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March 1976 35p

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Total average net circulation of 8535 per issue during 1974. UK 5663, overseas 2872.

studio sound

AND BROADCAST ENGINEERING

London is a good place to live. But in the music area particularly it has enjoyed an unusually prominent position for a long time—measured, if you like, in hundreds of years rather than record sales figures. Traditionally, it has been a clearing house for a vast range of musical styles and activities; at present, the spectrum feels at least as wide as anything else anywhere else. On the classical side, it enjoys more major orchestras than any other world city, with a correspondingly huge spread of more modest performing forces. These receive public and some private subsidy in order to survive, which is a fair solution to the daunting economic problem facing them. And despite the rising cost of admission, audiences are reasonable and comprised of all age groups.

As a result of what happened in and after 1963, London has become the centre of a flourishing music industry adrift from the old concepts and hierarchies of Tin Pan Alley, and a record and recording industry has grown up out of all proportion to what might reasonably have been expected. A lot of music is very loud. It means a lot to a lot of people. And it is anathema to a lot of others. But on it, and its continuing performance, depend the musicians who are the centre of the whole business.

Music in London has become a true popular culture: it is self-supporting and has a wide spread. But the electric folk music of our time has the misfortune not to appeal to the bureaucrats whose job it is to pass legislation of critical importance to its survival.

We are now faced with the spectacle of the Greater London Council imposing a ludicrous sound level limitation on performance and possibly on a studio control room. In their wisdom, they have assumed moral responsibility for our well being, which is one way if not the only or best one. But it is now painfully obvious from the lack of information about proceedings and the insistence on keeping any responsible press away from these discussions that the committee responsible is blundering into a decision it is neither qualified nor fit to make. There is apparently complete lack of open discussion with the many technicians and musicians in London capable of giving an involved, responsible and experienced viewpoint on the new music.

If the Leeds Corporation fiasco is repeated, live performance in London will stop, as by the same token should many acoustic events. The music will go elsewhere. What remains will be castrated. Of course, a state subsidy for the minority arts might rescue this ailing form. Lunchtime recitals by Black Sabbath CBE and Deep Purple in the V & A, tea provided in the interval.

Museums are for looking at, not living in.

This city is *alive*.

Lobotomy is not the solution.

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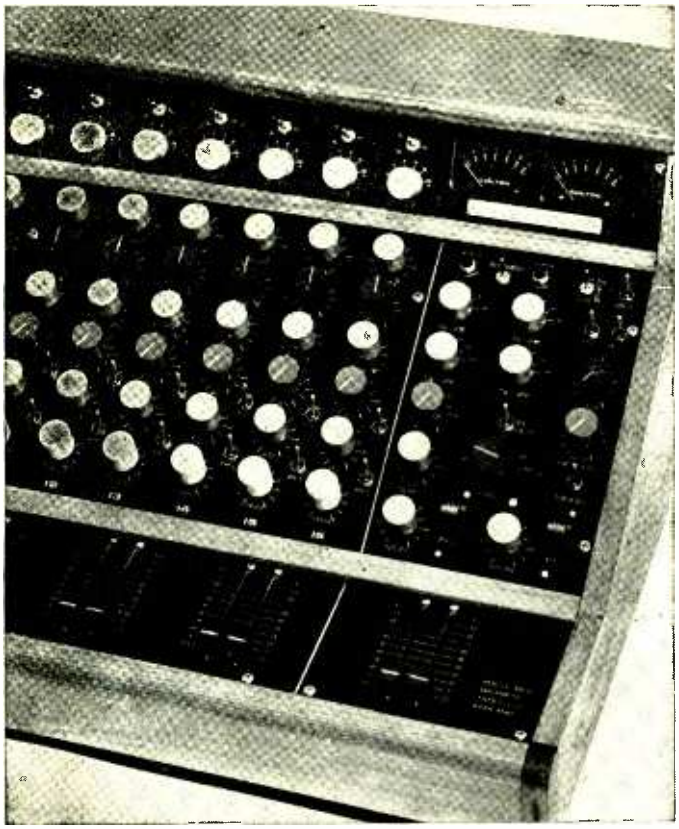
COLUMNS

REVIEWS

MARCH 1976 VOLUME 18 NUMBER 3



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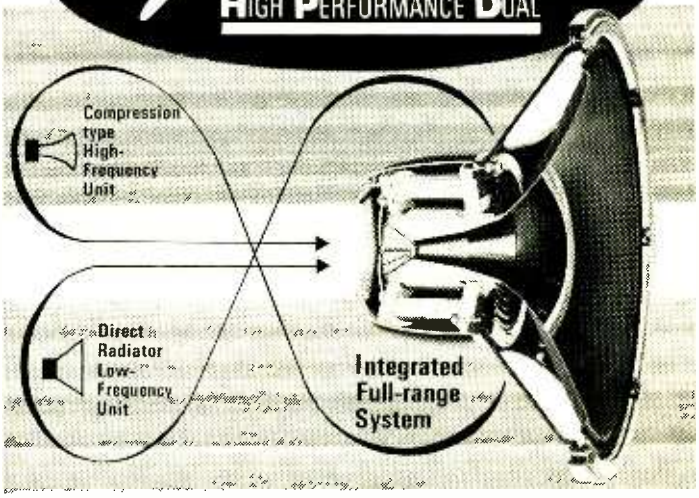

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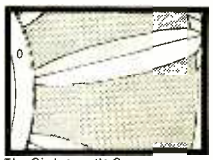

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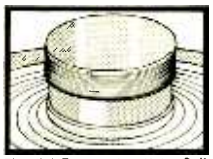

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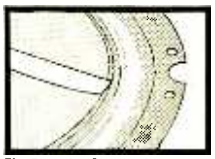

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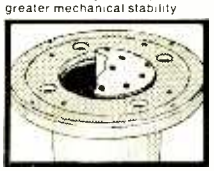

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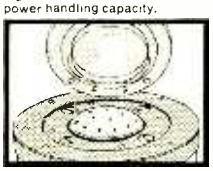

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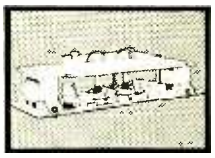

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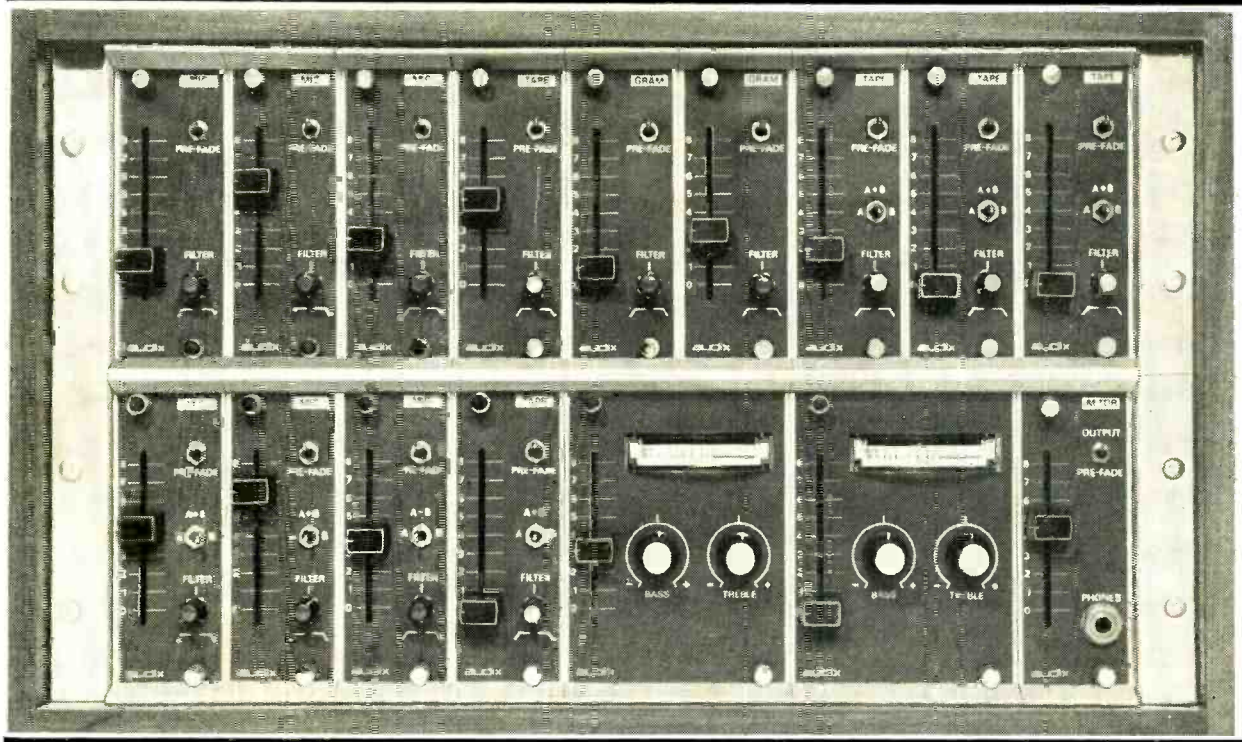

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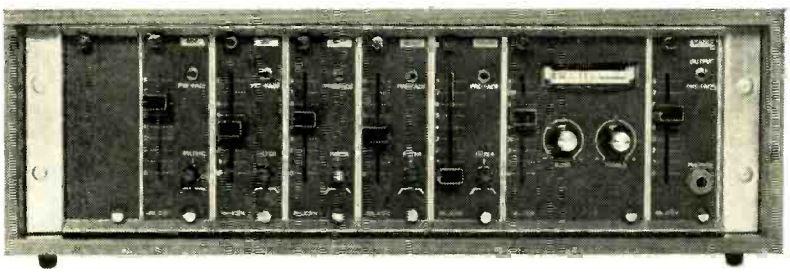

MXT-200 THE MIXER

The standard equipment is built up in 19 inch frames, each 9 modules wide. The frames may be stacked or placed end to end and housed in a console, rack or cabinet. You only order the input modules you now need. Additional modules may be plugged in the frames as your requirements change.

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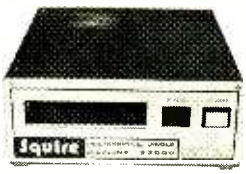

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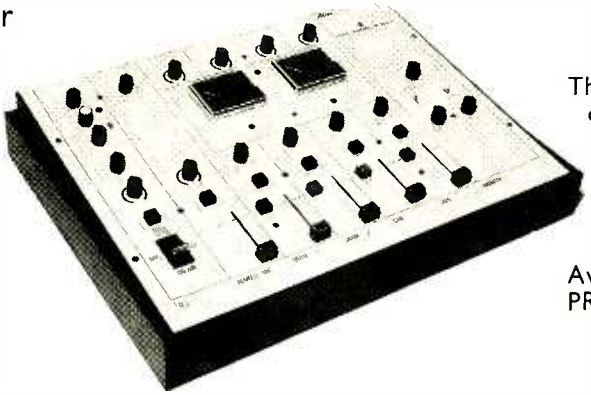

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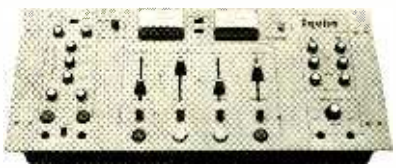

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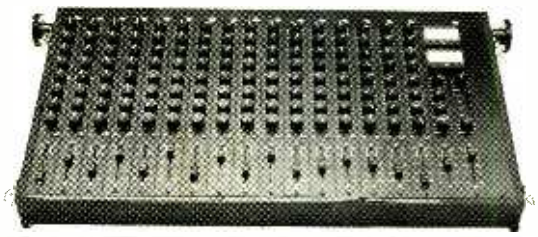

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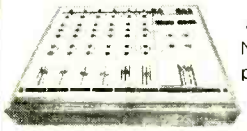

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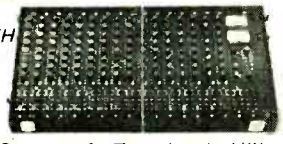

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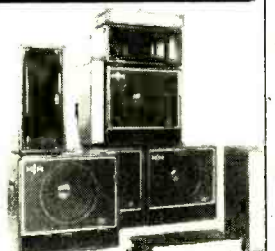

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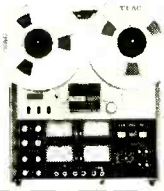

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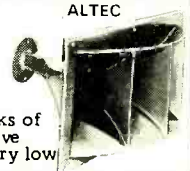

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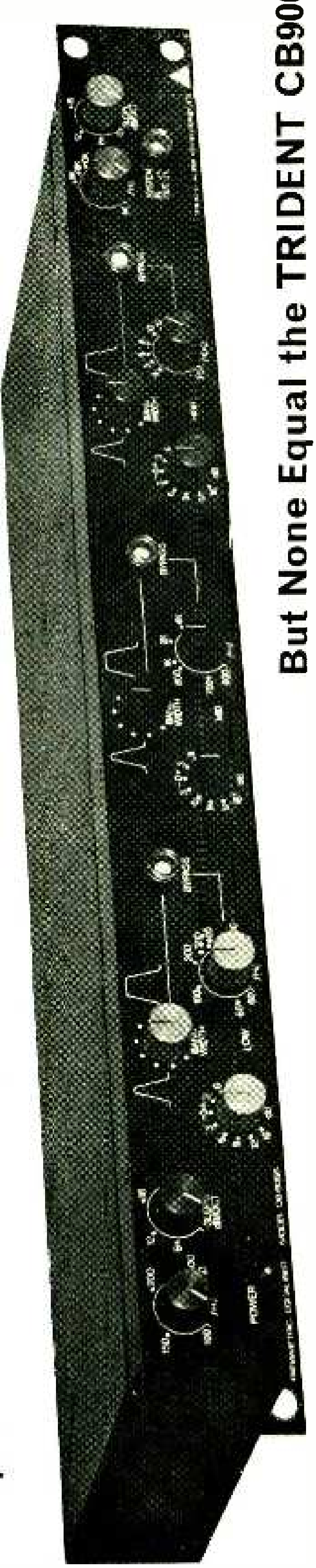

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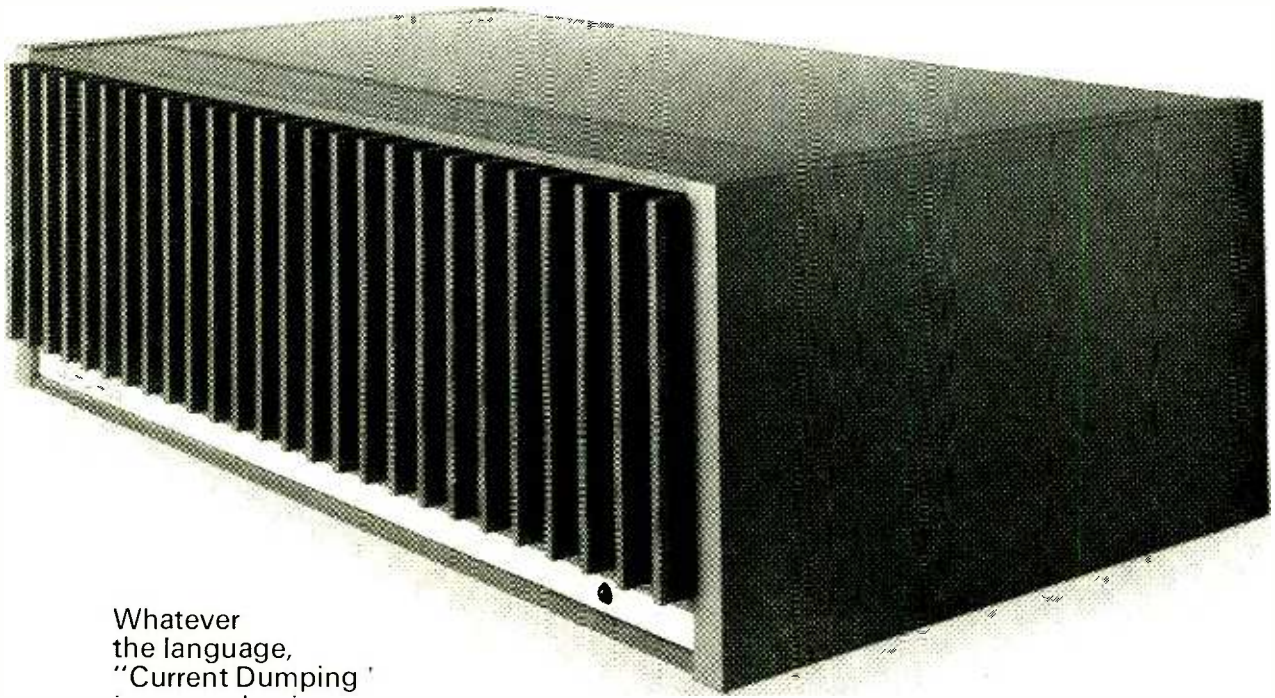

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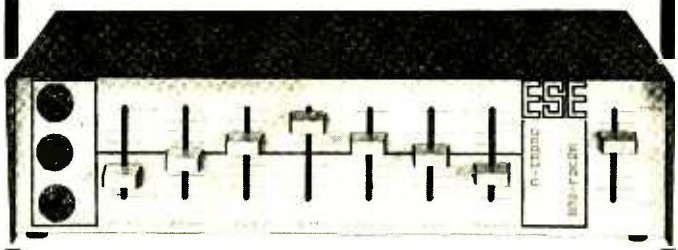

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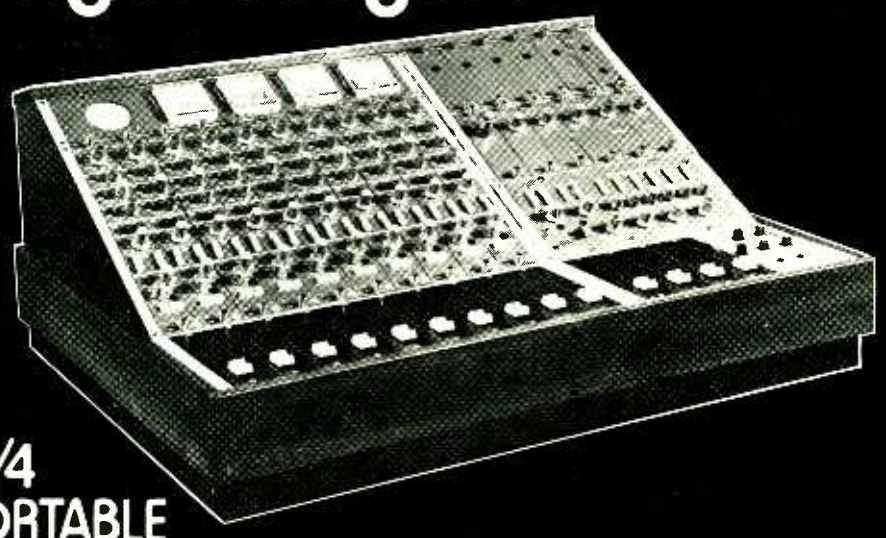

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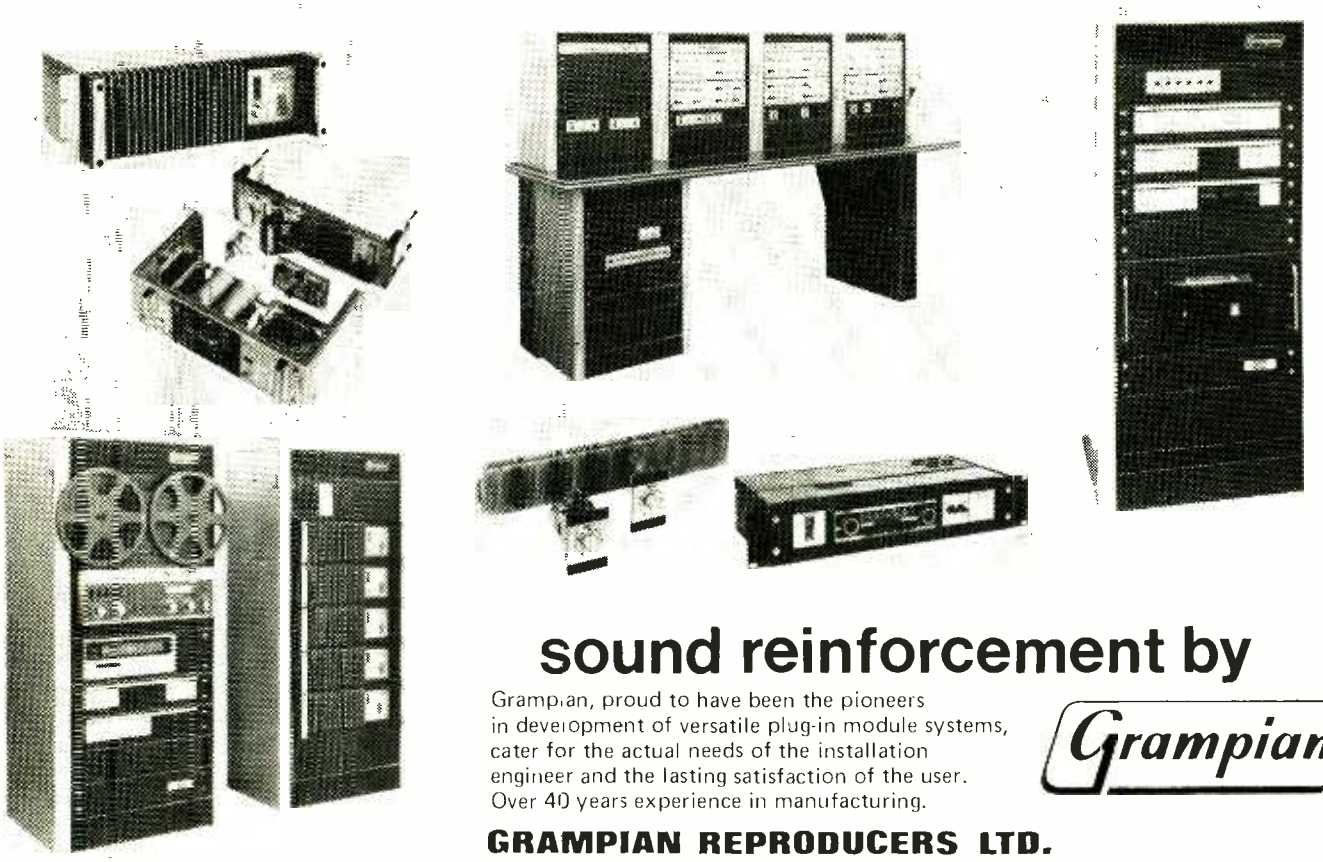

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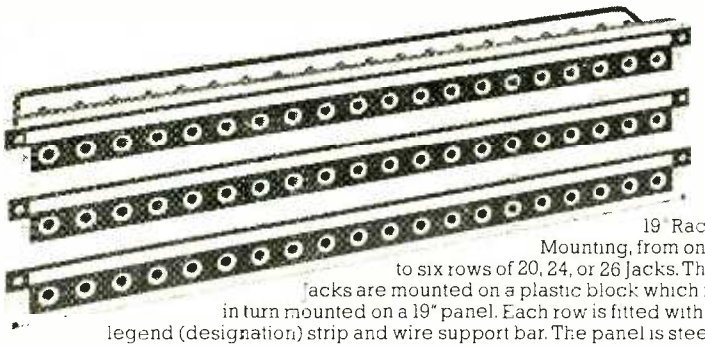

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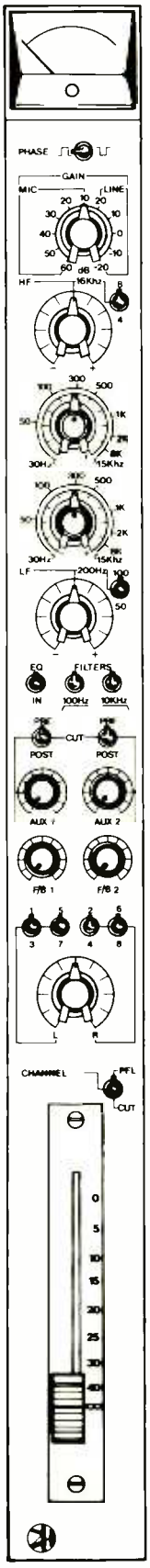

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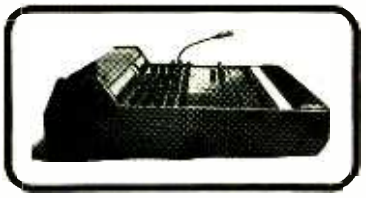

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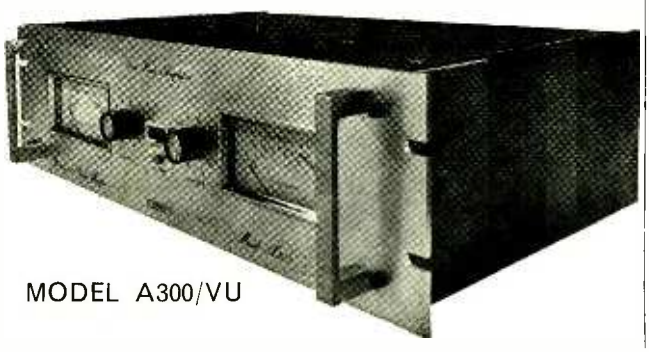

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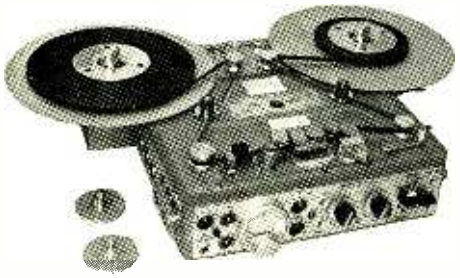

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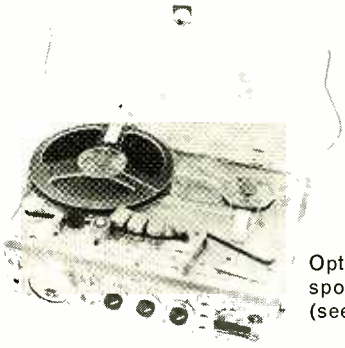

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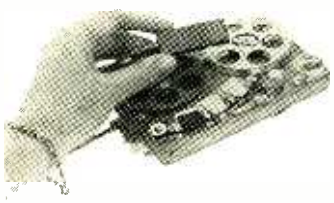

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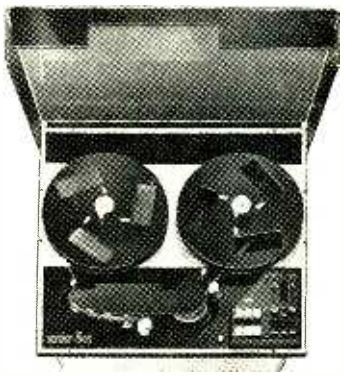

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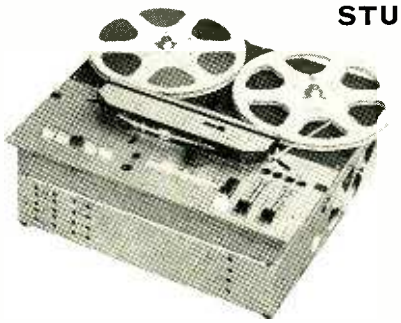

Model M.12—"The wow and flutter as measured to the DIN weighted quasi-peak method was the lowest that I have ever encountered."—*Studio Sound* magazine, May 1975.

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letters

Dear Sir, I would like to comment on the recent audio mixer survey published in the October and November issues of STUDIO SOUND.

While I appreciate that the survey was intended to be international by nature, I was very surprised at the general lack of emphasis placed on British equipment in the accompanying photographs. Out of a total of 18 photographs published, only seven (it may have been eight but one picture had no reference in the survey) were of English equipment and this I find quite disheartening.

In these days of much published British economic gloom and despondency, rising unemployment etc, British products need promotion more than ever.

Unlike many other British products facing competition from Overseas by way of price cutting or quicker deliveries we do not have these problems. English sound recording equipment is acknowledged worldwide as being possibly the finest available and is often chosen without hesitation in preference to US or European competition. Since most companies making this kind of equipment are fairly small and are therefore not subject to industrial disputes our delivery dates are also just as competitive as our overseas rivals.

British recording equipment manufacturers are therefore in a unique and enviable position and I for one take exception to a British magazine excluding equipment of domestic origin for the sake of showing equipment that in at least two cases is not available in this country.

I am surprised that your magazine has not come to this realisation earlier but can only put it down to the generally apathetic view of our own ability which has not only permeated our own country but which has in some cases spread abroad to give foreign newspaper coverage out of proportion to our problems.

In conclusion I would like to point out that this is not a 'sour grapes' letter because the photographs we submitted were not published. None of the other major English console manufacturers were represented to any degree either so we have no reason to feel victimised.

Yours faithfully, Malcolm F. Toft, Managing Director, Trident Audio Developments Ltd, 4/10 North Road, Islington, London N7 9HN.

