	0·12	BD187	0·70	BF271	0·30	OC44	0·15	2N404	0·20	2N2904	0·17	2N3415	0·15	2N4293	0·17
AC142	0·14	AF139	0·30	BC169	0·12	BD188	0·70	BF272	0·80	OC45	0·12	2N404A	0·28	2N2904A	0·21	2N3416	0·28	2N5172	0·18
AC142K	0·17	AF178	0·50	BC170	0·12	BD189	0·75	BF273	0·35	OC70	0·10	2N524	0·42	2N2905	0·21	2N3417	0·28	2N5457	0·32
AC151	0·15	AF179	0·50	BC171	0·14	BD190	0·75	BF274	0·35	OC71	0·10	2N527	0·49	2N2905A	0·21	2N3525	0·75	2N5458	0·32
AC154	0·20	AF180	0·50	BC172	0·14	BD195	0·85	BFW10	0·60	OC72	0·14	2N598	0·42	2N2906	0·15	2N3646	0·09	2N5459	0·40
AC155	0·20	AF181	0·45	BC173	0·14	BD196	0·85	BFX29	0·27	OC74	0·14	2N599	0·45	2N2906A	0·18	2N3702	0·10	28301	0·50
AC156	0·20	AF186	0·45	BC174	0·14	BD197	0·90	BFX84	0·22	OC75	0·15	2N696	0·12	2N2907	0·20	2N3703	0·10	28302A	0·42
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AC165	0·20	AL102	0·85	BC177	0·19	BD199	0·95	BFX88	0·22	OC77	0·25	2N698	0·24	2N2923	0·14	2N3705	0·10	28303	0·55
AC166	0·20	AL103	0·85	BC178	0·19	BD200	0·95	BFX87	0·24	OC81	0·15	2N699	0·85	2N2924	0·14	2N3706	0·09	28304	0·70
AC167	0·20	A8Y26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N706	0·08	2N2925	0·14	2N3707	0·11	28305	0·84
AC168	0·24	A8Y27	0·30	BC180	0·24	BD206	0·80	BFY50	0·20	OC82	0·15	2N706A	0·09	2N2926 (G)	0·12	2N3708	0·07	28306	0·84
AC169	0·14	A8Y28	0·25	BC181	0·24	BD207	0·95	BFY51	0·20	OC82D	0·15	2N708	0·12	2N2926 (Y)	0·11	2N3709	0·09	28307	0·84
AC176	0·20	A8Y29	0·25	BC182	0·10	BD208	0·95	BFY52	0·20	OC83	0·20	2N711	0·30	2N2926 (O)	0·11	2N3710	0·09	28321	0·55
AC177	0·24	A8Y50	0·25	BC182L	0·10	BDY20	1·00	BFY53	0·17	OC84	0·20	2N717	0·35	2N2926 (R)	0·10	2N3711	0·09	28322	0·42
AC178	0·28	A8Y51	0·25	BC183	0·10	BF115	0·24	BPX25	0·85	OC139	0·20	2N718	0·24	2N2926 (B)	0·10	2N3819	0·28	28322A	0·42
AC179	0·28	A8Y52	0·25	BC183L	0·10	BF117	0·45	BSX19	0·15	OC140	0·20	2N718A	0·50	2N2926 (B)	0·10	2N3820	0·50	28323	0·56
AC180	0·17	A8Y54	0·25	BC184	0·12	BF118	0·70	BSX20	0·15	OC169	0·25	2N726	0·28	2N2926 (B)	0·10	2N3821	0·35	28324	0·70
AC180K	0·20	A8Y55	0·25	BC184L	0·13	BF119	0·70	BSY25	0·15	OC170	0·25	2N727	0·28	2N2926 (B)	0·10	2N3823	0·28	28325	0·70
AC181	0·17	A8Y56	0·25	BC186	0·28	BF121	0·45	BSY26	0·15	OC171	0·25	2N743	0·20	2N2926 (B)	0·10	2N3903	0·22	28326	0·70
AC181K	0·20	A8Y57	0·25	BC187	0·28	BF123	0·50	BSY27	0·15	OC200	0·25	2N744	0·20	2N2926 (B)	0·10	2N3904	0·30	28327	0·70
AC187	0·28	A8Y58	0·25	BC207	0·11	BF125	0·45	BSY28	0·15	OC201	0·28	2N914	0·14	2N3010	0·70	2N3905	0·28	28701	0·42
AC187K	0·20	A8Z21	0·40	BC208	0·11	BF127	0·50	BSY29	0·15	OC202	0·28	2N918	0·30	2N3011	0·14	2N3906	0·27	40361	0·40
AC188	0·22	BC107	0·09	BC209	0·12	BF152	0·55	BSY38	0·18	OC203	0·25	2N929	0·21	2N3053	0·17	2N4058	0·12	40362	0·45
AC188K	0·20	BC108	0·09	BC212L	0·11	BF153	0·45	BSY39	0·18	OC204	0·25	2N930	0·21						
AC189	0·22	BC109	0·10	BC213L	0·11	BF154	0·45	BSY40	0·28	OC205	0·35	2N1131	0·20						
AC191	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	BSY41	0·28	OC309	0·40	2N1132	0·28						
AC192	0·20	BC114	0·15	BC225	0·25	BF156	0·48	BSY95	0·12	1N46A	0·20	2N1302	0·14						
AC193	0·20	BC115	0·15	BC226	0·35	BF157	0·55	BSY95A	0·12	PS97	0·42	2N1303	0·14						
AC194	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	GCZP71	0·43	2N1304	0·17						
AC195	0·20	BC117	0·15	BCY31	0·26	BF159	0·60	G111E	0·50	ORP12	0·43	2N1305	0·17						
AC197	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	G400	0·30	ORP60	0·40	2N1306	0·21						
AC198	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	G407	0·25	ORP61	0·40	2N1307	0·21						
AC199	0·35	BC120	0·80	BCY34	0·25	BF163	0·40	G424	0·20	ST140	0·12	2N1308	0·23						
AC207	0·30	BC125	0·12	BCY70	0·14	BF164	0·40	G425	0·50	ST141	0·17	2N1309	0·23						
AC211	0·28	BC126	0·18	BCY71	0·18	BF165	0·40	G426	0·35	T1843	0·30	2N1613	0·20						
AC234	0·21	BC132	0·12	BCY72	0·14	BF167	0·22	G428	0·20	UT46	0·27	2N1711	0·20						
AC235	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	G441	0·30	2G301	0·09	2N1889	0·32						
ACY26	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	G442	0·30	2G302	0·18	2N1890	0·45						
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	G444	0·35	2G303	0·19	2N1893	0·37						
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·30	G450	0·22	2G304	0·24	2N2147	0·72						
ACY44	0·35	BC139	0·40	BD123	0·85	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57						
AD130	0·38	BC140	0·30	BD124	0·60	BF180	0·30	MAT101	0·20	2G308	0·35	2N2160	0·60						
AD140	0·48	BC141	0·30	BD131	0·50	BF181	0·30	MAT120	0·19	2G309	0·25	2N2192	0·35						
AD142	0·48	BC142	0·30	BD132	0·60	BF182	0·40	MAT121	0·20	2G339	0·20	2N2193	0·35						
AD143	0·38	BC143	0·30	BD133	0·65	BF183	0·40	MPF102	0·42	2G339A	0·16	2N2194	0·35						
AD149	0·50	BC145	0·45	BD135	0·40	BF184	0·25	MPF104	0·37	2G344	0·18	2N2217	0·22						
AD161	0·33	BC147	0·10	BD136	0·40	BF185	0·30	MPF105	0·37	2G345	0·16	2N2218	0·20						

DIODES AND RECTIFIERS

AA119	0·08	BY133	0·21	OA10	0·35
AA120	0·08	BY164	0·50	OA47	0·07
AA129	0·08	BYX38/300	0·42	OA70	0·07
AAY30	0·09			OA79	0·07
AAZ13	0·20	BYZ10	0·35	OA81	0·07
BA100	0·10	BYZ11	0·30	OA85	0·09
BA116	0·21	BYZ12	0·30	OA90	0·06
BA126	0·22	BYZ13	0·25	OA91	0·06
BA148	0·14	BYZ16	0·40	OA95	0·07
BA154	0·12	BYZ17	0·35	OA200	0·06
BA155	0·14	BYZ18	0·35	OA202	0·07
BA156	0·12	BYZ19	0·28	SD10	0·05
BY100	0·15	CG62		SD19	0·06
BY101	0·12	(Eq) OA91		IN34	0·07
BY105	0·17		0·8	IN34A	0·07
BY114	0·12	CG651		IN914	0·08
BY126	0·14	(Eq) OA70		IN916	0·08
BY127	0·15	OA79	0·06	IN914B	0·06
BY128	0·15	OA5	0·35	18021	0·10
BY130	0·16	OA85L	0·21	18951	0·06

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200	50	80	90
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U24	20	Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·50
U25	25	300 MHz NPN Silicon Transistors 2N708, BSY27	0·50
U26	30	Fast Switching Silicon Diodes like IN914 Micro-Min.	0·50
U27	12	NPN Germanium AF Transistors TO-1 like AC127	0·50
U29	10	1 Amp SCR's TO-3 can, up to 600 PIV CR81/25-600	1·00
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U31	20	Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·50
U32	25	Zener Diodes 400mW DO-7 case 3-18 volts mixed	0·50
U33	15	Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0·50
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U35	25	Silicon Planar Transistors PNP TO-18 2N2906	0·50
U36	25	Silicon Planar NPN Transistors TO-5 BFY50/51/52	0·50
U37	30	Silicon Alloy Transistors SO-2 PNP OC200, 2S	0·50
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U45	7	3A SCR. TO66 up to 600PIV	1·00

Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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Q9	7	OC 81 type transistors	0·50
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Q13	3	AF 117 type transistors	0·50
Q14	3	OC 171 H.F. type transistors	0·50
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Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0·50
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Q23	10	OA 202 Silicon diodes sub-min.	0·50
Q24	8	OA 81 diodes	0·50
Q25	15	IN914 Silicon diodes 75 PIV 75mA	0·50
Q26	8	OA95 Germanium diodes sub-min. IN69	0·50
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Q28	2	Silicon power rectifiers BYZ 13	0·50
Q29	4	Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·50
Q30	7	Silicon switch transistors 2N706 NPN	0·50
Q31	6	Silicon switch transistors 2N708 NPN	0·50
Q32	3	PNP Silicon transistors 2 × 2N1131, 1 × 2N 1132	0·50
Q33	3	Silicon NPN transistors 2N1711	0·50
Q34	7	Silicon NPN transistors 2N2369, 300MHz (code PS97)	0·50
Q35	3	Silicon PNP TO-5, 2 × 2N2904 & 1 × 2N2905	0·50
Q36	7	2N3646 TO-18 plastic 300 MHz NPN	0·50
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100	0·25	0·33	0·47	0·47	0·50	0·58	0·93	1·40
200	0·35	0·37	0·49	0·49	0·57	0·61	0·75	1·60
400	0·43	0·47	0·56	0·56	0·67	0·75	0·93	1·75
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800	0·63	0·70	0·80	0·80	0·90	1·20	1·50	4·00

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PIV	300mA	750mA	1A	1·5A	3A	10A	30A
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100	0·04	0·06	0·06	0·13	0·16	0·23	0·75
200	0·05	0·08	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·85
800	0·10	0·17	0·11	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·14	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·38	0·57	0·75	—

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SN7420	0·15	0·14	0·12	SN7485	£3·60	£3·50	£3·40	SN74166	£3·50	£3·25	£3·00
SN7422	0·50	0·48	0·45	SN7486	0·32	0·31	0·30	SN74174	£2·30	£2·20	£2·10
SN7423	0·50	0·48	0·45	SN7489	£5·50	£5·25	£5·00	SN74175	£1·60	£1·50	£1·40
SN7425	0·50	0·48	0·45	SN7490	0·67	0·64	0·58	SN74176	£2·50	£2·40	£2·30
SN7427	0·45	0·43	0·40	SN7491	£1·00	0·96	0·90	SN74177	£2·50	£2·40	£2·30
SN7428	0·70	0·65	0·60	SN7492	0·67	0·64	0·58	SN74180	£2·00	£1·80	£1·40
SN7430	0·15	0·14	0·12	SN7493	0·67	0·64	0·58	SN74181	£5·50	£5·00	£4·75
SN7432	0·45	0·42	0·40	SN7494	0·77	0·74	0·68	SN74182	£2·00	£1·80	£1·60
SN7433	0·80	0·75	0·70	SN7495	0·77	0·74	0·68	SN74184	£3·50	£3·25	£3·00
SN7437	0·64	0·62	0·60	SN7496	0·87	0·84	0·78	SN74190	£1·95	£1·90	£1·85
SN7438	0·64	0·62	0·60	SN74100	£1·85	£1·80	£1·55	SN74191	£1·90	£1·85	£1·80
SN7440	0·15	0·14	0·12	SN74104	0·97	0·94	0·88	SN74192	£1·95	£1·90	£1·85
SN7441	0·67	0·64	0·58	SN74105	0·97	0·94	0·88	SN74193	£2·00	£1·80	£1·75
SN7442	0·67	0·64	0·58	SN74107	0·40	0·38	0·36	SN74194	£2·70	£2·60	£2·50
SN7443	£1·30	£1·25	£1·20	SN74110	0·55	0·53	0·50	SN74195	£2·00	£1·90	£1·80
SN7444	£1·30	£1·25	£1·20	SN74111	£1·25	£1·15	£1·10	SN74196	£1·80	£1·70	£1·60
SN7445	£1·80	£1·77	£1·75	SN74118	£1·00	0·96	0·90	SN74197	£1·80	£1·70	£1·60
SN7446	0·97	0·94	0·88	SN74119	£1·35	£1·25	£1·10	SN74198	£5·50	£5·00	£4·50
SN7447	£1·00	0·97	0·96	SN74121	0·40	0·37	0·34	SN74199	£5·50	£5·00	£4·50
SN7448	£1·00	0·97	0·96	SN74122	£1·40	£1·30	£1·10				

The AL50 HI-FI AUDIO AMPL 50W pk 25w (RMS)

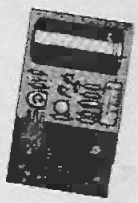
0·1% DISTORTION! HI-FI AUDIO AMPLIFIER

- Frequency Response 15Hz to 100,000—1dB.
- Load—3, 4, 8 or 16 ohms. • Supply voltage 10-35 Volts.
- Distortion—better than 0·1% at 1kHz.
- Signal to noise ratio 80dB.
- Overall size 63 mm × 105 mm × 13 mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT—TESTED—GUARANTEED.

BRITISH MADE. only £3·25 each

STABILISED POWER



MODULE SPM80 **£2·95**

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm × 105 mm × 20 mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p.

TRANSFORMER BMT80 £1·95 p. & p. 25p

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41/14 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

All indicators 0-9 + Decimal point. All side viewing. Full data for all types available on request.

INTEGRATED CIRCUIT PAKS

Manufacturers "Fall Outs" which include Functional and Part-Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C's and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	12 + 7400	0·50	UIC46	5 × 7446	0·50	UIC86	5 × 7486	0·50
UIC01	12 × 7401	0·50	UIC47	5 × 7447	0·50	UIC90	5 × 7490	0·50
UIC02	12 × 7402	0·50	UIC48	5 × 7448	0·50	UIC91	5 × 7491	0·50
UIC03	12 × 7403	0·50	UIC50	12 × 7450	0·50	UIC92	5 × 7492	0·50
UIC04	12 × 7404	0·50	UI351	12 × 7451	0·50	UIC93	5 × 7493	0·50
UIC05	12 × 7405	0·50	UIC53	12 × 7453	0·50	UIC94	5 × 7494	0·50
UIC06	8 × 7406	0·50	UIC54	12 × 7454	0·50	UIC95	5 × 7495	0·50
UIC07	8 × 7407	0·50	UIC60	12 × 7460	0·50	UIC96	5 × 7496	0·50
UIC10	12 × 7410	0·50	UIC70	8 × 7470	0·50	UIC100	5 × 74100	0·50
UIC13	8 × 7413	0·50	UIC72	8 × 7472	0·50	UIC121	5 × 74121	0·50
UIC20	12 × 7420	0·50	UIC73	8 × 7473	0·50	UIC141	5 × 74141	0·50
UIC30	12 × 7430	0·50	UIC74	8 × 7474	0·50	UIC151	5 × 74151	0·50
UIC40	12 × 7440	0·50	UIC75	8 × 7475	0·50	UIC154	5 × 74154	0·50
UIC41	5 × 7441	0·50	UIC76	8 × 7476	0·50	UIC193	5 × 74193	0·50
UIC42	5 × 7442	0·50	UIC80	8 × 7480	0·50	UIC199	5 × 74199	0·50
UIC43	5 × 7443	0·50	UIC81	5 × 7481	0·50			
UIC44	5 × 7444	0·50	UIC82	5 × 7482	0·50	UICX1	25 Assorted 74's	1·50
UIC45	8 × 7445	0·50	UIC83	5 × 7483	0·50			

Packs cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

STEREO PRE-AMPLIFIER TYPE PA100

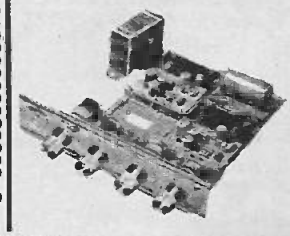
Built to a specification and NOT a price, and yet still the greatest value on the market, the PA1000 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Force switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50KΩ	Filters: Rumble (high pass)	100 Hz
2. Radio, Tuner	35mV into 30KΩ	Scratch (low pass)	8kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
All input voltages are for an output of 250mV.		Input overload	+26dB
Tape and P.U. inputs equalised to RIAA curve within ±1dB from 20Hz to 20kHz.		Supply	+35 volts at 20mA
		Dimensions	292 × 82 × 35 mm

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £23.00 FREE p.&p

only £11·95



The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak	Input 1 (Cer.) 300mV into 1M
Freq. res. 25Hz-25kHz	Input 2 (Aux.) 4mV into 30K
Harmonic distortion	Bass control ±12dB at 60Hz
typically 0·25% at 1 watt	Treble con. ±14dB at 14kHz

£12·25 free p. & p.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0·50
C 2	200	Capacitors mixed values approx. count by weight	0·50
C 3	50	Precision Resistors 1%, mixed values	0·50
C 4	75	¼th W Resistors mixed preferred values	0·50
C 5	5	Pieces assorted Ferrite Rods	0·50
C 6	2	Tuning Gangs, MW/LW/VHF	0·50
C 7	1	Pack Wire 50 metres assorted colours	0·50
C 8	10	Reed Switches	0·50
C 9	3	Micro Switches	0·50
C10	15	Assorted Pots & Pre-Sets	0·50
C11	5	Jack Sockets 3 × 3·5mm 2 × Standard Switch Types	0·50
C12	40	Paper Condensers preferred types mixed values	0·50
C13	20	Electrolytics Trans. types	0·50
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·50
C15	4	Mains Toggle Switches, 2 Amp D/P	0·50
C16	20	Assorted Tag Strips & Panels	0·50
C17	10	Assorted Control Knobs	0·50
C18	4	Rotary Wave Change Switches	0·50
C19	3	Relays 6—24V Operating	0·50
C20	4	Sheets Copper Laminate approx. 10" × 7"	0·50

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20.

DTL MICROLOGIC CIRCUITS

	Price each 1-24	25-99	100 up
Epoxy TO-5 case uL900 Buffer	35p	33p	27p
uL914 Dual 2/i/p gate	35p	33p	27p
uL923 J-K flip-flop	50p	47p	45p

Data and Circuits Booklet for IC's Price 7p.

DUAL-IN-LINE IC's. TWO Ranges PROFESSIONAL & NEW LOW COST.

PROF. TYPE No.	1-24	25-99	100 up.
TSO 14 pin type	30p	27p	25p
TSO 16 " "	35p	32p	30p
LOW COST No.			
BP8 14	15p	13p	11p
BP8 16	16p	14p	12p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application (DTL 930 Series only).

LINEAR I.C.'s—FULL SPEC.

Type No.	1-24	Price 25-99	100 up
BP 201C—SL201C	63p	53p	45p
BP 701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	36p	34p	30p
BP 709P—μA709C	36p	34p	30p
BP 710—72710	44p	42p	40p
BP 711—μA711	45p	43p	40p
BP 741—72741	75p	60p	50p
μA703C—μA703C	28p	26p	24p
TAA 263—	70p	60p	55p
TAA 293	90p	75p	70p
TAA 350	170p	158p	150p

S.G.S. EA1000 £2·63

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	1-24	Price 25-99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

SYSTEM 12 STEREO

Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms; the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner. Further details available on request.

ONLY £16·95 FREE p. & p.

