NOVEMBER 1973

electronics today INTERNATIONAL

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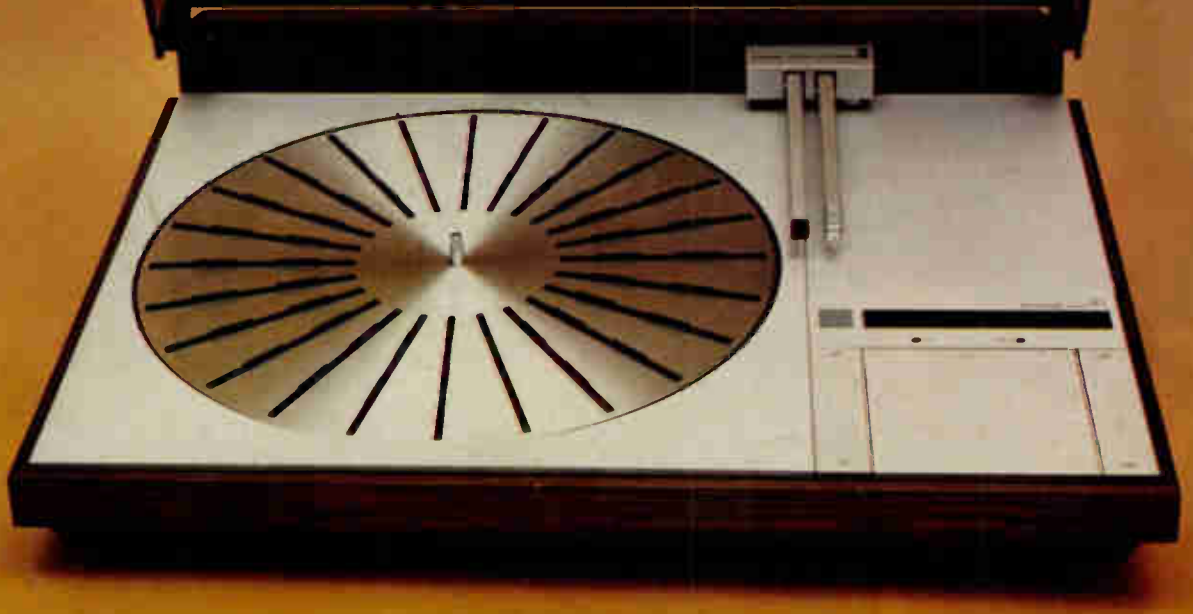

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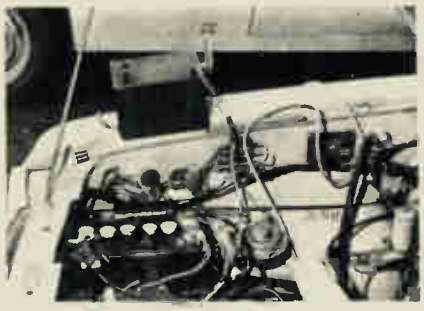

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main features

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news & information

Cover: B & O's Beogram 4000 uses new engineering techniques and looks superb. Complete review on page 52.

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The only thing in common with other £54 amplifiers is the price.

Not surprisingly, for most people quality of hi-fi equipment is largely governed by quantity of money.

Which means if they start off with around £50 to spend on an amplifier the most they'll end up with is, say, 15 watts per channel RMS, a frequency response of around 25-20,000Hz and a fair level of distortion.

Take a quick look down any specification and you'll see for yourself this is true. But for one notable exception:

Eagle's AA4 amplifier. Which not only outperforms other amps in its price range, but in many cases others costing a lot more.

For a start it has 20 watts RMS power per channel both channels driven.

And a frequency response of 20-36,000Hz ±2dB.

There are scratch and rumble filters and a distortion that's better than 0.2% even at full rated output.

We could go on, but sending the coupon for our Audio colour brochure will tell you more than we can ever say here.

It will also give you details of our AA2 amplifier which for £38.00 has all the quality and looks of the AA4 with an output power of 10 watts per channel.

To complete either set, you might also be interested in the AA8, our AM FM MPX stereo tuner.

It has an FET front end, switched AFC and interstation muting. And though it can be used with any amplifier, it's specially designed to go with the AA4 and AA2, for which it's a perfect match in terms of looks and performance.

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LONG LIVE RADIO

FIFTEEN YEARS AGO few people would have given any future for sound radio: television was the new medium which took all the money and the best personnel while 'steam' radio took a back seat.

Ten years ago there was only one choice of radio programme available for part of the morning when both BBC Home and Light Services put out 'Music While You Work'. Today in London (and soon in many other parts of the country) there is a choice of seven programmes: the four BBC National Networks, BBC Local Radio and the two IBA commercial stations. Unlike many other parts of the world, these stations provide a real choice and cater for most tastes. The choice at times is even more as the BBC are 'splitting' the AM and FM networks for educational and sports programmes.

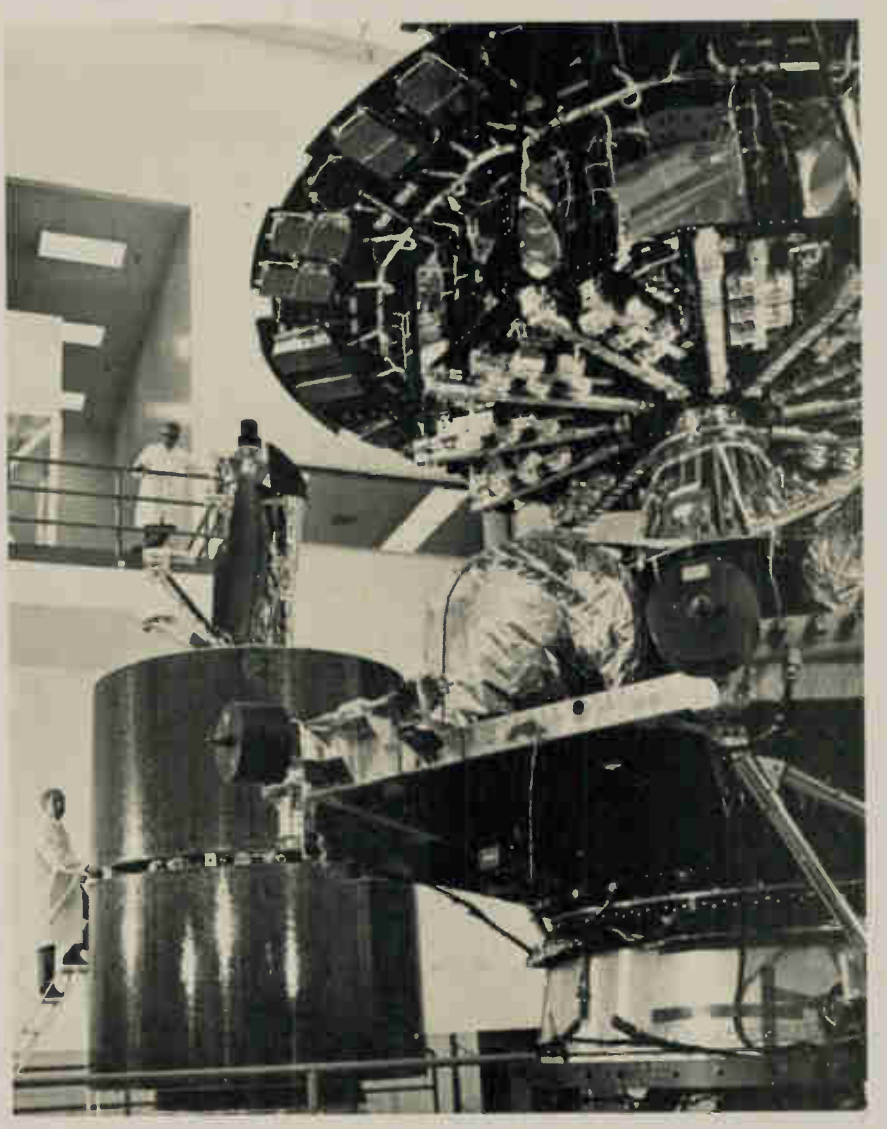
This growth has been gradual but none the less remarkable. The expansion owes a lot to the faith placed in the medium by the BBC who resisted the temptation in the difficult years to reduce choice or lower standards. In a cautious, and very British way, the BBC modified radio and in our opinion improved it considerably.

With the abolition of the radio licence fee (which held back the growth of car radios) and the continued reduction in the price of radios (especially AM/FM combinations) taken with increased choice of programmes, the future of radio looks more promising than ever.

BBC television improved immeasurably after the introduction of ITV and this in turn improved the commercial network; this has led to what many informed foreigners say is the best TV service in the world. If the same thing happens with radio it has a rosy future. We wish it well. — H.W.M.

news digest

In the background an Intelsat IV communications satellite is undergoing final testing whilst in the foreground another unit is being assembled.



TEN YEARS OF COMMUNICATIONS SATALLITES

When the fifth Intelsat IV communications satellite achived a successful 22,300-mile-high orbit over the Alantic Ocean recently, it marked a decade of progress since space scientists proved that satellites could appear to "hover" in the sky by synchronously matching the earth's rotational speed.

The lastest Intelsat IV was launched from Cape Kennedy on August 23, exactly 10 years to the day that Syncom, the world's first synchronous satellite, become operational.

It was on August 23, 1963 that President Kennedy officially inaugurated the new age of synchronous satellite communications by speaking by telephone across the Atlantic to the Prime Minister of Nigeria via the 147lb, single-channel syncom, launched July 26, 1963.

Today, five 3100lb Intelsat IVs, each with a capacity to provide an average of 5,000 two-way telephone calls or 12 simultaneous colour television programmes, are operating in synchronous orbit over the Atlantic, Pacific and Indian Oceans, effectively linking most of the world's population.

The latest Intelsat IV, the fifth to be launched and positioned successfully in five attempts, was developed and built by Hughes Aircraft Company, El Segundo, California, and a team of subcontractors from Europe, Japan and Canada for the 83-nation International Telecommunications Satellite Corporation (Comsat).

The new satellite will undergo two weeks of tests before it is placed in commercial service, Comsat said. By the end of this year 91 antennae at 73 earth stations in 55 countries are expected to be operating with the five Intelsats.

The first two Intelsat IVs were launched in January and December 1971 over the Atlantic to provide commercial operations between the U.S. and Europe. The third spacecraft was launched over the Pacific in January 1972. The fourth was launched last June over the Indian Ocean. Each satellite has a design lifespan of seven years.

The satellites have brought to the world's living rooms live colour television coverage of such historic events as three Apollo moon walks, President Nixon's visit to Peking, the Munich Olympic Games and celebrations of the 2,500th anniversary of the Persian Empire.

SIX NEW CALCULATORS

Advance Electronics have recently introduced six new calculators, shown for the first time at the 1973 Business Efficiency Exhibition. Two of these, the Advance 88 and Advance 80 are handheld units, the other four are a range of compact desk calculators.

The Advance 88 has been developed specifically to offer features that are normally associated with larger and much more powerful desk calculators. It is claimed to be the most sophisticated general purpose handheld business calculator available from a U.K. manufacturer. The calculator is a full 16-digit floating point unit with 2 accumulating memories and automatic square root key. Although strictly a handheld model the 88 has full size key switches and will operate for several hours on bullt-in rechargeable batteries. When required the calculator can be used in conjunction with the special mains powered desk top recharger unit, Advance claim this unit to be a World first at the recommended price of £115.

The Advance 80, ideally suited to financial calculations, incorporates a percentage feature enabling mark-up and

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H39	6	Integrated Circuits. 4 Gates BMC 962. 2 Flip Flops BMC 945	55p
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B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	55p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	55p
H6	40	250m W. Zener Diodes DO-7 Min. Glass Type	55p
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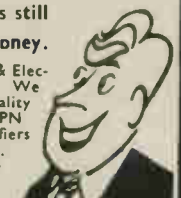

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YES, a complete kit of parts including Printed Circuit Board. A four position switch gives X-hatch, Dots, Vertical or Horizontal lines. Integrated Circuit design for easy construction and reliability. This was a project in the September 1972 edition of Television.

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news digest

The Advance 88 (above) at £115 is claimed to be the most sophisticated general purpose handheld calculator available in the U.K.

discount calculations to be performed without re-entry of data or the need for preliminary calculation. Answers are displayed to eight significant digits with fully floating decimal point. The user may optionally fix the decimal point to display answers 'round-off' at two decimal places, and the instrument will chain calculate, square automatically, and features the very important 8-digit constant facility in both multiply and divide.

The Advance 80 may be used on internal dry batteries or operated on an optional mains adaptor which doubles as a desk plinth. This mains unit is also designed for re-charging optional rechargeable cells whilst the calculator is in use on the stand. The recommended price is £57.50.

The Advance 160 family of desk calculators have been introduced to replace the very seccessful Executive 16 range. Market demand has led to the incorporation of new features.

The four models each have simple key operations for both arithmetic and percent functions. A full 16-digit resolution is provided with four-rule automatic constant, self clearing and underflow features. The normally floating decimal point may be optionally fixed between 0 and 6 places.

Provision is made for automatic accumulation into memory of answers and in two memory models the accumulation of percent extensions.

VAT calculations can be performed in the simplest possible way on these new machines.

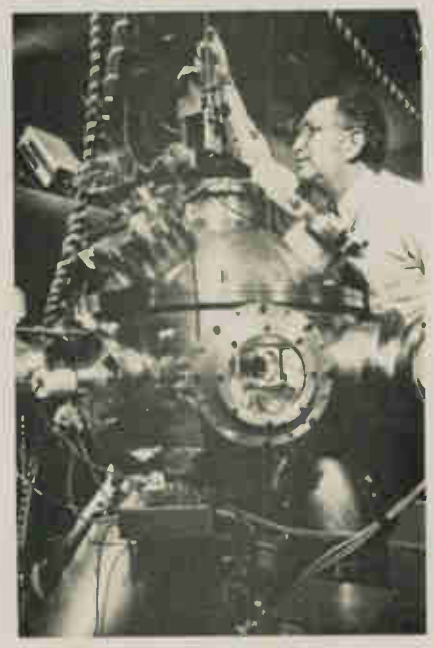
The four models are:

Advance 161 1 memory £115.
Advance 161R 1 memory with square root £130.
Advance 162 2 memory £145.
Advance 162R 2 memory with square root £175.

"PIECES OF EIGHT"

"Aargh! Jim lad, shiver me timbers! I've found 'em. At long last, me pieces of eight!" So said Athena's Peter Mills who was aptly cast in the role of Long John Silver when we called by the electronic component distributor's Egham office to discuss the subject of eight-pin DIL packages. It's a real treasure island at Athena for "pieces of eight" and the old apple barrel hasn't looked better! As for the owl - well he flew by just to be wise after the event - thought the whole exercise was a bit of a hoot....

To be serious, Athena report a very good stock position on 8-pin DIL packages, linears and hyrids at Egham - despite a shortage effecting other distributors. Pricing, Athena reports, is competitive.



HIGH POWER LASERS FOR THERMONUCLEAR FUSION

The use of High-power lasers to produce controlled thermonuclear fusion is under study at the University of Rochester USA under the joint sponsorship of the University, General Electric Company of the USA, Esso Research and Engineering Co., and Northeast Utilities.

Dr. Leonard M. Goldman, a physicist on loan to the project from GE(USA)'s Research and Development Centre in Schenectady, New York, adjusts instrumentation on the target chamber within which fuel pellets of deuterium or lithium deuteride will be heated and vaporizes by bursts of light from a high-power laser system. Nuclear fusion, the basic reaction by which the sun converts matters into energy, requires temperatures of 100 million degrees.

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news digest

SCOPELESS ANALYSER

An entirely new engine analyser incorporating unique features intended to simplify operation, has been introduced by Leslie Hartridge Ltd., the Lucas group test equipment manufacturers.

Known as the Hartridge Scopeless Analyser (H.S.A.) it dispenses with the difficult to interpret, traditional oscilliscope. Instead, all readings are presented simply and graphically on four large scale meters, which feature 'pass or fail' zone illumination.

After 'hook-up' using clip-on inductive sensors, the operator presses the test sequence buttons, one after another for all 18 tests, noting down any 'fail' readings on a detachable record card. Each meter and its 'pass or fail' zone is only illuminated when the relevant test selection button is pressed.

The H.S.A. is also the only analyser available in the U.K. which can be supplied with a self test unit, to check and guarantee the accuracy of the analyser.

No adjustment is necessary for vehicle polarity and there is an automatic cut-out on the ignition circuit during contact breaker and cranking tests.

The use of digital and analogue intergrated components mounted on plug-in printed circuit boards is claimed to maximise reliability and ease of maintenance.

NEW UHF TV STATIONS

The high power main stations and four relay stations have recently been added to the IBA's network. The main stations are Presely, Pembrokeshire, Channel 43 carrying HTV Wales programmes and Llanddona, Anglesey, Channel 60 with the same programme.

The Relay stations are Abergavenny, Channel 49, Ebbw Vale, Channel 59, Bethesda, Channel 60 and Ventnor (Isle of Wight), Channel 49.

The main stations are horizontally polarized, the relay stations vertically polarized.

NO TUBE TV

A TV camera without a conventional vacuum tube has been developed by Fairchild. In place of the vidicon there are a series of charge-coupled device (CCD) sensors. These are arranged in an array of 10,000 photosensors assembled on a 24-pin DIL Package.

CCD sensors are basically bulk silicon that releases charge carriers in proportion to the light falling on them. These sensors are scanned by a clocking system and fed to a receiver as a conventional signal.

The new camera utilising these sensors is known as the MV-100 and is remarkable in other ways. Power consumption is less than 1W and the size is a mere 3½ x 1½ x 2¼in. The whole unit weighs only 6oz. and will operate in conditions varying from bright sunlight to subdued room lighting.

Applications envisaged for the MV-100 are security, industrial and medical applications.

SKY NOISE RESEARCH

Engineers at the Post Office Research Station on Martlesham Heath near Ipswich, are measuring "sky noise" - not sonic booms but the "sound" of the weather. The work is a vital part of the development of satellite communication systems using higher radiowave frequencies than the present generation of satellites which will be working to maximum capacity in a few years. One of the big problems in using these frequencies is that signals to and from satellites are seriouly weakened by adverse weather conditions, such as rain and snow. So, to enable such systems to operate economically and efficiently, engineers need accurate measurements of loss of signal strength.

The aerial pictured here will be producing the data once suitable satellites - being provided by the Italians and the USA - are available. In the meantime, radio noise from outer space is being measured in much the same way that a microphone picks up sound waves. Mr. Dennis Knox, head of the aerial research group at Martlesham, is comparing a photograph of the areas surrounding the aerial with a "sound trace" produced as the aerial scans the horizon; buildings and trees are indicated by high signal loss. The aerial operates continuously, producing a record of the "sound of the weather".

news digest

LOW-LIGHT LEVEL TV CAMERA

A highly sensitive "see-in-the-dark" TV camera originally developed for use by military pilots is being tested and evaluated for commercial fishing at night in the Gulf of Mexico, RCA reports.

The camera, which also has the same type of imaging as that used in cameras that transmitted colour pictures from the moon, is being tested by Zapata Corporation's Remote Sensing Group in association with Zapata Protein, a commerical menhaden fishing operation based in Louisiana, USA.

The menhaden are processed into fish meal or use by poultry and animal feed producers as a high protein food supplement. Most of the fish oil is shipped to Europe for use in the manufacture of shortening.

Mounted atop a mast of one of Zapata's 170-foot boats "mother ships", the RCA camera is employed to direct two smaller 40-foot boats to schools of menhaden. Once in the vicinity of the school, the ship's captain directs the "netting" operation by viewing the scene on his television monitor.

The sensitive camera spots the fish by observing the bioluminescence given off by the schools as they move through the water. The movement is readily apparent on a TV monitor connected to the camera by cable, he said.

The camera employs RCA's Silicon Intensifier Target tube, a type used in the colour TV camera that sent back live pictures from the Moon during the last three Apollo missions.

COMPUTER FILE SECURITY

Accessing a remote computer over Post Office telephone lines can raise some difficult security problems. Anyone in possession of the computer's telephone number and user's code word (password) can obtain all the confidential data in any files stored in that computer.

Personnel authorised to use a terminal may leave the company to work for a competitor. Even if they are above reproach, the vital information may be inadvertently disclosed if it is written down to aid the memory.

A new unit, designed and manufactured in Britain, eliminates the security problem by allowing authorised people to gain access to their company's computer without knowing its telephone number or the file password.

The security unit is connected between the user's terminal and the Post Office modem and stores both the computer telephone number and the user's unique file access password. Once the correct key is turned in a lock on the security unit, dialling is performed automatically at the press of a button. When connection with the computer is established, the file password is transmitted automatically by pressing a button on the unit.

Only one person need know the computer telephone number and the file access password, thereby greatly decreasing the chance of this vital information falling into the wrong hands.

Each standard unit will store one telephone number of up to 13 digits and four passwords each of eight ASCII characters; each password has a separate high-security lock and each lock requires a different key. The locks are approved by the British Insurance Association and have no serial numbers, as is normal high-security practice. If desired, the Computer File Protector will store several telephone numbers and more than four passwords to special order.

There are three standard models. One version differs substantially from the others in that it outputs a digital code which is then converted to dialling pulses by a Post Office automatic dialler. This is model CFP-301.

The simplest model in the range, the CFP-101, stores the password but does not store any telephone numbers.

Type CFP-201 connects directly into the telephone line and can, if necessary, be programmed with inter-group dialling pauses which are needed for trunk dialling on the Continent.

For additional security, the passwords can consist of non-valid ASCII characters; that is, one of the many combinations of eight binary digits that are not used in the ASCII 64 character set. This means that additional security is assured because it is impossible for the Teletype to print out the passwords as the character codes will not be recognised.

Programming the units with telephone numbers and passwords can either be carried out by the manufacturers or by the user. The task involves soldering short wire links into a matrix of holes. The matrix is 'scrambled' in a haphazard way so that it is not possible to read the numbers by inspecting the links unless one is in possession of a list of detailed instructions. The telephone number or the password can easily be changed at any time.

HANDHELD DIGITAL MULTIMETER

A new battery powered digital multimeter, so small that it can be held and generally operated with only one hand, has been announced by Hewlett-Packard.

The new HP 970A measures A.C and D.C. volts (up to 500V) and ohms (1kΩ to 10MΩ) quickly and accurately, selecting automatically from five ranges. A 3½ digit LED display features fully automatic decimal placement and polarity indication.

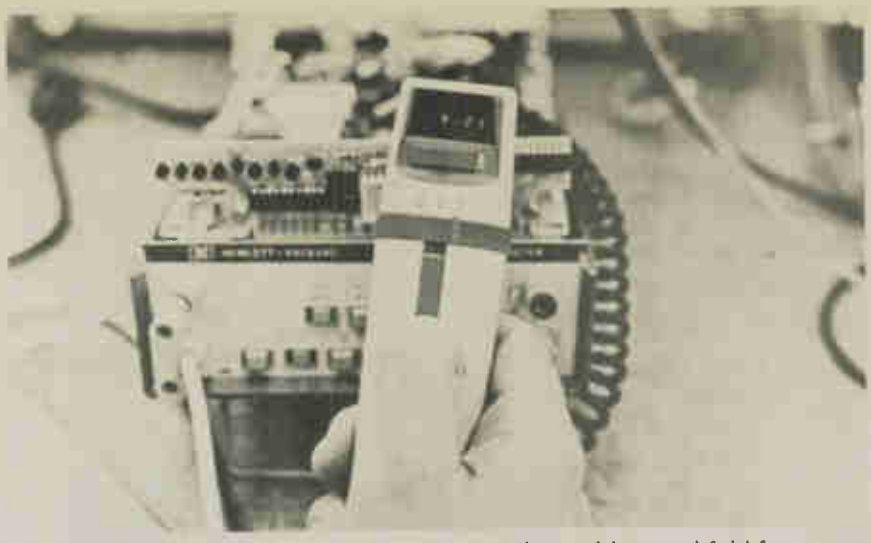
Heart of the new instrument is a postage stamp-sized thin film hybrid, integrating both digital and analog circuitry.

The probe tip and display are both located at the top of the HP 970A whose size is roughly that of a thick pen. After setting the wristband-type function selector (A.C., D.C. or kΩ) and clipping on the common lead, a user simply touches the test point with the probe and the solid state LED display automatically indicates the correct reading - - in volts or kilohms. The minus sign turns on if the voltage is negative. The decimal point positions itself automatically.

Since the display is close to the point of contact, one need hardly shift ones eyes off the probe while working in closely packed wiring.

continued on page 15

news digest



A switch inverts the display so it will be readable with the probe in any position.

Nickel-cadmium rechargeable batteries and a battery charger are standard with the Model 970A. Battery life permits more than 2000 measurements using "Press to Read" switch or 2½ hours of continuous operation. The case is made of highly resistant plastic, measuring 15cm long by 4cm wide. The instrument weighs just 180 grams with batteries.

DC voltage from 0.1000V full scale (0.0001V resolution) is read to an accuracy of ± 0.7 per cent of reading + 0.2 per cent of range.

AC voltages from 0.003V to 500V are read to ± 2 per cent of reading + 0.5 per cent of range at frequencies below 1kHz. From 1kHz to 3.5kHz, the Model 970A measures 1V to 500V.

Ohms ranges are 1 kilohm full scale (0.001kohm resolution) to 10,000 kilohms. Maximum current will not exceed 10mA.

Input resistance on the voltage ranges is 10 megohms. Input capacitance on A.C. is less than 30pF. Input voltage protection is 1000V peak.

Autoranging is quick. On the D.C. and ohms settings it takes less than two seconds to settle to a proper reading.

Three probe tips are included with the Model 970A: Short, long and concave. The tips detent to three angular positions and fold for storage. A standard banana jack can be inserted instead of the tip, facilitating constant monitoring via two clip leads.

An optional bench cradle converts the DMM to bench use and adds A.C. and D.C. current measuring capacility - from 100 microamperes to 1 ampere full scale. Here, range selection is manual.

The price of the HP 970A in the UK is £138, exclusive of VAT.

FIREMAN'S PERSONAL RADIO PAGING SYSTEM

For the first time in Scotland, the noisy public-disturbing sirens traditionally used for calling out retained fireman from their homes or from where they work will be replaced by a personal radio paging system.

The vital significance of this innovation is that proving trials carried out by the Scottish Central Area Fire Brigade showed that there was a 30 per cent increase in response from retained firemen, compared with the number reacting to sirens, and that there was a significant saving of time in their arrival at the scene of the fire. The Multitone system reduced the callout time by as much as 2 minutes 11 seconds.

One of the principle disadvantages of sirens is that because of competing noise factors such as strong winds and traffic, they often go unheard. In addition, even house bells can be missed if a man happens to be at the bottom of his garden.

The paging system, developed by London-based Multitone Electric Co. Ltd. in co-operation with the Communications Branch of the Scottish Home and Health Department, is designed to selectively and simultaneously alert a group, or groups of retained fireman to assemble at their unattended fire station.

As a result of the success of pilot trials, carried out by the Scottish Central Area Fire Brigade, the Multitone paging system has become fully operational and is now being used to cover a station district - this includes a wholetime/retained station at Falkirk and three retained stations at Larbert, Denny and Slamannan involving a total area of 110 square miles.

Fifty-six retained fireman are each equipped with a small 5 oz radio receiver which fits easily into a jacket pocket. When a fireman is required, his receiver sounds a 'bleep' alert tone, warning him to proceed immediately to the station. As the paging system covers a wide area, retained fireman can be 'bleeped' if they are several miles from the fire station.

The receivers possess a one-way speech facility so that the officers are able to receive on-the-spot instructions from control.

continued on page 80

STEREO 21

electronics TODAY INTERNATIONAL
product test

How good can a kit for a stereo system be which costs less than £18? We asked an inexperienced constructor to build it up – no problems. Then we asked an experienced technical reviewer to test it.....

MAKERS SPECIFICATION

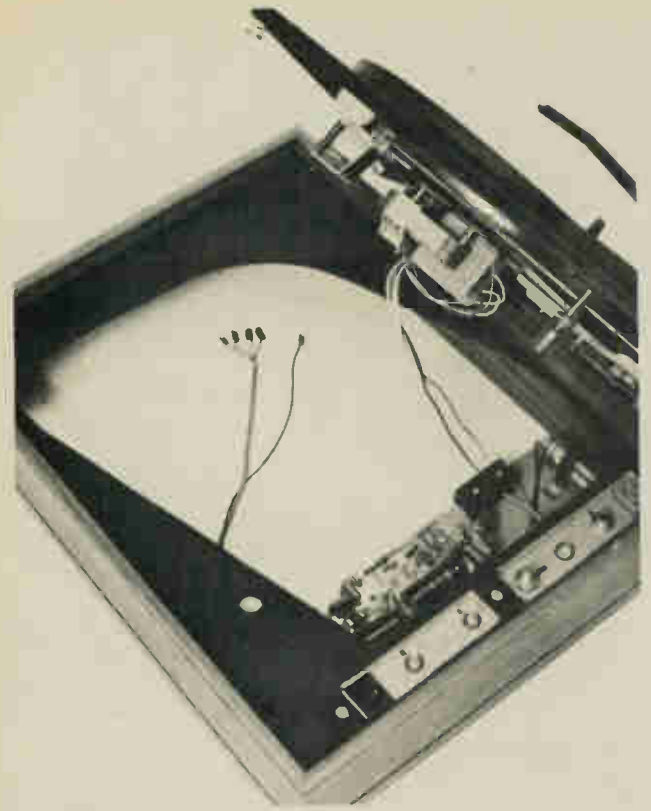
Power Output:	2.7W (tested at 2.5W 8 ohms)
Output (Speakers)	Suitable 8 or 15 ohms (lower output at 15 ohms)
Aux Input:	120mV
Tape Input:	600mV
Speaker Cabinets:	15½ x 8 x 4 inches
Speakers:	8 x 5 inch eliptical
Plinth with cover:	15⅝ x 12¼ x 6 inches
Record Playing Unit:	BSR autochanger deck C129R complete with cartridge.
Price UK:	£17.95 inc. VAT. Packing and postage £1.45

Manufacturers and suppliers:
Radio and TV Components (Acton) Ltd., 21, High Street, Acton, London W3 6NG.

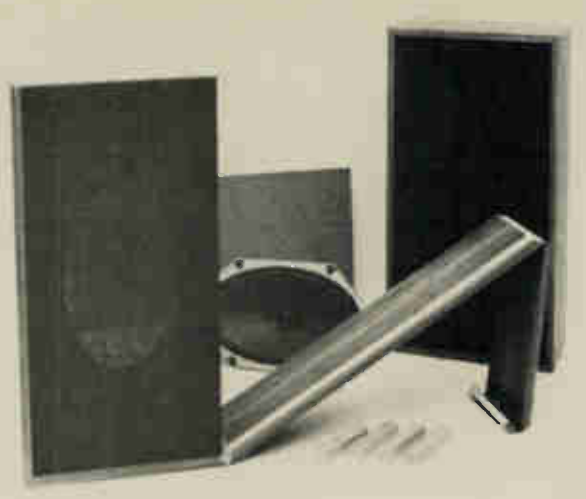
THIS IS a compact stereo record player system, supplied in kit form but one involving only very simple assembly work. For example, the amplifier is supplied ready built, wired and tested and the woodwork for the record plinth and loudspeakers is precut, drilled and finished. Soldering has been eliminated and the few connections that have to be made are done with push-on tags. The makers claim that any young teenager could build the system in an evening by following the step by step instructions.

The system is not intended for serious Hi-Fi listening, rather as one suitable for youngsters and their 'pop' records, at a not too high sound level, or for quiet listening with reasonably good sound quality. The maximum power output is in fact about 2.5W per channel. The record player deck is a B.S.R. C129R which operates at 33 1/3, 45 and 78 r.p.m. and is an auto-changer that will accommodate 7, 10 or 12 inch records. This is supplied with a pick-up cartridge.

The amplifier employs an integrated circuit and each channel has its own volume control to facilitate stero balance. There is an output (jack) socket for stero headphones, a tone

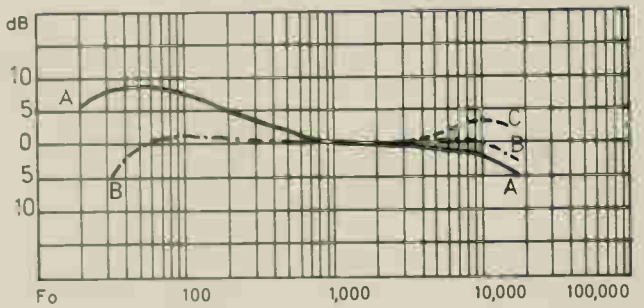


Assembly of the amplifier within the plinth. Wires shown are the only internal connections required.



Parts and assembly of the loudspeakers. All the wooden parts are precut, slotted and finished.

FREQUENCY RESPONSE



A-A: Overall response from tape or auxillary input.
B-B: Response (via pickup) from frequency test record.
C-C: Amount of treble lift (A) at 10kHz.

control for treble lift or cut, an output for connecting to a tape recorder, for taping discs and also an input for a radio tuner, tape recorder or cassette player etc.

CONSTRUCTION

Fully illustrated instructions are supplied covering stage by stage assembly, connections and operation plus a fault finding table should the constructor go astray somewhere. Photographs clearly show all the wood parts for the plinth and loudspeakers with each part numbered. Few tools are required other than a screwdriver and a hand drill with a few bits up to ¼inch diameter. Glue is also required and any wood-to-wood type will do. No difficulty was experienced in assembling the woodwork because all the various pieces are accurately cut and drilled. Once this work is completed and the glue is dry it is only a matter of fitting the amplifier into the plinth and the two eliptical loudspeakers into their respective boxes. Wiring is no problem because of the push on connecting tags but do double check on this before switching on for initial tests.

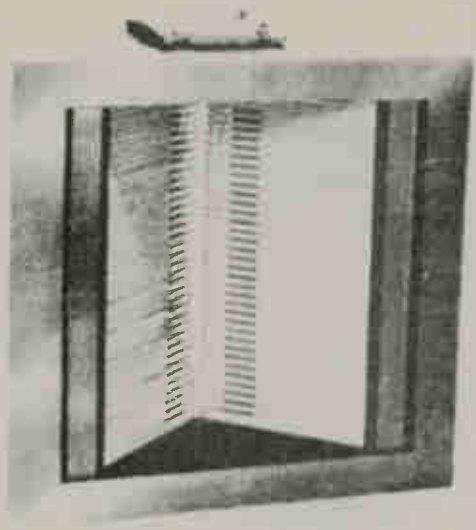
PERFORMANCE

The power output was measured across an 8 ohm load and was 2.5W r.m.s. With a 4 or 15 ohm load the power barely reaches 2W before clipping occurs so if alternative loudspeakers are contemplated at any time they should be 8 ohm types. The distortion factor at 1000Hz and with 2.5W output was well under 1% a figure that would be unacceptable for high fidelity but is low enough for good quality reproduction. The hum and noise level was in the region of −30dB, also an acceptable performance figure for such a simple low cost system.

The auxilliary and tape inputs were as specified but the frequency response via these does, as the graph shows, rise rather considerably at the low frequency end. This was not however, the case from the pickup input and a test record showed a fairly uniform response. The tone control affects treble response only and, if set midway, provides the response shown in the graph.

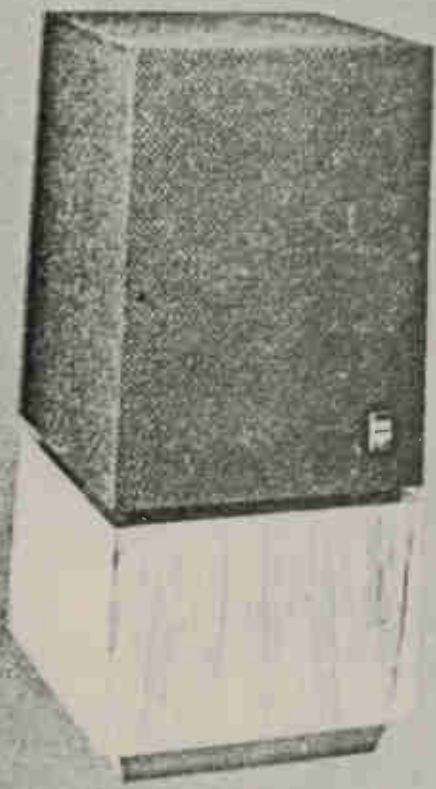
Increasing the control to maximum then lifts the treble by about 5dB at 10,000Hz. The rising bass response from the auxilliary and tape inputs could of course be advantageous since the loudspeakers are fairly small and themselves have little useful response below about 100Hz. It is possible that the makers intended this performance i.e., to provide a constant bass boost to offset the lack of response from the speakers. From a listening point of view the system produces a very pleasant sound *providing* the volume is not turned too high. The treble response is good but, because of the small size of the speakers, bass response is limited as one would expect despite the lift ataround 100Hz from the amplifier. Better loudspeakers might well be a worthwhile proposition if only to enhance the bass. An alternative would be to build larger speaker boxes with an 8 or 10 inch bass-midrange speaker and use the eliptical, in the same box, as a tweeter fed via 2 or 4μFd capacitor as a simple frequency divider.

The Stereo 2I kit retails at £17.95 including VAT and packing and postage is £1.50. For a total outlay of £19.45 the kit is good value for money, well turned out and for a few hours work builds into a very acceptable little stereo system but one I must repeat that cannot be regarded as, or is intended to be capable of true Hi-Fi performance. ●



Heil Air Motion Transformer handles mid range and treble in conjunction with conventional woofer — the manufacturers, ESS, are believed to be actively developing a bass version of the Heil unit.

Ohm A unit covers full frequency range using single conical driver.



LOUDSPEAKERS

-an explosion of new designs

by Irving M. Fried

Some of the most revolutionary innovations in years are coming onto the market in various parts of the world. Not all these speakers are available in the U.K. but no doubt those which prove themselves will appear sooner or later.

THIS year, as every other year, will find old and respected manufacturers and brand new companies alike presenting their "new" "improved" or "breakthrough" loudspeakers to the general public. Once again, you will be asked to accept each system as "the speaker of the future," one that "makes all others obsolete." Just as surely many new models will, like so many previous "break-throughs," sink quietly into oblivion. The number of enduring advances in the art of loudspeakers is very small.

But from time to time, manufacturers do manage a significant advance in basic design principles, largely by using new materials and technologies. And 1973 is such a time. I believe that some of the new loudspeakers described below will endure and find their market niches – but possibly not in the positions their proponents envisage.