STUDIO SOUND aims to serve an international industry with an international magazine, albeit with an English accent. But that accent does not mean that it is a promotional magazine for either the British recording industry or the British hardware industry. We take what comes, and hopefully do it justice whether it's from England, America or Outer Mongolia (where we have a small circulation). In Triad's case, the omission certainly does not reflect their prompt help with information, but rather that their consoles have been shown frequently in these pages before. A broader point is that, given the balance of world console output, eight photos out of 18 represents a British bias anyway.—**Ed.**

Dear Sir, In 'News' on p26 of your December issue, John Dwyer makes a kind reference to Pennine Radio, the ILR service for the Bradford area. However, unfortunately he gives details of the MW station incorrectly. The station uses 235m (1277 kHz) not 246m and the transmitters have a power of rather under 150W (300W is the maximum authorised power but has not been found necessary to match VHF coverage).

Yours faithfully, Pat Hawker, Engineering Information Service, Independent Broadcasting Authority, 70 Brompton Road, London SW3 1EY.

Dear Sir, I was most interested in the article by Michael Gerzon in May 1975 STUDIO SOUND *on Dummy Head Recording, as at last it seemed as if the horse was gaining on the cart, and we were beginning to look at sound as heard by the listener, rather than as reproduced by the loudspeaker. The article dealt with three important criteria in dummy head recording (and thus in the way we hear direction) ie microphone spacing, the acoustic shadow of the head, and the influence of the pinnae.*

The article provided a good review of some research work relating to the influence of the ridges of the pinnae in providing directional 'coding' (in terms of sound coloration) to the inner ear. While in no way disputing the validity of this approach, I would like to draw attention to a paper by Brown in the Journal of the Proceedings of the Physiological Society, 1910.

In this paper, Brown hoped to demonstrate an analogy between three-dimensional perception of sight, and the three-dimensional perception of sound. He placed one end of a stethoscope on a watch, while the ear-pieces were placed in the auditory meata *of a subject's ears. Thus the sound by-passed the pinnae and was transmitted to the inner ear via the auditory meatus. The sound of the watch was heard* outside the subject's head, *central, and in the front. Closing off one of the flexible tubes to either ear transferred the sound directly to the other ear (ie not in front), while a gradual closing off of the tubes could make the watch move from a central position outside the head, to either ear* in the plane of the ear.

This simple experiment can easily be repeated, and gives the results indicated by Brown, our sense of hearing being unlikely to change over the last 60 years! Thus, the precise role of the pinnae in providing horizontal direction location may not be so marked as previously thought. Where they may be more effective is in the location of sounds in a vertical plane, ie above or below the plane of the head. This is borne out 1) by the fact that the sound via the stethoscope appears in the same horizontal plane as that of the ears, irrespective of the watch position relative to the listeners head, and 2) from figs. 5a and 5b of Gerzon's article showing the relative time delays in the horizontal and vertical planes.

Only further inter-disciplinary research into hearing mechanisms will elucidate the complexities of auditory transmission, and is perhaps unfortunate that this important sense of perception is the least understood in basic scientific terms.

Yours faithfully, Dr James Crabbe, University of Manchester, St Anselm Hall, Victoria Park, Manchester M14 5BX.

Dear Sir, In my recent article on Radio in Eastern Europe (STUDIO SOUND *Nov 75) I inadvertently referred to the death of President Svoboda of Czechoslovakia. This should have read 'departure'. Gen. Svoboda suffered a long and serious illness, and was succeeded in office by President Gustav Husak; but he celebrated his 80th birthday on November 25, as the Czechoslovak press reported. I can only apologise and say that I hope Gen. Svoboda will enjoy better health for many years to come.*

Yours faithfully, John Fisher, Naille, Upper Swainswick, Nr. Bath, Avon.

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news

Function generator

The *119* provides sine, triangle square waves over a range 0.02 Hz to 2.2 MHz. A front panel control allows adjustment of the time symmetry of all waveforms. The voltage controlled master oscillator can be operated by an external control voltage providing three decades of frequency over 10V.

There are two front panel outputs; the high one delivers 10V p to p into 50 ohms, or 20V into an open circuit. The corresponding low output levels are 316 and 632 mV. An amplitude control allows 30 dB of level adjustment for both outputs which are available simultaneously. A front panel switch inverts the pulse and ramp waveforms while an offset control will superimpose up to ±10V dc on the output signal. A further ttl compatible pulse output will sink up to 20 ttl loads.

The instrument costs £155 basic. Dana Electronics Ltd, Collington Street, Luton, Beds. Phone: 0582-24236.

Trident move

Trident Audio Developments, the manufacturing facility, recently moved their plant to premises at Shepperton Studios, Squiresbridge Road, Shepperton, Middlesex. The new phone no is 09328-60241. Reasons given for the move include 'increased demands for their products and projected future growth'.

Among the latest orders received are a 28 input 24 output A series console for Cherokee Studios, California. There is also a 40 input version in the pipeline. They also plan to manufacture a pa/reinforcement / mini studio portable mixer of modular construction incorporating new features 'and a particularly radical approach to flexibility for expanding the system to multichannel operation.'

Was Herod right?

To continue our policy of putting the well intentioned Leeds and GLC sound level regulations in their own peculiarly daft perspective, we now draw readers attention to an spl test run at a Christmas Bazaar in a Hampstead Primary School. This leaves no doubt as to why teachers feel tired and irritable and suffer from headaches after a day at school. But it also suggests that if local authorities ban loud music they should also ban children as well.

For the test, incidentally at 2p a time to raise funds for the school PTA, children were encouraged to scream as loud as they could into a Castle precision sound level meter mounted one metre away. A prize was offered for the loudest female and male scream recorded. In all, nearly 200 separate attempts were monitored with the outright winner a girl of 12 notching up the literally ear-shattering level of 122 dBA. The loudest boy, a year younger, reached 120 dBA. Both these levels are on the border of what is generally accepted to constitute the threshold of pain.

Moreover, analysis of the results shows surprisingly high mean level. For 92 female screams, the average was 114 dBA; for 85 male screams the average was exactly the same. Even a four year old girl managed to register 111 dBA and virtually everyone broke the Leeds and GLC 'laws' photo, p.28.

Particularly interesting is the contrast with a similar test run recently in the USA. The winners there achieved a mere 107 decibels.

Adrian Hope

Limiters

Universal Audio has added two further units to its range of compressors. The *LA-4* and *LA-5* feature rms action of the control elements which, although claimed to be 'more natural sounding', makes them unsuitable for direct use with disc cutting or transmitter over-modulation protection. In both models, the gain reducing element is opto-electronic. The attack and release times, defined as a 63% shift in respect of the ultimate steady state level, are quoted as 1 to 10 ms and 100 to 500 ms. The actual value depends on the signal period within the limiting area.

The *LA-4* includes the usual front panel facilities associated with compressor limiters intended for recording studio use. The *LA-5* offers a more simple control arrangement in line with applications in public address and sound reinforcement. Both units feature suitable interfaces for use with balanced line. The *LA-4* costs $346, £198; *LA-5*, $286, £164. United Recording Electronics Industries, 11922 Valerio Street, North Hollywood, Ca 91605, USA. Phone: (213) 764 1500. Telex: 65: 1389.

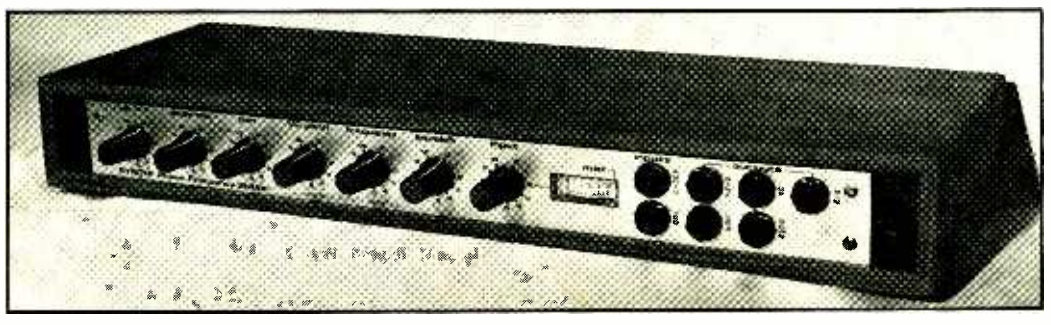
Frequency shifter

In line with other modules in the EMS *Synthi* range, the latest addition is essentially voltage controlled over a range of shift .05 to 1k Hz. It uses the quadrature oscillator/linear multiplier technique to obtain the shift deriving the quadrature signal from a Walsh function generator. This type of circuit digitally generates a 32 step sine/cosine signal, the harmonics of which are filtered out by voltage controlled two pole filters tracking with the master oscillator. This should give better quadrature accuracy than is possible with linear sine/cosine generation resulting in less intermodulation of input signal with oscillator.

The frequency phase shifter generates two output signals; the first shifts everything upwards by a given amount, the second shifts the output down the frequency spectrum by a similar amount. Naturally, the tonic relationships fall apart when the shift is much in excess of 5 Hz. But interesting 'new' sounds are produced when higher shifts are utilised. Mixing either up or down shift signals with the cleanfeed produces heavy phasing effects. Frequency shifts in the order of 3 to 5 Hz find use in sound reinforcement situations to reduce howlround by lifting the output away from the closely spaced acoustic resonances. Typically, a 6 dB increase in usable spl can be expected.

Features of the EMS device include full panning facilities between up, down and cleanfeed, switchable noise gating and a meter for level indication. Various quadrature outputs are available for use with other equipment. The manufacturers quote oscillator signal in output as below 50 dB (noise gate off) and overall signal-to-noise ratio of 66 dB. Power requirements are normal ac line. EMS (London) Ltd, 277 Putney Bridge Road, London SW15 2PT. Phone: 01-788 3491. US: EMSA Inc, 460 West Street, Amherst, Mass 01002, USA.

EMS Synthi-phase frequency shifter



Two Pye TVT OB TV for Denmark

Originating at the Montreux Exhibition, the order for the supply of two colour ob vehicles has been valued at over £750 000. The vans are of the four and two camera type, although the smaller truck will carry three cameras—one studio *LDK 5*, and two colour portable *LDK 15*.

Of the smaller ob, there is enough room to include a full complement of video and sound mixing appara-

26 ▶

Orban Parasound's Model 516EC Dynamic Sibilance Controller

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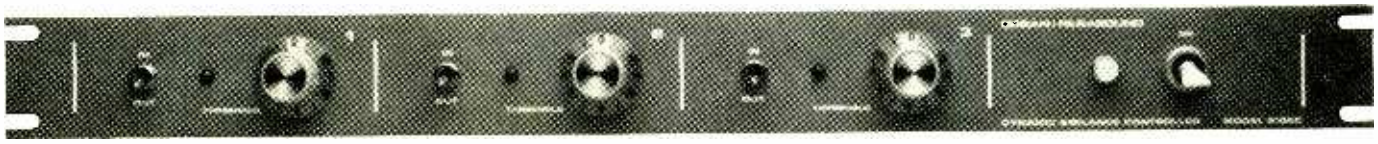

For full information on the Orban 516EC D.S.C., the 621B Parametric Equaliser and other Orban products contact:

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tus including both audio and video tape recorders. The larger van includes separate production, vision and audio control rooms, and is fully equipped for independent programme origination and transmission.

Music prize

A £1000 travelling scholarship is to be given to a young British classical musician in a scheme arranged by The Royal Society of Arts and sponsored by the EMI group of companies.

Young professional string players are invited to take part, and the finalists will be auditioned by a panel of judges, both pro musicians and other distinguished musical luminaries. Keith Grant, secretary of the Royal Society, commented: 'The purpose of the scholarships in the Royal Society of Arts scheme is to enable singers and players to travel and study abroad. Public money is virtually unobtainable for this purpose, and therefore, we are extremely grateful that a company such as EMI has agreed to sponsor our scheme.'

French Crown

M. Claude Venet has taken over as commercial director of Macinnes France, the French importers of Amcron. The Paris based subsidiary has just completed a move to a new location. This will provide sales, service and stores under one roof. Macinnes France, 45 Rue Fessart, Paris 19. Phone: 203 30 01.

Cassette duplication

This one is so simple to use that the manufacturers claim that it 'can truly be operated by a child.' Very useful for all children in the audio-visual industry. Actually, the machine is a one for one copier working at 32 times normal playing speed. The master cassette (of which a copy is required) slots into the left hand bay, the blank cassette fits into the right hand one. Press the button, wait about a minute and you have a good copy with all tracks copied on one pass.

Other features include automatic rewind, track selection, monitor light, and built in level control. The *C1* Super Cassette Copier costs $695 or $795 export. Pentagon Industries Inc, 4751 North Olcott, Chicago, Ill 60656, USA. Phone: (312) 867 9200. Telex: 253058.

Wind of change?

The traditional stability of the British broadcasting system may soon be undermined, according to a recently published article by three university professors. The reasons they give are that developments in cable and other dissemination systems weaken the argument that central control of broadcasting is necessary because of a shortage of frequencies; that rising costs and falling revenue have produced a financial crisis in broadcasting; and that society itself has grown less stable, so that the values reflected in broadcasting are less generally accepted and increasingly attacked. The existence of the Annan committee has caused further uncertainty.

The article, *The Political Economy of Broadcasting*, appears in the January issue of Lloyds Bank Review. The authors are J. D. Abel, Assistant Professor of Television and Radio at Michigan State University, R. A. Hill, Research Fellow in Economics at the University of Exeter, and M. W. Spicer, Lecturer in Economics at the same university.

They argue that what is needed from broadcasting is diversity, which they begin by defining as satisfying the broadest possible range of tastes. This offers true freedom of choice for the viewer, and allows the greatest possible outlet for creative talent in broadcasting. The greatest restriction on diversity is the amount of money that can be spent on programmes. The coming of commercial television made it imperative for both channels to maximise audiences, the ITV companies because they needed advertising, and the BBC because it became increasingly clear that the public was not willing to pay a compulsory receiving licence fee to support an organisation whose programmes they did not watch. The result was that BBC tv and ITV programmes competed at a lower level than the BBC had been used to, and diversity suffered.

The Pilkington committee recommended that the BBC should have the second tv channel, when it came, and they got it. The BBC was able to say, when critics pointed at BBC 1, that they were still fulfilling their public service function by putting out prestige programmes on the second channel. The authors argue: 'BBC 2 was still-born . . . Never intended to have a minority character, still less to compete with other channels, it failed to attract a substantial audience and became increasingly indistinguishable from its peers.'

In radio central control (necessary it was argued because of the need to control frequencies to secure finance and to obtain adequate standards) became corrupted into the BBC ethos under John Reith; the idea that the BBC was entitled to a monopoly and must defend it at all costs. The evidence was the refusal to allow rediffusion in the Thirties (see STUDIO SOUND Dec 73, p53), the opposition to commercial television and then local commercial radio, and the opposition to the pirate stations.

But the authors maintain that the number of frequencies available is greater than is supposed. The radio services are full of duplications on vhf and medium and long waves. When the present duplication of tv services on 405 and 625 lines can end, three more tv channels will be available, including TV4, not to mention the possibilities opened up by cable television. The frequency allocation is a shortage which exists solely in the mind of the BBC and is used as a weapon to enforce its monopoly. When the question of local radio came up, the authors say, the BBC ducked the issue and went for what were vhf-only local stations, so that they could move into and take over local radio as well.

The last shadow that clouds the face of diversity is the self-imposed impartiality of the BBC, a tactical weapon, they say, 'to justify its existence as a state monopoly independent of government'. This impartiality has come to mean a reflection of the middle ground consensus. The same is true of the IBA, which is restricted by the legal arrangements within which it works. Social change is inhibited and access outside a well defined range of opinion is restricted.

They propose three remedies to the ills of the present television system: a reduction of competition between BBC and ITV; the introduction of pay tv, and an increase in the number of channels. The BBC would produce less competitive programmes, leaving the ITV companies to the mass audience. They offer financing from direct taxation as a solution to the then inevitable outcry against increased licence revenue; saturation of the colour television market and rising inflation will in any case require higher and more frequent increases in licence revenue, so that the BBC will be just as dependent on government as if it were financed from taxes.

Pay tv would mean that those who wanted to watch minority programmes could pay more for them, justifying their cost per thousand viewers. The number of channels could be increased as already outlined.

In radio, the duplication should be ended and the additional frequencies allocated to competing commercial broadcasters.

Lloyds Bank Review is an unexpected source for an article of this kind, though they publish all kinds of articles of general interest. But the analysis of broadcasting offered seems superficial and self-serving. At one moment, for example, 'diversity' means 'diversity of programming'. At another, where the authors complain that the IBA chose areas to operate local radio stations where BBC stations already existed, the word seems to mean geographical diversity. They suggest that the experiments in pay tv conducted in 1966 and 1967 were successful, though they don't labour the point. The results of those experiments generally showed that the average viewer would pay for little except old films. The paradox between the suggestion that the BBC should be castrated as they suggest in order that the commercial companies should clean up, and the suggestion that the radio services be made more competitive speaks for itself.

Above all, their suggestion that BBC 2 is 'indistinguishable' from its peers does nothing more than approach the truth. BBC 2 for all its faults, is both worthwhile and different. It may be that the BBC is trying to overcome the fusty image of BBC 2, as they see it, but their guilt complex doesn't hide the fact that British Broadcasting would be immeasurably worse off without it.

John Dwyer

UK-4

Neat and tidy it certainly is not—the current surround sound scene that is. To confuse the issue still further, here is the news.

After an initial flurry of commercial activity, SQ system seems to be sinking in the United Kingdom. The extent to which CBS in London is out of touch with anything and everything relating to quadraphonics would bring tears to the eyes of its founding fathers. At one time the company had a succession of quadraphonic sales managers but the post no longer exists and the records press office currently knows of no one in the company qualified to talk on the subject. However the situation, as gleaned from a variety of mainly USA CBS sources, is as follows.

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NEWS

CBS have never pressed any SQ material in this country (the reason given is lack of demand, which is hardly surprising when it is only on supply at inflated import price!) and originally imported its quadraphonic pressings from the USA.

But legal problems arose because these pressings carry the trademark 'Columbia', which is owned by CBS in the USA but EMI in the UK, and it is considered too difficult to obliterate each mention of the offending word on sleeve and label with an oversticker before sale in the UK.

It is thus easier to import SQ (whether labelled as such or as stereo) from the Dutch plant, which does press in SQ, as, incidentally, do the Japanese and Israeli plants.

One suggestion that accounts for the current apparent lethargy on the part of CBS for SQ is that the company is deliberately holding fire until the Tate decoder is available domestically. This, reputedly, is the best thing for SQ since sliced bread.

Over recent months EMI has come to the forefront of UK SQ promotion by adopting a single inventory approach whereby that classical product which is suitable for four channel issue is mixed down only into quadraphonic format and released as such. Mixdown direct to two channel SQ format without a four channel master, is often employed. The matrix master is used for the production of both discs and consumer tapes, with the disc label indicating quadraphonic capability and stereophonic compatibility. Those multitrack recordings which are considered unsuitable for quad release are mixed into stereo for normal issue. Incidentally, the rear-channel information on most current productions is ambient, as compared with the instrumental sound of many CBS Columbia classical and other EMI pop product. This classical ambience encoding is a safe course of action to adopt, because the stereo instrumental position is conventional, with no ambiguities introduced on playback and revealing themselves to listeners familiar with the traditional layout of a symphony orchestra, for example.

The Sansui QS system finds more favour than SQ among technicians, but because Sansui is not a record company like CBS, there is still relatively little software available. Doubtless through recognising this fact, Sansui have recently been pushing their synthesiser, which converts stereo material into four-channel material by spreading the extreme left and right edges of the stereo spread out and around to rear left and rear right, while leaving centre front unambiguously where it belongs. The synthesiser produces impressive results in practice, especially where the studio engineer, mixing for both quadraphonic and stereo, has put rear left and rear right at extreme left and extreme right in the stereo mix. In such case, as if by magic, the stereo mix recreates the quadraphonic mix when reproduced via the Sansui synthesiser. Many radio stations in the USA have incorporated these synthesisers in their transmitters and now put out so-called '24-hour quadraphonics', even though all the original programme material is in fact in stereo. Cynical observers have wondered what happens when a disc jockey lays his hands on a real live quadraphonic disc and plays it over the air on such a station. Do the engineers always remember to switch out the synthesiser, or does the material sometimes go out double-encoded? And heaven knows what happens if the listener also owns a synthesiser and happens to be using it at the time, thereby ending up with triple-encoded material to decode!

CD4 moves on a pace, with the record racks of some shops (such as Imhof's in Oxford Street, London) crammed with Quadradisc recordings. Two criticisms have been voiced on these, one minor, one significant. Firstly, because the masters are still cut at half speed, there is inevitably a loss of true deep bass, but subtle equalisation of the bass that is present disguises this on most programme material. Secondly and much more important, is the appalling quality of some of the CD4 pressings of USA origin. Words cannot describe how badly these can compare with Japanese versions of the same material, and no-one should judge CD4 on the strength of what they suspect to be a poor pressing. But there are good pressings around, and the results they produce can be technically impressive.

On the UD4 front, little or nothing is happening, but it is worth a note in passing that JVC are unhappy about the CD4 switch position on some UD4 decoders. Indeed, it is sound general policy to judge a system only when decoded by hardware produced by a manufacturer with a vested interest in the system; the chances are that the switch position to decode a rival system will have been built in primarily as a sales necessity and will do the rival system less than full justice. For instance, don't judge QS as a system, using the QS position on a Sony decoder and don't judge SQ using Sansui gear.

As previously reported, the Ambisonics system is still something of an unknown quantity, and there are the potential makings of a fine patent battle between the NRDC (who own the Ambisonic rights) and Duane Cooper (who owns the BMX rights). There are of course, close similarities between BMX and Ambisonics, and BMX is used as the base matrix of the UD4 system developed by Nippon Columbia. This already confused patent situation was recently confounded further by the publication of a BBC patent (BPI 414 166) that more or less reclaims BMX. Under British Patent Law, it is quite possible for three applications for the same invention to travel in parallel through the Patent Office without hindering each other, whereas in the USA similar applications legally 'interfere' with each other. There is currently interference between the NRDC and Duane Cooper applications in the USA, and as even the simplest interference proceeding is guaranteed to take years off the life of the patent attorney involved, here is another reason for hoping that the NRDC, Cooper and Nippon Columbia can negotiate rather than litigate. On a purely financial basis, it would cripple all the parties involved to fight it out in the courts. Also, it now emerges that much of the £30 000 given to the Ambisonics team in the UK has been spent on a veritable lorry-load of further patents. These cover not only refinements of the basic Ambisonic/BMX coding system but also techniques and hardware which are readily adaptable to the reproduction of virtually any other surround sound material with allegedly enhanced results. It may yet be that Britain rules the waves in surround sound.

How do the BBC fit into all this? As their recent patent suggests the Corporation has devised its own H matrix, which resembles BMX. It has carried out various test runs on all systems. But, as disclosed recently by John Dwyer, the BBC cancelled publication of the results of these tests at the last minute. One explanation is that the results were so woolly as to be not worth publishing—another is that they favoured QS which, for some reason, was considered undesirable.

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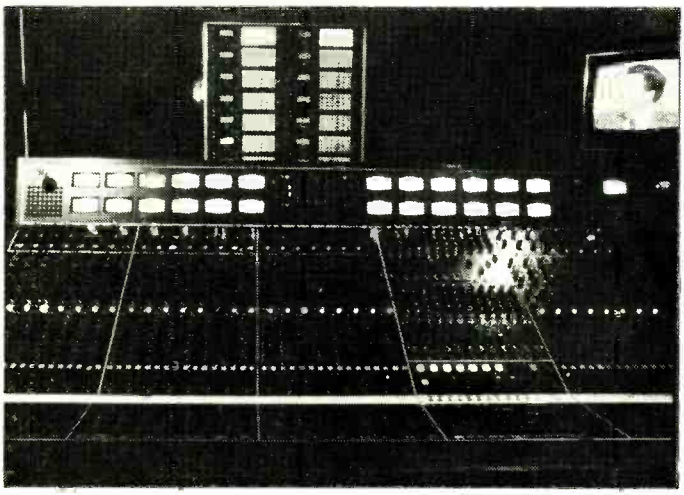

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Live sound~engineering and practice

FRANK OGDEN

Hardware for live sound, and the the associated engineering skill required to install and operate it, developed at a rate about two steps behind that employed in the recording industry. Of late, some areas have caught up.

IN sound amplification and reinforcement applications two areas can clearly be defined. The first includes live theatre amplification and some music stage work, whereby the sound system should definitely play a low profile; the judgement upon system quality should rest upon lack of audible intrusion. The second category includes those applications which are fundamental to the performance and make a lot of noise to a lot of people over a large area such as at rock gigs and festivals. The requirements for each are totally different although many of the principles are the same.

The first application requires limited power carefully presented. Moreover, the quality should be such as to blend totally with the musical surroundings. For a moment it is easier to look at the basic mic techniques as this forms the fundamental link in the chain. Typically, two methods of miking are employed to obtain a reasonable power output before howl around, without the performers obviously using a microphone. The classic method is to point floor mounted or side mounted cardioid or hyper-cardioid microphones towards the front of the stage, the speaker array being placed at the top and sides of the stage. Because side sounds cause distractions to the audience, it is rare to place speakers at the sides and to the rear of the auditorium. The system works well, but even using the most highly directional rifle mikes, the resulting level increase is not dramatic. When used with this miking technique the power requirements of the speakers and amplifiers are moderate.

For some applications it can be useful to use radio microphones but these have drawbacks of their own. Without doubt the effective level obtainable with personally carried radio mikes is far higher than heavily directional microphones pointed from outside the stage area when howl around is the limiting factor in the system. Unfortunately there are several deficiencies in this method. The first of these is the discontinuity of reception by the receiving set. In the United Kingdom the situation is not helped by the 10 mW power limit on the transmitter section. Secondly, the number of microphones that can be employed is small due to channel separation, for the permissible band is narrow, and multiplicity costs a lot of money in any case. Thirdly, there must be some artistic/aesthetic consideration as to how and where to hide lavalier mikes and the associated electronic hardware. Also, radio microphone systems are inherently noisy in operation. This is because the obtainable signal to noise ratio after passing through the detector stage of the receiving set rarely gets above 60 dB referenced to full modulation. Ideally, full modulation is something which should rarely be approached in theatre conditions. It is unpleasant to hear the top registers of a rock vocalist cracking up because of system overload, never mind a fortissimo soprano.

Where radio mic systems are at present gainfully employed, situations might be further improved by a duplex receiver array with automatic switch to feed signals from the set with the highest input signal level as outlined in the ZDF article, STUDIO SOUND, Feb 76, p34. There is a case for a new generation of radio mikes which employ a minaturised noise reduction principle. With modern design techniques these need be no bulkier or much more expensive than present systems. In the proposed radio mic scheme, companding information is encoded on a subcarrier adjacent to the audio channel. This function amounts to an extra channel which directly controls the audio gain of the receiving set in relation to the gain boost employed in the microphone compressor circuitry. Because the band width of the companding channel could be quite large or even comparable to the audio channel, noise pumping effects would be totally eliminated.

Very worthwhile improvements in overall sound quality and system level can be obtained by acoustic treatment around the stage areas and to a lesser extent throughout the auditorium where aesthetic considerations permit. Prominent examples of this technique include the famed inverted mushrooms suspended from the roof of the Albert Hall.

Regarding the practical installation of low level sound reinforcement systems, there are a couple of cautions that should be observed. The most fundamental of these ties up with the low signal level produced by the microphones in support situations. It makes them far more prone to interference from other electrical circuits concerned with stage lighting, curtain raising etc. Paradoxically, interference tends to be more troublesome in modern theatre installations where the spots and sundry stage lighting are controlled by thyristors with control hardware removed to the back of the auditorium in the lighting boxes.

Remedies are fairly obvious although suppression at source and re-routing of mic lines can sometimes be difficult. Other solutions include simple microphone to line level converters as close to the microphone terminations as possible as well as rf filters inserted in the line. Similarly induction coupling between mic lines and low impedance speaker lines can cause stability problems where close proximity is unavoidable. This situation can often be remedied by judicious use of low pass filters somewhere in the signal circuit.

In the second category, sound amplification as opposed to sound reinforcement, the hardware owes rather more to recording studio facilities than the classical column units inclined down from the ceiling. The system comprises all the essential ingredients found in the monitor chain of the control room. These include mikes, with or without antipop filters, producing levels close to 10 dB below line level on heavy peaks. There is a mixing desk which features several sends per mic channel for selective fold back and echo/reverb. Also, these channels might include a three or four section eq network. Naturally there will be at least an A-B pan and full input pads to accept input levels as high as 0 dB. The large black rotary knob of the hammer green finish box marked 'volume' has long since been replaced by a plastic track slider fader. Further, the stereo or quad output from the desk will be amplified to levels as high as 120 dB near the stacks.

Generally the whole concept of high level sound amplification results in operational methods very close to a reduction mix for a recording. Indeed, the situation can be even more involved through the interface of pre-recorded backing tracks with the live performance. This implies that, unless the crossfade procedure is very well known, the pa engineer will have to mark operating instructions in the score to keep at least one bar ahead of the band.