All prices quoted in new pence Geo No. 388-7006
Please send all orders direct to warehouse and despatch department

BI-PAK

P.O. BOX 5, WARE · HERTS

Postage and packing add 10p. Overseas add extra for airmail. Minimum order 50p. Cash with order please

Guaranteed Satisfaction or Money Back

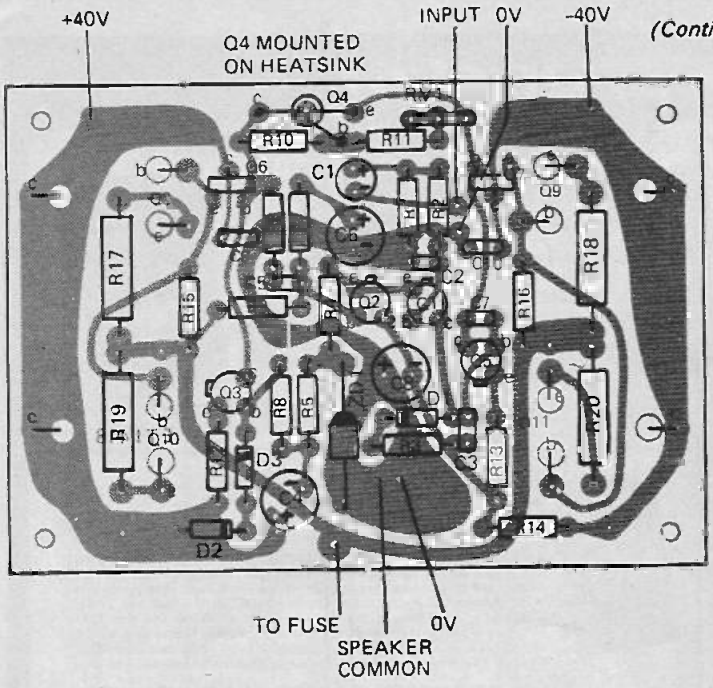


Fig. 3. How the components are mounted on the printed circuit board.

(Continued from page 53)

Countersunk screws and spacers are used to ensure that the printed circuit board stands well clear of inner face of the lid. These should be installed at this stage – but do not yet attach the board itself.

The heatsink for Q4 should be attached to the lid using a countersunk screw and insulating washers. The heatsinks for the output transistors, and the output transistors, should now be installed. Make quite sure that the correct transistors are in the right places. Insulating washers must again be used.

Connect short leads to the emitter, base and collector of the output transistors (the connection to the collectors is made via the transistor mounting screw)'

Press transistor Q4 into its heatsink.

Install metal connecting pins in the printed circuit board for terminating connections to the output transistors Q8, Q9, Q10, and Q11. Pins are also required for Q4. The pin positions are clearly marked on the printed circuit board overlay.

Now connect all leads from the power supply etc, to the printed circuit board and then fit the board over the leads from the output transistors and screw firmly into place.

Solder the leads from the various external connections to the appropriate pins on the board. Do not wrap the wire around the pins by more than half a turn as it will otherwise be very difficult to remove later (if necessary).

Install and connect all remaining components.

Ensure that the mains earth lead is securely attached to the case as must also be the transformer shield. The input shield should be earthed to the case at the input socket.

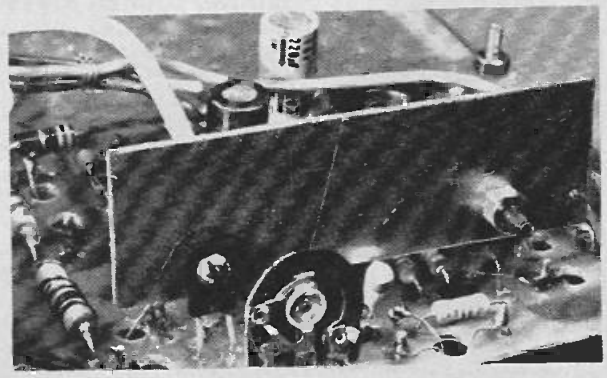


Fig. 4 A heat sink (detailed in Fig. 5) locates Q6 and Q7. In this illustration, Q7 can be seen just to left of the potentiometer.

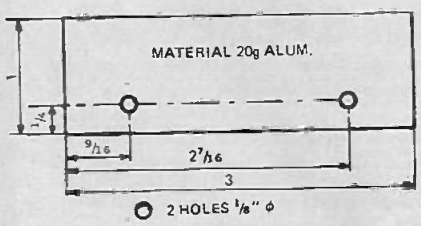
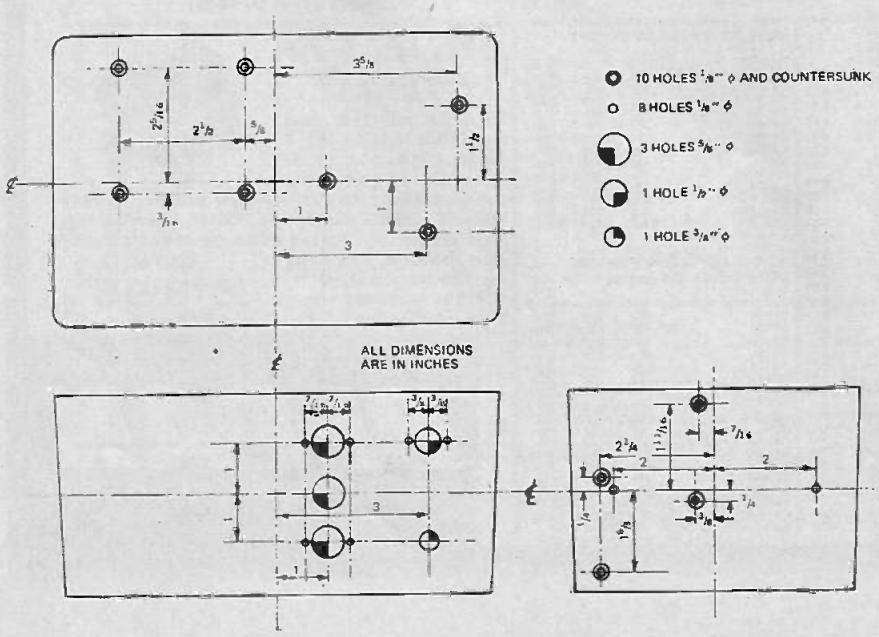


Fig. 5 Details of heat sink for Q6 and Q7.

Drilling details for ITT die-cast box 8¾" x 5¾" x 4"



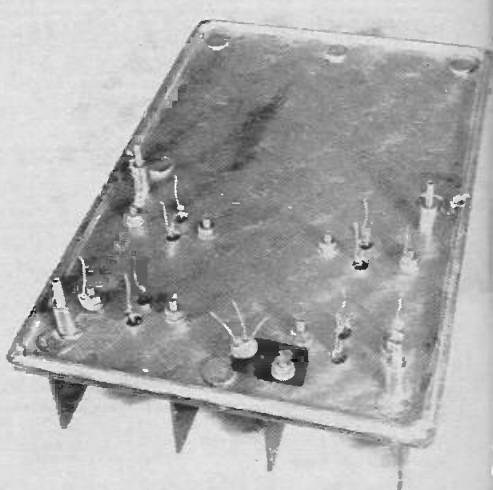


Fig. 6. Lid of the die-cast box showing heat sinks (and output transistor leads). Transistor Q4 and its associated heat sink is clearly visible.

100W GUITAR AMPLIFIER

Now carefully check out all connections – ensure that there are no loose ends of wire laying around inside the case.

The unit is now ready for testing.

TESTING PROCEDURE

A multimeter capable of measuring 100mA d.c. is required. Insert the meter in series with the +40V supply and rotate trimpot RV1 so that the wiper is nearest Q4 (i.e. maximum resistance). Switch the unit on and adjust RV1 until a reading of 65 mA is obtained. Allow the amplifier to warm up for about five minutes and then readjust the output current to 70–80 mA. (Note – the current will increase as the unit warms up). Switch the unit off and reconnect the positive power lead to the pc board.

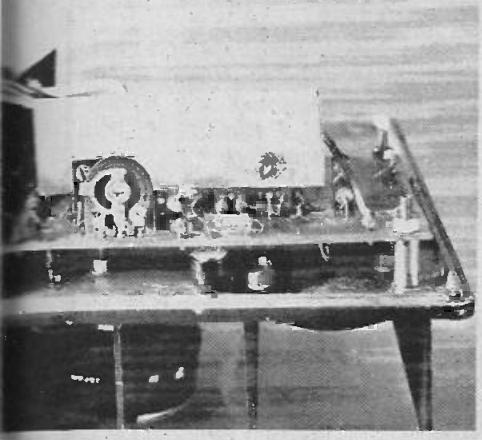
Switch the multimeter to the volts range and check the voltage between the outputs and OV. It should be within 200 mV of zero (either polarity).

If both measurements are correct the amplifier is ready for use. Switch off and disconnect the multimeter.

Connect a loudspeaker to the output and again switch on – no sound should be heard from the speaker.

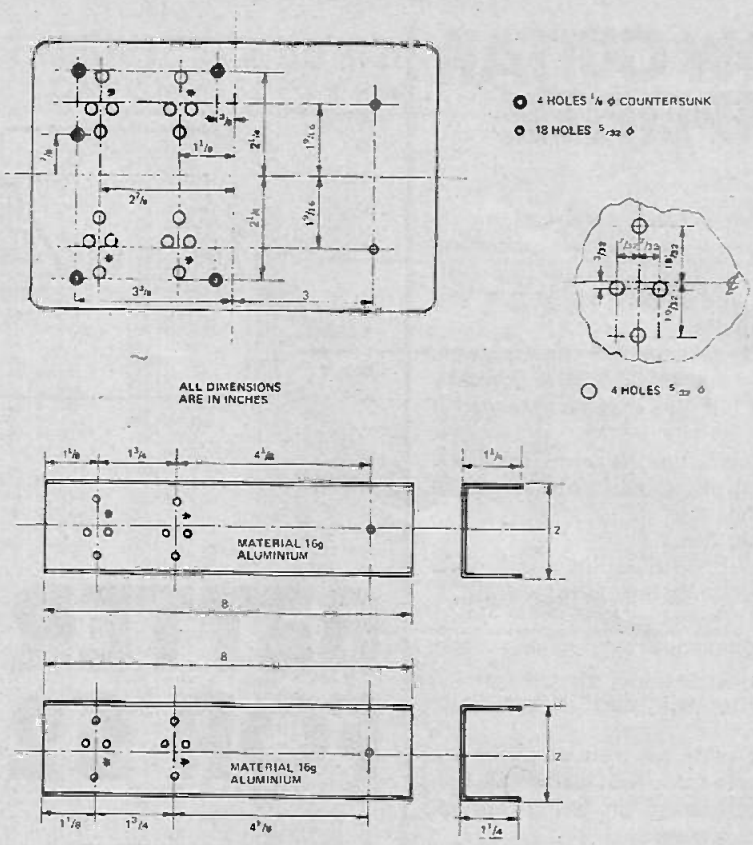
PREAMPLIFIER

The preamplifier used to drive this unit must be capable of producing approximately 1 volt into 3.9k.



SPECIFICATIONS

Output Power (into 4 ohms)	100 watts (continuous)
Frequency Response	50 Hz–20 kHz ±1 dB 20 Hz–150 kHz ±3 dB
Total Harmonic Distortion (0.1 watt – 80 watts)	20 Hz–20 kHz < 0.5%
Damping Factor (4 ohm load)	80
Input Impedance	≏3.9 k



Drilling details of ITT box lid and associated heat sinks

PARTS LIST: ETI 413

R1	Resistor	3.9k ½W 5%
R2	"	820 ohm ½W 5%
R3	"	220 " ½W 5%
R4	"	1.5k ½W 5%
R5	"	470 ohm ½W 5%
R6	"	220 " ½W 5%
R7	"	220 " ½W 5%
R8	"	470 " ½W 5%
R9	"	4.7k ½W 5%
R10	"	2.2k ½W 5%
R11	"	820 ohm ½W 5%
R12	"	68 ohm ½W 5%
R13	"	100 " ½W 5%
R14	"	33 " ½W 5%
R15	"	47 " ½W 5%
R16	"	47 " ½W 5%
R17	"	0.25 " 2W 5%
R18	"	0.25 " 2W 5%
R19	"	0.25 " 2W 5%
R20	"	0.25 " 2W 5%
RV1	Preset Resistor	470 ohm Large type Trimpot
C1	Capacitor	4.7µF 25V TAG tantalum
C2	"	390pF ceramic
C3	"	0.0015 µF polyester
C4	"	220 µF 16V electrolytic (PC type)
C5	"	39pF ceramic
C6	"	220 µF 16V electrolytic (PC type)
C7	"	33 pF ceramic
C8	"	47 µF 50V electrolytic (PC type)
C9	"	0.1 µF polyester
C10	"	0.1 µF "
C11	"	4500 µF 64V electrolytic
C12	"	4500 µF 64V electrolytic
D1	Diode	EM401, IN 4005 or similar
D2	"	" " "
D3	"	" " "
ZD1	Zener diode	ZL15
DB1	Bridge Rectifier	4A 200 PIV
Q1	Transistor	BFX 30
Q2	"	BFX 30
Q3	"	BFX 30
Q4	"	BFY 50
Q5	"	BFY 50
Q6	"	BD 139
Q7	"	BD 140
Q8	"	AY 8149, 2N 3055
Q9	"	AY 9149, MJ 2955
Q10	"	AY 8149, 2N 3055
Q11	"	AY 9149, MJ 2955
T1	Transformer	56V CT@ 1.5A (Repanco 0722 or equivalents)

PC Board ETI 413
3A Fuse
Fuse holder
Die cast box 5¾ x 8¾ x 4"
2 Heat Sinks
1 " "
1 RCA socket
Output socket (2 pin din etc.)
4 spacers, ½" long for P.C. board.
1 three core flex and plug
2 Fan top heat sink for Q3 and Q5
Heat sink for Q4 (chassis mounting type, transistor vertical to chassis)
Screws etc.

100W GUITAR AMPLIFIER

Electronics Today International is currently developing a matching preamplifier specifically for use with this unit and suitable for all P.A. and pop group use.

The ETI preamplifier has multiple inputs – up to eight are normally provided but this may be extended if required.

Each input has its own individual tone controls. Other features of the unit include:

Mixing facilities.
Echo facility on all inputs.
Simulated stereo output to two channels (switchable)
Master room equalizer.

Full constructional details of this preamplifier will start in our March issue.

Kits of parts for main amplifier will be available from A.E. Marshall & Son. See advertisement on facing page and inside front cover.

ERRATA

PROJECT – WIDE RANGE VOLTMETER ETI 107

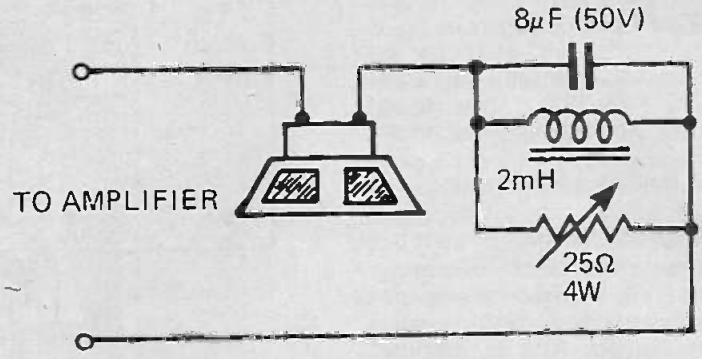
Integrated circuit IC1 as originally specified was an LM308H. This can be advantageously be replaced by an LH0042C.

The LH0042C has much lower input current (typically 15 pA at 25°C resulting in lower zero errors on the low ranges. The IC is also slightly cheaper than the LM308H. It is supplied by National Semiconductor Corporation.

No changes are required to the circuitry and pin connections remain the same.

SAFETY BARRIERS

A typographical error occurred in the above article which indicated that Mr D.R. Gaunt had left Kent Instruments. This is not so – Mr Gaunt is still with Kent's design and development department. We apologise for any embarrassment this error may have caused Mr Gaunt.



BETTER SOUND FOR £2

A dramatic improvement in speaker response for under £2!

Economy loudspeaker enclosures often contain just one wide range drive unit – usually of five inches or more in diameter.

Such speakers often sound 'peaky' due to the drive unit's characteristic of having too much output around 1000Hz.

A really dramatic improvement can be effected simply by wiring a choke/capacitor combination in series with the speaker.

This removes a lot of the energy around 1000Hz. The choke/capacitor combination is then bridged with a 25ohm potentiometer to bring some of the response back up.

The net result is a 6dB to 10dB decrease in that region, and what was previously a closed-in honky little sound now becomes a big spread-out spacious sound.

Losses in the network will decrease the speaker's efficiency – meaning that you will have to turn the volume control up a bit, but most amplifiers can easily provide the extra power required.

Figure 1 shows how the components are connected into circuit. The various bits may be built into the speaker enclosure – or even located alongside the amplifier. Once set, the potentiometer will not require subsequent adjustment.

The potentiometer is set merely by listening to some of your favourite music and choosing the setting you prefer best.

This simple modification can be used to advantage with any single drive unit speaker enclosure. It is perhaps the simplest and cheapest way to improve response that you can ever make. ●

This extraordinarily simple, yet effective modification, was recently suggested by Henry Kloss, now President of the Advent Corporation.

SPECIAL OFFER

A E Marshall and Son (see ads pages 2 and 59) have purchased a quantity of Advance mini Executive calculators.

Orders to the value of £10 or more will entitle you to purchase a calculator at a special reduced price.

LARGEST STOCKS **SEMICONDUCTORS & COMPONENTS** BRAND NEW

WE SUPPLY NEARLY ALL THE COMPONENTS FOR PROJECTS IN THIS MAGAZINE

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2N2906A	23p	2N4926	90p	AD162	51p	BC258	9p	BF245	33p	GET114	20p
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IS130	8p	BA115	7½p	BY127	17½p	OA85	10p
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BLOWING BUBBLES

Radio beam creates giant heat bubbles in ionosphere

United States Department of Commerce scientists are creating immense, invisible, short-lived bubbles in the upper atmosphere in a new kind of investigation made possible by an advanced radio transmitter.

The heated bubbles are formed in seconds at altitudes up to 320km by the action of a 100MW radio beam.

They grow to their full 80 to 160km size in about 20 min under the influence of geomagnetic forces. Composed of the electrified gas of the ionosphere, the bubbles elongate upward and downward under constriction of "tubes of force" that are generated and shaped by the earth's magnetic field.

Within minutes or hours, depending on time of day and conditions in the high-level environment, the modified region of the ionosphere rebounds to its natural state.

Observations of these effects on the upper atmosphere should lead to better understanding of the ionosphere, to improvements in long-distance radio communications, and to the advancement of plasma physics.

Results of the first year of research were reported recently in the journal *Science* by two Department of Commerce scientists – Mr. William F. Utlaut, Deputy Director of the Institute for Telecommunications Sciences (ITS), Office of Telecommunications; and Mr. Robert Cohen, consultant to the Aeronomy Laboratory, National Oceanic and Atmospheric Administration (NOAA) – both located in Boulder, Colorado.

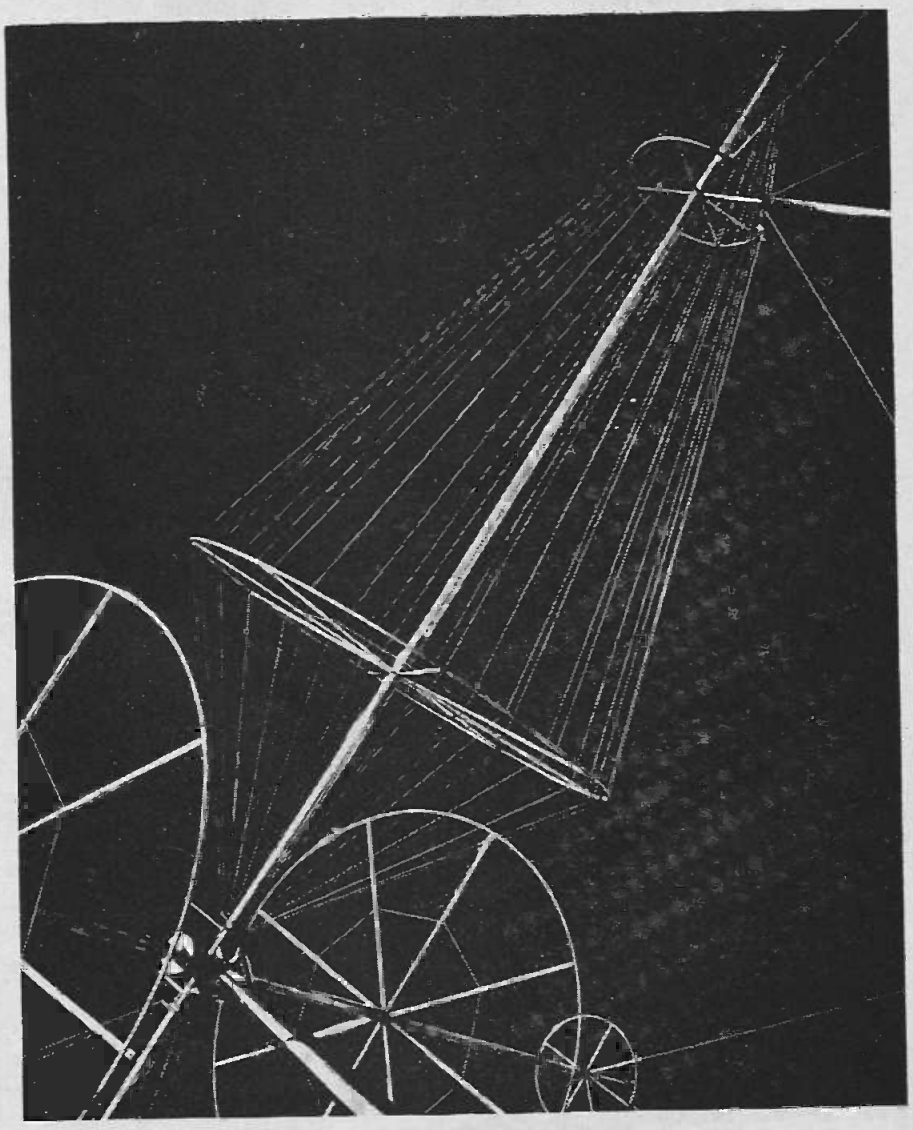
The two scientists had originally expected the intense radio beam only to heat electrons, but they found that they were also producing a variety of ionospheric instabilities. They regard this mixture of expected and unexpected events as genuine modification of the ionosphere.