Every twenty years or so a wave of fruitful innovation overtakes the loudspeaker industry. The last such broad advance was back in the middle 1950's when the first air-suspension systems and the first successful electrostatic, ribbon, and ionic drivers appeared.

I'd like to begin this survey of some of the more interesting new loudspeakers with those systems whose basic driver principles are the main subject of interest. I'll try, whenever possible and for the sake of the record, to mention past products that bear a resemblance. Manufacturers' claims for their products always are difficult to assess until the products themselves can be evaluated fully, and a certain extravagance is to be expected in someone who has worked hard on what he considers to be a successful design. The many quotes, some of which come from product literature, rather than directly from engineers and company executives, are to be understood in this light.

The most radically different new loudspeaker is the Ohm A. Invented and patented by the late Lincoln Walsh, famous in high fidelity history for his Brook all-triode amplifier, it has no direct antecedents in the art (though some claim the Hegeman tweeters of the fifties worked on the same principles). The Ohm A driver looks like an inverted funnel, the large end of which is fastened to an infinite baffle box. The funnel, or cone, is made of copper and titanium, forming a composite cone of rather large size and heavy mass. The theory of operation is, for the bass below 200 Hz, that of mass loading; and, for the midrange and treble, high-velocity wave-train propagation down the cone, with radial propagation of all frequencies of musical interest.

The Ohm A has been publicly demonstrated and is in limited production. It is very inefficient, but when driven by amplifiers of sufficient power seems to give a good account of itself – according to many auditioners. Traditionally the British metal-cone speaker designs of the past (G.E.C., Jordan-Watts, and Jordan) have been lauded for their clarity, while drawing some complaints of a metallic edge to high-frequency sounds. None has been precisely of the Ohm A shape, of course, and it will be interesting to see what the final evaluations of the Ohm A will be.

Very similar in design and built under the same basic Walsh patents – but intended only for treble propagation – is the Infinity Wave Transmission Line tweeter, which is used in the new Infinity Holosonic Monitor. Replacing the electrostatic drivers that have characterized the company's deluxe offerings, the tweeter also resembles a funnel, but with the large diameter upward. This cone is made of plastic with a thin aluminum skin – a laminate that, it is stated, will support a sound transmission speed of 11 000 feet per second (about ten times that of sound in air). A voice coil at the cone apex "plucks" it, causing it to emit waves orthogonally: i.e., in circles, spreading outward from the cone surface. The design objective is the simulation of that Grail of speaker theory, the perfect pulsating sphere.

As incorporated into the Monitor of Infinity, the tweeter is intended to handle up to 200 watts of programme input and is said to display a flat impedance characteristic to 100 kHz. The designer says it can be driven at living-room level with a 25-watt amplifier – transistorized or valved.

ESS (formerly Electrostatic Sound Systems), also known heretofore for expensive "hybrid" (electrostatic and dynamic) designs, now presents the Heil Air Motion Transformer as "the loudspeaker of the future". Invented by Oskar Heil, the unit is a midrange and treble driver whose corrugated plastic diaphragm (with imprinted voice coil, called a "conduction cortex") folds on itself, reducing and expanding the volume of the "multiple interfacing cavities" presented by the magnet's vaned pole pieces and projecting sound outward with an "almost perfect transfer of kinetic energy." Dr. Heil further claims near-instantaneous acceleration of the diaphragm, very low distortion, and omnidirectional dispersion in the horizontal plane since sound is "squeezed" out from both front and back of the driver.

First demonstrations of the Heil unit have led to marked disagreements among those present, which always seems to happen with dramatically unconventional loudspeakers. Part of the problem, it appears, is that the first design to be offered publicly has a new enclosure shape, a truncated pyramid, in which response below 500 Hz is handled by a decidedly conventional ducted woofer. More advanced bass systems are projected for future use with the Heil.

Needless to say, the Heil unit will be endlessly discussed and described. Among other things it claims to be "the first new principle of sound propagation in fifty years." Various aspects of the design suggest past

products such as the Kelly Ribbons of the fifties, the compression-throat tweeters of the twenties, the perennial acoustic lens, and so on – all of which principles seem to be amalgamated in the Heil.

Another company claiming to make obsolete all electrostatics is Audio Research, famous for its all-tubed amplifiers. The Magneplanar loudspeaker is offered as a replacement for free-standing, full-range electrostatic loudspeakers, intended to solve their inherent problems (particularly the need for a power supply) and to improve their quality and performance.

The Magneplanar stands six feet tall, four feet wide, and *one inch* thick! Each speaker is hinged twice like a folding screen, forming three panels that are set up in zigzag fashion: two with woofers, the other with the tweeter. Each woofer or tweeter diaphragm is made of thin Mylar (as in electrostatics), to which are glued closely spaced vertical wires. The diaphragm is stretched over a frame; bar magnets are attached to the same frame and inter-leaved with the wires, which make up the voice coil. A crossover operates at 3 200 Hz, though there is provision for using two amplifiers if desired.

The Magneplanar bears a strong family resemblance to the short-lived Ge-Go Orthophase from France a few years back, though in modern dress. It sounds like no other loudspeaker, and is thus (again, as with the Heil) the center of brisk debate. One valid criticism is acknowledged by the manufacturer: its lack of extreme bass. A new add-on flat-panel subwoofer now is available.

Another flat loudspeaker is the Fisher Sound Panel. While not claimed to be state-of-the-art, the unit is offered as an alternative to bookshelf loud-speakers. A single flat slab of acoustic polymer has two voice coils fastened to it. Because of the panel's physical design and the placement of the two coils, one acts as a woofer and the other as a tweeter. Sound is produced equally from front and rear.

More mundanely, several manufacturers claim to have developed improved woofers, with better "attack", power handling, and distortion characteristics. Infinity's new woofer (in its Monitor, already discussed) uses what is described as a patented magnetic system that permits it to handle 200 watts of continuous power without damage – including the demagnetization that conventional woofers can suffer with superpower amplifiers.

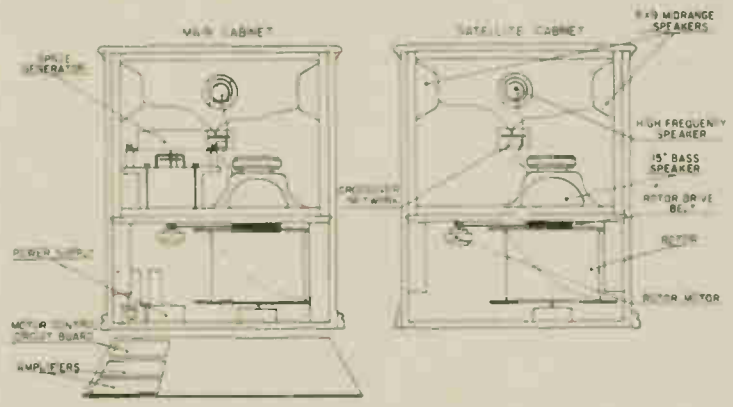
Also mentioned are ported-dustcap woofers (Onkyo), copper caps over magnetic poles (Sony, Pioneer), huge magnetic systems (SAE), and laminated magnets (LDL). None of these, properly speaking, is a new idea, though some appear to have been patentably innovative in their present forms. Two points are interesting here, however. First, the emphasis on unconventional refinements in magnetic structures surely represents a step forward from the insistence on sheer magnet mass that characterized loudspeaker advertising only a few years ago. Second, manufacturers are now agreeing that woofers as well as tweeters need improving. To recoin a phrase: A woofer and a tweeter do not a speaker make – meaning that as one art advances so must the other, and that the advances must be co-ordinated.

Other new loudspeakers, rather than presenting new drive principles as such, seem primarily to be concerned with the way in which the energy at the driver is presented to the air in the room – and hence to the ears of the listener. Some of the systems we have discussed – the Ohm A and the Heil Air Motion Transformer for example – adopt unusual means to this end, of course; and there are others.

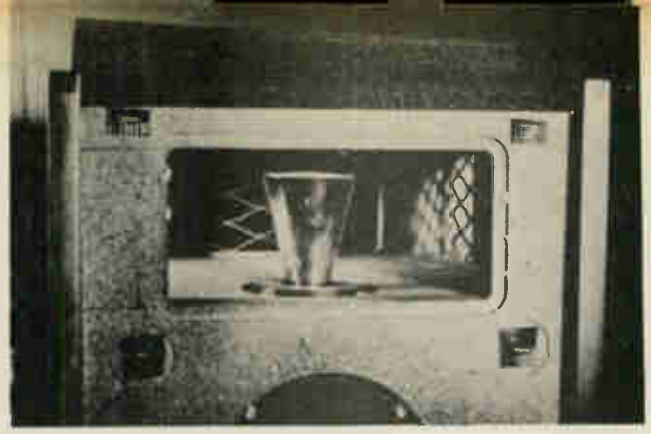
Leslie, heretofore known for its electric-organ speakers, has a new design for home use, including its own built-in amplifier. A baffle in the woofer system of these speakers slowly rotates, "sweeping" the room. Built into the electronics is a phase-shifting system: as a unit the baffle and phase shifter is intended to subdue standing waves in the listening room. The phase shifter, which can be turned off, also is intended to produce quasi-quadraphonic spatial effects when a pair of Leslies are used in the back of the room, supplementing a conventional pair of the front.

Several new companies have combinations of small drivers, generally in omni or reflecting arrays – each product with its own special claims and virtues, though some readers doubtless will see the interest in this type of design as a reflection of the phenomenal success the Bose 901 system has enjoyed. Design Acoustics uses small drivers on multiple intersecting planes, operating above a conventional woofer which faces vertically. Epicure Products has its various "tower" loudspeakers. APL (Applied Physics Laboratories) uses sixteen full-range drivers, each one "individually equalized" for optimum performance. The Array 12 employs eleven 4½-inch drivers, each with its own "special network" – to smooth the midrange, claimed by Array to be rough in all comparable multidriver systems. The eleven drivers are in a ducted enclosure; a high crossover feeds a single tweeter described as a polycarbonate dome. LDL, whose novel magnet system was mentioned earlier says its multiple-driver array may be used without an equalizer.

In complete contrast to all the above is a fascinating new approach demonstrated last September at the New York High Fidelity Music Show. It is the product of a new group headed by Saul Marantz (founder of Marantz, which now is owned by Superscope). The unit is called the Jon Dahlquist loudspeaker after its designer, and it should be available this year. The Jon Dahlquist Phase Array speaker is planar. (The first samples looked like the Quad electrostatic). It is not, however, a dipole (or doublet), radiating front and rear; Dahliquist strongly rejects such concepts. Rather he states that the flat shape is a device to avoid the diffraction distortions common to conventional enclosure loudspeakers. Mounted on the flat baffle are five dynamic speakers, each chosen for a special range of frequencies. These are joined by a complex crossover network, which equalizes their on-axis response with special compensation for on-axis time-delay distortions. The purpose of all this is to keep all phase



Woofer system of the Leslie Plus 2 enclosure. The driver faces downwards into a revolving baffle that 'sweeps' the room. System is similar to that used in electronic organs.



The Infinity tweeter is related to the Ohm A's operating principles though cone orientation is reversed. It is combined with transmission – line bass driver.

relationships coherent – that is, in step with each other at all frequencies – just as they would be in radiating from a live source.

Dahlquist believes that a good loudspeaker should only operate on the frontal hemisphere, and never backward; that good dispersion forward is a virtue; but that it is better to have poor dispersion than to let any signals be reflected. Indeed, the design concept of the loudspeaker is to keep from "wasting energy" in either directions and to keep from confusing the stereo image. Mr. Dahlquist, it might be noted, speaks from a vast background of research and development on other kinds of loudspeakers – and sounds like a spokesman for the English (BBC) school of speaker research, or the corresponding French (ORTF) school. His ideas and his patented speaker represent a divergence from the prevailing US school of wide, or even omnidirectional, dispersion. The design is a refreshing restudying of the principles of sound propagation and of the relationship of the speaker to the room and to the listener. I suspect that the Dahlquist will have a lasting effect on speaker design.

Despite some evidence of a trend away from electrostatics, two speakers have come out with that ever-glamorous drive in new formats, each claiming to correct all the problems of its predecessors.

The Crown International Auralinear is a hybrid. It has paralleled electrostatic cells used for the full range above 350 Hz, with dynamic woofers in acoustic-suspension enclosures used below that frequency. The cells stand free in the room, radiating from both front and back. Electronic protection circuits are built into the crossovers. Crown claims that the Auralinear represents enormous advances over the "timorous, touchy, and crackling old electrostatics." All the virtues are there, with a new ruggedness and ability to reproduce at very high levels.

The Dayton-Wright (named not for two men but one, Mike Dayton-Wright), from Canada, is a free-standing full-range electrostatic, claimed to cover the full range of sound with "electrostatic quality" in all frequency bands. Each speaker has eight electrostatic cells mounted in two ranks, one above the other, and with provision for coupling the cells in various ways, depending on the configuration that best suits the room's acoustics. Normally, each cell is used full range. The driver assembly is encased in a plastic bag filled with a nonconductive gas. Designer Dayton-Wright claims to have solved problems "inherent in other electrostatics" – lack of efficiency, nonlinearity, inability to handle extreme dynamic range – by eliminating insulating sheathing in the drivers in favour of the nonconductive gas so that the speaker can take high signal voltages and produce long excursions without arcing and thus be low in distortion and high in output. He also says his design eliminates the phase distortion of crossovers and keeps wave fronts from the various elements coherent.

While Crown and Dayton-Wright have developed interesting (and expensive) new designs, some manufacturers are trying to get better performance from less floor space – an important practical consideration, particularly in quadraphonics. Noteworthy are the JBL sound columns and the EPI Microtower, two adaptations of the tuned columns that date back to high fidelity's earliest days. The results are excellent in terms of cost and space and show how much one can improve on old designs with modern materials and know-how.

The search for more realistic bass reproduction in speakers take several forms; most manufacturers are offering "new approaches" of varying complexity and cost. Perhaps most newsworthy are the various transmission-line loudspeakers turning up in the deluxe sector of the market.

The transmission-line concept is not new; old hands will remember the acoustical labyrinths of the late thirties and early fifties. A decade or so ago the British revived the idea of enclosing a driver in a long tube leading from the back of the driver. According to its proponents, the principle can be used wherever the criterion is more *natural* bass propagation, or wherever it is more *accurate* midrange or bass propagation. Thus some manufacturers have adopted transmission lines for both bass and midrange, justifying the complexity and expense by the more accurate reproduction made possible by high-quality drive systems. Properly executed, the technique provides a dead acoustic environment for the driver, killing reflections back to it from the enclosure and sound feed through enclosure walls. In addition, bass lines can be tuned like organ pipes, lowering the free-air resonance of a driver (to get deeper fundamentals in the bass) and smoothing the impedance characteristics of the loudspeaker (thus making more efficient the transfer of power from the amplifier).

All of these virtues contribute to the transient performance claimed by transmission-line advocates. There are some vices, however, lowered overall efficiency and susceptibility to subsonic disturbances being the most important. But the designers have been busy, and a number of successful transmission-line systems are available from Infinity Systems, ESS, Radford Music and Sound, and IMF. The configurations vary of course from model to model.

A related idea, again from England, is the active-line loudspeaker. The transmission lines we have been discussing are passive – i.e., driven from one end only. In the new IMF ALS-40 loudspeaker the bass line is driven conventionally at the top end, and driven at its "port" end by a subsonic-resonance woofer through a complex phase-shifting network. The design team at IMF makes the following claims for the active-line principle: that it reduces cabinet size for equivalent performance; that it increases efficiency and power-handling capacity (i.e., acoustic power into the room); and that it eliminates subsonic problems.

Certainly no one has repealed the laws of physics, though speaker designers are wont to accuse each other of claiming to do so. All that can be said about the current state of the loudspeaker art is that some manufacturers are succeeding in making sonic advances, by a better understanding and application of the laws of physics, acoustics, and psychoacoustics. In short the art is not standing pat even though the laws within which it operates are. We are seeing more and more fresh design ideas; and some of them are, I think, better solutions to the eternal quest for the ideal loudspeaker. At the worst, there is a rebirth of excitement in loudspeaker design, and the purchaser this year is given some real choices. But the verdicts on today's new designs is of course that of the market place. ●

The loudspeaker

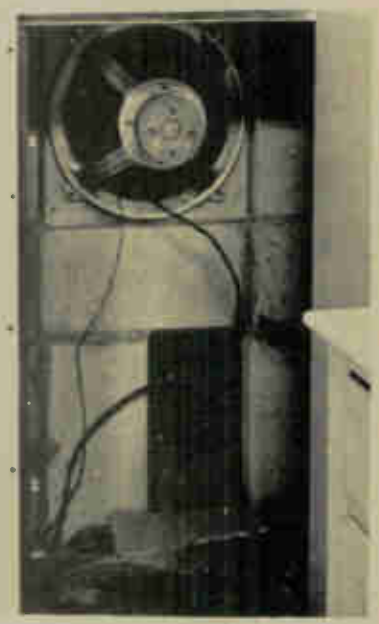


Fig. 2. A 38cm (15") bass driver is mounted in a concrete enclosure at the throat of the horn (see Fig. 1.), This driver is driven by a signal common to both stereo channels.

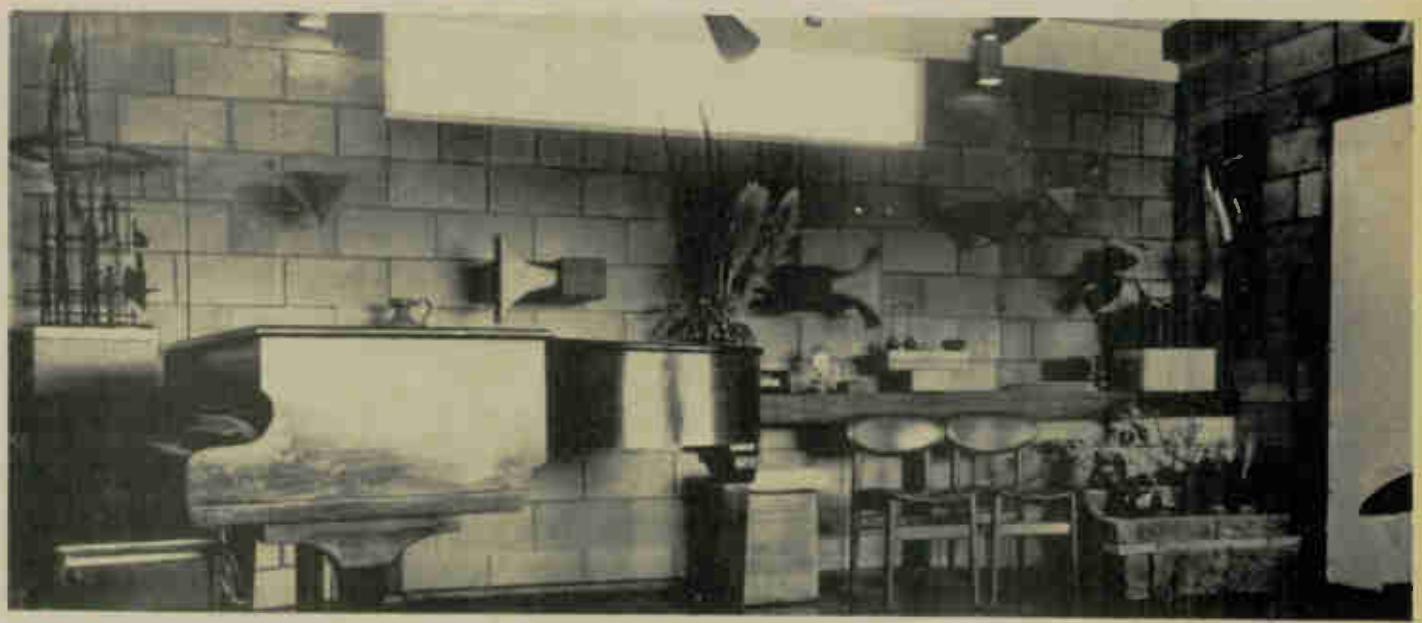


Fig. 3. The speaker system for the stereo channels is unobtrusively mounted. Concrete pressure horns will be hidden in a cupboard.

'There was an old women who lived in a shoe...' Well we can't prove that one but our Australian edition have come across a man who lives in a loudspeaker!

AUDIO fans are forever saying "If only I had a better bass response – perhaps if I used a . . .". Most go no further than the day-dream stage as the cost and sheer magnitude of obtaining really good bass response is usually beyond them.

There are some, however, who determine that the day-dream shall become a reality, regardless of the work, cost and self sacrifice involved. Such a man is Peter Schmedding of Canberra.

Peter has had a life-long love of organ music and, having for one reason or another missed the opportunity to learn the organ himself, decided to build an audio system capable of reproducing recordings of the "King of Instruments" with sound as faithful to the original bass as possible.

It soon became obvious that the main limitation to reproduction at 20

house

IT'S NO JOKE – THERE REALLY IS A MAN WHO LIVES IN A LOUDSPEAKER

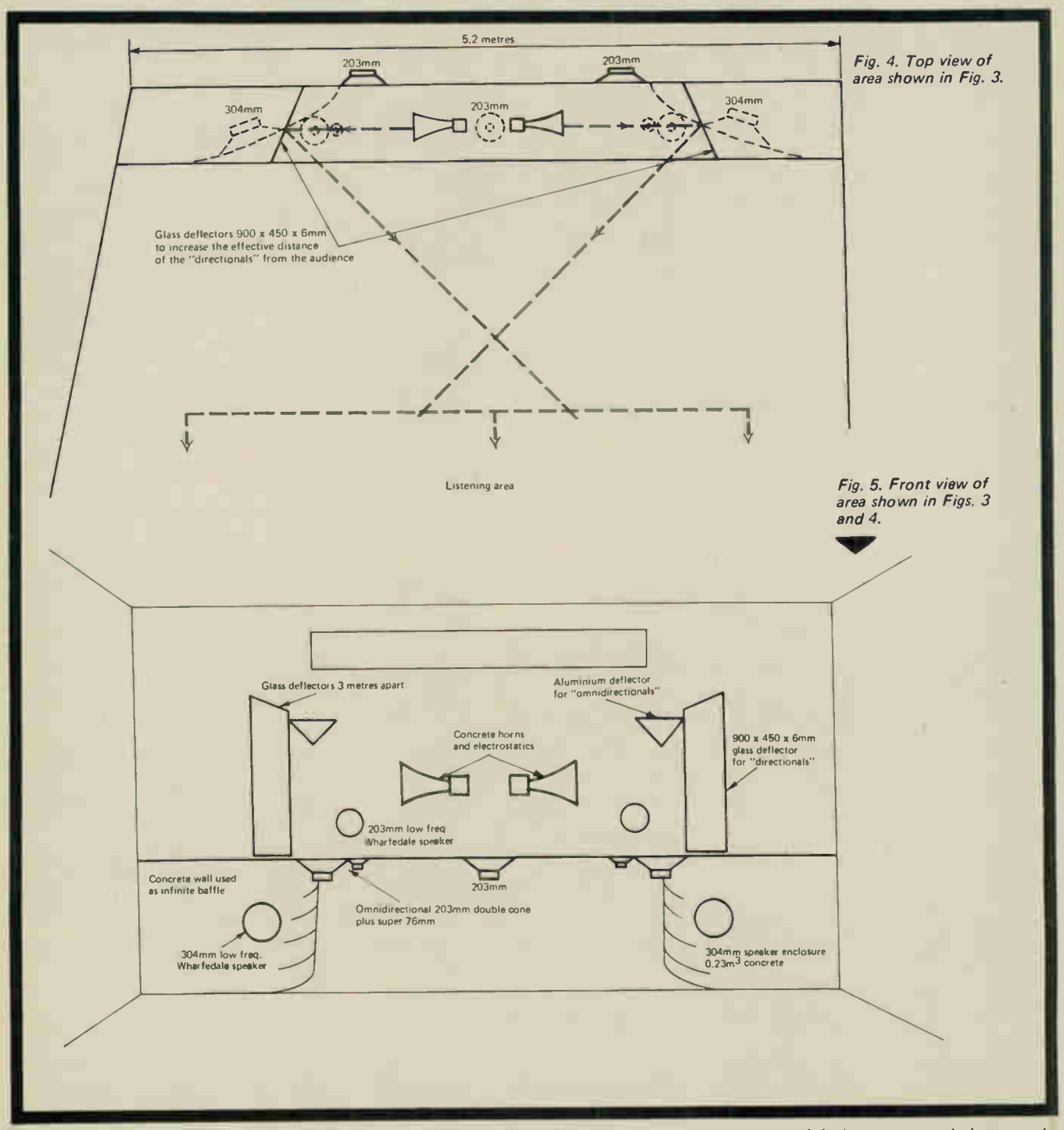


Fig. 4. Top view of area shown in Fig. 3.

Fig. 5. Front view of area shown in Figs. 3 and 4.

to 30 Hz was the acoustic properties of the room itself and hence, undaunted, Peter decided to design a special music room as an extension to his house which could at least reproduce the octave 30 to 60 Hz.

He sought the aid of Brian Sudding of the Australian Broadcasting Commission (ABC) who designed the room and furniture to the, one would think, incompatible standards of building codes and acoustic requirements.

Apart from the roof, the entire extension including the reinforced concrete block walls, was built by Peter himself with the aid of his wife who mixed up the odd batch of mortar etc. – what a wife!

We heard about Peter and his music room from a friend at the ABC who said 'you really must go and see it. He's actually designed the room as an exponential horn – and it sounds good'. So, somewhat tongue in cheek, we decided to go and see and hear it – together with our acoustical consultant Louis Challis and a stack of test gear and records.

The layout of the room can be seen from Fig. 1. It is of concrete block construction with the new front wall extending from the original house at an angle of 40°. The design of the

room started with this basic angle and was calculated in wavelengths rather than feet and inches to fabricate an LF horn to cover one octave only, 30 to 60 Hz. The driver for this horn is a 38 cm (15") woofer in a concrete enclosure at the throat of the horn. This is carefully installed so as to be invisible until a louvred door is opened, at the end of what is otherwise used as a sewing room. The ceiling of the room slopes from 3.15 metres at the centre to 2.65 metres at the sides.

The sounds from this low frequency unit propagate out with diminishing intensity towards the main music room and surprisingly, through a louvred-panel room divider which introduces some reflections and some minor degree of transmission loss in the sound path. The drive for the horn is the summed left and right signals in the 30 to 60 Hz octave. The other speakers for the two stereo channels are mounted on one 'side' of the horn and propagate their sound by direct radiation to the listeners.

From the description it may be assumed that Peter has built a room and a system, with money as a secondary consideration – but such an assumption is far from the truth.

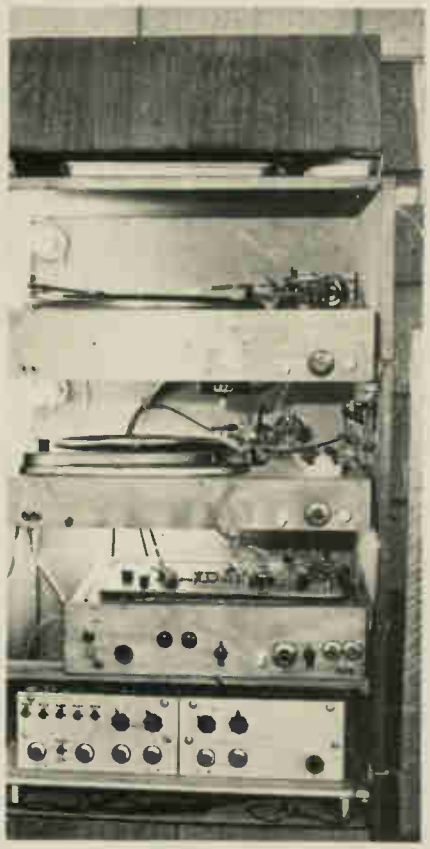


Fig. 8. The equipment rack contains two turntables (one with a homemade arm), a tape recorder and the four Sinclair 25 watt amplifiers.

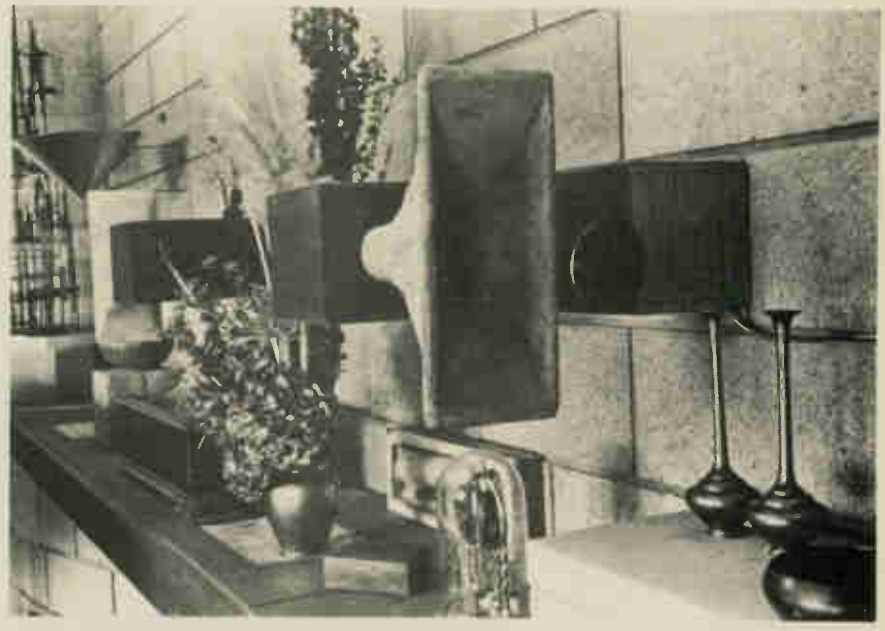


Fig. 6. The concrete pressure horns and Magnavox electrostatics will eventually be hidden in a cupboard in accordance with Peter's view that speakers should be heard and not seen.

The power amplifiers, for example, are Sinclairs – two Z30's and two Z50's. Preamplifiers are home constructed using locally available components.

Loudspeakers are mainly Wharfedales, but with carefully modified crossover networks to provide an almost flat frequency response in the middle of the listening area.

Whilst most speaker manufacturers favour direct radiators at high frequencies, Mr. Schmedding has chosen to use plate glass reflectors which are intended to provide – but do not do so totally successfully – added diffusion. In fact, off axis, the high frequency performance above 12 kHz suffers a significant loss of level due to the directivity of the source and the reflectors. A slight curvature in the glass would probably cure this minor problem.

Fig. 7. The 3 inch and omnidirectional speakers are mounted face up in the bench top. A copper cone reflector (visible in Fig. 3 and 6) disperses the sound horizontally.

MEASURING ROOM CHARACTERISTICS

Our signal source was a beat frequency oscillator, Bruel & Kjaer type 4014 to which was coupled a high speed level recorder. (Bruel & Kjaer type 2305B). A signal from this source was fed directly into the auxiliary input of the main amplifier system.

The acoustical signal was detected by a 1.25 cm diameter. Bruel & Kjaer pressure microphone fitted to a remote preamplifier of a Bruel & Kjaer sound level meter. This functioned as a signal amplifier for the level recorder.

The first signals were recorded with the microphone in the middle of the room. The results were excellent. Firstly, the overall response was better than ± 10 decibels from 20 Hz to 20 kHz, and although the response was not flat, the notches in the response were not excessive.

For comparison we repeated this measurement with the beat frequency oscillator's output modulated by an 8 Hz signal with a 20 Hz deviation. This clearly showed up the overall

shape of the room's response which is unusually flat to 17 kHz.

By opening the windows it was found that the audible low frequency response was boosted by as much as 10 dB between 25 Hz and 100 Hz, and simultaneously the response between 200 and 600 Hz was depressed.

Having established the room characteristics we then used a swept tone frequency response test record to measure the real performance of the built-in record playing system. This test record, which requires external equalization, provides a correctly equalized performance between 20 Hz and 1 kHz.

Fig. 9. The listening area with the equipment rack on the right. (Extraordinary looking device held by Louis Challis is a sound level meter)

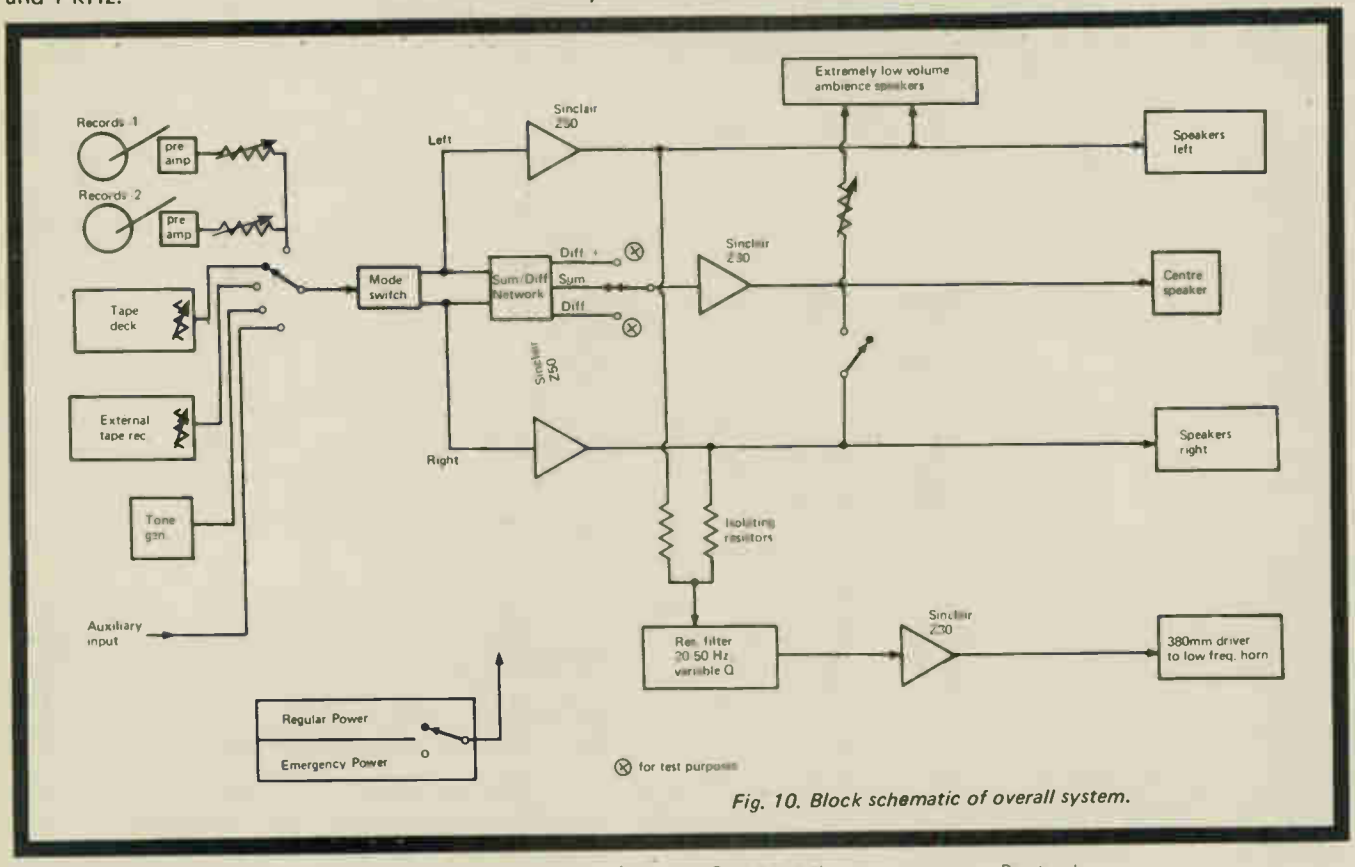


Fig. 10. Block schematic of overall system.

This measurement showed that the record player preamplifier provides exemplary performance above 30 Hz but degrades the basic room and speaker performance between 20 Hz and 30 Hz.

Peter Schmedding's system has two minor limitations. Firstly, recordings of classical music with any real content below 40 Hz are few and far between — although, surprisingly this is less true of contemporary music. Secondly, the main cartridge fitted to Mr. Schmedding's tone arm is a low cost unit which does not provide the trackability that his system so justly deserves.

But overall, Peter has achieved his aim. The bass response is clean and very dramatic. On records that do have content down round 30 Hz, those reinforced concrete block walls could be felt to shake!