From the technical point of view, signal to noise ratio is not so important as an ability to cope with heavy signal peaks which can cause hardware of the wrong specification to run into clipping. When this happens, the grated tops will be only too familiar to those involved in live sound. Obvious answers include a judicious use of compressors and/or limiters. These must be used sparingly, for nothing sounds worse than to lose the first syllable of every word. Compressors with longer attack times are preferable to those with shorter times since the former are less audible in operation. When used for overload prevention, compressors require careful setting up. If the compression threshold is fixed too low, during the absence of signals the gain creeps up causing feedback. This problem can be particularly troublesome if long release times are used as running adjustments become rather awkward. Overall it seems better to use equipment with a high power capacity in reserve than opt straight for compressors.

However, power capacity does not tell the whole story. In early pa systems valve preamps were the universal standard. By their nature they possessed far more head room in every operation because of the high ht voltage powering them. With transistor front ends, the ratio between output swing and dc line voltage is much less. Therefore good circuit design requires a compromise between dynamic headroom and signal to noise ratios, for even with noise gates, the latter are important. Generally front ends employ virtual earth circuitry arrangements around the attenuator pad network. For most applications virtual earths provide the best of noise and headroom, particularly when used with modern low noise operational amplifiers.

Modern sound amplification systems for stage work generally us- multiple fold back circuits driven from separate sends on the mic channels as briefly outlined before. Large systems tend to separate fold back functions into several circuits to reduce acoustic feedback problems by putting the sound where it's needed and nowhere else. Examples of this include individual fold back for vocalists with, perhaps, another circuit for other members of the band at a much higher level. This is because a guitarist with one ear against his stack needs to hear what the vocalists are trying to do rather more than the vocalists need to. The eq aspects of fold back are very individual since the prime function is to provide an audible cue more than anything else. When the ear is subjected to loud noises, sounds stand a better chance of getting through from another source if they are predominantly middle in make up. Since middle is what's required, it is pointless pumping out large quantities of top and bottom when doing so just increases the risk of feedback at these ends of the audible spectrum. Additionally, a good fold back system employs several parametric notch filters to rid the system of specific mid-range resonances without detracting from audible impact.

Until recently, public address and sound reinforcement changed little since the initial development work in the 1930s. Past history was typified by column loudspeakers driven through 100V lines powered by a battery of antiquated amplifiers whose system performance by modern standards was indifferent. It was not simply because of the valve amplification then employed; indeed many of the amplifiers were capable of extremely creditable results. The real problems with the early installations lay in the acoustic properties of the loudspeakers employed and, to a slightly lesser but still noticeable extent, the properties of the inevitable line transformers used throughout the system.

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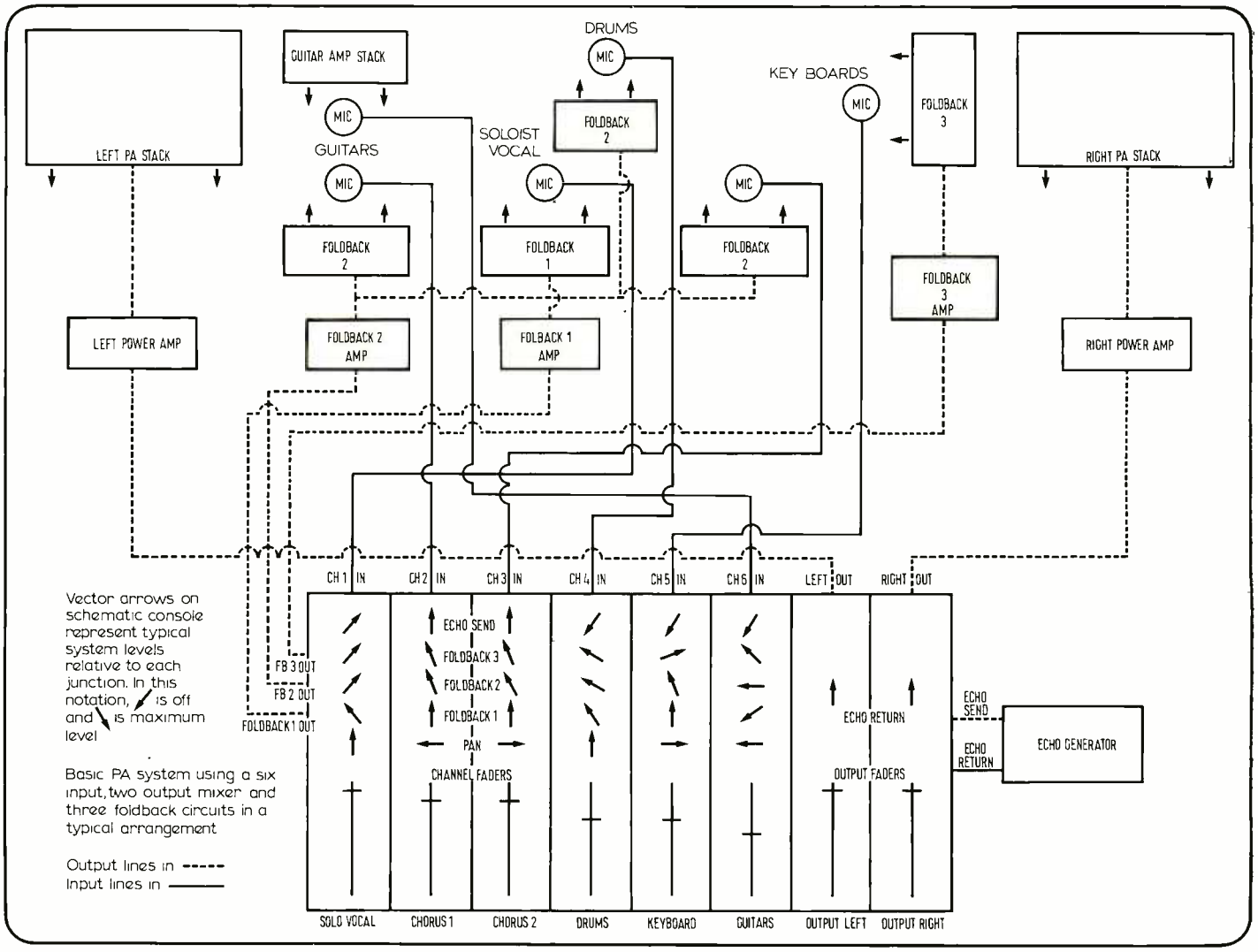


LIVE SOUND—ENGINEERING AND PRACTICE

Design changed fairly radically with the advent of high quality transistor amplification; low impedance outputs means direct coupled speaker lines averaging about 20V line levels. Further, multiple drive units with passive crossovers began to appear, incorporated in full range horn loaded enclosures. This type of speaker system presents a highly reactive load to the amplifier as well as a far from ideal impedance characteristic. Where the length of speaker lines is short, life for the installation engineer is perfectly straightforward. Where lines are long, the intuitive action is simply to increase the gauge of the conductors to reduce their self resistance. Unfortunately, this provides only part of the answer. While this certainly reduces resistance, the inductance of the lines remains static and the self capacitance of the conductors increases roughly in proportion to the increase in diameter; typically, heavy duty lines create upwards of 0.01 μF over 10m. The effect of this situation is to produce a resonant circuit, which, under certain conditions, could have a resonant frequency comparable to the transition frequency of the amplifier output transistors. Characteristics of resonance include large increases of impedance at the resonant frequency accompanied by a hefty phase change about zero point (resonant frequency peak). Virtually all transistor power amplifiers employ large amounts of negative feedback, typically about 50 dB in most designs. With the high frequency capability of silicon transistors, many amplifiers exhibit greater than unity gain around the resonant frequency of the speaker lines connected to them. This means that the feedback loop, which remains negative all the time that the amplifier has more than unity gain in normal operation, can turn positive with ill-chosen loads. This results in transient ringing or oscillation.

More insidious, the system could oscillate only on certain parts of the signal wave form, causing mysterious effects which show only when the level is turned up. This is often the cause of mysterious system failures from otherwise untraceable causes. Static checks or full power checks with dummy loads don't help. The system must be tested using sinewave drive at full power through the speakers as installed. It is essential to use gated bursts of drive signal in about a 1:5 on/off ratio to avoid damage to the drive units. Presence of hf instability can usually be traced more efficiently by a transistor radio and headphones with the ferrite rod held close to the suspect speaker lines than by looking at the amplifier output signal on an oscilloscope. This type of instability tends to show as audible spikes at twice or four times the test frequency. A mw pocket radio makes a most efficient test tool for the pa engineer; it also helps to uncover interference caused by lighting control thyristors etc.

As in all things there can be a compromise. With heavyweight sound reinforcement gear, the use of self-powered speaker systems (ie with slave power amps built in) driven by a small signal line source alleviates all the foregoing problems. On the deficit side, it means multiplicity of amplifier units resulting in greater capital outlay and the complication of extra mains power sources to power them. From the point of view of sheer physical sweat, they are also rather heavy to lift. The transition point from use of discrete to integral amplifiers comes about when the individual cabinets are required to handle anything in excess of about 100W. Of course, it is feasible to mount heavyweight power amplifiers in close proximity to stacks and drive them from signal lines but this means that there are more black boxes to handle, wire ups and so on to account for. Perhaps a better solution is to have one self-powered cabinet with speaker output lines for driving 'parasitic' speaker units.

From a listening viewpoint, choice of stacks is totally a matter for subjective preferences. Technical provisos include production, before burnout, of the desired spl as well as those outlined earlier whereby undue cable lengths between cabinet and amplifier should be reduced as far as possible to minimise reactive effect. It is difficult to define the best speaker arrangement. Generally cabinets for large gigs do the job most effectively when they are medium throw, mounted high up, and point towards the back of the audience. To an extent this avoids blasting the first 12 rows with physically damaging quantities of sound . . . as such speaker placement is common sense. However, careful regard must be made to phasing since acoustic 'holes' can readily be created.

Often forgotten, it should be pointed out that the line amplifier drives in the mixing console are generally only capable of driving a definite number of inputs to slave amplifiers. This is particularly so where long balance lines are terminated by a suitably low resistance. For example, a large sound system with 24 slaves each terminated by 600 ohms gives a load impedance seen by the drive amplifier of a mere 25 ohms . . . There are few standard line amplifiers which will perform satisfactorily with this order of impedance. When hooking up multiple speaker systems, it occasionally happens that line connections can get switched around with acoustically disastrous results due to incorrect phasing. This particular trap can easily be avoided by the use of Cannons or other polarised connectors. Systems using unpolarised connectors cause endless hassle.

To obtain the best system performance, virtually all sound reinforcement/amplification installations require the use of graphic equalisation to even out the subjective acoustic response of an auditorium, although its use is no substitute for thoughtful acoustic design. Careful deployment of the lowest frequency centres can make up for the falling bass response inherent in most folded horn bass bin speakers. However, bass make up is only obtained at the expense of top end headroom. Graphic eq can also be used to advantage to level out mid range peaks and troughs caused by cancellations from multiple speaker arrays although these should be equalised as a last resort. Once again, it is operationally better to heave the units about to minimise colorations at source rather than correcting them afterwards.

Situations often require link ups between house pa and band pa because it may be physically impossible to get the right equipment on the stage. Or perhaps the pa function can't be properly carried out using front stacks due to bad acoustics. Whatever the reason, the house pa should be hooked in through a graphic equaliser to match up the system characteristics. Those who have ever worked with Palais de Dance sound systems will require no further explanations. Most perform so badly that, without this kind of help, they tend to make even the best band systems sound like rubbish.

Automation is a word that has been kicked round the recording industry for an appreciable time. There is a strong case for using some sort of 'automated' mixing console facility in sound reinforcement and amplification. Virtually all gigs play more than one band in a show. This means that problems arise when altering the pa from one band to another. Such problems result in the inevitable 'one, two, three, testing . . . one, two, three, testing . . . can you hear me John? . . . I am not getting anything through . . . Shit. That's the wrong plug', all too familiar to pa engineers. Orange Musical, the London-based equipment firm, has already written the writing on the wall with the advent of their latest programmable guitar amplifier. Ingenious in design, it uses a calculator style keyboard. This amplifier enables the user to program four combinations of volume/eq/reverb/sustain plus other effects. On this particular mode three other buttons, also mounted on the keyboard select the programming mode: channel, function and level setting. The last function gives the user the option to select one of six increments of volume, eq etc. Further, it allows the operator to up-date the level of a specific function of a channel setting without having to cancel everything and start again. A programme controller of a similar sort would be of very great help to an overworked engineer if it were incorporated into individual mic channels of a pa mixing console. The effect would be to give the sound engineer several combinations of every function on the mixer desk, if the automation circuit were designed to be suitably comprehensive. Technically, it is only a small step to increase the number of level increments of individual controls to any number that one wishes, within reason. The ultimate in automation would take the form of a black box mounted in the stage area which serves solely as a signal processing box. After the various control combinations had been set the band would need only to select the appropriate button instantly to set up and adjust the pa according to the song, thus obviating the need for the engineer to keep up with the score. The system could be interfaced with foot switches in much the same way that echo and reverb facilities are operated at the moment.

Survey: sound reinforcement systems

The subject of sound reinforcement is too wide to deal with individual equipment specifications piecemeal. Furthermore, the following organisations and services specialise rather more in hardware for live music presentation than paging and industrial applications.

Forthcoming surveys
Broadcast cartridge machines (copy by March 1)
We would be grateful for full details including pictures, prices and agents.

AMEK
Amek, 8 Stockport Road, Altrincham, Cheshire WA15 8ET
Phone: 061-928 8688

Product line
MIXERS

A series of low budget mixers with eight, 12, 16 or 20 inputs and two or four outputs. Full equalisation, foldback, echo send, line and mic inputs are provided. Monitoring is on vus. The S/M series is constructed from a range of modules for eight and 16 outputs with 16 or 24 inputs.

ATLAS
Atlas Sound, 10 Pomeroy Road, Parsippany, New Jersey 07054, USA
Phone: (201) 887 7800
UK: Canadian Instruments & Electronics Ltd, 38 Waverley Street, Nottingham

Product lines
SPEAKERS

Environment resistant loudspeakers for public address applications.

AUDIX
Audix Ltd, Station Road, Wenden, Saffron Walden, Essex CB11 4L9
Phone: 0799-40888 Telex: 817444

Product lines
AMPLIFIERS
COMPRESSOR/LIMITERS
DISTRIBUTION SYSTEMS
MIXERS
LOUDSPEAKERS
PO LINE INTERFACE
RACKS
SWITCHING MATRICES

The pa side is mainly based on an industrial product line although some of the mixing consoles and power amplifiers are manufactured to broadcast quality standards of performance. Amplifier ratings range between 15 and 200W per unit. Some of the speakers include multiple driver columns with additional hf units for full frequency dispersion. Suitable for permanent installation in auditoriums.

BGW
BGW Systems, PO Box 3742, Beverly Hills, Ca 90212, USA
Phone: (213) 973 8090
Export agent: Telesco International Corp, 1 Dupont Street South, Plainview, LI, NY 11803, USA
Phone: 516 433 6210
UK: Webland International Ltd, Mirabel House, 117/121 Wandsworth Bridge Road, London SW6 2NA
Phone: 01-736 0987

Product line
AMPLIFIERS

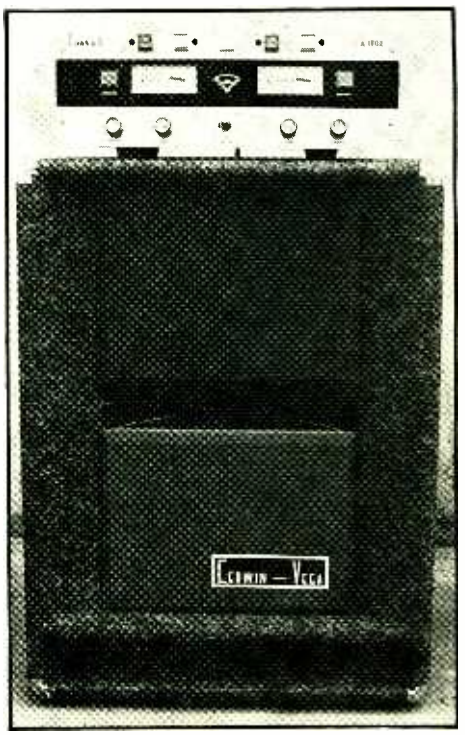
The company manufacture a range of amplifiers rated between 100 and 900W/channel. Available in stereo and quad configurations within one cabinet.

BOZAK
Bozak Inc, PO Box 1166, Darien, Conn 06820
Phone: (203) 838 6521

Product lines
MIXERS
POWER AMPLIFIERS
SPEAKERS
Six and ten input mixers, 65, 80 and 150W dual power amplifiers with 8 ohm outputs and distortion of 0.2%. Speakers for general or concert applications.

CERWIN-VEGA
Cerwin-Vega, 6945 Tujunga North Hollywood, Ca 91605
Phone: (213) 769 4869
UK: Cerwin-Vega (UK), 281 Balmoral Drive, Hayes, Middlesex
Phone: 01-573 1566

Product lines
AMPLIFIERS



Cerwin-Vega

PACKAGED PA
STACKS

Several basic packages up to 52 000W. The largest (2800 to 52 000W) uses a four or five way speaker system driven by active crossover networks through amplifiers of their own manufacture. All units are horn loaded, the bass rear loaded dual folded, and the lmf forward facing collapsible structure. Package includes custom designed Turner mixing desks and system (power rating to 36 000W) uses three way horn loaded drive units. The smallest system is designed for stage back up of vocals and instrumentals. (Power rating between 200 to 600W).

Amplifier range offers units between 225 and 400W per channel to FTC rating. Demonstration facilities of complete range available.

COURT
Court Acoustics, 50 Dennington Park Road, West Hampstead, London NW6
Phone: 01-435 0532

Product line
SPEAKERS

Basic systems are a 45 cm 200W horn with 0.33 cubic metre ported back chamber, a 120W short to medium throw midrange/HF system with built-in crossovers at 7000 Hz and triamp switching, and a 120W medium to long throw JBL radial horn system. Fold back monitors consist of 150W JBL two way systems with variable level control retailing for about £350.

Court JBL stage monitor

CUSTOM SOUND

Custom Sound, Custom House, Arthur Street, Oswestry, Salop
Phone: 0691 59201/2
Germany: Gerd Mayer KG, 655 Bad Kreuznach, Konigsberger Str 18/20
Phone: 0671 61207

Product lines
AMPLIFIERS
LOUDSPEAKERS
MIXERS

A range comprising a mixer amplifier with five channels + reverb. Also a 12/2 console to full sound reinforcement specification. The company manufacture amplifiers based on 150W building block claimed to produce full output at less than 0.1% distortion. The speaker range includes bins cabinets and stacks as well as floor monitoring wedges. Power rating is between 75 and 300W.

DUKANE

Dukane Corporation, Communications Systems Division, St Charles, Ill 60174, USA

Product lines
MICROPHONES
MIXERS
AMPLIFIERS
SPEAKERS

Microphone range includes pocket and hand held radio mics. Modular mixers with a wide range of input boards are available. Also separate complex audio equalisers. The *1A921B* power amplifier is rated at 200W with 1.5% distortion. Radial, multicell and cabinet speaker assemblies are also manufactured.

EAGLE

Eagle International, Precision Centre, Heather Park Drive, Wembley HA0 1SU
Phone: 01-902 8832 Telex: 922131
Belgium: Eagle International, AS, 147 Rue du Midi, Bruxelles 1
Phone: Bruxelles 5130477

Product lines
AMPLIFIERS
SPEAKERS

Basically an industrial range of simple mixers, power amplifiers and speakers with system ratings to 120W/basic block.

EMT

Franz Vertriebsgesellschaft mbH, D-763 Lahr 1, Postfach 1520, West Germany
UK: F W O Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ
Phone: 01-953 0091 Telex: 27502
USA: Gotham Export Corporation, 741 Washington Street, New York, NY 10014.
Phone: (212) 741 7411

Product line
DELAY SYSTEMS

Electronic delay systems for sound reinforcement.

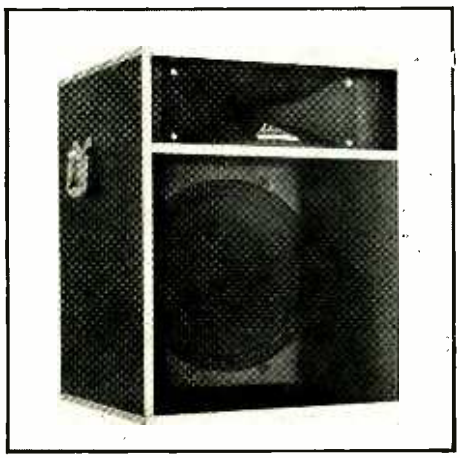
FM ACOUSTICS

FM Acoustics Ltd, Seestrasse 91, PO Box 18, CH-8702 Zollikon, Switzerland
Phone: 01-65 51 53
UK: Feldon Audio Ltd, 126 Great Portland Street, London W1N 5PH
Phone: 01-580 4314

Product lines
AMPLIFIERS
LOUDSPEAKERS

The company manufacture a single model of amplifier and a complete range of stacks based on horn loaded drivers, folded and conventional. The amplifier claims a rated power of 400W/channel into 4 ohms at less than 0.2% thd, typically less than 0.02%. By the FTC ruling, power output is 300W/channel into 8 ohms. Other features include led peak power indicators from 0 to 30 dB in 5 dB steps. Protection circuits claim proof against most eventualities.

Speaker range comprises two way horn full range systems supplied as a single cabinet, and a three way modular system with the driver units mounted in separate cabinets. Power ratings per cabinet or modular stack range from 100W to 400W.



FM Acoustics 1212 Fx

GATELY

Gately Electronics Inc, 57 West Hillcrest Avenue, Havertown, Penna 19083, USA
Phone: (215) 449 6400

Product line
MIXERS

The *Micromixer* was designed for band reinforcement and is built to order from either PA or stereo modules. Studio consoles also manufactured.

GOLDRING

Goldring Ltd, 10 Bayford Street, Hackney, London E8 3SE
Phone: 01-985 1152 Telex: 897105
Japan: Toa Electric Co Ltd, Takarazuka

Product lines
AMPLIFIERS
COMPRESSOR/LIMITERS
CABLES
CONNECTORS
MICROPHONES
MIXERS
GOOSENECKS
STANDS
RACKS
SPEAKERS

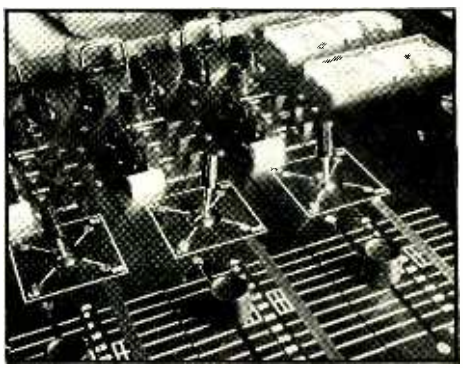
A complete range of lightweight public address mainly intended for industrial and hotel applications.

H/H

H/H Electronic, Industrial Site, Cambridge Road, Milton, Cambridge CB4 4AZ
Phone: 0223 65945/6/7
USA: Audiotechniques Inc, 142 Hamilton Ave, Stamford, Conn 06902
Phone: (203) 359 2312

Product lines
POWER AMPLIFIERS
ECHO UNIT
MONITOR SYSTEM

The *S500-D* two channel power amplifier delivers up to 500W into 2.5Ω with less than 0.02% distortion. Frequency response is ±1 dB dc to 20 kHz at full power. *Multi-Echo* and *Echo-Unit* are both tape delay echo units with various delay facilities.



Interface Electronics 100Q

INTERFACE

Interface Electronics, 3810 Westheimer, Houston, Texas 77027. USA
Phone: 713-626 1190
Canada: Noresco Manufacturing, 100 Floral Pkwy, Toronto M6L 2C5
Phone: 416-249 7316
Italy: Audio Products International, Viale Rimen dl Lambrate 13, Milan 20134
France: Studio Equipment, 24 rue di l'Abbe Groult, Paris 75015

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SURVEY: SOUND REINFORCEMENT

Puerto Rico: Electronica Fernandez, 208 E Roosevelt, Hato Rey 00918
Phone: 767-3600

Product line
MIXERS

Range of mixers for two, four and eight outputs. Fitted with quadraphonic panning. Eight, 16, 24 and 32 inputs available. The *24X4-24LS* is a monitor mixer and provides eight separate mixes for group monitoring. Conductive plastic faders are incorporated.

JASMYN

Jasmyn Electronics, Boreland House, Blegbie Estate, Humbie, East Lothian EH36 5PN, Scotland
Phone: 087-533 211

Product lines
AMPLIFIERS
SPEAKER STACKS

The amplifier range comprises a series of heavy duty pa units with ratings per channel of between 150 and 400W. All units appear to incorporate protection systems that on paper look bullet proof. Quoted im distortion by SMPTE around 0.03%. Available in one to four channel format per chassis. Things like vus and Cannons are extra. Prices range from £86 to £300.

The speaker series comprise various arrays including horn loaded hf units with overall ratings up to 200W. Active crossovers are available. Facilities for custom building.

LEXICON

Lexicon, 60 Turner Street, Waltham, Mass 02154, USA
Phone: 617-891 6790
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ
Phone: 01-953 0091 Telex: 27502

Product line
DELAY SYSTEMS

Electronic delay systems for sound re-inforcement and sound studios.

MALATCHI

Malatchi Electronic Systems Inc, 3731 East Colfax, Denver, Colorado 80206, USA
Phone: 303-321 3520

Product lines
MIXERS
AMPLIFIERS
SPEAKERS

Speaker systems include *Hornblower* horn loaded re-Inforcement speaker handling 200W, the *Gremlin* has trable horn loaded and handles 100W. Also stage monitors. Rugged mixing systems are manufactured for group mixing. Mixers are modular with four mixing busses, full equalisation and overload indicators on each channel.

MM ELECTRONICS

MM Electronics, French's Mill, French's Road, Cambridge CB4 3NP
Phone: 0223 66559

Product lines
MIXING CONSOLES
SLAVE AMPLIFIERS
STACKS

The consoles are available as either a comprehensive 12/2 or basic 6/1 mixer. The smaller model incorporates one of the standard range of 150W slaves. The larger desk has a four section eq network on each mic channel as well as the usual echo send and pan facilities. The stack comprises a three way network with passive crossovers; it handles 200W.

MUSTANG

Mustang Communications, Nelson Street, Scarborough, North Yorkshire YO12 7SZ
Phone: 0723-63298
Belgium: ARC SPRL, ru Th Decuyper, 134, 1200 Bruxelles
Phone: 02/771 32 17

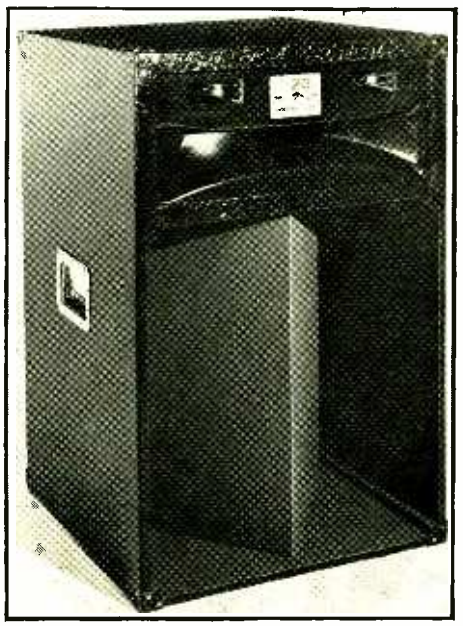
Product lines
POWER AMPLIFIERS
MIXERS
LIGHTING UNITS

The four and six channel mixers are modular and accept input modules to match specific sources. 100W into 8 ohms with 0.3% distortion is delivered by the *A140* slave amplifier. Transformers available to match any speaker combinations.

PEAVEY

Peavey Sound Equipment, Box 2898, Meridian, Miss 39301, USA.
Phone: (601) 483 5365
UK: Top Gear Musical Wholesale Company, Harbour Way, Shoreham-by-Sea, Sussex BN4 5HS
Phone: 07917 61626

Malatchi Hornblower



Product lines
AMPLIFIERS
LOUDSPEAKERS
MICROPHONES
MIXERS

Essentially oriented towards band work in pubs, clubs and small theatres. Amplifier powers range from 100 to 400W; some models also include a simple four or six way mic mixer. More complex facilities are available in the shape of 12/2 desks.

PHILIPS

UK: Pye Business Communications Ltd, Cromwell Road, Cambridge CB1 3HE
Phone: 0223-45191 Telex: 81547
USA: Philips Audio Video Systems Corporation Audio Division, 91 McKee Drive, Mahwak NJ 07430
Phone: (201) 529 3800

Product lines
MICROPHONES
PREAMPLIFIERS
POWER AMPLIFIERS
SPEAKERS

Complete systems for the sound re-inforcement of theatres, conferences and industrial applications.