Chief among the non-surprises was a finding that the radio beam raised temperatures of the ionospheric electrons by as much as 35%. But a prediction that the expected temperature change would cause slightly enhanced reflection of radio signals sent up to diagnose the modified region of the ionosphere turned out to be the reverse of what occurred.

Another major surprise was the artificial creation of a natural phenomenon known as spread F – "F" referring to the upper layer of the radio-reflecting region of the ionosphere and "spread" describing the patchy pattern of reflected signals.

"Since the advent of rockets and satellites", say the scientists in their *Science* report, "man has employed artificial modification of the ionosphere as a method for studying it. Modification has been accomplished by such means as chemical releases, atomic bombs, and small electron-beam accelerators. The possibility of active experimentation with the ionosphere by temporarily modifying it using high-power, ground-based radio transmissions has long been a desire of researchers. By contrast with the other techniques, ionospheric modification using radio transmissions at frequencies that interact with the ionosphere represents an attractive and hygienic alternative, in view of its relative controllability, repeatability, and rapid reversibility."

The natural ionospheric plasma has scientific advantages over laboratory plasmas, such as those used in nuclear fusion research. Chief among the advantages is the ionosphere's unbounded nature, as opposed to the experiment-disrupting walls of laboratory containment devices. This outdoor plasma now can be simultaneously modified and observed



One of the ten elements of the 110m diameter radio transmitter array.

(Continued on page 78)

TRANSDUCERS IN MEASUREMENT AND CONTROL

PART 8

The eighth article of a series by Peter Sydenham, M.E. Ph.D., M.Inst. M.C., Non-contact and many lesser known methods of determining temperature are discussed.

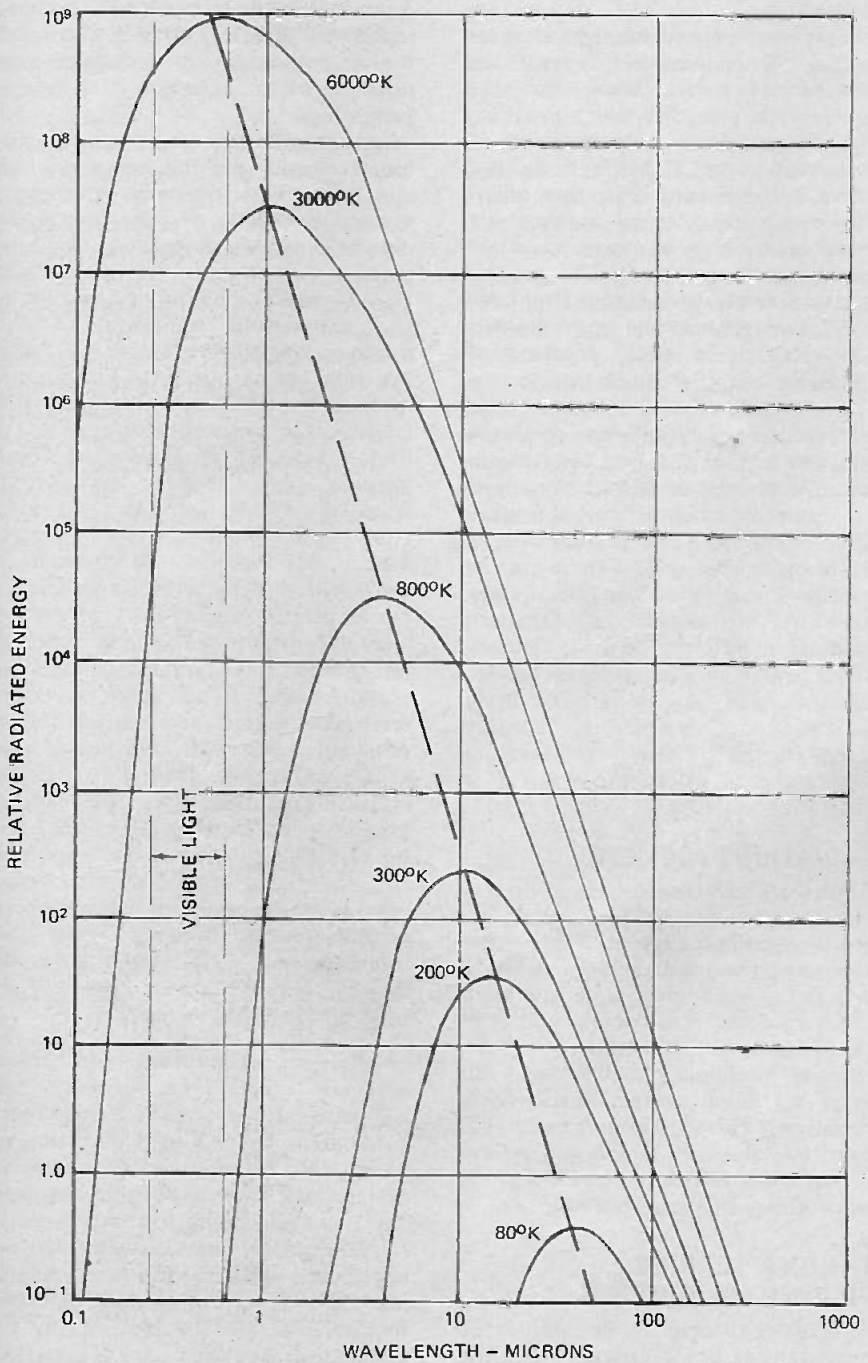


Fig. 1. Distribution of black body radiation as temperature varies. The total energy radiated at a particular temperature is represented as the area under the curve for each.

The two previous articles in this series were concerned with scales, standards and the transfer of heat, all of which are common to every temperature sensing procedure. The introduction led to discussion of thermometers using the expansion principle and then to the direct electrical methods, namely, resistance, thermocouple, thermistor and semiconductor thermometry.

Another significant group of devices operate without need for mechanical contact with the medium to be measured – they make use of the *radiated* energy of substances.

THE RADIATION PHENDMENA

All physical objects radiate energy, the quantity depending upon their temperature and emissivity (the degree to which surfaces come close to ideal radiators). The presence of radiation must have been realised since antiquity, but only as visual experiences or feelings of warmth which were accepted without satisfactory explanation. Once it had been shown, in the late 18th century, that heat was in fact, energy, it was only a matter of time before quantitative explanation was evolved.

The relationship between the radiation from a surface and its temperature was first proposed by Stefan in 1879. His work, coupled with that of Boltzmann in 1884 led to the Stefan-Boltzmann law that states that the energy radiated from a unit area of surface in a given time is proportional to the fourth power of its absolute temperature. The law only applies for sources that are known as black body or full radiators. Such sources absorb all energy falling upon them and thus appear black to the eye. The law, however, only provides part of the picture for no information is available to explain where the broadband blackbody source-radiation peaks. A family of several curves, (Fig.1), shows the relationship between energy, temperature and wavelength for an ideal black body radiator.

It was a scientist called Wien who, in

1896, provided science with the law that describes how the peak shifts wavelength with temperature and how the energy is distributed across the spectrum at each value of temperature. A little later, in 1900, Max Planck suggested a modified expression that gave closer agreement with observed values over a wider range of wavelengths and temperature. However, for most purposes, Wein's law is adequate. As black body radiation enters into numerous scientific and industrial endeavours, tables have been computed for the many possible combinations and special slide rules made for calculating the total power, peak emission and distribution. For much of the need, however, simple graphs like Figure 1, suffice to estimate the energy within a given bandwidth. The actual energy received at the detector is found by subtracting the losses of the optical system (airpath attenuation, reflection and absorption losses in elements and detector efficiency) from the total known to be received at the entrance aperture of the instrument. If working over a long atmospheric path, the original radiation will no doubt be filtered by the transmission windows of the path. Finally, the detector output will be the transduced energy received through the instrument but modified by the spectral response of the detector. In other words, a detector should optimally be matched to have a significantly overlapping spectral response.

If an enclosure is uniformly heated, radiation issuing from a small hole will be very close to that from a perfect black-body. The actual substance from which the enclosure is made and the shape of the cavity matter little. An early source, used by Summer and Pringsheim in 1897 was a hollow sphere of copper, blackened on the inside. This was heated in a molten salt bath. It served for the study of radiation from 200 to 600°C. For higher temperatures they used a blackened iron cylinder heated by gas combustion. A modern source, used to establish the gold point of the IPTS scale (1063°C) has molten gold inside a cavity. Several manufacturers supply temperature-controlled cavities for standardising detectors in infrared work.

In practice some sources to be measured are close enough to the ideal black body for the laws to be used without modification. Looking into an industrial furnace is a good example, a hole bored to a depth of at least five times its diameter into the surface of an incandescent body is another near-perfect arrangement, for all energy entering such a cavity is internally reflected and absorbed at each reflection so that virtually none escapes.

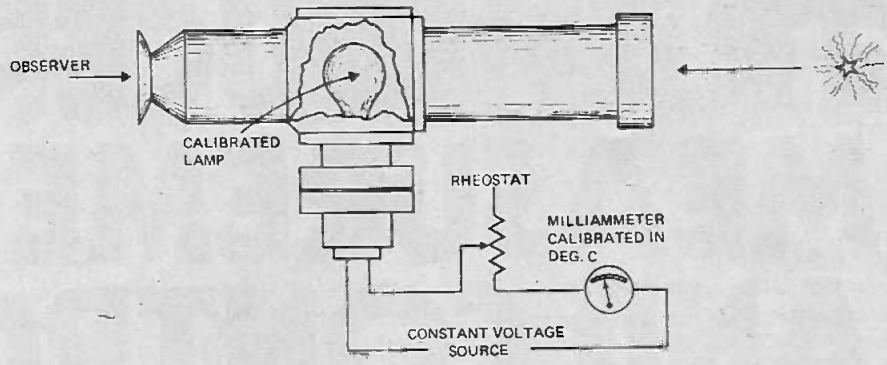


Fig. 2. The basic disappearing-filament optical pyrometer — the rheostat is adjusted until the light filament just disappears. Temperature is read from the dial.

There are, however, many instances (surfaces for example), where the appearance is not black and the emissivity is not unity but something less. A gray body is one similar in performance to a black body but where the emissivity is less than unity. Tables of emissivity of surfaces are available. By way of example, carbon can absorb as much as 94% of incident energy whereas unoxidised silver only 7%. This might lead one to think visual experience is a good measure of emissivity but that is not true for the eye has response over a narrow band of the black body radiation spectrum only. In fact, at infrared wavelengths the reverse situation applies. An object can never be brighter than the black body of the same temperature. Not all are black or even gray — some have an emissivity that follows no obvious law, perhaps peaking at various wavelengths, with zero at others. These are known as non-gray bodies. Gases do not radiate as black body radiation but rather at specific wavelengths. The temperature measurement of gases requires a different approach.

RADIATION PYROMETRY

There are two basic groups of devices by which temperature can be measured using radiation. These either determine the total radiation emitted or just the radiation in a narrow band of wavelengths. It is necessary in both cases to know something of their emissive behaviour, for all surfaces fall short of being perfect black body radiators. Temperatures calculated from the observed valued will always be low to some extent; corrections will be necessary if precision is needed.

THE DISAPPEARING FILAMENT PYROMETER

Instruments used to determine the temperature of a source from its apparent brightness were formally called pyrometers as they were developed mainly for furnace work. A more recently introduced term is radiometer but this term is also used for instruments used for measuring other forms of radiation than visible and infra-red.

Early pyrometers made use of the human eye as the detector of radiation. This biological photocell system is capable of only low grade accuracy when determing absolute radiation level but has quite high acuity when comparing two sources in the same field of view. In the disappearing pyrometer, (Fig.2), the eye sees the source (often through a calibrated filter to reduce the brightness to an acceptable level) and a heated filament in a common focal position. The filament current is adjusted until it just disappears into the background. In simple instruments, the current rheostat is calibrated directly in degrees, but in more precise cases the current is carefully determined with a standard resistor and a voltage measuring potentiometer. The value is then referred back to standardization curves obtained when the instrument was calibrated against sub-standard black body sources. Special tungsten lamps, usually with a strip filament, have been evolved for this purpose in order to retain their luminous efficiency over as long a period of calibration as possible. Such pyrometers can be intercompared by simultaneously viewing a common source — which need not be a black body.

Many processes need continuous operation and for these the balancing-out procedure has been automated. The cost of the instrument is naturally higher than for a manual device but often the total system application demands greater precision, faster response, improved reliability or continuous operation for measurement records and control, and all of these require the manual element to be eliminated. One technique alternately scans from a standard source to the surface of interest using a rotating or

nodding mirror. A photo-cell determines if the brightnesses are equal and if not, the error signal is used to alter the source heater power accordingly. In recent years, a number of these instruments have been reported in the technical literature. A schematic of an early I.C.I. unit Figure 3 (used for monitoring fast moving synthetic fibre threads as they are made) illustrates the concept. A small heated aluminium plate provides a reference background temperature that, in this case, can be varied from 45° to 280°C. The nylon line moves between this source and the detector. After collimation by a calcium-fluoride lens assembly (special materials are need for optimal operation at the infra wavelengths generated – there is little to be seen by eye at these temperatures) the image falls onto a infra-red photo-conductive cell. At the rear of the detector head is an eccentric cam that causes the unit to oscillate from the background to the background plus nylon-thread. The signals obtained are low level and noisy so synchronous detection is incorporated. The chopper wheel produces a higher fixed frequency signal from the cell. This is synchronously rectified in a unit called a phase-sensitive detector which produces the error signal which is used to control the heat of the source until balance is achieved. The temperature is measured as the power level to the background source.

One difficulty in pyrometry is that the emissivity may be an uncertain quantity and results subsequently imprecise. An approach to overcoming this, uses two measurements made at two different wavelengths within the broadband radiation. The principle, (hopefully invoked), is that the energy radiated at one wavelength increases with temperature at a rate different to that at another. Opinion differs on the effectiveness of this method. Benedict (in his book 'Fundamentals of Temperature, Pressure and Flow Measurements – see bibliography in last month's article) suggests it is rarely helpful, but research workers of the Central Electricity Generating Board in Britain have made use of it in a system for monitoring the surface temperature of a captive pulverized coal particle (of 0.25mm diameter). Their application was to observe the events leading up to combustion as the coal is heated using the heat from focussed lamps. This difference in outlook illustrates how instrumental methods can be condemned by a personal experience which may not have been adequate. The design of instruments is so incredibly fraught with unknowns and compromises that reasons for the lack of success can often only be found by extensive and perhaps prohibitive extra research.

Until quite recently, pyrometry was useful only for measuring high temperatures for, as can be seen in Figure 1, the total power radiated falls off as the fourth power as the temperature decreases. Traditionally, the pyrometer served as a means to measure visibly hot objects. A white-hot tungsten lamp peaks at 3000°K but, by reference to Figure 1 again, it can be seen that very little of the energy is actually radiated at visible wavelengths. Visual experience of radiation virtually disappears at around 800°K but there is still energy in the infra-red regions and this can be sensed as warmth. At absolute zero, no radiation occurs but as virtually nothing can be maintained at zero temperature, all objects emit radiation. The lower the temperature the longer the wavelength and the smaller the power level.

INFRA-RED RADIOMETERS

The infra-red portion of black body radiation has been the subject of scientific interest since it was discovered but little practical use was made of it until the 1940's when military scientists developed heat-seeking devices during the Second World War. Since then IR technology has improved enormously, especially in the area of detectors.

Visibly responsive photo-detectors such as the common silicon photocell

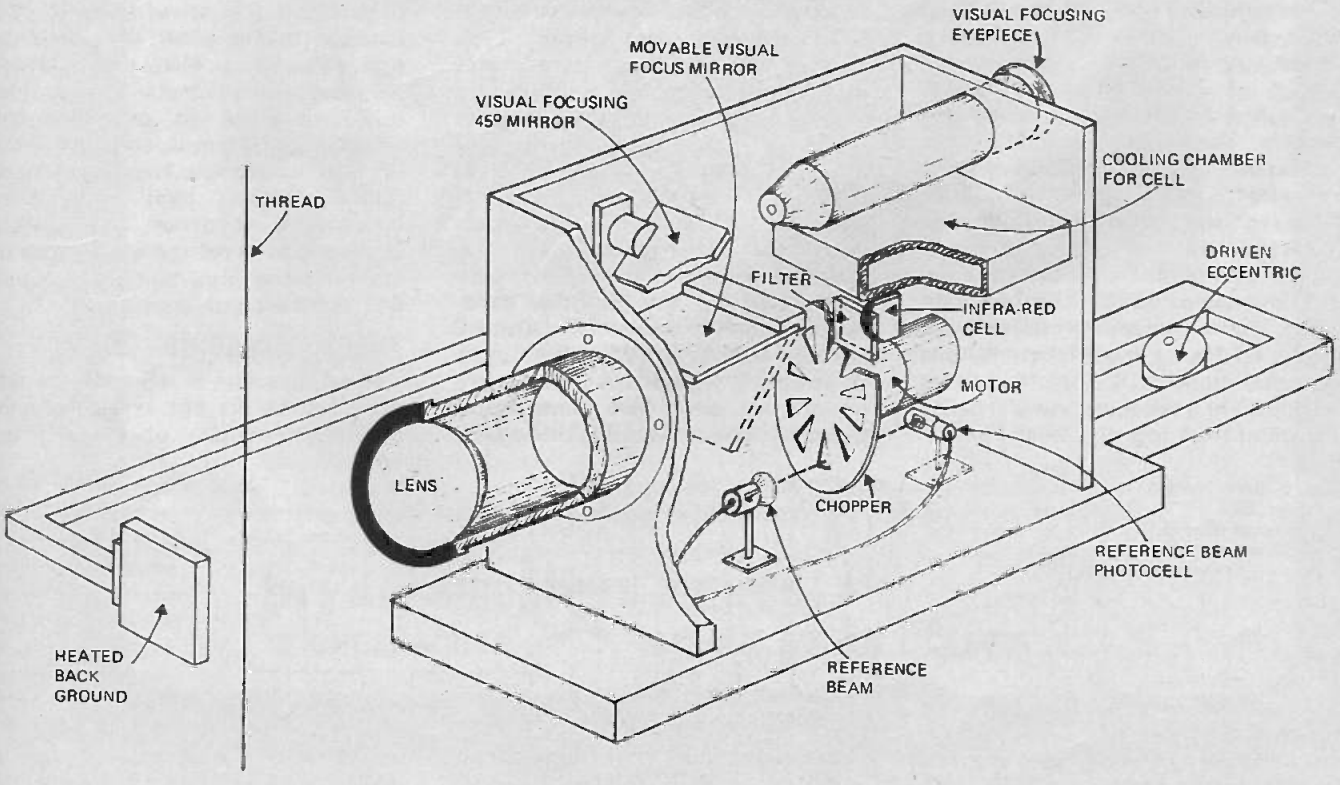


Fig. 3. Schematic of the I.C.I. nylon thread non-contact thermometer.

have some response in the near-infrared region but little as the wavelength increases. Early IR cells used the impinging heat to alter the resistance of a fine wire or, later, deposited films – these are known as bolometers. They are characterized by broadband response but lower sensitivity.