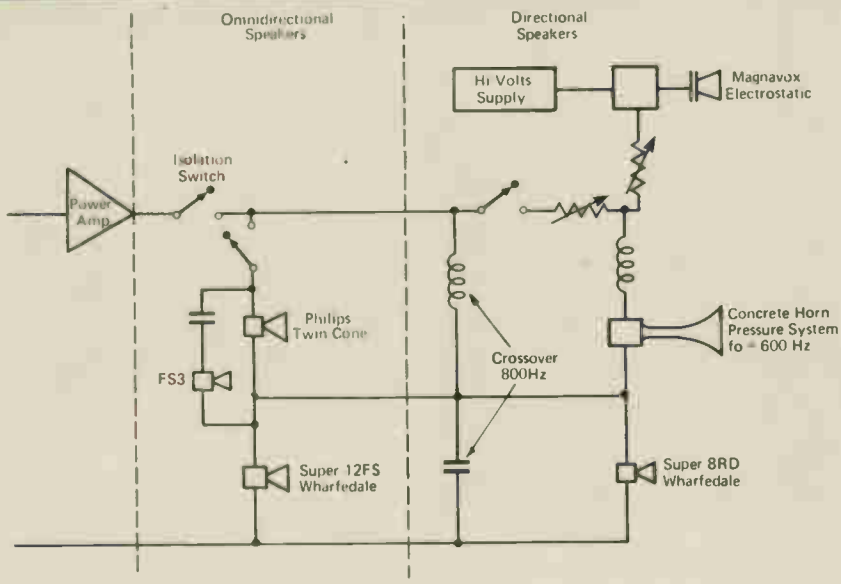
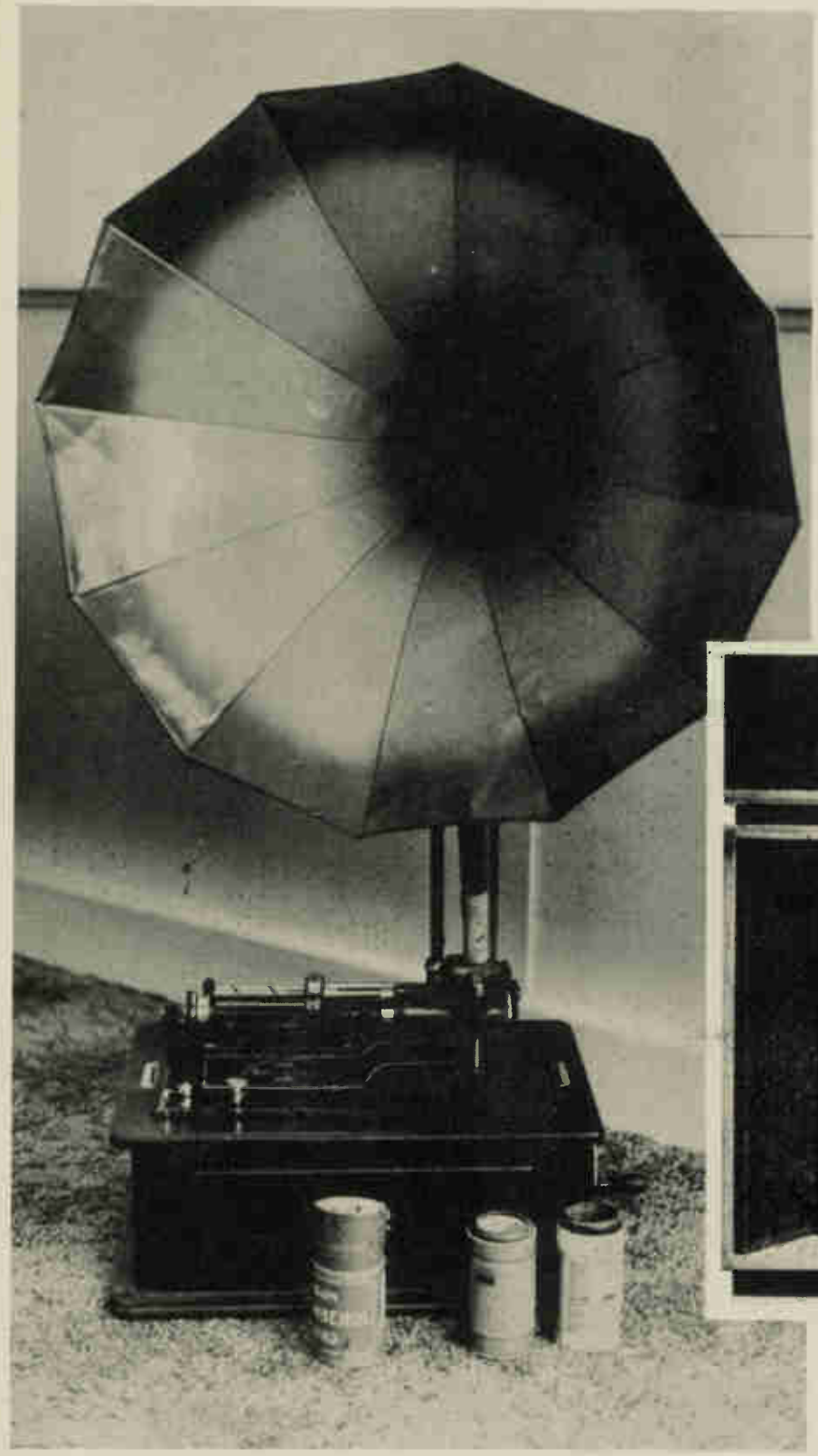


Fig. 11. Speaker system for one channel of stereo system.

Horn loaded loudspeakers

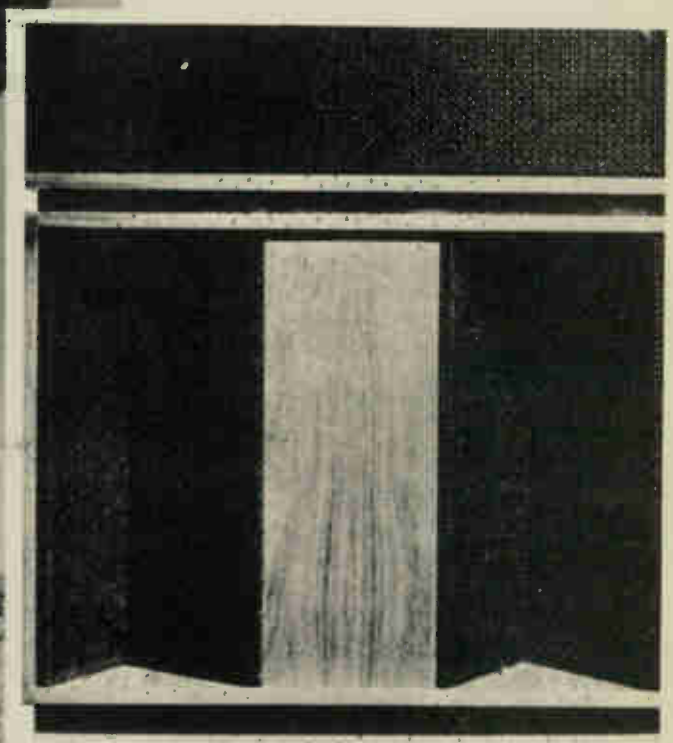
– Terry Mendoza reports



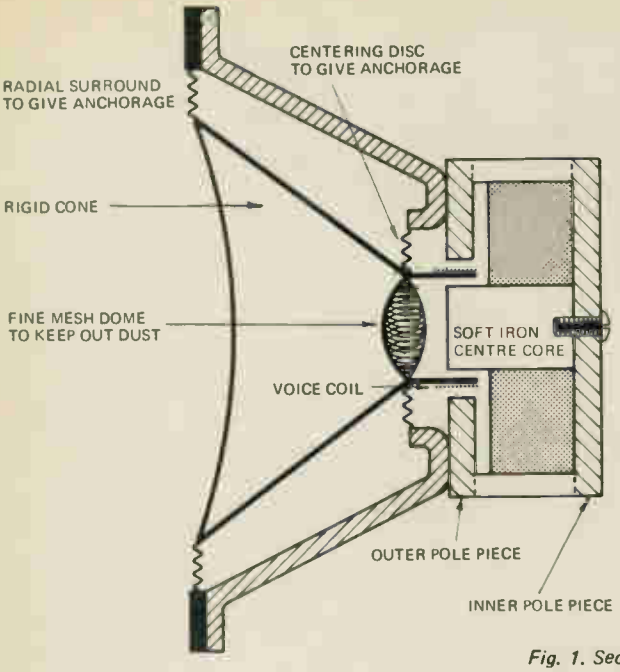
THE function of a loudspeaker is to *transduce* electrical energy from an amplifier into corresponding mechanical movements. Under the influence of these movements the loudspeaker cone impresses similar pressure fluctuations on the body of air adjacent to itself, and it is these pressure variations reacting with the tympanum of the outer ear that produce what we perceive as sound.

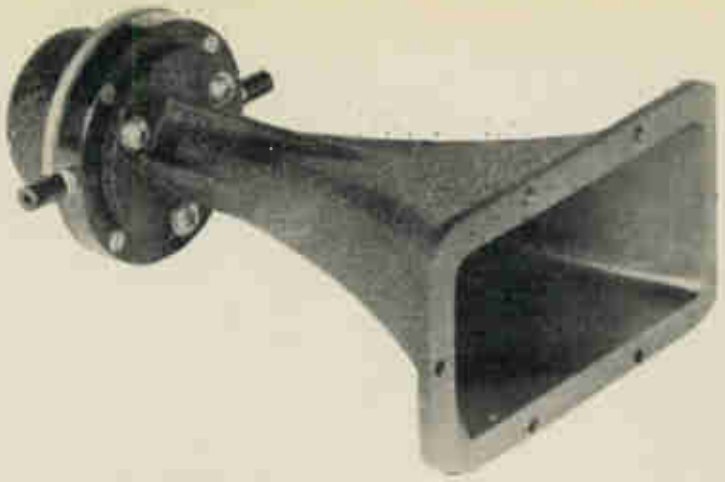
Generally loudspeakers are very inefficient, in fact most direct radiating types convert only about 1% of their electrical energy input into sound. This means that to produce the 0.5 acoustic watts that is generally considered to be the minimum requirement for hi-fi reproduction at least 50 watts of power must be supplied by the amplifier.

Numerous factors contribute to this low efficiency. Some energy is lost within the loudspeaker coil in the



Belle Klipsch is a domestic horn loaded speaker derived from Klipsch units made for theatre use.





Goodmans Midax 650 mid-range driver

Fig. 1. Section through typical moving coil loudspeaker.

Fig. 2

form of heat. More is lost overcoming the inherent stiffness of the coupling of the paper cone to its radial anchorage. The stiffness is a deliberate attempt to hold the cone such that it can only rigidly pump the air — faithfully following the electrical variations in the coil. (Fig. 1). Loose radial anchorage would permit cone oscillation after the sudden cessation of a signal.

The majority of the efficiency loss however is due to the poor coupling between the 'piston' of the loudspeaker cone and the body of the air that the cone has to push before it.

In Fig. 2 'A' and 'B' represent two frictionless perfect pistons within a cylinder. If the gap between 'A' and 'B' is filled with air and 'A' pushed in, 'B' will move out — though not exactly in phase with 'A' due to the compressible nature of gases. When 'A' is suddenly halted the inertia of 'B' will cause it to overshoot. The lower pressure thus caused will 'suck' it back and this cycle will then be repeated until B oscillates to a halt. A situation similar to this is found in two separate aspects of loudspeaker systems.

Firstly, when a signal is impressed across the speaker voice coil, the coil and cone (known collectively as the driver) will move in one direction; when the voltage polarity across the coil is reversed (half a cycle later) an ideal driver would start to move in the opposite direction. This it does, but only after first overcoming the inertia of cone and driver that only half a cycle earlier had been intent on impelling itself forward.

Secondly consider the loudspeaker cone which has been pushing a volume of air before it. As the cone begins to retrace its steps, the thin layer of air nearest to the cone, with less mass (and consequently less inertia) than the cone/voice coil combination, follows them back again instead of transmitting its energy to the next (hypothetical) thin layer adjacent to it.

Reverting to Fig 2, piston 'B' can only exactly complement the action of piston 'A' if the gap is filled with an incompressible fluid. Unfortunately, with actual loudspeakers the driver 'A' has a harder task than to pump incompressible liquid or compressible air down an enclosed 'energy link' to react on an eardrum — represented by piston 'B' — the driver has to pump into the open air. It is like trying to power a car with the cylinder head removed from the engine block!

But if the air could be made to behave like an incompressible liquid, a very efficient coupling between the driver and the air would result. A number of methods have been devised to approach this ideal; by far the most effective of these, with efficiencies of up to 50%, is the method known as 'horn loading.'

The acoustic properties of horns have been understood for thousands of years — the 'bell' of wind instruments relies on the horn principle for efficiency, directivity, and characteristic tone. The antiquated 'hearing trumpet' was another application utilising the horn for sound reinforcement.

As already discussed, the task of the horn is rigidly to link the movements of the driving diaphragm to the air in the vicinity. The more rigid the linkage, the better the transfer of energy will be, thus giving the desired increase in efficiency. When energy is transferred, work is performed. Work, as far as the driver is concerned, is the overcoming of the acoustic impedance presented to it. This impedance has two components — a resistive one due to the energy radiated (the productive part of the work), and a reactive one due to the energy stored. This is where there is fruitless cyclical interchange with the driving surface (which is in fact happening in the example quoted earlier when the thin air layer follows the cone on its return journey).

Essentially, the horn acts as an acoustic transformer; it works on the principle of trying to avoid a *rapid* expansion of wavefront area at any frequency.

This avoidance assumes especial importance in the region near the driver. To understand why this should be so, consider a theoretical point source of sound. It pulsates at a constant frequency and near the source the wavefronts rapidly grow in area. Further away the percentage increase in wavefront area is not nearly so marked. This can be seen by considering wavefront expansion near the sound source.

Let us assume that the radius of this expansion increases from 1 unit to 2 units. The surface area of a sphere is

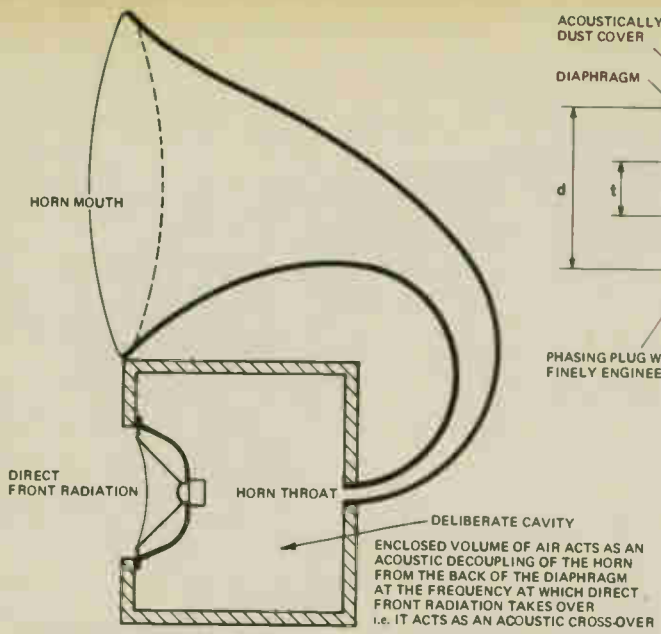


Fig. 3. Horn loading is used for the putput of the rear of this speaker to augment the direct radiation from the cone.

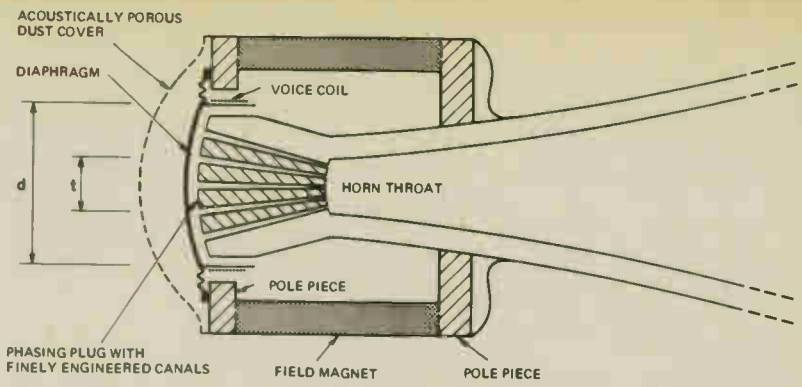


Fig. 4. Cross-sectional drawing of a typical horn-loaded high frequency driver. Note the difference between diameter 'd' and throat diameter 't' that is necessary for efficient loading.

Horn loaded loudspeakers

$4\pi r^2$ therefore the percentage increase in area is

$$\frac{4\pi\,(2^2 - 1^2) \times 100}{4\pi\,1^2}$$

This equals 300% increase. But considering adjacent wavefronts further away, where the radius is going from 10 units to 11 units the area increase is less rapid.

$$\frac{4\pi\,(11^2 - 10^2) \times 100}{4\pi\,10^2}$$

= 21% area increase

So it can be seen that the narrower end of the horn, nearest the source, is the most critical area for satisfactory acoustic loading.

The horn throat, as it is called, has an aperture lying between one third and one quarter of the active area of diaphragm driving it. Increased loading is possible with a smaller throat/diaphragm ratio, but this is never carried out in practice as it leads to distortion due to friction of the air as it enters the throat.

Horn loaded speakers nowadays are designed to cover an audio range of no more than three octaves, additional horn loaded assemblies being used as required.

However it is fairly common practice to use horn loading for the rear of a loudspeaker — to provide good bass response, the front of the cone being used to directly radiate the output above that handled by the horn. (Fig. 3).

When horns are to be used for high frequencies, a phasing plug is interposed between the diaphragm and throat to ensure the correct phase relationships by reducing any effective cavities. Even a small cavity can become a resonating chamber at high frequencies — this will give rise to a shrill harsh output from the horn. (Fig. 4). The extremely small clearances used for the phasing plug of a high frequency horn ensure that such cavity resonances as do occur will fall above the range handled by the horn.

HORN CONFIGURATIONS

After the throat comes the horn itself. There are five inter-related variables involved here — flare shape, flare rate, horn length and cross-sectional shape, and size of mouth.

The ideal would be a horn possessing a shape that would provide an acoustic resistance that remains constant and of high value for all frequencies within the audible spectrum.

The rate of flare expansion will be dependant upon the algebraic function chosen for the flare curve (Fig. 5) and on the length of horn between throat and mouth. The slower the flare rate, the deeper will be the lower frequency

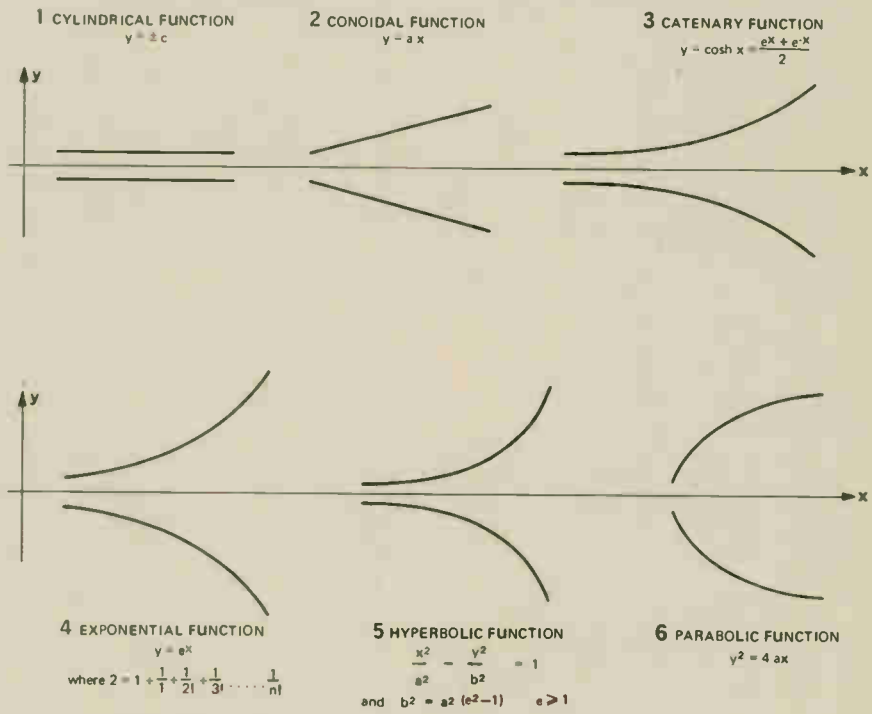


Fig. 5. Flare curves generated by various algebraic functions (see text). Note that 'a' and 'c' are constants.

cut-off e.g. for a particular flare curve, if the flare *length* is doubled (i.e. flare *rate* reduced by 50%) the cut-off at the lower end of the frequency spectrum will drop by one octave. (Fig. 6).

The flare curve may follow any algebraic function from phase (where x = o for all values of y) which is known as infinite baffle, to cylindrical — passing through parabolic and hyperbolic.

The hyperbolic group covers conical, exponential and catinary curves. The first type of horn to be used in conjunction with a sound reproducer was the conical variety. This became popular in the days of Berliner's phonograph.

However a conical horn, with zero flare, has an acoustic loading that changes almost continuously throughout the frequency spectrum. It has very poor frequency response because of its extremely low acoustic impedance at the bass end — as can be seen from Fig. 7. Nevertheless, a zero flare gives the lowest *distortion* of all the curves.

It should be noted that the theoretical results illustrated in Fig. 7 can never be fully achieved in practice because an actual horn system has a finite length and mouth size dictated by space considerations. Even disregarding the enormous horn sizes that would be involved, the cut-off frequency found in practice varies between 1.2 and 1.7 times the theoretical cut-off frequency.

A cone shaped horn has a constant slope giving zero flare. The parabola is one case in which the flare is negative i.e. the slope *decreases* with distance from the throat. It can be seen from Fig. 7 that the acoustic resistance afforded by a parabolic curve is even *less* consistent than for a conical one. Taking cases where the flare has a positive value we can see that the graph of acoustic impedance continues to improve up to the point where an exponential function is reached. The exponential or logarithmic horn gives the best overall compromise and this is the most commonly used curve for domestic and public entertainment speaker horn applications.

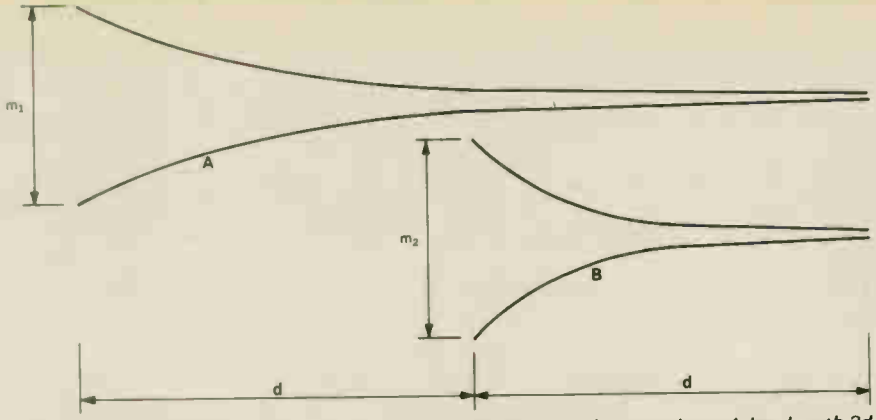


Fig. 6. $m_1 = m_2$ and flare curves for both horns are the same however horn A has length 2d and horn B has length d, ∴ horn A has a cut-off frequency one octave below that of horn B.

If the positive flare is increased still further, one comes to the shape known as the catinary curve (this is the curve taken up by a slack rope or chain hanging freely under the action of gravity). The catinary function has the property of providing a virtual cylinder at the throat with almost no wavefront expansion in this area. At regions remote from the throat it approaches the exponential shape.

Finally we come to the cylindrical form of horn. At first sight this comes nearest to our already stated 'ideal' with its uniform acoustic resistance throughout the spectrum. But a moment's consideration will reveal that at the remote 'mouth' end the wavefronts will still be in the same (plane) configuration as they were at the throat. There will be a 'virtual source' at the mouth end and no means to prevent the rapid spherical wavefront expansion — the very condition we are seeking to avoid.

The wider extremity of the horn terminates in the mouth. The greater the mouth area, the lower is the bass frequency that it can effectively handle. A mouth circumference of around forty feet and a diameter of thirteen feet is required to propogate a frequency of 100Hz.

How then could the reproduction afforded by such devices as the Edison Bell Phonograph be tolerated? The answer is to be found within the mechanism of the ear which produces difference tones corresponding to the successive pairs of partial tones of a musical note. Thus it can provide a bass even when none is given out by the apparatus.

Several compromises are often adopted to bring the dimensions of a bass horn to a manageable size.

One method is to employ 'horn folding' so that the horn is compacted to a cabinet-like enclosure. (Fig. 8). This solution has two main disadvantages; firstly it is almost impossible to retain a true exponential curve if the horn is folded. In addition, the treble frequencies, which tend to travel along the horn axis, have their relative phase affected by successive reflections and this leads to various peaks and troughs in the response curve. Apart from this, unless the reflecting material is chosen with great care, diffusion and absorbtion can occur.

A second solution, usually combined with the folded-horn design, is to create a triangular cabinet termed a corner horn. The principle — somewhat loosely applied in this case — is that the corner of the listening room can be utilised as an extension of the horn flare. This is intended to provide loading down to a lower frequency than that permitted by the horn alone. Of course it is a rare corner of a room that has an exponential shape, but this approximation does in practice lead to an enhancement of the bass end of the frequency spectrum.

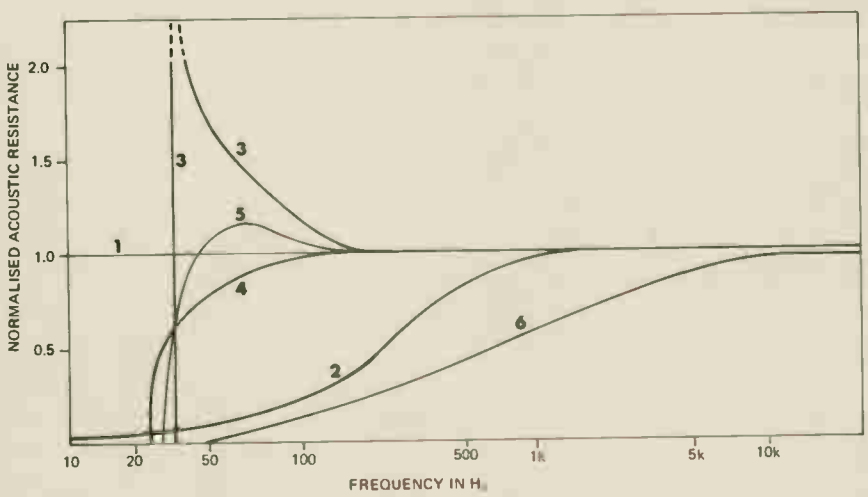


Fig. 7. Acoustic resistance at horn throat for various flare shapes — numbers on curves relate to functions shown on Fig. 5.

Continued on page 33

Klipschorn folded horn speakers

In the U.S.A. these speakers are highly respected and will shortly become available in the U.K. through their Germany distributors: Audio International, 6 Frankfurt/main 56, Gonzenheimer Str. 2a, Box 560 229, West Germany.

electronics TODAY INTERNATIONAL product test

THIS is an unusual review, in that, to a greater degree than any we have previously published, it highlights the present lack of internationally agreed standards for audio equipment measurements.

The review is that of the Klipschorn KDFB, one of the range of speakers manufactured by Klipsch and Associates in America.

Paul Klipsch originally demonstrated the folded horn technique back in the 1940's, as a means of improving bass response of horn loaded bass speaker units. The basic physical design of the Klipschorn has not changed since 1948, and units built since then can be brought up-to-date with minor modifications.

Our review is unusual in that Paul Klipsch — a well-known and thoroughly respected engineer and manufacturer — claims efficiencies of 50% to 80% for his products. Yet our most carefully conducted measurements — using several (and duplicated) methods — consistently resulted in efficiency figures around 3% — higher than most other speakers of course — but far short of what is claimed.

Over the past years we at Electronics Today International have been plagued, as have other reviewers, with difficulties in performing measurements on a diverse range of speakers, many of which seem to have a different set of physical characteristics, thus complicating our task of reviewing, evaluating and measuring the performance of the system. One of the most difficult of these tasks, by and large, is that of measuring speaker efficiency, which by definition is the ratio of acoustical output to electrical input. At first sight such a measurement seems particularly simple, but this is not in fact so, and measurements of acoustic power output require very carefully controlled conditions in order to be able to provide an accurate result.

THE MEASUREMENT OF ACOUSTIC POWER

There are two main methods available for the measurement of acoustical power. The first is to place the loud speaker (or other acoustical source) in a free field, and perform a large number of measurements on either a full sphere, or hemisphere, around the object, thus providing the integrated sound pressure level from which sound power can be derived. The second method is to place the acoustic source in a reverberant chamber to measure the reverberant sound energy (preferably using pink noise as the excitation if the source is a loud speaker). These methods provide particularly accurate measures of acoustic power.

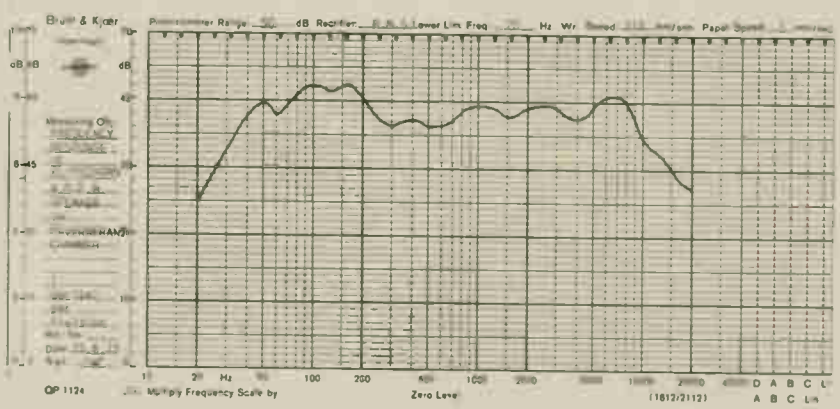
Until recently, we did not have a suitable reverberant chamber at our disposal, but we have now built our own 340 cubic metre reverberant chamber. This has a nominal cut-off frequency of 63Hz and an upper limit of 10kHz. This provides us with an excellent means of measuring the acoustical output from any loudspeaker. In particular, frequencies above 250Hz require a minimal number of measurements precisely to quantify the sound pressure level, and thus the sound power being radiated from the source. Electrical power input to the speaker is measured by a precision high-frequency watt meter which has a nominal 0.1% precision, this being considerably more accurate than the degree to which anyone can specify the acoustical power.

The Klipschorn enclosure is extremely large, measuring 125 cm high in its most elaborate form, and requires a corner location, preferably with two hard reflective walls, with no obstructions for some distance on either side. These walls then form an extension of the bass horn.

The front panel is 75 cm wide and may be veneered in a range of timbers with various finishes to suit all tastes. (The unit tested was the 'decorator' model and is intended for finishing to the purchaser's requirements). The top section, which contains a mid-range horn, and the horn type tweeter, is covered with a black grille cloth extending around the side for approximately four inches.

The main enclosure contains a 36 cm (15") bass speaker radiating into a double folded horn via twin passages, which approximate an exponential shape. The claimed cut-off frequencies for the bass speaker are 28Hz and 550Hz, and the cross-over network for the bass horn rolls off at approximately 440Hz at the top end.

The mid-range unit has a cast horn approximately 55 cm long, and is mounted on a separate panel that mounts on to the top of the bass enclosure. This panel also supports the horn tweeter which has a moulded plastic horn 3.6 cm long. The mid-range unit covers the frequencies



The Klipschorn enclosure must be located in a corner of the listening room.

from 400Hz to 6kHz, and the tweeter covers the range from 5kHz to 19kHz. The cross-over network is complex and includes an ideal protection circuit around the tweeter. The circuit arrangement is shown on the diagram attached. The two zener diodes wired back to back in parallel with the tweeter started limiting the tweeter voltage above 3.5 volts, with an upper limit of approximately 5 volts. In the past the manufacturers experienced considerable problems with transients burning out the tweeter driver. This modified network has almost completely eliminated damage to the tweeters, at the expense of generating distortion, which however is not audible.

A removable panel on the side of the main enclosure facilitates easy removal of the woofer by the loosening of four wing nuts. The woofer itself is particularly interesting for a number of reasons: Firstly, it has a huge magnet assembly, measuring 15 cm by 15 cm by 3.6 cm; and secondly, because of the lack of the roll surround which is seen on most woofers today. The omission of the roll surround is because the excursions required by the speaker are smaller than for the standard acoustical suspension type, or similarly loaded bass units.

DOPPLER DISTORTION

Klipsch has stated that a major design aim of his speaker systems is the reduction of distortion caused by a Doppler effect. Briefly, as a speaker cone radiates complex sound waves into a room, a Doppler shift of some frequencies is necessarily caused by its very back and forth motion. Hence, many spurious tones, or sidebands not related to the desired sound, are created by the frequency modulation action, thus introducing a form of intermodulation distortion. This form of intermodulation is more serious (its magnitude is higher, and its audible effects more disagreeable) than the more familiar kind of intermodulation in which relatively isolated tones interact.

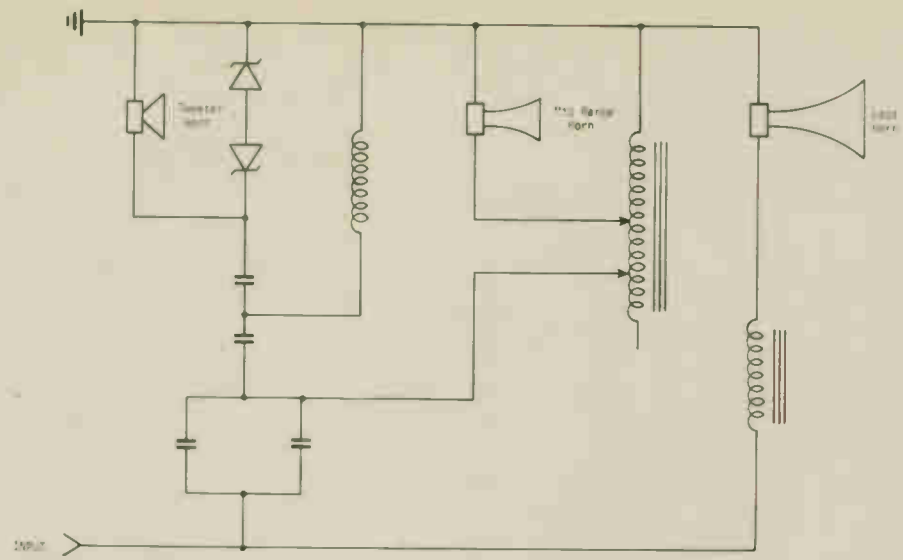
Paul Klipsch has stated that the bass diaphragm motion should not exceed 0.15 cm if this type of distortion is not to be created. Careful computation shows that diaphragm distortion is not significantly different in its components to intermodulation distortion, and these cannot be readily disassociated from one another. To prove this we carried out a series of measurements on a number of different types of speakers driving them with simultaneous low frequency high level signals together with a standard imposed high frequency low level signal.

We computed that by feeding the speaker with a two-tone signal consisting of a 50Hz component together with a 500Hz component, the measured significant components ($f_2 + f_1$ and $f_2 - f_1$) which lie respectively at 450 and 550Hz should be −30dB with respect to the 500Hz component when the 50Hz component has a peak velocity of 0.24 cm/sec. These components are known technically as the first order sideband components. We then proceeded to carry out extensive laboratory measurements to assess the subjective effect resulting from the generation of such components, and then to correlate these with our computations. The results of our measurements show excellent correlation between the theoretical and practical results.

The results of our subjective tests were that, on most – but not all – programme material, it is particularly difficult to detect this phenomena even if listened for by trained musicians.

To evaluate a speaker such as the Klipschorn subjectively or in fact, even to use them in his house presents the intending purchaser with a significant number of very real problems. The first of these is that in order to utilise them in the manner in which they are intended one needs a considerable spacing between the pair, (Paul Klipsch recommends 10 metres). Secondly, to develop the full low frequency response down to approximately 30Hz, one needs a room with unusually large dimensions. Last but not least, each speaker has to be mounted in a corner of the room with no obstructions near the speakers.

At the time of performing our evaluation we experienced difficulty in finding any room which met these requirements. Hence, the tests that we performed were conducted in rooms the dimensions of which were significantly smaller than those recommended, and out of fairness to



Circuit diagram of Klipschorn cross over network

the speakers we must emphasize that the low frequency performance was of necessity degraded. Nevertheless, when tested under conditions which were imperfect in terms of the criteria stated, the results were still gratifying, and the performance would satisfy most audiophiles in terms of clarity and lack of colouration.

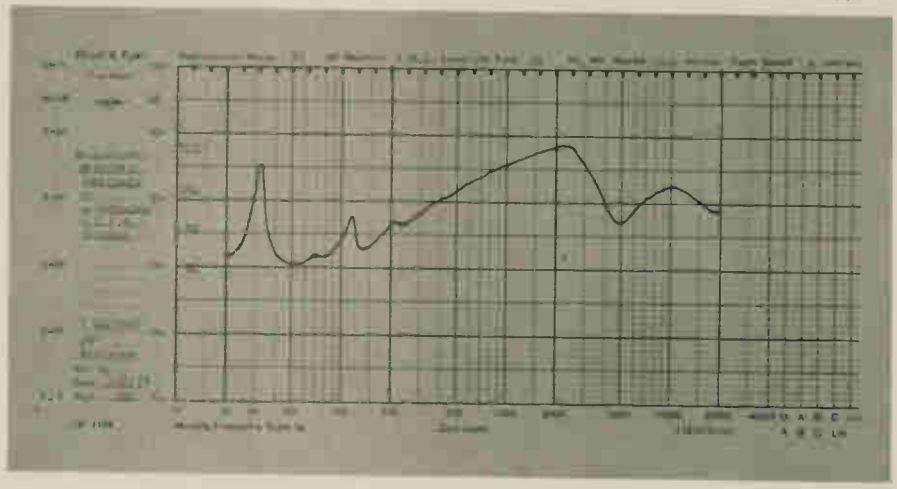
Due to the speaker response being dependent on a corner location, we had to measure the response in a reverberant chamber and make corrections for the room characteristics. To perform this test, pink noise was used as a source and the spectrum was scanned with a third-octave spectrometer. The resultant hand plot of the frequency response does not show the peak to trough excursions normally seen on our free field frequency response test. Tests at different points on the spectrum however, showed that the peak and trough deviations were not greater than 3dB above or below the spectrum shown. The overall frequency response from 30Hz to 15kHz is within ±6dB.

The impedance curve for this speaker system was the most non-linear that we have measured to date. In particular there is a very significant peak at 32Hz – of 27 ohms impedance – and another peak at approximately 2kHz, in excess of 32 ohms impedance. Such a range of impedances would have bothered a valve amplifier but would be unlikely to cause significant distress to most modern transistorised amplifiers, unless it was desired to use an additional speaker system in parallel with the Klipschorn horns.

In his literature, Paul Klipsch claims a typical efficiency of 50 per cent and maximum efficiency of 80 per cent, depending upon frequency. But we cannot see how these claims can be substantiated if efficiency is measured by generally recognised methods.

We proceeded to measure efficiency using a number of different methods. All of these methods gave us answers which were consistent within the order of accuracy of the acoustical measurements ±3dB (±30%). Our measured results show that the typical efficiency was 3% in the octave band centred on 500Hz. A close examination of Klipsch's papers leads us to believe that the discrepancy between our measured results, and those quoted by Klipsch, is the result of our performing our measurements on the basis of total radiated acoustical power over a total electrical power input in accordance with current international practice. We believe that Paul Klipsch most probably carried out his measurements with a microphone on axis of one or more of the drivers, so that his measurements were based on the combination of the directivity of these speakers together with the resultant sound pressure level. If our efficiency of 3% is multiplied by the computed directivity factor for the mid-range horn, our apparent efficiency (on axis of the speaker) is approximately 50%. Whilst Paul Klipsch may be completely correct in his appraisal and statement of the efficiency, the lack of standardisation in measurements for such speakers does leave much to be desired.