SHURE

Shure Brothers Inc, 222 Hartrey Avenue, Evanston, Ill 60204, USA
UK: Shure Electronics Ltd, Eccleston Road, Maidstone, Kent ME15 6AU
Phone: 0622-59881 Telex 96121

Product lines
MICROPHONES
PREAMPLIFIERS
POWER AMPLIFIERS
SPEAKERS

The Shure *Vocal Master* Sound System consists of two speaker columns and an amplifier console which accepts six microphones and is rated at 100W output. All cables are supplied. Shure produce a wide range of microphones for most applications.

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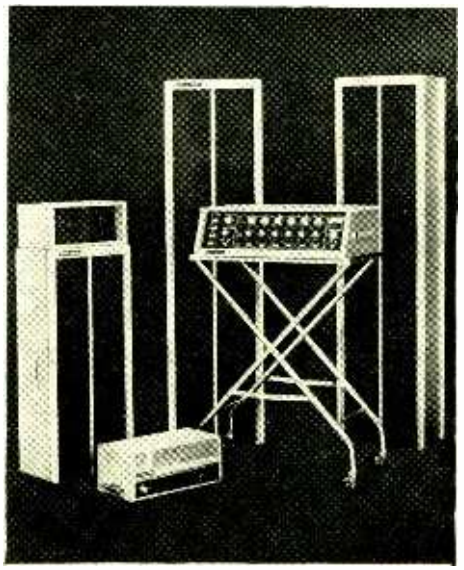
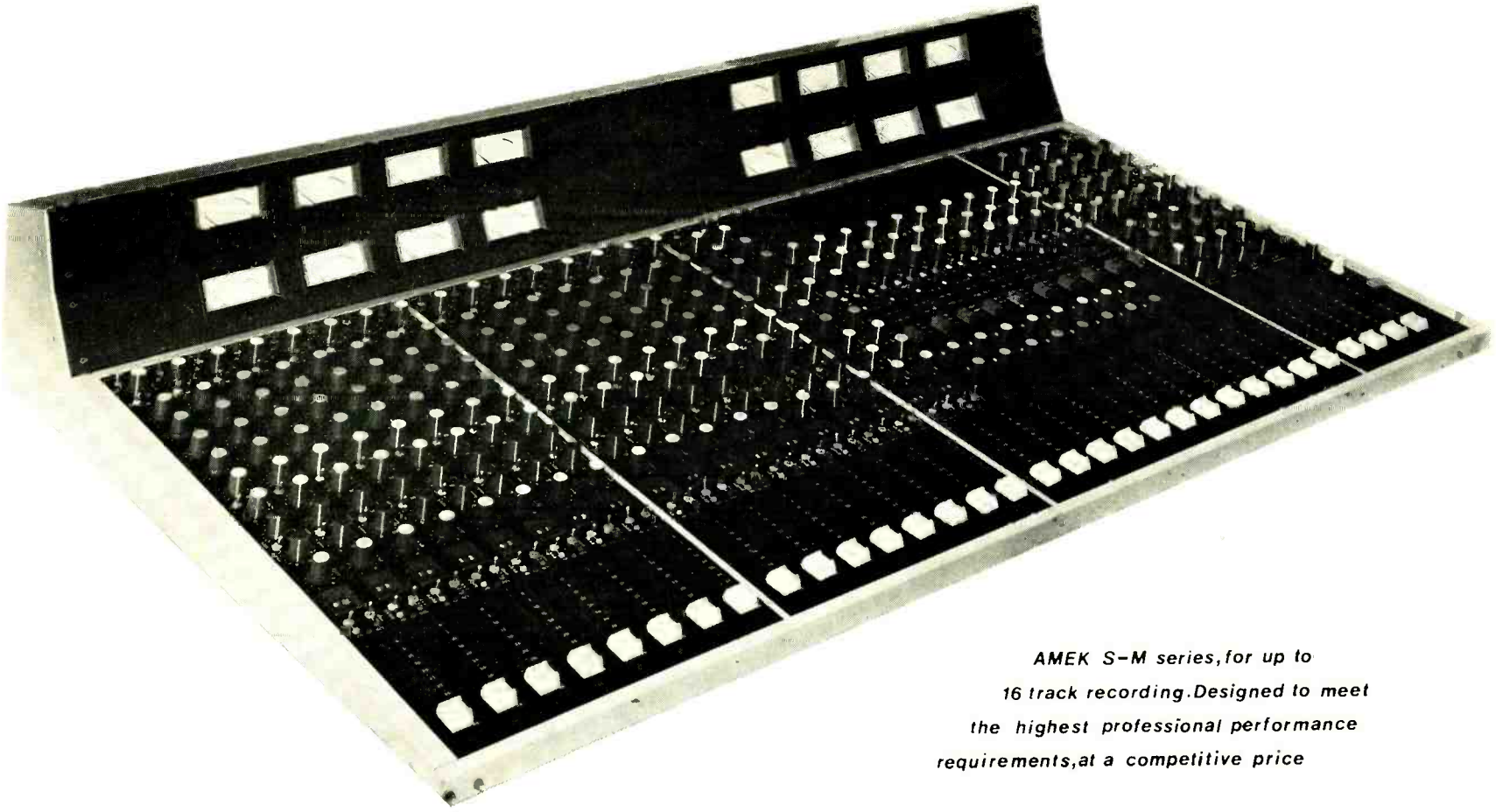
Shure Vocal Master Sound System





AMEK S-M series, for up to 16 track recording. Designed to meet the highest professional performance requirements, at a competitive price

For multitrack & sound reinforcement consoles, contact Nick Franks & Graham Langley

AMEK 8 STOCKPORT ROAD ALTRINCHAM CHESHIRE WA15 8ET ENGLAND

SURVEY: SOUND REINFORCEMENT

SPECTRA
Spectra Sonics, 770 Wall Avenue, Ogden, Utah 84404, USA
Phone: 801-392 7531

Product line
AMPLIFIED SPEAKER SYSTEMS

Speaker systems with electronic crossovers and separate amplifiers for the bass, middle and top. Two bass speakers with 10 cm edgewound copper ribbon voice coils are driven by 200W. A radial horn loaded compression driver driven by 120W for middle and two compression drivers using single wound self supporting voice coils driven by 60W for treble. Price of the *3085* is about £3176.

TECH-CRAFT
Bogen Division/Lear Siegler Inc, PO Box 500, Paramus, New Jersey 07652, USA
Phone: (201) 343 5700 Telex: 710-990-5047

Product lines
PRE-AMPLIFIERS
POWER AMPLIFIERS
SPEAKERS

The *TCB250* delivers 275W into 0.9 ohms with less than 1% distortion. Output level indicators are provided for signal monitoring. A wide range of pre-amplifiers and equalisers are available together with chassis and cabinet speaker systems.

TURNER
Turner Division, CONRAC Corporation, 909 17th Street NE, Cedar Rapids, Iowa 52402, USA
Phone: (319) 365 0421 Telex: 464437
UK: Canadian Electronics Ltd, 35 Waverley Street, Notts NG7 4EB
Phone: 0602-71157/8

Product line
MICROPHONES

A range of models suitable for sound re-inforcement and studio work.

TYCOBRAHE
Tycobrahe Sound Co, 665 Valley Drive, Hermosa Beach, Ca 90254, USA
Phone: (213) 372 1595

Product lines
LOUDSPEAKERS
POWER AMPLIFIERS
MIXERS
CABLES
TRAVELLING CASES
INTERCOMS

A 24 channel mixer designed specifically for concert re-inforcement with separate mix and pan for main and monitor outputs. Both high intensity and monitor loudspeakers are produced for concert applications.

UREI
United Recording Electronics Industries, 11922 Valerio Street, North Hollywood, Ca 91605, USA
Phone: (213) 764 1500 Telex: 65 1389
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Hertfordshire WD6 4RZ
Phone: 01-953 0091 Telex: 27502

Product lines
CROSSOVER NETWORKS
FEEDBACK SUPPRESSORS
GRAPHIC EQUALISERS
MEASUREMENT SYSTEMS

Includes active crossover networks customer adjusted to required crossover frequencies. The feedback suppressors use the parametric notch principle to remove up to four individual notches. The UREI measuring set analyses acoustic resonances or otherwise using a pulse technique relating to the Fourier transform.

WEM
Watkins Electric Music Ltd, 66 Offley Road, London SW9 0LU
Phone: 01-735 6568

Product lines
SPEAKERS
MIXERS
AMPLIFIERS

The *X39 Reflex BIN* has a 37 cm woofer in reflex section. Two twin coned 30 cm units behind tractrix rate flares for the whole middle range and Electro-voice HF Horn Flare with Italian *RCF* driver. Handling power 100W. The *Stereomaster* live music mixing console come in either 16 or 24 channel versions with stereo outputs and three foldback circuits.

'In the interests of safety, WEM will not sell systems in excess of 1000W to anybody . . . in 1973 WEM equipped the Lincoln Pop Festival with a thundering 10 000W of power which promptly blew the writer (Charlie Watkins) off the stage when an organist inadvertently hammered a chord miked through the system.'

STOP PRESS

Copy received after deadline.

EUROPA CONCERT SYSTEMS
Soundcraft Electronics Ltd, 5/8 Great Sutton Street, London EC1V 0BX.
Phone: 01-251 3631/2/3

Product line
PA HIRE

The company, on a hire basis, provides hardware and an operating crew for most types of performance including rock, folk and orchestral venues. System hardware comprises Soundcraft mixers, Court Acoustics JBL cabinets and Crown amplifiers.

HARWELL
Harwell Instruments Ltd, Spices Yard, South End, Croydon, CR0 1BF.
Phone: 01-467 1813

Product lines
LOUDSPEAKERS
SYSTEM INSTALLATIONS

Bass horns and full range speaker systems up to 400W per cabinet. Also amplifiers rated at 25 and 100W/channel and discotheque mixers. The company specialises in pub, club and disco installations. Some equipment suitable for open air gigs.

TANNOY
Tannoy Ltd, Norwood Road, West Norwood, London SE27
Phone: 01-670 1131.

Product lines
INDUSTRIAL PA
LOUDSPEAKERS

Generally industrial pa applications, but chassis dual concentric loudspeaker units find oem use in very high quality music and foldback situations.

VITAVOX
Vitavox Ltd, Westmoreland Road, London, NW9 9RJ
Phone: 01-204 4234

Product line
HORN LOUDSPEAKERS

A range on horn drivers and reflex horn loaded bass bins for concert/club pa and industrial usage.

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agony

Normally, the system of charging clients by the week on flat-rate basis worked fine, provided that no two engineers went sick or on vacation at the same time as bargain-hunting clients were booked in.

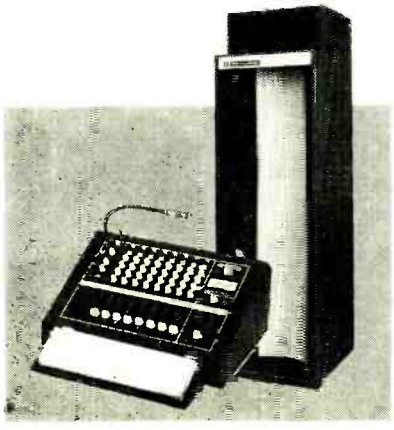
The inevitable happened. A sun-soaked beach on the Isle de Levant, a virulent strain of summer flu and a customer demanding discount on a pound of flesh . . . the remaining engineer and his tape op, both highly valued by their employers, were, by this time, grey in colour and zomboid in expression. They had just about had enough. The final straw came when the producer accused both skeletons of sleeping on the job and that he had come to make a record and not spend his valuable time standing around while studio operatives sat drinking coffee and yawning.

They complained bitterly to the boss who promised to do what he could bar telling the client to get lost, for the money was rolling in. The boss in turn consulted his wife, who suggested that a little tea party would do the world of good for public relations—and would also give the overworked engineers a few well-deserved hours off.

And so it was. Pots of tea, cream cakes, fondants with a centre piece of an inviting chocolate cake baked in the studio's kitchen. It was a pity that the engineers were too tired to eat for everyone else agreed that the fare was splendid, including the producer who commented that the chocolate cake was particularly good.

And so the session restarted with things going quite well for the next four hours or so. Then things started to happen. The producer paced about looking uneasy and finally exited from the control room not to return for many hours. For few people have the time to stand around making hit records having consumed the best part of a chocolate cake made with Ex Lax laxative choc bar.

Standing Room Only for SR



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work

Threshold retrospective

This Westlake scheme is all very well but it's playing hell with the competitive principle. There's a mess of people traipsing back and forth between the Manor and Threshold to see what all the fuss is about and, if they all send for Hidley on a heavy session, the freelance engineer soon won't know if he's recording in Stornoway or San Francisco. Strawberry has gone Westlake and Kingsway Recorders (among others) have shown interest.

The first British Westlake was Threshold, which used to be Decca's Studio One. The Threshold label, wholly owned by the Moody Blues but manufactured and distributed by Decca, has been around since 1969, but the studio, also wholly owned by the Moodies, was turned over to Threshold at the beginning of 1974. They spent a harrowing few months dodging three-day-weeks, electricity overtime bans and steel strikes before they began to use the place on July 10, and there was an official opening a week later.

So how has the idea worked? I talked to Moodies producer Tony Clarke and engineer Derek Varnals. Derek told me, 'We're very pleased with the sound of the room. It's very comfortable to work in.' There had been no standardisation at Decca and so each engineer had to get used to six different acoustics, and the Threshold control room compared very favourably. 'For a room to work well it has to be as uniform as you can get it, and the bigger the better.' In general, Tom Hidley, the man behind Westlake, didn't work on rooms less than 20 feet square. The difficulty of using small rooms was created by standing waves, which built up in any room but caused more severe problems when space was restricted. In effect, rooms were tuned to a particular frequency. As the room size increased, Varnals said, the frequency got lower and lower and so easier to deal with, as it went out of the main audio range.

I suggested to him that the use of a symmetrical room, which is the basis of the Westlake idea, made the difficulties from standing waves more acute, not less. Before Hidley, the assumption had been that the best way to avoid standing waves was to avoid parallel surfaces, so that sound reflections didn't interact with one another to produce these waves. 'Yes, you used to arrange that if the sound strikes the wall it won't come back in the same direction, but that way it reflects back on some other poor sod. The idea works for standing waves, but not for acoustics. Acoustics is a matter of material and angles.' You wanted evenness of response, he said, especially at the bass end, which was why Westlake control rooms had so much bass absorption.

The need for a smooth room response also explained why the speakers needed to be well powered. The monitors are Westlake designs with JBL drivers, equalised in one-third octave bands to allow a flat response to be obtained at the console. This enabled both a good sound level and a good bass response. 'Now if the room has a hole in it, a dip at a particular frequency, then you have to raise the amount of power delivered at that frequency in order to fill the hole.' Hence the need for more power.

The energy from the speakers was reflected back into the room by the use of hard surfaces all round them, hence the familiar rock walls at the side of the speakers. The rock has the additional advantage, as we pointed out in our Manor visit, that the high frequencies are not beamed into the room, but dispersed by the uneven but reflective texture of the bricks.

An additional check on the room acoustic that I haven't seen in other studios is a B & K calibrating microphone and Hewlett Packard Real Time Analyser. Tony Clarke thought this both useful and 'great fun'. The rta shows a small picture of the sound levels in a room at any instant and at any particular frequency. In conjunction with this they occasionally used a B & K sweep generator to see if the room had preserved its flatness. This doesn't need to be done very often, of course, but Derek Varnals said they did it among other maintenance jobs when they had a couple of days spare. Tony Clarke added that they had noticed that since they had opened the studio a dip had developed at around 1 kHz. He thought it unusual, and couldn't explain what had caused it. 'Perhaps it was the nicotine.' The rta had shown it up and allowed them to correct it.

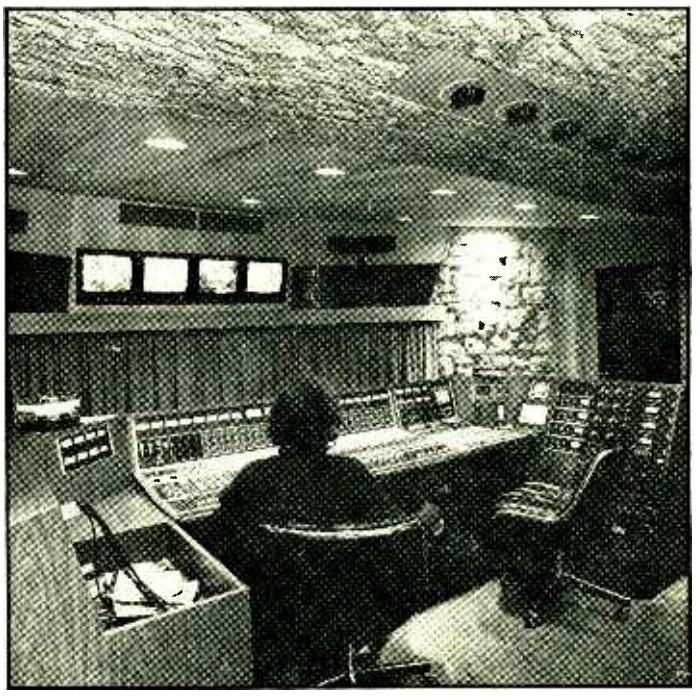
Several weeks of the building period were spent wiring up. There are 32 mic lines coming from five panels in the studio. All the equipment comes up on the patch bay. There are also tie lines connecting the studio with the Decca studios, control rooms and other facilities in the rest of the building. Threshold have four echo channels on which they can use a Cooper Time Cube, a Pandora digital delay, two EMT Plates, two AKG *BX20*s or a Master Room unit, but if necessary they can use echo units in other Decca studios. Similarly, the Decca studios can plug through to Threshold equipment.

Decca staff also do any maintenance that's needed. 'We use Decca's electricity and Decca's air conditioning', said Tony Clarke. 'There's no frontier here; they don't need passports to come in and out.' Although the two organisations were separate, the arrangement had relieved Threshold of a lot of overheads. 'It's a really good arrangement from our point of view. You see, this was destined to be a Manor type operation out in the country. But with the overheads and one thing and another I'm glad it's here now.' Town and Country Planning had also helped dish the country studio.

Since they had opened, he estimated, about 70 per cent of the studio time had been taken by Threshold; Decca had taken 15 to 20 per cent, and the rest was by miscellaneous other people. 'The arrangement was that it should be an independent operation, but we're always claiming priority on it, so Decca's claim on it has to come second.' It wasn't a case of running a studio for Threshold or the Moody Blues and getting other bands in while they weren't using it, to help pay the bills. 'It paid for itself in the first album. In fact I'd say it probably paid for itself in the first week. That's not being flash. The first tape we did here, the double album of golden goodies, paid for the place.' That was a compilation album called *This is the Moody Blues*, which took a week or ten days to mix. 'We've done six million-selling albums in this room.'

A lot of people wanted to use the studio: 'We've had approaches from name people to use the studio but we just haven't been able to let them have the time.' Artists used to the Westlake acoustic in America were also interested in using the studio when they were in the country, but they, too, often had to wait. And the arrival of a West-

Control room Threshold Studios



laked Manor and the prospect of a similar Strawberry had stimulated rather than diluted the demand, since when Manor is unavailable artists want to go to Threshold.

Was there any chance that, bearing in mind the differences between this and the other studios in the Decca building, Decca would have the other similarly treated, particularly if bands couldn't get into Threshold? Apparently not. Much of the work in the other studios is classical anyway, and the rock work could be done at Threshold: 'This satisfies a whole outlet for them,' said Tony Clarke.

Derek Varnals added that to convert the existing studios to the Westlake system would be expensive and, even if that were no obstacle, not all the control rooms would be amenable to such an alteration.

Was there anything Derek Varnals would do differently if he had the chance to build the studio again? All he could think of was that the electrics had had to be put in first because they were behind the wood cladding and decor. For that reason the lights above the desk had been put rather too far back along the ceiling, so that they weren't directly over the desk. It was a small thing that could easily be altered. He liked the dbx limiters, but they had automatic attack and recovery times, 'which is great for individual things, like piano and so on, but doesn't work so well for limiting overall.' For overall limiting the UREI *1176* had proved more versatile.

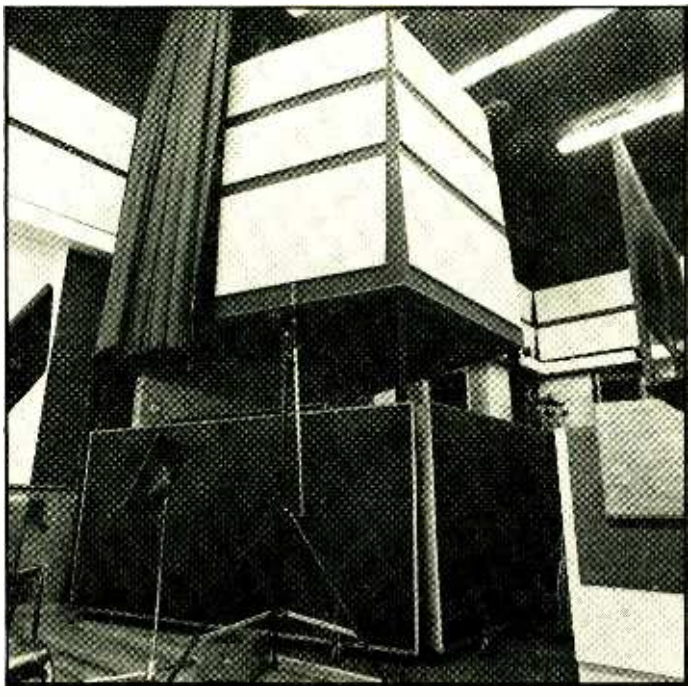
They had been pleased with the 3M tape machines, which they had bought direct through Westlake. 'We bought a lot of spares, and we haven't used much of them. But if anything did break down we might have to wait a month if we didn't have it.'

They had chosen an Automated Processes desk 'because of the speed of delivery . . . and it looked lovely. Everyone was crowding round it'. Tony thought artists liked working with a complicated piece of equipment.

Decca's chief electronics engineer, Bob Goodman, had spent two weeks in the United States working with AP on the desk, with good results. An example Derek Varnals gave was the improvement in the design of the frequency generator, which was made, he said, a great deal more accurate with minimal alteration. The desk had proved completely reliable.

Threshold have standardised on dbx noise reduction, the only London studio so far that seems to have done so. Tony Clarke said that he was still as enthusiastic as ever about dbx, and that the demonstrations they had given were both very impressive and, it had proved, genuine. I asked Derek Varnals if the advantages of greater noise reduction had to be traded off with some effect on the sounds of instruments. He said that occasionally you could hear the noise itself varying, as on solo bass for example, but it was only the noise varying, and the instruments were unaffected. But didn't he think it would be less objectionable to hear a slightly higher level of noise if that were constant? He thought the occasions when you could hear breathing were rare in pop recording, and in any case, with dbx you could avoid the necessity to use noise gating. If you were recording a solo with other mics open around the studio, you could leave all 24 tracks up without the need to use noise gates to stop odd noises that would get on to the mix. 'You have to get the best noise level relative to the music balance, and if 90 per cent of your concentration is taken up with keeping out clicks, sniffs, bumps and coughs then you get to the stage when you need automated mixing.' Normally for solos you kept the mic down until it was needed, and with dbx there was no tape hiss.

The drum booth



Tony Clarke had used automated mixing: 'It was like painting by numbers.' One problem he had discovered (with one system type) was that with each update the cues got later and later because of the delay between reading and writing the data track on repeated run throughs. 'It's slipping backwards and backwards.'

'Not only that,' Varnals added, 'but they say you can come back a week later and do a mix just as you did before. But that's only true if the desk is set up exactly the same.' The levels into the noise reduction systems had to be exactly the same, and the tape machine alignment had to be exactly the same. A small change in these parameters made a considerable difference to the end result.

The main studio is almost the same as it was when Vera Lynn, unDamed, did *The White Cliffs of Dover*, or so they tell me. The major change is the Westlake-type drum trap. It's a big studio for the major use of a rock band, measuring 18m by 14m by 6m in height. In the old days it was used for classical music on occasions and, though it hasn't been used for that or light orchestral work for a long time, often has 30 or 40 strings occupying it. The studio handled a variety of work, I was told, and Derek thought that doing tv tracks for the *Supersonic Show* was good for the studio because everyone had to work so quickly.

All the microphones used, about 40 of them, are Neumann—not a dynamic to be seen. Most people like to have a few AKGs about, but 'a *U47* can take a higher level than anything you like.' For bass drum, Derek preferred an older model Neumann with a built-in bass cut which he equalised at the desk. 'It gets rid of that awful clunk you get on bass drum.' The mic is type *KMS85*. 'The rest are the usual *84*s, *87*s and *88*s.'

He's been at Decca now for 12 years. Had things changed for the better in that time? The monitoring available now made the old record sound a lot better than they did before, he thought. 'It's got a lot more complicated. I'd hate to start now because there's so much to learn.' **John Dwyer**

Wood & Sparrow

In most companies the chief executive allows himself a little space for an office. Often, indeed, he thinks about where to put his four acres and a cocktail cabinet before he thinks about where the work is to be done. Not so John Wood. The only desk space he allows himself has knobs on, if you see what I mean.

The John Wood dubbing studio has been in business for three years. An unhappy Wood left De Lane Lea around Christmas, 1971, and set up his company in February 1972. He had been at De Lane Lea 14 years, having started there at 15 as a tea boy. Now his studio has a hand in 65 to 70 per cent, he estimates, of the commercials shown on tv in this country.

His fellow directors are Patrick Allen, actor and voice-over-veteran and Derek Sparrow, the technical director, who had spent nine years at De Lane Lea. They didn't have an easy start, and only now are they sufficiently confident of their own trading position to think about moving into new areas. In the beginning they could not borrow the money for new off-the-shelf equipment. So Derek Sparrow designed and assembled the re-recorders himself. Wood, with the help of a bricklayer and a plumber, built the studios in the basement of 27 Broadwick Street, Soho, in ten months. Within the first four months of opening Wood had clocked up, he says, 500 hours of overtime. Since he was 19 he has spent, he estimates, 29 000 hours at the dubbing console.

He says the last two months have been the best ever. In the face of such a statement one gropes for the economic equivalent of 'Don't you know there's a war on?' 'Some types of ads,' he replies, 'carry on no matter what the economic situation is like.' He cited the example of Mars who, if they closed down their plant for even a short period, would incur a contractors' fee of £20 000 to free the pipes of

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solidified chocolate, not to mention the cost of laying off staff. Therefore they have to stimulate demand in order to keep sales where they are. This means putting six bars of Yucch in a pack at a special price and launching a national campaign to promote the offer. 'So some ad campaigns actually have to increase. Then there are the Save It campaigns, the COI commercials we do.'

They decided at the outset that they would not follow other studios in taking in all types of work. They do only commercials, and perhaps the advertising agencies know it. Effects are available on cartridges, the advantages of which have been adequately covered in these pages. Speed and convenience are important when you're booking up to 14 different half hour sessions in each studio. Two of the studios are built back to back, sharing the projection room. This makes it easier for staff operating in one studio to co-operate with their colleagues in another if something goes wrong. 'It has a number of advantages', said Wood.

The desks were built by Paul Brook of Sonifex, who also made the amps and pre-amps for the film reproducers and recording equipment. Those in studios one and two are 12 input desks with three track switchable outputs. They operate from re-record machines which will adapt to any format from eight to 35 mm. They work on loops and, for commercials, there is no need for rock and roll. The desk in the radio studio is an 8/2. There is also a transfer bay which can be used from any gauge to any gauge.

In the studio a cctv camera hung in the ceiling looks at the screen. The picture and sound can come up on a tv monitor at the side of the room so that the final product can be seen as it will be by the rest of us. Wood says this system is used every dub, because the way our hearing response changes with volume has to be accounted for, and the television set will add pecularities of its own. 'This saves us having to do a lot of remixing because the balance is incorrect.' Another interesting point is that the speakers are above the screen rather than behind it. John Wood recalled a university experiment which had showed that our ears place sound sources four per cent below their true position, and he thought that sound didn't improve when it had to penetrate a movie screen. Thus the treble response is better and the sound still seems to come from the screen.

Wood told me they had been approached to build John Wood type studios in Holland, Germany, South Africa and Brazil. A project in Holland is now being studied, and another in South Africa. The money is being put up by large film companies, says John Wood, who are also prepared to give them a share in the equity. In return for that he and his two fellow directors will supervise the building, staffing, equipping and running of the studios, under the auspices of a new company they have set up called Sparrowood. Wood says that, as each commercial in South Africa will have to be made in eight languages, there should be no shortage of work there. In Holland, too, although the music studios are fairly advanced he estimates that the film dubbing studios are many years behind.

One change of approach, however, will be that the studios will handle industrial films as well as commercials and other work. Wood is approaching these projects as he approached the building of his first studio: 'The first and most important thing was to get the right people in, the right staff. Next was to get the best equipment in by custom building it yourself. Then you get nice premises for the people to work in, but getting the right people is the most important thing.' He has already been doing some talent-spotting and knows who to ask.