A chart of detectors is given in Figure 4; and as can be seen, apart from bolometers, no device covers the spectrum. Because of this detectors must be chosen to suit the wavelength of interest.

Detectors with peak response at 35μm wavelength are available, so it can be seen that temperatures down to a few degrees absolute can be detected provided the noise level is controlled. Much of the noise seen by a detector is generated as emission from its own components and adjacent mounts. Furthermore, at room temperature the electrical resistance noise of the element can swamp the signal. For sensitive IR radiation detection, the detector is usually cooled by operating it on the bottom of a specially designed dewar flask filled with liquid nitrogen or helium or, for continuous operation, on the end of a miniature cryostat. One important parameter of the design of IR radiometers is the cost of the detector – for they can be as high as £2500.

The sensitivity of IR detectors is now universally quoted as the specific detectivity (D^*). This is a normalized value of sensitivity that makes allowances for different active element areas, electrical bandwidth of operation and the measured noise equivalent power (NEP is the rms infra-red signal incident upon the detector that produces a unity signal-to-noise ratio). All detectors can be intercompared on this common basis. Without becoming involved with actual D^* figures, it suffices to say one reported modern IR system can sense the detail of a television tower through 70 km of thick fog.

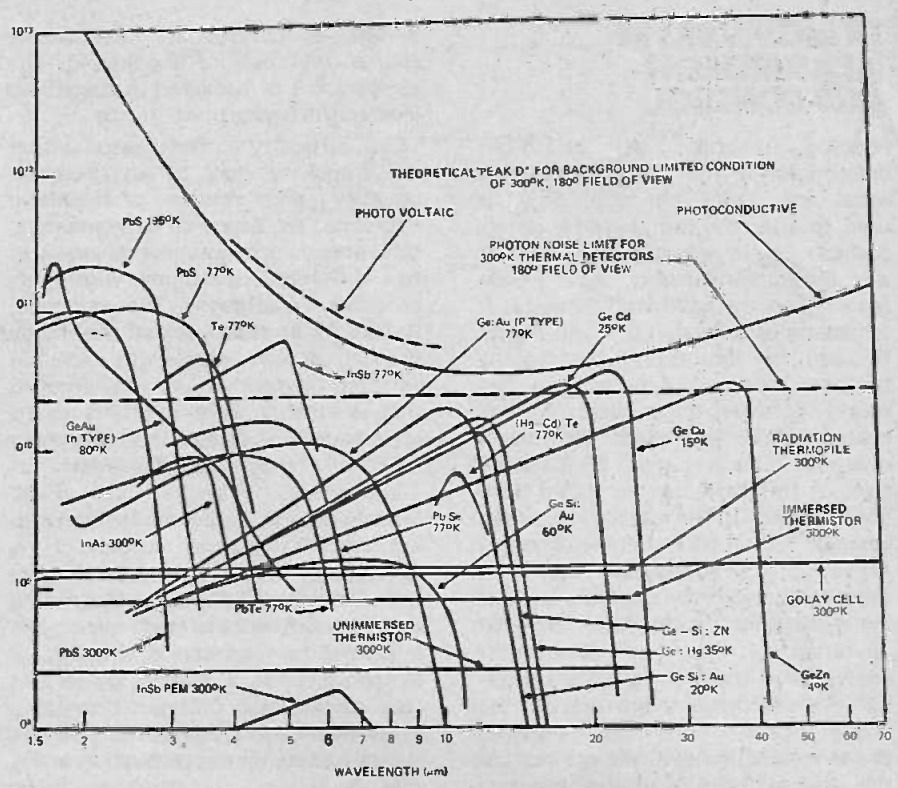


Fig. 4. Relative response of photodetectors operating over the visible to far infrared spectrum.

The basic IR radiometer is very similar in principle to the thread temperature measuring pyrometer already described, the main difference being that the temperature reference is not placed behind the object, for that is usually not possible. Instead, a small black body source is built-in so that it and the scene are viewed alternately.

The relatively low power levels involved with low temperatures means that the IR radiometer must have a high gain telescope to gather as much energy as is practicable. In the unit shown in Fig. 5, a folded reflector telescope is used. Refracting elements are to be avoided in IR work (unless small) for the cost of the exotic materials needed rises rapidly with size. Reflectors, on the other hand, require only low-cost reflective coatings. The entrance aperture to the telescope, however, needs a transmitting cover but some simple expediencies, such as using thin plastic sheet helps – in this case the focussing properties are of no importance.

A chopper system (perhaps a rotating wheel or vibrating slit) is incorporated to enable synchronous detection to be used. This can allow signals as small as 100dB below the noise level to be recovered. In the system illustrated, the chopper also serves to switch the detector to the scene and reference source alternately. Many rocket probes have carried radiometer devices like this into space to determine the emission and transmission losses of the sky and atmosphere. Narrow bandpass optical filters (only nanometre bandwidths at times) are usually employed to select the wavelengths of interest along with multiple detectors with different peak responses.

THERMAL IMAGING

Initial interest in IR was for the detection of the hot exhaust plumes and engine covers of aircraft, the

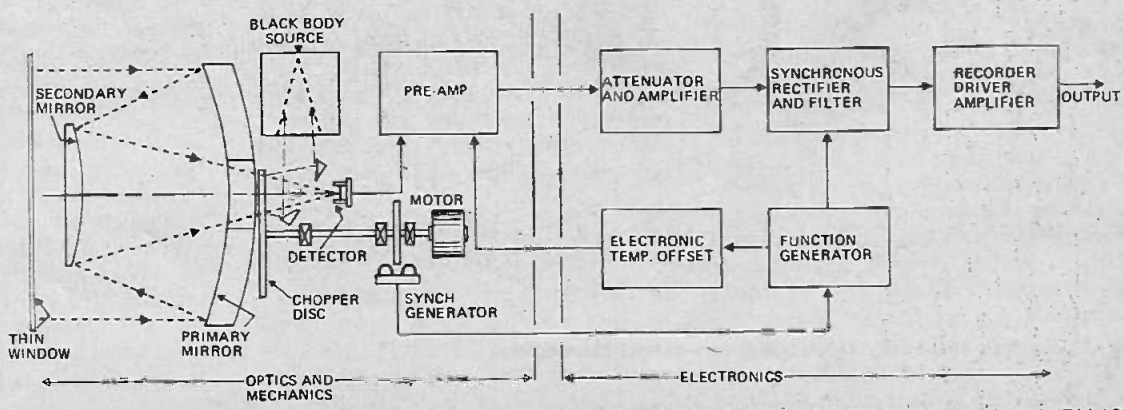


Fig. 5. Basic block diagram of a radiometer used in the infrared regions.

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virtue of heat sensing being that the enemy cannot detect when they have been detected — as is the case with radar. The prime purpose was simply to detect the presence of the source but the trend moved to establishing thermal pictures of objects so that they might be identified, especially at night or in fog.

Thermal pictures are produced by scanning the detector across the scene in a systematic manner, as is done in television. It is necessary to scan the detector, for matrices of detectors are not yet available with sufficient detectivity and spatial resolution. Infra-red television camera tubes exist and they are used occasionally. One use is to plot a thermal map of a tool-bit whilst it is cutting in a lathe operation. Currently attempts are made to develop adequate arrays of detectors but in general, thermal imaging instruments still use mechanical scanning arrangements to sweep a single detector across a scene.

The scanning arrangement generally consists of a motor which drives a scanning optical element. This may be a rotating square, prism or flat with mirrored surfaces or it might be an oscillating mirror. This method — in effect — scans the detector across the scene, (Fig.6), for it is desirable to have the detector stationary especially when cooled. Synchronized to the drive, by electrical or mechanical means, is a moving light source which exposes a film or appears as a moving spot on a CRO screen. The brightness of the spot is controlled by the output of the detector which is decided in turn by the temperature of the element of scene being viewed. A line is thus reproduced on the film or screen which has temperature transformed into visible luminance level. In airborne units the second axis of the picture is provided by the flight movement — as the aircraft flies it produces a continuous strip thermal map of surface features below. In Figure 7 are scenes produced in this way. The power lines are quite clear: even their thermal shadows are to be seen.

Stationary thermal imaging devices have a second scanner, usually a large nodding mirror, that provides the frame fillup. As the frame rate is considerably slower than the line rate, the mirrors can be large. Their frequency of oscillation is low.

Military thermal scanners were the first to be developed and they are at least as sensitive as being able to detect the heat wakes where a ship passed many hours before, or where planes or vehicles stood on the ground. As the

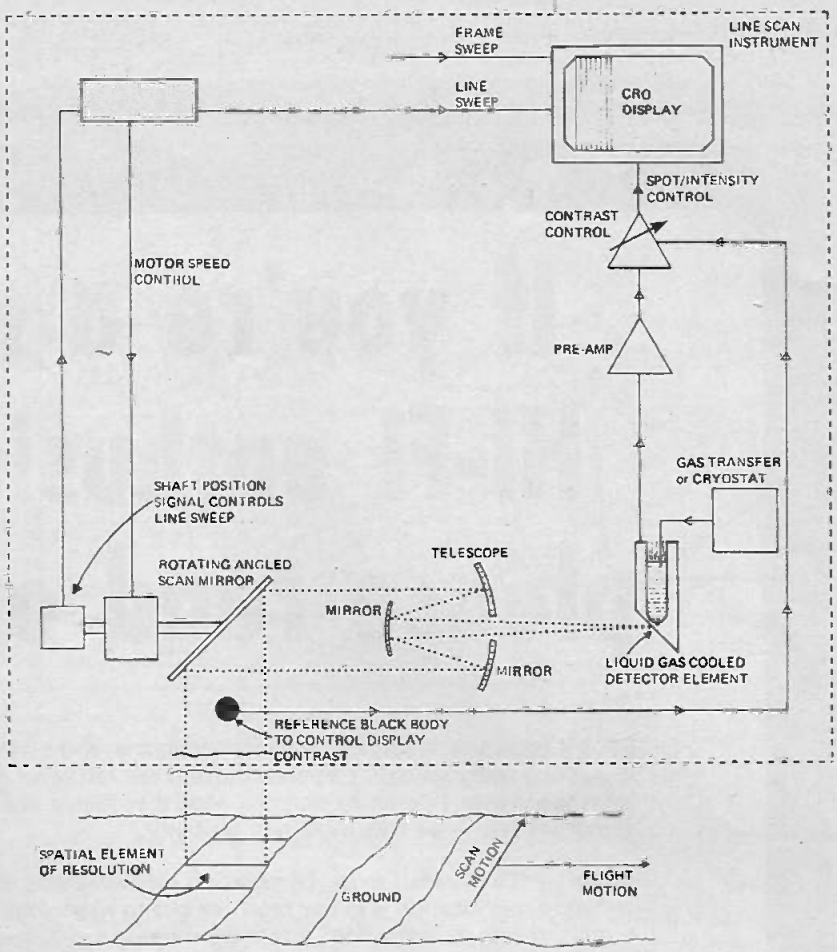

Fig. 6. Schematic of airborne thermal scanning apparatus used in remote sensing for civil and military purposes.

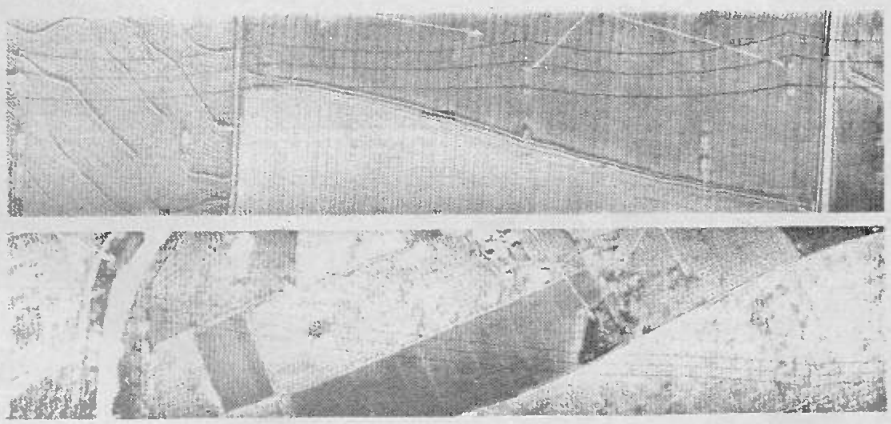

Fig. 7. Thermal maps of countryside in California made with a Daedulus thermal scanner. Note especially the wind shadows and what could be thermal shadows of the power lines.

details were released from official secrecy, civil interests blossomed. Now under the name of remote sensing, (which also includes other radiation methods as well as IR and visible) countries are observing, to name just a few uses, the cloud formation from satellites, the mineral potential of previously poorly prospected areas, the movement of ground water, effluent discharges at sea, and thermal currents around power station cooler discharge channels. Recent publicity has been given to the Earth Resources Technology Satellite (ERTS). This was launched by NASA this year, and participating countries will receive data on the thermal emission of the land as seen as the satellite sweeps across, from 900 km up. The satellite's salient features are shown in Fig. 8. Differences over short and long periods will assist geological exploration, agricultural problems such as pest infestation and the control of pollution.

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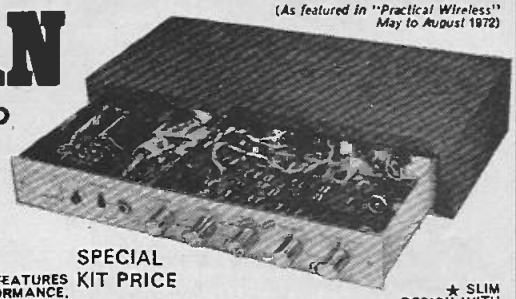

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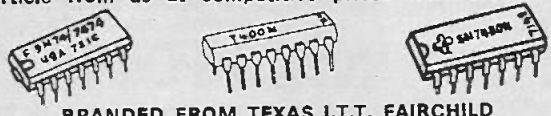

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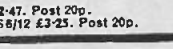

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SC35B	200	79p	
SC35D	400	85p	
6 AMP RANGE (TO48)			
SC40A	100	85p	
SC40B	200	90p	
SC40D	400	£1·00	
SC40E	500	£1·20	3 Amp
10 AMP RANGE (TO43)			
SC45A	100	95p	T048
SC45B	200	£1·00	
SC45D	400	£1·25	
SC45E	500	£1·45	
15 AMP RANGE (TO48)			
SC50A	100	£1·25	
SC50B	200	£1·35	
SC50D	400	£1·85	
SC50E	500	£1·85	
DIAC D32		25p	
TRIACS—			
Additional Types			
40430	(TO66)	85p	15 Amp
40669	(Plastic)	£1·00	
40486	(TO5)	80p	T048

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Type	Volts P.I.V.	Price 1-11
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BO5/10	100	25p
ONE AMP. ⅛"×⅛" TUBULAR		
B1/05	50	25p
B1/10	100	25p
B1/20	200	34p
B1/60	600	35p
ONE AMP (G.I.) TUBULAR		
W005	50	30p
W01	100	35p
W02	200	40p
W06	600	45p
TWO AMPS ½H×½L×¼		
B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ½H×½L×½		
B4100	100	60p
B4/200	200	65p
B4/400	400	70p
B4/600	600	75p
B4/800	800	£1·00
SIX AMPS ½H×½L×½		
B6/100	100	70p
B6/200	200	75p
B6/400	400	90p
B6/600	600	£1·00

SILICON CONTROLLED RECTIFIERS

Type	Volts P.I.V.	Price 1-11	
ONE AMP			
CRS 1/05	50	25p	
CRS 1/10	100	30p	
CRS 1/20	200	30p	
CRS 1/40	400	35p	
CRS 1/60	600	45p	
THREE AMP (TO48)			
CRS 3/05	50	30p	
CRS 3/10	100	30p	
CRS 3/20	200	35p	1 Amp
CRS 3/40	400	45p	T05
CRS 3/60	600	55p	
FIVE AMP (TO66)			
CRS 5/400	400	80p	
SEVEN AMP (TO48)			
CRS 7/100	100	60p	
CRS 7/200	200	65p	
CRS 7/400	400	70p	
CRS 7/600	600	95p	
SIXTEEN AMP			
SCR 16/100	100	65p	
SCR 16/200	200	70p	3 Amp
SCR 16/400	400	80p	T048
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	With case	£4·95
TE15	Grid Dip Meter 440 KHz-280 mHz	£13·45
500	20 K/V Multimeter	£9·25
	With leather case	£10·50
200H	20 K/V Multimeter	£4·29.
	With case	£9·50
AF105	50 K/V Multimeter	£8·50.
	With case	£9·50
U4341	AC/DC Multimeter with transistor tester. Steel case	£10·50
TE20D	RF Generator 120KHz-500MHz	£15·95
	Carr. 35p	
TE22D	Audio Generator 20Hz-200KHz	£17·50
	Carr. 35p	
C1-5	3" Pulse Scope 10Hz-10mHz	£39·00
	Carr. 50p	
TE65	Valve Voltmeter 28 ranges	£17·50
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Erase Heads for above	75p
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SILICON RECTIFIERS

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Type	P.I.V.	1-11
1 amp miniature		
IN4001	50	8p
IN4002	100	7p
IN4003	200	8p
IN4004	400	8p
IN4005	600	10p
IN4006	800	12p
IN4007	1000	15p
1.5 amp miniature		
PL4001	50	8p
PL4002	100	9p
PL4003	200	10p
PL4004	400	10p
PL4005	600	12p
PL4006	800	15p
PL4007	1000	16p

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741C D.I.L.	55p
747C TO99	£1·10
747C D.I.L.	£1·10
72741P D.I.L.	60p
72748P D.I.L.	60p

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for one reason or another. Acoustic thermometers may fill the need, especially at the extremes of the temperature scale, for example, in gas plasmas (15,000°C) or in cyrogenic systems near absolute zero.

The speed of sound propagation usually travels slower as the temperature of solids and liquids rises – and conversely in gases. The velocities of sound propagation in various media are given in Fig. 9. The method then, is to determine the speed of sound and compute the temperature of the medium from this, knowing the velocity at a known temperature.

Two ways of doing this have been developed. The first way is where the sound wave is launched in the medium itself; the alternative is where the waves travel in a secondary material which is in thermal equilibrium with the medium. In either case there are two choices. A pulse can be transmitted, and the flight time measured; alternatively, the resonant frequency may be determined. Again, both methods require a sending transmitter and receiver although one may double for each if reflections occur. One pulse technique, known as the sing-around method, emits a send-pulse as one is received. The system then resonates giving a frequency-variable output with temperature change. Piezo-electric crystals are sometimes employed to couple to the cavity of interest. Magnetostriction is also used. Quartz crystals have already been mentioned in their role as temperature sensors in the previous article in this series – their operation is also acoustic. Thin wires have been used to sense temperatures in nuclear reactors (gas-filled cavities, discussed below, could be grouped as acoustic).

Other methods using sound that could be useful are to monitor the echo returned between dissimilar metals, for the reflection alters with temperature; to look for wave bending due to thermal gradients, and to sense when a solid surface becomes liquid and starts to reflect.

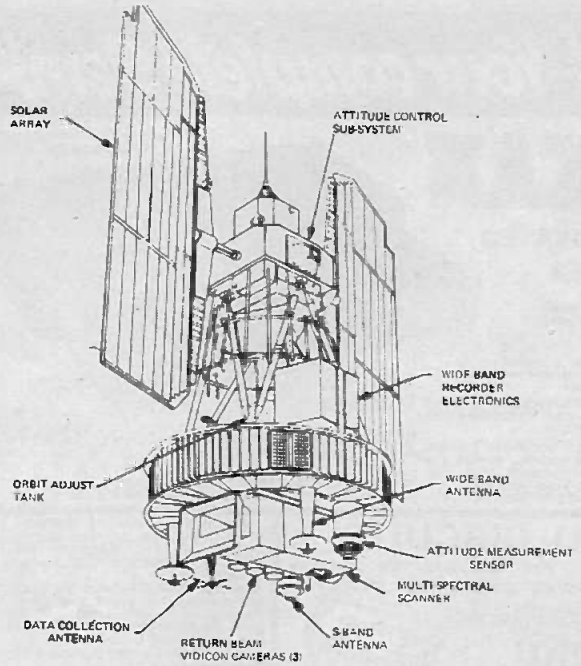

Fig. 8. The ERTS satellite currently orbiting the Earth to provide thermal emission data over long periods.