We would like to emphasize to prospective purchasers, that Klipschorns *will* sound louder – at any point in a room – than conventional speakers. But it is only when the listener is positioned within a 90° (horizontal) and 30° (vertical) sector in front of the speaker that the sound will be *dramatically* louder. But such a segment of a room is quite extensive and the serious listener is unlikely to find this limitation to be a major handicap. We also wish to emphasize that, despite our different results, these speakers *are* more efficient than most. To illustrate this, if a typical



MEASUREO PERFORMANCE OF KLIPSCHORN SPEAKER SERIAL NO: 4K475

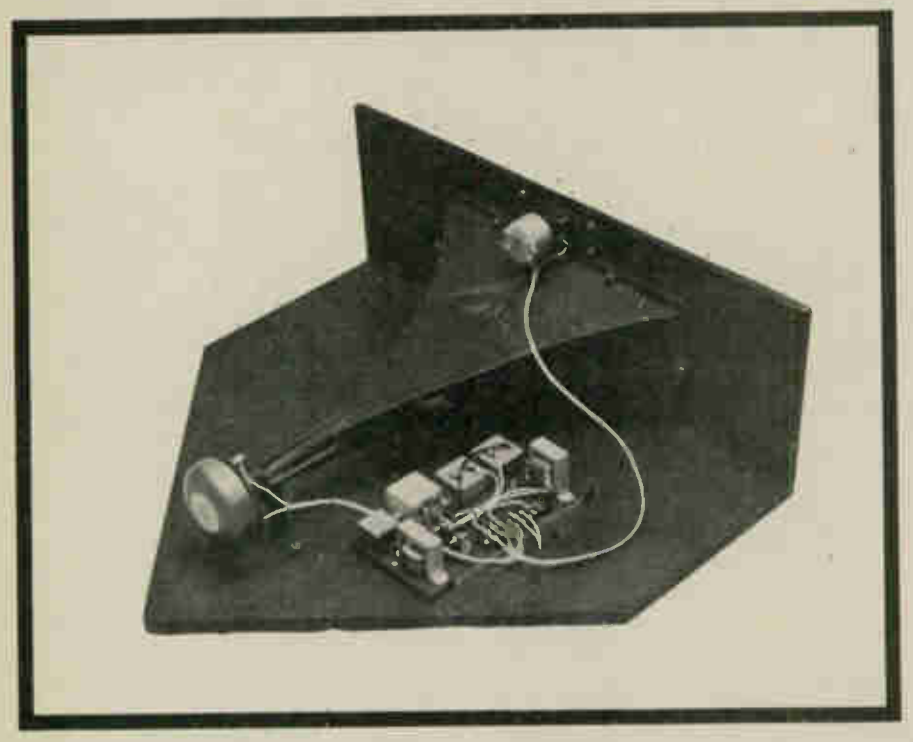
Frequency Response:
30Hz to 15kHz ±6dB
Total Harmonic Distortion (for 1 watt input):
100Hz 1.7%
1kHz 1.7%
6.3kHz 1.4%
Electro-acoustic Efficiency at 1kHz:
3%
Cross-over Frequencies:
250Hz
5000Hz
Measured Impedance:
100Hz 8Ω
1kHz 27Ω
6.3kHz 13Ω
Dimensions:
124.8cm x 75cm x 67cm.
Weight:
67kg

acoustic suspension speaker were to require 100 watts to generate a certain (high) sound level, the Klipschorns would need a mere five watts to generate a similar level anywhere in the listening room – and even less than that if heard directly in front of them.

Klipschorns are for serious audiophiles. They are large, heavy and costly – and for optimum results it is almost literally necessary to design the listening room around the speaker.

But serious audiophiles willingly tolerate such idiosyncracies and for such people Klipschorns have a lot to offer.

The sound produced is most certainly one of the cleanest we have heard to date, and there is a distinct advantage in the smaller cone excursions of the bass unit in reducing distortion. ●



As our measured figures for efficiency were so much at variance with those quoted by Klipsch, we telephoned the company – in Arkansas, USA – for their comments.

A company spokesman, Richard R. Moore made the following comments:

"Klipsch have never had the opportunity to perform measurements of efficiency using a reverberant chamber. Because of this we have not been in a position to reconcile many of the earlier figures quoted in our literature with our more recent data."

"Whilst not disagreeing with ETI's measurements of efficiency, we would have expected a figure somewhere between 5% and 10%.

Mr. Moore pointed out that our choice of 500 Hz for the octave band pink noise centre frequency used in our measurement would have been close to the Klipschorn's lower crossover frequency (nominally 400 Hz) and this would have affected our figure by 2-3 dB.

"We totally agree that measurements such as these should be standardised and approve of your use of a reverberant chamber for efficiency measurements."

Recommended retail price: approximately £1200 pair. ('decorator' model as tested).

Horn loaded loudspeakers

Continued from page 29

SPEAKER COLOURATION

Commerical loudspeaker units tend to each have their own distinctive 'sound' – largely attributed to colouration by the speaker unit or cabinet.

The main component that can lead to colouration in horn loudspeaker systems is flimsiness of horn cabinet construction materials – lack of rigidity leads to resonance of the panel materials thereby absorbing low frequency energy. Thus the advocation by the experts of sand-filled panels or concrete slabs for the walls of the horn.

Many compromises are involved to bring the chief benefit of vastly improved efficiency of transduction between electrical fluctuation and air-pressure fluctuation.

A major advantage of horn loading is that a smaller, lighter diaphragm can be used, this has less inertia and a correspondingly reduced tendency to 'overshoot'. Also the cone movement is less and therefore mechanical resistance on the driver can be made much higher than for a direct radiator type speaker. This improves the acoustic damping on the cone.

Horn loading, to sum up, is the principle of the effective coupling of a loudspeaker drive device to the surrounding air. It is exactly parallel with transformer practice – the horn transforms high-pressure high impedance conditions at the driver to low-pressure, low-impedance conditions, facilitating the effective transmission of sound waves through the air. ●

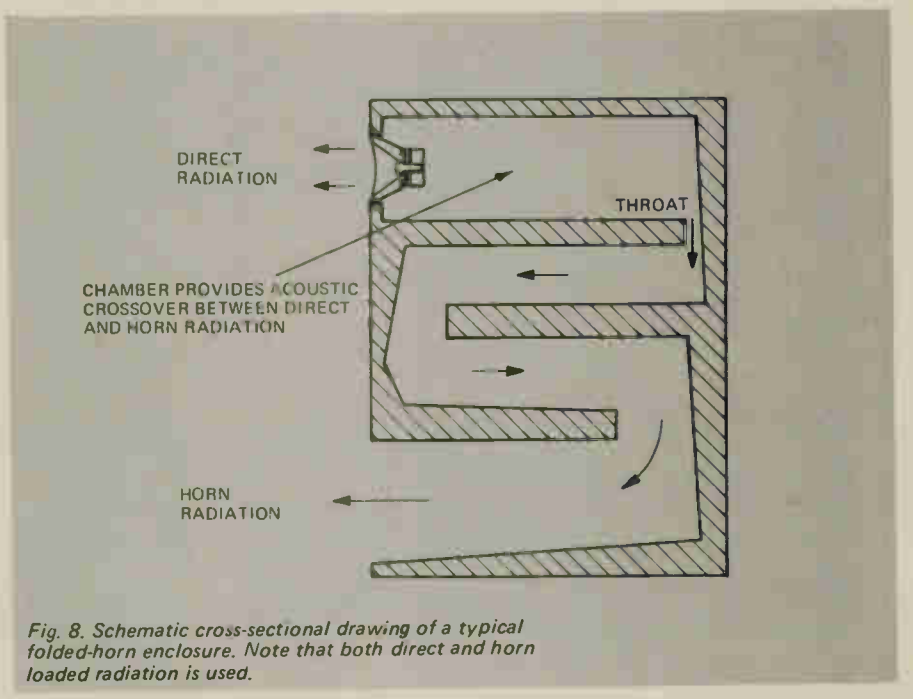


Fig. 8. Schematic cross-sectional drawing of a typical folded-horn enclosure. Note that both direct and horn loaded radiation is used.

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WHAT TO LOOK FOR IN DECEMBER..

LINEAR ELECTRIC MOTORS

There has been a big row about the Government's handling of the future of the 'Hovertrain'. What principle do these work on? Could magnetically levitated ground transportation be the saviour of the railways? In this feature, written by Professor E.R. Laithwaite of Imperial College, the leading authority and designer, the principles and potential are discussed.

MIXER PREAMPLIFIER

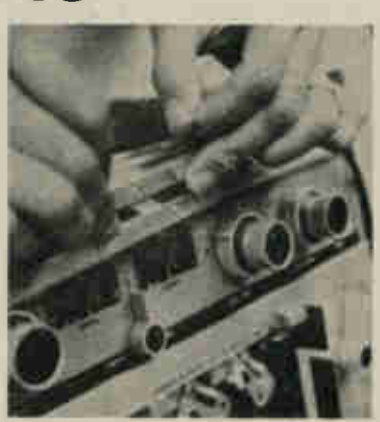
The 100W Guitar Amplifier, described in our February issue, was truly a success but required a mixer preamplifier. Our Master Mixer in April was one alternative but many readers have requested a far simpler, and thus cheaper, version. Next month's ETI describes a very simple circuit using two IC's which will have many uses other than with the 100W amplifier.

NUCLEAR FALLOUT

The recent French nuclear tests at Mururoa Atoll have once again highlighted the danger of nuclear fallout. This article describes the effects, the history and the future dangers. Is the effect minimal compared to background levels of radiation, as some people say, or could the effects be long term and prove a hazard to our grandchildren? How far does fallout reach in miles? These questions and others are covered in this feature.

CREATIVE AUDIO

"Sound is, potentially. one of the most creative of media..." So starts part one of *Creative Audio* in next month's ETI. In this part, tape editing is discussed in some detail, not only general information but practical methods and tips for the home enthusiast.



ON SALE MID-NOVEMBER–20p

ETI TAKES A PRIDE IN BEING REALLY UP-TO-DATE, SO WE OURSELVES DO NOT ALWAYS KNOW WHAT WILL BE IN THE NEXT ISSUE SO THE FEATURES MENTIONED ON THIS PAGE ARE ONLY SOME OF THOSE THAT WILL BE INCLUDED.

electronics today INTERNATIONAL

SPECIAL OFFER!

THE ADVANCE 'INTERNATIONAL' CALCULATOR KIT FOR £26.95

EXCLUSIVE OFFER FOR ETI READERS ONLY

In ETI we have recently said quite a bit about the Advance Executive Pocket Calculator in recent issues. There was the competition in July for three of these which attracted over 2000 entries and this response encouraged ETI and Advance to arrange for the supply of the kit version, known as the International, to our readers at £3 less than usual. This offer only applies to readers using the form on the right. A very large demand is expected and readers should allow a reasonable time for clearing all orders.

The Advance International is a kit version of the Executive and has the same facilities: Add, Subtract, multiply and divide together with a constant facility on multiply and divide and with fixed or floating decimal point. There is also a 'clear last entry' key.

A prototype kit was reviewed in last month's ETI and the kit is discussed and compared with others in the *Electronics Tomorrow* feature on page 60. This has been prepared by an outside contributor who was asked to say what he thought, ignoring our offer.

The offer expires on 30th November.

Cut

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DIRECTORY OF HI-FI STEREO AMPLIFIERS

THE DIRECTORY OF HI-FI STEREO AMPLIFIERS has been compiled by ETI in co-operation with the manufacturers, importers or distributors. It is intended as an instant comparison chart with the specifications given in common form where possible.

Considerable care has been taken in the compilation but readers are advised to check with the maker's literature before coming to any decision (incidently makers literature often contains serious errors and any compilation from this is bound to be invalid.) One maker of superb equipment quote THD as 15% instead of 0.15%).

Manufacturers vary considerably in their methods of quoting specifications and frequently have very strong views with regard to the method they use. Where possible we have tried to resolve these or convert them. This applies mainly to output power where several methods are used. For this reason, manufacturers leaflets may show a different figure, though not if r.m.s. is used.

Listings are made by price. This method has been chosen over the alternatives as we feel that most people will know what they have available to spend. All prices quoted are manufacturer's recommended prices including VAT. High discounts are available on most of the amplifiers quoted. However the price listing puts the majority of amplifiers in a similar order to that which discount houses will show.

The floating pound has led to several price increases for imported units and even during the preparation of this feature literally dozens of prices have changed. All changes that have been notified to us have been included.

A number of blank spaces have been left. These are usually due to the manufacturer not having the information in a suitable form or where ETI have been unable to accept the information supplied. It should not be assumed that the absence of specification means that it is poor.

It is emphasised that all figures are those quoted by the makers and units have not been tested to ensure that they meet these. However experience has shown that tested results rarely vary from the quoted figures to any significant extent.

Considerable care has been taken in this compilation and the information is given in all good faith. Proof copies of the listings were sent to everyone included on the list for checking. ETI cannot however accept responsibility for errors or omissions.

Further information on the amplifiers quoted is available from the makers or distributors, these are listed on page 46 and the index number corresponds to the number given against each unit.

DIRECTORY OF HI-FI STEREO AMPLIFIERS

MODEL	PRICE INC OF VAT £ p	POWER OUTPUT (R.M.S.) W INTO Ohms		FREQUENCY RESPONSE RANGE Hz–kHz		dB +	dB –	TOTAL HARMONIC DISTORTION AT 1 kHz LOW O/P % AT W		HIGH O/P % AT W		HUM & NOISE (–dB) *	Channel separation at 1 kHz (–dB)
SINCLAIR "PROJECT 605"	32.94	15	4	27	23	0	3	0.1	1	0.1	15	70U	50
PHILIPS RH580	33.55	6	8	65	20	3	3	1.5	1	1.5	5	55U	30
EAGLE TSA 149	35.20	7	8	25	18	0	2	.8	1	.8	7	56W	46
TEXAN	38.50	20	8	15	22	0	1	.07	50mW	.09	20	60U	51
SONY TA 70	38.50	8	8										
KELETRON KSA 1000 II	39.05	10	8	10	100	0	3	.08	1	.08	10	70W	50
TELETON SAQ307	39.60	8	8	20	20			1	1	1	8		
TELETON SAQ206B	39.60	8	8	20	20			1	1	1	8		
AUDIOTRONIC LA.1700	41.25	17	8	20	50	0	1	.8	1	.8	17	60U	
AMSTRAD INTEGRA 4000 II	41.25	15	8	20	20	0	2	.3	1	.5	12	54W	36
EAGLE AA.2	41.80	10	8	25	20	0	2	.5	1	.5	10	58W	48
TRIPLETONE HI-FI 77 II	42.35	10	8	10	100	0	3	.08	1	.08	10	70W	50
TRIO KA2000A	42.90	16	8	20	30	0	2	.8	1	.8	16	70U	
SINCLAIR SYSTEM 2000	43.94	8	4	40	25	0	1	.06	1	.06	8	65U	50
KELETRON KSA 1500 II	44.10	15	8	10	100	0	3	.08	1	.08	15	70W	50
METROSOUND ST20 II	46.20	10	8	30	30	0	2	1	1	1	10	65W	
ALBA UA 700	47.96	15	8	30	18	0	1	.1	1	.1	15	55U	38
SONY TA.88	49.50	11	8			1	3	.5	1	1	11		
EAGLE TSA 151	49.83	15	8	20	32	0	2	.2	1	.2	15	58W	50
ROTEL 211	49.90	10	8	20	65	0	3	1	1	1	10	45U	
TELETON GA202	49.94	16	8	30	30			1	1	1	16		

* W = weighted; U = unweighted

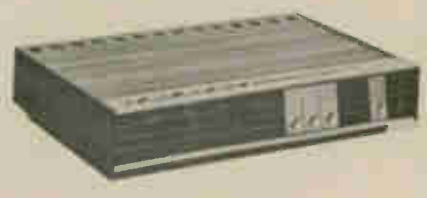
Sinclair Project 605

Eagle TSA149. The TSA151 also listed is of a very similar appearance.

Teleton SAQ307

Texan

Teleton SAQ206B



Philips RH580

Sony TA 70

Amstrad Integra 4000 II

INPUTS						FACILITIES						SIZE (APPROX.) (IN INCHES)	FURTHER INFORMATION (INDEX NO.)
MAG. PU 1	MAG. PU 2	CERAMIC	TUNER	TAPE & REPLAY	Mic.	HEADPHONE	HIGH FILTER	LOW FILTER	LOUDNESS	TAPE O/P	SHORT CIRC. PROT.		
3/50													13
3/47		100/100	100/140	100/140					✓	✓	✓	13.1/8 x 2.7/8 x 8.1/2	6
3/47		80/100	180/100	180/100		✓				✓		11 x 3.3/4 x 8.3/4	10
7/47						✓	✓	✓		✓		14.3 x 1.9 x 5.9	7
3.5/50			250/100	440/100		✓	✓		✓			13 x 3.1/2 x 9.7/10	25
4/47		3/47	100/50	100/50		✓	✓			✓	✓	15 x 3.7/8 x 9.1/2	15
3				235		✓	✓	✓	✓	✓	✓	15.1/4 x 8.7/8 x 3.1/8	27
3				235		✓	✓	✓	✓	✓	✓	15.1/4 x 8.7/8 x 3.1/8	27
2.6	2.6		150	150		✓	✓	✓	✓			14 x 5.1/2 x 10	23
3.5/47		55		100/150		✓	✓	✓	✓	✓		13.1/2 x 9 x 2.3/4	16
3/47		80/100	180/100	180/100		✓	✓	✓		✓		10.3/4 x 3.3/4 x 8.1/2	10
2.5/47		30/47	100/50	100/50		✓	✓		✓		✓	15 x 3.7/8 x 9.1/2	15
2			130	130		✓			✓	✓		10.1/4 x 4.1/8 x 9.3/8	28
3/47		30/220		125/1		✓	✓	✓		✓		12 x 6 x 6	13
4/47		30/47	100/50	100/50		✓	✓			✓	✓	15 x 3.7/8 x 9.12	15
2.5/47			150/100	100/500								15.1/4 x 3.1/2 x 10	5
5/50			100/150		2.3/50	✓			✓			16.1/2 x 7.5/8 x 4	4
3/50			250/50	250/50			✓					5.1/8 x 9 x 6.1/2	25
3/47		100/100	200/100	200/100								13 x 4 x 8.3/4	10
2.7/45		140/100	170/50	150/50					✓	✓		13 x 6.1/2 x 4	14
3				130		✓	✓		✓	✓		15 x 10 x 4	27

Eagle AA2

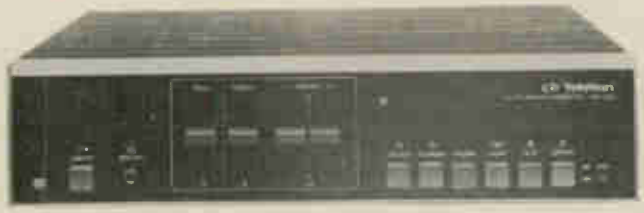
Keletron KSA 1500 Mk.II

Sony TA 88

Trio KA2000A

Alba UA700

Sinclair System 2000



Teleton GA202

DIRECTORY OF HI-FI STEREO AMPLIFIERS

MODEL	PRICE INC OF VAT £ p	POWER OUTPUT (R.M.S.) W INTO Ohms		FREQUENCY RESPONSE RANGE Hz–kHz		dB +	dB –	TOTAL HARMONIC DISTORTION AT 1 kHz LOW O/P % AT W		HIGH O/P % AT W		HUM & NOISE (–dB) *	Channel separation at 1 kHz (–dB)
TRIPLETONE HI-FI 1818 II	53.35	20	8	10	100	0	3	.08	1	.08	20	70W	50
SANSUI AU101	53.42	15	8	20	60	0	2	.2	1	.7	18	70U	50
SINCLAIR SYSTEM 4000	54.94	17	8	40	25	0	1	.04	1	.04	17	650	50
AMSTRAD IC 2000 Mk.II	55.00	20	8	15	30	0	2	.18	1	.2	20	60U	60
PIONEER SA 500A	55.96	13	8	30	50	1	2	.09	1	.09	10	75	
TRIO KA2002A	57.75	17	8	20	50	0	2	.8	1	.8	17	70U	
METROSOUND ST40	59.40	20	8	20	30	0	1	.1	1	.1	20	65W	
AUDIOTRONIC LA.4000	60.50	40	8	5	70	0	1	.4	1	.4	40	65U	
EAGLE AA4	61.60	20	8	15	36	0	2	.2	1	.2	20	64W	56
ROTEL RA 311	62.90	20	8	15	70	0	3	1	1	1	20	45W	
RAVENSBROOK	63.25	20	8	20	50	0	3	.1	1	.3	18	53U	40
SANYO DCA 1400K	64.95	20	8	15	70	0	3	.1	1	.8	20	70U	
SHARP SM-510H	69.22	46	8	30	30	0	1.5	.15	1	.15	15.5	65U	40
JVC VN-300	69.85	60	4	20	40	0	1.5	.5	1	.5	60		
TRIO KA4002A	71.50	58	8	20	40	0	1.5	.5	1	.5	58	60U	
WHARFDALE LINTON	71.50	15	8	30	20	0	1	.1	1	.1	10	63U	56
SHARP SM-511H	73.95	82	4	30	30	0	1.5	.1	1	.1	20	65U	40
EAGLE AA6B/AA68	74.80	20	8	15	36	0	2	.2	1	.2	20	64W	56
ARMSTRONG 621	75.90	40	8	25	25	0	1	.08	1	.08	40	65U	45
LEAK DELTA 30	76.98	15	8	30	20	0	1	.1	1	.1	10	63U	50
METROSOUND ST60	77.00	30	8	20	50	0	2	.08	1	.08	30	65W	
SONY TA 1055	77.00	23	8	10	60	0	3	.1	1	.5	23		
J.E. SUGDEN A21	79.75	20	8	30	20	0	1	.02	1	.1	20	73W	40

* W = weighted; U = unweighted


Sansui AU101


Metrosound ST40


Sanyo DCA 1400


Amstrad IC 2000 MkII


Eagle AA4


Sharp SM-510H


Pioneer SA 500A


Rotel RA311


Trio KA-2002


Rogers Ravensbrook


JVC VN-300

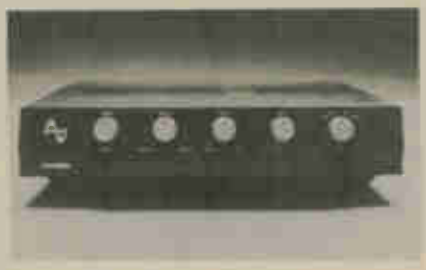
INPUTS						FACILITIES						SIZE (APPROX.) (IN INCHES)	FURTHER INFORMATION (INDEX NO.)
MAG. PU 1	2	CERAMIC	TUNER	TAPE & REPLAY	Mic.	HEADPHONE	HIGH FILTER	LOW FILTER	LOUDNESS	TAPE O/P	SHORT CIRC. PROT.		
2.5/47	2/50	30/47	100/50	100/50		✓	✓		✓	✓		15 x 3.7/8 x 9.1/2	15
3/50				200/50								4.17/32 x 16 x 10.15/16	11
3/47		30/220		125/1		✓	✓	✓		✓	✓	12 x 6 x 2	13
3/47		55		70/150			✓	✓	✓			17.1/2 x 6.5/8 x 3.5/8	16
2.5/50			200/100	200/100								13 x 4.5/8 x 12.7/16	22
2/50	2/50		150/50	150/50					✓	✓		13 x 4.5/8 x 9.7/16	28
2.5/50			100/150	100/150						✓		14.7/8 x 3.3/4 x 10.1/2	5
50/100	2.5/50		150/50	150/50	2.2/22	✓	✓	✓		✓		16 x 5.1/8 x 11.1/2	23
3/47		80/100	180/100	180/100		✓	✓	✓		✓		13 x 4 x 10.1/2	10
2.5/40		140/94	170/46	150/46			✓		✓	✓		14 x 7.1/2 x 4.1/2	14
2/47	3/47			100/100			✓	✓				14.1/2 x 9.7/8 x 4.3/4	3
2.5/50												11.5/8 x 10 x 4.1/4	21
3	3	160	160	200					✓	✓		14.1 x 5.1 x 9.4	18
3			120	120			✓	✓	✓	✓		5.1/2 x 15 x 12	26
2.5/50	2.5/50		150/100	150/100		✓	✓	✓	✓	✓		13 x 4.5/8 x 9.7/16	28
3.5/47	20/33		60/50	400/47			✓		✓				19
3	3	150	150	200		✓			✓	✓		14.7 x 5.1 x 9.4	18
3/47		80/100	180/100	180/100		✓	✓	✓	✓	✓		15 x 4.1/2 x 10.1/2	10
2.7/68	10/47		120/68	250/68			✓	✓	✓			12.1/4 x 3.1/4 x 11.1/4	8
2/47	10/33		25/47				✓					13.5 x 4.7 x 10	19
3/47			50/120	50/120			✓	✓				20.1/8 x 3.3/8 x 12.1/2	5
2/47			250/50	250/50	2/47		✓					16.1/8 x 4.3/4 x 11.1/8	25
2.5/47		60/100	100/200	100/200		✓	✓	✓		✓	✓	15.9 x 5.8 x 11.1	9

Trio KA-4002

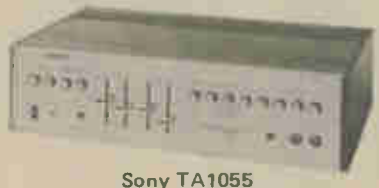
Eagle AA6

Metrosound ST60

Sharp SM-511H



Armstrong 621



Sony TA1055

Wharfdale Linton

Leak Delta 30

JE Sugden A21

DIRECTORY OF HI-FI STEREO AMPLIFIERS

MODEL	PRICE INC OF VAT £ p	POWER OUTPUT (R.M.S.) W INTO Ohms		FREQUENCY RESPONSE RANGE Hz–kHz		dB +	dB –	TOTAL HARMONIC DISTORTION AT 1 kHz LOW O/P % AT W		HIGH O/P % AT W		HUM & NOISE (–dB) *	Channel separation at 1 kHz (–dB)
MARANTZ 1030	82.50	15	4	20	20	0	1	.5	1	.5	15		30
RAVENSBOURNE	82.50	35	8	25	35	0	3	.06	1	.1	35	60U	45
PHILIPS RH520	85.00	15	4	15	30	2	2	.3	10	.5	15	60U	40
FERROGRAPH 20+20	85.80	20	8	20	25	0	1	.18	1	.18	20	60U	60
SANSUI AU505	86.58	25	8	20	60	0	2	.1	1	.5	25	70U	50
ROTEL RA611	92.90	30	8	5	100	0	3	.5	1	.5	30	40U	
AKAI AA5200	93.50	20	8	20	50	0	3	.1	1	.1	20	65U	60
LEAK DELTA 70	94.49	35	9	30	20	0	1	.1	1	.1	25	66U	50
YAMAHA CA-500	98.00	22	8	15	50	0	3	.05	1	.05	20	60W	50
SONY TA 3130F	99.00	70	8	10	20	0	2	.05	1	.1	70		
J.E. SUGDEN A48	104.50	40	8	30	20	0	1	.015	1	.07	38	75W	40
CAMBRIDGE P50	104.50	25	8	25	25	0	0.5	.02	1	.05	25	60U	45
SONY TA 1140	110.00	40	8	15	80	0	2	.05	1	.1	40		
PIONEER SA6200	114.95	22	8	15	80	0	1	.08	1	.08	16	75W	
ROTEL RA810	116.05	40	8	4	75	0	3	.3	1	.3	40	65U	
AKAI AA5500	118.80	30	8	20	50	0	3	.05	1	.05	30	65U	60
MARANTZ 1060	121.00	30	4	20	20	0	1	.5	1	.5	30		30
SANSUI AU555A	121.81	25	8	20	40	0	1	.1	1	.5	25	70U	60
PHILIPS RH521	125.00	30	4	15	40	2	2	.3	25	1	30	90W	45
QUAD 33-303	125.40	45	8	20	35	0	1	.03	1	.03	45	90W	40
TRIO KA6004	126.50	40	8	20	20			.5	1	.5	40	75U	

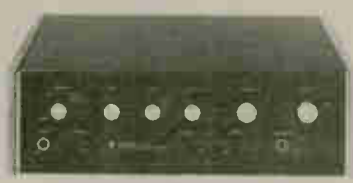
* W = weighted; U = unweighted

Marantz 1030

Ferrograph 20+20

Akai AA-5200

Rogers Ravensbourne



Sansui AU505

Yamaha CA500

Philips RH520

Rotel RA611

Sony TA 3130F

INPUTS						FACILITIES						SIZE (APPROX.) (IN INCHES)	FURTHER INFORMATION (INDEX NO.)
MAG. PU 1	MAG. PU 2	CERAMIC	TUNER	TAPE & REPLAY	Mic.	HEADPHONE	HIGH FILTER	LOW FILTER	LOUDNESS	TAPE O/P	SHORT CIRC. PROT.		
2.1/47											✓	14.1/4 x 12 x 4.3/4	24
2/47	4/47			200/100			✓	✓				14.3/4 x 10.1/4 x 5.1/4	3
2/50		50/100	100/100	250/100		✓			✓	✓	✓	16.1/2 x 11.3/4 x 4.3/4	6
3/47	3/100	100/2000	100/2000	150/50			✓	✓		✓		18 x 5 x 8.3/4	17
3/50			200/50		4/50							4.17/32 x 16 x 10.15/16	11
2.5/47	2.5/47		150/40	230/47			✓	✓	✓			16.1/2 x 9.1/2 x 5	14
3				150			✓	✓	✓			17.2 x 5.7 x 13.2	14
2/47	10/33		25/47				✓	✓		✓		13.5 x 4.7 x 10	19
3/50			200/50	200/50					✓		✓	15.3/4 x 11.3/4 x 5.1/2	2
												7.7/8 x 5.7/8 x 12.3/4	25
2.5/47	10/47		100/200	100/200		✓	✓	✓	✓	✓	✓	3.8 x 6.8 x 11	9
3/47	100/100					✓				✓	✓	16.1/2 x 9.5/8 x 2	29
1.2/47	1.2/47		130/100	130/100			✓	✓	✓			15.3/4 x 5.3/4 x 12.1/2	25
2.5/50			150/100	150/100								16.11/32 x 5.3/16 x 12.29/32	22
2/100	2/100		200/45	200/45								18.1/2 x 12 x 5.1/2	14
3				150	3		✓	✓	✓			17.2 x 5.7 x 13.2	14
1.5/47											✓	14.1/4 x 14 x 4.3/4	24
2/50			180/50	180/50								5.3/8 x 15.9/16 x 10.15/16	11
2/50		100/100	100/100	250/100	1/2	✓	✓	✓	✓	✓	✓	18.1/2 x 4.3/4 x 11.3/4	6
2/68	5.6/68	100	100/100	100/100				✓		✓	✓	4.3/4 x 6.1/4 x 12.3/4	1
2.5/50	2.5/50		200/100	200/100	3/50		✓	✓	✓	✓		17.1/8 x 6.1/32 x 11.13/16	28

J.E. Sugden A48

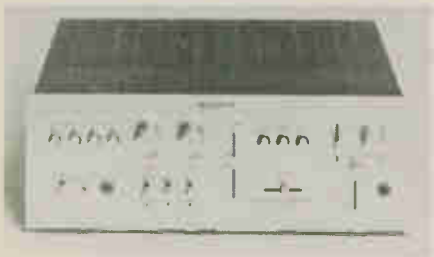
Rotel RA810

Philips RH521

Cambridge P50

Akai AA-5500

Quad 33-303



Sony TA1140

Pioneer SA6200

Marantz 1060

Trio KA6004

DIRECTORY OF HI-FI STEREO AMPLIFIERS

MODEL	PRICE INC OF VAT £ p	POWER OUTPUT (R.M.S.) W INTO Ohms		FREQUENCE RESPONSE RANGE Hz–kHz		dB +	dB –	TOTAL HARMONIC DISTORTION AT 1 kHz LOW O/P % AT W		HIGH O/P % AT W		HUM & NOISE (–dB) *	Channel separation at 1 kHz (–dB)
JVC VN-700	130.25	50	4	10	23	0	3	.05	1	.05	50	82U	
ONKYO 725	130.54	22	8	15	70	0	1	.05	.5	.1	22		
YAMAHA CA-700	141.19	60	8	15	50	0	3	.05	1	.05	50	65W	50
PIONEER QL600A	141.32	13	8	20	20	0	1.5	.09	1	.1	10		
ROTEL RA1210	141.90	60	8	3	100	0	3	.3	1	.3	60	70U	
J.E. SUGDEN P51/C51	143.00	45	8	30	20	0	1	.01	1	1	45	75W	40
PIONEER SA7100	144.65	25	8	7	80	0	1	.05	1	.04	20	80W	
FERROGRAPH 60+60	148.50	60	8	25	20	0	1	.03	1	.08	60	63U	60
SANSUI AU6500	159.52	30	8	10	30	0	1	.04	1	.1	30	70U	50
TRIO KA8004	165.00	80	8	10	50	0	2	.4	1	.4	55	110U	
JVC VN900	169.40	60	8	10	23	0	3	.05	1	.05	60	86	
ONKYO 733	176.24	34	8	10	70	0	1	.03	.5	.1	34		
AKAI AA5800	178.20	45	8	10	50	0	3	.05	1	.05	20	65U	60
REVOX A78	179.30	40	8	20	20	1	1	.1	1	.1	40	65U	60
SANSUI AU7500	194.21	40	8	10	30	0	1	.04	1	.1	40	75U	50
PIONEER SA8100	202.72	50	8	7	80	0	1	.05	1	.04	40	80W	
ONKYO 732	229.70	56	8	10	80	0	1	.03	.5	.1	56		
MARANTZ 1120	242.00	60	4	20	20	0	.5	.2	1	.2	60	140U	40
PIONEER SA9100	249.25	75	8	7	80	0	1	.04	1	60	.04	80U	60
SANSUI AU9500	310.85	80	8	15	40	01	1	.04	1	.1	80	75U	50
MARANTZ 1200	412.50	100	4	20	20	0	.25	.15	1	.15	100		40

* W = weighted; U = unweighted

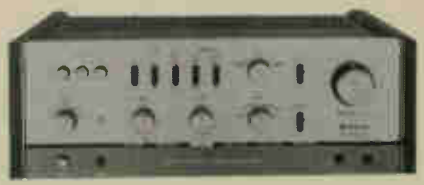
JVC VN-700

Rotel RA-1210

Sansui AU6500

Onkyo 725

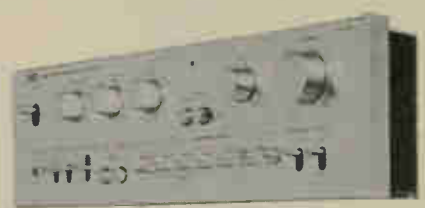
Pioneer SA-7100



Trio KA-8004

Yamaha CA 700

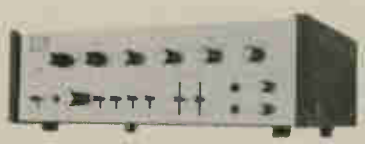
Ferrograph 60+60



JVC VN-900

Onkyo 733

INPUTS						FACILITIES						SIZE (APPROX.) (IN INCHES)	FURTHER INFORMATION (INDEX NO.)
MAG. PO 1	2	CERAMIC	TUNER	TAPE & REPLAY	Mic.	HEADPHONE	HIGH FILTER	LOW FILTER	LOUDNESS	TAPE O/P	SHORT CIRC. PROT.		
2.5/68			200/100	200/100								5.3/8 x 16.5/8 x 12.1/2	26
2.4/50	2.4/50		100/100	100/100								12.5 x 15.6 x 5.4	12
3/50	0.2/100		200/50				✓	✓	✓		✓	15.3/4 x 11.3/4 x 5.1/2	2
			100/120									16.15/16 x 5.7/16 x 13.1/4	22
1/100	1/100		200/45		200/45							16.1/2 x 12 x 5.1/2	14
2.5/47	2.5/47		150/200	150/200	2.5/47							11.5 x 5.5 x 9.8	9
2.5/50			150/100	150/100								16.15/16 x 5.7/16 x 13.7/16	22
2.5/47				200/470								14 x 17.3/4 x 6	17
2.5/50			100/50									5.9/16 x 17.3/8 x 12.11/16	11
2.5/30	2.5/50		150/100	150/12	2.5/50	✓	✓	✓	✓	✓	✓	17.1/8 x 6.1/32 x 11.13/16	28
2.5/68			200/100	200/100								5.3/8 x 16.5/8 x 12.1/2	26
2.4/50	2.4/50		100/100		1.8/50							17.5 x 14 x 5.4	12
3				180	3							17.2 x 5.7 x 13.2	14
3/47		230/800	100/100	100/100	3/100	✓	✓	✓	✓	✓	✓	16.38 x 6.1/4 x 9.5/8	20
2.5/50			100/50		2.5/50							17.3/8 x 5.9/16 x 12.11/16	11
2.5/50			150/100	150/100								16.15/16 x 5.7/16 x 13.7/16	22
2.0/50	2.0/50		100/100		1.8/50							17.5 x 14 x 5.4	12
1.1/47											✓	15.3/8 x 13.1/4 x 5.3/4	24
2.5/50			150/100	150/100								16.15/16 x 5.3/16 x 13.7/16	22
2.5/50			100/50		2.5/50							5.9/16 x 19.11/16 x 13.11/16	11
1.35/47											✓	15.3/8 x 14 x 5.3/4	25



Akai AA5800

Pioneer SA8100

Pioneer SA9100

Revox A78

Onkyo 732

Sansui AU 9500

Sansui AU7500

Marantz 1120

Marantz 1200

INDEX NO.	MANUFACTURER OR DISTRIBUTOR
1.	The Acoustical Manufacturing Co. Ltd., St. Peters Road, Huntingdon.
2.	Jonathan Fallowfield Ltd., Strathcona Road, North Wembley, Middlesex.
3.	Rogers Developments (Electronics) Ltd., 4/14 Barmeston Road, London, SE6 3BN.
4.	Alba (Radio & Television) Ltd., Tabernacle Street, London, EC2A 4DY.
5.	Metrosound Audio Products Ltd., Cartersfield Road, Waltham Abbey, Essex, EN9 1JF.
6.	Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, WC2H 8AS.
7.	Henry's Radio Ltd., Sales Department, 303 Edgware Road, London, W2 1BW.
8.	Armstrong Audio Ltd., Warlters Road, London, N7 0RZ.
9.	J.E. Sugden & Co. Ltd., Carr Street, Cleckheaton, Yorks.
10.	Eagle International, Precision Centre, Heather Park Drive, Wembley, HA0 1SU.
11.	Vernitron Ltd., Thornhill, Southampton.
12.	J. Parkar & Co. (London) Ltd., 1 Beresford Avenue, Wembley, Middx., HA0 1YX.
13.	Sinclair Radionics Ltd., London Road, St. Ives, Huntingdonshire, PE17 4HJ.
14.	Rank Audio Products, P.O. Box 70, Great West Road, Brentford, Middx.
15.	K & K Electronics Ltd., 60 St. Marks Rise, London, E8 2NR.
16.	AMS Trading (Amstrad) Ltd., 89 Ridley Road, Dalston, London, E8.
17.	The Ferrograph Co. Ltd., 442 Bath Road, Cippenham, Slough, Bucks, SL1 6BB.
18.	Sharp Electronics (U.K.) Ltd., Sharp House, 107 Hulme Hall Lane, Manchester, M10 8HL.
19.	Rank Radio International, P.O. Box 596, Power Road, Chiswick, London, W4 5PW.
20.	C. E. Hammond & Co. Ltd., Lamb House, Church Street, London, W4 2PB.
21.	Sanyo Marubeni (U.K.) Ltd., Sanyo House, Bushey Mill Lane, Watford, Herts.
22.	Shriro (U.K.) Ltd., Shriro House, The Ridgeway, Iver, Bucks.
23.	All branches of Lasky's Radio Ltd. or G.W. Smith, c/o Audiotronic House, The Hyde, London, NW9 6JJ.
24.	Pyser-Britex (Swift) Ltd., Fircroft Way, Edenbridge, Kent.
25.	Sony U.K. Ltd., Pyrene House, Sunbury Cross, Sunbury on Thames, Middx.
26.	Denham & Morley (Overseas) Ltd., Denmore House, 453 Caledonian Road, London N7 9BA.
27.	Teleton Electro (U.K.) Co. Ltd., Teleton House, Waterhouse Lane, Chelmsford, Essex.
28.	B.H. Morris & Co. (Radio) Ltd., Trio House, The Hyde, London, NW9 6JP.
29.	Cambridge Audio, The River Mill, St. Ives, Huntingdon.