One reason why his studio had escaped much of the bad financial weather, he thought, was that the place was a friendly one to go into. 'We spend £80 a month on Cona coffee,' he said. Often people who used the studio dropped by for a cup even when they didn't have a session. (Normally that's the kind of hype you don't print but, on this occasion, it happens to be true; I heard someone greet a visitor while I was there with, 'I spose all you want is coffee'.) But an even more likely reason for survival is likely to be that Wood doesn't employ an accountant full time, but pays a fee to have one go over the books once a month. The coffee may help keep him afloat, but if it doesn't, knowing how much he has spent on it will.

John Dwyer

John Wood & Patrick Allen

Tal & Ton

The requirements of a building housing a recording studio are diverse. The ideal should possess good neighbours or better still, none at all; large rooms, easy access, solid construction, hot and cold plumbing, high ceilings and low rents. In addition, all the best establishments have a certain aura derived from a former use of the building. Inevitably, the selection process leads to the conversion of some very unlikely sites such as country houses. sawmills, churches, castles and the like.

One of the strangest conversion jobs in recent times must surely be the installation of a recording studio, Tal & Ton, in a fortress in downtown Gothenburg, Sweden. The fortress was built 300 years ago as a defence against the Danes who, at the time, had some fairly heavy colonialist ideas. Successive members of the Swedish nobility commissioned, for reasons which aren't entirely clear, self portraits on the various ceilings throughout the building and these have remained intact to the present day. In keeping with military specifications of the day, the walls measure some 130 cm in thickness—as studio owner Jan Setterberg says: 'No sound insulation problems here.'

Setterberg, who comes from a university background, got into the business by starting together with a friend, a Swedish company called EA Produktor dedicated to the manufacture of pa and disco gear. Naturally, the desk and monitor hardware for Tal & Ton was manufactured by this company although he has since relinquished his interests to concentrate on studio matters full time. He has a partner in the new venture in the form of Bob Lander, an ex-guitarist with the Swedish group 'Spotnicks'. Bob does most of the session balance work.

The hardware complement of the 16 track facility includes most of the items normally associated with this level of recording. The multi-track is a 3M *79* coupled back to the desk through 16 separate remix channels. Twelve mic channels handle mic and line sources. For these, Setterberg claims an equivalent noise voltage of a mere 0.5 μV although he gives no indication as to how this was measured. There is the usual collection of compressor limiters together with a high speed *A77* and AKG *BX20* and Master-room spring lines. He describes the latter as being 'incredibly good'. The monitors are home brewed by EA Produktor and comprise a tri-amplified system based on JBL drive units. Total system power is 325W.

Like all new conversion jobs, things are never totally smooth. The last word rests with Jan: 'Our studio is still very new and we have a lot of work and recording to do. We still have a few minor problems with electronics and acoustics. However, we feel that a good studio should never be 100% finished, so we are improving all the time. But this is what recording is all about, isn't it?'

Richard Schofield

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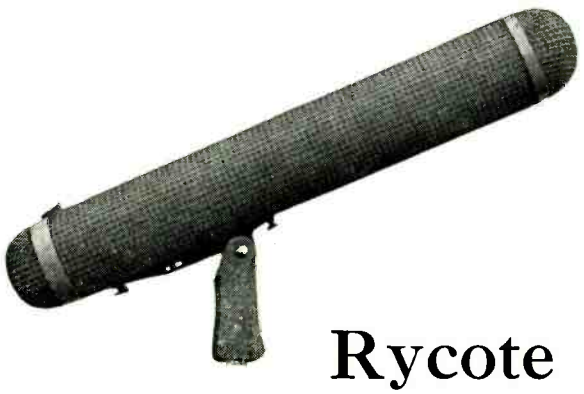

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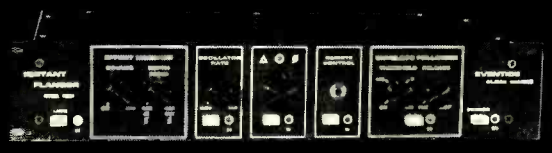

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reviews

Surrey Electronics Stereo disc amplifier

Hugh Ford

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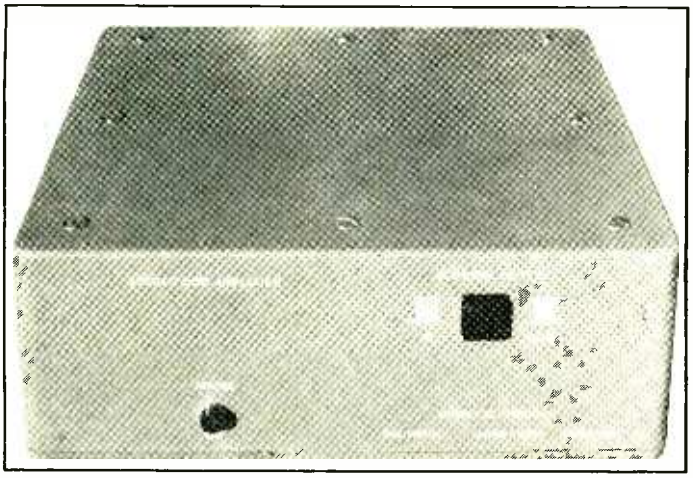
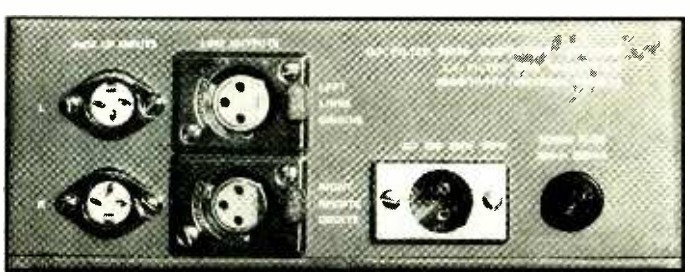
Frequency response accuracy and stability: Within 1.5 dB of BS1928/1965: RIAA using 2% components.
Lf filter: 24 Hz, 18 dB/octave.
Hf filter: 10 kHz, 18 dB/octave front panel push switch.
Change in response below 9 kHz: Within 0.5 dB.
Distortion: 600 ohm output impedance feeding 600 ohm load. Sensitivity set at maximum. 30 Hz at +10 dB(V.7) 0.3%, 100 Hz at +17 dB(V.7) 0.3%, 1 kHz at +17 dB(V.7) 0.3%, 10 kHz at +17 dB(V.7) 0.3%. 20 kHz at +17 dB(V.7) 0.4%. With 50 ohm output impedance feeding 600 ohm load the above figures apply at levels 6 dB higher.
Noise: Sensitivity set for 6 mV input at 1 kHz to give 0 dB(V.7) output. 20 Hz to 20 kHz, mean reading meter —58 dB(V.7). 20 Hz to 20 kHz, peak program meter —54 dB(V.7).
Crosstalk: 1 kHz —65 dB; 40 Hz-20 kHz —58 dB; 30 Hz —53 dB.
Mains input: *XM* connector. 110 or 200-250V 50-60 Hz, 5VA.
Mains fuse: Rear panel mounted. 20 mm, 250 mA.
Dimensions: 190 x 190 x 70 mm.
Weight: 2.3 kg.
3 metres mains lead with *XM* connector and two lock DIN plugs supplied.
Price: £85.
Manufacturers: Surrey Electronics, The Forge, Lucks Green, Cranleigh, Surrey.





THE SURREY ELECTRONICS stereo disc preamplifier is designed to accept signals directly from magnetic pickup cartridges and to perform the functions of applying the RIAA equalisation and of providing a line level output into the conventional line impedances. For some reason which I have never understood, there appears to be a lack of preamplifiers designed to perform this function to professional standards, and it is my belief that the Surrey Electronics preamplifier fills this gap.

The complete preamplifier together with its power supplies and output stages is mounted in an aluminium diecast box which is finished in blue epoxy paint both inside and outside, with all the external facilities being clearly identified in white printing. One end of the box accommodates a mains pilot light and the only external control, which takes the form of a low pass scratch filter with a nominal turnover frequency of 10 kHz and an attenuation of 18 dB per octave.

At the other end of the box there are the two input sockets in the form of locking DIN connectors, the two floating outputs in the form of three-pin *XLR* sockets, the *XM* type mains connector and the metric mains fuseholder. All the electronic components are mounted within the box on a single printed board which is relatively easy to remove for servicing, but is not identified with component references. However, the instruction leaflet supplied with the unit provided a circuit and also a component layout diagram.

The standard of construction and wiring was to good professional standards, and clearly much thought has been given to the provision of sensible interfacing with signal circuits. In particular it is worthy of note that the internal power supplies are fully stabilised by integrated circuit stabilisers which provided full performance when the incoming mains voltage was lowered as far as 180V from the minimal 240V setting.

During the review measurements I found only one fault with the unit, which may be attributed to too good a standard of finish! This was quite simply that the paint on the main box and its lid acted as an insulator, with the result that hum pickup occurred via the lid unless it was screwed down on the main box with considerable force. In other respects the earthing was arranged for minimum hum problems; the case of the unit was connected to the incoming mains earth, and the internal zero volt line isolated from the incoming mains earth but common to the input and output signal connectors.

Frequency response

The overall response of the preamplifier when loaded into a 600 ohm resistive load was found to be extremely close to the RIAA curve. **Fig. 1** shows the deviation of the preamplifier's response from the ideal RIAA characteristic with the scratch filter both in and out of circuit. In the 'flat' mode the response is within 0.1 dB of the ideal from 200 Hz to 20 kHz with a −1.0 dB dip in response at 50 Hz and the specified 18 dB per octave roll-off below 24 Hz, which is a very desirable characteristic to avoid rumble effects.

When the scratch filter is in circuit, the response falls at 18 dB per octave above 9 kHz with a −3 dB point around 12 kHz. The introduction of this filter into circuit has a minimal effect below 9 kHz, the only effect being a +0.4 dB boost around 7 kHz.

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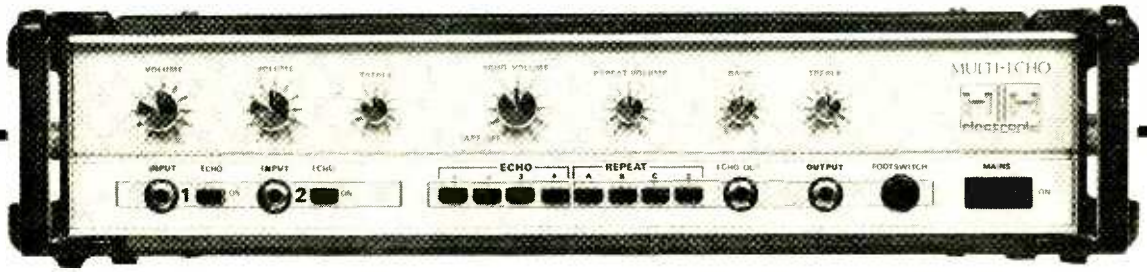

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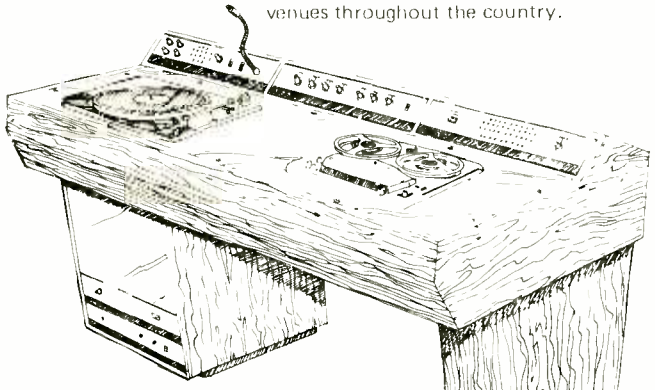

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SURREY AMPLIFIER

While this data was obtained with the internal preset gain controls set for maximum gain, reduction of the overall gain did not upset the overall response in any way.

Distortion

Fig. 2 shows the relation between individual harmonic distortion and frequency at an output level of +10 dBm into a 600 ohm load. It is to be seen that at all audio frequencies the second harmonic content of the output is below 0.25% and that at higher frequencies it is in the order of 0.1%. The level of the more subjectively objectionable third harmonic was less than 0.03% over the majority of the audio frequency spectrum, but rising in the bass to 0.1% at 50 Hz.

The measurement on intermodulation distortion to the SMPTE method with 50 Hz and 7 kHz tones in the amplitude ratio 4:1 before passing through an inverse RIAA correction curve showed that the intermodulation distortion at +17 dBm equivalent peak rms output was 1.0%, falling to 0.45% at +10 dBm and 0.15% at 0 dBm—all respectable performances, when compared with the common parameters of tape and disc.

Noise and hum

As with the other parameters the noise in the two channels was to all intents and purposes identical, giving the following noise output levels into a 600 ohm load with the input shorted (see below).

The figures (below) were obtained with the amplifiers set for maximum gain, where the sensitivity is 1.1 mV for 0 dBm output at 1 kHz, such that the overall gain is approximately 58 dB.

Inputs and outputs

The available gain as stated above is such that 0 dBm output at 1 kHz into 600 ohms requires an input of 1.1 mV at maximum gain, the input clipping point being 28 mV. With the internal sensitivity control set for minimum gain, the sensitivity for 0 dBm output into 600 ohms became 14.5 mV with an associated input clipping point at 180 mV. Provided that excessive gains are not required with high output magnetic cartridges these clipping levels are more than adequate.

The input impedance is controlled by series resistors of nominal 47k ohms resistance running into a virtual earth point, such that the input impedance is controlled by the series resistors and is independent of the gain setting. This was confirmed by measurement, and the input impedance was within the 5% tolerance of the series resistors.

On the output end the signal circuits are transformer coupled and floating, with an earth connection available on the output sockets. The measured output impedance was 625 ohms, but when required this impedance may be lowered by shorting out the 300 ohm series resistors in each signal output connection.

Other matters

Crosstalk between the channels was measured with one channel delivering +10 dBm into 600 ohms and the other channel with its input shorted and its output loaded into 600 ohms. The resulting measured crosstalk is shown in **fig. 3**, from which it is to be seen that while the crosstalk is 3 dB better than specification at 30 Hz it is very much better than specification at all other audio frequencies.

FIG. 1
SURREY PREAMPLIFIER
FREQUENCY RESPONSE

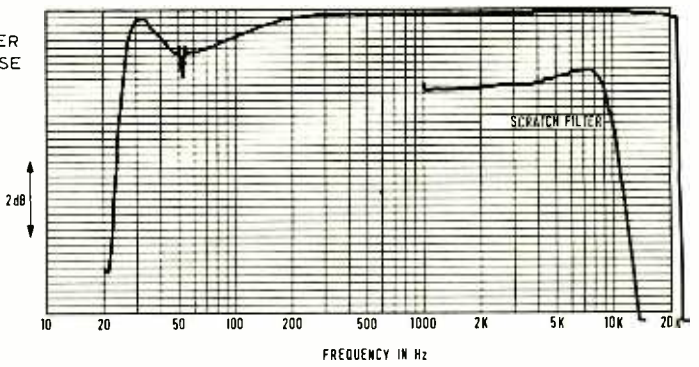


FIG. 2
SURREY
DISTORTION

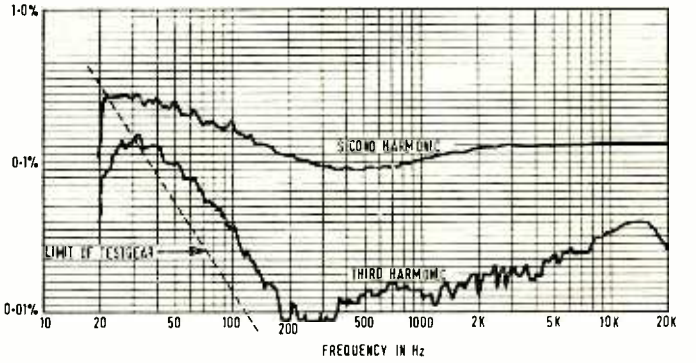
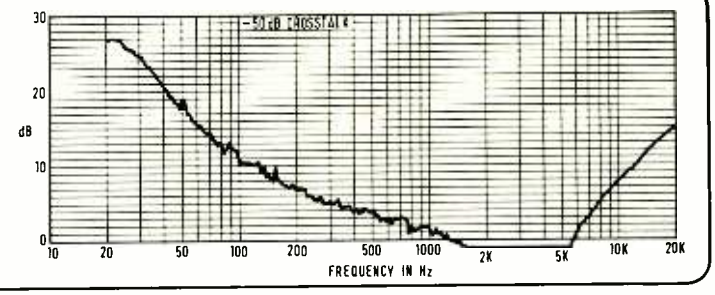


FIG. 3
SURREY
CROSSTALK
+10dBm OUTPUT



20 Hz to 20 kHz unweighted	—57 dBm rms.
'A' weighted	—60.8 dBm(A) rms.
CCIR weighted reference 1 kHz	—52.5 dBm with DIN quasi-peak meter.
50 Hz and mains harmonics	less than —70 dBm.

Summary

The Surrey Electronics stereo disc amplifier offers good performance that is substantially better than the manufacturer's specification; furthermore it is clear that considerable thought has been given to the facilities offered.

While some people might prefer alternative mechanical construction, I feel that the use of a diecast box has much to be recommended in the way of strength and screening—the latter being shown by the extremely low hum levels which were measured.

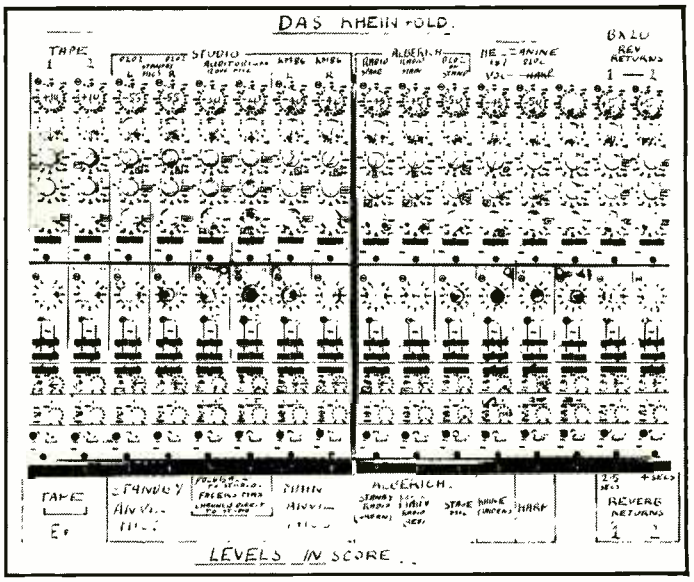
The only fault found was the poor earthing of the box lid, but I am sure that Surrey Electronics will take note of this in future production.

Sound at the Royal Opera House

PHILIP LEAVER*

The requirements of sound engineering for live, traditional opera dictate subtlety of deployment rather than quantity of output. The design and use of the Royal Opera House sound system gives a good example of the interface between performers and audience

*THE ROYAL OPERA HOUSE, COVENT GARDEN, LONDON



FORTUNATELY for us, builders of the present opera house designed an auditorium with fair acoustics, which have been acceptable for well over 100 years; not only for listening but (so I'm told) good for singing. The situation then is such that with artists on stage and musicians in the pit needing no amplification, it leaves the way clear for attention to the special effects side of pa.

These effects normally fall into categories as follows: relay to stage of remote stage bands, chorus etc and percussion and tape effects. Although there is no general artist pa, there is however a system in use for every opera and ballet, this being the orchestra relay to stage from the orchestra pit. This is necessary mainly due to the orchestra being 2m or so lower than the stage; also the stage itself overhangs the orchestra pit by approximately 1.5m masking many instruments. There are also many people off-stage who have to hear the orchestra, including the stage manager, repetiteurs, prompter etc. Amplification of soloists is rare, normally only when they are off-stage or maybe when echo has to be added. In this case, a radio mic is normally worn.

Radio mics are occasionally used when a singer's voice needs to be lifted slightly. A singer may walk on stage from the back, singing as he walks down to the middle, or front of the stage, and owing to possible masking effects of scenery, he may not initially be quite audible. In a case like this, the artist would wear a radio mic, which would be grouped and fed to a loudspeaker concealed in the scenery. In spite of the loudspeaker being in close proximity to the radio mic, feedback is not, in this case, a problem due to the very low level of amplification required.

Going to the other extreme we do have a call now and again for really massive amplification, like the dragon's voice in Siegfried, where it thunders from the stage and also from under the stalls. The dragon himself wears not one but two radio mics—the reason being that two is better than one when it comes to possible trouble. We use one purely as a standby and the other as the main channel. If you do experience trouble halfway through a cue, pushing up the spare fader may get you out of it, depending on what the trouble is. If you have a bad interference problem caused by outside sources, then there's a good chance that you've lost that as well, but it's another small safeguard.

While on the subject of reliability, it is sad to relate a tale underlining this. During the first night of *Das Rheingold*, the worst occurred when the singer's fear of technology proved him correct. At the best he had a suspicion of such things as radio microphones and the thought of strapping one let alone two microphones to him seemed an insurmountable task indeed. In the event, he only wore one. He was inside a glass tower, and when the appropriate cue arrived, up went the fader and, apart from a burst of interference, absolutely nothing. We spent the next 20 minutes cringing in the control room box at the side of the auditorium, while the singer did his very best to sing through very thick panes of glass. Part of the scenario involved raising and lowering the singer by a manual jack, operated by two stage hands below the stage. When in the raised position the singer's head appeared above the top of the tower, at which point, the majority of the audience got the full benefit of his performance.

While we're on the subject of belt and braces, there's another little story I could relate regarding a remote stage band. This was in the studio in the office block across from the opera house where we were relaying the band, live, to the stage. Unfortunately halfway through the show, a condenser mic power supply happened to fail, which left us in a very embarrassing situation—namely 12 musicians blowing their lungs out in the office block across the road and not a peep on stage. From then on we did specify dynamics as well as condenser mikes but unfortunately mishaps like that do a lot of damage and people, including us, just don't forget. However, accidents can't always be legislated against.

There are schools of thought who would suggest that electronics and modern technology have no place in a traditional art form such as the opera. However, the advantages of modern sound technology as such, easily outweigh any disadvantages resulting from their use.

At times we have occasion to crossfade tape recorded cues involving soloists and choruses with the live orchestra. In this case, the conductor takes his cue from the sound amplified through the sound system. We take most cues ourselves from a suitably marked-up score as opposed to verbal or cue lights from the stage manager. This is mainly because cues may be only one or two bars long, spread over two or three pages. Fader settings may be altered many times during one page of music, and to have a whole string of cue numbers given one after the other would not only take up too much of the stage manager's time but also be rather confusing to us. Even more so since we will be trying to listen to the cues with one ear, and listening to the effect we are creating with the other. Thus a system relying on cue lights would be totally confusing to everybody. More often than pre-recorded tapes, we use musicians, live, in a remote studio (in actual fact it's

in an office block across the road from the opera house). They have a television link, also a sound link comprising foldback from the orchestra pit to the studio. Naturally the music from the remote studio has to be blended in with the music from the main orchestra. To do this, the sound engineer normally has to bring up his faders one bar in advance of the musicians playing in the remote studio. To do this he has to fade according to instructions written in a musical score which include level changes, reverb and eq. A good example of this comes from the score of *Das Rheingold*, Scene 3, where the engineer has to fade up a chorus of anvils playing in the remote studio. We build up to a crashing climax over the next 16 bars progressively increasing both the volume and the number of sources around the auditorium. We then fade back down over the next 12 bars to nothing. After this sequence, we regroup and prepare to turn on the soloist's radio mic nine bars later. The following cues include a few simple level and eq changes followed by a startling application of echo to sources spread around the auditorium. Perhaps it doesn't sound much to read about, but I can tell you it's really hair-raising stuff to do.

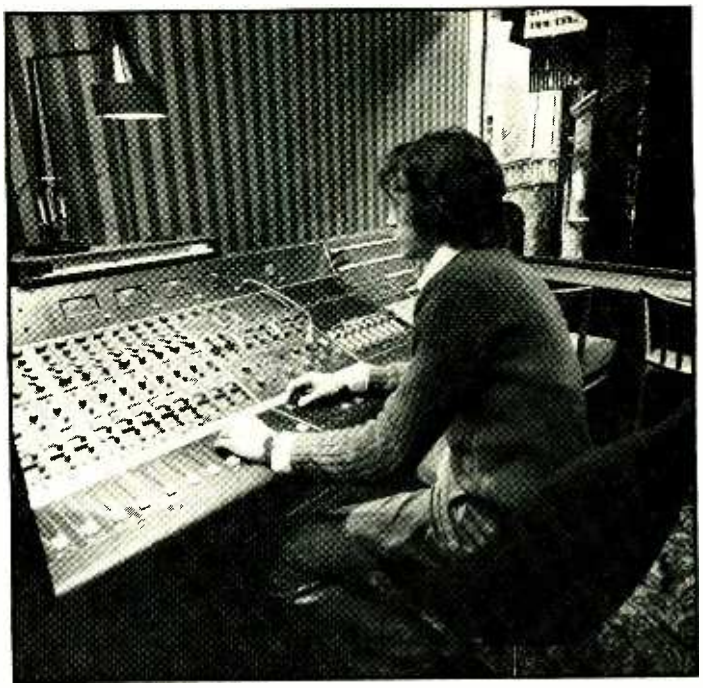
As an attempt at consistent levels for these productions, we use as a setting plot comprising a xerox copy of a photograph of the Neve desk. This is used initially as a check that we have all the settings as they should be. Any further information on changes we always include in the score. On the same xerox sheet, we include details of microphone placing and arrangements, and the group outputs and loudspeaker positions. In these days of complicated productions, the Neve desk has shown to be a little lacking in groups, being only 16/4. To make up for this there is a lot of doubling up and use of auxiliaries such as foldback as extra groups. To give a rough idea, the grouping arrangement is as follows: Group One feeds the Bose *1801* power amplifier, which, in turn, drives the Bose *901* loudspeakers on the prompt and op (opposite prompt) sides of the stage (left and right). Group Two feeds one H/H *100D* power amplifier, which then very gently powers a single *AR7* in the centre footlights. This has the very simple task of enhancing the centre image, on some vocal cues. Group Three feeds six H/H *100D* power amplifiers which drive an assortment of Altec loudspeakers, actually beneath the stalls. Group Four drives two H/H power amplifiers, powering AR *LSTs* on the prompt and op mid-perches (that's a position halfway between the stage and the flys). Here, of course, we run out of groups so we go on to a foldback channel that we're not using for any other purpose. It feeds another H/H *100D* driving an Altec *1208* on the op mezzanine level. Foldback Two is also used for another group output and that feeds H/Hs driving JBL *Studio Monitors* in the prompt and op amphi-theatre high up above the proscenium arch, and also feeds one Crown *D60* that drives an Altec *1208* in the centre of the dome above the auditorium.

Tape delay might be old hat to people in the studios but it really came into its own at the beginning of the season with Siegfried in which there was an off-stage (audible, not visible) horn player who played his piece and we had something like a four-second delay using the reverb with no cleanfeed.

We have a small pipe organ in a gallery on the prompt side of the stage; it's a single manual and pedal job and not normally loud enough to reach the audience. So usually, unless they want it very quiet, we do amplify this and add reverberation.

This is about the limit of the special effects employed by the Royal Opera. Their use is very guarded and restrained because they were, of course, never envisaged by the original composers. It all comes down to the fact that their use is to create atmosphere rather than effect.

The more mundane aspects of the job consist of maintenance of equipment, some aged and due for replacement and other equipment such as television, which is not quite so aged and not quite so troublesome. We also operate the video recording equipment for the Ballet Company, which can be very time-consuming. This is done mainly at rehearsals and purely for the ballet archives. There is one rather amusing setup that we've done, where it isn't possible to record piano sound on video at a rehearsal, thus avoiding scrapes with the musicians union. As we can't do a direct recording, we record the picture direct from the camera, of course, but we feed the picture of the conductor across to the remote studio where a pianist is waiting with headphones where he dubs the piano track back on to the video tape. So we end up



Above: *Sound Box showing the Neve 16/4 desk. The stage set can be seen to the upper right of the picture.*

Left: *Xerox copy of sound desk control layout with basic control levels marked on for rapid setting up.*

Below: *An example of a specific routing arrangement.*

with a performance of the ballet but with a piano sound track only.