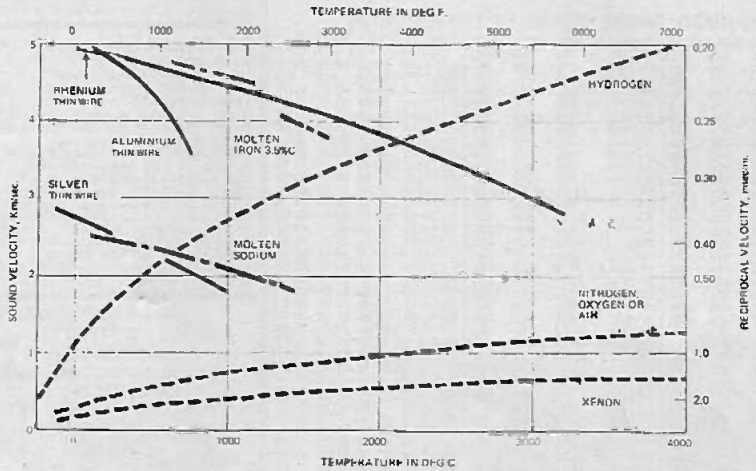

Fig. 9. Propagation velocities of sound in various selected media.

MISCELLANEOUS TEMPERATURE DETECTORS

Fluidic Sensors

A cavity filled with a gas oscillates at a frequency dependant upon the gas temperature. The upper limit of operation is currently decided by the sensor material. Hypersonic X15 aircraft used fluidic sensors to measure temperatures from 0° to 2500°C. Gas flows in, past the cavity, shown in Fig.10, and is exhausted. The frequency of oscillation within the cavity depends upon the velocity of sound in the gas. For a given gas and size, the frequency varies as the square root of the Kelvin temperature of the gas. Typical output frequencies lie in the range 5 to 40kHz. Response time is limited partially by the time taken to cycle the gas, and more so by the time for the complete cavity volume to change. Even so, rapid response is possible.

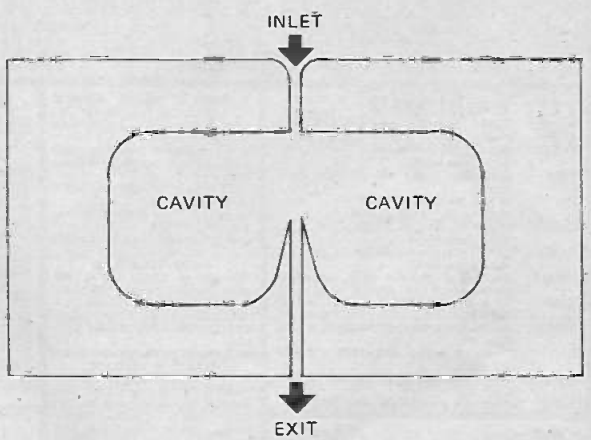

Fig. 10. Cross-section through a resonant fluidic temperature sensing cavity.

Eddy Currents

Temperature changes alter the conductivity of electrical conductors. By placing a sensing inductor coil near the test specimen it is possible to monitor temperature using the changes in impedance of the coil. This method is subject to many unwanted

(Continued on page 76)

INPUT GATE

LETTERS FROM OUR READERS

TOO MANY CAR PROJECTS

Thank you for such an excellent magazine. As a student of electrical engineering at the University of Aston, in Birmingham, I find it invaluable for up-to-date background information as a source of ideas for my final year project.

Congratulations also, on your choice of product reviews. Since I own a Sonab Turntable (HE755) I was pleased to read the review in the December issue of the 85s, and I agree with the comments expressed by your review. (I too, would like to know what is in the small squeeze tube).

One small fault, aren't you producing too many constructional projects for automobile owners. We don't all own cars! *A R Wieczorel, Birmingham*

We don't think we are producing too many car projects. They are in fact amongst the most popular of all projects. But please tell us what you do want. We value your opinion.

STUDENT'S APPRECIATION

November's issue of Electronics Today is the first of your issues I have purchased and may I congratulate you on a first class magazine. I found your articles on ceramic slides and fluorescent dimmer very interesting, and, particularly so, your article on Audio Visual Metronome (I am a student science teacher and applications of this instrument in the classroom are many indeed). Your news section is one of the most comprehensive I have seen in any magazine on any subject.

A small point I should like to mention, that applies to some of your articles; perhaps a small glossary of standard abbreviations used in the magazine would make these articles more easily understood to those not commercially or professionally involved in electronics.
J S O, Glasgow

Sorry JSO, we do try not to use abbreviations without explaining them when first used. We will give your request some thought but such a glossary would be quite a task and would need to be of book length to be of much value.

MURPHY FOREVER

I read with interest the article on Murphy's Law, but I was surprised to see that you and Mr NWT appear to doubt that the law holds.

Even non-engineers (like myself) must have come across the law, perhaps unknowingly, in other fields. It is amazing how often traffic lights go red just as one arrives, or a train that always runs late, arrives on time when you are late. I wonder if the AA or RAC keep statistics for the number of cars getting punctures or running out of petrol, on wet, cold days and warm sunny days.

If there are any people who seriously think the law does not hold, keep a record of the next few disasters, and the circumstances under which they occur. *J D J, Kensington*

A REFRESHING CHANGE

Please find enclosed coupon and PO for the ZN 414 as advertised in December ETI. However SINCE this coupon entitles me to one ic, I would be very grateful if you could tell me how I purchase any other such ic's should I wish to construct both of your projects next month? May I also take this opportunity to thank you for an excellent magazine which makes a refreshing change to the other such publications dealing with electronics produced each month. *M S, Lee on Solent*

See the Ferranti radio project in this issue for details of where to obtain the chips.

IN A BLACK HOLE

I read the article 'Of Utmost Gravity' in the September issue of your magazine with considerable interest. However I had to read it twice, and I will read it again, to digest the difficult theorisation of gravitation and black holes that hit me like a brick wall. The reason why this article took my breath away, is because as yet, I am only educated up to 'O' level physics; I can only accept one theory at a time, even then I am sceptical. When several theories are presented in this way it tends to widen the gap between fantasy and fact.

I cannot accept any theory as fact, now, because of the many paradoxes and inaccuracies I have learnt. For instance at school I learnt that light only travels in straight lines, yet on studying physics at home, I learn light can travel in a curve as in the increasing refraction of the increasing density of the Earth's atsmosphere (resulting in about 36' of refraction). I learnt that light travels at 3 x 10^8 m/s yet it has been proved that it travels slower in water than air. I learnt that light is an electromagnetic radiation, yet the current theory is that it is a stream of 'photons'.

There are many more, and it aggravates me when the man in the street accepts many of these theories as fact. In fact I believe one bloke's theory is as good as anybody else's – within reason.

Because of the interest aroused, I consider this article as excellent. May I take this opportunity of commending you on an excellent magazine with a good standard of technology.

I wrote this letter because I noted that you welcomed letters about articles, anyway I feel strongly about the second paragraph. J D Rushall, Walsall

We sympathize with your confusion JD but didn't they tell you at school that there is no such thing as an absolute law. There is always an exception to every law and as you progress in your studies you will find that this is due to certain factors not being included in the basic equations.

However, no-one can understand Einstein without going through many stages of laws and theories in order to develop such understanding. You must always say yes that is true under most conditions but maybe...

FOUR CHANNEL DECODER

Could you please let me know where I can get a circuit for building a decoder for use in a 4 channel system using a tape recorder or pick up.

As we don't get all your publications I don't know if you have published it yet. If you can't help me could you advise me as to where I can obtain a circuit please.
G B du Toit, South Africa

We don't know of any non commercial circuits which are available as yet but will certainly consider this for a future project when it has been decided which system is going to be used. *UK536*

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Completed by a decnr-styled cabinet. Size approx. 43 x 7½ x 19cms. Speakers are the famous Wharfedale Denton 2. Size approx. depth 8⅞in. x width 9⅞in. x height 14in. Turntable is the renowned Garrard SP 25 Mk III with the well known Goldring G800 magnetic cartridge plus deluxe plinth and cover. Size approx. depth 38½ x width 38 x height 19 ems. We at Audio Supplies have put a lot of research into this system and believe it is going to be the most popular system of the seventies.

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All goods are brand new, and carry manufacturers' guarantees. For an extra charge: 36 hour Securicor delivery (from when cheque is cleared).

Personal callers Note: we are easy to get to by public transport. (Open Mon, Tues, Weds, Thurs. 9.30 to 6 p.m. Sat. 9.00 to 5 p.m.) Late night Friday 9.30 to 7.30 p.m. Send large stamped addressed envelope with all correspondence (except orders) plus 15p for comprehensive price list if required. All prices are subject to change as and when necessary. (Full terms of business and conditions of sale available on request.)
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EQUIPMENT NEWS

SELECTIVE LEVEL METER

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

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

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

The range of application of the analyzer D 2040 can be extended even further by using a vibration pickup, which converts mechanical vibrations into electrical signals, or a standard microphone for space and sound analysis. The measuring range which extends down to 10 Hz permits an investigation of physical vibrations in connection with stability tests and the like. Acoustic analysis is possible even in the case of frequencies below the threshold of audibility.

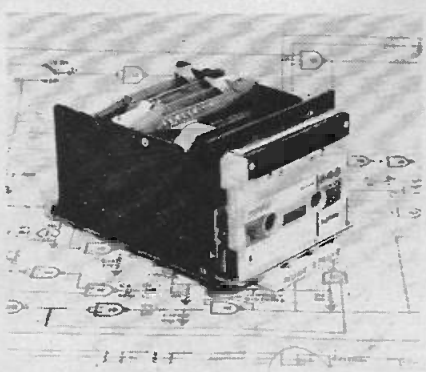
Further details from: Siemens Aktiengesellschaft, Presseabteilung, D-8520 Erlangen2, Postfach325, Federal Republic of Germany.

NEW CASSETTE TAPE RECORDERS

Said to represent a major advance in incremental digital cassette tape recorders, a new range of low cost units is being marketed exclusively by the systems division of IDM Electronics Ltd, Reading.

The Memodyne recorders are said to feature a truly incremental drive mechanism utilising a single stepping motor and special clutch assembly. This mechanism provides a simple and highly reliable drive for both the recording heads and for tape take up.

Two models of the deck are available, model 113 offers complete read/write capabilities with a bi-directional drive and is a



totally self-contained unit requiring only connection to 5 and 12 volts dc. This deck is capable of recording at speeds of up to 25 8 bit characters per second.

The model 200 is claimed to be unique in that it has been designed for operation off batteries. With a stand-by current of only 2μA and a peak recording current of 50 mA the unit is ideal for all types of battery operated recording equipment.

HEATHKIT 100 MHZ COUNTER

The new Heathkit solid-state 100 MHz counter IB-1101 closes the price gap in high frequency counters. Until now, 'low cost' counters were confined very much to the 15 MHz range. Instruments above that range were complex, costly and often more counter than you could ever use. Now, with the IB-1101, you have a truly low-cost counter in kit form with 1 Hz to 100 MHz capability and a list of features to rival counters costing a lot more.

The counter is said to have the following specifications; 5-digit readout; 8-digit capability; 1Hz to 100 MHz capability; 50 - 100 mV sensitivity; Gate time 1ms of 1 sec. with Auto Reset; Wide range input without adjustment; No special instruments necessary for calibration.

Further details from; Heath (Gloucester) Ltd, Gloucester, GL2 6EE, England.

HEATHKIT IB-1101 -Frequency Counter

FAST STORAGE OSCILLOSCOPE

The development of a new transfer storage CRT is announced by Tektronix. In it, the signal is stored on a high-speed target and then transferred to a bistable target for long viewing times.

The outstanding features are an extremely fast writing speed, infinite viewing time, and high burn resistance.

The CRT is used in the Tektronix 7623 storage oscilloscope which is said to provide a band width of 100 MHz and the following operating modes:-

1 Fast Bistable Mode for the retention of single-shot pulses having ultra-fast rise-time.
2 Variable Persistance Mode for the display without flicker, of low repetition-rate fast risetime signals and spectrum analyser waveforms.
3 Bistable Mode for the long-term display of very low frequency signals.
4 Non-storage Mode for conventional oscilloscope displays.

The 7623 is available with a standard transfer-storage CRT providing a stored writing speed of 90cm/μS or with a fast CRT giving a writing speed of 200cm/μS.

Other additions to the Tektronix range of storage instruments are the 100 MHz 7613 with variable persistence and the

EQUIPMENT NEWS

25 MHz 7313 with a bistable CRT. These models have stored writing speeds of 5 div/μS (0.9cm/div) and 5cm/μS respectively. All three instruments have CRT readout which clearly indicates the vertical and horizontal deflection parameters on the CRT adjacent to the displayed waveform and with the 27 supporting plug-in units available offer a very wide range of measurement capability.

Further details from: Tektronix UK Ltd, Beaverton House, PO Box 69, 36-38 Coldharbour Lane, Harpenden, Herts.

NEW CARTRIDGE RECORDER

Kennedy Company has announced its Model 330 Digital Cartridge Recorder. Combining the new 3M one-quarter-inch tape cartridge with its isoelastic drive system, and proven Kennedy electronics, Model 330 is said to be the first cartridge recorder designed solely for high reliability data recording.

The tape drive on Model 330 is fully bi-directional at 25 ips normal speed, resulting in a data transfer rate of 40,000 bits/second at 1600 cpi recording density it is claimed. Forward and reverse search modes, as well as rewind speed, are 90 ips. With 300 feet of high grade 0.25" one mil tape, total data capacity (gapless) is 23 x 10^6 bits for 4-track operation. Model 330 meets the proposed ANSI standard it is claimed.

Model 330 is equipped with a dual gap read/write head for read-after-write operation. One, two and four-track versions are available. Each track is treated independently, allowing cartridge interchange between transports of differing track configurations. Each track is equipped with a separate erase gap to ensure against inadvertent data erasure.

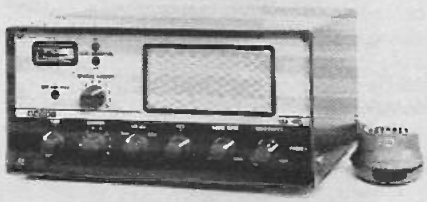
Power is provided by a dc motor/tachometer velocity servo system which provides both tape and reel drives. Manual controls are designed for simplicity. Insert cartridge and tape automatically advances to load point.

Model 330's size allows mounting in 5¼" of rack space. No exterior case is provided.

Further details from: Sintrom Limited, 2 Arkwright Road, Reading, Berks RG2 0LS.

NEW 25W HF SSB RADIOTELEPHONE

A new HF radiotelephone has just been introduced by Racal-Mobilcal Ltd which is specifically designed for use in fixed station or mobile applications. Designated TRA 1338, the equipment is a single side-band 25W HF radiotelephone which provides ten pre-set panel-switched crystal channels anywhere in the 2-8 MHz frequency band.



Broadband, all solid-state circuitry is employed throughout and other salient features include visual indication of antenna tuning and loading, the ability to match into all types of antenna from 1/10 wavelength and simplicity of operation. Attractively styled, the TRA 1338 in its standard version is supplied to operate from a negative earth 12V dc power supply and is protected from excess voltage and reverse polarity.

The radiotelephone can be supplied for SSB operation on both upper or lower sidebands, SSB on one sideband (either upper or lower) or SSB on one sideband with AM also available. All models are capable of operation in the CW telegraphy mode. Frequency stability is said to be better than ±50Hz.

The TRA 1338 is extremely compact, making it particularly suitable for mobile installations - even in private cars, being only 270mm wide by 135mm high and 240mm deep. Weight is under 6kg. The equipment is both complementary to, and fully compatible with the existing range of man-portable radiotelephones marketed by Racal-Mobilcal.

Further details from: Racal-Mobilcal Ltd 464 Basingstoke Road, Reading. RG12 1RG.

DOCUMENT TRANSCEIVER

The EMIfax HF146 desk-top facsimile system transmits and receives any type of document up to A4 size (220 x 305 mm), including invoices, lists, graphs, sketches and handwritten notes, over public or private

telephone networks and uses normal office stationery for reproducing transmitted copies, eliminating the need for expensive coated papers which create both cost and supply problems. The HF146 will be joined shortly by facsimile machines for a variety of applicaitons including fully-automatic document recorders, weather-chart transmitters and special facsimile equipment for military communication systems.

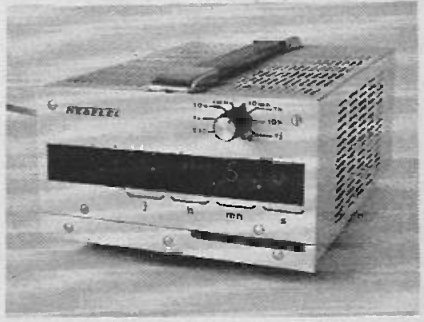
Far more versatile than telex, the facsimile machine is ideal for speeding up communications between the dispersed units of an organisation, whether at plant level or at national or international levels. Documents may be communicated simply by dialling the appropriate telephone number and hence being fully compatible with the document facsimile system most widely used throughout Europe – a significant factor for British organisations extending their operations on the Continent. Simple to operate, the facsimile machine takes under six minutes to transmit A4 sized documents, and correspondingly less time for smaller sheets. Automatic transmission of data is started by pressing a single switch on the transmitter and the process is complete within six minutes depending on document size. If required, normal conversation between the two locations can be then resumed via the telephone receivers.

SE DIGITAL CLOCK/DISPLAY

The SM 256 is a newly available digital unit of great versatility. It can be used either as a remote display for a Timer/Counter or DVM, and as a triggerable digital clock, or as a combination of both!

The Digital Clock section of the unit can be operated with either mains or crystal reference, and normally has a 6 decade display for hours, minutes and seconds. This display can be extended to include two or

(Continued on page 74)



Announcing the Tripletone twins.

Two brand new stereo amplifiers with a lot in common.

ADVANCED FEATURES: Both models feature the best of previous designs while taking advantage of the latest advances in circuit technology. Characteristic tripletone facilities such as middle, bass and treble dual concentric controls are presented in an all silicon design using plastic transistors and two field effect integrated circuits presenting a 2 Mohm input impedence for ceramic cartridges.

INCREASED FLEXIBILITY: Both models have input facilities for magnetic and ceramic cartridges, tuner and tape and incorporate a low pass (scratch) filter.

The extra control given by the three dual concentric potentiometers (bass, treble and middle) allows an effect similar to stereo to be produced from mono records and gives more flexible reproduction of stereo material.

VALUE FOR MONEY: Attractively presented in a low line teak cabinet with extruded aluminium control panel, both models cost a lot less than you'd expect.

The HI-FI 1818 costs only **£46.50** while the HI-FI 77 is of equally good value at **£36.50** meeting the requirements of lower powered systems.

TRIPLETONE HI-FI 1818

Power Output Each Channel – 18 watts RMS 1 KHz, 8 ohms
Tone Controls Bass ± 15dB@ 30 Hz. Middle ± 12dB @ 1 KHz Treble ± 15dB@ 10 KHz
Inputs Magnetic 3mV. – 47 K Ω (RIAA)
Ceramic 80mV.(2Mohm)
Tuner 100 mV, 100 K Ω Tape 100 mV, 100 K Ω
Outputs Speakers 8–16 ohms Headphones 8–16 ohms
Tape 200 mV (100 K Ω)

TRIPLETONE HI-FI 77

Power Output: Each Channel – 7 watts RMS 1 KHz. 8 ohms
All other specifications are same as the Hi-Fi 1818 model

Please send for further details of these models

Name .....

Address .....

.....

K&K ELECTRONICS LTD

Tripletone Audio Equipment is Manufactured by **K & K Electronics Ltd., 60, St. Marks Rise London, E8. Telephone 01-254 9941/4**

three decades of 'days' information if required.

The clock unit incorporates, as standard, 7 selectable triggering rates from 1 second to 1 day. If required, the unit can also be supplied with special triggering programmes, consisting of sequences of trigger points repeated at varying intervals, and being of varying lengths and rates.

The remote display section of the unit consists normally of 6 decades, accepting BCD inputs directly.

Versions of the unit are available to operate at voltages from 12 to 55 volts dc as a crystal controlled digital clock and triggering device, with the display tubes in-operative.

In the standard version the accuracy of the unit is that of the mains plus or minus 1 second. The crystal oscillator version of the instrument will give an improved short term accuracy of the order of one part in 10 to the sixth.

A narrow drawer at the bottom of the unit frees the reset keys for hours, minutes, seconds and, if fitted, days. Returning the drawer to its closed position starts the clock automatically.

If required, the digital clock can be used to trigger a printer in the following modes:

Internal Preset;

Completely automatic at rates from 1 second to 1 day, selected on the front panel switch;

External Input

1) Stored positive pulse from 2.4 volts to 20 volts.

2) Continuous level of + 2.4 volts to + 15 volts ('off' being from minus 12 volts to + 0.4 volts). When this continuous level is present the printer is repetitively triggered once per second.

Further details from: SE Laboratories (Engineering) Limited, North Feltham Trading Estate, Feltham, Middlesex.