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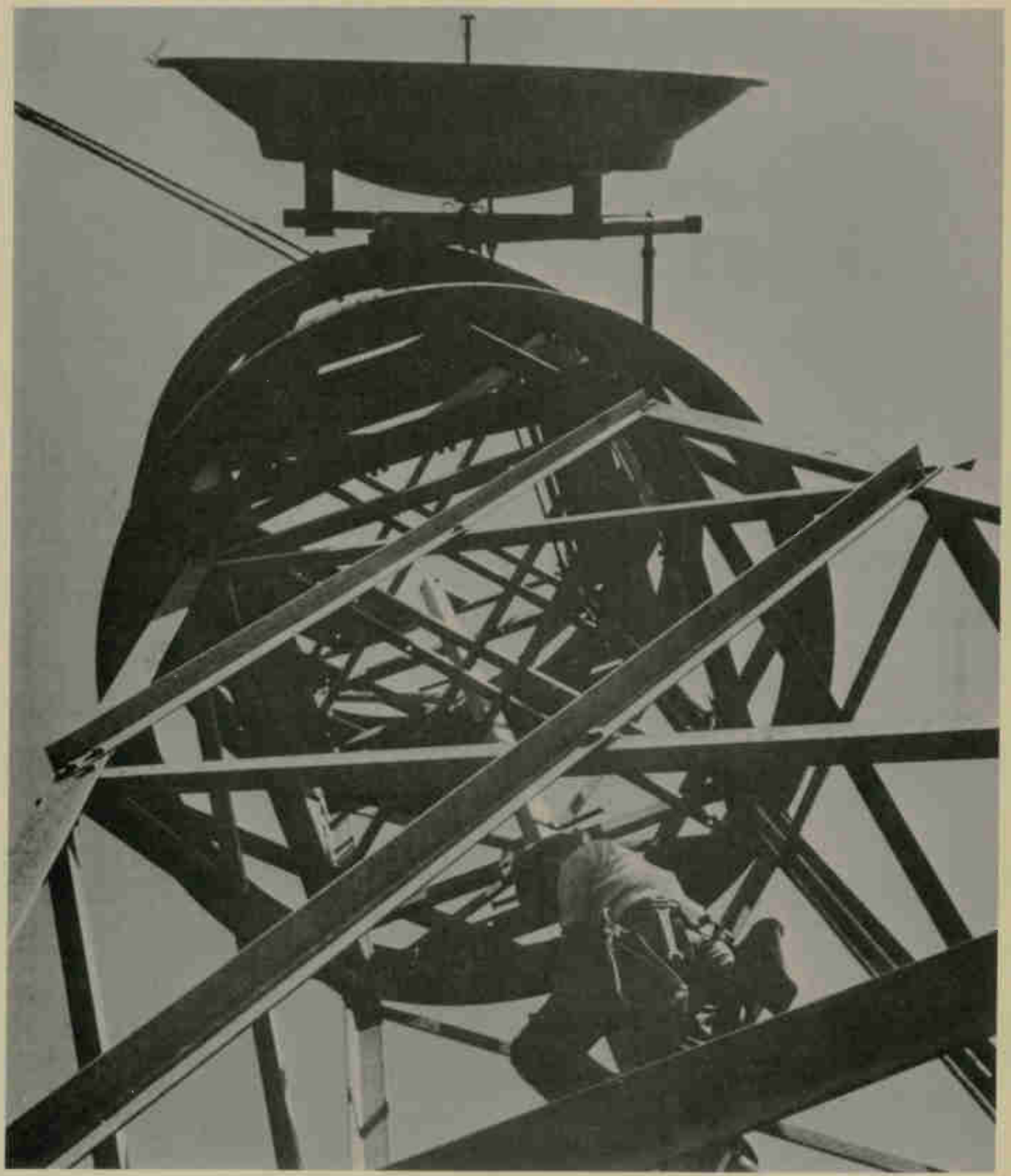


Do microwaves pose a hazard to mind and body?

by Gerald Silverberg

MODERN life has brought a plethora of man-made sources of radiation. Among the most subtle are those generated in the microwave spectrum, at frequencies from 30 Megahertz to 300 Gigahertz – nestled between radio and infrared waves at wavelengths from 1,000 to 0.1cm.

The Russians have long maintained that microwaves can cause a wide range of psychological and physiological abnormalities; particularly the "asthenic" syndrome: irritability, fatigue, headache, loss of memory and indecisiveness. Soviet scientific faith in microwave-induced aberrations is based on several years' observation of workers in industrial microwave environments conducted by the Academy of Medical Sciences (Moscow) during the late 1950s and early 1960s. As a result of these studies, permissible microwave exposure levels in the Soviet Union are one-thousandth of the U.S. ASA Standard for continuous exposure in industrial and military situations.

American scientists have remained generally sceptical about the potency of low-energy microwaves; it was not until the late 1960s that their researchers were able to replicate Soviet laboratory experiments. Thus, the U.S. project charged in 1957 by the three military services with determining microwave hazards, mainly investigated large-scale thermal effects; it set a 10 milliwatt/cm^2 exposure ceiling which is still in widespread though not mandatory, use in the United States. However, recent American findings indicate that microwaves *do* produce seemingly inexplicable physiological effects.

THE SOUND OF MICROWAVES

Exploring low-power-induced biological responses for several years, Allan Frey of Randomline, Inc., Willow Grove, Pa., has shown that human beings can hear microwaves directly. He reports in *IEEE Transactions on Microwave Theory and Techniques* for 1971 that his subjects report a variety of sounds, including buzzing and humming, when they are irradiated with trace amounts of radio frequency energy in the UHF and VHF spectrum. However, according to Frey, the microwave beam must be amplitude modulated or pulsed at audible frequencies to produce the effect. He says that some researchers who failed to confirm the phenomenon used unmodulated microwaves.

The intensity of the sensation is a function not of the average energy of the pulsed waveform, Frey maintains, but of the peak energy. Those familiar with high fidelity equipment are aware of the controversy about "peak music power" versus the more useful rms power ratings. Frey has shown that as far as hearing microwaves is concerned, peak power is a better measure than rms power. Since a microwave beam of low average power can be highly modulated, people can hear such low rms, high peak power beams; Frey reports a statistically significant threshold – about 0.3 mW/cm^2 average power – at which highly modulated signals become audible.

It is not clear how microwaves produce the sensation of sound, but Frey has ruled out one possibility: fluctuations in external air pressure impinging on the eardrum. In the hope of learning something about the mechanism, he looked for the periodicity pitch phenomenon associated with ordinary hearing: perception of tone from a pair of conventional acoustic pulses is related to the time delay between them. No relationship between delay and perceived frequency was observed for microwave hearing. In fact, trained musicians, irradiated with low level UHF energy carrying a 200 Hertz signal, reported hearing a mixture of higher frequencies, including harmonics of the original tone. Thus, Frey concludes that microwaves do not act directly and exclusively by a simple linkage with the ear-brain network.

STRAIGHT TO THE NERVES

Another possibility is that microwave electric fields trigger nerves directly; nerves transmit pulses electrochemically, the balance of sodium and potassium ions on either side of a nerve cell membrane being critical to the hearing process. Hermann P. Schwan of the Moore School of Electrical Engineering, University of Pennsylvania, has argued against direct stimulation of nerve tissue. Using a theoretical model of nerve action, he has shown that the electric field strength required across the boundary of a nerve cell is about 500 kilovolts per centimetre; a microwave beam of such intensity would burn a living organism to cinders. Frey, however, says that very intense microwave beams may not be required for nerve tissue stimulation; he suggests that the imperfect state of knowledge of nerve operation is sufficient reason for not rejecting out of hand a possibly delicate and subtle interaction between microwaves and flow of information to the brain.

In experiments with cats, Frey has evoked brain stem electro-encephalographic activity with microwave pulses as small as 30 microwatts/cm^2 average energy with 60 milliwatts /cm^2 peaks. Different neural phenomena associated with microwaves have been observed by other researchers: G.E. Hearn has shown that microwaves influence the frequency at which a flashing light is seen as a continuous image – an accepted indication of neural dysfunction; A. E. Bourgeois, Jr. has found that the sound threshold required for auditory perception decreases during microwave irradiation.

AN AVERSIVE RESPONSE

There is also evidence from American scientists that low-level microwaves can affect behaviour. In 1965, for example, Dr. Susan Korbel and W. D. Thompson, University of Arkansas psychologists, reported increased activity from rats irradiated with 1 mW/cm^2 rf energy. Allan Frey has constructed a shuttle box – a miniature room divided into two compartments by a low barrier; when he illuminated one side of the box with 1 mW/cm^2 UHF microwaves, lab rats distinctly avoided the irradiated side, spending only 30 per cent of their time there. Microwaves are clearly responsible for this behaviour, Frey concludes, although he has no explanation for how the rats sense the

UNREASONING RADIATION

radiation – at such low power levels, body temperature rise is insignificant – or why they dislike it.

Drs. Don R. Justesen and Nancy Williams King of the Neuropsychology Research Laboratories, U.S. Veterans Administration Hospital, Kansas City, Mo., and Rex L. Clarke, University of Kansas, have pursued microwaves' aversive effects further. In a conditioned suppression environment, they found that the radiation stimulates an aversive response in rats – the cessation of licking associated with a photoelectrically triggered sugar solution reward – by warning the animals of impending electric shock. The conditioning of aversive behaviour is impressive because the subjects have no natural inclination to make such responses, as they would with appetitive behaviour; in situations where the biophysical mechanisms are mysterious and conclusions based on statistical analysis of behaviour, it is absolutely essential to exorcise artifactual uncertainty.

These researchers suggest that modulated microwave cues suppress licking almost as efficiently as do audible tone cues. The subjects reacted to microwave signals as low as 1.2 milliwatts/gram of body weight, and one rat was able to sense .6 mW/gm – equivalent to about 1 mW/cm^2. The team writes in the US magazine *Science* for April 23, 1971, "We offer our data as evidence that confirms and extends the generality of Frey's findings; mammals are sensitive to something that inheres in or accompanies illumination by microwaves at low levels of available power."

Although U.S. scientific findings of specific low power biological effects are growing in number, the only microwave health hazard officially recognized in the USA is general body heating. The present exposure tolerances appear to be more than adequate in safeguarding against known heating effects: heat prostration, testicular damage and the formation of cataracts. However, scientific opinion and government concern, partly engendered by the Radiation Control Act of 1968 and the Occupational Safety and Health Act of 1970, appear to be motivating much more comprehensive studies.

THE NAVY INVESTIGATES

Is there a clear and present microwave danger? If not, what is the precise nature of the phenomena? The United States Navy, in particular, has embarked on an extensive research programme. One of their most ambitious experiments is being conducted by Dr. Dietrich Beischer at the Naval Aerospace Medical Institute, Pensacola Florida. Beischer has constructed an 8x8x10-foot chamber in which Navy volunteers will live for several months at a time; they will be under uniform exposure to microwaves beamed from a 16-foot antenna outside their quarters. (*Microwaves*, April, 1972) Beischer will be looking for long-term effects of extremely low power microwaves, initially less than 1 mW/cm^2, on a gamut of physiological and psychological variables: body weight, temperature, EEG and ECG rhythms, decision making, reaction time, anxiety, etc.

Dr. Beischer was reluctant to tell me more; the Navy has become sensitive since the appearance of a columnist's story about the project. The use of human guinea pigs is less shocking than it appears, however; communications technicians and plywood workers, who use microwave ovens to dry their products, are routinely exposed to the low level radiation that will be employed in the experiment. Except for cases of inadvertent overexposure, there have been no reports of microwave injury. The possibility of insidious long term damage exists, of course; high-power-microwave-induced cataracts have gone undetected for years. In any case, Beischer has had difficulty in procuring volunteers because of manpower shortages in the Navy, and it will be some time before any firm conclusions can be drawn from the project.

A DIFFERENT KIND OF HEAT

Animal experiments have highlighted phenomena which may represent clear hazards to man. Although these studies used not insubstantial amounts of microwave energy, the injuries they produced may not be of thermal origin in the usual sense. In 1961, for example, C.A. Van Ummersen, a Tufts University biologist, exposed chick embryos to microwaves for five hour periods, elevating their temperature only 3.5°C above the normal incubation temperature, but producing many abnormal embryos. Raising embryo temperature by other means had no serious consequences.

Dr. Russell Carpenter of HEW's North-eastern Radiological Health Laboratory and Elliot M. Livstone, Presbyterian University Hospital, Pittsburgh, reproduced Van Ummersen's results with the meal-worm beetle. Irradiating 140 pupae in 80 mW or 20 mW waveguides for 20-30 minutes or 120 minutes, respectively, they found that only 36

developed into normal adults. Again, pupae exposed only to the equivalent temperature ambient were mostly normal. Speculating about the mechanisms responsible for microwave-stymied growth, the researchers write, "Successful development and metamorphosis depend upon a system of delicate chemical balances involving so many enzymes and hormones and their interactions that there must indeed be almost countless targets for microwave radiation to strike." (*IEEE Transactions on Microwave Theory and Techniques,* February, 1971).

Carpenter has also attempted to understand how microwaves cause cataracts. The lens of the eye is particularly susceptible to microwave damage; Carpenter has shown that microwave injury is cumulative at subthreshold doses, i.e. repeated exposure to small amounts of microwave energy can create the same opacities produced by much larger single doses. Thus, cataract formation cannot be a purely temperature dependent phenomenon. In collaboration with Dr. Jin Kinoshita, Harvard Medical School, Carpenter detected a significant decline in ascorbic acid in rabbit lenses soon after irradiation. Drs. Van Ummersen and Frances Kogan found the DNA-synthesis-and-mitosis inhibition were also characteristic concomitants of microwave exposure.

The combination of microwaves with another stressor, such as physical

A microwave transmitter, one of more than 6 million in the US. Government agencies are undertaking a new look at the radiation hazards to man.

restraint, can synergize, according to Dr. Justesen. Harnessed rats subjected to 10.5 mW/gm radiation showed rises in body temperature 1°C greater than those of unharnessed rats exposed to the same radiation. Indeed, a few of the restrained rats succumbed to hyperthermia at a deep colonic reading of 43.5°C, while their untrammeled peers sweated it out at a more comfortable 39°C for a full four hours. Justesen told me that the irritation of the restraint, coupled with the novel stress introduced by the microwaves, can lead to a potentially lethal endogenous release of heat. "The heat at the seat is a good reflection of an animal's emotional state," he said. Microwaves can precipitate an emotional upheaval.

Concern about the biological effects of microwave radiation has been slow in coming in the U.S. One reason, ironically, is the thoroughness of the earlier military research on the thermal hazard. For years, the vast Russian documentation on the subject has been relegated to the back rooms of scientific establishments — the catch basins for persistent irritations which do not conform to prevailing patterns of thought.

The explanation of this benign neglect is complex. Allan Frey has pointed to the generally inadequate quality of available translations from the Russian. But perhaps of greater importance is the great gap between the scientific traditions of the two nations. The Soviets are satisfied with subjective observations of behaviour changes, a practice going back to Pavlov; American scientists are more reductionist. They must have hard objective statistics on behaviour and a microscopic understanding of the mechanism involved. Moreover, Russian experiments have frequently been reported without sufficient detail about experimental procedure. When US scientists have learned of these crucial fine points, they have often been able to confirm results which originally appeared to be dubious.

But a research effort of significant proportions is finally getting under way. The Office of Telecommunications Policy, part of the Office of the President, is co-ordinating the research activities of various government agencies implicated in mircowave safety: Defence HEW, Environmental Protection Agency, FCC, FAA. The Electromagnetic Radiation Management Advisory Council (ERMAC) associated with the OTP has drawn up plans calling for an expansion of microwave study and an increase of funds from the presently allocated $4 million to an impressive $63 million.

In a report issued in December, 1971, ERMAC emphasized the uncertain safety of the 6,000,000 transmitting devices now in use and the 200 000 microwave ovens predicted for the seventies. Using such phrases as "increasing anxiety" and "an era of energy pollution," the report concludes on this note: "Thus, the consequences of undervaluing or misjudging the biological effects of long-term, low-level exposure could become a critical problem for the public health, especially if genetic effects are involved."

The document, which was prepared with the obviously tendentious purpose of obtaining a major increase in funds, may exaggerate the urgency of the situation. Allan Frey, who is a member of the U.S. Standards Institute committee on microwave safety, told me there is insufficient reason to tighten the present 10mW/cm^2 limit, at least until more evidence is in. However, the pioneer in low level effects did say that he is still bothered by the sight of a major radio station opposite an elementary school.

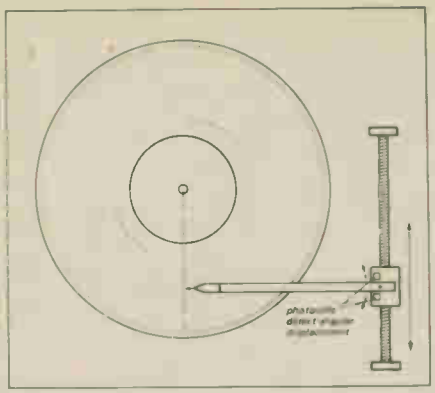


Fig. 1. Simplified drawing of Beogram 4000 shows how tone arm is free to pivot in horizontal plane. Photocells detect angular displacement and servo mechanism then drives complete arm assembly longitudinally to maintain the arm tangentially to record groove. (For simplicity the sensing arm and assembly guide rails have been deleted).

BEOGRAM 4000 TURNTABLE

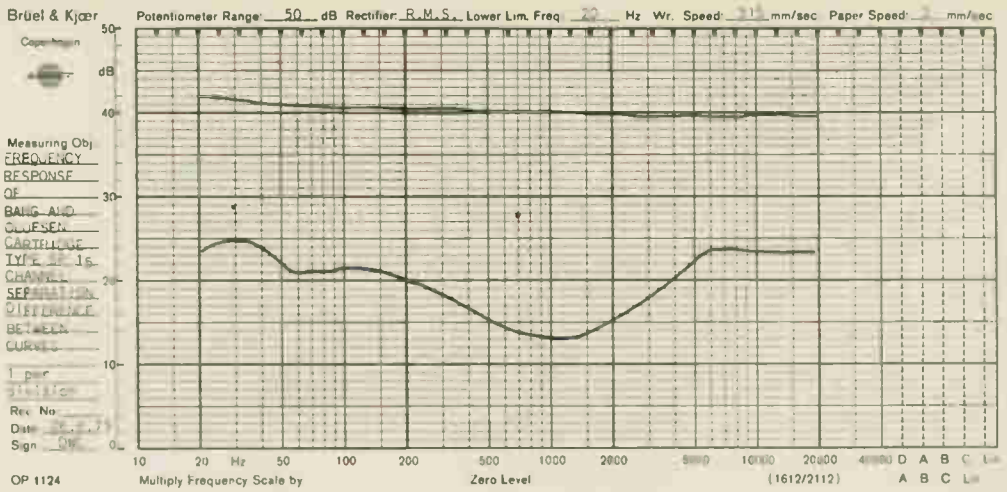
electronics TODAY INTERNATIONAL
product test

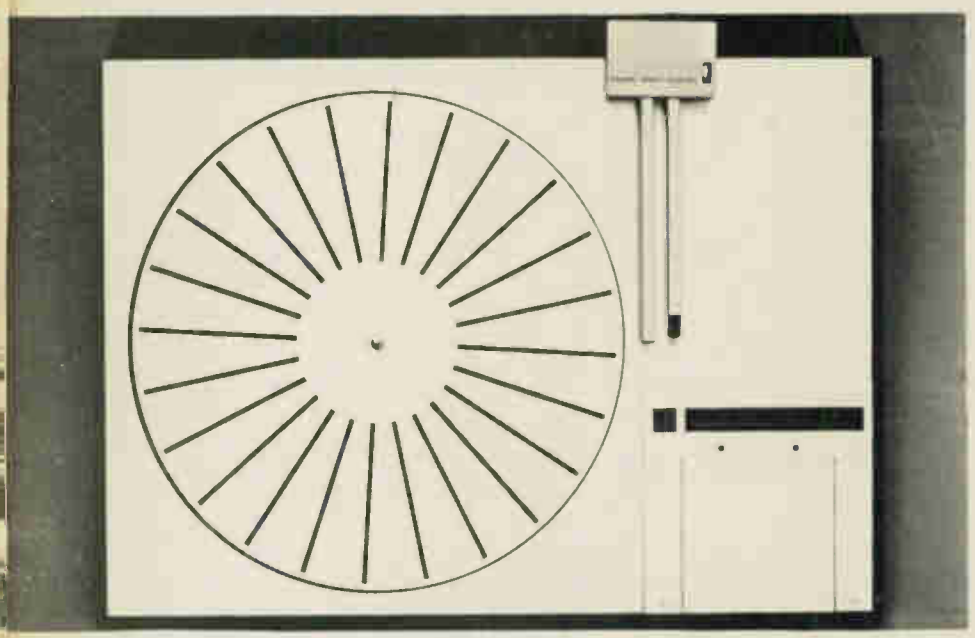
THE BEOGRAM 4000 reviewed in this article is as ahead of its time in terms of engineering, styling, and operating philosophy, as in the field of motor engineering was the ID series Citroen.

The most obvious difference between this and other turntables is the tangential arm which ensures that the pickup moves in a straight line across the full playing width of the record, thus ensuring that the stylus tracks the record groove at the same angle as that of the original recording cutter. This avoids distortion that is otherwise introduced due to the stylus tracking the record groove at a continually changing angle.

The tangential tone arm, plus a second 'sensing' arm, is cantilevered out from a slide which in turn is positively located but free to move longitudinally along a pair of guide rails. The complete slide assembly is driven up and down these rails, via worm gearing, by a small servomotor.

This brilliant example of Scandinavian design combines unique appearance with state of the art technology.





The tone arm is pivoted in both vertical and horizontal planes. The horizontal angle is monitored by a small lamp and shutter assembly in conjunction with a pair of light sensitive cells, such that as the tone arm deviates slightly to the left or right as the stylus advances across the record, a change in the light sensitive cells drives the tone arm assembly to the left or right as is required, seeking always to maintain the arm tangentially to the record groove, and never allowing the error in tracking angle to exceed 0.04°. This unusual system eliminates all the problems inherent in previous attempts to produce a linear tracking tone arm. There is negligible sideways resistance and because of this there is no noticable difference between left and right-hand channels. Also it will accurately track an eccentric record even to the extent of driving in reverse if necessary.

The turntable platter has a reflective metal surface on which are mounted a number of radial black plastic 'spokes'. A small lamp and photo-cell housed in the tip of the sensing arm (this is the arm to the left of the tone arm) detects the presence (or otherwise) of a record on the revolving platter. If a record is on the platter, the light reflected back to the photo-cell will be fairly steady, but if the platter is uncovered, the reflected light from the polished metal turntable will be regularly interrupted by the black radial spokes, hence a chopped dc voltage will be generated by the photo-cell.

When the turntable is switched on, and the record playing sequence initiated, the sensing arm and the tone arm move steadily along their guide rails until the sensing arm is over the edge of the record. If no pulse signal (from the spokes) is received, the sensor assumes that a 12" record is on the turntable. At this point the tracking sensor motor is de-energised and the tone arm automatically lowered. If a 10" record were on the platter then the sensing arm would continue to track inward until the edge of the record was detected and at that point the tone arm would be lowered as previously described.

Should a 7" record be resting on the turntable then the arm would automatically track across to the 7" position, and, apart from lowering the arm, the mechanism would cause the platter drive motor to switch to 45 rpm. A manually operated '33 rpm' overiding facility is provided for those 7" records that must be played at that speed. If there is no record on the platter at all, the sensor detects the moving spokes as the arm tracks across the platter, until, when the centre is reached, the arm is returned automatically to the rest position.

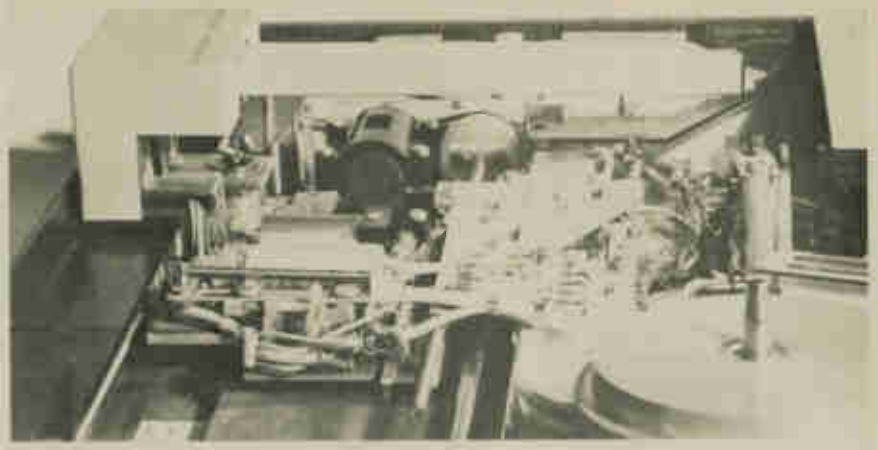
Manual over-ride controls are provided to enable the user to lower the tone arm on to any required part of the record. A calibrated scale assists the user to select any desired track — these manual controls are interlocked with the spoke sensing circuitry ensuring that the arm can only be lowered if a disc is on the platter.

The raising and lowering arrangement for the tone arm operates electropneumatically and incorporates an electromagnetic to overcome the spring loaded mechanism.

The advantage of this electropneumatic system is that should the power be removed from the turntable the arm will immediately rise, thereby protecting the record and the needle against possible damage should power be reconnected.

The Beogram 4000 is not only

BEOGRAM 4000 TURNTABLE



unusual in its method of operation, it is also a very fine example of modern industrial design, it is extraordinarily sleek – approximately half the height of nearly every other turntable on the market. The actual unit itself is a mere two inches high and the tinted perspex cover adds a further two inches.

The finish is exceptional. It consists of a black tapered base approximately one inch thick surmounted by an oil timbered surround also one inch thick. The top panel is manufactured from brushed aluminium in six sections, each neatly interlocking into the one next to it.

The platter, located on the left-hand side of the control panel, is also brushed aluminium on which are located the radial rubber spokes described above.

The turntable, tone and sensing arm assemblies are supported on a die-cast frame which is completely separate from the rest of the unit. This frame is supported on three horizontal springs and provides isolation to vibration in both the horizontal and vertical planes. The resonance frequency of this sprung assembly is approximately 4.5 Hz.

The control panel is divided into four sections, the rearmost of these is approximately one inch wide. The turntable speed checking strobe light is at the left hand end of this section, and a calibrated scale showing the position of the stylus on the record is across the remainder. Just below the scale are two red slotted adjustment buttons for 33 and 45 rpm speed control. These little red buttons illuminate to indicate the speed that has been selected.

The remainder of the panel is divided, from left to right into a 3/4" wide strip, a 3" wide strip and another 3/4" wide strip.

The left hand panel is labelled 33 at the front and 45 at the back. If the '33' end of this panel is pressed, the turntable will rotate but the tone and sensing arm assembly will not move across the record. This facility is provided so that a dust remover may be used on the record, prior to playing.

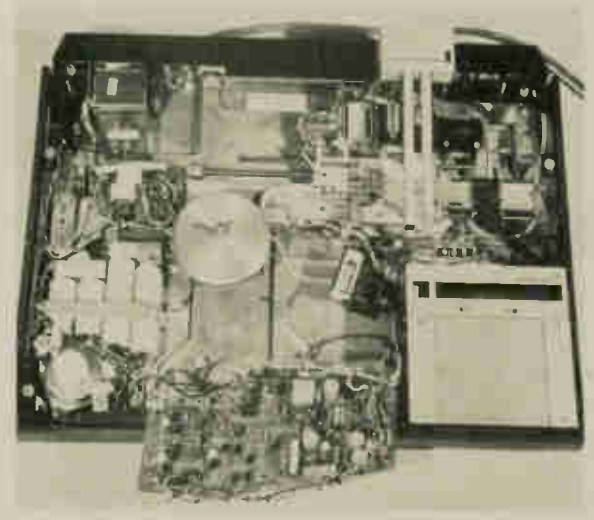
The centre panel has four arrows, one at the centre of each side. Pressing the panel at the appropriate place causes the tone arm to be lifted or lowered, or the arm driven to the left or right.

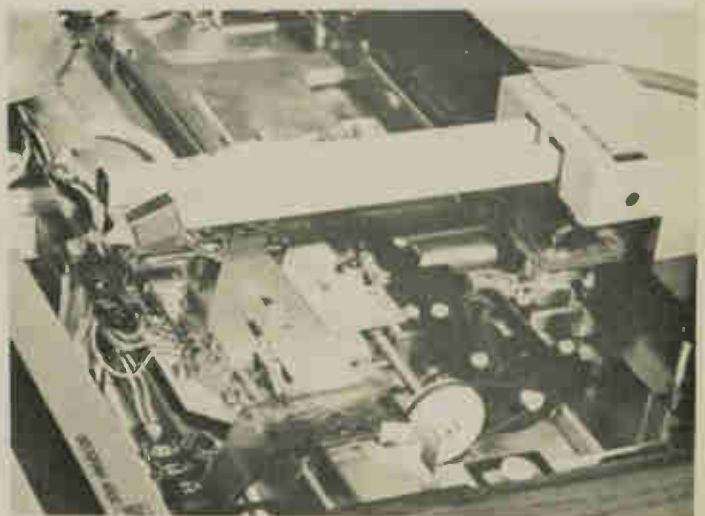
The right hand panel is labelled 'ON' at the front and 'OFF' at the rear and in most instances this is the only control that needs to be touched when one wishes to play a record. Pressing the panel at the 'ON' position immediately causes the turntable to rotate, the arm to track towards the centre and the automatic sensing and lowering process to take place as previously described.

All the electronic circuitry is located below deck on six printed circuit boards. These consist of a power supply board, a motor speed control board, a small computer board (to use B & O's terminology) that provides all the necessary interlocking between the lowering and raising modes of the tone arm, and two boards that contain the relay providing motor speed change control, and a pair of contacts that short the output from the cartridge until the tone arm is actually resting in the record groove – thus eliminating the obtrusive noise that one normally hears as the stylus drops onto the record and engages the groove. These boards are individually shaped so they fit into the available space below the turntable and the tone arm drive assemblies.

The cartridge is unusual for a number of reasons, firstly, because of its miniature size, and secondly, because the stylus is not replaceable. Rather, an exchange arrangement is involved whereby a damaged stylus may be exchanged for a new one at half price. Another unusual characteristic of the cartridge is the use of a naked diamond which is pressed into the stylus bar rather than the construction common to cheaper cartridges which generally use a diamond chip glued on to the stylus bar.

Each cartridge is supplied with an individual calibration graph. An interesting feature of the graph





MEASURED PERFORMANCE OF BEOGRAM 4000 WITH BANG & OLUFSEN SP15 CARTRIDGE SERIAL NOS: 61446 & 8002699

Frequency Response:
20Hz to 20kHz ±1dB
Channel Separation at 1kHz:
27dB
Channel Difference:
0.2dB
Sensitivity:
(Re 1kHz at 5 cm/sec)
3.1mV
Speed Accuracy:
Accurately Variable ±2%
Hum & Rumble:
50dB (A)
Wow & Flutter:
0.15% rms.
Dimensions:
10 x 49 x 38 cm.
Weight:
12 kg.

supplied is a resonance peak around 18 kHz. This peak is not in fact a fault or characteristic of the cartridge but rather is characteristic of the Bruel and Kjaer test record on which the calibration is performed. Surprisingly few testing authorities seem to be aware of this phenomenon.

The performance of the cartridge was very good in some respects and average in others. The frequency response was exceptionally smooth with no noticeable resonance in the audible range. The manufacturer's claim that the cartridge has useful response up to 45 kHz makes its suitable for discrete four-channel records if used with a suitable decoding unit.

The performance of the tone arm was very good, firstly in terms of operational simplicity and secondly in terms of excellent clarity. This was most noticeable on the AR demonstration record, band 5, side 2. Towards the end there is a quick succession of notes played on the flamenco guitar, and it was pleasing to hear the clarity with which these notes were produced. With some cartridges these notes tend to blur due to mistracking. Although the cartridge trackability was not quite as good as the *very* best that we have encountered, its frequency response and the advantage gained with the tangential tracking system provided very good performance.

Some mistracking was noticed at very high levels on such instruments as bells, triangles and harpsicords, but this slight mistracking is more than compensated for by the exceptional clarity and crispness of all type of program material, whether orchestral or electronically generated. Particularly noticeable was the added depth, which on some records resulted in notes being heard that we had never noticed before — presumably due to masking because of tracking angle error, particularly near the centre of the record.

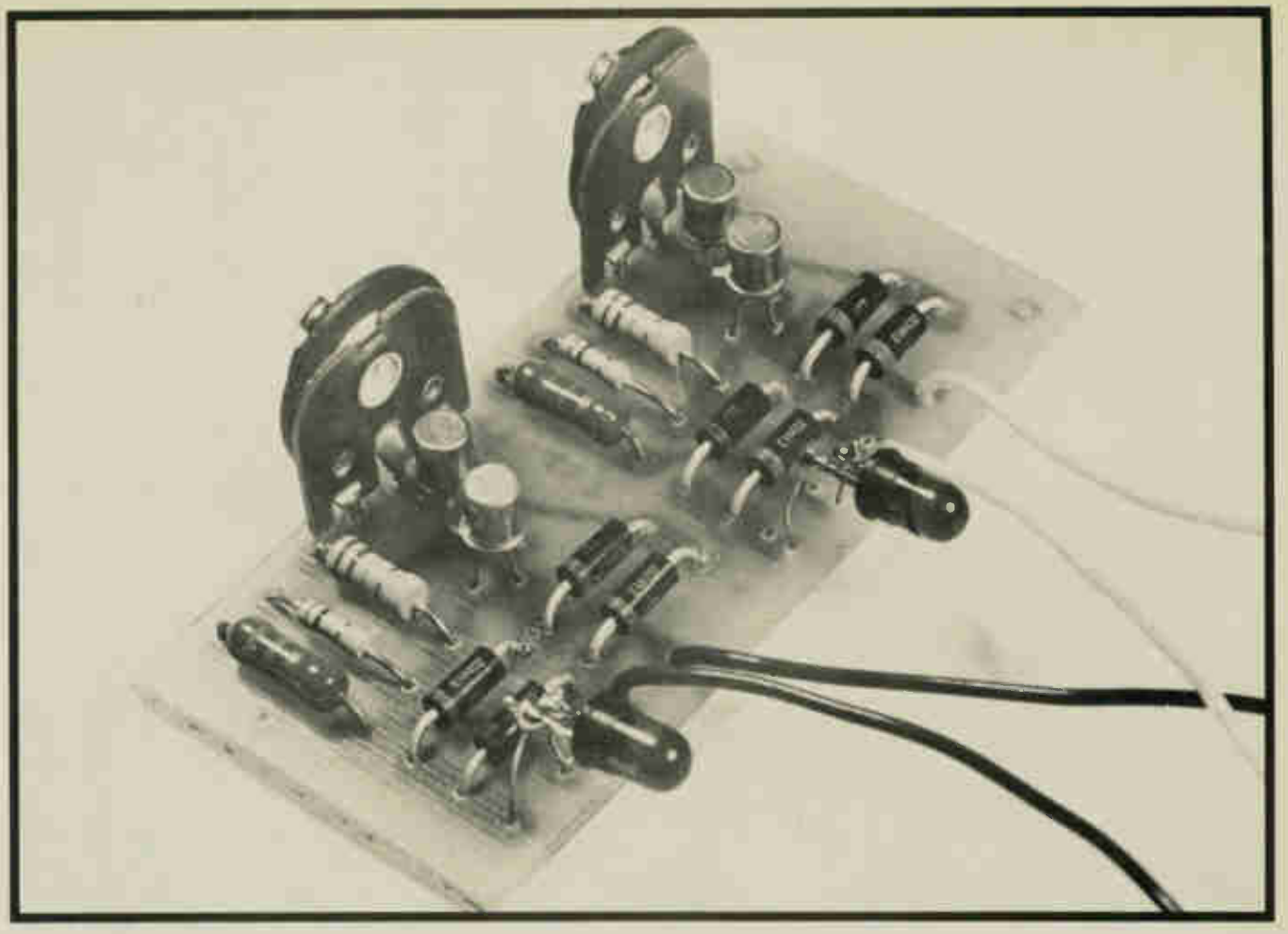
The measured performance was in accordance with the manufacturer's test data in nearly all respects, the only difference being a slightly higher wow figure. This is almost certainly due to differences in measuring equipment used by ourselves and the manufacturers — our equipment measuring right down to dc.

Hum was measured at a almost unbelievable low of 61 dB. The combined hum and rumble figure of 50 dB (A) is predominantly rumble, possibly from the drive system; the figure is still totally acceptable.

The speed adjustment is very easy to use and provides a change of approximately ±2%.