Cctv plays a very important role in the synchronisation between conductor and stage movements and associated singers. There are two basic systems; the most important is a camera trained on the conductor. From there, it is piped to sockets round the stage and to various other parts of the building as well. There is also a sound point adjacent to the video sockets, so that you can plug in a television monitor anywhere in the building and get picture and sound. The second system isn't quite so important. Basically it's used for the latecomers. As you probably know, we don't allow them in once the show has actually started. They have to wait

66 ▶

DAS RHEINGOLD CHANNEL ROUTING

	CHANNELS	GROUP 1	GROUP 2	GROUP 3	GROUP 4	FOLD BACK 1	FOLD BACK 2	REV SEND 1	REV SEND 2	
TAPE 1	1	✓		✓	✓		✓			
TAPE 2	2	✓		✓	✓		✓			
STUDIO D202	3	✓		✓	✓	✓	✓		✓	
STUDIO D202	4	✓		✓	✓	✓	✓		✓	
AUDITORIUM ROOF SM69	5	CHANNEL OUTPUT PATCHED DIRECT →								PATCHED DIRECT TO STUDIO AMP & H/PHONES
AUDITORIUM ROOF SM69	6	CHANNEL OUTPUT PATCHED DIRECT →								PATCHED DIRECT TO SPENDOR BC1/A IN STUDIO
STUDIO KM86	7	✓		✓	✓	✓	✓		✓	
STUDIO KM86	8	✓		✓	✓	✓	✓		✓	
RADIO CHANNEL A	9	✓	✓		✓		✓	✓		
RADIO CHANNEL B	10	✓	✓		✓		✓	✓		
STAGE D202	11	✓	✓					✓		
MEZ U87	12	✓	✓				✓	✓	✓	
MEZ D202	13					✓			✓	
	14									
BX20 1 RETURN	15	✓			✓		✓			
BX20 2 RETURN	16	✓		✓	✓	✓	✓			
		BOSE 1801 ↓ PS. OP. BOSE 901's STAGE	1x HH ↓ CENTRE FLOATS AR7	6x HH ALTEC UNDER STALLS	2x HH ↓ PS. OP. AR LST's PERCH	1x HH ↓ O.P. ALTEC T208 MEZ	3x HH 1x ALTEC 1208 CENTRE DOME 2x JBL's AMPHI THEATRE	BX20 1 2.5 SECS	BX20 2 4.0 SECS.	

Speaker technology for sound reinforcement

DAVE MARTIN *

Many gigs and festivals are characterised by the indifferent performance of the pa system; the sound quality of most would not be tolerated in the domestic environment. Most causes and remedies involve design and placement of the stacks.

* MARTIN AUDIO LTD

SHORTLY after I arrived in London from Australia, I went to a free outdoor concert hoping to see and hear a good sound system. What a disappointment, for the quality was terrible and the coverage poor. The system consisted of a large number of columns, stacked so as to form two walls on either side of the stage. This, it appeared, was a standard type of pa system. Small bands would have three or four 100W slave amplifiers driving perhaps 10 columns, larger bands several times this quantity, building up in size to the vast mountains of equipment used at that time by such as Pink Floyd. All in mono of course, with the mixing desk either at the side of the stage or right in front of the column stacks.

It was not uncommon for larger systems to grow to a height of 3m and attain a width of 6m. Unfortunately, while one column would stand on its 40 cm wide by 25 cm deep base it would not always do so with another one standing on top of it, and many precarious situations developed. It has been known for the roadie to leap for his life as part of, or all of, the pa came crashing down. This was in 1969 and very few people in the music business had heard of horn loaded sound systems although these had been standard fitment in cinemas since the early 1930s. This was soon to change.

In 1970 the American band Iron Butterfly played the Albert Hall, using fully horn loaded system. This employed two folded horn cabinets for the bass designed by RCA and known as *Cinema W* cabinets or *W bins*, with two 38 cm loudspeakers driving them. Augmenting these were compression drivers coupled to radial exponential horns for the high frequency end. The system created a minor sensation and was eventually purchased by Yes using Altec mixers and Crown *DC300* power amplifiers. This system set a new standard and within the next two years many major bands were converted to the bin and horn philosophy. Stereo mixers were introduced, mixing desks were relocated in the audience and bands began to use stage monitor loudspeakers, and many more microphones than they had in the past. These new systems were very much superior to the column systems contributing greatly increased efficiency, with a more extended frequency range. The older column systems were lucky to have a usable range of from 100 Hz to 5 kHz, while the best of the new systems would cover 40 Hz to 15 kHz. This new technology ousted the old, columns and mono mixers began to disappear from the scene. The race for more power was on, helped by the new generation of 600W power amplifiers arriving from the USA. No longer was it necessary to use 24 100W slave amplifiers to build a 2400W system, when the same job could be done with only four larger amplifiers. Heavy bands began to use more power than they had in the days of the column systems, this being fed into horn loaded systems with an efficiency many times greater than that of the older systems. Today it is not uncommon for systems having an rms input power to the loudspeakers of up to 5000W to be used in concert halls seating around 2000 people.

During the development of the horn loaded sound system, many different ideas were tried. Passive crossovers were used to separate the bass from treble, cruder systems using no real crossover at all, just a capacitor to block the bass from getting into the treble horns. It was gradually appreciated that electronic crossovers offered the best results and most systems were to be found using either a two-way electronic crossover at about 800 Hz or a three-way crossover, with crossover frequencies usually 800 Hz and 5 kHz. Many systems, in current use, use these crossover frequencies. In an attempt to improve the mid range performance, especially on vocals, there has been a recent trend towards the four-way electronic crossed over systems. Typically, using crossover frequencies of about 250 Hz, 1.3 kHz and 5 kHz, the majority of these systems use short straight axis horns, driven by 30 cm loudspeakers for the band 250 Hz to 1.3 kHz, although it has been known for 38 cm speakers to be used with less satisfactory results.

A typical three-way pa system using crossover frequencies of 800 Hz and 5 kHz is illustrated in **fig. 1.** Reference to measurements indicates that the total input power at the amplifier's clip point is 770W rms giving a power rating for the system used in the stereo mode of 1540W. However, many bands find that this amount of power is inadequate and it is common practice to double up the pa system thus increasing the drive power to 3080W. Some rock bands use these systems at or near their full power capability, and this has often led to situations where the audience is subjected to an spl in excess of 115 dBA. Listening to continuous levels of this order does nobody any good, and this practice tends to bring discredit on the industry. It has been instrumental in attracting the legislative attention of Leeds Council and the GLC. High sound pressure levels cause distress to some of the audience and can indeed alienate them, particularly those in the first 12 rows. The fact that people don't complain about Robin Trower suggests that they are either deaf or masochistic.

Many systems leave much to be desired in terms of quality. It is very enlightening to listen to a disc or a master tape of a band on good control room monitors and then go to a concert given by the same band. If one then judges the sound of the concert by the standard set at the studio, the results are usually disappointing in the extreme. Although hall acoustics act very often to the detriment of the sound system, not all of the blame lies with the acoustics but must be shared between the sound system and its operators. Audiences tend to be less critical of sound in a live environment than they would at home, and tend to be tolerant of poor sound quality.

Requirements for a better sound system include a reasonably uniform frequency response over the range 30 Hz to 16 kHz. A uniform spectral energy output over the desired operating range. Good polar response over as wide a band width as possible, consistent with achieving the desired angle of coverage in both the horizontal and vertical planes. Low harmonic and intermodulation distortion remaining low up to the maximum acoustic output. Good transient response with minimal resonance and stored energy effects. Adequate acoustic power output with which to establish the desired maximum sound pressure levels in the chosen environment. In the case of electronically crossed over systems, adequate power output in each frequency band in order to be able

to cope with the energy spectrum of the music to be reproduced while maintaining uniform headroom over the audio band. This is also necessary in order to avoid dynamic frequency response shift due to any one section running out of headroom. A further requirement for a transportable system is that it should be as compact as possible to minimise handling and transportation difficulties. It also follows that the system should be modular in order that the weight of any one particular item should be low enough to be easily handled.

We will now analyse a typical sound system in widespread use. For convenience I have chosen a JBL based system shown in fig. 1 but the following analysis could equally apply to sound systems using any other manufacturers' components. It is to be noted that the nominal impedance of the bass drivers is 16 ohms, measured at the lowest point on the impedance curve. The average impedance is considerably higher than this over the operating band 40 Hz to 800 Hz. The impedance of the mid-range compression drivers is more uniform over the operating range, such that the actual music input power at the amplifier clip points can be considered to be nearly equal for both bass and treble. Our first observation is that incautious use of the treble controls may result in the treble drivers disintegrating in a cloud of expensive smoke. This does happen, but infrequently, since there is very little actual power in this part of the music power spectrum. A typical average pressure spectrum of a rock band indicates perhaps 20 dB down at 5 kHz compared with mid band levels, although peaks run considerably higher than this, especially during a drum solo. In order to appreciate fully the distribution of the available drive power to the horns, it is necessary to establish the relative efficiency of the bass bins and horns.

A method of doing this is to use a passive crossover at 800 Hz with a step attenuator, calibrated in dBs controlling treble level. The system is adjusted such that the nominal impedance of both bass bin and horn are equal. A balance is generally established at an attenuator setting of around 6 to 8 dB. Therefore, it follows that the effective on-axis output of the pa system at full drive power is some 6 to 8 dB greater in the mid band. However, the bass end covers about four and a half octaves while the mid covers only two and a half. Probably two thirds of the total acoustic output of a rock band lies below the crossover frequency of 800 Hz and perhaps more than three quarters. Under conditions where the system is used at maximum level, it follows that there may be a dynamic frequency response shift of as much as 10 dB, in favour of the mid band. It is commonplace for systems to be used in this manner and as each of the large radial horns in this system can produce in excess of 130 dB at a distance of 1m, audiences are often subjected to intolerably high sound pressure levels, especially in the smaller venues.

It is important to consider possible out-of-phase effects in the sound system, between the various drivers, as these will make the axial frequency response more non-linear and act to the detriment of the end result. It will be noted that there are two different types of bass cabinet used in the system (fig. 1) with equal powers being fed into the bottom bin and the two smaller top bins. As this system is set up such that the front of the cabinets are lined up, the path length difference between the upper drivers and the lower drivers is about 20 cm, **fig. 2.** Cancellation between two sound sources radiating in the same plane will occur when the path length difference is equal to a halfwave length. As 20 cm corresponds to a half wavelength at about 800 Hz, the result is a tendency to create a hole in the axial frequency response maximising at 800 Hz. Angular displacement away from the axis in a vertical direction will worsen the situation as the effective path length distance between the upper and lower drivers will increase. In an optimally designed system, it is important to phase the drivers in the overlap region at the crossover point. However, because of the physical separation of the two sets of drivers, phasing only holds good for one horizontal plane. A better solution is to use an electronic crossover having a high rate of attenuation outside the operating bands, thus minimising the width of any resultant interference areas in the response curve.

With mid frequency horns, it should be noted that a combination of acoustic lens and radial horns are employed. If a mixture of different horns is used it is important to place all drivers in the same vertical plane. For instance, a displacement of 4.2 cm, representing a half wavelength at 4 kHz, will cause maximum interference effects at this frequency. Very often insufficient attention is paid to this aspect of horn use: it is not unusual for as many as three different types of horns to be used in the frequency band 800 to 5k Hz with scant attention being paid to the relative displacement of the drivers from the ideal phasing plane. It will be observed that the two radial horns are placed side by side, this effectively destroys the smoothness of the designed radiation pattern. At any point horizontally displaced from the central axis, cancellation will result because of the half length difference from the two horns to that point (see **fig. 3**). Similarly, the treble horns will suffer cancellation effects at any point other than on the central axis. The correct way to use radial horns is to stack them one on top of another. However, if an excessive number are stacked they will become very directional in the vertical plane.

It is interesting to examine the reasons as to why there is widespread use of mixed horn arrays in pa systems. An examination of the reasons given by people for using the large slant plate acoustic lens horn, used in this pa system include: a) it is a short throw device and will therefore cover the front rows in an auditorium; b) the lens directs the sound downwards, therefore will assist coverage of the front rows not reached by the radial horns above; c) the lens covers a very wide angle and therefore will further assist in covering the area at the front of the stage. A short throw horn may be defined as a horn which covers a wide 52 ▶

FIG 1

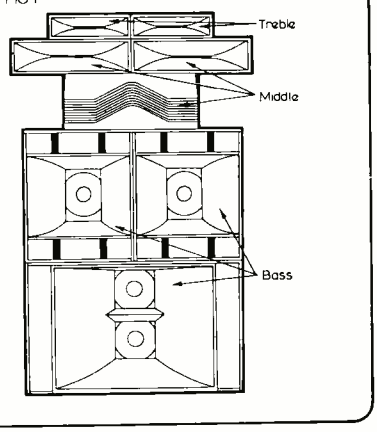
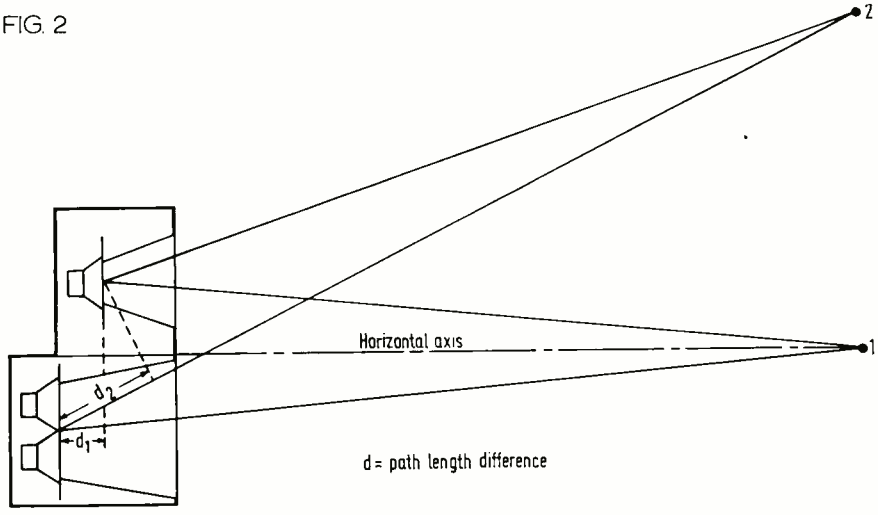


FIG. 2



Path length difference caused by incorrect positioning of bass horns

angle on its horizontal axis, and additionally a horn which by virtue of the wide angle of coverage has a lower sensitivity on axis. A long throw horn is one where the angle of coverage is restricted and in addition the vertical angle of coverage may be restricted resulting in very high sound pressure levels on axis. Such a horn may be expected to penetrate further towards the back of a hall than a short throw device. But is it necessary to use long throw horns in a pa system? Examinations of the polar response curves of the acoustic lens horn used in this pa system indicates a horizontal coverage of 140°, which compares to the 90° coverage of the radial horns above. Close investigation of vertical dispersion data, published by the manufacturer, indicates that the radial is considerably better than the lens. In no way does the sound from the lens get directed downwards by the slant plates, although it will undergo a slight displacement from the horizontal axis as it passes through them. It is doubtful if coverage of the first few rows can be obtained in this system by means other than relocating the mid and treble horns, or by tilting one mid and one treble horn downwards, as the horns are placed considerably above the heads of the audience.

Acoustic lenses have a certain air of mystique about them for their operation defies visual analysis. They appear as if they would direct sound downwards. It has been known for these big lens horns to be used upside down in order that they may cover the balcony. In one instance, the system builder, not wanting too much sound in the first few rows of the audience to the exclusion of those at the back but being unsure of how exactly the device worked, decided to compromise by angling the horn upwards at about 20° from the horizontal.

Misunderstandings of operation lead to such misuse all too frequently.

Returning to the short throw versus long throw argument, it is interesting to note that the JBL *2356* radial horn designated as a long throw with a rated distribution pattern of 40° horizontal by 20° vertical has an EIA sensitivity some 6.5 dB greater than the *2350* radial. However, we can achieve the same or greater sensitivity with wide horizontal coverage by stacking several of the radial horns. It should be noted that this will also reduce the vertical coverage so this technique should be used when a narrow vertical coverage is acceptable. Many people mistakenly use a mixture of acoustic lens horns, radial horns and long throw horns believing that the lens will cover the front rows, the radials will cover the middle rows and the long throws will cover the rear of the auditorium—while paying scant attention to the correct phasing of the array they have created. This results in severe frequency response irregularities.

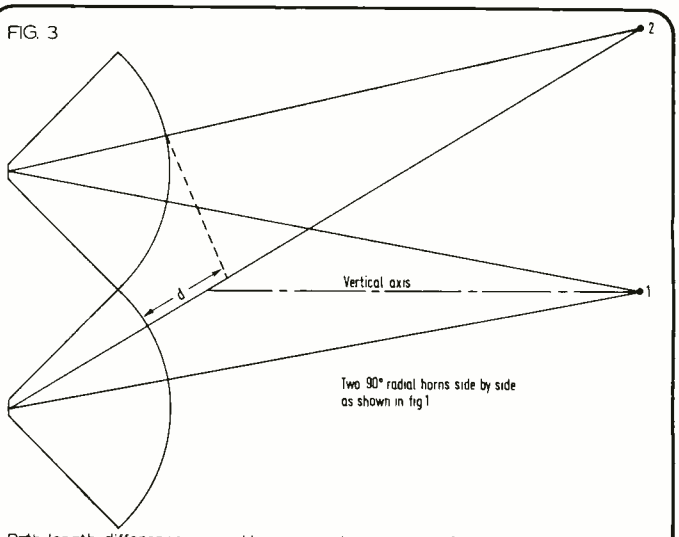
An examination of the harmonic distortion characteristics of compression driver/horn combinations is interesting, for it helps to explain the high levels of distortion produced by many sound systems when operated at high input power levels. The dominant distortion is second harmonic, and its principal cause is the non linearity of the air in the throat region, where the spl is many times greater than at the horn mouth.

Distortion produced depends on the acoustic level per square cm of throat area x $\frac{\text{measured frequency.}}{\text{horn cut off frequency}}$. The horn cut off frequency is the theoretical cut off frequency due to the rate of taper, and is about 220 Hz for a typical radial horn. A long throw radial horn has a cut off frequency of about 120 Hz. Typical second harmonic distortion curves for a radial horn with a cut off frequency of 220 Hz are shown in **figs. 7** and **8.** For an input level of 60W rms the distortion at 1 kHz is about 12% while at 4 kHz it is about 20%. Third harmonic distortion is approximately 25% of these values. It can be expected that intermodulation distortion will also be considerable.

Spectral analysis of a typical rock band indicates a considerable drop in average power output above 1.5 kHz. Distortion in frequency bands below this may form a considerable part of the total acoustic output at higher frequencies, making it more noticeable. From an examination of equal loudness curves (Fletcher Munson curves) it will be seen that the ear attains maximum

54 ▶

FIG. 3



Path length difference caused by incorrect placement of radial horns

FIG 4

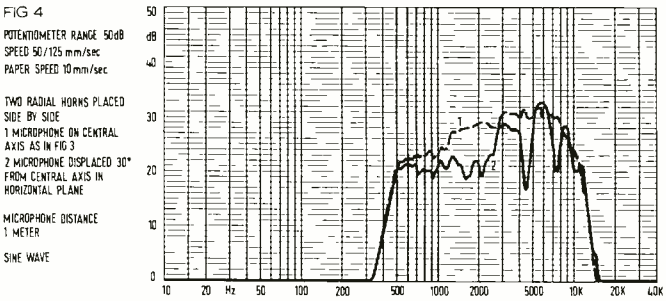
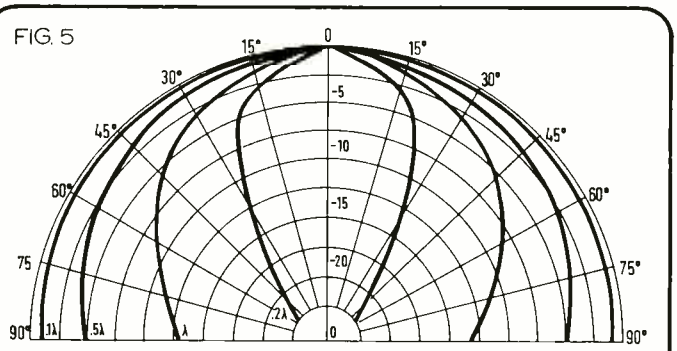


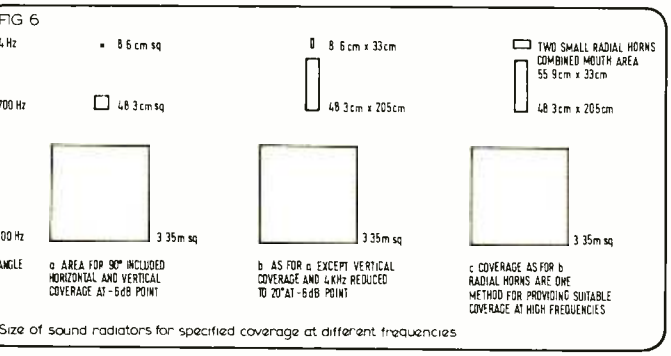
Illustration of frequency response variations when two radial horns are placed side by side

FIG. 5



Polar diagram of disk radiator having diameter equal to ·1λ, ·5λ, λ, and ·2λ where λ = wavelength

FIG 6



Size of sound radiators for specified coverage at different frequencies

BROADCAST
B.B.C.
London Weekend
London Broadcasting
Piccadilly Radio
Guyana Broadcasting
Radio Orwell
Government Communications
Radio Edinburgh
Swansea Sound
Rediffusion
Radio Luxemburg
Radio Fleet
Seychelles Broadcast
Thames T.V.
State of Bahrain

ENTERTAINMENT
Decca (France)
EMI
Queen
Kinks
The Who
David Essex
London Palladium
Sarm
Indigo
C.B.S.
Virgin Records
YES music
Olympic
AIR
United Artists
De Lane Lea
Screen Gems Columbia
Orange
Trident
Rolling Stones
Tin Pan Alley
Alvin Stardust
Island
Morgan
Eamon Andrews
Gooseberry
Molenaire
Warner
Chappell
Precision Tapes
R.C.A.

INDUSTRIAL
Hawker Sidley
Metropolitan Police
Rank Xerox
Birds Eye
Ministry of Defence
Lloyds Bank
Catholic Trust
Wiggins Teape
National City Trust
State of Israel
British Rail
Pye T.V.T.
S.T.C.
Alice

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sensitivity in the band 2-6 kHz; therefore distortion products falling within this band will be particularly audible.

Horns driven to full power produce a very objectionable type of distortion, imparting a hard brittle character to the music, especially evident on vocals. For low distortion, the power input to the horns must be kept low, or the horns operated at higher frequencies, outside the maximum power band. Current practice for both studio monitor and pa loudspeakers is to avoid using horns below about 1.3 kHz.

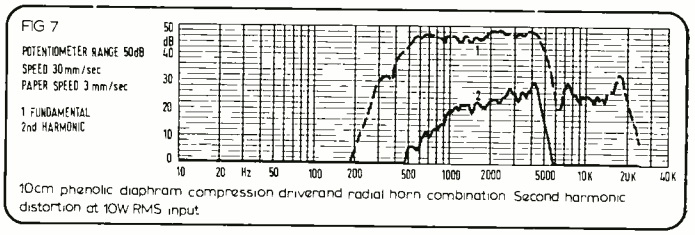
Fig. 5 provides data on the allowable size of plane radiators for various angles of polar coverage. **Fig. 6** uses this data to illustrate the size of plane radiators at three frequencies for specified horizontal and vertical coverage angles (although a typical pa system is not a plane radiator, it does approximate to one, especially a large system stacked such that the individual units form a flat wall). In order to achieve a uniform horizontal and vertical angle of coverage throughout the audio band, a sound system would need to alter its size inversely with frequency. If it could do so, and possessed a flat axial frequency response curve, the total acoustic output would also be flat. In practice these conditions are not met.

A typical four way pa system using horn loaded 38 cm loudspeakers for bass up to 250 Hz and horn loaded 25 cm loudspeakers for the band 250 Hz to 1.3 kHz may have a mid range section equal in size to the bass section. If adjusted for a flat axial frequency response it will suffer a dramatic variation of total acoustic output between 40 Hz to 1.3 kHz. Far more power will be generated in the bass region than in the mid band region.

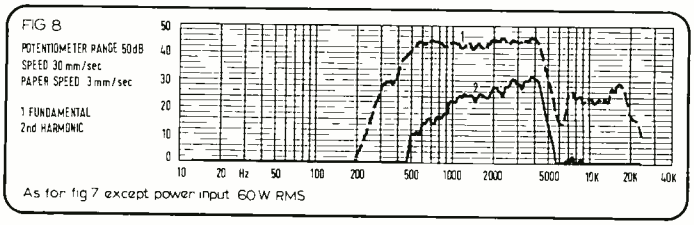
If this system is used in an auditorium having a long reverberation time, bass frequencies will excite the resonant modes of the auditorium to a much greater extent than middle frequencies, and may lead to boomy, ill-defined bass. No amount of system equalisation can cure this condition.

Such a system will suffer from poor polar response at middle frequencies tending towards a narrow beam which becomes narrower as the frequency rises. Cancellation effects off axis, similar to those experienced with incorrectly positioned radial horns, may also result. The larger the system, the worse will be the results, and unfavourable auditorium acoustics will make matters worse still, leading to this kind of review in the musical press:

'*But the emptiness of the hall merely accentuated some of the things that were wrong with the arrangements. The sound must go down in British rock history as one of the worst to have graced a festival. Faced with disastrous room acoustics in the first place, the sound men apparently worked on the principle of when in doubt, add another megawatt . . . So the boomy and squelchy sound of the hall was emphasised with the result that vocals and announcements were virtually inaudible, guitar solos reduced to faint tinklings at the edge of perception, and drums roared through the air like a herd of stampeding buffalo.*' (An excerpt from a review in *Melody Maker*, January 10, 1976.)



10cm phenolic diaphram compression driverand radial horn combination. Second harmonic distortion at 10W RMS input



As for fig 7 except power input 60 W RMS

A common myth amongst people in the music industry is that a high efficiency loudspeaker produces more output at low frequencies than a lower efficiency one (of the same size). Nothing could be further from the truth, for a high efficiency bass driver exhibits a rising response above about 150 Hz and a falling response below this point, when compared to a similar driver designated as a lower efficiency unit. A typical method of measurement is to use a warble tone in the band 100-500 Hz, a loudspeaker with a light cone and voice coil giving a higher sensitivity than one using the same magnet but with a heavier cone and voice coil. Use of a high efficiency light cone driver in a horn gives a unit strong in middle bass output but lacking in output in the low bass region. At high drive levels, heavy coned bass drivers tend to sound better than light coned drivers because cone breakup is reduced.

It has been shown that the design and operation of sound amplification systems requires great care if high quality sound is to be ensured. Large systems pose more problems than smaller ones, because of the multiplicity of drive units used in their construction and because their physical size is often incompatable with basic acoustic requirements. The author hopes that a better understanding of sound systems and their operation will lead to an improvement in live sound quality, while an awareness of the possible damaging effects of high sound pressure levels will lead users to operate at realistic levels.

NEWS

recording and transmission are long since fixed and thus now with us for many years to come, any surround sound system must compromise between mono and stereo compatibility on the one hand and surround sound capability on the other. Were it possible to redesign our mono and stereo parameters from scratch, it would doubtless also be possible to produce a surround sound system that offered excellent compatibility and capability. But this is a pipe dream, and the BBC, very reasonably, sees its responsibility as more towards existing owners of mono and stereo equipment than towards those prepared to equip themselves for surround sound. Thus, inevitably, the BBC is leaning more towards a compromise that favours good compatibility than one which favours good surround sound capability.

There are now signs that the BBC may eventually not clearly baptise any one surround sound system. Instead, the Corporation may issue a 'white book', similar to that issued on PAL colour and Ceefax data transmission. This will define, not the manner in which the signal is to be received, but the parameters which govern its transmission. In this way, the BBC will effectively be saying, 'This is what we are transmitting; what you do with it is your business'. After that, natural selection will take over, and only the manufacturer with the best approach to reproduction will stay in business. After all, there is nothing to prevent anyone from marketing a tv receiver which translates the PAL signals currently being transmitted into luminous pastel shades. Likewise, if the BBC ever start to transmit signals capable of surround sound reproduction, there will be nothing to prevent a manufacturer from offering hardware to produce all-round mono. But neither would sell too well.

At the time of writing, however, it is clear that the BBC has not yet decided on what set of parameters can reasonably be adopted. Equally clearly, therefore, further tests will have to be carried out. Is it too much to ask that the interested sectors of the British public, who after all support the BBC's very existence with their licence fees, might be let into the secret next time there is a series of encoded test transmissions?

Currently the American FCC is considering, albeit very slowly, which of the proposed transmission systems vetted by the NQRC it intends eventually to adopt as a standard. As it is inconceivable that the BBC can go it alone in defiance of such a standard, it might be said that whatever the BBC decides is not unduly relevant. It is, for instance, inconceivable that, if the BBC were to choose QS, the rest of the world's broadcaster and record manufacturers would feel obliged to follow suit.