NEW CRYSTAL CONTROLLED RECEIVER

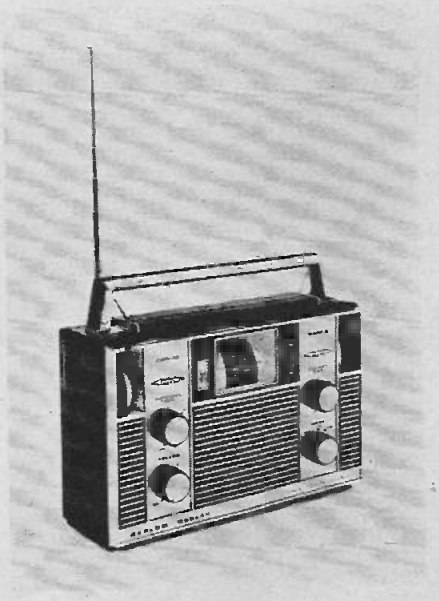
A new portable high-sensitivity short wave receiver, the Barlow Wadley XCR-30, is designed to provide precision frequency tuning over the full short wave spectrum up to 30 megahertz. With exceptional frequency stability for both amplitude modulated and single sideband transmissions, this compact unit is suitable as a standby receiver for marine use or small boat applications.

The receiver has been tested by the BBC and found to be well thought out in concept with many operational advantages and, as far as is known, this is the first time that a precision tuned HF receiver has been available in transistor-portable form, which gives it considerable advantages over normal types.

A multiple heterodyne circuit is incorporated in which the harmonics of a 1 megahertz quartz crystal control the frequency shown on the dials to an accuracy sufficient to locate and identify a station whose frequency is known.

The crystal stabilises the received frequency to eliminate tuning drift over long periods of time and to provide stable single sideband pitch. Frequency selection is a composite function of two dials, the whole number of the frequency (in megahertz) being displayed on one dial, the second dial displaying the remaining decimal portion of the frequency.

The electrical design closely follows the principles of the previous designs of Dr T L



Wadley, utilising the well known Wadley Loop principle, but with greatly simplified circuitry, resulting in a low cost equipment without sacrificing any of the essential performance characteristics.

Use of transistors greatly simplifies this type of design since there are no filament leads requiring elaborate decoupling and the greater compactness of the circuitry leads to an almost complete absence of screened compartments, the whole circuit being on a single printed circuit board with a common earth sheet on one side and the wiring on the other.

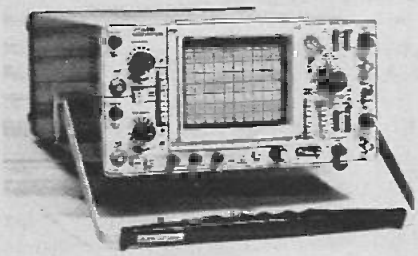
This, together with the careful choice of circuit configuration and general layout enables all spurious effects to be brought under firm control.

Further details from: Radio Shack Limited, 182 Broadhurst Gardens, London NW6.

25 LB OSCILLOSCOPES

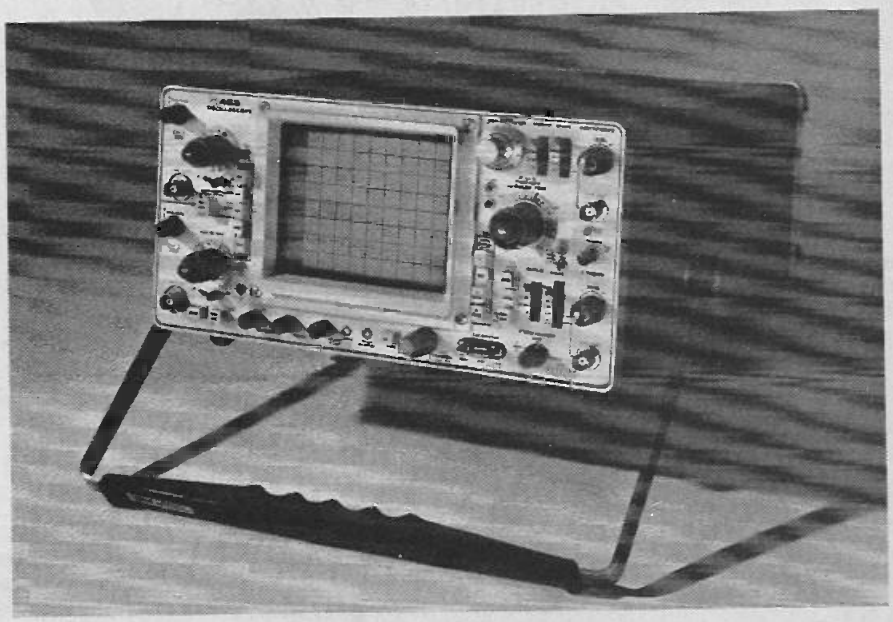
Tektronix announces two new small 25lb portable oscilloscopes, the 465 and the 475. Both oscilloscopes are said to represent significant price/performance breakthroughs rather than simply another evolution in portable instrument development. The 465 has a bandwidth of 100 MHz at a sensitivity of 5mV/division, whilst the 475 offers 200 MHz bandwidth at 2mV/division. Both instruments are dual-trace and will operate from ac power line or batteries. The large CRT provides a 10cm x 8cm display and the use of 18KV acceleration potential is said to ensure a bright, high resolution trace even under adverse ambient lighting conditions.

The 465 and the 475 incorporate a number of important new features such as Trigger View - enabling the operator to display an applied external trigger signal by a push-button control, probe-tip ground reference button, and variable sweep hold-off to facilitate the observation of complex waveforms such as composite TV signals or digital pulse trains. By the use of low-loss switches mounted directly on the circuit boards, triggering extends across the entire bandpass of both instruments.



The low prices of the 465 and 475 are due to new design and production techniques. By employing Tektronix own integrated circuit capability and designing circuit board interconnections, to eliminate much hand wiring, costs have been cut significantly. Four large PC boards place all components on the outside facing out for easier calibration and testing whilst the use of thick-film attenuators eliminate the need for adjustable inductors and capacitors, resulting in further reductions in calibration costs during production.

Further details from: Tektronix UK Ltd Beaverton House, Harpenden, Hertfordshire.



EQUIPMENT NEWS

PERIPHERAL MEDIA CONVERSION SYSTEMS

Perex Limited of Reading Berkshire, manufacturer of off-line data processing systems announce their System 2001 paper tape to magnetic tape converter. This system is one of a range of media conversion systems manufactured in Britain by Perex.

The System 2001 uses a Tally high speed paper tape reader to input data to the Kennedy Magnetic Tape unit at a speed of 500 characters/second.

The system illustrated uses a 7" magnetic tape 7 track 8707 system which allows the user to select between tape densities 200, 556, or 800 BPI and to also select one of several speeds from 10 ips to 25 ips.

The Tally and Kennedy equipment are linked by an interface system designed by Perex which converts the paper tape code typically ASCII or ISO7 to a standard magnetic tape code – ie 1900 code or EBCDIC. The converted information is stored in a buffered formatter until a complete block is formed when this is output to the magnetic tape.

Initial sales response to Sintrom for Perex products has shown that their range of standard and custom made off-line systems will be a powerful addition to the range of products marketed through the Sintrom European Sales network.

Further details from: Sintrom Pty Ltd 2 Arkwright Road, Reading, Berks RG2 OLS.

SURPRISE PACKET

(Continued from page 45)

by two fast-blow 1½ amp fuses in the main supply to each amplifier, and whilst very simple, they proved to be extremely effective against over-driving short circuits, and every other abuse that we tried.

The measured performance of the amplifier is very good. The frequency response is exceptionally flat under all conditions of loading and the distortion is exemplary, being less than 0.8% under all conditions of testing.

The intermodulation distortion was particularly good, being 0.3% at full load and less than 0.1% at 1 watt output.

One of the features we liked best was the output damping factor of 70. This is the best damping factor we have seen in any amplifier under £100, and there are many amplifiers at £200 which don't have as good a damping factor. This means that both the base and transient response of the loudspeakers attached to the amplifier is immeasurably improved when compared to that provided by an amplifier with a damping factor of, say, only 20.

The hum and noise performance are both very good and better than most other amplifiers at twice the price.

By now it must be clear how wrong our original impressions were. Not only is the amplifier good, but it took all the abuse (both verbal and accidental) that we gave it and came out on top. The Sansui AU-101 is a very good buy, particularly at the price – and with the money saved by buying this amplifier you can afford better speakers or a better cartridge. ●

MEASURED PERFORMANCE OF SANSUI AU-101 AMPLIFIER S/N 020100203

Power output	18W + 18W rms into 4Ω load 15W + 15W rms into 8Ω load		
Frequency response:			
At 1 watt output:	20 Hz to 20 kHz ± 0.5dB		
At 18 watts output:			
(into 4Ω load)	20 Hz to 20 kHz +0–2dB		
at 10 watts output:	20 Hz to 20 kHz +0–2dB		
Channel separation at maximum power:	100 Hz at 38dB 1 kHz at 48dB		
Hum and Noise compared with Rated Power	Volume control – minimum gain		–82dB
	Max. gain phono input		–68dB
	Auxiliary input		–82dB
Input sensitivity – 1 kHz	Phono 2.5 mV		50 kΩ
	Microphone 3 mV		50 kΩ
	Auxiliary 190 mV		
	Tape monitor 190 mV		
Total harmonic distortion	20 Hz	1 kHz	10 kHz
at 1 watt	0.3%	0.2%	0.5%
at 18 watts	0.6%	0.7%	0.8%
Intermodulation distortion			
at 1 watt			0.1%
at 18 watts			0.3%
Tone controls	+14dB at 50Hz –14dB at 50Hz +9db at 10kHz –12db at 10kHz		
Loudness control	+8dB at 50Hz +3dB at 10kHz		
Power consumption	79 watts at 18 watts + 18 watts output		
Amplifier dimensions:	16" wide 4 9/16" high x 11" deep Weight: 13 lbs.		
Price	£47.58		

POCKET-SIZE TV CAMERAS

(Continued from page 43)

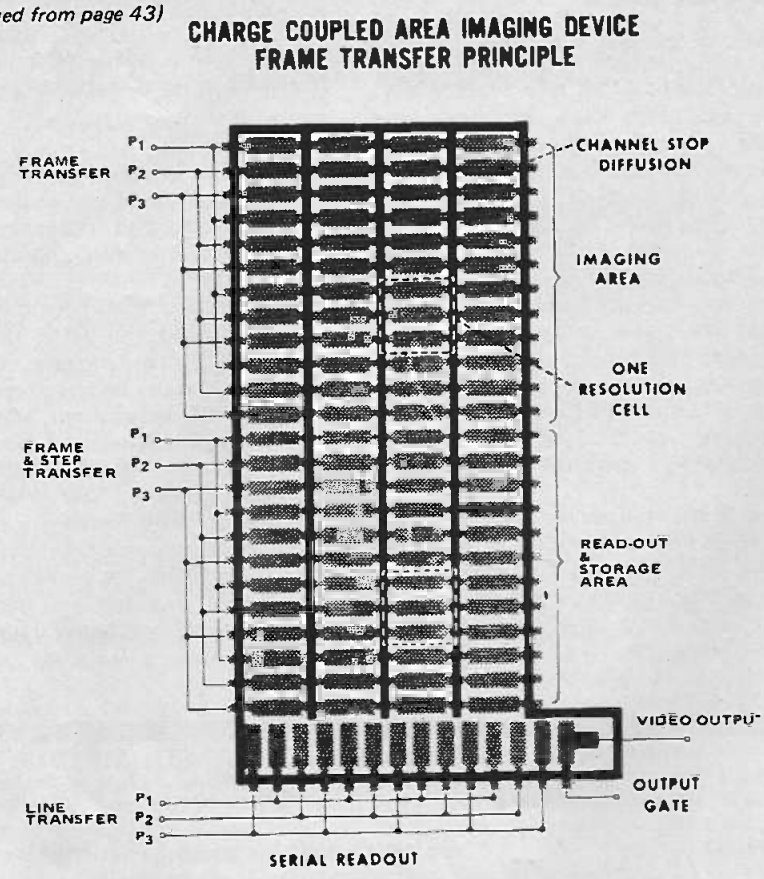


Fig 5 — Frame transfer principle in Bell's CCD sensor

of roughly the same overall performance although, comparing the two experimental devices, the Bell chip has nearly 10 times as many elements as RCA's chip but its image definition is only five times better since half its elements are used for transit storage.

The VTS requires three clock supplies: vertical transfer from sensor to storage, vertical transfer from store to output register, and horizontal transfer to read-out. The HTS requires two clocks: vertical line-by-line and horizontal 'read' each line.

Total chip area required is less with the HTS. Total transfer operations are also less with the HTS but the VTS could use a lower frequency for the vertical transfer.

For comparable picture quality, permissible dark current in the VTS is about half that for HTS. But a standard vertically interlaced signal at 60/sec frame frequency is provided in the HTS, with full 1/30 sec integration time for each field.

An integrated vertical scan generator is required for the HTS whereas the VTS requires no scan generator.

FUTURE DEVELOPMENTS

In an internally scanned charge transfer sensor of the RCA type, transfer loss at the operating frequency determines the maximum number of picture elements that can be used. Current developments indicate that, while a 150x150 element array scanned at 30 frames per second does not represent a final upper limit, this size is somewhat smaller than sensors envisaged for the charge-coupled variety.

The Bell Lab device is basically an analog shift register and Bell scientists are confident that their CCD technique can also be used to make devices for diverse information storage and processing applications such as: computer memories, telephone switching systems, echo suppression and bandwidth reduction in transmission lines, filter network synthesis, and an audio or similar delay requiring storage of a large number of information bits. In this last application, a 128x106 CCD array could, for example, delay an analog signal containing frequencies up to 13 kHz for a period of half a second. ●

TRANSDUCERS IN MEASUREMENT AND CONTROL

(Continued from page 68)

systematic errors, for example, changes in coil resistance with temperature and because of such errors the desired effect is very small. For example, only 0.05% change will occur in the coil for a degree change in an adjacent aluminium plate.

NON-ELECTRICAL TRANSDUCERS

A number of non-electrical output devices also exist to sense temperature. If a component, irradiated with the isotope Krypton 85, is raised in temperature, some of the isotope is initially released but then stops. To determine the temperature rise the part is heated until release just occurs again — and that is the temperature to which it was subjected in service.

Paints, pellets, crayons and liquid crystals (the cholesteric form) are available that change colour with temperature some remaining, others returning when cooled.

FURTHER READING

Several of the references given in Part 7 are relevant to the radiation methods discussed in this part. Acoustic methods, however, are not described in general texts as yet.

"Infrared Systems Engineering", R.D. Hudson, Wiley. 1969.

"Infrared Radiometry", J.R. Collins, Electronics World, Oct. 1967, pages 23-27 and 69.

"Using Infrared Thermometers effectively", H.L. Berman and M.R. Wank, Optical Spectra, July, 1069, 77-80.

"The Selection of a Biothermal Radiometer", D. Mitchell, C.H. Wyndham and T. Hodgson, J. Sci. Instrum., 1967, 44, 847-851.

"An Infrared Pyrometer for the Measurement of Nylon Thread Line Temperatures", H. Bevan and R.E. Ricketts, J. Sci. Instrum, 1967, 44, 1048-1050.

"Temperature Measurement of Particulate Surfaces", J.H. Bach, P.J. Street and C.S. Twamley, Jnl. Phys. E: Sci. Instrum. 1970, 3, 281-286.

"C.S.I.R.O. and the Australian Programme for the Earth Resources Technology Satellite (ERTS)", M.J. Duggin, C.S.I.R.O. Mineral Research Laboratories Investigation Report 95, July, 1972.

"Sound Ways to Measure Temperature", L.C. Lynnworth, Instrum. Technology, April, 1969, 17, 4.

"Ultrasonic Thermometry", S.S. Fain, L.C. Lynnworth and E.H. Carnevale, Inst. & Cont. System, Oct. 1969, 42, 107-110. ●

Sinclair Project 60

Z.50 & Z.30 Power Amplifiers

Z.50 40 watts RMS into 3 ohms using 40V. 30 watts into 8 ohms using 50V. Distortion 0.02% into 8 ohms.

RRP £5.48

Z.30

Z.30 20 watts RMS into 3 ohms using 30V. 15 watts into 8 ohms 35V. Distortion 0.02% into 8 ohms.

RRP £4.48

Stereo 60

Pre-amp and Control Unit. Accepts Mag and Ceramic P.U.'s. Press button input selection. Tone, balance, vol. controls. Brushed aluminium front.

RRP £9.98

Project 60 Stereo FM Tuner

With unique phase lock loop tuning principle. Squelch and AFC facilities. Fantastic audio quality. IC Decoder.

RRP £25

Power Supply Units

PZ.5 *30 volts unstabilised* £4.98
PZ.6 *35 volts stabilised* £7.98
PZ.8 *45 volts stabilised (less mains transformer)* £7.98
PZ.8 *mains transformer* £5.98

Guarantee

If within 3 months of purchasing any product direct from Sinclair Radionics Ltd., you are dissatisfied with it, your money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd.

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Project 60 offers more advantage to the constructor and user of high fidelity equipment than any other system in the world.
Performance characteristics are so good they hold their own with any other available system irrespective of price or size.
Project 60 modules are more versatile – using them you can have anything from a simple record player or car radio amplifier to a sophisticated and powerful stereo tuner-amplifier. Either power amplifier can be used in a wide variety of applications as well as high fidelity. The Stereo 60 pre-amplifier control unit may also be used with any other power amplifier system as can the AFU filter unit. The stereo FM tuner operates on the unique phase lock loop principle to provide the best ever standards of audio quality. Project 60 modules are very easily connected together by following the 48 page manual supplied free with Project 60 equipment. The modules are great space savers too and are sold individually boxed in distinctive white and black cartons. With all these wonderful advantages, there remains the most attractive of all – price. When you choose Project 60 you know you are going to get the best high fidelity in the world, yet thanks to Sinclair's vast manufacturing resources (the largest in Europe) prices are fantastically low and everything you buy is covered by the famous Sinclair guarantee of reliability and satisfaction.

Typical Project 60 applications

System	The Units to use	together with	Units cost
Simple battery record player	**Z.30**	Crystal P.U., 12V battery volume control, etc.	**£4.48**
Mains powered record player	**Z.30, PZ.5**	Crystal or ceramic P.U. volume control etc.	**£9.45**
12 W. RMS continuous sine wave stereo amp. for average needs	**2 x Z.30s, Stereo 60, PZ.5**	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	**£23.90**
25 W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers	**2 x Z.30s, Stereo 60, PZ.6**	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	**£26.90**
80 W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60 W. RMS into 8 ohms)	**2 x Z.50s, Stereo 60 PZ.8, mains transformer**	As above	**£34.88**
Indoor P.A.	**Z.50, PZ.8, mains transformer**	Mic., guitar, speakers, etc., controls	**£19.43**

F.M. Stereo Tuner **(£25)** & A.F.U. Filter Unit **(£5.98)** may be added as required.

(84A)

BLOWING BUBBLES

(Continued from page 60)

from ground sites.

The new Department of Commerce transmitter located at Platteville, Colorado, 64km east of Boulder, employs a 110m ten-element circular array of antennae, with an additional element in the centre for beam focusing. It is capable of projecting effectively a 100MW radio beam that is tunable between 5 and 10MHz, the usual range of ionospheric penetration frequencies.

The intense beam is transmitted straight up at very close to the penetration frequency – the frequency at which a radio wave passes completely through the ionosphere. The purpose here is to deposit a maximum of radio energy in the ionosphere. The closer the transmitted beam approaches the penetration frequency, the higher it reaches before being bent back to earth, the more it is slowed down, the longer it remains in the ionosphere, and the more its energy is absorbed by the ambient electrons. Absorption in the F region is maximized at the penetration frequency.

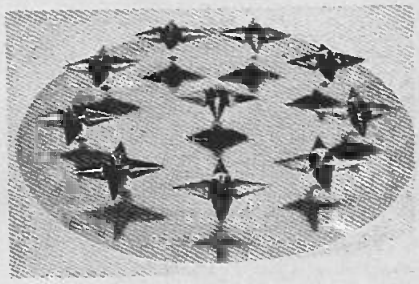
The electron heating takes place in about 20s. The heat bubble expands more slowly, however, because the negatively-charged electrons must drag the heavier, slower-moving positive ions with them, in order to maintain the electrical neutrality of the ionospheric plasma. Within 20 min or so, the dimensions of the heat bubble may grow to 80 or 160km.

When the transmitted beam was given left-circular polarization, airglow observations of excited oxygen atoms at the Å wavelength showed a predicted suppression, indicating a 35% electron temperature increase. Observations of the effects of transmissions with right-circular polarization, on the other hand, showed an enhancement of the 6300 Å emission. This unforeseen result implies, according to Utlaut and Cohen, that another process is also occurring, an increase in airglow produced by collisions of oxygen atoms with very hot electrons. The hot electrons are presumably activated by a plasma instability in the ionosphere. Because of the unstable condition, the powerful radio transmissions at ionospheric frequencies "pump" the electrons to high energy states.