Despite its apparent complexity, the Beogram 4000 is by far the simplest unit to use that we have ever encountered. Its almost totally automatic operation and inbuilt protection against misuse means that it may safely be used by young children.

It has a number of exceptional features including the tangential arm motion which puts it way ahead of its class in engineering design. ●



PROJECT 417

THE OVER-LED

Is your power amplifier clipping? This simple monitor lets you know.

MANY people are aware of distortion when they turn up the volume control on their hi-fi equipment – but are usually unaware of the cause.

Nine times out of ten this distortion is caused by 'clipping'. That is, the amplifier does not have enough reserve power to handle the peak music transients at the required volume.

During such peaks, the amplifier is driven into an overload condition and as a result the music peaks are 'clipped'. This results in harsh sounding reproduction.

This simple device, which may be built into your existing amplifier, or separately located, flashes a warning light if the power level at which clipping occurs is exceeded.

Two completely independent circuits are provided so that each channel of a stereo system may be monitored separately.

TABLE 1

SPEAKER IMPEDANCE						
RMS watts per channel	4Ω		8Ω		16Ω	
	R1	R3	R1	R3	R1	R3
5	68	5.6k	82	8.2k	120	12k
10	82	8.2k	120	10k	180	18k
15	100	10k	150	15k	220	22k
20	120	12k	180	18k	240	24k
25	150	15k	220	22k	270	27k
35	180	18k	240	24k	330	33k
50	220	22k	270	27k	390	39k
75	240	24k	330	33k	470	47k
100	270	27k	390	39k	560	56k

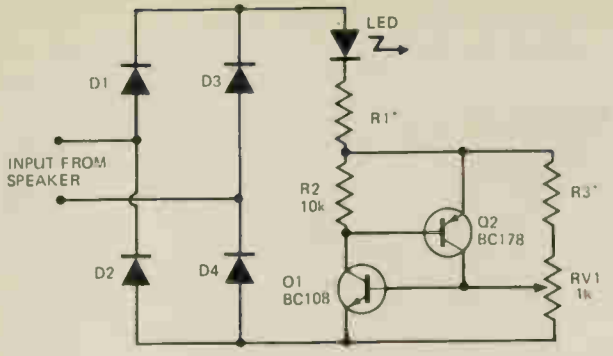


Fig. 1. Circuit diagram of overload detector. One channel only shown.

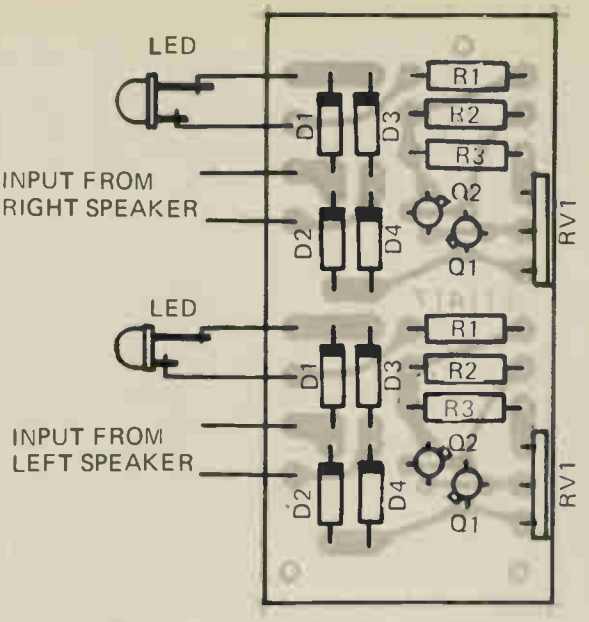


Fig. 2. Component overlay.

HOW IT WORKS

The output of each power-amplifier channel is monitored at the speaker terminals. The output is bridge rectified by D1-D4 so that both positive and negative transients may be detected.

Transistors Q1 and Q2 (together) are equivalent to a sensitive gate SCR (silicon controlled rectifier). If the voltage at the base of Q2 is more than about 0.6 volts above its emitter, Q1 and Q2 will each turn hard on and latch on, until the current through them drops to zero.

When transistors Q1 and Q2 are on, the current flowing through them also flows through the LED causing it to illuminate. Resistor R1 limits the peak current through the LED to about 100 mA. The range of calibration potentiometer RV1 is set by resistor R3. The values of R1 and R3 are provided in Table I for various amplifier power ratings and speaker impedances. These values are not critical. If your amplifier has a power rating other than that specified, the nearest values will do.

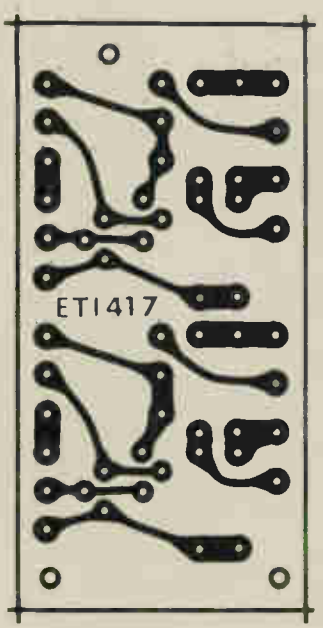


Fig. 3. Printed circuit board (full size).

PARTS LIST

One set required for each channel.

R1	resistor	as Table 1
R2	"	10k 5% ½ watt
R3	"	as Table 1
Q1	transistor	BC 108 or similar
Q2	"	BC178 or similar
D1 to D4	Diode	1N4001 or similar

LED light emitting diode TIL209 etc.

PCB ETI 417 (1 only required – each board has provision for two channels)

CONSTRUCTION

Mount all components on to the printed circuit board in accordance with the component overlay. Make sure that all diodes are correctly orientated, in particular the LED's. The LED's will not be damaged by reverse polarity but will not operate in that mode.

Whether the unit is mounted inside the amplifier or external to it in a small box will be a matter for the individual constructor. The printed circuit board may be mounted in any suitable position within the amplifier and leads extended to front-panel mounted LEDs if required.

Polarity of the leads to the amplifier output terminals is immaterial but make sure that the leads of separate channels are not mixed. This is best avoided by twisting each pair of leads to each channel.

CALIBRATION

There are several ways of calibrating the unit.

By far the best way is to connect an audio oscillator to the input of the amplifier (both channels driven at the same time), then, with the amplifier volume control at a low setting, adjust the oscillator to provide a 1 kHz sine-wave.

Set both trim potentiometers (RV1) so that their wipers are nearest R3.

Now increase the amplifier volume until clipping occurs. This is very easily identified as a sudden harshness of tone. Do not leave the volume control at this setting for more than a second or two, as apart from the pounding you are giving to your ears, some amplifiers will not tolerate a sine-wave input at clipping level for extended periods without damage.

Once the clipping point has been established, turn the volume down again, and then quickly turn up to the clipping point momentarily, meanwhile adjusting the trimming potentiometers RV1 until a point is reached where the light emitting diodes just come on.

Repeat the procedure a few times – finally arriving at a setting at which the LED's come on just before the clipping point.

If you do not have access to an oscillator, the device can be set by playing a test record that contains a sine-wave tone – or failing this – by playing a record of a solo instrument such as a flute. A recording of the human voice is also very effective. In such cases the same calibration procedure described above should be followed. ●

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SN[illegible]	0 20	0 18	0 16	SN74[illegible]N	0 20	0 18	0 16	SN74142N	2 88	2 88	2 52
SN[illegible]AN	0 38	0 38	0 33	SN[illegible]N	0 20	0 18	0 16	SN74145N	1 44	1 44	1 26
SN[illegible]N	0 20	0 18	0 16	SN[illegible]N	0 20	0 18	0 16	SN7414[illegible]N	2 30	2 30	1 83
SN[illegible]	0 20	0 18	0 16	SN7454N	0 20	0 18	0 16	SN74148N	2 01	2 01	1 63
SN[illegible]AN	0 38	0 38	0 33	SN7460N	0 20	0 18	0 16	SN74150N	2 30	2 30	2 01
SN[illegible]N	0 24	0 21	0 18	SN[illegible]N	0 33	0 30	0 27	SN74151N	1 15	1 15	1 00
SN[illegible]N	0 20	0 18	0 16	SN[illegible]N	0 38	0 38	0 34	SN74153N	1 09	1 09	0 95
SN[illegible]AN	0 44	0 44	0 38	SN74[illegible]N	0 44	0 41	0 37	SN74154N	2 30	2 30	2 01
SN[illegible]N	0 40	0 38	0 35	SN7474N	0 48	0 48	0 42	SN7415[illegible]N	1 15	1 15	1 00
SN[illegible]N	0 40	0 38	0 35	SN7475N	0 59	0 55	0 51	SN74156N	1 09	1 09	1 00
SN[illegible]	0 25	0 22	0 19	SN7476N	0 45	0 36	0 32	SN7415[illegible]N	1 09	1 09	0 95
SN[illegible]	0 33	0 33	0 28	SN7480N	0 80	0 70	0 50	SN74159N	2 44	2 44	2 14
SN[illegible]AN	0 44	0 44	0 38	SN7481N	1 25	1 10	0 95	SN74160N	1 58	1 58	1 38
SN[illegible]	0 20	0 18	0 16	SN74[illegible]N	0 87	0 80	0 72	SN741[illegible]N	1 58	1 58	1 38
SN[illegible]	0 25	0 23	0 21	SN[illegible]N	1 20	1 10	1 00	SN74162N	1 58	1 58	1 38
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SN[illegible]AN	1 80	1 80	1 57					SN74199N	2 88	2 88	2 52

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AF[illegible]	44p	BFX[illegible]4	55p	OA5	60p	ORP12	55p	2N2147	75p	2S303	70p
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BA[illegible]	10p	BFY[illegible]0	20p	OA200	8p	P346A	20p	2N2926	10p	40361	45p
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BC10[illegible]	12p	BFY90	75p	OC20	1 25	TIP30A	58p	2N3055	45p	40486	75p
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CRS 3/10AF	100v	40p
CRS 3/20AF	200v	45p
CRS 3/40AF	400v	55p
CRS 3/60AF	600v	65p
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CRS 5/400	400v	60p
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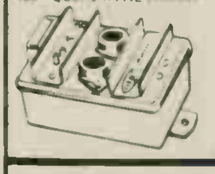

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B1/10	100v	25p
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B2/10	100v	40p
B2/20	200v	45p
B2/60	600v	50p
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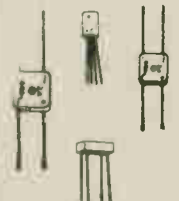
[illegible]H x [illegible]L x [illegible] dia



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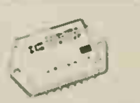
Integrated circuit radio as featured by many magazines (PW Jan 73 Reprint Ref No. 19 for 10p). £1 20.



Toshiba Power and Pre-amplifier modules
TH9013P 20 watt Power amplifier 22 0-22 or single 45 volts operated. £4 57.
TG9014P Stereo on two channel preamplifier £1 50 (circuit book No. 42 price 10p).

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3015F 7 SEG.
I.C. size complete with data price **£2** each or 4 for **£7** (digital clock circuits ref. No 31, 15p).

BUILD YOURSELF A POCKET CALCULATOR

A complete kit packaged in a polystyrene container and taking about 3 hours to assemble – thats the Sinclair Cambridge pocket calculator from Henry's Some of the many features include interface chip thick film resistor pack, printed circuit board electronic components pack Size 4⅓" long x 2" wide x ¹¹⁄₁₆" deep
Free of charge with the kit for the more advanced technologist is a 32-page booklet explaining how to calculate Logs, Tangents, Sines etc
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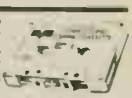

	3 for	6 for	10 for	25 for
C 60	£1 00	£1 80	£2 80	£6 75
C 90	£1 33	£2 57	£4 20	£10 25
C 120	£1 62	£3 15	£5 00	£12 25

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16" Twin spring unit	Reverbs	6 50 p & p 25p
Car Tachometer Electronic		7 50 p & p 15p
VHF 205 Marine band converter		3 95 p & p 15p
B2005 4 Ch. mic. mixer		2 95 p & p 15p
B2004 2 ch. Stereo mixer		4 75 p & p 15p

Henry's RADIO LIMITED
EDGWARE ROAD, W2

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FREE—Teak cabinet with complete kit.

KIT PRICE £28·50

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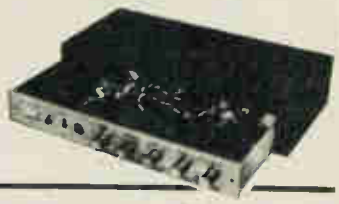
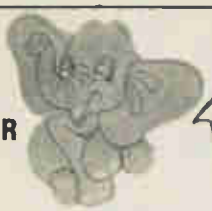
BUILD THE TEXAN

20 + 20 WATT IC STEREO AMPLIFIER

As featured by *Practical Wireless* 1972



BUILD THE NEW HENELEC STEREO FM TUNER



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Produced to give high performance with a realistic price. (Parts list and constructional details Ref. No. 5 30p). Henry's are sole distributors UK and Europe.

Kit price

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OR BUILT AND TESTED £24·95 (+ VAT)

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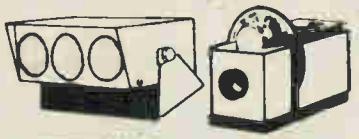

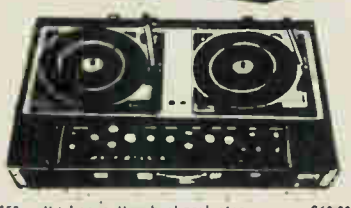

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System 25 (list approx. £109) £79·50
System 76 (list approx. £117) £89·50

(plus 10% VAT and plus £1·45 carr/packing)

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AMPLIFIERS (carr. etc. 20p).

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555, 3 watt 12 volt	£2·85
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608, 10 watt 24 volt	£4·10
410, 10 watt 28 volt	£4·95
Z30, 15 watt 30 volt	£3·57
E1206, 30 watt 45 volt	£9·75
Z50, 30 watt 50 volt	£4·37
E1210, 2½ + 2½ watts 12 volt	£5·25
RE500, 5 watt IC mains operated Amplifier with controls	£6·30
SAC14, 7 + 7 watt Stereo with controls	£8·00
SAC13, 15 + 15 watt Stereo with controls	£11·00
SINCLAIR UNITS (carr. 20p) Z30 £3·57, Z50 £4·37	
Stereo 60 Preamplifier	£7·97
PZ5 £3·97, PZ6 £6·37, PZ8 (for Z50) (TRANS £2·95)	£4·77

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Z40 15 Watt amplifier	£5·45
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PZ5 Mod. for 1 on 2 Z40	£4·98
PZ6 Mod. (S Tab) 1 on 2 Z40	£7·98
PZ8 Mod. S(Tab) 1 on 2 Z80	£7·98
TRANSFORMER FOR PZ8	£2·95
NEW FM TUNER	£11·95
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HC244R Stabilised version	£4·25 carr. 30p
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P11 24 volt 500mA (chassis)	£2·80 post 20p
P15 26/28 volt 1 amp (chassis)	£2·70 post 20p
P1080 12v 1 amp (chassis)	£3·25 post 20p
P1081 45v 0·9 amp (chassis)	£4·40 post 20p
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GARRARD 2 speed 9 volt tape decks. Fitted record/play and oscillator/Erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits. £9·50 carr. 30p.

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AVOMETER MOVEMENTS

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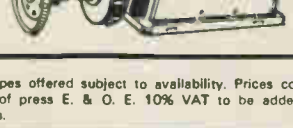
CHANNELS 21 TO 64

Brand new transistorised geared tuners for 625 Line Receiver 1F output. £2·50 Post 20p



All types offered subject to availability. Prices correct at time of press E. & O. E. 10% VAT to be added to all orders.

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0·01 Diam Mono Filament £1·50 per 25 metre reel
0·13 Diam 64 Fibres Sheathed £1·00 per metre
SPRAYS 15mm Diam. Mares Tails £8·50

TOP QUALITY SLIDER CONTROLS

60mm stroke high quality controls complete with knobs (post, etc. 15p any quantity)

Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K, 1 Meg 45p each

Ganged Log and Lin 10K, 22K 50K, 100K, 250K 65p each (Quantity discounts available) Complete with knobs

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* Polished wood cabinet £4·60 post 35p.

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FR4	4"	5 watt	£4·00
FR65	6½"	10 watt	£5·50
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AA12	5"	15 watt	£3·20
B110	5½"	15 watt	£5·60
B200	8"	15 watt	£6·45
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TWEETERS AND CROSSOVERS (post 20p)

K2006	10 watt	8 or 15 ohms	£1·90
FHT6	15 watt	8 ohms	£3·20
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Axcent 100	30 watt	8 ohms	£4·90
K4009	1kHz/5kHz	C/o	£2·00
SN75	3kHz var.	C/o	£1·75

SPEAKER KITS (carr. etc. 35p)

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20-3	8"	40 watt	£15·00 each
LINTON 2	20 watt		£15·95 pair
GLENDALE 3	30 watt		£28·95 pair
DOVEDALE 3	50 watt		£42·00 pair
KEF KK2			£20·40 each
KEF KK3			£32·00 each

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(carr. etc. 30p)

200H 20K/Volt Slimline with case £4·95. TLH33D 2K/Volt Robust with case £4·95. U437 10K/Volt Steel case, AC up to 40KHz £4·95. U4324 20K/Volt with AC current ranges £8·00. AF105 50K/Volt with Leather case £9·50. U4313 20K/Volt AC current. Steel case £10·50. U4341 Plus Built in transistor tester £10·50. Model 500 30K/Volt £9·95.

OTHER EQUIPMENT

SE250B Pocket Signal Injector 1·90 carr. 15p. SE500 Pocket Signal Tracer 1·50 carr. 15p. TE15 Grid Dip meter 440kHz-280mHz 13·45 carr. 30p. TE40 AC Millivoltmeter 1·2mHz 18·75 carr. 35p. TE65 28 Range valve voltmeter 19·25 carr. 40p. TE20D 120kHz-500mHz RF Generator 16·95 carr. 40p. TE22D 20Hz-200kHz Audio Generator 18·75 carr. 40p. SE350A Deluxe Signal Tracer 9·95 carr. 20p. SE400 Volts/ohms/R-C sub./RF field/RF gen. 11·25 carr. 20p.

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electronics tomorrow

CHEAP CALCULATOR COMPONENTS

WHERE is the cheapest place to buy calculator components if you wish to build up your own machine to your own specifications? Well first consider what you need based on one of the available LSI chips.

The prices (right) are based on recommended manufacturers one off prices and rough approximations on resistors, etc.

Before starting on the design of your calculator decide which main chip you are going to use. The two types mentioned above are the most popular and used in most available machines although other chips are available from MOSTEK and a new range from CALTEX will be available soon. A table of features of some of these chips is shown as Fig. 1, some features may seem unimportant but things like leading zero suppression can be most annoying if missing.

One point worth considering before buying is the availability and service. Texas chips are reasonably ex-stock at TISCO at Slough but Texas are a bit reticent about giving away too many data sheets, GIM are more helpful and their chips are available from Semi-Specs. Both Mostek and Caltex stocks are in a state of flux at present with Mostek changing to a new distributor after Emihus and Caltex have only recently reached franchise agreements with Guest International.

Having purchased your chip you are now faced with the choice of display. For a pocket machine the small LED (MAN3 type) is best with four (DL34) or six (TIL360) digit packages available for ease of wiring. Alternatives are phosphor-diode (DGI2H), Sperry, Large LEDs (MAN7, DL 707) Panaplex, Nixies, Liquid-Crystal, etc. The phosphor-diode need very little in the way of interfacing whereas the others require segment and digit drivers, the high voltage displays are only really suitable for mains desk machines. When comparing prices of displays add on the cost of interfacing before comparing different types. Interface chips such as the SN75491, SN 75492, CA3081 and CA3082 are available for space saving but not necessarily cost savings.

Keyboards for a desk machine can be made from simple push switches but for a pocket machine it might be best to purchase a ready made board, Guest International carry quite a good range.

Well so far you could have spent £50-£70, a lot of work, bought from several different places with different delivery times and ended up with a rather unprofessional looking machine. (I am still waiting for someone to make decent cases available to the amateur for this and similar projects). How would you like to be able to buy all the components from one place with a guarantee and 50% discount? "Sounds a good idea", you say, "but where do I buy from? Well here is a list -

1. Advance Electronics,Raynham Road, Bishops Stortford, Herts. 0279-55155.
2. Advance Telecommunications Equipment, Jafam House, Boundary Road, Woking, Surrey. 0486-25011.
3. Sinclair Radionics, St. Ives, Hunts.
4. Heath (Gloucester) Ltd., Gloucester, 0452-29451.

'Ah', you say, 'those are all kit calculator manufacturers'. Of course, buying a kit is the simplest and cheapest way of building a calculator even if you wish to modify it to your own specifications.

Advance Electronics (not connected with Advance Telecommunications) brought out a desk machine kit in September 1972, this proved to be an extremely popular kit which sold at £40, there may be some left but stocks are probably low. The author had several of these and modified them to give fixed and floating decimal places and then put clock chips in them as well (sharing the same display). The kit was based on the TMS1802 chip with MAN3 type LED display, the finished machine had an attractive case and a nice positive keyboard.

COST OF A TRUE 'OO–IT–YOURSELF' CALCULATOR

Texas TMS0100 family (previously 1802)	£29.00	
General Instrument C500 family		£13.50
Keyboard (approx price)	8.00	8.00
Case (assuming a good plastic box)	1.00	1.00
Display 9 of MAN3 Type LEDs	13.50	13.50
Resistors (about 20-30)	.60	.60
Capacitors	.40	.40
Transistors & Diodes	1.50	1.50
Display Driver ICs	4.00	2.00
Hardware	1.00	1.00
BASIC POCKET MACHINE	59.00	41.50
Mains power supply	4.00	4.00
BASIC DESK MACHINE	63.00	45.50
Rechargeable Cells	5.00	5.00
POCKET MACHINE (RECHARGEABLE)	68.00	50.50

Manuf.	Chip	Digits	Constant	Other Features
Texas Instr.	TMS0103	8	Yes	%, $^1/x$, $\sqrt{x}$ on other chips in this range.
General Instr.	C500	8	On all 4 functions	No leading Zero suppress.
" "	C550	4+4	"	"
Mostek Corp.	MK5010	10	No	
" "	MK5013/4	12	Yes	Memory, can be interfaced with printer chip.
Caltex Corp.	CT5032	12	Yes	Memory, Average, Print interface available.

Heathkit brought out a similar machine with a TMS0119 chip and Sperry display and, although I have not seen one, it would seem a good basis for a desk machine, the price is £39.60 (including VAT?) and is presently available. As this has a Sperry display it is a better bargain from the contents point of view than the Advance desk kit but as I haven't seen one I cannot comment on the finished product.

Advance Telecommunications brought out the first pocket machine kit in conjunction with Semicomps Ltd. of Wembley. This kit is based on the C500 chip and comes complete with a 600mAH NiCD battery and mains charging unit. Unfortuneatly the finished product was not very attractive but this might be a good point if you are only interested in the components as it has a nice display and 30 transistors. Price of the Supercal kit was just under £40. Heathkit followed with their IC2009 kit with the TMS0103 chip and a preassembled board of nine LEDs, 13 transistors, 4 driver ICs (SN75491/2s), 35 resistors, etc. Heath describe this as a portable rather than pocket machine, the price unfortuneatly is £59.40.

SINCLAIR CAMBRIDGE

Sinclair followed their Executive success with the Cambridge and the Cambridge kit. This was first announced at about the £33 area and advertised as such. Sinclair then received such large orders for the finished machine that they were able to buy larger quantities of components and thus to reduce the price of the kits, I have been assured that anybody who bought at the old price will obtain a refund on the price difference. The kit is based on the C500 chip with a nine digit LED package, one driver IC, one transistor, ten diodes and a scattering of resistors and capacitors. The author put together one of these kits in two and half hours, the assembly instructions were full of errors and a set of errata sheets covered most of the errors but one of two were missed out and I think it is worth mentioning them here:

1. It is not clear how to fit the battery clips as they may foul a line on the other side of the PCB, mine did and the batteries boiled.
2. It takes a few minutes to orient yourself with the PCB, it would have been best to mark them as side A and side B.
3. Diodes D2-D10 were incorrectly indentified. They are 1N914s and are described as black with a white band marking the positive end, in my kit they were half pink and half black and with these the black end is positive, there was no description of these at all and I think a lot of people would insert the diodes incorrectly.
4. The worst part about this change is that the zener diode supplied is described as half pink and half brown and therefore looks identical at first sight to the 1N914s supplied. However Sinclair also supplied another zener diode in a different package type with an errata sheet but did not say why this should be used in preference to the other, I built mine with the pink and brown one and it works.

Assembling the ON/OFF switch presented a small problem, the metal contact is a spring circlip designed to fly into a far corner of the room at the slightest provocation. Those of you who know the authors study will know why it took 20 minutes to find it again. The most galling thing was that when offering the keyboard up to the PCB the switch did not pass through the hole in the metal keyboard plate and the melinex washer. On checking I found a note on one of the errata sheets to say that I should have assembled the switch at this stage not earlier. Considering the earlier problems and adding those of holding keyboard and PCB together during refitting of the switch I decided to enlarge the hole until the switch would pass through, it works.

These are no functional tests throughout construction, as I had no suitable batteries I tested my machine by connecting the battery clips to a 6V battery and apart from one easily cured solder bridge (desolder braid in the kit) the machine worked. When the batteries were inserted the machine did not work due to the short mentioned earlier without my (accidental) functional test finding this short would have been impossible.

The finished product works well, although I haven't yet found why the DP key doesn't work. The case seems a bit insubstantial and I haven't yet tried my usual test of dropping it on a concrete floor. If Sinclair are after the schoolboy and housewife market with this machine the case (beautiful looking though it is) needs attention. I have taken mine apart several times to show people its guts and I think Sinclair might consider offering a clear plastic case for those who are schoolboys at heart.

Despite the above problems the Cambridge is a good machine as a finished product. The keyboard is more positive and has larger keys than most other comparable machines. The display has small lenses on each digit easily legible from two or three feet and a large readout aperture makes reading easy even at an angle.

The beautifully designed little brown case (despite the comments above) is only the size of a small pack of cigars or 20 kingsize cigarettes. Sinclair have obviously taken a lot of trouble, time and money to design a case so beautlfuuly compact and yet reasonably sturdy. Sinclair have said that the case would withstand the concrete floor test, but I think that the components would go flying - perhaps a screw to hold the case halves together would correct this problem.

For the market that it is intended for, the built version Cambridge is probably the best value for money by £10 or so. If anything goes wrong with either the bit or the finished product then there is a Sinclair guarantee to fall back on.

Sinclair have changed their instruction book and this should clear up most of our criticisms.

The last (at present) of the kits is the

continued on page 67

Manufacturer	Kit	Based On	Approx Price (Inc.VAT)	Points out of Ten as - Finished Unit	Kit	Component Set	Modification Ability	Comments	Available From
Advance Electronics	Desk Kit	TM51802	£44	8	9	8	9	Lots of room in the case. Sockets can be used for all SC's	Advance Electronics Bishops Stortford Herts.
ditto	International	TMS0100 Family	£27	9	9	7	4		See this issue
Advance Telecommunications	Supercal	C500	£38	4	*	7	4	Not very attractive case	Semicomps Ltd. Wembley, Middx.
Heathkit	IC2108 (Desk)	TM50119	£40	*	*	8	*	Heathkits offer good-looking products and their kits are world famous so these two kits should score where * appears	Heath (Gloucester) Ltd. Gloucester.
ditto	SC2009 (Portable)	TMS0103	£60	*	*	6	*		
Sinclair	Cambridge	C500	£28	6	5	5	4	See text.	Sinclair, St. Ives, Henry's Radio.

N.B. An asterisk shows that the kit has not been evaluated from that point of view.

The largest selection

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Packed with transistors, diodes, capacitors and resistors. COMPONENT VALUE £1.50
3 for ONLY 55p + p&p 30p

SPECIAL As above PLUS Power Transistors ONLY 55p each + p&p 15p

STABILISED POWER MODULES Complete with circuit diagrams etc
99p each + p&p 15p

PANOLINE BOARDS [illegible] approx
4 for 30p + p&p 20p

FIBRE-GLASS PRINTED CIRCUIT BOARDS

[illegible] approx 2 for 55p

DECON-DALO 33pC Marker

Etch resistant printed circuit marker pen 90p each

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Packs containing approx 30 sq ins various sizes all 1 metre 55p

REPANCO CHOKES & COILS

RF Chokes CH1 2 mH 25p CH2 5 mH 25p CH3 7 mH 25p CH4 10 mH 25p CH5 1 mH 25p
Coils DRX1 Crystal set 56p DRR2 Dual range 45p

COIL FORMERS & CORES

NORMAN [illegible] Cores and Formers 7p
[illegible] Cores and Formers 8p

SWITCHES

DP DT Toggle 25p SPST Toggle 18p

FUSES

[illegible] QUICK BLOW 4p each ANTI SURGE 5p each

EARPHONES

Crystal 2.5mm plug 33p [illegible] 2.5mm plug 22p
3.5mm plug 33p [illegible] 3.5mm plug 22p

DYNAMIC MICROPHONES

B1223 200 ohms plus on-off switch and 2.5mm and 3.5mm plugs £1.60

3-WAY STEREO HEADPHONE JUNCTION BOX

HJ012 £1.87

2-WAY CROSSOVER NETWORK

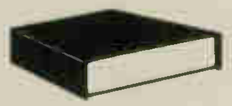
K4007 80 ohms [illegible] £1.21

CAR STEREO SPEAKERS

[illegible] £3.85p per pair

BI PAK CATALOGUE AND LISTS SEND S.A.E. AND 10p

INSTRUMENT CASES



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No.	Length		Width		Height	Price
BV1	8	x	5½	x	2	90p
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BA3	4	x	2½	x	1½	41p
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BA5	4	x	2	x	2	41p
BA6	3	x	2	x	1	34p
BA7	7	x	5	x	2	60p
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BA9	6	x	4	x	2	54p

Each complete with [illegible]
Please add 10p postage and packing for each box

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De Luxe Groov-Kleen

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Chrome Finish Model 60 £1.50

Ref 36A	Record Stylus Cleaning Kit	28p
Ref 43	Record Care Kit	£2.35
Ref 31	Cassette Head Cleaner	54p
Ref 32	Tape editing Kit	£1.54
Model 9	Wire Stripper/Cutter	83p
Ref P	Hi Fi Cleaner	31p
Ref 32A	Stylus Balance	£1.36
Ref J	Tape Head Cleaning Kit	51p
Ref 34	Cassette Case	£1.27
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X25 25 watt £1.93 CCN 240 15 watt £2.15
Model G 18 watt £2.15 SK2 Soldering Kit £2.86

STANDS
ST1 £1.21 ST2 77p

SOLDER
18SWG Multicore 7 oz 82p 22SWG 7 oz 82p
18SWG 22 ft 28p 22SWG Tube 22p

ANTEX BITS AND ELEMENTS

BITS No.

102	For model CN240	28p
102	For model CN240	28p
1100	For model CCN240	28p
1101	For model CCN240	28p
1102	For model CCN240	28p
1020	For model G240	28p
1021	For model G240	28p
1022	For model G240	28p
50	For model X25	37p
51	For model X25	37p
52	For model X25	37p

ELEMENTS
CCN 240 £1.16 CCN 240 £1.16
CN 240 £1.16 X25 £1.16

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NEW COMPONENT PAK BARGAINS

Pack No	Qty	Description	Price
C1	250	[illegible]	0.55
C2	200	[illegible]	0.55
C3	50	[illegible]	0.55
C4	75	[illegible]	0.55
C5	5	[illegible]	0.55
C6	2	[illegible]	0.55
C7	1	[illegible]	0.55
C8	10	[illegible]	0.55
C9	3	[illegible]	0.55
C10	15	[illegible]	0.55
C11		[illegible]	0.55
C12	40	[illegible]	0.55
C13	20	[illegible]	0.55
C14	1	[illegible]	0.55
C15	4	[illegible]	0.55
C16	20	[illegible]	0.55
C17	10	[illegible]	0.55
C18	4	[illegible]	0.55
C19	3	[illegible]	0.55
C20	4	[illegible]	0.55

Please add 10p post and packing [illegible]

PLUGS AND SOCKETS

SOCKETS

PS1	DIN 2 Pin (Speaker)	0.06
PS2	DIN 3 Pin	0.10
PS3	DIN 5 Pin 180	0.10
PS4	DIN 5 Pin 240	0.10
PS5	[illegible]	0.09
PS6	[illegible]	0.10
PS7	[illegible]	0.17
PS8	[illegible]	0.26
PS9	[illegible]	0.06
PS10	[illegible]	0.10
PS11	Car Aerial	0.09
PS12	[illegible]	0.09
PS13	[illegible]	0.14

INLINE SOCKETS

PS21	DIN 2 Pin (Speaker)	0.13
PS22	DIN 3 Pin	0.17
PS23	DIN 5 Pin 180	0.17
PS24	DIN 5 Pin 240	0.17
PS25	[illegible]	0.10
PS26	[illegible]	0.12
PS27	[illegible]	0.24
PS28	[illegible]	0.28
PS29	[illegible]	0.22
PS30	[illegible]	0.32
PS31	[illegible]	0.14
PS32	[illegible]	0.15
PS33	[illegible]	0.17

PLUGS

PS1	DIN 2 Pin (Speaker)	0.11
PS2	DIN 3 Pin	0.12
PS3	DIN 4 Pin	0.15
PS4	DIN 5 Pin 180	0.14
PS5	DIN 5 Pin 240	0.15
PS6	DIN 6 Pin	0.15
PS7	DIN 7 Pin	0.15
PS8	[illegible]	0.10
PS9	[illegible]	0.09
PS10	[illegible]	0.12
PS11	[illegible]	0.13
PS12	[illegible]	0.18
PS13	[illegible]	0.29
PS14	[illegible]	0.06
PS15	Car Aerial	0.15
PS16	Co-Axial	0.10

CABLES

CP1	[illegible]	0.06
CP2	[illegible]	0.08
CP3	[illegible]	0.08
CP4	[illegible]	0.23
CP5	[illegible]	0.30
CP6	[illegible]	0.10
CP7	[illegible]	0.07
CP8	[illegible]	0.06
CP9	[illegible]	0.04
CP10	[illegible]	0.10

CARBON POTENTIOMETERS

Log and Lin 4.7K 10K 22K 47K 100K 220K 470K 1M 2M

VC1	[illegible]	0.14
VC2	[illegible]	0.26
VC3	[illegible]	0.44
VC4	[illegible]	0.14
VC5	[illegible]	

HORIZONTAL CARBON PRESETS

[illegible] 0.06
100 220 470 1K 2.2K 4.7K 10K 22K 47K 100K 220K 470K 1M 2M 4.7M

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8 Books comprising
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156	Transistor Circuits Manual No 1	15p
160	Coil Design & Construction Manual	30p
161	Radio TV & Electronics Data Book	25p
170	Transistor Circuits for Radio Controlled Models	40p
174	Transistor Subminiature Receivers	32p
175	Transistor Test Equipment and Servicing Manual	25p
176	Transistor Audio Amplifier Manual	40p
177	Modern Transistor Circuits for Beginners	40p
178	A Comprehensive Radio Valve Guide Book 5	30p
183	How to Receive Foreign TV Programmes on your set by simple modifications	32p
185	Tested Shortwave Receiver Circuits using MAT's	30p
187	The TSL Mark 4 Valved FM Tuner and its construction	20p
198	Reactance Frequency Chart for Audio & RF use	15p
	Resistor Colour Code Disc Calculator	10p

CARTRIDGES

ACOS GP91 1SC	200mV at 1.2cms sec	£1.16
GP93 1	280mV at 1cm sec	£1.65
GP96 1	100mV at 1cm sec	£2.65
TTC J 2005	Crystal Hi Output	95p
J 2010 [illegible]	Crystal Hi Output Compatible	£1.10
J 2010 CS	Stereo Hi Output	£1.80
J 2105	Ceramic Med Output	£1.64

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The E12 Range of Carbon Film Resistors ⅓th watt available in PAKS of 50 pieces, assorted into the following groups

R1	50 Mixed 100ohms	820ohms	40p
R2	50 Mixed 1Kohms	8.2Kohms	40p
R3	50 Mixed 10Kohms	82Kohms	40p
R4	50 Mixed 100Kohms	1Megohm	40p

THESE ARE UNBEATABLE PRICES LESS THAN 1p EACH INC. V.A.T.

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C60 32p C90 41p C120 52p

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BI-PAK QUALITY COMES TO AUDIO!

AL10 AL20 AL30
AUDIO AMPLIFIER MODULES

The AL10, AL20 and AL30 units are similar in their appearance and in their physical specification. However careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

PARAMETER	CONDITIONS	PERFORMANCE
HARMONIC DISTORTION	Po = 3 WATTS r.m.s. 1 KHz	0.25%
LOAD IMPEDANCE		8 – 16Ω
INPUT IMPEDANCE	1 KHz	100 KΩ
FREQUENCY RESPONSE @ 3dB	Po = 2 WATTS	50 Hz – 25 KHz
SENSITIVITY for RATED O/P	Vin 25V Rs 820Ω 1KHz	75mV RMS
DIMENSIONS		3" x 2" x 1"

The above table relates to the AL10, AL20 and AL30 modules.
The following table outlines the differences in their working conditions.

PARAMETER	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D.	3 watts	5 watts	10 watts
(R.L. 8Ω) 1 KHz	RMS Min	RMS Min	RMS Min

AUDIO AMPLIFIER MODULES

AL10 3 Watts	£2.19
AL20 5 Watts	£2.59
AL30 10 Watts	£3.01

PRE-AMPLIFIERS

PA12 (Use with AL10 & AL20)	£4.35
PA100 (Use with AL30 & AL50)	£13.15

POWER SUPPLIES

PSU12 (Use with AL10 & AL20)	88p
SPM80 (Use with AL30 & AL50)	£3.25

TRANSFORMERS

T461 (Use with AL10 p&p 15p)	£1.38
T548 (Use with AL20 p&p 15p)	£1.93
BMT80 (Use with AL30 & AL50 p&p 25p)	£2.15

FRONT PANELS PA12 With Knobs £1.00

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL10, AL20 and AL30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs each individually designed for use with 'Ceramic cartridges' while the auxiliary input will suit most 'Magnetic cartridges'. Full details are given in the specification table. The four controls are: Input Selector, Volume and an off switch, Balance, Bass and Treble. Size 152mm x 57mm x 35mm.