Adrian Hope

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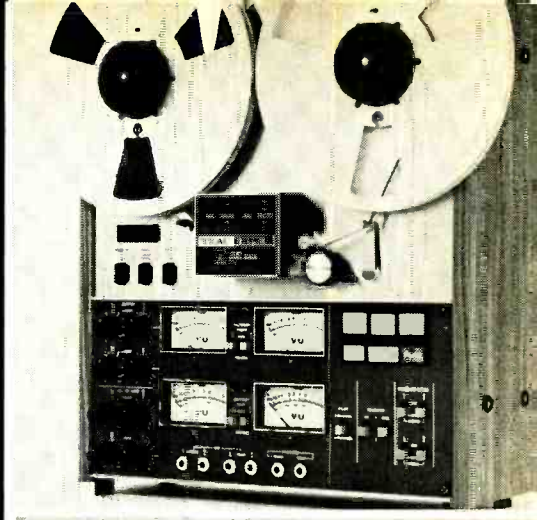

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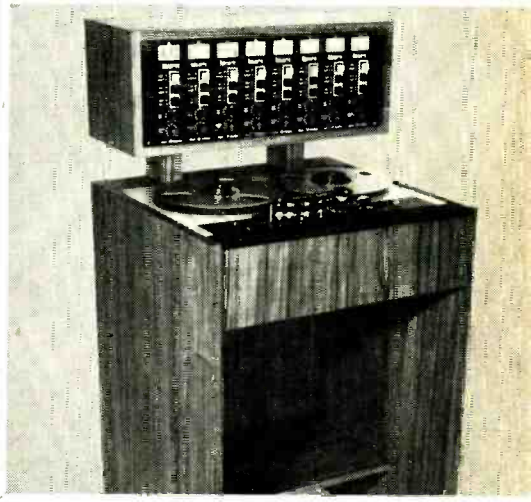

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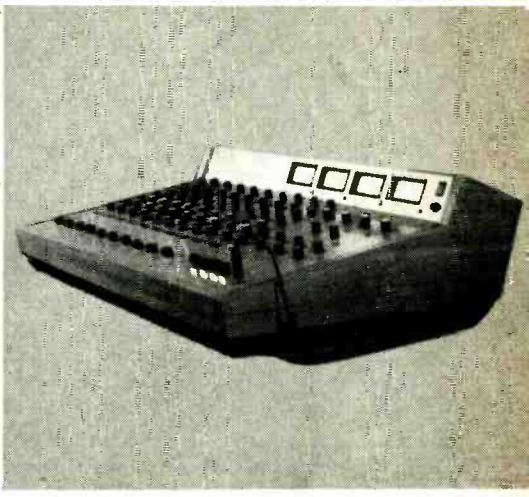

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AES 53rd Convention, a preview

The 53rd AES Convention will be held from March 2 to 5 at the Hotel International am Marktplatz, Zurich, Switzerland. The Convention follows the usual format of a lecture programme with accompanying exhibition. In addition to the regular Convention activities, various excursions to technical/recreational places of interest at a nominal extra fee. The Awards Banquet, a usual AES feature, will be held on the evening of March 4 at the Kursaal/ Casino in the nearby town of Baden. For further information contact: AES Headquarters Office, 60 East 42nd Street, New York, NY 10017, USA. Phone: (212) 661 2355. UK: Carol Atkinson. Phone: Orpington 25423. Europe: Miss T. K. Bakker, c/o Polygram BV, PO Box 23, NL 2670 Baarn, Holland. Phone: 2154 9911.

TECHNICAL PAPERS

THE majority of the papers will be in English, a number will be in German and some in French.

Tuesday, March 2 09.00h
INSTRUMENTATION
Chairman: **Dr J. Sennheiser,** Siemens-Albis AG, Zurich

EDT Investigations in small rooms and auditoria—Aristid Ducko Ing CSc, Slovak Techn University, Bratislava, Czechoslovakia.

Long-time spectra of the radio broadcast programme signal—Denes Huszty MSc, BEAG Elektroakusztikai Guar, Budapest, Hungary.

The present status of research on transient intermodulation distortion—Prof Dr Matti Otala, Techn, Research Centre, Oulu, Finland.

Possible methods for the measurement of transient intermodulation distortion—Prof Dr Matti Otala and Dipl Ing Eero Leinonen, Techn Research Centre, Oulu, Finland.

On-line computer studies of the trombone—Dr J. M. Bowsher, University of Surrey, Guildford, England.

Fidelity index—simplified—Dr Ing Juva Mantel, Dr Mantel & Partners, Munich, W-Germany.

Tuesday, March 2 14.00 and 19.00h
PSYCHOACOUSTICS—I & II
Chairman: **Dr R. Kurer,** Techn University, Berlin, W-Germany.

The recognition of wind instrument sounds tested by high-pass/low-pass filtering—Dr Udo Sirker, Musikwissenschaftl Institut, Cologne, W-Germany.

Psychoacoustical research of the vibration structure of superpositions of complex musical instrument tones—Rolf Dieter Weyer, Musikwissenschaft Institut, Cologne, W-Germany.

Evaluation of noise suppression systems in listening tests—Dr M. Krause, Techn University, Berlin, W-Germany.

Calculation of the stereophonic localisation area—Dezso Gaal, Kozepuletter-vezo Vallalat, Budapest, Hungary.

Automatic speech recognition with logical sequences—Denis Mellet, EPF-L Lausanne, Switzerland.

Transmission of natural sound transient — Afred Schaumberger, Olching, W-Germany.

Ambience related transmission system —H. Lauterslager and P. H. C. Nuyten, Phonogram International, Baarn, Holland.

NOTE: 'Late arrival' papers will be scheduled in the evening session.

Wednesday, March 3 09.00h
Chairman: **Dipl Ing E. Weiss,** Georg Neumann GmbH, Berlin, W-Germany.

On cutting technology using diamond hot stylus—Isao Owaki, Shinju Nakamura and Yukio Kosuda, Victor Company of Japan, Frankfurt, W-Germany.

The aspects of low inertia tone-arm design—Dipl Ing P. Rother, Geratewerk Lahr, Lahr, W-Germany.

A solution of the turntable suspension system—L. Klapproth, Geratewerk Lahr, Lahr, W-Germany.

Vibrational analysis of a stylus with a novel mechanical suspension—W. Fidi, AKG, Vienna, Austria.

Theoretical and experimental investigations on pick-ups—E. Kerschbaum, AKG, Vienna, Austria.

Tracing distortion correction—E. G. Trendell, Central Research Labs, EMI, Hayes, England.

Thursday, March 4 09.00h
SOLID AND AIR BORNE VIBRATIONS
Chairman: **Prof Dr E. Rathe,** Eidg Techn Hochschule, Zurich.

Moving sound image in the theatres—J. Borenius, The Finnish Broadcasting Co, Helsinki, Finland.

Effect of covering layers on acoustical characteristics of loudspeaker cones—Rezso Karcsay, Elekroakusztikai Gyar, Budapest, Hungary.

Vibration measurements in acoustics—Gunnar Rasmussen, Bruel & Kjaer, Naerum. Denmark.

Dauphin: an underwater acoustic system of identification—Dr Mario Rossi, EPF-L, Lausanne, Switzerland.

On the dynamics of sound transmission —influences on studio construction—Dipl Ing E. J. Volker, Hessischer Rundfunk, Frankfurt/M, W-Germany.

Sound insulating constructions for speech recording studios—Dr Dipl Ing B. Bernfeld, Elektrotechnik und Akustik, Oberursel, W-Germany.

Thursday, March 4 14.00h
SIGNAL PROCESSING
Chairman: **Dipl Ing P. Rother,** Geratewerk Lahr, W-Germany.

Automated individual equipment or computer controlled broadcasting house —Jeno Radnai, Hungarian Radio Budapest, Hungary.

Real-formant VS pseudo-formant in electro-acoustical music-production—V. Nosselt, University of Gent, Belgium.

Opto-electronical fader system — V. Reichlin-Meldegg, BEAG, Budapest, Hungary.

System for automatic speech/music balance of radio receivers—K. Ilmonen and M. Huotari, The Finnish Broadcasting Co, Helsinki, Finland.

The sound workshop model 500 real-time pitch shifter: a novel application of technology useful in time compression and expansion of audio—Richard F. Koch, Lynbrook, USA.

A versatile quadraphonic reproduction system—VORS—Prof Dr J. J. Geluk, Radio Nederland, Hilversum, Holland.

Friday, March 5 09.00h
MAGNETIC RECORDING
Chairman: **W. Hungerbuhler,** Sondor, Zollikon, Switzerland.

Design of tape speed control system in low inertia tape recorders—Steen Andersen, Nordisk Elektroakustik, Lynge, Denmark.

A fast step forward in sprocketed magnetic tape equipment—W. Hungerbuhler, Sondor, Zollikon, Switzerland.

Automated system for sound dubbing on to video tape—Cyril S. Selinger, Ampex Great Britain, Reading, England.

Adjustment for tape duplicating equipments—Angelo Bosco, AEG-Telefunken Italiana, Milano, Italy.

A pilottone follow up system with digital-analog signal processing—A. E. Stosberg, Studer, Regensdorf, Switzerland.

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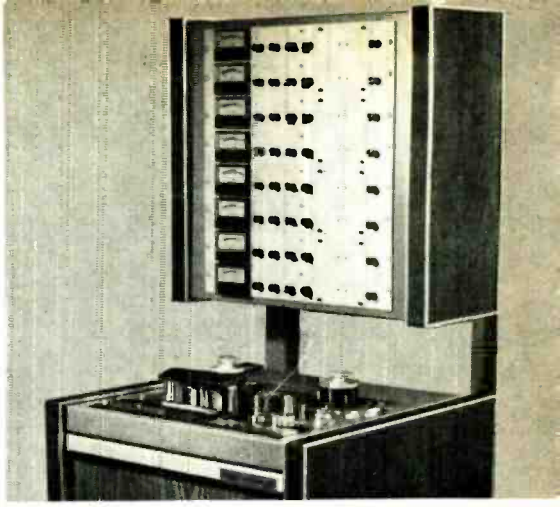

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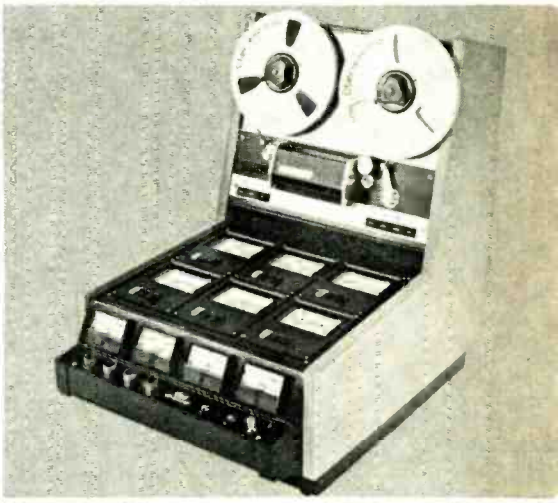

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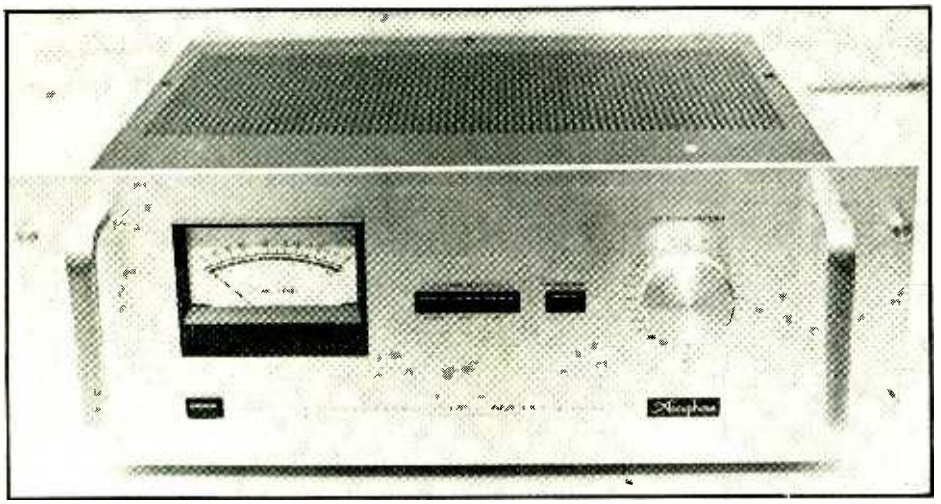
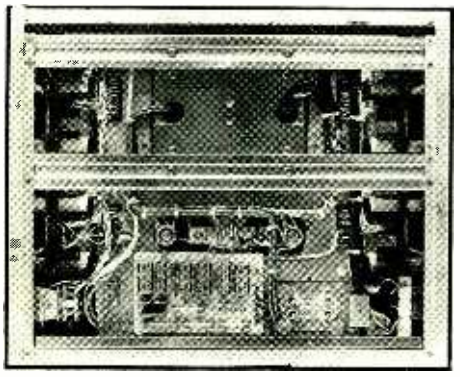


Accuphase M-60 monophonic power amplifier*

Hugh Ford



MANUFACTURER'S SPECIFICATION

Power output: (from 20 Hz to 20 kHz with no more than 0.1% total harmonic distortion) 450W, min rms at 4 ohms; 300W, min rms at 8 ohms; 150W, min rms at 16 ohms.
Total harmonic distortion: (from 20 Hz to 20 kHz at any power output from ¼W to rated power) 4 ohms 0.1% max, 8 ohms 0.1% max, 16 ohms 0.1% max.
Intermodulation distortion: will not exceed 0.1% at rated power output for any combination of frequencies between 20 Hz and 20 kHz.
Frequency response at rated power output: 20 Hz to 20 kHz +0, —0.2 dB; 2 Hz to 90 kHz +0, —3 dB.
Damping factor: 45 (at 8 ohms load, 20 Hz to 20 kHz).
Rise time: 3 μS.
Slewing rate: 25V/μS.
Input sensitivity and impedance: 2V, 100K ohms, for rated output at the maximum level control.
Hum and noise: 100 dB below rated output.
Output load impedance: 4, 8 and 16 ohms.
Subsonic filter: cut off frequency 17 Hz, 18 dB/oct.
Power level meter: switchable for volume level and peak level, calibrated to read 0 dB = 300W into 8 ohms and capable of reading down to —50 dB (3 mW).
Attenuator: precision, 1 dB stepping type.
Power requirement: voltage selector for 100V, 117V, 220V, 240V 50/60 Hz operation. Consumption 65W at zero signal output, 540W at rated output (8 ohms load), 800W at rated output (4 ohms load).
Semiconductor complement: 47 transistors, 51 diodes, 3 ICs.
Dimensions (whd): 482 x 170 x 345 mm.
Weight: 27 kg net, 32 kg packed.
Manufacturer: Kensonic Labatorary Inc, 2124-6 Motoishikawa-Chro, Midori-Ku, Yokohama, Japan.
UK agent: Belmont AV Ltd, Fircroft Way, Edenbridge, Kent. Phone: 073 271 4111.
*Not yet freely available in Britain, except by special order.

A BRIEF look at the manufacturers' specification shows that this amplifier is a serious contender in the high quality and high power market place, but the published specification has the heading 'Guarantee Specifications' and a little delving into the instruction manual shows that a far better performance is typical.

Unfortunately the instruction book has little to say about the circuitry design, and no circuit information is included (which does not assist with servicing) except that every stage is push-pull driven.

Inspection of the amplifier reveals that there are the usual large collection of output transistors which are mounted on really heavy heatsinks, and that the power supplies incorporate massive electrolytic capacitors and an appropriately large mains transformer. Both the mechanical and electronic construction of the amplifier are to the very highest standards and in these respects and that of styling the amplifier is beyond reproach.

The amplifier is designed to be mounted in a standard 483 mm rack, but it is equipped with plastic feet so that it can be set on a bench or other flat surface. The aluminium front panel is smartly finished with two heavy duty handles which serve to protect the front panel controls and the illuminated level meter which is clearly scaled in decibels from −50 dB to +3 dB and also in watts with 0 dB corresponding to 300W into 8 ohms. Three interlocked pushbuttons select the meter function which may be either 'off', peak indication or 'volume level' indication.

In addition to these features the front panel houses a push-button power on/off switch and a step attenuator which is in 1 dB steps down to 20 dB attenuation, from when it steps to −23 dB, −26 dB, −30 dB and infinite attenuation (off).

To the rear of the amplifier are two input connectors, the common horrible 'phono' socket and also an *XLR* type socket. The amplifier's output is via a solid clamping type barrier strip. The mains power input is via a two pole American blade type plug. This is associated with a further similar type of connector which provides for a 100W switched power takeoff. The remaining rear panel facilities are the line voltage selector and a re-set button for the internal trip which is used in lieu of a power fuse.

Power output and distortion

As is my usual practice great care was taken to supply the amplifier with a constant power input voltage (as the internal supplies are not stabilised) and to measure the output voltage with great accuracy across well defined loads. The input voltage was stabilised to better than ±0.5% and the voltage across the loads measured to within ±0.1% using 0.5% load resistors capable of dissipating several kilowatts with air blast cooling.

Under these conditions, power output at the onset of clipping of a 1 kHz sinewave at nominal line input voltage was as follows:

Load	Power into load
4 ohms	608W
8 ohms	389W
16 ohms	221W

These power levels give a very substantial margin above the rated outputs, investigating harmonic distortion at the rated output

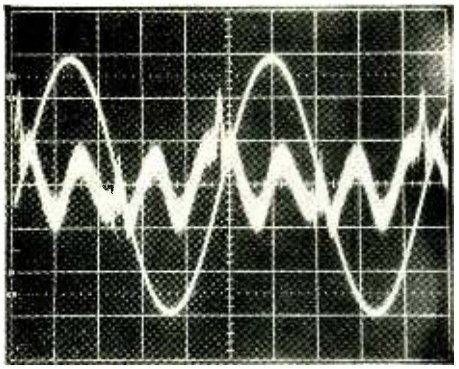
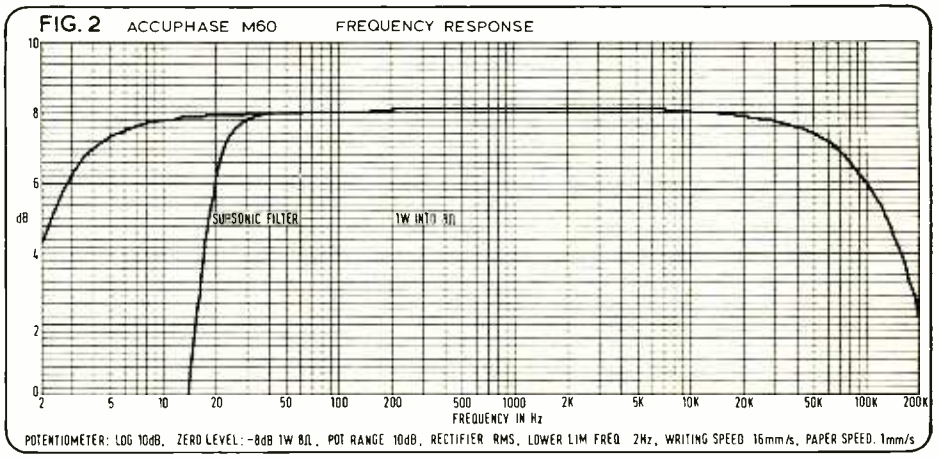


FIG. 1 .01% total harmonic, 10 kHz, 300W, 8Ω



levels of 450W, 300W and 150W into 4, 8 and 16 ohm loads respectively proved too much for my B & K analyser to give meaningful results. In fact the harmonic distortion was at least 80 dB down (0.01%) over the range 20 Hz to 20 kHz at any power level investigated below rated output.

Turning to total harmonic distortion, similar trouble was experienced using the high resolution Sound Technology oscillator and analyser. For the sake of giving some figures the following were the measured results at rated output:

Power and load	Total harmonic distortion		
	1 kHz	10 kHz	20 kHz
450W 4 ohms	0·0023%	0·012%	0·023%
300W 8 ohms	0·0025%	0·01%	0·02%
150W 16 ohms	0·0016%	0·01%	0·017%

All these distortion performance results are truly excellent, and examination of the distortion residual waveform showed that, at rated output at 10 kHz into 8 ohms (0.01% total harmonic), the residual was agreeably clean as is shown in **fig. 1,** although slight crossover distortion is evident.

Measurement of intermodulation distortion to the SMPTE method with 50 Hz and 7 kHz tones in the amplitude ratio 4:1 showed that the amplifier was also good in this respect:

Level	Intermodulation distortion		
Rated peak equivalent sinewave output:	4 ohms	8 ohms	16 ohms
	0·024%	0·014%	0·01%
—10 dB	0·024%	0·012%	0·005%
—20 dB	0·024%	0·007%	0·002%**
—30 dB	0·009%	0·004%	0·004%
—40 dB***	0·016%	0·014%	0·014%

***Results unreliable due to noise
**Measurement instrument residual

It was interesting to note that the above results into 8 ohms also applied with a load of 8 ohms in parallel with a 2 μF capacitor, and that this load did not at any time give symptoms of instability when used during the various measurements.

Frequency response and noise

The overall frequency response at 1W into 8 ohms is shown in **fig. 2** which also illustrates the effect of the low frequency high pass filter, inserted by means of the front panel switch. Both the overall response and the performance of the filter are, to all intents, in precise agreement with the manufacturers' specification. Furthermore, this frequency response held at any power level up to rated output.

Unfortunately the manufacturer fails to specify his noise measurement method, but both 'A' weighted rms measurement and band limited (20 Hz to 20 kHz) rms measurement gave figures better than the claimed 100 dB below rated output. The measured noise, with respect to 300W into 8 ohms, depended to a certain extent upon the input attenuator setting, being at its worst around the mid range of the attenuator. Here, the noise measured −114 dB(A) or −109 dB band limited in comparison with the results at minimum attenuation of −112.5 dB band limited or −119.0 dB(A). Certainly none of these results give any cause for complaint.

Input and output parameters

The input sensitivity of the amplifier was found to be 2.02V for an output of 300W into 8 ohms with corresponding figures of 2.01V for rated output into 16 ohms, or 1.77V in the case of 4 ohms loads. The input impedance shows a large variation with input attenuator setting, as the impedance is so large this variation is

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ACCUPHASE M60

irrelevant for virtually all likely applications of the amplifier. At zero attenuation, the input impedance was measured as 99 000 ohms in parallel with 92 pF, increasing to a maximum of 196 000 ohms in parallel with 67 pF at 30 dB attenuation.

As is to be seen from **fig. 3**, the output impedance remains virtually constant at around 10 milliohms up to 5 kHz above where it increases at around 6 dB/octave giving a damping factor near the specified 45 into 8 ohms at 20 kHz.

Checking the overall phase shift, from input to output, produced **fig. 4** from which it is to be observed that the phase shift is minimal within the audio band. Even at 100 kHz, where the gain is starting to fall rapidly, there is only around 80° phase shift.

Dynamic performance

Checking the claimed rise time and slew rate revealed figures of 3.5 μs for the rise time (10% to 90%) at half power, with an associated maximum slew rate of 35V/μs which is slightly faster than the manufacturer suggests. When loaded into 8 ohms in parallel with 2 μf, the amount of ringing on a fast input edge was rather excessive as is shown in **fig. 5** showing the effect upon a 1 kHz squarewave. Another point which may be cause for

FIG. 3
ACCUPHASE M60
OUTPUT IMPEDANCE

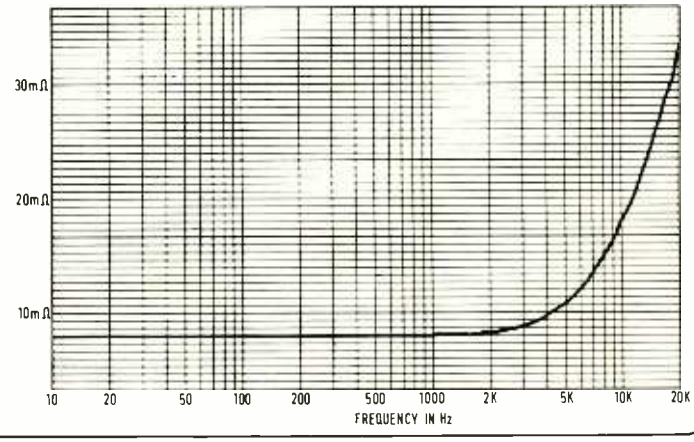


FIG. 4 ACCUPHASE M60 PHASE RESPONSE

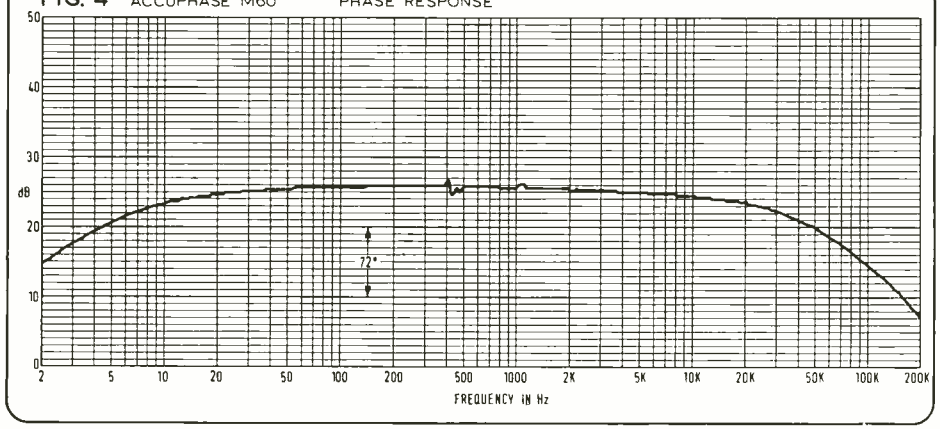


FIG. 5. 1 kHz, 8Ω//2 μF, 200 μs/div. 2V/div.

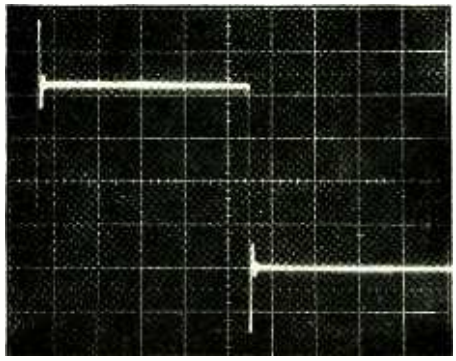
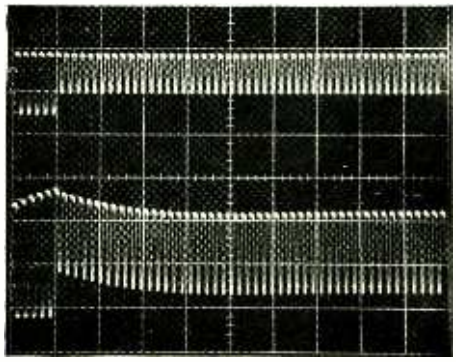


FIG. 6. Filter in 1 kHz asymmetrical burst.



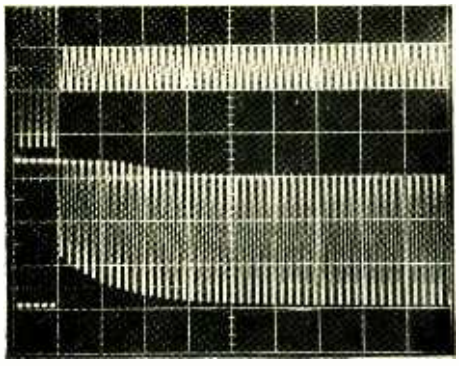


FIG. 7. 5 ms/div, 5 ms burst of 1 kHz, 10 dB; note overload 8Ω 300W at low level; filter in

concern is the amplifier's behaviour when an asymmetrical overload is applied. **Fig. 6** shows considerable shifting of the operating point, and similar results were obtained with a symmetrical burst into 10 dB overload as is shown in **fig. 7**. Rather peculiarly, these effects were not present when the inbuilt high pass filter was not in circuit. In other respects, the dc at the output was minimal and remained constant with temperature.

Continuous running at various power levels and at various frequencies failed to produce any excessive temperature rises, and only very severe overload led to tripping after which the amplifier restored to normal once the offending signal had been reduced to a normal level. The only thing which really upset the amplifier was very low frequency (4 Hz) full amplitude signals, but this is of little consequence and may even be an advantage from the point of view of speaker protection.

Metering and attenuator

Investigations into the attenuator accuracy showed that the cumulative error, within the range to −20 dB (1 dB steps), was less than 0.2 dB worst case with an associated worst case incremental error of 0.06 dB. The remaining steps of 23, 26 and 30 dB attenuation were within 0.25 dB of nominal which, overall, is good linear scaling.

Similarly the meter had good linearity, but its zero calibration which should represent 300W into 8 ohms was set 0.7 dB too low. In the peak mode, the meter had genuine peak reading performance with a relatively fast rise time of 60 ms and a slow fall time of 1.5s for 20 dB fall in indication. In the VOLUME mode the rectifier characteristic was nearer rms than the average law of a vu meter, but the ballistics do not claim to be to the vu standard

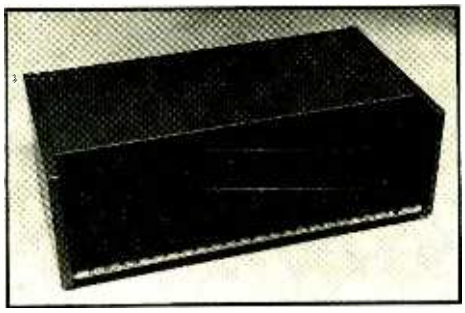
Summary

The Accuphase *M-60* takes its place among the best high power amplifiers that I have reviewed with very good distortion performance and a complete indifference to any load, including short circuits at full power and at high frequencies. I do, however, have slight reservations about the overall stability when overloads are applied.