Still another surprise noted in the airglow observations was the enhancement of infrared emissions from excited oxygen molecules (as opposed to atoms) by an unexplained mechanism.

Under certain natural and as yet theoretically unexplained conditions, F region echoes become diffuse, suggesting instabilities in the ionospheric plasma. If they do appear, it is almost always at night, generally after midnight. No one had predicted that the Platteville transmitter was capable of generating this spread F. But that is what the ionograms repeatedly revealed, in daytime as well as night.

Still another surprising observation experienced by the Boulder scientists was a large attenuation in radio-wave reflectivity from the regions of heated electrons. They had expected their diagnostic signals to undergo enhanced reflection from the modified portions of the ionosphere. ●



Model showing the geometric configuration of the 110m diameter antenna near Boulder, Colorado, used in transmitting a 100MW radio beam that modifies the ionosphere.

DUAL 1229 TURNTABLE

(Continued from page 39)

correct location of the cartridge in the tone arm. This gauge is fitted with a notch and when the stylus tip is centrally located in the notch the cartridge position is correct.

The construction of the turntable is very interesting, particularly as all the levers in the lift and cueing mechanism are pressed metal, however, to eliminate any noise during operation, plastic wheels and bushes are used throughout.

The motor is rather large (3" diameter by 2½") but otherwise of a conventional synchronous type, located under the turntable platter in the front left hand corner.

MEASURED PERFORMANCE

The measured performance was very good – in fact the unit is one of the best we have yet measured. The cartridge performance was interesting, and was almost identical with another cartridge of the same make we tested earlier. The slight variation of performance is indicative of good quality control. Although our test unit was fitted with a Shure M91ED, units on sale in UK are fitted with the Shure DM103ME. We understand that this cartridge (although unconfirmed) is a commercial version of the V15 and should give even better performance.

Wow and flutter at 0.05% is the best we have measured on any rim and pulley type turntable. Hum and rumble was also very good and one of the lowest we have measured.

The Dual is undoubtedly one of the best rim and pulley drive turntables we have seen to date. Its combination of simple yet adequate controls, with due emphasis on the more important components, such as the gimbal joint, gives the unit a wide market appeal.

The performance of this unit will satisfy the needs of most hi-fi purists.

At a recommended retail price of £112, the Dual model 1229 is competitively priced with other top quality turntables. *A267* ●

MEASURED PERFORMANCE OF DUAL TURNTABLE MODEL 1229 SERIAL NO. 039721 AND SHURE M91ED CARTRIDGE

Frequency Response	20 to 20kHz $\pm \frac{2}{1}$ dB
Cartridge Weight	5.8 grams
Channel Separation at 1kHz	28 dB
Channel Difference at 1kHz	Less than ½ dB
Output at 1kHz re 5cm/sec	4.6mV
Wow and Flutter %rms	0.05%
Hum & Rumble Equalised but Unweighted re 1kHz at 5cm/sec	47dB
Speed Accuracy	Adjustable on tapered drive shaft
Turntable Weight	7 lbs.
Transverse Friction	30 mg
Vertical Friction	Less than 5 mg
Recommended Retail Price £112 with Shure DM103ME Cartridge	

COMPONENT NEWS

DRY REED RELAYS FOR PCB MOUNTING

The latest series of dry-reed relays to be introduced by Elliott Relays (a division of Associated Automation) is their ERTN/G range, which comprises sixty different units. These relays, which are not polarity sensitive, provide from one to four Form C 'break-before-make' rhodium changeover contacts, and have been designed specially for PCB mounting: by attaching the coil endings to fixed terminals at right angles to the coil axes, direct connection to the board is made possible, and only a small area of the PCB is taken up.

A comprehensive selection of fifteen coils is available with each of the four form styles offered, nominal operating supplies being 5 to 110 V dc. The dry reed contacts have ac and dc resistive load switching capacities of 80 VA and 30 W respectively, a maximum permissible switching current of 1.5 A, constant current of 2A maximum, a switching voltage of 220 V dc to 60 Hz, and a minimum breakdown voltage of 490 V peak in their activated condition (560 V peak non-activated).

Contact resistance for the ERTN/G range is 150 milliohms maximum (insulation resistance being 100,000 Megohms minimum), and the ambient operating temperature range is −65 to +85°C for the standard bobbin package, which measures 67 mm long by 14 mm high by 21 mm wide (one Form C), 27 mm wide (two Form C), 38 mm (three Form C) or 45 mm (four Form C).

The main advantages to the user of these relays are inherent reliability (due to the glass enclosed contacts), fast switching speeds (4 μsec or less), practical package design flexibility, and a life expectancy of 10 million operations.

Further details from: Elliott Relays (A Division of Associated Automation Limited), 70 Dudden Hill Lane, London NW10.

TRIACS TRIGGERED DIRECTLY FROM IC'S

The 2N6068 series of sensitive gate triacs have just been introduced by Motorola Semiconductors Limited. Triacs in the series, which extends from the 25 volt 2N6068 to the 600 volt 2N6075, require the low average gate power of 0.5W for correct triggering and may, it is claimed, be triggered directly from the outputs of CMOS, TTL, HTL and operational amplifier integrated circuits. The only additional component required is a series current limiting resistor to control the gate trigger current.

Said to be rated for a continuous 4 amps the 2N6068 series of triacs will withstand a current surge of 30 amps for the duration of one full cycle of the mains supply within the junction temperature range of −40 to +110°C. Triggering is possible in all four quadrants, that is, with any combination of positive and negative voltages on the main terminals and gate terminal. Peak gate power is 10W and the gate voltage must not be allowed to exceed 5V.

The range has primarily been designed for full wave ac control applications (light dimmers, motor controls, heating control, power supplies and the like) where the triac has to be triggered by some forms of integrated circuit control system.

Further details from: Motorola Semiconductors Limited, York House, Empire Way, Wembley, Middlesex.

DUAL-IN-LINE RESISTOR NETWORKS

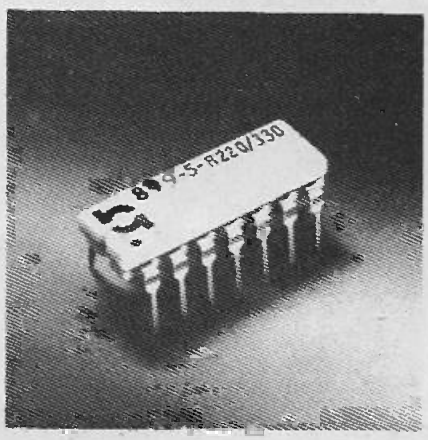
Beckman Instruments Ltd (Component International) of Glenrothes, Fife, have announced two new additions to the Helipot family of dual-in-line resistor networks.

Series 899-5 and 898-5 resistor packages, consisting of 24 or 28 thick film resistors, are designed primarily for pulse squaring networks or logic terminators. The resistors are placed in groups of two hooked together in series having a common line for power and a common line for ground.

The centre point of each pair is brought out to a separate terminal giving 12 or 13 centre points and two common lines.

The full line of Helipot dual-in-line resistor networks are said to feature total compatability with automatic insertion equipment, standard 14- and 16-pin packages (O-116), and significant savings in circuit board space.

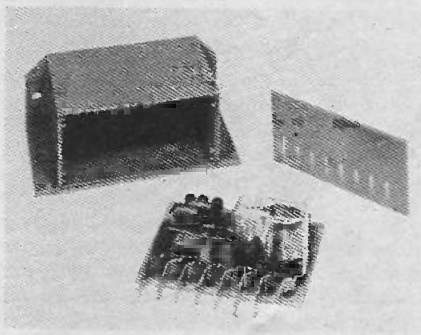
Additional models announced earlier by Beckman include the Series 899-1 and 898-1 digital pull-up network, offering 13 and 15 resistors of the same value, and the Series 899-3 and 898-3 digital line terminator array, containing seven or eight resistors of equal value, each isolated from the others and with each end connected to a separate pin.



Further details from: Beckman Instruments Ltd (Components International), Glenrothes. Fife, Scotland.

COMPONENT HOUSING

A small compact and inexpensive electronic component housing is announced by Logi-kontrol Ltd. The unit is ideal for small electronic sub assemblies, or for small projects.



Made of High Impact Polystyrene, it measures 90 x 50 x 37 mm including mounting flanges and has an internal volume of 10 cc. Among various unique features, it has facility for 2 printed circuit boards on which miniature mains transformers and relays may be mounted. Printed circuit fast-on connectors and snap-fit lid eliminate the need for a special plug and socket. Available in 5 different colours

Further details from: Logikontrol Ltd, 17 Little Edward Street, London NW1 4AT.

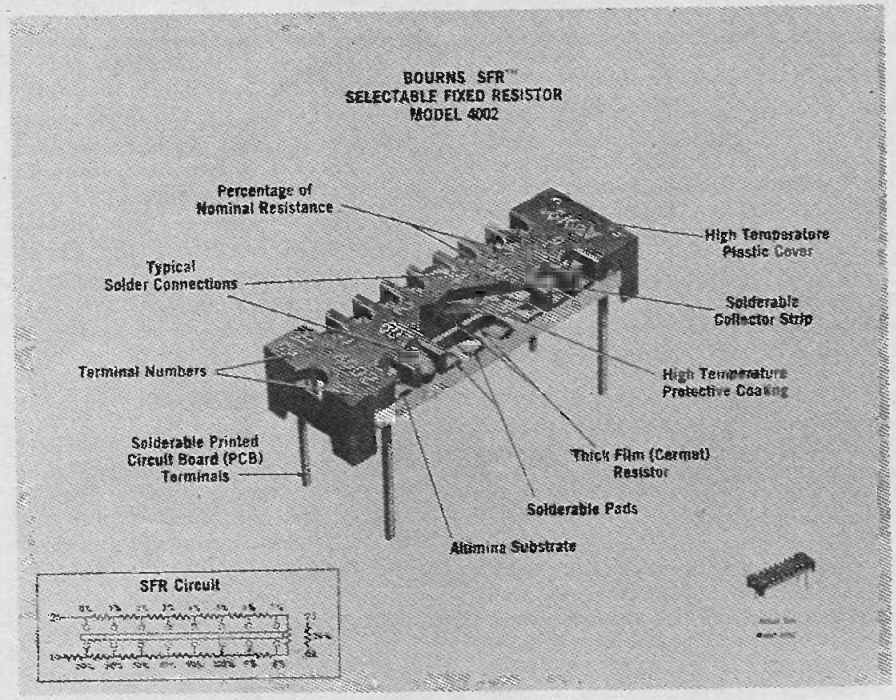
WIDE-ANGLE VIEWING LED

The Litronix RL 21 light emitting diode announced by Guest International features an extra large radiating area and high luminance at a current of just 20mA.

This LED is IC compatible and designed for front panel mounting, using either matt black or clear plastic clips which are supplied free. The terminations are rectangular section making them suitable for either soldering or wire-wrapping. It is ideal for wide-angle viewing and the standard device is available in a diffused red moulded package. However, clear red, diffused white, or clear packages are also available. Power dissipation at 25°C is 200mW and recurrent forward current is 1A max. Continuous forward current is 100mA max.

Further details from: Industrial Electronic Components Division, Guest International Limited, Nicholas House, Brigstock Road, Thornton Heath, Surrey CR4 7JA.

COMPONENT NEWS



BOURNS SELECTABLE FIXED RESISTOR

Bourns SFR Resistor Model 4002 is claimed to be truly unique! Ninety selectable resistance values in one tiny package; adjustability of a variable resistor without moving parts; stability of a cermet resistor; permanently and reliably set by soldering; occupies same mounting space as one, standard, ½ watt fixed resistor; just fifteen SFR resistor units provide circuit designers with a complete set of ±1% tolerance cermet fixed resistors with a resistance range of 33 ohms to 1,250,000 ohms.

Bourns SFR resistor eliminates fixed resistor stockpiling.

There are 1350 selectable resistance/values in only 15 units; a real micro-stock of precise resistor values. Tolerance is ±1% of any value within the 33 ohms to 1,250,000 ohms range.

The component also replace fixed resistors, primarily in applications where the ultimate resistance value can't be predetermined precisely at the design stage because of variables in related components.

The installation steps are as follows: Determine nominal resistance value; install on PCB; select resistance and solder. The SFR Resistor is compatible with normal printed circuit-board assembly, wave-soldering and PCB cleaning processes.

Precise resistance values can be set within ±1%, of required resistance value, at any point in the combined resistance range of the fifteen units, from 33 ohms to 1·25 megohms.

Further details from: Bourns (Trimpot) Ltd, Hodford House, 17/27 High Street, Hounslow, Middlesex.

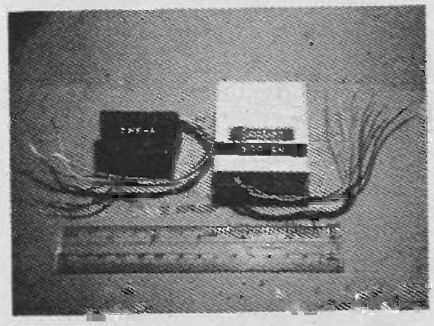
ELECTRONIC SOUND SYNTHESIS MODULES

Design Engineering (Wokingham) Limited, have been producing encapsulated electronic modules for sound synthesis for many years now, and the circuits and techniques used in their encapsulation have proved so reliable that they offer every module for sale on the understanding that if it fails within 2 years it will be replaced free of charge, unless it can be positively proven that obvious misuse has occurred.

There are two basic physical forms of module, as illustrated in the photograph. Size can be judged by the 6" rule photographed in foreground. Connecting leads are colour-coded and instructions issued with each module give comprehensive connection and use information.

Among the many specific types are the VCO-2 precision voltage-controlled oscillator, which operates on a log law of voltage/frequency, such that musical scales may be produced using a ladder of identical-value fixed resistors in conjunction with a keyboard. VCO-2 gives three locked output waveforms; sine, square and triangular, all symmetrical waveforms. Modules are available in matched and tracked groups if required (extra cost).

A sample/hold and envelope generator module, SHE-1 provides pitch memory when used with VCO-2, and also gives the facilities of variable attack and decay, slew (ie portmento), touch-sensitive playing (ie amplitude and decay depend on touch of playing technique).



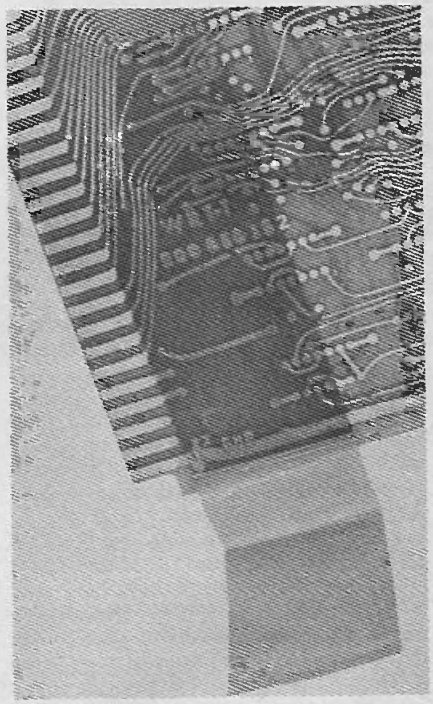
An example of what can be reproduced by way of a complete synthesiser using Dewtron (regd trademark) modules was exhibited at the British Musical Instruments Trade Fair in London in August this year, in the form of the 'Gipsy' synthesiser. Dewtron are now offering custom-built synthesisors to customers' requirements at very competitive prices. A similar model to the Gipsy will appear in music stores fairly soon. The two-year guarantee will apply to modules whether sold separately or inside built synthesisers of their own manufacture.

Further details from: Design Engineering Limited, 254 Ringwood Road, Ferndown, Dorset BH22 9AR.

PCB MASKING TAPE FROM 3M

Designed to protect printed circuitry during electroplating, Scotch X-1280 electrical masking tape, new from 3M, has a polyester base with a special adhesive to obviate adhesive transfer which normally necessitates solvent clean-up and causes plating bath contamination.

The tape protects the electroplated printed circuit patterns during solder stripping, and the gold or rhodium plating of finger tabs during differential or dual plating operations. It is also claimed to give improved mask line resolution between tin/lead and gold electroplating.



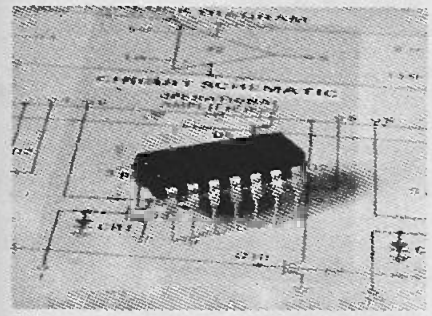
A feature of the tape, says 3M, is its conformability when used, in normal room temperature, with continuous roll laminators; it does not require static pressing.

Scotch X-1280 electrical tape has a tensile strength of 35 lbs/inch width (6 KN/m), a thickness of 4.1mils (0.10mm), an elongation of 125%, and a 35oz/inch width (350 N/m) adhesion to steel. It can be supplied in widths for all masking applications, from 0.5 inch (12mm) upwards.

Further details from: 3M United Kingdom Limited, 3M House, Wigmore Street, London W1A 1ET.

MC3401P QUAD OP-AMP

Motorola Semiconductors have just introduced the MC3401P integrated circuit which contains four separate Op-amps in a single plastic dual-in-line package. In quantities of more than 100 the MC3401P costs 37.3p putting the cost of individual operational amplifiers at less than 10p.



The low-cost and performance of the device make it ideally suited to industrial control and automotive applications in such circuits as active filters, multi-channel amplifiers, tachometers, oscillators, etc.

The MC3401P is said to feature a wide unity-gain bandwidth of 5MHz and a high open-loop gain of 1000 V/V minimum. Internally compensated, the device will operate from a single power supply of between 5 and 18 V over the temperature range of to 75°C. Four amplifiers in one package typically draw 8mA from the power supply and the input bias current required for each amplifier is 50nA. Input impedance is said to be typically 1MΩ. Undistorted output voltage swing can be as high as 13.5V with a slew rate of 0.6V/μsec. Isolation between amplifiers is typically 65dB at 1kHz.

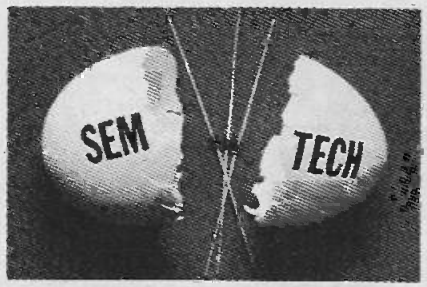
Further details from: Motorola Semiconductors Limited, York House, Empire Way, Wembley, Middlesex.

RADIATION RESISTANT SILICON RECTIFIERS

Semtech have introduced a new series of 'metoxilite' radiation resistant silicon rectifiers, the R1-4. These are general purpose rectifiers suitable for all applications and the series exceeds environmental requirements of current military and space programmes.

Features include: Monolithic non-cavity construction, fused metal oxide hermetic seal, superior thermal shock resistance, low thermal impedance and low reverse leakage.

Semtech are represented in the UK by Bourns (Trimpot) Limited.



Further details from: Bourns (Trimpot) Limited, Hodford House, 17/27 High Street, Hounslow, Middlesex.

NATIONAL'S CORE DRIVERS

The problems of tightly specified memory core drivers have been solved, it is claimed, by National Semiconductor, who are now making two dozen of the most-wanted NPN and PNP types – twice as many as before.

In general, the high-speed NPN process provides minimum BVCEO to 50V, VCE (sat) around 0.70V at 1 amp collector current, and switching speeds in the range of 12 ns ton and 50 ns toff at 500mA. PNP characteristics are similar.

The recently added 2N3722 and 2N3723 drivers are similar to the 2N3725 except that they are rated to 80V.

National's standard driver packages are TO-18 and low-profile TO-5 cans (the TO-5 is about half the height of the usual can). Since the packages are height-compatible, with logic IC packages, boards can be packed more compactly in memory systems.

Chips and quads are also available. The quads utilize four separate transistor chips assembled in a ceramic or moulded epoxy DIP. Specs are the same as the basic transistors except for package power ratings.

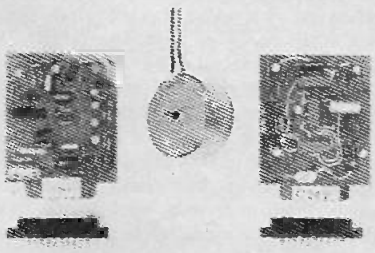
National is supplying the DH3725 (equivalent to MQ3725, 2QT3725 and SH6500 series) and the DH3467, which replaces four 2N3467 drivers, as standard products.

Further details from: National Semiconductor (UK) Limited, The Precinct, Broxbourne, Herts.