- Frequency response: 20Hz–30KHz ± 3dB
- Bass control: ±12dB at 60Hz
- Treble control: ±14dB at 14 KHz
- Input 1: Impedance 1 Meg ohm, Sensitivity 300 mV
- Input 2: Impedance 30 K ohms, Sensitivity 4 mV

EA1000 AUDIO AMP MODULE

Module Tested and Guaranteed.
Full build up diagrams and complete technical data supplied free with each module. Available separately at 10p each.

SPECIAL OFFER £2

The STEREO 20

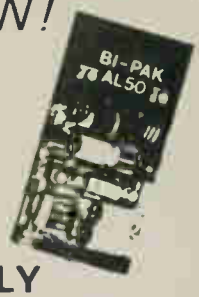
The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Transformer, Power supply and Power Amps. Attractively printed front panel and 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
- Freq res 25Hz–25kHz
- Harmonic distortion typically 0.25% at 1 watt
- Input 1 (cer.) 300mV into 1M
- Input 2 (Aux.) 4 mV into 30K
- Bass control ±12dB at 60 Hz
- Treble con ±14dB at 14 kHz

£13.48

BI-PAK DO IT AGAIN!

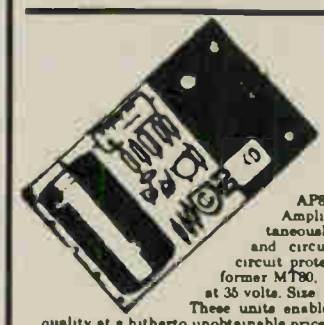
50W pk 25w (RMS)
0.1% DISTORTION
HI-FI AUDIO AMPLIFIER
THE AL50



- ★ Frequency response 15Hz to 100,000 - 1dB.
- ★ Load - 3, 4, 8 or 16 ohms.
- ★ Distortion - better than .1% at 1KHz.
- ★ Signal to noise ratio 80dB.
- ★ Supply voltage 10 - 35 Volts.
- ★ Overall size 63mm x 105mm x 13mm.

ONLY £3.58 each

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



STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) 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 62mm x 106mm x 30mm.

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.

PRICE £3.25

TRANSFORMER BMT80 £2.15 p. & p. 25p.

STEREO PRE-AMPLIFIER, TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 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.

Three 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
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 50KΩ
2. Radio, Tuner	35 mV into 50KΩ
3. Magnetic P.U.	1.5 mV into 50KΩ

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB, from 20Hz to 20KHz.

Base Control	± 15dB @ 20Hz	Treble Control	±15dB @ 20KHz
Filters: Rumble (High Pass)	100Hz		
Scratch (Low Pass)	8KHz		
Signal Noise Ratio	better than — 65dB		
Input overload	+ 26dB	Supply	+ 35 volts @ 20mA
Dimensions	292mm x 82mm x 36mm		

Price **£13.15**

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 and 1 PA100 ONLY £25.30 FREE p & p.

All prices quoted in new pence. Giro No. 388 7006

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BI-PAK

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Postage and packing add 10p. Overseas add extra for airmail. Minimum order 5/- Cash with order please.

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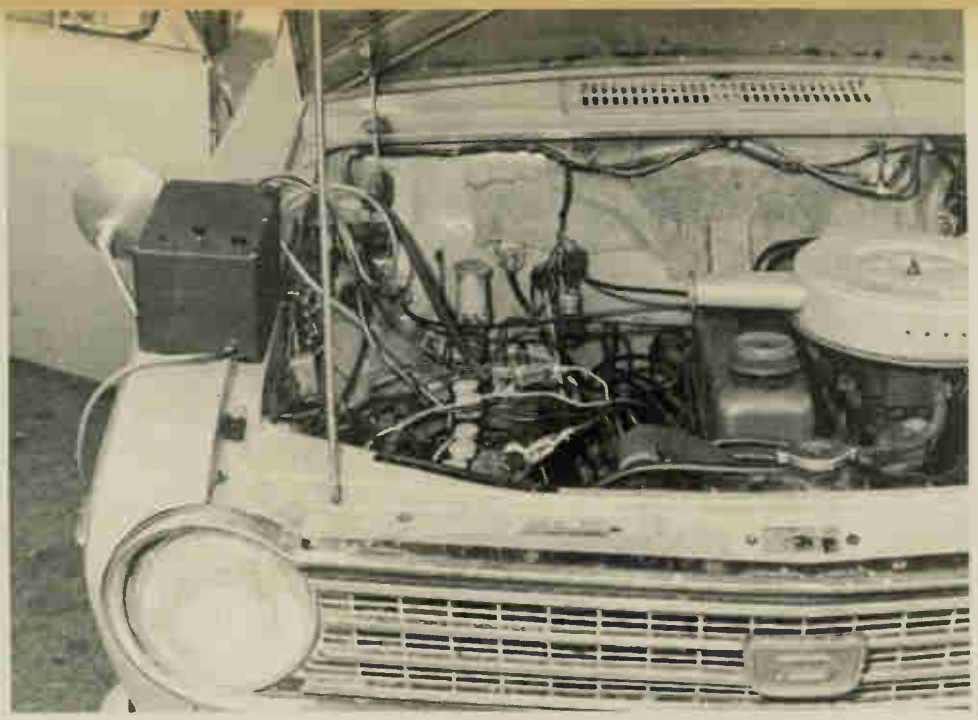


PROJECT

NOTE

This battery charger described in this article has been designed specifically for charging 12 volt lead acid batteries.

Six volt batteries may be charged but there will be no automatic voltage cutoff. Six volt batteries should therefore not be permanently connected to the charger.

International 309 battery charger

This battery charger is fully protected against ALL fault conditions.

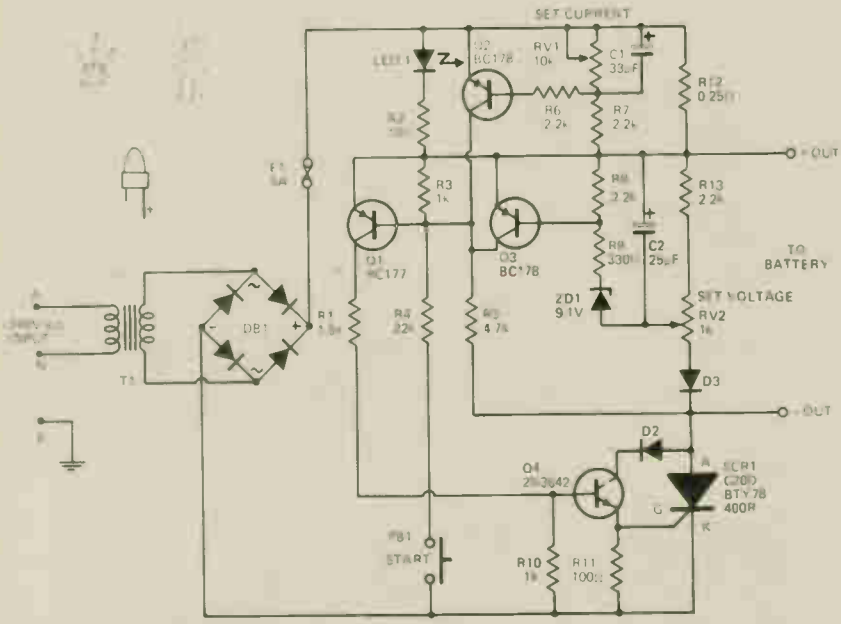


Fig. 1. Circuit diagram of battery charger.

AT first sight there would seem few circuits simpler to design than a battery charger.

But this is not so – to the extent that during our preliminary research we could not find a single unit that offered the protection against misuse that a charger really does need.

To be fully protected a charger must be able to:–

1. Operate into a short circuit.
2. Not be damaged by, or attempt to charge, a reverse connected battery.
3. Operate into a totally flat battery.
4. Be regulated for both current and voltage.
5. Be capable of floating a fully charged battery for extended periods.

In the International 309 charger all these conditions have been met.

Both current and voltage regulation are provided – initially the unit will charge at its maximum current limit of four amps – then, as the battery voltage rises, the charger changes automatically to a voltage limiting mode (maximum 14 volts).

In the voltage regulator mode of operation the current will be in the form of pulses with a relatively long time between them and the LED will noticeably flicker if the current falls to

SPECIFICATION

Charging Current

Within battery voltage range 1V to 14V	4 amps.
Cutoff Voltage	14 volts
Starting	
Automatic self start range	4-14 volts
Push button start	0-4 volts

Protection

Constant current charging of 4A for all battery voltages from 1V to 13.5V.
Protected against reversed battery.
Protected against reversed battery with start button pressed.

Charge Indication

Illumination of LED indicates charging.
Flicking of LED indicates charge current has fallen to less than 1 amp.

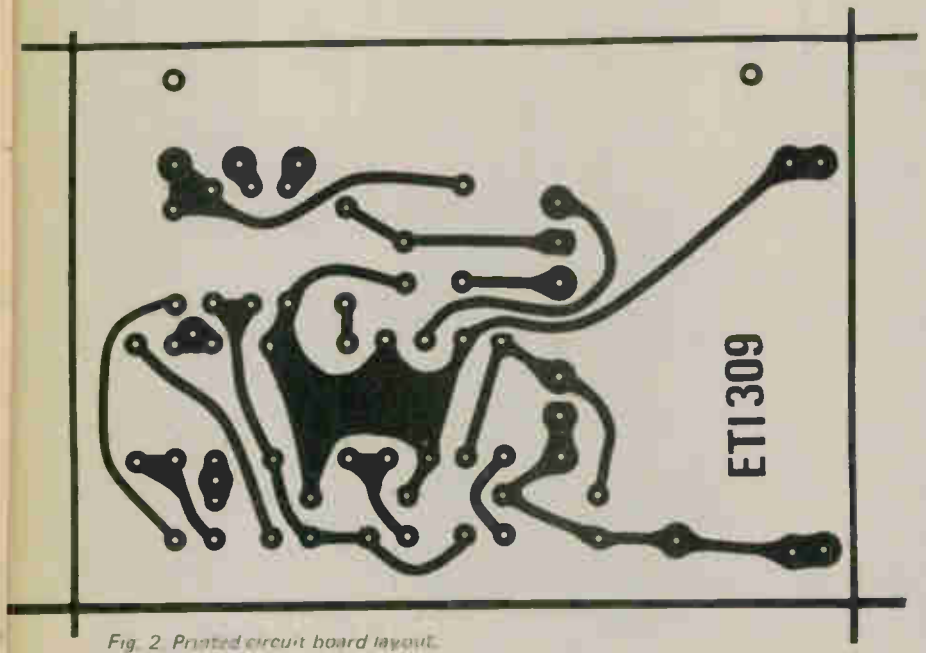


Fig. 2. Printed circuit board layout.

HOW IT WORKS

The battery charger is basically a switching regulator limiting the output voltage to 14 volts and the output current to four amps. Thus there are two modes of regulation, current and voltage, the changeover between these two modes being quite sharp. An increase of 0.1 volt above 14 volts causes the output current to drop from four amps to zero.

The 17 volt secondary of transformer T1 is bridge rectified by diode bridge DB1 to provide pulsating dc to the regulator. The main control element is SCR1 the gating sensitivity of which is increased by transistor Q4. A current of 2.0 mA through R1 is sufficient to turn Q4 and SCR1 on.

When a battery is connected with correct polarity across the output terminals, current will flow through R5 and the base emitter junction of Q1 turning Q1 on. This produces current in R1 sufficient to turn on Q4 and hence SCR1. The current flowing through SCR1 is sensed by R12, and if this current exceeds four amps average, Q2 turns on and is held on for a short time by virtue of the charge on C1. Hence the turn on of SCR1 on the next half-cycle is delayed thus reducing the average current. This control action ensures that the current stabilizes at four amps.

When the battery reaches 14 volts, transistor Q3 will turn on, the turn-on point being set by RV2. This again prevents SCR1 from turning on until later by by-passing the base current of Q1. Thus the current falls until the voltage across the battery stabilizes at 14 volts.

International 309 battery charger

one amp or less. On batteries of 30 amp hour rating or less which are in good condition this flickering of the LED indicates the fully charged condition. On older batteries, or those of greater than 30 AH capacity, the float current may never drop below one amp and no flickering will be seen.

In applications where it is required, batteries may be 'floated' continuously across the charger without damage to charger or battery.

The unit is normally self-starting (into batteries that are already charged to four volts or over). For totally flat batteries – or those charged to less than four volts – a starting button is provided to initiate the charging cycle; after an initial couple of seconds the battery voltage will have risen sufficiently to maintain operation.

The charger will not start if a battery is connected to it with reversed polarity – even if the start button is pressed. Nor will the charger be damaged if the output leads are accidentally shorted together – however if the start button is pressed whilst the leads are shorted, the protection fuse will blow.

This last condition is most unlikely to occur and it is solely to protect against this eventuality that the fuse has been incorporated. A blown fuse should therefore be a rare occurrence.

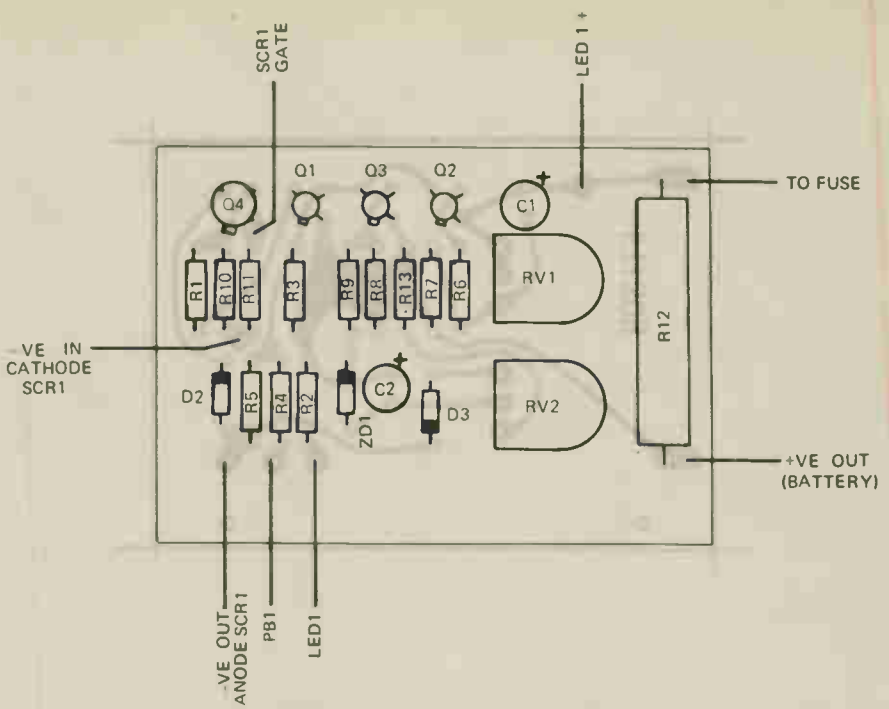


Fig. 3. Component overlay.

PARTS LIST			
R1	Resistor	1.5 k	5% ½ watt
R2	"	10 ohm	" "
R3	"	1 k	" "
R4	"	22 k	" "
R5	"	4.7 k	" "
R6	"	2,2 k	" "
R7	"	2.2 k	" "
R8	"	2.2 k	" "
R9	"	330 ohm	" "
R10	"	1 k	" "
R11	"	100 ohm	" "
R12	"	0.25 ohm	5% 15W (or 2 0.47 ohm 10W in parallel)
R13	"	2.2 k	" ½ watt
RV1	Large trimpot	10 k	
RV2	Large trimpot	1 k	
C1	Capacitor	33µF	6.3 volt electrolytic
C2	"	25µF	25 volt electrolytic
Q1	Transistor	BC177	or similar
Q2	"	BC178	"
Q3	"	BC178	"
Q4	"	2N3642	"
SCR1	C20D,BTY78-400R or similar		
D2,D3	Diode 1N4001 or similar		
DB1	Diode bridge BY164 or similar		
ZD1	Zener 9. 1V, BZY88C9V1		
LED 1	Light emitting diode TIL209 or similar		
T1	Transformer 17 volt at 4A or similar		
PCB	ET1 309		

Die-cast box 4¾ x 6¾ x 4", metal bracket, 3 core flex, two grommet mains terminal block, fuse holder, 5A fuse, single pole push button (push to make).

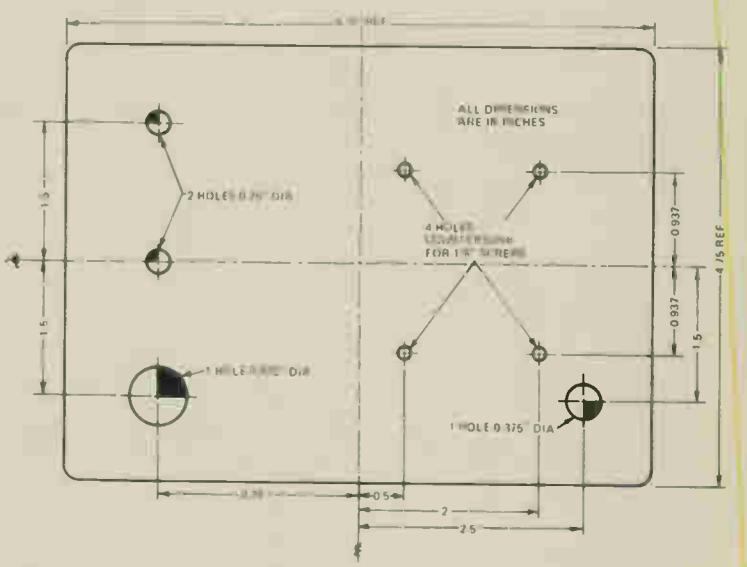


Fig. 4. Drilling details for lid of die-cast box.

CONSTRUCTION

We built our unit into a diecast box 4¾" x 6¾" x 4", all the components being mounted on the lid, drilling details for which are provided in Fig. 4.

Most of the components are mounted on a fibre-glass printed circuit board.

Assemble all components to the printed circuit board in accordance with the component overlay, making sure that all diodes and electrolytic capacitors are correctly orientated.

The transformer should be mounted onto the lid using countersunk screws making sure that the 240 volt input leads are away from the lid. The printed circuit board mounting bracket is secured to the front panel, such that it passes through the bracket, but is screwed directly to the front panel. The hole through the bracket provides clearance for the light emitting diode.

The diode bridge is mounted on the transformer side of the bracket and the SCR on the opposite side. The SCR must be insulated from its heat sink by mica or similar insulating

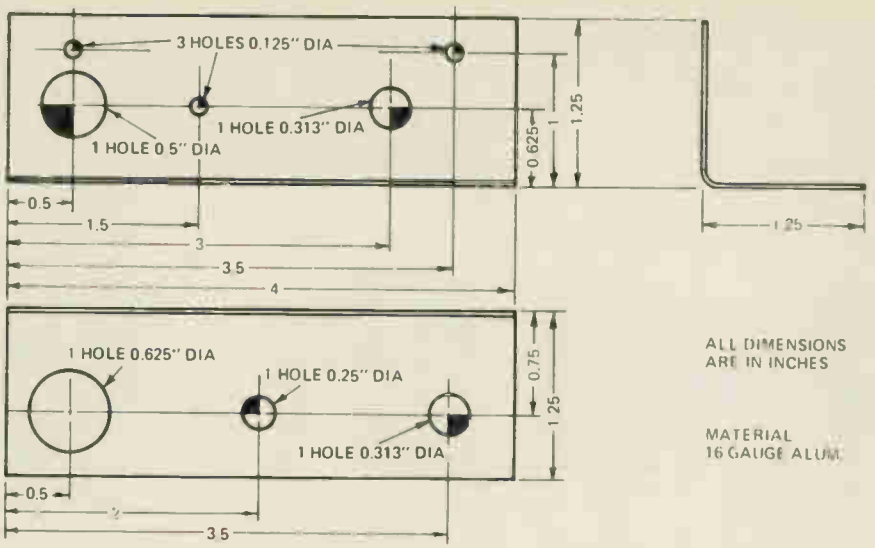


Fig. 5. Mounting bracket for printed circuit board.

washers. These should preferably be smeared with silicon grease to aid heat transference. The printed circuit board is then mounted to the bracket and connected as shown on the overlay and circuit diagrams.

For all four amp wiring use reasonably heavy gauge wire.

ADJUSTMENT

Current – Using an ammeter (10 amp range) in series with a flat battery, adjust RV1 for a four amp charge current. A four or five amp meter range may be used providing the meter does not have internal diode protection.

Alternately the voltage across R12 may be adjusted (using RV1) to one volt whilst charging a flat battery. Use a 2.5 volt or higher meter range.

Voltage – When the battery is fully charged the current will fall. When it has fallen to 2 amps, adjust RV2 for 14 volts across the battery. ●

ELECTRONICS TOMORROW

-continued from page 61

Advance International as appears in this issue of ETI. I have no experience of the kit or its contents but the kit is based on the Executive Mini, a good looking machine that passes the "concrete test" unscathed. By the way both Advance and Sinclair announced their "Executive" at the same time, the coincidence in name is accidental.

A visual summary of the various kits is given in Table 2.

All of the manufacturers have been asked for their feelings on modified kits and they all said that although they are willing to help with data they cannot suggest modified circuits and they cannot guarantee their products if modified. I think that most people will agree that this is reasonable, especially as some will replace destroyed components at a special price.

To summarise, if you want to build a calculator to your own specification, or on a chip for which there is no kit, the best place to start is with an existing kit. If you do not use the chip supplied with the kit you can advertise it in the classified columns and recover some of your costs, but do not ask the manufacturers to supply a kit without a chip. Similarly you can change displays and sell the unused units or use them in another project, a clock, frequency meter, counter, etc. Happy Calculatings.

APOLOGY

We incorrectly identified the red and green LEDs offered in our August issue as the SLA5 and SLA15 the codes should have been OSL5. We apologise for any inconvenience caused by this mistake which was due to data sheets not arriving on time.

The Heathkit SC2009 calculator kit.

MORE PRODUCTS

Electronics Tomorrow exists on data fed to us by manufacturers and distributors, some continuously send information on products likely to be of interest but we would like to hear from a few more. Please make sure that your technical department and PR department know of our requirements and write to *Electronics Tomorrow, ETI, 36, Ebury Street, London SW1W OLW.*

USEFUL ADDRESSES

1 Advance Electronics, Raynham Road, Bishops Stortford. 0279-55155.
2 Advance Telecommunications, Jafam House, Boundary Road, Woking. 0486-25011
3 Heathkits, Heath (Gloucester), Gloucester. 0452-29451.
4 Sinclair Radionics, London Road, St. Ives, Hunts. 0480-64311.
5 Semicomps Limited, Nortfield Estate, Wembley, Middlesex.
6 Semi-Specs, Premier House, Fairfield Road, West Drayton, Middlesex.
7 Guest International, Redlands, Coulsdon, Surrey.

FOIL CONSTRUCTION FOR BATTERIES

BY ISRAEL BERKOVITCH

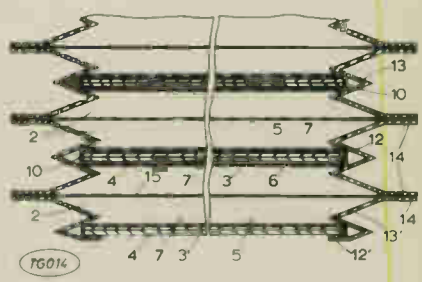
A new type of battery construction which promises great improvements in performance. Dr. Paul Eisler, who invented the printed circuit, has recently patented this new type of construction which amongst other advantages allows for very heavy charge and discharge currents.

COULD existing batteries be made more efficient by switching to foil type construction? A strong advocate of this system is Dr. Paul Eisler - well - known as the inventor of printed circuits - who argues that the uses for batteries could be widely extended by this means. Since the active area of the interface between the electrodes and the electrolyte is greatly and reliably increased by using foil electrodes as compared with other systems where the minute channels within the plate are liable to blocking, this construction gives big improvements in power to weight ratio in energy density to weight ratios. It can be operated at higher charge and discharge rate and - for a given capacity - becomes lighter; it also has lower internal resistance. Perhaps its most important claim - in view of the advantages that it may give to the electric car for use in town traffic - is the simplicity in charging and the very short time required.

As far as it is possible to judge prior to prototype development, the claims made by Dr. Eisler appear soundly founded and his battery could develop entirely new markets. There are of course many practical problems still to be solved and the battery will need to be put through an endurance test of charge-discharge cycles to assess reliability of structure and materials. But in the first patent (BP956,553) - the key one of a series on this theme - the inventor developed in great detail the application to a conventional lead-acid secondary cell.

In its simplest form the cell comprises a pair of spaced foils disposed opposite each other and secured by insulating tapes to form a chamber. This chamber contains electrolyte. The foils are made in at least two layers. The inner one forms the electrode and it is supported on barrier material that is electrically conducting but electrochemically is virtually inert. A series of such cells, naturally connected in series, may from a module, say a module of a 12V battery; several of these modules would then be connected in parallel to give the total capacity required for the whole battery. Within the module, for ease of construction, it would not be neccessary to have double barriers between each cell and the sequence would therefore be active layer e.g. positive electrode/barrier layer/negative electrode of neighbouring cell. So this system dispenses with the need to connect electrically the neighbouring cells; this connection is made through the barrier directly.

The maximum current density per square inch of superficial electrode area may be the same as in a standard battery but the total current can be very large without excessive development of gas and heat. This is because of the total current is, of course, the product of this current density times the foil surface area and it flows through the foil thickness perpendicular to the foil surface. In turn this means that heavy charge and discharge rates are possible. Furthermore, in this system it is easy to allow for passages of cooling fluid (air or water) between modules. The modules are thin and do not have any heat-insulating barrier which an electrical insulator would otherwise provide.

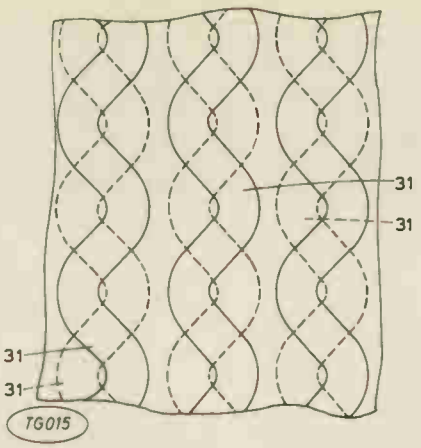


The end of the module needs only a barrier layer, the final electrode being on the inside of this. The general layout is shown in the diagram where the structure has been expanded at right angles to the foils for clarity in presentation. Within the cell each active layer (electrode) is covered by a previous separator film of such material as nylon or p.v.c. gauze. It can be seen that the series of cells is held within a concertina folded

tape which may be of thermoplastic material and finally the bottom of the module is sealed by potting in an elastomeric sealing compound. The completed module, of very small thickness, will in use be kept under endwise pressure so that it constitutes almost a multiple laminate. This ensures there is pressure contact all over the area of the foil and that the current path in the module is of maximum cross-section and minimum internal resistance.

A top slit allows the cell to be filled and there are also spilling channels for excess liquid when topping up. The slit serves as a gas vent. The final feature within the cell is a centre separator of fabric, crimped filter paper or other thin porous material. This holds the electrolyte but must also have a structure that allows a ready flow of liquid particularly in the vertical direction.

It can readily be seen that these concepts lend themselves to automatic production. So much of it is laminating films on to each other and sealing the edges of films, then cutting the



laminated foil into sizes required for the modules. Naturally the detail of the active layer depends on which battery is being constructed, since the principle can be widely applied. But if we confine ourselves to the lead-acid battery and consider both sides of a barrier layer covered with lead by electro-deposition, the active layers can be formed like a modern Plant plate. Alternatively powder layers can be used. Several methods have in fact been considered and this gain would presumably be one of the issues finally to be settled by appraisals linked with practical production.

The foils may be made with grooves to increase the surface area, to aid the anchoring active layer on to barrier layer and, by making them generally vertical, to aid vertical movement of liquids and gases. This grooving may be affected mechanically or by printing and etching.

Finally, what is a foil? For this purpose the term is discussed in terms of thickness but that does not really define what is involved in the system proposed. What is critical is that however the thickness is built up by the successive layers described, the material shall be flexible enough to be reeled and treated by what are known as foil techniques. This is what will control and reduce the production costs. And it is the combination of of this feature of manufacturing with the improved operating properties that should result in enhancing the prospects of the electric car and greatly extend the range of battery driven vehicle - a consummation that will be widely welcomed by present trends in public opinion.

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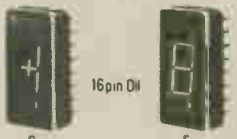

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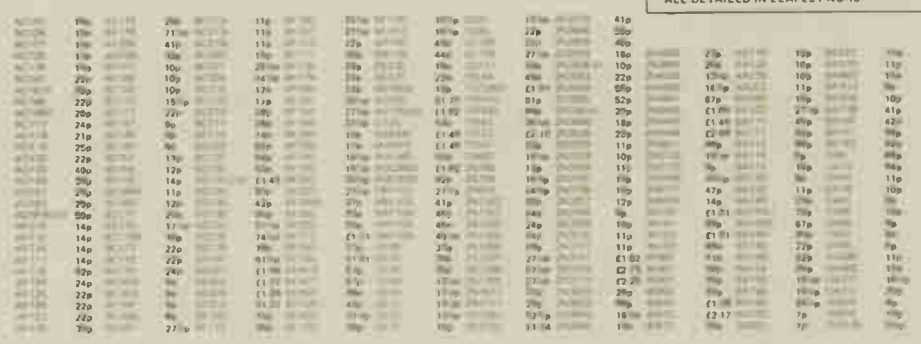

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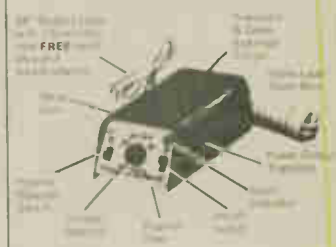

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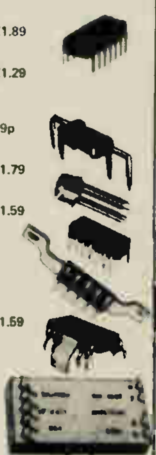

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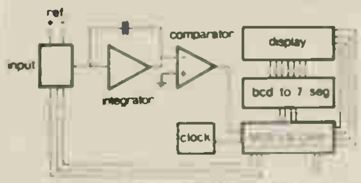

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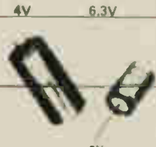
ELECTROLYTICS



µF	4V	6.3V	10V	16V	25V	40V	63V	100V
1							6½p	8p
1.5							6½p	
2.2							6½p	
3.3							6½p	
4.7							6½p	8p
6.8						6½p	6½p	
10					6½p		6½p	9p
15				6½p		6½p		
22			6½p		6½p		6½p	11p
33		6½p		6½p		6½p		
47	6½p		6½p		6½p	6½p	8p	
68		6½p		6½p			10p	
100	6½p		6½p		6½p	8p	11p	23p
150		6½p		6½p	6½p	10p	13p	
220	6½p		6½p	8p	10p	11p	19p	31p
330	6½p		8p				22p	39p
470		6½p	10p		13p	19p	26p	48p
680		10p		13p	20p	23p		59p
1000	10p		11p	17p	22p	25p	44p	79p
1500		12p	20p	23p				
2200		18p	20p		36p	44p	79p	149p
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[illegible]			11p	[illegible]	[illegible]
[illegible]			11p	[illegible]	11p
[illegible]			11p	[illegible]	11p
[illegible]			11p	[illegible]	11p
[illegible]			11p	[illegible]	11p
[illegible]			13p	[illegible]	11p
[illegible]			11p	[illegible]	[illegible]
[illegible]			11p	[illegible]	[illegible]
[illegible]			11p	[illegible]	21p
[illegible]			11p	[illegible]	[illegible]
[illegible]			11p	[illegible]	[illegible]

Other types obtainable upon application

DX MONITOR

Compiled by Alan Thompson

YOU MAY RECALL that in our September issue I dealt with "gear" and took you on a short conducted tour of my shack, A number of readers have asked where they can obtain the heavy-duty mains swith-cum-neon that I mentioned as controlling all the shack circuits. These ought to be generally available throughout the country but in case of difficulty you can obtain one from Tom Whitehouse Ltd., The Market, Swansea, Glam. for 72p (including p. and p. and VAT), if you will refer to "DOT" mains switches complete with red neon indicator. This firm are not normally mail-order suppliers, by the way, but will service orders for this item. The switches, as well as being very suitable for controlling the numerous circuits that one finds in a shack, are most decorative being of the rocker-type and fit into an oblong hole in a control panel by means of integral spring clips.

And down to work! A 4-page pamplet that recently came my way is a reprint by the North American Shortwave Association of an article by Dr. Richard E. Wood entitled *"Recognition of Languages"*. In this sort of work, Dr. Wood pinpoints some of the recognition clues to be found in various languages that may be heard on the air and it is very useful to anyone who has logged just about all the English stations he can hear and wants to spread his wings into the wider DX world. Copies can be obtained for a 9in. x 4in. addressed envelope and two International Reply Coupons (available at all main Post Offices) from NASWA, P.O. Box 8452, South Charleston, West Virginia 25303, U.S.A. If your local reference library has a copy of *"How to Listen to the World"* (the 1969-70 Edition), you can take the subject a bit further with another article by Dr. Wood entitled *"Languages in International Radio"*.

Personally, I always consider Arabic to be one of the more difficult languages to monitor for a Reception Report because there are so many types of the language to be heard. Generally, it can be recognised as the language that sounds harsh and as if the speaker was having to work really hard to get through his script: the other clear indication is the oft-repeated sound "el" or "al" which has the effect of making the language sound somewhat breathless, and the numerous guttural and throaty sounds that occur in the language all add to the general effect of something quite unlike any European language: in fact, it is difficult to mistake Arabic for anything other than allied languages like Somali, Kabyl, Hebrew or Persian. The Key words to listen for in an Arabic transmission are "Huna" or "Id'ha" followed by the station name - don't be too disappointed if the rare DX station broadcasting in Arabic suddenly identifies as "Huna London" as Arabic services are broadcast by the B.B.C., Voice of America, Radio Moscow and Radio Peking amongst other international broadcasters.

In the U.K., the Arabic World is medium-range DXing and most of the following ought to be audible throughout the darkness hours without too much trouble. Quite a number of the stations may be heard, too, during daylight hours on the 25, 19 and 16 metre bands so you can try your hand at identifying some of the ones that you hear as your experience grows. Here then are a hand-picked bunch that should get you attuned to Arabic speech and, maybe, give you a liking for the very special quality of Arab music:

ALGERIA: The Arabic Home Services (it has others in Kabyle and French) is broadcast on a variety of frequencies so let's concentrate on the External Service from 1800-2100 GMT. and was last reported on 11920, 9685 and 7270kHz. Radio Algiers has a habit of changing frequencies fairly often so don't be surprised if they moved by the time you read this!

EGYPT: The Arab Republic of Egypt to give it it's correct title has a bewildering collection of Home and External Services on a whole range of channels. For starters, try the "Voice of the Arabs" programme which is on the air from 0200 until about 2330 GMT. - best frequency for evening listening is 9850kHz, just outside the official 31 metre band.

IRAN: Radio Iran's Home Service is in Persian (not Arabic) and, being easy to hear gives the newcomer to this form of DXing a chance to note some of the differences between the two languages. Another wanderer around the bands, Radio Teheran can, at the moment, be found on 15085kHz where its 150kW output puts in a very potent signal until it closes somewhere around 2030 GMT. If you can't find it on that channel then give 9022 or 9040kHz a try - one or other is usually to be heard in parallel with the 19 metre band transmitter.

IRAQ: Nightingales seem to have a fascination for station staff - quite a number use its song as an interval signal and Radio Baghdad is no exception. If memory serves me correctly it is described as "the notes of a mechanical nightingale": whether the bird has been brainwashed into being mechanical in performance or is just a mechanical contrivance, look for that tune on or about 9740kHz at about 1800 when the "Voice of the Masses" External Service programme starts operating.

KUWAIT: One of my favourite radio stations for its pleasant music (in its English Service!) and one that issues what must be the most attractive QSL card complete with replicas of lots of Kuwait stamps. You really can't be trying very hard if you can't hear its potent signal on 15415kHz (or your radio wants a spot of re-alignment!) - nice English programme with lots of music starts up at 1630 and goes into Arabic about 1900 until finally signing-off around 2215 GMT.

LEBANON: Radio Beruit is one of those stations that is a so-and-so to log! If you do manage it, it has a most attractive QSL with a picture of the famed Cedars of Lebanon. You could try 5980kHz which has its Home programmes throughout the evening, but a better bet might be 15200kHz (or thereabouts - it has tried quite a few frequencies of late) with English between 1830 and 1900 followed by an hour of Arabic programmes.

SAUDI ARABIA: Like many other Arab states, Saudi Arabia has a number of different services. The English service is a very

professionally presented job with the identification "This is the Broadcasting Service of the Kingdom of Saudi Arabia", and you can hear this on 11855kHz from 1700 to 2000 daily: for Arabic programme give 9670kHz a try (this is Jiddah) or 9720kHz (which is Riyadh) from early evening until about 2300. The BSKSA does verify but not as consistently as one would like.

UNITED ARAB EMIRATES: If you haven't kept up with your geography this is the new name for what we used to call the Gulf States. Abu Dhabi is one of the Emirates in the Union and after a period of broadcasting in the 60 metre band has settled down on 9620kHz. Is audible most evenings and signs-off at 1950 GMT, a good deal earlier than most.

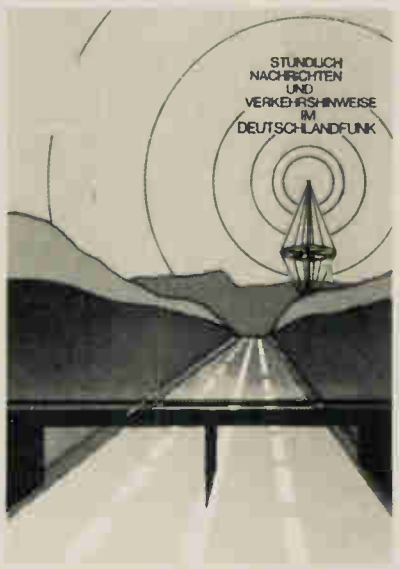
Those eight should give everyone - newcomers and old-hands alike - something to try in the weeks ahead and lots of them do QSL and accept reports in English: it is well to enclose reply postage in all cases (International Reply Coupons - remember? 10p at your Post Office - or mint stamps of the country if you have a supply available).