In other respects that standard of construction is beyond reproach, and this is a truly first class amplifier.

Quad 405 power amplifier

Hugh Ford



MANUFACTURER'S SPECIFICATION

Measurements apply to either channel, with or without the other channel operating.

Power output: The amplifier is intended for use with loudspeakers of 4-16 ohm nominal impedance. Power and distortion for various frequencies, continuous sinewave into 8 ohm resistive load. 100 Hz any level up to 100W <0.01% total, 1000 Hz any level up to 100W <0.01% total, 10 kHz any level up to 100W <0.05% total. For other impedances and frequencies see graphs alongside.

Notes:

1. In addition to the performance into a resistive load R, the amplifier will maintain full voltage within the same distortion rating into a load R+jX where X is any value from zero to infinity.
2. With the additional power limiter inserted the maximum output voltage is limited to 20V rms ±10% (50W 8 ohm) all other performance figures unchanged.

Output internal impedance and offset : 3.3 μH in series with 0.03 ohm. Offset <7 mV.

Frequency response: Ref 1 kHz, low frequency —1 dB at 20 Hz, high frequency —0.5 dB, 20 kHz; —3 dB. 50 kHz.

Signal input level: 0.5V rms ±0.5 dB for 100W into 8 ohms. Amplifier loads the input by 20 000 ohms in parallel with 220 pF.

Signal input slew rate limit: 0.1 V/μs; provided the rate of change of the input voltages does not exceed this figure and the amplifier is not driven into clipping, then the total of all distortions appearing in the audio range (20-20 000 Hz) due to transient or repetitive waveforms with frequency components inside or outside the audio range will be at least 80 dB below full rated power. If the major portion of the input energy is wanted signal then —80 dB (0.01%) represents the maximum possible distortion on programme.

Signal input overload: instantaneous recovery up to +20 dB overload.

Crosstalk: (input loaded by 1k ohm) 80 dB at 100 Hz, 70 dB at 1 kHz, 60 dB at 10 kHz.

Hum and noise: 'A' weighted —95 dB ref full power. Unweighted —90 dB ref full power (15.7 kHz bandwidth).

Protection: The amplifier is suitable for use under the most arduous music conditions and is electrically protected by current limiters; seven amps in-phase current at peak voltage and 3½A at zero voltage. Shorting both outputs simultaneously on signal for an extended period (minutes) is not protected.

Stability: unconditionally stable with any load and any signal.

Power input: 110-120-130V, 220-230-240V, 50-60 Hz, 30-150W depending on signal level.

Dimensions: height 115 mm, width 340.5 mm, depth 195 mm (allow an extra 38mm for plug and socket).

Weight: 9Kg.

Price: £115 plus VAT.

Manufacturer: The Acoustical Manufacturing Co Ltd, 30 St Peter's Road, Huntingdon, Cambs, UK.

IT is always exciting when a new product appears from the stable of the Acoustical Manufacturing Company, who have a long standing reputation for very high quality audio equipment and of course were the originators of the world famous Quad electrostatic loudspeaker.

The new Quad *405* power amplifier is the practical embodyment of the 'Current Dumping Audio Amplifier' described at the 50th Audio Engineering Society Convention by Peter Walker and Mike Albinson. Before proceeding with the details of the review I think that it is appropriate to quote in full the introduction to the paper: 'A new audio amplifier output stage in which the linearity of the main current carrying output transistors has no bearing on the overall amplifier performance, hence the need for biasing and allied problems associated with crossover are eliminated.'

In abbreviated terms, the principle of operation of this new amplifier is that a low power Class A amplifier with full voltage drive capability is used to drive the load at powers up to a few watts. Such an amplifier may be of extremely high quality and not complicated if it is not required to have a high current drive capability. Now, the current drive from this Class A amplifier is sensed, and this is used to control two current dumping transistors which need not be matched as their dumping current is monitored and fed back to the input of the Class A amplifier. It follows that the high current transistors need not be matched, nor is their temperature stability of interest as there are no crossover biasing circuits.

The Quad *405* takes the form of a two channel amplifier based on these principles, each channel being rated at 100W into 8 ohms, which is more than adequate for

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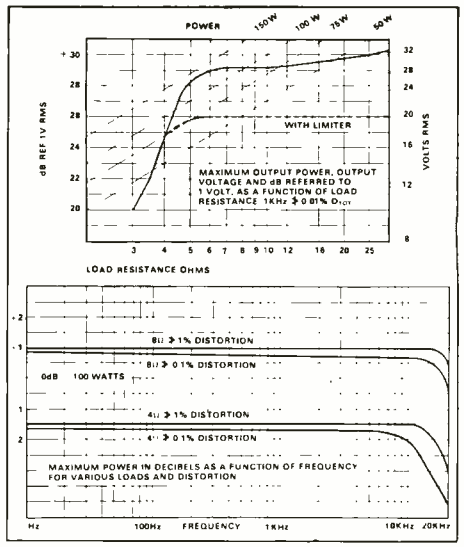
QUAD 405 POWER AMPLIFIER

domestic applications and is sufficient for many studios—that is all studio requirements where the producer doesn't want to 'feel the sound' with less efficient loudspeakers.

The presentation of the amplifier is most workmanlike, with the entire front of the amplifier taking the form of a finned heatsink to which the individual channel amplifiers are bolted as sub-assemblies. The remainder of the housing comprises the moulded plastic sides which are bolted to the heatsink and to which the two 'L shaped' covers are bolted, metal inserts being moulded into the plastic sides to take the bolts where required. No controls as such exist on the amplifier, that is with the exception of the mains voltage selector which covers all the common mains voltages. The power input is via a standard IEC connector, with its associated IEC standard fuseholder which is properly identified with the appropriate fuse ratings.

Signal connections take the form of a four pin DIN socket for the input—I loathe DIN connectors, but this type of connector has been used for the sake of compatibility with the Quad type *33* pre-amplifier. The speaker outputs are spring loaded connectors which take bare wires or AMP pins, and whilst terminal/sockets are much more convenient these are no longer permitted on high voltage amplifiers as a result of International safety regulations. I've never heard of anyone being killed by 100W of music, but it could be a very painful shock.

Internally the standard of construction is really excellent, with first class standards of wiring and construction. Each amplifier is in its entirety accommodated on a single printed board and maintenance is facilitated by every component being identified by screen printing on the boards. Furthermore, a complete amplifier channel may be removed by taking out four screws and then only five push-on type blade connectors. In addition, the instruction book includes a full circuit and parts list, plus the specification and operating hints.



Power output and distortion

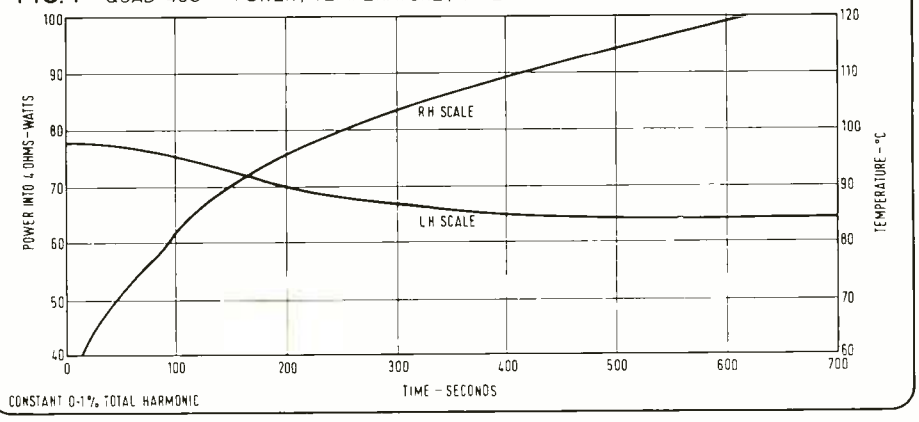
As is my normal practice, very great care was taken to produce accurate results, stabilised power being used to feed the amplifier and accurate (0.1%) digital voltmeters being used to determine voltage levels.

Initially, the power output at the onset of clipping of a 1 kHz sinewave was determined with the following results:

	Output power Left	Right
8 ohm load, both channels driven	122W	117W
8 ohm load, single channel driven	110W	107W
4 ohm load, both channels driven	68W	84W
4 ohm load, single channel driven	60W	78W

These levels are well above the rated power in the case of eight ohm loads and the amplifier did not take exception to driving into eight ohm loads continuously at very high levels. However, in the case of four ohm loads the available power was found to be very temperature sensitive, the above figures being obtained with the amplifier at its idling temperature; that is, the amplifier was left switched on with no

FIG. 1 QUAD 405 POWER / TEMPERATURE / TIME CHARACTERISTICS



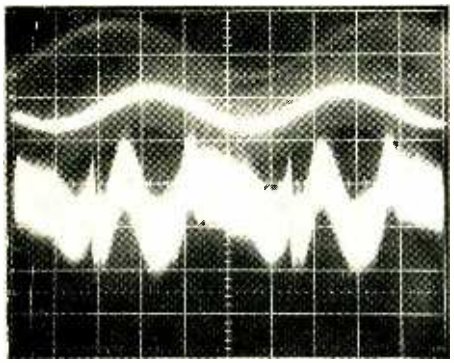


FIG. 2. Distortion components 0.011% at 10 kHz.

signals applied at an ambient temperature of 20°C. **Fig. 1** shows output power for 0.1% distortion at 1 kHz into four ohms and also dumping transistor case temperature plotted against time from idling temperature. It is to be seen that after about six minutes full power (0.1% total harmonic) operation the amplifier has stabilised its continuous drive capability at around 65W into four ohms, but the transistor temperature still continues to rise.

The real point about this issue is that certain loudspeakers with a nominal eight ohm impedance can show practical impedances as low as five ohms at selected frequencies and under these conditions (as with virtually all amplifiers) we are well down in available power; in the case of the Quad *605* the published curves for four ohms loads are rather optimistic, as they display conditions as may be found with a cold amplifier.

Anyhow, returning to the eight ohm performance, the measured distortion at 100W and below into eight ohms was astoundingly good as follows:

	Total Harmonic Distortion	
100 Hz	0.007%	0.006% *
1 kHz	0.007%	0.006% *
10 kHz	0.028%	0.011%
20 kHz	0.055%	0.08%
		* mainly noise

Analysis of the individual harmonics on a single channel gave results at 1 kHz and 100W into eight ohms of 0.005% second and 0.001% third harmonic, and at 1W 0.003% second and 0.004% third harmonic—really excellent results.

Likewise, the distortion performance at 50W and below into four ohms was first class, the following total harmonic measurements being made: at 1 kHz – 0.14%; 10 kHz – 0.02%; 20 kHz – 0.05%. Harmonic analysis at high frequencies showed that the main harmonic was the second and also that there was a notable absence of crossover distortion as is shown in **fig. 2,** which demonstrates 0.011% total harmonic distortion at 10 kHz.

As is to be anticipated, the measured levels of intermodulation distortion were very low, the SMPTE method using 50 Hz and 7 kHz tones in the amplitude ratio 4:1 giving 0.006% at 100W peak equivalent sinewave into eight ohms; it was impossible to measure meaningful results at lower levels due to noise masking the very low distortion products. A notable point made during all the distortion measurements was that the addition of a 2 μF capacitor in parallel with the eight ohm loads made negligible difference to the distortion—an unusual feature of considerable significance.

Before leaving the power output aspect of the amplifier it should be mentioned that by adding a single resistor to each channel (the resistors are supplied with the amplifier) the available voltage drive at the amplifier's output can be limited to 20V rms, so that it is safe to use the Quad *405* with loudspeakers of lower power ratings when this modification is incorporated.

Frequency response and noise

Fig. 3 shows the overall frequency response of the amplifier at 1W into eight ohms and it is noteworthy that this response curve is not only identical for both channels, but also that an identical plot was obtained at 100W into eight ohms. It is particularly nice to find that the frequency response has been carefully tailored at both the high and low frequency end—loudspeakers are just not interested in working below 20 Hz or above 20 kHz and furthermore can be easily damaged by high level 'out of band' signals.

Noise at the output was measured in

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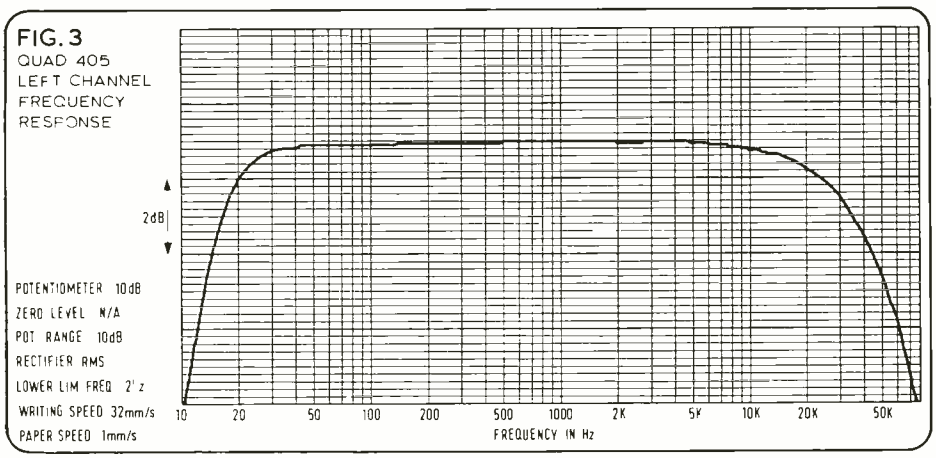


terms of rms noise relative to 100W output into eight ohms with the following results:

	Left channel	Right channel
Unweighted 20 Hz to 20 kHz	—88.2 dB	—88.4 dB
Unweighted 15.7 kHz bandwidth	—90.0 dB	—89.9 dB
'A' Weighted	—92.8 dB	—92.5 dB
CCIR Weighted ref 1 kHz	—83.6 dB	—83.4 dB

It is to be noted that while the 15.7 kHz bandwidth figure is just on the manufacturer's specification, the 'A' weighted figure falls slightly short of specification. Generally, it is felt that the noise performance meets realistic requirements and it was pleasing to find that hum levels in the output were well below noise.

Inputs and outputs

The input sensitivity for 100W output into eight ohms was found to be 0.512V on both channels, with either or both channels operating. Measurement of the input impedance gave an input resistance very close to the specified 20 000 ohms on both channels in parallel with 230/240 pF which is a realistic impedance for matching modern pre-amplifiers. It should be noted that the capacitive component of the input impedance correlates with the current specification, but that the specification has been modified from 50 pF.

Fig. 4 shows the relation between the output impedance and frequency, and serves to confirm the specified output impedance of 0.03 ohms in series with 3.3 microhenries. This works out as a damping factor of 267 relative to eight ohms, a figure which will satisy the damping factor addicts.

Investigations into the amplifier's stability gave first class results, **fig. 5** showing the classical squarewave performance into an eight ohm load in parallel with 2 μF. Overload recovery was also most impressive, the recovery from short tone bursts 10 dB into overload being absolutely clean with no visible distortion outside the overload burst. A less kind test is to drive the amplifier into overload with an asymmetrical waveform. **Fig. 6** shows the result of such a test where 1 kHz asymmetrical waveform as shown in the lower trace has been fed to the amplifier the output of which is shown in the upper trace.

Overall phase shift is small within the audio frequency band as shown in **fig. 7,** and as is to be expected the phase shift increases outside the audio band as a result of the intentional band limiting filters.

Interchannel cross talk was found to be extremely low and far better than specification —7 dB better at all frequencies. In fact, during all amplifier measurements it made virtually no difference if either or both channels were driven, so the power supply design must have been given considerable attention in the design process.

Summary

It is a reviewer's task to pick holes in equipment and also to mention its virtues: when a well respected manufacturer produces a new model every five or ten years it is for some good reason, as opposed to the 'this year's model' attitude of the less respected organisations who just change the colour of the knobs or add a couple of extra loudspeaker terminals for some gimmick which may have an equally gimmicky name.

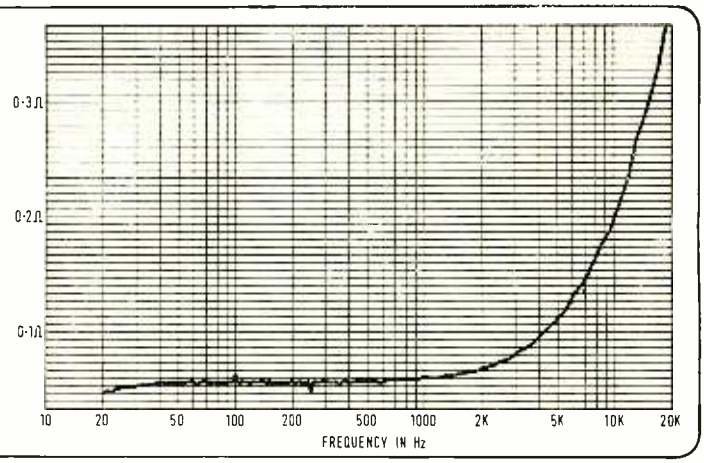
The Acoustical Manufacturing Company has an excellent track record for amplifier design (let alone loudspeaker design), and in spite of the few criticisms which I have of the Quad *405* there is no doubt that this new amplifier ranks amongst the world's best power amplifiers.

For once I will break my rule of excluding subjective comments on equipment (which I regard as highly controversial) and stick out my neck—using a well known high quality loudspeaker which has a peculiarly awkward impedance characteristic the Quad *405* sounds superb.

From a point of view of domestic applications and of monitoring classical material I do not have any reservations about the Quad *405* but I would not recommend the use of 4 ohm loudspeakers—particularly if rock music is to be reproduced at high levels.

On the other hand, an amplifier more suitable for the latter type of use will cost two or three times as much as the Quad if one looks for equivalent performance, and there are few amplifiers which fit in this slot.

FIG. 4
QUAD 405
OUTPUT IMPEDANCE



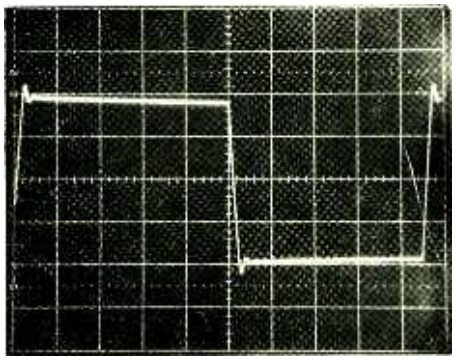


FIG. 5. 8Ω//2 μF, 1 kHz

FIG. 6. asymmetrical waveform, response 1 kHz

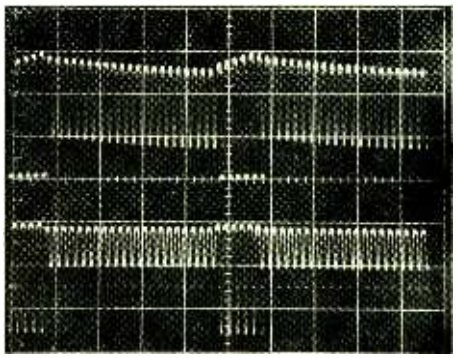
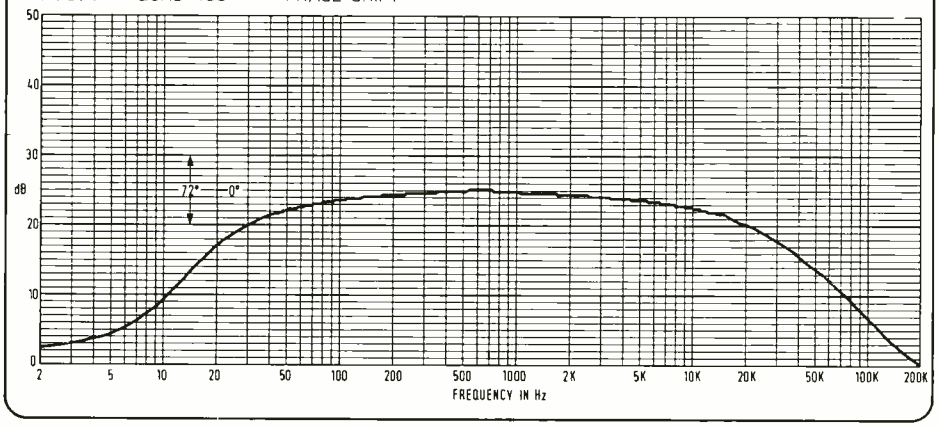


FIG. 7 QUAD 405 PHASE SHIFT



SOUND AT THE ROYAL OPERA HOUSE

until the first interval for admission. To save the poor things fuming in the bar, we do give them sound and a television picture of the stage as some small consolation. But overall the important system is the conductor picture.

There are two large screen monitors on the prompt and op sides of the stage, to allow the singers to see the conductor without having actually to stare in his direction all the time. This gives more realistic stage movement etc.

Despite the traditionalism that we have here, an ARP *2600* synthesiser finds a creative place in the sound effects side. It has been a useful source of thunderstorms and associated meteorological phenomena, tug boat whistles and, last but not least, red hot swords being plunged into buckets of water. We tried to simulate a murmuring crowd with occasional sword clinks but this had to be cut when somebody misinterpreted the effect as a noisy scene change. We don't envisage using the synthesiser live; a system malfunction could have disastrous results on a performance. The thought of a voltage controlled filter peaking into oscillation during a performance of Siegfried is totally unthinkable. Of course it's not only live synthesisers that cause problems. The sound of opera on disc tends to belie the hectic activity backstage during a live performance. A good example of this arose a few months ago where three singers were being amplified from the mezzanine level and then had to run up on stage and sing live. Shortly after that, they had to return to provide the vocal accompaniment for the doubles on stage.

This was a case where due to frenzied activity on the mezzanine it was not possible to get a consistent level relayed back through the sound system. But things can go very well provided the artist is not required to go through a series of stage movements. This was certainly the case in the 'Wood Bird' solo from *Siegfried*, where the artist performed on her own from the dome above the auditorium unimpeded by the activities of stage hands and electricians etc. The performance achieved a very uniform level from night to night. Another occasion required a singer to walk off to a microphone held by a member of the sound department, sing a few lines and walk off. Like anyone else actors and singers can become familiar with their surroundings. A few eyebrows from the upper circle must have been raised at the sight of a sound engineer crouching down holding the microphone in front of the singer—for that night a critical piece of stage scenery had been moved. This little episode underlines the fallibility of humans as well as machines.

As regards future directions, equipment-wise we'd like to see permanent positions for front-of-house loudspeakers. This is indeed a problem for us because as we're on the list of national monuments so we're not allowed to scar or mark the proscenium arch in any way. Nevertheless, with money, it certainly could be done. Future developments in the sound department really depend on forthcoming productions and the corresponding techniques required by them, and I really can't tell at this stage what the modern composers have in store for us.

At this time we have no plans for extra surround-sound loudspeakers fed through digital delay lines in the auditorium, because in opera circles there's a growing feeling that the more loudspeakers you have behind the audience the more you can distract their attention from the stage. However good an effect may be, once they've had a quick look round and acknowledged the effect—they might even like it—the spell is broken. The attention has been drawn away from the stage activity.

WORK

16T is good for you

Recently, they went from eight to 16 track and from all accounts, the conversion was worth it. Dave Kent-Watson, managing director of Indigo Sound Studios, reports a regular upsurgence in business, the effect of which has been to increase the staff to five.

The studio pulled quite a few names including Thin Lizzy, TRex, Jimmy Helms, Gene Pitney, Barclay James Harvest, Sarabande and Therapy. Use of their colour video and stereo facilities was called for when Chrysalis commissioned recordings of their most recent signing Mandalaband for promotion of that band's first album.

During the 16 track conversion job, an enthusiastic maintenance engineer cut his way through all the PO lines causing disruption and phone-in chaos for a couple of days. Virtue of necessity led to the installation of a new three in ten out switch board which caused more operational hassles than any of the new control room facilities.

agony

■The competent engineer was not on the best of terms with the guvnor, a man apparently noted for his lack of humour. The engineer was perpetually disturbed by the arrangement of the reception area; the poor girl inside communicated to the outside world through a little pigeon hole in a hastily-prepared partition. Anyway, he fancied her more than a bit and thought his chances better if she worked in open-plan surroundings. So came the weekend session and the opportunity for a bit of overtime.

On the Monday, the boss walked in and was rather astonished, not to say irritated, to find the telephone wires hanging off and the whole world ogling the very attractive receptionist. Instantly aware of what had happened, he called the obvious culprit into his office to account for the handiwork. Anticipating the result of his actions, our hero got in the first blow. He presented a petty cash slip for a moderate amount and the boss, dumbfounded, signed. Only after the encounter did the great man read this document, which related to the purchase of one screwdriver and one saw . . .

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Advertisements for this section must be pre-paid. The rate is **12p** per word, minimum **£1.80.** Box Nos. **25p** extra. Semi-display rates on application. Copy and remittance for advertisements in **APRIL 1976** issue must reach these offices by **16th FEBRUARY 1976** addressed to: The Advertisement Manager, **Studio Sound**, Link House, Dingwall Avenue, Croydon CR9 2TA.
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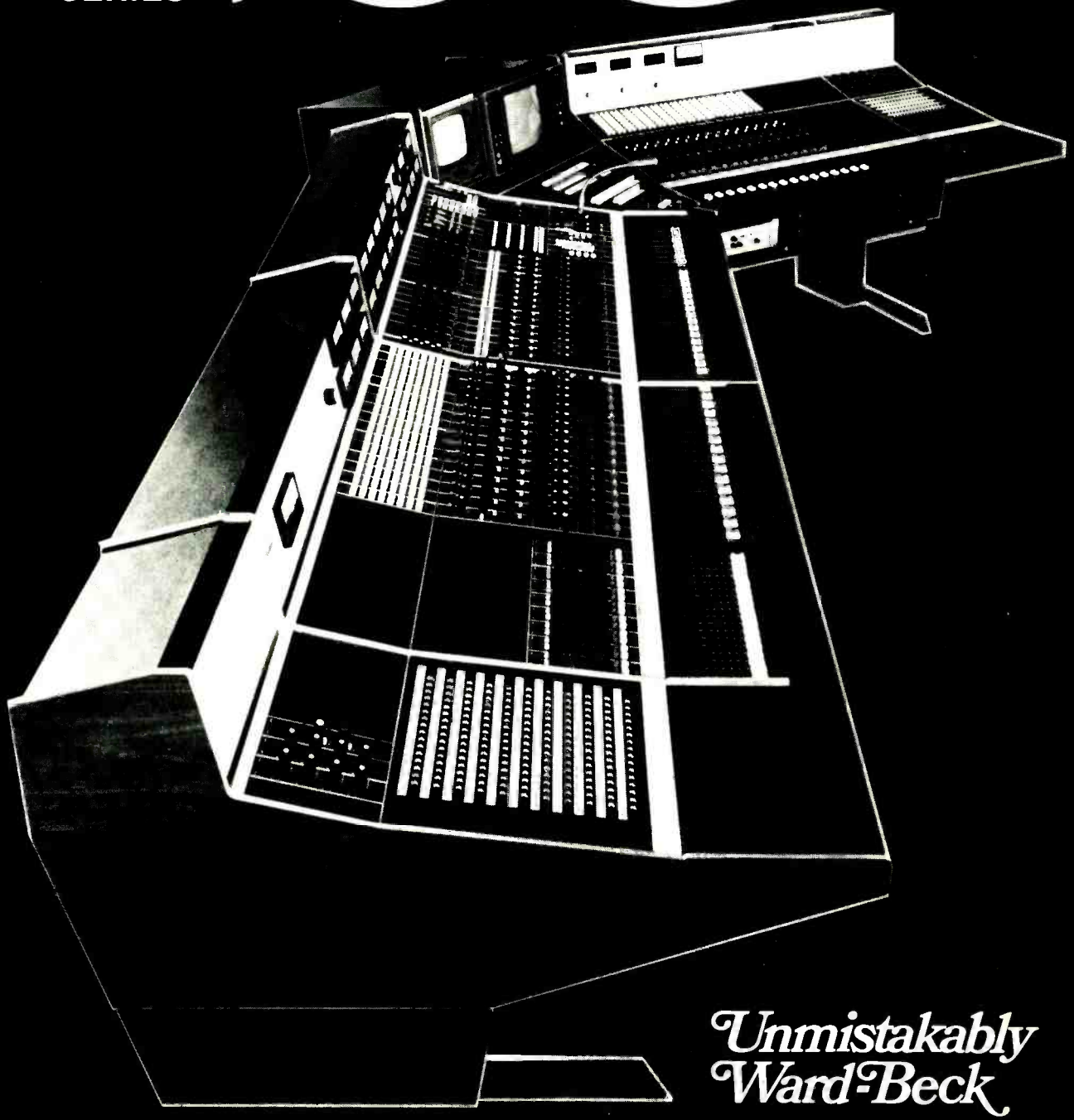

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