STEPPING MOTOR

Crouzet announce the introduction of a Stepping Motor and Control System which should have many applications in Tape Drives, Student Experimental Kits, XY Plotters, Counters etc.

The Motor consists of two windings – each with two phases giving a step angle of 18° ie 20 steps/revolution, Max drive frequency is 350 steps/second and a maintained torque (Max) of 1.1 cmN Max torque at 100sps 0.38cmN.



The Electronic Control System consists of a Commutator designed to provide the correct sequence of pulses to the four phases in both forward and reverse directions and an Oscillator and Pulse Shaping System to provide command to step and step direction. The relaxation Oscillator included in the system has a variable pulse rate of 5 – 250 Hz. The Pulse Shaping Circuits allow inputs from External Contacts, Proximity Switches or Voltage pulses to control both Stepping Speed and Direction.

The system is inexpensive and ideal for educational and Numerical Control development projects.

Further details from: Crouzet Limited, Thanet House, High Street, Brentford, Mx TW8 8EL.

RECORDINGS... CLASSICAL

REVIEWER: John Araneta

TCHAIKOVSKY – Symphony No. 4 in F minor – George Szell, London Symphony DECCA

There are at least twenty-two recordings of this symphony available. It may sound perverse to say it, but I rather think it a testimony of how difficult this symphony is to bring across that most of these recordings range from the mannered to the larger majority favouring safe, straight and generally indifferent readings. None of these recordings can wholly efface my memory of a live performance at the end of which the audience got up spontaneously to cheer Seiji Ozawa. One reads of such things after a Tchaikovsky concert by Kussevitzky, Furtwangler, Mengelberg, among others. I am hardly suggesting the revival of scoopy playing, excessive rubato, or vibrato these conductors were often capable of. Tastes change after all. But how many conductors today perform romantic works with true accelerandi and how many such works fail to make any effect because they must make do with sudden interchanges of dynamics or rhythm. I may not ordinarily take to the Schumann Fourth but Furtwangler's recording does make me feel there are few conductors around for this music. If mannered readings of the Tchaikovsky Fourth no longer present a solution for us, neither are straight readings the complete answer. Most straight readings of this work seem to fall back with the realization that difficult enough as it is to present a coherent idea of the structure behind say, the first movement, it also seems safer not to accept that heroic intensity called for by content, thus not lapsing into vulgarity or mannerism. But I feel this separation between "playing'. and "feeling" accounts for many dull or straight readings of romantic literature. Feeling is in the proper comprehension of how certain characteristics of romantic works should be treated: like accellerandi, transition passages (it seems easier to give attention to these in earlier music), the intensifying of sound gradually but surely – a demand in short that a conductor be creative as well.

Until the present recording came along, I was quite prepared never to hear on records a performance of the Tchaikovsky Fourth that would try to combine creativity with our present desire for fidelity to the printed score. Is this much heralded Szell release the Fourth we have been waiting for. Yes, almost. Almost, because there are times when Szell shows a Toscanini-like unwillingness to linger and intensify. (What a baleful influence has Toscanini been to modern conductors. Which does not mean he was incapable of creative conducting.) But there are far too many moments in this performance which must put this version at the very top of the list. Listening to the first movement I was first of all glad the initial statement of the motto theme was arresting enough and (thankfully) unmannered, the playing of clarinet and bassoon before the exposition beautifully piano then pianissimo. The exposition moves forward as it seldom does. No divorced sections, transitions treated with value, so that I was soon wondering what sort of performance this might be. But at the entrance of the timpani at 70, one knew this performance would be different from any other. Perhaps even after a fourth playing I feel Szell a bit unbending but one cannot help but wonder at the care and drive of this first movement. This is certainly the best structured and controlled first movement I have heard.

I think the second movement rather reserved and while Szell's fast treatment of the principal theme is unusual it is also effective and gives a strong feel of drive and character. The playing from 170-80 is true expressive playing, beautiful. The Scherzo is light, built up steadily and never vulgar. The virtuoso playing up to this point leads one to wonder what the finale will be like. But one hardly expects the unnerving series of true accelerandi. The speed of the playing must be heard to be believed, and more important the panache and accuracy. Every section follows into place unerringly and yet there seems no rush. The return of the subordinate theme is eloquently energetic and at 220 the rit. is unforgettable. As the movement draws to a close I doubt if anybody can suppress astonishment at the steady but intense control as everyone gives their all.

This record was made in the early sixties but the sound is quite good if not as startlingly clear as those of more recent vintage. – J.A.A.

CHOPIN – 4 Ballades. Ivan Moravec (piano). CONNOISSEUR

Now and then one comes across a performance which precludes any written statement on it. The difficulty is two-fold. How to convey the character of the performance – in such a case it seems to make no sense writing of how this or that series of bars are played. Beautiful is a useless word. And what has writing to do with such playing? One is forced to say simply, "Here it is. YOU have to hear it." At such times I feel the sole and only possible use of such a report must be limited to bringing such an event to notice. Here is Chopin playing as one seldom hears in a lifetime. What cliche! But so I feel here indeed is such a performance. (A friend who heard Hoffmann in his youth assures me the playing here is very reminiscent of the great pianist's style. But op.47 was done better!) How sure can I be that a recording can be called a performance? No myriad splices can bring together what we have here. After an initial playing, my reaction was to wonder at the audacity of the readings here. What liberties! Yet I cannot remember ever once thinking of the word "liberties" while actually listening. Creativeness rather. But this word has the sense of wilfulness somewhat defeating the spontaneity and intuition here. Have no doubt, Moravec can only have exerted the strongest will to achieve what he does here. One hears of player and instrument disappearing and of hearing only the music. Shall I tell you of every return of Tempo I on op.38? For once here is refrain as ouly the most ideal singer can give us, no longer mere refrain but a device stimulating the memory, not just the reminder of structure, but a recall. I have said nothing at all. Chopin here sounds like no salon composer one knows. Moravec brings out all the voices and the very complex structure of these pieces, and I am convinced of their structure after this. At times I just wonder, "How does he do it? How decide which, what, how?" Follow the score and you can decide for yourself how Moravec effects that opening transition from largo to moderato in the op.23. Just seven bars. One can talk about the suberb legato, pedalling. Pauses? One hears them. One thinks of Huneker's "noiseless suspensions" and if you think that is out of date reaction – here it is. You have to hear it. Recording? If it were playable with a grit surface I would have this disc. – J.A.A.

ELGAR – DREAM OF GERONTIUS – Soloists, King's College Choir, London Sym. Orch. & Chorus, Benjamin Britten (cond.) DECCA

I must confess I cannot stomach the Roman Catholic sweetness of this work. "It stinks of incense," Stanford said and I often feel I must agree. But it puzzles me that my more reformation-minded friends are with it. Having infuriated every Elgarian in reading distance I must now say there are times, and listening to these records after not having heard the score for over ten years, when I myself can be seduced. There are undoubted beauties in Elgar's score and I can feel for those solos from the Angel. One must also admit that in a fine performance, the intensity of "Take me away" can strike a justifying chord in me. I only wish that Elgar could not have spoiled his finale with that rhythm, and harp, and those ultimate chords. Feeling myself at last in some way admitted to that closed company of Elgarians, I find to my distress they do not like this recording. "It's not intense enough. It does not give." What shall I say? I do like Britten's detachment and his non-saccharine treatment of this score. I will say there are times when more intensity would not have gone amiss. Minton's Angel is ravishing, so that both available recordings do have superb Angels. Shirley Quirk's Priest and Angel of Agony are as fine as any. Much as I like this recording, I am afraid I cannot wholly accept Pears' Gerontius. There is as always with Peter Pears a moving projection of the text, but there is far too much vibrato in the voice to be pleasing. The choirs are almost always well controlled and it goes without saying that the sound of King's is just right for those choruses. Fine sound but I do wish import Decca pressings would not have those ever so occasional ticks and shush. – J.A.A.

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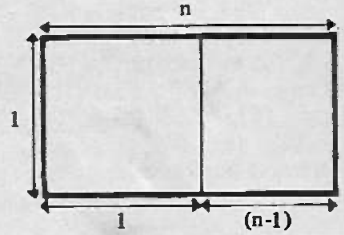
Solve a problem

Do you have a problem – in locating a device with special characteristics, in achieving a design or usage function, in applying electronic and (associated) techniques or merely as a challenge to ingenuity? Write and tell us – and, through this column, your fellow-readers in all engineering disciplines – about it. Here are other problems:

PROBLEM 009 AGAIN: *Mr Wigmore of Scunthorpe, Lincolnshire, offered this interesting side information with his solution to problem 009.*

If a rectangle is made this ratio (1:1·6180 etc) partitioned into a square and another rectangle, the smaller rectangle is in the same ratio, and so on ad infinitum

Proof:



Required condition is:

$$\frac{n}{1} = \frac{1}{n-1}$$

therefore

$$n^2 - n = 1$$

$$n^2 - n - 1 = 0$$

Solving,

$$n = \frac{1 \pm \sqrt{1 + 4}}{2}$$

$$= \frac{1 + \sqrt{5}}{2}$$

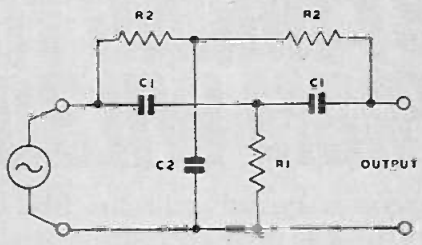
(neglecting negative root)

This 'magic number' was used by ancient Greek architects to produce the most aesthetic layout of a building. –J G Wigmore

In the 50 or so correct answers received to problem 009, there were a full 40 different methods. It seems that some of our readers enjoy furnishing themselves with mathematical problems. So here is one that requires a certain amount of intuition coupled with mathematical manipulation.

One year's free subscription for the best most intuitive answer – warning, this is not for beginners.

PROBLEM 012: In a twin T network, as shown, the circuit has infinite rejection (unloaded) at frequency f and thus provides an excellent notch filter. Its characteristics



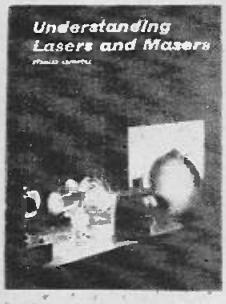
$f = \frac{1}{2}\pi C_1 R_2 \quad R_2 = 2R_1 \quad C_2 = 2C_1$
$= \frac{1}{2}\pi C_2 R_1$

imply a tuned circuit with infinite Q, that is negative, or at least zero, resistance. – How come? One year's free subscription for the best and most intuitive answer.

To readers with solutions: please help our mail department by writing the problem number prominently on the bottom left of the envelope. Since almost every problem has more than one solution, do not give up seeking or sending your solution to a problem even if one solution to it has been published in these columns. –Ed

BOOK REVIEWS

REVIEWERS: Brian Chapman, Jan Vernon.



UNDERSTANDING LASERS AND MASERS by Stanley Leinwoll. Published by Iliffe Books London 1965. Soft covers, 87 pages 8½" x 5½". Review copy supplied by Butterworth Pty. Ltd., **UK price 90p**

In 1960 the first laser was built, this followed on the development of the maser in 1954, and a paper by A.L. Schawlow and C.H. Townes in 1958 proposing that an optical maser was possible. Maser is an acronym for Microwave Amplification by the Stimulated Emission of Radiation, and is a method of utilizing the energy states within atoms to produce electromagnetic radiation.

Similarly the word laser has the same meaning with respect to radiation within the visible spectrum, that is, light.

When first introduced the laser was more of a scientific curiosity than a useful device, as no one really knew how to put the thing to work. Since that time however, laser usage has increased at an astounding rate and one is continually amazed at the places where lasers are finding application.

The laser has in fact created an enthusiasm amongst scientists, engineers and laymen which has rarely been equalled. One potential application however is a little disquieting – that of laser weaponry.

This book will fill the need of those in electronics and other technologies to know what lasers and masers are, how they work, what the applications are, and likely future developments. It is a most readable and worthwhile book. – B.C.

WORLDS – ANTIWORLDS – ANTIMATTER IN COSMOLOGY by Hannes Alfven, (translated from Swedish by Rudy Feichtner), 103 pages – W.H. Freeman and Company, San Francisco & London 1966. **Price £1·65p.**

Hannes Alfven (winner of the 1970 Nobel Prize in Physics) divides his time between the Royal Institute of Technology, Stockholm and the University of California, San Diego. He writes in Swedish. The original Swedish title of this book is Varlden – spegelvarlden: Kosmologi och antimateria. The English title means the same but its Wagnerian splendour loses a little in translation. But this does not apply to the book itself. It is readable, fascinating and thought provoking.

It presents a theory of the development of the galaxies which is not as well known as the most quoted theories but will no doubt attract more interest as further discoveries are made about anti-matter.

The theory originated with Doctor O. Klein, former Professor of Theoretical Physics at the University of Stockholm. Klein's model of the development of the metagalaxy assumes that there is symmetry between matter and antimatter and that the primordial state was a thin ambiplasma (a mixture of plasma and antiplasma) contracting under the influence of gravitation. Before this stage, space consisted of radiant energy. This radiation generated the proton-antiproton pairs, the primordial ambiplasma.

The present metagalaxy, says Klein, developed from a process of contraction due to gravitational attraction, annihilation as proton met antiproton, radiation of gamma rays and radio waves as a result of annihilation, and expansion as the pressure of radiation stopped contraction.

This expansion is occurring at the present time as manifested in the red shift of galaxies. At the same time condensation occurring within the metagalaxy (by virtue of gravitational irregularities) forms the galaxies which, consisting of ambiplasma, produce intense radiation as they contract and it is the intensity of this radiation which brings about the separation of matter and antimatter eventuating in galaxies in their present state.

Separation without complete annihilation would seem a flaw in the theory but Alfven draws a parallel with the Leidenfrost phenomenon in which a drop of water on a hot plate at a sufficiently high temperature does not instantly evaporate because it is insulated by a thin layer of water vapour. Lower the temperature and the drop vanishes in a small explosion.

When matter and antimatter meet, some will be annihilated but the intense radiation will keep the main masses separate.

Alfven's book is a careful and imaginative description of Klein's theory showing why the theory is possible.

His purpose is "to see how far we might go in cosmological speculation without having to introduce new natural laws".

There are chapters on cosmology and natural science, present and past theories of the creation of the metagalaxies, plasma physics and a chapter on matter and antimatter.

This latter chapter describes the structure of matter and the discovery of the positron and the antiproton. If matter and antimatter exist in the separate amounts, how are they distributed? As possible answers, the author says that every second star may be antimatter, or every second galaxy, or even half of our own solar system. With our present technology we cannot tell.

There is something very attractive about any discussion of this subject. Perhaps the thought that within our own solar system there may be planets which we can never land upon – we would be instantly annihilated. Or it is perhaps the symmetry that appeals to us?

Alfven writes very convincingly – he gives antimatter more status in his book by always referring to matter as Koinomatter (from the greek "Koinos" common or well known), therefore he implies antimatter exists in the metagalaxy.

But whether it does is at present not known. Arguments for the existence of antimatter (apart from laboratory experiments) include radio stars, quasars and other celestial objects with enormous energy outputs. Still he points out that it is beyond our powers at present to demonstrate that antimatter does or does not exist in the universe.

So what we are left with is our accumulation of observations, natural laws and fascinating theories. – Jan Vernon

RADIO AND ELECTRONIC LABORATORY HANDBOOK. by M. G. Scroggie. Bsc, CEng, FIEE. 8th edition 1971. Published by Iliffe Books. 614 pages 5½ x 8½, hard covers. UK price £7.50p.

Mr Scroggie, better known perhaps as "Cathode Ray", has been active in electronic literature for some 50 years and in that time has written over 800 technical articles and several books. Apart from the present volume under discussion, two of his most read books are "Foundations of Wireless and Electronics" and "Second Thoughts on Radio Theory".

The Radio and Electronic Laboratory Handbook has been a standard reference on the general principles of measurement and laboratory practice since it first appeared some 30 years ago. Don't get the idea that Mr Scroggie is an 'old fogey', or not up with modern technology just because he has been around for a long time. On the contrary, his works still remain among the most readable, without sacrificing accuracy or detail, of popular electronic literature available.

This eighth edition has been further extended over previous editions by the inclusion of material on semiconductors, integrated, circuits, operational amplifiers and digital instruments, and is therefore technically right up to the minute.

The book opens with discussions on the purpose and layout of a laboratory and then the fundamental principles of measurement are treated at great length with much clarity in the third chapter. Six chapters deal with basic measuring circuits, indicators, standards and composite equipment. Four chapters on the measurement of audio, RF and active devices are then followed by another on the measurement of equipment characteristics.

An essential feature of measurement, often overlooked, is the interpretation and recording of results and the methods of determining limits of error. This is the subject of the second last chapter, which is a mine of useful and timely advice on making the most of your results.

Lastly a really excellent reference section of 100 pages gives formulae, tables, design rules etc, most commonly required in the laboratory. BC

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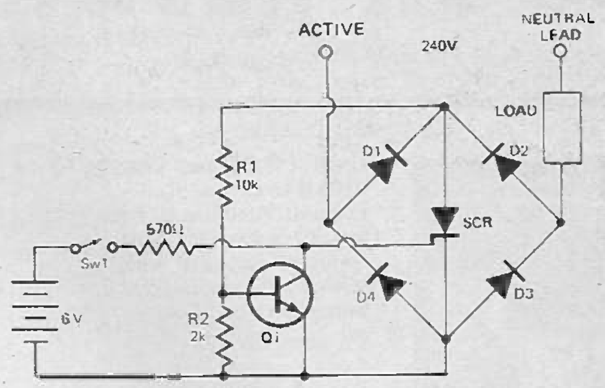
TECH-TIPS



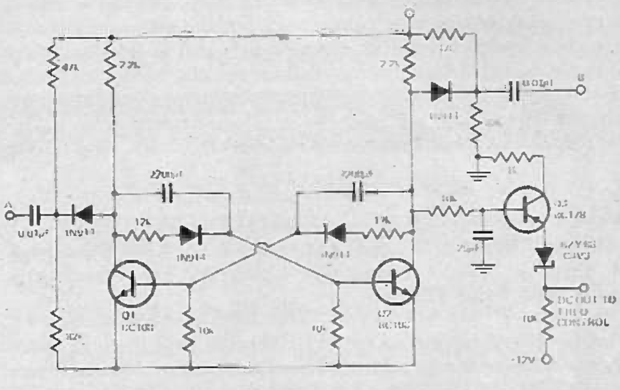
D1 - D4 and SCR chosen to suit load.

SIMPLE ZERO CROSSING SWITCH

In many control applications power control by zero point switching is preferable to phase control because minimum RFI is generated this way.

A simple circuit is shown which provides a solid-state zero point switch with a minimum of components. The values of R1 and R2 are chosen to provide the correct width trigger pulse for the SCR being used.

The unit will find many uses as a solid-state relay where large powers are required to be switched by reed or micro-switches.



PHASE LOCK CONTROL CIRCUIT

The circuit shown was used to phase lock a UJT oscillator at 10 times the frequency of a 16Hz oscillator which was varying ±25%.

The reference frequency is coupled in at B, and a trigger from the phase locked frequency enters at A. The resultant multivibrater pulse train at Q2 collector is filtered and then dc shifted by Q3 and a Zener diode. The resultant dc error signal may be used to correct the frequency of a voltage tuned multivibrator or UJT oscillator. The sync signal may be generated by counting down the B signal by the ratio of the two signals.

TECH TIPPING

We are sure that many experimenters have original circuit ideas which would be of interest to other readers.

Electronics Today International will pay £1.50 for each original item selected for inclusion in Tech Tips.

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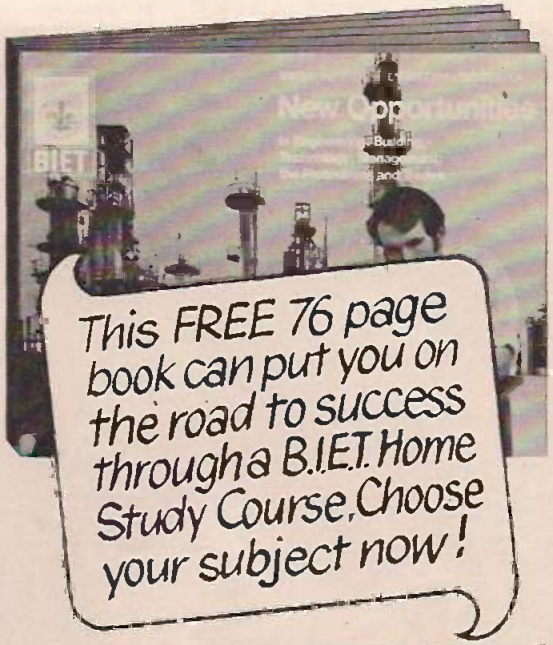

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