Changing back to English - gratefully as the tube of my hookah was getting caught up in the typewriter! - the long-awaited commercial radio should be with us by the time that you read this. The London Broadcasting Company's News Service will be going out on 719kHz (and 97.3 MHz VHF), with Capital Radio providing the entertainment service on 557kHz (and 95.8MHz VHF). Those whose beards reach their knees, like your compiler's, will, I am sure feel some nostalgia for the long departed pre-World War II commercial radio stations which used to enliven the rather dreary Sunday fare of the B.B.C. some 30 more years ago. Do you remember Radio Fecamp, Radio Lyons, Poste-Parisienne, Paris Eiffel Tower and the rest? Radio Luxemburg, of course, is still with us, having survived the war years, but it will be of much interest in months ahead to watch the development of a pattern of commercial local broadcasting in Great Britain and to compare it with, say, the vast diversity of local radio stations operating in the U.S.A. What is the future for the 'pirates'? Will they survive when advertisers will find it easier to 'spot' their coverage to particular areas as the commercial network of stations develops? Who can tell - certain it is that radio is likely to get a real shot in the arm from the arrival of these newcomers in the midst of established operations which have established a kind of peaceful co-existence over the last few years. On the pure DX front, the great interest will be the extent of the coverage of these stations since BBC local radio stations keep turning up in the most unexpected places - here on the South Wales coast, Radio Solent, Radio London and Radio Leeds are regularly heard in late evening hours although Radio Bristol's groundwave seems to get drowned in crossing the Bristol Channel.

Letters with your comments and queries are welcomed but, please, enclose a s.a.e. if you want a direct reply. If possible, send them by the 12th of each month to: Alan Thompson, 16 Ena Avenue, Neath, Glamorgan SA11 3AD.

QSL COLLECTORS CORNER

Our illustration shows the variety of QSL cards issued by Deutschlandfunk (DLF) and also depicts their massive pennant - a striking black, red and gold affair with inscription in black and white. DLF is one of the easier medium-wave stations to hear and they broadcast in English (Monday-Saturday) from 1745-1830 GMT. on 1268kHz, with some 600kW of power going to their aerial array. If you would like to hear *Alan Thompson, he has his own DX programme on DLF on alternative Wednesdays just about 1800 GMT. The next sessions of DX-CIRCLE, as the programme is called, will be aired on 17 and 31 october, and 14 and 28 November, and you can send your reception reports to English Service, DLF, 5 Cologne 51, West Germany, or, for DX-CIRCLE only, direct to Alan Thompson. 16 Ena Avenue, Neath, Glamorgan SA11 3AD. On request, correct reports are verified with QSL card and pennant -- nice additions to any collection.*



Could the reader who wrote to Alan Thompson about early British call signs please let him know his address. There is a reply waiting for him but the address has been mislaid!

eti EQUIPMENT NEWS

UNIVERSAL FIRE ALARM

Since the passing of the Fire Precautions Act 1971, there has grown a demand for a fire alarm system which can easily be fitted and which will be relatively inexpensive so so that it can be used for the smaller size of premises.

To meet this requirement Photain Controls Limited have developed their new Universal Fire Alarm Unit Type FB-73. The unit is a complete fire alarm system in that it incorporates Smoke Detection, Heat Detection and Manual Operation in the one unit and is also complete with an alarm bell which produces a noise in excess 85dB/m. Installations merely consists of fixing the unit on the wall and connecting it to a 220/240v 50/60 HZ mains supply. It is then ready for immediate operation.

It is contained in a pressed steel housing 155mm x 100mm x 70mm and is complete with 2 metres of 3 core cable for the mains connection.

The fire sensors are incorporated in the unit:-

Smoke Detector The alarm will operate within 30 seconds of the unit detecting a level of smoke equivalent to 20 per cent obscuration of a light beam over a distance of one metre.

Heat Detector The alarm will operate when the ambient temperature reaches 60°C and will automatically re-set when the temperature falls below 55°C.

In addition a manual pull switch is fitted so that the alarm can be operated at any time either to provide warning in the event of fire or for test purposes.

The price is £36.00 complete (plus 10% VAT in U.K)

Photain Controls Limited, Randalls Road, Leatherhead, Surrey.

PRECISION SOUND LEVEL METER TYPE 1404B

Dawe Instruments Limited, have announced their Precision Sound Level Meter Type 1404B. This instrument is the latest addition to the DAWE range and has been designed for applications which require the highest possible accuracy. Like the successful general purpose Sound Level Meter Type

1405C introduced last year, the new model provides exceptionally good value for its price.

The Type 1404B covers the range 34 to 130dB(A) and fully complies with B.S. 4197:1967 and IEC Publication 179:1965 for precision sound level meters. This grade of instrument is now called for in many specifications and is recommended in the Department of Employment's Code of Practice for reducing the exposure of employed persions to noise where the measurement is likely to be used for legal enforcement of a noise limit. As with many other specifications, this calls for dB/A measurements which correlate best with subjective noise ratings.

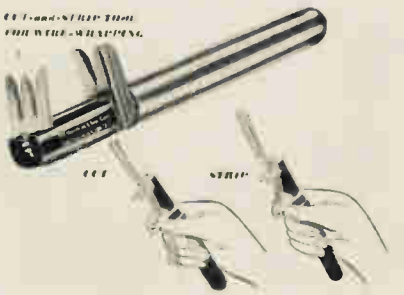
The instrument is compact and robust for field use and may be held in one hand. It employs solid-state circuitry throughout and consists of a condenser mircophone, weighting network, attenuators, high-gain amplifier and an easily read taut-band meter.

The Type 1404B is powered by a small battery which gives a typical operational life of 80 hours. The complete unit, including battery weighs less than 1kg and is provided with a carrying case. An optional Wind Shield Type 1404-1B is available for the mircophone to greatly reduce wind noise when taking measurements out of doors.

Dawe Instruments Ltd., Concord Road, Western Avenue, London W3 OSD.

WIRE STRIPPER

As part of their range of OK Machine and Tool Corporation, Wire Wrapping Equipment, Vero Electronics have introduced a Wire Cut and Strip Tool. This is a revolutionary new concept for easy and clean stripping of wires for wirewrapping, electronic and electrical applications. It has been designed for maximum efficiency and its slim size makes it ideal for storing in a tool kit. Operation is extremely easy, up to 4 wires being placed in the stripping slot, with the ends extending beyond the cutter blade. The tool is then pressed together and the wire pulled from between the blades. The wire is thus cut and stripped to the correct wire wrapping length.



The hardened steel cutting blades which are replaceable and the sturdy construction of the tool itself, ensure maximum life.

Vero Electronics Limited, Industrial Estate, Chandlers Ford, Eastleigh, Hampshire.

PORTABLE MANOMETER

A new type of portable manometer has been introduced by the Glasgow firm, Mercury Electronics (Scotland) Ltd.

Said to be the first truly portable, battery/mains instrument of its kind in the UK, the new M8 model is about a quarter the size and weight of previous models and has a response time three times faster - at 30 milliseconds.

Used to measure air pressures or, with suitable transducers, air flow, the instrument has applications ranging from the

medical field, in anaesthetics, respiratory tests, physiology and pharmacology through to industrial measurements on engines, pumps, in wind tunnels. in heating and ventilating systems and pressures on building structures. Pressure ranges within the scope of the instrument are from 1 to 3000mm water gauge.

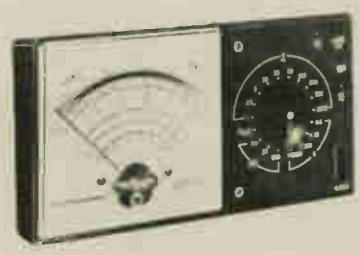
The measurement cell uses an optical diaphragm and an electrical resistance bridge circuit, a principle said to be exclusive to Mercury Electronics, which enables high sensitivity, accuracy and versatility to be incorporated at about 40 per cent less cost than is usual in equipment of this kind.

The instrument gives a direct reading of air pressure or flow on a Sifam large-scale centre-zero panel meter. Pushbuttons on the main panel allow different degrees of sensitivity, as well as electronic damping to be switched in if required.

Mercury Electronics (Scotland) Limited, Pollok Castle Estate, Newton Mearns, Glasgow.

NEW MULTI-METER

For service applications Eagle International have introduced two new multimeters to their range of test equipment. These are the KEW.66 and KEW.6610, 20,000 O.P.V. Multi-meter.



The KEW.66 has 28 measuring ranges and the KEW.6610 incorporates an additional 0-10A a.c. range for high current, heavy duty work. Both models feature overload protection, positive action rotary switch and an anti-parallax mirror scale for accurate read out. Supplied with test leads, batteries, manual and fitted case they are completely portable and thus ideally suited to site work.

Eagle International, Precision Centre, Heather Park Drive, Wembley, Middlesex, HAO ISU.

SOUND LEVEL METER

The lastest Sound Level Meter to be added to the very wide range of indicators, industrial meters and precision meters manufactured by Castle Associates in the CS16A.

At only £44.50, the CS16A is expected to be in great demand. It offers industry a Meter complying with BS 3489 as recommended in the Department of Employment's Code of Practice etc., at a price at least £10 cheaper than competitive meters.

The CS16A compliments its big brother, the famous, very sophisticated CS17A. While the CS17A offers every facility one could wish for on such a meter, the CS16A is a reduced specification unit offering everyday measuring equipment at a saving in cost. The controls of the CS16A have been kept to a minimum to help eliminate possible operator error. It has a range of 60dBA. "Slow" response and is the first British meter to use the new technology electret microphone. This is mounted on a 8in Goose-neck extension to improve the acoustic performance.

A Calibrator is an essential, but usally very expensive accessory for a Sound Level Meter. The Castle PSQ 101A Falling Ball Calibrator offers the ideal answer at only £19. Giving a broad spectrum of noise instead of the more usual 1kHz tone, the PSQ 101A eliminates error due to microphone peaks.

Custom Electronic Associates Limited. Castle Associates Division, Redbourn House North Street, Scarborough, Yorkshire, YO11 1DF.

INVERTERS

Those requiring the use of mains operated electrical equipment when away from a mains power source, will be interested in a new range of inverters from J. Lampitt & Co. (Engineers). These inverters produce mains voltage with outputs from 150–300W from 12V and from 300–600W from

24V. Applications in the fields of boating, Camping. Caravanning and on the site requirements are innumerable, Prices start from £39.05.

J. Lampitt & Co. (Engineers) 82 Bath Street, Walsall, WS1 3DE.

X–Y AND T–Y RECORDERS

Advance Electronics Ltd. is poised to make substantial in-roads into the X–Y and T–Y Recorder market with its extensive range of instruments offering a choice of modules covering a broad spectrum of applications. There are three ranges: the LR100 and HR2000 are X–Y recorders and the 'OmniScribe' is a T–Y Strip Chart Recorder. Together the instruments cover most market requirements.

The British made low-cost LR100 Series is now available from stock with an increasing range of plug-in modules, with a.c. and log a.c. measurement modules soon to be made available. Amplifier and time base modules can be fitted to either axis. The

LR100 Series X–Y Recorders is suited to industrial and analytical applications, and in the fields of medicine and education. The cost of basic LR100 is £182.

For a wider coverage of sensitivities, and the advantages of automatic features such as vacuum paper hold, electric pen lift with remote control and facilities for two-pen multiplexing. HR2000 X–Y Recorder is an instrument designed to satisfy the majority of X–Y plotting requirements.

Modules available give a choice of sensitivities, with or without timebase. Each module, which may be used on X or Y axis, is self-contained and plugs directly onto the recorder main frame, maintaining the assembly as one compact unit, although if required, e.g. for some rack mounting applications, the modules may be operated away from the main frame.

The Strip Chart Recorder market is catered for by the 'OmniScribe' 5000 series in a wide range of specifications and capabilities. These units have several novel features, including a capacitive re-balance system which is unaffected by noise and wear, and web feed sprocketless chart drive.

The basic instrument, with pushbutton selection of chart speeds, sells for £186.

Advance Electronics Ltd., Instrument Division, Raynham Road, Bishop's Stortford, Herts.

CONTINUITY TESTER

To meet the needs of the electronic and electrical manufacturing industry, Highams Electronic Communications Limited have produced a mains operated, bench model continuity tester. It has been specifically designed to overcome some of the problems in production and inspection testing.

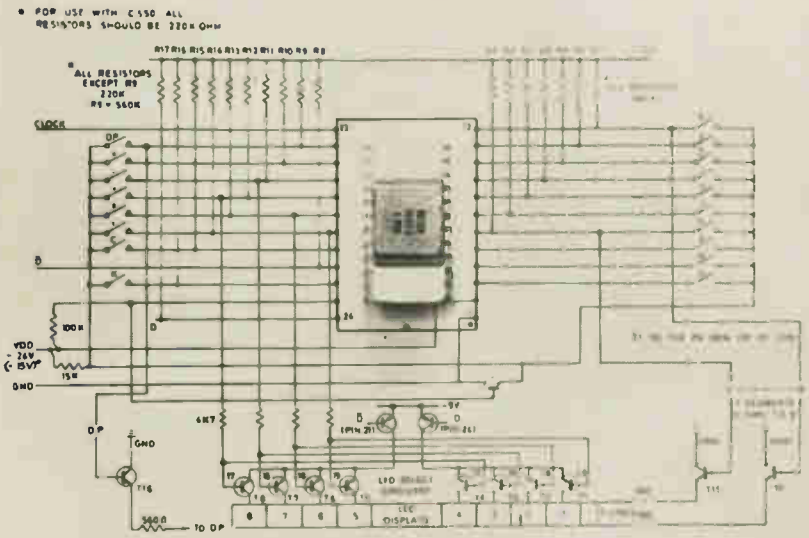
The three main features are: 1. As the tone tester has a variable range from 0–10 ohms it can be set to any value between these and will give you an audible and visual signal up to the value it has been set to. The tone tester can be set as low as 0.1 ohms. 2. Because ambient noise levels in industry are so varied the volume is adjustable mainly to overcome a high degree of ambient noise. In addition to this, there is a visual signal, as this may be preferred. 3. The main feature of HTM is that the voltage across the probes is only 10 millivolts and only draws 1 mircoamp. It will detect any form of connection that is going even slightly high resistance to a low level signal, that cannot be detected with any form of conventional meter.

Its size is 190 mm x 60 mm x 120 mm and finished in a rugged aluminium case. Mains operated 110/240v A.C. 50–60Hz. The audio signal is 1,500Hz. The continuity range is adjustable from 0–10 ohms. It has plugable probe clips. The HTM is priced at £22.00.

Highams Electronic Communications Lts., 58-60 Redchurch Street, London E2.

eti component news

CALCULATOR INTEGRATED CIRCUIT



A second-generation MOS calculator integrated circuit is the latest in the C500 series manufactured by General Instrument Microelectronics and differs in several important ways from "standard" calculator chips which have been offered so far.

Called the C550, the I.C. is intended for use with eight seven segment displays which can be light emitting diodes, liquid crystals or the hot filament variety. Although the display is limited to eight digits, answers can fall anywhere in the enormous range from 10^{-20} to 10^{+79}; the I.C. has the capability to operate with numbers over a range of 99 decades. The C550 achieves this by automatically internally changing to scientific notation when the capacity of the display is exceeded. The chip stores the answer with its sign together with a positive or negative exponent between -20 and +79. The true result is recovered by multiplying or dividing by powers of ten. An important side benefit of this approach is that it obviates the need for a ninth display for under and overflow indication and therefore cuts production and component costs.

A second feature of the C550 is that, unlike many other calculator I.Cs, partial results can be stored in the register normally employed for constant storage. This is achieved by merely pressing the constant key and enables partial results to be used as a divisor in a subsequent operation. Hence a calculation such as (5.6 + 6.8) ÷ (5.6 x 6.8) can be formed without first having to calculate the value of the divisor and having to clear the machine before proceeding (as has to be done with most eight digit calculators on the market today).

The clear key performs two functions. If the clear key and then a function key is pressed the last entry is cleared. If the clear key followed by a digit key is pressed the whole machine is cleared. This obviates the need for the usual "clear last entry key".

In addition to the special features the I.C. will add, subtract, multiply and divide. It will perform chain calculations and the constant store can hold a multiplier, divisor, subtrahend or addend. When the result is negative the minus sign shows and of course the decimal point facility is as usual.

The I.C. requires a single nominal 15V power supply and a 70kHz single phase clock pulse input; power consumption is typically 150mW. The C550 chip is housed in a 24 lead dual-in-line ceramic package and operation over the temperature range 0 to 50°C is possible.

The C550 costs £16 in small quantities.

SDS Components Ltd., Hilsea Trading Estate, Portsmouth, Hants., PO3 5JW.

KNOB FAMILIES

A.F. Bulgin & Co. Ltd., Swiss manufactured range of 'RITEL' Collet fixing Control Knobs to be known as "BULGIN MULTI-RANGE".

These Control Knobs cover four basic styles of which there is five sizes in each style, all conforming to accepted standards of modern 'matched family design' and manufactured to high specifications.

There are two styles of knob (circular or bartype), three styles of cap (plain flat, flat with indicator line or bevelled top), an option of pointer or dial, and three styles of 'not cover' (plain, with indicator line for circular knob, or with indicator line for bat knob). These components clip together to help you make up the knob you want.

All these component pieces are available in a variety of sizes. Knobs and nut covers come in black, light grey dark grey or red. Caps and pointers are available in blue yellow or green as well as the knob colours. Dials are transparent and can have any of a wide range of legending.

This range will no doubt prove of great interest to the engineer wanting a front panel of matched controls.

A.F. Bulgin & Co. Ltd., By-Pass Road, Barking, Essex.

SCHLUMBERGER PANEL METERS

Electroplan now distribute the Daystrom Schlumberger range of digital panel meters.

The photograph shows the 1220 bipolar, 3½ digit portable model, designed to operate from a battery source without regulation. The 1220 requires less than ¾ watt to operate from any DC source between 4.8

and 6 volts. This DPM does not require a warm up period and is therefore 'instantly' accurate. It has an accuracy of 0.2% over temperature range 0-50°C. A mains operated version, model 1221, is also available.

Another DPM, the 1295 DPM, uses a single 24-pin M.O.S. L.S.I. plug-in chip which contains all the digital logic, the polarity sensing logic, the comparator to sense threshold crossing, the overrange sensing logic, synchronisation of the 3½ digit display setting and storage register.

A 1294 is a 4½ digit bipolar DPM with a 1.9999 nixie tube display and a resolution of 10mV on the 200mV range. It is available in ten standard voltage and current ranges.

Electroplan Limited, PO Box 19, Orchard Road, Royston, Herts. SG8 5HH.

EX-STOCK PANEL COMPONENTS

A new range of British made miniature indicator lamps, push-button and microswitches, made by Feltec Components, is now available.

The Feltec range consists of over 3,000 different components, including neons and light-emitting diodes. The switches have a mechanical life of 100,000 operations, and are available with or without illumination,

in nearly 400 different configurations, whilst the lamp range gives a choice of over 2,000 variations. The range includes a tri-colour miniature cartridge lamp, available with any three of eight colours and twelve voltage ranges.

Components Division, FieldTech Limited, Heathrow Airport, London, Hounslow, Middlesex. TW6 3AF.

FAST TURN-OFF THYRISTORS

International Rectifier range (IR140 and IR141) are fast turn-off Thyristors with very low turn-on losses. The units are designed for use in such applications as radar pulse modulators, ultrasonic cleaning equipment, and high frequency inverters and convertors.

Maximum turn-off time is 15usec for the IR140 and 10usec for the IR141; re-applied dv/dt is 200 volts/usec for both types. The devices operate at up to 4KHz with no reduction in peak current capability, and can handle up to 28 amps peak current at 20KHz. They are housed in a TO-48 package.

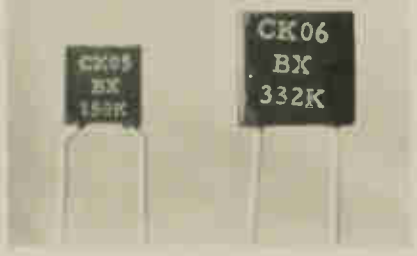
Versions are available from 50 to 400 volts.

International Rectifier, Hurst Green, Oxted, Surrey.

MULTILAYER CAPACITORS

The CKO5 and CKO6 capacitors are manufactured for operation over the temperature range -55 to +125°C, and are primarily intended for by-pass, coupling and filtering applications.

All the capacitors are of the axial lead type and are housed in small rectangular epoxy packages. Transfer moulding is standard for the smaller capacitance values while precision moulded epoxy shells are used to encapsulate the larger components.



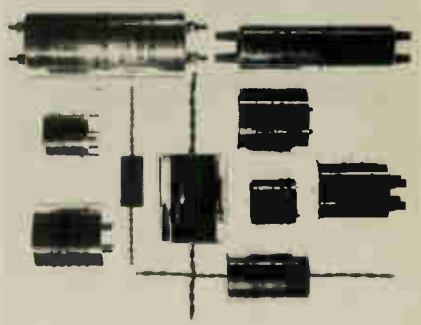
The range stocked by SDS is divided into two by package size. Type CKO5 capacitors are housed in packages which measure 4.83 x 4.83 x 2.29mm and CKO6 capacitors measure 7.37 x 7.37 x 2.29mm. CKO5 capacitors are available from 10pF to 1nF (200V), 1.2nF to 10nF (100V) and 12nF to 100nF (50V) in both the 10% and 20% preferred values. Type CKO6 capacitors range from 1.2nF to 10nF (200V), 12nF to 100nF (100V) and 120nF to 270nF (50V) also in 10% and 20% preferred values.

The leadout wires (made from 22AWG tinned copper wire) are set at 5.08mm (0.2 inch) centres.

SDS Components Ltd., Hilsea Trading Estate, Portsmouth, Hants., PO3 5JW.

MAINS FILTERS

The Maple SR range is a new range of interference filters, based on the use of high permeability ferrite cores. The design of the filters allows their use for the suppression of both symmetric or asymmetric interference in the 0-250v 50/60Hz region. Available in 5 standard values (1½, 3, 5, 10 and 15 Amps), the filters are encapsulated in epoxy resin and are housed



in extruded aluminium cans of two basic sizes – 34 mm x 38 mm dia. and 50mm x 51mm dia.

Components used are approved by both VDE (W. Germany) and SEV (Switzerland), and the filters are said to be particularly suitable for mains interference suppression in electronic instruments and equipment and also in preventing illegal levels or interference from being generated by thyristor controls, electrical machines, domestic appliances, etc.

Roxburgh Electronics, 22 Winchelsea Rd., Rye, Sussex.

SOLID-STATE METER RELAY

A new solid-state meter relay using operational amplifiers combines high sensitivity with an unusually fast response time. The unit has a low power consumption and good resistance to vibration and shock. It is self-contained and designed for easy panel mounting. Its uses are mainly in the medical and industrial fields, where monitoring and control of electrical signals are required and applications include the control of temperature, levels, rate of flow and speed.

The meter has twin set-points adjustable over the full 103mm scale. Input signals down to 10 mV can be accepted and thermocouples connected directly for temperature control with cold junction compensation if required. The high sensitivity of measuring circuit is achieved by using electronic rather than electro-mechanical measurement, and response time of the relay circuit is less than 250 milliseconds. A slower response can be built in, if required. The trip circuit operates independently of the indicator and is unaffected by shock or vibration.

In operation, the input signal is amplified and fed to both the indicator and to twin comparator circuits. The appropriate circuit is triggered when the amplifier signal exceeds a stable voltage obtained from an adjustable set-point potentiometer. The comparator output is then amplified to operate a highly dependable relay which is free from flutter regardless of vibration, shock and long periods of inactivity.

Crompton Parkinson Ltd., 50/52 Marefair, Northampton NN1 1NY.

GIANT SIZE PHOTOCELL

This new high power photoconductive cell has a viewing area of 29.5 mm diameter and is hermetically sealed in a plastic case 9.5 mm thick. It is capable of operating in an ambient temperature range from -30°C to +70°C.

This giant cell is ideally suitable for automatic lighting control where it can monitor varying ambient lighting conditions. It can also be used for any type of application where a large area has to be monitored and variations in illumination on any part of the cell will produce a variable output.

The cell will operate from any AC or DC supply up to 500v and has a continuous power dissipation of 500mW with a peak demand dissipation of 750mW. Its resistance at 10 lux is between 10-20k ohms and in dark its resistance is a minimum of 5M ohms.

It is available at £0.50 (plus 10% VAT) in small quantities.

Photain Controls Limited, Randalls Road, Leatherhead, Surrey.

LEO CATALOGUE

Litronix, the California-based developers and producers of solid state, light-emitting devices, have brought out an 8-page catalogue of their product range. The catalogue entitled *Our Line*, contains detailed electrical, optical and physical specifications for more than 70 products, including multi-diode array indicators; infra red, indicator and panel-mounted LED lamps; numeric and alphanumeric, single - and multi-digit displays; and opto isolators, or solid state relays. *Our Line* is available by return of post, from:

Litronix, Bevan House, Bancroft Court, Hitchin, Herts SG5 1LW.

NEW EEV GAS DETECTOR

Early warning of the presence of hydrocarbon gases in the atmosphere, essential in potentially hazardous areas such as the gas and petro-chemical industries, is provided by a small detector type VQ2 made by English Electric Valve Co. Ltd. under N.R.D.C. licence.

The VQ2, which will detect methane in air mixtures in concentrations from 0.1 per cent upwards, comprises two low power matched elements to form two arms of a Wheatstone bridge. One element contains a catalyst which causes methane

to burn on contact, with a resultant variation of its resistance. The other is a non-active compensating element so that variations in atmospheric pressure, humidity and ambient temperature have negligible effect on the bridge output.

The output from the bridge is virtually linear up to 3 per cent methane in air, with a minimum sensitivity of 15mV/per cent methane.

When used in a recommended bridge circuit maximum bridge power consumption is 0.48W, so making the device particularly suitable for portable battery operation.

EEV, Chelmsford, Essex CM1 2QU.

LOW-COST INFRA RED EMITTING DIODE

Following closely on their announcement of the MLED500 light emitting diode in a transparent TO-92 package, Motorola Semiconductors have just introduced an infra-red emitting version in the same style package.

Known as the MLED92, the device has a reverse breakdown voltage (BV_R) of 3V and a maximum forward current of 100mA. Output at a forward current of 50mA is 0.66mW.

The device is ideally suited for use with the TO-92 2N5777-80 infra red detectors to form infra-red couplers or interrupt modules.

MLED92 is a low-cost device, the price being less than 10p each for 100 up.

Motorola Semiconducters, York House, Empire Way, Wembley, Middlesex.

BACK NUMBERS

A limited quantity of back numbers of Electronics Today International are available at 25p each plus 7p postage (32p in all). Requests for these should be addressed to:

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ACOUSTO-OPTIC DEFLECTOR ENABLES LASER SCANNER TO TAKE, PROJECT AND FACSIMILE PICTURES WITH HIGH RESOLUTION

Employing a newly developed, simple, highly efficient acousto-optic deflector, RCA scientists have built a laser beam scanner that operates at TV rates, but projects a picture with 3 to 4 times the detail of conventional TV.

The laser scanner -- constructed as part of on-going electro-optic research at RCA Laboratories in Princeton, N.J. -- can be used for taking pictures as well as projecting them, according to Dr. George D. Cody, Director of the RCA Physical Electronics Laboratory.

Thus, it could be the forerunner of an advanced, high resolution facsimile system that, in effect, photographs at the sending terminal the picture it reproduces at the receiving terminal. Conventional facsimile systems require a photograph, rather than the object itself, in transmitting picture copies to receiving terminals, he explained.

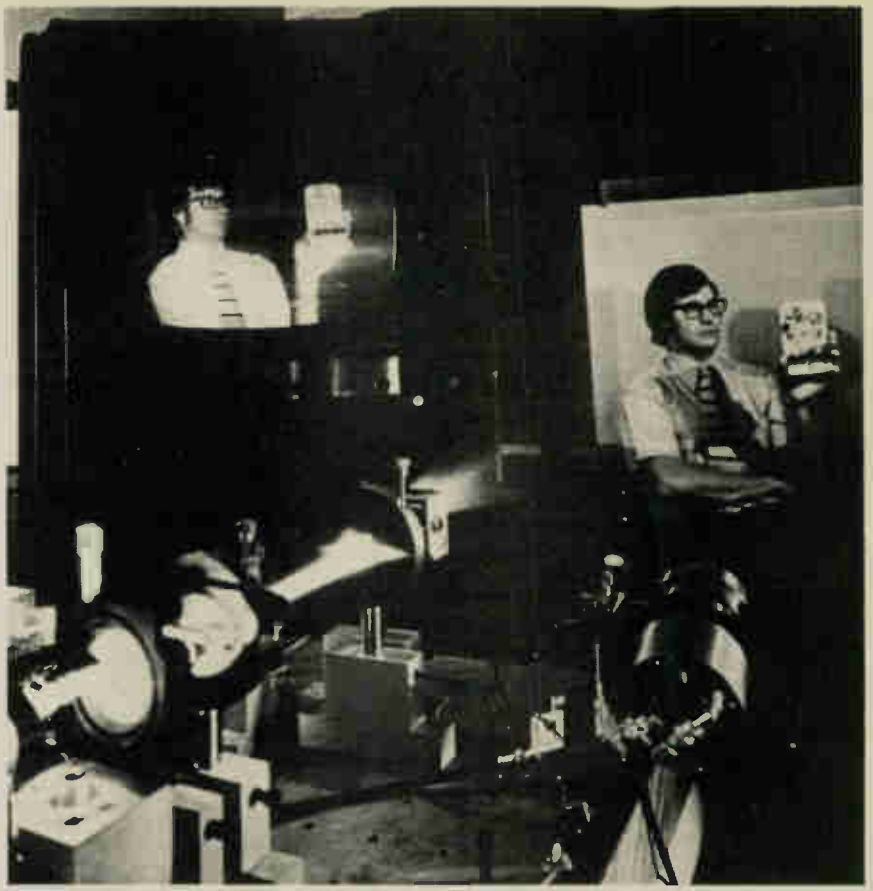
The RCA system's pickup tube "photographs" spot by spot and line by line, the reflection of the laser beam as it sweeps over a three-dimensional object. The signal from the pickup tube is electronically processed and then sent to the receiving terminal for conventional facsimile reproduction.

Laser scanners have many other potential applications. These include, scanned optical radar, computer print-out, and optical memories and image storage.

The highly efficient acousto-optic deflector in the experimental RCA scanner was developed by a research team headed by Dr. Istvan Gorog and including Peter V. Goedertier, Dr. Joseph D. Knox and Dr. Igal Shidlovsky.

The scanner has two deflectors vertical and horizontal. Since TV vertical deflection is relatively slow, a conventional oscillating galvanometer driven mirror is employed to direct the beam vertically. The fast moving horizontal deflector, however, is an anisotropic Bragg device, constructed out of paratellurite (TeO_2). It is capable of scanning up to 15,750 lines per second.

Although initial investigations by RCA scientists and other researchers indicated that anisotropic deflectors -- those made from crystals whose properties depend upon the direction of propagation of both the sound and light waves -- suffered severe dips in



efficiency at mid-frequency ranges, experimental work by Dr. Gorog's team indicated that this problem could be overcome. As a result, they developed TeO_2 deflectors with efficiencies as high as 90 per cent operating at television rates.

In developing these high efficiency deflectors, the RCA scientists found it necessary to devise a cold press bonding technique for attaching r.f. transducers to the TeO_2 crystals. In addition to its high efficiency, the paratellurite deflector has the advantage of simple fabrication, as it does not require the beam-steering mechanism of comparable deflectors. Furthermore, 1000 TV line limiting resolution can be achieved with a deflector having a using optical aperture of only 0.5cm.

This smallness facilitates diffraction-limited operation and ease of alignment, thereby permitting the use of relatively inexpensive, simple optical elements of just average quality in the scanner, Dr. Gorog states. Another advantage of the anisotropic TeO_2 deflector is that it operates at low r.f. drive power levels, and thus can be compatible with integrated circuitry.

LASER-INDUCED ELECTRICAL EFFECT DISCOVERED

An unusual and totally unexpected electrical effect has been discovered by Robert J. von Gutfeld and Eugene E. Tynan at IBM's Thomas J. Watson Research Centre at Yorktown, New York.

Von Gutfeld and Tynan have found that when the surface of a thin film of a metal such as molybdenum and tungsten is irradiated with brief pulses of laser light, voltage pulses of up to 0.05V are generated in the plane of the film, for 1kW of incident power. Such pulses can readily be detected without special amplification, and the planar direction of the voltage makes for simple attachment of electrical connections on the film surface.

Exploitation of the new effect could result in inexpensive arrays of fast photodetectors responsive over a broad optical spectrum and operable over a wide temperature range. Moreover, detectors based on the new effect would be resistant to the heat-degradation characteristic of such now-common photodetectors as silicon-based devices. Some experimental detectors based on the new effect in fact show an actual increase in sensitivity with rise in temperature.

The new phenomenon was discovered during studies of heat conductivity in which a pulse laser was used to 'inject' bursts of thermal energy into small samples of various materials under controlled and monitored conditions. A temperature gradient - a progressive change in temperature with distance - through the depth of the irradiated films does appear to play a central role in giving rise to the voltage, which nonetheless is at

right angles to the gradient.

At least as surprising as the voltage direction is the fact that the voltage polarity remains the same, for fixed contacts, no matter how one rotates the film in its own plane around the axis of the laser beam. The only way to reverse polarity for a sample to which measurement contacts are fixed is to shine the laser beam on the other side of the film. This constancy is decidedly unusual; other voltage effects have shown reversability, since they arise from asymmetries in either the laser beam or the detector circuit. Absence of such reversal seems to show that asymmetry at this level is not involved.

In a paper in the August 15 issue of *Applied Physics Letters,* Dr. von Gutfeld suggests that underlying the newly found effect is an asymmetry within the films themselves; microscopic distortion caused by such factors as stress arising while the film is being deposited and/or misplacement of atoms as they stack up while the film is being formed. This type of asymmetry would be independent of rotations around the laser-beam axis and could result in the 'crosswise' voltage observed, as von Gutfeld shows by an analysis of the so-called Boltzmann transport equations, which relate symmetry structure to electrical and thermal parameters. The voltage would, in fact, be a photo-induced transient thermoelectric effect. Such an interpretation is strengthened by the observation that the voltage is produced only by pulses of laser light, not by continuous irradiation - which would 'wash out' a temperature gradient between the near and the far sides of the film. Additional evidence that a temperature gradient is at work is that as pulses are lengthened or pulse rise-times become longer - giving the film a greater opportunity to reach front-to-back thermal equilibrium - the voltage diminishes.

Indeed, for the best results so far, the laser pulses should be extremely short, of a few nanoseconds long; the resulting duration of voltage pulses is roughly comparable.

Detectors exploiting the new effect should be versatile; voltages of comparable magnitude have been produced by selected laser wavelengths from blue through orange and red, in the visable spectrum, and then out to the near infrared. In addition, the new detectors promise to be extremely hardy. Whereas the performance of silicon-based photodetectors declines as ambient temperature rises, experiments at IBM's Research laboratory with molybdenum show an actual increase in sensitivity which seems to be linear. At an ambient temperature of 250°C, the voltage produced for a given laser energy is about 15 per cent higher than when the film is at room temperature. (This improvement may be related to the fact that temperature-rise may produce stresses of its own under certain conditions - stresses distinct from the 'locked in' stress of deposition mentioned earlier - or simply due to a linear dependence on temperature of the thermoelectric coefficients).

At present, von Gutfeld and Tynan are continuing study of the new effect in hopes of enhancing it, extending it to a broader range of light frequencies, and discovering other - possible superior - materials.

NEW ARMY COMMUNICATIONS SYSTEM

A multi-million pound programme for the development of a secure tactical trunk communication system for the British Army in the 1980s has been awarded to The Plessey Company Limited under a Ministry of Defence contract announced today. Known as *"Ptarmigan"*, it is the largest military communications development project ever undertaken in Britain.

Ptarmigan will provide the military equivalent of an STD type of person-to-person telephone service between units - either fixed or mobile - anywhere within the combat zone. Transmission channels are carried almost entirely by means of u.h.f. and v.h.f. radio links instead of by cables so that the necessary mobility is obtained.

The Ptarmigan System results from many years study of a new system concept of communications for the Army and supporting tactical Air Forces. It reduces the weaknesses of earlier military communications systems by departing from the chain of command principle which required local communication switching centres at each formation headquarters. Instead, a number of stored program controlled switching centres, located at suitable geographical points, are interconnected by multi-channel radio relay to form a grid network covering the whole tactical area.

The heart of the switching centres will be the Plessey PP250 processor which was developed by Plessey Telecommunications for its stored program control project.

Formation Headquarters will be connected by radio relay to any switching centre from which a multiplicity of routes can be provided to interconnect the different levels of command. Mobile system through a 'radio-telephone' subsystem known as Single Channel Radio Access.

Some of the special service features provided by Ptarmigan are:-

1. secure communication by speech, telegraph, facsimile and data:
2. provision of Conference and Broadcast facilities;
3. priority service for nominated subscribers;
4. a unique never-changing directory number for each subscriber;
5. automatic call transfer facilities;
6. designed to meet the standards agreed by the Eurogroup nations and NATO.

The commencement of Ptarmigan engineering development marks the end of a long period of study by the Ministry of Defence (Army), the Signals Research and Development Establishment and The Plessey Company Limited to arrive at the present state of project definition.

B.A.S.C. GETS GOING SETTING TELEVISION AERIAL STANDARDS

The principals of five major U.K. UHF aerial manufacturers met recently to reconstitute the British Aerial Standards Council, which although formed as long ago as 1963 confined itself primarily to technical interchange. Recent developments have prompted it to extend its activities considerably with the object of promoting high standards of performance, design and construction in television and VHF radio aerials available to the public.

Mr. James W. Woods, deputy chairman of J. Beam Aerials Ltd., of Northampton, who has been appointed chairman of B.A.S.C. says:

"There have been ever-increasing comments over the last year or so, both by the public and in the press, about the poor standard of many aerials now on the market. Considerable quantities of these are often the product of small part-time operators with little mechanical expertise and inadequate electronic measuring equipment. One recent newspaper article referred to them as 'fly-by-night manufacturers producing poor quality aerials at rock-bottom prices'.

"Poor television reception due to inefficient aerials inevitably provokes criticism and complaint by television set owners to the Ministry of Posts and Telecommunications. We, of the Aerial Standards Council, feel that the climate is right for much more attention to be given to the situation with a view to improving and maintaining the standard of aerials offered to the public. It will be the job of B.A.S.C. to do precisely this".

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